TABLE OF CONTENTS

AG. 534 – ZOOLOGY/SCIENCE OF ANIMAL REPRODUCTION

AG 534

ZOOLOGY/SCIENCE

OF

ANIMAL REPRODUCTION

FOR

IDAHO

SECONDARY AGRICULTURE INSTRUCTORS

Developed and written by:
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Provided through a grant from the
Idaho State Division of Vocational Education
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Administered through the
Department of Agricultural and Extension Education
University of Idaho
By
Douglas A. Pals, Project Director

FOREWORD

The Agricultural Science and Technology Curriculum Guides are the product of many years of careful planning and development. In 1987, an Agricultural Education Technical Committee was assembled to determine the competencies necessary to prepare students for careers in agriculture. In 1989, a committee of secondary agriculture instructors, state supervisory staff and University of Idaho Agricultural and Extension Education faculty arranged the competencies into an outline of courses appropriate for secondary agriculture programs in Idaho. These curriculum guides have been written to provide the secondary agriculture instructor with up-to-date instructional materials to be used in developing lessons for the student interested in pursuing a career in agriculture.

The arrangement of the guide follows the courses outlined in the Agricultural Science and Technology Curriculum Outline - The Guide to the 90's (Vo. Ed. #240) published in 1989. The format used in this guide was adapted from the curriculum guides developed for Idaho secondary agriculture instructors during the period of 1981-1985.

The original Idaho Agricultural Curriculum Guides used in the development of these materials were:

1981 - Livestock Production
1981 - Agricultural Mechanics
1982 - Farm Business Management
1985 - Crop and Soil Science

Many individuals made the original guides possible. The format used was adapted from curriculum developed by the Curriculum and Instructional Materials Center of the Oklahoma State Department of Vocational and Technical Education. Selected information and many of the transparency masters used in the guides were provided by the Vocational Instructional Services, Texas A & M University. Additional information and transparency masters were provided by the Department of Agricultural Communications and Education, College of Agriculture, University of Illinois and the Agricultural Education Program, Department of Applied Behavioral Sciences, University of California, Davis.

Laboratory exercises incorporated into the units of instruction were used from the Holt, Rinehart and Winston, Inc. book, Modern Biology, Biology Investigations and the Scott, Foresman, and Company Lab Manual for Biology. Credit appears on the first page of the materials used from these two sources.

Without the following individuals' dedication and commitment, this project would not have been completed.

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Katie Old, Graphic Artist
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USE OF THIS PUBLICATION

Introduction

This material must be taught. It does not replace the teacher, nor the teacher's expertise. The teacher needs to adapt the material to the local area and individual students. The teacher must also provide the necessary motivating techniques to help the students learn the material.

The pages in the guide are color coded to assist in identifying and locating the desired pages. The colors used are:

Table of Contents	Ivory
Semester Course Title Page	Green
Foreword	Yellow
Use of Publication	Salmon
Divider Page Between Units	Tan
Refer to Another Unit Page	Grey
Unit Objectives/Specific Competencies	White
Suggested Activities	Blue
Information Sheets	White
Transparency Masters	White
Assignment Sheets	White
Answers to Assignment Sheets	Gold
Instructors Notes for Laboratory Exercises	Blue
Laboratory Exercises	White
Answers to Laboratory Exercises	Gold
Unit Test	White
Answers to Test	Gold

Instructional Units

These units are not geared to a particular age level and must be adapted for the students with whom they are used. Units include objectives and competencies, suggested activities for the instructor and students, information sheet, transparency masters, assignment sheets, laboratory exercises, instructor notes for laboratory exercises, answers to assignment sheets and laboratory exercises, test and answers to test. Units are planned for more than one lesson or class period.

The teacher should carefully study each instructional unit to determine:

A. The appropriateness of the material for the age level

B. The amount of material that can be covered during a class period

C. Additional objectives and/or assignments, which could be developed

D. The skills that must be demonstrated

1. Supplies needed

2. Equipment needed

3. Amount of practice needed

4. Amount of class time needed for demonstrations

E. Supplementary materials, such as pamphlets, filmstrips and slides that must be ordered

F. Resource people who must be contacted

Objectives and Competencies

Each unit of instruction is based on stated objectives. These objectives state the goals of the unit, thus providing a sense of direction and accomplishment for the student.

The objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction; and specific objectives, stating the student performances necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Following is a list of performance terms and their synonyms that may have been used in this material:

Name	Identify	State a Rule	Apply a Rule
Label	Select	Calculate	
List in writing	Mark		
List orally	Point out		
Letter	Pick out		
Record	Choose		
Repeat	Locate		
Give	Match		

Describe	Order	Distinguish
Define	Arrange	Discriminate
Discuss in writing	Sequence	
Discuss orally	List in order	
Interpret	Classify	
Tell how	Divide	
Tell what	Isolate	
Explain	Sort	

Construct		Demonstrate	
Draw	Transcribe	Show your work	Replace
Make	Reduce	Show procedure	Turn on/off
Build	Increase	Perform an experiment	(Dis) assemble
Design	Figure	Perform the steps	(Dis) connect
Formulate	Conduct	Operate	
Reproduce	Compare	Remove	

Reading of the objectives by the student should be followed by a class discussion to answer any questions concerning performance requirements for each instructional unit.

Teachers should feel free to add objectives, which will fit the material to the needs of the students and community. When a teacher adds objectives, he/she should remember to supply the needed information, assignment sheets and/or laboratory exercises and criterion tests.

Suggested Activities

Each unit of instruction has a suggested activities sheet outlining steps to follow in accomplishing specific objectives. Duties of the instructor will vary according to the particular unit. However, for best use of the material they should include the following: provide students with objective sheet, information sheet, assignment sheets, and laboratory exercises; preview filmstrips, make transparencies, and arrange for resource materials and people; discuss unit and specific objectives and information sheet; give test. Teachers are encouraged to use any additional instructional activities and teaching methods to aid students in accomplishing the objectives.

Information Sheet

The information sheet provides content essential for meeting the cognitive (knowledge) requirements of the unit. The teacher will find that the information sheet serves as an excellent guide for presenting the background knowledge necessary to develop the skills specified in the unit objective.

Students should read the information sheet before the information is discussed in class. Students may take additional notes on the information sheet.

Transparency Masters

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheet. They are particularly effective when identification is necessary.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion. (NOTE: Stand away from the overhead projector when discussing transparency material. The noise of the projector may cause the teacher to speak too loudly.)

Assignment Sheets

Assignment sheets give direction to study and furnish practice for paper and pencil activities to develop the knowledge which is a necessary prerequisite to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

Laboratory Exercises

Laboratory exercises are found in selected units. The laboratory exercises include both science and agricultural mechanics activities. The science laboratory exercises often have instructions to the instructor prior to the actual laboratory. Procedures outlined in the laboratory exercise for agricultural mechanics give direction to the skill being taught and allow both student and teacher to check student program toward the accomplishment of the skill.

Test and Evaluation

Paper-pencil and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and can help the teacher spot difficulties being encountered by students in their efforts to accomplish the unit objective. Test items for objectives added by the teachers should be constructed and added to the test.

Test Answers

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

Care of Materials

The cost of reproduction of this guide prohibits the replacement of these materials. Therefore, please be extremely careful in handling originals. Make the necessary copies of the information sheets, transparencies, assignments and tests and replace originals in the curriculum guide notebook. Take extra care in keeping originals clear for future reproduction.

INTRODUCTION TO ANIMAL SCIENCE

AG 534 - A

UNIT OBJECTIVE

After completion of this unit, students will be able to identify the importance and scope of the livestock industry in the United States, Idaho and the community. This knowledge will be demonstrated by completion of assignment sheets and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Match terms associated with an introduction to the livestock industry to their correct definitions.
2. Name the types of livestock.
3. Name products and services livestock provide.
4. Identify the sources of Idaho cash farm receipts.
5. Identify Idaho's rank in the nation's agriculture for crops, livestock and livestock products.
6. Distinguish between primary and secondary food sources.
7. Describe reasons for and against using livestock as a food source.
8. List three specific careers in each of the seven areas of livestock industry employment.
9. Develop an opinion on the future of livestock production.
10. Conduct a community survey on the types of livestock raised in the area.
11. Be familiar with current employment information in the livestock industry.
12. Explain general laboratory procedures, equipment and report writing.
13. Demonstrate the use of a compound microscope.

INTRODUCTION TO ANIMAL SCIENCE

AG 534 - A

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

   A. Make transparencies and necessary copies of materials.

   B. Provide students with objective sheet and discuss.

   C. Provide students with information sheet and discuss.

   D. Provide students with assignment and laboratory sheets.

   E. Discuss and demonstrate the laboratory exercises.

   F. Obtain background information on the local livestock industry.

   G. Invite a local rancher to come in and talk about the livestock industry in the local community.

   H. Have students collect articles on the livestock industry and share them in class.

   I. Divide class into groups to conduct the community survey and have them report their results in class.

   J. Review and give test.

   K. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM 1--Food Chains

      2. TM 2--Manure as a Fertilizer

   E. Assignment sheets

      1. AS 1--Develop an Opinion on the Future of Livestock Production

      2. AS 2--Conduct a Community Survey on the Types of Livestock Raised in the Area

F. Instructor notes for laboratory exercises

G. Laboratory exercises

1. LE 1--General Laboratory Procedures, Equipment and Report Writing

2. LE 2--Using a Compound Microscope

H. Answers to laboratory exercises

I. I. Test

J. Answers to Test

III. Unit references

A. Badger, Daniel D., *Economics of Substitution and the Demand for Beef Feedlot Wastes: One Alternative for Solving Environmental Quality Problems*. Managing Livestock Wastes: The Proceedings of the 3rd International Symposium on Livestock Wastes, American Society of Agricultural Engineers, 1975.

B. Ensminger, M.E., *Animal Science*. The Interstate Printers and Publishers, Inc., Danville, Illinois, 1977.

C. Harper, Judson M., and Seckler, David, *Engineering and Economic Overview of Alternative Livestock and Waste Utilization Techniques*. Managing Livestock Wastes: The Proceedings of the 3rd International Symposium on Livestock Wastes, American Society of Agricultural Engineers, 1975.

D. *Idaho Agricultural Statistics*. United States Department of Agriculture, Washington D.C., 1989.

INTRODUCTION TO ANIMAL SCIENCE

AG 534 - A

INFORMATION SHEET

I. Terms and definitions

A. Product--An actual material provided by an animal that can be eaten, worn or used

B. Service--A benefit provided by an animal

C. Receipt--Money coming in or received for a product or service

D. Concentrate--Feed high in energy and low in fiber

Example: grain

E. Roughage--Feed that is bulky, contains more than 18% crude fiber and is low in energy

Example: pasture

F. Cultivate--Working land to produce a crop

G. By-products--Products left after the main products have been extracted

H. Flexibility--Capacity for change

I. Elasticity--Ability of a farm operation to withstand changes in the supply or demand

II. Types of livestock

A. Beef

B. Dairy

C. Sheep

D. Swine

E. Dairy goats

F. Horses

G. Rabbits

H. Fish

I. Fur-bearing animals

J. Poultry

III. Products and services livestock provide

A. Products

1. Meat
2. Eggs
3. Milk
4. Clothing
5. Medicine
6. Fertilizer
7. Miscellaneous products

   Example: Shoe polish, photographic film, soap, glue, lubricants

B. Services

1. Power

   (Note: Animals used for power are found primarily in developing nations.)

2. Recreation

   a. Horseback riding
   b. Racing
   c. Rodeos
   d. Back-packing

3. Transportation--mainly used for large range operations in the west

IV. Sources of Idaho cash farm receipts - 1987

A. Cattle and calves -- 27.8%

B. Dairy products -- 13.1%

C. Hogs -- .6%

D. Sheep, lambs and wool -- 1.2%

E. Other livestock -- 2.1%

F. Total livestock -- 45.2%

G. Total crops -- 54.8%

V. Idaho's rank in the nation's agriculture - 1988

A. Livestock and livestock products

1. American cheese - 5
2. Honey - 11
3. Sheep, lambs and wool - 11
4. Milk production - 13
5. Milk cows - 18
6. All cattle and calves - 22

B. Crops

1. Potatoes - 1
2. Barley - 1
3. Sugarbeets - 3
4. Hops - 3
5. Mint (all) - 3
6. Onions (summer storage) - 3
7. Prunes and plums (fresh) - 4
8. Dry edible beans - 5
9. Sweet corn (for processing) - 5
10. Sweet cherries - 6
11. Alfalfa hay - 6
12. Wheat (all) - 8
13. Apples - 10

VI. Primary and secondary food sources (Transparency 1)

A. Primary -- Food source deriving energy directly from sun

B. Secondary -- Food source deriving energy from plants or animals

(Note: A secondary food source requires energy from the primary source for maintenance. Therefore, energy is lost as it is transferred through secondary sources.)

VII. Livestock as a food source

A. Factors against using livestock--Livestock provide a secondary food source and therefore use more energy to produce the same amount of food

Example: 400 pounds of grain will feed one man for one year; 2,000 pounds of concentrates are needed to produce enough meat and livestock products to feed one man for one year

B. Factors for using livestock

1. Usable plant energy would otherwise be wasted

a. Much of the world's land is not cultivated -- 46.8% of the land in the United States is pasture or grazing land, not including Alaska or Hawaii

b. Forages provide a high percentage of animal food

c. 95% of all energy fixed by plants is unusable by man, but can be used by ruminants

d. Animals can use otherwise wasted by-products

Example: Cottonseed hulls, corncobs, beet pulp, rice bran and hulls, wood by-products

2. Animals provide higher quality food

a. Higher in protein content

b. Better quality protein -- more amino acids

c. More digestible protein

d. More preferred by consumers

3. Animals provide other needed products such as medicine, power and fertilizer (Transparency 2)

Example: Medicine -- Twenty-six steer pancreas are needed to produce enough insulin to keep one diabetic alive for one year. There are 1.25 million people in the United States who require insulin regularly

Fertilizer -- One ton of manure contains 500 pounds of organic matter, 10-30 pounds of nitrogen, 5-20 pounds of phosphoric acid and 10-30 pounds of potassium. The United States' livestock industry currently produces 1.6 billion tons of manure annually

4. Animals increase flexibility of farm operations

    a. Stimulate grain production

    b. Provide elasticity to grain production

        Example: In high grain production years the excess can be fed to livestock, while in low production years forage can be substituted and grain can be marketed as cash crop

VIII. Careers in the livestock industry

A. Farming/Ranching

1. Manager
2. Foreman
3. Herdsman

B. Research

1. Production
2. Processing
3. Marketing
4. New equipment and use

C. Industry

1. Food processing
2. Pesticides and herbicides
3. Feed manufacturing
4. Dairy processing

D. Business

1. Agricultural banking
2. Farm management
3. Grading and packaging
4. Marketing

E. Education

1. Agricultural extension specialist
2. Vocational agriculture instructor
3. College instructor
4. Governmental agencies

F. Communications

1. Farm reporting
2. Market reporting
3. Radio
4. Television

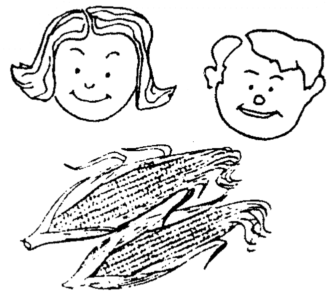
G. Service

1. Inspection and regulation
2. Plant and animal quarantine
3. Foreign service
4. Agricultural consultant
5. Veterinary

Food Chains

PRIMARY

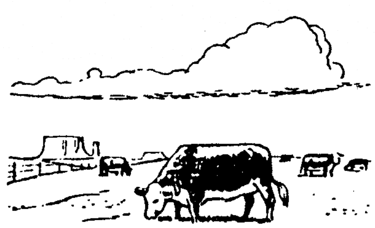
PLANT



MAN

SECONDARY

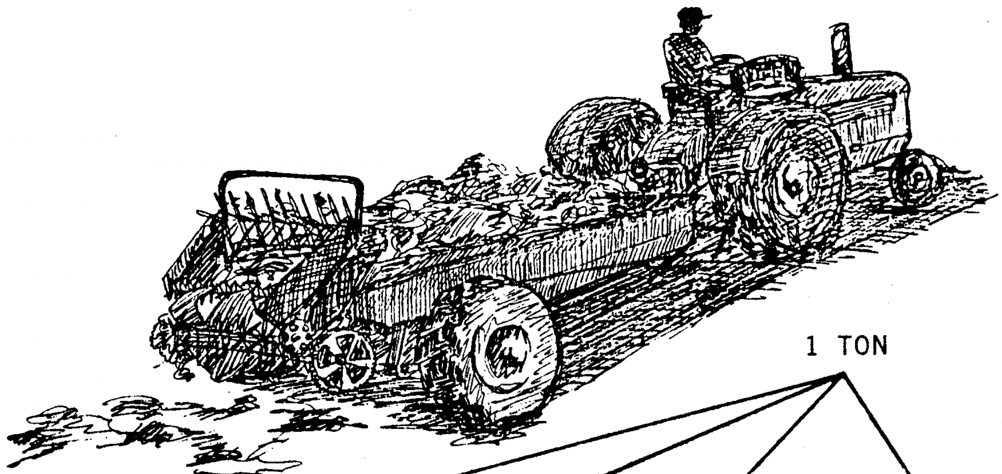
PLANT



ANIMAL

MAN

Manure As A Fertilizer



1 TON

500 LBS ORGANIC MATTER	10 - 30 LBS NITROGEN	5 - 20 LBS PHOSPHORIC ACID	10 - 30 LBS POTASSIUM

1 TON = $6.00 - $11.33 FERTILIZER VALUE

1.6 BILLION TONS PRODUCED IN THE UNITED STATES

VALUE OF YEARLY MANURE CROP AT 1980 PRICES IS

9.6 - 18.1 BILLION DOLLARS

INTRODUCTION TO ANIMAL SCIENCE

AG 534 - A

ASSIGNMENT SHEET #1--DEVELOP AN OPINION ON THE FUTURE OF LIVESTOCK PRODUCTION

Name ______________________________________ Score ___________________________________

The world food situation is getting more critical every day. The role livestock will play in providing the world's food supply will depend on public opinion and political decisions as well as technological developments.

Write a few paragraphs outlining your views on the future of livestock production and the role livestock should play in providing the world's food supply.

INTRODUCTION TO ANIMAL SCIENCE

AG 534 - A

ASSIGNMENT SHEET #2--CONDUCT A COMMUNITY SURVEY ON THE TYPES OF LIVESTOCK RAISED IN THE AREA

Name ______________________________ Score ______________________________

You have looked at the livestock industry on a national and state level. This assignment is designed to help you get an idea of the type and importance of livestock in your community.

Take an informal survey of your community to find out the types and approximate numbers of different livestock raised in the area. People to ask would be farmers, ranchers, agribusiness people, bankers and state extension people. Use at least three sources.

Sources	Types	Numbers
1.		
2.		
3.		

INTRODUCTION TO ANIMAL SCIENCE

AG 534 - A

INSTRUCTOR NOTES FOR LABORATORY EXERCISES

Lab #2

Allow approximately 80 minutes for activity
Have students read *Anatomy of the Microscope* before class, and then make the changes that are necessary to fit
the microscopes being used.

Part IV:

Demonstrate the procedure for high power focusing.

Remind students that fine adjustments should be approximately 1/4 of a turn.

Looking at the letter "a" under low power, image will be upside down.

Under high power, you cannot view the entire "a", only a small portion can be seen. It appears very rough and coarse.

INTRODUCTION TO ANIMAL SCIENCE

AG 534 - A

LABORATORY EXERCISE #1--GENERAL LABORATORY PROCEDURES,
EQUIPMENT AND REPORT WRITING

Name ______________________________________ Score ___________________________________

Part I: General Laboratory Procedures

The following is a list of general laboratory procedures. You will be required to write at least ten of these on a quiz.

1. Never "horse around" in the laboratory.

2. Never play with laboratory equipment or materials.

3. Always follow instructions and wait until you are told to begin before starting any investigation.

4. Never carry out unassigned experiments.

5. Never eat or taste anything in the laboratory. This includes food, drinks and gum, as well as chemicals found in the laboratory.

6. Wash your hands after *every* experiment.

7. Keep all books and other nonessential items away from the work area.

8. Keep your work area clean. Dispose of waste materials in appropriate containers.

9. Turn off any gas jets or any electrically operated equipment when you have completed the laboratory investigation.

10. Report all injuries or accidents to your teacher immediately.

11. Never use broken or cracked glassware.

12. Always wear shoes in the laboratory. Sandals are not suggested.

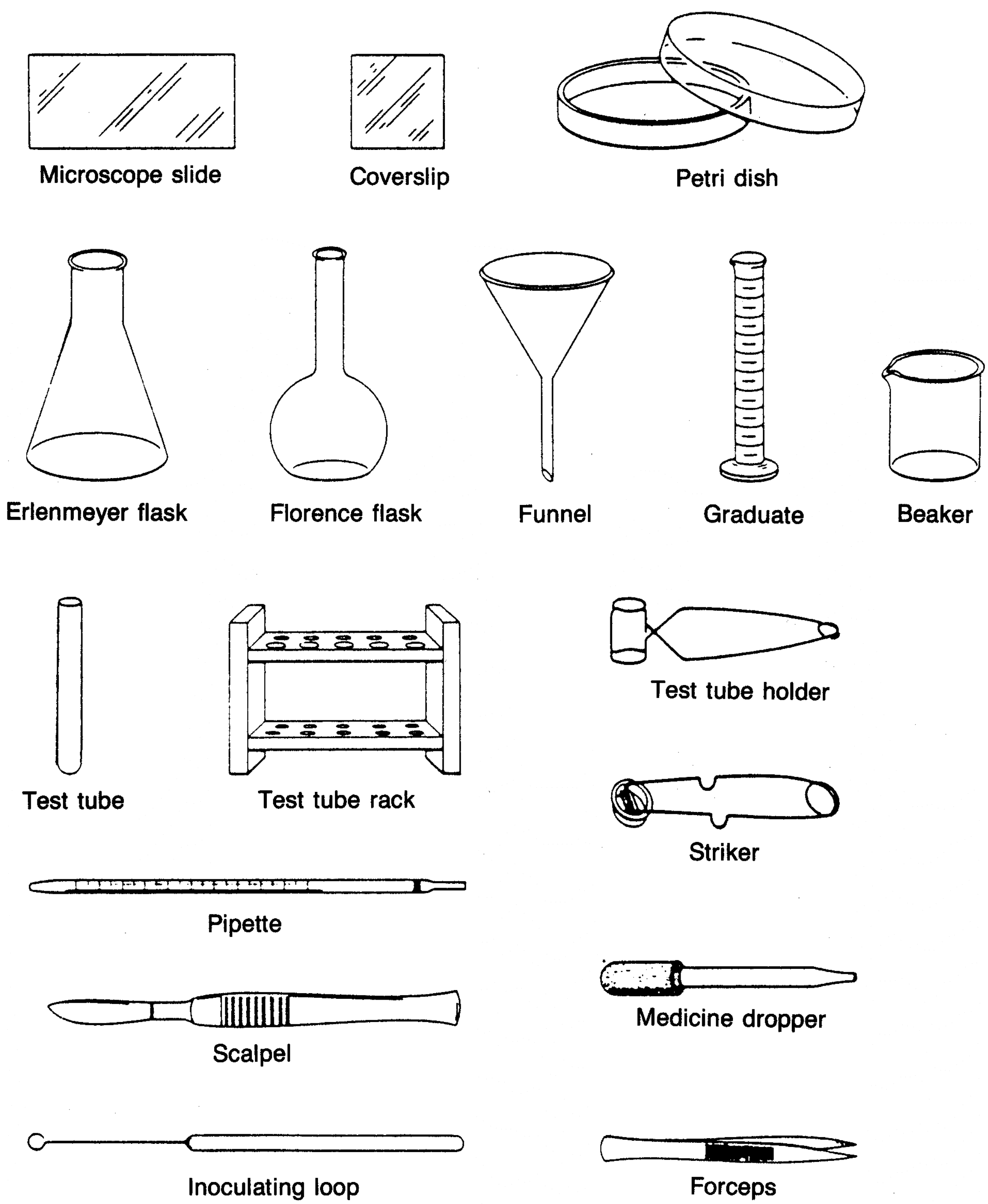
13. Tie back long hair and restrict any loose clothing.

14. Wear safety goggles, laboratory aprons and gloves when instructed to do so.

Part II: Laboratory Equipment

Various types of laboratory equipment are identified and illustrated below. Ask your teacher to show you examples of each. You will be required to identify all the illustrations on a quiz.

Laboratory Equipment



Part III: How to Write a Laboratory Report

The following information explains how to write laboratory reports. You will be asked to outline and explain these procedures on a quiz.

There are two different types of laboratory reports that you may be asked to write. The first is a report of a laboratory investigation in which the results and your interpretation of the results are the most important items required by your teacher. This type of investigation is usually found in a laboratory manual, where the procedure is already outlined for you. Such reports would contain the following parts.

Title — This is the name of the laboratory investigation you are doing. In an investigation from a laboratory manual, the title will be the same as the title of the investigation.

Hypothesis — The hypothesis is what you think will happen during the investigation. It is often posed as an "If...then" statement. For example: If sulfuric acid is added to sugar, then the sugar will be broken down into its chemical components.

Materials — This is a list of all the equipment and other supplies you will need to complete the investigation. In investigations taken from a laboratory manual, the materials are generally listed for you.

Procedure — The procedure is a step-by-step explanation of exactly what you did in the investigation. Investigations from laboratory manuals will have the procedure carefully written out for you, all you need to do is to read it very carefully. Often, in laboratory manuals, there will be questions in the procedure section that will help you understand what is happening in the investigation.

Data — Your data is what you have observed. It is often recorded in the form of tables, graphs and drawings.

Analyses and Conclusions — This is the most important and difficult part of the investigation. It explains what you have learned. You should include everything you have learned; you should explain any errors you made in the investigation; and you should evaluate your hypothesis. Keep in mind that not all hypotheses will be correct. That is normal. You just need to explain why things did not work out the way you thought they would. In laboratory manual investigations, there will be questions to guide you in analyzing your data. You should use these questions as a basis for your conclusions.

In some cases, you might be required to do an independent project. You may design your own investigation for a science fair project, or your teacher may have you design an investigation to perform in class.

The report for this type of investigation should include two sections not included in the previous type of report. In order for a laboratory report on an independently designed experiment to be complete, you must now include an introduction and a reference section. They should be included in your report in the following order:

Title

Introduction The introduction should include a clear, simple statement of your purpose. In addition, the introduction should include a discussion of the important ideas that led you to design and perform the experiment. For example, you could include such things as why you are doing this investigation, what is interesting about the topic to be investigated, and what information you have already gathered about the topic. In order to prepare a good introduction, you will need to do library research on the topic. Be sure to use proper citation methods when you use ideas from any reference source.

Hypothesis

Materials

Procedure

Data

Analyses and Conclusions

References List all the reference materials used to originate and to complete the project. Be sure to use complete citations, including author, title, date of publication and place of publication. Your teacher will give you the format preferred for the type of investigation you are doing.

Remember that a good laboratory report takes time. Do not wait until the night before the report is due to begin work on it.

Part IV: Quiz

1. List ten general laboratory procedures.

   a.____

   b.____

   c.____

   d.____

   e.____

   f.____

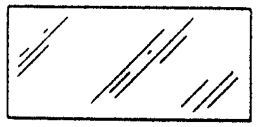
   g.____

   h.____

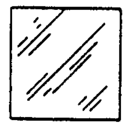
   i.____

   j.____

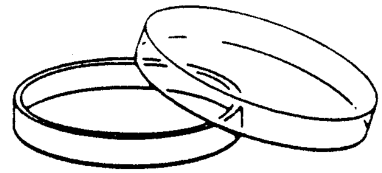
Identify the following types of laboratory equipment.



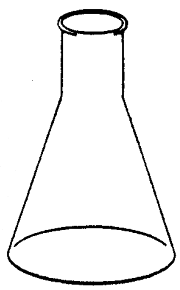
a. ____________



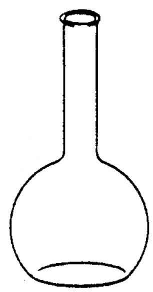
b. ____________



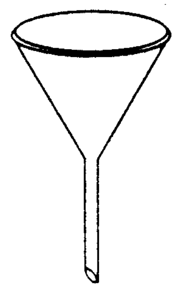
c. ____________



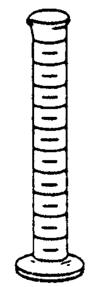
d. ____________



e. ____________

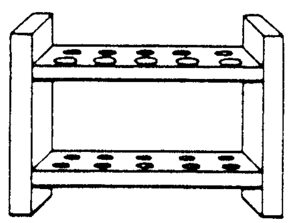


f. ____________



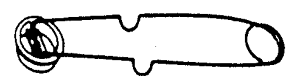
g. ____________

h. ____________



i. ____________

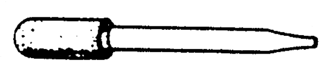
j. ____________



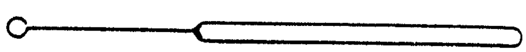
l. ____________

k. ____________

m. ____________



n. ____________



o. ____________

p. ____________

3. Outline and explain the procedures used in writing the two different types of laboratory reports.

INTRODUCTION TO ANIMAL SCIENCE

AG 534 - A

LABORATORY EXERCISE #2--USING A COMPOUND MICROSCOPE

Name ____ Score __________________________________

Materials needed

Compound microscope
Lens paper
Microscope slides and coverslips
Newspaper
Scissors
Droppers
Thread of two different colors

Part I: Procedure--Anatomy of a Microscope

1. When removing a microscope from the cabinet, always hold one hand under the *base* and firmly grasp the *arm* with the other hand. Hold the microscope upright and treat it like the precision instrument it is. Place the microscope on your desk with the arm away from you so that you can observe the parts more easily.

   Using the diagram on the next page, identify the parts of the microscope starting at the top. As you read about each of the parts, memorize its name and function.

2. At the top of the microscope is the first lens that is called the eyepiece. Most compound microscopes have numbers, such as 5, 10, or 15 written near the eyepiece. The numbers refer to the total magnification of the lens. The symbol "X" means times or magnification power. For example, if you are looking at a piece of wool using only a 10X eyepiece, it would be seen ten times larger than its natural size.

3. The *body tube*, which extends below the eyepiece, helps in focusing the lenses properly.

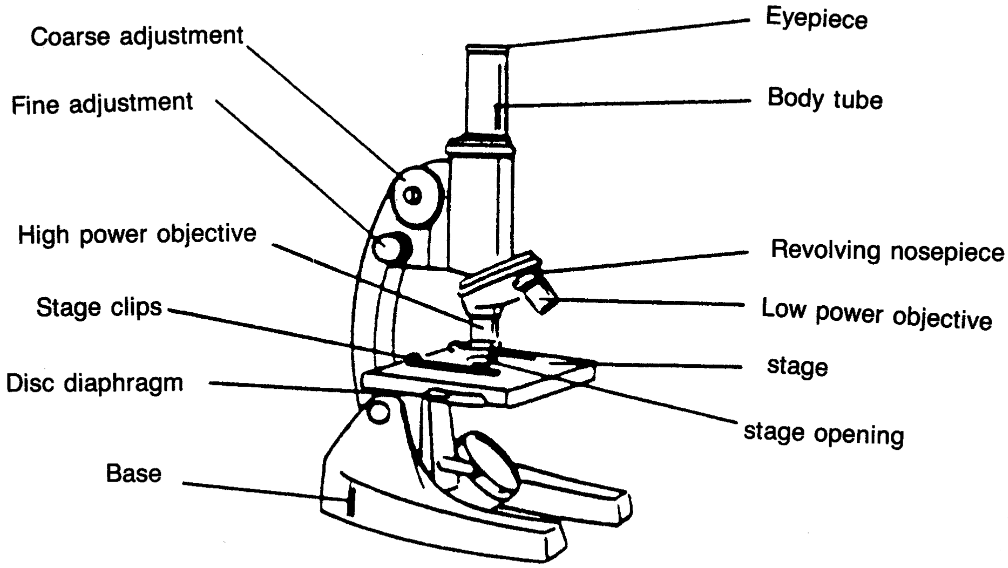
4. The body tube ends in a part known as the revolving nosepiece, under which are lenses called objectives. By turning the nosepiece, the objectives will turn and click into place. The objectives are low power or high power lenses. Low power usually consists of 5X or 10X, while high power consists of 43X to 100X magnification power.

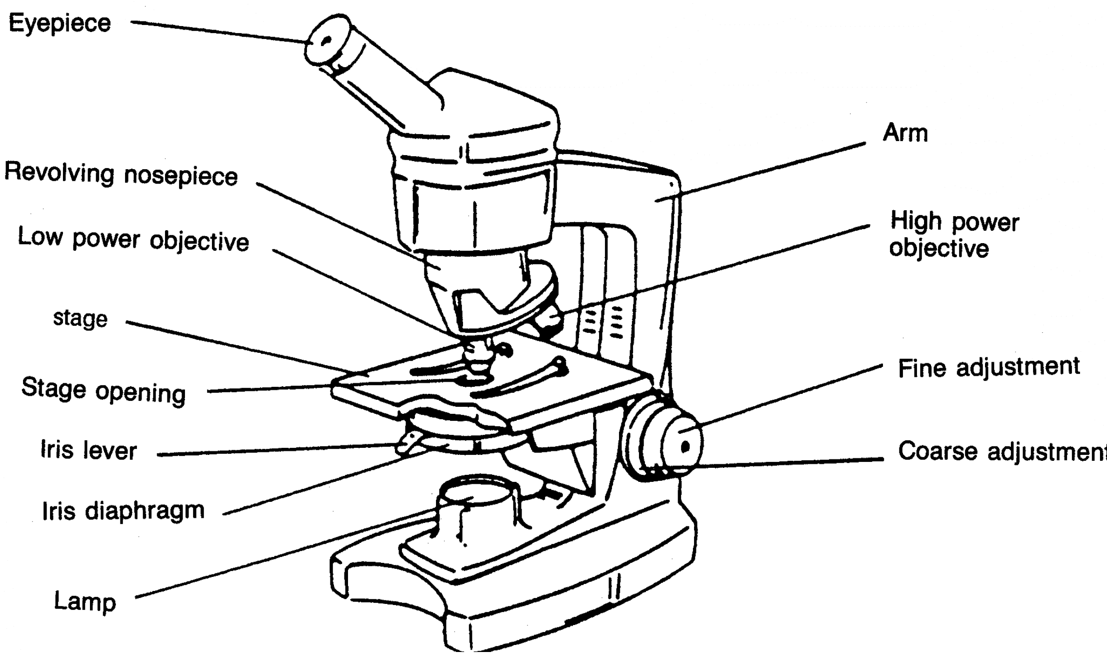
   Extreme care must be exercised when using these lenses; they must not hit the microscope slide when lowering the body tube. The objectives should be cleaned only with lens paper so that dirt and dust will not scratch them.

5. When a microscope has a double set of lenses (eyepiece and objective), it is called a compound microscope.

   If you multiply the number on the eyepiece by the number on the objective, the total magnification of the microscope will be known. For example, if the magnification of the eyepiece is 5X, and the magnification of the objective is 10X, then by multiplying, you get a total magnification of 50X.

6. The objectives overlook a flat platform called the *stage*. The stage has an opening in its center that allows light to enter the microscope. A slide is placed on this stage and kept from moving by the use of *stage clips*.


Coarse adjustment
Fine adjustment
High power objective
Stage clips
Disc diaphragm
Base
Eyepiece
Body tube
Revolving nosepiece
Low power objective
stage
stage opening


Eyepiece
Revolving nosepiece
Low power objective
stage
Stage opening
Iris lever
Iris diaphragm
Lamp
Arm
High power objective
Fine adjustment
Coarse adjustment

7. Underneath the stage is a diaphragm. The diaphragm regulates the amount of light entering the microscope. The diaphragm is adjustable for the type of lighting conditions used.

   On a microscope with an *iris diaphragm*, a lever controls the size of the opening through which light passes. A microscope with a *disc diaphragm* is operated by rotating a disc containing various sized openings. *Important: Adjusting the diaphragm is as important as correctly focusing a microscope.*

8. Your microscope may have a *lamp* or a *mirror* for a light source. If the microscope is equipped with a mirror, it can be turned toward the source of light so that the rays are diverted upwards through the body tube. *Caution:* Never use direct sunlight as a source of light; it can damage your eyes.

9. There are usually two pairs of adjustment wheels on a microscope. One large pair, when turned, move the body tube up or down rather rapidly. This will produce a *coarse adjustment* that is used for initial or first focusing. The second, smaller pair, is used to fine focus the image. This is called the *fine adjustment* and is for final focusing.

10. The bottom part of the microscope is the *base*. Make sure that the base is resting securely wherever it is placed for viewing.

11. Now place the microscope in its normal position for use, with the arm facing you. Before observing anything under the microscope, you should get it ready for viewing by following these simple steps:

    --Make sure the microscope is resting on a secure foundation.

    --Clean the eyepiece and all objectives by wiping them with a piece of lens paper.

    --Open the diaphragm all the way.

    --Turn the nosepiece until the low power objective (4X, 5X or 10X) clicks into place.

    --Look through the eyepiece with *both eyes open*. Doing this will reduce eyestrain.

    --Turn on the lamp or turn the mirror towards a light source until an evenly illuminated white light field is seen.

    --If the light is too bright or too dark, regulate it with the diaphragm.

    --If any tiny specks of dust appear, clean the lenses with fresh lens paper.

Part II: Analysis

1. Briefly describe the function of the following microscope parts:

   a. eyepiece ____

   ____

   b. objectives ____

   ____

   c. mirror or lamp ____

   ____

   d. revolving nosepiece ____

   ____

   e. stage ____

   f. stage clips ____

   g. diaphragm ____

   h. coarse adjustment ____

   ____

   i. fine adjustment ____

   ____

2. Why is the microscope called a compound microscope?

   ____

   ____

3. What would the magnification of your microscope be if you used:

   a. a 5X eyepiece and a 10X objective? ______________________

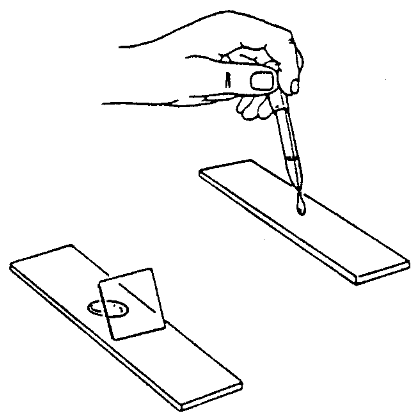
   b. a 10X eyepiece and a 40X objective? ______________________

   c. a 10X eyepiece and a 100X objective? ______________________

Part III: Making a Wet Mount

1. Cut out a small letter "a" from a newspaper column.

2. Carefully position it so that the letter "a" is in the center of a clean microscope slide and is right-side up. Using a dropper, place a drop or two of tap water over the specimen.



3. Holding a coverslip at a 45^{o} angle, slowly lower it into the drop of water containing the letter. Preparing a slide in this manner is known as a *wet mount*. If properly done, there should be no air bubbles trapped under the coverslip. If this is not the case, start over again.

   Why must all wet mount preparations be cut very thin?

   ____

   ____

Part IV: Low Power and High Power

When observing a specimen under *low power*, the following steps should be taken:

--Obtain a compound microscope and adjust the light as instructed at the beginning of this activity.

--Turn the nosepiece until the low power (10X) objective clicks into place. If the objective is not in place, the entire field will not be seen.

--Place the microscope slide on the stage under the stage clips with the letter "a" facing you in the center of the stage opening.

--Fasten the stage clips to the slide and lower the body tube until it stops. Most microscopes have an automatic stop on low power.

--Looking through the eyepiece, *slowly* raise the body tube with the coarse adjustment until the letter "a" comes into focus. Center the letter and use the fine adjustment to bring it into better focus. Look at the distance between the slide and the objective. This is called the *working distance*.

--At this point, adjust the diaphragm to control the amount of light.

While observing under low power, move the slide to the right and to the left. Then move it towards you and away from you. When you move the slide from left to right, in what direction does the letter move?

a. ____

When you move the slide away from you, in what direction does the letter seem to move?

b. ____

In order to see the entire field, the objective must be in place. (True or False)

c. ____

The distance between the slide and the objective is called the d. ____________________

When observing a specimen under *high power*, these steps should be taken:

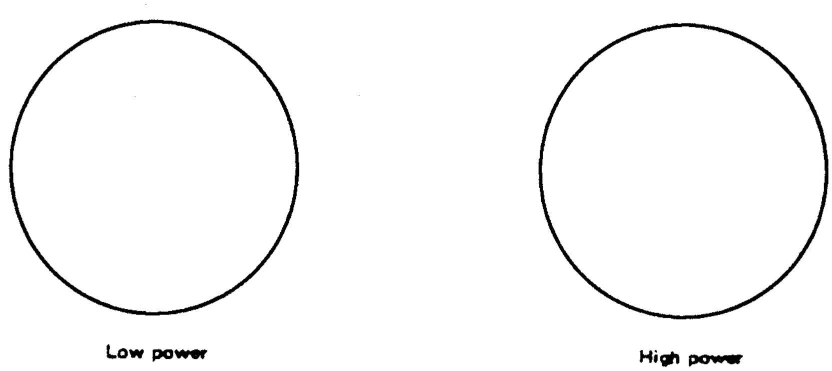
--Always position the specimen in the center of the field of view and fine focus under low power first.

--Open the diaphragm all the way. This is done because as you increase magnification, it becomes necessary for light rays to travel through additional lenses, producing a darker field.

--Turn the nosepiece until the high power objective clicks into place. Most microscopes are *parfocal*. This means that an object focused under low power will be approximately focused under high power.

--All focusing is done *only* with the fine adjustment. Not more than one turn either way should be needed for a sharp focus. Look at how small the working distance is on high power. Using the coarse adjustment knob might crack the slide or damage the objective lens.

Sketch the "a" as you see it under low and high powers. Try to sketch your specimens as accurately as you can.



When you changed from low to high power, how did the change affect the working distance of the lens?

e. ____

____

brightness of the field of view?

f. ____

size of the field of view?

g.____

Part V: Depth of Field and Resolution

Depth of field is the vertical amount of the specimen that will be in focus at one time while *resolution* is the ability of a microscope to show fine details clearly. Actually, resolution is just as important as magnification. To merely magnify a blur does not tell one anymore about it. The ability of a microscope to resolve very closely spaced objects depends on the quality of the lenses and the wavelength of the light being used.

1. Make a wet mount of two different colored threads that cross each other. Add a coverslip and observe under *low* and *high* power.

   a. Which diaphragm setting provides the clearest view on each power?

   ____

   b. How can the microscope be used to determine which thread is on the bottom?

   ____

   ____

   c. Are both threads in focus at once under low power?______________________

   d. high power? ____

   e. Under which power is the depth of field greater?

   ____

Part VI: Analysis

1. Given a prepared slide of a one-cell organism, briefly list the steps from the beginning that must be taken to locate the organism under high power (430X).

   ____

   ____

   ____

2. You are searching a slide for an object that is in the lower right-hand side of the field of view. In which direction would you move the slide on the stage in order to center the object?

   ____

3. The largest opening on the diaphragm is always best. (True or False) ____________

   Explain. ____________

   ____

4. When searching a slide for a small object, with which objective is it best to begin?

   ____

5. Microscope A has a 20X eyepiece and a 30X objective; microscope B has a 5X eyepiece and a 40X objective.

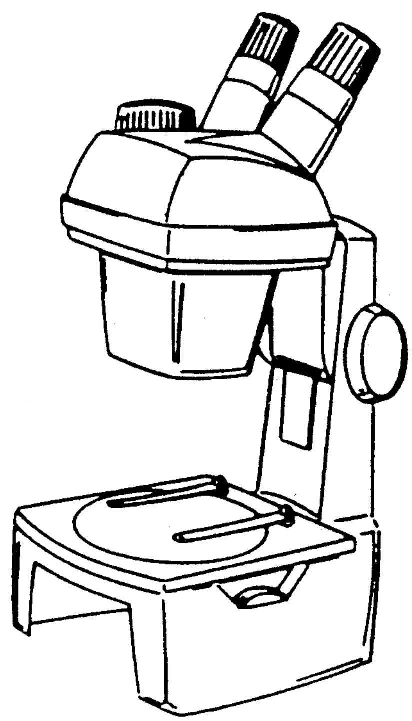
a. Which microscope has the greatest magnification? ____________

   ____

b. Which requires the most light? ____________

c. Which has the greatest depth of field? ____________

Part VII: The Stereoscopic Dissecting Microscope



In some cases, it is better to work with less magnification. This is true when the objects are opaque and too large to be seen whole under the lowest power of the compound microscope. Because the working distance is much greater, it is also possible to handle objects while they are being viewed with this microscope. Specimens are usually viewed by reflected light, and since there are two objectives and two eyepieces, a 3-dimensional effect is achieved.

1. Place the dissecting scope on a table and light its stage with a lamp. Adjust the eyepieces to fit the distance between your eyes. Use the focusing knob to move the objective as far down as it will go.

2. Focus on a plastic ruler by turning the focusing knob slowly toward you.

   a. What is the magnification with this objective?

   ____

   b. What is the field size in millimeters?______________________

   c. in micrometers? ____________________________

   d. How does the field size compare with the compound microscope low power field?

   ____

3. Magnification with this type of microscope can be increased by changing the eyepieces or objectives. If your microscope is so equipped, change to a higher magnification. What is the high power magnification?

   a.____

   How does the field size compare with the low power field?

   b.____

4. Select an object such as a leaf or insect to view. Focus the object under both low and high power. While looking through the microscope, move the specimen to the right. Which way did the image move?
   a.____

   Move the specimen toward you. Which way did the image move?

   b.____

   How does this movement compare with observation of movement when using the compound microscope?

   c.____

   ____

5. Examine other objects under the dissecting microscope. If possible, practice moving the objects about with forceps or dissecting needles as you view them.

Part VIII: Analysis

1. List several advantages to using a stereoscopic dissecting microscope.

2. When searching a slide for even small objects, it is best to start with low power. Explain.

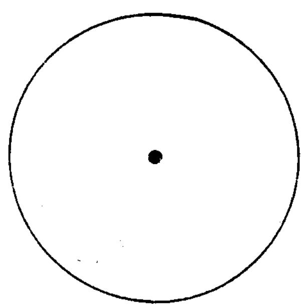
3. A microscope has a 10X field measuring 6 mm. What is the size of the field at 10X in micrometers? a. ______________

   b. at 20X? ______________

   c. at 45X? ______________

   d. What is the total magnification when using a 5X eyepiece with a 45X objective?

4. The circle below represents the field of view when using the 10X objective. Using the same center point, draw a circle that would approximate the field of view at 43X.



5. Why are objects frequently lost when switching to high power?

INTRODUCTION TO ANIMAL SCIENCE

AG 534 - A

ANSWER SHEET TO LABORATORY EXERCISES

Lab #1

Part III--Quiz

1. Answer should include ten of the following:

   Never "horse around" in the laboratory.
   Never play with laboratory equipment or materials.
   Always follow instructions and wait until you are told to begin before starting any investigation.
   Never carry out unassigned experiments.
   Never eat or taste anything in the laboratory. This includes food, drinks and gum, as well as chemicals found in the laboratory. Wash your hands after *every* experiment.
   Keep all booksand other nonessential items away from the work area.
   Keep your work area clean. Dispose of waste materials in appropriate containers.
   Turn off any gas jets or any electrically operated equipment when you have completed the laboratory investigation.
   Report all injuries or accidents to your teacher immediately.
   Never use broken or cracked glassware.
   Always wear shoes in the laboratory. Sandals are not suggested.
   Tie back long hair and restrict any loose clothing.
   Wear safety goggles, laboratory aprons, and gloves when instructed to do so.

2.

a.	Microscope slide	b.	Coverslip
c.	Petri dish	d.	Erlenmeyer flask
e.	Florence flask	f.	Funnel
g.	Graduate	h.	Test tube
i.	Test tube rack	j.	Test tube holder
k.	Pipette	l.	Striker
m.	Scalpel	n.	Medicine dropper
o.	Inoculating loop	p.	Forceps

3. Answer should include the following information:

<u>Laboratory Investigation Report:</u>

Title This is the name of the laboratory investigation you are doing. In an investigation from a laboratory manual, the title will be the same as the title of the investigation.

Hypothesis The hypothesis is what you think will happen during the investigation. It is often posed as an "If...then" statement. For example: If sulfuric acid is added to sugar, then the sugar will be broken down into its chemical components.

Materials This is a list of all the equipment and other supplies you will need to complete the investigation. In investigations taken from a laboratory manual, the materials are generally listed for you.

Procedure The procedure is a step-by-step explanation of exactly what you did in the investigation. Investigations from laboratory manuals will have the procedure carefully written out for you, all you need to do is to read it very carefully. Often, in laboratory manuals, there will be questions in the procedure section that will help you understand what is happening in the investigation.

Data Your data is what you have observed. It is often recorded in the form of tables, graphs and drawings.

Analyses and Conclusions This is the most important and difficult part of the investigation. It explains what you have learned. You should include everything you have learned; you should explain any errors you made in the investigation; and you should evaluate your hypothesis. Keep in mind that not all hypotheses will be correct. That is normal. You just need to explain why things did not work out the way you thought they would. In laboratory manual investigations, there will be questions to guide you in analyzing your data. You should use these questions as a basis for your conclusions.

Independent Project Report

Title

Introduction The introduction should include a clear, simple statement of your purpose. In addition, the introduction should include a discussion of the important ideas that led you to design and perform the experiment. For example, you could include such things as why you are doing this investigation, what is interesting about the topic to be investigated, and what information you have already gathered about the topic. In order to prepare a good introduction, you will need to do library research on the topic. Be sure to use proper citation methods when you use ideas from any reference source.

Hypothesis

Materials

Procedure

Data

Analyses and Conclusions

References List all the reference materials used to originate and to complete the project. Be sure to use complete citations, including author, title, date of publication and place of publication. Your teacher will give you the format preferred for the type of investigation you are doing.

Lab #2

Part II:

1.
   a. Lens closest to the eye that has 5X or 10X magnification power.
   b. Lens closest to the object being observed. These lenses usually have 5X, 10X, 43X or 100X magnification power.
   c. Provides an adequate light source for viewing.
   d. Allows observer to change from low (10X magnification) to high power (43X magnification).
   e. Supports the slide.
   f. Secures the slide.
   g. Regulates the amount of light entering the microscope.
   h. Brings objects into rapid but approximate focus.
   i. Brings objects into a more exact focus.

2. Because a double set of lenses (eyepiece and objective) is used

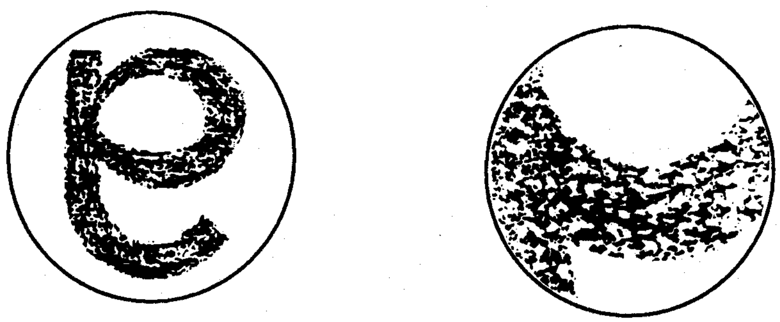
3. a. 50X b. 400X c. 1000X

Part III:

3. So that light can be transmitted *through* the object for viewing.

Part IV:

a. The letter will move from right to left.
b. Toward you.
c. True
d. Working distance



e. Working distance is much smaller with the high power
f. Brightness is decreased on high power
g. Field of view is restricted on high power

Part V:

1. a. Less light is desirable on low power
   b. Use the fine adjustment to focus up and down. The bottom thread will come into view as the scope is focused down.
   c. Probably
   d. No
   e. Low power

Part VI:

1. See steps outlined in procedure under high power
2. Down and to the right
3. False. At low power the excessive light does not allow the eye to see detail.
4. Low power; a greater area can be seen at once
5. a. Microscope A b. Microscope A c. Microscope B

Part VII:

2. a. Answers variable
   b. Answers may vary
   c. Answers variable, should be 1000X answer above
   d. Field size is larger

3. a. Variable
   b. Field size is smaller

4. a. Movement of image is the same as movement of object
   b. The specimen moves toward you
   c. Not reversed as with compound microscope

5. Students can practice dissecting objects, such as insects, leaves or presoaked seeds, just to get the feel of working with a stereoscope.

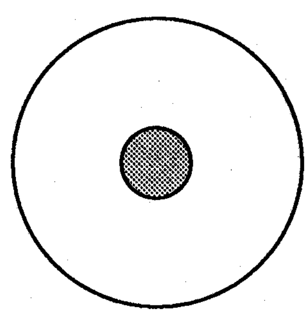
Part VIII:

1. Opaque objects can be viewed. Larger objects can be studied. Specimens can be dissected under the scope.

2. A larger field of view is available to find the objects.

3. a. 6000pm
   b. 3000pm
   c. approximately 1300pm+
   d. 225X

4. Students should draw a circle having an area approximately 1/4 the original circle



5. The object is not centered in the portion of the low power field that will be seen under high power.

INTRODUCTION TO ANIMAL SCIENCE

AG 534 - A

UNIT TEST

Name ______________________________ Score ______________________________

1. Match the terms on the right with the correct definitions by placing the appropriate numbers in the blanks provided.

_____a. An actual material provided by an animal that can be eaten, worn or used		1. Product
_____b. Feed, such as pasture, that is bulky, contains more than 18% crude fiber and is low in energy		2. Cultivate
_____c. Capacity for change		3. By-products
_____d. Working land to produce a crop		4. Elasticity
_____e. Money coming in or received for a product or a service.		5. Concentrate
_____f. A benefit provided by an animal		
_____g. Feed, such as grain, high in energy and low in fiber		6. Flexibility
_____h. Ability of a farm operation to withstand changes in the supply or demand		7. Receipt
_____i. Products left after the main products have been extracted		8. Service
		9. Roughage

2. Name ten types of livestock.

______________________, ______________________, ______________________

______________________, ______________________, ______________________

______________________, ______________________, ______________________

____

3. Name four products and three services livestock provide.

Products

a.______________________ c.______________________

b.______________________ d.______________________

Services

a.______________________ c.______________________

b.______________________

4. Identify the sources of Idaho cash farm receipts by writing the source by the appropriate percentage:

a. 13.1% ______________________

b. 1.2% ______________________

c. .6% ______________________

d. 27.8% ______________________

e. 2.1% ______________________

f. 54.8% ______________________

g. 45.2% ______________________

5. Identify Idaho's rank in the nation's agriculture for the following crops, livestock and livestock products.

a. Honey ______________________

b. All cattle and calves ______________________

c. Milk production ______________________

d. American cheese ______________________

e. Milk cows ______________________

f. Sheep, lambs, wool ______________________

g. Barley ______________________

h. Potatoes ______________________

i. Sugarbeets ______________________

j. Hops ______________________

k. All mint ______________________________

l. Wheat ______________________________

m. Apples ______________________________

6. Distinguish between primary and secondary food sources by placing a one (1) by the primary source and a two (2) by the secondary source.

_____a. Food source deriving energy from plants or animals

_____b. Food source deriving energy directly from the sun

7. Describe reasons for and against using livestock as a food source.

a. Arguments for using livestock as a food source:

____

____

____

____

b. Arguments against using livestock as a food source:

____

____

____

____

8. List three specific careers in each of the following areas of livestock industry employment.

a. Farming/Ranching
(1) ______________________________
(2) ______________________________
(3) ______________________________

b. Research
(1) ______________________________
(2) ______________________________
(3) ______________________________

c. Industry
(1) ______________________________
(2) ______________________________
(3) ______________________________

d. Business

(1) ________________________________

(2) ________________________________

(3) ________________________________

e. Education

(1) ________________________________

(2) ________________________________

(3) ________________________________

f. Communications

(1) ________________________________

(2) ________________________________

(3) ________________________________

g. Service

(1) ________________________________

(2) ________________________________

(3) ________________________________

INTRODUCTION TO ANIMAL SCIENCE

AG 534 - A

ANSWERS TO TEST

1. a. 1 e. 7 i. 3
   b. 9 f. 8
   c. 6 g. 5
   d. 2 h. 4

2. Beef, dairy, sheep, swine, dairy goats, horses, rabbits, fish, fur-bearing animals, poultry

3. Answers should include four products and three services from the following lists:

   Products -- Meat, eggs, milk, clothing, medicine, fertilizer, miscellaneous products
   Services -- Power, recreation, transportation

4. a. Dairy products e. Other livestock
   b. Sheep, lambs, wool f. Total crops
   c. Hogs g. Total livestock
   d. Cattle and calves

5. a. 11 h. 1
   b. 22 i. 3
   c. 13 j. 3
   d. 5 k. 3
   e. 18 l. 8
   f. 11 m. 10
   g. 1

6. a. 2 b. 1

7. a. Answers should include information from the following:

   Usable plant energy would otherwise be wasted: Much of the world's land is not cultivated; Forages provide a high percentage of livestock feed; 95% of all energy fixed by plants cannot be used by man, but can be used by ruminants; Animals use otherwise wasted by-products

   Animals provide higher quality food: Higher in protein content; Better quality protein (more amino acids); More digestible protein; More preferred by consumers

   Animals provide other needed products such as medicine, fertilizer and power

   Animals increase flexibility of farm operations: Stimulate grain production; Provide elasticity to grain production

   b. Livestock provide a secondary food source and therefore use more energy to produce the same amount of food

8. Answer should include three careers in each area:

   a. Farming/Ranching: Manager; Foreman; Herdsman

   b. Research : Production; Processing; Marketing; New equipment and use

   c. Industry: Food processing; Pesticides and herbicides; Feed manufacturing; Dairy processing

   d. Business: Agricultural banking; Farm management; Grading and packaging; Marketing

   e. Education: Agricultural extension specialist; Vocational agriculture instructor; College instructor; Governmental agencies

   f. Communications: Farm reporting; Market reporting; Radio; Television

   g. Service: Inspection and regulation; Plant and animal quarantine; Foreign service; Agricultural consultant; Veterinary

THE ORGANISMS

AG 534 - B

UNIT OBJECTIVE

After completion of this unit, students should be able to define terms related to organisms and list the categories of the classification system. Students should also be able to list traits that place an organism into a kingdom and define the five kingdoms in the classification system. This knowledge will be demonstrated by completion of laboratory exercises and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Define terms related to the organisms.
2. List the seven categories of the classification system in order from largest to smallest.
3. Outline the classification system for humans.
4. List three traits that help place an organism into a kingdom.
5. List and define the five kingdoms in the classification system.
6. State two biological principles for each of the categories that demonstrate commonness among organisms.
7. Outline the classification of the major livestock animals in the United States.
8. Examine cells from the five kingdoms.
9. Classify organisms.

THE ORGANISMS

AG 534 - B

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

   A. Make transparencies and necessary copies of materials.

   B. Provide students with objective sheet and discuss.

   C. Provide students with information sheet and discuss.

   D. Provide students with assignment and laboratory sheets.

   E. Discuss and demonstrate assignment sheets and laboratory exercises.

   F. Review and give test.

   G. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM 1--Classification System

      2. TM 2--Placing Organisms Into a Kingdom

      3. TM 3--Kingdoms

   E. Assignment sheet

      1. AS 1--Outline the Classification of the Major Livestock Animals in the United States

   F. Answer to assignment sheet

   G. Instructor notes for laboratory exercises

   H. Laboratory exercises

      1. LE 1--Examining Cells From the Five Kingdoms

      2. LE 2--Classifying Organisms

I. Answers to laboratory exercises

J. Test

K. Answers to test

III. Unit references

A. *Agricultural Education Curriculum*, College of Agriculture, University of Illinois, Urbana, Illinois, 1989.

B. Otto, James H., Towle, Albert, *Modern Biology*, Holt, Rinehart and Winston, Publishers, New York, 1985.

C. Slesnick, Irwin L.; Balzer, Leron; McCormack, Alan J.; Newton, David E.; Rasmussen, Fredrick A.; *Biology*, Scott, Foresman and Company, Glenview, Illinois, 1985.

THE ORGANISMS

AG 534 - B

INFORMATION SHEET

I. Terms and definitions

A. Binomial nomenclature--A system invented by Carolus Linnaeus for classifying organisms. Each organism is assigned a two-word Latin name
(Note: First word represents the genus; second word is descriptive.)

B. Prokaryote--Cell type that has a nucleus without a membrane around it. The nuclear material floats freely within the cell

C. Eukaryote--Cell type that has an organized nucleus surrounded by a membrane

D. Adaptation--A characteristic which enables the organism to survive in its environment

E. Autotrophs--Organisms that manufacture organic nutrients from inorganic raw materials

F. Biogenesis--The theory that all living things come only from preexisting living things

G. Biome--Large, easily differentiated community unit arising as a result of complex interactions of climate, other physical factors and biotic factors

H. Chordate--The phylum of animals characterized by the presence of a notochord at some stage of development

I. Colony--Association of unicellular or multicellular organisms of the same species

J. Community--An assemblage of populations that live in a defined habitat. The organisms constituting the community interact in various ways with one another

K. "Consumer" organisms--Those elements of an ecosystem that eat other plants or animals

L. Ecology--The study of the interrelations between living things and their environment

M. Ecosystem--All of the organisms of a given area

N. Epigenesis--The theory that development proceeds from a structureless cell by the successive formation and addition of new parts which do not preexist in the fertilized egg

O. Fossils--Any remains of an organism that have been preserved in the earth's crust

P. Genus--Taxonomic classification in which closely related species are grouped together

Q. Herbivore--A plant-eating animal

R. Heterotrophs--Organisms which cannot synthesize their own food from inorganic materials

S. Mammal--A member of a class of vertebrates characterized by having hair and mammary glands; includes such diverse types as shrews, bats, cats, whales, cattle and humans

T. Outbreeding--The mating of individuals of unrelated strains

U. Phenotype--The visible expression of the hereditary constitution of an organism

V. Phylogeny--The evolutionary history of a group of organisms

W. Polymorphism--Occurrence of several distinct phenotypes in a population

X. Population--The group of individuals of a given species inhabiting a specified geographic area

Y. Senescence--The gradual loss of vigor through the aging process

Z. Species--The unit of taxonomic classification, a population of similar individuals, alike in their structural and functional characteristics

AA. Taxonomy--The science of naming, describing and classifying organisms

BB. Territoriality--Behavior pattern or mold in which one organism (usually a male) delineates a territory of his own and defends it against intrusion by other members of the same species and sex

CC. Tissue--Specialized cells which together perform certain special functions

II. Classification system--Largest to smallest (Transparency 1)

A. Kingdom

B. Phylum

C. Class

D. Order

E. Family

F. Genus

G. Species

III. Classification system for humans

A. Kingdom -- Animalia

B. Phylum -- -- Chordata

C. Class -- Mammalia

D. Order -- Primates

E. Family -- Hominidae

F. Genus -- Homo

G. Species -- Homosapiens

IV. Traits that help place organism into kingdom (Transparency 2)

A. Kind of cells in organism: prokaryote or eukaryote

B. How organism obtains its food

C. How organism reproduces and develops

V. Five kingdoms (Transparency 3)

A. Animal kingdom (Animalia)

1. Eukaryotic cells
2. Multicellular organisms
3. Move about to obtain food
4. Digest food inside body

B. Plant kingdom (Plantae)

1. Eukaryotic cells
2. Multicellular organisms
3. Produce own food
4. Cannot move about

C. Fungi kingdom

1. Eukaryotic cells
2. Mostly multicellular organisms

3. Do not move about

4. Obtain food by absorbing it from living or dead organisms

D. Monera kingdom

1. Prokaryotic cells

2. Mostly one-celled organisms

3. Produce own food or obtain it from outside source

E. Protista kingdom

1. Eukaryotic cells

2. Many are one-celled

3. Produce own food or obtain it from outside source

VI. Biological principles that demonstrate commonness among organisms

A. Environmental interaction

1. Cells in organisms affect and interact with each other

2. Cells and organisms react and interact with their environment

B. Genes

1. All organisms pass on function and structure to their offspring

2. The combination of gene characteristics is variable

3. The DNA contains the genetic code in a linear arrangement

4. The RNA is the means of replicating and passing on the genetic code

C. Life

1. Life comes from life

2. Reproduction is required for life continuation

D. Physical and chemical reactions

1. Physical and chemical laws are obeyed by living creatures

2. All living organisms use the common molecular, biological and chemical reaction means

3. All living organisms must capture, store and release energy to sustain life

E. Evolution

1. All organisms arise from preexisting organisms. (The exception would be the assumption that the original living cell arose spontaneously. This assumption is commonly accepted but subject to serious question by some investigators)

2. Natural selection is responsible for organism evolution

3. The embryos of developing animals tend to resemble the embryos of their ancestors

4. Organisms adapt to their habitat through selection from environmental pressures

F. Cells

1. Cells are the fundamental units of life

2. Cells contain structures which are differentiated and interdependent

G. Development

1. All organisms exhibit characteristics of cell enlargement or cell division or both. This characteristic is termed growth

2. All organisms develop a characteristic body plan

CLASSIFICATION SYSTEM

Kingdom

Phylum

Class

Order

Family

Genus

Species

PLACING ORGANISMS INTO A KINGDOM

KIND OF CELL

METHOD OF OBTAINING FOOD

METHOD OF REPRODUCTION AND DEVELOPMENT

KINGDOMS

Animal

Plant

Fungi

Monera

Protista

THE ORGANISMS

AG 534 - B

ASSIGNMENT SHEET #1--OUTLINE THE CLASSIFICATION OF THE MAJOR LIVESTOCK ANIMALS IN THE UNITED STATES

Name ______________________________ Score ______________________________

Using resources in your library or agriculture classroom, outline the classification of the following animals:

	Cattle	Sheep	Horses	Goats	Chickens
Kingdom	Animal				
Phylum	Chordata				
Class	Mammalia				
Order	Artiodactyla				
Family	Bovidae				
Genus	Bos				
Species	Bostaurus				

THE ORGANISMS

AG 534 - B

INSTRUCTOR NOTES FOR LABORATORY EXERCISES

Lab #1

Background: The separate procedures do not have to be completed in any specific order. You may wish to set up five lab stations and divide the class into five groups. Have each group start at a different lab station doing a different procedure. This will minimize the amount of time that the students will need to wait for microscopes and prepared slides.

Solution preparation:

The following general instructions apply for the preparation of most solutions: Solvents should be added to solutes. Use distilled water, not tap water, for all reagents. When preparing an acid or base solution, *slowly* add the acid or base to the water. Never add water to a concentrated acid or base.

To make percentage solutions measure 1 ml of solute per percentage. Add the solute to enough solvent to make 100 ml of solution. When dissolving a solid in water, measure 1 g of solute per percentage and mix the solute with enough water to make 100 ml of the solution.

<u>Iodine solution (also available ready-made)</u>

Dissolve 5.0 g of potassium iodide [KI] and 1.5 g of iodine crystals in 500 ml of distilled water. Store in brown bottle or other glass container that shields the liquid from light. *CAUTION: Iodine dust and vapors are toxic and irritating. Avoid body contact and inhalation of fumes. Should body contact occur, flush immediately with water.* (Quantity needed: 500 ml)

<u>Methyl cellulose solution (also available ready-made)</u>

Dissolve 2 g of methyl cellulose in 38 ml of distilled water. Store in refrigerator. (Quantity needed: 40 ml)

<u>Methyl blue stain (also available ready-made)</u>

Dissolve 0.75 g of methylene blue in 50 ml of 95% ethyl alcohol. Dilute 5 ml of the alcohol and methylene blue solution with 45 ml of distilled water. This diluted solution is the stain. Bottle and store the remaining methylene blue and alcohol solution. *CAUTION: Ethyl alcohol is flammable. It is also irritating to the eyes. Flush spills with water. Do not ingest ethyl alcohol.* (Quantity needed: 50 ml)

Materials:

Prepared slides could include: Animal cells: human and frog blood cells, skeletal and cardiac muscle, nerve cells and epithelial cells

Plant cells: cross sections of leaves, stems and roots

Fungal cells: *Rhizopus, Lycogala* and mushroom cross sections

Protist cells: paramecia, diatoms, amebas and *Volvox*

Moneran cells: bacteria types and cyanobacteria, such as *Anabaena*

Part I:

Step 1: The tongue cells that students will observe are epithelial cells.

Part III:

To make yeast suspension, dissolve 0.1 g of yeast in 75 ml of warm (37^{o}C) water. Add 2-5 g of sugar.

Part IV:

Step 3. Cilia of paramecia are best seen under dim light or under a phase-contrast microscope

Part V:

You may suggest that students work on Table I as they do the laboratory. Students may need to use a textbook to complete Table I.

Lab #2

Inform the student that the construction and use of a classification key may be compared with solving a mystery or going on a treasure hunt, where each bit of information leads to another piece of information. Impress on them that one wrong choice somewhere along the way can cause them to take a wrong turn and end up in the wrong place with the wrong answer!

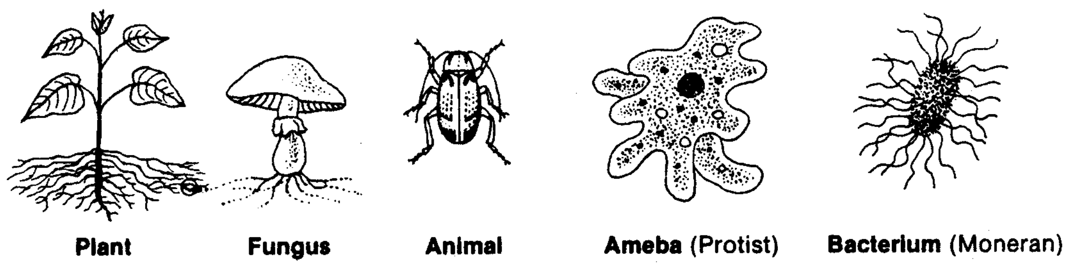
THE ORGANISMS

AG 534 - B

LABORATORY EXERCISE #1--EXAMINING CELLS FROM THE FIVE KINGDOMS

Name ______________________________ Score ______________________________

Slesnick, Irwin L., *Biology Laboratory Manual,* Scott, Foresman and Company, 1985. Reprinted by permission of Scott, Foresman and Company.



Introduction

A plant such as the one in the drawing above looks and behaves very differently from insects that might feed on it and from fungi that might grow on its roots. Likewise, different types of single-celled organisms, such as amebas and bacteria, vary in appearance. Differences in the cells of the organisms ultimately account for these variations. As the functional units of life, however, all cells have common characteristics. For example, every cell is made mainly of cytoplasm enclosed in some sort of membrane. All cells, at some point, also contain genetic material that directs the way the cell functions. In this laboratory you will examine cells representing organisms from each of the five kingdoms. You will observe similarities and differences in cell structure and function.

Materials needed:

5 microscope slides
Medicine dropper
Tap water
5 coverslips
Toothpick
Paper towels
Forceps
Compound microscope
Leaf

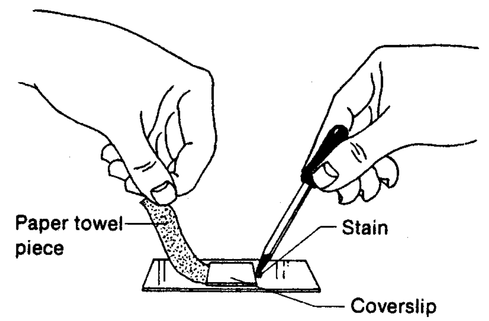
Yeast suspension
Paramecium culture
Nostoc or *Oscillatoria* culture
Methylene blue stain
Iodine solution
Methyl cellulose solution
Prepared slides of animal cells, plant cells, fungal cells, protist cells and moneran cells

Part I: Animal Cells

1. Prepare a wet mount slide of tongue cells using the following directions. Place a drop of water on the center of a clean slide. Use a clean toothpick to gently scrape the top surface of your tongue. Mix the tongue scrapings from the toothpick with the water on the slide. Gently lower a coverslip in place over the tongue cells and water mixture.

2. To make certain cell structures visible, stain the tongue cells with methylene blue stain by adding one drop of stain along one side of the coverslip. On the opposite side of the coverslip, place a small piece of paper towel, as shown in a. The paper towel draws the stain under the coverslip and across the slide.

a. Staining cells



3. Observe the stained tongue cells using the low power objective of your microscope. Estimate the length of a tongue cell, and record this figure in Table I in Part IV of this lab. Describe the general shape of the tongue cells in the space provided in the table. Also use the table to check off the cell structures that you observe.

4. Switch to high power, and bring the tongue cells into focus. CAUTION: Whenever you use a high power objective, very carefully lower the objective or raise the stage until the objective barely touches the slide. Then, look through the eyepiece and focus by slowly raising the objective or lowering the stage. Focusing this way will prevent damage to the lens and slide. Look for cell structures unobservable under low power. Check off these structures in the table.

5. Draw several tongue cells in the circle below. Label all the structures you observed.

____

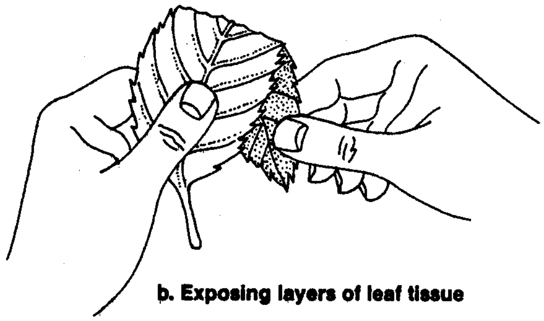
6. Remove the slide of your tongue cells from the stage. Obtain prepared slides of animal cells, and examine them under low and high power. In your table list the types of animal cells that you examined. Check off the cell structures you were able to observe in each cell.

7. In the circles below, draw the animal cells that you examined as they appeared under high power. Record the cell type on the line below the circle. Label the cell structures that you observed.

______________________ ______________________

<u>Part II: Plant Cells</u>

1. Fold the leaf in half so that the underside of the leaf is on the outside, as shown in b. Use your forceps to pull a thin layer of tissue from the underside of the leaf.



b. Exposing layers of leaf tissue

2. Make a wet mount of the leaf tissue, and stain the plant cells with iodine solution, as in step 2 of Part I.

3. As in Part I, view the plant cells under low power. Estimate the length of a plant cell, and record your estimate in the table. Use the space provided in the table to describe the shape of the plant cell, and check off the cell structures that you observe in the plant cell.

4. Switch to high power, and adjust the focus on the microscope. As always, turn the adjustment knobs slowly to avoid damaging the slide and the objective. In the table check off additional cell structures that were unobservable under low power. Try to observe the different kinds of plastids in the plant cell.

5. Draw plant cells in the circle below, labeling all the cell structures you observed.

6. Remove your wet mount of the plant cells from your microscope. Obtain and examine prepared slides of plant cells. View these slides under low and high power. In the spaces provided in the table, list the plant cells that you examined. Check off cell structures that you observe.

7. In the circles above, draw the plant cells that you observed as they appeared under high power. Label the cell parts, as you did in Part I.

Part III: Fungal Cells

1. Put one drop of yeast suspension in the center of a clean slide. Add a coverslip. Stain the yeast cells with methylene blue stain, using the same method you used in Step 2 of Part I.

2. Observe the yeast cells under low power. Estimate the length of a yeast cell, and record your measurement in Table I. Also describe the shape of the cells in the space provided.

3. Examine the yeast cells under high power. As before, use the table to check off cell structures that you observe.

4. In the circle below, make a labeled drawing of yeast cells as they appear under high power.

5. Obtain prepared slides of fungal cells, and examine them under low and high power. Describe the general shapes of the fungal cells in the space in the table, and check off the structures you observe.

6. In the circles above, draw and label the cells you observed, as they appear under high power.

Part IV: Protist Cells

1. Make a wet mount slide of *Paramecium* cells by placing a drop of *Paramecium* culture on the center of a clean microscope slide. Add a drop of methyl cellulose. This material thickens the liquid, slowing the motion of the paramecia for easier viewing. Add a coverslip.

2. Examine the paramecia under low power. Locate one *Paramecium* that is swimming slowly enough for you to estimate its length. Record your estimate in the space provided in Table I.

3. Switch to high power, and observe the *Paramecium*. Look for the following structures: food vacuole, contractile vacuole and cilia. Use the table to check off the cell structures that you observe. Look for nuclei of different sizes. How many nuclei do you observe?

(a)____

4. In one of the circles below, draw and label a *Paramecium* cell as it appears under high power.

5. Remove the *Paramecium* slide, and examine prepared slides of other protists. Record the cell structures that you observe when viewing the different cells under high power, by checking the appropriate boxes in the table.

6. In the spaces below, draw and label the protist cells, as before.

<u>Part V: Moneran Cells</u>

1. Remove several drops of *Nostoc* or *Oscillatoria* culture from a culture tube. Place one drop of the culture on a clean slide. Add a coverslip.

2. Examine the moneran cells under low power. Estimate the length of one cell, and record this measurement in Table I, as before. Look for a slimy substance that covers the outside of the cells. This substance may help the cells stick together to form long strands of organisms that you observe.

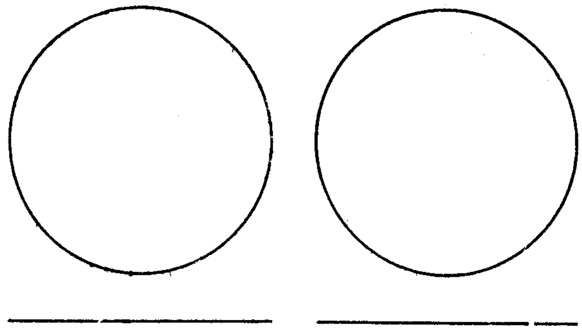
3. View the moneran cells under high power, checking off the cell structures you observe. Which structures observable in other cells, are absent in moneran cells?

   (b)____

4. In the circle below, draw and label a moneran cell under high power. Write the cell type on the line below the circle.

5. Obtain prepared slides of other moneran cells, and view these under low and high power. Record the cell structures that you observe by checking off the appropriate boxes in the table.

6. Make labeled drawings of these moneran cells in the circles below.



7. When you complete Parts I-IV, remove the coverslips from your wet mount slides. Put the coverslips in containers provided by your teacher. Wash your slides under running tap water. Dry them with paper towels, or allow them to air dry.

Table 1. Cells from the five kingdoms.

Cell type	Size	Shape	Cell structures: Cytoplasm	Cell wall	Genetic material	Nuclear membrane	Vacuole	Leucoplasts	Chloroplasts or chromoplasts	Other observations
Animal cells										
Plant cells										
Fungal cells										
Protist cells										
Moneran cells										

Part VI: Analysis

1. Using your laboratory data, list the cell structures that are common to all cells from the five kingdoms.

   ____

2. Can individual cell size alone be used to determine the kingdom to which a cell belongs? Explain.

   ____

   ____

3. Use your data from Table I and your textbook to summarize the features that differentiate the cells of one kingdom from the cells of other kingdoms. List these structures in Table II below.

Table II: Cell features of each kingdom

Cell types	Feature that differentiates cell
Animal cells	
Plant cells	
Fungal cells	
Protist cells	
Moneran cells	

4. Explain how certain cell structures are specialized for certain functions by filling in Table III below.

Table III: Function of certain cell structures

Cell type	Cell structure	Function for cell
Moneran cell: *Nostoc*	Slimy outer coating	
Paramecium		Allow organism to move; propel food into *Paramecium's* mouth
Fungal cell		Allows cytoplasm and other cellular material to move from cell to cell; aids transport within organism
Leaf cell	Chloroplast	
Tongue cell	Centromere	

THE ORGANISMS

AG 534 - B

LABORATORY EXERCISE #2--CLASSIFYING ORGANISMS

Name ____________________________________ Score _________________________________

Selection from *Modern Biology*, Biology Investigations, Teacher's Edition, by James H. Otto, Albert Towle, W. David Otto, and Myra E. Madnick. Copyright 1977 by Holt, Rinehart and Winston, Inc. Printed by permission of the publisher.

Part I: A Study of Classification

The classification categories in biology are: kingdom, phylum, class, order, family, genus and species. A system of classification may be applied to any number of objects.

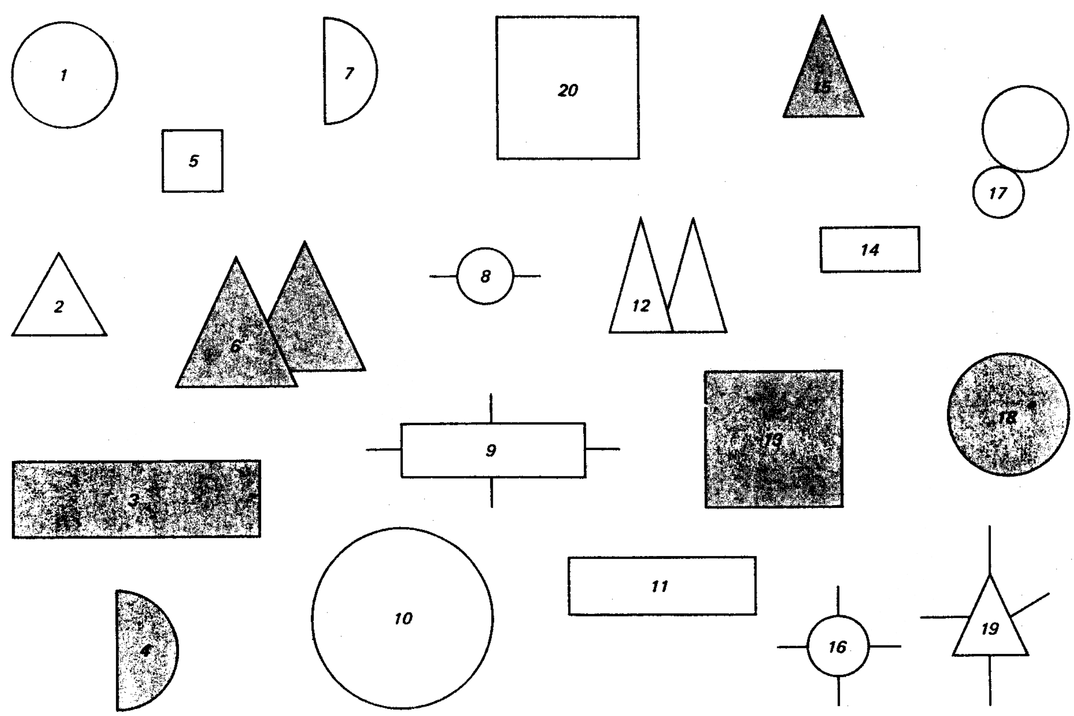
a. Examine the figures below and list some of the characteristics that you observe.________________

____

b. If considered in biological terms, what classification category would each individual figure represent? ____

c. What classification category would the entire group of figures represent? ____________________

Cut the figures apart. Be sure that the identifying number stays with the figure. Assemble the figures into two groups based on a common characteristic. For instance, put all figures with curved lines into one group. The second group, then, will be figures with straight lines.



d. By thus separating the figures into two smaller groups, what classification category has been achieved? ____________________

You should now have in the straight line group 12 straight-line figures: 1 rectangle and 1 triangle with lines projecting from them and 10 others being shaded or unshaded triangles, squares or rectangles. The group of figures with curved lines, representing the other phylum, will not be used further in this part of the investigation.

Using the characteristic of lines projecting from the figures, divide the 12 figures into two groups.

e. In this division, what classification category has been achieved?

____

f. What characterizes the remaining 10 figures? ____________________

____

____

Separate the shaded figures from the unshaded figures. (Save the shaded figures for later use.)

g. What classification category has been achieved? ____________________

h. What characterizes the remaining 6 figures? ____________________

____

Separate the triangles from the other 4 figures. (Save the triangles for later use.)

i. What classification category does each group represent?

____

The remaining 4 figures can be divided into two smaller groups on the basis of being squares or rectangles. Make the separation and save the rectangles.

j. What classification category is represented by the group of squares and the group of rectangles?

____

The group of squares should now have in it a large square and a small square. Make the final separation on the basis of the size of the squares.

k. What classification category do you now have? ____________________

In this classification, the genus category contains but two distinct species. In biological classifications of organisms, a genus contains several related but distinct species.

l. How are the figures (species) related? ____________________

m. How are the figures different? ____

____

Part II: Completing a Key to Straight-Line Figures

Classification keys are usually based on pairs of opposing statements. Each pair of statements is increasingly specific in describing the item to be identified. Using the characteristics observed in Part I, fill in the blanks of the key with the characteristic needed to complete each pair of statements. The number in the column at the right refers you to the next pair of statements. When you come to "Fig.#_____," insert the number of the figure being described.

KEY TO KINGDOM OF FIGURES

1a. All figures have curved lines ....Curved figures

1b. All figures have ____________ lines 2

2a. All figures have projecting lines..3

2b. All figures have ______ projecting lines..4

3a. Figure is a triangle with lines..Fig.#______________

3b. Figure is a ______________ with lines...Fig.#______________

4a. Figures are shaded 5

4b. Figures are not _______________ 8

5a. Figures are triangles...6

5b. Figures are ___________ or ____________ 7

6a. Figure is ____________ triangle ....Fig.#______________

6b. Figure is _____________ triangles ....Fig.#______________

7a. Figure is a _____________ ....Fig.#______________

7b. Figure is a ______________ ....Fig.#______________

8a. Figures are triangles...9

8b. Figures are ___________ or ____________ 10

9a. Figure is __________ triangle ....Fig.#______________

9b. Figure is ___________ triangles ....Fig.#______________

10a. Figures are squares 11

10b. Figures are ___________________ 12

11a. ______________ square..Fig.# ______________

11b. ______________ square..Fig.# ______________

12a. Figure is ______________ rectangle...Fig.# ______________

12b. Figure is ______________ rectangle...Fig.# ______________

After completing the key, blacken the number of each figure and write the number on the back. Mix the figures and use the key to identify each of the 12 figures by number (species). If you can correctly identify each figure by number, you have accurately completed the key.

Part III: Using a Classification Key to Identify Certain Species of Fish

Study the terms defined below. All of these refer to structures of fish.

TERMS REFERRING TO THE STRUCTURE OF FISH

barbel--a fleshy projection from the lips or head

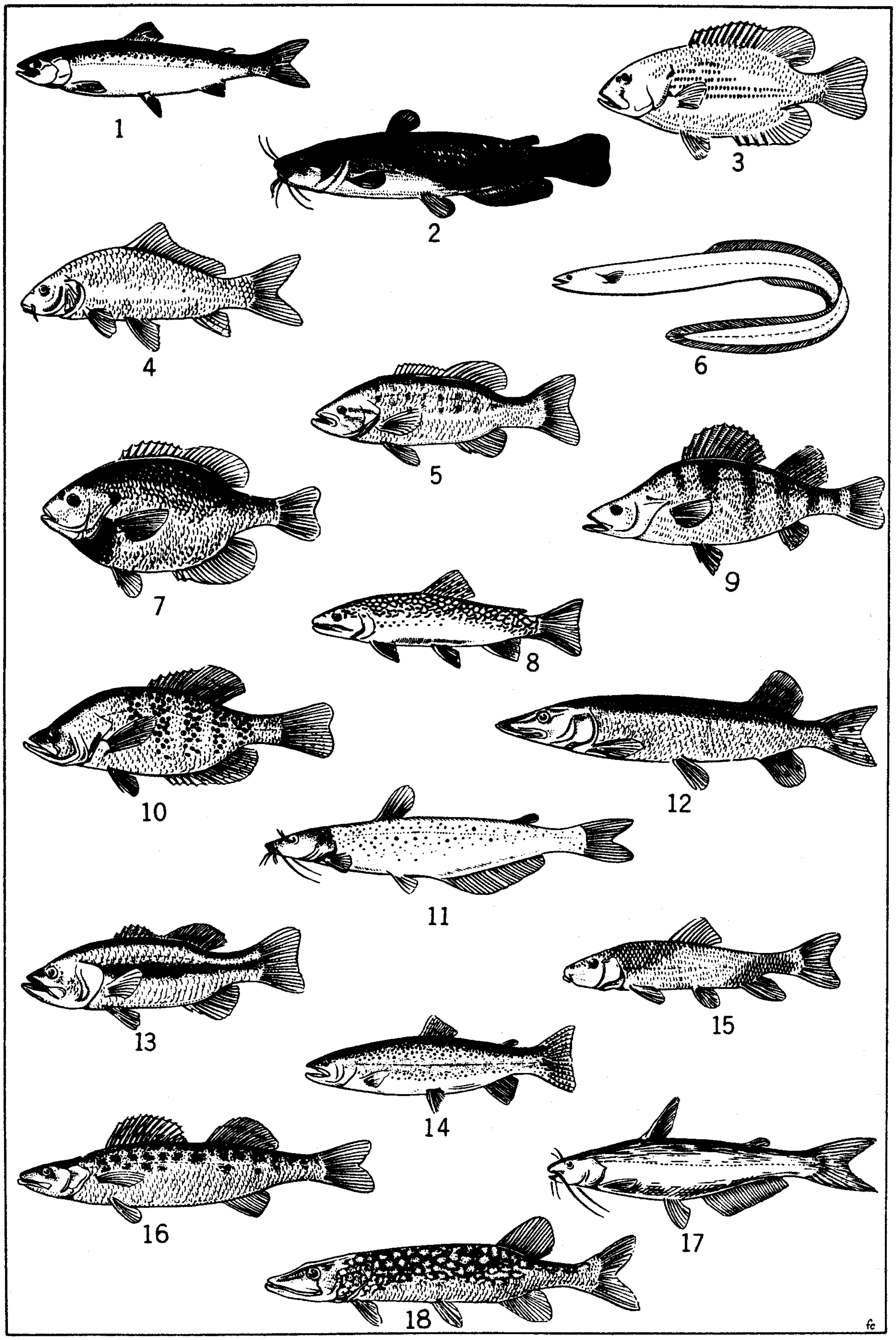
FINS

adipose--a small fin on the top mid-line of the body near the tail fin
anal--a fin along the lower mid-line of the body near the tail fin
caudal--tail fin
dorsal--the fin or fins along the top mid-line of the body
pectoral--the paired fins nearest the head, corresponding to front legs or arms
pelvic--the paired fins nearest the tail, corresponding to hind legs
scales--overlapping growths of the skin

Closely examine one of the drawings of a fish shown on the next page. Read both statements listed under number 1 in the classification key. One of these statements should describe the fish you have chosen; the other should not. Refer to the number after the statement that fits your fish and look for that number in the key. Again select the statement that describes the fish you picked. Continue through the key until you come to a name after one statement. This should be the name of the fish you picked. Practice using the key to identify several of the fish shown.

Example:

Suppose you want to find the name of fish number 2. Look at the classification key. Note that each numbered item presents two possibilities. We see that our fish has no scales, or at least we cannot see any. So we choose item 1b. This refers us to number 12. So we go down the page to number 12. Our fish is not elongated or snakelike (item 12b), so we go to number 13 of the key. The fish we are classifying has barbels growing from its lips and the top of its head (item 13a), so we go to number 14 of the key. Since our fish has a caudal fin that is rounded, and a blunt head, we see that it is the *Bullhead Cathead Catfish* (also known as *horn pout* in some parts of the country.)



Native Fish

CLASSIFICATION KEY TO CERTAIN FISH

1a.	Body noticeably covered with scales	2
1b.	Scales not covering body or too small to be seen	12
2a.	Dorsal fin single	3
2b.	Dorsal fins two or more, joined or separated	6
3a.	Body more than four times as long as broad (top to bottom); front edge of dorsal fin far back on body; mouth large, hinge back of eye	4
3b.	Body less than four times as long as broad; front edge of dorsal fin about midway between head and tail; mouth not large, hinge in front of eye	5
4a.	Dark lines forming netted design on body; fins not spotted	Pickerel
4b.	Body covered with yellow spots; fins spotted	Northern pike
5a.	Mouth turned downward; barbels absent; dorsal fin not elongated	White sucker
5b.	Mouth not turned downward; barbels present; dorsal fin elongated	Carp
6a.	Two dorsal fins separated, the anterial spiny and the posterior soft	7
6b.	Two dorsal fins united, forming an anterior spiny portion and a posterior soft portion	8
7a.	Top of head concave, forming a hump in front of dorsal fin; dark vertical bars on body	Yellow perch
7b.	Top of head not concave, body sloping to dorsal fin and not forming a hump; dark blotches on body	Wall-eyed pike
8a.	Body more than three times as long as broad	9
8b.	Body less than three times as long as broad	10
9a.	Hinge of jaws behind the eye; notch between spiny and soft dorsal fin deep and nearly separating into two fins	Large-mouth black bass
9b.	Hinge of jaws below the eye; notch between spiny and soft dorsal fin not nearly separating into two fins	Small-mouth black bass
10a.	Mouth large, hinge below or behind eye	11
10b.	Mouth small, hinge in front of eye	Bluegill
11a.	Five to seven spines in dorsal fin; dark spots forming broad vertical bars on sides	White crappie
11b.	Ten or more spines in dorsal fins; sides flecked with dark spots	Rock bass (Redeye)
12a.	Body much elongated and snakelike; dorsal, caudal and anal fins continuous	Eel
12b.	Body not elongated and snakelike; dorsal, caudal and anal fins separate; adipose fin present	13
13a.	Barbels growing from lips and top of head; head large and broad	14
13b.	Barbels lacking; head not large and broad	16
14a.	Caudal fin deeply forked; head tapering	15
14b.	Caudal fin rounded or slightly indented but not forked; head blunt	Bullhead catfish
15a.	Dorsal fin rounded at top; body silvery, speckled with black markings	Channel catfish
15b.	Dorsal fin long and pointed at top; body bluish-gray without speckles	Blue catfish
16a.	Caudal fin deeply forked; back not mottled and with few spots	Atlantic salmon
16b.	Caudal fin square or slightly indented; back mottled or spotted	17
17a.	Back and caudal fin spotted; broad horizontal band along sides	Rainbow trout
17b.	Back mottled with dark lines; caudal fin not spotted; fins edged with white	Brook trout

Part IV: Summary

a. Based on what you have learned in this investigation, discuss how classification is a useful tool for a biologist. ____________________

____

____

____

Fill in the blanks:

b. A group of closely related species is a ____________________

c. A subdivision of a family is a ____________________

d. The largest of the classification categories is the ____________________

e. The most specific of the classification groupings is the ____________________

f. A group of closely related classes is a ____________________

g. The subdivision of an order is the ____________________

h. A ____________________ is composed of several closely related orders.

Part V: Investigations On Your Own

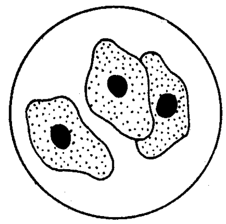
Select commonly seen groups of related objects (automobiles, canned goods, etc.) and classify them into the major classification categories. Construct a key to their identification. Try your classification key with some individuals in your class to see how well it works.

THE ORGANISMS

AG 534 - B

ANSWER SHEET TO LABORATORY EXERCISES

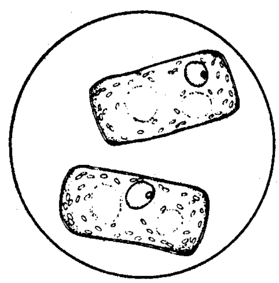
<u>**Lab #1**</u>
<u>Part I:</u>
Step 5:



Human tongue cells

Step 7: Drawings will very depending on slide available.

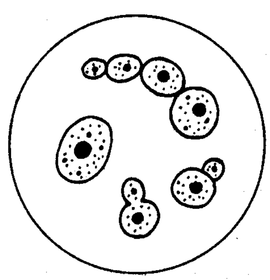
Part II:
Step 5:



Plant cells

Step 7: Drawing will vary depending on slides available.

Part III:
Step 4:



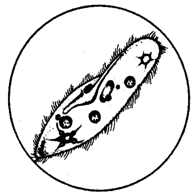
Yeast cells

Step 6: Drawings will very depends on slides available.

<u>Part IV:</u>

3. a. Students should see several

Step 4:



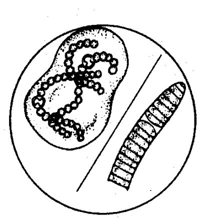
Paramecium

Step 6: Drawings will vary depending on slides available.

<u>Part V:</u>

3. b. Nuclei

Step 4:



Nostoc / Oscillatoria

Step 6: Drawing will vary depending on slides available.

Table I:

Animal cells:	Generally smaller than most other cells and irregular in shape. Animal cells lack cell walls and plastids. Some may have small vacuoles (vesicles) and cilia.
Plant cells:	Large, generally box-shaped cells with cell walls, larger vacuoles and plastids.
Fungal cells:	Single or multicellular organisms of variable size and shape. Lack plastids but may have vacuoles.
Protist cells:	Single cells of variable size and shape. Some may have cell walls, chloroplasts, cilia and more than one nucleus.
Moneran cells:	Single cells of variable size and shape with cell wall. Lack nuclear membrane. Some may have bacterial flagellum.

Part VI:

1. Cell membrane, genetic material, cytoplasm

2. No. Cells within the same kingdom vary in size; cells in different kingdoms are often similar in size.

3. Table II: Cell features of each kingdom

Cell Types	Features that differentiates cell
Animal Cells	Lack cell wall; have centromere
Plant Cells	Multicellular with chloroplasts
Fungal Cells	Gaps in cell walls of certain fungi
Protist Cells	More than one nucleus per cell
Moneran Cells	Lack nucleus

4. Table III: Function of certain cell structures

Cell Type	Cell Structure	Function for cell
Moneran cell: *Nostoc*	Slimy outer coating	Allows cells to adhere to one another in long strands
Paramecium	Cilia	Allow organism to move; propel food into *Paramecium's* mouth
Fungal cell	Discontinuous cell wall	Allows cytoplasm and other cellular material to move from cell to cell; aids transport within organism
Leaf cell	Chloroplast	Structure that manufactures glucose
Tongue cell	Centromere	Aids cell division

Lab #2

Part I:

a. Figures with straight lines, curved lines; some triangles, squares or rectangles; lines projecting from them; single or double figures; shaded or unshaded
b. Species
c. The kingdom of figures
d. Phylum
e. Class
f. Shaded or unshaded squares, rectangles, single or double triangles
g. Order
h. Triangles or squares and rectangles
i. Family
j. Genus
k. Species
l. Both figures (species) are squares.
m. One figure is larger than the other.

Part II:

1b. straight
2b. no
3a. 19
3b. rectangle, 9
4b. shaded
5b. squares, rectangles
6a. one, 15
6b. two, 6
7a. square, 13
7b. rectangle, 3
8b. squares, rectangles
9a. one, 2
9b. two, 12
10b. rectangles
11a. Large, 20
11b. Small, 5
12a. large, 11
12b. small, 14

Part III:

1. Atlantic salmon
2. Bullhead catfish
3. Rock bass (Redeye)
4. Carp
5. Small-mouth black bass
6. Eel
7. Bluegill
8. Brook trout
9. Yellow perch
10. White crappie
11. Channel catfish
12. Northern pike

13. Large-mouth black bass
14. Rainbow trout
15. White sucker
16. Wall-eyed pike
17. Blue catfish
18. Pickerel

Part IV:

a. The classifying of organisms enables biologists to organize and by grouping living organisms according to characteristics shared by the organisms, biologists are able to observe natural relationships and study characteristics of the group as a whole.
b. Genus
c. Genus
d. Kingdom
e. Species
f. Phylum
g. Family
h. Class

THE ORGANISMS

AG 534 - B

UNIT TEST

Name ______________________________ Score ______________________________

1. Match the terms on the right with the correct definitions by placing the appropriate numbers in the blanks provided.

_____a.	Cell type that has a nucleus without a membrane around it. The nuclear material floats freely within the cell	1.	Binomial nomenclature
		2.	Prokaryote
_____b.	The group of individuals of a given species inhabiting a specified geographic area	3.	Eukaryote
_____c.	A member of a class of vertebrates characterized by having hair and mammary glands; includes such diverse types as shrews, bats, cats, whales, cattle and humans	4.	Adaptation
		5.	Autotrophs
		6.	Biogenesis
_____d.	Organisms that manufacture organic nutrients from inorganic raw materials	7.	Biome
_____e.	Association of unicellular or multicellular organisms of the same species	8.	Chordate
		9.	Colony
_____f.	Occurrence of several distinct phenotypes in a population	10.	Community
_____g.	An assemblage of populations that live in a defined habitat and interact in various ways with one another organisms	11.	"Consumer"
_____h.	Those elements of an ecosystem that eat other plants or animals	12.	Ecology
_____i.	Organisms which cannot synthesize their own food from inorganic materials	13.	Ecosystem
		14.	Epigenesis
_____j.	The gradual loss of vigor through the aging process	15.	Fossils
_____k.	The phylum of animals characterized by the presence of a notochord at some stage of development	16.	Genus
_____l.	The theory that all living things come only from preexisting living things	17.	Herbivore
		18.	Heterotrophs
_____m.	Large, easily differentiated community unit arising as a result of complex interactions of climate, other physical factors and biotic factors	19.	Mammal

_____n.	A system invented by Carolus Linnaeus for classifying organisms. Each organism is assigned a two-word Latin name	20. Outbreeding
		21. Phenotype
_____o.	The theory that development proceeds from a structureless cell by the successive formation and addition of new parts which do not preexist in the fertilized egg	22. Phylogeny
		23. Polymorphism
_____p.	Taxonomic classification in which closely related species are grouped together	24. Population
		25. Senescence
_____q.	A characteristic which enables the organism to survive in its environment	26. Species
_____r.	Cell type that has an organized nucleus surrounded by a membrane	27. Taxonomy
		28. Territoriality
_____s.	Any remains of an organism that have been preserved in the earth's crust	29. Tissue
_____t.	The mating of individuals of unrelated strains	
_____u.	The study of the interrelations between living things and their environment	
_____v.	The evolutionary history of a group of organisms	
_____w.	The visible expression of the hereditary constitution of an organism	
_____x.	Behavior pattern or mold in which one organism (usually a male) delineates a territory of his own and defends it against intrusion by other members of the same species and sex	
_____y.	A plant-eating animal	
_____z.	The unit of taxonomic classification, a population of similar individuals, alike in their structural and functional characteristics	
_____aa.	The science of naming, describing and classifying organisms	
_____bb.	All of the organisms of a given area	
_____cc.	Specialized cells which together perform certain special functions	

2. List the seven categories of the classification system in order from largest to smallest.

   a.____

   b. ____

   c.____

   d. ____

   e.____

   f.____

   g. ____

3. Outline the classification system for humans.

   a.____

   b. ____

   c.____

   d. ____

   e.____

   f.____

   g. ____

4. List three traits that help place an organism into a kingdom.

   a.____

   b. ____

   c.____

5. List and define the five kingdoms in the classification system.

   a.____

   ____

   ____

   b. ____

   ____

   ____

   ____

c.____

d.

e.

6. State two biological principles for each of the following categories that demonstrate commonness among organisms.

Environmental interaction

a.

b.

Genes

a.

b.

Life

a.

b.

