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AG. 532 – ZOOLOGY/SCIENCE OF ANIMAL NUTRITION

AG 532

ZOOLOGY/SCIENCE

OF

ANIMAL NUTRITION

FOR

IDAHO

SECONDARY AGRICULTURE INSTRUCTORS

Developed and written by:
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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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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 532 - 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 532 - 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 532 - 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

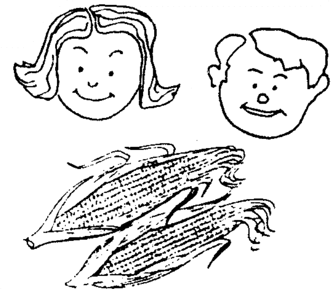
1. Farm reporting
2. Market reporting
3. Radio
4. Television

G. Service

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

Food Chains

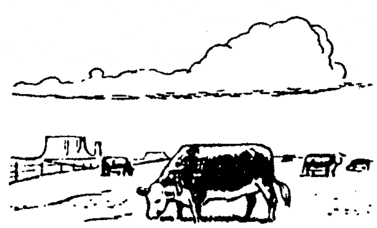
PRIMARY

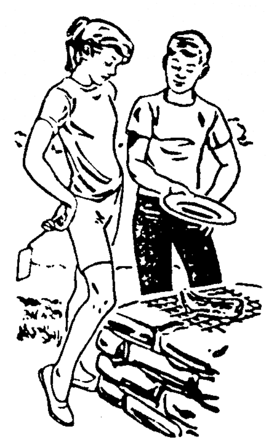


PLANT

MAN

SECONDARY



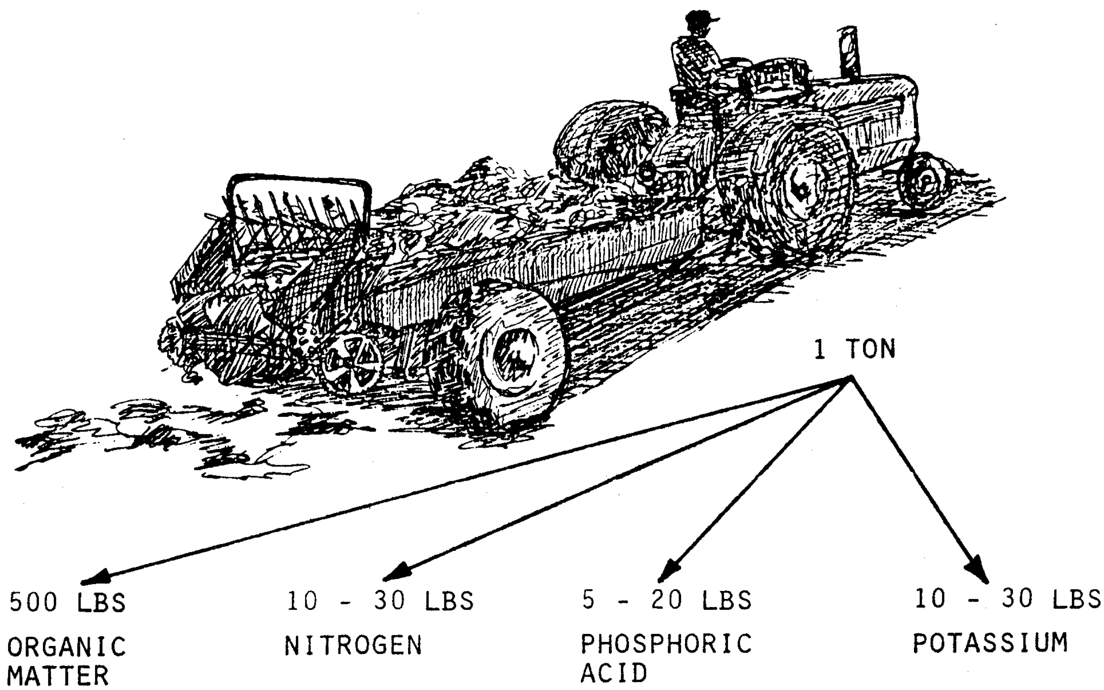


PLANT

ANIMAL

MAN

Manure As A Fertilizer



1 TON = $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

AG 532 - 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

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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 532 - 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 532 - 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.

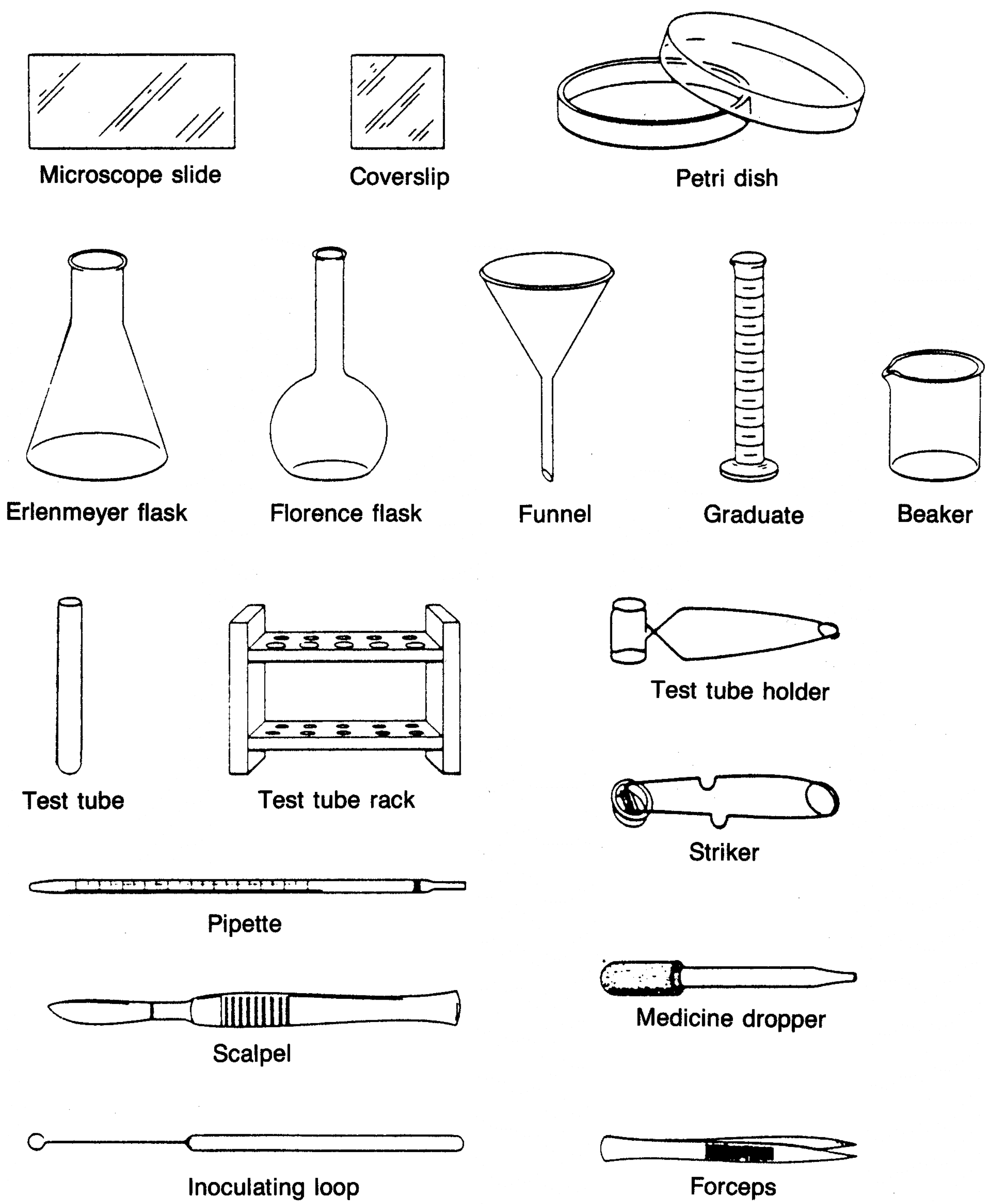
13. Tie back long hair and restrict any loose clothing.

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



<u>Part III: How to Write a Laboratory Report</u>

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.____

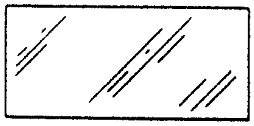
    g.____

    h.____

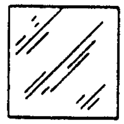
    i.____

    j.____

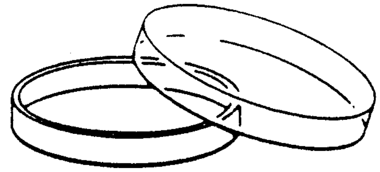
Identify the following types of laboratory equipment.



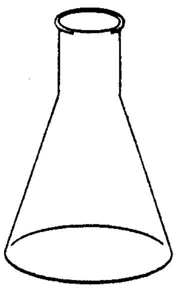
a. ______________



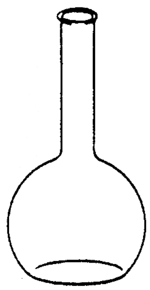
b. ______________



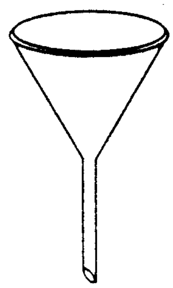
c. ______________



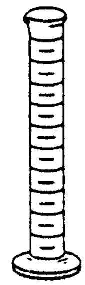
d. ______________



e. ______________

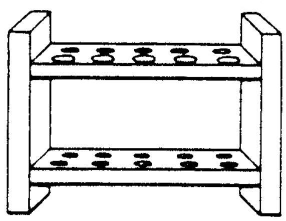


f. ______________

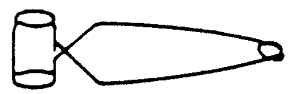


g. ______________

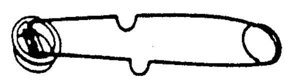
h. ______________



i. ______________



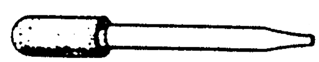
j. ______________



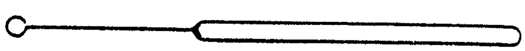
l. ______________

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 532 - 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.

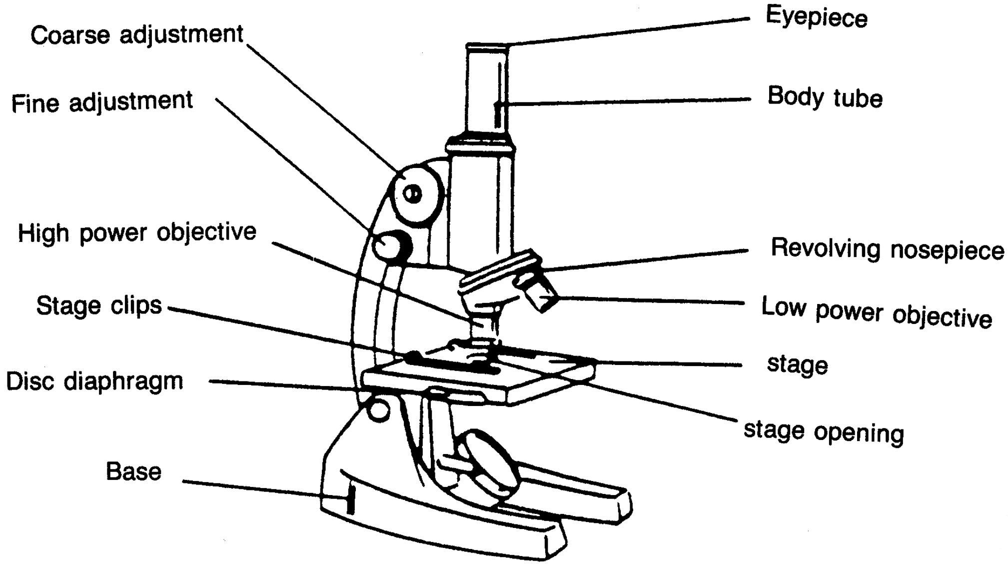
4. The body tube ends in a part known as the revolving nosepiece, under which are lenses called objectives. By turning the nosepiece, the objectives will turn and click into place. The objectives are low power or high power lenses. Low power usually consists of 5X or 10X, while high power consists of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