Physical and chemical reactions

a.

b.

Evolution

a.

b.

Cells

a.____

b. ____

Development

a.____

b. ____

THE ORGANISMS

AG 534 - B

ANSWERS TO TEST

1.

a.	2	k.	8	u.	12
b.	24	l.	6	v.	22
c.	19	m.	7	w.	21
d.	5	n.	1	x.	28
e.	9	o.	14	y.	17
f.	23	p.	16	z.	26
g.	10	q.	4	aa.	27
h.	11	r.	3	bb.	13
i.	18	s.	15	cc.	29
j.	25	t.	20		

2. Kingdom; Phylum; Class; Order; Family; Genus; Species

3.

a.	Kingdom	--	Animalia
b.	Phylum	--	Chordata
c.	Class	--	Mammalia
d.	Order	--	Primates
e.	Family	--	Hominidae
f.	Genus	--	Homo
g.	Species	--	Homosapiens

4. Kinds of cells in organism: prokaryote or eukaryote; How organism obtains its food; How organism reproduces and develops

5.
   a. Animal kingdom (Animalia): Eukaryotic cells; Multicellular organisms; Move about to obtain food; Digest food inside body
   b. Plant kingdom (Plantae): Eukaryotic cells; Multicellular organisms; Produce own food; Cannot move about
   c. Fungi kingdom: Eukaryotic cells; Mostly multicellular organisms; Do not move about; Obtain food by absorbing it from living or dead organisms
   d. Monera kingdom: Prokaryotic cells; Mostly one-celled organisms; Produce own food or obtain it from outside source
   e. Protista kingdom: Eukaryotic cells; Many are one-celled; Produce own food or obtain it from outside source

6. Answer should include two of the following for each category:

Environmental interaction: Cells in organisms affect and interact with each other; Cells and organisms react and interact with their environment

Genes: All organisms pass on function and structure to their offspring; The combination of gene characteristics is variable; The DNA contains the genetic code in a linear arrangement; The RNA is the means of replicating and passing on the genetic code

Life: Life comes from life; Reproduction is required for life continuation

Physical and chemical reactions: Physical and chemical laws are obeyed by living creatures; All living organisms use the common molecular, biological and chemical reaction means; All living organisms must capture, store and release energy to sustain life

Evolution: All organisms arise from preexisting organisms; Natural selection is responsible for organism evolution; The embryos of developing animals tend to resemble the embryos of their ancestors; Organisms adapt to their habitat through selection from environmental pressures

Cells: Cells are the fundamental units of life; Cells contain structures which are differentiated and interdependent

Development: All organisms exhibit characteristics of cell enlargement or cell division or both; This characteristic is termed growth; All organisms develop a characteristic body plan

CELL STRUCTURE

AG 534 - C

UNIT OBJECTIVE

After completion of this unit, students should be able to define terms associated with cell structure and state the basic ideas of the cell theory. Students should also be able to list and describe the cell components and functions and the differences between plant and animal cells. This knowledge will be demonstrated by completion of laboratory exercises and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Match terms associated with cell structure to their correct definitions..
2. List the three things which define a cell.
3. State the four basic ideas of the cell theory.
4. List the three ways that cells can differ from one another.
5. Label the correct parts of an animal cell.
6. List and describe the cell components and their functions.
7. Name and describe the functions of the cell organelles.
8. Describe the differences between plant and animal cells.
9. List and describe the functions of the major types of specialized animal cells.
10. Identify and describe cells.
11. Study cell parts.
12. Identify differences between plant and animal cells.

CELL STRUCTURE

AG 534 - C

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

- A. Make transparencies and necessary copies of materials.
- B. Provide students with objective sheet and discuss.
- C. Provide students with information sheet and discuss.
- D. Provide students with laboratory exercises.
- E. Discuss and demonstrate laboratory exercises.
- F. Review and give test.
- G. Reteach and retest if necessary.

II. Instructional materials

- A. Objective sheet
- B. Suggested activities
- C. Information sheet
- D. Transparency masters
  1. TM 1--Diagram of a "Typical" Animal Cell
  2. TM 2--Types of Animal Cells
  3. TM 3--Formed Elements of Blood
- E. Instructor notes for laboratory exercises
- F. Laboratory exercises
  1. LE 1--What Are Cells?
  2. LE 2--Studying Cell Parts
  3. LE 3--Animal and Plant Cell Differences
- G. Answers to laboratory exercises
- H. Test
- I. Answers to test

III. Unit references

A. *Agricultural Education Curriculum*, College of Agriculture, University of Illinois, Urbana, Illinois, 1989.

B. Otto, James H., Towle, Albert, *Modern Biology*, Holt, Rinehart and Winston, Publishers, New York, 1985.

C. Slesnick, Irwin L.; Balzer, Leron; McCormack, Alan J.; Newton, David E.; Rasmussen, Fredrick A.; *Biology*, Scott, Foresman and Company, Glenview, Illinois, 1985.

CELL STRUCTURE

AG 534 - C

INFORMATION SHEET

I. Terms and definitions

A. Organelles--Special structures in the cytoplasm. Each performs one or more special tasks to help keep the cell alive, e.g., the mitochondria, Golgi complex, ribosomes, contractile vacuole, and so on

B. Nerve--Composed of many neurons bunched together

C. Neuron--Nerve cells that transmit messages from one part of the body to another

D. Adenosine Triphosphate (ATP)--A chemical compound produced in the mitochondrion. Stores energy that is used to carry out cellular functions

E. Chromosomes--Molecules of DNA wrapped around proteins, which are found in the nucleus; control cell functions and the inheritance of traits

F. Centriole--Small, dark-staining organelle lying near the nucleus in the cytoplasm of animal cells

G. Differentiation--A process of changing a relatively unspecialized cell to a more specialized cell

H. DNA--Deoxyribose nucleic acid; present in chromosomes and contains genetic information

I. Erythrocyte--Red blood cells

J. Golgi bodies--Cell organelle found in the cytoplasm of all cells except mature sperm and red blood cells

K. Hemoglobin--The red, iron-containing, protein pigment of the erythrocytes that transports oxygen and carbon dioxide and aids in regulation of pH

L. Leukocytes--White blood cells; colorless cells exhibiting phagocytosis and ameboid movement

M. Lysosome--Intracellular organelle present in many animal cells; contains a variety of hydrolytic enzymes that are released when the lysosome ruptures

N. Messenger RNA--A particular kind of ribonucleic acid which is synthesized in the nucleus and passes to the ribosomes in the cytoplasm; combines with RNA in the ribosomes and provides a template for the synthesis of an enzyme or some other specific protein

O. Microtubule--A cytoplasmic organelle, an elongated slender tube; contains a specific protein, tubulin

P. Mitochondria--Spherical or elongated intracellular organelles which contain the electron transmitter system and certain other enzymes

Q. Nucleolus--A spherical body found within the cell nucleus believed to be the site of synthesis of ribosomes

R. Nucleus--The organelle of a cell containing the hereditary material

S. Plasma membrane--A living, functional part of the cell through which all nutrients entering the cell and all waste products or secretions leaving it must pass

T. Platelet--A small, colorless blood corpuscle of mammals that plays an important role in blood coagulation

U. Reticulum--A network of fibrils or filaments, either within a cell or in the intercellular matrix

V. Ribonucleic acid (RNA)--Nucleic acid containing the sugar ribose; present in both nucleus and cytoplasm and of prime importance in the synthesis of proteins

W. Ribosomes--Minute granules composed of protein and ribonucleic acid; the site of protein synthesis

X. Transfer RNA--A form of RNA which serves as adaptor molecules in the synthesis of proteins. An amino acid is bound to a specific kind of transfer RNA and then arranged in order by the complementary nature of the nucleotide triplet (codon) in template or messenger RNA and the triplet antocodon of transfer RNA

Y. Vacuole--Small space within a cell, filled with watery liquid and separated by a vacuolar membrane from the rest of the cytoplasm

II. Cell

A. Specific, separate mass of living material that is surrounded by a semi-permeable membrane

B. The basic structural unit of life

C. All organisms (except viruses) are composed of one or more cells

III. Cell theory

A. All organisms are made of one or more cells

B. Cells are alike in their structure and composition

C. All cells carry out similar functions that keep them alive

D. New cells arise only from old cells, usually by dividing into two equal parts at regular intervals

IV. How cells differ from each other

A. Size

B. Shape

C. Organization

V. Animal cell diagram (Transparency 1)

VI. Cell components and functions

A. Plasma membrane (Cell membrane)

1. Encloses the cell, separating it from the outside environment

2. Regulates passage of liquids into and out of the cell

B. Nucleus

1. Contains the heredity information that directs all cell activity

2. Contains the nucleolus

C. Nucleolus

1. Produces ribonucleic acids (RNA)

2. Assembles subunits of ribosomes

D. Cytoplasm

1. Living material inside the cell

2. Assists in transport of substances within the cell

VII. Cell organelles

A. Endoplasmic reticulum

1. Cell skeletal system

2. Serves as transport network and storage area for substances within the cell

B. Ribosome--Manufactures cell proteins

C. Golgi apparatus--Packages and distributes proteins for storage within cell and transport out of cell

D. Lysosome

1. Breaks down food and foreign material

2. Removes waste materials from cell

E. Mitochondrion

1. Serves as powerhouse for cell--releases body heat and energy

2. Produces ATP (Adenosine Triphosphate) in which energy for cell activities is stored

F. Vacuole

1. Supports cell wall of plant cells through internal pressure

2. Digests food materials, remove wastes and stores substances

G. Microtubules (Centrioles)

1. Long, thin, hollow cylinders found in many cells

2. Give support to cell, help keep its shape

3. Aid in moving the cell or moving other substances past the cell

H. Microfilaments

1. Thin, tiny, threadlike fibers

2. Contract like muscles

3. Aid in cell movement

I. Microvilli

1. Modified plasma membrane that forms fingerlike projections for more surface area

2. Found in intestines

VIII. Differences between plant and animal cells

A. Plant cells

1. Cell wall

a. Made of cellulose

b. Gives support and shape

2. Plastids

a. Leucoplasts

(1) Colorless structures where glucose is changed into starch

(2) Storage for starch, lipids or proteins

b. Chromoplasts

(1) Manufacture and store pigments

(2) Give fruits, vegetables and leaves their bright color

c. Chloroplasts

(1) Contain green chlorophyll pigment

(2) Site of photosynthesis (food production) in the plant cell

B. Animal cells

1. Microtubules give the cell its shape

2. Centrioles

a. Located near nucleus

b. Function in cell division for reproduction

IX. Specialized animal cells (Transparency 2)

A. Blood cells (Transparency 3)

1. Red blood cells contain hemoglobin to carry oxygen to cells and carbon dioxide from cells

2. White blood cells--important in body defense

a. Phagocytic leukocytes flow to the infection site and engulf the bacteria

b. Lymphocytes attack foreign cells directly or secrete an enzyme that immobilizes foreign substances

c. Many white blood cells die while defending the body and make up pus

3. Platelets--important in blood clotting

B. Nerve cells--Carry messages and direction throughout the nervous system

C. Muscle cells

1. Striated--Skeletal or voluntary muscle cells (controlled by conscious choice)

2. Smooth--Involuntary muscle cells found in the walls of the digestive tract, blood vessels, urinary organs and reproductive organs

3. Cardiac--Conduct impulses within the heart

D. Bone cells--Make up most of the skeleton on vertebrate animals

E. Fat cells

1. Make up fat (adipose tissue) which is deposited around internal organs, between muscle branches and under the skin

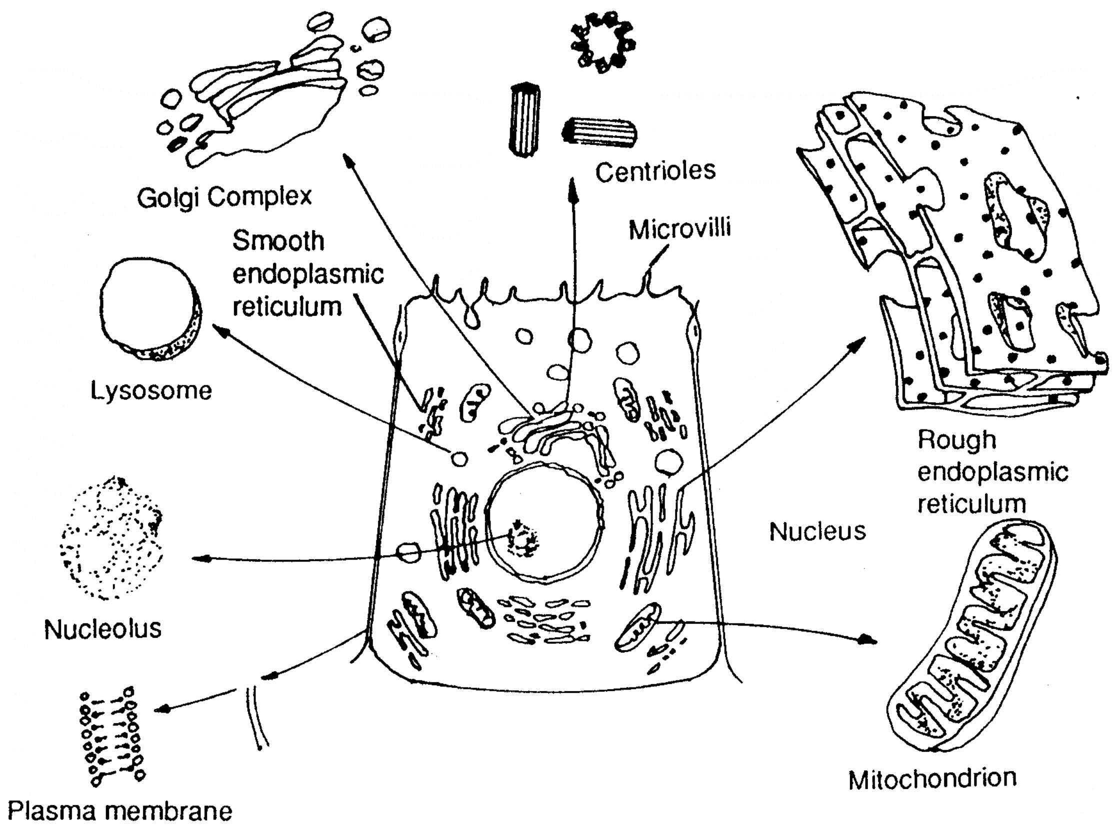
2. Supplies reserve energy when food supply is scarce or sporadic

F. Gamete (sex cells)

1. Reproductive cell

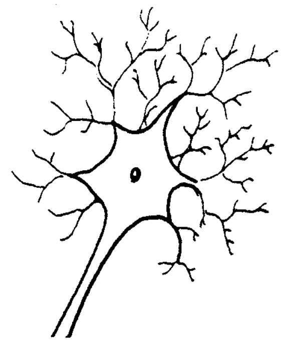
2. An egg or sperm

DIAGRAM OF A "TYPICAL" ANIMAL CELL



Types of Animal Cells

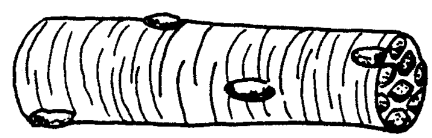
Nerve cell, showing cell body (soma) surrounded by numerous dendritic extensions and a portion of the axon extending below.



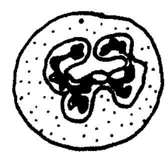
Epithelial cell from lining of the mouth.

Smooth musle cell from intestinal wall.

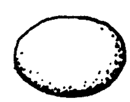
Striated muscle cell from skeletal muscle.



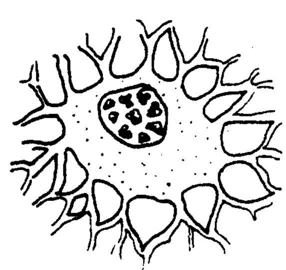
White blood corpuscle.



Red blood corpuscle (erythrocyte).

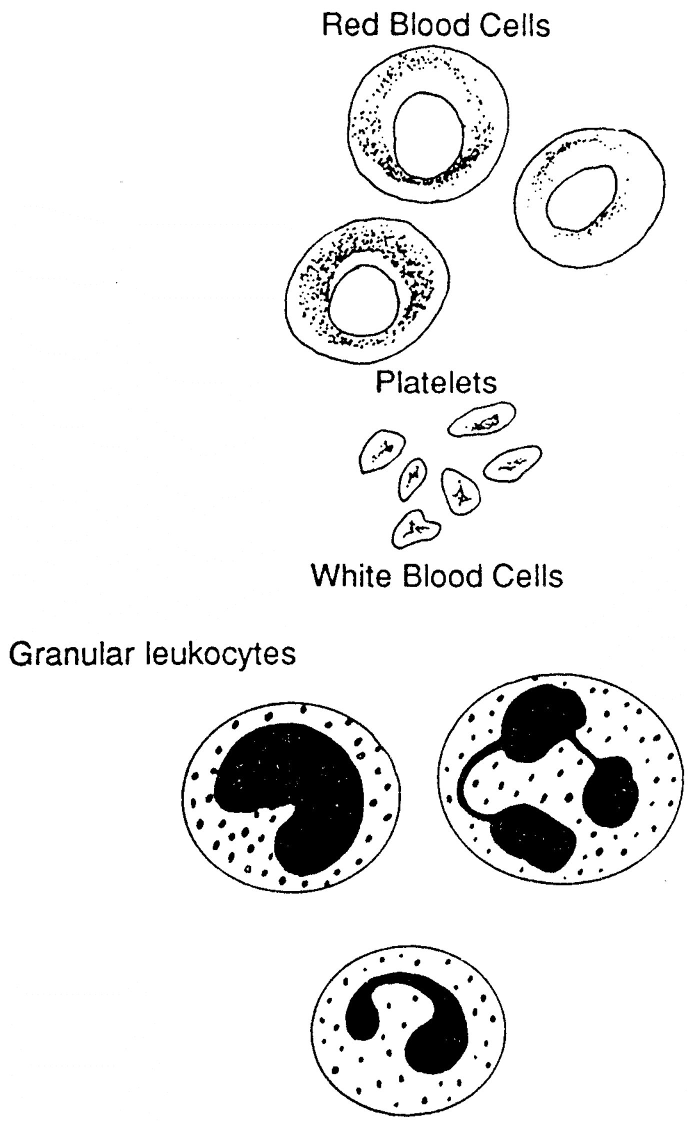


Bone cell.



Human spermatozoon. (Not drawn to the same scale.)

Formed Elements of Blood



CELL STRUCTURE

AG 534 - C

INSTRUCTOR NOTES FOR LABORATORY EXERCISES

Lab #1

Point out to students that the cell theory was not generally accepted in Hooke's time.

Cork cells are excellent for use in observing the cell wall structure. Ask students to think about whether cork cells are living or nonliving.

Students may have to make several attempts before slicing the cork thin enough for observation. It is easier to use large corks when cutting.

Part I:

Step g: It is important that students understand that the cork cells are not living and therefore are lacking cellular structures.

Part II:

Caution students to avoid using too much water in the preparation of the slide. The drop of water should come to the edge of the cover glass.

Step d: Point out to students that iodine will enable them to see the parts of the cell more clearly.

Part III:

Point out to students that the chromosomes are only visible when the cell is dividing.

Lab #2

Sugar helps prevent the exploding of the nuclei and chloroplasts. Make a .58 M sucrose solution as directed below. Buffering this solution will also prevent the explosion of the cell parts. To buffer the solution add 0.1 g of potassium bisulphate (KH_2PO_4). The pH should be about 5.7.

Solution preparation:

The following general instructions apply for the preparation of most solutions: Solvents should be added to solutes. Use distilled water, not tap water, for all reagents. When preparing an acid or base solution, *slowly* add the acid or base to the water. Never add water to a concentrated acid or base.

To make percentage solutions measure 1 ml of solute per percentage. Add the solute to enough solvent to make 100 ml of solution. When dissolving a solid in water, measure 1 g of solute per percentage and mix the solute with enough water to make 100 ml of the solution.

Iodine solution (also available ready-made)

Dissolve 5.0 g of potassium iodide [KI] and 1.5 g of iodine crystals in 500 ml of distilled water. Store in brown bottle or other glass container that shields the liquid from light. *CAUTION: Iodine dust and vapors are toxic and irritating. Avoid body contact and inhalation of fumes. Should body contact occur, flush immediately with water.*

Sucrose solution

0.58 M: Put 99.5 g of sucrose in a flask. Add enough distilled water to make exactly 500 ml of solution. Stir until sucrose is dissolved, heating if necessary. Refrigerate. Quantity is enough for 50 students.

Part I:

You may wish to prepare the pea mixture ahead of time and give 30 to 50 ml to each student for filtration.

If time and availability of centrifuge are limited, prepare the filtrate and centrifuge it ahead of time for the students. The layers will remain separated and intact for over 24 hours. (Longer if refrigerated.)

Supervise the students' placement of test tubes in the centrifuge so that the centrifuge is balanced.

Lab 3:

Students will specifically observe the cell walls of plant cells and the plasma membranes of animal cells. They will also observe the food-producing organelles of plants--the chloroplasts.

Part I:

Point out to students that such movement (cyclosis) often requires observing one cell for several minutes.

On diagram: Students can stain the *Elodea* with iodine and observe one of the spike cells. The nucleus should become more clearly defined with iodine stain.

Part II:

Human cheek cells are excellent for the observation of cell membranes as well as cytoplasm.

Part II:

On diagram: Stress to students that although they appear different, both cork and cheek cells are the basic units of life.

CELL STRUCTURE

AG 534 - C

LABORATORY EXERCISE #1--WHAT ARE CELLS?

Name ______________________________ Score ______________________________

Materials needed

Microscope
Slides
Cover glasses
Forceps
Bottle cork
Razor blade
Onion
Scalpel
Iodine stain

Part I: Observing Cork Cells

More than 300 years have passed since Robert Hooke first described cork cells in his book *Micrographia*. In this investigation, you will repeat Hooke's early experiment with cork cells.

Carefully shave a very thin section from a bottle cork with a razor blade. Prepare a wet mount slide of the cork slide. Examine the specimen under low power, studying it in different positions. In the space provided, draw a sketch of what you observe.

Now examine the specimen under high power. Draw the cells as you see them under high power.

a. How would you describe the units that compose the cork? ____________________

____

b. Are these units of similar shape? ____________________

c. Are they of similar size? ____________________

d. Are they filled with any material? ____________________

e. If so, explain what that content appears to be. ____________________

____

f. Are there spaces between the cells? ____________________

____

g. Do you think that these cells are alive? ____________________

Part II: Onion Cells

The epidermis of the onion is ideal for cell study because it is composed of a single layer of cells. As you study these cells, you are looking into functioning units of living material.

Cut an onion lengthwise. Remove a thick scale and peel the delicate, transparent tissue from the *inner surface*. Cut a square of the tissue and mount it on a slide in a drop of water. (Note: Avoid wrinkling the tissue.) Add a cover glass. Examine the living cells under low power.

a. What is the shape of the cells? ____________________

b. Are they similar in shape? ____________________

c. What color is the living cytoplasm? ____________________

Carefully raise one side of the cover glass and add a drop of iodine stain.

d. What effect does iodine have on the cells? ____________________

____

Select one cell that shows the contents clearly. Move it to the center of the microscopic field. Using high power, examine all the parts of the cell.

e. What is the appearance of the cytoplasm? ____________________

f. What is the appearance of the nuclei? ____________________

____

g. Are the nuclei always in the same position in the cell?

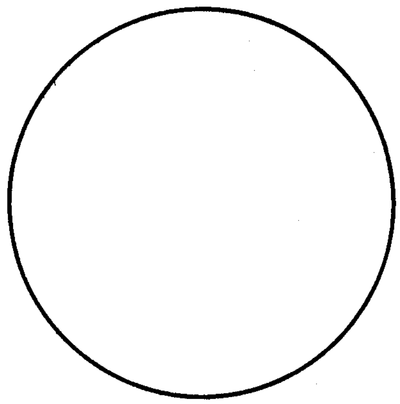
____

h. Does the onion epidermal cell have depth? ________________________

i. Explain your answer. ________________________________

____

Draw the onion cells under high power.



Part III: Summary

a. What are the units of cork seen under the microscope? ____________________

____

b. How did the cork units differ from those of the onion epidermis? ______________

____

____

c. Why is an iodine stain used in this investigation? ____________________

____

d. Identify and give the function of the nucleus. ______________________

____

Part IV: Investigations On Your Own

1. Observe many different types of nonliving and living cells. Compare your findings to the cork and onion cells that you observed in this investigation. Draw sketches of the cells and their organelles.

2. It is possible to observe the mitochondria of some cells under the light microscope. Cut a strip of celery stalk containing "strings". Place this strip, with the inner surface up, in a 5% sucrose solution. Cut a thin strip from between the "strings". Observe the mitochondria. If you add a few drops of 0.001% Janus Green B solution, the mitochondria will stain a blue color. However, this color will quickly fade because of enzyme action.

CELL STRUCTURE

AG 534 - C

LABORATORY EXERCISE #2--STUDYING CELL PARTS

Name ______________________________________ Score ___________________________________

Slesnick, Irwin L., *Biology Laboratory Manual*, Scott, Foresman and Company, 1985. Reprinted by permission of Scott, Foresman and Company.

Introduction

One way scientists study the insides of cells is by breaking cells apart and spinning them in an *ultracentrifuge*. The ultracentrifuge spins test tubes containing cellular materials at very high speeds. The rapid spinning breaks the cell walls and causes the heaviest cell parts to sink to the bottom of the test tube. Then, these cell parts can be removed for further study. Spinning the remaining material allows additional cell parts to be isolated for study. Though you probably do not have access to an ultracentrifuge, you can isolate and study some cell parts by spinning cellular material in a *centrifuge*. The centrifuge works on the same principle as the ultracentrifuge, but the centrifuge spins at lower speeds. In this laboratory exercise you will use a centrifuge to isolate parts of plant cells.

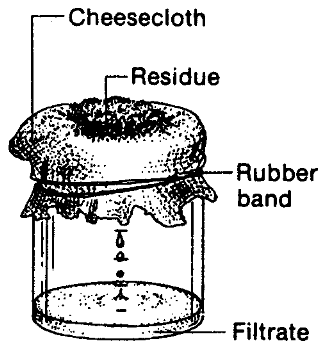
Materials needed

100 ml 0.58 M sucrose solution
50 ml fresh, green peas
Blender
Cheesecloth square, 12 cm x 12 cm
250-ml beaker
Rubber band
Stirring rod
Centrifuge tube
Centrifuge
5 microscope slides
Toothpick
2 ml iodine solution
5 coverslips
Compound microscope
4 disposable Pasteur pipettes
Colored pencils

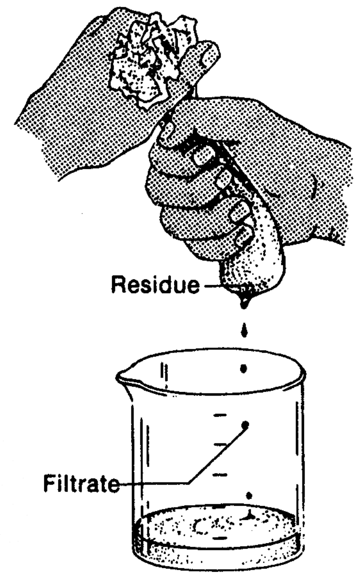
Part I: Procedure

1. Pour 100 ml of sucrose solution into a blender. Add about 50 ml of peas. Securely cover the blender with its fitted lid. Blend the mixture at highest speed for three minutes. The blending of this mixture will break the cell walls and release cell parts into the sucrose solution.

2. Loosely stretch a piece of cheesecloth over a beaker. Secure the cheesecloth with a rubber band. Pour the blended pea and sucrose mixture through the cheesecloth into the beaker, as shown in **a** on the following page. The liquid that passes through the cheesecloth is called the *filtrate*. The solid material that collects on top of the cheesecloth is called *residue*. If the cheesecloth becomes clogged and no longer allows liquid to pass through it, remove the rubber band, and fold the corners of the cheesecloth, as shown in **b.** Then, gently squeeze the pea and sucrose mixture so that more filtrate drips into the beaker.



a. Filtering pea mixture



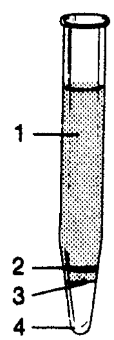
b. Squeezing residue

3. Stir the filtrate with a clean stirring rod. Fill a centrifuge tube three-quarters full of filtrate. Insert your tube and another student's tube, equally full of filtrate, into the holders opposite each other in the centrifuge. This placement balances the centrifuge and allows the centrifuge to spin evenly. Spin the centrifuge at the highest speed possible for ten minutes.

4. While your filtrate is spinning, make a wet mount slide of a small sample of residue, and stain the sample with iodine. *CAUTION: Avoid getting iodine on your hands. Iodine can stain your hands and clothes and is poisonous if ingested.*

5. View the stained residue under a microscope at low and high power. A blue-black color indicates the presence of starch. In the table below record if starch was present in the sediment. Sketch and label cell parts you recognize in the space provided in the Cell Parts Table.

6. After ten minutes, stop the centrifuge, and remove your centrifuge tube. The tube should contain four distinct layers of material. Observe these layers, and use colored pencils to draw them in **c**, below. Number the layers from top to bottom.



7. Use a pipette to carefully remove several drops of material from the lightest material at the top of the centrifuge tube. Place a drop of this material on a clean microscope slide. Stain this material with iodine, and add a coverslip.

8. Observe the stained material under low and high power. Record the results of the starch test in the table. Sketch what you see in the space in the table.

9. Repeat steps 7 and 8 for the other three layers.

Table. Cell Parts

Layer	Labeled sketch of cell parts observed	Results of starch test	Cell part	Function
Residue			Fibers	
1 (top)			Cell Wall	
2				
3				
4 (bottom)			Leucoplast	

Part II: Analysis

1. Complete the right half of the Cells Parts Table.

2. What does the iodine test indicate about the functions of certain cell parts?____________________

____

3. Which plant cell parts were not separated using this technique? Give reasons why you might not have been able to see these cell parts.

____

____

____

4. Rank the cell parts you observed in order of density from least dense to most dense. Explain how you knew the relative density of the cell parts.

____

____

____

CELL STRUCTURE

AG 534 - C

LABORATORY EXERCISE #3--ANIMAL AND PLANT CELL DIFFERENCES

Name ______________________________ Score ______________________________

Materials needed

Elodea leaves (*Anacharis*)
Microscope
Slides
Cover glasses
Medicine dropper
Colored pencils
Human cheek cells
Toothpick (flat type)
Methylene blue

Part I: Cells of a Leaf

Although most cells of plants and animals are similar in structure, there are a few major differences. In this investigation, you will observe these differences under the microscope.

Prepare a wet mount of an *Elodea* leaf. The whole leaf should be used. Examine the leaf under the low power of the microscope. Then select a portion of the leaf where the cells are particularly distinct. Center this portion in the microscope field. Bring it into focus under high power. Use the fine adjustment to observe the cells at various depths.

a. In which layer are the widest cells located? ______________________________

____

Observe the small, oval, green bodies that appear in the cells. These are the chloroplasts.

b. Are any of the chloroplasts moving? ______________________________

c. If you see movement, are all the chloroplasts moving in the same direction? ____________

d. Are they all moving at the same speed? ______________________________

e. Can you observe any structures for movement? ______________________________

f. Explain how the chloroplasts move. ______________________________

____

Draw some cells of an *Elodea* leaf. Use arrows to indicate the direction of chloroplast movement. Label your drawing, indicating the **cell wall, chloroplasts, cytoplasm and nucleus.**

Part II: Human Epithelial Cells

In this part, you will examine the cell structure of human epithelial (cheek) cells, and you will note the absence of the cell wall that was present in the elodea cells.

Gently scrape the inside of your cheek with a clean toothpick. Prepare a wet mount of the material that you have scraped from your cheek. Add a drop of methylene blue and a cover glass. Examine the cells under low power of the microscope. Switch to high power. Carefully look for the outer edge of the cytoplasm.

a. How does it compare with the outer edge of the elodea cells? ________________________________

b. What is this outer edge called? ________________________________

c. Describe the shape of the cheek cells. ________________________________

d. In what ways do the cheek cells differ from the elodea cells? ________________________________

____

____

e. Why did you use methylene blue in this investigation? ________________________________

____

f. Describe the appearance of the cytoplasm. ________________________________

____

In the space provided, draw a single cheek cell (high power) and label the **plasma membrane**, **cytoplasm**, and **nucleus**.

Part III: Summary

a. In what ways do elodea cells differ from human cheek cells? ______________________

____

b. What is the function of chloroplasts? ______________________

____

c. Why are chloroplasts green in color? ______________________

____

d. What is the outer covering of a cheek cell called? ______________________

e. Do cheek cells contain chloroplasts?______________________

f. Are both plants and animals composed of cells?______________________

Explain your answer based on observations of elodea and cheek cells.

____

____

Part IV: Investigations On Your Own

1. You can investigate many types of plant cells and identify the cell walls as well as the organelles. You may want to include potato cells, tomato pulp cells, and beet cells in your investigation.

2. There are many interesting investigations that one can do with human cells. Some skin taken from under the fingernails can be studied. These cells can be compared with those from the cheek. Identify the structures that you observe.

CELL STRUCTURE

AG 534 - C

ANSWERS TO LABORATORY EXERCISES

Lab #1:

Part I:

Diagram: Power 100X; 430-450X

a. Appear like stacked boxes.
b. No
c. Yes
d. No
e. They may be filled with water.
f. No, they are closely joined.
g. No

Part II:

a. Rectangular
b. Yes
c. Grey
d. The individual structures become more distinct
e. Yellow in color
f. Yellow to brown
g. No
h. Yes
i. Different parts of the cell are in focus as the body tube is raised and lowered.

Diagram: Power 430X

Part III:

a. Empty cell walls
b. The cork units were not alive - no cytoplasm.
c. To help in the examination of cell structures.
d. Nucleus contains the chromosomes (will not be evident).

Lab #2

Part II:

1. Table--Cell Parts

Layer	Labeled Sketch of cell parts observed	Results of starch test	Cell Part	Function
Residue	Students may sketch large pieces of cell walls and fibers	Negative	Fibers	Strengthen the cell walls
1 (top)	Students may sketch cell walls fragments and mitochondria	Negative	Cell wall	Protects the cell
2	Students should sketch chloroplasts	Negative	Chloroplast	Manufactures food for the plant
3	Students should sketch nuclei	Negative	Nucleus	Directs the cells' activities
4 (bottom)	Students should sketch leucoplasts	Positive	Leucoplast	Stores starch

2. The presence of starch indicates that the cell part functions to store food.

3. Cell membranes, endoplasmic reticulum, Golgi apparatus, mitochondria, microtubules, microfilaments, ribosomes and nucleoli remained unobservable. They were broken apart or are too small to see with compound microscope.

4. Cell wall fragments; chloroplasts; nuclei; leucoplasts. The cell parts settle according to their density after being centrifuged. Least dense materials are at the top.

Lab #3

Part I:

a. The inner layers
b. Most likely
c. Yes
d. No
e. No
f. They are carried along in the circulating cytoplasm.

Part II:

a. It appears to be thinner and less rigid.
b. Plasma membrane
c. Broad and flat
d. Cheek cells tend to be less uniform in shape because of the plasma membrane, rather than the rigid surface of the cell wall.
e. It makes cell structures more distinct.
f. Grainy and dotted

Part III:

a. Elodea cells have rigid cell walls and chloroplasts. Cheek cells have thin cell membranes.
b. Production of food
c. They contain the pigment chlorophyll.
d. Cell membrane
e. No, they are animal cells.
f. Yes. They are both made up of structural units called cells.

CELL STRUCTURE

AG 534 - C

UNIT TEST

Name ______________________________________ Score ___________________________________

1. Match the terms on the right with the correct definitions by placing the appropriate numbers in the blanks provided.

_____a. The organelle of a cell containing the hereditary material	1. Organelles
_____b. Red blood cells	2. Nerve
_____c. Composed of many neurons bunched together	3. Neuron
_____d. White blood cells; colorless cells exhibiting phagocytosis and ameboid movement	4. Adenosine Triphosphate (ATP)
_____e. Small, dark-staining organelle lying near the nucleus in the cytoplasm of animal cells	5. Chromosomes
	6. Centriole
_____f. A living, functional part of the cell through which all nutrients entering the cell and all waste products or secretions leaving it must pass	7. Differentiation
	8. DNA
_____g. A particular kind of ribonucleic acid which is synthesized in the nucleus and passes to the ribosomes in the cytoplasm; combines with RNA in the ribosomes and provides a template for the synthesis of an enzyme or some other specific protein	9. Erythrocyte
	10. Golgi bodies
	11. Hemoglobin
_____h. Present in chromosomes and contains genetic information	12. Leukocytes
_____i. Special structures in the cytoplasm. Each performs one or more special tasks to help keep the cell alive	13. Lysosome
_____j. The red, iron-containing, protein pigment of the erythrocytes that transports oxygen and carbon dioxide and aids in regulation of pH	14. Messenger RNA
	15. Microtubule
_____k. Intracellular organelle present in many animal cells; contains a variety of hydrolytic enzymes that are released when the organelle ruptures	16. Mitochondria
	17. Nucleolus
_____l. A network of fibrils or filaments, either within a cell or in the intercellular matrix	18. Nucleus
	19. Plasma membrane
_____m. A cytoplasmic organelle, an elongated slender tube; contains a specific protein, tubulin	20. Platelet

_____n.	Nucleic acid containing the sugar ribose; present in both nucleus and cytoplasm and of prime importance in the synthesis of proteins	21. Reticulum
		22. Ribonucleic acid (RNA)
_____o.	Cell organelle found in the cytoplasm of all cells except mature sperm and red blood cells	23. Ribosomes
_____p.	A form of RNA which serves as adaptor molecules in the synthesis of proteins	24. Transfer RNA
		25. Vacuole
_____q.	A chemical compound produced in the mitochondrion. stores energy that is used to carry out cellular functions	
_____r.	Small space within a cell, filled with watery liquid and separated by a vacuolar membrane from the rest of the cytoplasm	
_____s.	A spherical body found within the cell nucleus believed to be the site of synthesis of ribosomes	
_____t.	Minute granules composed of protein and ribonucleic acid; the site of protein synthesis	
_____u.	Nerve cells that transmit messages from one part of the body to another	
_____v.	A small, colorless blood corpuscle of mammals that plays an important role in blood coagulation	
_____w.	Spherical or elongated intracellular organelles which contain the electron transmitter system and certain other enzymes	
_____x.	Molecules of DNA wrapped around proteins, which are found in the nucleus; control cell functions and the inheritance of traits	
_____y.	A process of changing a relatively unspecialized cell to a more specialized cell	

2. List the three things which define a cell.

   a.____

   b.____

   c.____

3. State the four basic ideas of the cell theory.

   a.____

   ____

b. ____

____

c.____

____

d. ____

____

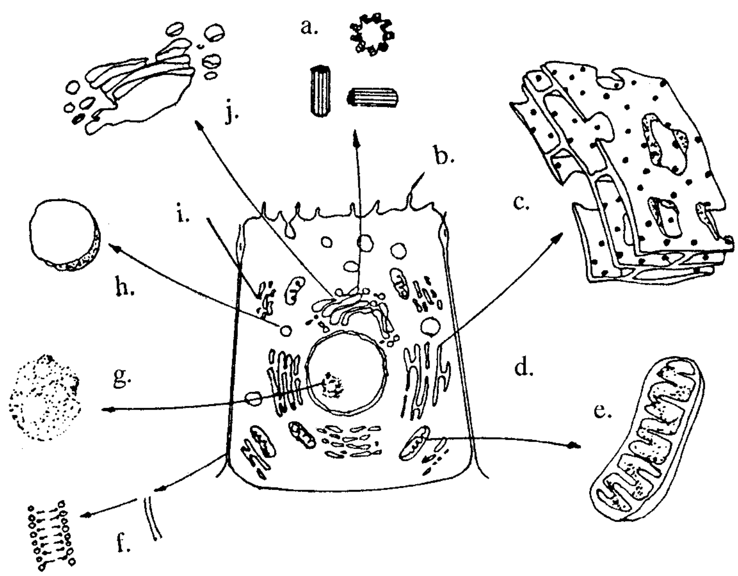
4. List the three ways that cells can differ from one another.

a.____

b. ____

c.____

5. Label the correct parts of the cell on the diagram below.



a.____________________ b. ____________________

c.____________________ d. ____________________

e.____________________ f. ____________________

g. ____________________ h. ____________________

i.____________________ j.____________________

6. List and describe the cell components and their functions.

a.____

____

____

b. ____

____

____

c.____

____

____

d. ____

____

____

7. Name and describe the functions of the cell organelles.

a.____

____

____

b. ____

____

____

c.____

____

____

d. ____

____

____

e.

f.

g.

h.

i.

8. Describe the differences between animal and plant cells.

a. Plant cells

b. Animal cells

9. List and describe the functions of the major types of specialized animal cells.

a.

b.

c.

d.

e.

f.

CELL STRUCTURE

AG 534 - C

ANSWERS TO TEST

1.

a. 18	j. 11	r. 25
b. 9	k. 13	s. 17
c. 2	l. 21	t. 23
d. 12	m. 15	u. 3
e. 6	n. 22	v. 20
f. 19	o. 10	w. 16
g. 14	p. 24	x. 5
h. 8	q. 4	y. 7
i. 1		

2. Specific, separate mass of living material that is surrounded by a semi-permeable membrane; The basic structural unit of life; All organisms (except viruses) are composed of one or more cells

3. All organisms are made of one or more cells; Cells are alike in their structure and composition; All cells carry out similar functions that keep them alive; New cells arise only from old cells, usually by dividing into two equal parts at regular intervals

4. Size; Shape; Organization

5.

a. Centrioles	b. Microvilli
c. Rough endoplasmic reticulum	d. Nucleus
e. Mitochondrion	f. Plasma membrane
g. Nucleolus	h. Lysosome
i. Smooth endoplasmic reticulum	j. Golgi Complex

6. Answer should include the following information:
   a. Plasma membrane (Cell membrane): Encloses the cell, separating it from the outside environment; Regulates passage of liquids into and out of the cell
   b. Nucleus: Contains the heredity information that directs all cell activity; Contains the nucleolus
   c. Nucleolus: Produces ribonucleic acids (RNA); Assembles subunits of ribosomes
   d. Cytoplasm: Living material inside the cell; Assists in transport of substances within the cell

7. Answer should include the following information:
   a. Endoplasmic reticulum: Cell skeletal system; Serves as transport network and storage area for substances within the cell
   b. Ribosome--Manufactures cell proteins
   c. Golgi apparatus--Packages and distributes proteins for storage within cell and transport out of cell
   d. Lysosome: Breaks down food and foreign material; Removes waste materials from cell
   e. Mitochondrion: Serves as powerhouse for cell--release body heat and energy; Produces ATP (Adenosine Triphosphate) in which energy for cell activities is stored
   f. Vacuole: Supports cell wall of plant cells through internal pressure; Digests food materials, remove wastes, and stores substances
   g. Microtubules (Centrioles): Long, thin, hollow cylinders found in many cells; Give support to cell, help keep its shape; Aid in moving the cell or moving other substances past the cell

h. Microfilaments: Thin, tiny, threadlike fibers; Contract like muscles; Aid in cell movement

i. Microvilli: Modified plasma membrane that forms fingerlike projections for more surface area; Found in intestines

8. Answer should include the following information:

a. Plant cells: Cell wall is made of cellulose and gives support and shape; Plastids--Leucoplasts: Colorless structures where glucose is changed into starch; Storage for starch, lipids or proteins; Chromoplasts: Manufacture and store pigments; Give fruits, vegetables and leaves their bright color; Chloroplasts: Contain green chlorophyll pigment; Site of photosynthesis (food production) in the plant cell

b. Animal cells: Microtubules give the cell its shape; Centrioles: Located near nucleus; Function in cell division for reproduction

9. Answer should include the following information:

a. Blood cells: Red blood cells contain hemoglobin to carry oxygen to cells and carbon dioxide from cells; White blood cells--important in body defense; Phagocytic leukocytes flow to the infection site and engulf the bacteria; Lymphocytes attack foreign cells directly or secrete an enzyme that immobilizes foreign substances; Many white blood cells die while defending the body and make up pus; Platelets--important in blood clotting

b. Nerve cells--Carry messages and direction throughout the nervous system

c. Muscle cells: Striated--skeletal or voluntary muscle cells (controlled by conscious choice); Smooth--involuntary muscle cells found in the walls of the digestive tract, blood vessels, urinary organs and reproductive organs; Cardiac--conduct impulses within the heart

d. Bone cells--Make up most of the skeleton on vertebrate animals

e. Fat cells: Make up fat (adipose tissue) which is deposited around internal organs, between muscle branches and under the skin; Supplies reserve energy when food supply is scarce or sporadic

f. Gamete (Sex cells): Reproductive cell; An egg or sperm

FUNCTIONS OF THE CELL

AG 534 - D

UNIT OBJECTIVE

After completion of this unit, students should be able to define terms associated with cell functions and explain cellular transport. Students should also be able to explain photosynthesis, respiration and fermentation. This knowledge will be demonstrated by completion of laboratory exercises and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Match terms associated with cell functions to the correct definitions.
2. Explain the different ways materials can pass through a cell membrane (Cellular Transport).
3. List three reasons why photosynthesis is the most important process in the world.
4. Explain the processes involved in photosynthesis.
5. List five factors that affect photosynthetic rate.
6. Explain the process of respiration.
7. Outline the relationship between photosynthesis and respiration.
8. Explain the process of aerobic respiration.
9. Explain the process of fermentation.
10. Define homeostasis and explain how cells achieve this state.
11. Study the movement of substances across membranes.

FUNCTIONS OF THE CELL

AG 534 - D

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

   A. Make transparencies and necessary copies of materials.

   B. Provide students with objective sheet and discuss.

   C. Provide students with information sheet and discuss.

   D. Provide students with laboratory exercises.

   E. Discuss and demonstrate laboratory exercises.

   F. Review and give test.

   G. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM 1--Importance of Photosynthesis

      2. TM 2--Photosynthesis

      3. TM 3--Photosynthesis and Respiration in Relation to Dry Weight

      4. TM 4--Diagram of Aerobic Respiration

      5. TM 5--Diagram of Fermentation

   E. Instructor notes for laboratory exercises

   F. Laboratory exercises

      1. LE 1--Studying the Movement of Substances Across Membranes

   G. Answers to laboratory exercises

   H. Test

   I. Answers to test

III. Unit references

A. *Agricultural Education Curriculum*, College of Agriculture, University of Illinois, Urbana, Illinois, 1989.

B. Otto, James H., Towle, Albert, *Modern Biology*, Holt, Rinehart and Winston, Publishers, New York, 1985.

C. Slesnick, Irwin L.; Balzer, Leron; McCormack, Alan J.; Newton, David E.; Rasmussen, Fredrick A.; *Biology*, Scott, Foresman and Company, Glenview, Illinois, 1985.

FUNCTIONS OF THE CELL

AG 534 - D

INFORMATION SHEET

I. Terms and definitions

A. Diffusion--Movement of molecules from a region of high concentration to a region of low concentration

B. Permeable--Allowing the passage of substances; as in a membrane which allows substances to pass through

C. Selectively permeable membrane--Membrane through which some substances can pass but others cannot

D. Osmosis--Diffusion of water through a selectively permeable membrane

E. Hypotonic--A condition in which one solution has a lower concentration of dissolved material than another solution

F. Hypertonic--A condition in which one solution has a greater concentration of dissolved material than another solution

G. Isotonic--A condition in which two solutions have equal concentrations of dissolved substances

H. Plasmolysis--A condition in which a cell shrinks from loss of water

I. Endocytosis--Process in which large solids are taken in by a cell (also called phagocytosis)

J. Exocytosis--Process in which large solids are discharged from the cell

K. Pinocytosis--Process in which cells take in very small particles and droplets of liquids

L. Cell respiration--Process of breaking molecules apart to release energy

M. Glycolysis--A series of reactions in cell respiration in which a glucose molecule is broken down into two molecules of pyruvic acid, forming two molecules of ATP

N. Aerobic respiration--A series of reactions, conducted in the presence of oxygen, in which glucose in converted to carbon dioxide and water

O. Fermentation--Process in which the breakdown of glucose is completed without oxygen; glucose is converted to carbon dioxide and either alcohol or lactic acid

P. Photosynthesis--Process by which plants transform solar energy into chemical bond energy

Q. Chloroplasts--Special plant organelles in which photosynthesis takes place

R. Homeostasis--The ability of an organism to maintain a stable environment when outside conditions change

S. Hydrolysis--The splitting of a compound into parts by the addition of water between certain of its bonds, the hydroxyl group being incorporated in one fragment and the hydrogen atom in the other

T. Metabolism--The sum of all the physical and chemical processes by which living organized substance is produced and maintained; the transformation by which energy and matter are made available for the uses of the organism

U. Adenosine diphosphate (ADP)--A molecule which functions in energy storage and transfer; formed from ATP

V. Adenosine triphosphate (ATP)--A molecule which stores energy that is used to carry out cellular functions; formed when ADP accepts a phosphate group plus energy

II. Cellular transport

A. Passive transport

1. Moves molecules from regions of high concentration to regions of lower concentration

2. Does not require cellular energy

B. Active transport

1. Method of moving cells from lower concentration region to higher concentration region

2. Requires cellular energy

3. Allows cells to get rid of substances that would be harmful in high concentrations

Example: Wastes are actively transported out of some kidney cells

C. Endocytosis

1. The taking in of large molecules or particles by a cell without passing through the plasma membrane

a. Cell forms pocket, surrounds the substance, seals itself, and becomes a vacuole within the cell

b. Material is then broken down and absorbed into the cell

2. Phagocytosis--Process by which simple unicellular animals can take in relatively large particles of food from their environment

3. Pinocytosis--Liquids or macromolecules are taken in instead of large particles

D. Exocytosis--The passage of large molecules to the outside of a cell enclosed in a membrane

1. Molecule enclosed in membrane in cytoplasm, moves to plasma membrane, membranes fuse, the part of the membrane at the surface of the cell opens up and allows it to pass

2. Protein molecules, lipids and many cell wastes are discharged by exocytosis

III. Reasons photosynthesis is the most important process in the world (Transparency 1)

A. Plants produce food by photosynthesis

B. Plants produce food used directly by man

C. Plants produce food used indirectly by man through meat and milk produced by livestock

(Note: Green plants, through the process of photosynthesis, are the basic factory of the world, on which all life is dependent. A corn plant produces about 5 grams of sugar during 14 hours of sunlight. During a 100-day period, a 20-acre field of corn with 20,000 plants per acre could produce two and one-half tons of. sugar An estimated 150 billion tons of sugars are produced by plants each year by photosynthesis. This would be a pile of sugar 40 miles square at the base and 2 miles high at the peak.)

IV. Process of photosynthesis (Transparency 2)

A. Carbon dioxide (CO_2) enters the leaf from the surrounding air through the stoma

(Note: After CO_2 enters the stoma, it enters the intercellular spaces of the mesophyll tissue. Here it comes in contact with the wet walls of the mesophyll cells. The CO_2 dissolves in the water of the mesophyll cells.)

B. Water moves from the soil into the root, stems and leaves through the xylem tissue

C. The molecules of water (H_20) and carbon dioxide (CO_2) are synthesized (put together) in the chlorophyll of a plant with energy from sunlight

D. The end result is the formation of sugar which is transported by the phloem tissue to the part of the plant where it is used

(Note: The process can be illustrated by the chemical equation which is written: 6 parts carbon dioxide (6 CO_2) + 6 parts water (6 H_2O) + 672 K cal of radiant energy (sunlight) in the presence of chlorophyll of plants = sugar ($C_6H_{12}O_6$) retained by the plant + oxygen (6 O_2) given off into the atmosphere.)

V. Factors that affect photosynthetic rate

A. Water supply

B. Temperature

C. Light quality

D. Light intensity

E. Deficiency of certain plant nutrients

VI. Process of respiration

(Note: As will all living things, plants require energy to carry out their growth and development process. This energy comes from a very complex process called respiration. In a sense, respiration in plants is the reverse of photosynthesis as sugar is broken down to produce energy.)

A. Sugar is broken down to produce energy for essential plant functions

B. Respiration consumes oxygen (O_2) and glucose ($C_6H_{12}O_6$)

C. Respiration gives off carbon dioxide (CO_2) and water (H_2O)

(Note: The process can be illustrated by the chemical equation which is written: Sugar ($C_6H_{12}O_6$) + 6 parts oxygen (6 O_2) = six parts carbon dioxide (6 CO_2) + 6 parts water (6 H_2O).)

VII. Relationship between photosynthesis and respiration (Transparency 3)

Photosynthesis	Respiration
1. A building process (+)	1. A destruction process (-)
2. Sugars manufactured	2. Sugars consumed
3. CO_2 is consumed	3. CO_2 is given off
4. Oxygen is given off	4. Oxygen is consumed
5. Requires light	5. Goes on day and night
6. Only takes place in cells containing chlorophyll	6. Carried on in all cells
7. Sugar ($C_6H_{12}O_6$) is the end product	7. Energy produced for plant functions is end product

(Note: A green plant grown in the dark loses in weight because its stored foods are respired and nothing is added through photosynthesis.)

VIII. Aerobic respiration (Transparency 4)

A. Breakdown of glucose in presence of oxygen

1. Pyruvic acid converted to carbon dioxide and water

2. Additional 36 molecules ATP eventually formed from products of these reactions (total of 38 molecules ATP formed--two formed in glycolysis)

B. Chemical equation

ADP + Phosphate + Glucose + Oxygen ----- Carbon dioxide + Water + Energy

ADP + P + $C_6H_{12}O_6$ + $6O_2$ ---- CO_2 + $6H_2O$ + ATP

IX. Fermentation (Transparency 5)

A. Breakdown of glucose without oxygen

1. Pyruvic acid converted to carbon dioxide and either alcohol or lactic acid

2. No additional energy is produced

a. Total energy is the two ATP produced in glycolysis

b. Very inefficient in energy production

B. Energy from fermentation

1. Some organisms, such as bacteria, obtain all their energy from fermentation

2. Some cells revert to fermentation when oxygen is in short supply

Example: Muscle cells during intense exercise

X. Homeostasis

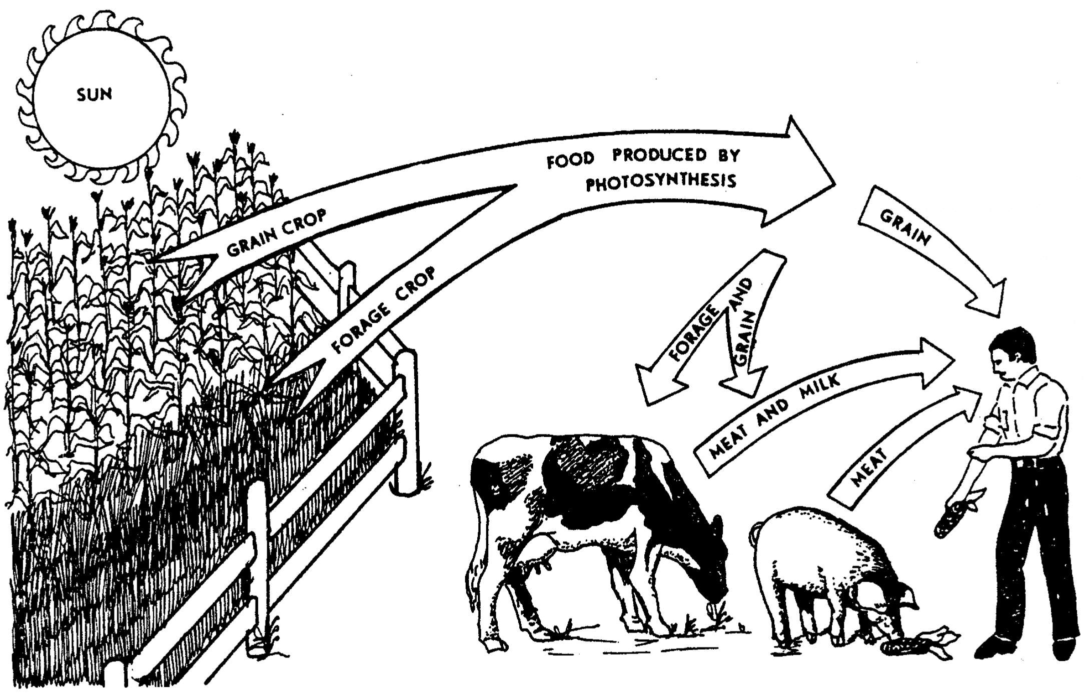
A. The ability of a cell or organism to maintain a stable internal environment when outside conditions change. The internal stability of living things

B. Feedback mechanism

1. Makes homeostasis possible by helping the cell respond to both internal and external changes

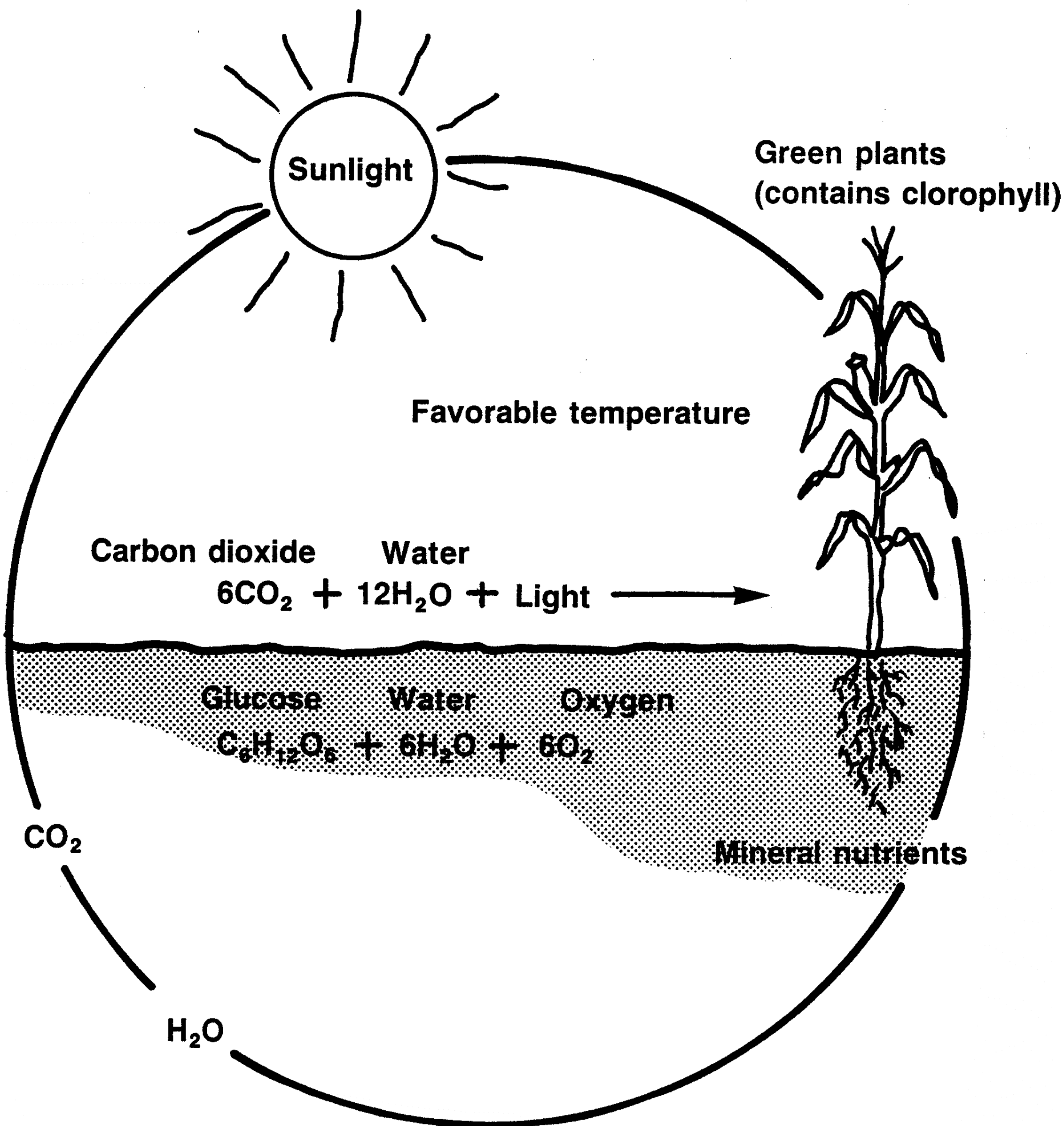
2. Example: Damaged cell--Increased rate of chemical building blocks entering the cell for repairing the cell. As a result, more waste products form in the cell and must also have increased rate of excretion

Importance of Photosynthesis

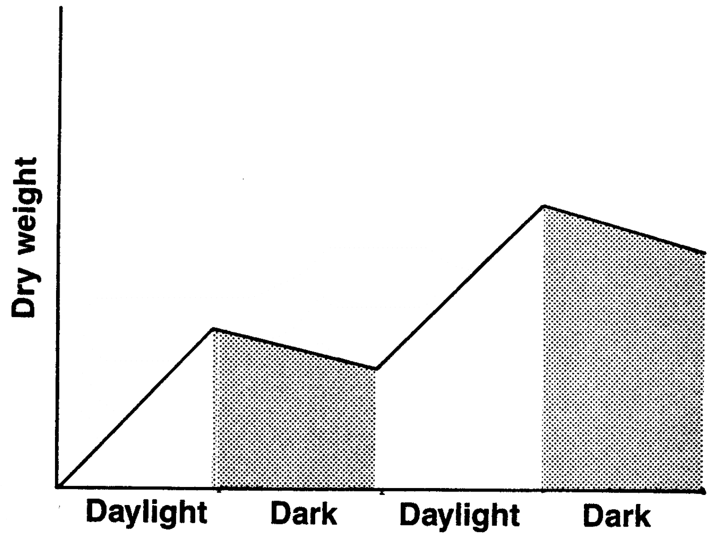


Through the process of photosynthesis, crop plants produce food. This plant-produced food is used directly by man or indirectly through meat and milk produced by livestock.

Photosynthesis



Photosynthesis and Respiration in Relation to Dry Weight



Daylight hours

- The sugar produced by photosynthesis is greater than the sugar used by respiration.
- Result is increase in dry weight.

Dark hours

- No sugar is produced by photosynthesis.
- Sugar is used by respiration.
- Result is decrease in dry weight.

Diagram of Aerobic Respiration

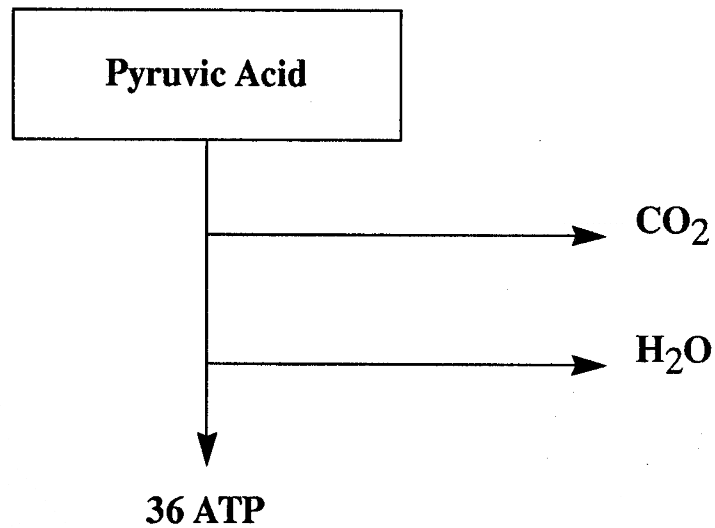
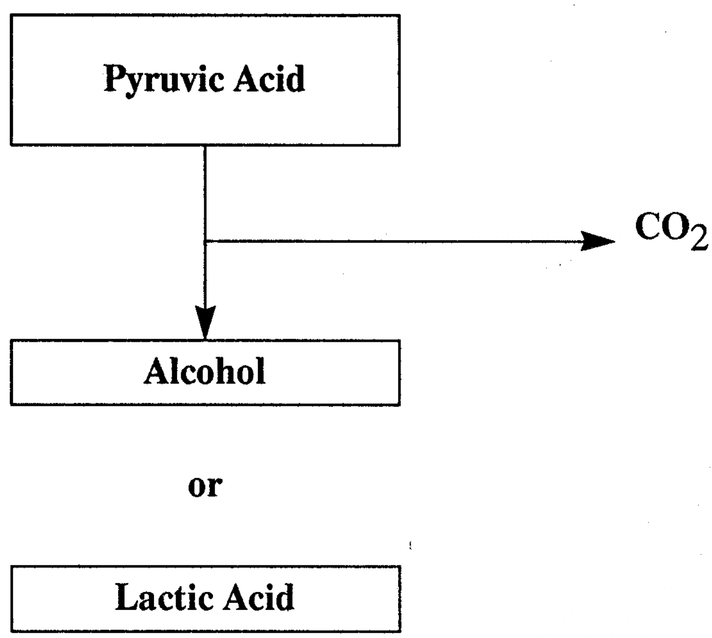


Diagram of Fermentation



FUNCTIONS OF THE CELL

AG 534 - D

INSTRUCTOR NOTES FOR LABORATORY EXERCISE

Solution preparation:

The following general instructions apply for the preparation of most solutions: Solvents should be added to solutes. Use distilled water, not tap water, for all reagents. When preparing an acid or base solution, *slowly* add the acid or base to the water. Never add water to a concentrated acid or base.

To make percentage solutions measure 1 ml of solute per percentage. Add the solute to enough solvent to make 100 ml of solution. When dissolving a solid in water, measure 1 g of solute per percentage and mix the solute with enough water to make 100 ml of the solution.

<u>Albumin solution (10%)</u>

Add 20 g of egg albumin or 30 ml of egg white to 180 ml of distilled water. Refrigerate until needed.

<u>Benedict's Solution (also available ready-made)</u>

Add 173 g of sodium or potassium citrate and 100 g of anhydrous sodium carbonate [Na_2CO_3] to 700 ml of distilled water. Heat until chemicals are dissolved. Filter. Dissolve 17.3 g crystalline copper sulfate [$CuSO_4$] in 100 ml of distilled water. Slowly pour the first solution into the copper sulfate solution, stirring constantly. Dilute with distilled water to make exactly 1 L of Benedict's solution.

<u>Glucose solution (10%)</u>

Dissolve 50 g of glucose in 450 ml of distilled water. Refrigerate.

<u>Iodine solution (also available ready-made)</u>

Dissolve 5.0 g of potassium iodide [KI] and 1.5 g of iodine crystals in 500 ml of distilled water. Store in brown bottle or other glass container that shields the liquid from light. *CAUTION: Iodine dust and vapors are toxic and irritating. Avoid body contact and inhalation from fumes. Should body contact occur, flush immediately with water.*

<u>Salt solution (10%) [NaCl]</u>

Dissolve 40 g of salt in 360 ml of distilled water. Refrigerate.

<u>Starch solution (10%)</u>

Dissolve 100 g of cornstarch in 250 ml of distilled water, forming a paste. Pour the paste into 650 ml of boiling (distilled) water. Cook for several minutes, stirring constantly. Cool and refrigerate.

Dialysis tubing should be at least 25 mm in diameter.

It is recommended that students wear safety glasses or goggles throughout this laboratory exercise.

You may wish to provide equipment for setting up hot water baths in step 10.

You may wish to prepare the mixture for the inside of the cell model ahead of time.

Part I:

Step 5: Make sure that the students tie off the ends of their cell models securely. If liquid leaks out of their cell models, have the student empty the liquid into a container and retie the ends securely before proceeding with the experiment.

Step 7: Cell model should sit in the iodine solution for at least 30 minutes. The longer it stays in the iodine, the closer to equilibrium the solutions will be.

Step 9: Students can use the end of the string to pull the cell model out of the iodine solution. Students should use a spoon to transfer the cell to another clean container.

Step 10: Students can also test for oil by placing several drops of the liquid on a piece of brown paper. After the water evaporates, a translucent spot indicates the presence of oil.

Caution students to be careful when using the Bunsen burner. Make sure that loose hair and clothing are secured away from the flame.

Students can also detect starch by adding two drops of iodine solution to 2 ml of liquid from the beaker. This test may yield a stronger color change if starch is present.

Part II:

If aquarium water is not available, use dechlorinated tap water. Allow several liters of tap water to stand out in an open container, such as an aquarium, for several days.

A biuret, nitric acid or ninhydrin test can also be used to test for protein. Caution students to handle these reagents carefully if you decide to use these tests. Contact with the skin can cause stains or burn the skin.

EXTENSION: Students can do Part II using an animal cell such as a cheek or blood cell.

Part IV:

The *Elodea* cells returned to normal because the concentration of water was greater on the outside of the cell when the cell was placed in aquarium water. Water flowed into the cell by osmosis, restoring it to its normal dimensions.

The vacuole of the cell shrank because the concentration of water inside the cell was higher than that outside the cell. Water left the vacuole by osmosis, restoring the cell to its normal state.

FUNCTIONS OF THE CELL

AG 534 - D

LABORATORY EXERCISE #1--STUDYING THE MOVEMENT
OF SUBSTANCES ACROSS MEMBRANES

Name ______________________________ Score ______________________________

Slesnick, Irwin L., *Biology Laboratory Manual*, Scott, Foresman and Company, 1985. Reprinted by permission of Scott, Foresman and Company.

Introduction

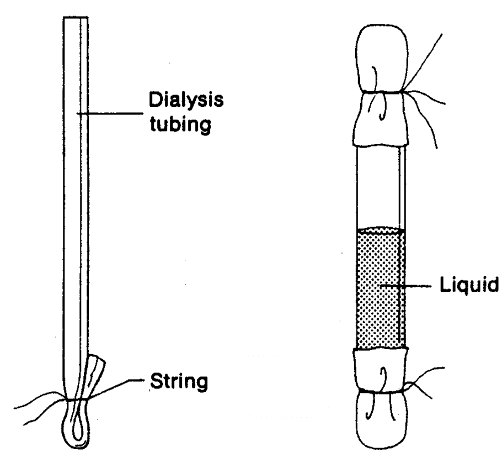
To carry out basic life functions, cells need to exchange materials with their environment. These materials move in and out of the cell, passing through the cell membrane. Some molecules can move easily and quickly across the cell membrane by diffusion. Other molecules cannot diffuse across the cell membrane. In this laboratory you will make a model of a cell. Then, you can study the diffusion of various substances across a material that is *selectively permeable* to certain materials, as is a cell membrane. You will also observe plant cells in different environments to learn how the movement of water across the cell membrane affects the cell.

Materials needed

Dialysis tubing, 15 cm long
Tap water
Thread, 30 cm
50-ml graduated cylinder
250-ml graduated cylinder
Large beaker, small bowl
  or small container
10 ml 10% starch solution
10 ml 10% glucose solution
3 ml vegetable oil
10 ml 10% albumin solution
Stirring rod
Small funnel
500-ml beaker
200-ml dilute iodine solution
Spoon
2 test tubes
Medicine dropper
2 ml Benedict's solution
Bunsen burner
Test-tube holder
3 *Elodea* leaves
3 microscope slides
3 coverslips
Grease pencil
Aquarium water
10% salt solution
Distilled water
Compound microscope

Part I: Diffusion Across the Membrane of a Model Cell

1. Soak a piece of dialysis tubing in tap water for several minutes. To separate the tube walls, rub the surfaces of the tube between your thumb and forefinger. Fold one end of the tubing, and secure that end with string, as shown in **a.**



a. Setting up dialysis tubing **b. Cell model**

2. Measure and mix 10 ml of starch solution with 10 ml of glucose solution and 10 ml of albumin (protein) solution. Then, add 3 ml of oil to the mixed solutions. Stir this mixture, and pour it into a graduated cylinder. On the line below, record the volume of the liquid.

    (a)____

3. Using a funnel, pour the liquid from step 2 into your dialysis tubing until the tubing is half full. Firmly tie off the open end of the tubing as shown in **b.** on previous page. Leave the long thread attached. Record the amount of liquid left in the graduated cylinder on the line below.

    (b)____

4. To find the volume of liquid in your cell model, subtract the volume recorded on line (a) from that recorded on line (b). Write this sum on the space in Table I below.

5. Invert your cell model over the sink. Make sure that no liquid leaks from your cell model. Then, rinse the surface of the cell model under tap water. Place the cell model in a clean 250-ml beaker.

6. Fill the larger graduated cylinder with about 200 ml of iodine solution. CAUTION: Avoid getting iodine on your hands. It stains and is poisonous if ingested. Record the volume of iodine solution on the line below.

    (c)____

7. Pour enough iodine solution over your cell model to cover the top surface of the cell model. Record on line (d) the volume of iodine solution remaining in your graduated cylinder.

    (d)____

8. Allow your cell model to remain in the iodine solution overnight. To find the amount of iodine surrounding the cell, subtract the volume on line (c) from that on line (d). In the space in the table, record the amount of iodine solution surrounding your cell model.

Table 1. Movement of substance across a membrane.

Liquid	Volume		Iodine present		Starch present		Oil present		Glucose present		Albumin present	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Liquid surrounding cell model												
Liquid inside cell												

9. After at least 24 hours have passed, use the attached string to lift the cell model out of the beaker. Let the excess liquid drip back into the beaker. Place the cell model in a clean, empty beaker, bowl, or container. Measure the amount of liquid remaining in the 250-ml beaker, and record this amount in the table.

10. Run the following tests on the liquid in the 250-ml beaker to determine if any of the substances inside the cell model have diffused through the membrane. If starch crossed the membrane, it would react with iodine, producing a blue-violet color. In Table I, record if a reaction of starch and iodine occurred. Look for oil droplets on the surface of the liquid. Record your observations in the table. Put about 2 ml of liquid into each of two test tubes. You will test the liquid in one test tube for albumin and the liquid in the other test tube for glucose. To test for albumin, heat the test tube over a Bunsen burner until the contents in the test tube come to a boil. A cloudy, white precipitate indicates albumin is present. To test for glucose, add 1 ml of Benedict's solution to the second test tube. Heat the test tube over the Bunsen burner for five minutes. If glucose is present, the heated liquid will turn green, orange, yellow, red or brown.

11. Remove the cell model from the container and untie one end of the dialysis tubing. Pour the liquid into the smaller graduated cylinder. Record in Table I the volume of liquid in the graduated cylinder. This amount is the volume of liquid that remained in your cell model. Repeat the tests in step 10 using the liquid from your cell model. Record in the table the substances that were present. You will be checking for the presence of the original substances in the liquid and for the movement of iodine into the liquid.

12. Dispose of the liquids and clean your equipment.

<u>Part II: Osmosis in a Living Cell</u>

1. Use a grease pencil to label one slide "Aquarium water", the second slide, "Salt water", and the third "Distilled water". Place several drops of the liquid named on the label in the center of the slide that bears that label.

2. Select three small *Elodea* leaves, and place each one in the liquid on the center of the slide. Add a coverslip.

3. Examine each slide under the microscope using low power first, then high power. In the spaces provided, draw and label a typical cell from each leaf as it appears under high power. Notice the size of the vacuole in each cell.

Part III: Analysis

1. Table II lists approximate molecular weights of the molecules dissolved in the liquids used in Part I. Use this information to explain the results of the laboratory. How is a substance's molecular weight related to the substance's diffusion rate?

____

____

Table II. Molecular weight

Substance	Approximate molecular weight
Water	18
Glucose	180
Iodine	250
Starch	1,000
Oil	1,000
Albumin	40,000

2. Did the amounts of liquid inside and outside the cell model change significantly? Explain why or why not.

____

____

3. In Part II, how did the three liquids affect the *Elodea* cells? Use the terms *osmosis, isotonic, hypertonic and hypotonic* to explain your results.

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4. How does the structure of the *Elodea* cell protect the cell if the cell is placed in distilled water? What might happen to blood cells placed in distilled water? Explain your answer.

____

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5. Kidney machines use dialysis tubing in a special bath to remove wastes from a patient's blood. What causes the waste products in the blood to pass through the tubing into the bath?

____

____

Part IV: Going Further

1. Use forceps to dunk the *Elodea* leaf that was in salt water into a beaker of aquarium water. Then, using aquarium water, make a wet mount of the leaf. After about ten minutes, observe the leaf cells under low power and then high power. Draw some of the leaf cells. Compare your drawing to the drawings that you did in step 3 of Part II. If the cell changed in appearance, explain why.

2. Repeat the above procedure with the leaf that was placed in distilled water. Again, draw the leaf cells, and explain any changes that you observe.

FUNCTIONS OF THE CELL

AG 534 - D

ANSWERS TO LABORATORY EXERCISE

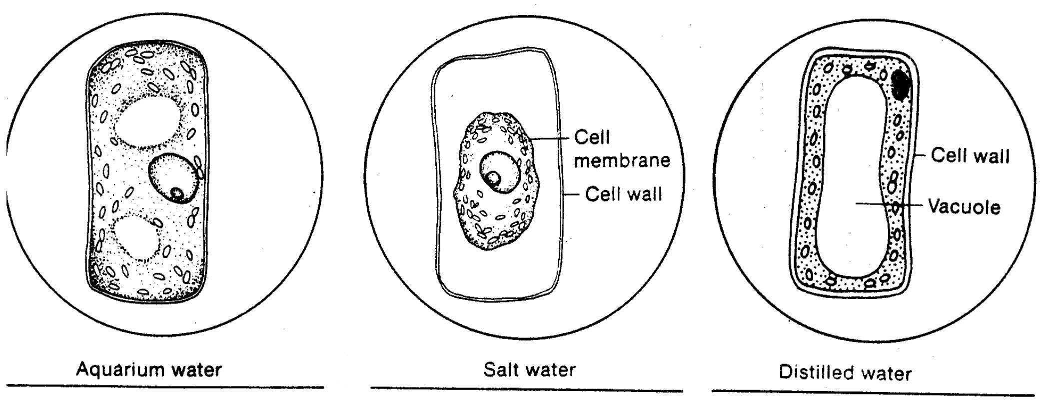
Part I:

(a) Approximately 33 ml
(b) Answers will vary, but should be around 15 ml
(c) Answers may vary, but should be about 200 ml
(d) Answers may vary, but may range between 0 and 25 ml

Table I: Glucose will probably diffuse out of the cell model. Iodine will probably diffuse into cell model. The volume of liquid inside and outside the cell model will probably remain relatively constant.

Part II:

Step 3:



Part III:

1. The larger the molecular weight, the slower the rate of diffusion.

2. No, because diffusion was taking place in both directions. About the same amount of water entered as left the cell.

3. Osmosis occurred in all slides. Because aquarium water is isotonic to the cell, the amount of water flowing in and out of the cell was equal. Salt water is hypertonic to the cell, so water flowed out of the cell and the cell shrank. Distilled water is hypotonic to the cell, so the net flow of water into the cell caused the vacuole to enlarge. (Excess water is stored in the vacuole.)

4. The rigid cell wall prevents the cell membrane from expanding to the bursting point in a hypotonic solution. A blood cell, which lacks a cell membrane, will burst in a hypotonic solution.

5. Wastes move from a region of high concentration (in the blood) to a region of low concentration (into the bath) by diffusion.

FUNCTIONS OF THE CELL

AG 534 - D

UNIT TEST

Name ______________________________ Score ______________________________

1. Match the terms on the right with the correct definitions by placing the appropriate numbers in the blanks provided.

_____a. A series of reactions in cell respiration in which a glucose molecule is broken down into two molecules of pyruvic acid, forming two molecules of ATP

_____b. Special plant organelles in which photosynthesis takes place

_____c. Allowing the passage of substances; as in a membrane which allows substances to pass through

_____d. Process in which cells take in very small particles and droplets of liquids

_____e. A molecule which functions in energy storage and transfer

_____f. Process by which plants transform solar energy into chemical bond energy

_____g. A condition in which one solution has a lower concentration of dissolved material than another solution

_____h. The splitting of a compound into parts by the addition of water between certain of its bonds, the hydroxyl group being incorporated in one fragment and the hydrogen atom in the other

_____i. A condition in which two solutions have equal concentrations of dissolved substances

_____j. Process in which the breakdown of glucose is completed without oxygen; glucose is converted to carbon dioxide and either alcohol or lactic acid

_____k. Process in which large solids are taken in by a cell

_____l. Membrane through which some substances can pass but others cannot

1. Diffusion
2. Permeable
3. Selectively permeable membrane
4. Osmosis
5. Hypotonic
6. Hypertonic
7. Isotonic
8. Plasmolysis
9. Endocytosis
10. Exocytosis
11. Pinocytosis
12. Cell respiration
13. Glycolysis
14. Aerobic respiration
15. Fermentation
16. Photosynthesis
17. Chloroplasts
18. Homeostasis
19. Hydrolysis
20. Metabolism

_____m. A condition in which a cell shrinks from loss of water

21. Adenosine diphosphate

_____n. Diffusion of water through a selectively permeable membrane

22. Adenosine triphosphate

_____o. Process of breaking molecules apart to release energy

_____p. The sum of all the physical and chemical processes by which living organized substance is produced and maintained; the transformation by which energy and matter are made available for the uses of the organism

_____q. A condition in which one solution has a greater concentration of dissolved material than another solution

_____r. A molecule which stores energy that is used to carry out cellular functions

_____s. A series of reactions, conducted in the presence of oxygen, in which glucose is converted to carbon dioxide and water

_____t. Movement of molecules from a region of high concentration to a region of low concentration

_____u. The ability of an organism to maintain a stable environment when outside conditions change

_____v. Process in which large solids are discharged from the cell

2. Explain the different ways materials can pass through a cell membrane.

a.____

____

____

b. ____

____

____

c.____

____

____

d. ______________________________

____

____

3. List three reasons why photosynthesis is the most important process in the world.

a. ______________________________

____

b. ______________________________

____

c. ______________________________

____

4. Explain the processes involved in photosynthesis.

a. ______________________________

____

b. ______________________________

____

c. ______________________________

____

d. ______________________________

____

5. List five factors that affect photosynthetic rate.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

6. Explain the process of respiration.

____

____

____

____

7. Outline the relationship between photosynthesis and respiration.

Photosynthesis	Respiration
a.________________	a. ________________
b. ________________	b. ________________
c.________________	c. ________________
d. ________________	d. ________________
e.________________	e. ________________
f.________________	f.________________
g. ________________	g. ________________

8. Explain the process of aerobic respiration.

____

____

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____

____

9. Explain the process of fermentation.

____

____

____

____

10. Define homeostasis and explain how cells achieve this state.

FUNCTIONS OF THE CELL

AG 534 - D

ANSWERS TO TEST

1.

a. 13	i. 7	p. 20
b. 17	j. 15	q. 6
c. 2	k. 9	r. 22
d. 11	l. 3	s. 14
e. 21	m. 8	t. 1
f. 16	n. 4	u. 18
g. 5	o. 12	v. 10
h. 19		

2. Answer should include the following information:

   a. <u>Passive transport</u>: Moves molecules from regions of high concentration to regions of lower concentration; Does not require cellular energy
   b. <u>Active transport</u>: Method of moving cells from lower concentration region to higher concentration region; Requires cellular energy; Allows cells to get rid of substances that would be harmful in high concentrations
   c. <u>Endocytosis</u>: The taking in of large molecules or particles by a cell without passing through the plasma membrane; Cell forms pocket, surrounds the substance, seals itself, and becomes a vacuole within the cell; Material is then broken down and absorbed into the cell; Phagocytosis--Process by which simple unicellular animals can take in relatively large particles of food from their environment; Pinocytosis--Liquids or macromolecules are taken in instead of large particles
   d. <u>Exocytosis</u>: The passage of large molecules to the outside of a cell enclosed in a membrane; Molecule enclosed in membrane in cytoplasm, moves to plasma membrane, membranes fuse, the part of the membrane at the surface of the cell opens up and allows it to pass; Protein molecules, lipids and many cell wastes are discharged by exocytosis

3. Plants produce food by photosynthesis; Plants produce food used directly by man; Plants produce food used indirectly by man through meat and milk produced by livestock

4. Answer should include the following information:

   Carbon dioxide (CO_2) enters the leaf from the surrounding air through the stoma; Water moves from the soil into the root, stems and leaves through the xylem tissue; The molecules of water (H_20) and carbon dioxide (CO_2) are synthesized (put together) in the chlorophyll of a plant with energy from sunlight; The end result is the formation of sugar which is transported by the phloem tissue to the part of the plant where it is used

5. Water supply; Temperature; Light quality; Light intensity; Deficiency of certain plant nutrients

6. Answer should include the following information: Sugar is broken down to produce energy for essential plant functions; Respiration consumes oxygen (O_2) and glucose ($C_6H_{12}O_6$); Respiration gives off carbon dioxide (CO_2) and water (H_2O)

7.

Photosynthesis	Respiration
a. A building process (+)	a. A destruction process (-)
b. Sugars manufactured	b. Sugars consumed
c. CO_2 is consumed	c. CO_2 is given off
d. Oxygen is given off	d. Oxygen is consumed
e. Requires light	e. Goes on day and night
f. Only takes place in cells containing chlorophyll	f. Carried on in all cells
g. Sugar ($C_6H_{12}O_6$) is the end product	g. Energy produced for plant functions is end product

8. Answer should include the following information:

a. Breakdown of glucose in presence of oxygen: Pyruvic acid converted to carbon dioxide and water; Additional 36 molecules ATP eventually formed from products of these reactions total of 38 molecules ATP formed--two formed in glycolysis)

b. Chemical equation:
ADP + Phosphate + Glucose + Oxygen -----→ Carbon dioxide + Water + Energy
ADP + P + $C_6H_{12}O_6$ + $6O_2$ -----→ CO_2 + $6H_2O$ + ATP

9. Answer should include the following information:

Breakdown of glucose without oxygen; Pyruvic acid converted to carbon dioxide and either alcohol or lactic acid; No additional energy is produced; Total energy is the two ATP produced in glycolysis; very inefficient in energy production; Energy from fermentation: Some organisms, such as bacteria, obtain all their energy from fermentation; Some cells revert to fermentation when oxygen is in short supply

10. Answer should include the following information:

The ability of a cell or organism to maintain a stable internal environment when outside conditions change; The internal stability of living things; Feedback mechanism: Makes homeostasis possible by helping the cell respond to both internal and external changes

ANIMAL TISSUES, SYSTEMS AND ORGANS

AG 534 - E

UNIT OBJECTIVE

After completion of this unit, students should be able to describe the primary animal tissues and identify the types of tissues. Students should also be able to list the functions and major organs of each of the animal systems. This knowledge will be demonstrated by completion of laboratory exercises and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Describe the four primary animal tissues.
2. Identify the types of epithelial tissue when given a description of each.
3. Identify the types of connective tissue when given a description of each.
4. Identify the types of muscular tissue when given a description of each.
5. Identify the types of nervous tissue when given a description of each.
6. State the functions and list the three major organs of the circulatory system.
7. State the functions and list the seven major organs of the digestive system.
8. State the functions and list the two major organs of the respiratory system.
9. State the function and list the two major organs of the excretory system.
10. State the function and list the three major organs of the nervous system.
11. State the function and list the major organ of the endocrine system.
12. State the functions and list the major organ of the skeletal system.
13. State the function and list the major organ of the muscular system.
14. State the function and list the two major organs of the reproductive system.
15. Discuss the nervous system anatomy.
16. Discuss the respiratory system.
17. Discuss the structure of the heart.

ANIMAL TISSUES, SYSTEMS AND ORGANS

AG 534 - E

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

A. Make transparencies and necessary copies of materials.

B. Provide students with objective sheet and discuss.

C. Provide students with information sheet and discuss.

D. Provide students with laboratory exercises.

E. Discuss and demonstrate laboratory exercises.

F. Review and give test.

G. Reteach and retest if necessary.

II. Instructional materials

A. Objective sheet

B. Suggested activities

C. Information sheet

D. Transparency masters

1. TM 1--Typical Neuron
2. TM 2--Types of Epithelial Tissue
3. TM 3--Arrangement of Connective Tissue in a Muscle
4. TM 4--Muscular Tissue
5. TM 5--Circulatory System
6. TM 6--Digestive System
7. TM 7--Respiratory System
8. TM 8--Excretory System
9. TM 9--Nervous System
10. TM 10--Endocrine System
11. TM 11--Skeletal System

12. TM 12--Muscular System

13. TM 13--Reproductive System

E. Laboratory exercises

1. LE 1--Nervous System Anatomy

2. LE 2--Respiratory System

3. LE 3--Heart Structure

F. Answers to laboratory exercises

G. Test

H. Answers to test

III. Unit references

A. *Agricultural Education Curriculum*, College of Agriculture, University of Illinois, Urbana, Illinois, 1989.

B. Otto, James H., Towle, Albert, *Modern Biology*, Holt, Rinehart and Winston, Publishers, New York, 1985.

C. Slesnick, Irwin L.; Balzer, Leron; McCormack, Alan J.; Newton, David E.; Rasmussen, Fredrick A.; *Biology*, Scott, Foresman and Company, Glenview, Illinois, 1985.

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ANIMAL TISSUES, SYSTEMS AND ORGANS

AG 534 - E

INFORMATION SHEET

I. Primary animal tissues

   A. Epithelial tissue

      1. Covers an internal or external surface

      2. Body surface, body cavities linings, body ducts and passages and the secretory portion of glands which provide lubricating mucus or hormones and enzymes

   B. Connective tissue

      1. Sheets or bands of tissue composed of strands or fibrils of three proteins (collagen, elastin, reticulum) distributed in a watery matrix of ground substance

      2. Forms a part of the skeletal system (for example, a ligament connects a bone to another bone)

      3. Forms the firm attachment against which a muscle pulls (muscle connections to bone)

      4. Surrounds, collects and forms a harness to regulate and control muscle fibers, muscle fiber bundles and entire muscles during contraction and relaxation

   C. Muscular tissue

      1. Most common tissue found in most animals

      2. The cell or muscle fiber is made up of elongated strands specialized for contraction

      3. The contractile elements of the fiber are micro fibrils

   D. Nervous tissue (Transparency 1)

      1. Conducts impulses after receiving some stimulus

      2. Neuron--The essential cell of the nervous system

      3. Dendrites--Nerve fibers connected to the nerve cell body that conduct impulses <u>toward</u> the cell body

      4. Axon--Nerve fibers connected to the nerve cell body that conduct impulses <u>away</u> from the cell body

II. Types of epithelial tissue (Transparency 2)

A. Simple (single-layered)

1. Squamous

a. Flat

b. Found in blood vessels and linings of body cavities and viscera

2. Cuboidal

a. Short prism

b. Found in ducts and passageways and the active tissue of glands

3. Columnar

a. Tall, sometimes ciliated

b. Found in intestines and trachea

4. Pseudostratified columnar

a. Vary in length

b. Found in upper respiratory

B. Stratified (multi-layered)

1. Stratified squamous

a. Cuboidal shaped; thickest and toughest of epithelial tissues

b. Forms outer skin layer; the first part of the digestive tract, and, in ruminants, the fore stomach

2. Stratified columnar--found in pharynx and salivary ducts

3. Transitional

a. Stretches from many layers thick to a single layer

b. Found in areas subjected to stretching, such as the bladder

4. Glandular

a. Can be cuboidal or columnar

b. Found in mucous or hormonal glands

5. Yellow

a. Kinked fibers that tend to regain shape after being stretched

b. Found at base of skull

6. Branching

a. Netlike, star shaped

b. Found in lymphatic tissue and bone marrow

III. Types of connective tissue (Transparency 3)

A. Endomysium--Connective tissue surrounding the individual muscle fibers

B. Perinysium--Connective tissue around groups or bundles of muscle fibers

C. Epinysium--Connective tissue surrounding the entire muscle

IV. Types of muscular tissue (Transparency 4)

A. Striated-voluntary--The skeletal muscles

B. Striated-involuntary--The cardiac muscle of the heart; controlled by the autonomic system

C. Smooth-involuntary--Muscles of the gastrointestinal tract; also found in the walls of blood vessels, urinary tract and reproductive tract

V. Types of nervous tissue

A. Sensory--Conduct impulses from skin or sense organs to nerve center

B. Motor--Conduct impulses from the nerve centers to muscles or glands

C. Association--Form connections between other neurons

VI. Circulatory system (Transparency 5)

A. Function--Carries gases, digested food and other materials to all parts of the body

B. Major organs

1. Heart

2. Arteries

3. Veins

VII. Digestive system (Transparency 6)

A. Function--Takes in food, digests food and eliminates undigested wastes

B. Major organs

1. Mouth
2. Pharynx
3. Esophagus
4. Stomach(s)
5. Small intestine
6. Large intestine (includes cecum, colon and rectum)
7. Accessory organs (includes pancreas, liver, gall bladder)

VIII. Respiratory system (Transparency 7)

A. Function--Takes in air, uses certain gases from the air, expels waste gases

B. Major organs

1. Lungs
2. Air passages

IX. Excretory system (Transparency 8)

A. Function--Eliminates wastes produced inside the cells

B. Major organs

1. Kidney
2. Bladder

X. Nervous system (Transparency 9)

A. Function--Collects information from inside and outside the body to help regulate body functions

B. Major organs

1. Brain
2. Spinal cord
3. Nerves

XI. Endocrine system (Transparency 10)

A. Function--Helps regulate the chemical substances in the body

B. Major organs--Ductless glands

Example: Pineal, Pituitary, Thyroid, Parathyroids

XII. Skeletal system (Transparency 11)

A. Function--Provides a framework for the body and protects many vital organs

B. Major organs--Bones

XIII. Muscular system (Transparency 12)

A. Function--Acts on the skeleton to allow body movement

B. Major organs--Muscles

XIV. Reproductive system (Transparency 13)

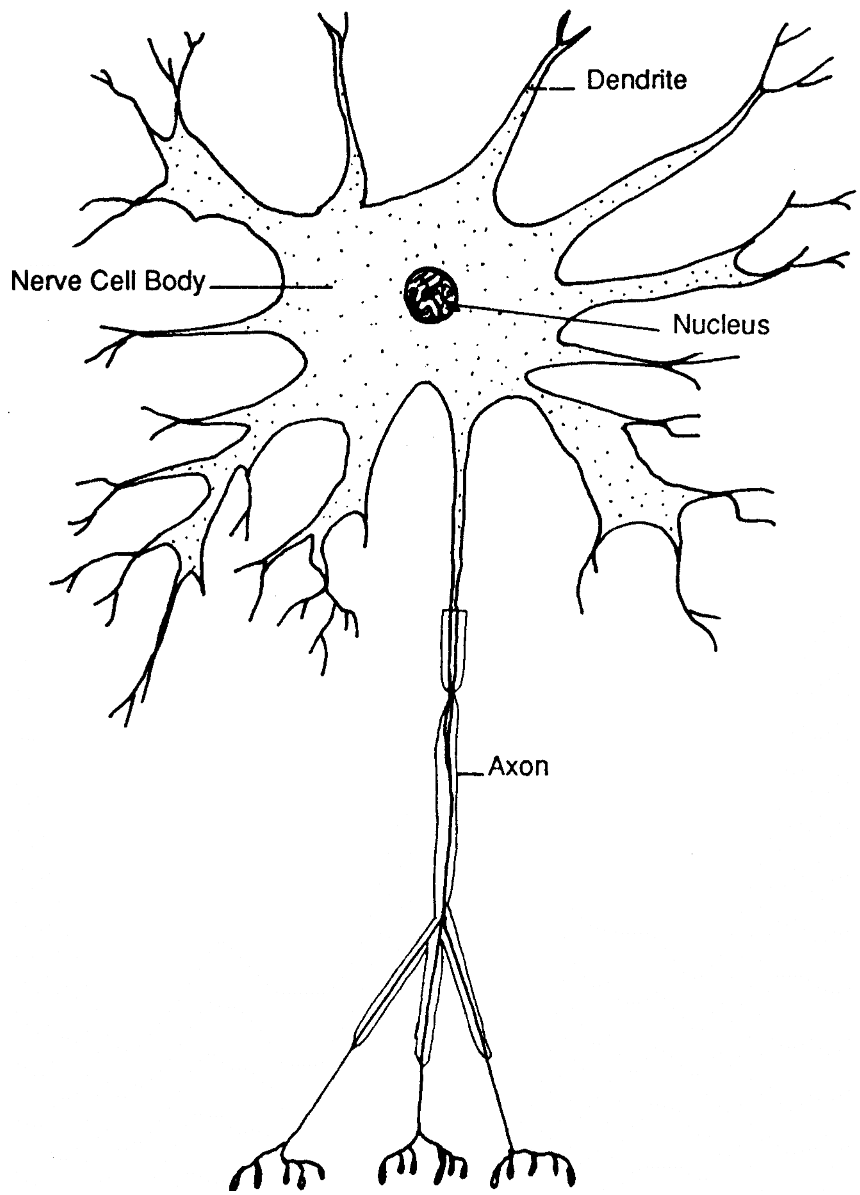
A. Function--Makes the sex cells necessary for producing offspring

B. Major organs

1. Ovaries

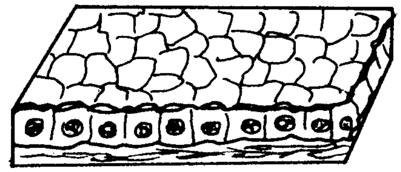
2. Testes

Typical Neuron

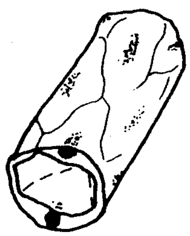


Types of Epithelial Tissue

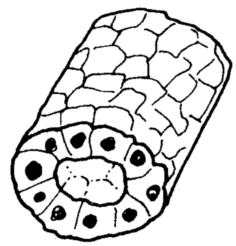
Simple Squamous



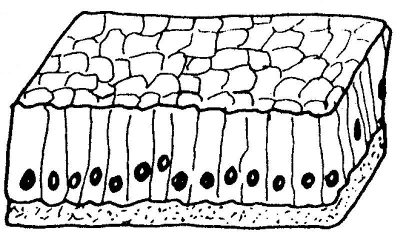
Simple Cuboidal



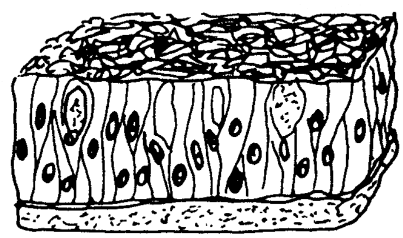
Simple Squamous in Tubular Arrangement



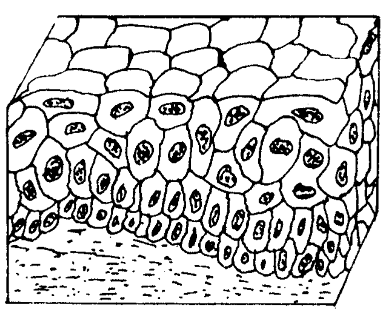
Simple Cuboidal forming a small duct



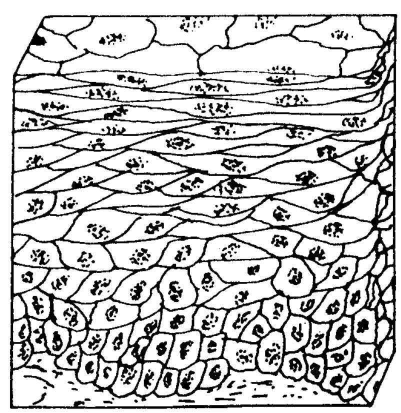
Simple Columnar



Pseudostratified Columnar with Cilia

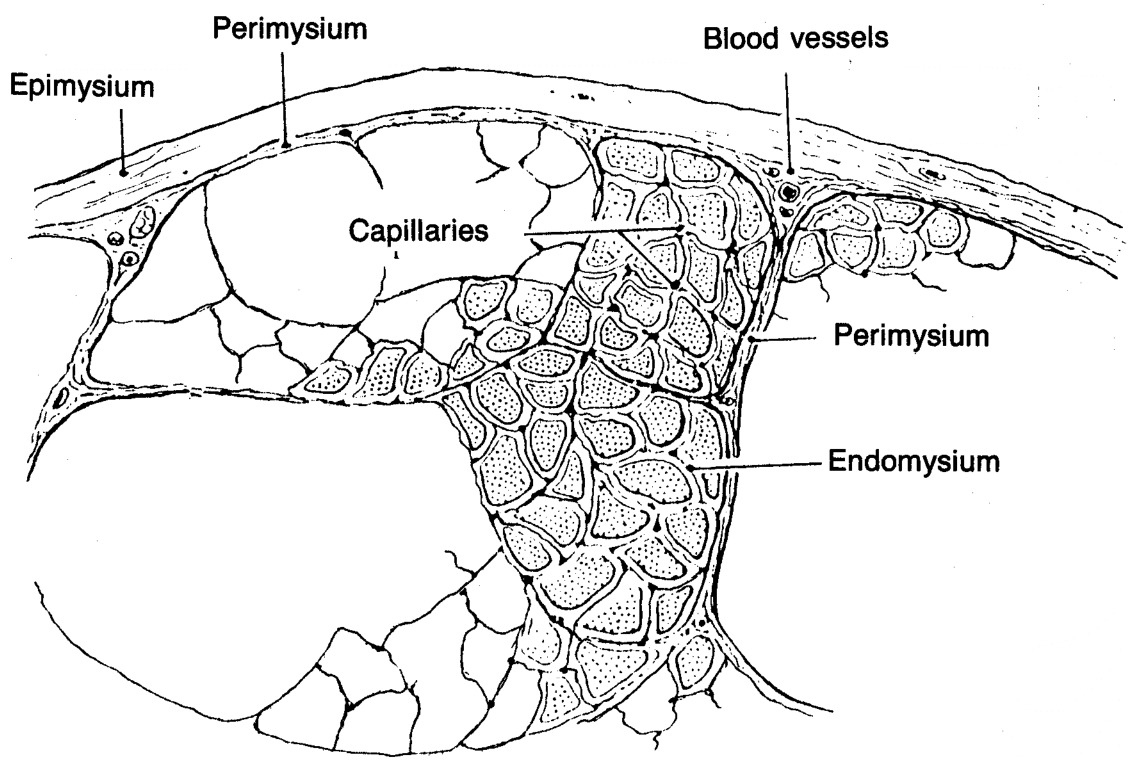


Transitional

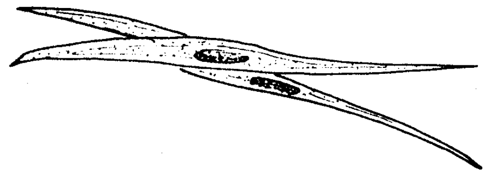


Stratified Squamous (Moist Type)

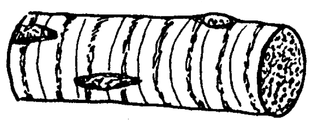
Arrangement of Connective Tissue in a Muscle



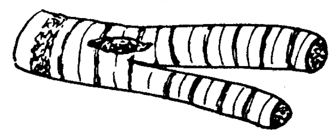
Muscular Tissue



Elongate, spindle-shaped, pointed ends - Smooth



Elongate, cylindrical, blunt ends - Skeletal



Elongate, cylindrical; fibers branch and fuse - Cardiac

Comparison

	Skeletal	*Smooth*	*Cardiac*
Location	Attached to skeleton	Walls of viscera	Wall of heart
Number of nuclei per cell	Many	One	One
Position of nuclei	Peripheral	Central	Central
Cross striations	Present	Absent	Present
Speed of contraction	Most rapid	Slowest	Intermediate
Ability to remain contracted	Least	Greatest	Intermediate
Type of control	Voluntary	Involuntary	Involuntary

CIRCULATORY SYSTEM

Function--Carries gases, digested food and other materials to all parts of the body

MAJOR ORGANS

Heart
Arteries
Veins

DIGESTIVE SYSTEM

Function--Takes in food, digests food, eliminates undigested wastes

MAJOR ORGANS

Mouth
Pharynx
Esophagus
Stomach(s)
Small intestine
Large intestine
Accessory organs

RESPIRATORY SYSTEM

Function--Takes in air, uses certain gases from the air, expels waste gases

MAJOR ORGANS

Lungs
Air passages

EXCRETORY SYSTEM

Function--Eliminates wastes produced inside the cells

MAJOR ORGANS

Kidney
Bladder

NERVOUS SYSTEM

Function--Collects information to regulate body functions

MAJOR ORGANS

Brain
Spinal cord
Nerves

ENDOCRINE SYSTEM

Function--Regulation of body chemical substances

MAJOR ORGANS

Ductless glands

SKELETAL SYSTEM

Function--Body framework, protects vital organs

MAJOR ORGANS

Bones

MUSCULAR SYSTEM

Function--Allows body movement

MAJOR ORGANS

Muscles

REPRODUCTIVE SYSTEM

Function--Produce sex cells

MAJOR ORGANS

Ovaries
Testes

ANIMAL TISSUES, SYSTEMS AND ORGANS

AG 534 - E

LABORATORY EXERCISE #1--NERVOUS SYSTEM

Name ______________________________ Score ______________________________

Introduction

Examination of the fetal pig allows you to observe organs you may otherwise never have the opportunity to examine. A study of the nervous system would not be complete without examination of the brain itself. Because the brain is soft, study of this organ is limited. Because of the close similarity of a pig's brain to a human's brain, this study will allow you to observe and identify several structures nearly identical to your own.

Next, let's review the functions of the parts of the brain we will study in this lab. The *Pia mater* and *Dura mater* are membranes that protect the brain. The *Cerebrum* controls emotions and intelligence; interprets all senses, such as vision and hearing; contains motor and sensory areas. The *Cerebellum* coordinates muscular activities.

Materials needed

Fetal pig
Scissors
Dissecting pan
Tweezers

Part I: Procedures

1. Remove the skin from the top of the fetal pig's head by making the 3 cuts shown in Figure 1.

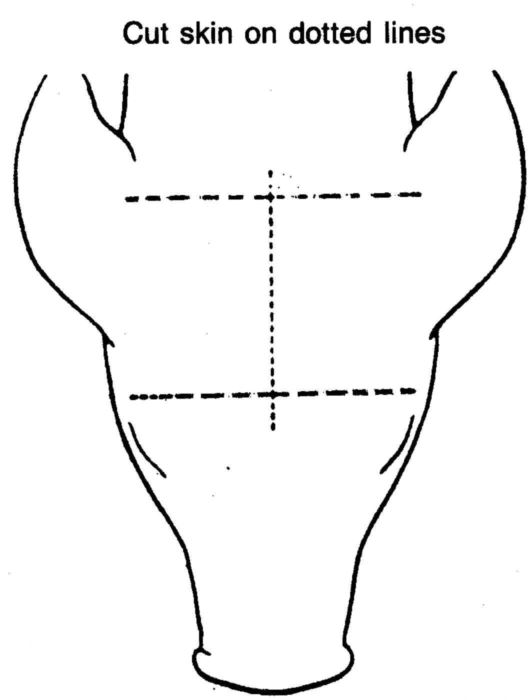


Figure 1

2. Peel back the skin. An area where the skull bones appear to meet, forming an X, should be visible.

3. Carefully insert scissors or tweezers through this point of weakness (soft spot) and slide point between bone and brain tissue. DO NOT push straight down into the brain tissue. It is very soft and is easily destroyed.

4. Use tweezers to slowly break away as much skull as possible beginning at the soft spot. CAUTION: Be careful of flying bone chips. For maximum safety, eye goggles should be worn. DO NOT dig deeply into the brain tissue. When you finish, your pig should resemble the diagram in Figure 2.

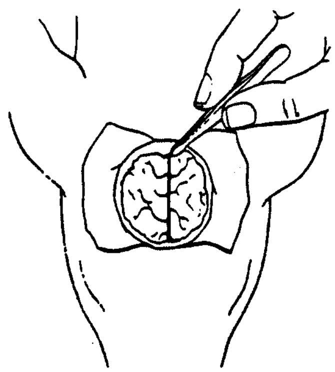


Figure 2

5. Attempt to locate the following parts based on the description of the structures which follows:
   a. Dura mater - tough membrane just below the skull

   b. Pia mater - thin membrane lying over the brain

   c. Cerebrum - large mass of brain tissue divided into left and right halves

   d. Longitudinal fissure - long furrow which divides cerebrum into left and right halves

   e. Gyri - small folds or ridges of the cerebrum

   f. Sulci - small fissures or furrows between gyri

The alternating gyri and sulci give brain tissue its characteristic convoluted (wrinkled) surface.

6. On figure 3, fill in the parts underlined in step 5.

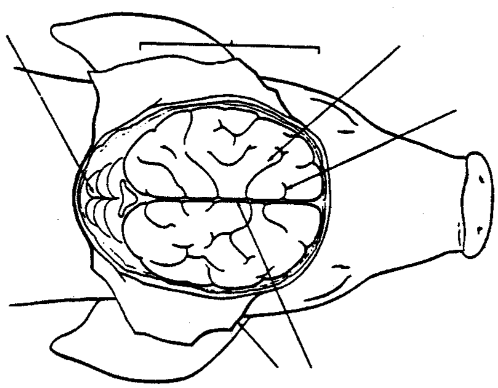


Figure 3

7. Continue to break bone away from the skull toward the neck. Notice that the bone is becoming thicker as you proceed back toward the neck. Further removal of the bone should expose the pig's *cerebellum*. The cerebellum is a mass of brain tissue below the cerebrum. If you have difficulty seeing the cerebellum, remove the meninges (a jelly-like substance.)

8. Label the cerebellum on Figure 3.

Part II: Analysis

1. Match the following four parts of the brain to their functions.
   (Note: The functions may be used more than once.)

_____Dura mater	a.	Controls emotions
_____Cerebrum	b.	Protects the brain
_____Cerebellum	c.	Coordinates muscular activity
_____Pia mater		

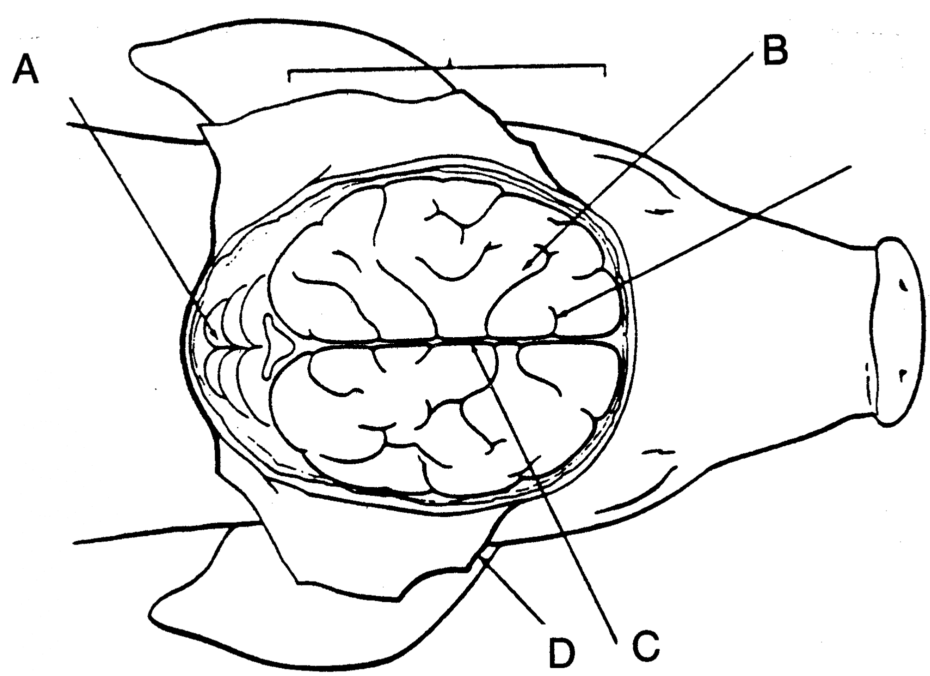
2. List two types of materials required to perform this experiment.
   a.______________________________

   b. ______________________________

3. Using the figure below, identify the parts labeled A, B, C, and D.

   a.____________________ c. ____________________

   b. ____________________ d. ____________________



ANIMAL TISSUES, SYSTEMS AND ORGANS

AG 534 - E

LABORATORY EXERCISE #2--RESPIRATORY SYSTEM

Name ______________________________________ Score ___________________________________

Introduction

The respiratory systems of pigs and humans are very similar. Thus, by observing fetal pig respiratory structures, you can see what your own respiratory system is like.

The respiratory system may be divided into two general areas or regions. First, several structures are located in the oral (mouth) cavity. The remaining organs are located in the thoracic (chest) cavity.

Before we begin the dissection, let's review the functions of the parts of the respiratory system we will explore in this lab.

Hard and soft palate--separate nasal chamber from oral chamber (mouth). The palates are the roof of the mouth and the floor of the nasal chamber

Epiglottis--covers trachea during swallowing; prevents food and water from entering the lungs

Trachea--passageway for air from pharynx to lungs

Diaphragm--muscle below lungs involved in inhalation and exhalation processes

Alveoli--air sacs in lungs where gas exchange with blood occurs

Materials needed

Fetal pig	Pencil
Scissors	Dissecting pan

Part I: Oral Cavity

1. With scissors, cut along each side of your pig's mouth to drop the lower jaw. This is necessary to observe the structures located in the back of the mouth.

2. Locate the structures described on the following page in Table 1 as shown in Figure 1 on your fetal pig.

Table 1

Part	Location and Function
Tongue	Found on lower jaw. Contains taste buds and helps to push food back into esophagus when swallowing
Esophagus	Found at back of mouth. Leads to stomach; horizontal, narrow opening at back of mouth
Nasopharynx (Pharynx)	Found at back of mouth. Carries air from nasal chamber or space above palate (roof of mouth) into trachea, an opening that appears somewhat round at back of mouth
Hard palate	Found in upper jaw of pig. Front portion of roof of mouth. Separates nasal chamber (space above mouth) from mouth
Soft palate	Found in upper jaw of pig. Back portion of roof of mouth. Separates nasal chamber from mouth
Epiglottis	Found in back of mouth. Appears on back end of tongue. Looks somewhat like a flap. It closes shut when swallowing occurs and thus prevents food or liquid from entering lungs
Glottis	Found at back of mouth of pig. Opening that leads to the trachea. Seen as slit under epiglottis in pig. Closed by the epiglottis
Nares	Found at very front of upper jaw. Two small openings (nostrils) through which air passes in and out of nasal chamber

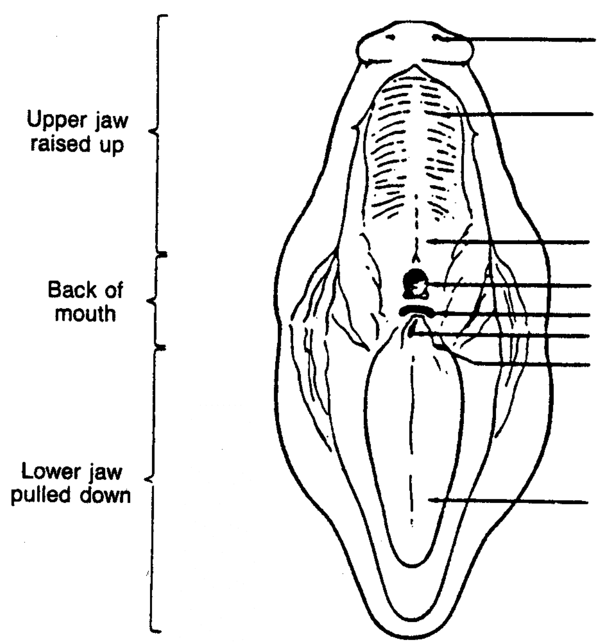


Figure 1

3. Label the following structures in Figure 1: Tongue, Hard palate, Soft palate, Nares, Esophagus, Epiglottis, Glottis and Nasopharynx.

   If all structures shown are not visible, extend the cuts to expose all of the mouth. You may need to cut through the jawbones.

Part II: Chest Cavity

1. The heart is located between the lungs. It is enclosed in a tough membrane called the pericardium. Partially covering the heart is a gland called the thymus.

2. Remove as much of the pericardium and thymus as necessary to totally expose the heart. DO NOT remove any lung tissue.

3. Cut the vessels leading to and from the heart. Also, cut any pericardium or other tissue that may be holding the heart. Remove the heart from the pig. DO NOT damage or cut the lungs.

4. Extend the cut in your pig's chest cavity made during the removal of the heart. Continue cutting in a straight line along the middle of the chest up to the chin.

5. Locate the *trachea*, a long tube composed of ringlike sections extending along the middle of the chest cavity.

6. Push aside muscle attached to the anterior (or top) portion of the trachea. A slight bulge in the trachea is the *larynx*, or voice box.

7. Cut lengthwise into the larynx with scissors. *Vocal cords* should be visible.

8. Locate the *left* and *right lungs*. These organs are composed of soft tissue and have many lobes which occupy most of the chest cavity.

9. Remove any tissue covering the lower portion of the *trachea*. The *trachea* branches into each lung. These branches are the *left* and *right bronchi*.

   Between the chest and abdominal cavity is a very thin muscle. This muscle, called the *diaphragm*, separates the thoracic cavity from the abdominal cavity and aids in inhaling and exhaling.

10. Using the above descriptions and what you observe in your fetal pig, label the following structures on Figure 2: Trachea, Larynx, Vocal cords, Diaphragm, Left lung, Right lung, Left bronchus, and Right bronchus.

    (Remember, left and right sides are reversed in Figure 2)

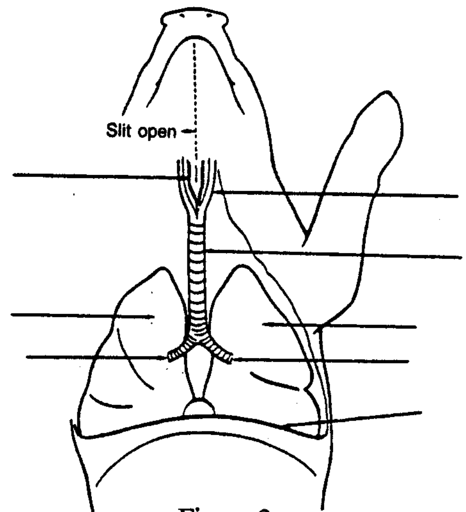


Figure 2

Part III: Lung Anatomy

1. Remove either the left or right lung by cutting with scissors where the bronchus branches from the trachea.

2. Starting where the bronchus enters the lung, use a pencil to push aside all of the soft lung tissue. This should reveal the branches of the bronchus. These branches are called *bronchial tubes*.

   The *bronchial tubes* branch extensively in the lungs. They end as many small air sacs called *alveoli*. *Alveoli* are very thin-walled and are surrounded by capillaries of the lungs. It is in the *alveoli* where gas exchange occurs between blood and air.

Part IV: Analysis

1. Match the part of the respiratory system to its correct function.

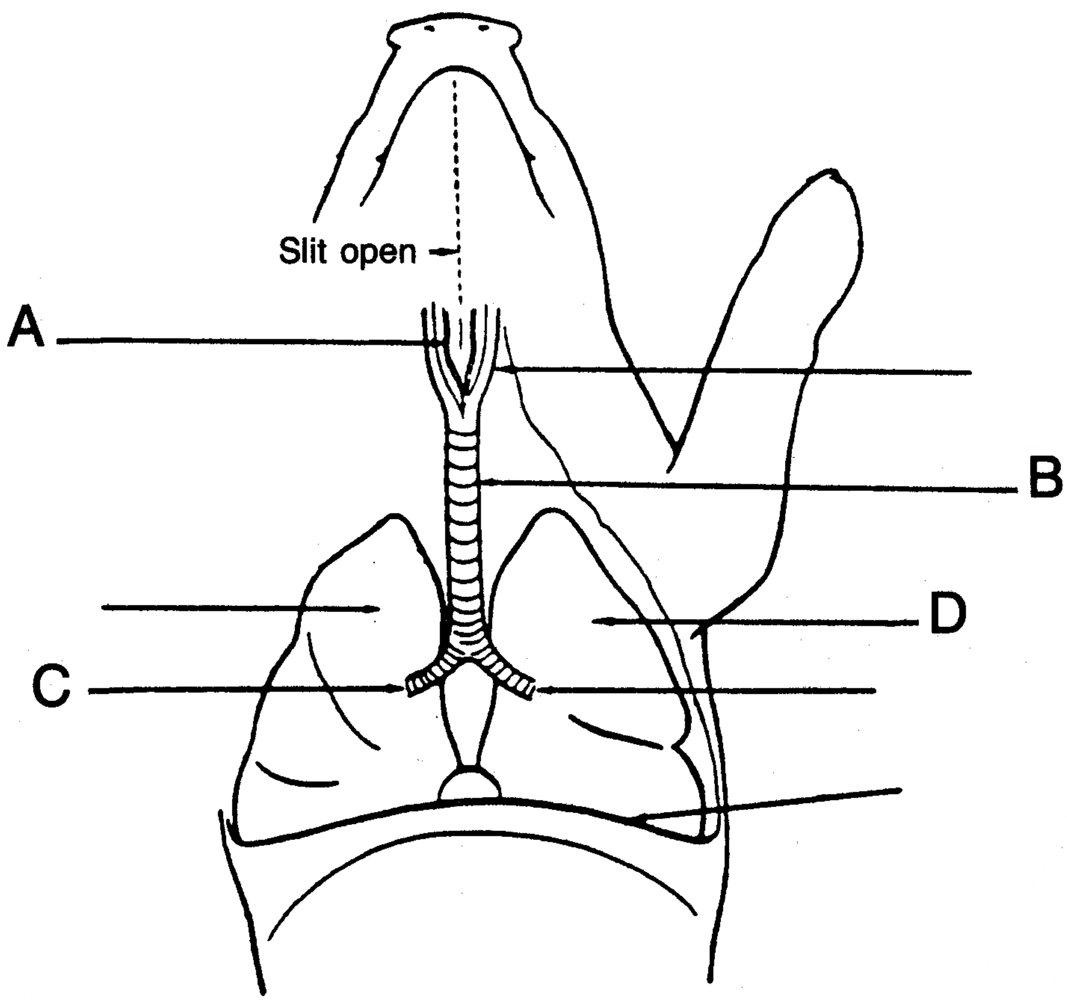
_____Nasopharynx	a.	Muscle below lungs involved in inhalation and exhalation process
_____Epiglottis	b.	Air sacs in lungs
_____Diaphragm	c.	Passageway for air from pharynx to lungs
_____Alveoli	d.	Covers trachea during swallowing

2. List two materials required to perform this lab.

   a.____

   b. ____

3. Identify the parts labeled A through D on the figure below.



A. ____________________ B. ____________________

C. ____________________ D. ____________________

ANIMAL TISSUES, SYSTEMS AND ORGANS

AG 534 - E

LABORATORY EXERCISE #3--HEART STRUCTURE

Name ______________________________ Score ______________________________

Introduction

The heart is a muscular organ which pumps blood. It is divided into four chambers. The two upper chambers take in blood. The two lower chambers pump blood out of the heart. An upper chamber is called an *atrium*. A lower chamber is called a *ventricle*.

Blood moves in only one direction in the heart. Between each atrium and each ventricle there is a valve. The valve acts like a door that opens in one direction. Each valve keeps the blood moving in only one direction.

Blood first moves into the two upper chambers. The top chambers then pump blood through the valves into the lower chambers. As the lower chambers fill with blood, the valves close. When the lower chambers squeeze together, blood is forced out of the heart. Blood does not move back into the top chambers.

Figure 1 traces the flow of blood though the animal heart. It contains the names and locations of all the major blood vessels and heart structures. Trace the path of blood from the head through the heart and back out to the head. Do the same for blood coming from the legs.

Heart Structure

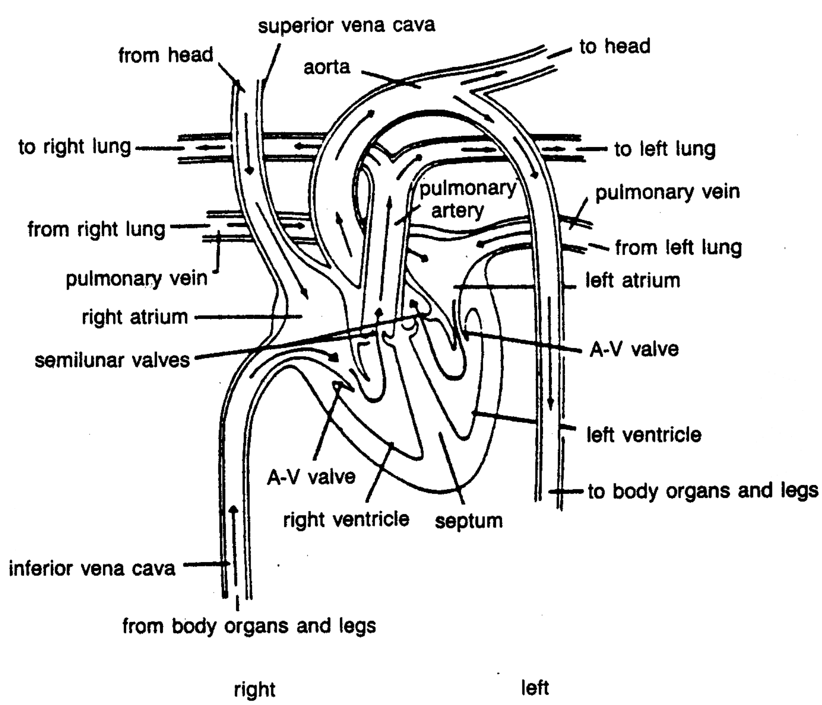


Figure 1

Before beginning the experiment, let's become familiar with the terms *deoxygenated* and *oxygenated*. All blood vessels bringing blood to the heart's right side and leaving from the right ventricle contain blood that is deoxygenated. Deoxygenated blood is blood that is low in oxygen and high in carbon dioxide.

All blood vessels bringing blood to the heart's left side and leaving from the left ventricle contain oxygenated blood. Oxygenated blood is blood that is high in oxygen and low in carbon dioxide.

Materials needed

Cow heart (or sheep)
Dissecting pan
Paper towels
Probe

Part I: Examine the Outside of the Heart

1. Place the heart in the dissecting pan so that it looks like the diagram titled Figure 2. The right side of the heart is on your left side. The left side of the heart is on the right.

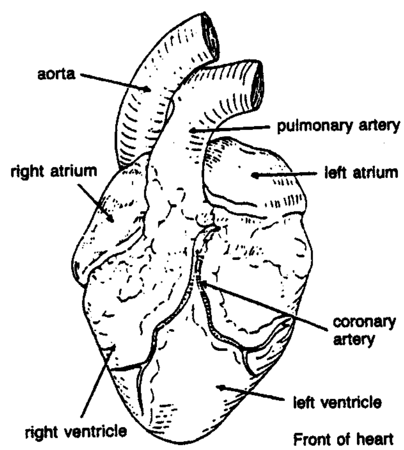


Figure 2

Table 1

Front Parts of the Heart

Part	Location	Traits	Name
A	across front of heart center	small blood vessel	coronary artery (KOR uh ner ee)
B	bottom center and right	large muscle section or chamber	left ventricle (VEN trih kul)
C	bottom left	large muscle section or chamber	right ventricle
D	top right	small muscle section or chamber	left atrium (AY tree um)
E	top left	small muscle section or chamber	right atrium
F	top center	large blood vessel from right ventricle	pulmonary artery (POOL muh ner ee)
G	top center behind F	large blood vessel from left ventricle largest artery in body	aorta (ay ORT uh)

2. Use the information in Table 1 and the diagram in Figure 2 to find the following parts on your cow heart: (Place an X after each part you successfully locate).

Coronary artery	______	Right atrium	____
Left ventricle	______	Pulmonary artery	____
Right ventricle	______	Aorta	____
Left atrium	______		

3. Turn the heart over. Note: Right and left change when the heart is turned over. Use the information in Figure 3 and Table 2 to find the following parts: (Place an X after each part you successfully locate).

Vena cava veins	______	Pulmonary vein	____

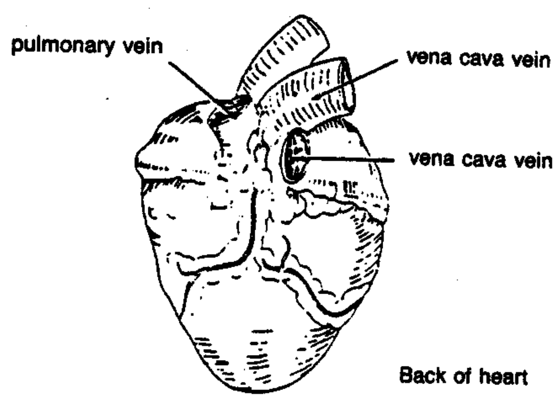


Figure 3

Back Parts of the Heart

Part	Location	Traits	Name
A	top of right atrium (top right)	two large blood vessels, holes may be all that can be seen	vena cava veins (VEE na KAY va)
B	top of left atrium (top left)	large blood vessel, hole may be all that can be seen	pulmonary vein

Table 2

Part II: Examine the Inside of the Heart

1. Your teacher will cut the front and back sections of your cow heart apart. Keeping both halves together, lay the heart in the dissecting pan as you did in the first step of Part I.

2. Remove the top half of the heart and lay it aside. Examine the bottom half of the heart. Note which chamber is the largest.

   a. The largest chamber is the ________________________.

3. Examine the thickness of the muscle that makes up the sides of the heart ventricles. Examine the walls of the atria for thickness, too.

   a. Which chamber, the atrium or ventricle, has thicker walls? ____________________________

   b. Of the right or left ventricle, which has thicker walls? ________________________________

4. Find all of the parts shown in the diagram titled Figure 4. As you locate each part, check it off the list below.

Aorta	______	Left ventricle	____
Valve	______	Left heart valve	____
Right atrium	______	Left atrium	____
Right heart valve	______	Pulmonary artery	____
Right ventricle	______		

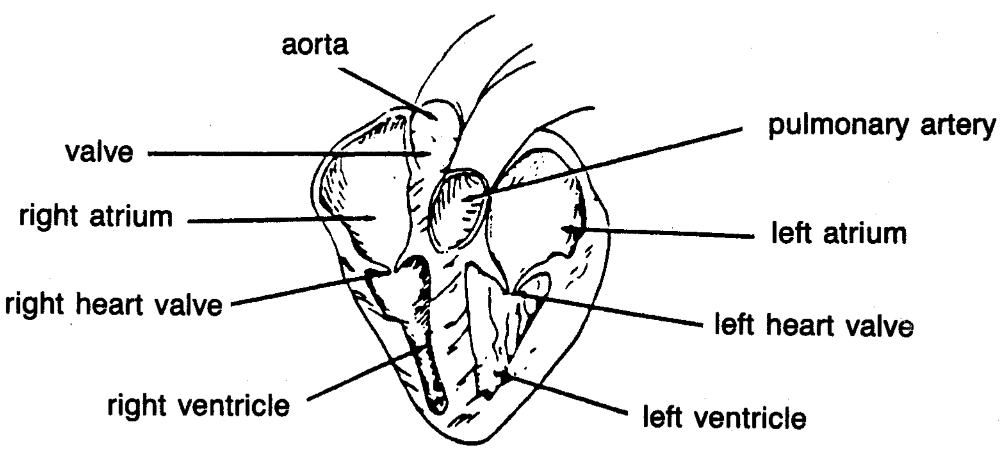


Figure 4

5. Examine the top half of your cow heart. Look for the valves. Remember that valves keep the blood flowing in one direction in the heart. The closing of the valves makes the noise we know as the heart beat.

6. Find all the parts shown in the diagram titled Figure 5. As you locate each part, check it off the list shown below.

Pulmonary artery	______	Right ventricle	____
Left atrium	______	Right heart valve	____
Left heart valve	______	Right atrium	____
Left ventricle	______	Artery valve	____
		Aorta	____

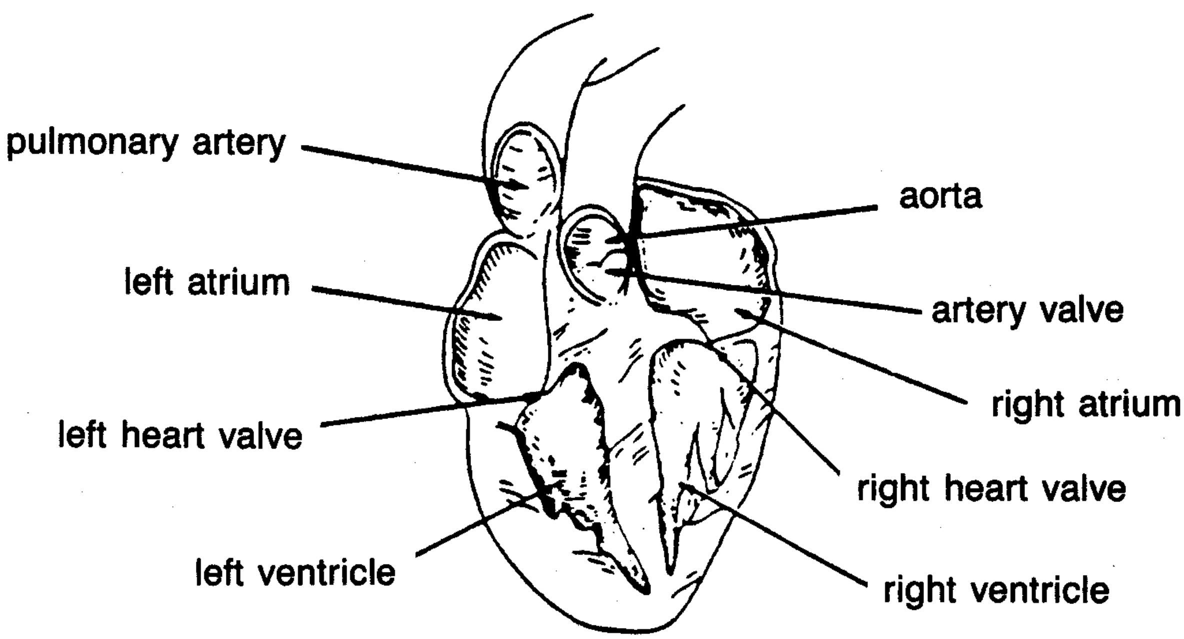


Figure 5

Part III: Analysis

1. What are the largest chambers of the heart?

____

2. What chambers are at the top of the heart?

____

3. Which have thicker walls, atria or ventricles?

____

4. Which ventricle, left or right, has thicker walls?

____

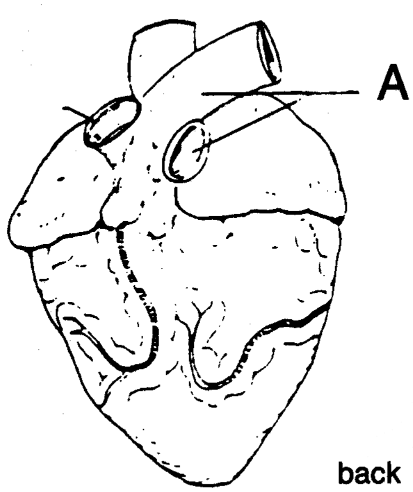
5. Which ventricle pumps blood to the body?

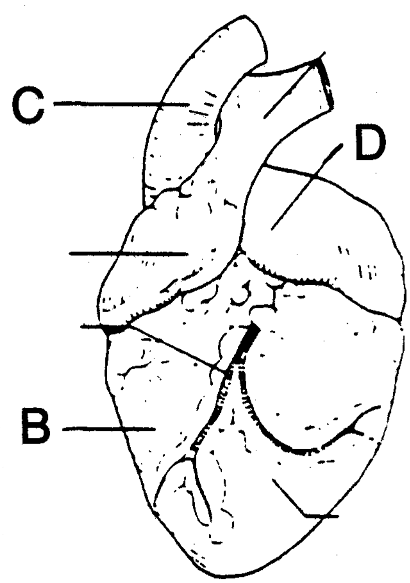
____

6. Which ventricle pumps blood to the lungs?

____

7. Identify the parts labeled A through D on the diagrams below.





A. ______________________________ C. ______________________________

B. ______________________________ D. ______________________________

8. Which side of the heart has blood high in oxygen?

____

9. Which side of the heart has blood low in oxygen?

____

10. From what body organ does the blood get oxygen? ______________________________

11. Blood is kept moving in only one direction by ______________________________

12. The largest artery in the body is called the ______________________________

ANIMAL TISSUES, SYSTEMS AND ORGANS

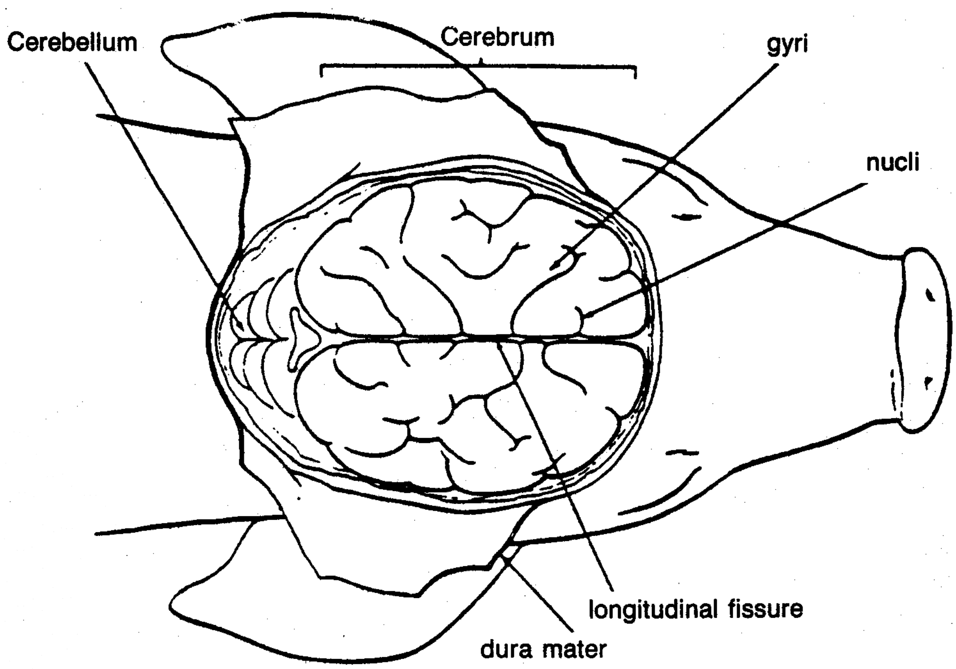
AG 534 - E

ANSWERS TO LABORATORY EXERCISES

Lab #1

Part I:

Step 6:



Part II:

1. b, a, c, b
2. Answer should include any two of the following: Fetal pig, dissecting pan, scissors, tweezers
3. a. Cerebellum
   b. Gyri
   c. Longitudinal fissure
   d. Dura mater

Lab #2

Part I, II:

Students should have labeled Figure 1 and Figure 2 as you see them below:

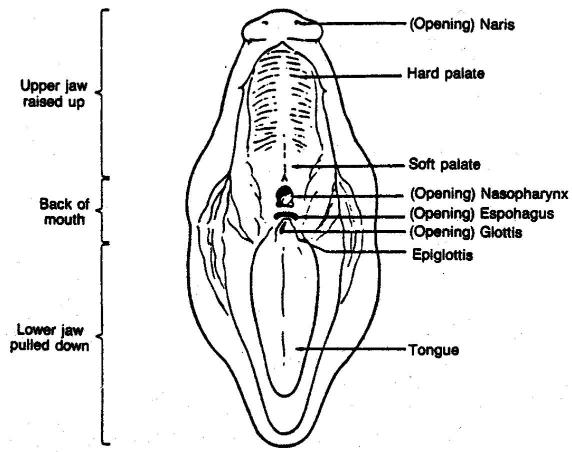


Figure 1

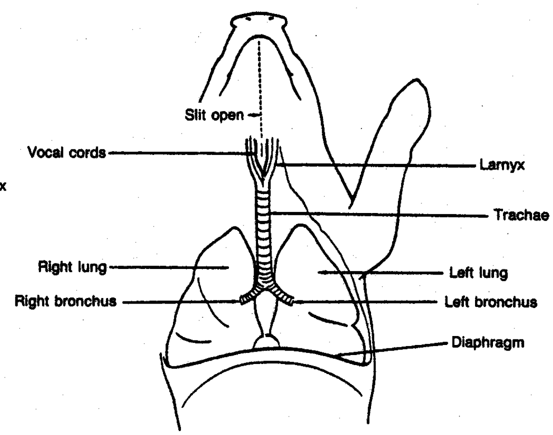


Figure 2

Part IV:

1. c, d, a, b
2. Answer should include any two of the following: Fetal pig, scissors, pencil or dissecting pan
3. A. Vocal cords B. Trachea
   C. Right bronchus D. Left lung

Lab #3

Part I:

Students should have checked off all parts listed in Part I, steps 2 and 3.

Part II:

2. a. Largest chamber in the heart is the Ventricle.
3. a. Chamber with the thickest walls is the Ventricle.
   b. Left ventricle has the thicker walls.
4. Students should have checked off all parts listed in Part II, steps 4 and 6.

Part III:

1. Ventricles
2. Atria
3. Ventricles
4. Left
5. Left
6. Right

7. A. Vena Cava Veins
   B. Right Ventricle
   C. Aorta
   D. Left atrium
8. Left
9. Right
10. Lungs
11. Valves
12. Aorta

ANIMAL TISSUES, SYSTEMS AND ORGANS

AG 534 - E

UNIT TEST

Name ______________________________ Score ______________________________

1. Describe the four primary animal tissues.

   a. ____

   ____

   ____

   b. ____

   ____

   ____

   c. ____

   ____

   ____

   d. ____

   ____

   ____

2. Identify the types of epithelial tissue described below. Write the correct name in the blank.

   a. ____________________ Found in ducts and passageways; short prism-shaped

   b. ____________________ Found in pharynx and salivary ducts

   c. ____________________ Kinked fibers that tend to regain shape after being stretched

   d. ____________________ Found in blood vessels; flat-shaped

   e. ____________________ Forms outer skin layer; thickest and toughest of epithelial tissues

   f. ____________________ Tall; found in intestines and trachea

   g. ____________________ Netlike, star-shaped

   h. ____________________ Stretches from many layers thick to a single layer

i. ____________________________ Found in upper respiratory; vary in length

j. ____________________________ Found in mucous or hormonal glands

3. Match the types of connective tissue with their correct description by placing the appropriate number in the blank.

1. Endomysium 2. Perinysium 3. Epinysium

_____a. Connective tissue around groups or bundles of muscle fibers

_____b. Connective tissue surround the individual muscle fibers

_____c. Connective tissue surrounding the entire muscle

4. Identify the types of muscular tissue described below. Write the correct name in the blank.

a.______________________________ Muscles of the gastrointestinal tract

b. _____________________________ The skeletal muscle

c.______________________________ The cardiac muscle

5. Identify the types of nervous tissue described below. Write the correct name in the blank.

a.____________________________ Conduct impulses from skin or sense organs to nerve centers

b. ___________________________ Form connections between other neurons

c. ____________________________ Conduct impulses from the nerve centers to muscles or glands

6. State the functions and list the three major organs of the circulatory system.

Functions: ____

____

Major organs:

a.____

b. ____

c.____

7. State the functions and list the seven major organs of the digestive system.

Functions: ____

____

Major organs:

a.____________________

b. ____________________

c.____________________

d. ____________________

e.____________________

f.____________________

g. ____________________

8. State the functions and list the two major organs of the respiratory system.

Functions: ____________________

____

Major organs:

a.____________________

b. ____________________

9. State the function and list the two major organs of the excretory system.

Function: ____________________

____

Major organs:

a.____________________

b. ____________________

10. State the function and list the three major organs of the nervous system.

Function: ____________________

____

Major organs:

a.____________________

b. ____________________

c.____________________

11. State the function and list the major organ of the endocrine system.

    Function: ____

    ____

    Major organ: ____

12. State the functions and list the major organ of the skeletal system.

    Functions: ____

    ____

    Major organ: ____

13. State the function and list the major organ of the muscular system.

    Function: ____

    ____

    Major organ: ____

14. State the function and list the two major organs of the reproductive system.

    Function: ____

    ____

    Major organs:

    a.____

    b. ____

ANIMAL TISSUES, SYSTEMS AND ORGANS

AG 534 - E

ANSWERS TO TEST

1. Answer should include the following information:
   a. Epithelial tissue: Covers an internal or external surface; Body surface, body cavities linings, body ducts and passages and the secretory portion of glands
   b. Connective tissue: Sheets or bands of tissue composed of strands or fibrils of three proteins (collagen, elastin, reticulum) distributed in a watery matrix of ground substance; Forms a part of the skeletal system; Forms the firm attachment against which a muscle pulls (muscle connections to bone); Surrounds, collects and forms a harness to regulate and control muscle fibers, muscle fiber bundles and entire muscles during contraction and relaxation
   c. Muscular tissue: Most common tissue found in most animals; The cell or muscle fiber is made up of elongated strands specialized for contraction; The contractile elements of the fiber are micro fibrils
   d. Nervous tissue: Conducts impulses after receiving some stimulus; Neuron--The essential cell of the nervous system; Dendrites--Nerve fibers connected to the nerve cell body that conduct impulses <u>toward</u> the cell body; Axon--Nerve fibers connected to the nerve cell body that conduct impulses <u>away</u> from the cell body

2.

a.	Cuboidal	f.	Columnar
b.	Stratified columnar	g.	Branching
c.	Yellow	h.	Transitional
d.	Squamous	i.	Pseudostratified columnar
e.	Stratified squamous	j.	Glandular

3. a. 2 b. 1 c. 3

4. a. Smooth-involuntary
   b. Striated-voluntary
   c. Striated-involuntary

5. a. Sensory b. Association c. Motor

6. Function--Carries gases, digested food and other materials to all parts of the body
   Major organs: Heart; Arteries; Veins

7. Function--Takes in food, digests food and eliminates undigested wastes
   Major organs: Mouth; Pharynx; Esophagus; Stomach(s); Small intestine; Large intestine (includes cecum, colon and rectum); Accessory organs (includes pancreas, liver, gall bladder)

8. Function--Takes in air, uses certain gases from the air, expels waste gases
   Major organs: Lungs; Air passages

9. Function--Eliminates wastes produced inside the cells
   Major organs: Kidney ; Bladder

10. Function--Collects information from inside and outside the body to help regulate body functions
    Major organs: Brain; Spinal cord; Nerves

11. Function--Helps regulate the chemical substances in the body
    Major organs: Ductless glands

12. Function--Provides a framework for the body and protects many vital organs
    Major organs: Bones

13. Function--Acts on the skeleton to allow body movement
    Major organs: Muscles

14. Function--Makes the sex cells necessary for producing offspring
    Major organs: Ovaries; Testes

GENETICS AND HEREDITY

AG 534 - F

UNIT OBJECTIVE

After completion of this unit, students should be able to describe meiosis and mitosis. Students should also be able to use the pungent square to predict traits of offspring and list the pairs of chromosomes for various livestock species. This knowledge will be demonstrated by completion of assignment sheets, laboratory exercises and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Define terms related to genetics and heredity.
2. Identify the phases of mitosis and meiosis.
3. Explain why genes are important in animal breeding.
4. List and describe the two ways in which genes control inherited traits.
5. Define dominant gene and recessive gene.
6. Define and give an example of incomplete dominance.
7. Demonstrate the use of the pungent square to predict the traits of the offspring when the male and female carry heterozygous gene pairs of a given trait.
8. Explain how the sex of the offspring is determined in mammals and poultry.
9. Define and give an example of sex-linked characteristics.
10. Explain linkage, crossover and mutation.
11. Match traits of beef animals to their respective heritability estimates.
12. Calculate estimated annual progress from genetic selection.
13. Describe the components of the modified contemporary comparison system for dairy bull evaluation.
14. List the pairs of chromosomes for each of the various species of livestock.
15. Examine the phases of meiosis and mitosis.
16. Predict inheritance.
17. Study genetics by breeding fruit flies.

GENETICS AND HEREDITY

AG 534 - F

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

   A. Make transparencies and necessary copies of materials.

   B. Provide students with objectives and discuss.

   C. Provide students with information and discuss.

   D. Provide students with assignment sheets and laboratory exercises.

   E. Demonstrate laboratory exercise procedures.

   F. Develop information on dihybrid crosses for more interested students.

   G. Arrange a field trip to allow students an opportunity to see the different livestock breeding programs in the area.

   H. Take pictures of different hereditary characteristics which may result from selective breeding.

   I. Review and give test.

   J. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheets

   D. Transparency masters

      1. TM 1--The Phases of Mitosis

      2. TM 2--Meiosis

      3. TM 3--Inheritance of Color

      4. TM 4--Sex Determination

      5. TM 5--Swine Heritability Estimates

E. Assignment sheets

1. AS 1--Calculate Estimated Improvement From Genetic Selection (Swine)

2. AS 2--Calculate Estimated Annual Progress From Genetic Selection (Sheep)

3. AS 3--Calculate Estimated Annual Progress From Genetic Selection (Beef)

F. Answers to assignment sheets

G. Instructor notes for laboratory exercises

H. Laboratory exercises

1. LE 1--Mitosis and Meiosis

2. LE 2--Sex-Linked Traits

3. LE 3--Predicting Inheritance

4. LE 4--Influence of Chance on Inheritance

5. LE 5--Breeding Fruit Flies to Study Genetics

I. Answers to laboratory exercises

J. Test

K. Answers to test

III. Unit references

A. Barrick, R., and Harmon, H., *Animal Production and Management*, McGraw-Hill Book Company, New York, 1988.

B. Bearden and FuQuay, *Applied Animal Production,* Prentice-Hall, Englewood Cliffs, New Jersey, 1980.

C. Bundy, C.E., et al., *Livestock and Poultry Production*, 5th edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1982.

D. Ensminger, M.E., *Animal Science*, Interstate Publishers, Danville, Illinois, 1983.

E. *Idaho State Board for Vocational Education Curriculum Guide in Livestock Production*, University of Idaho and the Idaho State Board for Vocational Education.

F. Lasley, John F., *Genetics of Livestock Improvement*, 3rd edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1978.

G. Sorensen, A.M., *Animal Reproduction Principles and Practices*, McGraw-Hill Book Company, New York, 1979.

GENETICS AND HEREDITY

AG 534 - F

INFORMATION SHEET

I. Terms and definitions

A. Gene--Complex molecule that determines hereditary characteristics of living animals; located at definite places on the chromosomes

B. Chromosome--Thread-like structure which exists in pairs and carries genes

C. Mutation--Random changes that take place in a gene

(Note: These are very rare and may be harmful.)

D. Mitosis--Division of a body cell into two duplicate body cells

E. Meiosis--Division of a sex cell, producing a cell or cells containing only one of each gene and chromosome pair

F. Genetics--Branch of biology that deals with the heredity and variation of organisms

G. Gamete--Mature germ cell; egg or sperm

H. Fertilization--Union of the egg and sperm

I. Zygote--Fertilized egg

(Note: In the zygote, the genes and chromosomes are restored to pairs.)

J. Homozygous--Animal that is pure for a certain gene, such as the polled gene

K. Heterozygous--Animal that is a carrier of a pair of unlike genes

L. Phenotype--The outward appearance of the animal

(Note: Individuals of the same phenotype look alike, but may not breed alike.)

M. Genotype--Genetic make-up of the animal

(Note: Individuals of the same genotype breed alike.)

N. Lethal gene--Genetic factor that causes death of the young during prenatal life, at birth or soon after

(Note: These may be discovered and therefore removed by test mating, especially a bull to his daughters.)

O. F1--Symbol which represents the first cross from a mating

P. F2--Symbol which represents second cross from a mating

Q. Heritability--Percentage of differences in a trait that can be explained by inheritance as opposed to environment

R. Dwarfism--Inherited characteristic of cattle resulting in small, deformed animals

(Note: Dwarf carrier calves cannot be distinguished from non-dwarf carrier calves. A purebred breeder would therefore want to get rid of all offspring and parents known to carry the dwarf characteristic.)

II. Mitosis (Transparency 1)

A. Interphase--period between cell divisions

1. Genetic material in form of chromatin

a. A complex of DNA and protein

b. Spread throughout nucleus

2. Centrosome located outside nuclear membrane

a. Small oval area

b. Contains one or two smaller structures called centrioles

3. DNA in the chromatin replicates itself before cell division occurs

B. Prophase

1. Long threads of chromatin gradually shorten and thicken--visible as chromosomes

a. Each chromosome consists of two identical parts called chromatids

b. Chromatids held together at single point called the centromere

2. Nucleoli and nuclear membrane break down and disappear into the cytoplasm

3. Astral rays (protein fibers) form around each centriole (a centriole and its rays are called an aster)

4. Asters leave centrosome--move toward opposite sides of the cell

5. Spindle formed as more protein fibers form between the two centrioles

   a. Spindle shaped like a football

   b. Ends of the spindle are called poles

   c. The region across the middle is called the equator

C. Metaphase

1. Chromosomes move toward middle of spindle between the two poles and line up (side by side) at equator

2. Chromatids

   a. Paired

   b. Short, thick, coiled around one another

   c. Attach to spindle fibers at their centromeres

D. Anaphase

1. Chromatids separate; move to opposite poles

2. Now have same number of chromosomes at each pole as were in the parent cell

E. Telophase

1. Chromosomes become thin threads of chromatin

2. Spindle fibers and asters disappear

3. Nuclear membrane reappears

4. Nucleoli appear in the two new nuclei

5. Centrosomes reappear

6. Cytoplasm begins to divide at equator

   a. Cell membrane pinches inward to form a groove or furrow

   b. Furrow deepens until the two cells are separated

III. Meiosis (Transparency 2)

A. First stage of meiosis

1. Interphase I

    a. Genetic material in form of chromatin

    b. DNA replicates when meiosis is about to occur

2. Prophase I

    a. Fine threads of chromatin shorten and thicken

    b. Chromosomes become visible

        (1) Each chromosome consists of two identical chromatids joined at their centromere

        (2) Homologous chromosomes begin to move toward each other

    c. Tetrad--arrangement formed when the homologous chromosomes move close together; there is a total of four chromatids since each chromosome consists of two chromatids

    d. Synapsis--close contact between homologous chromosomes resulting from the chromatids of a tetrad twisting around one another

    e. Tetrads move toward middle of cell

3. Metaphase I

    a. Tetrads line up along equator of cell

4. Anaphase I

    a. Homologous chromosomes of the tetrad separate

        (1) One goes to one pole, the other one goes to the other pole

        (2) The chromatids of individual chromosomes do not separate yet

5. Telophase I

    a. Cytoplasm divides

    b. First stage of meiosis is completed

        (1) Result: Production of two haploid daughter cells; each containing one chromosome of each pair that was in the parent cell

        (2) Chromosomes are no longer paired; the total number of chromosomes in each daughter cell is half the number of chromosomes that was in the parent cell

B. Second stage of meiosis

(Note: There is no replication of DNA in the daughter cells during the second stage of meiosis.)

1. Prophase II

   a. Very brief - sometimes even passed over

   b. Each chromosome consists of two chromatids attached in the region of their centromere

2. Metaphase II--chromosomes line up along equator

3. Anaphase II--chromatids of each chromosome separate and move to opposite poles of the cells

4. Telophase II

   a. Meiosis is completed

   b. Four haploid cells have been formed

IV. Importance of genes in animal breeding

A. Genes determine individual characteristics such as

1. Hair color

2. Body conformation

3. Body type

4. Horned/polled

5. Hair type

6. Growth rate

7. Production

B. Breeding stock can be selected for desirable characteristics to be passed to offspring

V. Gene inheritance

A. Simple--One pair of genes determines the inheritance of a particular factor

B. Multiple--Several pairs of genes determine the inheritance of a particular factor

Example: Genes affecting meat production, milk and butterfat production, and growth rate

(Note: Growth rate is hard to identify and is controlled by several genes.)

VI. Genes

A. Dominant--Genes that have the ability to cover up or mask the presence of one member of a set of genes in the F1 generation

Examples: Pure polled; white face in Herefords; drop ears in swine

(Note: Dominance is usually designated by a capital letter.)

B. Recessive--Genes that are covered up or masked in the F1 generation

Example: Horned; erect ears in swine

(Note: Recessive genes are usually designated by a small letter.)

C. Incomplete dominance--Genes that are neither completely dominant nor recessive and which only contribute to a certain characteristic (Transparency 3)

Example: Crossing a red Shorthorn and a white Shorthorn results in a roan color of red and white hairs. Neither characteristic completely masks or is masked by the other.

VII. Punnent square to predict gene combinations

A. Cross a pure polled (PP) bull with horned (pp) cows

1. Mating: PP x pp

		Male	
		P	**P**
Female	**p**	**Pp**	**Pp**
	p	**Pp**	**Pp**

2. F1: Genotype - Pp
Phenotype - polled

B. Cross F1 males (Pp) with F1 females (Pp)

1. Mating: Pp x Pp

		Male	
		P	**p**
Female	**P**	**PP**	**Pp**
	p	**Pp**	**pp**

2. F2: Genotypic ratio - 1PP:2Pp:1pp
Phenotypic ratio - 3 polled; 1 horned

VIII. Sex determination (Transparency 4)

A. A female egg contains an X chromosome

B. A male sperm contains either an X or Y chromosome

C. Egg and sperm unite randomly to form zygote

1. If egg and sperm contain like chromosomes (X and X), a female is conceived

2. If egg and sperm contain unlike chromosomes (X and Y), a male is conceived

(Note: The male sperm therefore determines the sex of the offspring.)

IX. Sex-linked characteristics

A. Sex-linked gene

1. Gene found on X chromosome

2. In male, will be expressed (whether dominant or recessive) in the phenotype

B. Example: Colorblindness

1. Normal vision = C colorblindness = c

2. XX = female, XY = male

3. Normal vision female = $X^C X^c$ (normal vision is dominant)

4. Normal vision male = $X^C Y$ (the Y chromosome does not carry genetic information)

X. Linkage--Genes linked on the same chromosome (if there was no crossing over, these two genes would never be separated during meiosis)

XI. Crossover

A. Splits up the genes that would normally stay linked on the same chromosome

B. Production of new chromosomes--can make new kinds of chromosomes relative to the genes by crossing over (e.g. chromosomes that you pass on to your offspring could be from your mother and father)

XII. Mutation

A. Sudden change in the characteristics of an organism due to a change in the chemical structure of the DNA

B. Causes

1. DNA replication error

2. Radiation exposure

3. Toxic chemical exposure

4. Genetic abnormalities such as extra chromosomes, or the crossing or breaking of chromosomes

C. Future generations

1. Mutations that help an animal survive are continued -- survivors reproduce

2. Harmful mutations are less likely to be passed to future generations since the animals often don't survive to reproduce

XIII. Heritability--Percentage of differences in a trait that can be explained by inheritance as opposed to environment

XIV. Heritability percentages for economically important beef traits

(Note: The higher the percentage, the faster a herd can be improved by genetic selection for that trait.)

(CAUTION: These are estimates only. Actual percentages will vary.)

A. Calving interval (fertility) 10%

(Note: This percentage is somewhat misleading as animals with poor fertility are automatically eliminated from the calculations since they have no offspring in which to measure differences.)

B. Birth weight 40%

C. Weaning weight 30%

D. Final feedlot weight 60%

(Note: This is generally figured at one year of age or at the end of the testing period.)

E. Feedlot gain 45%

F. Feed efficiency 40%

G. Carcass grade 40%

H. Rib-eye area 70%

I. Retail product (lb) 65%

(Note: Carcass traits are the most heritable.)

XV. Calculate annual progress of beef based on genetic selection -- progress is calculated by multiplying heritability by the selection differential and then multiplying by the amount contributed from the animal selected (Assignment Sheet #3)

(Note: Selection differential can be much higher in bulls than heifers, because fewer bulls need to be kept and therefore selection can be more rigid.)

Example: Goal -- improvement in final feedlot weights
Procedure -- select heifers weighing 50 pounds more than the herd average
-- select bulls weighing 200 pounds more than the herd average

Selection differential for heifers	50 lb
Heritability estimate (60%)	x .6
Expected increase from females	30 lb
Contribute 1/2 to offspring	x .5
Heifer contribution	15 lb
--- 15 lb ---	

Selection differential for bulls	200 lb
Heritability estimate (60%)	x .6
Expected increase from males	120 lb
Contribute 1/2 to offspring	x .5
Bull contribution	60 lb
Heifer contribution	15 lb
Expected increase in final feedlot weights of progeny	75 lb

(Note: While selection for heredity is important, overall genetic improvement only accounts for about 30% compared to an overall of 70% for environmental and management factors. This is why it is also important to select among animals in the same environmental conditions.)

XVI. Heritability estimates for dairy

(Note: Studies have shown that differences between individual cows are due to: herd influences-35%; year and season-15%; inheritance-25%; and short term factors such as nervousness or mastitis-25%.)

Trait			Heritability
A.	Production:		
	1.	Milk production	25%
	2.	Fat percentage	50%
	3.	Protein percentage	50%
	4.	Feedlot gain	45%
B.	Physical traits:		
	1.	Stature	40%
	2.	Udder support	20%
	3.	Legs and feet	15%
C.	Management traits:		
	1.	Milking speed	25%
	2.	Birth weight	40%
	3.	Temperament	40%
	4.	Fertility	5%

(Note: This heritability estimate may be somewhat misleading since an infertile heifer is automatically eliminated from the data collection since she has no offspring to measure differences in. A heifer with an infantile vulva or a coarse, bullish appearance should always be selected against.)

XVII. Modified contemporary comparison system for dairy bull evaluation

A. Predicted difference - indicates the average increase in production of a bull's daughters over the breed herd average

1. Milk--measured in pounds

2. Fat--measured in pounds and as a percentage

3. Dollars--indicates increase in profits by using a particular bull

B. Repeatability - percent of reliability for predicted differences; reliability increases as number of daughters, especially those in different herds, increase

Example:

Sire Code	Sire Name	Repeatability
7H477	Glendell Arlinda Chief	99%

Predicted Differences

Milk	Fat %	Fat	Dollars
+2035	-.09	+60	+218

Daughters of the bull Glendell will have an increased milk production of 2035 pounds, a decreased fat percentage of .09 percent, an increased overall fat production of 60 pounds and an increased value of milk production of $218. These average increases will happen 99% of the time.

(Note: The pounds of fat increase even though the percentage of fat decreases because of the big increase in overall milk production.)

XVIII. Heritability percentages for economically important swine traits (Transparency 5)

(Note: The higher the percentage, the faster a herd can be improved by genetic selection for that trait.)

(Caution: These are estimates only. Actual percentages will vary.)

A. Production traits

1. Litter size at birth 10%

2. Litter size at weaning 10%

3. Litter weaning weight 15%

(Note: Production traits generally have low heritability percentages.)

B. Feedlot traits

1. Post-weaning gain 30%

2. Feed efficiency 35%

(Note: Feedlot traits generally have medium heritability percentages.)

C. Carcass traits

1. Length 50%

2. Backfat thickness 50%

3. Loin eye area 50%

4. Yield of lean cuts 55%

(Note: Carcass traits generally have higher heritability percentages. These traits should receive added emphasis in selecting for genetic improvement.)

XIX. Heritability percentages for economically important sheep traits

(Note: The higher the percentage, the faster a flock can be improved by selection for that trait. Forty percent and above is generally considered a high heritability, between 20% and 39% medium, and under 20% is low.)

(Caution: These are estimates only. Actual percentages will vary.)

Characteristic	Percentage	Level
A. Face covering	56%	High
B. Loin eye area	53%	
C. Staple length (yearling)	47%	
D. Yearling weight	40%	
E. Skin folds	40%	
F. Grease fleece weight	38%	Moderate
G. Fleece grade	35%	
H. Birth weight	30%	
I. Weaning weight and rate of gain	30%	
J. Milk yield	26%	
K. Finish or condition at weaning	17%	Low

L. Multiple births and other reproductive traits 15%

M. Conformation at weaning 10%

XX. Calculate annual progress of sheep based on genetic selection--progress is calculated by multiplying heritability by the selection differential and then multiplying by the amount contributed from the animal selected (Assignment Sheet #2)

(Note: Selection differential can be much higher in rams than ewes, because fewer rams need to be kept and therefore selection can be more rigid.)

Example: Goal--improvement in yearling weights
Procedure--select ewes weighing 5 pounds more than the herd average as yearlings
--select rams weighing 20 pounds more than the herd average as yearlings

Selection differential for ewes	5 lb
Heritability estimate (40%)	x .4
Expected increase from females	2 lb
Contribute 1/2 to offspring	x .5
Ewe contribution	1 lb
Selection differential for rams	20 lb
Heritability estimate (40%)	x .4
Expected increase from males	8 lb
Contribute 1/2 to offspring	x .5
Ram contribution	4 lb
Expected increase in yearling weights of progeny	5 lb

(Note: While selection for heredity is important, overall genetic improvement only accounts for about 30% compared to an overall of 70% for environmental and management factors. This is why it is also important to select among animals in the same environmental conditions.)

XXI. Chromosome pairs of different species

A. Cattle 30 pairs

B. Swine 19 pairs

C. Sheep 27 pairs

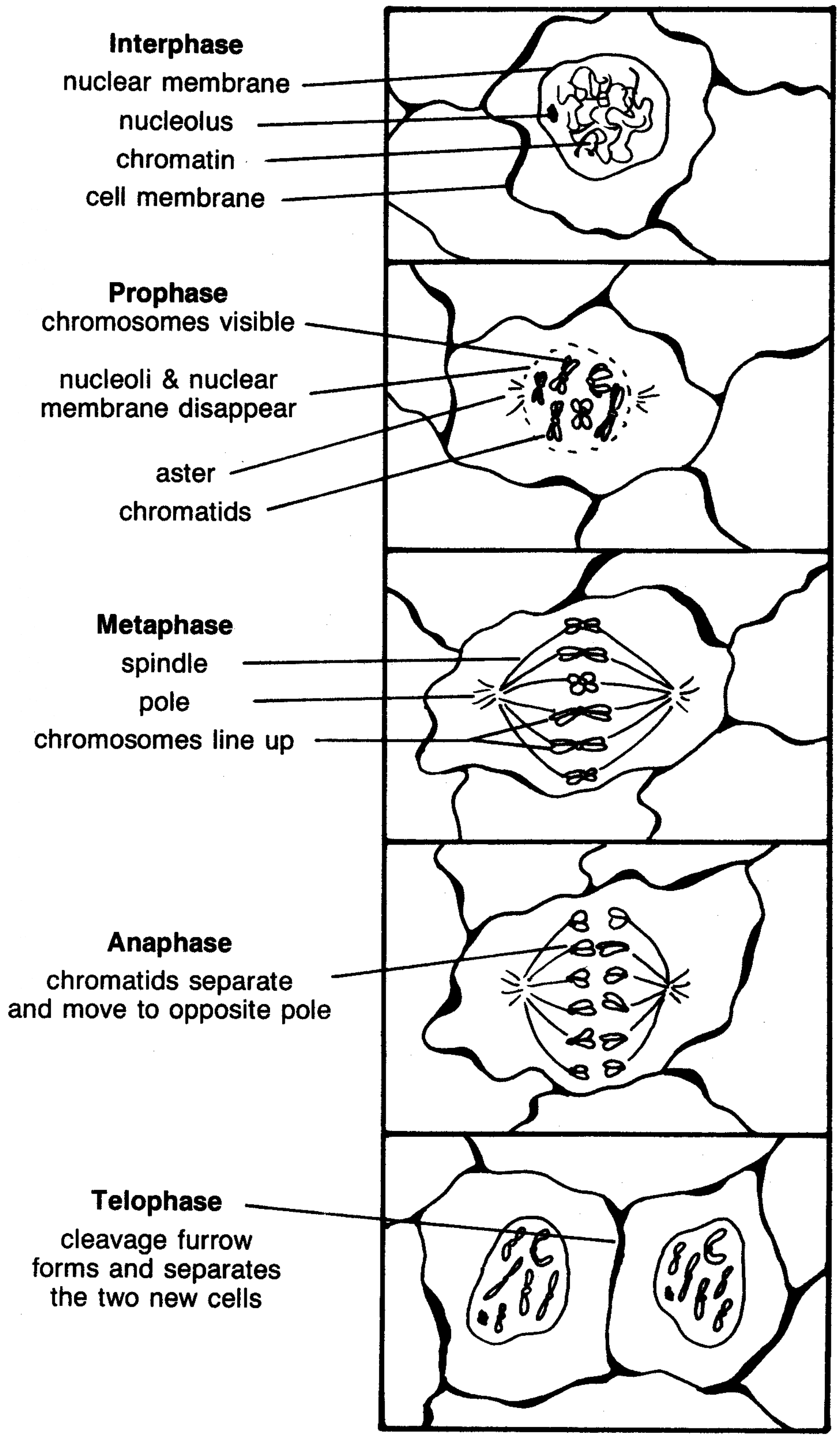
D. Chickens 39 pairs

E. Humans 23 pairs

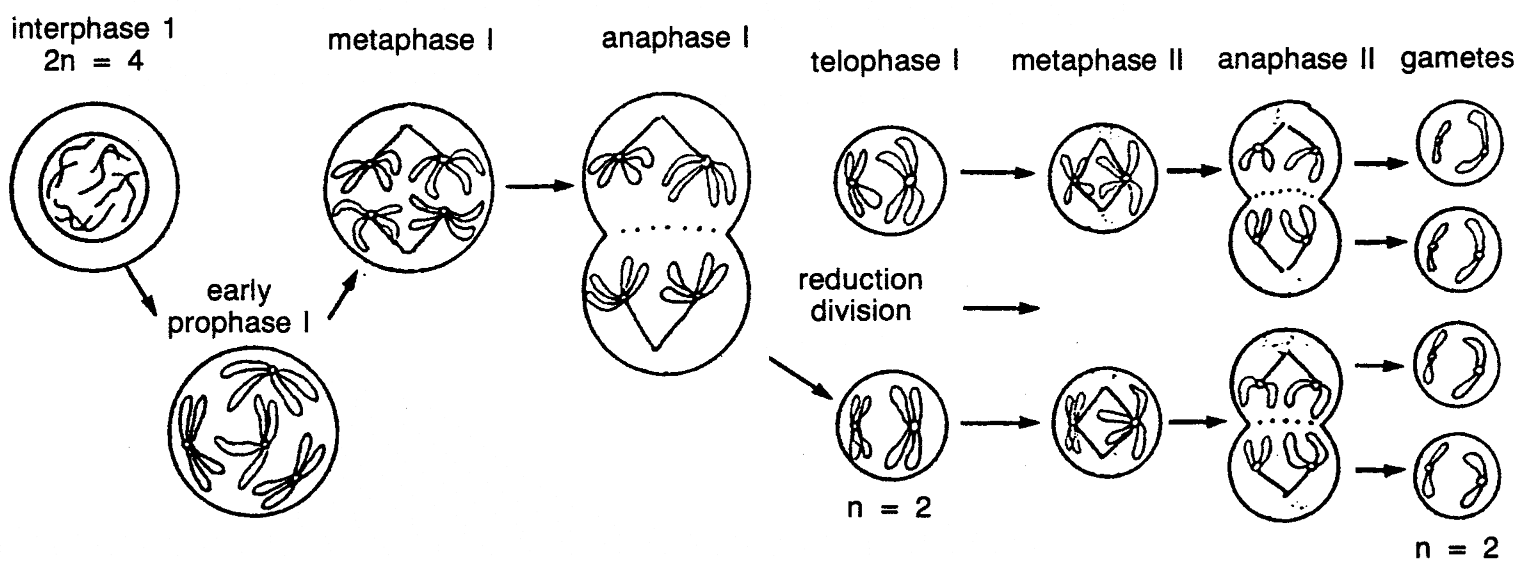
F. Horses 32 pairs

(Note: With all possible combinations in chromosome pairs and genes, each parent of the livestock species can transmit over one billion different samples of inheritance. Therefore, no two animals within a given breed are exactly alike except identical twins.)

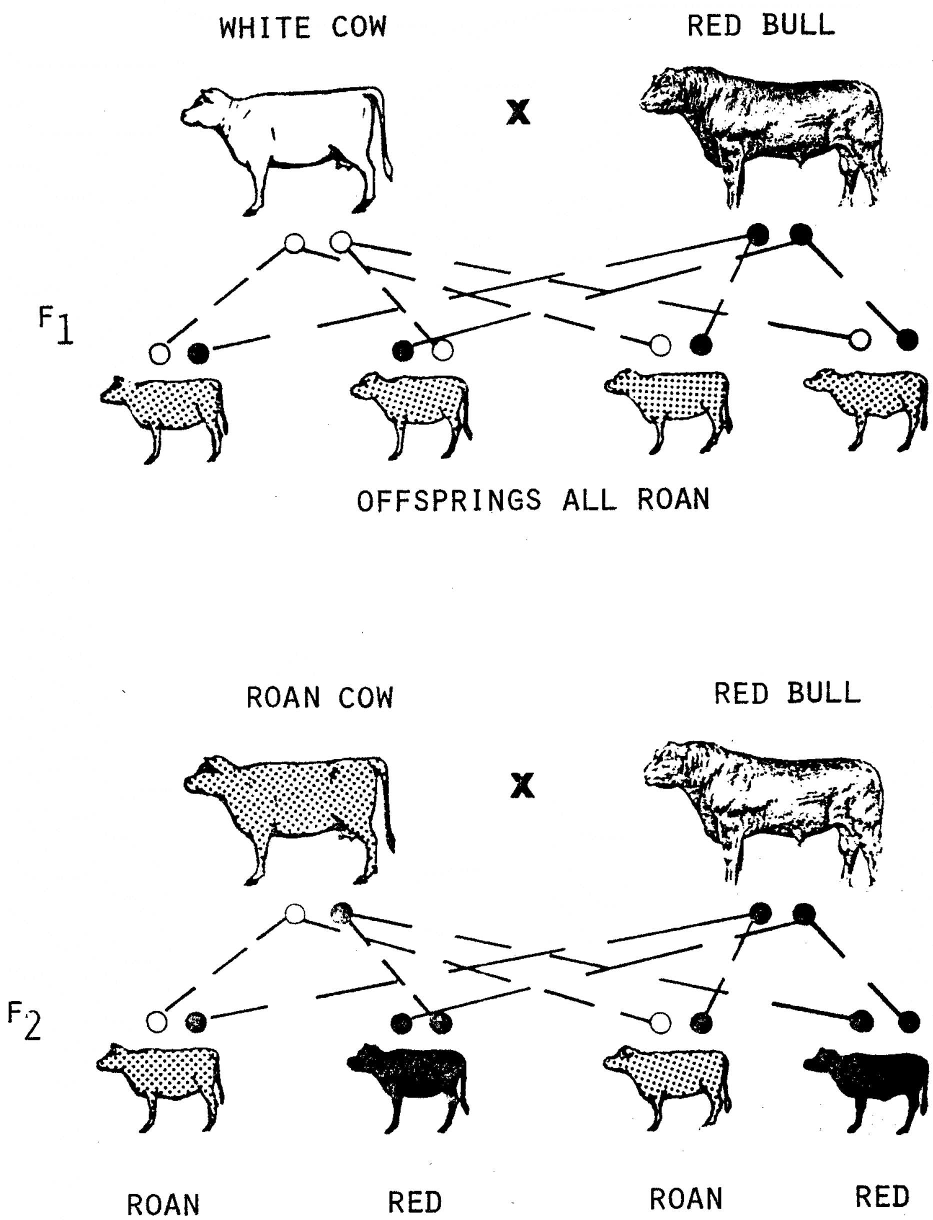
The Phases of Mitosis



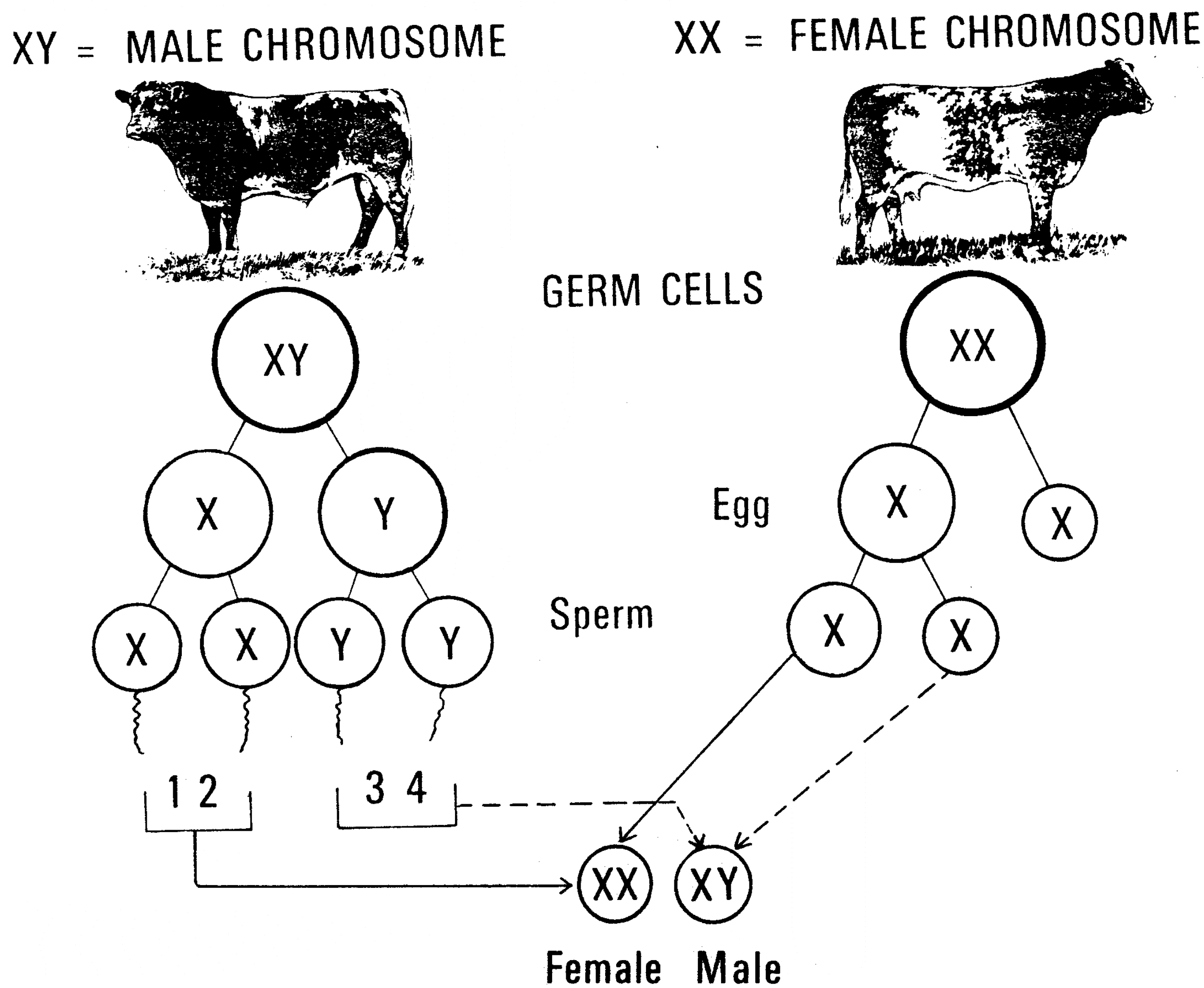
Meiosis


interphase 1
2n = 4
early
prophase I
metaphase I
anaphase I
telophase I
reduction
division
n = 2
metaphase II
anaphase II
gametes
n = 2

Inheritance of Color



Sex Determination



SWINE HERITABILITY ESTIMATES

TRAITS	APPROXIMATE HERITABILITY	
Production traits:		
Litter size at birth	10%	
Litter size at weaning	10%	LOW
Litter weaning weight	15%	
Feedlot traits:		
Post-weaning weight	30%	MEDIUM
Feed Efficiency	35%	
Carcass traits:		
Length	50%	
Backfat thickness	50%	HIGH
Loin eye area	50%	
Yield of lean cuts	55%	

GENETICS AND HEREDITY

AG 534 - F

ASSIGNMENT SHEET #1--CALCULATE ESTIMATED
IMPROVEMENT FROM GENETIC SELECTION (SWINE)

Name ______________________________ Score ______________________________

Swine herd improvement is accomplished by providing the proper environment and by selecting animals with superior genetic potential.

Calculate the expected increase in carcass length of the offspring of a boar that measured 1.2 inches longer than the herd average and gilts that measured .8 inches longer than the herd average.

Calculations for gilt contribution:

Gilt contribution ______________________________

Calculations for boar contribution:

Boar contribution ______________________________

Expected increase in carcass length ______________________________

If the herd carcass length average was 29.3 inches, what would the new expected average be? ______________________________

GENETICS AND HEREDITY

AG 534 - F

ASSIGNMENT SHEET #2--CALCULATE ESTIMATED ANNUAL PROGRESS FROM GENETIC SELECTION (SHEEP)

Name ______________________ Score ______________________

Sheep improvement is accomplished by providing the proper environment and by selecting animals with superior genetic potential. Selection has not received major emphasis in sheep production, but can increase profits (especially through selection of quality rams).

Calculate the expected increase in fleece weight of the offspring of a ram that has a grease fleece weight 8 pounds more than the flock average at weaning and ewes that have a grease fleece weight 3 pounds more than the flock average at weaning. Use a 38% heritability for grease fleece weight.

Calculations for ewe contribution:

Ewe contribution ______________________

Calculations for ram contribution:

Ram contribution ______________________

Expected increase in grease fleece weights

If the flock grease fleece weight average was 10 pounds, what would the new expected average be? ______________________

GENETICS AND HEREDITY

AG 534 - F

ASSIGNMENT SHEET #3 -- CALCULATE ESTIMATED ANNUAL PROGRESS FROM GENETIC SELECTION (BEEF)

Name ______________________________ Score ______________________________

Beef herd improvement is accomplished by providing the proper environment and by selecting animals with superior genetic potential.

Calculate the expected increase in weaning weight of the offspring of a bull that weighed 300 pounds more than the herd average at weaning and heifers that weighed 90 pounds more than the herd average at weaning.

Calculations for heifer contribution:

Heifer contribution ______________________________

Calculations for bull contribution:

Bull contribution ______________________________

Expected increased in weaning weights ______________________________

If the herd weaning weight average was 500 lb, what would the new expected average be? ______________________________

GENETICS AND HEREDITY

AG 534 - F

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

Gilt contribution	.2 "
Boar contribution	.3 "
Expected increase in carcass lengths	.5 "
New herd average	29.8 "

Assignment Sheet #2

Ewe contribution	.57 lb
Ram contribution	1.52 lb
Expected increase in grease fleece weights	2.09 lb
New flock average	12.09 lb

Assignment Sheet #3

Heifer contribution	13.5	lb
Bull contribution	45	lb
Expected increase in weaning weights	58.5	lb
New herd average	558.5	lb

GENETICS AND HEREDITY

AG 534 - F

INSTRUCTOR NOTES FOR LABORATORY EXERCISES

Lab #1

The principle of mitosis is the same for both plant and animal cells.

Mitosis insures genetic continuity and identity of the daughter cells.

Part I:

Point out to the students that interphase was once considered a "resting period", but this is not accurate because of the activity in this phase.

Part II:

The differences between plant and animal mitosis are only those of detail.

In diagrams showing stages of mitosis, have students mark those phases where there are definite differences in the details of mitosis from that of the plant cells.

Part III:

The diagram provided emphasizes the reduction of the chromosomes to half their original number.

Part IV:

Sperm formation (spermatogenesis) is identical, except that the primary spermatocyte divides to form two secondary spermatocytes. Thus, no polar bodies are formed and four sperms result.

Lab #2

Solution preparation:

In order to prepare a solution of a given percentage, use the number of grams of material equal to the percentage and add enough solvent to equal 100 ml. For example, a 10% sodium hydroxide solution is prepared by dissolving 10 g sodium hydroxide in 90 ml water.

To reduce the concentration of an existing solution, pour the required percentage number of milliliters of the solution into a graduated cylinder. Add enough distilled water to bring the total volume in milliliters to equal the percentage of the original solution. For example, to reduce 95% alcohol to 80%, pour 80 ml of 95% alcohol into a graduated cylinder. Add enough distilled water to bring the volume to 95 ml. You now have 95 ml of 80% alcohol.

<u>Hydrochloric acid, 20%</u>

20 parts conc. hydrochloric acid
16 parts water

Carefully pour acid into water. *Never pour water into the acid.*

Part III:

The pipe cleaners should soak for an hour previous to use. They should remain in the solutions until you are ready to use them, for some may turn brown if they dry out. It is important that the brom thymol blue be a weak solution and in its transition color, which is blue green. Dilute about as much powdered brom thymol blue as will stick to half a wet toothpick in 500 ml of hot tap water. If the solution is not in its blue-green transition color, it may be adjusted as follows: Dilute a few drops of the 1% base about 10-fold, and a few drops of the 10% acid about 100-fold. Add a drop of the dilute base to the indicator solution. It should turn a deep blue. If it does not transmit light, it is too concentrated and should be diluted. Next add a few drops of the dilute acid one drop at a time until the indicator turns the blue-green color. If you go past this point, add a drop of the acid. If the indicator seems to go directly from blue to yellow and back, the acid and base solutions are too strong and should be diluted further. *It is essential that the indicator be in its transition color when supplied to the students.*

Four test tubes should be filled with the indicator and labeled, representing the "cytoplasm" of four cells. The pipe cleaner "chromosomes" should be distributed to the cells as directed in the procedure for the student, and the solutions observed for any change in color.

Instruct the students to use forceps to remove and handle the pipe cleaners.

Part IV:

The teacher should carefully dispose of the solutions in the test tubes.

<u>Lab #3</u>

Part I:

With complete dominance, whenever two individuals for a single trait are crossed, the same ratio is obtained.

Part VI:

Randomly distribute ears of corn having the 1:1 or 3:1 ratio of color. These may be obtained from several biological supply houses.

<u>Lab #4</u>

The times for the rounds should be approximately 1-2 minutes in duration. The students should remove the beans as quickly as possible from the boxes.

Part III:

The probability of a 7 being rolled is greater than for any other number. As you get further away from 7 (either higher or lower) the probability of rolling that number gets smaller. Therefore, 2 and 12 have the lowest probability.

Lab #5

Stocks of flies should be ordered about five weeks before they will be used. This is so that they may be recultured to increase the number of flies. Both old stocks for initial observation and new stocks for crosses will be required.

Ether is highly explosive and its vapors are dangerous. For these reasons we strongly recommend that you use a commercial, non-ether preparation that will anesthetize and immobilize the fruit flies. This type of non-ether preparation is available from biological supply houses.

Schedule:

Day 1	Have students practice handling the flies and make the F_1 cross
Day 7	Discard the F_1 parents and observe the F_1 larvae
Day 14	Transfer six F_1 adults to a fresh vial
Day 21	Record the F_1 offspring and discard the F_1 adults in the fresh vial used to make the F_2 generation
Day 28	Record and discard the F_2 offspring

Part I:

Step 3: Over-anesthetized and dead fruit flies have wings that stick out at right angles to their bodies.

Step 7: You may want the students to save the mixed fruit flies for observation by other classes. If so, have the students place the flies in the vials as they recover. If the flies are not to be used again have the students place the anesthetized flies in the oil morgue. The oil morgue humanely disposes of the flies.

Part II:

Generally it is easier and more accurate for the teacher to collect the virgin flies.

Step 7: The reciprocal cross of vestigial wing males and wild type females may give skewed results due to the males' handicaps in courtship behavior.

GENETICS AND HEREDITY

AG 534 - F

LABORATORY EXERCISE #1--MITOSIS AND MEIOSIS

Name ______________________________________ Score ___________________________________

Selection from Modern Biology, Biology Investigations, Teacher's Edition, by James H. Otto, Albert Towle, W. David Otto, and Myra E. Madnick.

Materials needed

Prepared slides of onion root tip
Microscope
Prepared slide of whitefish blastula
Colored pencils

Part I: Mitosis in Plant Cells

In this part, you will observe the phases of cell division known as mitosis. The genetic materials are replicated and distributed through the process of mitosis.

Observe the stages of mitosis by examining the cells of an onion root tip with the microscope. The phases of mitosis are: *prophase, metaphase, anaphase* and *telophase*. *Interphase* is the phase when a cell is preparing for mitosis.

Observe the onion root tip under low power of your microscope. Locate an area of the root tip where mitotic changes can be observed. These changes are best observed in the region between the tip of the root and where the cells are beginning to elongate. Turn to high power to observe the cells more closely. How many stages can you locate? Refer to the information sheets and/or a biology textbook to help you identify the phases.

a. What role does the spindle play in the dividing cell? ______________________________________

____

b. Where does the cellulose wall form in the mother cell ____________________________________

____

c. What is its function ____

____

d. How can you differentiate prophase from metaphase? ______________________

____

____

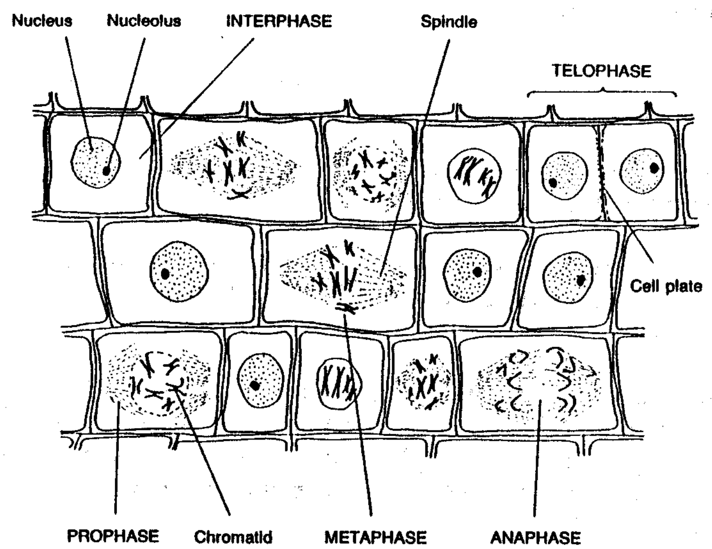
____

e. What occurs during interphase ______________________

____

In the diagram, label each of the phases of mitosis. Also identify the: **nucleus, nucleolus, spindle, chromatid, cell plate.**

Onion Root Tip (Mitosis)



Part II: Mitosis in Animal Cells

In this part, you will observe the mitotic phases in animal cells. You will observe certain structures that were not present during mitosis in plant cells.

Locate as many phases of mitosis as you can in the prepared slide of the whitefish blastula.

a. How do the poles of the spindle differ from those of the onion root tip? ______________________

____

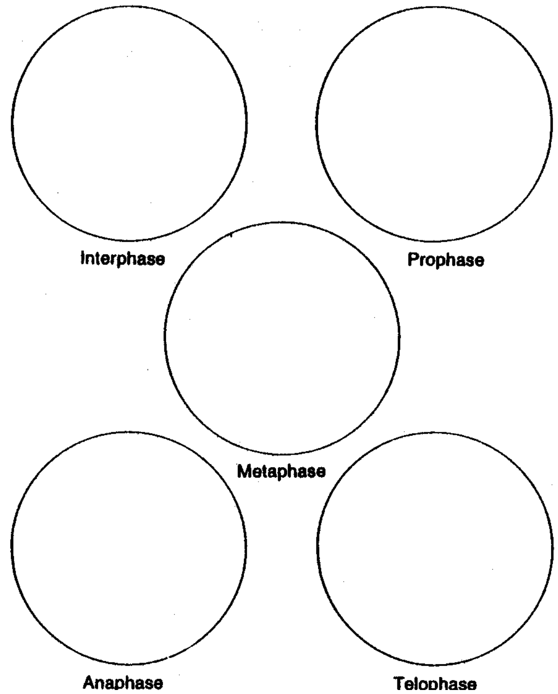
b. Compare the separation of daughter cells with that of the plant cell wall______________________

____

c. Are there any structures in the animal cell that were not present in the plant cell? ______________

d. Are there any mitotic structures present in both the plant and animal cells ____________________

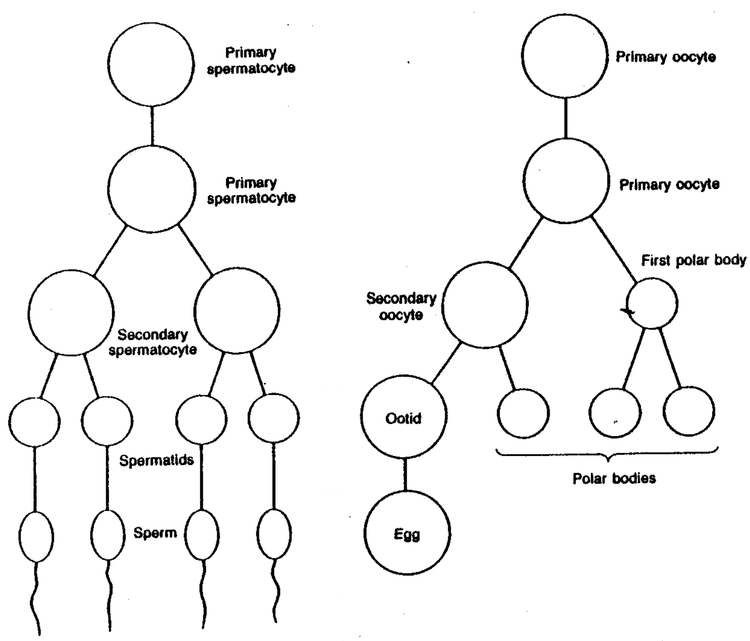
In the space provided, draw an animal cell in each stage of mitosis. Identify structures that differ from plant cell mitosis.



Part III: Chromosome Changes During Meiosis

Meiosis is a process that occurs only in the reproductive cells. This process allows for the reduction in chromosome number during spermatogenesis and oogenesis.

Simplified diagrams of egg and sperm formation are given. Use these diagrams to indicate changes that occur during meiosis. Refer to the information sheet and/or a biology textbook to help you identify the stages.



Sperm formation (spermatogenesis)

Egg formation (oogenesis)

Draw 2 pairs of chromosomes (use a different color for each) in the first stage of egg formation, the primary oocyte. Mark one chromosome of each pair *A* and one *B*.

a. What happens in the second cell during oogenesis ______________________________

____

Show this in the space provided.

b. What are the chromosomes called following this division? ______________________

____

The chromosomes form pairs, separate, and move toward opposite poles. The primary oocyte divides, forming a secondary oocyte and the first polar body. Follow these steps in the diagram. Identify the chromosomes as *A* and *B* and use colored pencils to illustrate changes.

c. What has occurred during this phase? ______________________________________

____

d. What happens when the chromatids separate during the division of the secondary oocyte? ______

____

e. What is the chromosome number of the ootid and second polar body? ________________

f. What happens to the ootid? ____

____

Fill in the chromosomes of the egg cell and the 3 polar bodies.

g. What is the function of the polar bodies in reproduction?__________________________

____

____

Show the chromosome changes for sperm formation just as you did in egg formation.

Part IV: Summary

a. List the stages of mitosis ____

____

b. What is the significance of the mitotic process? ____

____

c. How does mitosis in plant cells differ from mitosis in animal cells? ____

____

d. What structures are present in both plant and animal cells? ____

____

e. In what cells does meiosis occur? ____

f. How would you define meiosis? ____

____

g. What is the significance of meiosis? ____

____

____

h. During which stages of the reproductive process does meiosis occur?____

____

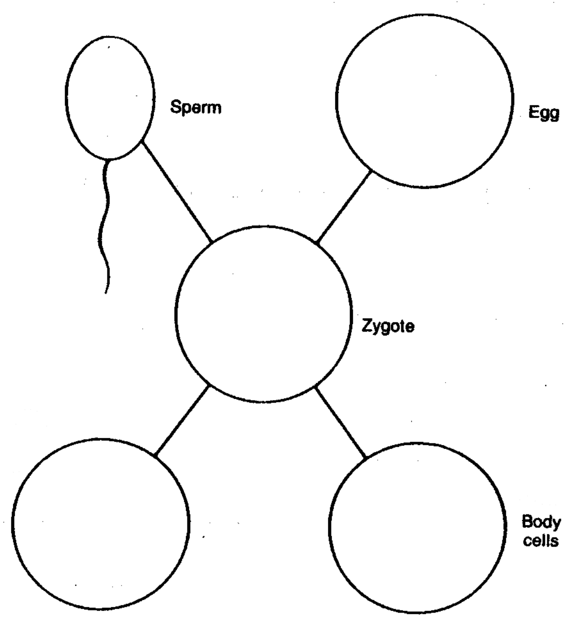
i. What would occur if there were no reduction of chromosome number? ____

____

Part V: Investigations On Your Own

1. Examine different types of animal and plant cells and observe the phases of mitosis. Many prepared slides are available for this type of observation.

2. What happens when the sperm and egg cells produced in oogenesis and spermatogenesis meet? The union of the two cells is called *fertilization*. Illustrate the chromosome makeup of these cells by using colored pencils to fill in the diagram provided. When the zygote (fertilized egg) divides, body cells are formed. Fill in the chromosomes of the body cells.



GENETICS AND HEREDITY

AG 534 - F

LABORATORY EXERCISE #2--SEX-LINKED TRAITS

Name ______________________________ Score ______________________________

Materials needed

2 pennies
Adhesive tape
Forceps
4 test tubes (15 cm)
2 untreated white pipe cleaners
4 pipe cleaners soaked in 10% hydrochloric acid solution
2 pipe cleaners soaked in 1% sodium hydroxide solution
Weak brom thymol blue solution

Part I: How is Sex Determined?

Each human body cell contains 23 pairs of chromosomes. One of these pairs is different in the male and female.

a. What is this 23rd pair of chromosomes called? ______________________________

____

Examine the genotype in Figure 1.

♂XY x ♀XX

Female → / Male ↓	X	X
X	XX	XX
Y	XY	XY

Figure 1

b. What is the genotype of the female? ______________________________

c. Following meiosis, how many different sex chromosomes will be in the eggs? ______________

d. What difference may be seen in the genotype of the male? ______________________________

e. What is the possibility of chromosomes in sperm following meiosis? ____________________

Now let's demonstrate the probability involved in sex determination. Tape an "X" on one side of a penny, and on the other side, tape a "Y". On another penny, tape an "X" on both sides. Now, flip both coins and let them land.

f. What "chromosomes" appear? ____

Continue the flips for at least 30 times. Record the chromosome combination that appears each time in the table.

g. What is the approximate ratio of genotypes obtained from flipping the pennies? _____________

CHROMOSOME COMBINATIONS FROM FLIPPING PENNIES	
X and X	X and Y

Figure 2

Now diagram the inheritance of sex chromosomes in the Punnett square.

♂XY x ♀XX

Female → Male ↓		

Figure 3

h. What is the probability that the offspring will be male? ______________________________

____

i. female? ____

j. Which gamete actually determines the sex of the offspring ______________________________

____

k. Why is it impossible to predict accurately the sex of offspring? ____________________

____

Part II: Color Blindness -- A Sex-Linked Trait

When a gene is carried on a sex chromosome, it is said to be sex-linked. In humans, the genes controlling color vision are located on the X chromosome. The X chromosome carrying a gene for normal vision is represented X^C, while X^c represents a gene for color blindness. Study the following table before diagramming the inheritance of color blindness in humans.

GENOTYPES		
Female	**Vision Ability**	**Male**
X^CX^C	normal	X^CY
X^CX^c	carrier	----
X^cX^c	color blind	X^cY

Use the Punnett square to determine the color vision ability of the offspring of a couple whose genotypes are X^cY and $X^C X^c$.

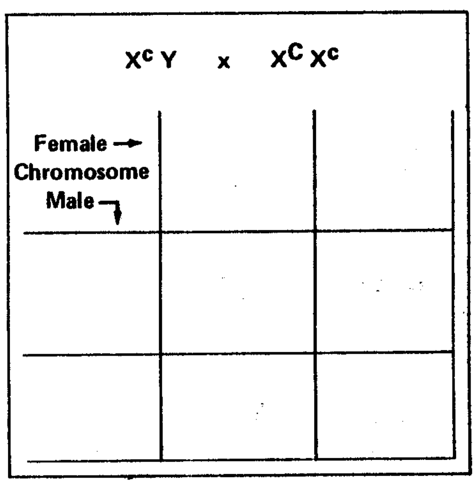


Figure 4

a. What percent of the females are color blind? ______________________________

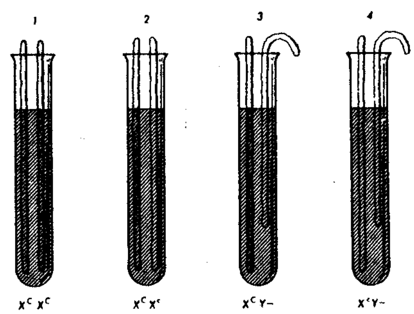
b. What is their genotype? ____

c. What percent of the males are color blind? ____________________

d. How is it possible that some male offspring have normal vision when the male parent is color blind? ____________________

Part III: A Model of Sex Linkage

In this part, you will use pipe cleaners to represent sex-linked chromosomes and test tubes to represent body cells. Obtain 4 pipe cleaners that have soaked for an hour in a 10% hydrochloric acid solution, 2 pipe cleaners soaked for an hour in a 1% sodium hydroxide solution, and 2 untreated pipe cleaners. Bend 2 untreated cleaners into a cane shape to represent the Y chromosome. Those soaked in the hydrochloric acid solution will represent the X^C chromosome, while those soaked in the sodium hydroxide solution represent the X^c chromosome. Number the test tube "cells" *1* through *4*. Fill each tube two thirds full of brom thymol blue solution. This model demonstrates the masking of the genes when a dominant and recessive gene are present in the same cell. *The color which appears in the test tube cells indicates the phenotype*. The solution turns yellow in the presence of acid (hydrochloric). Distribute the variously treated "chromosomes" as shown:



Technique for setting up the test tube "cells" and pipe cleaner "chromosomes"

Figure 5

Set up two acid "chromosomes" in tube 1; an acid and a base in tube 2; an acid and an untreated cleaner in tube 3; and a base and an untreated in tube 4. Observe any color change in the tubes. Record your observations and conclusions in the following table:

Genes	Color change	Color vision	Sex
X^CX^C			
X^CX^c			
X^CY^-			
X^cY^-			

Part IV: Summary

a. Why is sex determination considered a matter of chance?

____

____

b. Explain why males more often exhibit sex-linked traits than females. ______________

____

____

c. In the demonstration using pipe cleaners, what percent of the males would be color blind? ______

d. females? ____

e. If the male had been color blind and the female a carrier, what percent of the females would be color blind? ____

f. What percent of the males would be color blind? ______________________________

Part V: Investigations On Your Own

Hemophilia is a sex-linked trait of humans inherited in the same manner as color blindness. Because it often results in death, it is said to be lethal. Prepare a report on this sex-linked disease and other sex-linked traits not studied in this laboratory exercise. Include in your report an analysis of where it occurs in populations and the consequences of it being inherited.

GENETICS AND HEREDITY

AG 534 - F

LABORATORY EXERCISE #3--PREDICTING INHERITANCE

Name ______________________________ Score ______________________________

Materials needed

Genetic corn showing a 1:1 ratio of purple-nonpurple
Genetic corn showing a 3:1 ratio of purple-nonpurple
Straight pins

Part I: Predicting Ratios in a Monohybrid Cross

In this part, you will diagram the inheritance of a single trait. Flower position on pea plants is the trait to be studied here.

The parent plants crossed by Mendel are shown in the diagram. *Axial flowers* grow along the stem. *Terminal flowers* develop only at the tip of the stem. Mendel found in pea plants that axial (A) flower position is dominant to terminal (a) flower position. Examine the genotypes of each parent.

a. Which parent is homozygous for the dominant trait? ______________________________

b. the recessive trait? ______________________________

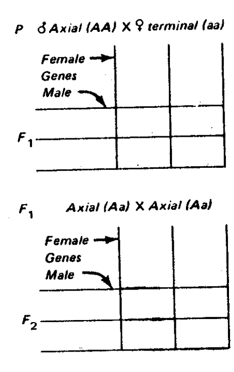
c. What gene will be contained in the gamete of the male parent? ______________________________

d. the female parent? ______________________________

Diagram the cross in the F_1 Punnett square.

e. What genes were inherited by the F_1 offspring? ______________________________

f. When planted, what will be the position of the flowers produced by the F_1 plants? ____________



g. How is the Principle of Unit Characters demonstrated? ______________________________

____

____

h. of dominance? ____

____

____

In the Punnett square, cross the F_1 offspring with themselves to obtain the F_2 generation.

i. Why is this called a monohybrid cross? ______________________________________

____

j. What ratio do you predict for phenotype among the F_2 offspring? ____________________

____

k. What is the predicted ratio of genotype among the F_2 offspring? ____________________

____

l. When complete dominance is involved, would the predicted ratios obtained in this cross hold true for any monohybrid cross? ____

Part II: What Ratios Are Obtained in a Dihybrid Cross?

In horses, black coats and trotting gait are dominant while the recessive alleles are white and pacing gait. If the male is homozygous for both dominant traits:

a. What is the genotype of the male? ____

b. What genes are present in the sperm? ____

c. If the female is recessive for both traits, what genes are present in the eggs? ______________

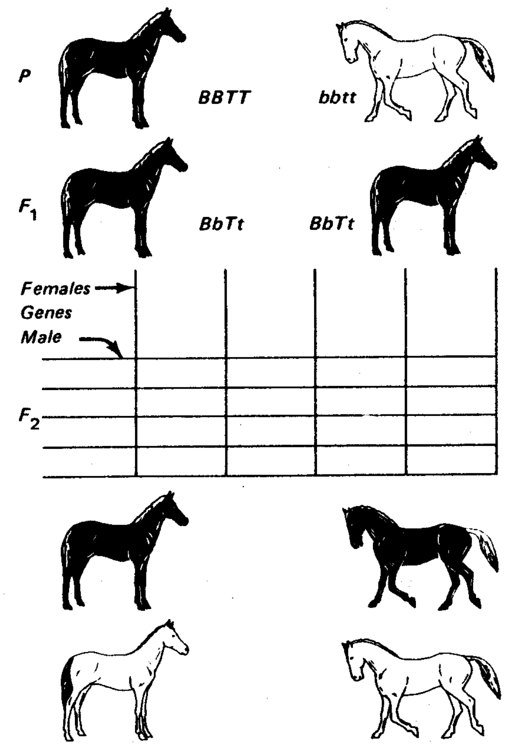
d. What is the genotype of the F_1 generation? ___________________________________

e. What is the phenotype of the F_1 generation? __________________________________

____

Assuming a male and female are produced in the F_1, use these as parents to produce the F_2 generation.