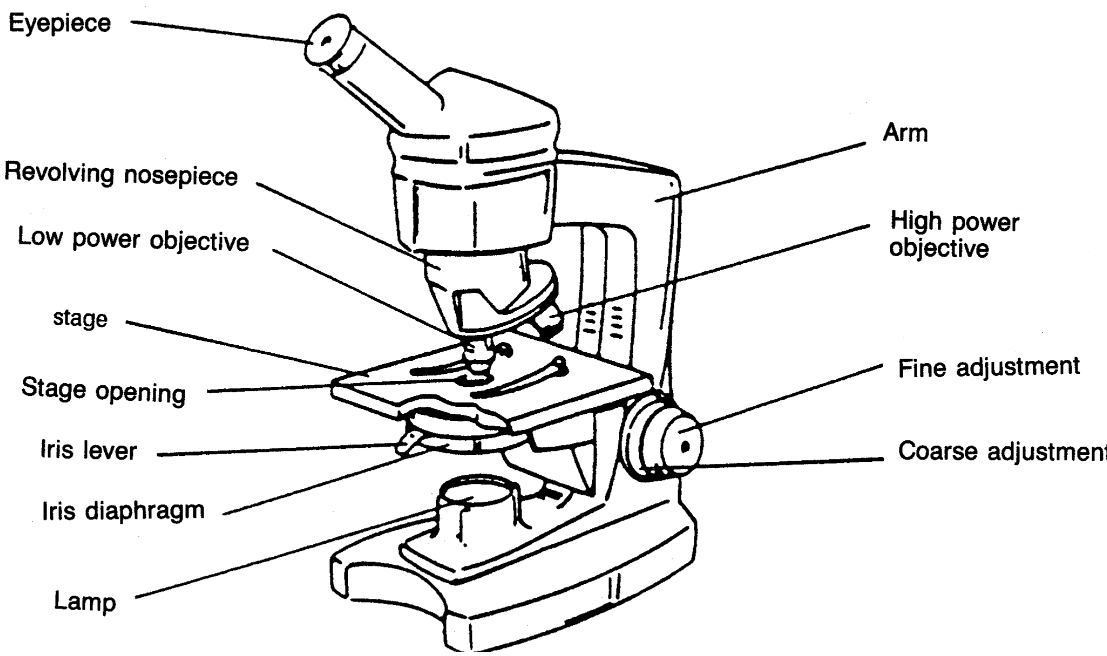
   Extreme care must be exercised when using these lenses; they must not hit the microscope slide when lowering the body tube. The objectives should be cleaned only with lens paper so that dirt and dust will not scratch them.

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? ______________________________

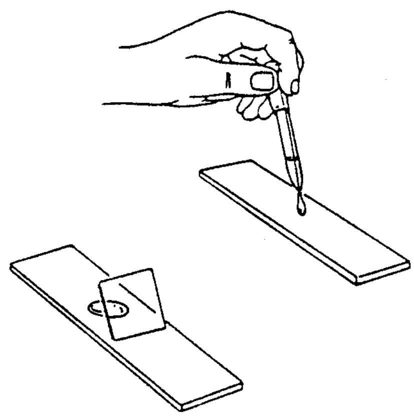
   b. a 10X eyepiece and a 40X objective? ______________________________

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

<u>Part III: Making a Wet Mount</u>

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?

   ____

   ____

<u>Part IV: Low Power and High Power</u>

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:

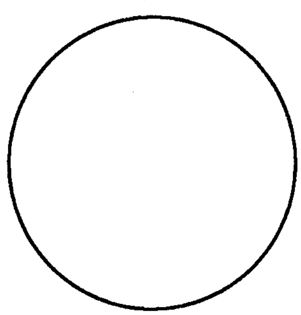
--Always position the specimen in the center of the field of view and fine focus under low power first.

--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.

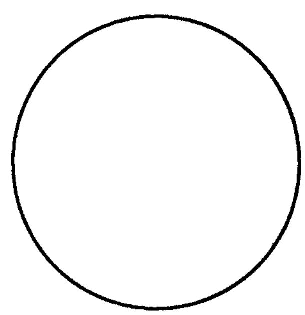
--Turn the nosepiece until the high power objective clicks into place. Most microscopes are *parfocal*. This means that an object focused under low power will be approximately focused under high power.

--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.



Low power



High power

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.

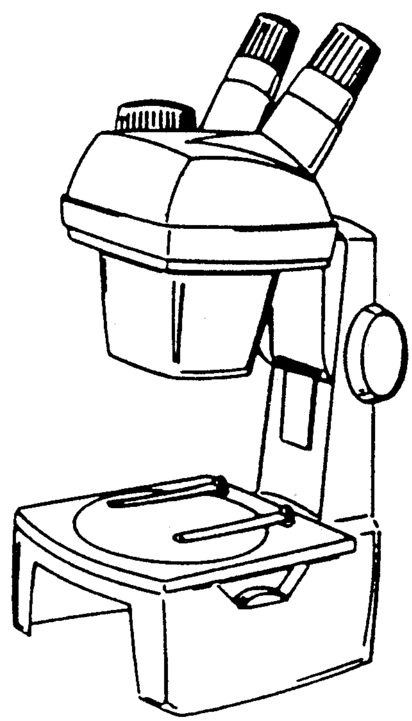
a. Which microscope has the greatest magnification? ____________

   ____

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.

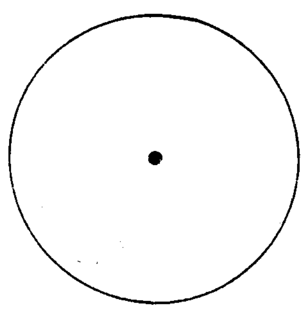
3. A microscope has a 10X field measuring 6 mm. What is the size of the field at 10X in micrometers? a.

   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 532 - 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:

Laboratory Investigation Report:

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

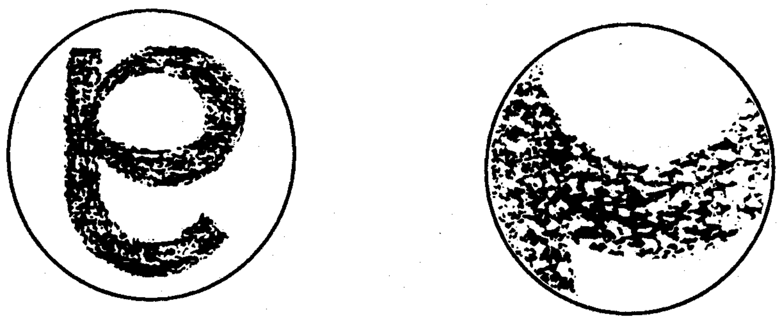
3. a. 50X b. 400X c. 1000X

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.

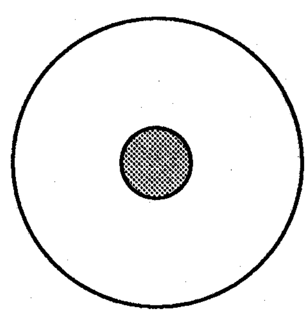
Part VIII:

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 532 - 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		6. Flexibility
_____g. Feed, such as grain, high in energy and low in fiber		7. Receipt
_____h. Ability of a farm operation to withstand changes in the supply or demand		8. Service
_____i. Products left after the main products have been extracted		9. Roughage

2. Name ten types of livestock.

______________________ , ______________________ , ______________________

______________________ , ______________________ , ______________________

______________________ , ______________________ , ______________________

____

3. Name four products and three services livestock provide.

<u>Products</u>

a.______________________ c.______________________

b.______________________ d.______________________

<u>Services</u>

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 532 - 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 532 - 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

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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.

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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

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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

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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.