Diagram the possible inheritance of the offspring from such a cross in the Punnett square and list the ratio of phenotypes.



____**black-trotters**

____**black-pacers**

____**white-trotters**

____**white-pacers**

f. **Would a dihybrid cross of this type always produce the same phenotype ratio?**__________________

Explain.______________________________

____

g. **Summarize the genotypes of the F_2 offspring in the spaces below.**

____**BBTT**	____**BbTT**	____**bbTT**
____**BBTt**	____**BbTt**	____**bbTt**
____**BBtt**	____**Bbtt**	____**bbtt**

h. Are the ratios obtained from these offspring predictable?______________________________

Explain. ____

____

____

<u>Part III: How is Incomplete Dominance Shown in a Plant and Animal?</u>

In inheritance involving incomplete dominance, both alleles in a gene pair exert an equal influence on a trait.

When a snapdragon plant bearing red flowers is crossed with a snapdragon plant bearing white flowers, plants bearing pink snapdragons are produced.

a. If the male parent is homozygous for red snapdragons, what kind of gene will be present in the sperm? ____

b. If the female is homozygous for white, what kind of gene will be present in each egg? _________

____

c. What is the genotype of the F_1? ______________________________

Female → Genes Males ↓		

Cross two plants producing pink snapdragons to obtain the F_2 generation.

d. Indicate the ratios of colors in the snapdragon flowers produced ______________________

Part IV: How Do Genetic Traits Appear in Corn?

The color of corn grains (purple or nonpurple) is an inherited characteristic that is easily observed. When pure strains of corn producing purple grains are crossed with pure strains of corn producing nonpurple grains, all of the offspring have purple grains.

Determine what kind of cross produced your ear of corn by counting the number of purple and yellow kernels. Use a straight pin to mark your starting row. Record your count of each row in the table. *Do not pick the kernels from the ear.*

Kind of grains	Number in each row												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
Purple													
Nonpurple (yellow)													

a. What percent of the seeds were purple? ______________________________

____

b. nonpurple? ______________________________

____

c. What is the ratio of purple to nonpurple seeds? ______________________________

____

d. Based on the ratios, what are the genotypes of the parents crossed to obtain your ear of corn?

____

____

____

e. Explain any evidence of purple color in the nonpurple grains. ______________________________

____

Part V: Summary

a. The following are Mendel's Law and Principles that have been demonstrated in the crosses you have completed in this laboratory exercise. Explain each of these principles.

Principle of Dominance ______________________________

____

Principle of Unit Characters ______________________________

____

Law of Independent Assortment ______________________________

____

____

Can you answer the following questions?

b. In a cross of two individuals heterozygous for a single trait, what genotype and phenotype ratios would be obtained ______________________________

____

c. What phenotype ratio is obtained when individuals heterozygous for two traits are crossed?

____

d. Explain if the Law of Independent Assortment would apply if the genes for coat color and gait in horses were carried on the same chromosomes ______________________________

____

e. On the basis of your results, explain how genetic principles yield predictable results ____________

____

Part VI: Investigations On Your Own

Obtain an ear of corn showing a 9:3:3:1 ratio (purple-smooth-yellow-shrunken seeds) and determine the genotypes of the parents by counting the characteristics inherited on your ear of corn. Classify and record your count of the seeds. Summarize your findings by determining the genotype and phenotype ratios. Outline a cross of the F_1 and F_2 generations which were used to produce the ratios as you have determined them.

GENETICS AND HEREDITY

AG 534 - F

LABORATORY EXERCISE #4--INFLUENCE OF CHANCE ON INHERITANCE

Name ______________________________ Score ______________________________

Materials needed

2 boxes (bottom half of half-gallon milk carton)
100 red beans
100 white beans

Part I: Demonstrating Chance

The class should be divided into pairs for this study. Each pair of investigators should have two boxes of beans. Each box contains a mixture of 50 red beans and 50 white beans.

a. If each box represents a set of genes from one parent, what could each bean represent?

____

In a series of rounds that will be timed by your teacher, take one bean from each box and lay the pairs in rows: red-red, red-white, and white-white.

b. Why must a bean be chosen from each box?______________________________

____

After each round, count the beans in each row and record the selected combinations in the table.

c. How many combinations are possible using two kinds of beans?______________________________

d. What accounts for the variation in offspring represented by the pairs of genes? ______________________________

____

Round	Number of pairs of beans in:			
	Row 1 Red-Red	Row 2 Red-White	Row 3 White-White	Total Pairs
Section 1				
Section 2				
Section 3				
Section 4				
Class Totals				

Part II: Summary

Summarize your observations by calculating the ratios for each type of gene pair using the following procedure:

1. Add the total of your 3 rows and divide the sum by 4. (The 4 represents the reduction that occurs in the formation of eggs and sperm during meiosis.)

2. Divide the quotient into the total for each row.

3. The number obtained expresses a ratio. A sample calculation is given.

   Sample Calculation

   (1) $37 \div 86 + 41 = 164$
   $164 \div 4 = 41$

   (2) $37 \div 41 = 0.9$
   $86 \div 41 = 2.1$
   $41 \div 41 = 1.0$

   (3) Ratio .9 red-red; 2.1 red-white; 1.0 white-white; or 1:2:1

a. Express the ratio in whole numbers. ______________________________

____

b. Why is it necessary to have so many beans in each box? ______________________________

____

c. Why is it necessary to select so many pairs? ______________________________

____

d. What are the chances of selecting the same color in a gene pair? ______________________________

e. What are the chances of selecting a different color? ______________________________

f. Explain the importance of using two different colors ______________________________

____

g. What genetic principles are demonstrated by this study? ______________________________

____

h. How does chance selection of genes, as demonstrated with beans, provide the basis for variation in organisms? ______________________________

____

____

____

Part III: Investigations On Your Own

Roll dice for 100 times and keep a tabulation of the sum of the numbers which appear on the dice. Plot the tabulations on a sheet of graph paper. Determine the probability of rolling dice to achieve a 2, 3, 4, or 5, etc. Write up your results and include a discussion of how a little knowledge of probability is useful in the study of genetics.

GENETICS AND HEREDITY

AG 534 - F

LABORATORY EXERCISE #5--BREEDING FRUIT FLIES
TO STUDY GENETICS

Name ____________________________________ Score __________________________________

Slesnick, Irwin L., *Biology Laboratory Manual*, Scott, Foresman and Company, 1985. Reprinted by permission of Scott, Foresman and Company.

Introduction

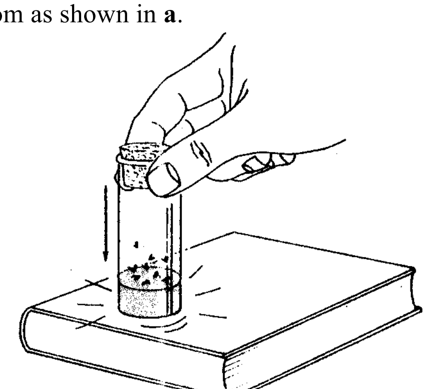
The fruit fly *Drosophila melanogaster* is especially good for genetic research. This is because the flies are small, feed on an inexpensive yeast cell media, and have a short life cycle. Due to these three factors a large population of fruit flies can be raised quickly and inexpensively in a small area. The fruit fly goes through a full generation, from the birth of parents to the birth of offspring, in just ten to fourteen days. This quick maturation enables the results of breeding experiments to be quickly seen. In this laboratory, you will make crosses of fruit flies to study the resulting offspring.

Materials needed

Living *Drosophila* cultures (Wild wing type and vestigial wing type)
Anesthetic
Instant *Drosophila* medium (Commercial preparation)
Two small vials with plastic-foam plugs (4" x 1 1/2")
Forceps
Old culture of "mixed-strain" fruit flies
Re-anesthetizer (Consists of a petri dish, gauze or cotton balls, and tape)
Artist's paint brush
Stereoscopic microscope
White index card
Labels or masking tape
Morgue consisting of a jar of oil (Vegetable or motor oil)

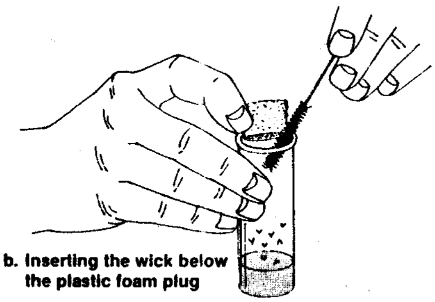
Part I: Anesthetizing and Observing the Fruit Flies

1. Obtain a culture of the mixed fruit flies. Gently tap the bottom of the culture vial on a book to force the flies to the bottom as shown in **a**.



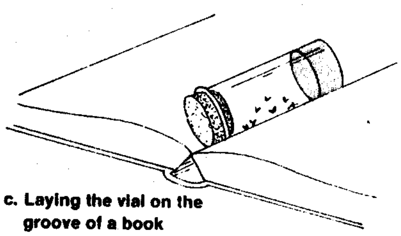
a. Tapping the vial

2. Add the anesthetic to the wick supplied with the anesthetic. Insert the wick into the culture vial just below the plastic foam plug as shown in **b**.



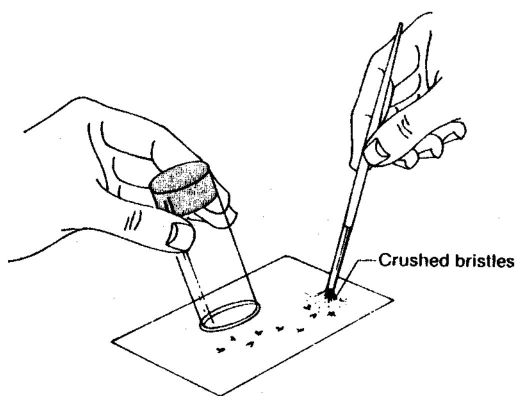
b. Inserting the wick below the plastic foam plug

3. Lay the culture vial on its side in the groove of an open book as shown in **c**, so that the flies do not get stuck in the medium as they become immobilized. Within four minutes all flies should become anesthetized and immobile.



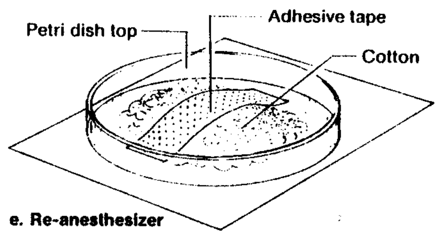
c. Laying the vial on the groove of a book

4. Transfer the flies to a white index card as shown in **d**. Examine the flies under the stereoscopic microscope. Use the paint brush to move the flies around on the card.



d. Transferring the fruit flies to an index card
Check the accuracy of each
Student's ability to sort the
Flies according to sex.

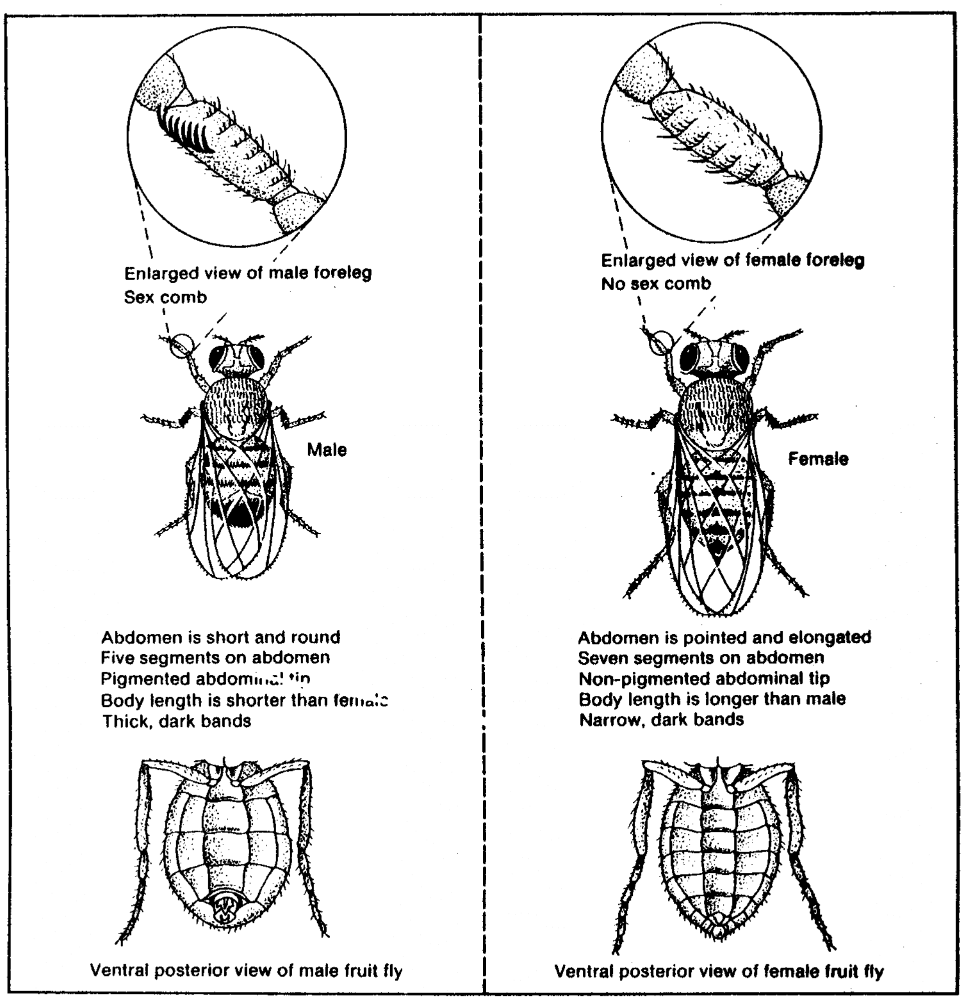
5. If the flies start to recover from the anesthetic use the re-anesthetizer to re-anesthetize the flies. Do this by placing a few drops of the anesthetic on the gauze attached with tape to the bottom of the petri dish which will serve as a re-anesthetizer. Place the dish over the recovering flies until the flies are immobilized once again. Refer to **e** showing the set-up of the petri dish re-anesthetizer.



e. Re-anesthesizer

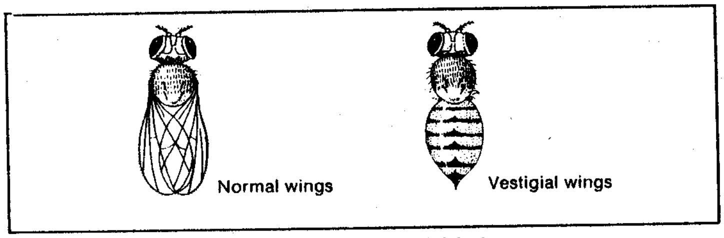
6. Sort your flies according to their sex. Notice in **f** that the male fruit flies have a sex comb, a dark, blunt-shaped abdomen, and five bands compared to the female's lack of a sex comb, and pointed abdomen with seven bands. In addition, the female is generally larger than the male fruit fly. Besides the sex differences, what other distinct difference do you notice?

a.____



f. Physical traits of male and female fruit flies

Draw the difference that you observe on the wingless fruit fly in **g**.



g. Comparison of normal wild type wings and vestigial wings

7. Dispose of the fruit flies when you are finished observing them according to instructions given by your teacher.

Part II: Performing the Parental F_1 Cross

1. Flies from the stock vials of wild wing type and vestigial wing type contain both males and females. In performing a cross the females that are used must be virgins. To be assured of using females that are virgins, the females must be collected before they are twelve-hours-old. This is because female fruit flies are capable of mating with the males only after they are twelve-hours-old. What problems would occur in genetic experimentation if day-old females taken from stock vials containing males and females were used in genetic crosses?

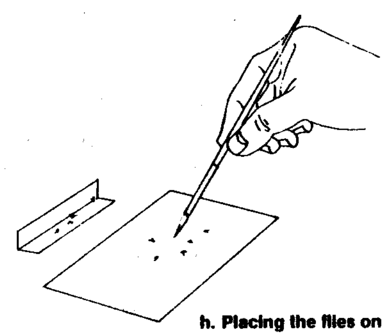
   a ____

   ____

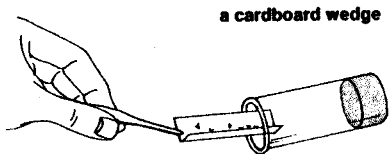
   ____

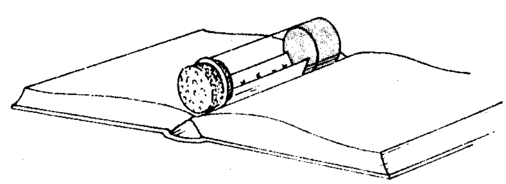
2. Anesthetize flies from the stock vials of the wild wing and the vestigial wing fruit flies. Select tthree wild winged males and three vestigial winged females.

3. Place the six future parents on a cardboard wedge made from an index card as shown in **h**. Place the wedge on its side in a fresh vial of media until the flies recover. Keep the wedge in the vial throughout the reproductive cycle as a substance on which the larvae can form pupae. Place the vial in an open book as shown in i until the flies recover.



h. Placing the flies on a cardboard wedge





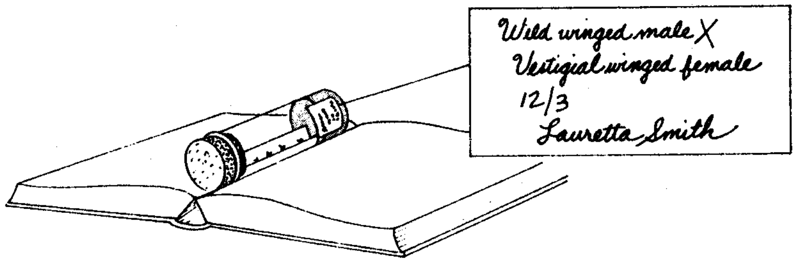
i. How to rest the vial until the fruit flies recover

4. Stick a label on your vial with the following information:

Genetic cross ______________________________

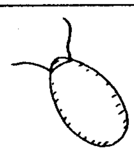
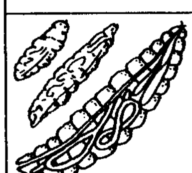
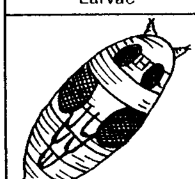
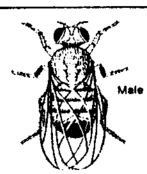
Date ______________________________

Your name ______________________________



5. Incubate the flies at about 25-28 degrees Celsius. On about day seven, remove the parent flies from the vial. Dispose of the parent flies as instructed by your teacher. Depending mostly on temperature, the adult flies of the F_1 generation should emerge in about 10 to 14 days. While you are waiting for the F_1 flies to emerge, use the stereoscopic microscope to examine the stages in the life cycle of the fruit fly. Record your observations over the 10-14 day life cycle in the table below.

Table I. Observations of stages in the fruit fly life cycle

Stage	Date observed	Description/Observations
 Egg		
 Larvae		
 Pupa		
 Adult		

6. After 50 adult flies hatch in the vial, carefully anesthetize them following steps 1-5 in Part I. Then, select any three females and any three males. Place the six flies in a fresh vial of media as you did with the parents of this generation in illustrations **h** and **i**. Label the vial. The offspring that result from this cross will be the F_2 generation.

7. Re-anesthetize the remaining F_1 adults. Count and sort the flies from the F_1 parental cross according to sex and wing type. Record the data in Table II. Dispose of the fruit flies as directed by your teacher. Complete the Punnett Square next to Table II showing the expected results from the parental cross. Remember to include in your count the six F_1 flies used in the cross in step 6.

Table II. The F_1 Generation **Parent Cross; Vestigial ♀ x Wild ♂**

	wild		vestigial	
Individual totals	♂	♀	♂	♀
Class Total				

Parent Cross; Vestigial ♀ x Wild ♂
V = Wild wing
v = Vestigial wing
Parent genotypes _______ x _______

F_1 generation

F_1 phenotypes: ________________

F_1 genotypes: ________________

		Eggs	
		v	v
Sperm	V		
	V		

Part III: Observing and Interpreting the Results of the F_1 Cross

1. When the larvae are seen in the vials of the F_1 cross (in about seven days) remove the six adults and dispose of them in the manner instructed by your teacher.

2. After more than 50 flies have emerged from the vial (in about 15 days from the date of the cross) anesthetize, count, and sort the flies according to sex and wing type. Dispose of the counted flies as directed by your teacher. Record the data you collect in Table III. Complete the Punnett Square next to Table III showing the expected results from the F_1 cross. The F_1 cross results in the F_2 generation of fruit flies.

Table III. The F_2 Generation **F_1 males x F_1 females**

	wild		vestigial	
Individual totals	♂	♀	♂	♀
Class Total				

Parent Cross: F_1♂ x F_1♀
V = Wild wing
v = Vestigial wing
Parent genotypes
F_1 genotypes: ________ x ________

F_2 generation
F_2 phenotypes: ________________
F_2 genotypes: ________________

		Eggs	
		V	v
Sperm	V		
	v		

Part IV: Analysis

1. List two differences in body structures that enable you to distinguish male from female fruit flies. ____

____

2. Explain whether it would be necessary to use virgin females for an F_2 cross. ________________

____

3. Explain how genetic dominance was shown in the F_1 generation. ________________________

____

____

4. For what reasons are parents removed from culture vials on about the seventh day after the larvae appear? ____________________

____

____

5. What are the genotypic differences between the F_1 flies and the wild type parent flies? ____________________

____

6. How do the F_2 wild type flies compare genetically with the original parent wild type flies?

____

____

7. How do the results of the F_1 cross illustrate the Law of Segregation? ____________________

____

____

____

8. What percentage of the F_2 flies did you expect to have vestigial wings? ____________________

____

9. Considering the total number of F_2 flies counted, how many should have had vestigial wings?

____

10. What percentage should have had wild type wings? ____________________

____

11. How many of the total should have had wild type wings? ____________________

____

12. How would you explain the difference between expected and actual results in the F_2 generation? ____________________

____

____

____

GENETICS AND HEREDITY

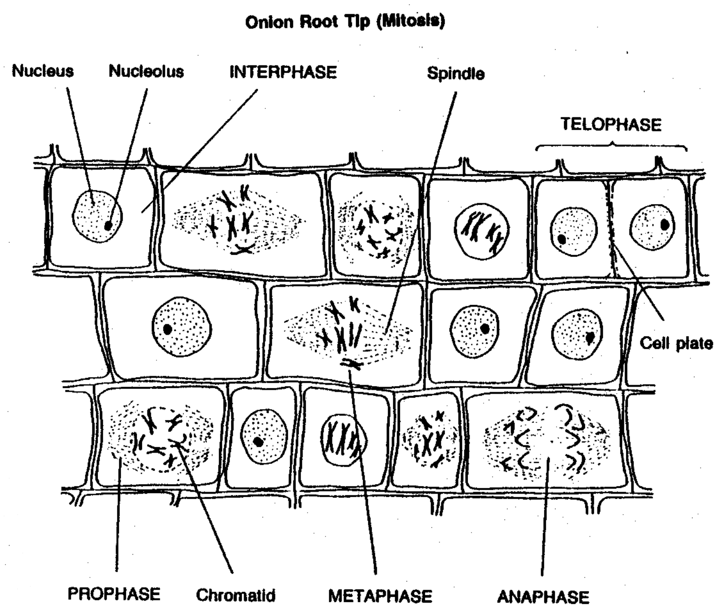
AG 534 - F

ANSWERS TO LABORATORY EXERCISES

Lab #1

Part I:

a. The chromosomes migrate along the spindles.
b. Across the center or the equatorial plate
c. To separate the 2 daughter cells
d. Prophase: formation of asters, disintegration of nucleolus, moving of chromatids to the equator.
   Metaphase: chromatids line up at equator.
e. A period of growth and other activities (not part of cell division)



Part II:

a. A centriole is present at the poles of the spindle in the animal cell.
b. Animal cells pinch in two; plant cells form a cell wall between daughter cells.
c. Centrioles
d. Chromosomes and spindle fibers

Part III:

a. The chromosomes replicate, but do not separate.
b. Tetrads
c. The chromatids form pairs and separate from the tetrad.
d. Reduction-division occurs.
e. Haploid (n) chromosome number
f. Matures into an egg
g. They have no function and will gradually disintegrate.

Part IV:

a. Prophase, metaphase, anaphase, and telophase
b. Insures genetic continuity
c. Centrioles are observed in animal cells; cell plate in plant cells
d. Chromosomes and spindle fibers
e. Reproductive cells
f. Reduction of chromosome number during spermatogenesis and oogenesis.
g. Chromosome number is halved so that full complement can recur at fertilization.
h. Spermatogenesis and oogenesis
i. At fertilization there would be twice as many chromosomes in the zygote.

<u>**Lab #2**</u>

Part I:

a. Sex chromosomes
b. XX
c. one, an X
d. Y
e. X or Y
f. two X's, or an X and Y

Figure 2: Evaluated to the satisfaction of instructor.

g. 1:1

Figure 3

♂XY x ♀XX

Female → Male ↓	X	X
X	XX	XX
Y	XY	XY

h. 50%
i. 50%
j. male
k. It is purely a matter of chance.

Part II:

Figure 4

X^cY x X^CX^c

Female → Chromosome Male ↓	X^C	X^c
X^c	X^CX^c	X^cX^c
Y	X^CY	X^cY

a. 50%
b. X^cX^c
c. 50%
d. The male offspring inherited X^c from the female parent.

Part III:

Genes	Color change	Color vision	Sex
X^CX^C	Yellow	normal	female
X^CX^c	Yellow	normal/carrier	female
X^CY^-	Yellow	normal	male
X^cY^-	Blue	color blind	male

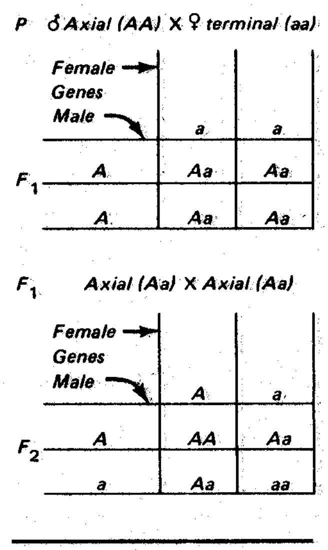
Part IV:

a. There is a 50% probability that a female X will be paired with a male Y chromosome.
b. Males are lacking a corresponding gene on the Y chromosome; therefore, whatever gene is inherited on the female X is exhibited by the male.
c. 50%
d. None
e. 50%
f. 50%

<u>Lab #3</u>

Part I:

a. Male
b. Female
c. A
d. a

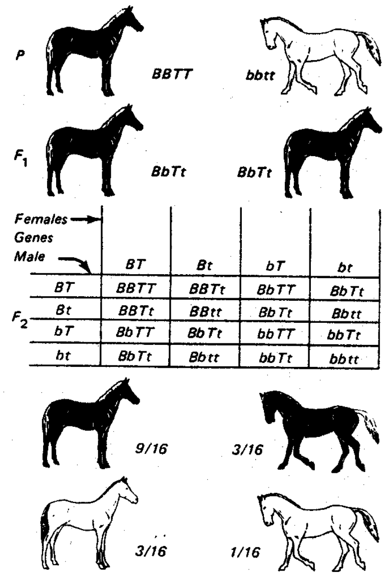


e. A and a
f. Axial
g. The characteristic is determined by a pair of genes, one contributed by each parent.
h. The A gene exerted its influence in spite of the presence of gene a. Gene a was prevented from exerting its influence.
i. Two individuals hybrid for a single trait are being crossed.
j. 3 axial to 1 terminal
k. 1AA : 2Aa : 1aa
l. Yes

Part II:

a. BBTT
b. B and T
c. b and t
d. BbTt

e. black, trotters



9 black-trotters
3 black-pacers
3 white-trotters
1 white-pacers

f. Yes. Only if complete dominance is involved in both traits.

g.

1 BBTT	2 BbTT	1 bbTT
2 BBTt	4 BbTt	2 bbTt
1 BBtt	2 Bbtt	1 bbtt

h. Yes, if both parents possess two traits that are completely dominant and both parents are hybrid for the traits.

Part III:

a. r
b. w
c. rw

Female → Genes Males ↓	r	w
r	rr	rw
w	rw	ww

d. 1 red, 2 pink, 1 white

Part IV:

a. 50% or 75% depending on the strain. Answers will vary.
b. Answers will vary. 50% or 75% depending on the strain.
c. 1:1 or 3:1, depending on the strain used.
d. Corn having a 1:1 ratio of purple to nonpurple seeds would be the result of a cross between a purple hybrid (Pp) and a nonpurple parent (pp). Corn having a 3:1 ratio would be the result of a cross between two purple hybrids (Pp x Pp).
e. There is none since a gene for purple produces a completely purple seed. Purple is dominant over nonpurple.

Part V:

a. The dominant genes prevent the expression of the recessive genes.
The characteristics are determined by pairs of genes represented by symbols.
Since genes are separated independently of each other during meiosis, it is a matter of chance which genes are present in the gametes.
b. The genotype ratio is 3:1 and the phenotype ratio is 1:2:1.
c. The phenotype ratio is 9:3:3:1.
d. The Law of Independent Assortment applies only when genes are located on different chromosomes.
e. Knowledge of dominance and recessiveness of a trait yield predictable ratios in the offspring.

<u>Lab #4</u>

Part I:

a. A gene or chromosome
b. To represent the gene or chromosome contributed by each parent
c. Three
d. Variation is due to the chance combination of different genes upon fertilization.

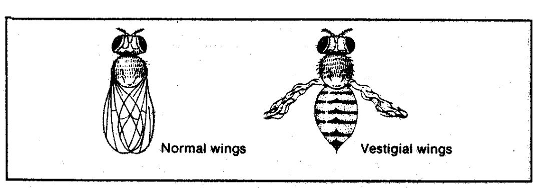
Part II:

a. Should approximate a 1:2:1 ratio
b. To ensure chance selection
c. Large samples are more reliable in obtaining ratios.
d. 50:50
e. 50:50
f. Each color represents one of the gene pairs.
g. Chance distribution and combination of genes; Law of Segregation.
h. Chance selection of genes allows for recombination of traits in the offspring, with the number of possible combinations being directly proportional to the number of chromosomes and genes in the cells of the organism.

<u>Lab #5</u>

Part I:

a. Some flies have crooked, wrinkled wings while others have normal wings.
b.



g. Comparison of normal wild type wings and vestigial wings

Part II:

a. The results of the crosses between males and females would not be valid. This is because the genotype of the male that mated with the female would be unknown if an earlier mating took place in the vial. Thus, the mating cross would not be controlled.

Table I. Observations of stages in the fruit fly life cycle

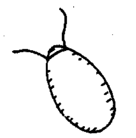
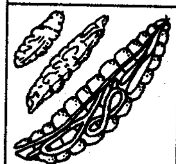
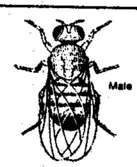
Stage	Date observed	Description/Observations
 Egg	If kept at 25° C 24 hours (Day 1)	Very small elliptical or oblong shape that is creamy white in color. Has two hair-like projections on one end.
 Larvae	96 hours (Days 2-6)	A crawling, wormlike animal that is creamy white in color. Slow moving. The body is segmented. Makes tunnels as it moves through food layer.
 Pupa	96 hours (Days 7-10)	A light brown organism encrusted within a thin transparent brown shell. Some adult insect parts (like the eyes and wings) can be seen developing within the pupa.
 Adult	Days 11-14	Has body parts present in most adult insects including head, thorax, and abdomen. Flies in vial above food layer. Adults emerge from the pupa initially unable to fly. Eventually wings expand and dry.

Table II: Totals should show 100% wild winged phenotype

Parent genotypes vv x VV
F1 phenotypes: All wild
F1 genotypes: All Vv

Punnett Square:

Vv	Vv
vV	Vv

Part III:

Table III: Totals should show 75% wild and 25% vestigial winged phenotypes

F1 genotypes: wild Vv x wild Vv
F2 phenotypes: 3/4 wild , 1/4 vestigial
F2 genotypes: VV, Vv, vv

Punnett Square:

VV	Vv
vV	vv

Part IV:

1. Males have a sex comb, five-banded abdomen, blunt abdomen, and smaller size.
2. No. All flies in the F_1 vial will have the same genotype.
3. Only the wild wing phenotype appeared in the F_1 generation. The vestigial wing trait was masked.
4. So that the parents will not be counted in the offspring count from the cross.
5. The F_1 flies are heterozygous even though they have a wild phenotype.
6. 50% of the F_2 wild type flies have the same genotype (VV) as the parent wild type flies and 50% have a (Vv) genotype.
7. Since each fly has two alleles for a trait that segregates during gamete formation, the offspring of the F_1 cross represent the random combination of these gametes to produce the 3 to 1 ratio.
8. 1/4 or 25%
9. Student answer will vary depending on experimental results.
10. 3/4 or 75%
11. About 3/4 of the total number of F_2 flies
12. There could have been sources of error that entered into the experiment. For example, any of the following could have changed the expected results: death of larvae or eggs, failure to clear parents from vial before counting the flies, small sample size, failure to use virgin females for the crosses.

GENETICS AND HEREDITY

AG 534 - F

UNIT TEST

Name ______________________ Score ______________________

1. Define terms related to genetics and heredity.

   a. Gene ______________________

   b. Chromosome ______________________

   c. Mutation ______________________

   d. Mitosis ______________________

   e. Meiosis ______________________

   f. Genetics ______________________

   g. Gamete ______________________

   h. Fertilization ______________________

   i. Zygote ______________________

   j. Homozygous ______________________

k. Heterozygous ____

____

l. Phenotype ____

____

m. Genotype ____

____

n. Lethal gene ____

____

o. F1 ____

____

p. F2 ____

____

q. Heritability ____

____

r. Dwarfism ____

____

2. Identify the phases of mitosis. Write the name of the phase in the blank before the correct description.

______________________ a Chromatids separate; move to opposite poles; now have same number of chromosomes at each pole as were in the parent cell

______________________ b. Long threads of chomatin shorten and thicken; nucleoli and nuclear membrane break down and disappear into cytoplasm; spindle formed

______________________ c. Chromosomes become thin threads of chromatin; spindle fibers and aster disappear; nuclear membrane reappears; cytoplasm begins to divide at equator

______________________ d. Chromosomes move toward middle of spindle between the two poles and line up at equator; chromatids are paired, short, thick and coiled around one another

______________________________ e. Period between cell divisions; genetic material in form of chromatin; centrosomes located outside nuclear membrane; DNA in chromatin replicates itself before cell division occurs

3. Identify the phases of meiosis. Write the name of the phase in the blank before the correct description. The stage of meiosis is identified at the end of the description.

______________________________ a. Very brief; sometimes even passed over; each chromosome consists of two chromatids attached in the region of their centromere (2nd stage)

______________________________ b. Homologous chromosomes of the tetrad separate; the chromatids of individual chromosomes do not separate yet (1st stage)

______________________________ c. Genetic material in form of chromatin; DNA replicates when meiosis is about to occur (1st stage)

______________________________ d. Meiosis is completed; four haploid cells have been formed (2nd stage)

______________________________ e. Chromatids of each chromosome separate and move to opposite poles of the cells (2nd stage)

______________________________ f. Fine threads of chromatin shorten and thicken; chromosomes become visible; tetrads move toward middle of cell (1st stage)

______________________________ g. Chromosomes line up along equator (2nd stage)

______________________________ h. Cytoplasm divides; first stage of meiosis is completed; chromosomes are no longer paired (1st stage)

______________________________ i. Tetrads line up along equator of cell (1st stage)

4. Explain why genes are important in animal breeding.

a.____

____

____

b. ____

____

5. List and describe the two ways in which genes control inherited traits.

   a. ____

   ____

   b. ____

   ____

6. Define dominant gene and recessive gene.

   a. Dominant gene ______________________________________

   ____

   b. Recessive gene ______________________________________

   ____

7. Define and give an example of incomplete dominance.

   ____

   ____

   ____

   ____

8. Estimate the possible gene combinations if you mated a polled bull *(Pp)* carrying a recessive gene for horns to a horned cow (*pp)* carrying recessive genes for horns.

   a. How many pure polled? ______________________________

   b. How many polled with recessive genes for horns? ______________

   c. How many pure polled? ______________________________

9. Explain how the sex of the offspring is determined in mammals and poultry.

a.____

b. ____

c.____

10. Define and give an example of sex-linked characteristics.

11. Explain linkage.

12. Explain crossover.

13. Explain mutation.

14. Match traits of beef animals to their respective heritability estimates. (Note: Some percentages will be used more than once.)

_____a.	Rib-eye area	1.	30%
_____b.	Weaning weight	2.	40%
_____c.	Birth weight	3.	45%
_____d.	Calving interval	4.	60%
_____e.	Retail product	5.	65%
_____f.	Carcass grade	6.	70%
_____g.	Feedlot gain	7.	10%
_____h.	Feed efficiency		
_____i.	Final feedlot weight		

15. Calculate the estimated increase in pasture gain due to genetic selection in the following problem.

Data: Select heifers that gain .25 lb per day more than the herd average
Select bulls that gain .5 lb per day more than the herd average
Pasture gain has a heritability of 30%

Answer: ____

16. Describe the two components of the modified contemporary comparison system for dairy bull evaluation.

a. Predicted difference. ____

____

____

____

b. Repeatability. ____________________

____

____

____

17. List the pairs of chromosomes for each of the various species of livestock.

a. Cattle ____________________

b. Swine ____________________

c. Sheep ____________________

d. Chickens ____________________

e. Humans ____________________

f. Horses ____________________

GENETICS AND HEREDITY

AG 534 - F

ANSWERS TO TEST

1. a. Gene--Complex molecule that determines hereditary characteristics of living animals; located at definite places on the chromosomes
   b. Chromosome--Thread-like structure which exists in pairs and carries genes
   c. Mutation--Random changes that take place in a gene
   d. Mitosis--Division of a body cell into two duplicate body cells
   e. Meiosis--Division of a sex cell, producing a cell or cells containing only one of each gene and chromosome pair
   f. Genetics--Branch of biology that deals with the heredity and variation of organisms
   g. Gamete--Mature germ cell, egg or sperm
   h. Fertilization--Union of the egg and sperm
   i. Zygote--Fertilized egg
   j. Homozygous--Animal that is pure for a certain gene such as the polled gene
   k. Heterozygous--Animal that is a carrier of a pair of unlike genes
   l. Phenotype--The outward appearance of the animal
   m. Genotype--Genetic make-up of the animal
   n. Lethal gene--Genetic factor that causes death of the young during prenatal life, at birth or soon after
   o. F_1--Symbol which represents the first cross from a mating
   p. F_2--Symbol which represents second cross from a mating
   q. Heritability--Percentage of differences in a trait that can be explained by inheritance as opposed to environment
   r. Dwarfism--Inherited characteristic of cattle resulting in small, deformed animals

2. a. Anaphase
   b. Prophase
   c. Telophase
   d. Metaphase
   e. Interphase

3. a. Prophase II
   b. Anaphase I
   c. Interphase I
   d. Telophase II
   e. Anaphase II
   f. Prophase I
   g. Metaphase II
   h. Telophase I
   i. Metaphase I

4. Genes determine individual characteristics (such as: hair color, body conformation, body type, horned/polled, hair type, growth rate, production); Breeding stock can be selected for desirable characteristics to be passed to offspring

5. Simple--One pair of genes determines the inheritance of a particular factor; Multiple--Several pairs of genes determine the inheritance of a particular factor

6. a. Dominant--Genes that have the ability to cover up or mask the presence of one member of a set of genes in the F_1 generation

   b. Recessive--Genes that are covered up or masked in the F_1 generation

7. Incomplete dominance--Genes that are neither completely dominant nor recessive and which only contribute to a certain characteristic

   Example: Crossing a red and white Shorthorn results in a roan color which is a combination of red and white hairs. Neither characteristic completely masks or is masked by the other.

8. a. none
   b. two
   c. two

9. a. A female egg contains an X chromosome
   b. A male sperm contains either an X or Y chromosome
   c. Egg and sperm unite randomly to form zygote (male sperm determines the sex of the offspring)

10. Gene found on X chromosome; in male, will be expressed (whether dominant or recessive) in the phenotype

    Example: Colorblindness

    1. Normal vision = C colorblindness = c
    2. XX = female, XY = male
    3. Normal vision female = $X^C X^c$ (normal vision is dominant)
    4. Normal vision male = $X^C Y$ (the Y chromosome does not carry genetic information)

11. Linkage--Genes linked on the same chromosome (if there was no crossing over, these two genes would never be separated during meiosis)

12. Splits up the genes that would normally stay linked on the same chromosome; Production of new chromosomes--can make new kinds of chromosomes relative to the genes by crossing over

13. Answer could include the following information:

    a. Sudden change in the characteristics of an organism due to a change in the chemical structure of the DNA
    b. Causes: DNA replication error; Radiation exposure; Toxic chemical exposure;
       Genetic abnormalities such as extra chromosomes, or the crossing or breaking of chromosomes
       Mutations that help an animal survive are continued -- survivors reproduce; Harmful mutations are less likely to be passed to future generations since the animals don't survive to reproduce

14.
a.	6	f.	2
b.	1	g.	3
c.	2	h.	2
d.	7	i.	4
e.	5		

15.
Heifer contribution	=	.0375	lb
Bull contribution	=	.075	lb
Answer	=	.1125	lb

16. a. Indicates average increase in production of a bull's daughters over the breed herd average; differences are figured in pounds of milk and fat and dollars
    b. Indicates reliability of predicted differences; it is figured as a percent and increases with the number of daughters, especially those in different herds

17. a. 30 pairs
    b. 19 pairs
    c. 27 pairs
    d. 39 pairs
    e. 23 pairs
    f. 32 pairs

MACROSCOPIC MALE FUNCTIONAL ANATOMY

AG 534 - G

UNIT OBJECTIVE

After completion of this unit, students should be able to identify and describe the function of the parts of the male reproductive system. Students should also be able to differentiate reproductive structures of the bull, ram, boar and stallion, and trace a spermatozoan in the male reproductive tract. This knowledge will be demonstrated by completion of a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. List the male primary and accessory sex organs and the copulatory organ.
2. Describe the functions of the male reproductive organs.
3. Label the reproductive tract of a bull.
4. Arrange in order the pathway of the spermatozoan in the male reproductive tract.
5. List four problems related to the temperature of the testes and the three structures that regulate the temperature.
6. Define monorchid and explain how it may be determined in the stallion.
7. Explain the cause of a scrotal hernia.
8. Indicate where sperm is mixed with the accessory fluids first to become semen.
9. Describe the differences between the penis structures of the bull and the stallion.

MACROSCOPIC MALE FUNCTIONAL ANATOMY

AG 534 - G

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

- A. Make transparencies and necessary copies of materials.
- B. Provide students with objectives and discuss.
- C. Provide students with information and discuss.
- D. Review and give test.
- E. Reteach and retest if necessary.

II. Instructional materials

- A. Objective sheet
- B. Suggested activities
- C. Information sheet
- D. Transparency masters
  1. TM 1--Reproductive Tract of a Bull
  2. TM 2--Cross Section of Bull and Stallion Penis
- E. Test
- F. Answers to test

III. Unit references

- A. Barrick, R., and Harmon, H., *Animal Production and Management*, McGraw-Hill Book Company, New York, 1988.
- B. Bearden and FuQuay, *Applied Animal Production*, Prentice-Hall, Englewood Cliffs, New Jersey, 1980.
- C. Bundy, C.E., et al., *Livestock and Poultry Production*, 5th edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1982.
- D. Ensminger, M.E., *Animal Science*, Interstate Publishers, Danville, Illinois, 1983.
- E. *Idaho State Board for Vocational Education Curriculum Guide in Livestock Production*, University of Idaho and the Idaho State Board for Vocational Education.

F. Lasley, John F., *Genetics of Livestock Improvement*, 3rd edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1978.

G. Sorensen, A.M., *Animal Reproduction Principles and Practices*, McGraw-Hill Book Company, New York, 1979.

MACROSCOPIC MALE FUNCTIONAL ANATOMY

AG 534 - G

INFORMATION SHEET

I. Components of male reproductive system

(Note: These components should be examined when fertility testing bulls.)

A. Primary sex organs--Gonads (testes or testicles)

B. Accessory sex organs

1. Epididymis

(Note: This can be up to 500 feet long and is located in the scrotum.)

2. Vesicular glands

3. Prostate

C. Copulatory organ--Penis

(Note: In a boar the penis is shaped like a corkscrew and interlocks with the female reproductive tract. This allows a large volume, 200-300 ml, of semen to be ejaculated.)

II. Functions of male reproductive organs

A. Testes--Produce spermatozoa, the male germ cells, and testosterone

B. Epididymis--Collects, stores and allows maturation of sperm

C. Vas deferens--Transports spermatozoa; serves as storage place for spermatozoa until ejaculation

D. Ampulla--May serve as temporary storage for sperm in bulls and rams

E. Penis--Transports sperm from the male to the female

F. Urethra--Transports urine and semen

H. Cowpers gland--Secretes an alkaline material which serves to clean the urethra prior to ejaculation; produces a lubricating substance

(Note: In swine this gland produces a fluid that gels and is the last to be ejaculated. It forms a plug in the sow's cervix.)

H. Prostate gland--Secretions that nourish and stimulate sperm activity

I. Seminal vesicle--Secretes a substance high in simple sugar (fructose) which serves as a nutrient for spermatozoa transport; neutralizes urine; adds volume

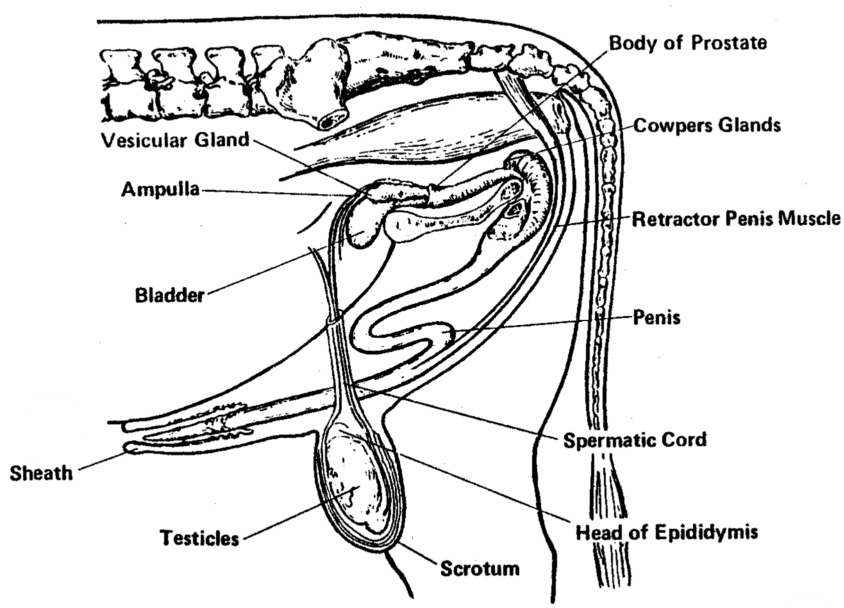
J. Retractor penis muscle--Relaxes to allow copulation and retracts the penis after copulation

K. Scrotum--Maintains the temperature of the testes; serves as protection for the testes

L. Sheath--Provides opening to the male reproductive tract

M. Spermatic cord--Supports the testes

III. Reproductive tract of a bull (Transparency 1)



IV. Spermatozoan pathway

A. Testes

B. Efferent ductules

C. Epididymis

D. Deferent duct

E. Penis body cavity

F. Urethra

G. Glans penis

V. Temperature is critical to the testes

   A. Related problems

      1. Sterility

      2. Lower sperm motility

      3. Decreased percent of normal sperm cells

      4. Lower sperm concentration

   B. Structures that regulate temperature

      1. Cremaster muscles

      2. Dartos muscles

      3. Tortuous vessels

VI. Monorchid

   A. Condition resulting when one testis descends, but the other is retained

   B. This may be determined in the stallion by palpating the superficial inguinal ring to see if the deferent duct passes through it. (If the testis hasn't passed through the superficial inguinal ring, the deferent duct will be absent.)

VII. Scrotal hernia is caused when loops of intestine pass into the scrotal sac through an opening in the inguinal canal

VIII. Sperm is mixed with the first accessory fluid in the colliculus seminalis (two slits - one is an opening from a deferent duct and the other from a vesicular gland)

IX. Penis structures of a bull and stallion (Transparency 2)

   A. Bull

      1. Fibroelastic type

         a. Very fibrous

         b. Some elasticity

         c. Little change in size during erection

      2. Sigmoid flexure (S curve)

         a. Folds during relaxed state to allow retraction and protection of penis

         b. Straightens during erection to extend penis for copulation

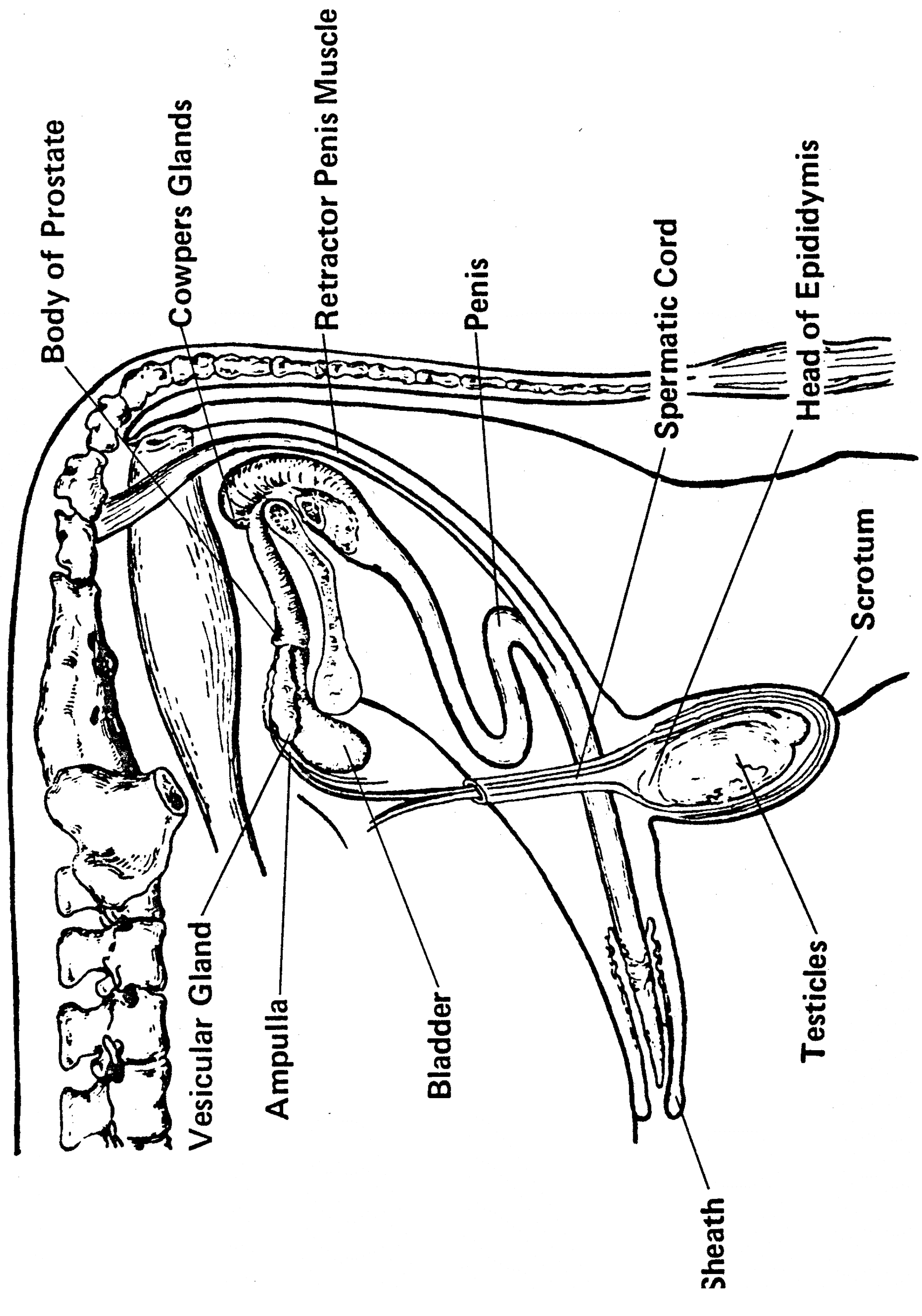
B. Stallion

1. Vascular type

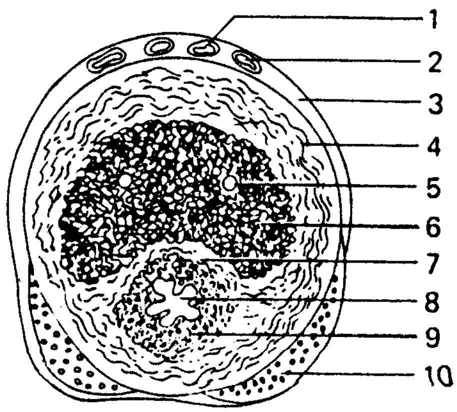
a. Softer, more sparse connective tissue

b. Depends upon engorgement of the cavernosum for length, diameter and turgidity

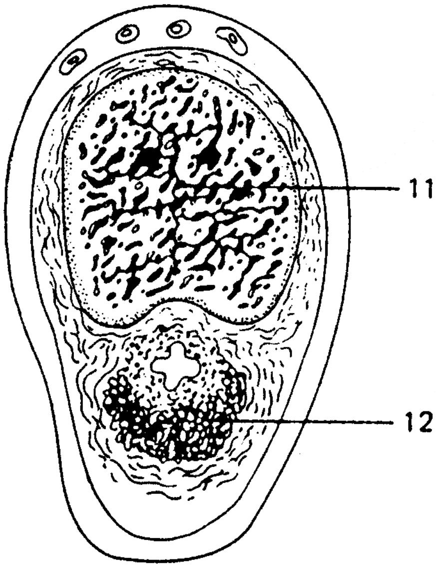
Reproductive Tract of a Bull



Cross-section of Bull and Stallion Penis



Bull



Stallion

1 Dorsal artery of the penis
2 Dorsal vein of the penis
3 Connective tissue cover
4 Tunica albuginea penis
5 Large veins
6 Corpus cavernosum penis
7 Septum of albuginea
8 Urethra
9 Corpus spongiosum penis
10 Retractor penis muscles
11 Septum penis
12 Bulbospongiosus muscle

MACROSCOPIC MALE FUNCTIONAL ANATOMY

AG 534 - G

UNIT TEST

Name ______________________________ Score ______________________________

1. List the male primary and accessory sex organs and the copulatory organ.

   a. Primary sex organs ______________________________

   ____

   b. Accessory sex organs ______________________________

   ____

   c. Copulatory organ ______________________________

   ____

2. Describe the functions of the male reproductive organs.

   a. Testes ______________________________

   ____

   b. Epididymis ______________________________

   ____

   c. Vas deferens ______________________________

   ____

   d. Ampulla ______________________________

   ____

   e. Penis ______________________________

   ____

   f. Urethra ______________________________

   ____

   g. Cowpers gland ______________________________

   ____

h. Prostate gland ____

____

i. Seminal vesicle ____

____

j. Retractor penis muscle ____

____

k. Scrotum ____

____

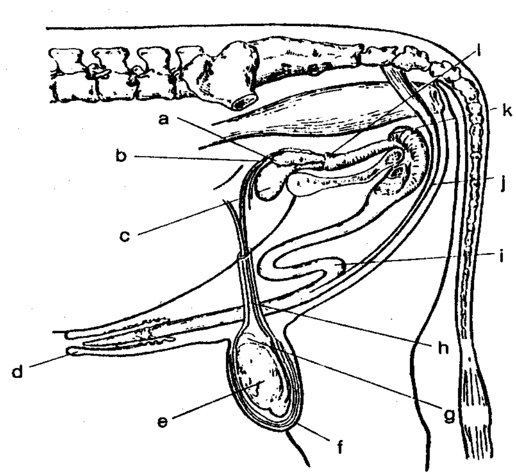
l. Sheath ____

____

m. Spermatic cord ____

____

3. Label the reproductive tract of a bull.



a.______________________________ g.______________________________

b.______________________________ h.______________________________

c.______________________________ i.______________________________

d.______________________________ j.______________________________

e.______________________________ k.______________________________

f.______________________________ l.______________________________

4. Arrange in order the pathway of the spermatozoan in the male reproductive tract. Place a "1" next to the first part of the pathway, a "2" by the second part, etc.

_____a. Glans penis

_____b. Efferent ductules

_____c. Penis body cavity

_____d. Testes

_____e. Urethra

_____f. Deferent duct

_____g. Epididymis

5. List four problems related to the temperature of the testes and the three structures that regulate the temperature.

Related problems:

a.____

b ____

c ____

d ____

Structures:

a ____

b ____

c ____

6. Define monorchid and explain how it may be determined in the stallion.

____

____

____

____

____

7. Explain the cause of a scrotal hernia.

8. Indicate where sperm is mixed with the accessory fluids first to become semen.

9. Describe the differences between the penis structures of the bull and the stallion.

MACROSCOPIC MALE FUNCTIONAL ANATOMY

AG 534 - G

ANSWERS TO TEST

1. a. Gonads (testes or testicles)
   b. Epididymis, vesicular glands, prostate
   c. Penis

2. a. Testes--Produce spermatozoa, the male germ cells, and testosterone
   b. Epididymis--Collects, stores and allows maturation of sperm
   c. Vas deferens--Transports spermatozoa; serves as storage place for spermatozoa until ejaculation
   d. Ampulla--May serve as temporary storage for sperm in bulls and rams
   e. Penis--Transports sperm from the male to the female
   f. Urethra--Transports urine and semen
   g. Cowpers gland--Secretes an alkaline material which serves to clean the urethra prior to ejaculation; produces a lubricating substance
   h. Prostate gland--Secretions that nourish and stimulate sperm activity
   i. Seminal vesicle--Secretes a substance high in simple sugar (fructose) which serves as a nutrient for spermatozoa transport; neutralizes urine; adds volume
   j. Retractor penis muscle--Relaxes to allow copulation and retracts the penis after copulation
   k. Scrotum--Maintains the temperature of the testes; serves as protection for the testes
   l. Sheath--Provides opening to the male reproductive tract
   m. Spermatic cord--Supports the testes

3. a. Vesicular gland
   b. Ampulla
   c. Bladder
   d. Sheath
   e. Testicles
   f. Scrotum
   g. Head of Epididymis
   h. Spermatic cord
   i. Penis
   j. Retractor penis muscle
   k. Cowpers glands
   l. Body of prostate

4. a. 7
   b. 2
   c. 5
   d. 1
   e. 6
   f. 4
   g. 3

5. Related problems: Sterility; Lower sperm motility; Decreased percent of normal sperm cells; Lower sperm concentration

   Structures: Cremaster muscles; Dartos muscles; Tortuous vessels

6. A condition resulting when one testis descends, but the other is retained. In a stallion it is determined by palpating the superficial inguinal ring to see if the deferent duct passes through it. If the testis hasn't passed through the superficial inguinal ring, the deferent duct will be absent

7. Scrotal hernia is caused when loops of intestine pass into the scrotal sac through an opening in the inguinal canal

8. Sperm is mixed with the first accessory fluid in the colliculus seminalis (two slits - one is an opening from a deferent duct and the other from a vesicular gland)

9. Answer should include the following:

Bull:	Very fibrous; some elasticity; little change in size during erection; folds during relaxed state to allow retraction and protection of penis; straightens during erection to extend penis for copulation (S curve)
Stallion:	Softer; more sparse connective tissue; depends upon engorgement of the cavernosum for length, diameter, and turgidity

MICROSCOPIC ANATOMY OF SPERMATOGENESIS

AG 534 - H

UNIT OBJECTIVE

After completion of this unit, students should be able to identify the cell types of the reproductive organs and describe the structure and function of the reproductive organs. Students should also be able to identify the primary cells found in the seminiferous tubules and indicate how many spermatozoa form from a single primary spermatocyte in livestock species. This knowledge will be demonstrated by completion of a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Define terms related to microscopic anatomy and spermatogenesis.
2. Match cell types to their correct descriptions.
3. Match reproductive organs to their correct cell types.
4. Identify the types of cells found in the scrotum, parietal vaginal tunic, testis, visceral vaginal tunic and seminiferous tubules.
5. Identify the type of tissue that makes up the tunica albuginea.
6. Explain the major purpose of the ciliated columnar epithelial cells, and indicate where they are found in the male reproductive tract.
7. Describe the function of the sustentacular cells.
8. Identify the primary cells found in the seminiferous tubules.
9. Explain spermatogenesis in detail, from its beginning to the mature spermatozoa.
10. Diagram to show how many spermatozoa form from one spermatogonia.
11. Indicate the number of days to complete spermatogenesis in the bull, ram, and boar.
12. List two factors that arrest spermatogenesis in bulls.

MICROSCOPIC ANATOMY OF SPERMATOGENESIS

AG 534 - H

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

   A. Make transparencies and necessary copies of materials.

   B. Provide students with objectives and discuss.

   C. Provide students with information and discuss.

   D. Review and give test.

   E. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM 1--General Epithelial Cell Types of Reproductive Organs

      2. TM 2--Total Spermatozoa That Form From Single Spermatogonia

   E. Test

   F. Answers to test

III. Unit references

   A. Barrick, R., and Harmon, H., *Animal Production and Management*, McGraw-Hill Book Company, New York, 1988.

   B. Bearden and FuQuay, *Applied Animal Production*, Prentice-Hall, Englewood liffs, New Jersey, 1980.

   C. Bundy, C.E., et al., *Livestock and Poultry Production*, 5th edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1982.

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E. Lasley, John F., *Genetics of Livestock Improvement*, 3rd edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1978.

F. Sorensen, A.M., *Animal Reproduction Principles and Practices*, McGraw-Hill Book Company, New York, 1979.

MICROSCOPIC ANATOMY OF SPERMATOGENESIS

AG 534 - H

INFORMATION SHEET

I. Terms and definitions

   A. Tunica--Covering

   B. Corpus--A structure constituting the main part of an organ

   C. Recti--Straight

   D. Albuginea--White

   E. Parietal--The walls of a cavity

   F. Spermatocytogenesis--Seed cell production

   G. Efferent--Carrying away from a central part

   H. Sustentacular--Supporting

II. General epithelial cell types (Transparency 1)

   A. Stratified squamous epithelium cells

      1. In layers; rounded basal cells gradually change to flattened cells at surface; found on abrasive surfaces

      2. Protective cells

      3. Penis, vagina lining

   B. Cuboidal epithelium cells

      1. Cube-shaped

      2. Protect (slightly)

      3. Rete testes, ovaries

   C. Columnar epithelium cells

      1. Simple

         a. Uniform size, shape; side by side

         b. Line structures or passageways for fluids

         c. Deferent ducts

2. Pseudostratified

   a. Appear to be in layered columns, but are just overcrowded from rapid growth

   b. Line tubular structures

   c. Uterus

3. Ciliated

   a. Hairlike border that moves

   b. Beat in waves to move objects

   c. Efferent ductules, oviducts

4. Stereociliated

   a. Hairlike border that can't move

   b. Brush objects that are moving across

   c. Epididymis

5. Secretory

   a. Develops, stores, and expels fluid in cells

   b. Clear area when stained (indicating secretion), goblet-shaped when swelled

   c. Cervix

D. Glandular cells

1. Secretory

2. Three types--found in glands

   a. Tubular--Secrete into lumen; triangle-shape

   b. Alveolar--Secretion stored in lumen until passed out; triangle shape; change height when secrete

   c. Compound--In endocrine glands; shaped like cords and clumps; secretion fuses through and between surrounding cells into bloodstream

III. Reproductive organs

A. Scrotum

1. Outer skin

a. Protective

b. Stratified squamous epithelium cells

2. Fascia--Layer of connective tissue

3. Tunica dartos--Nonstriated muscle fibers

B. Parietal vaginal tunic

1. Wall sheath covering

2. Layer of fascia lining

a. Dense connective tissue

b. Simple squamous epithelium cells form slick surface for testes to move freely

C. Testis

1. Covering tissues

a. Visceral vaginal tunic

b. Tunica albuginea

2. Internal structures

a. Seminiferous tubules

b. Interstitial cells

c. Nerves

d. Blood vessels

e. Rete testes

f. Efferent ductules

D. Visceral vaginal tunic

1. Outer covering of testis

a. Dense connective tissue

b. Covered with simple squamous epithelium cells

2. Gives shape and support to testis

E. Tunica albuginea

1. White, thick, dense connective tissue

2. Gives structure to the testis

3. Contains large blood vessels near surface of testis

F. Seminiferous tubules

1. Sperm-producing tubes of the testis

2. Make up the mass of the testis

3. Long, coiled, microscopic

4. Structure

a. Basement membrane--Lines tubules, supported by collagen fibers, spermatogonia rest on it

b. Sustentacular cells

(1) Ramified, pillar-shaped cells

(2) Extend from basement membrane to lumen of tubule

(3) Sustain spermatogenic cells during progression and maturation

(4) Do not divide

IV. Spermatogenesis (seed production)--The development of the spermatozoan; a process of cell division in which the chromosome number is halved

A. Spermatocytogenesis (seed cell production)--The division of cells from the beginning of sperm formation until a change in shape occurs

1. Spermatogonia

   a. Type A cells--Original cells formed; contain two or more nucleoli and lie dormant until they begin mitosis and form dormant Type A cells and active Type B cells

   b. Type B cells--Similar to Type A cells, but have only one nucleolus

2. Spermatocytes

   a. Sixteen primary spermatocytes formed from each Type B spermatogonia

   b. Each primary spermatocyte divides to form two secondary spermatocytes

3. Spermatids

   a. Two spermatids formed from each secondary spermatocyte

   b. Chromosome number halved (1n)

B. Spermiogenesis (seed production)--Spermatids transform into spermatozoa

1. Immature spermatozoa

   a. Formed by metamorphis of the spermatids

   b. Motile, tadpole-like cells

   c. Forms head, midpiece and tail

   d. Passed through tubular structures of testes

   e. Cytoplasmic droplet passes off tail during passage through the epididymis

   f. Forward motion begins in epididymis

2. Mature spermatozoa

   (Note: Spermatozoa is plural for spermatozoon.)

V. Diagram showing total spermatozoa that form from single spermatogonia (Transparency 2)

One Type B Spermatogonia
|
|
16 Primary Spermatocytes
|
|
32 Secondary Spermatocytes
|
|
64 Spermatids (1n)
|
|
64 Spermatozoa

VI. Number of days to complete spermatogenesis

A. Bull - 54

B. Ram - 49

C. Boar - 34.4

VII. Factors that arrest spermatogenesis (stop sperm production) in bulls

A. Scrotum cut becoming infected

B. Stress conditions such as long travel combined with stress of climate, excitement, new surroundings, etc.

GENERAL EPITHELIAL CELL TYPES OF REPRODUCTIVE ORGANS

Stratified Squamous Epithelium Cells

- **Penis**
- **Vagina Lining**

Cuboidal Epithelium Cells

- **Rete Testes**
- **Ovaries**

Simple Columnar Epithelium Cells

- **Deferent Ducts**

Pseudostratified Columnar Epithelium Cells

- **Uterus**

Ciliated Columnar Epithelium Cells

- **Efferent Ductules**
- **Oviducts**

Stereociliated Columnar Epithelium Cells

- **Epididymis**

Secretory Columnar Epithelium Cells

- **Cervix**

TOTAL SPERMATOZOA THAT FORM FROM SINGLE SPERMATOGONIA

ONE TYPE B SPERMATOGONIA

SIXTEEN PRIMARY SPERMATOCYTES

ONE PRIMARY SPERMATOCYTE =
TWO SECONDARY SPERMATOCYTES

(16 PRIMARY SPERMATOCYTES =
32 SECONDARY SPERMATOCYTES)

ONE SECONDARY SPERMATOCYTE = TWO SPERMATIDS

(32 SECONDARY SPERMATOCYTES = 64 SPERMATIDS (1N))

ONE SPERMATID = ONE SPERMATOZOA

TOTAL:

64 SPERMATOZOA FROM ONE SPERMATOGONIA

MICROSCOPIC ANATOMY OF SPERMATOGENESIS

AG 534 - H

UNIT TEST

Name ______________________________________ Score ___________________________________

1. Define the following terms related to microscopic anatomy and spermatogenesis.

   a. Tunica ____

   b. Corpus ____

   c. Recti ____

   d. Albuginea ____

   e. Parietal ____

   f. Spermatocytogenesis ____

   g. Efferent ____

   h. Sustentacular ____

2. Write the number of the cell type in the blank before the correct description.

   1. Stratified squamous epithelium cells
   2. Simple columnar epithelium cells
   3. Cuboidal columnar epithelium cells
   4. Pseudostratified columnar epithelium cells
   5. Ciliated columnar epithelium cells
   6. Secretory columnar epithelium cells
   7. Stereociliated columnar epithelium cells
   8. Tubular glandular cells
   9. Alveolar glandular cells
   10. Compound glandular cells

   _____a. Cube-shaped cells; protect (slightly)

   _____b. Develops, stores, and expels fluid in cells; clear area when stained (indicating secretion), goblet-shaped when swelled

   _____c. Shaped like cords and clumps; secretion fuses through and between surrounding cells into bloodstream

   _____d. Hairlike border that moves; beat in waves to move objects

   _____e. Uniform size, shape; side by side; line structures or passageways for fluids

   _____f. Secretion stored in lumen until passed out; triangle shape; change height when secrete _____g. Hairlike border that can't move; brush objects that are moving across

_____h. In layers; rounded basal cells gradually changed to flattened cells at surface; protective cells

_____i. Secrete into lumen; triangle shape

_____j. Appear to be in layered columns, but are just overcrowded from rapid growth; line tubular structures

3. Write the number of the reproductive organ in the blank before the correct cell type.

1. Cervix
2. Epididymis
3. Uterus
4. Efferent ductules, oviducts
5. Deferent ducts
6. Penis, vagina lining
7. Rete testes, ovaries

_____a. Simple, columnar epithelium cells

_____b. Cuboidal epithelium cells

_____c. Stratified squamous epithelium cells

_____d. Pseudostratified columnar epithelium cells

_____e. Secretory columnar epithelium cells

_____f. Ciliated columnar epithelium cells

_____g. Stereociliated columnar epithelium cells

4. Identify the type of cell in each of the following reproductive organs.

a. Scrotum ____

b. Parietal vaginal tunic ____

c. Testis ____

d. Visceral vaginal tunic ____

e. Seminiferous tubules ____

5. Identify the type of tissue that makes up the tunica albuginea.

____

6. Explain the major purpose of the ciliated columnar epithelial cells, and indicate where they are found in the male reproductive tract.

7. Describe the function of the sustentacular cells.

8. Identify the primary cells found in the seminiferous tubules.

9. Explain spermatogenesis in detail, from its beginning to the mature spermatozoa.

10. Diagram to show how many spermatozoa form from one spermatogonia.

11. Indicate the number of days to complete spermatogenesis in the bull, ram and boar.

    a. Bull ____________________

    b. Ram ____________________

    c. Boar ____________________

12. List two factors that arrest spermatogenesis in bulls.

    a. ____________________

    b. ____________________

MICROSCOPIC ANATOMY OF SPERMATOGENESIS

AG 534 - H

ANSWERS TO TEST

1. a. Tunica--covering
   b. Corpus--a structure constituting the main part of an organ
   c. Recti--straight
   d. Albuginea--white
   e. Parietal--the walls of a cavity
   f. Spermatocytogenesis--seed cell production
   g. Efferent--carrying away from a central part
   h. Sustentacular--supporting

2. a. 3 f. 9
   b. 6 g. 7
   c. 10 h. 1
   d. 5 i. 8
   e. 2 j. 4

3. a. 5 e. 1
   b. 7 f. 4
   c. 6 g. 2
   d. 3

4. a. Stratified squamous epithelium cells
   b. Simple squamous epithelium cells
   c. Interstitial cells
   d. Simple squamous epithelium cells
   e. Sustentacular cells

5. Connective tissue

6. Major purpose--move objects. Found in male reproductive tract--efferent ductules

7. To sustain spermatogenic cells during progression and maturation

8. Sustentacular cells

9. Spermatogenesis (seed production) is the development of the spermatozoan; a process of cell division in which the chromosome number is halved. Spermatocytogenesis (seed cell production) is the division of cells from the beginning of sperm formation until a change in shape occurs. The spermatogonia forms Type A cells and Type B cells. Each Type B spermatogonia divides to form 16 primary spermatocytes. Each primary spermatocyte divides to form two secondary spermatocytes. Each secondary spermatocyte forms two spermatids and the chromosome number is halved. In spermiogenesis (seed production), the spermatids transform into spermatozoa. An immature spermatozoon is formed by metamorphis of each spermatid. It forms a head, midpiece and tail, passes through the tubular structures of the testes and passes off the cytoplasmic droplet during passage through the epididymis, and becomes a mature spermatozoa.

10.

One Type B Spermatogonia
|
|
16 Primary Spermatocytes
|
|
32 Secondary Spermatocytes
|
|
64 Spermatids (1n)
|
|
64 Spermatozoa

11. a. Bull: 54
    b. Ram: 49
    c. Boar: 34.4

12. a. Scrotum cut becoming infected
    b. Stress conditions such as long travel combined with stress of climate, excitement, new surroundings, etc.

HORMONES AND PUBERTY IN THE MALE

AG 534 - I

UNIT OBJECTIVE

After completion of this unit, students should be able to write the correct hormone name when given the abbreviation of each and identify sources and actions of the major reproductive hormones. Students should also be able to describe puberty and relate age, weight and size to puberty. This knowledge will be demonstrated by completion of a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Describe a hormone.
2. Identify the complete hormone names for the abbreviations.
3. Identify the sources of the major reproductive hormones.
4. Identify the actions of the major reproductive hormones.
5. Describe puberty.
6. List and describe the factors affecting attainment of puberty.
7. Describe the relationship of size, weight and age to puberty.
8. List and discuss factors to consider when selecting breeding stock at puberty.
9. Define gonadotropic.
10. Describe the functions of the four parts of the hypophysis.
11. List the effects of testosterone on secondary sex characteristics in the bull.
12. List the bull-to-cow ratios when using young bulls for the first time and when using mature bulls.

HORMONES AND PUBERTY IN THE MALE

AG 534 - I

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

   A. Make transparencies and necessary copies of materials.

   B. Provide students with objectives and discuss.

   C. Provide students with information and discuss.

   D. Review and give test.

   E. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM 1--Hormone Names and Abbreviations

      2. TM 2--Hypothalamic Hormones

      3. TM 3--Hypophyseal Hormones

      4. TM 4--Gonadal Hormones: Androgens

      5. TM 5--Gonadal Hormones: Estrogens and Progesterones

      6. TM 6--Measures of Puberty

      7. TM 7--Factors Affecting Attainment of Puberty

      8. TM 8--Age at Puberty

   E. Test

   F. Answers to test

III. Unit references

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B. Bearden and FuQuay, *Applied Animal Production*, Prentice-Hall, Englewood Cliffs, New Jersey, 1980.

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D. Ensminger, M.E., *Animal Science*, Interstate Publishers, Danville, Illinois, 1983.

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F. Lasley, John F., *Genetics of Livestock Improvement*, 3rd edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1978.

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HORMONES AND PUBERTY IN THE MALE

AG 534 - I

INFORMATION SHEET

I. A hormone is a substance made by cells that passes through and between the cells into the bloodstream. The bloodstream carries it to a specific organ or tissue to bring about a reaction that helps to coordinate the body functions

II. Hormone names and abbreviations (Transparency 1)

A. Gonadotropic Releasing Hormone (GNRH)

B. Follicle Stimulating Hormone Releasing Hormone (FSHRH)

C. Luteinizing Hormone Releasing Hormone (LHRH)

D. Interstitial Cell Stimulating Hormone Releasing Hormone (ICSHRH)

E. Prolactin Inhibitory Hormone (PIH)

F. Follicle Stimulating Hormone (FSH)

G. Luteinizing Hormone (LH)--found in female, same as ICSH in male

H. Prolactin (PRL)

I. Interstitial Cell Stimulating Hormone (ICSH)--found in male, same as LH in female

J. Human Chorionic Gonadotropin (HCG)

K. Pregnant Mare Serum (PMS)

III. Sources and actions of major reproduction hormones (Transparencies 2, 3)

A. Hypothalamic - source: hypothalamus (Transparency 2)

1. GNRH--stimulates release of FSH and LH

2. FSHRH--stimulates release of FSH

3. LHRH or ICSHRH--stimulates release of LH or ICSH

4. PIH--inhibits release of PRL

5. Oxytocin--milk letdown, sperm transport, parturition

B. Hypophyseal - source: pituitary (Transparency 3)

1. FSH--follicle growth, spermatogenesis
2. LH or ICSH--testosterone and sperm production, ovulation and corpus luteum formation
3. Prolactin--progesterone secretion, lactation
4. Oxytocin--sperm transport, parturition, milk letdown

C. Gonadal (Transparencies 4, 5)

1. Androgens - source: testis (Transparency 4)
    a. Growth and development of sex organs
    b. Spermatogenesis
    c. Muscle development
    d. Libido (brain)
    e. Interaction (endocrine glands)
2. Estrogens - source: ovary (Transparency 5)
    a. Growth and development of sex organs
    b. Duct growth (mammary)
    c. Vascular growth (endometrium)
    d. Activity (myometrium)
    e. Growth (body tissues)
    f. Libido (brain)
    g. Interaction (endocrine glands)
3. Progesterones - source: ovary
    a. Growth and development of sex organs
    b. Alveolar development (mammary)
    c. Glandular growth (endometrium)
    d. Interaction (endocrine glands)

D. Placenta - HCG

1. Mainly LH (or ICSH) in action

2. Found in urine of pregnant women

E. Endometrial cups

1. PMSG--mostly FSH action

2. Estrogens--growth and development of sex organs and mammary

3. Progesterones--growth and development of sex organs and mammary

IV. Puberty is the point in time of an animal's life when it attains breeding capability. In the male, androgens and sperm are produced and the reproductive organs have matured (penis free of sheath to impregnate female) (Transparency 6)

V. Factors affecting attainment of puberty (Transparency 7)

A. Hormonal

1. Androgens and gonadotropins initiate spermatogenesis

2. Androgens stimulate penis and accessory gland growth

B. Genetic factors

1. Larger breeds usually later puberty than smaller breeds

2. Interaction with hormones

a. Genetic action plays role in puberty through hormone production and release

b. Androgens depress growth of long bones--if androgens are produced sooner, animal will be smaller

C. Nutritional factors

1. Overfeeding--earlier puberty

2. Underfeeding--later puberty

3. Influences hormone initiation

D. Environmental factors

1. Environmental stress delays puberty (insects, low and high temperatures, high humidity, drought, dust storms, etc.)

2. Can affect nutritive factors (may hasten or delay puberty)

VI. Relationship of size, weight and age to puberty

A. Weight

1. Major factor in attaining puberty

2. Animals seem to show little development of reproductive system until reaching a certain weight

B. Age--animals seem to reach puberty at a certain average age (Transparency 8)

1. Bull - 6-18 months

2. Ram - 4-12 months

3. Boar - 4-8 months

4. Stallion - 12-24 months

C. Size--larger breeds usually reach puberty slower than smaller breeds

VII. Factors to consider when selecting breeding stock at puberty

A. Age--select for young age at puberty

B. Size--select for large size at puberty

C. Weight--select heavier animals at puberty

(Note: When selecting breeding stock at puberty, should consider a combination of age, size and weight.)

VIII. Gonadotropic--hormone that supports and stimulates the function and growth of the gonads

IX. Parts of the hypophysis

A. Pars distalis (anterior pituitary)--secretes gonadotropins and prolactin

B. Pars tuberalis (stalk)--wrapped around the pars distalis; functions as integral part of it

C. Pars intermedia (intermediate lobe)--secretions have effects on pigmentation

D. Pars nervosa (posterior pituitary)--neural structure; stores oxytocin

X. Testosterone effects on bull's secondary sex characteristics

   A. Coarser, curlier, drier hair

   B. Larger, longer horns

   C. Bass voice

   D. Heavier muscling

   E. Crest (enlarged neck)

   F. Less growth of long bones

XI. Bull-to-cow ratio

   A. Young bull of 15 months--15 to 20 cows

   B. Two-year-old--25 to 30 cows

   (Note: Over 25 cows may cause calving period to last 4 to 6 months.)

HORMONE NAMES AND ABBREVIATIONS

Gonadotropic Releasing Hormone (GNRH)

Follicle Stimulating Hormone Releasing Hormone (FSHRH)

Luteinizing Hormone Releasing Hormone (LHRH)

Interstitial Cell Stimulating Hormone Releasing Hormone (ICSHRH)

Prolactin Inhibitory Hormone (PIH)

Follicle Stimulating Hormone (FSH)

Luteinizing Hormone (LH)

Prolactin (PRL)

Interstitial Cell Stimulating Hormone (ICSH)

Human Chorionic Gonadotropin (HCG)

Pregnant Mare Serum (PMS)

HYPOTHALAMIC HORMONES

GNRH - stimulates release of FSH and LH

FSHRH - stimulates release of FSH

LHRH or ICSHRH - stimulates release of LH or ICSH

PIH - inhibits release of PRL

Oxytocin - milk letdown, sperm transport, parturition

HYPOPHYSEAL HORMONES

FSH - follicle growth, spermatogenesis

LH or ICSH - testosterone and sperm production; ovulation and corpus luteum formation

Prolactin - progesterone secretion, lactation

Oxytocin - sperm transport, parturition, milk letdown

GONADAL HORMONES: ANDROGENS

Sex organs growth and development

Spermatogenesis

Muscle development

Libido (brain)

Interaction (endocrine glands)

GONADAL HORMONES: ESTROGENS AND PROGESTERONES

ESTROGENS

Sex organs growth and development
Duct growth (mammary)
Vascular growth (endometrium)
Activity (myometrium)
Growth (body tissues)
Libido (brain)
Interaction (endocrine glands)

PROGESTERONES

Sex organ growth and development
Alveolar development (mammary)
Glandular growth (endometrium)
Interaction (endocrine glands)

MEASURES OF PUBERTY

LIBIDO

+

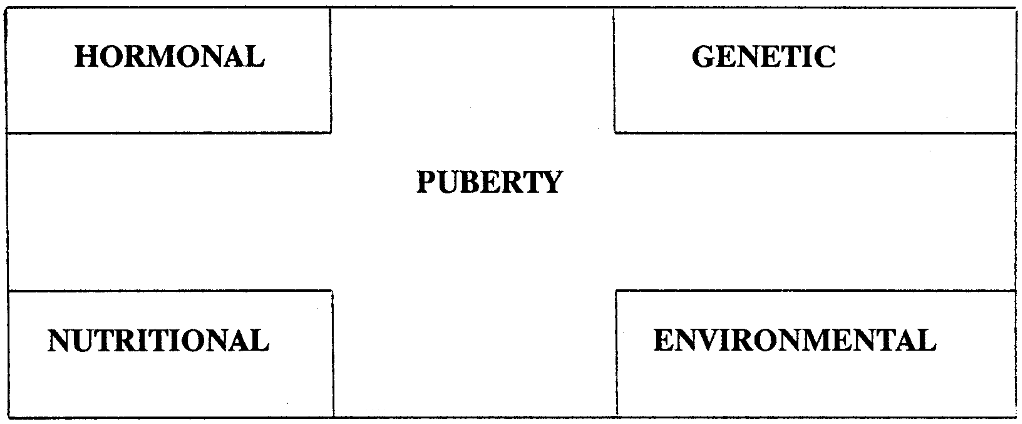
SPERM PRODUCTION

+

SEX ORGAN DEVELOPMENT

PUBERTY

FACTORS AFFECTING ATTAINMENT OF PUBERTY



AGE AT PUBERTY

	Puberty	
Male	**Months**	**Range (months)**
Bull	10	6 - 18
Ram	7	4 - 12
Boar	6	4 - 8
Stallion	18	12 - 24

HORMONES AND PUBERTY IN THE MALE

AG 534 - I

UNIT TEST

Name ______________________________ Score ______________________________

1. Describe a hormone.

____

____

____

2. Write the complete hormone names for the abbreviations below.

   a. GNRH ____
   b. FSHRH ____
   c. LHRH ____
   d. ICSHRH ____
   e. PIH ____
   f. FSH ____
   g. LH ____
   h. PRL ____
   i. ICSH ____
   j. HCG ____
   k. PMS ____

3. Write the sources of the major reproductive hormones listed below.

   a. Hypothalamic hormones ______________________________________
   b. Hypophyseal hormones ______________________________________
   c. Gonadal: Androgens ______________________________________
   d. Gonadal: Estrogens ______________________________________
   e. Gonadal: Progesterones ______________________________________
   f. HCG ____

g. PMSG ____________________

4. In the blanks provided, write the actions of the major reproductive hormones.

Hypothalamic

a. GNRH ____________________

b. FSHRH ____________________

c. LHRH or ICSHRH ____________________

d. PIH ____________________

e. Oxytoxin ____________________

Hypophyseal

f. FSH ____________________

g. LH or ICSH ____________________

____

h. Prolactin ____________________

i. Oxytocin ____________________

Gonadal

j. Androgens ____________________

____

k. Estrogens ____________________

____

l. Progesterones ____________________

____

Placenta

m. HCG ____________________

Endometrial cups

n. PMSG ____________________

o. Estrogens

p. Progesterones

5. Describe puberty.

6. List and describe the factors affecting attainment of puberty.

a.

b.

c.

d.

7. Describe the relationship of size, weight and age to puberty.

8. List and discuss the three factors to consider when selecting breeding stock at puberty.

   a.____

   b. ____

   c.____

9. Define gonadotropic.

10. Describe the functions of the four parts of the hypophysis.

    a. Pars distalis (anterior pituitary)____________________________

    b. Pars tuberalis (stalk____________________________

    c .Pars intermedia (intermediate lobe)____________________________

    d. Pars nervosa (posterior pituitary____________________________

11. List the effects of testosterone on secondary sex characteristics in the bull.

    a ____

    b ____

    c ____

    d ____

    e ____

    f ____

12. List the bull-to-cow ratios when using young bulls for the first time and when using mature bulls.

HORMONES AND PUBERTY IN THE MALE

AG 534 - I

ANSWERS TO TEST

1. A hormone is a substance made by cells that passes through and between the cells into the bloodstream. The bloodstream carries it to a specific organ or tissue to bring about a reaction that helps to coordinate the body functions.

2. a. Gonadotropic Releasing Hormone
   b. Follicle Stimulating Hormone Releasing Hormone
   c. Luteinizing Hormone Releasing Hormone
   d. Interstitial Cell Stimulating Hormone
   e. Prolactin Inhibitory Hormone
   f. Follicle Stimulating Hormone
   g. Luteinizing Hormone
   h. Prolactin
   i. Interstitial Cell Stimulating Hormone
   j. Human Chorionic Gonadotropin
   k. Pregnant Mare Serum

3. a. Hypothalamus
   b. Pituitary
   c. Testis
   d. Ovary
   e. Ovary
   f. Placenta
   g. Endometrial cups

4. a. GNRH - stimulates release of FSH and LH
   b. FSHRH - stimulates release of FSH
   c. LHRH or ICSHRH - stimulates release of LH or ICSH
   d. PIH - inhibits release of PRL
   e. Oxytocin - milk letdown, sperm transport, parturition
   f. FSH - follicle growth, spermatogenesis
   g. LH or ICSH - testosterone and sperm production, ovulation and corpus luteum formation
   h. Prolactin - progesterone secretion, lactation
   i. Oxytocin - sperm transport; parturition; milk letdown
   j. Androgens - Sex organs growth and development; Spermatogenesis; Muscle development; Libido (brain); Interaction (endocrine glands)
   k. Estrogens - Sex organs growth and development; Duct growth (mammary); Vascular growth (endometrium); Activity (myometrium); Growth (body tissues); Libido (brain); Interaction (endocrine glands)
   l. Progesterones - Sex organ growth and development; Alveolar development (mammary); Glandular growth (endometrium); Interaction (endocrine glands)
   m. HCG--Mainly LH (or ICSH) in action
   n. PMSG - mostly FSH action
   o. Estrogens - growth and development of sex organs and mammary
   p. Progesterones - growth and development of sex organs and mammary

5. Puberty is the point in time of an animal's life when it attains breeding capability. In the

male, androgens and sperm are produced and the reproductive organs have matured (penis free of sheath to impregnate female)

6. a. Hormonal: Androgens and gonadotropins initiate spermatogenesis; Androgens stimulate penis and accessory gland growth
   b. Genetic factors: Larger breeds usually later puberty than smaller breeds; Interaction with hormones
   c. Nutritional factors: Overfeeding - earlier puberty; Underfeeding - later puberty; Influences hormone initiation
   d. Environmental factors: Environmental stress delays puberty; Can affect nutritive factors (may hasten or delay puberty)

7. a. Weight: Major factor in attaining puberty; Animals seem to show little development of reproductive system until reaching a certain weight
   b. Age - animals seem to reach puberty at a certain average age
      Bull - 6-18 months; Ram - 4-12 months; Boar - 4-8 months; Stallion - 12-24 months
   c. Size - larger breeds usually reach puberty slower than smaller breeds

8. a. Age--select for young age at puberty
   b. Size--select for large size at puberty
   c. Weight--select heavier animals at puberty

9. Hormone that supports and stimulates the function and growth of the gonads

10. a. Secretes gonadotropins and prolactin
    b. Wrapped around the pars distalis; functions as integral part of it
    c. Secretions have effects on pigmentation
    d. Neural structure; stores oxytocin

11. a. Coarser, curlier, drier hair
    b. Larger, longer horns
    c. Bass voice
    d. Heavier muscling
    e. Crest (enlarged neck)
    f. Less growth of long bones

12. a. Young bull of 15 months--15 to 20 cows
    b. Two-year-old--25 to 30 cows

EJACULATION AND SEMEN COLLECTION

AG 534 - J

UNIT OBJECTIVE

After completion of this unit, students should be able to explain the process of mating and describe the passage of sperm through the tract during ejaculation. Students should also be able to describe the various methods of collecting semen and discuss semen evaluation. This knowledge will be demonstrated by completion of laboratory exercises and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Explain the process of mating.
2. Describe the composition of semen.
3. List the point of semen deposition in the female by the bull, ram, boar and stallion.
4. Describe the passage of sperm through the tract during ejaculation.
5. List the males that have fractionated ejaculates and describe the three fractions of each.
6. Describe the various methods of collecting semen and one advantage and disadvantage of each.
7. Describe in detail the use of the artificial vagina for collecting semen from the bull, ram, boar and stallion.
8. Describe in detail the use of the electroejaculate for collecting semen from the bull and ram.
9. Name the parts of a sperm cell.
10. Label the types of abnormal sperm.
11. Describe the three factors used in semen evaluation.
12. Describe the quality of bovine semen based on color, foreign material, wave pattern and progressive motility.
13. Evaluate semen based on color, foreign material, wave pattern, motility and abnormal sperm.
14. Collect and evaluate semen.

EJACULATION AND SEMEN COLLECTION

AG 534 - J

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

A. Make transparencies and necessary copies of materials.

B. Provide students with objectives and discuss.

C. Provide students with information and discuss.

D. Provide students with laboratory exercises.

E. Demonstrate laboratory exercise procedures.

F. Obtain equipment used for each method of semen collection to show to students.

G. Contact veterinarian and arrange a field trip for students to observe the various methods of semen collection.

H. Obtain semen samples for use in class.

I. Review and give test.

J. Reteach and retest if necessary.

II. Instructional materials

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Semen Collection: Siphon
2. TM 2--Semen Collection: Spoon
3. TM 3--Semen Collection: Sponge
4. TM 4--Semen Collection: Cup
5. TM 5--Semen Collection: Blotting
6. TM 6--Semen Collection: Massage
7. TM 7--Semen Collection: Condom
8. TM 8--Semen Collection: Vaginal Insert

9. TM 9--Semen Collection: Urethral Fistula

10. TM 10--Artificial Vaginas for Domestic Animals

11. TM 11--Artificial Vagina - Bull

12. TM 12--Parts of a Sperm Cell

D. Laboratory exercises

1. LE 1--Evaluate Semen Based on Color, Foreign Material, Wave Pattern, Motility and Abnormal Sperm

2. LE 2--Semen Collection and Evaluation

3. LE 3--Semen Evaluation

E. Test

F. Answers to test

III. Unit references

A. Barrick, R., and Harmon, H., *Animal Production and Management*, McGraw-Hill Book Company, New York, 1988.

B. Bearden and FuQuay, *Applied Animal Production*, Prentice-Hall, Englewood Cliffs, New Jersey, 1980.

C. Bundy, C.E., et al., *Livestock and Poultry Production*, 5th edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1982.

D. Ensminger, M.E., *Animal Science*, Interstate Publishers, Danville, Illinois, 1983.

E. *Idaho State Board for Vocational Education Curriculum Guide in Livestock Production*, University of Idaho and the Idaho State Board for Vocational Education.

F. Lasley, John F., *Genetics of Livestock Improvement*, 3rd edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1978.

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EJACULATION AND SEMEN COLLECTION

AG 534 - J

INFORMATION SHEET

I. Mating process

   A. Libido

      1. Visual

      2. Odor

   B. Erection

   C. Extension

   D. Mounting

   E. Intromission

   F. Thrusting

   G. Ejaculation

II. Semen

   A. Composition - sperm, accessory fluids

   B. Point of deposition in female

      1. Bull and ram--face of cervix

      2. Boar--cervix and uterus

      3. Stallion--cervix and sometimes uterus

   C. Passage of sperm through tract during ejaculation

      1. Tail of epididymis

      2. Deferent duct

      3. Colliculus seminalis

      4. Urethral canal

D. Fractionated ejaculation

1. Boar

a. First fraction - accessory fluids, gelatinous pellets, few sperm; clear

b. Second fraction - sperm-rich; milky

c. Third fraction - coagulated fluid with sperm; hard to separate

2. Stallion

a. First fraction - accessory fluids, few sperm

b. Second fraction - sperm-rich; milky

c. Third fraction - stringy mucus

III. Semen collection

A. Siphoning (Transparency 1)--follows normal copulation; pipette inserted into vagina after ejaculation to syphon out semen

1. Advantages

a. Can be used to artificially inseminate (AI) if needed

b. Semen satisfactory for evaluation

2. Disadvantage--semen is contaminated with fluids from female tract

B. Spooning (Transparency 2)--follows normal copulation; long-handled sterile spoon used to dip semen from floor of anterior vagina

1. Advantage--semen satisfactory for evaluation

2. Disadvantage--semen contaminated with fluids from female tract

C. Sponge (Transparency 3)--sponge placed in vagina before copulation

1. Advantage--semen satisfactory for evaluation

2. Disadvantage--semen contaminated with fluids from female tract

D. Cup (Transparency 4)--use cup to catch drippings from stallion's penis as he dismounts from servicing mare

1. Advantage--semen may be used to AI

2. Disadvantages

a. Diluted sample

b. Contaminated with fluids from female tract

E. Blotting (Transparency 5)--following normal copulation of sow; place flat side of microscopic slide against lips of vulva as boar dismounts to catch semen pulled from vagina

1. Advantage--easy method for evaluation

2. Disadvantages

a. Very small volume

b. Must be evaluated immediately

F. Massage (bull) (Transparency 6)--insert hand into rectum to massage the area of the ampulle, vesicular glands and prostate. Causes sperm to pass through the urethra by gravity to drip from the prepuce

1. Advantage--bull easy to handle, not excited

2. Disadvantages

a. Poor quality semen

b. Higher incidence of bacteria

G. Condom (Transparency 7)--condom placed over glans penis of stallion before he mounts the mare

1. Advantage--entire volume may be collected

2. Disadvantage--exacting technique required

H. Vaginal insert (Transparency 8)--tapered insert with a flange on the end inserted in vagina before copulation

1. Advantage--collection is free of contamination

2. Disadvantages

a. Difficult to insert

b. Some males don't like the way it feels

c. Penis could bypass flange

d. Penis may be damaged because of the flange rigidity

I. Urethral fistula (Transparency 9)--tube placed under anus connected to male urethra allowing passage of urine through urethra proper or sperm collection under anus at time of copulation

1. Advantages--experimentation; pure sample

2. Disadvantage--requires exacting surgery

J. Artificial vagina (AV) (Transparency 10)--made to simulate animal's vagina; consists of outer support with inner jacket containing temperature-controlled water and pressure, and collecting funnel and container. As male mounts the female, the sheath is grasped and the penis is directed into the artificial vagina for ejaculation

1. Advantage--closest to natural conditions

2. Disadvantages

a. Must simulate normal or best temperature, pressure, lubrication and position for optimum male response

b. Animals must be treated as individuals since they differ

K. Gloved-hand method (boar)--as boar mounts sow, use gloved hand to massage and strip odoriferous fluid from prepuce. Glans penis is grasped and pulled to side of sow for collection

1. Advantage--simple method for boar semen collection

2. Disadvantage--very tiring procedure

L. Electroejaculation--electrode inserted into rectum to stimulate ejaculation; not widely used with boars or stallions

1. Advantages

a. Collect semen without sexual response from the male

b. Collect from males unable to copulate

c. Female in estrus not needed

2. Disadvantages

a. Equipment cost

b. Possibility of misuse

IV. Semen collection with artificial vagina

(Note: Exercise caution to protect animal used as a mount, animal being collected, and person doing the collecting.)

A. Bull (Transparency 11)

1. Mount--female in estrus, teaser animal or dummy
2. Restrain mount
3. Clean bull's sheath and belly
4. Lead bull to mount to tease and be teased
5. As bull mounts, grasp sheath and direct penis into AV
6. Hold AV near buttocks parallel to angle of vagina
7. Let bull serve the AV (don't thrust AV on penis)
8. Do not touch penis

B. Ram

1. Very similar to bull
2. Be alert--after mounting, ram moves very quickly and makes a rapid, single thrusting motion
3. If disinterested, stimulate by grasping wool in front of the dock on the ewe and shaking the tail

C. Boar

1. Not a common method, but is satisfactory
2. A lot of pressure is necessary
3. As boar mounts, can grasp penis to direct into AV
4. Fractionated ejaculation--only collect the second fraction (sperm-rich) and let the rest fall to the ground

D. Stallion

1. Mare--hobbled, tail wrapped
2. Teasing--lead stallion close to mare; do not let mount
3. Wash, rinse, and blot-dry penis
4. Allow stallion to approach and tease mare

5. As stallion mounts, direct penis into AV
6. Hold AV level with and to one side of vulva; don't thrust AV
7. When finished, wash penis
8. Strain semen to remove gelatinous portion

V. Semen collection with electroejaculator

A. Bull

1. Restrain bull in chute
    a. No more restraint than necessary
    b. Responds best when standing normally
    c. Bull usually lifts right hind leg when stimulated, prepare to collect from that side
2. Wash and lubricate probe
3. Wash sheath and belly
4. Wet probe with water; insert through anus into rectum
    a. Pull on tail slightly (raise only horizontally, not too high)
    b. Insert probe with a pushing, slightly turning motion
5. After probe is inserted; hold tail down (so bull can't push probe out)
6. Turn ejaculator on as probe is being inserted
    a. After inserted, begin stimulation at low power and rhythmic manner
    b. Stimulation--one second pause-relaxation-one second pause-etc.
    c. Begin with low power - increase gradually
    d. Maximum power - 20 volts
7. When fluid changes to milky color, place collection funnel over the glans penis
8. Remove collection funnel when fluid is clear again

B. Ram

1. Similar to bull

2. Smaller probe; same power source as bull

3. Restrain ram

a. Chute

b. Place knee in his flank to hold against fence or wall

c. Lay on side; restrain feet and legs

VI. Parts of a sperm cell (Transparency 12)

A. Head

B. Neck

C. Middle piece

(Note: The middle piece of the sperm cell stores energy for the sperm cell.)

D. Tail

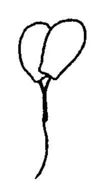
(Note: The tail propels the sperm.)

VII. Types of abnormal sperm

(Note: For a sample to be acceptable these should not exceed ten percent.)

A. Tailless head

B. Two heads



C. Abnormal shaped head

D. Two tails

E. Coiled tail

F. Abnormal middle piece

VIII. Factors used in semen evaluation (total number of viable sperm)

A. Volume of ejaculate and concentration per unit volume--determines the total number of cells in the semen. If no sperm are present, male is sterile

B. Motility

1. Percent of living or moving cells

2. Cells must be living to fertilize

C. Morphology

1. Percent normal cells

a. Primary abnormalities--testicular origin

b. Secondary abnormalities--occur in duct system (deteriorated)

2. Rate of forward movement is determined--abnormal cells usually don't swim forward

IX. Evaluating quality of bovine semen

A. Color--acceptable color ranges from milky to creamy

(Note: This indicates sperm per cubic millimeter of 500,000 or above. Other colors indicating less than 500,000 sperm/cu mm would be opalescent (cloudy) to watery.)

B. Foreign material--blood or pus in the semen indicates a serious problem and is unacceptable; bedding, dust or fecal material should be disregarded

(Note: Pus may appear as snowflakes around the edges of a tilted vial.)

C. Wave pattern

(Note: This is best determined by placing a thick drop of semen on a slide under a microscope on low power and with reduced light.)

1. Acceptable

   a. Very good - 4 - Dark, distinct waves moving rapidly

   b. Good - 3 - Waves apparent, but with moderate motion

2. Not acceptable

   a. Fair - 2 - Waves barely distinguishable

   b. Poor - 1 - No waves, but motile sperm are present

   c. Very poor - 0 - No waves and no sperm motility

D. Progressive motility

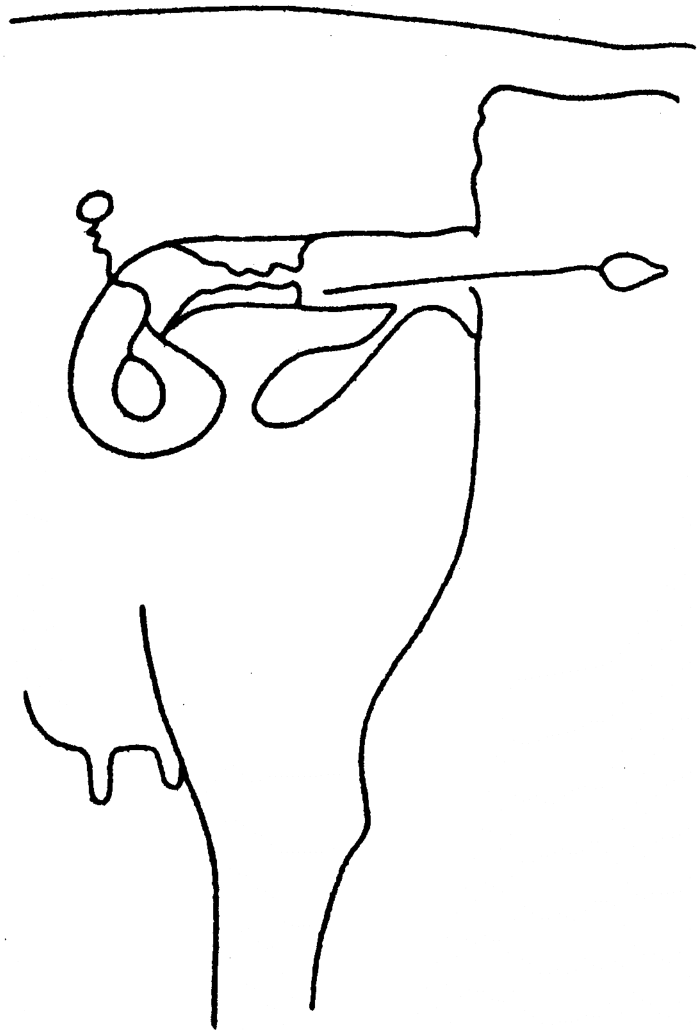
(Note: Other types of motility which involve circling or jerking without forward motion are undesirable. Motility is best determined by putting a thin, diluted drop of semen on a slide under a microscope on low power, 100X.)