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.* (Quantity needed: 500 ml)

Methyl cellulose solution (also available ready-made)

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

Methyl blue stain (also available ready-made)

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

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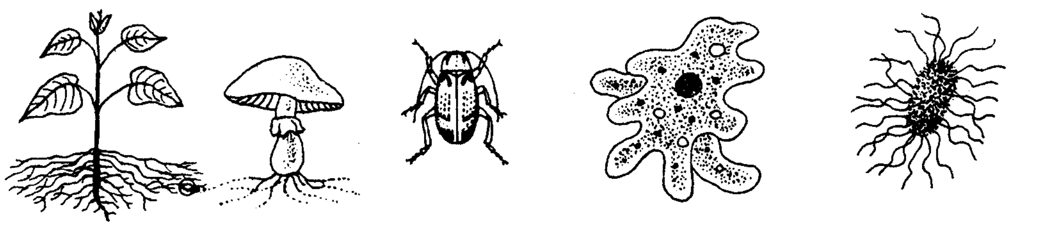
LABORATORY EXERCISE #1--EXAMINING CELLS FROM
THE FIVE KINGDOMS

Name ______________________________ Score ______________________________

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



Plant **Fungus** **Animal** **Ameba** (Protist) **Bacterium** (Moneran)

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

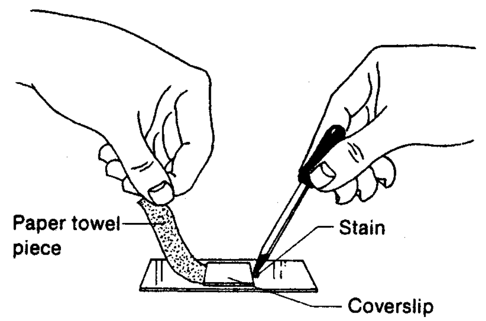
Yeast suspension
Paramecium culture
Nostoc or *Oscillatoria* culture
Methylene blue stain
Iodine solution
Methyl cellulose solution
Prepared slides of animal cells, plant cells, fungal cells, protist cells and moneran cells

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.

____

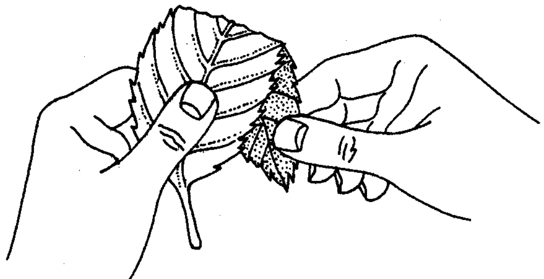
6. Remove the slide of your tongue cells from the stage. Obtain prepared slides of animal cells, and examine them under low and high power. In your table list the types of animal cells that you examined. Check off the cell structures you were able to observe in each cell.

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.

______________________ ______________________

Part II: Plant Cells

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?

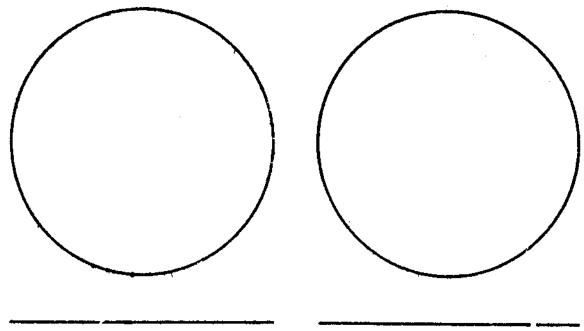
(b)____

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 532 - B

LABORATORY EXERCISE #2--CLASSIFYING ORGANISMS

Name ____________________________________ Score ____________________________________

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.

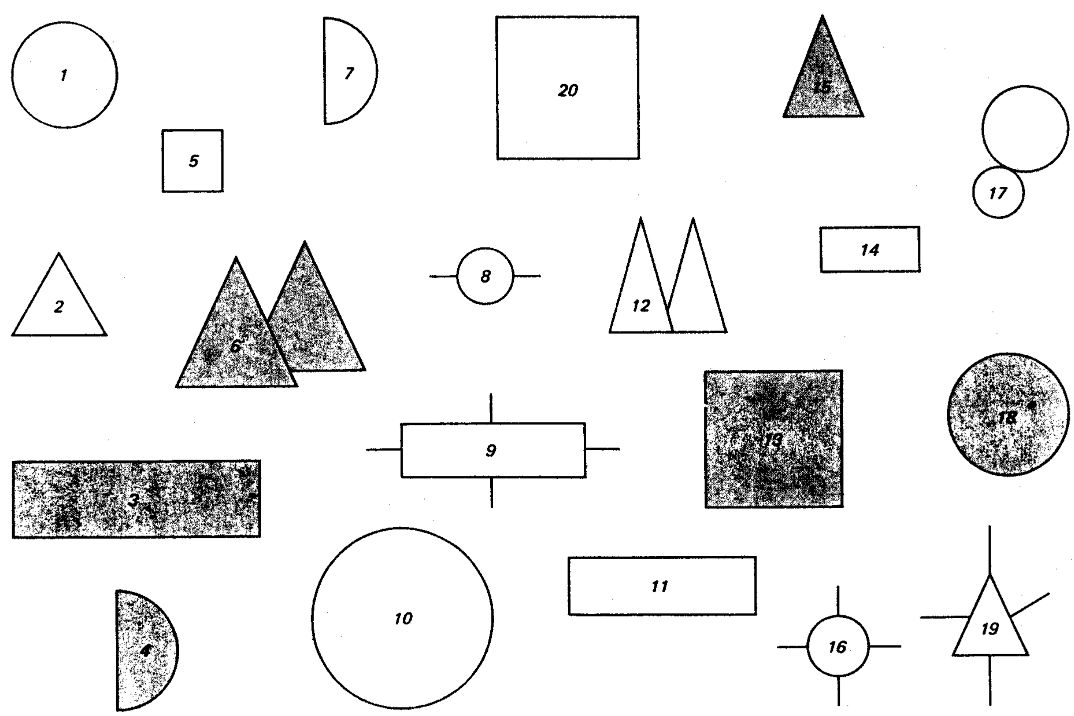
a. Examine the figures below and list some of the characteristics that you observe.________________