1. Acceptable samples should have a progressive motility exceeding 50 percent

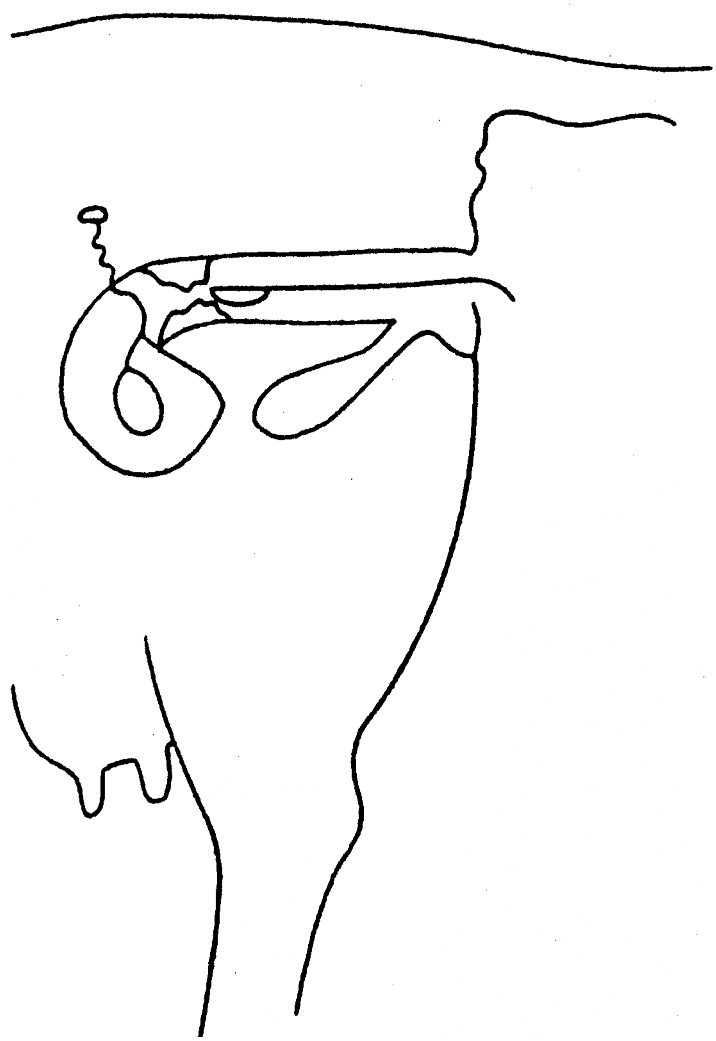
2. Ratings

a.	Very good	- 5 -	80-100% motile sperm cells
b.	Good	- 4 -	60- 80% motile sperm cells
c.	Fair	- 3 -	40- 60% motile sperm cells
d.	Poor	- 2 -	20- 40% motile sperm cells
e.	Very poor	- 1 -	0- 20% motile sperm cells

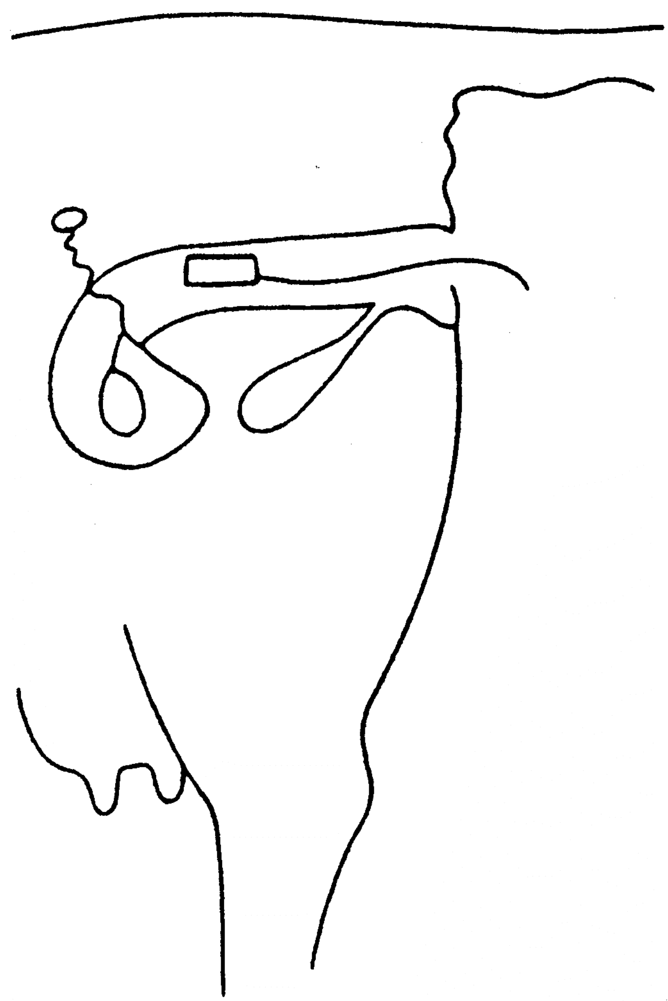
Semen Collection: Siphon



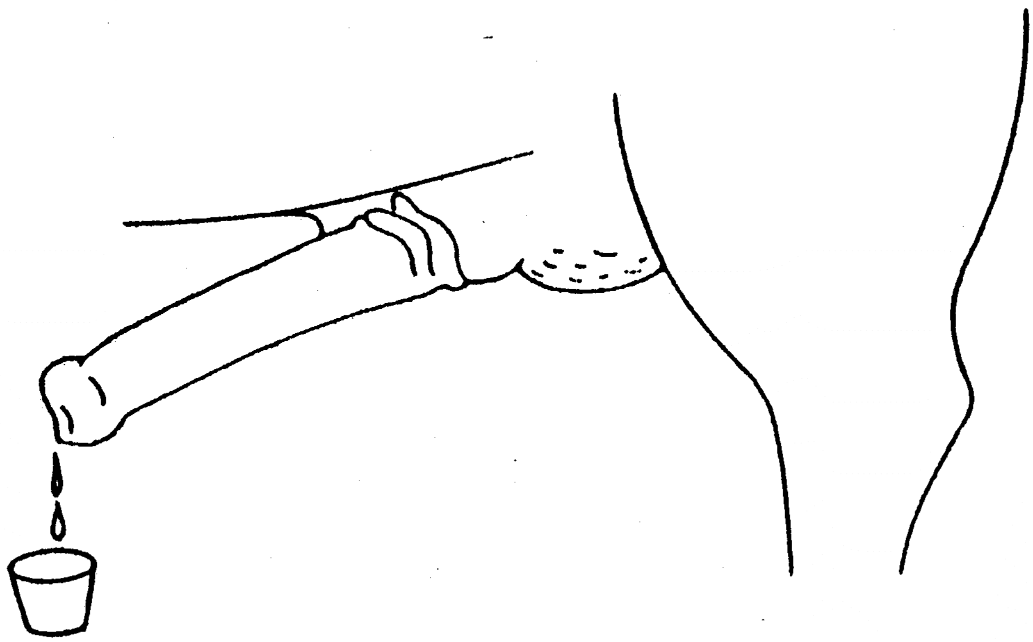
Semen Collection: Spoon



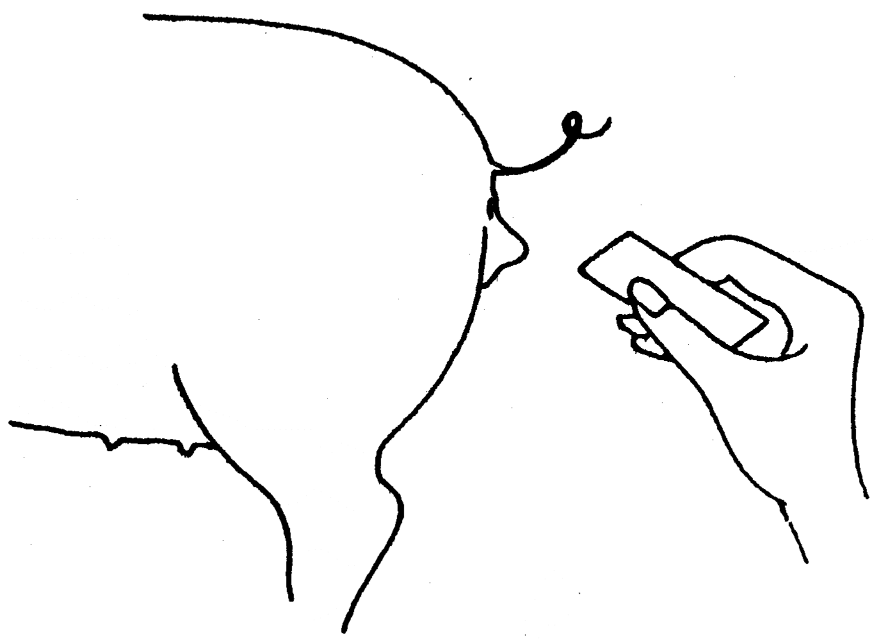
Semen Collection: Sponge



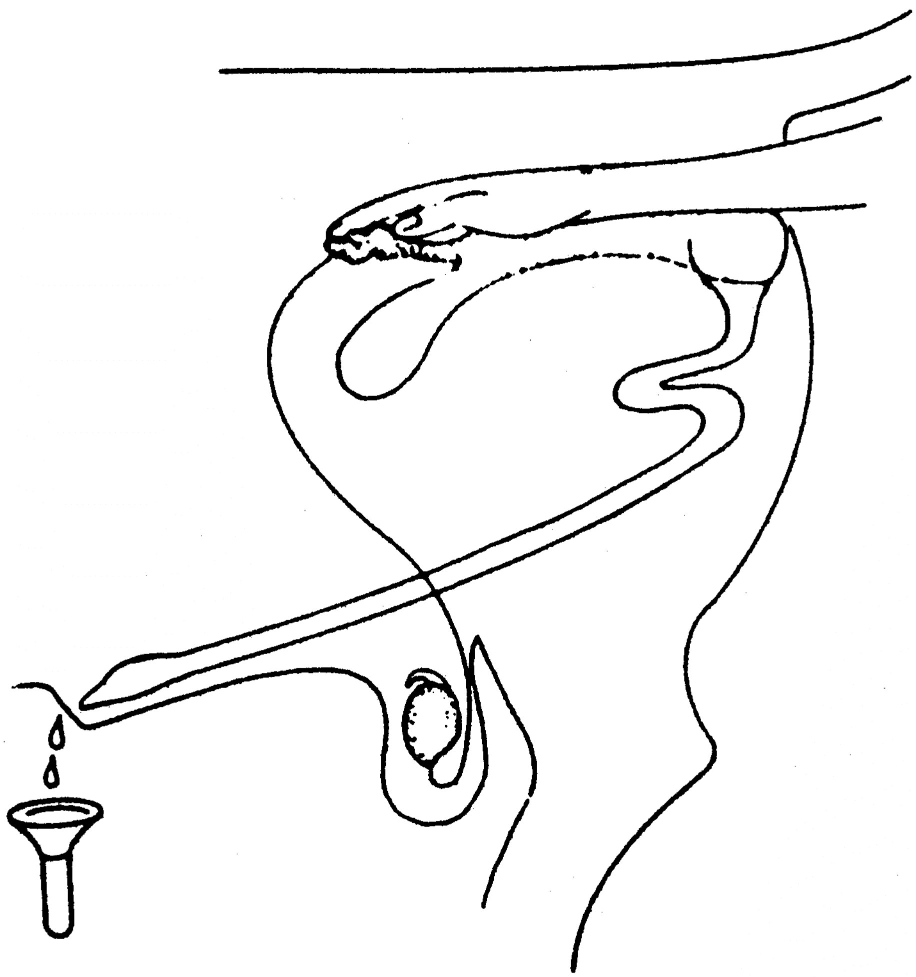
Semen Collection: Cup



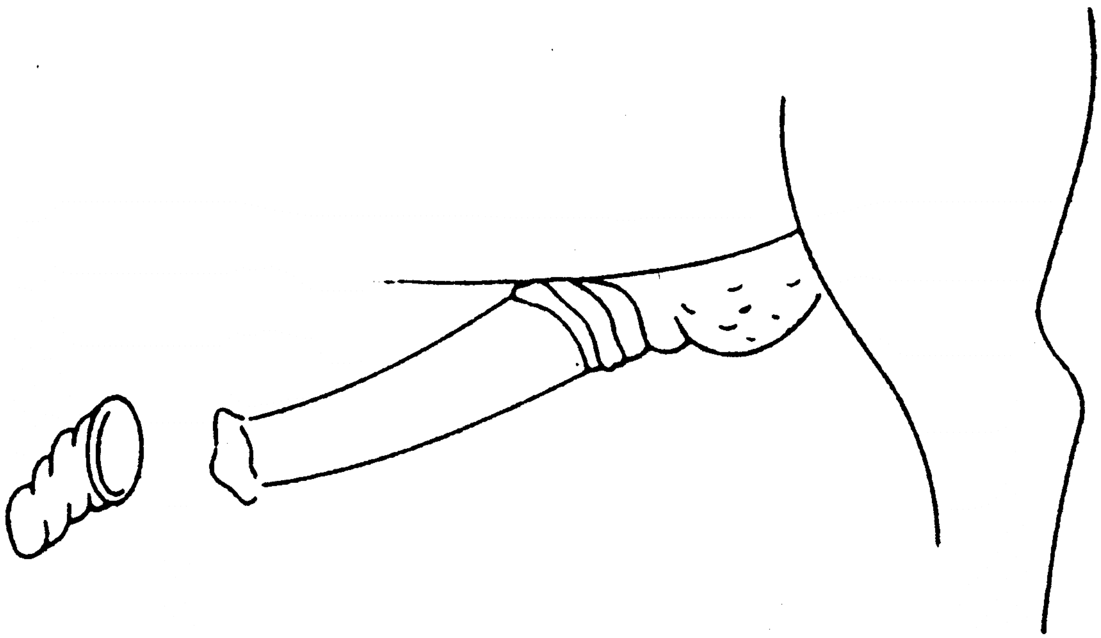
Semen Collection: Blotting



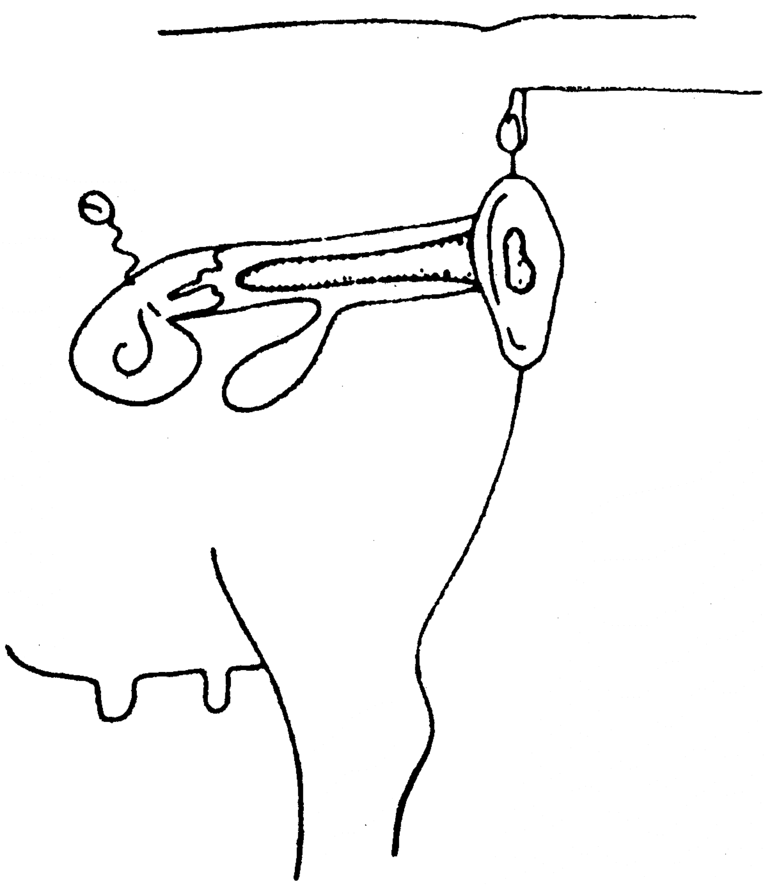
Semen Collection: Massage



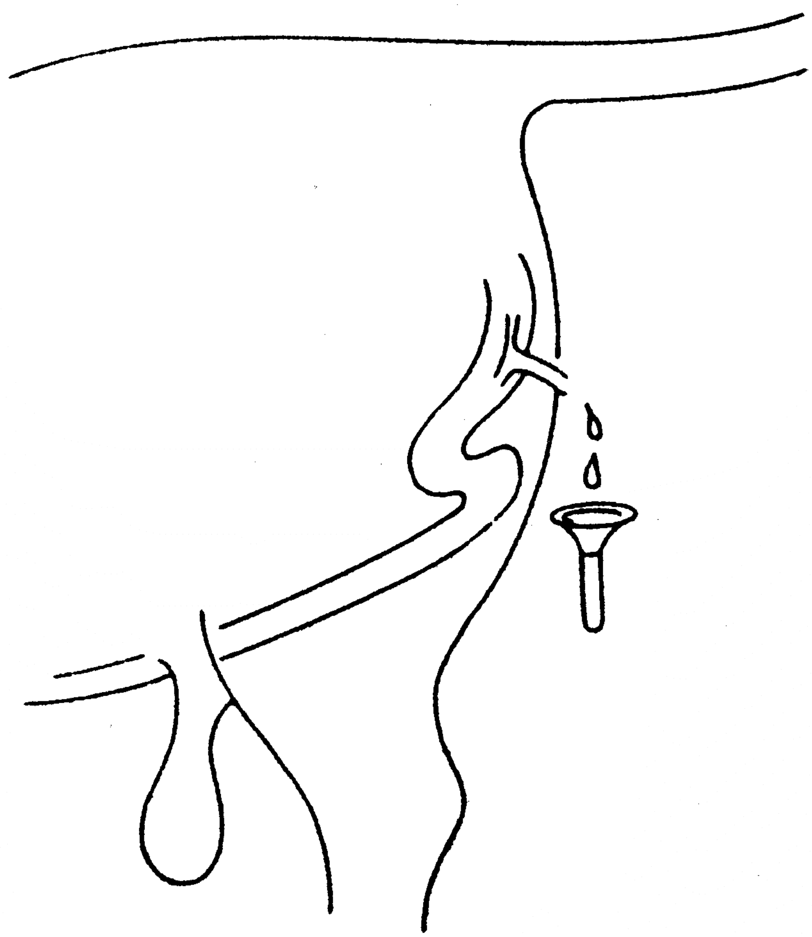
Semen Collection: Condom



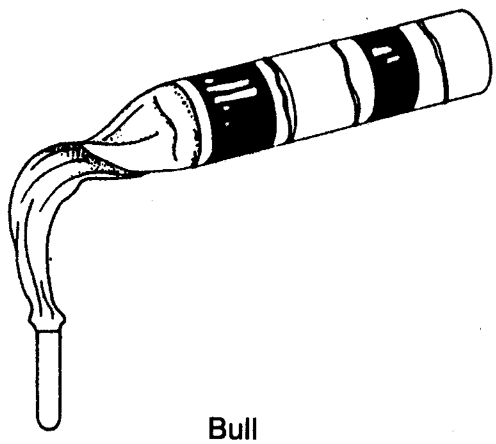
Semen Collection: Vaginal Insert



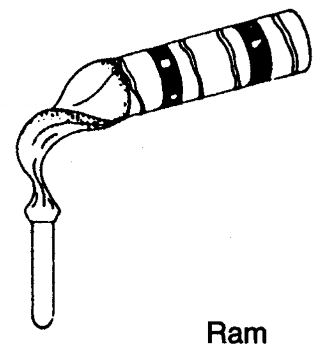
Semen Collection: Urethral Fistula



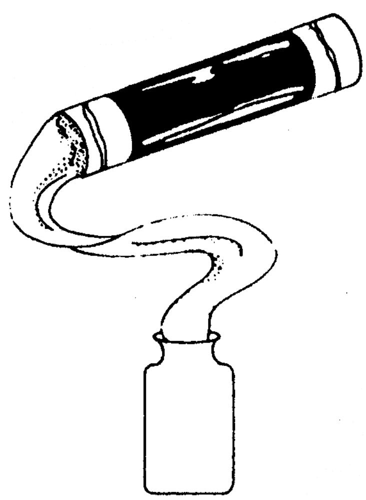
Artificial Vaginas for Domestic Animals



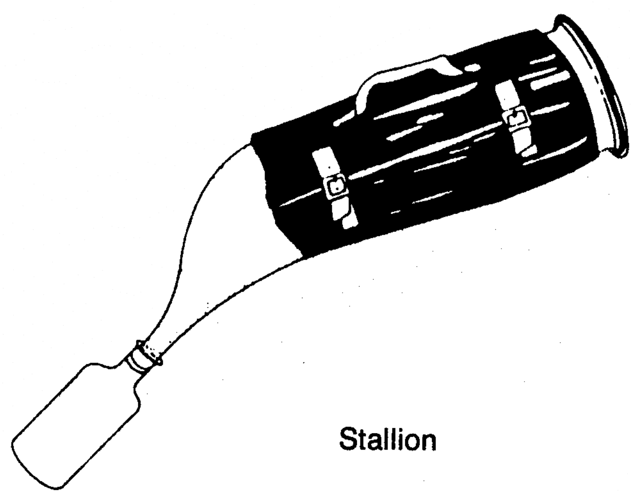
Bull



Ram

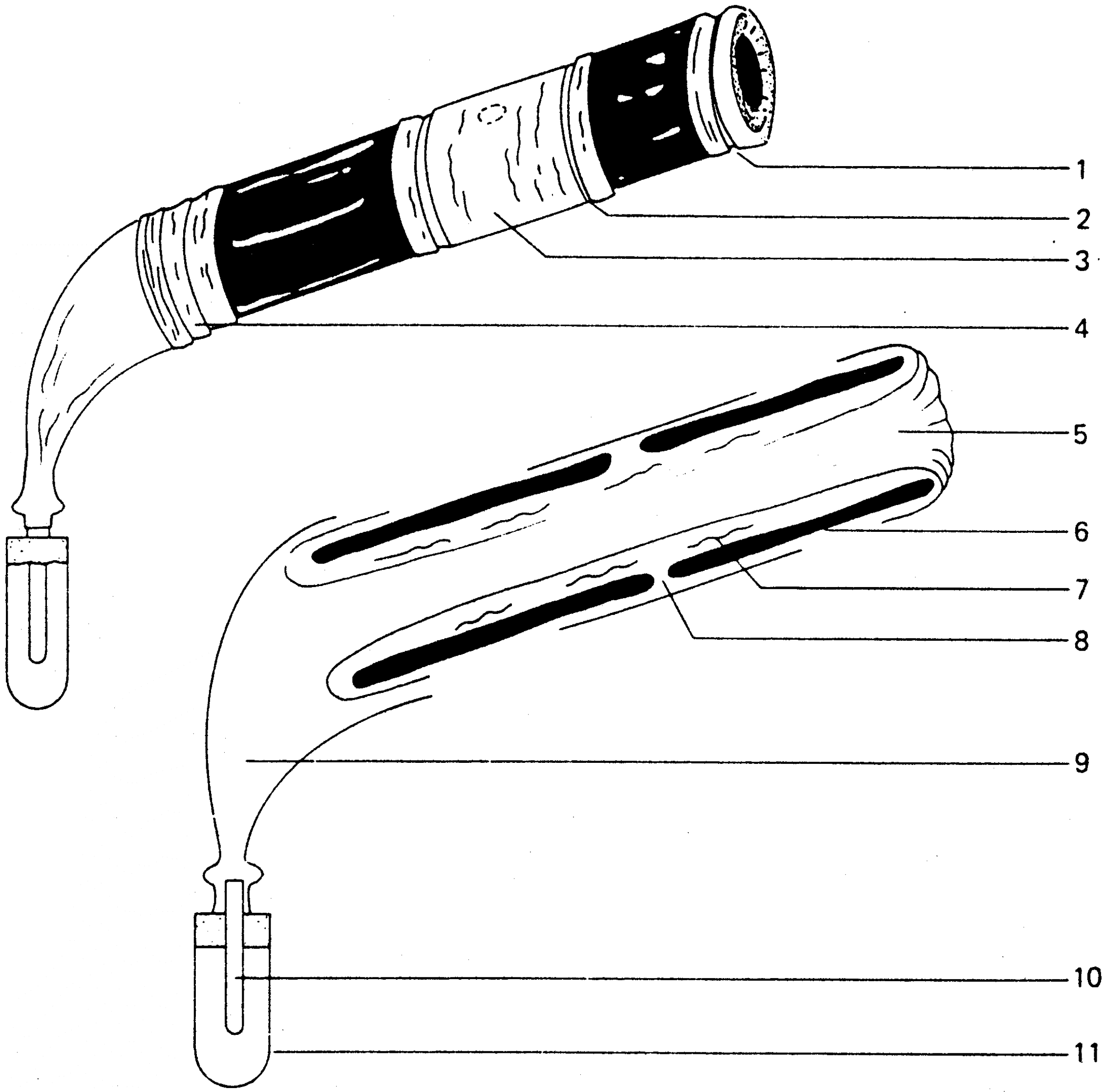


Boar



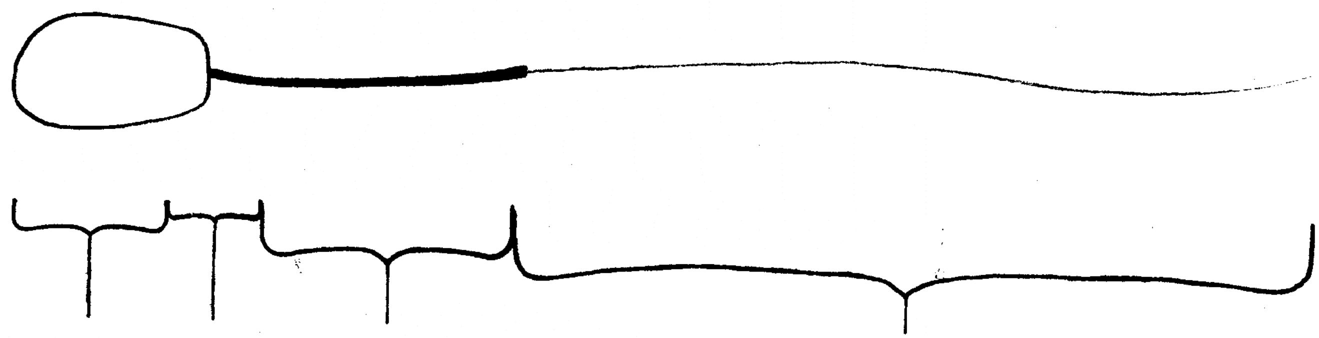
Stallion

Artificial Vagina — Bull



1 Retainer band
2 Retainer band
3 Pressure sleeve
4 Retainer band
5 Inner liner
6 Casing
7 Water
8 Pressure valves
9 Funnel
10 Collecting tube
11 Insulator

Parts of Sperm Cell



EJACULATION AND SEMEN COLLECTION

AG 534 - J

LABORATORY EXERCISE #1--EVALUATE SEMEN BASED ON COLOR, FOREIGN MATERIAL, WAVE PATTERN, MOTILITY, AND ABNORMAL SPERM

Name ___________________________________ Score _________________________________

Color and foreign material can be observed without a microscope. Only blood or pus are considered important foreign material. Wave pattern should be observed under low power (100X) using a fairly thick drop of sperm on the slide. Progressive motility or movement in a forward direction is best determined by placing a small drop of semen on a slide and then diluting it with physiological saline or buffered 2.9 percent sodium citrate solution. A cover slip should then be placed over the diluted sperm and the light reduced so the sperm cells are distinct. Circling or jerky motility should also be observed and estimated.

LAB SHEET FOR SEMEN EVALUATION

Semen sample no ________________________

Color of semen __________________________ Estimated sperm concentration ________________

Foreign material ________________ (yes or no) If yes, then describe ________________________

____

____

____

Wave pattern (rate from 0 to 4 ____

Abnormal motility (estimate percentage of abnormal motility ___________________________________

Progressive motility (estimate percentage and rate from 1 to 5)

Percentage _________________________

Rating _____________________________

Abnormal sperm (estimate percentage of abnormal sperm) _____________________________________

EJACULATION AND SEMEN COLLECTION

AG 534 - J

LABORATORY EXERCISE #2--SEMEN COLLECTION AND EVALUATION

Name ______________________________________ Score ___________________________________

Materials needed

Rams
Electroejaculator
Conical centrifuge tubes with stoppers
Thermos
Pasteur, capillary and graduated plastic pipets
Vortex mixer
Microscope
Microscope slides and coverslips
Warmer tray
Water bath
Centrifuge
Dead-Alive stain
Sodium citrate solution (98.6 mM)
Egg yolk extender (98.6 mM Na citrate; 20% egg yolk)
Skim milk extender (98.6 mM Na citrate; 20% pre-heated skim milk)
Spectrophotometer
Frozen straws of bull semen
95oF water in container (thermos wide mouth)

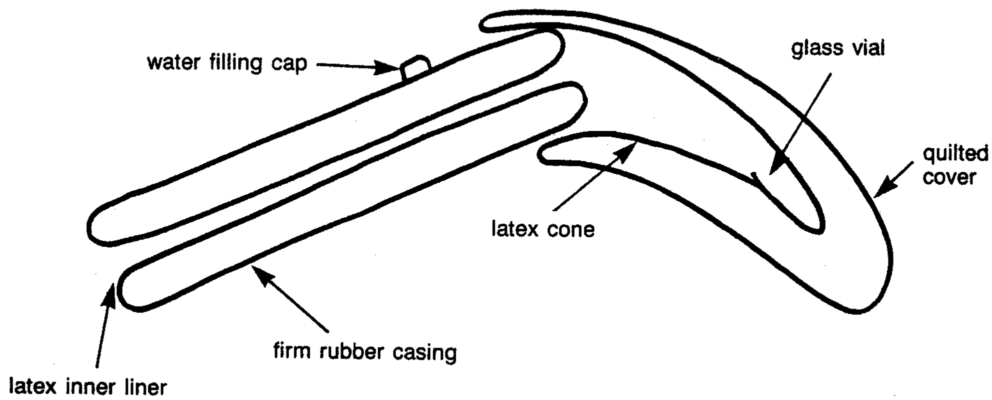
Introduction

Semen Collection

The Artificial Vagina

Semen of the bull, the ram, the boar, and the stallion is most satisfactorily collected through the use of an artificial vagina. These artificial vaginas consist of a relatively firm outer casing with an inner flexible liner folded over the ends of the casing. The space between the casing and the liner is filled with hot water prior to collection of semen. A collecting cone is placed over one end of the assembled casing and liner and this cone directs semen into a collecting vial. The following diagram is a schematic drawing of an artificial vagina (AV).

Artificial vagina.



The male from which semen is to be collected mounts a female or another male (the mount animal) in a manner similar to the first phases of natural copulation. In some instances a covered framework (the dummy) is used in place of the mount animal. When the male mounts, a technician making the collection manipulates the penis into the artificial vagina. If a dummy is used, the artificial vagina is sometimes positioned within the posterior of the dummy. With satisfactory conditions, ejaculation occurs immediately following a vigorous thrust by the ram or bull. Ejaculation occurs in a fraction of a minute with the stallion also, but over a period of several minutes with the boar.

Suitable conditions for successful collection include: (a) stimulus pressure sufficient to bring about desire of the male to mount, to have intromission and to ejaculate; (b) training, experience and adaptability of the male so that he will copulate in close proximity to human handlers and under the artificial conditions prevailing; (c) a mount animal sufficiently immobilized or willing to stand for an intended copulation or a dummy (the mount animal usually presents fewer problems in developing stimulus pressure in the male from which semen is to be collected); (d) an artificial vagina adapted to the species and frequently modified for the individual male; (e) skillful manipulation of the artificial vagina by the technician making the collection.

Electroejaculation

Semen of the bull and the ram may be discharged through the use of rectal electrodes of the electroejaculator and collected within a funnel-shaped device. Electroejaculation is usually possible in a species in which the male has a fibroelastic type of penis, but the technique has been less developed for species in which the males have a vascular type of penis. Electroejaculation is usually used only with bulls and rams which are unable or unwilling to mount and to serve an artificial vagina. Results are rather variable as to the quality of the ejaculate collected, and are dependent upon the skill of the technician making the collection, as well as individual animal variability.

Semen Extension and Preservation

Extenders for Semen

"Extender" as a term in this field is fairly recent, and not universally accepted. "Extender" is used to connote the extension of semen to increase the number of insemination units and to increase the length of time of usage. Presently-used extenders may be divided into two categories: (a) those in which milk is the predominant constituent and (b) yolk-containing extenders. A few other extenders have been proposed, but for practical purposes, these two categories suffice.

Homogenized milk extender has the disadvantage of being rather opaque when microscopically examined for sperm motility. Non-motile sperm are not readily visible, and this makes motility rating difficult. Skim milk extender has excellent microscopic visibility but is inferior to homogenized milk in promoting sperm livability, particularly with fluid semen.

Yolk-containing extenders range from simple combinations of yolk and buffer, such as yolk-citrate, to complex mixtures of materials such as are present in Cornell University Extender (CUE). Yolk-containing extenders are sometimes combined with glycerol and used for semen freezing. CUE, the most common yolk-containing fluid semen extender, does not utilize glycerol. CUE has poorer microscopic visibility because of the dispersion of yolk fat globules. CUE cannot be used in freezing of sperm.

Preservation of sperm

Practical artificial insemination in the livestock species necessitates preservation of semen for at least one to several days. If semen cannot be preserved, males must be in close proximity to females and many of the potential advantages of artificial insemination are lost. Bull semen is most successfully preserved in that it may be kept in either fluid form in a refrigerator (4-5oC) for a few days, or in frozen form in liquid nitrogen (-196oC) for months or years. Stallion semen may likewise be preserved in fluid or in frozen form, although conditions for frozen storage are less well defined. Among farm animals, the greatest present increase in artificial insemination is with swine; boar semen is preserved in fluid form. Ram semen may be preserved in fluid form, but its use is only experimental in western countries.

Part I: Semen Collection by Electroejaculation

1. Restrain the ram to be collected within the chute.

2. Place electrode probe within bucket of soapy water (soapy water serves as a lubricant) and then place probe fully within rectum.

3. Gradually increase "signal" intensity to the electrode over a period of 3 to 8 seconds and then return to zero.

4. Rest 5 to 15 seconds between stimulations.

5. Repeat stimulation process to induce erection, protrusion and ejaculation. The timing of the stimulations and the voltage applied should be keyed to the ram's response. Ideally, protrusion of the penis occurs before ejaculation.

6. Avoid collecting the first fluid discharged and attempt to procure the portion having higher sperm concentration. Collect the semen into the hand-held centrifuge tube. Stopper the tube, label it and insert it into the thermos.

Part II: Semen Extension and Preservation

1. Combine the semen samples collected in a single centrifuge tube and designate it as the Semen Pool. Record the volume of the Semen Pool.

2. Determine the sperm concentration of the Semen Pool using the turbidimetric technique. Perform a motility and dead-alive evaluation on the Semen Pool (Pre-extension data). Record the data.

3. Divide the Semen Pool equally into four test tubes. Designate the centrifuge tubes as 1, 2, 3, and

4. Tube 1 is the sperm in seminal plasma treatment (Treatment 1) and should be left to cool to room temperature. Once cooled, stopper the tube and place it in a test tube rack in the refrigerator.

5. Centrifuge the remaining 3 tubes, decant the supernatant (seminal plasma) carefully and replace the seminal plasma with the sodium citrate solution (1.0 ml) for Tube 2 (Treatment 2), the egg yolk extender (1.0 ml) for Tube 3 (Treatment 3), and the skim milk extender (1.0 ml) for Tube 4 (Treatment 4). Gently vortex the samples and repeat the centrifugation steps twice to thoroughly wash the sperm with the treatment solution.

6. Cool to room temperature, then place the tubes in the rack in the refrigerator.

7. At 24 hours post-extension, remove the tube from the refrigerator and place it in the 37oC water bath.

8. Following warming, gently agitate the tube since the spermatozoa will settle to the bottom and evaluate the sample for motility and live sperm (Post-extension data). Record the data. Compare the post-extension data among treatments and with the pre-extension data. Which extender best maintained sperm viability over the 24 hour storage period?

			Post-extension (24 h) treatment		
	Pre-Extension	Seminal plasma	Sodium critrate	Egg yolk	Skim milk
Percent					
Motile sperm	________	________	________	________	________
Live sperm	________	________	________	________	________

EJACULATION AND SEMEN COLLECTION

AG 534 - J

LABORATORY EXERCISE #3--SEMEN EVALUATION

Name ______________________________________ Score ___________________________________

Materials needed

Semen
Two or more freshly collected ejaculates
Microscope
Slide warmer +38oC
Waterbath +32oC
Glass rods or plastic pipets
Glass slides (25 x 75 mm) and coverslips (22 x 22 mm)
Hemocytometer, including coverslip, two pipets and mouthpiece
Spectronic 20 colorimeter (B & L) complete with tubes for turbidimetric estimation of sperm concentration
Lens and tissue paper
0.2 ml "blow" pipets
Parafilm squares 20 x 20 mm

Introduction

Substantial variation in seminal characteristics is noted among the farm mammals with regards to sperm numbers per ejaculate, total ejaculate volume and frequency of semen collection (Table 1)

Table 1. Semen Characteristics of Farm Animals

	Cattle				
	Dairy	Beef	Sheep	Swine	Horses
Volume (ml)	6	4	1	225a	60
Sperm conc. (109/ml)	1.2	1.0	3.0	0.2	0.15
Sperm/ejac. (109)	7	4	3	45	9
Motile sperm (%)	70	65	75	60	70
Morphologically normal sperm (%)	80	80	90	60	70
Ejaculate/wk	4	4	20	3	3

a Gel not included.

Differences among species in the numbers of sperm ejaculated reflect differences in sperm production per gm of testis, testis size, sperm resorption (within the epididymis, for example) and other sperm losses. Differences in the volume of seminal plasma and hence in the total volume of the ejaculate, as well as differences in chemical and physical characteristics of the ejaculate are due to variations in size, structure and function of accessory glands. Semen of stallions and of boars is not only much more voluminous than bull and ram semen, but has gelatinous components. Sperm numbers, ejaculate volume and other semen traits vary seasonally, and this is more pronounced in some species.

Gross Examination

A *gross examination* should be routinely made of the ejaculate and its volume recorded. With boar and stallion semen, separate recordings are sometimes made of the fluid portion of the ejaculate (in contrast with the gelatinous portion). The gross observation gives opportunity to note certain abnormalities or contaminants of the ejaculate.

Motility Evaluation

A *motility evaluation* should be made by examining a drop of semen microscopically. A major problem with motility evaluation is its subjective nature, although uniformity in procedure and experience of the evaluator improve accuracy of these determinations. Motility evaluations are routinely made on all semen samples. In some laboratories evaluations are made of motility of whole semen while other laboratories prefer dilution prior to evaluation.

Dead-Alive Evaluation

A dead-alive count may be made by staining sperm on a glass slide, drying and counting differentially. Dead-alive stain counts are less subjective than are motility evaluations, but are somewhat more time-consuming and are not usually done routinely.

Concentration Determination

Sperm concentration should be routinely determined on all samples. A *hemocytometer* may be used, although it is more time-consuming than *turbidimetric* estimation of sperm numbers. With the former, diluted samples are counted microscopically against a grid background in a uniform thickness field similar to procedures used for blood cell counts. Turbidimetric estimations are made by diluting samples and measuring light absorbance within a colorimeter. A sample with higher sperm concentration has greater light absorption. Colorimeters must be calibrated initially by comparison with hemocytometer counts.

Morphology Evaluation

Sperm morphology observations may be made by staining of samples and microscopic evaluation. Some morphologically abnormal sperm may be noted in the examination of semen for motility or in a dead-alive stain.

Part I: Gross Examination

1. Record semen volume; for males producing gelatinous semen, record both fluid and gelatinous volumes.

2. Note whether the semen appears normal.

Part II: Motility Evaluation

1. Place a small drop of sodium citrate solution on a clean glass slide warmed to 38oC. This drop should be of such size that placing a coverslip upon it (#3 below) will allow it to occupy all the space under the coverslip, but not flood out beyond it.

2. With a clean glass rod, place a very small dab of whole semen on the drop of buffer.

3. Cover the semen-buffer drop with a coverslip.

4. Examine the drop with low magnification (microscope). If the sperm are close together so as to make a motility estimate difficult, prepare a second slide.

5. Rate motility on a basis of 0 to 100% where 0 represents an estimated 0-5% progressively motile, 1 represents 5-15%, etc. Do not rate closer than the nearest 10%. Record motility.

Part III: Dead-Alive Stain

1. Place a drop of warm (38oC) eosin-aniline blue stain near one end of a glass slide on slide warmer (38oC).

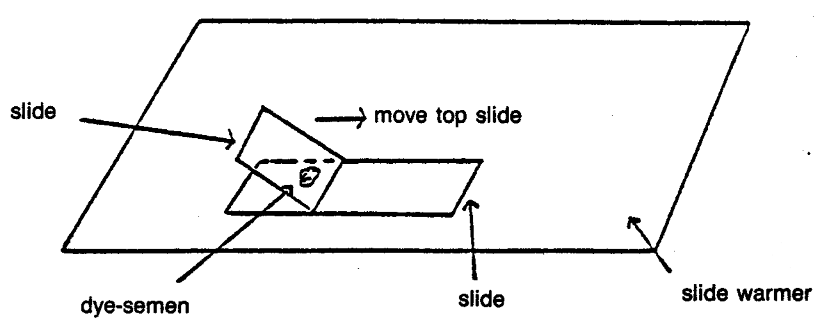
2. With a glass rod, mix a small amount of semen with the stain in 2 or 3 circular movements of the rod.

3. With a second slide, approach the dye-semen drop at an angle (Figure 1) and spread in a thin layer on the first slide.

4. Immediately transfer the slide to a hot plate for rapid drying or pass it near a flame until dry.

5. Count 100 sperm under "high dry" magnification of microscope, recording the number that are stained (dead). The base of the head of some sperm will be stained and the remainder clean; these are counted as dead. In counting 100 sperm, count "at least 100". If the last microscopic field you examine has more than 100, count the entire field and then calculate the percent stained. Record the data.

Preparing a Dead-alive Stain



Part IV: Abnormal Sperm Morphology Evaluation

1. Using the same slide prepared for the Dead-Alive evaluation, count 100 sperm under "high dry" magnification or oil immersion and record the number of sperm that have abnormal morphologies. Refer to the figure below for a description of the various sperm abnormalities encountered.

2. Record the percentage of abnormal sperm.

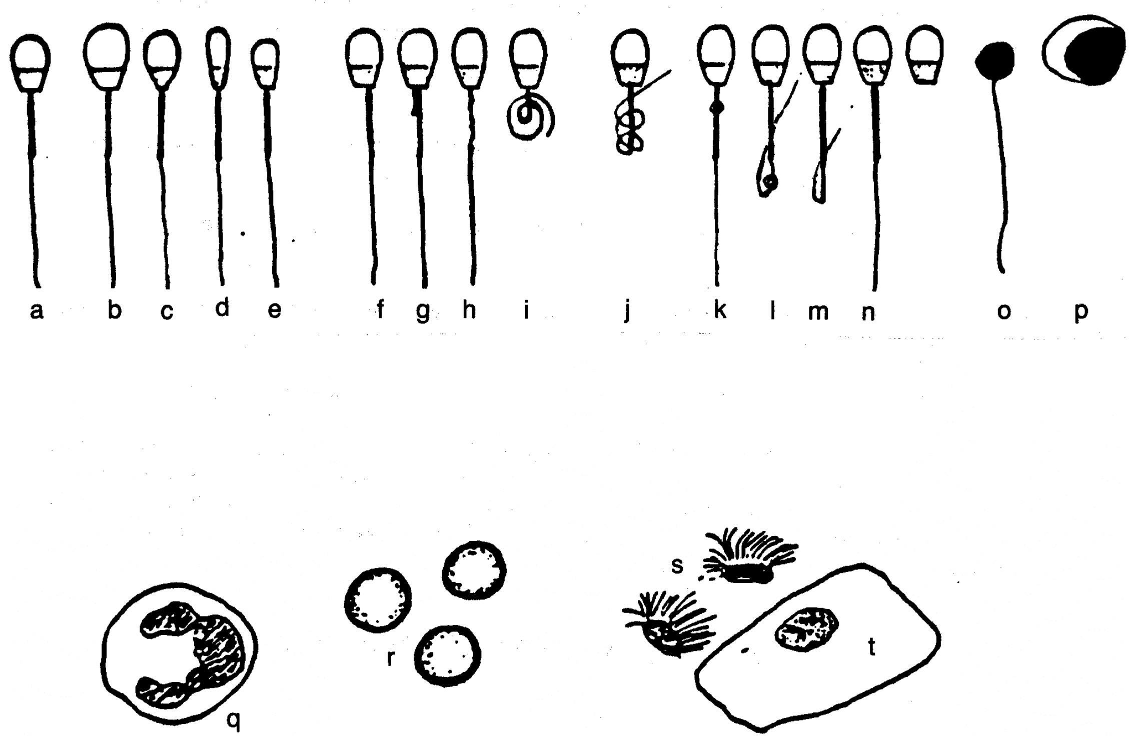


Figure 2

Figure 2. Normal bovine cell (a and n) and several abnormal cells appearing in bull semen. b-e, Head abnormalities; f-i, midpiece abnormalities; j, tail abnomality; k, proximal protoplasmic droplet; l, distal protoplasmic droplet and bent tail; m, bent tail; n, loose normal head; o, spermatid; p, spermatogonium; q, neutrophilic granulocyte; r, erythrocytes; s, medusa cells; t, epithelial cell

Part V: Determining Sperm Numbers with a Hemocytometer

1. Draw 0.005 ml of mixed semen into a standard red-cell dilution pipette; this is indicated by the 0.5 mark on the pipette stem.

2. Draw semen column within the stem slightly higher in the pipette so that there is a small amount of space in the stem below the column; wipe end of pipette clean. The air below the column minimizes loss of the measured semen in the next step.

3. Fill pipette to 1.01 ml by drawing to the 101 mark above the bulb, using the diluting fluid.

4. Cover both ends of the pipette; vigorously agitate 20 times.

5. Discard several drops of diluted material to be sure the stem of the pipette now contains adequately mixed material from the bulb.

6. Place cover glass over the ruled field of a cytometer and let a drop of the diluted sperm suspension run under the glass.

7. Make the count with 100x magnification of the microscope (low power), counting the four corner squares and the center square, as shown in figure on the following page. The area encompassed by the 25 squares is 1 mm, and the space between cover glass and cytometer is 0.1 mm for a total 0.1 mm3 suspension. The pipette dilution (1/200) times the squares counted (5/25) times 1/10 mm3 suspension (1/200 x 5/25 x 1/10 = 1/10,000). Hence, the number of sperm counted times 10,000 is the sperm concentration per mm3; multiply by an additional 1,000 and you have the count per ml. The total sperm counted in the five squares times 10,000,000 will be the sperm per ml. It is more convenient to take the number counted (example 120), count off two decimal places (1.20) for billions of sperm (1.20 billion) or (1.20 x 109).

8. In making the count, pay attention only to the sperm head, not the tail. Within each square, count all sperm not touching the border of the "large" square; also count those touching the upper and the left border. Record the data.

Sperm to Count in Cytometer

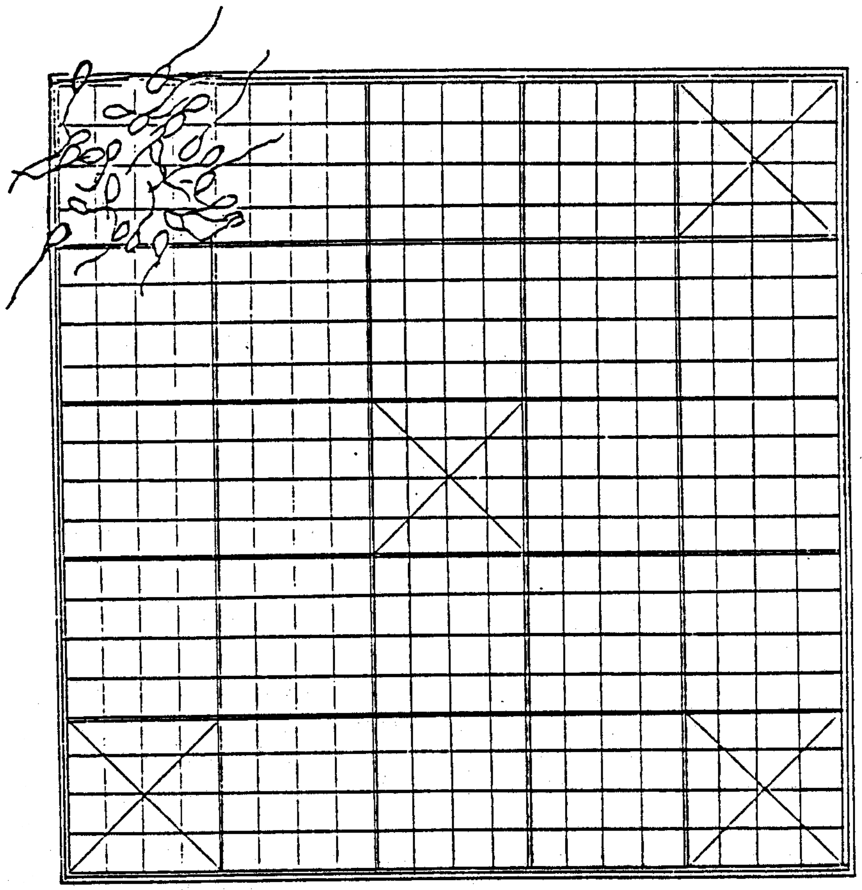


Figure 3

a. Count sperm in five "large" squares (each corner square and the center as indicated by X in figure).

b. Count all sperm within these squares; count those whose heads touch the upper and left border of each square; do not count those touching the other borders.

c. Count squares in which the head is located; ignore the tail.

d. Multiply by 10,000,000 (total in five squares) to get sperm/ml.

Part VI: Turbidimetric Determination of Sperm Numbers

1. Dispense 8.0 ml of sodium citrate solution into as many "Spectronic 20" tubes (colorimetric tubes) as there are ejaculates anticipated. Place in 32oC water bath.

2. Using the warm pipette, withdraw 0.1 ml semen from a suitably mixed sample; wipe exterior of pipette free of semen.

3. Discharge semen into buffer; draw buffer into pipette to flush and discharge again into tube contents.

4. Turn on "Spectronic 20" about 5 minutes before use. Adjust light wave length to 660. Adjust transmission so that galvanometer reads 100% when a tube containing only buffer is in place, and 0 when the tube is removed.

5. Wipe exterior of tube; cover with parafilm and invert to mix; place tube in instrument, cover and read galvanometer. The greater the number of sperm, the more the turbidity and the lesser transmission of light.

6. The following table gives sperm concentration per ml semen processed in our routine. Record the data.

Turbidimetric Estimation of Sperm Numbers

G	Conc	G	Conc	G	Conc
87	0.09	62	0.71	37	1.61
86	0.12	61	0.73	36	1.66
85	0.14	60	0.76	35	1.71
84	0.16	59	0.79	34	1.76
83	0.18	58	0.82	33	1.81
82	0.21	57	0.85	32	1.87
81	0.23	56	0.88	31	1.93
80	0.25	55	0.91	30	1.99
79	0.27	54	0.94	29	2.05
78	0.30	53	0.97	28	2.11
77	0.32	52	1.01	27	2.17
76	0.35	51	1.04	26	2.24
75	0.37	50	1.08	25	2.30
74	0.40	49	1.11	24	2.37
73	0.42	48	1.15	23	2.44
72	0.45	47	1.19	22	2.52
71	0.47	46	1.23	21	2.60
70	0.50	45	1.27	20	2.69
69	0.52	44	1.31	19	2.79
68	0.55	43	1.35	18	2.89
67	0.57	42	1.39	17	2.99
66	0.60	41	1.43	16	3.10
65	0.62	40	1.48	15	3.21
64	0.65	39	1.52	14	3.32
63	0.67	38	1.57	13	3.44

G = galvanometer reading, percent transmission
Conc = sperm concentration per ml semen x 109

Part VII: Cleaning Glassware

1. Wash in detergent solution, about 45oC. Pipettes should be flushed with rubber bulb in this as well as subsequent wash waters.

2. Rinse in tap water bath, about room temperature.

3. Rinse in distilled water bath, about room temperature.

4. Beakers, flasks, tubes and similar glassware may then be inverted to dry.

5. Pipettes may be flushed with alcohol and then ether to facilitate drying.

6. Hemocytometers should be washed very carefully in steps 1-3 above, rinsed in alcohol, and then dried with lens paper.

7. Slides and coverslips should be washed as in steps 1-3, rinsed in alcohol and then dried with towels or lens paper.

RESULTS:

Semen Data

Sample	Volume (ml) Whole semen	Sperm	Seminal plasma	Sperm/ml Hemocytometer	Turbimetetric	Motility %	Dead-Alive %	Abnormal %
1								
2								
3								
4								

EJACULATION AND SEMEN COLLECTION

AG 534 - J

UNIT TEST

Name ______________________ Score ______________________

1. Explain the process of mating.

    a.______________________

    b. ______________________

    c.______________________

    d. ______________________

    e.______________________

    f.______________________

    g. ______________________

2. Describe the composition of semen.

    ____

    ____

3. List the point of semen deposition in the female by the bull, ram, boar and stallion.

    a. Bull ______________________

    b. Ram______________________

    c. Boar ______________________

    d. Stallion ______________________

4. Describe the passage of sperm through the tract during ejaculation.

    a.______________________

    b. ______________________

    c.______________________

    d. ______________________

5. List the males that have fractionated ejaculates and describe the three fractions of each.

   a. ______________________________

      1. ______________________________

      2. ______________________________

      3. ______________________________

   b. ______________________________

      1. ______________________________

      2. ______________________________

      3 ______________________________

6. Describe the various methods of collecting semen and one advantage and disadvantage of each.

   a. Siphoning

      Description ______________________________

      ____

      Advantage ______________________________

      ____

      Disadvantage ______________________________

      ____

   b. Spooning

      Description ______________________________

      ____

      Advantage ______________________________

      ____

      Disadvantage ______________________________

      ____

c. Sponge

Description ____

____

Advantage ____

____

Disadvantage ____

____

d. Cup

Description ____

____

Advantage ____

____

Disadvantage ____

____

e. Blotting

Description ____

____

Advantage ____

____

Disadvantage ____

____

f. Massage (bull

Description ____

____

Advantage ____

____

Disadvantage ____

____

g. Condom

Description ____

____

Advantage ____

____

Disadvantage ____

____

h. Vaginal insert

Description ____

____

Advantage ____

____

Disadvantage ____

____

i. Urethral fistula

Description ____

____

Advantage ____

____

Disadvantage ____

____

j. Artificial vagina

Description ____

____

Advantage ____________________

____

Disadvantage ____________________

____

k. Gloved-hand method (boar)

Description ____________________

____

Advantage ____________________

____

Disadvantage ____________________

____

l. Electroejaculation

Description ____________________

____

Advantage ____________________

____

Disadvantage ____________________

____

7. Describe in detail the use of the artificial vagina for collecting semen from the bull, ram, boar and stallion.

a. Bull ____________________

____

____

____

____

____

____

b. Ram

c. Boar

d. Stallion

8. Describe in detail the use of the electroejaculate for collecting semen from the bull and ram.

   a. Bull ______________________________

   ____

   ____

   ____

   ____

   ____

   ____

   b. Ram ______________________________

   ____

   ____

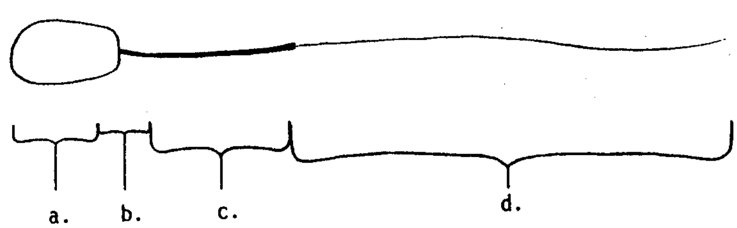
   ____

   ____

   ____

   ____

9. Name the parts of a sperm cell.



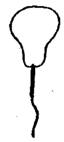
a ______________________________

b ______________________________

c ______________________________

d ______________________________

10. Label the types of abnormal sperm.

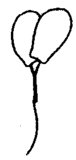


a. ____________________

b. ____________________

c. ____________________

d. ____________________



e. ____________________

f. ____________________

11. Describe the three factors used in semen evaluation.

a ____

____

b ____

____

c ____

____

12. Describe the quality of the following semen sample by putting "acceptable" or "unacceptable" by each area.

Semen sample #3 has 35% progressive motile sperm cells, 8% abnormal sperm cells, a barely noticeable wave pattern, several specks of bedding material and a milky color.

a. Color ____

b. Foreign material ________________________________

c. Wave pattern ____________________________________

d. Progressive motility ______________________________

e. Abnormal sperm __________________________________

EJACULATION AND SEMEN COLLECTION

AG 534 - J

ANSWERS TO TEST

1. a. Libido: Visual, odor
   b. Erection
   c. Extension
   d. Mounting
   e. Intromission
   f. Thrusting
   g. Ejaculation

2. Composition - sperm, accessory fluids

3. a. Bull--face of cervix
   b. Ram--face of cervix
   c. Boar--cervix and uterus
   d. Stallion--cervix and sometimes uterus

4. a. Tail of epididymis
   b. Deferent duct
   c. Colliculus seminalis
   d. Urethral canal

5. a. Boar
      1. First fraction - accessory fluids, gelatinous pellets, few sperm; clear
      2. Second fraction - sperm-rich; milky
      3. Third fraction - coagulated fluid with sperm; hard to separate

   b. Stallion
      1. First fraction - accessory fluids, few sperm
      2. Second fraction - sperm-rich; milky
      3. Third fraction - stringy mucus

6. Answers should include one advantage and one disadvantage for each method:

   a. Siphoning--Follows normal copulation; pipette inserted into vagina after ejaculation to syphon out semen
      Advantage: Can be used to artificially inseminate (AI) if needed; semen satisfactory for evaluation
      Disadvantage--Semen is contaminated with fluids from female tract

   b. Spooning--Follows normal copulation; long-handled sterile spoon used to dip semen from floor of anterior vagina
      Advantage--Semen satisfactory for evaluation
      Disadvantage--Semen contaminated with fluids from female tract

   c. Sponge--Sponge placed in vagina before copulation
      Advantage--Semen satisfactory for evaluation
      Disadvantage--Semen contaminated with fluids from female tract

d. Cup--Use cup to catch drippings from stallion's penis as he dismounts from servicing mare
Advantage--Semen may be used to AI
Disadvantage--A diluted sample; contaminated with fluids from female tract

e. Blotting--Following normal copulation of sow; place flat side of microscopic slide against lips of vulva as boar dismounts to catch semen pulled from vagina
Advantage--Easy method for evaluation
Disadvantage--Very small volume; must be evaluated immediately

f. Massage (bull)--Insert hand into rectum to massage the area of the ampulle, vesicular glands and prostate. Causes sperm to pass through the urethra by gravity to drip from the prepuce
Advantage--Bull easy to handle, not excited
Disadvantage--Poor quality semen; higher incidence of bacteria

g. Condom--Condom placed over glans penis of stallion before he mounts the mare
Advantage--Entire volume may be collected
Disadvantage--Exacting technique required

h. Vaginal insert--Tapered insert with a flange on the end inserted in vagina before copulation
Advantage--Collection is free of contamination
Disadvantage--Difficult to insert; some males don't like the way it feels; penis could bypass flange; penis may be damaged because of the flange rigidity

i. Urethral fistula--Tube placed under anus connected to male urethra allowing passage of urine through urethra proper or sperm collection under anus at time of copulation
Advantage--Experimentation; pure sample
Disadvantage--Requires exacting surgery

j. Artificial vagina--Made to simulate animal's vagina, consists of outer support with inner jacket containing temperature-controlled water and pressure, and collecting funnel and container. As male mounts the female, the sheath is grasped and the penis is directed into the artificial vagina for ejaculation
Advantage--Closest to natural conditions
Disadvantage--Must simulate normal or best temperature, pressure, lubrication and position for optimum male response; animals must be treated as individuals since they differ

k. Gloved-hand method (boar)--As boar mounts sow, use gloved hand to massage and strip odoriferous fluid from prepuce. Glans penis is grasped and pulled to side of sow for collection
Advantage--Simple method for boar semen collection
Disadvantage--Very tiring procedure

l. Electroejaculation--Electrode inserted into rectum to stimulate ejaculation. Not widely used with boars or stallions.
Advantage--Collect semen without sexual response from the male; collect from males unable to copulate; female in estrus not needed
Disadvantage--Equipment cost, possibility of misuse

7. a. Bull: Mount--female in estrus, teaser animal or dummy; Restrain mount; Clean bull's sheath and belly; Lead bull to mount to tease and be teased; As bull mounts, grasp sheath and direct penis into AV; Hold AV near buttocks parallel to angle of vagina; Let bull serve the AV (don't thrust AV on penis); Do not touch penis

   b. Ram: Very similar to bull; Be alert--after mounting, ram moves very quickly and makes a rapid, single thrusting motion; If disinterested, stimulate by grasping wool in front of the dock on the ewe and shaking the tail

   c. Boar: Not a common method, but is satisfactory; A lot of pressure is necessary; As boar mounts, can grasp penis to direct into AV; Fractionated ejaculation--only collect the second fraction (sperm-rich) and let the rest fall to the ground

   d. Stallion: Mare--hobbled, tail wrapped; Teasing--head stallion close to mare; do not let mount; Wash, rinse, and blot-dry penis; Allow stallion to approach and tease mare; As stallion mounts, direct penis into AV; Hold AV level with and to one side of vulva; don't thrust AV; When finished, wash penis; Strain semen to remove gelatinous portion

8. a. Bull

      1. Restrain bull in chute: No more restraint than necessary; Responds best when standing normally; Bull usually lifts right hind leg when stimulated, prepare to collect from that side
      2. Wash and lubricate probe
      3. Wash sheath and belly
      4. Wet probe with water; insert through anus into rectum: Pull on tail slightly (raise only horizontally, not too high); Insert probe with a pushing, slightly turning motion
      5. After probe is inserted; hold tail down (so bull can't push probe out)
      6. Turn ejaculator on as probe is being inserted: After inserted, begin stimulation at low power and rhythmic manner; Stimulation--one second pause-relaxation-one second pause-etc.; Begin with low power - increase gradually; Maximum power - 20 volts
      7. When fluid changes to milky color, place collection funnel over the glans penis
      8. Remove collection funnel when fluid is clear again

   b. Ram
      1. Similar to bull
      2. Smaller probe; same power source as bull
      3. Restrain ram: Chute; Place knee in his flank to hold against fence or wall; Lay on side; restrain feet and legs

9. a. Head
   b. Neck
   c. Middle piece
   d. Tail

10. a. Abnormally shaped head
    b. Tailless head
    c. Coiled tail
    d. Two tails
    e. Two heads
    f. Abnormal middle piece

11. a. Volume of ejaculate and concentrate per unit volume--determines the total number of cells in the semen. If no sperm are present, male is sterile
    b. Motility: Percent of living or moving cells; Cells must be living to fertilize
    c. Morphology: Percent normal cells--Primary abnormalities--testicular origin; Secondary abnormalities--occur in duct system (deteriorated); Rate of forward movement is determined--abnormal cells usually don't swim forward

12. a. acceptable c. unacceptable e. acceptable
    b. acceptable d. unacceptable

BREEDING SOUNDNESS EVALUATION

AG 534 - K

UNIT OBJECTIVE

After completion of this unit, students should be able to describe how to evaluate the internal reproductive organs for breeding soundness. Students should also be able to describe the traits that are desirable in selecting a herd sire and females for each species. This knowledge will be demonstrated by completion of a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. List and describe in detail the criteria used for evaluating the outward signs of fertility in the male.
2. List the internal reproductive organs that are evaluated for breeding soundness.
3. Explain how the internal reproductive organs are evaluated for breeding soundness.
4. Describe two problems that may be found when evaluating the internal reproductive organs for breeding soundness.
5. List and discuss the kinds of performance records which might be used when selecting breeding animals.
6. Explain how a pedigree might be used when selecting breeding stock.
7. List the desirable and undesirable characteristics to look for when evaluating beef breeding stock.
8. Match the parts of a dairy cow to a description of how they should look in an ideal animal.
9. Distinguish between desirable and undesirable general appearance, body capacity, mammary systems and dairy character when evaluating dairy animals.
10. Describe the components of the modified contemporary comparison system for bull evaluation.
11. List desirable and undesirable characteristics of breeding swine.
12. Describe the reasons for considering various selection factors when choosing quality swine breeding stock.
13. Describe the primary difference between sheep selection and selection of other meat animals.
14. List characteristics to avoid when selecting breeding sheep.

15. Describe the desirable conformation for a meat-type sheep.

16. List five factors used to evaluate wool quality.

17. Describe the ideal fleece.

BREEDING SOUNDNESS EVALUATION

AG 534 - K

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

   A. Make transparencies and necessary copies of materials.

   B. Provide students with objectives and discuss.

   C. Provide students with information and discuss.

   D. Review and give test.

   E. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM 1--Desirable Characteristics of a Beef Bull

      2. TM 2--Desirable Characteristics of a Beef Cow

      3. TM 3--Dairy Cattle: General Appearance

      4. TM 4--Dairy Cattle: Body Capacity

      5. TM 5--Dairy Cattle: Mammary Systems

      6. TM 6--Dairy Character

      7. TM 7--Desirable Characteristics of a Boar

      8. TM 8--Desirable Characteristics of a Gilt

      9. TM 9--Ideal Meat-Type Sheep

   E. Test

   F. Answers to test

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BREEDING SOUNDNESS EVALUATION

AG 534 - K

INFORMATION SHEET

I. Criteria for evaluating outward signs of male fertility

  A. Masculine traits

    1. Crest

    2. Muscling

    3. Behavior

    4. Development of reproductive organs

  B. Feet and legs (problems discourage or prevent mounting)

    1. Postlegged

    2. Sickle-hocked

    3. Narrow chest floor

    4. Weak pasterns

    5. Damaged dew claws

    6. Corns between hooves

  C. Penis and prepuce

    1. Penis

      a. Normal size and shape

      b. Hair rings (from mounting other bulls)

      c. Damage (scar tissue or lacerations)

      d. Normal direction when extended

      e. Abnormal growths

      f. Frenulum

2. Prepuce
    a. Injury
    b. Swelling
    c. Scar tissue

D. Scrotum
1. Measure size
2. Outer skin
    a. Scratches
    b. Punctures
    c. Lacerations
    d. Frostbite
    e. Infection
3. Tone
    a. Desirable--firm, live-feeling
    b. Undesirable--meaty or muscular texture; fibrous; soft and spongy
4. Check temperature (infection)

E. Epididymis
1. Check size, tone, location
2. Problems
    a. Too hard or too soft (should be full and firm)
    b. Fever and swelling from infection and inflammation

F. Deferent duct and spermatic cord--check for swollen area, growths, and absence of segments

II. Evaluating internal reproductive organs for breeding soundness

A. Organs
1. Ampullae
2. Vesicular glands
3. Prostate

4. Urethral area

5. Internal pudendal rings

B. To evaluate, palpate per rectum for normality

C. Problems

1. Vesicular glands--enlargement or hardness from infection (white blood cells in semen indicate this)

2. Inguinal rings--examine to see if testes have an open passageway back into the abdominal cavity or if a testis has not descended (cryptorchid)

III. Performance records for breeding animal selection

A. Heritability records

1. Heritability--ability to pass a characteristic from one generation to another

2. Can predict characteristics for future generations

3. Use to produce offspring with more desirable characteristics

B. Breeding problems

1. Reduce breeding problems through complete records

2. Identify and cull animals that don't breed or have difficulty breeding

3. Also cull animals with dangerous dispositions

C. Production and efficiency

1. Need good records to monitor animal production

a. Pounds milk produced

b. Pigs weaned per litter

c. Percent lamb crop

d. Percent calf crop

e. Pounds meat produced

2. Cull poor producers and inefficient animals

D. Health

1. Probably most overlooked performance criterion in livestock operation

2. Susceptibility to many diseases is inheritable

3. Identify and cull animals with chronic health problems

4. Also use records for disease prevention program

IV. Selecting breeding stock with pedigree

A. Pedigree--record of individual's ancestors related to it through its parents

B. Indicates prolificacy, productiveness, and conformation of animal and its progeny

C. Production records provided in dairy pedigrees

D. Provide animal's rank for certain traits in comparison with its contemporaries (e.g. weaning weights)

E. Help detect carriers of undesirable recessive genes

F. Needs to be used in conjunction with visual inspection of animal

V. Desirable and undesirable characteristics of beef breeding stock (Transparencies 1, 2)

(Note: The two extremes are presented. There is a lot of area in between.)

A. Characteristics indicating reproductive efficiency

1. Bull

a. Desirable--Masculine, alert head; well-developed crest, muscling and genitalia; deep, wide chest

b. Undesirable--Sleepy; poorly muscled and poorly developed; unbalanced or small testicles

2. Cow

a. Desirable--Long and lean with smooth muscling; feminine head and body; good functional udder; normal genitalia

b. Undesirable--Coarse, heavy front; masculine characteristics; excess fat deposits; infantile vulva

B. Characteristics indicating muscling, freedom from waste and size

(Note: Too much muscling in heifers and even in bulls can cause poor reproductive performance.)

1. Desirable--Long body; reasonable height; well-muscled with prominent forearms; wide rear-quarters; thick loins; long rump; trim through the brisket, flank and twist; well-turned top; correctly balanced from front to rear

2. Undesirable--Short coupled, compact and close to the ground; full flanks, brisket and twist; blocky from all points of view; narrow hindquarters; wide, flat back

C. Characteristics indicating structural soundness

1. Desirable--Straight, squarely set legs with sufficient set in hock to provide a cushion; large and wide feet with deep heels

2. Undesirable--Legs that are sickle-hocked, postlegged or cowhocked; toes that point out or in; knees that allow legs to go over center; legs that won't completely straighten; too straight of pasterns; any other deformity of skeletal structure

VI. Description of ideal dairy animal

A. Breed characteristics--true to particular dairy breed

B. Head--moderate in length; clean-cut and alert

C. Shoulder blades--blend tightly into body

D. Back--straight and strong

E. Rump--long and wide; level from hooks to pins with refined, level tailhead; thurls high and wide

F. Legs and feet--strong; fore legs straight and squarely set; hind legs straight with slight set when viewed from the side; strong pasterns

G. Neck--long and clean-cut; blends smoothly with shoulders

H. Withers--sharp

I. Ribs--wide apart; highly sprung

J. Thighs--flat

K. Skin--loose and pliable

L. Barrel--long and deep, increasing in spring of rib toward the rear

M. Heart girth--deep, full crops; wide chest floor

N. Udder--symmetrical with evenly balanced quarters; moderate crease between halves when viewed from rear; strongly attached

O. Teats--uniform and squarely placed; moderate size

P. Mammary veins--large; twisting and branching

VII. Desirable and undesirable dairy animals (Transparencies 3, 4, 5, 6)

A. General appearance (Transparency 3)

1. Desirable--Head true to breed type; shoulders blend smoothly and tightly into body; strong and straight back; long, wide rump that is nearly level from hooks to pins; flat, strong leg bones; short, strong pasterns; deep heels; straight hind legs when viewed from the rear and having a slight set to the hock when viewed from the side

2. Undesirable--Coarse head and shoulders; winged shoulders; weak back and loin; narrow, sloping rump; frail or light boned; cowhocked, sickle-hocked or postlegged hind legs; weak, sloping pasterns; shallow heel

B. Body capacity (Transparency 4)

1. Desirable--Long body; deep fore and rear rib; fore ribs are widely spaced and have good "spring of rib"; wide chest floor; wide down the top with full crops

2. Undesirable--Narrow and shallow; ribs hug body; "slabsided"

C. Mammary systems (Transparency 5)

1. Desirable--Symmetrical, level udder, with evenly balanced quarters; squarely placed teats of moderate length; strong fore udder attachment with fore udder blending into the body; high and wide rear udder attachment that causes udder to have a crease when viewed from the rear and to be held well above the hocks

2. Undesirable--Tilted udder; small, poorly attached udder; bulging fore udder; quartered or cut up when viewed from the side; light or dry quarters; teats that point out or are too long, too short or abnormally shaped; broken udder floor; udder hanging below the hocks-especially in younger cows

D. Dairy character (Transparency 6)

1. Desirable--Angular and open appearance; sharp over the withers; long and trim neck with trim brisket; wide apart, wide, long ribs; flat thighs; clean over the hip and pin bones

2. Undesirable--Coarse and fleshy; excess fat indicated by a full brisket; rounding over the withers and back, and rounded thighs; short, heavy neck and throat

VIII. Modified contemporary comparison system for dairy bull evaluation

A. Predicted difference - indicates the average increase in production of a bull's daughters over the breed herd average

1. Milk--measured in pounds

2. Fat--measured in pounds and as a percentage

3. Dollars--indicates increase in profits by using a particular bull

B. Repeatability - percent of reliability for predicted differences; reliability increases as number of daughters, especially those in different herds, increase

Example:

Sire Code	Sire Name	Repeatability
7H477	Glendell Arlinda Chief	99%

Predicted Differences

Milk	Fat %	Fat	Dollars
+2035	-.09	+60	+218

Daughters of the bull Glendell will have an increased milk production of 2035 lb., a decreased fat percentage of .09 percent, an increased overall fat production of 60 lb. and an increased value of milk production of $218. These average increases will happen 99% of the time.

(Note: The pounds of fat increase even though the percentage of fat decreases because of the big increase in overall milk production.)

IX. Desirable and undesirable characteristics of breeding swine (Transparencies 7, 8,)

A. Characteristics indicating reproductive efficiency

1. Boars (Transparency 7)

a. Desirable--Well-developed testicles of equal size; normal genitalia; twelve to fourteen teats; aggressive behavior; masculine, alert head; deep, wide chest; heavy muscling with minimal fat covering

b. Undesirable--Unbalanced or small testicles; sleepy or inactive; swollen or damaged sheath and genitalia; excess finish

2. Sows (Transparency 8)

a. Desirable--Twelve to fourteen evenly spaced functional teats; feminine head; straight underline; normal genitalia; good scale without excess fat deposits; long and lean with good muscling

b. Undesirable--Blind or inverted teats; infantile vulva; excess finish; small frame; masculine appearance; high-strung and nervous disposition

(Note: Blind or inverted nipples are highly heritable.)

B. Characteristics indicating muscling and freedom from excess finish

1. Desirable--Long body with well arched back; deep sides and ample chest capacity; deep, full hams; trim head and jowls; high tail setting with a lack of fat deposits; minimum amount of backfat covering; wide stance

2. Undesirable--Short body; close to the ground; excess fat deposits over back, tailhead, jowls, brisket and flanks; shallow hams and poorly developed loins

C. Characteristics indicating structural soundness

1. Desirable--Toes of equal size and spread; strong and ample bone; sound feet and legs with straight, strong pasterns; legs set out on the corners

2. Undesirable--Toes of unequal size that lead to breakdown of pasterns; legs that turn out and appear "cowhocked from the rear"; postleggedness

(Note: Structural soundness is important, especially in raising swine in confinement or on a concrete flooring. A breeding animal that is not structurally sound will not stay in the breeding herd very long.)

X. Selection factors for choosing quality swine breeding stock

A. Structural soundness

1. Sound feet and legs are especially important in swine raised on concrete and in confinement

2. Sound skeletal structure will increase longevity in the breeding herd

B. Reproduction traits

1. Infantile vulvas, indicating an undeveloped reproductive tract, are becoming more common preventing many gilts from being used as replacements

2. Swollen or abnormal testicles and sheath on boar animals may lead to sterility

C. Underlines

1. Gilts and boars should have twelve to fourteen evenly spaced, functional nipples

2. Blind or inverted nipples should be selected against as they are highly heritable

D. Conformation and type

1. Breeding swine should possess those traits for meat-type swine as well as specific breeding traits

2. Breed character is an important visual characteristic to look for

E. Disposition

1. Bold, aggressive boars tend to be better breeders

2. Aggressive gilts tend to be better mothers and more prolific

F. Muscling

1. Excessive muscling is not always desirable in breeding stock as it may lead to Porcine Stress Syndrome - PSS

2. Breeding swine should be as muscled as top quality market animals as such traits are highly heritable

XI. Sheep selection is different from selecting other meat animals since wool is also an important product and affects the evaluation.

(Note: The fleece also makes it more difficult to judge conformation.)

XII. Characteristics to avoid when selecting breeding sheep

A. Missing teeth

B. Overshot or undershot jaw

C. Extreme fatness or thinness

D. Lumps or swelling under chin

E. Wool covering face

F. Fine-boned

G. Narrow, short or shallow bodied

H. Ragged, coarse or open fleeces

I. Excessive skin folds

J. Abnormal testicles

K. Unsound feet and legs

XIII. Conformation of a meat-type sheep (Transparency 9)

A. Desirable conformation

1. Large size

2. Long body

3. Adequate spring of rib

4. Wide, muscular back and loin

5. Widely set legs

6. Adequate but not excessive chest depth

7. Long and level rump

8. Full, thick, muscular leg

9. Large bone

(Note: Heavier boned sheep have more muscling. Rams need more rugged bone than ewes. The best place to determine the amount of bone is at the cannon bone.)

10. "Coke bottle" shaped with a trim neck blending into prominent shoulders when viewed from the top

B. Undesirable conformation

1. Legs too short, too long or crooked

2. Weak back

3. Long neck

4. Narrow chest

5. Overly fat with excess folds in brisket

6. Sloping rump

7. Paunchy

8. Inadequate muscling

XIV. Factors used to evaluate wool quality

A. Fineness

B. Staple length

C. Density and uniformity

(Note: Fleece is usually the most dense at the top and gets less dense towards the belly.)

D. Crimp

E. Amount of yolk

F. Purity

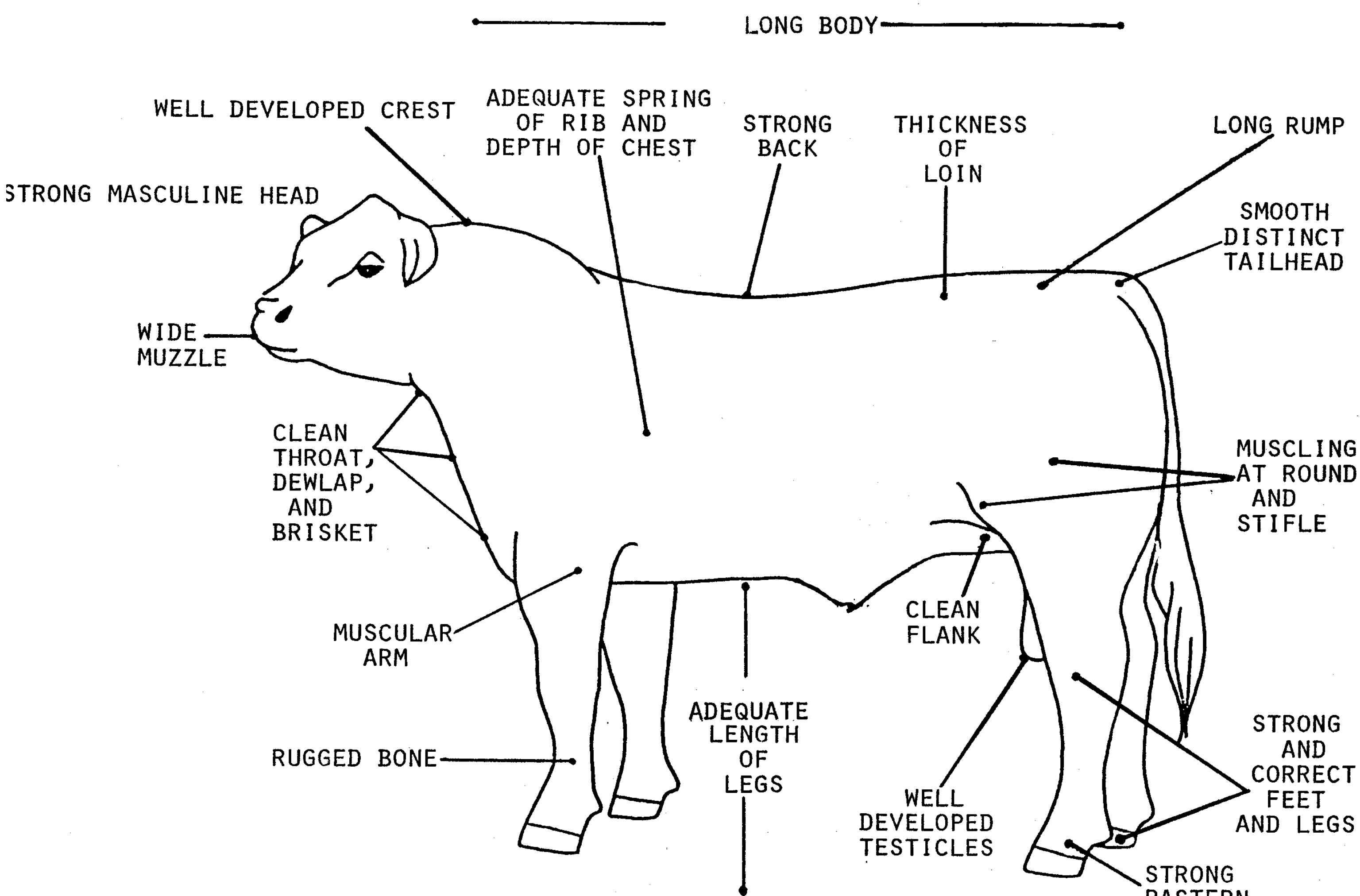
G. Amount of foreign matter

H. Shrinkage

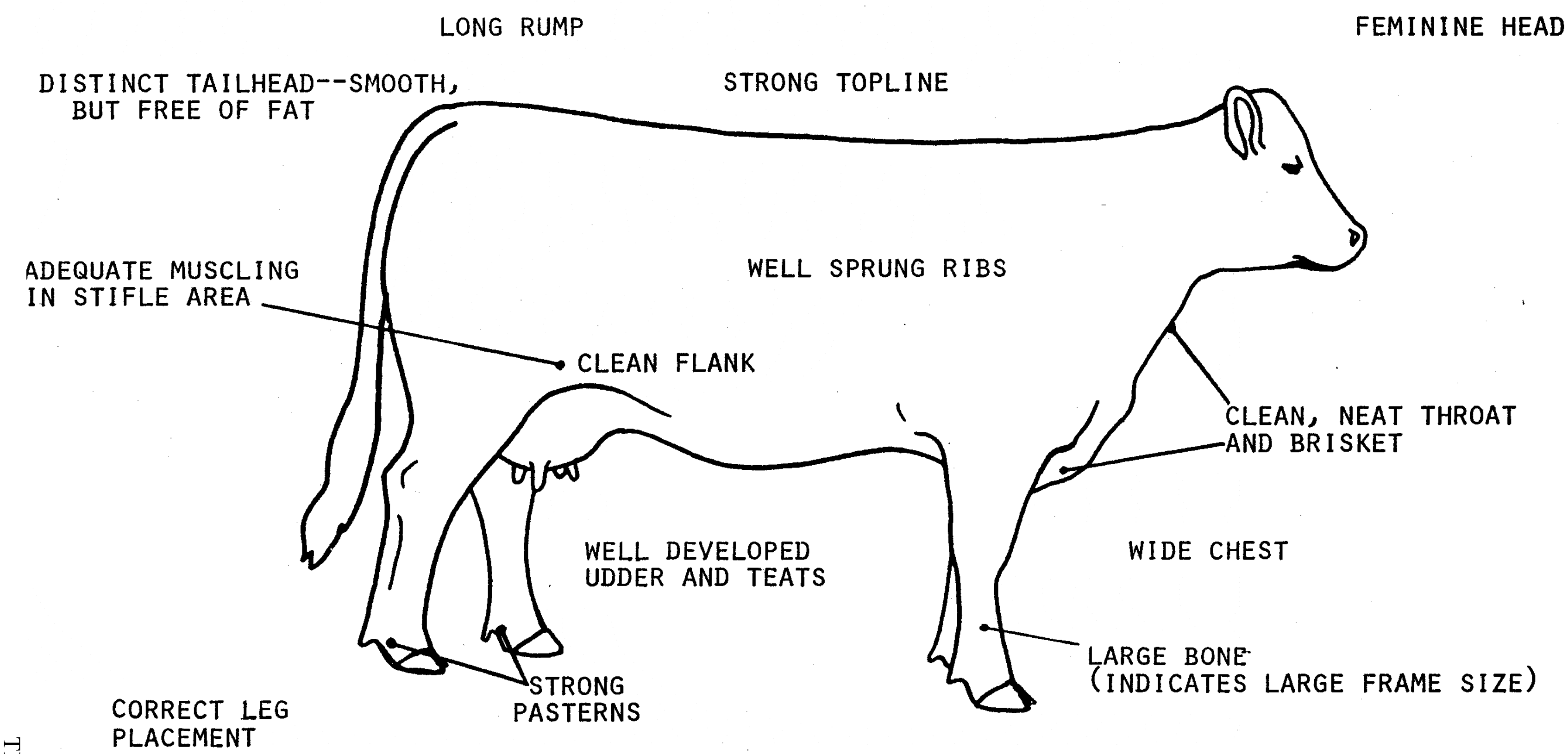
XV. Ideal fleece--fleece fiber should be long with a fine, distinct crimp; the fleece should be dense, sound and uniform in length and fineness and should be bright and clean with a medium amount of yolk; it should contain no black fibers or kemp

(Note: Black fleeces are becoming more popular and actually are worth more if a market can be found.)

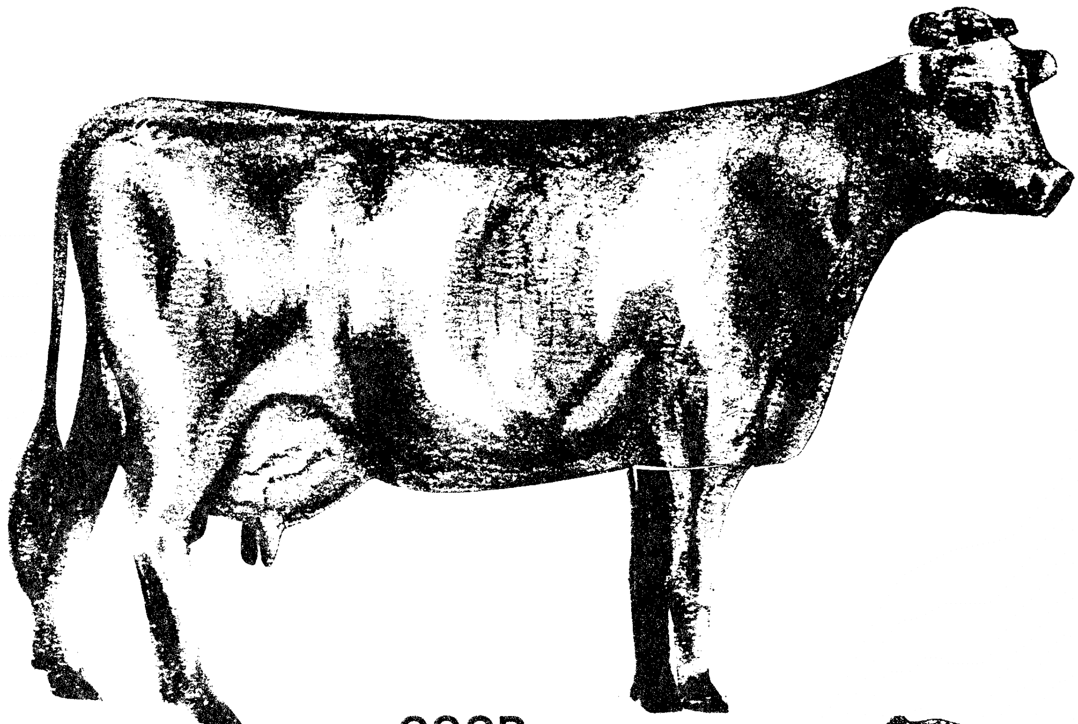
Desirable Characteristics Of A Bull



Desirable Characteristics Of A Cow



General Appearance



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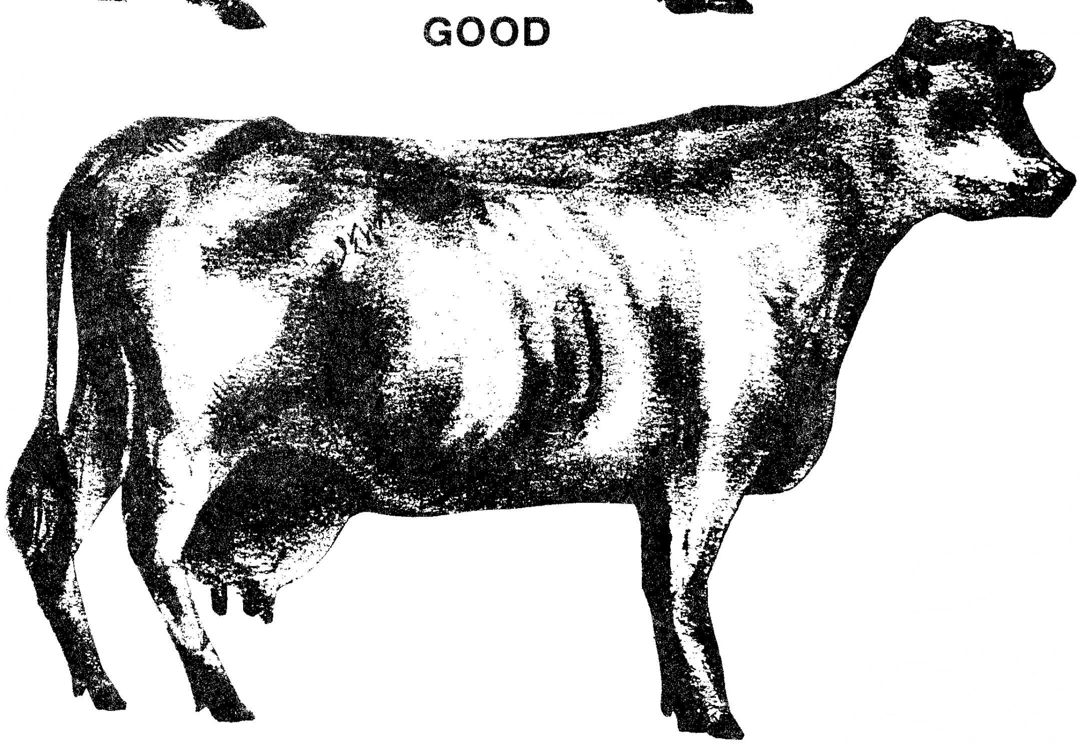
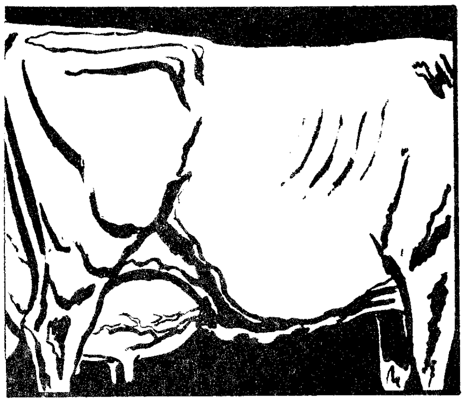


POOR

TM 3

Body Capacity



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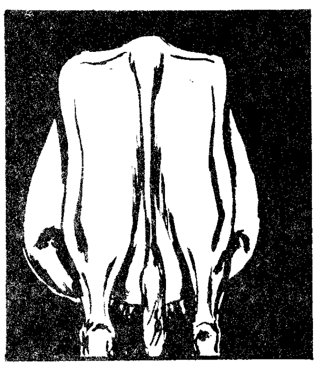
POOR



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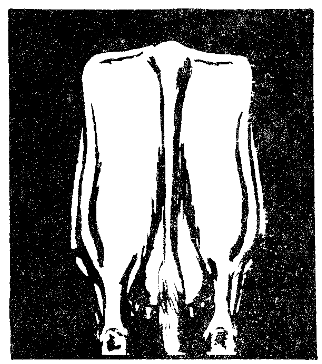

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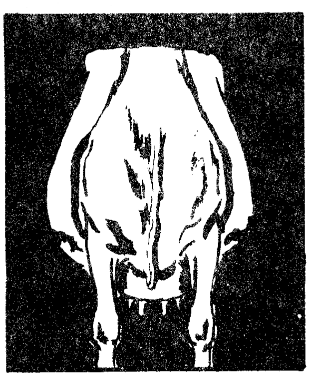
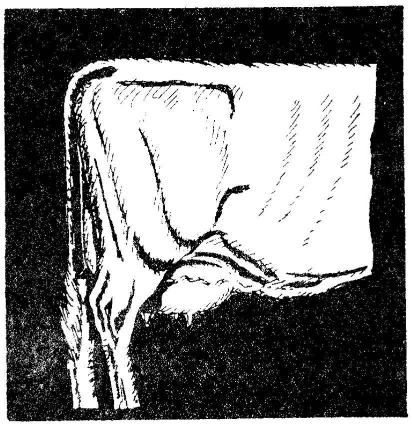


GOOD

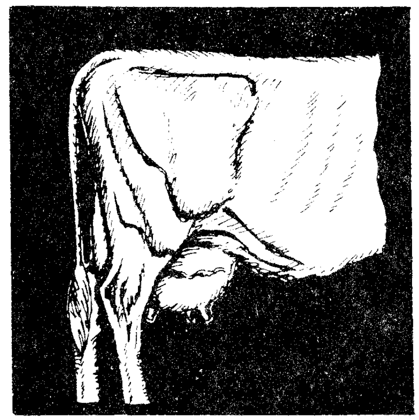
POOR

TM 4

Mammary Systems



GOOD UDDER AND FORE UDDER ATTACHMENT



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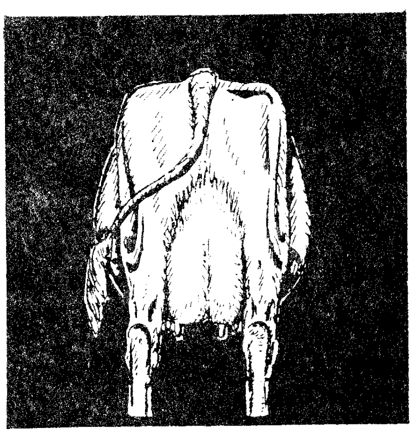
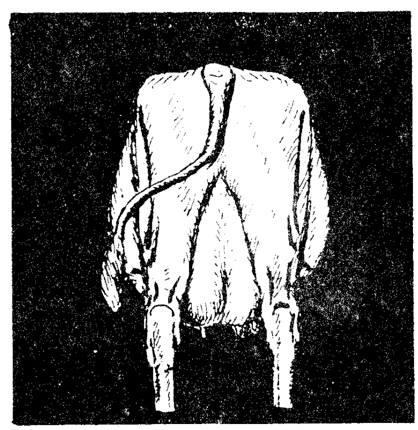
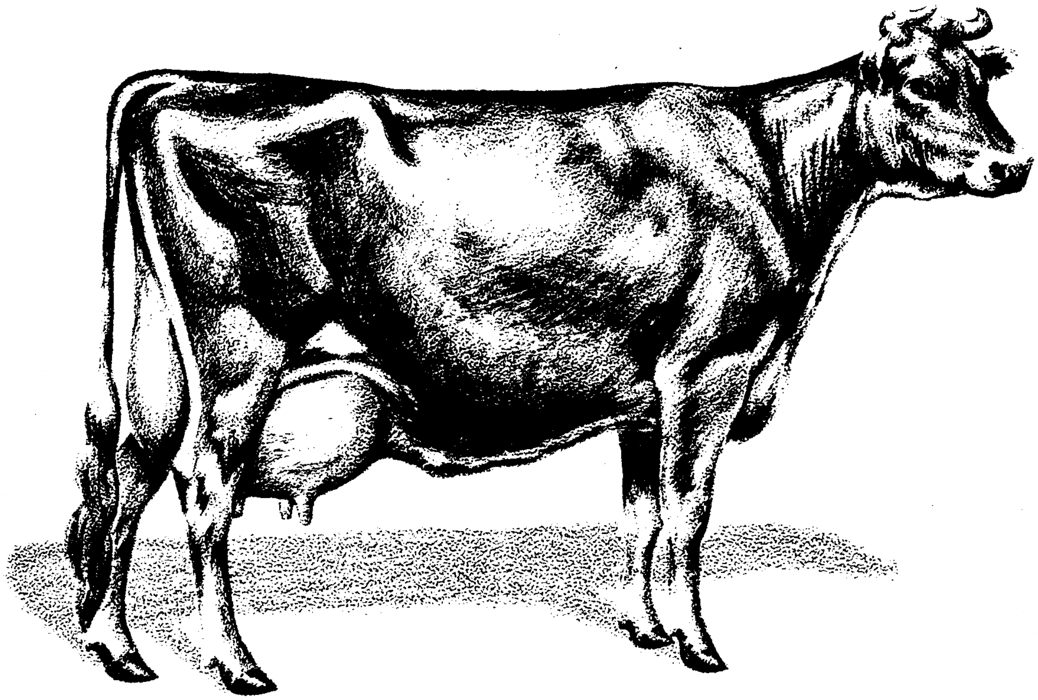


GOOD UDDER AND REAR UDDER ATTACHMENT



POOR UDDER AND REAR UDDER ATTACHMENT

Dairy Character



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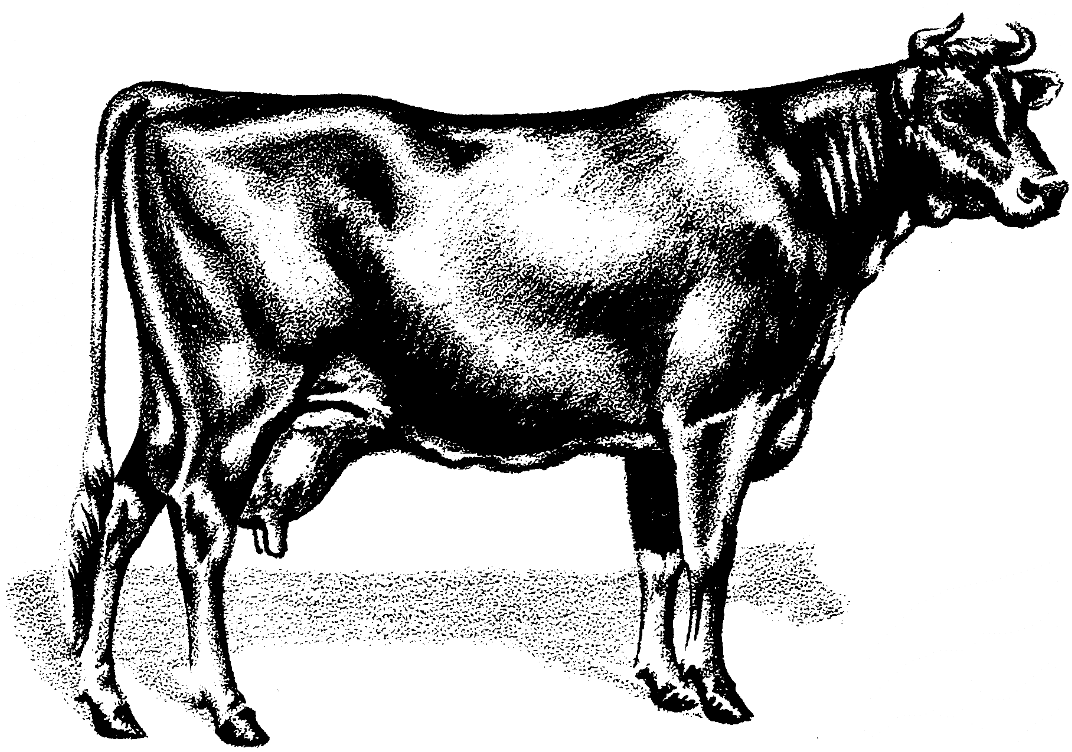
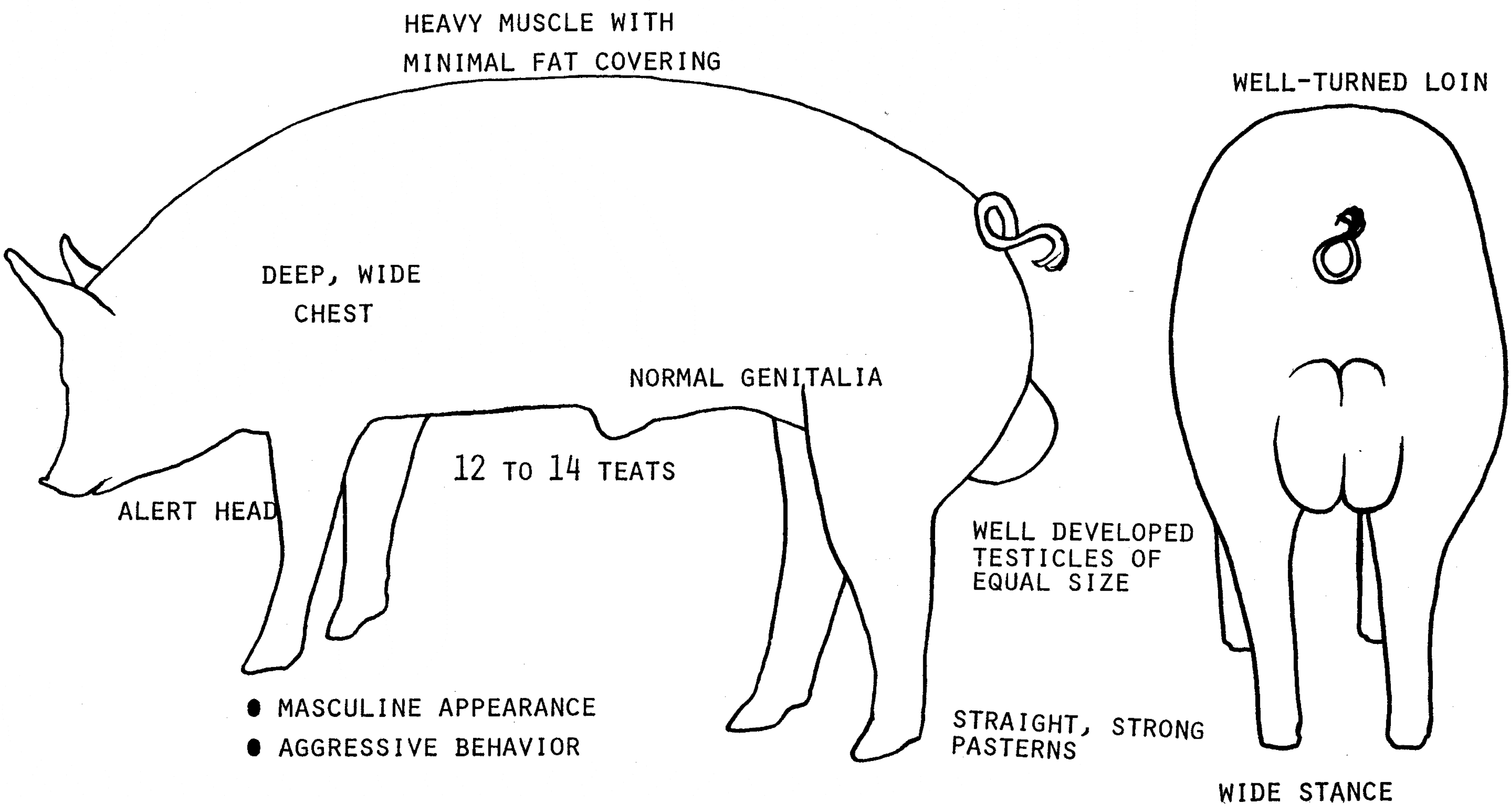
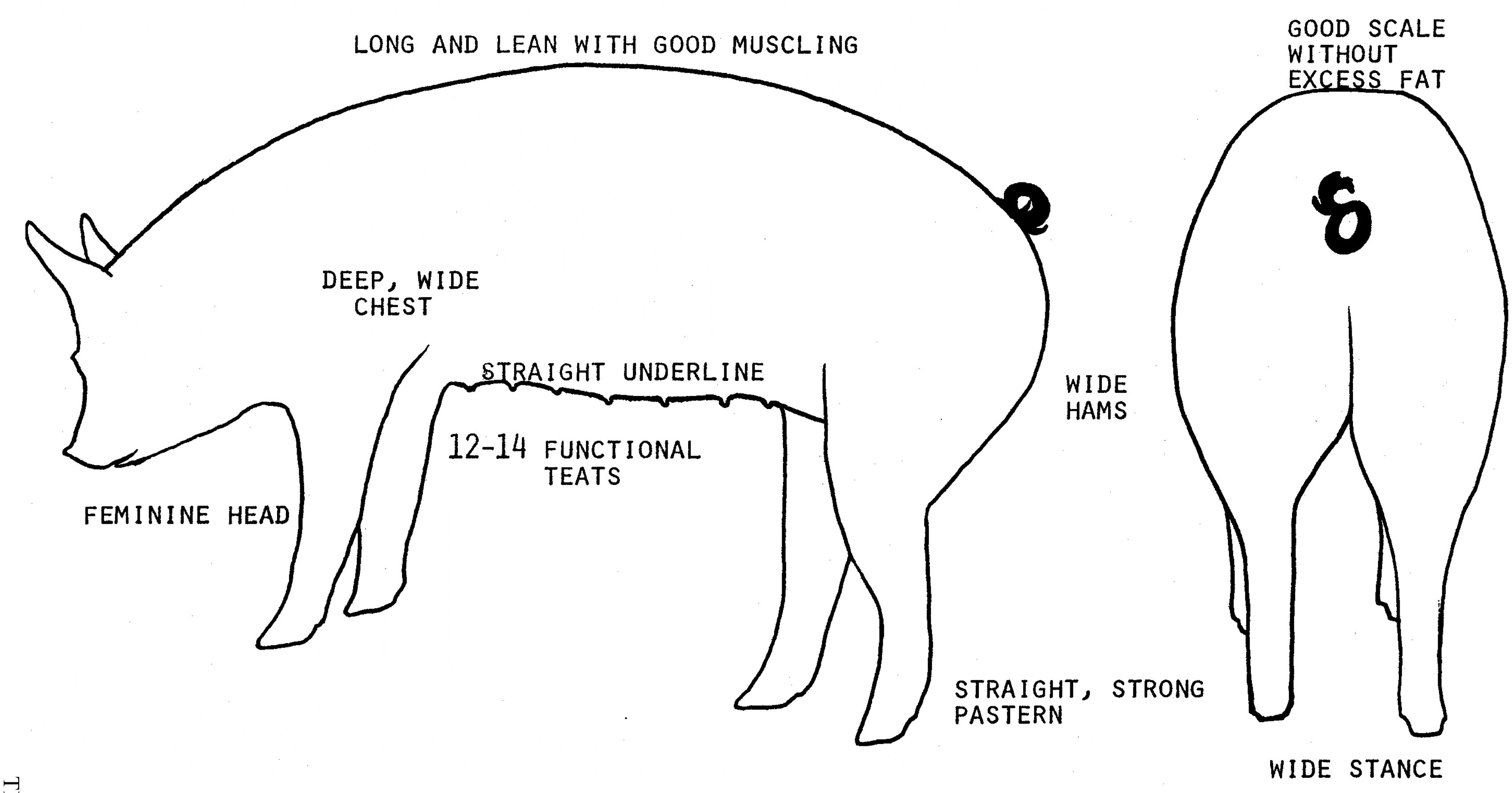


POOR

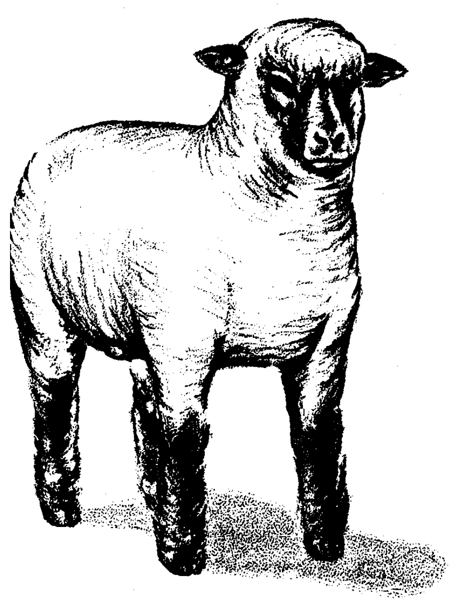
Desirable Characteristics Of A Boar



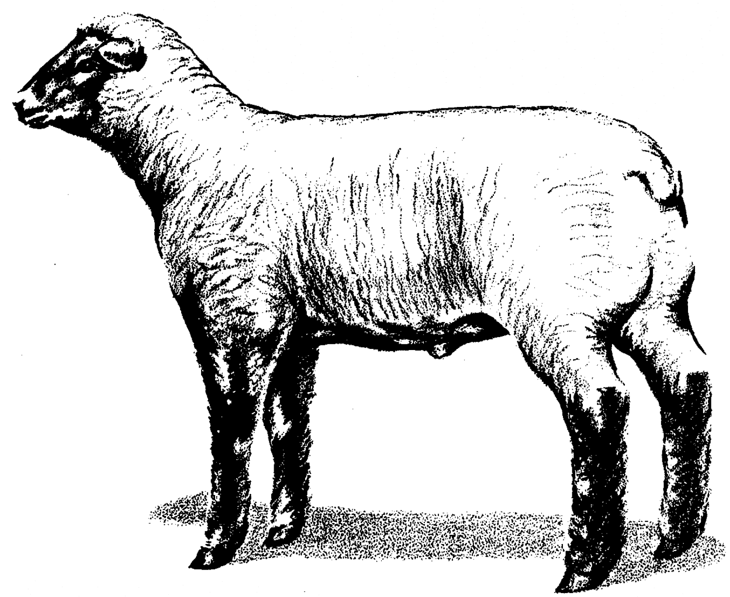
Desirable Characteristics Of A Gilt



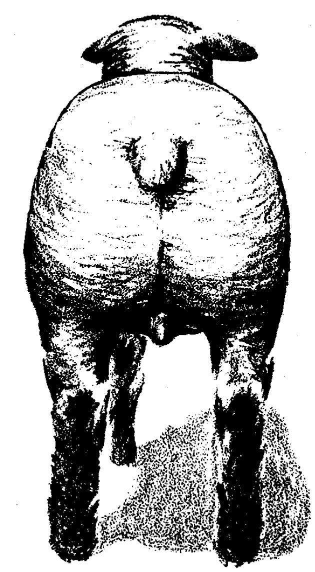
Ideal Meat-Type Sheep



FRONT VIEW



SIDE VIEW



REAR VIEW

BREEDING SOUNDNESS EVALUATION

AG 534 - K

UNIT TEST

Name ______________________________ Score ______________________________

1. List and describe in detail the criteria used for evaluating the outward signs of fertility in the male.

   a. ____

   ____

   ____

   ____

   b. ____

   ____

   ____

   ____

   c. ____

   ____

   ____

   ____

   d. ____

   ____

   ____

   ____

   e. ____

   ____

   ____

   ____

f. ______________________________

____

____

____

2. List the internal reproductive organs that are evaluated for breeding soundness.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

3. Explain how the internal reproductive organs are evaluated for breeding soundness.

____

____

4. Describe two problems that may be found when evaluating the internal reproductive organs for reproductive soundness.

a. ______________________________

____

b. ______________________________

____

5. List and discuss the kinds of performance records which might be used when selecting breeding animals.

a. ______________________________

____

____

b. ______________________________

____

____

c. ______________________________

____

____

d. ______________________________

____

____

6. Explain how a pedigree might be used when selecting breeding stock.

____

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____

____

____

7. List two desirable and two undesirable characteristics in each of the following areas to look for when evaluating beef breeding stock.

		Desirable	Undesirable
a.	Characteristics indicating reproductive efficiency of a bull	____________ ____________	____________ ____________
b.	Characteristics indicating reproductive efficiency of a cow	____________ ____________	____________ ____________
c.	Characteristics indicating muscling, freedom from waste and size	____________ ____________	____________ ____________
d.	Characteristics indicating structural soundness	____________ ____________	____________ ____________

8. Match the parts of the dairy cow to the description of how they should look in the ideal dairy animal.

1. Breed characteristics	9. Ribs
2. Head	10. Thighs
3. Shoulder blades	11. Skin
4. Back	12. Barrel
5. Rump	13. Heart girth
6. Legs and feet	14. Udder
7. Neck	15. Teats
8. Withers	16. Mammary veins

_____a. Long and deep, increasing in spring of rib toward the rear

_____b. Straight and strong

_____c. Long and clean-cut, blends smoothly with shoulders

_____d. Flat

_____e. Sharp

_____f. True to particular dairy breed

_____g. Symmetrical with evenly balanced quarters; moderate crease between halves when viewed from rear; strongly attached

_____h. Deep, full crops; wide chest floor

_____i. Long and wide; level from hooks to pins with refined, level tailhead; thurls high and wide

_____j. Wide apart; highly sprung

_____k. Strong; fore legs straight and squarely set; hind legs straight with slight set when viewed from the side; strong pasterns

_____l. Large, twisting and branching

_____m. Blend tightly into body

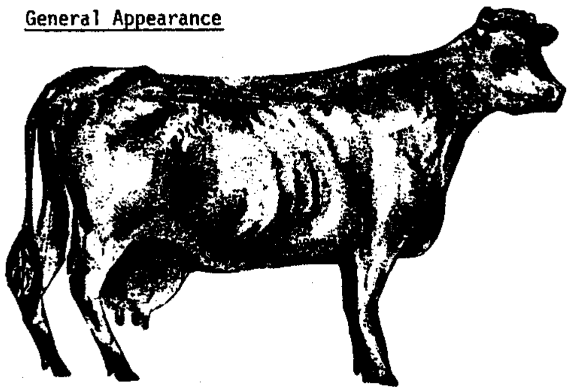
_____n. Moderate in length; clean-cut and alert

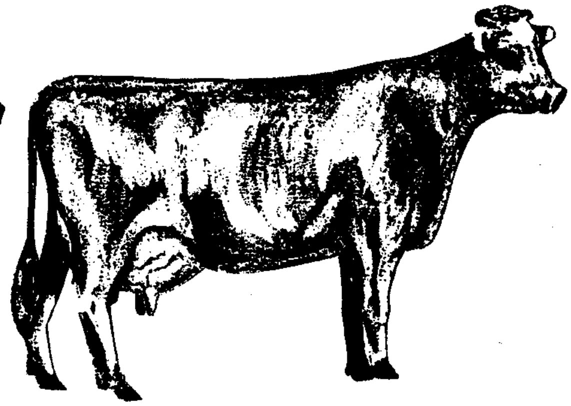
_____o. Uniform and squarely placed; moderate size

_____p. Loose and pliable

9. Distinguish between desirable and undesirable general appearance, body capacity, mammary systems and dairy character by writing desirable or undesirable beneath the appropriate pictures.

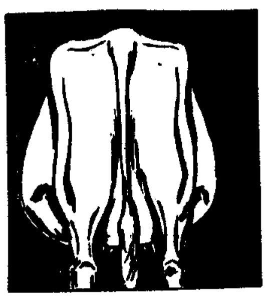
General Appearance

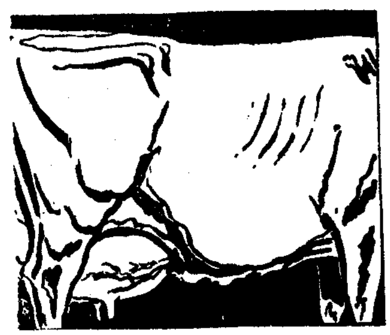




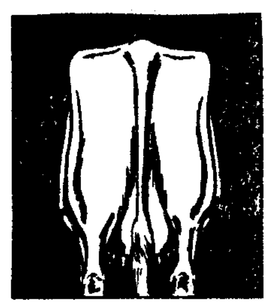
a. ______________________ b. ______________________

Body Capacity



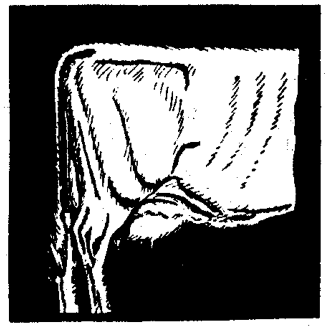


c. ______________________ d. ______________________

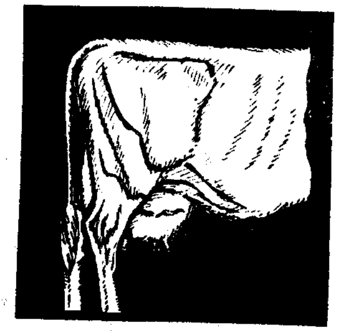


e. ______________________ f. ______________________

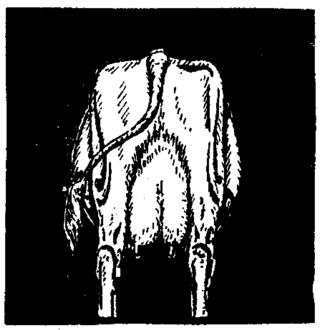
Mammary Systems



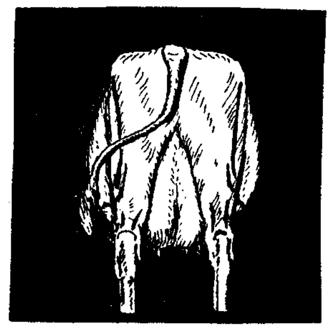
g. ______________________________



h. ______________________________

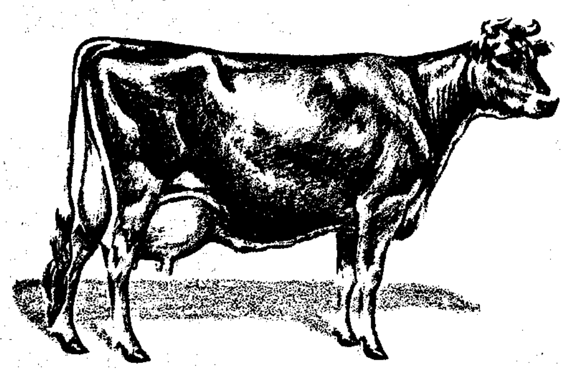


i. ______________________________

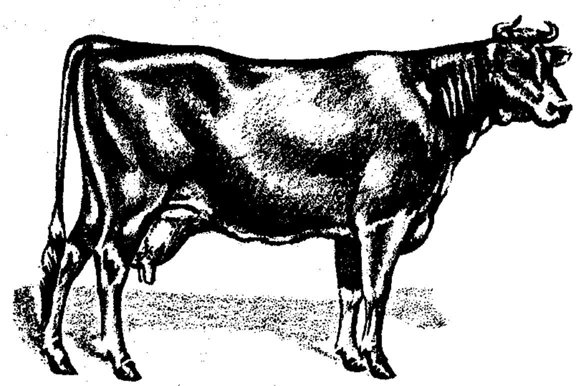


j. ______________________________

Dairy Character



k. ______________________________



l. ______________________________

10. Describe the two components of the modified contemporary comparison system for bull evaluation:

    a. Predicted difference: ____________________

    ____

    ____

    ____

    ____

    b. Repeatability: ____________________

    ____

    ____

    ____

    ____

11. Describe two desirable and two undesirable characteristics to look for in each of the following areas when evaluating swine breeding stock.

		Desirable	Undesirable
a.	Characteristics indicating reproductive efficiency of a boar	____________ ____________	____________ ____________
b.	Characteristics indicating reproductive efficiency of a sow	____________ ____________	____________ ____________
c.	Characteristics indicating muscling, freedom from waste and size	____________ ____________	____________ ____________
d.	Characteristics indicating structural soundness	____________ ____________	____________ ____________

12. Describe the reason for considering the following factors in selecting swine breeding stock.

    a. Structural soundness ______________________________

    b. Reproduction traits ______________________________

    c. Underline ______________________________

    d. Conformation and type ______________________________

    e. Disposition ______________________________

    f. Muscling ______________________________

13. Describe the primary difference between sheep selection and the selection of other meat animals.

    ____

14. List characteristics to avoid when selecting breeding sheep.

    a. ______________________________

    b. ______________________________

    c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

j. ______________________________

k. ______________________________

15. Describe the desirable conformation for a meat-type sheep.

____

____

____

____

____

16. List five factors used to evaluate wool quality.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

17. Describe the ideal fleece.

____

____

____

____

____

BREEDING SOUNDNESS EVALUATION

AG 534 - K

ANSWERS TO TEST

1. a. Masculine traits: Crest; Muscling; Behavior; Development of reproductive organs

   b. Feet and legs: Postlegged; Sickle-hocked; Narrow chest floor; Weak pasterns; Damaged dew claws; Corns between hooves

   c. Penis: Normal size and shape; Hair rings (from mounting other bulls); Damage (scar tissue or lacerations); Normal direction when extended; Abnormal growths; Frenulum

   Prepuce: Injury; Swelling; Scar tissue

   d. Scrotum: Measure size;
   Outer skin: Scratches; Punctures; Lacerations; Frostbite; Infection;
   Tone: Desirable--firm, live-feeling; Undesirable--meaty or muscular texture; fibrous; soft and spongy
   Check temperature (infection)

   e. Epididymis: Check size, tone, location
   Problems: Too hard or too soft; Fever and swelling from infection and inflammation

   f. Deferent duct and spermatic cord--check for swollen area, growths, and absence of segments

2. Ampullae; Vesicular glands; Prostate; Urethral area; Internal pudendal rings

3. To evaluate, palpate per rectum for normality

4. Vesicular glands--enlargement or hardness from infection (white blood cells in semen indicate this); Inguinal rings--examine to see if testes have an open passageway back into the abdominal cavity or if a testis has not descended (cryptorchid)

5. a. Heritability records: Ability to pass a characteristic from one generation to another; Can predict characteristics for future generations; Use to produce offspring with more desirable characteristics

   b. Breeding problems: Reduce breeding problems through complete records; Identify and cull animals that don't breed or have difficulty breeding; Also cull animals with dangerous dispositions

   c. Production and efficiency--Need good records to monitor animal production: Pounds milk produced; Pigs weaned per litter; Percent lamb crop; Percent calf crop; Pounds meat produced; Cull poor producers and inefficient animals

   d. Health: Probably most overlooked performance criterion in livestock operation; Susceptibility to many diseases is inheritable; Identify and cull animals with chronic health problems; Also use records for disease prevention program

6. Pedigree--record of individual's ancestors related to it through its parents; Indicates prolificacy, productiveness, and conformation of animal and its progeny; Production records provided in dairy pedigrees; Provide animal's rank for certain traits in comparison with its contemporaries (e.g. weaning weights); Help detect carriers of undesirable recessive genes; Needs to be used in conjunction with visual inspection of animal

7. Answer should include two of the following in each area.

   a. Desirable: Masculine, alert head; well-developed crest, muscling and genitalia; deep, wide chest

      Undesirable: Sleepy; poorly muscled and poorly developed; unbalanced or small testicles

   b. Desirable: Long and lean with smooth muscling; feminine head and body; good functional udder; normal genitalia

      Undesirable: Coarse, heavy front; masculine characteristics; excess fat deposits; infantile vulva

   c. Desirable: Long body; reasonable height; well-muscled with prominent forearms; wide rear-quarters; thick loins; long rump; trim through the brisket, flank and twist; well-turned top; correctly balanced from front to rear

      Undesirable: Short coupled, compact and close to the ground; full flanks, brisket and twist; blocky from all points of view; narrow hindquarters; wide, flat back

   d. Desirable: Straight, squarely set legs with sufficient set in hock to provide a cushion; large and wide feet with deep heels

      Undesirable: Legs that are sickle-hocked, postlegged or cowhocked; toes that point out or in; knees that allow legs to go over center; legs that won't completely straighten; too straight of pasterns; any other deformity of skeletal structure

8.

a. 12	e. 8	i. 5	m. 3
b. 4	f. 1	j. 9	n. 2
c. 7	g. 14	k. 6	o. 15
d. 10	h. 13	l. 16	p. 11

9.

a. Undesirable	e. Undesirable	i. Desirable
b. Desirable	f. Undesirable	j. Undesirable
c. Desirable	g. Desirable	k. Desirable
d. Desirable	h. Undesirable	l. Undesirable

10. a. Indicates average increase in production of a bull's daughters over the breed herd average; Differences are figured in pounds of milk, fat and dollars

    b. Indicates reliability of predicted differences; It is figured as a percent and increases with the number of daughters, especially those in different herds

11. Answer should include two of the following:

    a. Desirable: well-developed testicles of equal size; normal genitalia; twelve to fourteen teats; aggressive behavior; masculine, alert head; deep, wide chest; heavy muscling with minimal fat covering

       Undesirable: unbalanced or small testicles; sleepy or inactive; swollen or damaged sheath and genitalia; excess finish

    b. Desirable: twelve to fourteen evenly spaced functional teats; feminine head; straight underline; normal genitalia; good scale without excess fat deposits; long and lean with good muscling

       Undesirable: blind or inverted teats; infantile vulva; excess finish; small frame; masculine appearance; high-strung and nervous disposition

    c. Desirable: long body with well arched back; deep sides and ample chest capacity; deep, full hams; trim head and jowls; high tail setting with a lack of fat deposits; minimum amount of backfat covering; wide stance

       Undesirable: short body; close to the ground; excess fat deposits over back, tailhead, jowls, brisket and flanks; shallow hams and poorly developed loins

    d. Desirable: toes of equal size and spread; strong and ample bone; sound feet and legs with straight, strong pasterns; legs set out on the corners

       Undesirable: toes of unequal size that lead to breakdown of pasterns; legs that turn out and appear "cowhocked from the rear"; postleggedness

12. a. Sound feet and legs are especially important in swine raised on concrete and in confinement; sound skeletal structure will increase longevity in the breeding herd

    b. Infantile vulvas are becoming more common, preventing many gilts from being used as replacements; swollen or abnormal testicles and sheath on boar animals may lead to sterility

    c. Gilts and boars should have twelve to fourteen evenly spaced, functional nipples; blind or inverted nipples should be selected against as they are highly heritable

    d. Breeding swine should possess those traits for meat-type swine as well as specific breeding traits; breed character is an important visual characteristic to look for

    e. Bold, aggressive boars tend to be better breeders; aggressive gilts tend to be better mothers and more prolific

    f. Excessive muscling is not always desirable in breeding stock as it may lead to Porcine Stress Syndrome - PSS; breeding swine should be as muscled as top quality market animals as such traits are highly heritable

13. Sheep selection is different from selecting other meat animals since wool is also an important product and affects the evaluation.

14. Missing teeth; Overshot or undershot jaw; Extreme fatness or thinness; Lumps or swelling under chin; Wool covering face; Fine-boned; Narrow, short or shallow bodied; Ragged, coarse or open fleeces; Excessive skin folds; Abnormal testicles; Unsound feet and legs

15. Answer should include the following:

    Large size; Long body; Adequate spring of rib; Wide, muscular back and loin; Widely set legs; Adequate but not excessive chest depth; Long and level rump; Full, thick, muscular leg; Large bone; "Coke bottle" shaped with a trim neck blending into prominent shoulders when viewed from the top

16. Answer should include five of the following:

    Fineness; Staple length; Density and uniformity; Crimp; Amount of yolk; Purity; Amount of foreign matter; Shrinkage

17. Fleece fibers should be long with a fine, distinct crimp; the fleece should be dense, sound and uniform in length and fineness and should be bright and clean with a medium amount of yolk; it should contain no black fibers or kemp

SEMEN PRODUCTION, PROCESSING AND STORAGE

AG 534 - L

UNIT OBJECTIVE

After completion of this unit, students should be able to describe the various ways of processing sperm and list the constituents of semen extender. Students should also be able to calculate semen extension and list the advantages and disadvantages of the various methods of packaging semen. This knowledge will be demonstrated by completion of a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Discuss the processing of fresh bull sperm, including the extenders used.
2. List and describe the three methods of processing frozen sperm.
3. List the five components of semen extender.
4. Explain how to calculate semen extension for processing fresh semen when given volume, concentration, motility, normality and number of viable cells per insemination.
5. Explain how to calculate semen extension for processing frozen semen when given volume, concentration, motility, normality and number of viable cells per insemination.
6. List six advantages and three disadvantages of packaging semen in straws.
7. List four advantages and five disadvantages of packaging semen in ampules.
8. List four advantages and six disadvantages of packaging semen in pellets.
9. Explain which method of selecting a sire is the most effective.
10. Explain what 60-90 NR means.

SEMEN PRODUCTION, PROCESSING AND STORAGE

AG 534 - L

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

A. Make transparencies and necessary copies of materials.

B. Provide students with objectives and discuss.

C. Provide students with information and discuss.

D. Review and give test.

E. Reteach and retest if necessary.

II. Instructional materials

A. Objective sheet

B. Suggested activities

C. Transparency masters

1. TM 1--Semen Extender Composition

2. TM 2--Liquid Semen Extension Calculation

3. TM 3--Frozen Semen Extension Calculation

D. Test

E. Answers to test

III. Unit references

A. Barrick, R., and Harmon, H., *Animal Production and Management*, McGraw-Hill Book Company, New York, 1988.

B. Bearden and FuQuay, *Applied Animal Production*, Prentice-Hall, Englewood Cliffs, New Jersey, 1980.

C. Bundy, C.E., et al., *Livestock and Poultry Production*, 5th edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1982.

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F. Lasley, John F., *Genetics of Livestock Improvement*, 3rd edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1978.

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SEMEN PRODUCTION, PROCESSING AND STORAGE

AG 534 - L

INFORMATION SHEET

I. Processing bull sperm

A. Liquid (fresh)

1. Most economical for using particular available sire on limited number of cows within short time period

2. Maintains viability for only 1-2 days--stored in refrigerator at 39oF

3. Extenders

a. Illini variable temperature (IVT)--maintains sperm viability under variable temperatures (carbon dioxide depresses motility and conserves cell energy)

b. Coconut water extender (CWE) and coconut milk extender (CME)--for non-refrigerated storage

B. Frozen

1. Stored indefinitely

2. Straws

a. Thin-walled plastic tubes; most commonly used has .5 ml capacity

b. Extended semen must equalize so sperm is protected during freezing process

c. Siphon the extended semen by vacuum to fill the straw

d. Seal with plastic plugs or polyvinyl powder

e. Spread on rack for vapor freezing in less than 5 minutes (liquid nitrogen)

3. Ampules

a. Look like mini-coke bottles; most commonly used ampules have .5ml or 1 ml capacity

b. Extended semen must equalize

c. Fill with syringe fitted with plastic tube

d. Flame-sealed

e. Place on metal canes with clips to freeze (liquid nitrogen)

4. Pellets

a. Less extender used (1 part semen: 3 parts extender)

(1) Egg yolk - 20%

(2) Glycerol - 4.7%

(3) Carbohydrate - 75.3%

b. Storage increased by 3 times

(1) Drop of extended semen frozen on block of dry ice with depressions melted in it

(2) Pellets shaken into metal tubes for storage (brass weight added to each so doesn't float from container)

(3) Tubes placed into cannisters in liquid nitrogen refrigerator

II. Semen extender composition (Transparency 1)

A. Nutrients

1. Egg yolk (most common)

2. Milk

3. Coconut milk

4. Reconstituted dried buttermilk

B. Buffer--neutralizes waste products released by the sperm during metabolism

1. Sodium citrate

2. Sodium phosphate

C. Antibacterial agents--destroy disease organisms and reduce sperm metabolism

1. Penicillin

2. Streptomycin

D. Glycerol--sometimes added to improve conception with milk extenders

E. Antifreeze--necessary in frozen semen; most common is glycerol

F. Example extender make-up for fresh semen

40% egg yolk
60% 2.9% sodium citrate
Mix thoroughly and add:
500 units penicillin/ml
1 mg streptomycin/ml

G. Example extender make-up for frozen semen

20% egg yolk
80% 2.9% sodium citrate
Mix thoroughly and add:
500 units penicillin/ml
1 mg streptomycin/ml

Divide mixture in half and add 15% glycerol to the half to be added to the semen last

(Note: EYC (Egg yolk citrate) is a term used to identify the extender.)

III. Semen extension calculation (Transparencies 2, 3)

A. Liquid (Transparency 2)

1. Total viable cells = Volume (ml) x Concentration/ml x % Motile x % Normal
2. Units of extended semen =

$$\frac{\text{Total viable cells}}{\text{Number viable cells/insemination}}$$

(Note: The volume of the unit determines the amount of added extender-the unit must always have 10 million viable cells present.)

3. Extender needed =

Total volume extended semen - Volume of semen

4. Example:

Volume = 7 ml
Concentration = 1×10^9/ml
Motility = 70%
Normality = 90%

Formula = $\frac{7 \times 1 \times 10^9 \times .7 \times .9}{10 \times 10^6}$ = 441 units

* Assume 1 ml volume/insemination

1 ml dosage x 441 units = 441 ml extended semen

441 ml extended semen - 7 ml semen = 434 ml extender

174 ml egg yolk + 260 ml citrate = 434 ml EYC (extender)

Add 441 x 500 units penicillin/ml = 220,500 units penicillin

Add 441 x 1 mg streptomycin/ml = 441 mg streptomycin

B. Frozen semen (in straws)

1. Same calculation steps as with fresh semen, with addition of:

    a. Number viable sperm/unit before freezing must be 15 million or 1 1/2 the number used in processing liquid semen (to offset sperm mortality during processing and thawing)

    b. Glycerol must be added to 6-12% by volume

2. Example: (Transparency 3)

Volume = 6 ml
Concentration = $.9 \times 10^9$ ml
Motility = 80%
Normality = 80%

$$\frac{6 \times .9 \times 10^9 \times .8 \times .8}{15 \times 10^6} = 230 \text{ units}$$

* Assume semen processed in .5 ml straws, using 20% egg yolk in extender

.5 ml straw x 230 units = 115 ml extended semen

115 ml - 6 ml semen = 109 ml extender

22 ml egg yolk + 87 ml citrate = 109 ml EYC

Add 115 x 500 units penicillin/ml = 57,500 units penicillin

Add 115 x 1 mg streptomycin/ml = 115 ml streptomycin

115 ml extended semen x 7.5% glycerol = 8.6 ml glycerol

109 ml EYC - 8.6 ml glycerol = 100 ml EYC needed

a. Divide EYC in half - add first half to semen. Add glycerol to second half, then gradually add all together

b. This example for .5 ml straws. If use 1 ml, the volume of extended semen is greater, but required number viable sperm/unit remains the same

IV. Semen packaging

A. Straws

1. Advantages

a. Greater recovery after processing and thawing

b. Slightly increased conception (as compared to ampules)

c. Less storage space required

d. Lower cost (straw vs. glass)

e. Won't explode

f. All sperm removed at time of insemination

g. Uniform freezing (size and shape)

h. Quick thaw

2. Disadvantages

a. Transfer time critical (prevent thawing)

b. Small labeling

c. End plugs may split or blow

B. Ampules

1. Advantages

a. Transfer between storage units less critical

b. Easier to read labels

c. Larger, easier to handle

d. Sanitary package

2. Disadvantages

a. More storage required

b. Slower thaw time

c. Greater sperm loss in processing and thawing

d. May explode if sealed improperly

e. Slightly lower conception rates

f. About 15-20% sperm left in ampule

C. Pellets

1. Advantages

a. Quick, simple production

b. Can avoid glycerolization

c. Least amount storage space required

d. Low equipment cost

e. Greater live sperm recovery

2. Disadvantages

a. Difficult to label

b. Chips may relocate on other pellets or packages

c. Bacterial contamination

d. Clumsy to handle

e. Quick thaw when exposed

f. Need separate extender when thawed

V. Sire selection

A. Pedigree records

1. Study records of all related individuals for the desired traits

2. Show genetic potential of animal

B. Performance records

1. Only available for mature sires

2. Best, most effective method (desirable traits have been proven)

VI. Nonreturn rates (NR)

A. Used to report breeding results (female has not returned to estrus for rebreeding and is pregnant)

B. Nonreturn rates at 30 to 60 are usually high (80-85%)

C. 60-90 NR (rates at 60 to 90 days)

1. Lower (70-75%)

   a. Some cows identified in estrus for rebreeding that were missed on previous heat check

   b. Some early embryonic mortality may also have occurred and cow recycled

2. Assumed standard in artificial insemination

3. Based on first service (repeat breeding livestock not considered in subsequent reports)

SEMEN EXTENDER COMPOSITION

Nutrients

(Egg yolk, Milk, Coconut Milk, Reconstituted Dry Buttermilk)

Buffer

(Sodium Citrate, Sodium Phosphate)

Antibacterial Agents

(Penicillin, Streptomycin)

Glycerol

Antifreeze

LIQUID SEMEN EXTENSION CALCULATION

Total viable cells = Volume (ml) x Concentration/ml x % Motile x % Normal

$$\text{Units of extended semen} = \frac{\text{Total viable cells}}{\text{Number viable cells/insemination}}$$

Extender needed =

Total volume extended semen - Volume of Semen

Example:

Volume = 7 ml

Concentration = 1×10^9/ml

Motility = 70%

Normality = 90%

$$\text{Formula: } = \frac{7 \times 1 \times 10^9 \times .7 \times .9}{10 \times 10^6} = 441 \text{ units}$$

*Assume 1 ml volume/insemination

1 ml dosage x 441 units = 441 ml extended semen

441 ml extended semen - 7 ml semen = 434 ml extender

174 ml egg yolk + 260 ml citrate = 434 ml EYC (extender)

Add 441 x 500 units penicillin/ml = 220,500 units penicillin

Add 441 x 1 mg streptomycin/ml = 441 mg streptomycin

FROZEN SEMEN EXTENSION CALCULATION

Same calculation steps as with fresh semen, with addition of:

Number viable sperm/unit before freezing must be 15 million or 1 1/2 the number used in processing liquid semen

Glycerol must be added to 6-12% by volume

Example:

Volume = 6 ml

Concentration = $.9 \times 10^9$ ml

Motility = 80%

Normality = 80%

$$\frac{6 \times .9 \times 10^9 \times .8 \times .8}{15 \times 10^6} = 230 \text{ units}$$

*Assume semen processed in .5 ml straws, using 20% egg yolk in extender

.5 ml straw x 230 units = 115 ml extended semen

115 ml - 6 ml semen = 109 ml extender

22 ml egg yolk + 87 ml citrate = 109 ml EYC

Add 115 x 500 units penicillin/ml = 57,500 units penicillin

Add 115 x 1 mg streptomycin/ml = 115 ml streptomycin

115 ml extended semen x 7.5% glycerol = 8.6 ml glycerol

109 ml EYC - 8.6 ml glycerol = 100 ml EYC needed

Divide EYC in half - add first half to semen. Add glycerol to second half, then gradually add all together

SEMEN PRODUCTION, PROCESSING AND STORAGE

AG 534 - L

UNIT TEST

Name ______________________________ Score ______________________________

1. Discuss the processing of fresh bull sperm, including the extenders used.

2. List and describe the three methods of processing frozen sperm.

   a. ______________________________

   b. ______________________________

   c. ______________________________

3. List the five components of semen extender.

   a. ______________________________

   b. ______________________________

   c. ______________________________

d. ______________________________

e.______________________________

4. Explain how to calculate semen extension for processing fresh semen when given volume, concentration, motility, normality and number of viable cells per insemination.

Volume = 7 ml
Concentration = 1 x 10^9 ml
Motility = 70%
Normality = 90%
Number of viable cells/insemination = 10 x 10^6
*Assume 1 ml volume/insemination

5. Explain how to calculate semen extension for processing frozen semen when given volume, concentration, motility, normality and number of viable cells per insemination.

Volume = 6 ml
Concentration = $.9 \times 10^9$ ml
Motility = 80%
Normality = 80%
Number of viable cells/insemination = 15×10^6
*Assume semen processed in .5 ml straws, using 20% egg yolk extender

6. List six advantages and three disadvantages of packaging semen in straws.

Advantages

a.

b.

c.

d.

e.

f.

Disadvantages

a.______________________________

b. ______________________________

c.______________________________

7. List four advantages and five disadvantages of packaging semen in ampules.

Advantages

a.______________________________

b. ______________________________

c.______________________________

d. ______________________________

Disadvantages

a.______________________________

b. ______________________________

c.______________________________

d. ______________________________

e.______________________________

8. List four advantages and six disadvantages of packaging semen in pellets.

Advantages

a.______________________________

b. ______________________________

c.______________________________

d. ______________________________

Disadvantages

a.______________________________

b. ______________________________

c.______________________________

d. ______________________________

e. ______________________________

f. ______________________________

9. Explain which method of selecting a sire is the most effective.

____

____

10. Explain what 60-90 NR means.

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SEMEN PRODUCTION, PROCESSING AND STORAGE

AG 534 - L

ANSWERS TO TEST

1. Most economical for using particular available sire on limited number of cows within short time period; Maintains viability for only 1-2 days--stored in refrigerator at 39oF

   Extenders

   a. Illini variable temperature (IVT)--maintains sperm viability under variable temperatures (carbon dioxide depresses motility and conserves cell energy)

   b. Coconut water extender (CWE) and coconut milk extender (CME)--for non-refrigerated storage

2. Straws: Thin-walled plastic tubes; Most commonly used has .5 ml capacity; Extended semen must equalize so sperm is protected during freezing process; Siphon the extended semen by vacuum to fill the straw; Seal with plastic plugs or polyvinyl powder; Spread on rack for vapor freezing in less than 5 minutes (liquid nitrogen)

   Ampules: Look like mini-coke bottles; Most commonly used ampules have .5 ml or 1 ml capacity; Extended semen must equalize; Fill with syringe fitted with plastic tube; Flame-sealed; Place on metal canes with clips to freeze (liquid nitrogen)

   Pellets: Drop of extended semen frozen on block of dry ice with depressions melted in it; Pellets shaken into metal tubes for storage (brass weight added to each so doesn't float from container); Tubes placed into cannisters in liquid nitrogen refrigerator

3. Nutrients; Buffer; Antibacterial agents; Glycerol; Antifreeze

4. a. Total viable cells = Volume (ml) x Concentration/ml x % Motile x % Normal

   b. Units of extended semen = $\dfrac{\text{Total viable cells}}{\text{Number viable cells/insemination}}$

   c. Extender needed = Total volume extended semen - Volume of semen

   Formula = $\dfrac{7 \times 1 \times 10^9 \times .7 \times .9}{10 \times 10^6}$ = 441 units

   1 ml dosage x 441 units = 441 ml extended semen
   441 ml extended semen - 7 ml semen = 434 ml extender
   174 ml egg yolk + 260 ml citrate = 434 ml EYC (extender)
   Add 441 x 500 units penicillin/ml = 220,500 units penicillin
   Add 441 x 1 mg streptomycin/ml = 441 mg streptomycin

5. a. Number viable sperm/unit before freezing must be 15 million or 1 1/2 the number used in processing liquid semen (to offset sperm mortality during processing and thawing)

b. Glycerol must be added to 6-12% by volume

$$\frac{6 \times .9 \times 10^9 \times .8 \times .8}{15 \times 10^6} = 230 \text{ units}$$

.5 ml straw x 230 units = 115 ml extended semen
115 ml - 6 ml semen = 109 ml extender
22 ml egg yolk + 87 ml citrate = 109 ml EYC
Add 115 x 500 units penicillin/ml = 57,500 units penicillin
Add 115 x 1 mg streptomycin/ml = 115 ml streptomycin
115 ml extended semen x 7.5% glycerol = 8.6 ml glycerol
109 ml EYC - 8.6 ml glycerol = 100 ml EYC needed
Divide EYC in half - add first half to semen. Add glycerol to second half, then gradually add all together

6. Advantages (Answer should include six of the following:) Greater recovery after processing and thawing; Slightly increased conception (as compared to ampules); Less storage space required; Lower cost (straw vs. glass); Won't explode; All sperm removed at time of insemination; Uniform freezing (size and shape); Quick thaw

   Disadvantages: Transfer time critical (prevent thawing); Small labeling; End plugs may split or blow

7. Advantages: Transfer between storage units less critical; Easier to read labels; Larger, easier to handle; Sanitary package

   Disadvantages (Answer should include five of the following:) More storage required; Slower thaw time; Greater sperm loss in processing and thawing; May explode if sealed improperly; Slightly lower conception rates; About 15-20% sperm left in ampule

8. Advantages (Answer should include four of the following:) Quick, simple production; Can avoid glycerolization; Least amount storage space required; Low equipment cost; Greater live sperm recovery

   Disadvantages: Difficult to label; Chips may relocate on other pellets or packages; Bacterial contamination; Clumsy to handle; Quick thaw when exposed; Need separate extender when thawed

9. Performance records: Only available for mature sires; Best, most effective method (desirable traits have been proven)

10. Used to report breeding results (female has not returned to estrus for rebreeding and is pregnant); Nonreturn rates at 30 to 60 are usually high (80-85%); 60-90 NR (rates at 60 to 90 days); Lower (70-75%): Some cows identified in estrus for rebreeding that were missed on previous heat check; Some early embryonic mortality may also have occurred and cow recycled; Assumed standard in artificial insemination; Based on first service (repeat breeding livestock not considered in subsequent reports)

MACROSCOPIC FEMALE FUNCTIONAL ANATOMY

AG 534 - M

UNIT OBJECTIVE

After completion of this unit, students should be able to match the parts of the female reproductive tract to their correct descriptions and trace the path of the ovum in the female reproductive tract. Students should also be able to identify the structures of the ovary and relate them to their functions. This knowledge will be demonstrated by completion of a laboratory exercise and unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Identify the parts of the female reproductive tract.
2. Match the parts of the female reproductive tract to their correct descriptions.
3. List the order of the ovum pathway in the female reproductive tract.
4. Identify the function and the three portions of the broad ligament.
5. List the three functions of the follicle.
6. Describe the corpus hemorrhagicum.
7. Describe the corpus luteum and state its function.
8. Describe the corpus albicans and state its two functions.
9. Describe the differences in the ovaries of the cow, ewe, sow, and mare.
10. State the two general functions of the oviduct.
11. Match structures of the oviduct with their correct functions and descriptions.
12. Explain how the sow's oviduct differs from the cow's oviduct.
13. Explain how the mare's oviduct differs from the cow's oviduct.
14. Explain how the ewe's oviduct differs from the cow's oviduct.
15. List and describe the three types of uteruses.
16. Describe the caruncles and state their function.
17. Describe the uterus of the cow and ewe, sow, and the mare.
18. List five functions of the uterus.
19. List the three functions of the cervix.

20. Describe the cow's cervix structure.
21. Describe how the cervix of the ewe, sow and mare differs from that of the cow.
22. State the function of the vagina.
23. Describe the structure of the vagina.
24. Describe and list the function of the vestibule.
25. State the function of the vulva and clitoris.
26. Examine the anatomy of the female reproductive tract.

MACROSCOPIC FEMALE FUNCTIONAL ANATOMY

AG 534 - M

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

  A. Make transparencies and necessary copies of materials.

  B. Provide students with objectives and discuss.

  C. Provide students with information and discuss.

  D. Provide students with laboratory exercise.

  E. Demonstrate laboratory exercise procedures.

  F. Review and give test.

  G. Reteach and retest if necessary.

II. Instructional materials

  A. Objective sheet

  B. Suggested activities

  C. Information sheet

  D. Transparency masters

    1. TM 1--Reproductive Tract of a Cow

    2. TM 2--Parts of Reproductive Tract Positioned Within a Cow's Body

    3. TM 3--Reproductive Tract of a Sow

    4. TM 4--Reproductive Tract of a Mare

  E. Laboratory exercises

    1. LE 1--Anatomy of the Female Reproductive Tract

  F. Answers to laboratory exercise

  G. Test

  H. Answers to test

III. Unit references

A. Barrick, R., and Harmon, H., *Animal Production and Management*, McGraw-Hill Book Company, New York, 1988.

B. Bearden and FuQuay, *Applied Animal Production*, Prentice-Hall, Englewood Cliffs, New Jersey, 1980.

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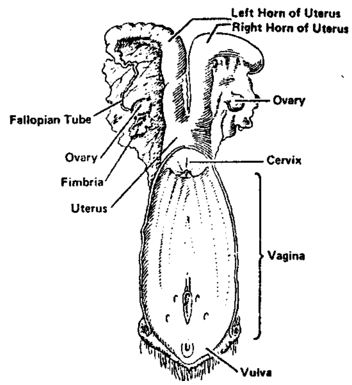
MACROSCOPIC FEMALE FUNCTIONAL ANATOMY

AG 534 - M

INFORMATION SHEET

I. Parts of the female reproductive tract (Transparency 1, 2, 3, 4)



II. Functions of parts of female reproductive tract

A. Vulva--Opening of the female reproductive tract

B. Vagina--Channel for birth of fetus; receives male penis during copulation

C. Cervix--Divider between the vagina and the uterus; secretes a fluid or mucus that forms a plug at end of cervix inside the uterus when pregnancy occurs

D. Uterus--Provides environment for nourishment and development of the fetus

E. Horns of uterus--Part of uterus where fetal development takes place

F. Fallopian tube--Path between ovary and uterus; fertilization occurs here

G. Ovaries--Produce eggs and certain hormones

III. Pathway of the ovum

A. Ovary (ovum growth)

B. Oviduct (ovum fertilization)

C. Uterus (growth and development of fertilized ovum)

D. Cervix

E. Vagina

F. Vestibule

G. Vulva

IV. Ovary: Structure and functions

A. Broad ligament--supports reproductive tract

1. Mesovarium

2. Mesometrium

3. Proper ligament

B. Follicle

1. Produce or contain the growing ovum

2. Produce and store estrogen

3. Ruptures when mature (every 3 weeks) to release the ovum into the oviduct

C. Corpus hemorrhagicum (CH)--fluffy tissue that is the result of a small hemorrhage from the follicle's rupture point

D. Corpus luteum (CL)

1. Originates from the corpus hemorrhagicum

2. Produces estrogen

3. Develops papillum--teat-like protrusion at rupture point

E. Corpus albicans (CA)

1. Scar resulting from the degenerating corpus luteum

2. Functions

a. Removes luteal tissue

b. Returns ovary to normal shape, size and function

F. Differences among species

1. Cow (as described above)

a. Almond shape

b. 1-2 mature follicles

2. Ewe (very similar to cow with some exceptions)

a. 2-3 ova released at ovulation--may be 2-3 follicles protruding followed by multiple CH, CL and CA

b. Sac surrounding ovary--deeper, more distinct

3. Sow

   a. Looks like cluster of grapes

   b. Multiple follicles form multiple CH, CL, and CA

   c. Definite coning of rupture point--no papillum

   d. Not much support

4. Mare

   a. Kidney shaped

   b. May have several follicles on ovaries, but only one ruptures at ovulation

   c. No papillum

V. Oviduct: Structure and functions

A. Also called uterine tube, salpinx, or fallopian tube

B. Fertilization site and passageway for fertilized ovum into the uterus

C. Mesosalpinx--supports the oviduct

D. Infundibulum

   1. Terminal portion of oviduct

   2. Structured to receive ovum after ovulation

E. Ampulla

   1. Funnel-like part of oviduct

   2. Passageway for ovum

   3. Location of union of the sperm and ovum

F. Isthmus--narrow part of oviduct

G. Tubouterine junction--valvelike interior of oviduct that restricts fluid passage from uterus to oviduct, but allows movement from oviduct to uterus

H. Differences among species

   1. Cow (described above)

2. Ewe (compared to cow)

   a. Very long in relationship to size of ewe

   b. Greater constriction at tubouterine junction

   c. Better developed internal valve

3. Sow--infundibulum almost engulfs ovary

4. Mare

   a. Oviduct flares abruptly into infundibulum

   b. Thicker infundibulum

VI. Uterus: Structure and functions

A. Shapes

1. Bipartite

   a. Two distinct horns; relatively large body

   b. Cow, ewe, mare

2. Bicornuate

   a. Two long horns; proportionately small body

   b. Sow

3. Simplex

   a. Single rounded body without horns

   b. Human

B. Caruncles

1. Rounded points found in and on the uterus folds

2. Serve as attachment points of the placenta during pregnancy for nutrient and waste exchange

C. Differences among species

1. Cow and ewe very similar

a. Bipartite

b. Caruncles

c. Supported by broad ligament and round ligament

d. Firm textured

2. Sow

a. Very long uterus

b. Horns look like intestines

c. Bicornuate

d. No caruncles--placenta attaches over entire surface during pregnancy

3. Mare

a. Bipartite

b. More flaccid than others

c. No caruncles

D. Functions

1. Passageway to transport sperm to oviduct after copulation

2. Incubator for developing the fetus

3. Secretes fluids to bathe the sperm

4. Supplies nourishment for embryo prior to attachment

5. Contracts to expel fetus at parturition

VII. Cervix: Structure and functions

A. Composed of large amount of connective tissue and some muscle; very firm

B. Functions

1. Passageway for sperm following copulation (opens; secretes fluid)

2. Seals after copulation to maintain uterus in undisturbed state

3. Opens and lubricates the birth canal

C. Structure (cow)

1. Lined with longitudinal folds

a. Form prominent ridges

b. Slanted to prevent foreign material from entering the uterus

2. Cranial cervix--blends into body of uterus

3. Caudal cervix--forms fornix (circular depression) around protruding cervix

4. Os uteri--looks like a rosette

D. Differences among species

1. Cow and ewe very similar

a. Ewe has more distinct circular folds

b. Ewe has greater number of circular folds

2. Sow

a. Long and firm

b. Extends from floor of pelvic cavity into the peritoneal cavity

c. No protrusion or fornix

3. Mare

a. Numerous tall longitudinal folds that provide little protection to penetrate

b. Opens during estrus

VIII. Vagina: Structure and function

A. Copulatory organ of the female (receives penis during copulation)

B. Structure (cow)

1. Extends from cervix to a point cranial to the urethral orifice

2. Walls--muscular; usually collapsed

3. Covered with peritoneum (forms the rectovaginal pouch allowing penetration into peritoneal cavity)

4. Fornix around intravaginal part of cervix (can be problem when inseminating)

5. Hymen--membrane at junction of vagina and vestibule

C. Differences among species

1. Cow--described above

2. Ewe--similar to cow (smaller)

3. Sow

a. Definite annular fold at site of hymen

b. No fornix

4. Mare

a. Deep fornix around intravaginal part of cervix

b. Prominent on floor at junction with the vestibule

IX. Vestibule

A. Extends from site of hymen to lips of the vulva

B. Suburethral diverticulum--blind pocket in vestibule floor

C. Acts as entrance and passage to vagina

D. Vestibular glands lubricate vestibule during copulation and parturition

E. Differences among species

1. Cow and ewe as described

2. Sow--small suburethral diverticulum; minor vestibular glands

3. Mare--no suburethral diverticulum; minor vestibular glands

X. Vulva and clitoris

A. Function--entrance to the reproductive internal organs

B. Cow

1. Labium (lip) on each side of vulva
2. Ventral commissure
3. Glans clitoris--homologous of penis in male
4. Size, shape, position all important in breeding animals

C. Ewe

1. Labia may be divided slightly into major and minor lips
2. Lips more prominent during estrus
3. Clitoris well hidden in ventral commissure

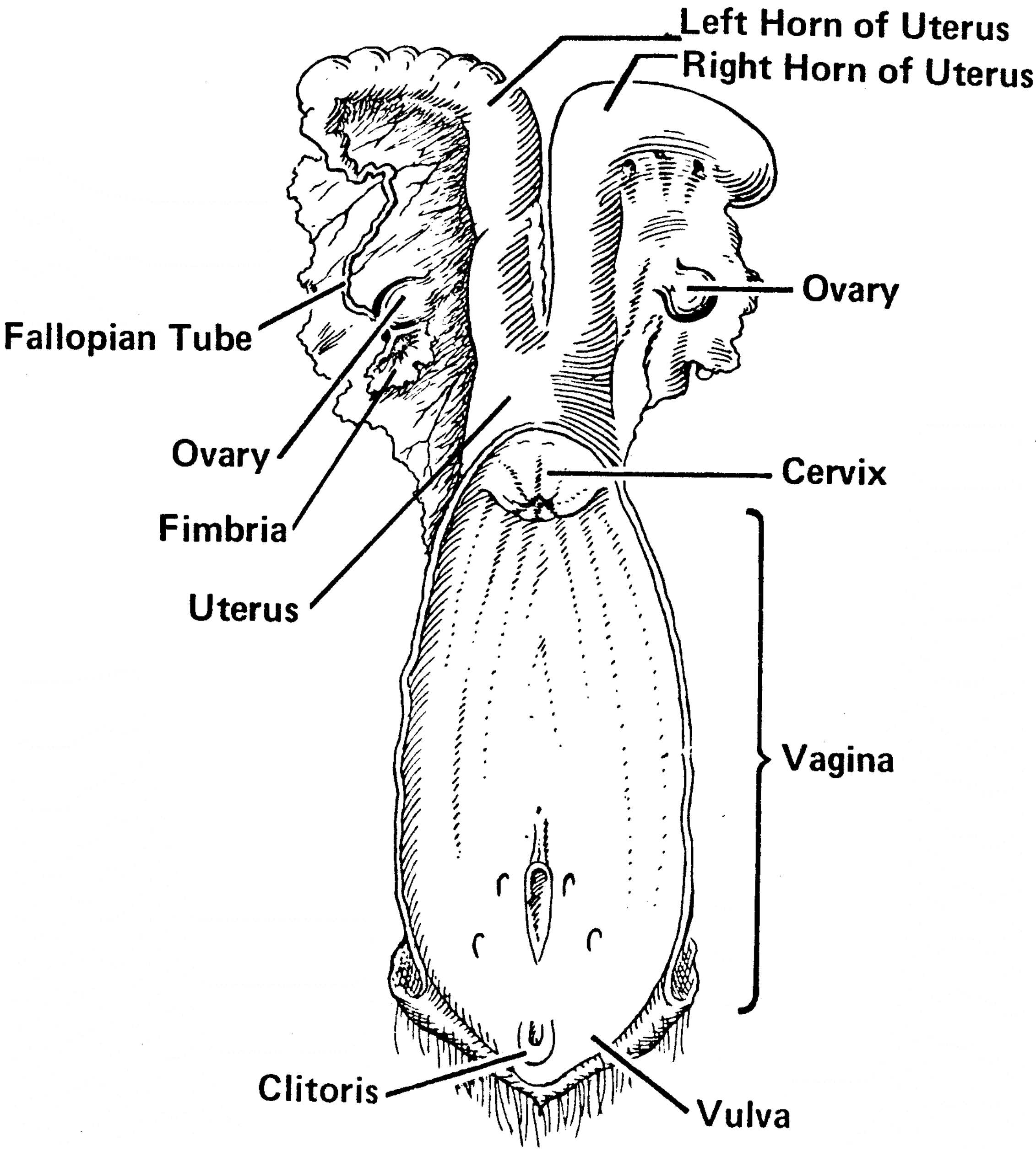
D. Sow

1. Lips--wrinkled; come to point at ventral commissure
2. Labia becomes turgid with fluid during estrus
3. Clitoris--small exteriorly, but may be long under floor of the vestibule

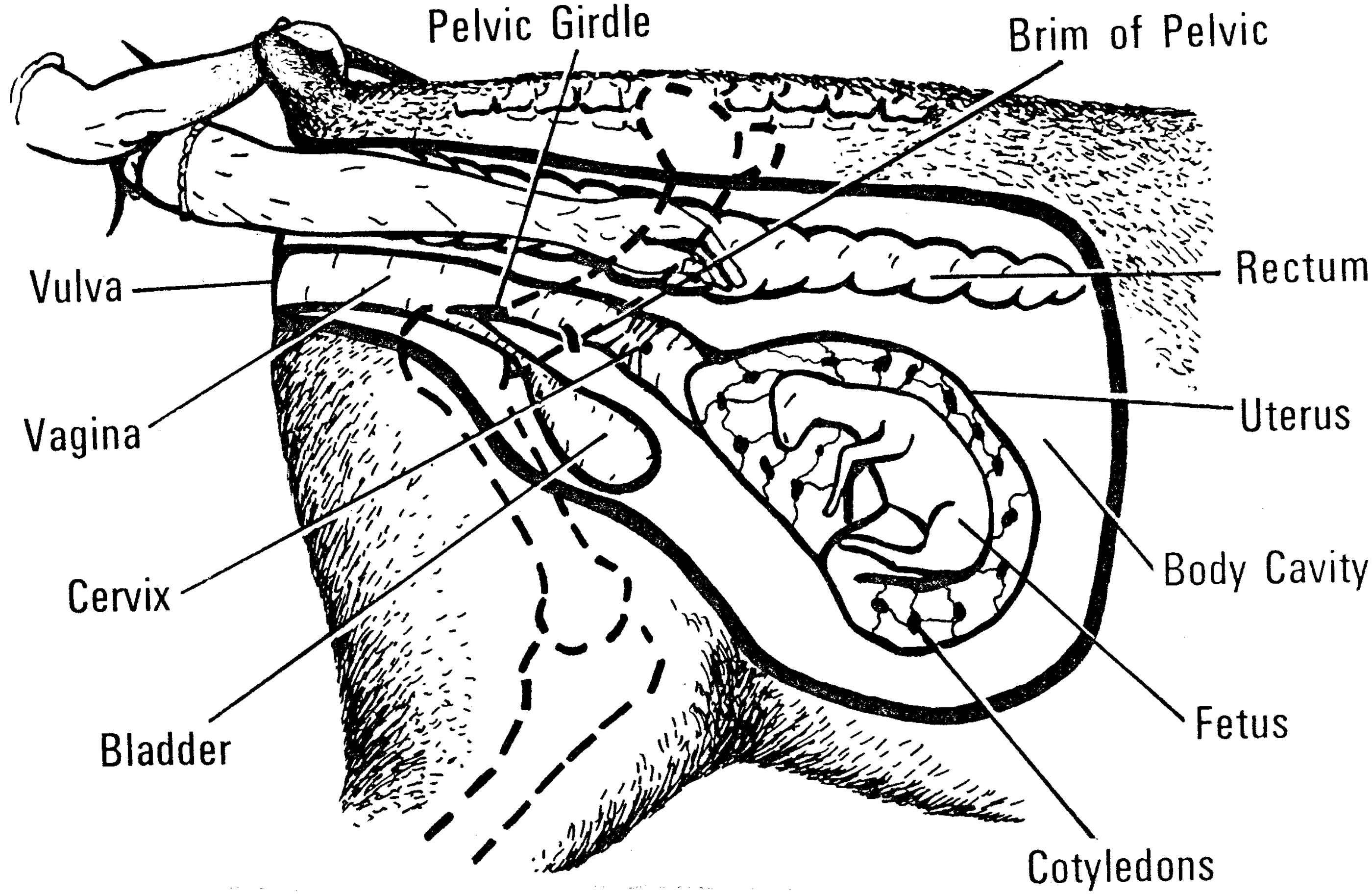
E. Mare

1. Vulva--composed of thick rounded labia
2. Ventral commissure--rounded, not pointed
3. Clitoris--prominent
4. Vulva opens and closes during estrus

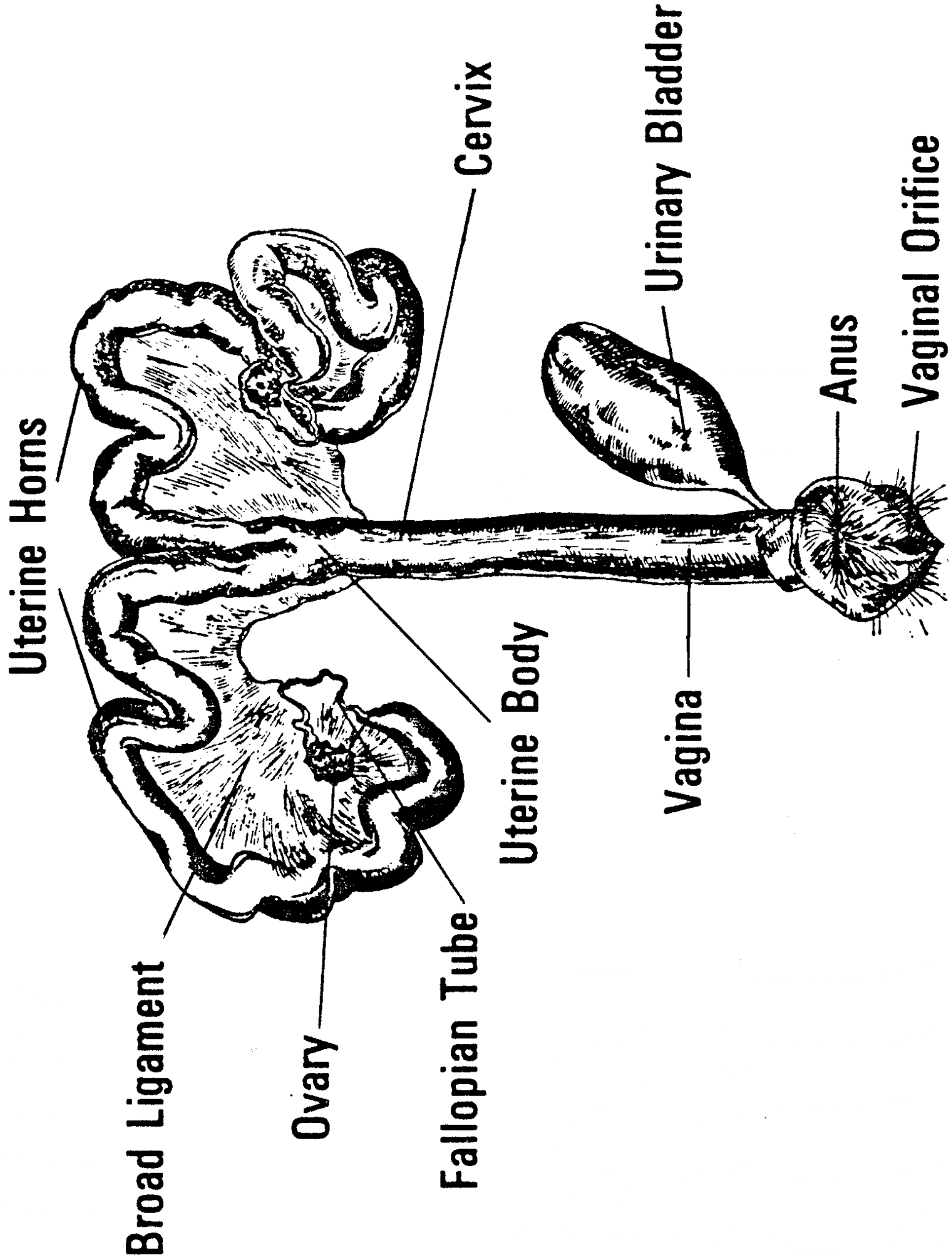
Reproductive Tract of a Cow



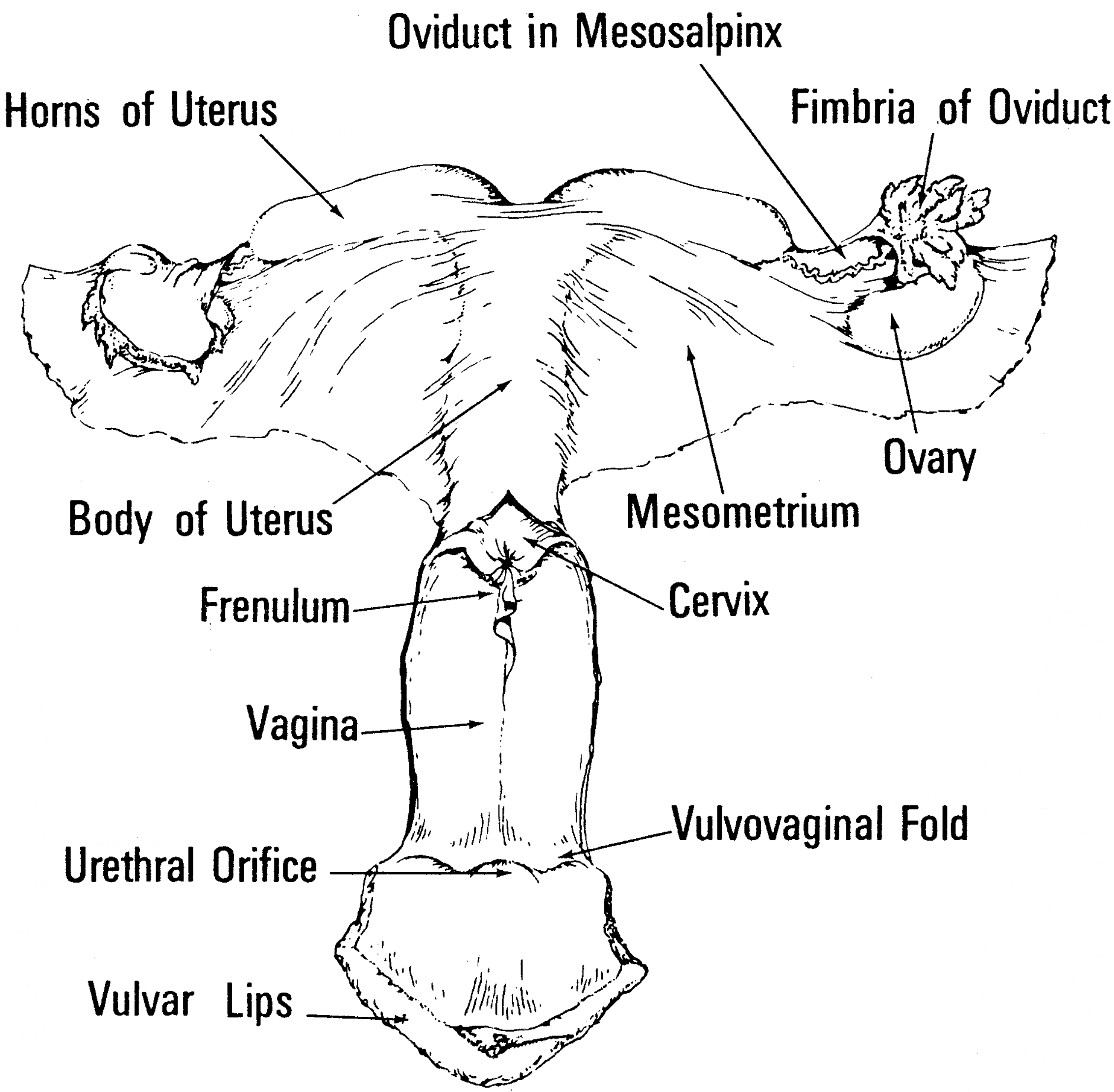
Parts of Reproductive Tract Positioned Within Cow's Body



Reproductive Tract of a Sow



Reproductive Tract of a Mare



MACROSCOPIC FEMALE FUNCTIONAL ANATOMY

AG 534 - M

LABORATORY EXERCISE #1--ANATOMY OF THE FEMALE REPRODUCTIVE TRACT

Name ______________________________ Score ______________________________

Materials needed

Specimens:
    Excised cow reproductive tract
    Excised sow reproductive tract
Dissecting kits: scissors, scalpel, probes, forceps
Dissecting trays
Hypodermic needle, 23 gauge
Syringe, 1 ml
Tissue culture dish
Stereomicroscope
Physiologic saline

Introduction

Female Reproductive Tract

The female reproductive tract is composed of ovaries, oviducts, uterus, vagina and external genitalia. The female reproductive tract of the cow will be examined in this exercise.

Ovary

The ovary consists of the *medulla* and the *cortex*. The ovarian medulla consists of irregularly arranged fibro-elastic connective tissue and an extensive nerve and blood vessel system which enters the ovary by way of the hilus. The *hilus* is the place of attachment between the ovary and the *mesovarium* or supporting ligament.

The ovarian cortex contains the *follicles, corpora hemorrhagica, corpora lutea* and *corpora albicantia*. Follicles are involved in ova formation and estrogen production, whereas corpora lutea are involved in progesterone production.

Oviduct

The oviduct is divided into the *fimbriae, infundibulum, ampulla* and *isthmus*. The fimbriae are irregular processes adjacent to the ovary and extending from the funnel-shaped infundibulum. The diameter of the oviduct decreases progressively though the consecutive infundibular, ampullar and isthmic portions. The ampulla comprises about half of the oviductal length. The isthmus is connected directly to the uterine horn.

Uterus

The uterus consists of two *horns*, a *body* and a *cervix*. The uterine horns of the sow are long in comparison to the uterine body and are examples of the *bicornuate* type of uterus. The *bipartite* type of uterus is represented by the cow where a septum divides the uterine body allowing for a larger ratio of length of uterine body to length of uterine horns. The cervix is the constricted posterior portion of the uterus which opens into the vagina. Dissection of the cow uterus will allow for observation of button-shaped structures located on the inner wall known as *caruncles*. Caruncles are maternal sites of fetal membrane attachment.

Vagina

The *vagina* is the site of semen deposition in the cow, whereas semen is deposited in the cervix of the sow. The *fornix* in the vagina is the arch formed by the projecting cervix. The fornix is absent in the sow where the cervix is continuous with the vagina.

External Genitalia

The external genitalia is composed of the *vestibule*, *vulva*, and *clitoris*. The external *urethral orifice* opens into the ventral surface of the vestibule.

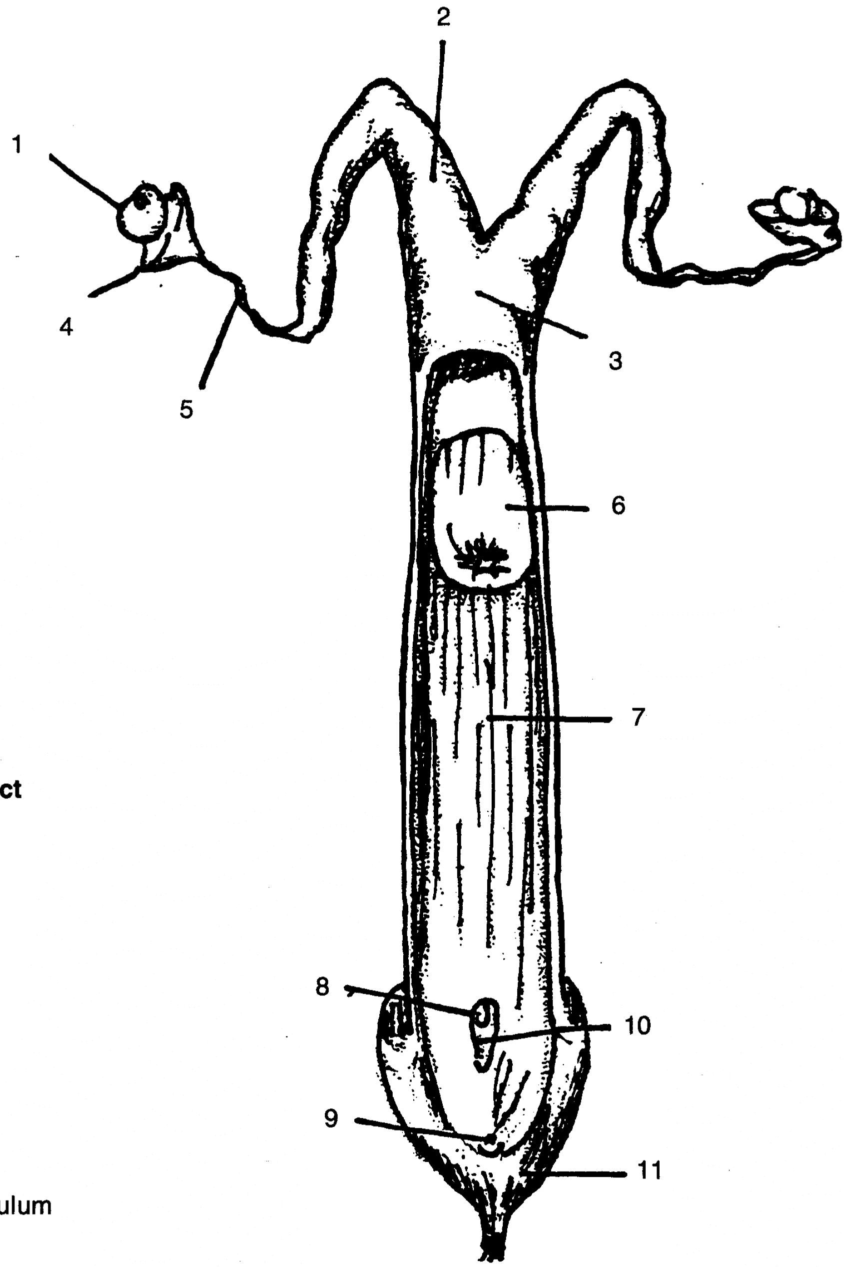
Note the *suburethral diverticulum* in the cow tract. *Gartner's tubules*, remnants of the embryonic structures known as the Wolffian ducts, appear as two small papilla in the vestibule.

Procedure

1. Examine the excised reproductive tracts of the cow and sow.

2. Know the structures cited in the introduction and in Figures 1 and 2.

3. Your teacher will aspirate ovarian follicles with the hypodermic needle and syringe using a sub-surface approach through the cortex. The follicular fluid will be transferred to a tissue culture dish containing physiologic saline and scanned using the stereomicroscope to locate an ovum.



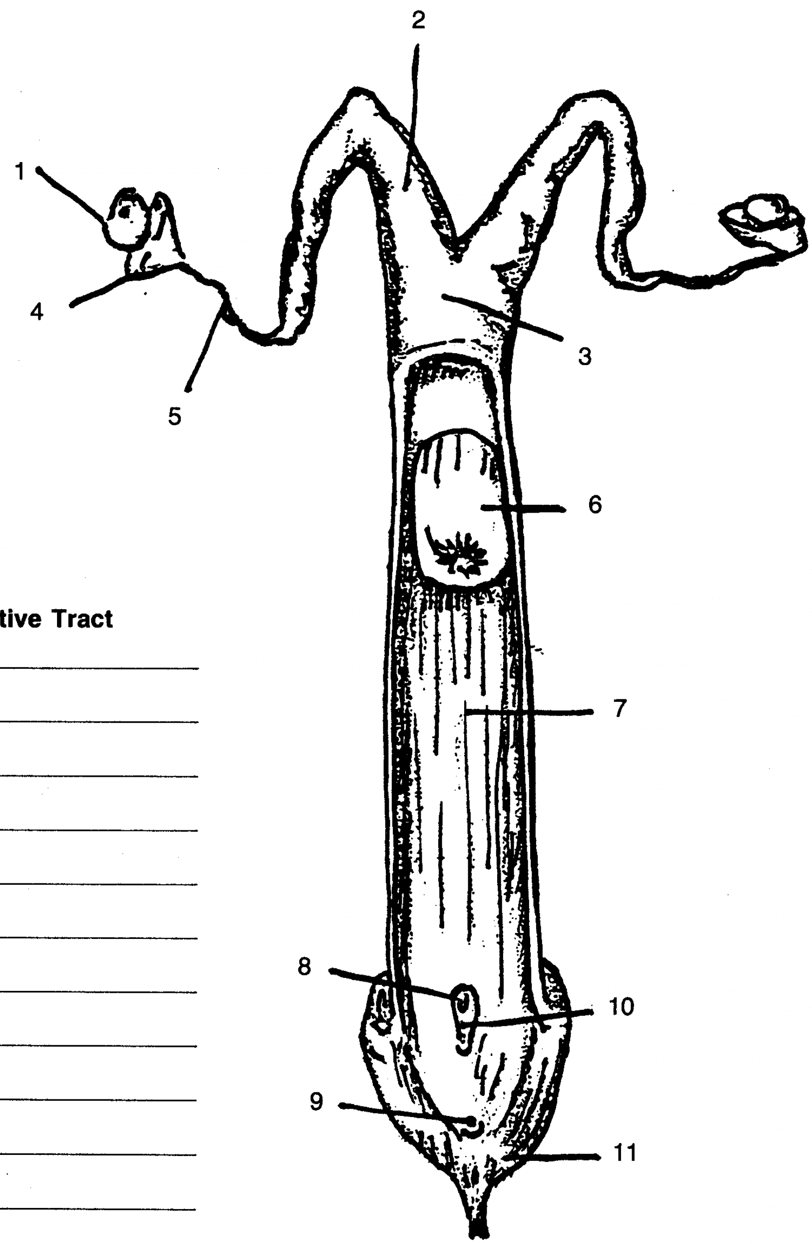
Cow Reproductive Tract

1 Ovary
2 Uterine Horn
3 Uterine Body
4 Infundibulum
5 Oviduct
6 Cervix
7 Vagina
8 Utrethra
9 Clitoris
10 Suburethral Diverticulum
11 Vulva

Cow Reproductive Tract

Figure 1

Name ____________________________________

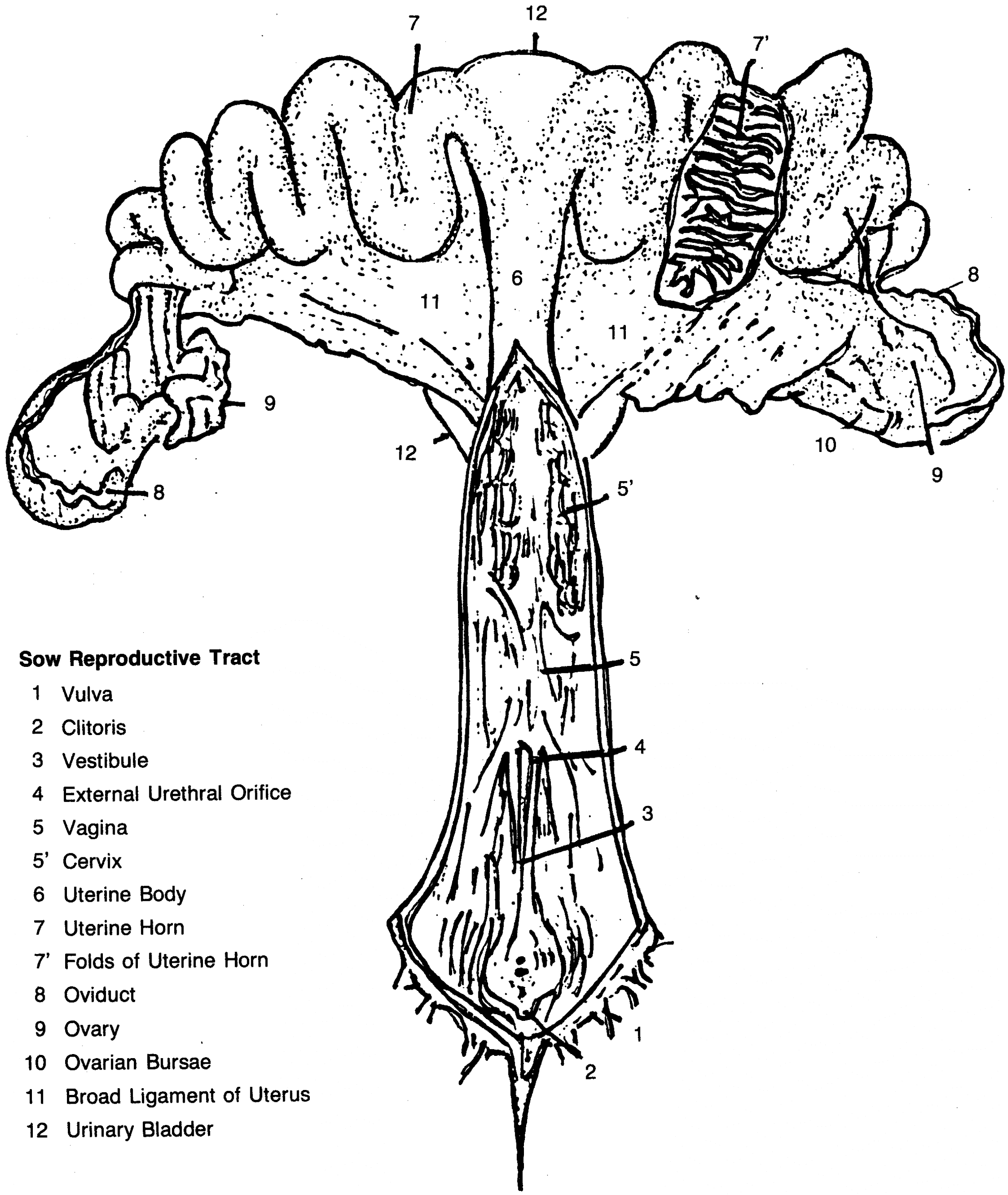


Cow Reproductive Tract

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________
11. ______________________

Cow Reproductive Tract

Figure 1



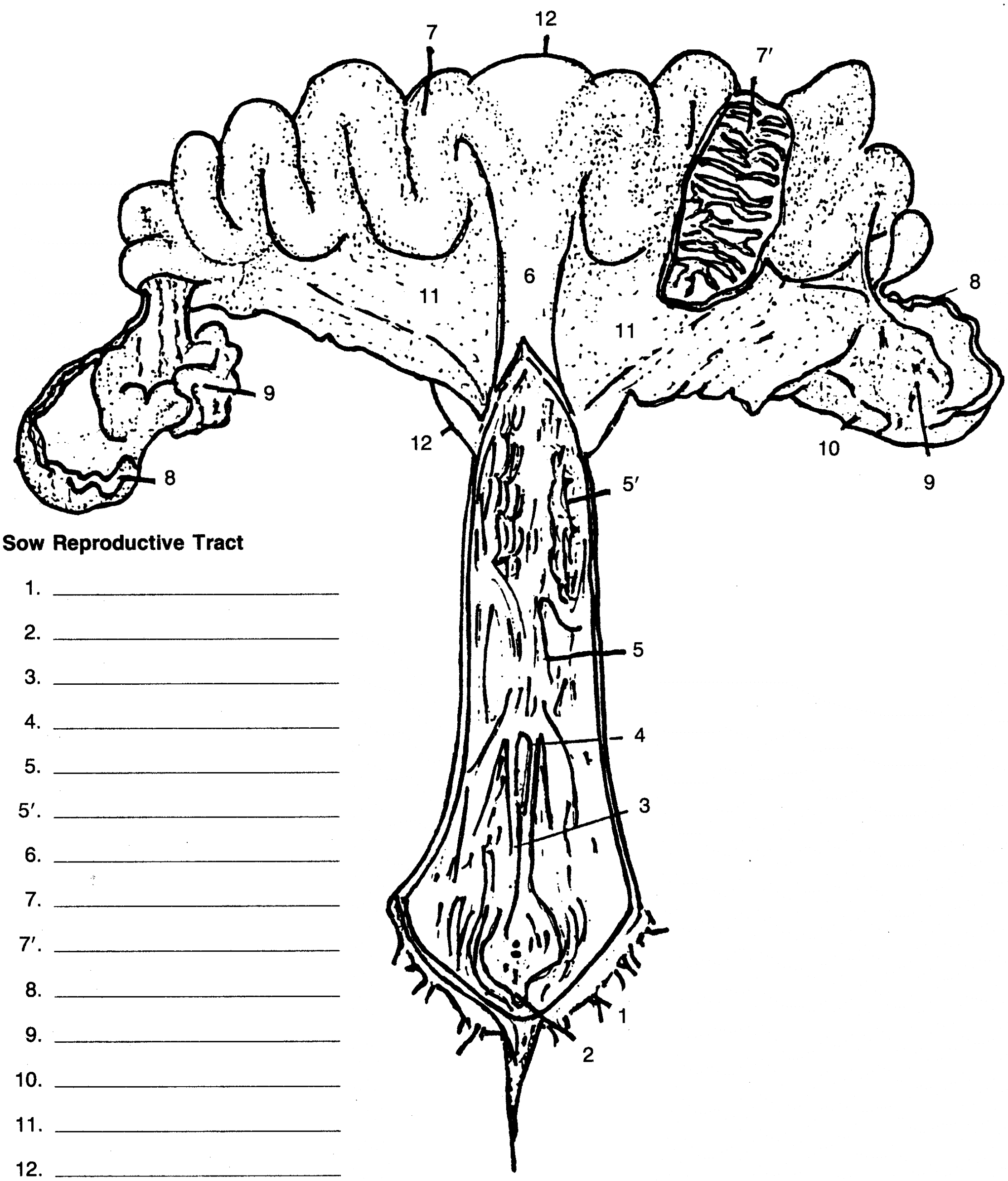
Sow Reproductive Tract

1 Vulva
2 Clitoris
3 Vestibule
4 External Urethral Orifice
5 Vagina
5' Cervix
6 Uterine Body
7 Uterine Horn
7' Folds of Uterine Horn
8 Oviduct
9 Ovary
10 Ovarian Bursae
11 Broad Ligament of Uterus
12 Urinary Bladder

Sow Reproductive Tract

Figure 2

Name ____________________________________



Sow Reproductive Tract

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
5′. ____________________
6. ____________________
7. ____________________
7′. ____________________
8. ____________________
9. ____________________
10. ____________________
11. ____________________
12. ____________________

Sow Reproductive Tract

Figure 2

MACROSCOPIC FEMALE FUNCTIONAL ANATOMY

AG 534 - M

ANSWERS TO LABORATORY EXERCISES

Lab #1

Sow Reproductive Tract

1. Vulva
2. Clitoris
3. Vestibule
4. External Urethral Orifice
5. Vagina

5'. Cervix

6. Uterine Body
7. Uterine Horn

7'. Folds of Uterine Horn

8. Oviduct
9. Ovary
10. Ovarian Bursae
11. Broad Ligament of Uterus
12. Urinary Bladder

Cow Reproductive Tract

1. Ovary
2. Uterine Horn
3. Uterine Body
4. Infundibulum
5. Oviduct
6. Cervix
7. Vagina
8. Urethra
9. Clitoris
10. Suburethral Diverticulum
11. Vulva

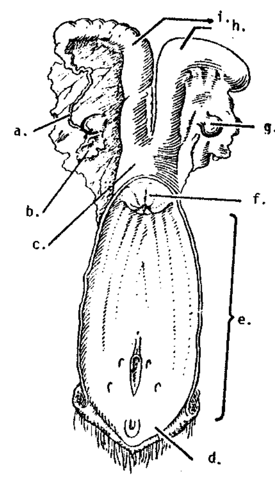
MACROSCOPIC FEMALE FUNCTIONAL ANATOMY

AG 534 - M

UNIT TEST

Name ______________________________ Score ______________________________

1. Identify the parts of the female reproductive tract below by writing the correct names in the blanks provided.



2. Match the female reproductive organs to the correct functions.

1. Fallopian tube
2. Uterus
3. Vagina
4. Vulva
5. Ovary
6. Horns of uterus
7. Cervix

_____a. Channel for birth of fetus; receives male penis during copulation

_____b. Opening of the female reproductive tract

_____c. Provides environment for nourishment and development of the fetus

_____d. Produces eggs and certain hormones

_____e. Divider between vagina and uterus; secretes a fluid or mucus that forms a plug at end of cervix inside the uterus when pregnancy occurs

_____f. Path between ovary and uterus, fertilization occurs here

_____g. Part of the uterus where fetal development takes place

3. List the order of the ovum pathway in the female reproductive tract.

   a.____

   b. ____

   c.____

   d. ____

   e.____

   f.____

   g. ____

4. Identify the function and the three portions of the broad ligament.

   Function____________________________________

   a.____

   b. ____

   c.____

5. List the three functions of the follicle.

   a.____

   b. ____

   c.____

6. Describe the corpus hemorrhagicum.

7. Describe the corpus luteum and state its function.

8. Describe the corpus albicans and state its two functions.

____

____

____

9. Describe the differences in the ovaries of the cow, ewe, sow, and mare.

a. Cow ____

____

____

b. Ewe ____

____

____

c. Sow ____

____

____

d. Mare ____

____

____

10. State the two general functions of the oviduct.

a.____

b. ____

11. Use the most specific answer to match structures of the oviduct with their correct functions and descriptions. Answers may be used more than once.

1. Isthmus
2. Ampulla
3. Infundibulum
4. Mesosalpinx
5. Tubouterine junction

_____a. Location of union of the sperm and ovum

_____b. Narrow part of oviduct

_____c. Terminal portion of oviduct

_____d. Supports the oviduct

_____e. Passageway for ovum

_____f. Funnel-like part of oviduct

_____g. Valve-like interior of oviduct that restricts fluid passage from uterus to oviduct, but allows movement from oviduct to uterus

12. Explain how the sow's oviduct differs from the cow's oviduct.

____

____

13. Explain how the mare's oviduct differs from the cow's oviduct.

____

____

14. Explain how the ewe's oviduct differs from the cow's oviduct.

____

____

15. List and describe the three types of uteruses.

a.____

____

b. ____

____

c.____

____

16. Describe the caruncles and state their function.

____

____

____

____

17. Describe the uterus of the cow and ewe, sow, and the mare.

    a. Cow and ewe ____

    ____

    ____

    b. Sow ____

    ____

    ____

    c. Mare ____

    ____

    ____

18. List five functions of the uterus.

    a.____

    b. ____

    c.____

    d. ____

    e.____

19. List the three functions of the cervix.

    a.____

    ____

    b. ____

    ____

    c.____

    ____

20. Describe the cow's cervix structure.

    ____

    ____

    ____

21. Describe how the cervix of the ewe, sow and mare differs from that of the cow.

    a. Ewe ______________________________

    ____

    b. Sow ______________________________

    ____

    c. Mare ______________________________

    ____

22. State the function of the vagina.

    ____

    ____

23. Describe the structure of the vagina.

    ____

    ____

    ____

    ____

    ____

    ____

24. Describe and list the function of the vestibule.

    ____

    ____

    ____

    ____

    ____

25. State the function of the vulva and clitoris.

    ____

    ____

MACROSCOPIC FEMALE FUNCTIONAL ANATOMY

AG 534 - M

ANSWERS TO TEST

1.
   a. Fallopian tube
   b. Fimbria
   c. Uterus
   d. Vulva
   e. Vagina
   f. Cervix
   g. Ovary
   h. Right horn of uterus
   i. Left horn of uterus

2.
   a. 3
   b. 4
   c. 2
   d. 5
   e. 7
   f. 1
   g. 6

3. Ovary; Oviduct; Uterus; Cervix; Vagina; Vestibule; Vulva

4. Function--Supports reproductive tract
   Portions--Mesovarium; Mesometrium; Proper ligament

5. Produce or contain the growing ovum; Produce and store estrogen; Ruptures when mature to release the ovum into the oviduct

6. Fluffy tissue that is the result of a small hemorrhage from the follicle's rupture point

7. Originates from the corpus hemorrhagicum; Produces estrogen; Develops papillum--teat-like protrusion at rupture point

8. Scar resulting from the degenerating corpus luteum
   Functions--Removes luteal tissue; Returns ovary to normal shape, size and function

9.
   a. Cow : Almond shape; 1-2 mature follicles
   b. Ewe: 2-3 ova released at ovulation--may be 2-3 follicles protruding followed by multiple CH, CL and CA; Sac surrounding ovary--deeper, more distinct
   c. Sow: Looks like cluster of grapes; Multiple follicles form multiple CH, CL, and CA; Definite coning of rupture point--no papillum; Not much support
   d. Mare: Kidney shaped; May have several follicles on ovaries, but only one ruptures at ovulation; No papillum

10. Fertilization site and passageway for fertilized ovum into the uterus

11.
   a. 2
   b. 1
   c. 3
   d. 4
   e. 2
   f. 2
   g. 5

12. Sow--Infundibulum almost engulfs ovary

13. Mare--Oviduct flares abruptly into infundibulum; Thicker infundibulum

14. Ewe--Very long in relationship to size of ewe; Greater constriction at tubouterine junction; Better developed internal valve

15. a. Bipartite: Two distinct horns; relatively large body
    b. Bicornuate: Two long horns; proportionately small body
    c. Simplex: Single rounded body without horns

16. Rounded points found in and on the uterus folds: Serve as attachment points of the placenta during pregnancy for nutrient and waste exchange

17. a. Cow and ewe: Bipartite; Caruncles; Supported by broad ligament and round ligament; Firm textured
    b. Sow: Very long uterus; Horns look like intestines; Bicornuate; No caruncles--placenta attaches over entire surface during pregnancy
    c. Mare: Bipartite; More flaccid than others; No caruncles

18. Passageway to transport sperm to oviduct after copulation; Incubator for develpoing the fetus; Secretes fluids to bathe the sperm; Supplies nourishment for embryo prior to attachment; Contracts to expel fetus at partuition

19. Passageway for sperm following copulation (opens; secretes fluid); Seals after copulation to maintain uterus in undisturbed state; Opens and lubricates the birth canal

20. Lined with longitudinal folds; Cranial cervix--blends into body of uterus; Caudal cervix--forms fornix (circular depression) around protruding cervix; Os uteri--looks like a rosette

21. a. Ewe has more distinct circular folds; Ewe has greater number of circular folds
    b. Sow--Long and firm; Extends from floor of pelvic cavity into the peritoneal cavity; No protrusion or fornix
    c. Mare--Numerous tall longitudinal folds that provide little protection to penetrate; Opens during estrus

22. Copulatory organ of the female (receives penis during copulation)

23. Extends from cervix to a point cranial to the urethral orifice; Walls--muscular; usually collapsed; Covered with peritoneum (forms the rectovaginal pouch allowing penetration into peritoneal cavity); Fornix around intravaginal part of cervix (can be problem when inseminating); Hymen--membrane at junction of vagina and vestibule

24. Extends from site of hymen to lips of the vulva; Suburethral diverticulum--blind pocket in vestibule floor; Acts as entrance and passage to vagina; Vestibular glands lubricate vestibule during copulation and parturition

25. Entrance to the reproductive internal organs

MICROSCOPIC FEMALE FUNCTIONAL ANATOMY

AG 534 - N

UNIT OBJECTIVE

After completion of this unit, students should be able to list and describe the steps in follicular growth and describe cell division during oogenesis. Students should also be able to explain how to distinguish between a follicle and a corpus luteum by palpation in the cow. This knowledge will be demonstrated by completion of a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Describe in detail a follicle, corpus hemorrhagicum, corpus luteum, corpus albicans, and an atretic follicle.
2. List and describe the steps in follicular growth.
3. Describe cell division during oogenesis.
4. List the types of cells found in the oviduct, uterus, cervix, vagina, vestibule and vulva.
5. Indicate where the majority of the oocytes are located at birth.
6. Explain how one would distinguish between a follicle and a corpus luteum by palpation in the cow.
7. Indicate when the myometrium is most active.

MICROSCOPIC FEMALE FUNCTIONAL ANATOMY

AG 534 - N

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

   A. Make transparencies and necessary copies of materials.

   B. Provide students with objectives and discuss.

   C. Provide students with information and discuss.

   D. Review and give test.

   E. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM 1--Cow Ovarian Structure

      2. TM 2--Follicular Growth

   E. Test

   F. Answers to test

III. Unit references

   A. Barrick, R., and Harmon, H., *Animal Production and Management*, McGraw-Hill Book Company, New York, 1988.

   B. Bearden and FuQuay, *Applied Animal Production*, Prentice-Hall, Englewood Cliffs, New Jersey, 1980.

   C. Bundy, C.E., et al., *Livestock and Poultry Production*, 5th edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1982.

   D. Ensminger, M.E., *Animal Science*, Interstate Publishers, Danville, Illinois, 1983.

   E. *Idaho State Board for Vocational Education Curriculum Guide in Livestock Production*, University of Idaho and the Idaho State Board for Vocational Education.

F. Lasley, John F., *Genetics of Livestock Improvement*, 3rd edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1978.