____

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

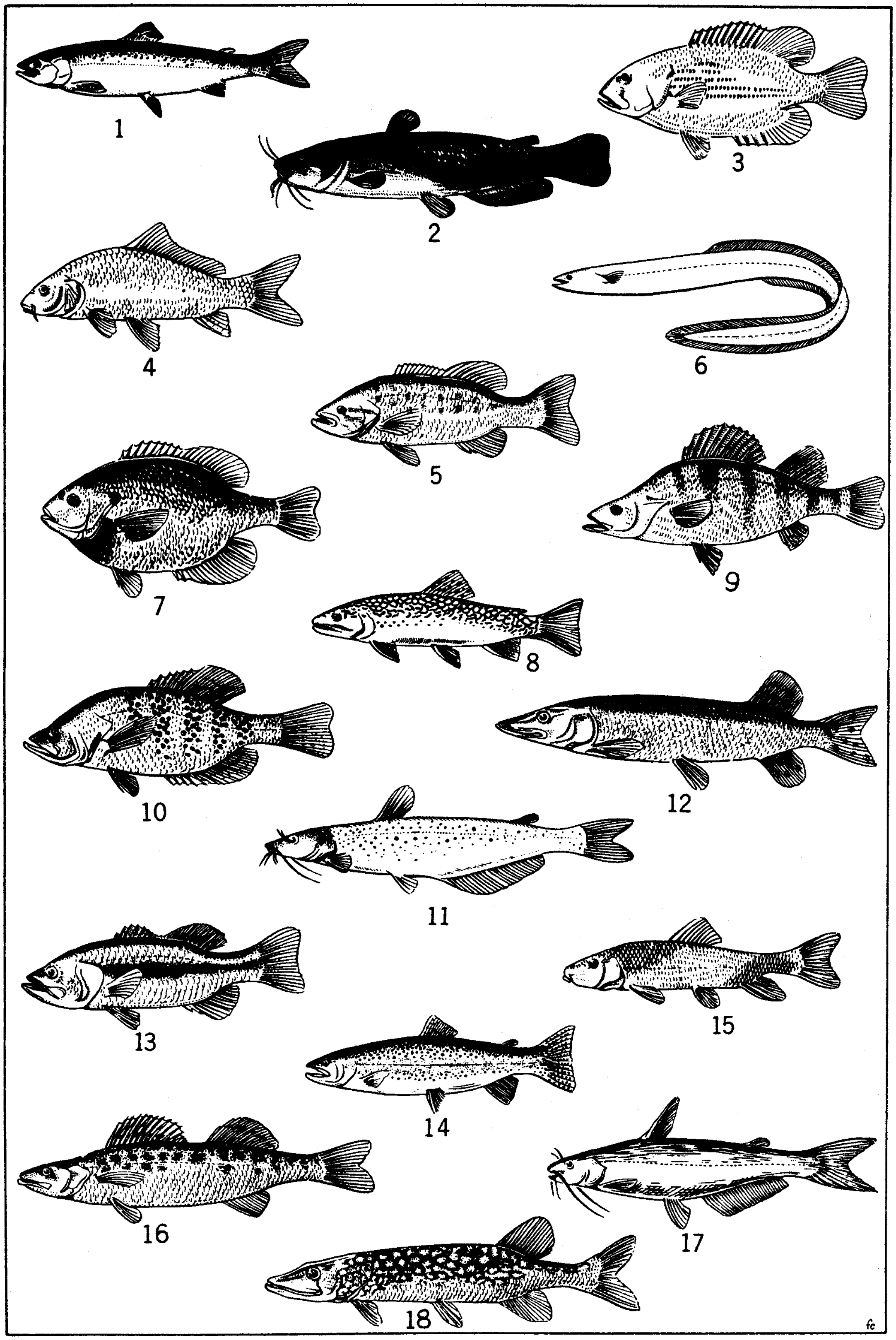
FINS

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

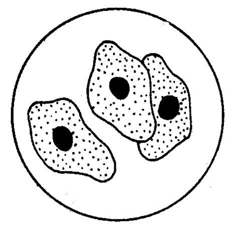
Select commonly seen groups of related objects (automobiles, canned goods, etc.) and classify them into the major classification categories. Construct a key to their identification. Try your classification key with some individuals in your class to see how well it works.

THE ORGANISMS

AG 532 - B

ANSWER SHEET TO LABORATORY EXERCISES

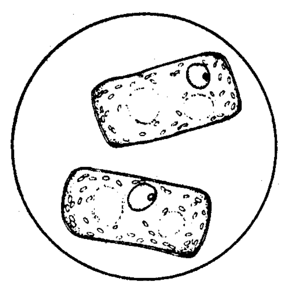
Lab #1
Part I:
Step 5:



Human tongue cells

Step 7: Drawings will very depending on slide available.

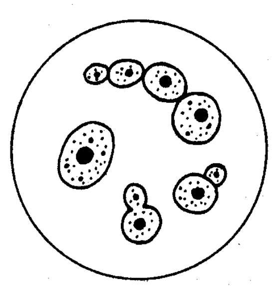
Part II:
Step 5:



Plant cells

Step 7: Drawing will vary depending on slides available.

Part III:
Step 4:



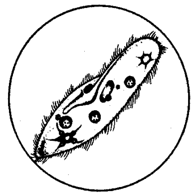
Yeast cells

Step 6: Drawings will very depends on slides available.

Part IV:

3. a. Students should see several

Step 4:



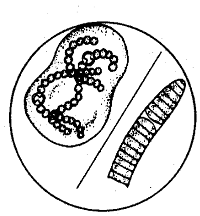
Paramecium

Step 6: Drawings will vary depending on slides available.

Part V:

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 532 - 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

_____b. The group of individuals of a given species inhabiting a specified geographic area

_____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

_____d. Organisms that manufacture organic nutrients from inorganic raw materials

_____e. Association of unicellular or multicellular organisms of the same species

_____f. Occurrence of several distinct phenotypes in a population

_____g. An assemblage of populations that live in a defined habitat and interact in various ways with one another organisms

_____h. Those elements of an ecosystem that eat other plants or animals

_____i. Organisms which cannot synthesize their own food from inorganic materials

_____j. The gradual loss of vigor through the aging process

_____k. The phylum of animals characterized by the presence of a notochord at some stage of development

_____l. The theory that all living things come only from preexisting living things

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

1. Binomial nomenclature
2. Prokaryote
3. Eukaryote
4. Adaptation
5. Autotrophs
6. Biogenesis
7. Biome
8. Chordate
9. Colony
10. Community
11. "Consumer"
12. Ecology
13. Ecosystem
14. Epigenesis
15. Fossils
16. Genus
17. Herbivore
18. Heterotrophs
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 532 - 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 532 - 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 532 - 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 532 - 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