G. Sorensen, A.M., *Animal Reproduction Principles and Practices*, McGraw-Hill Book Company, New York, 1979.

MICROSCOPIC FEMALE FUNCTIONAL ANATOMY

AG 534 - N

INFORMATION SHEET

I. Ovarian structures (Transparency 1)

A. Follicle--Tissue in stroma (hollow bag), 3 stages of development:

1. Primary follicle--Ovum surrounded by single layer of nurse cells

2. Secondary follicle--Ovum surrounded by several layers of nurse cells

3. Growing follicle--Nurse cells in secondary follicle begin to separate. Will respond to hormones causing follicular growth. Characterized by presence of fluid-filled cavity (antrum)

B. Corpus hemorrhagicum--Ruptured follicle; walls fold in; bloody appearance

C. Corpus luteum--Formed when the corpus hemorrhagicum fills with yellow cells derived from the stratum granulosum and the tunica interna

D. Corpus albicans--Formed when connective tissue cells invade the corpus luteum

E. Atretic follicle--Follicle that begins development but dies and deteriorates as it progresses. After death, the cytoplasm shrinks, the zona pellucida thickens and fragments, and the follicle deteriorates and is invaded by connective tissue cells of the surrounding stroma

II. Steps in follicular growth (Transparency 2)

A. Primary follicle

B. Secondary follicle

C. Growing follicle

1. Antrum--Fluid-filled cavity

D. Stratum granulosum--Cells lining the follicle; become stratified in 5-10 layers of cells

E. Primary oocyte

1. Zona pellucida--Forms around primary oocyte

2. Corona radiata--Formed as granulosa cells elongate adjacent to the zona

3. Tunica interna--Spindle-shaped epithelioid cell layer formed from stroma cells around the granulosa cells

4. Tunica interna and granulosa cells work together to produce estrogen

5. Tunica externa--Stroma cells and connective tissue cells form this layer for support around follicle

F. Mature follicle

1. Looks like blister on ovary

2. Cumulus oophorus--Granulosa cells surrounding the ovum

III. Oogenesis

A. The majority of the oocytes are located under the tunica albuginea at the time of birth

B. Cell division

1. Primary oocyte (2N)--produces 2 daughter cells

a. Secondary oocyte (1N)--receives majority of cytoplasm

b. First polar body (1N)--basically just a nucleus

2. Secondary oocyte (1N)--divides to form

a. Ootid (1N)--fertilized ovum

b. Second polar body

IV. Cell types of reproductive structures

A. Oviduct

1. Connective cells--support oviduct

2. Muscle cells--assist in moving sperm and ovum

3. Ciliated cells--hairlike border that beats in waves to assist movement through oviduct

4. Secretory cells--produce fluid that serves as medium for active sperm cells and floating ovum

B. Uterus

1. Connective cells--support uterus

2. Muscle cells--help move sperm through tract

3. Secretory cells--produce progesterone to bath early developing embryo

4. Columnar epithelium cells--line glandular openings

5. Pseudostratified cells--provide lining during rapid proliferation

C. Cervix

1. Connective tissue--supports the cervix
2. Ciliated cells--beat in waves toward vagina; help move sperm
3. Secretory cells--secrete mucus

D. Vagina

1. Stratified squamous epithelium cells--protective cells in lining

E. Vestibule

1. Secretory cells--lubricate for copulation
2. Stratified squamous epithelium cells--protective cells

F. Vulva

1. Secretory cells--sweat glands
2. Stratified squamous epithelium cells--protection

V. Using palpation in cow to distinguish between follicle and corpus luteum

A. By rectum

B. Follicle--10-20 mm; feels like bulging blister

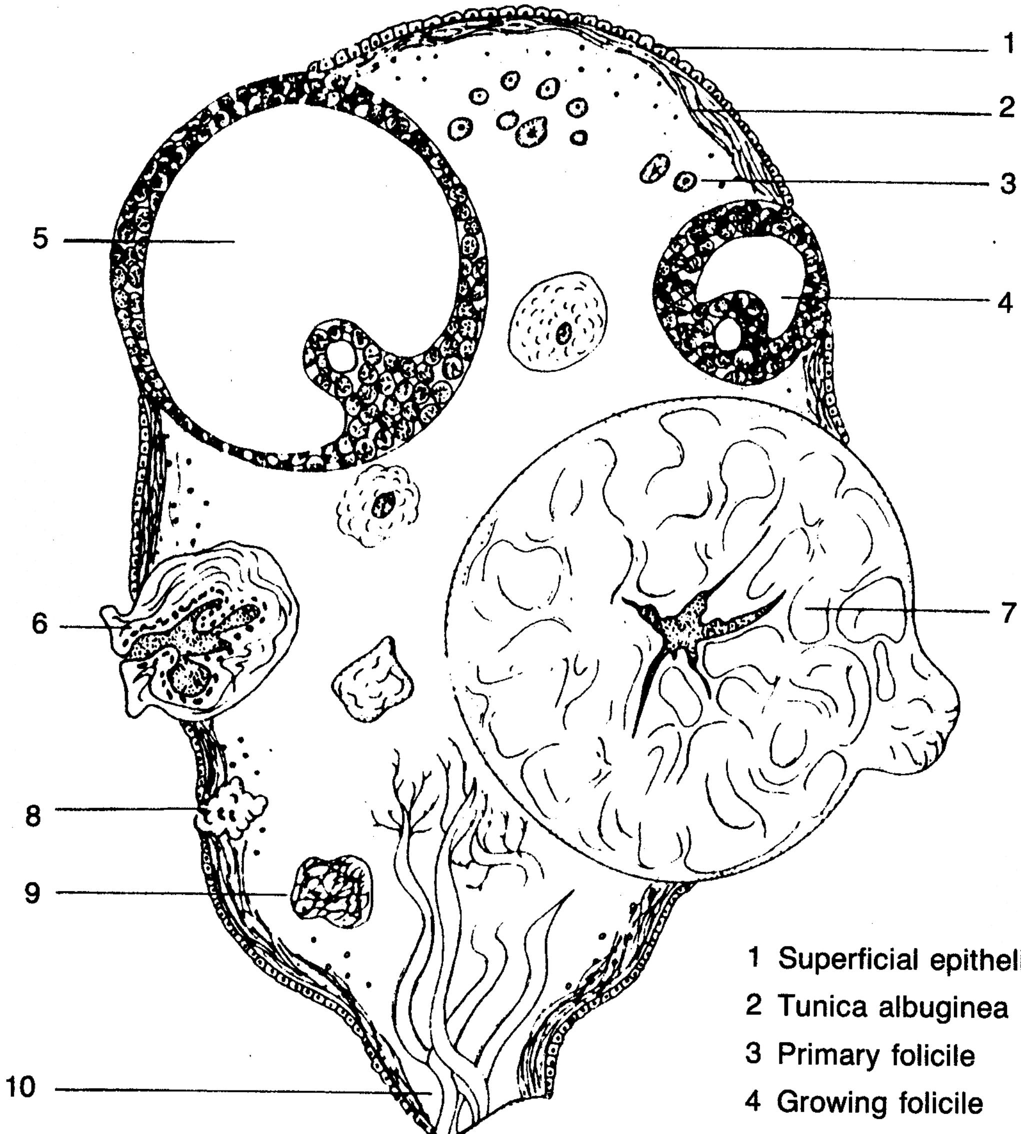
C. Corpus luteum--may (or may not) be larger than follicle; has distinct papillum (teat-like projection) at rupture point

VI. Myometrium

A. Muscles of the uterus

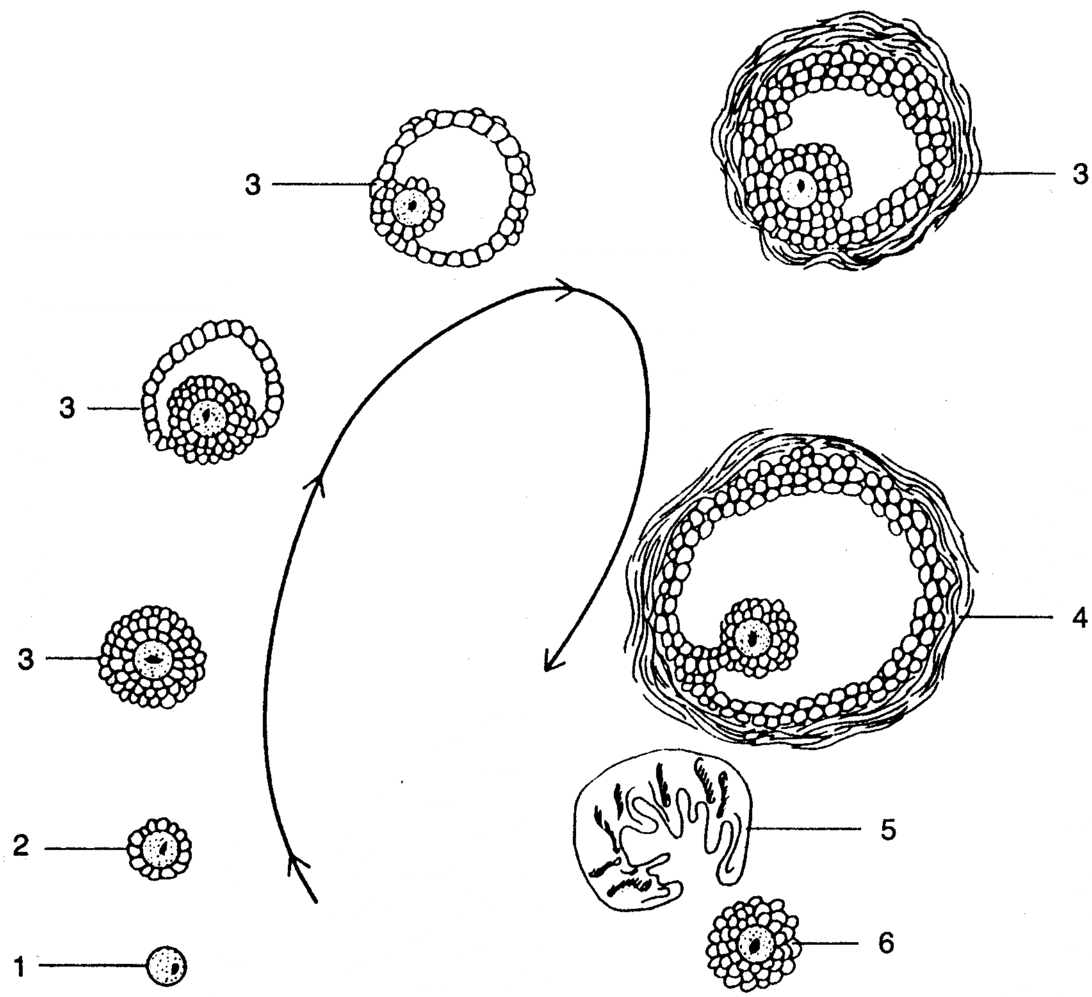
B. Most active under influence of estrogen at time of estrus to move the sperm up the tract

Cow Ovary Structure



1 Superficial epithelium
2 Tunica albuginea
3 Primary folicile
4 Growing folicile
5 Mature folicile
6 Corpus hemorrhagicum
7 Corpus luteum
8 Corpus albicans
9 Atretic follicle
10 Hilus

Follicular Growth



1 Oocyte
2 Primary follicle
3 Growing follicle
4 Mature follicle
5 Corpus hemorrhagicum
6 Ovum cell mass

MICROSCOPIC FEMALE FUNCTIONAL ANATOMY

AG 534 - N

UNIT TEST

Name ______________________________ Score ______________________________

1. Describe in detail a follicle, corpus hemorrhagicum, corpus luteum, corpus albicans, and an atretic follicle.

   a. Follicle ______________________________

   ____

   ____

   ____

   b. Corpus hemorrhagicum ______________________________

   ____

   ____

   ____

   c. Corpus luteum ______________________________

   ____

   ____

   ____

   d. Corpus albicans ______________________________

   ____

   ____

   ____

   e. Atretic follicle ______________________________

   ____

   ____

   ____

2. List and describe the steps in follicular growth.

   a.

   b.

   c.

   d.

   e.

   f.

3. Describe cell division during oogenesis.

4. List the types of cells found in the oviduct, uterus, cervix, vagina, vestibule, and vulva.

Oviduct

a.________________________________

b. ________________________________

c.________________________________

d. ________________________________

Uterus

a.________________________________

b. ________________________________

c.________________________________

d. ________________________________

e.________________________________

Cervix

a.________________________________

b. ________________________________

c.________________________________

Vagina ________________________________

Vestibule

a.________________________________

b. ________________________________

Vulva

a.________________________________

b. ________________________________

5. Indicate where the majority of the oocytes are located at birth.

____

6. Explain how one would distinguish between a follicle and a corpus luteum by palpation in the cow.

____

____

____

7. Indicate when the myometrium is most active.

____

____

MICROSCOPIC FEMALE FUNCTIONAL ANATOMY

AG 534 - N

ANSWERS TO TEST

1. a. Follicle--Tissue in stroma (hollow bag), 3 stages of development: Primary follicle; Secondary follicle; Growing follicle
   b. Corpus hemorrhagicum--Ruptured follicle; walls fold in, bloody appearance
   c. Corpus luteum--Formed when the corpus hemorrhagicum fills with yellow cells derived from the stratum granulosum and the tunica interna
   d. Corpus albicans--Formed when connective tissue cells invade the corpus luteum
   e. Atretic follicle--Follicle that begins development but dies and deteriorates as it progresses. After death, the cytoplasm shrinks, the zona pellucida thickens and fragments, and the follicle deteriorates and is invaded by connective tissue cells of the surrounding stroma

2. a. Primary follicle--ovum surrounded by single layer of nurse cells
   b. Secondary follicle--ovum surrounded by several layers of nurse cells
   c. Growing follicle--nurse cells begin to separate; will respond to hormones causing follicular growth; Characterized by presence of antrum--fluid-filled cavity
   d. Stratum granulosum--cells lining the follicle; become stratified in 5-10 layers of cells
   e. Primary oocyte: Zona pellucida--forms around primary oocyte; Corona radiata--formed as granulosa cells elongate adjacent to the zona; Tunica interna--spindle-shaped epithelioid cell layer formed from stroma cells around the granulosa cells; Tunica interna and granulosa cells work together to produce estrogen; Tunica externa--stroma cells and connective tissue cells form this layer for support around follicle
   f. Mature follicle: Looks like blister on ovary; Cumulus oophorus--granulosa cells surrounding the ovum

3. Primary oocyte (2N)--produces 2 daughter cells: Secondary oocyte (1N)--receives majority of cytoplasm; First polar body (1N)--basically just a nucleus

   Secondary oocyte (1N)--divides to form: Ootid (1N)--fertilized ovum; Second polar body

4. <u>Oviduct</u>--Connective, muscle, ciliated, secretory

   <u>Uterus</u>--Connective, muscle, secretory, columnar epithelium, pseudostratified

   <u>Cervix</u>--Ciliated, secretory, connective

   <u>Vagina</u>--Stratified squamous epithelium cells

   <u>Vestibule</u>--Secretory, stratified squamous epithelium

   <u>Vulva</u>--Secretory, stratified squamous epithelium

5. The majority of the oocytes are located under the tunica albuginea at the time of birth

6. By rectum; Follicle--10-20 mm; feels like bulging blister; Corpus luteum--may (or may not) be larger than follicle; has distinct papillum (teat-like projection) at rupture point

7. Most active under influence of estrogen at time of estrus to move the sperm up the tract

HORMONES AND PUBERTY IN THE FEMALE

AG 534 - O

UNIT OBJECTIVE

After completion of this unit, students should be able to identify the hormones with their target organs and list the hormones related to female reproduction that originate in the hypothalamus, hypophysis and the gonads. Students should also be able to describe the four factors related to puberty and their effects and explain the advantage of shortening the prepubertal interval. This knowledge will be demonstrated by completion of a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. List the hormones originating in the hypothalamus, hypophysis and the gonads that are related to female reproduction.
2. Identify the target organs of the various hormones related to female reproduction.
3. Identify the action of each of the various hormones related to female reproduction.
4. Describe the four factors related to puberty and their effects.
5. List the ages and ranges for the onset of puberty in the various species.
6. Explain why one would want to shorten the prepubertal interval.

HORMONES AND PUBERTY IN THE FEMALE

AG 534 - O

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

A. Make transparencies and necessary copies of materials.

B. Provide students with objectives and discuss.

C. Provide students with information and discuss.

D. Review and give test.

E. Reteach and retest if necessary.

II. Instructional materials

A. Objective sheet

B. Suggested activities

C. Information sheet

D. Test

E. Answers to test

III. Unit references

A. Barrick, R., and Harmon, H., *Animal Production and Management*, McGraw-Hill Book Company, New York, 1988.

B. Bearden and FuQuay, *Applied Animal Production*, Prentice-Hall, Englewood Cliffs, New Jersey, 1980.

C. Bundy, C.E., et al., *Livestock and Poultry Production*, 5th edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1982.

D. Ensminger, M.E., *Animal Science*, Interstate Publishers, Danville, Illinois, 1983.

E. *Idaho State Board for Vocational Education Curriculum Guide in Livestock Production*, University of Idaho and the Idaho State Board for Vocational Education.

F. Lasley, John F., *Genetics of Livestock Improvement*, 3rd edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1978.

G. Sorensen, A.M. , *Animal Reproduction Principles and Practices*, McGraw-Hill Book Company, New York, 1979.

HORMONES AND PUBERTY IN THE FEMALE

AG 534 - O

INFORMATION SHEET

I. Female reproduction hormones--origin, action and target organ

  A. Hypothalamus

    1. Gonadotropic releasing hormone (GNRH)

      a. Action--stimulates release of follicle stimulating hormone (FSH) and luteinizing hormone (LH)

      b. Target organ--adenohypophysis

    2. Prolactin inhibitory hormone (PIH)

      a. Action--inhibits release of prolactin

      b. Target organ--adenohypophysis

    3. Oxytocin

      a. Action--milk letdown

      b. Target organ--myometrium

  B. Hypophysis

    1. Follicle stimulating hormone (FSH)

      a. Action--stimulates growth of follicle to maturity

      b. Target organ--ovary

    2. Luteinizing hormone (LH)

      a. Action--ovulation and corpus luteum formation

      b. Target organ--ovary

    3. Prolactin (PRL)

      a. Action--stimulates corpus luteum development and maintenance

      b. Target organ--ovary

C. Gonads

1. Estrogen--excitatory hormones

    a. Sex organs--growth and development

    b. Mammary--duct growth

    c. Endometrium--vascular growth

    d. Myometrium--activity

    e. Body tissues--growth

    f. Brain--libido

    g. Endocrine glands--interaction

2. Progesterone

    a. Sex organs--growth and development

    b. Mammary--alveolar development

    c. Endometrium--glandular growth

    d. Endocrine glands--interaction

II. Factors related to puberty

A. Hormones (hypothalamus and pituitary)--stimulate ovaries to produce ovum; accompanied by libido

B. Genetic factors

1. Inbreeding--delays puberty

2. Crossbreeding--shortens puberty

3. Animal breed determines when reach puberty

C. Nutritional factors

1. Underfeeding--delays puberty

2. Overfeeding--shortens time to puberty

D. Environmental factors

1. Stress conditions delay puberty (temperature, humidity, etc.)

2. Season of birth--spring lambs may reach puberty in winter; summer and fall lambs probably won't reach puberty until following year

3. Presence of male hastens puberty

4. Close confinement of swine seems to hasten puberty (compared to open lot)

III. Onset of puberty

A. Heifer

1. Average age: 11 months

2. Range: 7-18 months

B. Ewe

1. Average age: 7 months

2. Range: 6-9 months

C. Gilt

1. Average age: 7 months

2. Range: 5-8 months

D. Filly

1. Average age: 14 months

2. Range: 10-24 months

IV. Shortening the prepubertal interval

A. The earlier puberty can begin, the more offspring the animal can produce in her lifetime

B. Cows that calve early the first time exposed tend to continue to breed early in later years

HORMONES AND PUBERTY IN THE FEMALE

AG 534 - O

UNIT TEST

Name ______________________________ Score ______________________________

1. Complete the following chart by listing the hormones related to female reproduction that originate in the hypothalamus, hypophysis and gonads. Then identify the action and target organ of each.

Hypothalamus

a. Hormone ______________________________

Action ______________________________

____

Target organ ______________________________

b. Hormone ______________________________

Action ______________________________

____

Target organ ______________________________

c. Hormone ______________________________

Action ______________________________

____

Target organ ______________________________

Hypophysis

a. Hormone ______________________________

Action ______________________________

____

Target organ ______________________________

b. Hormone ______________________________

Action ______________________________

____

Target organ ______________________________

c. Hormone ______________________________

Action ______________________________

____

Target organ ______________________________

Gonads

a. Hormone ______________________________

Action and target organ

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

b. Hormone ______________________________

Action and target organ

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

2. Describe the four factors related to puberty and their effects.

a. ______________________________

____

b. ____

____

c.____

____

d. ____

____

3. List the ages and ranges for the onset of puberty in the various species.

   a. Heifer______________________________________

   b. Ewe ______________________________________

   c. Gilt______________________________________

   d. Filly ______________________________________

4. Explain why one would want to shorten the prepubertal interval.

____

____

____

____

HORMONES AND PUBERTY IN THE FEMALE

AG 534 - O

ANSWERS TO TEST

1. Hypothalamus

   a. Gonadotropic releasing hormone (GNRH)
      Action--stimulates release of follicle stimulating hormone (FSH) and luteinizing hormone (LH)
      Target organ--adenohypophysis
   b. Prolactin inhibitory hormone (PIH)
      Action--inhibits release of prolactin
      Target organ--adenohypophysis
   c. Oxytocin
      Action--milk letdown
      Target organ--myometrium

   Hypophysis

   a. Follicle stimulating hormone (FSH)
      Action--stimulates growth of follicle to maturity
      Target organ--ovary
   b. Luteinizing hormone (LH)
      Action--Ovulation and corpus luteum formation
      Target organ--ovary
   c. Prolactin (PRL)
      Action--stimulates corpus luteum development and maintenance
      Target organ--ovary

   Gonads

   a. Estrogen--excitatory hormones
      a. Sex organs--growth and development
      b. Mammary--duct growth
      c. Endometrium--vascular growth
      d. Myometrium--activity
      e. Body tissues--growth
      f. Brain--libido
      g. Endocrine glands--interactions

   b. Progesterone
      a. Sex organs--growth and development
      b. Mammary--alveolar development
      c. Endometrium--glandular growth
      d. Endocrine glands--interaction

2. a. Hormones (hypothalamus and pituitary)--stimulate ovaries to produce ovum; accompanied by libido
   b. Genetic factors: Inbreeding--delays puberty; Crossbreeding--shortens puberty; Animal breed determines when reach puberty

c. Nutritional factors: Underfeeding--delays puberty; Overfeeding--shortens time to puberty

d. Environmental factors: Stress conditions delay puberty; Season of birth--spring lambs may reach puberty in winter; summer and fall lambs probably won't reach puberty until following year; Presence of male hastens puberty; Close confinement of swine seems to hasten puberty (compared to open lot)

3.

Animal	Average Age	Range
Heifer	11	7-18 months
Ewe	7	6-9 months
Gilt	7	5-8 months
Filly	14	10-24 months

4. The earlier puberty can begin, the more offspring the animal can produce in her lifetime; Cows that calve early the first time exposed tend to continue to breed early in later years

ESTRUS AND THE ESTROUS CYCLE

AG 534 - P

UNIT OBJECTIVE

After completion of this unit, students should be able to describe estrus symptoms and indicate the length of the estrous cycle for each species. Students should also be able to describe the activity of the oviduct at the time of ovulation and explain the menstrual cycle. This knowledge will be demonstrated by completion of a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Describe the following terms: proestrus, estrus, metestrus, diestrus, and anestrus.
2. Describe in detail the symptoms of estrus in the cow.
3. Describe in detail the symptoms of estrus in the ewe.
4. Describe in detail the symptoms of estrus in the sow.
5. Describe in detail the symptoms of estrus in the mare.
6. Describe the growth of ovarian structures through an estrous cycle.
7. Indicate the length of the estrous cycle for the cow, sow, ewe and mare.
8. Describe the activity of the oviduct at the time of ovulation.
9. Explain the menstrual cycle and how the cyclic pattern of women differs from that of domestic animals.

ESTRUS AND THE ESTROUS CYCLE

AG 534 - P

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

   A. Make transparencies and necessary copies of materials.

   B. Provide students with objectives and discuss.

   C. Provide students with information and discuss.

   D. Review and give test.

   E. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM 1--Estrus in the Cow

      2. TM 2--Estrus in the Ewe

      3. TM 3--Estrus in the Sow

      4. TM 4--Estrus in the Mare

   E. Test

   F. Answers to test

III. Unit references

   A. Barrick, R., and Harmon, H., *Animal Production and Management*, McGraw-Hill Book Company, New York, 1988.

   B. Bearden and FuQuay, *Applied Animal Production*, Prentice-Hall, Englewood Cliffs, New Jersey, 1980.

   C. Bundy, C.E., et al., *Livestock and Poultry Production*, 5th edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1982.

   D. Ensminger, M.E., *Animal Science*, Interstate Publishers, Danville, Illinois, 1983.

E. *Idaho State Board for Vocational Education Curriculum Guide in Livestock Production*, University of Idaho and the Idaho State Board for Vocational Education.

F. Lasley, John F., *Genetics of Livestock Improvement*, 3rd edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1978.

G. Sorensen, A.M., *Animal Reproduction Principles and Practices*, McGraw-Hill Book Company, New York, 1979.

ESTRUS AND THE ESTROUS CYCLE

AG 534 - P

INFORMATION SHEET

I. Terms

A. Proestrus (before desire)

1. Period of preparation for mating
2. Entire system in stage of development and excitement
3. Estrogen--rising; responsible for changes

B. Estrus (desire)

1. Animal very excited
2. Only time female will accept the male
3. Estrogen very high
4. Ovulation occurs in most species (except the cow)

   (Note: Ovulation of a cow occurs 8-10 hours after standing heat.)

C. Metestrus (after desire)

1. Estrogen low
2. Progesterone low
3. Animal recovering from excitement of breeding; preparing for pregnancy

D. Diestrus (between desire)

1. Progesterone is high
2. Animal between periods of sexual excitement

E. Anestrus (without desire)

1. Animal that does not show libido for extended period of time (e.g. seasonally polyestrous animals)
2. Short term situation (e.g. period of expected estrus when ovulation occurs without any outward signs)

II. Estrus in the cow (Transparency 1)

A. Polyestrous--cycles continuously

1. Estrus--16 hours
2. Cycle--21 days

B. Symptoms

1. Stand to be mounted (cows homosexual in activity)
2. Attempt to mount other cows
3. Mucus smeared on buttocks
4. Nervous acting
5. Seek bull; stay nearby
6. Rubbed tailhead or mud on hips (has been mounted)
7. Chin resting on cow's rump by other cows, tail raising, licking the vulva, excessive urination

III. Estrus in the ewe (Transparency 2)

A. Seasonally polyestrous--cycles normally from mid-fall to early spring

1. Estrus - 30 hours
2. Cycle - 17 days

B. Symptoms

1. Stand to be mounted
2. Search out ram
3. Swollen vulva
4. Nervous acting; walks fence bleating for ram
5. Moves dock or tail back and forth rapidly in presence of ram

IV. Estrus in the sow (Transparency 3)

A. Polyestrous

1. Estrus - 44 hours
2. Cycle - 21 days

B. Symptoms

1. Stand to be mounted

2. Nervous acting

3. Sometimes attempt to mount other females

4. Small amount of mucus on vulva

5. Swollen vulva

V. Estrus in the mare (Transparency 4)

A. Seasonally polyestrous (although some cycle continuously)--better breeding season from March-July

1. Estrus - 6 days

2. Cycle - 21 days

B. Symptoms

1. Stand to be mounted

2. Nervous acting

3. Show interest in stallion

a. Won't let him approach - kicks

b. Frequent urination

3. More nervous acting; urination followed by winking motion of vulva (lips open and close)

5. Becomes quieter around stallion, raises her tail, urinates, winks vulva

VI. Growth of ovarian structures through estrous cycle

A. Follicle

1. Follicle growth to maturity

a. Under influence of FSH

b. Most rapid in late proestrus and estrus

2. Ruptures--releases ovum

B. Corpus hemorrhagicum (CH)

1. Develops in cavity of ruptured follicle

2. Lasts about 2 days

C. Corpus luteum (CL)

1. Develops gradually from follicle lining cells

2. Mature size--8-10 days after start of estrus

3. 12 day life

4. Progesterone produced in proportion to size of CL

D. Corpus albicans (CA)

1. Gradually acquired structure (slow demise of CL)

2. Gradually changes size as cells dissolve and are reabsorbed into ovary

VII. Oviduct activity during ovulation

A. Ciliated cells beat in rhythmic manner to sweep ovum into oviduct for fertilization

B. Secreted fluids also aid in movement

VIII. Menstrual cycle

A. Menstruation--period when uterine lining is sloughed and the cellular debris and blood are passed to exterior

1. Cycle - 28 days

2. Ovulation - day 13

B. Menstrual flow (3-5 days)

1. Flow ceases when endometrium lining repairs itself

2. Proliferative phase--repair and growth under influence of estrogen after menstrual flow

C. Secretory phase--Progesterone and estrogen continue growth after ovulation and CL formation

D. Differences in cyclic patterns of women and domestic animals

1. No period of estrus in women

2. Period of menstruation in women

ESTRUS IN THE COW

Polyestrous--cycles continuously

Estrus--16 hours

Cycle--21 days

Symptoms

Stand to be mounted (cows homosexual in activity)

Attempt to mount other cows

Mucus smeared on buttocks

Nervous acting

Seek bull; stay nearby

Rubbed tailhead or mud on hips (has been mounted)

Chin resting on cow's rump by other cows, tail raising, licking the vulva, excessive urination

ESTRUS IN THE EWE

Seasonally polyestrous--cycles normally from mid-fall to early spring

Estrus - 30 hours

Cycle - 17 days

Symptoms

Stand to be mounted

Search out ram

Swollen vulva

Nervous acting; walks fence bleating for ram

Moves dock or tail back and forth rapidly in presence of ram

ESTRUS IN THE SOW

Polyestrous

Estrus - 44 hours

Cycle - 21 days

Symptoms

Stand to be mounted

Nervous acting

Sometimes attempt to mount other females

Small amount of mucus on vulva

Swollen vulva

ESTRUS IN THE MARE

Seasonally polyestrous (although some cycle continuously)--better breeding season from March-July

Estrus - 6 days

Cycle - 21 days

Symptoms

Stand to be mounted

Nervous acting

Show interest in stallion

Won't let him approach - kicks

Frequent urination

More nervous acting; urination followed by winking motion of vulva (lips open and close)

Becomes quieter around stallion, raises her tail, urinates, winks vulva

ESTRUS AND THE ESTROUS CYCLE

AG 534 - P

UNIT TEST

Name ______________________________________ Score ___________________________________

1. Describe the following terms: proestrus, estrus, metestrus, diestrus, and anestrus.

   a. Proestrus ____

   b. Estrus ____

   c. Metestrus ____

   d. Diestrus ____

   e. Anestrus ____

2. Describe in detail the symptoms of estrus in the cow.

   a.________________________________

   b. ________________________________

   c.________________________________

   d. ________________________________

   e.________________________________

   f.________________________________

   g. ________________________________

3. Describe in detail the symptoms of estrus in the ewe.

   a.________________________________

   b. ________________________________

   c.________________________________

   d. ________________________________

   e.________________________________

4. Describe in detail the symptoms of estrus in the sow.

   a.________________________________

   b. ________________________________

   c.________________________________

   d. ________________________________

   e.________________________________

5. Describe in detail the symptoms of estrus in the mare.

   a.________________________________

   b. ________________________________

   c.________________________________

   d. ________________________________

   e.________________________________

6. Describe the growth of ovarian structures through an estrous cycle.

   a. ____________________

   ____

   ____

   b. ____________________

   ____

   ____

   c. ____________________

   ____

   ____

   d. ____________________

   ____

   ____

7. Indicate the length of the estrous cycle for the cow, ewe, sow and mare.

   a. Cow ____________________

   b. Ewe ____________________

   c. Sow ____________________

   d. Mare ____________________

8. Describe the activity of the oviduct at the time of ovulation.

   ____

   ____

   ____

9. Explain the menstrual cycle and how the cyclic pattern of women differs from that of domestic animals.

   ____

   ____

   ____

   ____

ESTRUS AND THE ESTROUS CYCLE

AG 534 - P

ANSWERS TO TEST

1. a. Proestrus (before desire): Period of preparation for mating; Entire system in stage of development and excitement; Estrogen--rising; responsible for changes
   b. Estrus (desire): Animal very excited; Only time female will accept the male; Estrogen very high; Ovulation occurs in most species (except the cow)
   c. Metestrus (after desire): Estrogen low; Progesterone low; Animal recovering from excitement of breeding; preparing for pregnancy
   d. Diestrus (between desire): Progesterone is high; Animal between periods of sexual excitement
   e. Anestrus (without desire): Animal that does not show libido for extended period of time; Short term situation

2. Cow: Stand to be mounted (cows homosexual in activity); Attempt to mount other cows; Mucus smeared on buttocks; Nervous acting; Seek bull, stay nearby; Rubbed tailhead or mud on hips (has been mounted); Chin resting on cow's rump by other cows, tail raising, licking the vulva, excessive urination

3. Ewe: Stand to be mounted; Search out ram; Swollen vulva; Nervous acting, walks fence bleating for ram; Moves dock or tail back and forth rapidly in presence of ram

4. Sow: Stand to be mounted; Nervous acting; Sometimes attempt to mount other females; Small amount of mucus on vulva; Swollen vulva

5. Mare: Stand to be mounted; Nervous acting; Show interest in stallion; Won't let him approach - kicks; Frequent urination; More nervous acting; urination followed by winking motion of vulva (lips open and close); Becomes quieter around stallion, raises her tail, urinates, winks vulva

6. a. Follicle
      1. Follicle growth to maturity; Under influence of FSH; Most rapid in late proestrus and estrus
      2. Ruptures--releases ovum

   b. Corpus hemorrhagicum (CH)
      1. Develops in cavity of ruptured follicle
      2. Lasts about 2 days

   c. Corpus luteum (CL)
      1. Develops gradually from follicle lining cells
      2. Mature size--8-10 days after start of estrus
      3. 12 day life
      4. Progesterone produced in proportion to size of CL

   d. Corpus albicans (CA)
      1. Gradually acquired structure (slow demise of CL)
      2. Gradually changes size as cells dissolve and are reabsorbed into ovary

7. a. Cow--21 days
   b. Ewe--17 days
   c. Sow--21 days
   d. Mare--21 days

8. Ciliated cells beat in rhythmic manner to sweep ovum into oviduct for fertilization; Secreted fluids also aid in movement

9. Answer should include the following information:

   a. Menstruation--period when uterine lining is sloughed and the cellular debris and blood are passed to exterior; Cycle - 28 days; Ovulation - day 13
   b. Menstrual flow (3-5 days); Flow ceases when endometrium lining repairs itself; Proliferative phase--repair and growth under influence of estrogen after menstrual flow
   c. Secretory phase--Progesterone and estrogen continue growth after ovulation and CL formation
   d. Differences in cyclic patterns of women and domestic animals: No period of estrus in woman; Period of menstruation in women

OVULATION CONTROL

AG 534 - Q

UNIT OBJECTIVE

After completion of this unit, students should be able to list advantages and disadvantages of synchronized ovulation, list the compounds used for ovulation control and explain why two injections of prostaglandins are needed to control ovulation. Students should also be able to describe a general plan for breeding sheep in anestrus and outline a method of increasing litter size. This knowledge will be demonstrated by completion of a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. List six advantages and four disadvantages of synchronized ovulation.
2. List the various compounds used for ovulation control and the class (or classes) of livestock they are used for.
3. Distinguish between the action of progesterone, progestogens, and prostaglandins for ovulation control.
4. Explain why it is necessary to have a functional CL before using prostaglandins.
5. Explain why two injections of prostaglandins are needed to control ovulation.
6. Explain why intramuscular injection requires a higher dosage than intrauterine injection.
7. Explain the difference between prostaglandin and prostaglandin analogue.
8. List the detrimental side effects that are present in swine when synchronized with progestogens.
9. Outline a general plan for breeding sheep in anestrus.
10. Outline a method for increasing the number of pigs per litter.
11. List the four programs used to superovulate mares.
12. State the hormone sequence that is used to superovulate a cow.
13. Explain why one would want to breed calves before they normally reach puberty.

OVULATION CONTROL

AG 534 - Q

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

A. Make transparencies and necessary copies of materials.

B. Provide students with objectives and discuss.

C. Provide students with information and discuss.

D. Review and give test.

E. Reteach and retest if necessary.

II. Instructional materials

A. Objective sheet

B. Suggested activities

C. Information sheet

D. Transparency masters

1. TM 1--Advantages of Synchronized Ovulation

2. TM 2--Disadvantages of Synchronized Ovulation

3. TM 3--Advantages of Breeding Calves Before Normal Puberty

E. Test

F. Answers to test

III. Unit references

A. Barrick, R., and Harmon, H., *Animal Production and Management*, McGraw-Hill Book Company, New York, 1988.

B. Bearden and FuQuay, *Applied Animal Production*, Prentice-Hall, Englewood Cliffs, New Jersey, 1980.

C. Bundy, C.E., et al., *Livestock and Poultry Production*, 5th edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1982.

D. Ensminger, M.E., *Animal Science*, Interstate Publishers, Danville, Illinois, 1983.

E. *Idaho State Board for Vocational Education Curriculum Guide in Livestock Production*, University of Idaho and the Idaho State Board for Vocational Education.

F. Lasley, John F., *Genetics of Livestock Improvement*, 3rd edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1978.

G. Sorensen, A.M., *Animal Reproduction Principles and Practices*, McGraw-Hill Book Company, New York, 1979.

OVULATION CONTROL

AG 534 - Q

INFORMATION SHEET

I. Advantages of synchronized ovulation (Transparency 1)

   A. Can synchronize large group to ovulate at same time

   B. Shorten calving season

   C. Reduce labor required for AI breeding

   D. Reduces overall management problems with AI

   E. Market uniform calf crop (same age)

   F. Improves management practices (cattle grouped-closer observation, better feeding practices, etc.)

II. Disadvantages of synchronized ovulation (Transparency 2)

   A. Low conception rates

   B. Cost

   C. Concentrated labor required during breeding and calving season

   D. Cows all calving at once (especially bad if have many calving problems)

III. Compounds used in ovulation control

   A. Progesterone

      1. Neutralizes the corpus luteum and its natural production of progesterone to rearrange cycle

      2. Used in cattle

   B. Prostaglandins

      1. Ceases function of the corpus luteum

      2. Must have functional corpus luteum

         a. No effect on developing CL before 5 days of age

         b. No effect on waning CL after about 16 days of age

3. Two injections given 10-12 days apart

   a. First injection--eliminates any CL that are present; new estrous cycle formed

   b. Second injection--catches those with ovaries in cycle between 5 days proestrus and 5 days postestrus when first shot was given

4. Intramuscular injection requires higher dosage than intrauterine injection because of the short half-life of the substance

   a. Metabolizes quickly once in circulation

   b. Half-life about 2-3 minutes; approximately 90% deactivated in single passage through body

5. Prostaglandin analogue

   a. Very similar to prostaglandin compounds

   b. Can separate the effects of the prostaglandins (e.g. analogues produce less sweating in mares than prostaglandins)

6. Used in cows, ewes, sows and mares

C. Progestogens

1. Destroy existing corpus luteum producing progesterone

2. Detrimental side effects in swine

   a. Development of cystic follicles

   b. Lowered fertility

3. Used in ewes

IV. Breeding sheep in anestrus

A. Progestogen for 12 days

B. Followed by 500 IU PMSG

C. Ewes showing signs of estrus should be bred

D. Ewes not showing signs of estrus - second injection of 500 IU PMSG 16 days later, then bred

V. Super ovulation

A. Increasing number of pigs per litter - inject cycling sows with 1200 to 2000 IU PMSG intramuscularly on day 5 or 6 of the estrous cycle

B. Mare - 4 programs

1. Equine pituitary extract
2. HCG
3. Prostaglandin analogue
4. Methallibure - 20 days; then HCG fed 10 days after withdrawal

C. Cow--injection of PMSG followed by a prostaglandin or analogue

VI. Advantages of breeding calves before normal puberty (Transparency 3)

A. Shorten generation interval

B. Enhance genetic selection

C. Opportunity to produce more offspring in lifetime

D. Cows that calve earlier tend to continue to breed early in later years

ADVANTAGES OF SYNCHRONIZED OVULATION

*** Can synchronize large group to ovulate at same time**

*** Shorten calving season**

*** Reduce labor required for AI breeding**

*** Reduces overall management problems with AI**

*** Market uniform calf crop**

*** Improves management practices**

DISADVANTAGES OF SYNCHRONIZED OVULATION

*** Low conception rates**

*** Cost**

*** Concentrated labor required during breeding and calving season**

***Cows all calving at once**

ADVANTAGES OF BREEDING CALVES BEFORE NORMAL PUBERTY

* Shorten generation interval

* Enhance genetic selection

* Opportunity to produce more offspring in lifetime

* Cows that calve earlier tend to continue to breed early in later years

OVULATION CONTROL

AG 534 - Q

UNIT TEST

Name ______________________________ Score ______________________________

1. List six advantages and four disadvantages of synchronized ovulation.

Advantages

a.______________________________

b. ______________________________

c.______________________________

d. ______________________________

e.______________________________

f.______________________________

Disadvantages

a.______________________________

b. ______________________________

c.______________________________

d. ______________________________

2. List the various compounds used for ovulation control and the class (or classes) of livestock they are used for.

a.______________________________

____

b. ______________________________

____

c.______________________________

____

3. Distinguish between the action of progesterone, progestogens, and prostaglandins for ovulation control.

   a. Progesterone: ______________________________

   ____

   b. Prostaglandins: ______________________________

   ____

   c. Progestogens: ______________________________

   ____

4. Explain why it is necessary to have a functional CL before using prostaglandins.

   ____

   ____

   ____

5. Explain why two injections of prostaglandins are needed to control ovulation.

   ____

   ____

   ____

6. Explain why intramuscular injection requires a higher dosage than intrauterine injection.

   ____

   ____

   ____

7. Explain the difference between prostaglandin and prostaglandin analogue.

   ____

   ____

   ____

8. List the detrimental side effects that are present in swine when synchronized with progestogens.

   a. ______________________________

   b. ______________________________

9. Outline a general plan for breeding sheep in anestrus.

a.____

b. ____

c.____

d. ____

10. Outline a method for increasing the number of pigs per litter.

11. List the four programs used to superovulate mares.

a.____

b. ____

c.____

d. ____

12. State the hormone sequence that is used to superovulate a cow.

13. Explain why one would want to breed calves before they normally reach puberty.

OVULATION CONTROL

AG 534 - Q

ANSWERS TO TEST

1. Advantages: Can synchronize large group to ovulate at same time; Shorten calving season; Reduce labor required for AI breeding; Reduces overall management problems with AI; Market uniform calf crop (same age); Improves management practices (cattle grouped-closer observation, better feeding practices, etc.)

   Disadvantages: Low conception rates; Cost; Concentrated labor required during breeding and calving season; Cows all calving at once (especially bad if have many calving problems)

2. a. Progesterone: cattle
   b. Prostaglandins: cows, ewes, sows and mares
   c. Progestogens: ewes

3. a. Progesterone: Neutralizes the corpus luteum and its natural production of progesterone to rearrange cycle
   b. Prostaglandins: Ceases function of the corpus luteum
   c. Progestogens: Destroy existing corpus luteum producing progesterone

4. No effect on developing CL before 5 days of age; No effect on waning CL after about 16 days of age

5. a. First injection--eliminates any CL that are present; new estrous cycle formed
   b. Second injection--catches those with ovaries in cycle between 5 days proestrus and 5 days postestrus when first shot was given

6. Intramuscular injection requires higher dosage than intrauterine injection because of the short half-life of the substance; Metabolizes quickly once in circulation; Half-life about 2-3 minutes; approximately 90% deactivated in single passage through body

7. Prostaglandin analogue is very similar to prostaglandin compounds, however, it can separate the effects of the prostaglandins (e.g. analogues produce less sweating in mares than prostaglandins)

8. Development of cystic follicles; Lowered fertility

9. Progestogen for 12 days; Followed by 500 IU PMSG; Ewes showing signs of estrus should be bred; Ewes not showing signs of estrus - second injection of 500 IU PMSG 16 days later, then bred

10. Inject cycling sows with 1200 to 2000 IU PMSG intramuscularly on day 5 or 6 of the estrous cycle

11. Equine pituitary extract; HCG; Prostaglandin analogue; Methallibure - 20 days; then HCG fed 10 days after withdrawal

12. Injection of PMSG followed by a prostaglandin or analogue

13. Shorten generation interval; Enhance genetic selection; Opportunity to produce more offspring in lifetime; Cows that calve earlier tend to continue to breed early in later years

ARTIFICIAL INSEMINATION

AG 534 - R

UNIT OBJECTIVE

After completion of this unit, students should be able to list advantages and disadvantages of artificial insemination (AI) and describe the differences between artificial insemination techniques. Students should also be able to outline an AI program and its management. This knowledge will be demonstrated by completion of an assignment sheet, laboratory exercises and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. List seven advantages of artificial insemination of the cow.
2. List four disadvantages of artificial insemination of the cow.
3. Describe the signs of estrus in cows.
4. State which sign of estrus is the most important with regard to time of insemination.
5. Describe the three methods of checking for estrus in cattle.
6. List the necessary records needed in an artificial insemination program.
7. Explain the A.M.-P.M. insemination rule.
8. Indicate the optimum time of insemination for cows.
9. Label equipment necessary for artificial insemination.
10. Describe and outline the steps of the rectocervical technique for artificially inseminating a cow.
11. Indicate the best temperature to thaw frozen semen to be used immediately.
12. List five advantages and three disadvantages of artificial insemination of the ewe.
13. Explain why sheep artificial insemination is so poorly accepted in the United States.
14. Discuss five areas of management of a sheep artificial insemination program.
15. Indicate the optimum time of insemination for ewes.
16. Describe and outline the steps of the speculum technique for artificially inseminating a ewe.
17. List five advantages and five disadvantages of artificial insemination of the sow.
18. Discuss three areas of management of a swine artificial insemination program.

19. Indicate the optimum time of insemination for sows.

20. Describe and outline the steps of the vaginocervical method for artificially inseminating a sow.

21. List three advantages and two disadvantages of artificial insemination for mares.

22. Describe two methods of restraint for mares during insemination.

23. Indicate the optimum time of insemination for mares.

24. Describe and outline the steps of the vaginocervical method for artificially inseminating a mare.

25. Identify events from an estrous cycle chart.

26. Inseminate a reproductive tract acquired from a slaughterhouse.

27. Inseminate a cow.

ARTIFICIAL INSEMINATION

AG 534 - R

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

   A. Make transparencies and necessary copies of materials.

   B. Provide students with objectives and discuss.

   C. Provide students with information and discuss.

   D. Provide students with assignment sheet and laboratory exercises.

   E. Demonstrate laboratory exercise procedures.

   F. Review and give test.

   G. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM 1--Time To Breed (Cow)

      2. TM 2--Time of Insemination and Conception Rate (Mare)

      3. TM 3--Time To Breed (Sow)

      4. TM 4--Tools Used in Inseminating

   E. Assignment sheet

      1. AS 1--Identify Events From an Estrous Cycle Chart

   F. Answers to assignment sheet

   G. Laboratory exercises

      1. LE 1--Inseminate a Reproductive Tract Acquired From Slaughterhouse

      2. LE 2--Inseminate a Cow

H. Test

I. Answers to test

III. Unit references

A. Barrick, R., and Harmon, H., *Animal Production and Management*, McGraw-Hill Book Company, New York, 1988.

B. Bearden and FuQuay, *Applied Animal Production*, Prentice-Hall, Englewood Cliffs, New Jersey, 1980.

C. Bundy, C.E., et al., *Livestock and Poultry Production*, 5th edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1982.

D. Ensminger, M.E., *Animal Science*, Interstate Publishers, Danville, Illinois, 1983.

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F. Lasley, John F., *Genetics of Livestock Improvement*, 3rd edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1978.

G. Sorensen, A.M., *Animal Reproduction Principles and Practices*, McGraw-Hill Book Company, New York, 1979.

ARTIFICIAL INSEMINATION

AG 534 - R

INFORMATION SHEET

I. Artificial insemination of the cow

A. Advantages

1. Wider selection and use of outstanding sires

2. Rapid genetic and herd improvement

3. Rapid proof of bull is available

4. Can overcome physical barriers to mating

   Examples: Very large bull with young heifers; injured bull that can't mount cows

5. Danger of a bull is eliminated

6. Disease is reduced

7. New crosses can be tried experimentally without purchasing a new sire

8. Improved herd management due to increased observation

9. Elimination of cost of purchasing and keeping a bull

B. Disadvantages

1. Skilled technician required

2. Closer supervision of female is required

   (Note: Cows need to be supervised two to four times a day to detect heat.)

3. May have increase in inbreeding

4. May be subject to abuses

   Examples: Switching semen; poor, unsanitary practices by incompetent technician

5. Cost of initiating program

C. Signs of estrus (Transparencies 1, 2, 3)

1. Standing to be ridden

2. Riding others

3. Nervousness; restlessness

4. Clear, thin, wet sticky mucus flowing from vulva

5. Minor indications

a. Dirt or mud on flanks or back

b. Hair standing up on tailhead

c. Bellowing

d. Holding up milk

D. Most important indication of estrus--Standing to be ridden

(Note: Regular observation, 2-4 times daily, is necessary for an effective heat detection program.)

E. Checking for estrus

1. Personal observation

2. Marker animals

a. Grease on brisket

b. Collar (with oil or dye)

c. Chin-ball marker (fits on halter; ink reservoir)

d. Heat-mount detector (placed on rump of cows being observed; loaded with ink)

3. Teaser animals

a. Young bull calves

b. Pseudohermaphrodites (males that have testes but appear as females exteriorly)

c. Nymphomaniac (sex-crazed female)

d. Steers treated with testosterone

e. Spayed females injected with estrogen

f. Vasectomized male

F. Management

1. Initiate nutrition program several weeks before start breeding program

2. Decide whether or not to use synchronization

3. Find reliable semen source

4. Hire or train an inseminator

5. Facilities

    a. Adequate for holding, moving and securing the stock

    b. Design holding pen with water and feeding facilities to keep cows found in estrus until bred

6. Keep records of

    a. Breeding history

    b. Ease of calving

    c. Time to rebreed following parturition

    d. Cyclic activity

7. Time of insemination

    a. A.M. - P.M. rule

        (1) Cows detected first in estrus in the morning are bred that same afternoon

        (2) Cows detected first in estrus in the afternoon are bred the following morning

    b. Optimum time is 12-18 hours after beginning of estrus

8. Equipment used in inseminating (Transparency 4)

    a. Nitrogen chest

    b. Thaw box

    c. Inseminating tube

    d. Disposable gloves

    e. Polybulb

    f. Ampule

g. Straw

h. Straw clippers

9. Technique--rectocervical with straws (consists of inserting one arm in the rectum and directing the inseminating tube through the vagina and cervix for semen deposition in the anterior cervix)

   a. Secure cow

   b. Prepare thaw box (wide mouth thermos with thermometer)

   c. Obtain and prepare semen

      (Note: Thawing at 95-98oF for 10-30 seconds is recommended when semen is to be used immediately.)

   d. Dry straw

   e. Insert straw into gun

   f. Snip end of straw

   g. Slip sheath (plastic cover) over gun

   h. Put on plastic sleeve and lubricate with water

   i. Insert arm into rectum - locate cervix with fingers

   j. Clean vulva with towel

   k. Insert inseminating gun (through vagina, into cervix)

   l. Inseminate into anterior cervix

   m. Record information

   n. Clean up and release cow

II. Artificial insemination of the ewe

A. Advantages

1. Intensive use of outstanding sires

2. Rapid genetic improvement

3. Crossbreeding

4. Reduced investment in rams

5. Lowered maintenance costs (no ram to keep)

B. Disadvantages

1. Skilled technician required

2. Inbreeding

3. Cost (especially labor)

C. Poorly accepted in U.S.--larger sheep herds are on rangeland that requires many acres for nutritional needs; it's harder to concentrate stock

D. Management

1. Herd must be concentrated

2. Check for estrus at least twice a day

3. Teaser animals

a. Aproned or vasectomized rams

b. Crayon secured in chest harness (mark ewes in estrus)

4. Synchronizing agent (if desired)

5. Facilities

a. Alley to crowd ewes

b. Crate for insemination

E. Optimum insemination--15 hours after onset of estrus

F. Technique--speculum method (place speculum into vagina and pass catheter through it into the cervix as far as possible before depositing the semen)

1. Secure ewe

2. Prepare semen

3. Lubricate speculum (tube)

4. Insert speculum

5. Locate os cervix

6. Inseminate

7. Clean up

8. Record information

9. Release ewe

III. Artificial insemination of the sow

A. Advantages

1. Extension of superior boars

2. Economical (greater use of boar)

3. Disease control

4. Elimination of injury (use heavy boars on small females)

5. Utilize outside boars

6. Simple, easy to learn process

B. Disadvantages

1. Constant observation for heat detection

2. Skilled technician required

3. Special equipment required

4. Increased labor

5. Semen storage can be a problem

6. Number of inseminations per ejaculate are small

C. Management

1. Observe sows twice a day for signs of estrus

a. Swollen vulva

b. Pressure on rump and loin

2. Separate sows in estrus

3. Chutes usually unnecessary

a. Grunting of boar helps keep quiet

b. Can quiet by massaging clitoris and mammary

D. Optimum insemination--30 hours after onset of estrus

E. Technique--vaginocervical method (insert tube through vagina into cervix where semen is deposited)

1. Isolate sow

2. Obtain semen

3. Assemble inseminating tube and fill with 50 ml semen

4. Inseminate (into body of uterus)

5. Discard disposables

6. Record information

7. Release sow

IV. Artificial insemination of the mare

A. Advantages

1. Widespread use of outstanding sires

2. Danger of stallion eliminated

3. Better disease control

B. Disadvantages

1. Skilled technician required

2. Registration restrictions by purebred associations

C. Management

1. Mares in growing, healthy condition at beginning of breeding season

2. Check twice a day for estrus

3. Facilities

a. Ability to separate mares easily

b. Pass mares through chutes, alleyways and breeding stall before estrus (so they become familiar with the set up)

4. Study breeding restrictions related to registration in the various breed associations

5. Restraining mare

a. Breeding chute

(1) Constructed of heavy lumber

(2) Solid tailgate within 6 inches of vulva (restrict kicking)

(3) Gate on front and one side (release mare)

b. Hobbles (soft cotton rope hobbles best)

(1) 40 ft. rope with 3 ft. loop tied in middle

(2) Pass rope ends through front legs, an end around each rear pastern and then looped around pastern again

(3) Twist end around the rope (between its near pasterns and neck) and tie to neck loop at shoulder

6. Wrap tail

7. Twitching (control nervous mares by twisting upper lip or ear)

D. Optimum insemination--mid to late estrus

E. Technique--vaginocervical (consists of inserting an arm into the vagina and locating the os cervix followed by passing a catheter alongside the arm into the cervix and depositing the semen at that point)

1. Secure mare

2. Wash vulva area

3. Put on plastic sleeve

4. Prepare semen and draw 20-30 ml into syringe

5. Lubricate sleeve

6. Insert arm into vagina (index finger in cervical opening)

7. Insert inseminating tube to replace index finger

8. Deposit semen

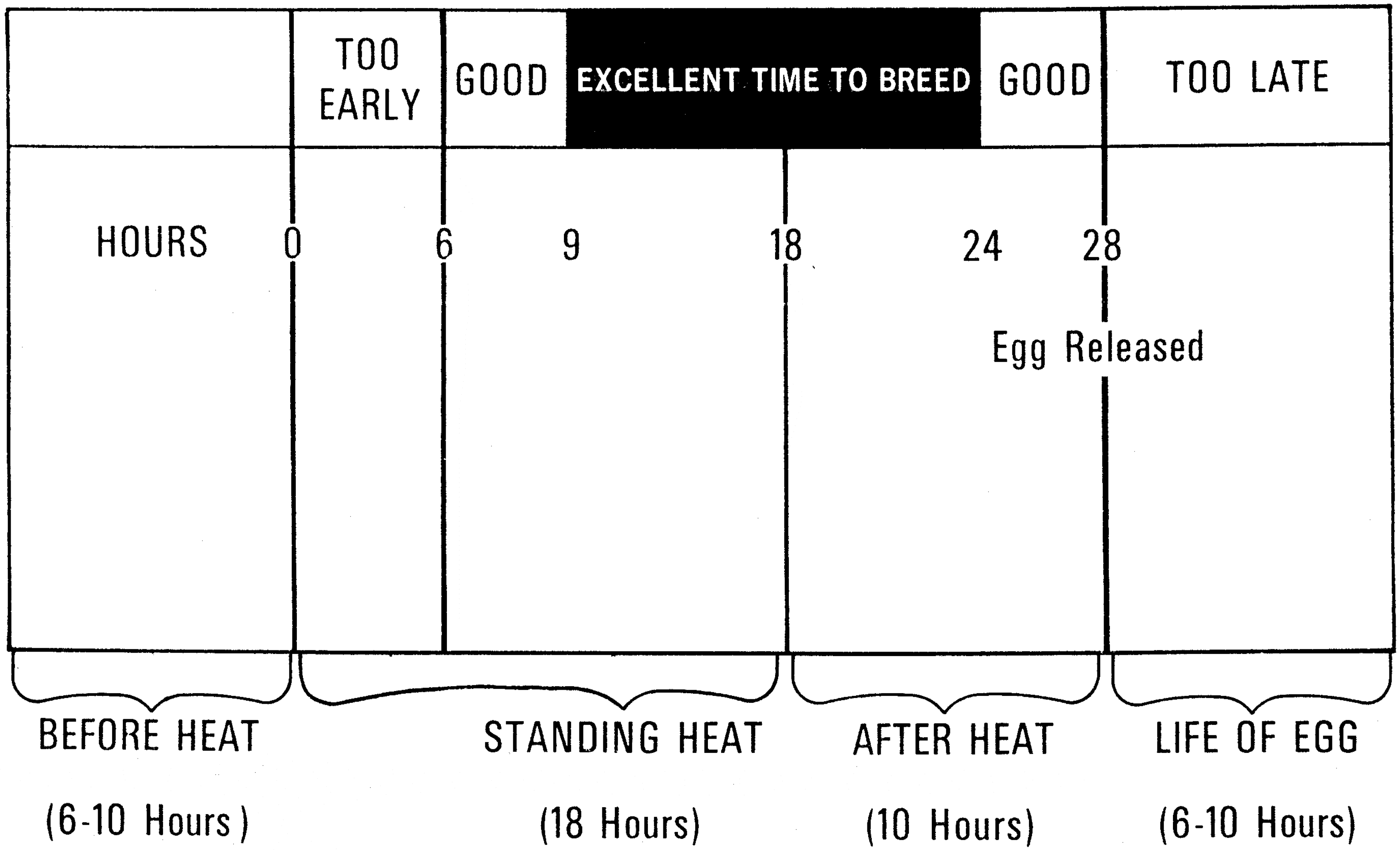
9. Discard disposable equipment

10. Clean up

11. Record information

12. Release mare

Time To Breed (Cow)



Time of Insemination and Conception Rate (Mare)

	Days Before Ovulation						Day Of Ovulation			Days After Ovulation		
	−5	−4	−3	−2	−1		0			1		3
NUMBER OF MARES INSEMINATED	30	20	89	124	164		256			13		1
CONCEPTION RATE %	10	40	52	65	60		60			54		0

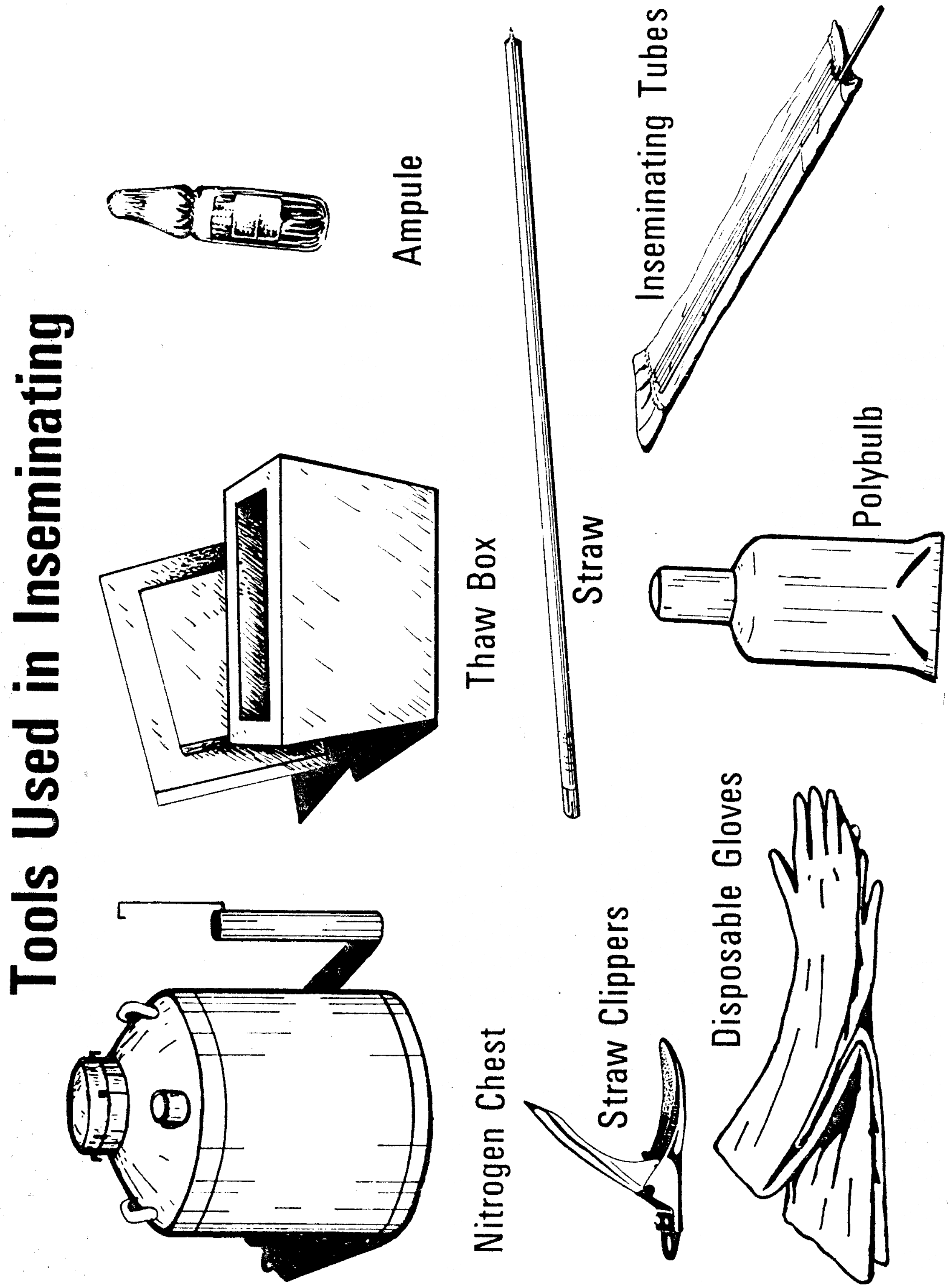
Note: It Appears That The Conception Rate Was The Highest Two Days Before Ovulation, With One Day Before Ovulation And The Day Of Ovulation Being The Same.

Time To Breed (Sow)

	TOO EARLY	GOOD	EXCELLENT TIME TO BREED	TOO LATE
HOURS	10 15	20 25	30 35	40

Egg Released

6-12 Hours BEFORE HEAT	24-36 Hours STANDING HEAT	12 Hours AFTER HEAT


Tools Used in Inseminating
Nitrogen Chest
Thaw Box
Ampule
Straw
Inseminating Tubes
Straw Clippers
Disposable Gloves
Polybulb

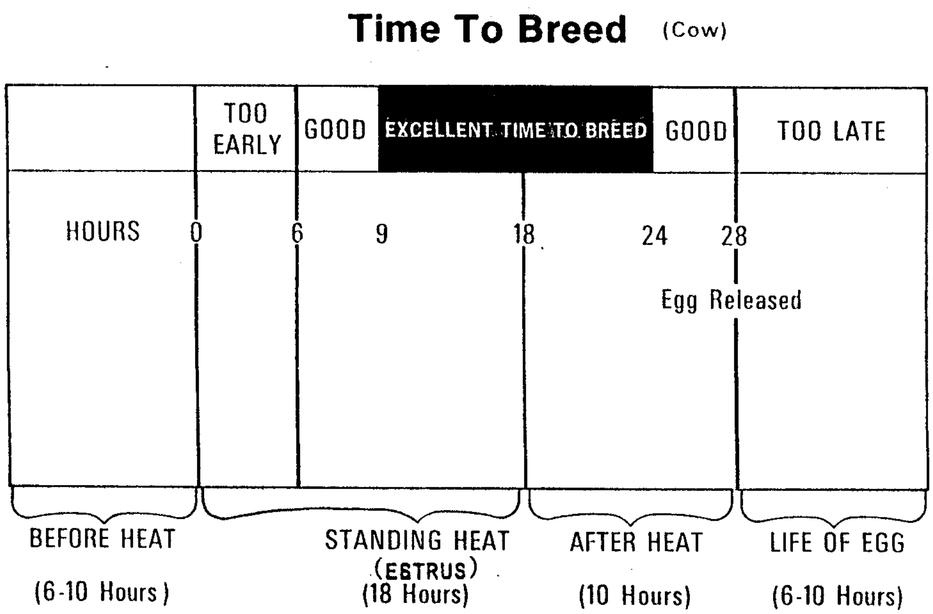
ARTIFICIAL INSEMINATION

AG 534 - R

ASSIGNMENT SHEET #1--IDENTIFY EVENTS FROM AN ESTROUS CYCLE CHART

Name ____________________ Score ____________________

From the chart below identify the different events associated with estrus in the cow. Answer each of the questions by using the chart.



1. With respect to the beginning of standing heat:

   a. When is the best time to breed? ____________________

   b. When is the egg released? ____________________

2. How long does the egg last after ovulation? ____________________

3. With respect to the information in the chart, describe when you would inspect the herd for heat and explain why ____________________

____

____

____

____

ARTIFICIAL INSEMINATION

AG 534 - R

ANSWERS TO ASSIGNMENT SHEET

1. a. Nine to 24 hours after the beginning of standing heat

   b. Twenty-eight hours after the beginning of standing heat

2. Six to 10 hours after ovulation

3. Answer should include inspection from two to four times per day in order to breed during a period of time from 9 to 24 hours after standing heat begins.

ARTIFICIAL INSEMINATION

AG 534 - R

LABORATORY EXERCISE #1--INSEMINATE A REPRODUCTIVE TRACT ACQUIRED FROM SLAUGHTERHOUSE

I. Equipment and materials

A. Disposable glove

B. Inseminating tube

C. Polybulb or syringe

D. Bottle of dye

E. Scissors

F. Paper towels

G. Cow reproductive tract

II. Procedure

A. Place glove on left arm

(Note: Place glove on right arm if you are left-handed.)

B. Depress polybulb, place in dye, and slowly release bulb to fill

C. Place left hand over cervix as if in cow

D. Insert tube into the vulva with right hand, guiding tube through the three rings of the cervix

E. Deposit dye by depressing the polybulb when past the third ring on the cervix

(Note: Count slowly to ten while depressing the polybulb.)

F. Remove tube

G. Cut open the dead tract to locate the point of deposit or dye

(Note: The dye should be deposited somewhere between the third and fourth rings of the cervix.)

ARTIFICIAL INSEMINATION

AG 534 - R

LABORATORY EXERCISE #2--INSEMINATE A COW

I. Tools and equipment

A. Nitrogen chest

B. Ampule/straw of semen

C. Thaw box

D. Disposable glove

E. Inseminating tube

F. Polybulb or syringe

G. Lubricant

H. Paper towels

II. Procedure

A. Place cow in chute

B. Remove ampule/straw from nitrogen chest

C. Place ampule/straw in thaw box

D. Place disposable glove on left arm

(Note: Place glove on right arm if you are left-handed.)

E. Place polybulb or syringe on end of inseminating tube

F. Open ampule/straw of semen

G. Depress polybulb or syringe, place in ampule, and slowly release to draw semen into tube

(Note: Cut open the top of ampule by scribing knife blade around top on the etch mark.)

H. Place syringe in mouth with tube in horizontal position

(Note: This will leave both hands free.)

I. Lubricate glove

(Note: K-Y jelly is the best lubricant to use, but mild soap will work.)

J. Insert left hand into rectum for removal of feces

K. Clean exterior of the vulva with paper towels

L. Locate cervix with left hand in rectum and hold in palm of hand

(Note: If cow is straining to expel your arm, relax a minute and the cow will also relax. The cervix will be a firm, cylindrical structure.)

M. Insert tube into the vulva with right hand; locate cervical guide tube opening and gently insert through the three rings of the cervix

(Note: Tube should be inserted at a slight upward incline to reduce chance of entering urethra.)

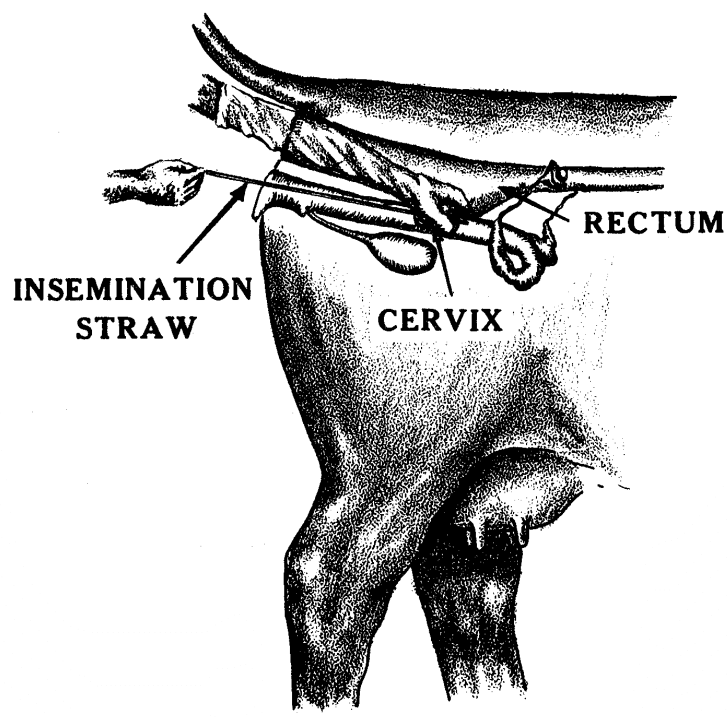
N. Deposit semen at the end of the cervix by pressing the polybulb between the thumb and fore finger of the right hand; squeeze slowly

O. Remove tube from vagina; remove hand from rectum

P. Locate and squeeze clitoris between thumb and finger

(Note: This improves conception rate by about 5%. The clitoris is located right at the base of the vulva.)

III. Diagram of procedure



ARTIFICIAL INSEMINATION

AG 534 - R

UNIT TEST

Name ______________________________ Score ______________________________

1. List seven advantages of artificial insemination of the cow.

   a.______________________________

   b. ______________________________

   c.______________________________

   d. ______________________________

   e.______________________________

   f.______________________________

   g. ______________________________

2. List four disadvantages of artificial insemination of the cow.

   a.______________________________

   b. ______________________________

   c.______________________________

   d. ______________________________

3. Describe the signs of estrus in cows.

   a.______________________________

   b. ______________________________

   c.______________________________

   d. ______________________________

   e.______________________________

4. State which sign of estrus is the most important with regard to time of insemination.

____

5. Describe the three methods of checking for estrus in cattle.

a. ____

____

b. ____

____

c. ____

____

6. List the necessary records needed in an artificial insemination program.

a. ____

b. ____

c. ____

d. ____

7. Explain the A.M.-P.M. insemination rule.

____

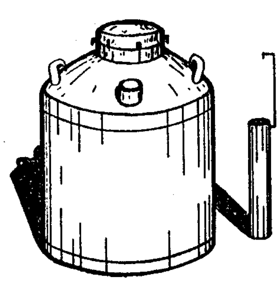
____

____

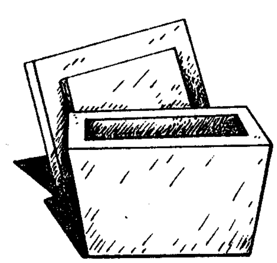
8. Indicate the optimum time of insemination for cows.

____

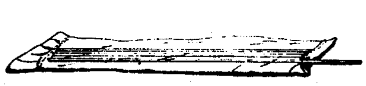
9. Label the following equipment necessary for artificial insemination.



a. ____________________



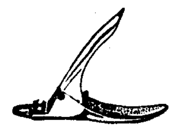
b. ____________________



c.____________________

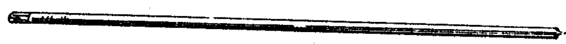
d.____________________

e.____________________



f.____________________

g.____________________



h.____________________

10. Describe and outline the steps of the rectocervical technique for artificially inseminating a cow.

Description: ____

____

____

Steps:

a.____

b. ____

c.____

d. ____

e.____

f.____

g. ____

h. ____

i.____

j.____

k. ____

l.____

m. ____

n. ____

11. Indicate the best temperature to thaw frozen semen to be used immediately.

____

12. List five advantages and three disadvantages of artificial insemination of the ewe.

Advantages

a ____

b ____

c ____

d ____

e ____

Disadvantages

a ____

b ____

c ____

13. Explain why sheep artificial insemination is so poorly accepted in the United States.

____

____

____

14. Discuss five areas of management of a sheep artificial insemination program.

a.____

b. ____

c.____

d. ____

e.____

15. Indicate the optimum time of insemination for ewes.

____

16. Describe and outline the steps of speculum technique for artificially inseminating a ewe.

    Description: ______________________________

    ____

    ____

    Steps:

    a. ______________________________

    b. ______________________________

    c. ______________________________

    d. ______________________________

    e. ______________________________

    f. ______________________________

    g. ______________________________

    h. ______________________________

    i. ______________________________

17. List five advantages and five disadvantages of artificial insemination of the sow.

    Advantages

    a. ______________________________

    b. ______________________________

    c. ______________________________

    d. ______________________________

    e. ______________________________

    Disadvantages

    a. ______________________________

    b. ______________________________

    c. ______________________________

    d. ______________________________

    e. ______________________________

18. Discuss three areas of management of a swine artificial insemination program.

    a.____

    b.____

    c.____

19. Indicate the optimum time of insemination for sows.

20. Describe and outline the steps of the vaginocervical method for artificially inseminating a sow.

    Description: ____________________________________

    Steps:

    a.____

    b.____

    c.____

    d.____

    e.____

    f.____

    g.____

21. List three advantages and two disadvantages of artificial insemination for mares.

<u>Advantages</u>

a.______________________________

b. ______________________________

c ______________________________.

<u>Disadvantages</u>

a.______________________________

b. ______________________________

22. Describe two methods of restraint for mares during insemination.

a.______________________________

____

____

____

b. ______________________________

____

____

____

23. Indicate the optimum time of insemination for mares.

____

24. Describe and outline the steps of the vaginocervical method for artificially inseminating a mare.

Description: ______________________________

____

____

Steps:

a.______________________________

b. ______________________________

c.______________________________

d. ______________________________

e.______________________________

f.______________________________

g. ______________________________

h. ______________________________

i.______________________________

j.______________________________

k. ______________________________

l.______________________________

ARTIFICIAL INSEMINATION

AG 534 - R

ANSWERS TO TEST

1. Answer should include seven of the following: Wider selection and use of outstanding sires; Rapid genetic and herd improvement; Rapid proof of bull is available; Can overcome physical barriers to mating; Danger of a bull is eliminated; Disease is reduced; New crosses can be tried experimentally without purchasing a new sire; Improved herd management due to increased observation; Elimination of cost of purchasing and keeping a bull

2. Answer should include four of the following: Skilled technician required; Closer supervision of female is required; May have increase in inbreeding; May be subject to abuses; Cost of initiating program

3. Standing to be ridden; Riding others; Nervousness; restlessness; Clear, thin, wet sticky mucus flowing from vulva; Minor indications: Dirt or mud on flanks or back; Hair standing up on tailhead; Bellowing; Holding up milk

4. Standing to be ridden

5. a. Personal observation
   b. Marker animals: Grease on brisket; Collar; Chin-ball marker; Heat-mount detector
   c. Teaser animals: Young bull calves; Pseudohermaphrodites; Nymphomaniac; Steers treated with testosterone; Spayed females injected with estrogen; Vasectomized male

6. Breeding history; Ease of calving; Time to rebreeding following parturition; Cyclic activity

7. Cows detected first in estrus in the morning are bred that same afternoon; Cows detected first in estrus in the afternoon are bred the following morning

8. Optimum time is 12-18 hours after beginning of estrus

9. a. Nitrogen chest
   b. Thaw box
   c. Inseminating tube
   d. Disposable glove
   e. Polybulb
   h. Straw clippers
   f. Ampule
   g. Straw

10. Description: Consists of inserting one arm in the rectum and directing the inseminating tube through the vagina and cervix for semen deposition in the anterior cervix

    Steps: Secure cow; Prepare thaw box (wide mouth thermos with thermometer); Obtain and prepare semen; Dry straw; Insert straw into gun; Snip end of straw; Slip sheath (plastic cover) over gun; Put on plastic sleeve and lubricate with water; Insert arm into rectum - locate cervix with fingers; Clean vulva with towel; Insert inseminating gun (through vagina, into cervix); Inseminate into anterior cervix; Record information; Clean up and release cow

11. 95-98oF for 10-30 seconds

12. Advantages: Intensive use of outstanding sires; Rapid genetic improvement; Crossbreeding; Reduced investment in rams; Lowered maintenance costs (no ram to keep)

    Disadvantages: Skilled technician required; Inbreeding; Cost (especially labor)

13. Poorly accepted in U.S. because larger sheep herds are on rangeland that requires many acres for nutritional needs; it's harder to concentrate stock

14. a. Herd must be concentrated
    b. Check for estrus at least twice a day
    c. Teaser animals: Aproned or vasectomized rams; Crayon secured in chest harness (mark ewes in estrus)
    d. Synchronizing agent (if desired)
    e. Facilities: Alley to crowd ewes; Crate for insemination

15. 15 hours after onset of estrus

16. Description: Place speculum into vagina and pass catheter through it into the cervix as far as possible before depositing the semen

    Steps: Secure ewe; Prepare semen; Lubricate speculum (tube); Insert speculum; Locate os cervix; Inseminate; Clean up; Record information; Release ewe

17. Answer should include five of each of the following:

    Advantages: Extension of superior boars; Economical (greater use of boar); Disease control; Elimination of injury (use heavy boars on small females); Utilize outside boars; Simple, easy to learn process

    Disadvantages: Constant observation for heat detection; Skilled technician required; Special equipment required; Increased labor; Semen storage can be a problem; Number of inseminations per ejaculate are small

18. a. Observe sows twice a day for signs of estrus: Swollen vulva; Pressure on rump and loin
    b. Separate sows in estrus
    c. Chutes usually unnecessary: Grunting of boar helps keep quiet; Can quiet by massaging clitoris and mammary

19. 30 hours after onset of estrus

20. Description: Insert tube through vagina into cervix where semen is deposited

    Steps: Isolate sow; Obtain semen; Assemble inseminating tube and fill with 50 ml semen; Inseminate (into body of uterus); Discard disposables; Record information; Release sow

21. Advantages: Widespread use of outstanding sires; Danger of stallion eliminated; Better disease control

    Disadvantages: Skilled technician required; Registration restrictions by purebred associations

22. a. Breeding chute: Constructed of heavy lumber; Solid tailgate within 6 inches of vulva (restrict kicking); Gate on front and one side (release mare)
    b. Hobbles (soft cotton rope hobbles best): 40 ft. rope with 3 ft. loop tied in middle; Pass rope ends through front legs, an end around each rear pastern and then looped around pastern again; Twist end around the rope (between its near pasterns and neck) and tie to neck loop at shoulder

23. Mid to late estrus

24. Description: Consists of inserting an arm into the vagina and locating the os cervix followed by passing a catheter alongside the arm into the cervix and depositing the semen at that point

    Steps: Secure mare; Wash vulva area; Put on plastic sleeve; Prepare semen and draw 20-30 ml into syringe; Lubricate sleeve; Insert arm into vagina (index finger in cervical opening); Insert inseminating tube to replace index finger; Deposit semen; Discard disposable equipment; Clean up; Record information; Release mare

FERTILIZATION AND EMBRYO TRANSFER

AG 534 - S

UNIT OBJECTIVE

After completion of this unit, students should be able to describe mechanisms involved in sperm and ovum transport and list ovum barriers to sperm penetration. Students should also be able to indicate where fertilization takes place and describe embryo transfer. This knowledge will be demonstrated by completion of a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Describe the mechanisms involved in sperm and ovum transport.
2. List in order the barriers to sperm penetration of the ovum.
3. Define syngamy.
4. Indicate where fertilization takes place.
5. Indicate how long it takes sperm to reach the point of fertilization in the cow, ewe, and sow.
6. Explain where sperm is deposited in the normal copulation of the horse.
7. List six advantages and four disadvantages of embryo transplants.
8. Discuss synchronization, condition, superovulation and insemination as related to embryo transfer.
9. Describe the main reason for transferring embryos in swine.
10. Describe in outline form the surgical procedure for embryo transplant in the cow.
11. Describe in outline form the non-surgical procedure for embryo transplant in the cow.
12. Describe in outline form the surgical procedure for embryo transplant in the ewe.
13. Describe in outline form the surgical procedure for embryo transplant in the sow.
14. Describe in outline form the non-surgical procedure for embryo transplant in the sow.
15. Describe in outline form the non-surgical procedure for embryo transplant in the mare.
16. Distinguish between "good" and "bad" eggs.

FERTILIZATION AND EMBRYO TRANSFER

AG 534 - S

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

   A. Make transparencies and necessary copies of materials.

   B. Provide students with objectives and discuss.

   C. Provide students with information and discuss.

   D. Make arrangements with veterinarian or research station for students to watch an embryo transplant.

   E. Review and give test.

   F. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM 1--Ovum Transport in the Oviduct

      2. TM 2--Sperm Approaching the Egg Cell Mass

      3. TM 3--Sperm Penetration

      4. TM 4--Syngamy, Fusion of the Male and Female Pronuclei, and Cleavage

      5. TM 5--Site of Fertilization in the Oviduct

   E. Test

   F. Answers to test

III. Unit references

   A. Barrick, R., and Harmon, H., *Animal Production and Management*, McGraw-Hill Book Company, New York, 1988.

   B. Bearden and FuQuay, *Applied Animal Production*, Prentice-Hall, Englewood Cliffs, New Jersey, 1980.

C. Bundy, C.E., et al., *Livestock and Poultry Production*, 5th edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1982.

D. Ensminger, M.E., *Animal Science*, Interstate Publishers, Danville, Illinois, 1983.

E. *Idaho State Board for Vocational Education Curriculum Guide in Livestock Production*, University of Idaho and the Idaho State Board for Vocational Education.

F. Lasley, John F., *Genetics of Livestock Improvement*, 3rd edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1978.

G. Sorensen, A.M., *Animal Reproduction Principles and Practices*, McGraw-Hill Book Company, New York, 1979.

FERTILIZATION AND EMBRYO TRANSFER

AG 534 - S

INFORMATION SHEET

I. Mechanisms involved in sperm transport

   A. Pass into cervix by own movement

   B. As the sperm enter the cervix, orient themselves into current of thin mucus during estrus

   C. Myometrium moves them through the uterus

   D. Moved through oviduct by uterine contractions and a thin fluid secreted by glandular cells

II. Mechanisms involved in ovum transport (Transparency 1)

   A. Fimbria on terminal oviduct--acts as funnel to receive ovum

   B. Fluids (abdominal cavity and that escaping from follicle during ovulation) serve as medium for free-floating ovum

   C. Cilia lining oviduct assists in moving ovum

   D. Inflow of fluids assists in moving ovum

   E. Forming of fimbria around the ovary assists in moving ovum

III. Barriers to sperm penetration of the ovum (Transparencies 2, 3)

   A. Outer cells

   B. Zona pellucida

   C. Vitelline membrane

IV. Syngamy--the fusion of the male and female pronuclei to form a zygote (Transparency 4)

V. Fertilization takes place in the oviduct (Transparency 5)

VI. Time for sperm to reach point of fertilization

   A. Cow--12-13 minutes

   B. Ewe--8 minutes

   C. Sow--30 minutes

VII. The stallion ejaculates into the open cervix and semen flows into the uterus. A large volume with low concentration is ejaculated

VIII. Embryo transplants

A. Advantages

1. Extend productivity of valuable dams

2. Continue productive life of females that are injured or for some other reason cannot develop a young, but are still fertile

3. More rapid proof of a dam through greater numbers of offspring in short period of time

4. Shorten generation interval by superovulating prepubertal females and transferring embryos to mature recipients

5. Transfer embryos from proven stock to underdeveloped areas with native unproductive stock to utilize the genetic potential in an entirely different environment

6. Importation of new bloodlines and breeds where restrictions prohibit importing the entire animal

7. Induced twinning by transferring an additional embryo to the existing pregnancy

B. Disadvantages

1. Propagation of low-fertility cattle is very undesirable but is possible if a particular animal's merits are based on factors other than reproduction

2. Cost

3. Response to hormones is erratic

4. Repeated treatment with protein hormones (PMSG and FSH) induces antibody formation, and animals become unresponsive with repeated treatment

C. Synchronization important

1. Donor and recipient must be in same stage of estrous cycle for conception results

2. May use progestogens and prostaglandins

D. Condition--Only healthy cattle in good flesh should be considered for transfer

E. Superovulation may be induced (although not all animals will respond) for multiple ova for transfer

F. Insemination

1. Conducted shortly after detection of estrus and at 12 hour intervals for three inseminations

2. Must have high-quality semen

G. Major reason for use in swine is to increase litter size

IX. Procedure for embryo transfer

A. Surgical - cow

1. Both recipient and donor prepared for surgery

a. Reproductive tract exposed

b. Presence of a corpus luteum on ovary determined (animal not used if no CL present)

2. Select embryo; draw into Pasteur pipette

3. Puncture uterus

4. Insert ova

5. Discharge ova into lumen

B. Nonsurgical - cow

1. Similar to artificial insemination

2. Draw embryo into fine tube or straw

3. Pass embryo into upper ipsilateral horn before expulsion

C. Surgical - ewe

1. Insert a catheter with a balloon near the bifurcation

2. Inflate balloon to occlude one horn of the uterus

2. Catheter is the return flow for fluid infused through a hypodermic needle in the upper horn

D. Surgical - sow

1. Transfer embryo into oviduct by passing a polyethylene tube into fimbriated end

2. Deposit embryos from a Pasteur pipette

3. To deposit in the uterus, puncture and deposit in lumen

E. Nonsurgical - sow

1. Insert outer catheter against cervix with second catheter penetrating the cervix into the uterus

2. Flush ovum through inner catheter or a thin tube

F. Nonsurgical - mare

1. Direct three-way system catheter into cervix by a hand in the vagina

2. Remove arm

3. Insert arm into rectum to help manipulate catheter into uterus

X. "Good" eggs versus "bad" eggs

A. "Good" eggs

1. Two-celled ova that are only two days old

2. Round and full with intact zona pellucida and the normal stage of development according to time of recovery

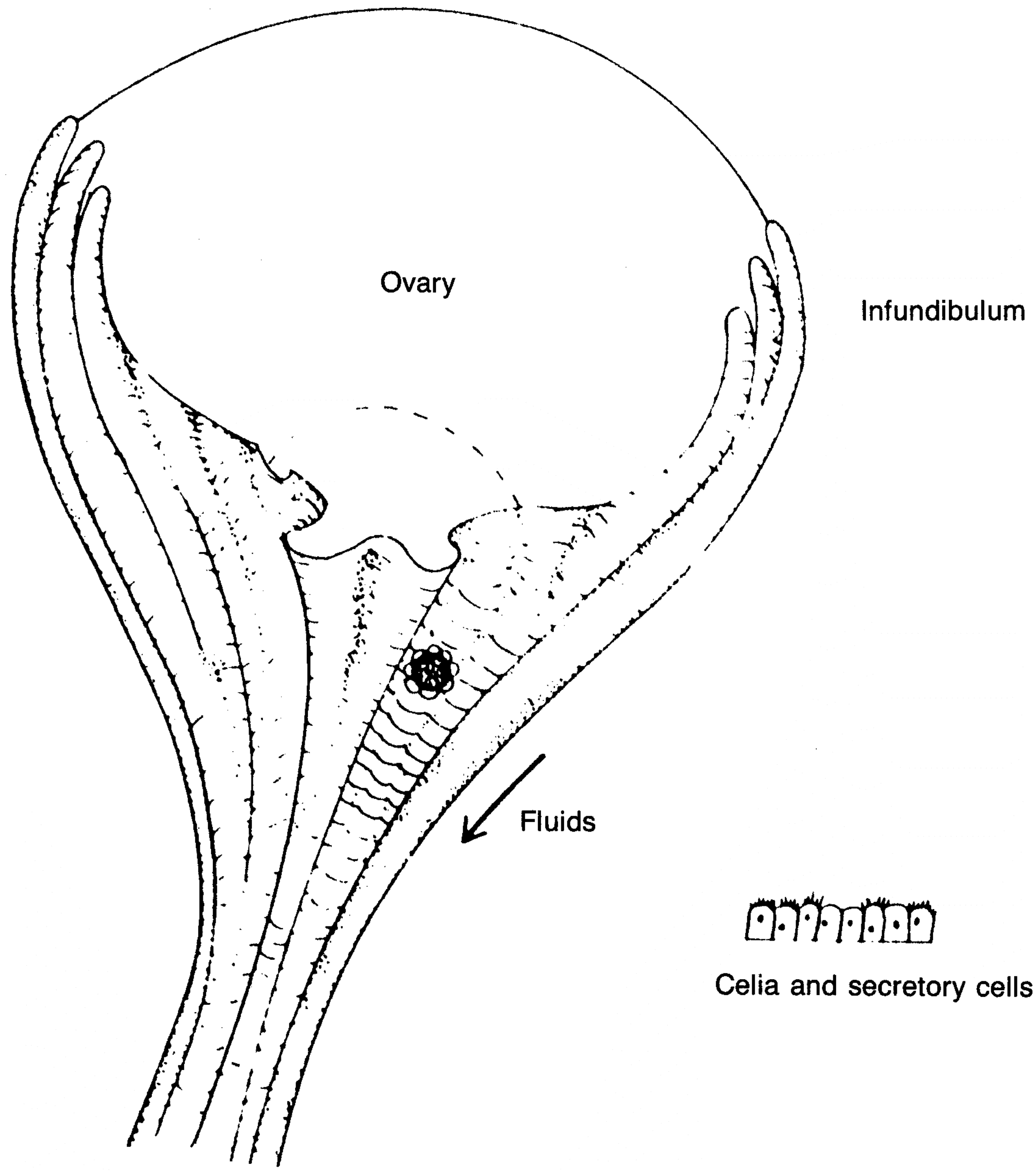
B. "Bad" eggs

1. Single-celled ova (non-fertilized)

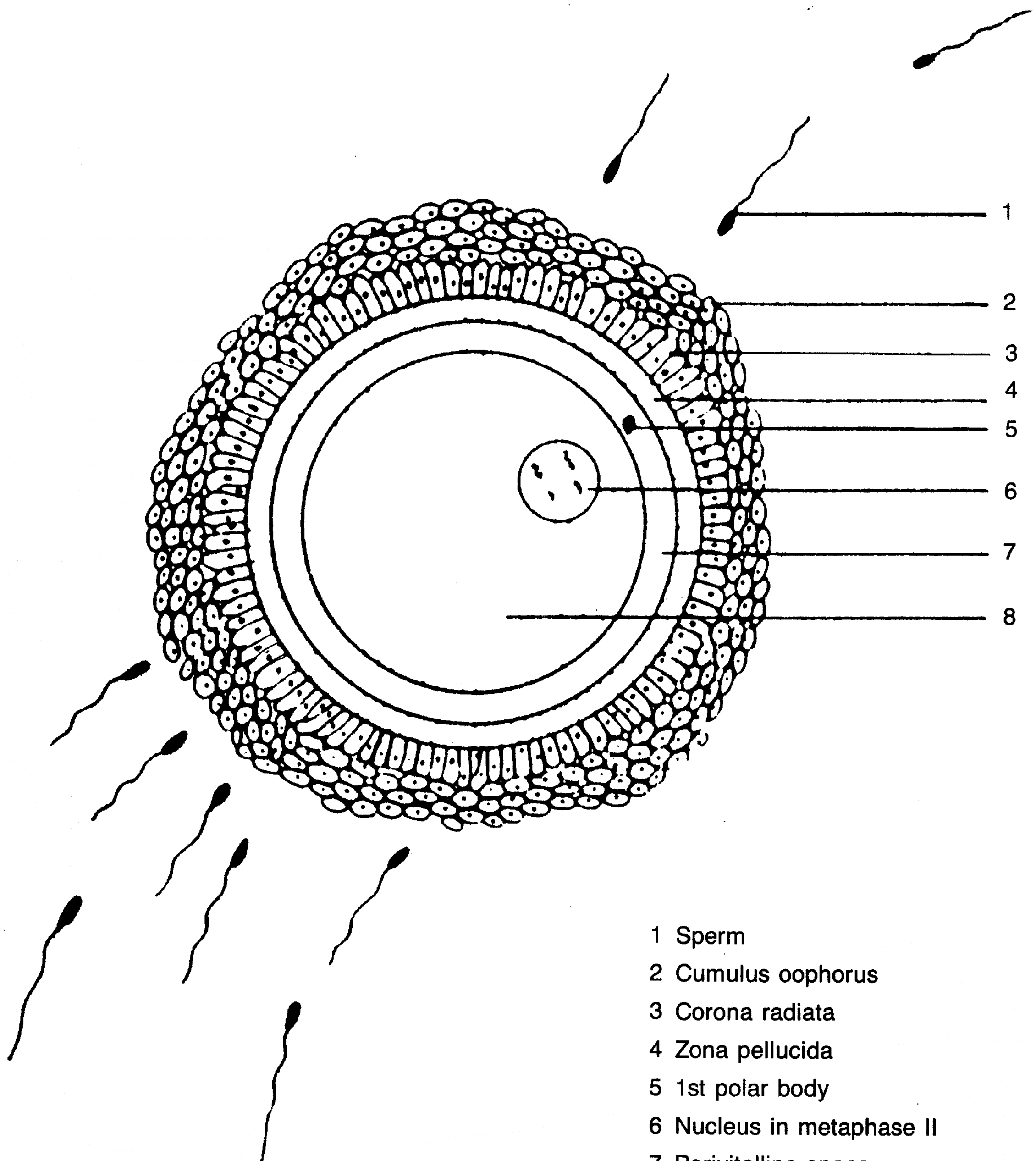
2. Two celled ova more than two days old

3. Misshapen ova

Ovum Transport in the Oviduct

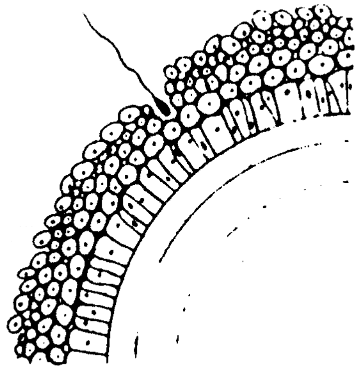


Sperm Approaching the Egg Cell Mass

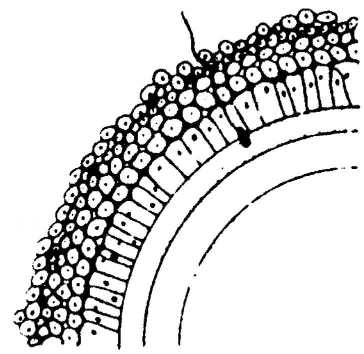


1 Sperm
2 Cumulus oophorus
3 Corona radiata
4 Zona pellucida
5 1st polar body
6 Nucleus in metaphase II
7 Perivitelline space
8 Vitellus

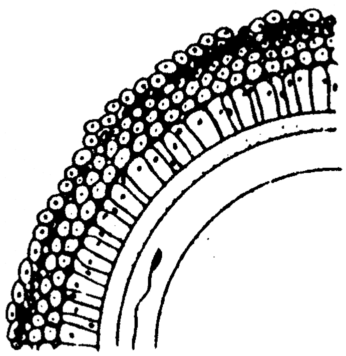
Sperm Penetration



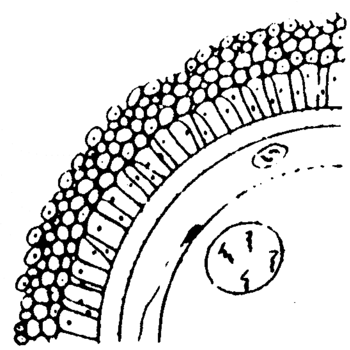
In cumulus



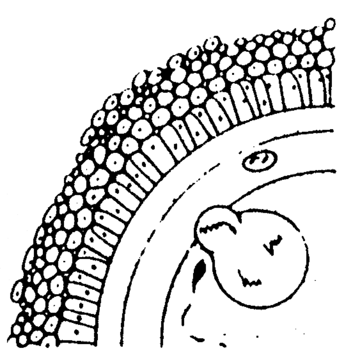
In zona



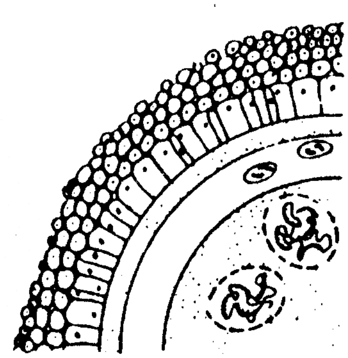
In perivitelline space



In viteline membrane

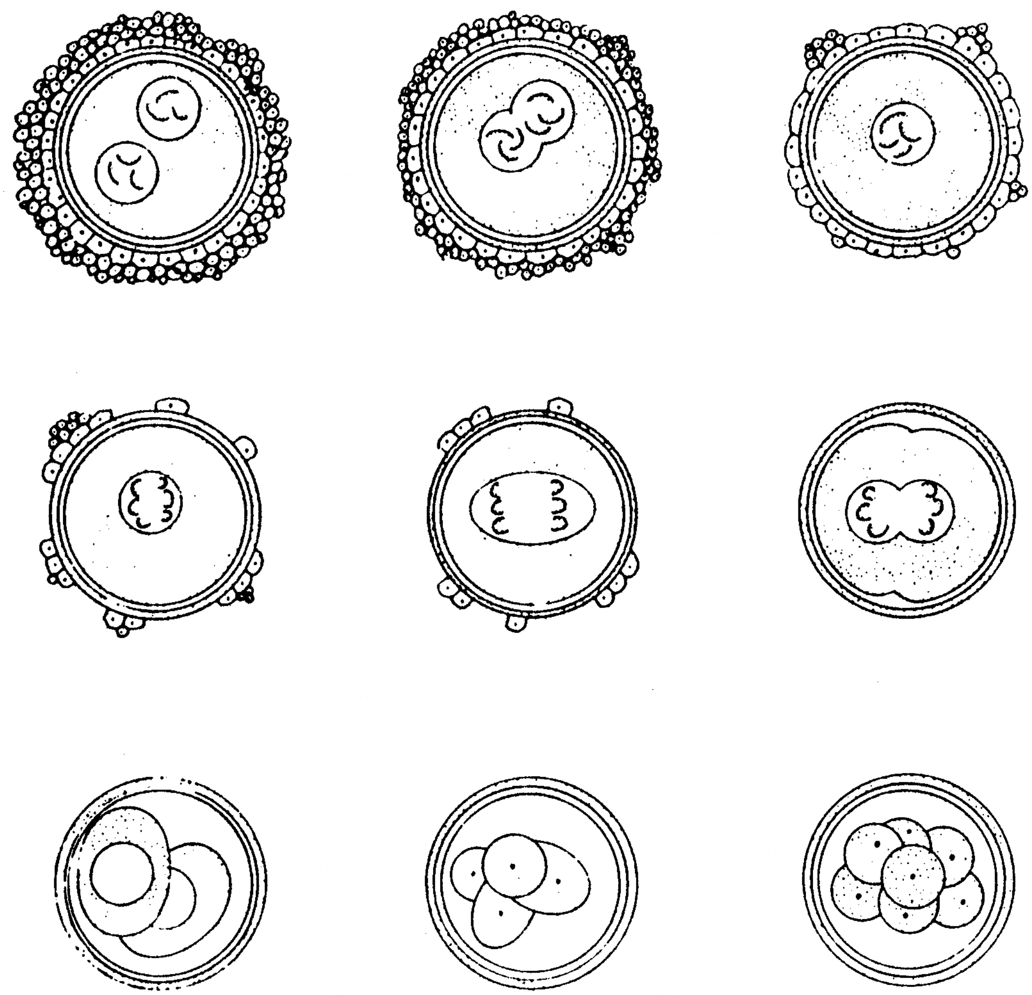


In vitellus

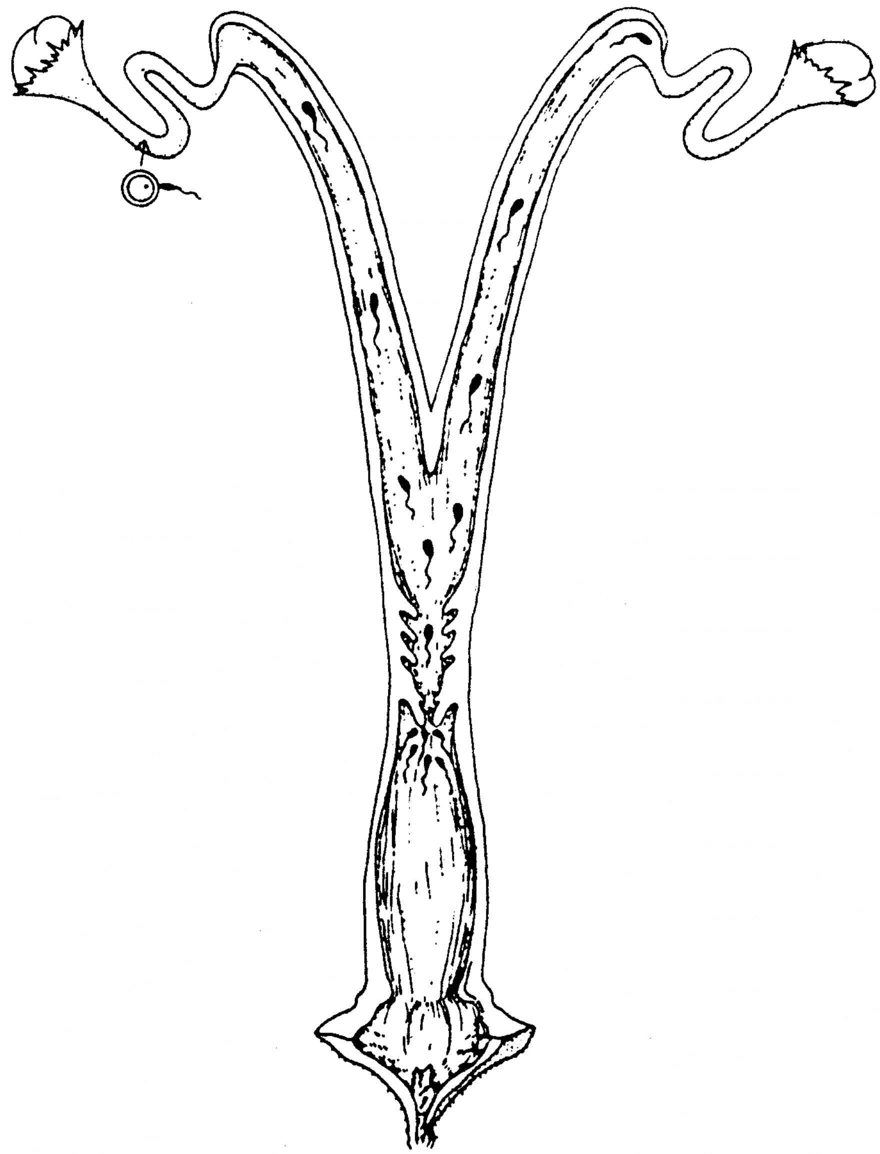


Pronuclei

Syngamy, Fusion of the Male and Female Pronuclei, and Clevage



Site of Fertilization in the Oviduct



FERTILIZATION AND EMBRYO TRANSFER

AG 534 - S

UNIT TEST

Name ______________________________ Score ______________________________

1. Describe the mechanisms involved in sperm and ovum transport.

   Sperm

   a.______________________________

   b. ______________________________

   c.______________________________

   ____

   d. ______________________________

   ____

   Ovum

   a.______________________________

   b. ______________________________

   ____

   c.______________________________

   d. ______________________________

   e.______________________________

2. List in order the barriers to sperm penetration of the ovum.

   a.______________________________

   b. ______________________________

   c.______________________________

3. Define syngamy.

   ____

   ____

4. Indicate where fertilization takes place.

____

5. Indicate how long it takes sperm to reach the point of fertilization in the cow, ewe and sow.

   a. Cow ________________________________

   b. Ewe ________________________________

   c. Sow ________________________________

6. Explain where sperm is deposited in the normal copulation of the horse.

____

____

7. List six advantages and four disadvantages of embryo transplants.

Advantages

a.______________________________________

____

b. ______________________________________

____

c.______________________________________

____

d. ______________________________________

____

e.______________________________________

____

f.______________________________________

____

Disadvantages

a.______________________________________

____

b. ______________________________

____

c.______________________________

____

d. ______________________________

____

8. Discuss synchronization, condition, superovulation and insemination as related to embryo transfer.

   a. Synchronization______________________________

   ____

   b. Condition______________________________

   ____

   c. Superovulation ______________________________

   ____

   d. Insemination ______________________________

   ____

9. Describe the main reason for transferring embryos in swine.

____

____

10. Describe in outline form the surgical procedure for embryo transplant in the cow.

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____

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____

____

____

11. Describe in outline form the non-surgical procedure for embryo transplant in the cow.

12. Describe in outline form the surgical procedure for embryo transplant in the ewe.

13. Describe in outline form the surgical procedure for embryo transplant in the sow.

14. Describe in outline form the non-surgical procedure for embryo transplant in the sow.

15. Describe in outline form the non-surgical procedure for embryo transplant in the mare.

16. Distinguish between "good" and "bad" eggs.

FERTILIZATION AND EMBRYO TRANSFER

AG 534 - S

ANSWERS TO TEST

1. Sperm:

   a. Pass into cervix by own movement
   b. As the sperm enter the cervix, orient themselves into current of thin mucus during estrus
   c. Myometrium moves them through the uterus
   d. Moved through oviduct by uterine contractions and a thin fluid secreted by glandular cells

   Ovum:

   a. Fimbria on terminal oviduct--acts as funnel to receive ovum
   b. Fluids (abdominal cavity and that escaping from follicle during ovulation) serve as medium for free-floating ovum
   c. Cilia lining oviduct assists in moving ovum
   d. Inflow of fluids assists in moving ovum
   e. Forming of fimbria around the ovary assists in moving ovum

2. a. Outer cells
   b. Zona pellucida
   c. Vitelline membrane

3. Syngamy--the fusion of the male and female pronuclei to form a zygote

4. Fertilization takes place in the oviduct

5. a. Cow--12-13 minutes
   b. Ewe--8 minutes
   c. Sow--30 minutes

6. The stallion ejaculates into the open cervix and semen flows into the uterus

7. Answer should include six of the following advantages: Extend productivity of valuable dams; Continue productive life of females that are injured or for some other reason cannot develop a young, but are still fertile; More rapid proof of a dam through greater numbers of offspring in short period of time; Shorten generation interval by superovulating prepubertal females and transferring embryos to mature recipients; Transfer embryos from proven stock to underdeveloped areas with native unproductive stock to utilize the genetic potential in an entirely different environment; Importation of new bloodlines and breeds where restrictions prohibit importing the entire animal; Induced twinning by transferring an additional embryo to the existing pregnancy

   Disadvantages: Propagation of low-fertility cattle is very undesirable but is possible if a particular animal's merits are based on factors other than reproduction; Cost; Response to hormones is erratic; Repeated treatment with protein hormones (PMSG and FSH) induces antibody formation, and animals become unresponsive with repeated treatment

8. Synchronization: Donor and recipient must be in same stage of estrous cycle for conception results; May use progestogens and prostaglandins

   Condition--Only healthy cattle in good flesh should be considered for transfer

   Superovulation may be induced (although not all animals will respond) for multiple ova for transfer

   Insemination: Conducted shortly after detection of estrus and at 12 hour intervals for three inseminations; Must have high-quality semen

9. Major reason for use in swine is to increase litter size

10. Both recipient and donor prepared for surgery: Reproductive tract exposed; Presence of a corpus luteum on ovary determined (animal not used if no CL present); Select embryo; draw into Pasteur pipette; Puncture uterus; Insert ova; Discharge ova into lumen

11. Similar to artificial insemination; Draw embryo into fine tube or straw; Pass embryo into upper ipsilateral horn before expulsion

12. Insert a catheter with a balloon near the bifurcation; Inflate balloon to occlude one horn of the uterus; Catheter is the return flow for fluid infused through a hypodermic needle in the upper horn

13. Transfer embryo into oviduct by passing a polyethylene tube into fimbriated end; Deposit embryos from a Pasteur pipette; To deposit in the uterus, puncture and deposit in lumen

14. Insert outer catheter against cervix with second catheter penetrating the cervix into the uterus; Flush ovum through inner catheter or a thin tube

15. Direct three-way system catheter into cervix by a hand in the vagina; Remove arm; Insert arm into rectum to help manipulate catheter into uterus

16. "Good" eggs: Two-celled ova that are only two days old; Round and full with intact zona pellucida and the normal stage of development according to time of recovery
    "Bad" eggs: Single-celled ova (non-fertilized); Two celled ova more than two days old; Misshapen ova

BIOTECHNOLOGY

AG 534 - T

UNIT OBJECTIVE

After completion of this unit, students should be able to define biotechnology and list four broad applications of biotechnology in agriculture. Students should also be able to describe current genetic research projects in plants and animals of major impact on agriculture. This knowledge will be demonstrated by completion of assignment sheets, a laboratory exercise, and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Define biotechnology.
2. List four broad applications of biotechnology in agriculture.
3. List four common uses of biotechnology in agricultural science that have been around for some time.
4. List and explain the three major techniques of biotechnology.
5. Describe five current genetic research projects in plants of major impact on agriculture.
6. Describe five current genetic research projects in animals of major impact on agriculture.
7. List four areas of biotechnology applications in food processing.
8. Describe four areas of public concern about biotechnology.
9. Match the occurrence in the history of genetic engineering to the correct year of occurrence.
10. List eight areas of career opportunities in biotechnology.
11. List eight specific occupational titles in agricultural biotechnology.
12. Determine the ethics of biotechnology.
13. Research a career in biotechnology.
14. Make yogurt.

BIOTECHNOLOGY

AG 534 - T

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

   A. Make transparencies and necessary copies of materials.

   B. Provide students with objectives and discuss.

   C. Provide students with information and discuss.

   D. Have students clip newspaper and magazine articles on biotechnology and briefly summarize them to the class.

   E. Provide students with assignment sheets and laboratory exercises.

   F. Discuss assignment sheets.

   G. Demonstrate laboratory exercise procedures.

   H. Review and give test.

   I. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM 1--Biotechnology Applications for Plant Agriculture: Present and Future

      2. TM 2--Biotechnology Applications for Animal Agriculture: Present and Future

      3. TM 3--Biotechnology Applications in Food Processing

   E. Assignment sheets

      1. AS 1--Determining the Ethics of Biotechnology

      2. AS 2--Research a Career in Biotechnology

   F. Instructor notes for laboratory exercise

G. Laboratory exercise

1. LE 1--Making Your Own Yogurt

H. Test

I. Answers to test

III. Unit references

A. *Agricultural Education Curriculum*. College of Agriculture, University of Illinois, Urbana, Illinois.

B. *Animal Biotechnology*. Upjohn, Kalamazoo, Michigan 49001.

C. Barrick, R., and Harmon, H., *Animal Production and Management*, McGraw-Hill Book Company, New York, 1988.

D. Bearden and FuQuay, *Applied Animal Production*, Prentice-Hall, Englewood Cliffs, New Jersey, 1980.

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G. *Idaho Agriscience Workshop - Secondary Agriculture Instructors*. Department of Agricultural and Extension Education, University of Idaho, Moscow, Idaho 83843, October, 1989.

H. *Idaho State Board for Vocational Education Curriculum Guide in Livestock Production*, University of Idaho and the Idaho State Board for Vocational Education.

I. *IMAGE - Institute for Molecular and Agricultural Genetic Engineering*. University of Idaho, Moscow, Idaho 83843.

J. Lasley, John F., *Genetics of Livestock Improvement*, 3rd edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1978.

K. Of the Earth: *Agriculture and the New Biology*. Monsanto Company, 800 N. Lindbergh Boulevard, St. Louis, Missouri 63167.

L. *Plant Biotechnology*. Upjohn, Kalamazoo, Michigan 49001.

M. Sorensen, A.M., *Animal Reproduction Principles and Practices*, McGraw-Hill Book Company, New York, 1979.

IV. Additional sources for information

A. *Biotechnology Strategies for Life (1986).* MIT Press, Cambridge, Massachusetts 02142.

B. *Biotechnology: The Challenge (1987).* United States Department of Agriculture, Washington D.C. 20250-1300.

C. *Genetic Engineering*. (Videotape, Monsanto) Modern Talking Picture Service, 5000 Park Street N., St. Petersburg, Florida 33709.

D. *Genetic Engineering: A Natural Science* (booklet). Monsanto Company, 800 N. Lindbergh Boulevard, St. Louis, Missouri 63167, 1988.

E. *Genetic Engineering in Food and Agriculture*. Report No. 110, Council for Agricultural Science and Technology.

F. *Of the Earth: Agriculture and the New Biology* (videotape). Venard Films, Ltd., Box 1332, Peoria, Illinois 61654-1332.

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BIOTECHNOLOGY

AG 534 - T

INFORMATION SHEET

I. Biotechnology

A. The application of living organisms to improve, modify or produce industrial products or processes

B. Four broad applications in agriculture

1. Plant and animal production

2. Food processing and manufacturing

3. Environmentally-secure animal waste disposal

4. Conversion of agricultural residues to new products

C. Common uses in agricultural science that have been around for some time

1. Use of microorganisms to produce fermented food substances and antibiotics

2. Selection of animals to produce desired traits in offspring

3. Hybridization in plants

4. Artificial insemination

D. Three major techniques

1. Genetic engineering--involves the division and recombination of cell DNA (the material which controls the passing of specific characteristics from one generation to the next)

a. DNA can be divided and restructured in combinations which would never occur in nature

b. Can reconstruct totally synthetic genes to cause organisms to perform desired functions or exhibit desired traits

c. Also called Recombinant DNA technology

2. Monoclonal antibody technology

a. Scientists fuse an antibody-producing cell to a cancer cell to create a hybrid cell (called a hybridoma)

b. Screen the hybridomas for those that produce the desired antibodies

c. Clone and culture selected cells to secrete large quantities of highly concentrated monoclonal antibodies

3. Bio-processing

a. A living cell is cultured in a vessel, then the desired protein is extracted

b. Necessary to harvest the fruits of monoclonal antibody and genetic engineering technologies

c. Raising bread; mass producing an animal protein from genetically engineered bacteria

II. Current genetic research of major impact on agriculture (Transparencies 1, 2)

A. Plants (Transparency 1)

1. Higher protein-content seed (higher nutritional quality)

2. Plants to withstand extreme heat and cold

3. Improved milling and baking properties in wheat

4. Plants to grow in over-irrigated, salty soil, or that can be irrigated with salt water

5. Plants to tolerate too much or too little water

6. Oil crops that produce less saturated, edible oils

7. Plants immune to diseases

8. Feed crops with higher nutritional quality and better digestive qualities

9. Others??

B. Animals (Transparency 2)

1. Pregnancy testing kit for detection as early as 17th day of gestation (Bovine Pregnancy Specific Protein B)

2. Natural growth hormones

a. Regulate milk production

b. Regulate muscle growth

3. Embryo splitting and transfer

a. Birth of identical twins

b. Increase selection accuracy and intensity

4. Preserve fish germ plasm (cryopreservation of embryos - freezing under special conditions)

5. New vaccines

   a. Stimulate specific components of the immune system

   b. Composed of specific molecules from the pathogenic microbe

   c. No undesirable side effects

   d. Excellent protection

6. Others??

III. Biotechnology applications in food processing (Transparency 3)

A. Food additives

1. Amino acids

2. Natural forms of vitamins

B. Fermentation processes

1. Add bacteria to meat to "outcompete" pathogens which may speed spoilage

2. This technology already exists in the cheese-making industry

C. Enzyme production

D. Product transformation

1. Low calorie foods

2. Altered fatty acid structure (no-calorie ice cream!!)

E. Others??

IV. Areas of public concern about biotechnology

A. Cloning

1. Not understood (public thinks that whole human beings can and will be cloned)

2. Actually refers to gene cloning

B. Playing `God'

1. Many feel that man has no right to be involved with the hereditary materials of animals and humans

2. Many question if we are responsible enough to use this technology without abusing it

C. Environmental

1. Many question whether or not we know what the long-term effects of biotechnology on the environment might be

2. Many question whether or not there is even any way to predict long-term effects

D. Overproduction

1. Producers are concerned about overproduction, which will drive prices down

2. Many are concerned that the new technology will only be available to the very large producers, which will force the smaller ones out of business

V. History of genetic engineering

A. 1944 - DNA identified as genetic material

B. 1953 - Double strand DNA structure identified

C. 1973 - First transgenic bacteria prepared

D. 1976 - First genetic engineering company (Genetech) established

E. 1980 - First patent for genetically engineered microbe

F. 1982 - Approval of first genetically engineered drug

G. 1986 - First field test of genetically engineered plant

H. 1987 - Genetic engineering patent extended to higher life forms

VI. Areas of career opportunities in biotechnology

A. Scientists and engineers

B. Business and finance (new business opportunities created)

C. Producers

D. Communication specialists (interpreting and transferring information)

E. Natural resources (dealing with environmental concerns)

F. Sales personnel

G. Lawyers

H. Professional managers

I. Marketing personnel

J. Regulatory specialists

K. Financial analysts

L. Others??

VII. Specific occupational titles in agricultural biotechnology

A. Scientific/Research Director

B. Molecular Biologist

C. Enzymologist

D. Immunology Specialist

E. Food Additive Biochemist

F. Pesticide and Herbicide Researcher

G. Statistician

H. Genetics Engineer

I. Soil Biologist

J. Plant Breeding Specialist

K. Plant Physiologist

L. Bacterial Geneticist

M. Microbial Biotechnician

N. Fertilizer and Microbial Nitrogen Fixation Specialist

O. Vaccine Biologist

P. Soil Biochemist

Q. Genetic Sequence Computer Analyst

R. Cytobiologist

S. Endocrinologist

T. Bioproducts Developer

U. Animal Cell Culture Biochemist

V. Plant Tissue Culture Technician/Propagator

W. Embryo Transplant Researcher

X. Plant and Animal Disease Diagnostician

Y. Others??

BIOTECHNOLOGY APPLICATIONS FOR PLANT AGRICULTURE: PRESENT AND FUTURE

PHOTOSYNTHESIS

a. Genetically changed photosynthetic enzymes will be more efficient.

b. Plant make-up will be genetically altered to cause it to put more photosynthetic energy into grain, fruit, or vegetable production.

NITROGEN FIXATION IN NON-LEGUMINOUS PLANTS

a. 79% of the earth's atmosphere is nitrogen

b. Transfer of nitrogen-fixing genes to non-leguminous plants such as corn

c. Reduced need for supplemental nitrogen

HERBICIDE RESISTANCE

a. Decrease plant stress from herbicide use or carryover

b. Build in a resistance in plant seeds

DISEASE RESISTANCE

a. Alter plant makeup so specific diseases have no effect

b. Cause plants to produce their own resistant chemicals

PEST RESISTANCE

a. Transfer resistance which is controlled by one gene

b. Cause plant to stop producing whatever attracts the pest

c. Reduced need for chemical pesticides

STRESS TOLERANCE

Genetically alter the plant so that it will automatically adjust to any weather

PRODUCT QUALITY

Eliminate negative side effects of product processing

UNIQUE HYBRIDS

Perennial grain or vegetable crops

BIOTECHNOLOGY APPLICATIONS FOR ANIMAL AGRICULTURE: PRESENT AND FUTURE

REPRODUCTION

a. Saving and storing of valuable embryos

b. Sexing of animals

c. Cloning of valuable animals (reproducing genetically identical copies)

ANIMAL HEALTH

a. Build in disease resistance

b. Eliminate harmful side effects of vaccines

ANIMAL NUTRITION

a. Implant bacteria for non-ruminants to fully utilize cellulose (allow monogastric animals such as hogs to use more roughages)

b. Improve nutritional value of feeds

BY-PRODUCT UTILIZATION

Transfer livestock waste through bioprocessing into useful and beneficial products such as vitamins

GROWTH/LEAN MEAT PRODUCTION/MILK PRODUCTION

a. Growth hormones to speed weight gain and feeding efficiency

b. Develop vaccines to suppress growth-inhibiting hormones

c. Make animal products more nutritionally desirable (red meat, for example)

BIOTECHNOLOGY APPLICATIONS IN FOOD PROCESSING

FOOD ADDITIVES

a. Amino acids

b. Natural forms of vitamins

FERMENTATION PROCESSES

a. Add bacteria to meat to "outcompete" pathogens which may speed spoilage

b. This technology already exists in the cheese-making industry

PRODUCTION OF ENZYMES

PRODUCT TRANSFORMATION

a. Low calorie foods

b. Altered fatty acid structure (no-calorie ice cream!)

BIOTECHNOLOGY

AG 534 - T

ASSIGNMENT SHEET #1--DETERMINING THE ETHICS OF BIOTECHNOLOGY

Name ______________________________ Score ______________________________

Question: Should biotechnology research be actively pursued? Applied?

Activity: Class discussion/debate/position paper

Value Assessment Criteria:

1. Reciprocity--What choice would you support if you were a: (1) farmer, (2) seed dealer, (3) chemical dealer, (4) consumer.

2. Consistency--Would your choice be different if addressing a group of: (1) farmers, (2) environmentalists, or (3) consumers.

3. Coherence--How will the choice affect the relationship between farmers and agribusinessmen? Farmers and non-farmers? U.S. and foreign agriculture? How will biotechnology applications affect government agricultural policy?

4. Comprehensiveness--Where will biotechnology research lead? Will all farmers adopt the technology? What will happen if they do?

5. Adequacy--Will biotechnology solve the farm economy problems? The grain surpluses? Will it lead to further problems? How will it affect food prices?

6. Duration--Will biotechnology solve world hunger? What will the long-term effects be? Will biotechnology benefit or hurt the environment? Why must the research be carefully controlled?

BIOTECHNOLOGY

AG 534 - T

ASSIGNMENT SHEET #2--RESEARCH A CAREER IN BIOTECHNOLOGY

Name ______________________________ Score ______________________________

Choose one career in agricultural biotechnology that is of interest to you. Research for information in the areas below and write a paper on your findings.

Career/Job Title

Responsibilities

Educational/Training/Background Needed

Location of Employment

(This may be general or specific, such as: the Northwest, Chicago, Boise, a foreign country, etc.)

Salary Range

Why you would or would not be interested in pursuing this career.

BIOTECHNOLOGY

AG 534 - T

INSTRUCTOR NOTES FOR LABORATORY EXERCISE

Discuss with the students that the microscopic bacteria were at work for the 6 to 8 hours, multiplying and causing the mixture to thicken. Explain that scientists use this process extensively in biotechnology when they multiply microorganisms using flasks and petri dishes in the laboratory.

BIOTECHNOLOGY

AG 534 - T

LABORATORY EXERCISE #1--MAKING YOUR OWN YOGURT

Name ______________________________ Score ______________________________

Introduction

An example of a microbial process similar to those used by the scientist working in the biotechnology field is the process using bacteria to make yogurt. Yogurt is a form of sour milk. Originally prepared from whole milk boiled down to half its volume, yogurt can also be made by adding dry-milk solids to boiled milk to achieve a custard-like consistency. Two microscopic bacteria used as starter cultures are *Streptococcus thermophilus* and *Lactobacillus bulgaricus*. Large amounts of these bacteria are inoculated into the milk, and lactic acid develops rapidly. Evaporation thickens the yogurt and some proteins coagulate under the acidic conditions. In a few hours the yogurt is ready for consumption.

Materials needed

1 quart milk
1 cup powdered milk
1/3 cup unflavored commercial yogurt
Fresh or frozen fruit (optional)
1 cooking thermometer
Small containers (styrofoam coffee cups) with lids (old cottage cheese or yogurt containers would also work)
Small cooler

Procedure

1. Heat 1 quart of milk to about 170o F, stirring often and using a thermometer to check the temperature.

2. Let the milk cool to about 130o F then add 1 cup of powdered milk and 1/3 cup of unflavored commercial yogurt. This yogurt serves as the source of the bacteria necessary for the process to take place (fresh or frozen fruit may be added.)

3. Mix thoroughly and pour into small containers with lids. Be sure to observe the liquid at this stage.

4. Use a small cooler for the incubation step. Fill the cooler with several inches of water at 130o F.

5. Place the containers of the mixture in the cooler, close the lid tightly, and let the containers stand for 6 to 8 hours.

6. During this time bacteria will multiply and yogurt will thicken. Refrigerate and enjoy.

7. You may want to purchase some yogurt and compare tastes.

BIOTECHNOLOGY

AG 534 - T

UNIT TEST

Name ______________________________ Score ______________________________

1. Define biotechnology.

____

____

2. List four broad applications of biotechnology in agriculture.

a.____

b. ____

c.____

d. ____

3. List four common uses of biotechnology in agricultural science that have been around for some time.

a.____

b. ____

c.____

d. ____

4. List and explain the three major techniques of biotechnology.

a.____

____

____

____

b. ____

____

____

____

c. ______________________________

____

____

____

5. Describe five current genetic research projects in plants of major impact on agriculture.

a. ______________________________

____

b. ______________________________

____

c. ______________________________

____

d. ______________________________

____

e. ______________________________

____

6. Describe five current genetic research projects in animals of major impact on agriculture.

a. ______________________________

____

b. ______________________________

____

c. ______________________________

____

d. ______________________________

____

e. ______________________________

____

7. List four areas of biotechnology applications in food processing.

a.______________________________

b. ______________________________

c.______________________________

d. ______________________________

8. Describe four areas of public concern about biotechnology.

a.______________________________

____

b. ______________________________

____

c.______________________________

____

d. ______________________________

____

9. Match the occurrence in the history of genetic engineering to the correct year of occurrence.

1. 1944	5. 1980
2. 1953	6. 1982
3. 1973	7. 1986
4. 1976	8. 1987

_____a. Genetic engineering patent extended to higher life forms

_____b. First transgenic bacteria prepared

_____c. First patent for genetically engineered microbe

_____d. DNA identified as genetic material

_____e. Approval of first genetically engineered drug

_____f. Double strand DNA structure identified

_____g. First field test of genetically engineered plant

_____h. First genetic engineering company (Genetech) established

10. List eight areas of career opportunities in biotechnology.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

h. ____________________

11. List eight specific occupational titles in agricultural biotechnology.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

h. ____________________

BIOTECHNOLOGY

AG 534 - T

ANSWERS TO TEST

1. The application of living organisms to improve, modify or produce industrial products or processes

2. Plant and animal production; Food processing and manufacturing; Environmentally-secure animal waste disposal; Conversion of agricultural residues to new products

3. Use of microorganisms to produce fermented food substances and antibiotics; Selection of animals to produce desired traits in offspring; Hybridization in plants; Artificial insemination

4. a. Genetic engineering--involves the division and recombination of cell DNA; DNA can be divided and restructured in combinations which would never occur in nature; Can reconstruct totally synthetic genes to cause organisms to perform desired functions or exhibit desired traits; Also called recombinant DNA technology

   b. Monoclonal antibody technology: Scientists fuse an antibody-producing cell to a cancer cell to create a hybrid cell (called a hybridoma); Screen the hybridomas for those that produce the desired antibodies; Clone and culture selected cells to secrete large quantities of highly concentrated monoclonal antibodies

   c. Bio-processing: A living cell is cultured in a vessel, then the desired protein is extracted; Necessary to harvest the fruits of monoclonal antibody and genetic engineering technologies; Raising bread; Mass producing an animal protein from genetically engineered bacteria

5. Answer should include five of the following:

   Higher protein content seed (higher nutritional quality); Plants to withstand extreme heat and cold; Improved milling and baking properties in wheat; Plants to grow in over-irrigated, salty soil, or that can be irrigated with salt water; Plants to tolerate too much or too little water; Oil crops that produce less saturated, edible oils; Plants immune to diseases; Feed crops with higher nutritional quality and better digestive qualities; Others??

6. a. Pregnancy testing kit for detection as early as 17th day of gestation (Bovine Pregnancy Specific Protein B)
   b. Natural growth hormones: Regulate milk production; Regulate muscle growth
   c. Embryo splitting and transfer: Birth of identical twins; Increase selection accuracy and intensity
   d. Preserve fish germ plasm (cryopreservation of embryos - freezing under special conditions)
   e. New vaccines: Stimulate specific components of the immune system; Composed of specific molecules from the pathogenic microbe; No undesirable side effects; Excellent protection
   f. Others??

7. Food additives; Fermentation processes; Enzyme production; Product transformation; Others??

8. a. Cloning: Not understood (public thinks that whole human beings can and will be cloned); Actually refers to gene cloning
   b. Playing `God': Many feel that man has no right to be involved with the hereditary materials of animals and humans; Many question if we are responsible enough to use this technology without abusing it
   c. Environmental: Many question whether or not we know what the long-term effects of biotechnology on the environment might be; Many question whether or not there is even any way to predict long-term effects
   d. Over-production: Producers are concerned about overproduction, which will drive prices down; Many are concerned that the new technology will only be available to the very large producers, which will force the smaller ones out of business

9.

a. 8	e. 6
b. 3	f. 2
c. 5	g. 7
d. 1	h. 4

10. Answer should include eight of the following:

    Scientists and engineers; Business and finance; Producers; Communication specialists; Natural resources; Sales personnel; Lawyers; Professional managers; Marketing personnel; Regulating specialists; Financial analysts; Others?

11. Answer should include eight of the following:

    Scientific/Research Director; Molecular Biologist; Enzymologist; Immunology Specialist; Food Additive Biochemist; Pesticide and Herbicide Researcher; Statistician; Genetics Engineer; Soil Biologist; Plant Breeding Specialist; Plant Physiologist; Bacterial Geneticist; Microbial Biotechnician; Fertilizer and Microbial Nitrogen Fixation Specialist; Vaccine Biologist; Soil Biochemist; Genetic Sequence Computer Analyst; Cytobiologist; Endocrinologist; Bioproducts Developer; Animal Cell Culture Biochemist; Plant Tissue Culture Technician/Propagator; Embryo Transplant Researcher; Plant and Animal Disease Diagnostician; Others?

GESTATION AND PREGNANCY DETERMINATION

AG 534 - U

UNIT OBJECTIVE

After completion of this unit, students should be able to list the gestation lengths for domestic animals, list the embryonic membranes, and the age of developmental periods of the embryo. Students should also be able to outline methods of pregnancy determination and list the determining characteristics for age of the fetus in the cow. This knowledge will be demonstrated by completion of a laboratory exercise and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. List the gestation lengths for the cow, mare, sow and ewe.
2. Describe the importance of progesterone to maintenance of pregnancy.
3. Indicate the source of progesterone in the cow, mare, sow and ewe.
4. List and describe the three stages of development of prenatal young.
5. List and describe the three cell layers of the gastrula.
6. List and describe the three extraembryonic membranes.
7. List the age of the embryo developmental periods of the calf.
8. List the age of the embryo developmental periods of the lamb.
9. List the age of the embryo developmental periods of the pig.
10. List the age of the embryo developmental periods of the foal.
11. List the three types of placentae structure, the layers of cell types in each, and the species in which each is found.
12. List and describe the three placentae shapes and the species in which each is found.
13. List four reasons for pregnancy determination.
14. Name five distinct indications of pregnancy detectable in rectal examination.
15. Name the techniques used in pregnancy testing of ewes and sows.
16. List the determining characteristics for age of the fetus in the cow at 30 days of gestation, 120 days of gestation, and 270 days of gestation.
17. Pregnancy test a cow using rectal examination.

GESTATION AND PREGNANCY DETERMINATION

AG 534 - U

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

A. Make transparencies and necessary copies of materials.

B. Provide students with objectives and discuss.

C. Provide students with information and discuss.

D. Provide students with laboratory exercise.

E. Demonstrate laboratory exercise procedures.

F. Review and give test.

G. Reteach and retest if necessary.

II. Instructional materials

A. Objective sheet

B. Suggested activities

C. Information sheet

D. Transparency masters

1. TM 1--Spread and Differentiation of Mesoderm

2. TM 2--Prenatal Development From Conception to Birth

3. TM 3--Stages of Pregnancy

E. Laboratory exercise

1. LE 1--Pregnancy Test a Cow Using Rectal Examination

F. Test

G. Answers to test

III. Unit references

A. Barrick, R., and Harmon, H., *Animal Production and Management*, McGraw-Hill Book Company, New York, 1988.

B. Bearden and FuQuay, *Applied Animal Production*, Prentice-Hall, Englewood Cliffs, New Jersey, 1980.

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F. Lasley, John F., *Genetics of Livestock Improvement*, 3rd edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1978.

G. Sorensen, A.M., *Animal Reproduction Principles and Practices*, McGraw-Hill Book Company, New York, 1979.

GESTATION AND PREGNANCY DETERMINATION

AG 534 - U

INFORMATION SHEET

I. Gestation periods

(Note: The following gestation periods are based on an average.)

A. Cow--283 days

B. Mare--336 days

C. Sow--114 days

D. Ewe--150 days

II. Progesterone and pregnancy maintenance

A. Importance--maintains quiet condition in uterus with increased ability to transfer nutrients and remove waste products

B. Source

1. Placenta - ewe, mare

2. Corpus luteum - sow, cow

III. Stages of development of prenatal young

A. Ovum--period of time from fertilization until change in shape and cellular makeup

1. Zygote continues to divide until solid mass of cells is formed (morula)

2. Blastula--fluid-filled cavity that develops from the morula

3. Zona pellucida ruptures

B. Embryo--cell structures change from indifferent types to specialized cells to develop into tissues and organs to form the gastrula

1. Gastrula--three cell layers

a. Ectoderm (outer skin)

(1) Outer skin, epidermis, hair, hooves, brain and nervous system

(2) Lines mouth

b. Mesoderm (middle skin) (Tranparency 1)

(1) Structural tissue (muscle, cartilage, ligaments and bones)

(2) Organs of circulation (heart, vascular system, lymph vessels)

(3) Gonads and genital ducts

c. Entoderm (inner skin)

(1) Glands

(2) Liver

(3) Gastrointestinal tract lining

2. Extraembryonic membranes

a. Chorion--outer covering

b. Amnion--innermost membrane surrounding embryo; protects the embryo; collects urine later on

c. Allantois--responsible for vascularization of outer membrane; collects urine early on

C. Fetus--extraembryonic membranes attach to the endometrium; structure changes from free-floating to attached; organ and structure development; major growth and development

1. Placenta

2. Reproductive embryology--indifferent stages of reproductive organs for male and female are present; genetic makeup determines which will develop and which will regress

a. Gonad (testis, ovaries)

b. Mesonephric tubules (efferent ducts in males, vestigal structures in females)

d. Mesonephric ducts (male epididymis, deferent ducts, vesicular glands)

d. Mullerian ducts (female-oviducts, cornua, body of the uterus, cervix, vagina; male-vestigal structures)

e. Muller's tubercle (male-colliculus seminalis; female-site of the hymen)

f. Urogenital sinus (male-pelvic urethra, prostate gland, bulbourethral glands; female-vestibule)

g. Genital tubercle

(1) Phallus (male-penis; female-clitoris; glans of both)

(2) Urethral groove (female-vaginal lips; male-shaft of penis)

(3) Shaft (male-structural body of penis; female-structural body of clitoris)

h. Labioscrotal swellings (male-scrotum; female-labia of vulva)

IV. Embryo developmental periods (Tranparency 2)

A. Calf

1. Primitive streak (19.5 days)

2. Neurula (20.5 days)

3. Tailbud embryo (30 days)

4. Late embryo (40 days)

5. Early fetus (52 days)

B. Lamb

1. Primitive streak (14 days)

2. Neurula (17 days)

3. Tailbud embryo (19 days)

4. Late embryo (32 days)

5. Early fetus (40 days)

C. Pig

1. Primitive streak (12 days)

2. Neurula (15 days)

3. Tailbud embryo (17 days)

4. Late embryo (29 days)

5. Early fetus (36 days)

D. Foal

1. Primitive streak (15 days)

2. Tailbud embryo (26 days)

3. Late embryo (35 days)

4. Early fetus (55 days)

V. Placentae structure

A. Epitheliochorial

1. Cow, sow, mare

2. All six layers of cell types

a. Endothelium--line blood vessels of endometrium (dam)

b. Connective tissue--forms network to hold things together (dam)

c. Epithelium--covering surface of uterus (dam)

d. Epithelium of chorion (placenta-fetus)

e. Connective tissue (placenta-fetus)

f. Endothelium (placenta-fetus)

B. Syndesmochorial

1. Ewe

2. Only five layers of cell types--no epithelium layer in the dam (refer to total 6 layers in epitheliochorial structure)

C. Hemochorial

1. Woman

2. The three cell layers in the fetus only

VI. Placentae shape

A. Diffuse

1. Mare, sow

2. Villi attach most or all placental surface

B. Cotyledonary

1. Cow, ewe

2. Cotyledons serve as points of nutrient exchange

C. Discoid

1. Woman

2. Round, flattened with some curvature (like a disc)

VII. Reasons for pregnancy determination

A. Predict date of parturition

B. Make preparations for parturition

C. Supply necessary nutrients and management

D. Eliminate nonbreeders

1. Cut winter feed bills

2. Increase profits

Example: Setting goal of 90-95% calf crop within 30 days

VIII. Indications of pregnancy (Tranparency 3)

A. Palpation of fetus

B. Presence of fluid in uterine horn

(Note: The uterine horn changes in shape and size during different stages of pregnancy.)

C. Presence of "fetal membrane slip"

D. Palpation of amnionic vesicle

(Caution: If this is not done carefully it can result in hemorrhaging and should be avoided unless necessary.)

E. Presence and size of cotyledons

(Note: These can be detected by about the 65th day of pregnancy.)

F. Diameter and pulse rate of uterine artery

G. Location of uterus

(Note: Uterus begins to descend over front of pelvic girdle after 75 days of pregnancy.)

IX. Pregnancy testing ewes and sows

A. Ewes

1. Ultra-sonic devices measure fluid in uterus

2. Rectal-abdominal palpation

(Note: The ewe is laid on her back and a plastic tube is placed in her rectum to push the fetus to the abdominal wall. The fetus is then palpated through the abdominal wall.)

B. Sows--Ultra-sonic devices measure fluid in uterus

X. Determining characteristics for fetus age in cow

A. 30 days of gestation

1. .05 inches long

2. One uterine horn slightly enlarged; thin

3. Embryonic vesicle size of marble

B. 45 days of gestation

1. 1 - 1.25 inches long

2. Uterine horn slightly enlarged, thinner walled and prominent

3. Embryonic vesicle size of chicken egg

C. 60 days of gestation

1. 2.5 inches long

2. Uterine horn--size of banana, fluid filled and pulled over pelvic brim into body cavity

3. Fetus--size of mouse (head--size of a marble)

D. 90 days of gestation

1. 5 - 6 inches long

2. Both uterine horns swollen; 3 - 3 1/2 inches in diameter; pulled deeply into body cavity

3. Fetus--size of rat (head--size of ping-pong ball)

4. Uterine artery--.12 - .2 inches in diameter

E. 120 days of gestation

  1. 10 - 12 inches long
  2. Fetus--size of small cat (head--size of lemon)
  3. Uterine artery - .25 inches in diameter

F. 150 days of gestation

  1. 12 - 16 inches long
  2. Fetus--size of large cat (head--size of baseball)
  3. Uterine artery - .25 - .4 inches in diameter

G. 180 days of gestation

  1. 20 - 24 inches long
  2. Horns filling with fetus cavity
  3. Fetus--size of small dog (head--size of orange)
  4. Uterine artery - .4 - .5 inches in diameter

H. 210 days of gestation

  1. 24 - 32 inches long
  2. Uterine artery--.5 inches in diameter
  3. Difficult to determine age by fetal size

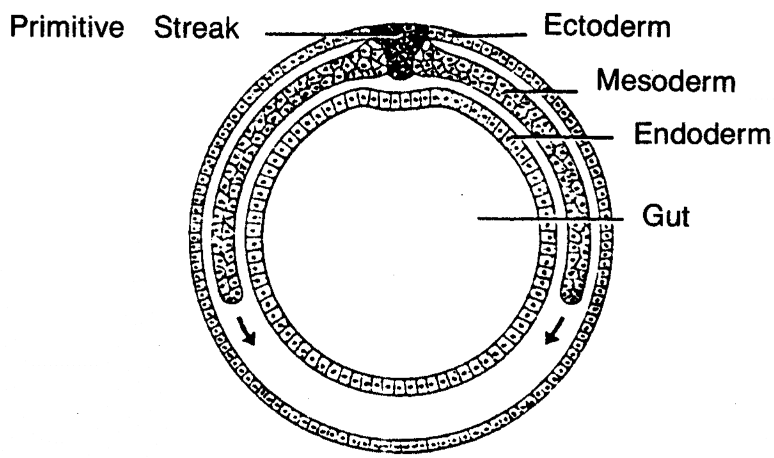
I. 240 days of gestation

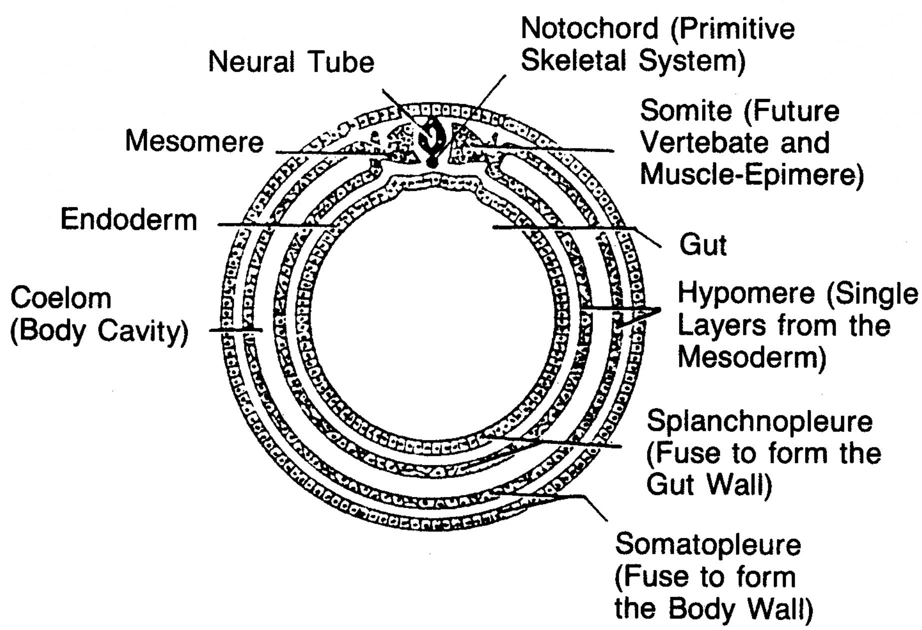
  1. 28 - 36 inches long
  2. Uterine artery - .5 - .6 inches in diameter
  3. Difficult to determine age by fetal size

J. 270 days of gestation

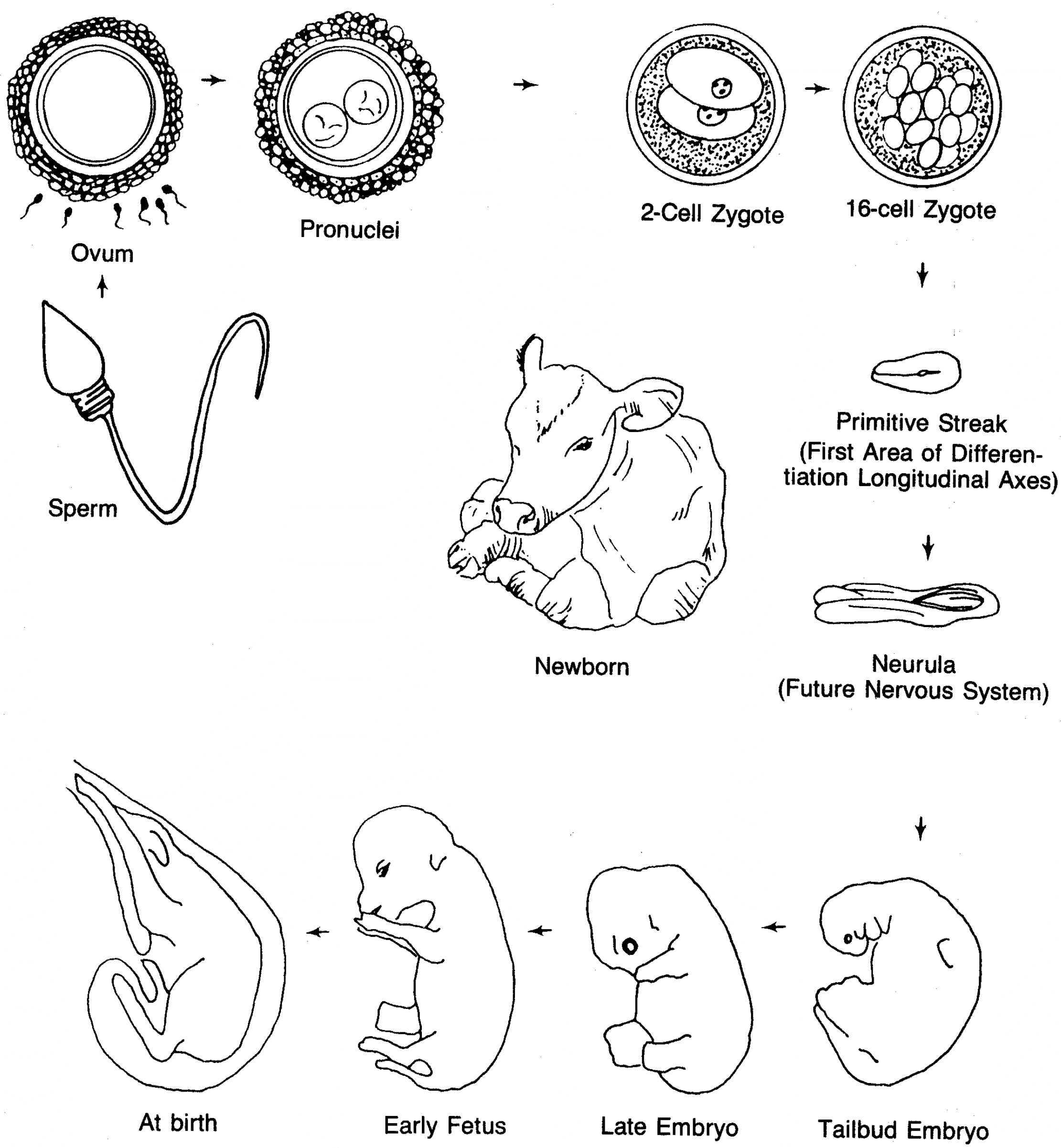
  1. 28 - 38 inches long
  2. Uterine artery - .5 - .75 inches in diameter
  3. Difficult to determine age by fetal size

Spread and Differentiation of Mesoderm

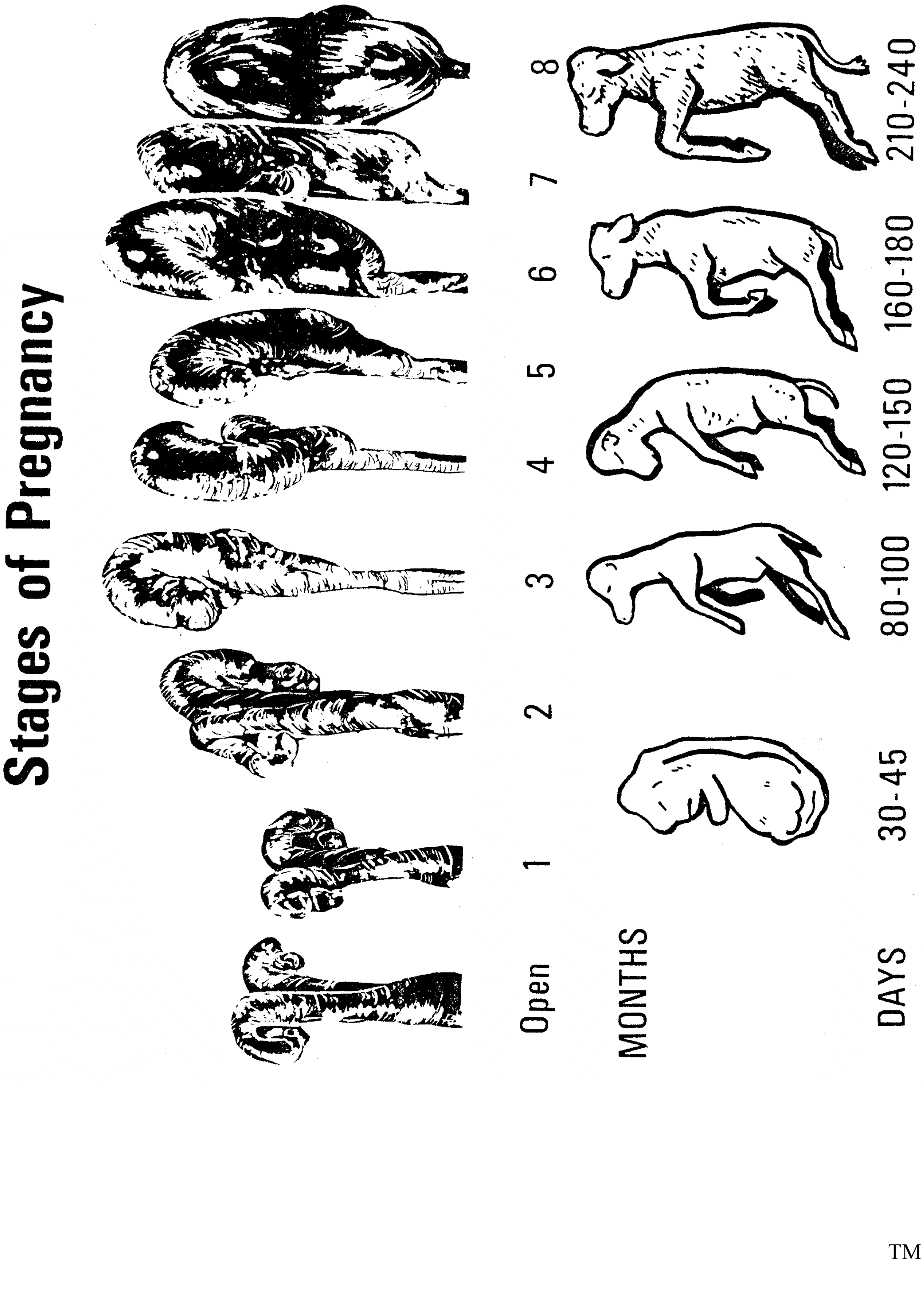




Prenatal Development from Conception to Birth



TM 2


Stages of Pregnancy
Open
MONTHS
1
2
3
4
5
6
7
8
DAYS
30-45
80-100
120-150
160-180
210-240

GESTATION AND PREGNANCY DETERMINATION

AG 534 - U

LABORATORY EXERCISE #1--PREGNANCY TEST A COW USING RECTAL EXAMINATION

Tools and equipment

A. Chute

B. Plastic gloves

C. Lubricant

D. Cow showing indications of pregnancy

Procedure

(Caution: A person trained in pregnancy testing should be on hand to assist with instruction.)

A. Place cow in chute

B. Place plastic glove on left hand

(Note: Be sure to remove any jewelry that you might be wearing.)

C. Wet plastic glove with water and apply lubricant

D. Grasp the cow's tail with right hand and move the tail to the left side of the cow

E. Insert left hand and arm into the cow's rectum to a depth of approximately six inches

(Caution: This should be done carefully to prevent damage to the cow or the fetus.)

F. Remove feces as necessary in order to be able to palpate with fingers

G. Locate the cervix and position hand in the same manner as in artificial insemination

H. Notice position of cervix in relation to pelvic cavity

(Note: If cervix is not found on pelvic floor at an approximate depth of six inches, it is a good indication that the cow could be pregnant. If this is the case, while holding the cervix in the hand, attempt to pull the cervix back up on the floor of the pelvic girdle for easier palpation.)

I. Move hand slowly down the tract to the separation of the uterus where the two uterine horns lead off, without turning loose of reproductive tract

J. Palpate each horn in order to determine if one horn is larger than the other

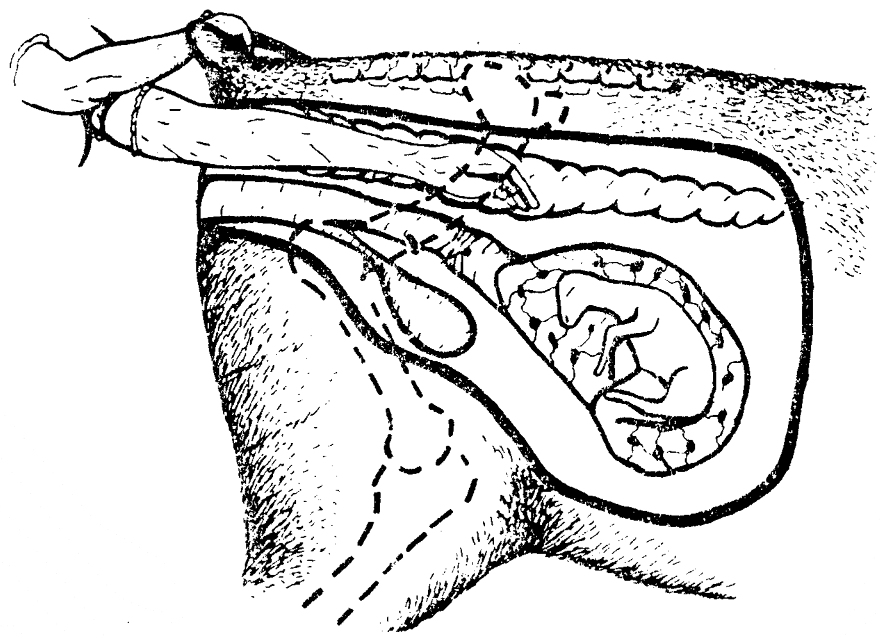
(Note: Remember, do not turn loose of the tract because you might forget which horn you are palpating.)

(Caution: Do not squeeze the horns, simply rub or palpate each one.)

K. Rely on the different stages and indications of pregnancy and determine if the cow you are examining is pregnant

L. Reveal your findings to the instructor for evaluation

III. Diagram of procedure



GESTATION AND PREGNANCY DETERMINATION

AG 534 - U

UNIT TEST

Name ______________________________ Score ______________________________

1. List the gestation lengths for the cow, mare, sow and ewe.

   a. Cow ______________________________

   b. Mare ______________________________

   c. Sow ______________________________

   d. Ewe ______________________________

2. Describe the importance of progesterone to maintenance of pregnancy.

   ____

   ____

   ____

3. Indicate the source of progesterone in the cow, mare, sow and ewe.

   a. Cow ______________________________

   b. Mare ______________________________

   c. Sow ______________________________

   d. Ewe ______________________________

4. List and describe the three stages of development of prenatal young.

   a. ______________________________

   ____

   ____

   ____

   b. ______________________________

   ____

   ____

   ____

c.____

5. List and describe the three cell layers of the gastrula.

a.____

b.____

c.____

6. List and describe the three extraembryonic membranes.

a.____

b.____

c.____

7. List the age of the embryo developmental periods of the calf.

a. Primitive streak ____________________________

b. Neurula ____________________________

c. Tailbud embryo ____________________________

d. Late embryo____________________________

e. Early fetus ____________________________

8. List the age of the embryo developmental periods for the lamb.

    a. Primitive streak ____________________

    b. Neurula ____________________

    c. Tailbud embryo ____________________

    d. Late embryo____________________

    e. Early fetus ____________________

9. List the age of the embryo developmental periods for the pig.

    a. Primitive streak ____________________

    b. Neurula ____________________

    c. Tailbud embryo ____________________

    d. Late embryo____________________

    e. Early fetus ____________________

10. List the age of the embryo developmental periods for the foal.

    a. Primitive streak ____________________

    b. Tailbud embryo ____________________

    c. Late embryo____________________

    d. Early fetus ____________________

11. List the three types of placentae structure, the layers of cell types in each, and the species in which each is found.

    A. ____________________

    Cell types:

    a. ____________________

    b. ____________________

    c. ____________________

    d. ____________________

    e. ____________________

f. ______________________________

Species: ______________________________

B. ______________________________

Cell types:

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

Species: ______________________________

C. ______________________________

Cell types: ______________________________

____

Species: ______________________________

12. List and describe the three placentae shapes and the species in which each is found.

a. Shape: ______________________________

Description: ______________________________

____

Species: ______________________________

b. Shape: ______________________________

Description: ______________________________

____

Species: ______________________________

c. Shape: ______________________________

Description: ______________________________

____

Species: ______________________________

13. List four reasons for pregnancy determination.

a.____

b. ____

c.____

d. ____

14. Name five distinct indications of pregnancy detectable in rectal examination.

a.____

b. ____

c.____

d. ____

e.____

15. Name the techniques used in pregnancy testing of ewes and sows.

Ewes

a.____

b. ____

Sows____

____

16. List the determining characteristics for age of the fetus in the cow at 30 days of gestation, 120 days of gestation, and 270 days of gestation.

30 days

a.____

b. ____

c.____

120 days

a.____

b. ____

c.____

270 days

a.____

b. ____

c.____

GESTATION AND PREGNANCY DETERMINATION

AG 534 - U

ANSWERS TO TEST

1. Cow--283 days; Mare--336 days; Sow--114 days; Ewe--150 days

2. Maintains quiet condition in uterus with increased ability to transfer nutrients and remove waste products

3. Cow--Corpus luteum; Mare--Placenta; Sow--Corpus luteum; Ewe--Placenta

4. a. Ovum--period of time from fertilization until change in shape and cellular makeup
   b. Embryo--cell structures change from indifferent types to specialized cells to develop into tissues and organs to form the gastrula
   c. Fetus--extraembryonic membranes attach to the endometrium; structure changes from free-floating to attached; organ and structure development; major growth and development

5. a. Ectoderm (outer skin): Outer skin, epidermis, hair, hooves, brain and nervous system; Lines mouth
   b. Mesoderm (middle skin): Structural tissue (muscle, cartilage, ligaments and bones); Organs of circulation (heart, vascular system, lymph vessels); Gonads and genital ducts
   c. Entoderm (inner skin): Glands; Liver; Gastrointestinal tract lining

6. a. Chorion--outer covering
   b. Amnion--innermost membrane surrounding embryo; protects the embryo; collects urine later on
   c. Allantois--responsible for vascularization of outer membrane; collects urine early on

7. a. 19.5 days
   b. 20.5 days
   c. 30 days
   d. 40 days
   e. 52 days

8. a. 14 days
   b. 17 days
   c. 19 days
   d. 32 days
   e. 40 days

9. a. 12 days
   b. 15 days
   c. 17 days
   d. 29 days
   e. 36 days

10. a. 15 days
    b. 26 days
    c. 35 days
    d. 55 days

11. A. Epitheliochorial
       1. Endothelium--line blood vessels of endometrium (dam)
       2. Connective tissue--forms network to hold things together (dam)
       3. Epithelium--covering surface of uterus (dam)

4. Epithelium of chorion (placenta-fetus)
5. Connective tissue (placenta-fetus)
6. Endothelium (placenta-fetus)

Found in: Cow, sow, mare

B. Syndesmochorial
1. Endothelium--line blood vessels of endometrium (dam)
2. Connective tissue--forms network to hold things together (dam)
3. Epithelium of chorion (placenta-fetus)
4. Connective tissue (placenta-fetus)
5. Endothelium (placenta-fetus)

Found in: Ewe

C. Hemochorial
1. Epithelium of chorion (placenta-fetus)
2. Connective tissue (placenta-fetus)
3. Endothelium (placenta-fetus)

Found in: Woman

12 a. Diffuse: Villi attach most or all placental surface; Mare, sow
b. Cotyledonary: Cotyledons serve as points of nutrient exchange; Cow, ewe
c. Discoid: Round, flattened with some curvature (like a disc); Woman

13. Predict date of parturition; Make preparations for parturition; Supply necessary nutrients and management; Eliminate nonbreeders

14. Answer should include five of the following:

Palpation of fetus; Presence of fluid in uterine horn; Presence of "fetal membrane slip"; Palpation of amnionic vesicle; Presence and size of cotyledons; Diameter and pulse rate of uterine artery; Location of uterus

15. Ewes: Ultra-sonic devices measure fluid in uterus; Rectal-abdominal palpation
Sows: Ultra-sonic devices measure fluid in uterus

16. 30 days of gestation: .05 inches long; One uterine horn slightly enlarged; thin; Embryonic vesicle size of marble

120 days of gestation: 10 - 12 inches long; Fetus--size of small cat (head--size of lemon); Uterine artery - .25 inches in diameter;

270 days of gestation: 28 - 38 inches long; Uterine artery - .5 - .75 inches in diameter; Difficult to determine age by fetal size

PARTURITION AND THE POSTPARTUM PERIOD

AG 534 - V

UNIT OBJECTIVE

After completion of this unit, students should be able to describe factors influencing parturition and describe the process of parturition. Students should also be able to explain what to do if the cow retains her placenta and list problems involved with induced parturition in cattle. This knowledge will be demonstrated by completion of laboratory exercises and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Define terms associated with parturition and the postpartum period.
2. List the six factors influencing parturition.
3. Explain what changes occur in progesterone and estrogen at parturition in the cow, ewe, sow,and mare.
4. Describe the process of parturition in the cow and ewe.
5. Describe the process of parturition in the sow.
6. Describe the process of parturition in the mare.
7. List the problems that may arise during the birth of a calf and methods of alleviating them.
8. List the problems that may arise during the birth of a lamb and methods of alleviating them.
9. List the problems that may arise during the birth of piglets and methods of alleviating them.
10. List the problems that may arise during the birth of a foal and methods of alleviating them.
11. Discuss the relationship of the postpartum period to ensuing estrous activity and conception in the cow.
12. Discuss the relationship of the postpartum period to ensuing estrous activity and conception in the ewe.
13. Discuss the relationship of the postpartum period to ensuing estrous activity and conception in the sow.
14. Discuss the relationship of the postpartum period to ensuing estrous activity and conception in the mare.

15. Explain what "foal heat" is and how it differs from postpartum estrus in the sow.

16. Explain what should be done if the cow retains her placenta.

17. List the problems involved with induced parturition in cows.

18. Indicate when it would be profitable to induce parturition in cattle.

19. Assist a cow in calving.

20. Assist a ewe at lambing.

21. Farrow a sow.

PARTURITION AND THE POSTPARTUM PERIOD

AG 534 - V

SUGGESTED ACTIVITIES

I. Suggested activities for instructor

   A. Make transparencies and necessary copies of materials.

   B. Provide students with objectives and discuss.

   C. Provide students with information and discuss.

   D. Provide students with laboratory exercises.

   E. Demonstrate laboratory exercise procedures.

   F. Review and give test.

   G. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM 1--Normal Calf and Lamb Delivery Position

      2. TM 2--Calf in Wrong Position: Head Back

      3. TM 3--Calf in Wrong Position: Leg Back

      4. TM 4--Calf in Wrong Position: Dog-Sitting Position

      5. TM 5--Calf in Wrong Position: Backwards With Rear Legs Extended

      6. TM 6--Calf in Wrong Position: Upside Down and Backward

      7. TM 7--Calf in Wrong Position: Breech

   E. Laboratory exercises

      1. LE 1--Assist a Cow in Calving

      2. LE 2--Assist Ewe at Lambing

      3. LE 3--Farrow a Sow

F. Test

G. Answers to test

III. Unit references

A. Barrick, R., and Harmon, H., *Animal Production and Management*, McGraw-Hill Book Company, New York, 1988.

B. Bearden and FuQuay, *Applied Animal Production*, Prentice-Hall, Englewood Cliffs, New Jersey, 1980.

C. Bundy, C.E., et al., *Livestock and Poultry Production*, 5th edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1982.

D. Ensminger, M.E., *Animal Science*, Interstate Publishers, Danville, Illinois, 1983.

E. *Idaho State Board for Vocational Education Curriculum Guide in Livestock Production*, University of Idaho and the Idaho State Board for Vocational Education.

F. Lasley, John F., *Genetics of Livestock Improvement*, 3rd edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1978.

G. Sorensen, A.M., *Animal Reproduction Principles and Practices*, McGraw-Hill Book Company, New York, 1979.

PARTURITION AND THE POSTPARTUM PERIOD

AG 534 - V

INFORMATION SHEET

I. Terms and definitions

A. Parturition--The act or process of giving birth

B. Breech--Backward at birth

C. Embryotomy--Cutting up of a fetus while it is still inside the mother to remove it

(Note: This procedure is done by a veterinarian.)

D. Afterbirth--Placenta; expelled by dam after parturition

E. Dystocia--Difficult labor or delivery

F. Cesarean section--Surgical removal of the fetus

G. Postpartum--The period of time after birth

H. Uterine involution--Return of muscles, caruncles, vascular system, connective tissue, etc. of uterus to normal size and shape after parturition

II. Factors influencing parturition

A. Hormonal control

1. Progesterone

a. Decreases in latter part of pregnancy

b. Responsible for quiet condition of myometrium

c. Decreases as estrogen level increases

d. Rises slightly in mare in latter part of pregnancy

2. Estrogen

a. Increases in latter part of pregnancy

b. Important in labor initiation, expulsion of placenta and lactogenesis

c. Peaks at parturition

d. Much higher concentration than progesterone in mare in latter stages of pregnancy

3. Oxytocin

a. Supplements action of myometrial contraction

b. Peaks at moment of delivery in cow, ewe and mare

4. Relaxin

a. Released by ovary just prior to parturition

b. Stimulated by prostaglandins

c. Works with estrogen to open birth canal

B. Other compounds

1. Fetal adrenal--responsible for parturition

2. Prostaglandins

a. Produced by pregnant horn; released into uterine vein draining that side

b. Cause decrease in progesterone

III. Parturition--cow and ewe

A. Stage 1--period immediately before birth (Transparency 1)

1. Calf (lamb) assumes normal delivery position

a. Front feet and legs form wedge with head between them

b. Followed by shoulders, rib cage, hip area, hind legs and feet

2. Cervix dilates

B. Stage 2--actual period of birth

1. Rupture of membranes

2. Passage of fluids

3. Expulsion of fetus

- C. Stage 3--period after birth
  - 1. Passage of placenta
  - 2. Involution of reproductive tract

IV. Parturition--sow

- A. Membranes pushed into birth canal
  - 1. Rupture
  - 2. Release fluid
- B. Pigs expelled
- C. Placenta expelled

V. Parturition--mare

- A. Stage 1
  - 1. Cervix relaxes and dilates
  - 2. Uterus contracts--foal assumes position similar to calf
- B. Stage 2
  - 1. Chorioallantoic membrane moves into cervical canal and ruptures, followed by amnioallantoic membrane
  - 2. Foal expelled (same position as calf)
- C. Stage 3--placenta expelled

VI. Possible problems during parturition--cow

- A. Problems
  - 1. Calf too big
  - 2. Cow too small
  - 3. Calf in wrong position (e.g. breech) (Transparencies 2, 3, 4, 5, 6, 7)
  - 4. Lack of effort on part of the cow
- B. Remedies
  - 1. Pull calf
    - a. By hand
    - b. With calf-pullers

2. Cesarean--surgically open abdominal cavity and remove calf

3. Symphysiotomy--pelvis split (in young heifer), then spread so calf may be extracted through pelvis instead of cesarean

4. Use arm to rotate calf to correct position

VII. Possible problems during parturition--ewe

A. Problems

1. Lamb too large

2. Ewe too small

3. Cervix not dilated

B. Remedies

1. Pull by hand

2. Cesarean (rare)

VIII. Possible problems during parturition--sow

A. Problems

1. Piglets too large

2. Small gilt

B. Remedies

1. Pull by hand

2. Cesarean

IX. Possible problems during parturition--mare

A. Problems

1. Fetus turned crosswise

2. Foal too large

B. Remedies

1. Use arm to rotate foal to correct position

2. Cesarean

X. Relationship of postpartum period to ensuing estrus activity and conception

A. Cow

1. Uterine involution--30-40 days

2. Beef cow returns to estrus in 40-60 days

3. Dairy cow returns to estrus in 30-40 days

4. Rebreed at second fertile estrus (60-90 days)

B. Ewe

1. Uterine involution--17-28 days

2. Seasonal breeders (if lambed during normal season, won't rebreed for several months)

C. Sow

1. Uterine involution--28 days

2. Returns to normal estrus after pigs are weaned

3. Rebreed 2-10 days after pigs weaned

4. Postpartum estrus

a. 3-10 days after parturition

b. Infertile estrus (no follicles develop)

D. Mare

1. Returns to normal estrus 45 days after parturition

2. Ready to rebreed at this time

3. Foal heat--estrus 5-15 days after parturition

a. May be rebred to reduce foaling interval

b. Mare must be healthy, expelled entire placenta, have no infection or discharge, and her reproductive tract must be in latter stages of involution

XI. Retained placenta in cow

A. More frequent in premature births, twin births, cows deficient in Vitamin A or selenium, and cows with uterine disease

B. Do not try to remove the placenta

C. Treat cow with high doses of antibiotics to combat infection

XII. Induced parturition in cattle

A. Problems

1. Retained placenta

2. Rebreeding--lower conception

B. Reasons for inducing parturition

1. Advance late-calving cows to keep them on schedule with herd

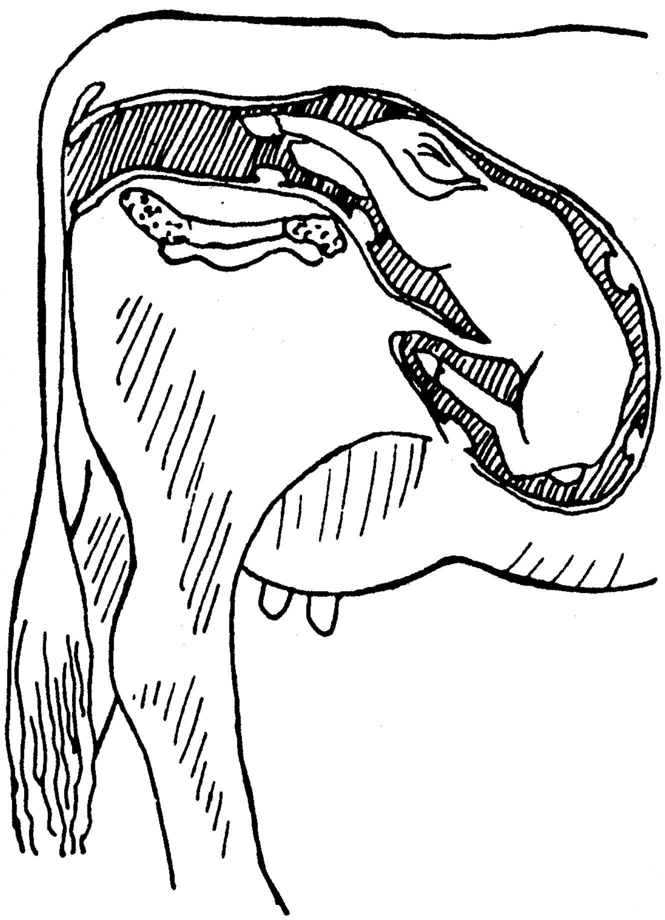
2. Concentrated labor--have a group calve at a given time

3. Smaller calf at parturition--reduces calving problems

4. Shorten generation interval

NORMAL CALF AND LAMB DELIVERY POSITION

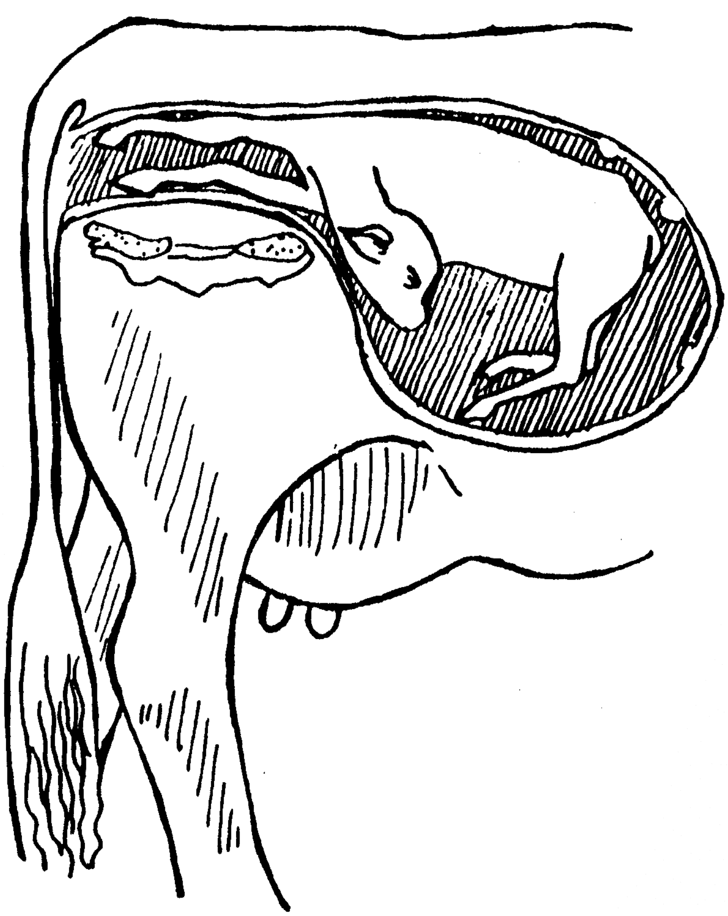
Normal--Both front legs are outstretched in the birth canal with the head and neck extended between or along the legs



CALF IN WRONG POSITION: HEAD BACK

Head back--Head and neck must be pulled around in line with the birth canal

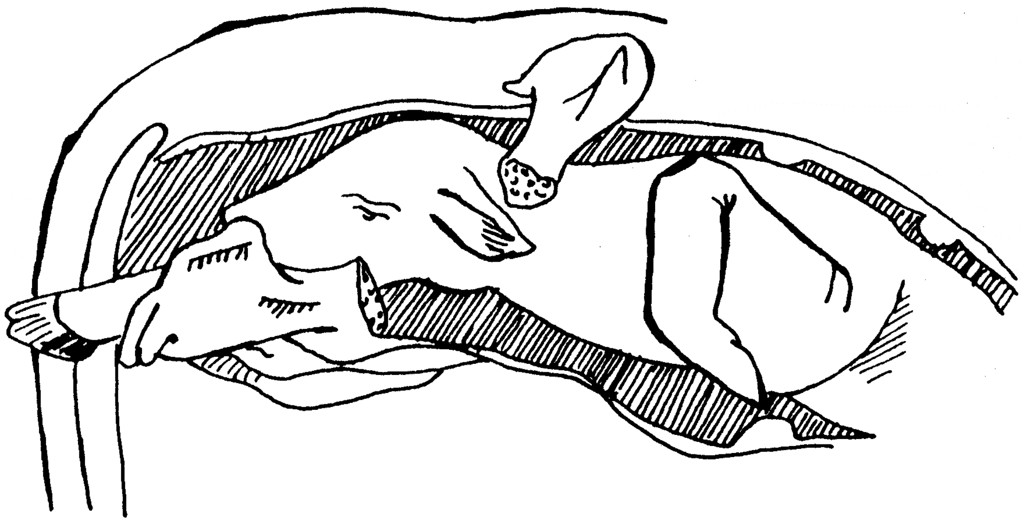
(NOTE: Push the calf or lamb back and quickly release it in order to grasp its nose with your hand. If this doesn't work, you may use an obstetrical chain. Place the chain around the poll, under the ears, and through the mouth. Take care not to cut the birth canal with the open jaws of the calf or lamb.)



CALF IN WRONG POSITION: LEG BACK

Leg back--Calf or lamb is pushed back and folded foot is held in hand

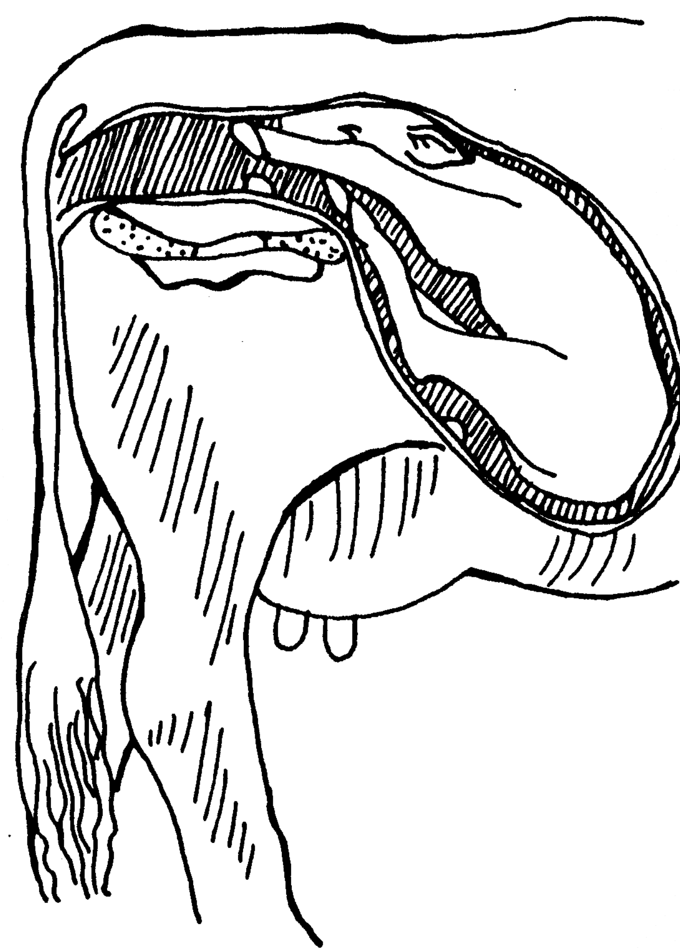
(NOTE: In extreme cases, an obstetrical chain may need to be used.)



CALF IN WRONG POSITION: DOG-SITTING POSITION

Dog-sitting position--Rear legs must be pushed back before birth can occur

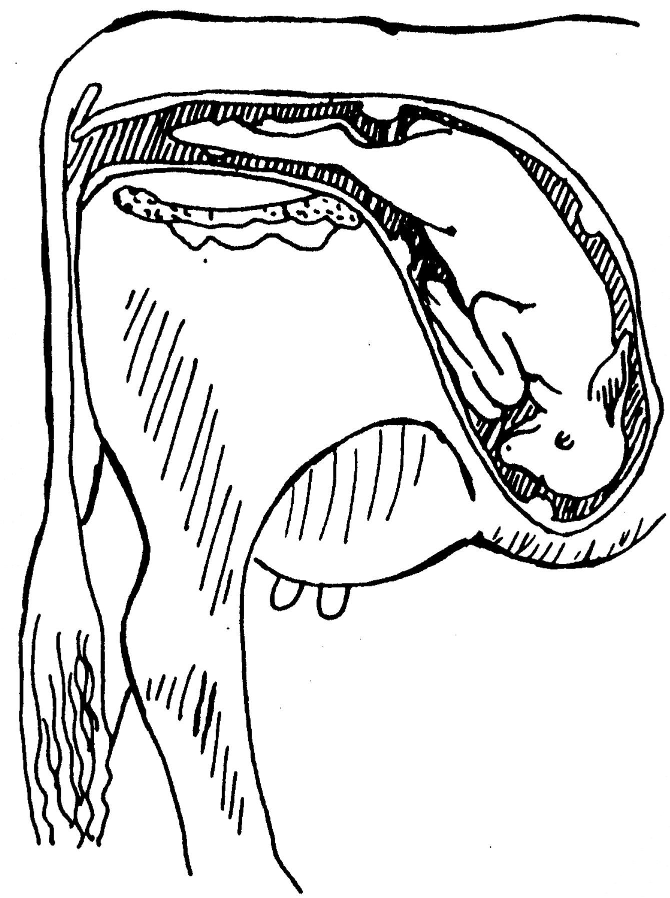
(NOTE: Veterinary assistance is needed as soon as possible.)



CALF IN WRONG POSITION: BACKWARDS WITH REAR LEGS EXTENDED

Backwards with rear legs extended--Breech birth in this position often requires no assistance

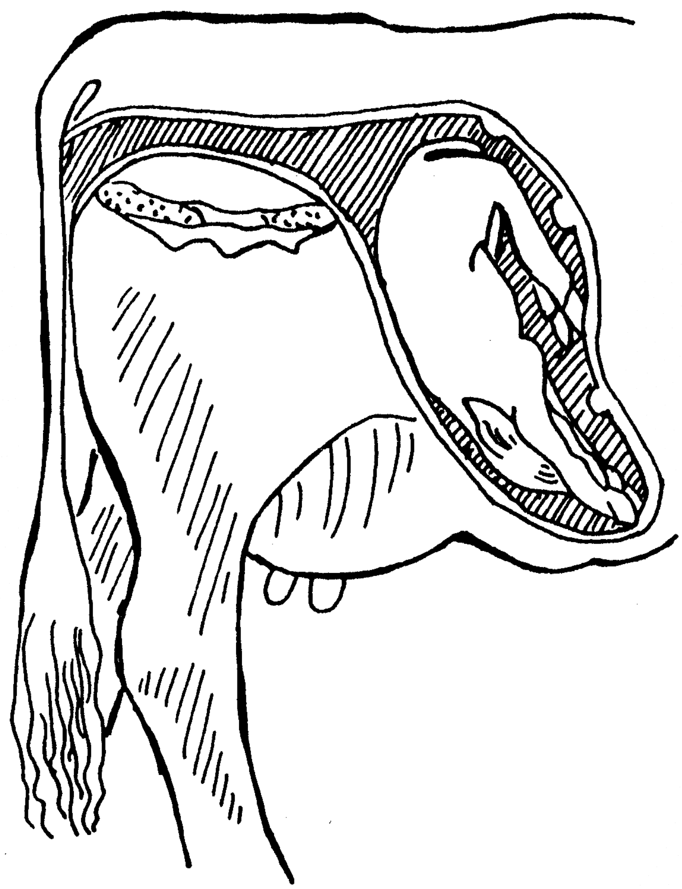
(NOTE: Any delay in the birth of a calf or lamb may cause it to suffocate when navel cord separates. Therefore, assistance will be required if there is a delay.)



CALF IN WRONG POSITION: UPSIDE DOWN AND BACKWARD

Upside down and backward--Calf or lamb has rotated from the normal position because of a twisting of the uterus

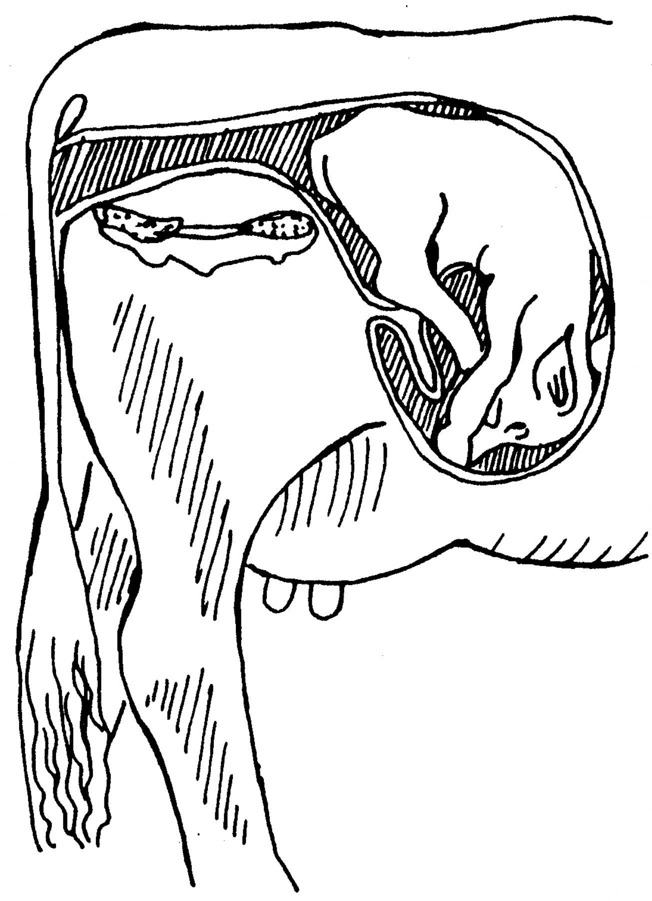
(NOTE: Veterinary help is needed. Never try to pull a calf or lamb in this position.)



CALF IN WRONG POSITION: BREECH

Breech--Calf or lamb should be pushed forward and rear legs pulled into birth canal

(NOTE: Place obstetrical chains on one rear leg at a time, push calf forward, and then pull leg into birth canal.)



PARTURITION AND THE POSTPARTUM PERIOD

AG 534 - V

LABORATORY EXERCISE #1--ASSIST A COW IN CALVING

Name ______________________________________ Score ___________________________________

I. Tools and equipment

A. Obstetrical chains

B. Obstetrical handles

C. Mechanical calf pullers

D. Obstetrical soap

E. Broad-range antibiotic

F. Furacin boluses

G. Tincture of iodine

H. Cow or heifer calving

I. Means of restraint if necessary

J. Plastic gloves

(Note: All equipment should be sterile.)

II. Procedure

(Note: This procedure should be followed if there is no progress after two or three hours of labor.)

A. Restrain animal if necessary

B. Scrub your hands and arms thoroughly with obstetrical soap

C. Wash cow's or heifer's vulva with obstetrical soap

D. Insert hand very slowly and gently, palm side down

E. Check calving position of fetus

F. Correct calving position to the normal position or call veterinarian if professional assistance is necessary

(CAUTION: If it is necessary to call veterinarian, do not continue with this exercise.)

G. Lubricate vaginal walls and fetus liberally using obstetrical soap

(Note: An ounce of lubrication is worth a ton of pressure.)

H. Make a loop in one end of obstetrical chain by placing small links through the large link at one end of chain

I. Place obstetrical chain on one foreleg above calf's fetlock and pull loop snugly

J. Make a loop on other end of obstetrical chain and place loop on other foreleg

K. Place mechanical calf pullers on lower portion of hindquarters with band on pullers over top of rump

L. Hook obstetrical chain onto cable of calf pullers

M. Take up slack on cable and chain

N. Examine calving position, making sure fetus is still in normal position

O. Pull down on mechanical calf pullers at a 45 degree angle from cow

P. Apply pressure slowly and firmly with calf pullers

(Note: If there is no progress, a veterinarian should be consulted. An extreme amount of pressure on pelvis can cause a fractured pelvis or nerve damage resulting in paralysis of the hindquarters.)

Q. Continue applying constant pressure downward until calf has arrived

R. Check calf's breathing

(Note: If calf has trouble breathing, remove the mucus from the nose and mouth. If the calf continues to have trouble breathing, grasp hind legs and swing it back and forth to dislodge mucus.)

S. Treat calf's navel cord with tincture of iodine

T. Give cow vaccination of broad-range antibiotic according to label directions

U. Check cow for retained placenta and paralysis twelve hours after delivery

(Note: If a retained placenta occurs, furacin boluses should be given according to label directions. If paralysis occurs, the cow may need assistance to get on her feet. Sometimes a cow may need assistance for several days or weeks. Other cases may result in permanent paralysis.)

PARTURITION AND THE POSTPARTUM PERIOD

AG 534 - V

LABORATORY EXERCISE #2--ASSIST EWE AT LAMBING

Name ______________________________ Score ______________________________

I. Tools and equipment

A. Sheep shearing clippers

B. Lambing pen

C. Tincture of iodine

D. Obstetrical soap

E. Broad-range antibiotic

F. Furacin boluses

G. Ewe ready to lamb

II. Procedure

A. Tag lamb by sheering wool from around udder, flank, and dock

B. Place ewe in lambing pen two or three days before lambing

C. Check for signs of labor twice daily

D. Check labor progress when it begins, but do not disturb the ewe unless she has labored for some time and shows no signs of progress

E. Scrub hands and arms thoroughly with obstetrical soap

F. Wash ewe's vulva with obstetrical soap

G. Check to see that lamb is in proper position by inserting hand into vulva

(Note: Many times there is more than one fetus so put one lamb in position to be delivered first.)

H. Correct to normal lambing position

(Note: Call veterinarian because of fetal position if necessary.)

I. Lubricate vaginal walls and fetus using obstetrical soap

(Note: An ounce of lubrication is worth a ton of pressure.)

J. Check lambing position

K. Pull each of lamb's forelegs alternately outward and downward as the ewe strains

L. Continue pulling until lamb is born

(Note: If another fetus is present, check its position and pull on its forelegs until it is born, relubricating if necessary.)

M. Check lamb's breathing

(Note: If lamb has trouble breathing, remove the mucus from the nose and mouth. If the lamb continues to have trouble breathing, grasp its hind legs and swing it back and forth to dislodge mucus.)

N. Treat lamb's navel cord with tincture of iodine

O. Give ewe vaccination of broad-range antibiotic according to label directions

P. Check ewe for retained placenta and paralysis twelve hours after delivery

(Note: If retained placenta occurs, furacin boluses should be given according to label directions. If paralysis occurs, the ewe may need assistance for several days; in other cases, there may be permanent paralysis.)

PARTURITION AND THE POSTPARTUM PERIOD

AG 534 - V

LABORATORY EXERCISE #3--FARROW A SOW

Name ______________________________________ Score ___________________________________

I. Tools and equipment

A. Farrowing facility (disinfected)

B. Tincture of iodine

C. Towels

D. Obstetrical soap

E. Disinfectant

F. Hot water, 20 gallons

G. POP (Purified Oxytocin Principle)

H. Cord

I. Scissors or knife

J. Broad-range antibiotic

K. Sow ready to farrow

II. Procedure

A. Sterilize farrowing facilities 3 or 4 days before farrowing

Example: One pound household lye mixed with 20 gallons hot water

B. Wash sow with soap and water before placing in farrowing facility 3 or 4 days before farrowing

C. Cut sow's ration in half 3 or 4 days before farrowing

(Note: No feed should be given to sow from twelve hours before farrowing to twelve hours after farrowing, but she should have free access to water at all times.)

D. Check for birth of a pig every 15 minutes after labor begins

(Note: If there is more than 30 minutes between pigs or if sow has labored for 2 1/2 hours and shows no signs of progress, then a vaginal examination is necessary. If there are no obstructions and the pig is in the normal position, then the sow may have uterine inertia. A 1 to 2 cc dose of POP [Purified Oxytocin Principle] should be given intramuscularly or subcutaneously every 20 to 30 minutes as needed.)

E. Pull umbilical cord out of sow gently when pig is born if it doesn't break off by itself

F. Remove mucus from pig's mouth

G. Dry pig off as soon as mucus is removed

H. Tie umbilical cord about one inch from body

I. Cut off remainder of umbilical cord with scissors or knife

J. Dip or swab umbilical cord of pig in tincture of iodine to disinfect area

K. Check sow for retained placenta 12 hours after delivery

L. Give sow injection of broad-range antibiotic according to label directions

(Note: It is important to provide the new litter with a heat lamp in a corner. This will attract them to the safety of the corner and keep them warm.)

PARTURITION AND THE POSTPARTUM PERIOD

AG 534 - V

UNIT TEST

Name ______________________________ Score ______________________________

1. Define terms associated with parturition and the postpartum period.

   a. Parturition ____
   ____

   b. Breech ____

   c. Embryotomy ____
   ____

   d. Afterbirth ____
   ____

   e. Dystocia ____

   f. Cesarean section ____
   ____

   g. Postpartum ____

   h. Uterine involution ____
   ____

2. List the six factors influencing parturition.

   a. ____

   b. ____

   c. ____

   d. ____

   e. ____

   f. ____

3. Explain what changes occur in progesterone and estrogen at parturition in the cow, ewe, sow, and mare.

   a. Progesterone ____________________

   ____

   ____

   ____

   b. Estrogen ____________________

   ____

   ____

   ____

4. Describe the process of parturition in the cow and ewe.

   a. ____________________

   ____

   ____

   b. ____________________

   ____

   ____

   c. ____________________

   ____

   ____

5. Describe the process of parturition in the sow.

   a. ____________________

   ____

   b. ____________________

   ____

   c. ____________________

   ____

6. Describe the process of parturition in the mare.

   a. ______________________________

   b. ______________________________

   c. ______________________________

7. List the problems that may arise during the birth of a calf and methods of alleviating them.

   Problems ______________________________

   Remedies ______________________________

8. List the problems that may arise during the birth of a lamb and methods of alleviating them.

   Problems ______________________________

   Remedies ______________________________

9. List the problems that may arise during the birth of piglets and methods of alleviating them.

   Problems ______________________________

Remedies ____

____

____

____

10. List the problems that may arise during the birth of a foal and methods of alleviating them.

Problems ____

____

____

Remedies ____

____

____

____

11. Discuss the relationship of the postpartum period to ensuing estrous activity and conception in the cow.

a. ____

____

b. ____

____

c. ____

____

d. ____

____

12. Discuss the relationship of the postpartum period to ensuing estrous activity and conception in the ewe.

a. ____

____

b. ____

____

13. Discuss the relationship of the postpartum period to ensuing estrous activity and conception in the sow.

    a. ____________________

    ____

    b. ____________________

    ____

    c. ____________________

    ____

    d. ____________________

    ____

14. Discuss the relationship of the postpartum period to ensuing estrous activity and conception in the mare.

    a. ____________________

    ____

    b. ____________________

    ____

15. Explain what "foal heat" is, and how it differs from postpartum estrus in the sow.

    ____

    ____

    ____

    ____

16. Explain what should be done if the cow retains her placenta.

    a. ____________________

    ____

    b. ____________________

    ____

17. List the problems involved with induced parturition in cows.

    a. ______________________________

    b. ______________________________

18. Indicate when it would be profitable to induce parturition in cattle.

    a. ______________________________
       ____

    b. ______________________________
       ____

    c. ______________________________
       ____

    d. ______________________________
       ____

PARTURITION AND THE POSTPARTUM PERIOD

AG 534 - V

ANSWERS TO TEST

1. a. The act or process of giving birth
   b. Backward at birth
   c. Cutting up of a fetus while it is still inside the mother to remove it
   d. Placenta; expelled by dam after parturition
   e. Difficult labor or delivery
   f. Surgical removal of the fetus
   g. The period of time after birth
   h. Return of muscles, caruncles, vascular system, connective tissue, etc. of uterus to normal size and shape after parturition

2. Progesterone; Estrogen; Oxytocin; Relaxin; Fetal adrenal; Prostaglandins

3. *Progesterone*: Decreases in latter part of pregnancy; Responsible for quiet condition of myometrium; Decreases as estrogen level increases; Rises slightly in mare in latter part of pregnancy

   Estrogen: Increases in latter part of pregnancy; Important in labor initiation, expulsion of placenta Peaks at parturition; Much higher concentration than progesterone in mare in latter stages of pregnancy

4. a. Stage 1--Period immediately before birth: Calf (lamb) assumes normal delivery position; Front feet and legs form wedge with head between them; Followed by shoulders, rib cage, hip area, hind legs and feet; Cervix dilates
   b. Stage 2--Actual period of birth: Rupture of membranes; Passage of fluids; Expulsion of fetus
   c. Stage 3--Period after birth: Passage of placenta; Involution of reproductive tract

5. a. Membranes pushed into birth canal; Rupture; Release fluid
   b. Pigs expelled
   c. Placenta expelled

6. a. Stage 1: Cervix relaxes and dilates; Uterus contracts--foal assumes position similar to calf
   b. Stage 2: Chorioallantoic membrane moves into cervical canal and ruptures, followed by amnioallantoic membrane; Foal expelled (same position as calf)
   c. Stage 3--Placenta expelled

7. Problems: Calf too big; Cow too small; Calf in wrong position; Lack of effort on part of the cow
   Remedies: Pull calf (by hand or with calf-pullers); Cesarean; Symphysiotomy; Use arm to rotate calf to correct position

8. Problems: Lamb too large; Ewe too small; Cervix not dilated
   Remedies: Pull by hand; Cesarean (rare)

9. Problems: Piglets too large; Small gilt
   Remedies: Pull by hand; Cesarean

10. Problems: Fetus turned crosswise; Foal too large
    Remedies: Use arm to rotate foal to correct position; Cesarean

11. a. Uterine involution--30-40 days
    b. Beef cow returns to estrus in 40-60 days
    c. Dairy cow returns to estrus in 30-40 days
    d. Rebreed at second fertile estrus (60-90 days)

12. a. Uterine involution--17-28 days
    b. Seasonal breeders (if lambed during normal season, won't rebreed for several months)

13. a. Uterine involution--28 days
    b. Returns to normal estrus after pigs are weaned
    c. Rebreed 2-10 days after pigs weaned
    d. Postpartum estrus: 3-10 days after parturition; Infertile estrus (no follicles develop)

14. a. Returns to normal estrus 45 days after parturition
    b. Ready to rebreed at this time

15. Foal heat refers to estrus in the mare 5-15 days after parturition. The mare may be rebred at this time. Postpartum estrus in the sow is an infertile estrus--no follicles develop

16. Do not try to remove the placenta; Treat cow with high doses of antibiotics to combat infection

17. Retained placenta; Rebreeding-lower conception

18. Advance late-calving cows to keep them on schedule with herd; Concentrated labor--have a group calve at a given time; Smaller calf at parturition--reduces calving problems; Shorten generation interval

REPRODUCTIVE DISEASES

AG 534 – W

UNIT OBJECTIVE

After completion of this unit, students should be able to identify symptoms of major reproductive diseases and list necessary specimens for diagnosis of reproductive diseases. Students should also be able to identify venereal diseases and explain why torsion of the umbilical cord causes abortion. This knowledge will be demonstrated by completion of a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Identify symptoms of major reproductive diseases.
2. List the necessary specimens needed for diagnosing by the veterinarian or diagnostic laboratory.
3. Identify the five diseases transmitted by coitus only (venereal diseases).
4. Describe the importance of preventive measures and the need for the veterinarian and diagnostic laboratory.
5. Indicate the hormone that may be deficient during gestation.
6. Explain what causes torsion of the umbilical cord and why it would cause abortion.

REPRODUCTIVE DISEASES

AG 534 - W

SUGGESTED ACTIVITIES

I. Suggested activities for instruction

   A. Make transparencies and necessary copies of materials.

   B. Provide students with objectives and discuss.

   C. Provide students with information and discuss.

   E. Give test.

   F. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM 1--Symptoms of Major Reproductive Diseases

      2. TM 2--Venereal Diseases

   E. Test

   F. Answers to test

III. Unit references

   A. Barrick, R., and Harmon, H., *Animal Production and Management*, McGraw-Hill Book Company, New York, 1988.

   B. Bearden and FuQuay, *Applied Animal Production*, Prentice-Hall, Englewood Cliffs, New Jersey, 1980.

   C. Bundy, C.E., et al., *Livestock and Poultry Production*, 5th edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1982.

   D. Ensminger, M.E., *Animal Science*, Interstate Publishers, Danville, Illinois, 1983.

   E. *Idaho State Board for Vocational Education Curriculum Guide in Livestock Production*, University of Idaho and the Idaho State Board for Vocational Education.

F. Lasley, John F., *Genetics of Livestock Improvement*, 3rd edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1978.

G. Sorensen, A.M., *Animal Reproduction Principles and Practices*, McGraw-Hill Book Company, New York, 1979.

REPRODUCTIVE DISEASES

AG 534 - W

INFORMATION SHEET

I. Symptoms of major reproductive diseases (Transparency 1)

A. Abortion

B. Retained placenta

C. Repeated long estrus cycles

D. Fever (infection)

II. Specimens necessary for diagnosis

A. Fetus

B. Placenta

(Note: Both should be fresh or refrigerated.)

III. Venereal diseases (transmitted by coitus) (Transparency 2)

A. Vibriosis

B. Infectious Bovine Rhinotracheitis (IBR)

C. Trichomoniasis (Tric)

D. Brucellosis (Bangs disease)

E. Leptospirosis

IV. Preventive measures are important, especially since reproductive diseases usually result in abortion which could mean heavy financial losses for the stockman

V. The veterinarian and diagnostic laboratory play an important role in diagnosing the disease so preventive measures can be taken to reduce further losses

VI. Hormone which may be deficient during gestation--progesterone

VII. Abortion resulting from torsion of the umbilical cord

A. Caused by cows falling and turning over

B. Blood and nutrient supply to embryo cut off

SYMPTOMS OF MAJOR REPRODUCTIVE DISEASES

Abortion

Retained placenta

Repeated long estrus cycles

Fever (infection)

VENEREAL DISEASES

Vibriosis

Infectious Bovine Rhinotracheitis (IBR)

Trichomoniasis (Tric)

Brucellosis (Bangs disease)

Leptospirosis

REPRODUCTIVE DISEASES

AG 534 - W

UNIT TEST

Name ______________________________ Score ______________________________

1. Identify symptoms of major reproductive diseases.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

2. List the necessary specimens needed for diagnosing by the veterinarian or diagnostic laboratory.

   a. ______________________________

   b. ______________________________

3. Identify the five venereal diseases transmitted by coitus only.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

4. Describe the importance of preventive measures and the need for the veterinarian and diagnostic laboratory.

   ____

   ____

   ____

   ____

   ____

   ____

5. Indicate the hormone that may be deficient during gestation.

____

6. Explain what causes torsion of the umbilical cord and why it would cause abortion.

____

____

____

____

REPRODUCTIVE DISEASES

AG 534 - W

ANSWERS TO TEST

1. a. Abortion
   b. Retained placenta
   c. Repeated long estrus cycles
   d. Fever (infection)

2. a. Fetus
   b. Placenta

3. a. Vibriosis
   b. Infectious Bovine Rhinotracheitis (IBR)
   c. Trichomoniasis (Tric)
   d. Brucellosis (Bangs disease)
   e. Leptospirosis

4. Preventive measures are important, especially since reproductive diseases usually result in abortion which could mean heavy financial losses for the stockman. The veterinarian and diagnostic laboratory play an important role in diagnosing the disease so preventive measures can be taken to reduce further losses

5. Progesterone

6. Caused by cows falling and turning over; Blood and nutrient supply to embryo cut off

AG. 534 ZOOLOGY / SCIENCE OF ANIMAL REPRODUCTION

X. Scientific Method Term Project

Based on: Idaho Science Content Guide and Framework. Grades 9 - 12.
Standard II. Science Themes. Goal A. Change and Constancy.

Goal. Understand the contribution of genetics to the development of pedigrees.

Performance Objectives. All students will:

- Relate the two classifications of animal breeders.
- Understand the purpose of using selection and mating systems to produce livestock.
- Identify the two major types of mating systems.
- Define the term, “heterozygous.”
- Define the term, “homozygous.”
- Identify the two forms of inbreeding.
- Identify the four types of outbreeding.
- Define the term, “heterosis.”
- Understand the origins for the classification of “composite or synthetic” breeds.

Progress Indicators. All students will:

- Produce an example of inbreeding lineage by creating a bracket pedigree of a selected animal.
- Produce an example of linebreeding heritage by creating an arrow pedigree showing the genetic pathways of contribution for a selected animal.
- Produce an example of a two-breed rotation cross for a selected animal.
- Produce an example of a three-breed rotation cross for a selected animal.
- Produce an example of a terminal (static) crossbreeding for a selected animal.
- Produce an example of a modified-terminal crossbreeding for a selected animal.
- Produce a bracket example of a grading up.
- Trace the lineage of a synthetic (composite) breed.
- Produce a portfolio of the diagrams with explanations for each.
- Document the scientific methods of the study.

    ♦ **State the Problem.** Write a statement regarding the purpose of the research. This can be in the form of a question; i.e. ,“What is the relationship between genetic composition and the development of pedigree in breeding animals?”
    ♦ **Gather Information.** Research the information necessary to produce the examples. Write an introduction to the portfolio. Write an abstract summarizing the research. The abstract should briefly document the steps of the research, organizing the information according to the steps of the scientific method.

- **Form an Hypothesis.** Write a statement suggesting the answer to the question formulated in the form of the problem statement.
- **Collect Data through Experimentation.** This project is a documentation of breeding methods which were in themselves experiments. Define the methods used and the results produced. Organize the data in the form of the charts specified.
- **Analyze Data and Form a Conclusion.** Write a statement comparing the hypothesis to the data gathered and to the problem statement. Discuss how the data supports any conclusions reached. Relate the conclusion to the resolution of the problem statement. Produce the information in the graphic forms as requested under **Progress Indicators**.
- **Report Results.** Produce the portfolio with an introduction, abstract, and titled graphics. Graphics should be computer-generated, if possible.
- **Propose a Theory.** Write a statement explaining why or how the results supported the primary question within the problem statement.

From:
"Mating Systems" (pp. 243-256)
Scientific Farm Animal Production:
An Introduction to Animal Science
5th Edition (1995)
by Robert E. Taylor

Prentice Hall
Englewood Cliffs, NJ

SCIENTIFIC METHOD MATRIX

AG. 534 ZOOLOGY / SCIENCE OF ANIMAL REPRODUCTION

ACTIVITIES MEETING GOALS PER STANDARD

IDAHO K-12 SCIENCE CONTENT GUIDE AND FRAMEWORK

Standard I. Habits of the Mind	Goal A. Science Processes
Genetics and Heredity	
Calculate Estimated Improvement from Genetic Selection (Swine)	X
Calculate Estimated Annual Progress from Genetic Selection (Sheep)	X
Calculate Estimated Annual Progress from Genetic Selection (Beef)	X
Sex-Linked Traits	X
Predicting Inheritance	X
Influence of Chance on Inheritance	X
Ejaculation and Semen Collection	
Evaluate Semen Based on Color, Foreign Material, Wave Pattern, Motility, and Abnormal Sperm	X
Semen Evaluation	X
Standard I. Habits of the Mind	**Goal B. Values**
Ejaculation and Semen Collection	
Semen Collection and Evaluation	X
Macroscopic Female Functional Anatomy	
Anatomy of theFemale Reproductive Tract	X
Artificial Insemination	
Inseminate a Reproductive Tract	X
Inseminate a Cow	X
Biotechnology	
Making Your Own Yogurt	X
Gestation and Pregnancy Determination	
Pregnancy Test a Cow Using Rectal Examination	X

Standard I. Habits of the Mind	Goal B. Values
Parturition and the Postpartum Period	
Assist a Cow in Calving	X
Assist Ewe at Lambing	X
Farrow a Sow	X
Standard II. Science Themes	**Goal A. Change and Constancy**
Genetics and Heredity	
Breeding Fruit Flies to Study Genetics	X
Standard II. Science Themes	**Goal B. Systems and Interactions**
Genetics and Heredity	
Mitosis and Meiosis	X
Standard III. Nature of Science	**Goal A. Science and Technology in Society**
Biotechnology	
Determining the Ethics of Biotechnology	X
Standard III. Nature of Science	**Goal B. History and Cultural Perspective**
Biotechnology	
Research a Career in Biotechnology	X

AGRICULTURAL SCIENCE AND TECHNOLOGY CURRICULUM
SCIENTIFIC METHOD MATRIX

AG. 534 ZOOLOGY / SCIENCE OF ANIMAL REPRODUCTION

IDAHO K-12 SCIENCE CONTENT GUIDE AND FRAMEWORK

Key - X	Standard I. Habits of the Mind		Standard II. Science Themes			Standard III. Nature of Science	
Section / Activity	Goal A. Science Processes	Goal B. Values	Goal A. Change and Constancy	Goal B. Systems and Interactions	Goal C. Models, Scale, and Structure	Goal A. Science and Technology in Society	Goal B. History and Cultural Perspective
Genetics and Heredity							
Calculate Estimated Improvement from Genetic Selection (Swine)	X						
Calculate Estimated Annual Progress from Genetic Selection (Sheep)	X						
Calculate Estimated Annual Progress from Genetic Selection (Beef)	X						
Mitosis and Meiosis				X			
Sex-Linked Traits	X						
Predicting Inheritance	X						
Influence of Chance on Inheritance	X						

Key - 4	**Standard I. Habits of the Mind**		**Standard II. Science Themes**			**Standard III. Nature of Science**	
Section / Activity	**Goal A. Science Processes**	**Goal B. Values**	**Goal A. Change and Constancy**	**Goal B. Systems and Interactions**	**Goal C. Models, Scale, and Structure**	**Goal A. Science and Technology in Society**	**Goal B. History and Cultural Perspective**
Genetics and Heredity							
Breeding Fruit Flies to Study Genetics			X				
Ejaculation and Semen Collection							
Evaluate Semen Based on Color, Foreign Material, Wave Pattern, Motility, and Abnormal Sperm	X						
Semen Collection and Evaluation		X					
Semen Evaluation	X						
Macroscopic Female Functional Anatomy							
Anatomy of the Female Reproductive Tract		X					
Artificial Insemination							
Inseminate a Reproductive Tract		X					
Inseminate a Cow		X					
Biotechnology							
Determining the Ethics of Biotechnology						X	

Key - X	**Standard I. Habits of the Mind**		**Standard II. Science Themes**			**Standard III. Nature of Science**	
Section / Activity	**Goal A. Science Processes**	**Goal B. Values**	**Goal A. Change and Constancy**	**Goal B. Systems and Interactions**	**Goal C. Models, Scale, and Structure**	**Goal A. Science and Technology in Society**	**Goal B. History and Cultural Perspective**
Biotechnology							
Research a Career in Biotechnology							X
Making Your Own Yogurt		X					
Gestation and Pregnancy Determination							
Pregnancy Test a Cow Using Rectal Examination		X					
Parturition and the Postpartum Period							
Assist a Cow in Calving		X					
Assist Ewe at Lambing		X					
Farrow a Sow		X					