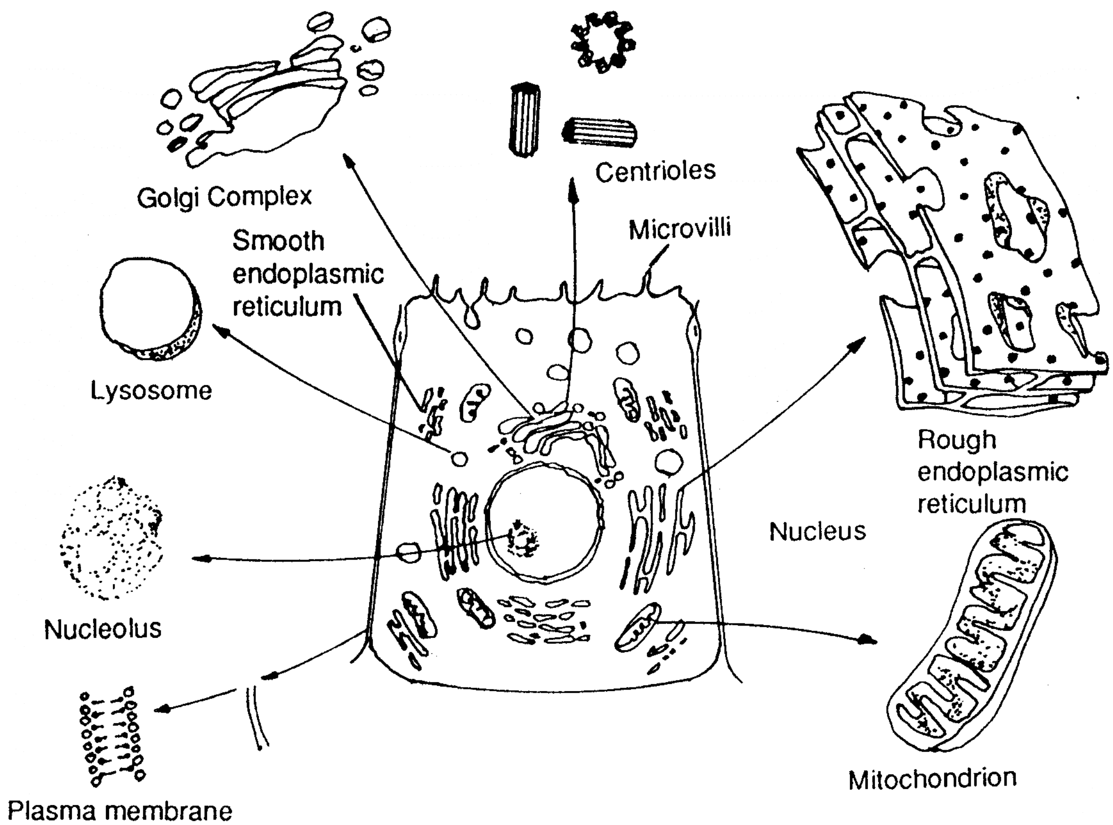
2. Supplies reserve energy when food supply is scarce or sporadic

F. Gamete (sex cells)

1. Reproductive cell

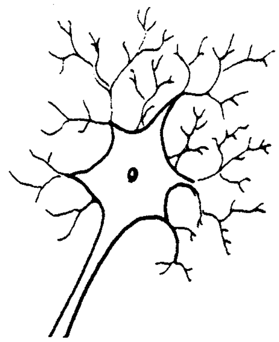
2. An egg or sperm

DIAGRAM OF A "TYPICAL" ANIMAL CELL



Types of Animal Cells

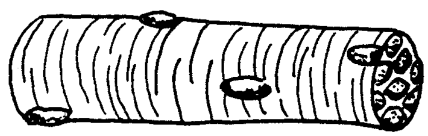
Nerve cell, showing cell body (soma) surrounded by numerous dendritic extensions and a portion of the axon extending below.



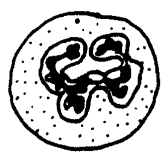
Epithelial cell from lining of the mouth.

Smooth musle cell from intesti-nal wall.

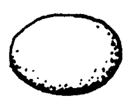
Striated muscle cell from skeletal muscle.



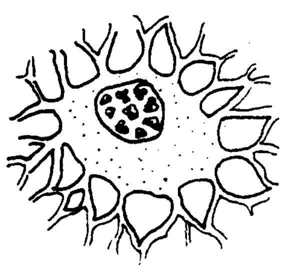
White blood corpuscle.



Red blood corpuscle (erythrocyte).



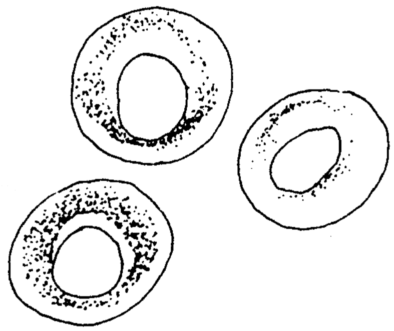
Bone cell.



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

Formed Elements of Blood

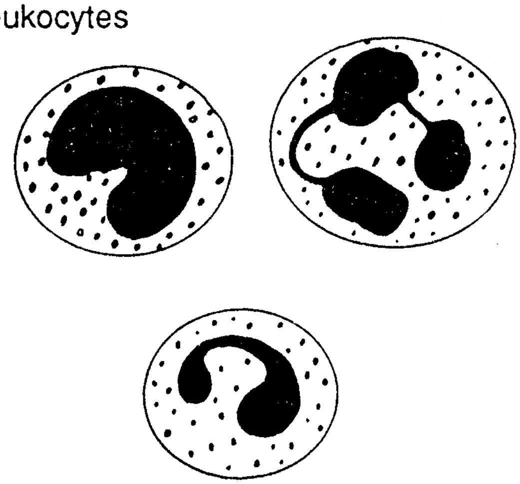
Red Blood Cells



Platelets

White Blood Cells

Granular leukocytes



CELL STRUCTURE

AG 532 - 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 532 - 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 532 - 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.

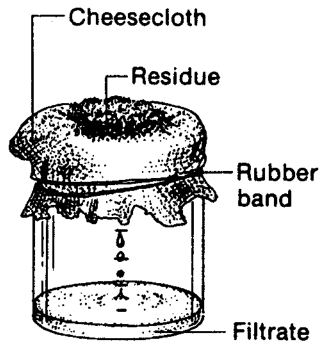
Materials needed

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

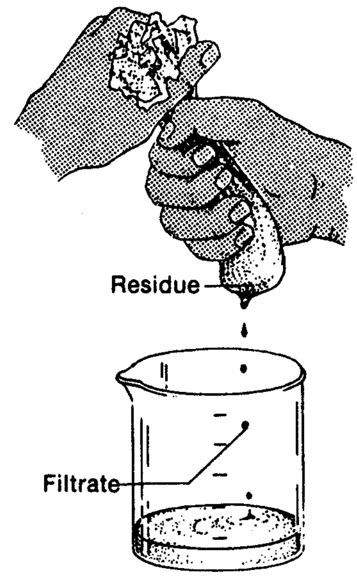
Part I: Procedure

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



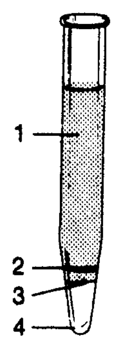
b. Squeezing residue

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 532 - 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.**

<u>Part II: Human Epithelial Cells</u>

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 532 - 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 532 - 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.

Blank	Definition	Term
_____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. ____________________

____

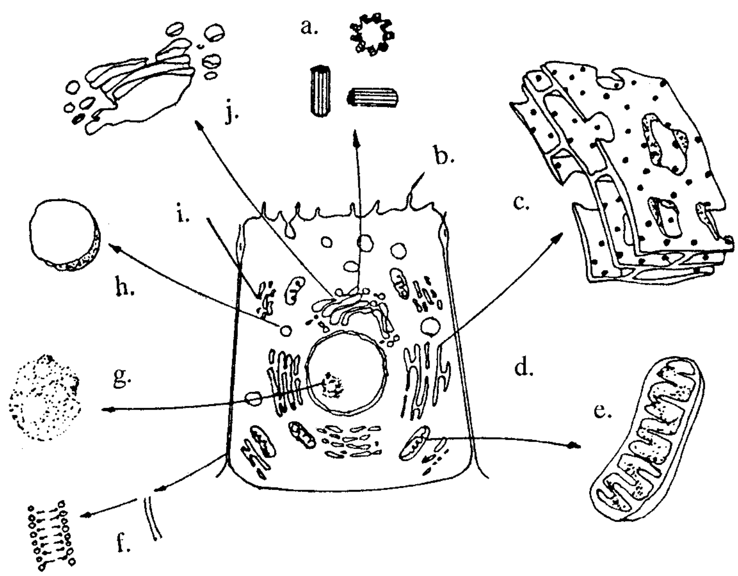
4. List the three ways that cells can differ from one another.

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 532 - C

ANSWERS TO TEST

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

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 532 - 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 532 - 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 532 - 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

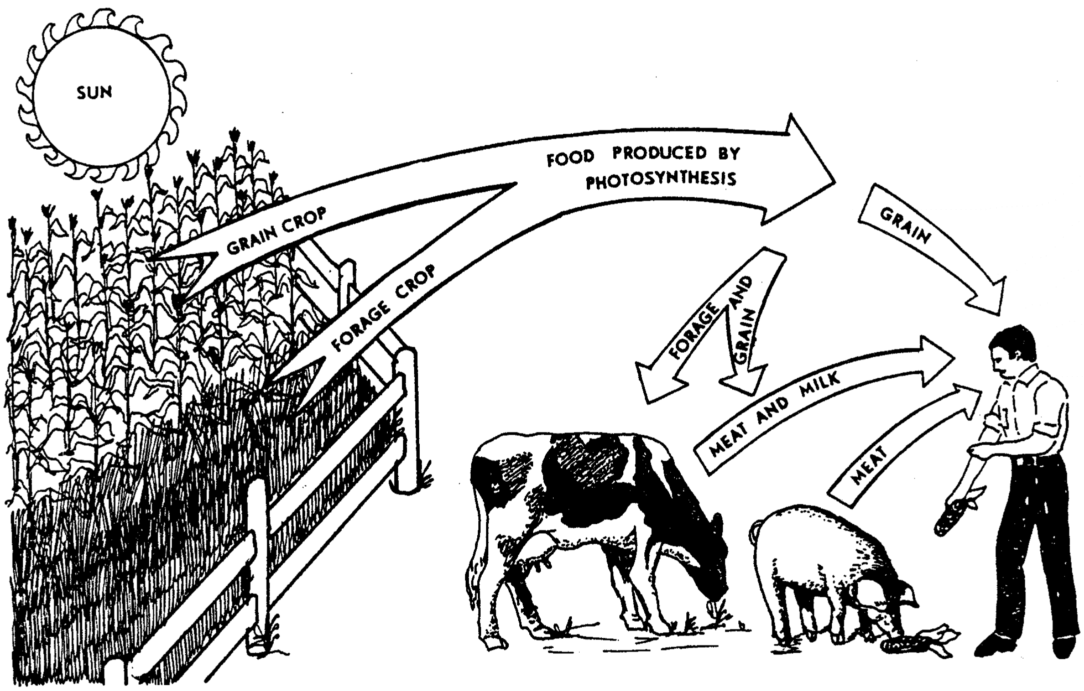
A. The ability of a cell or organism to maintain a stable internal environment when outside conditions change. The internal stability of living things

B. Feedback mechanism

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

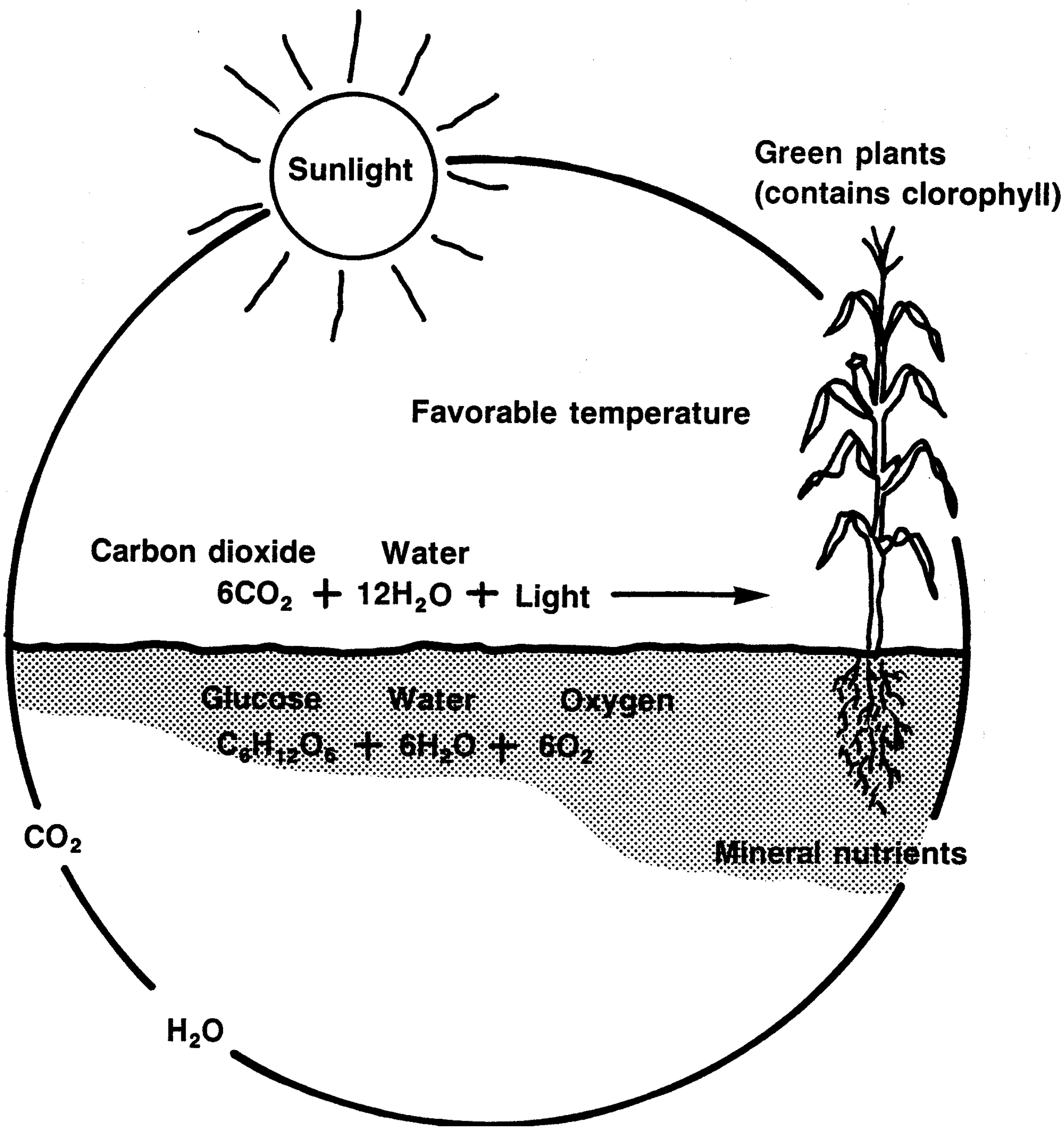
2. Example: Damaged cell--Increased rate of chemical building blocks entering the cell for repairing the cell. As a result, more waste products form in the cell and must also have increased rate of excretion

Importance of Photosynthesis

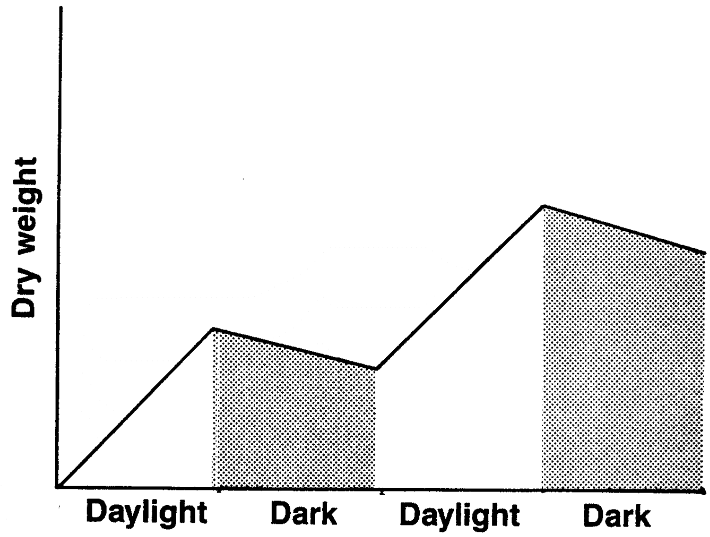


Through the process of photosynthesis, crop plants produce food. This plant-produced food is used directly by man or indirectly through meat and milk produced by livestock.

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

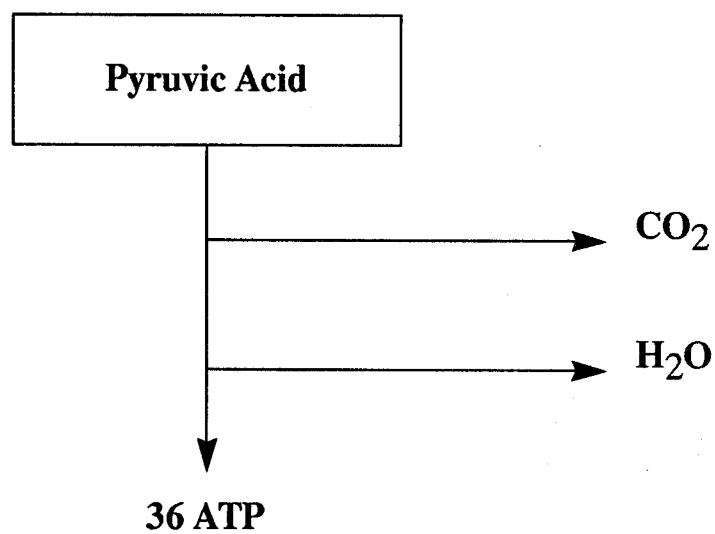
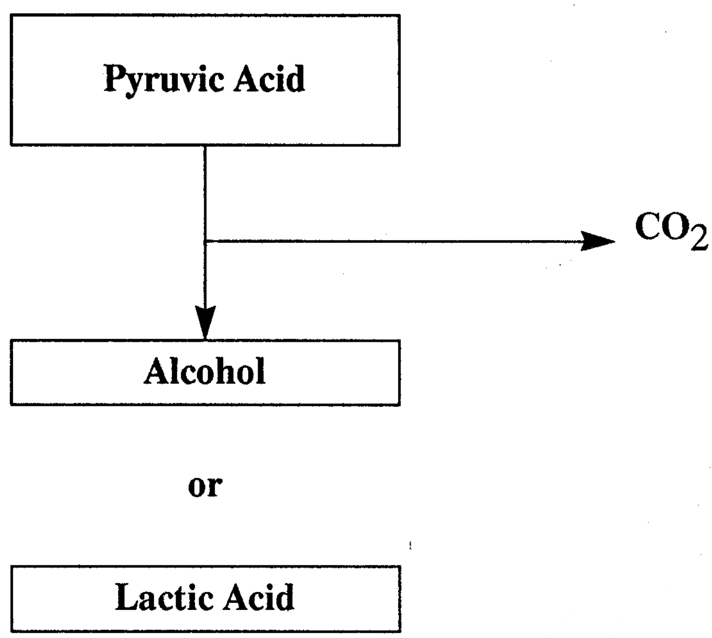


Diagram of Fermentation



FUNCTIONS OF THE CELL

AG 532 - 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.

Albumin solution (10%)

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

Benedict's Solution (also available ready-made)

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.

Glucose solution (10%)

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

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 from fumes. Should body contact occur, flush immediately with water.*

Salt solution (10%) [NaCl]

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

Starch solution (10%)

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 532 - 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

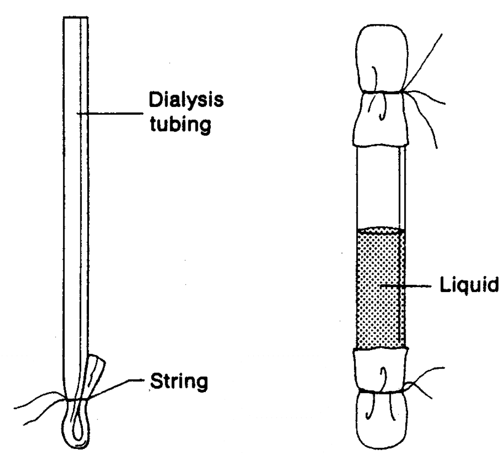
To carry out basic life functions, cells need to exchange materials with their environment. These materials move in and out of the cell, passing through the cell membrane. Some molecules can move easily and quickly across the cell membrane by diffusion. Other molecules cannot diffuse across the cell 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.

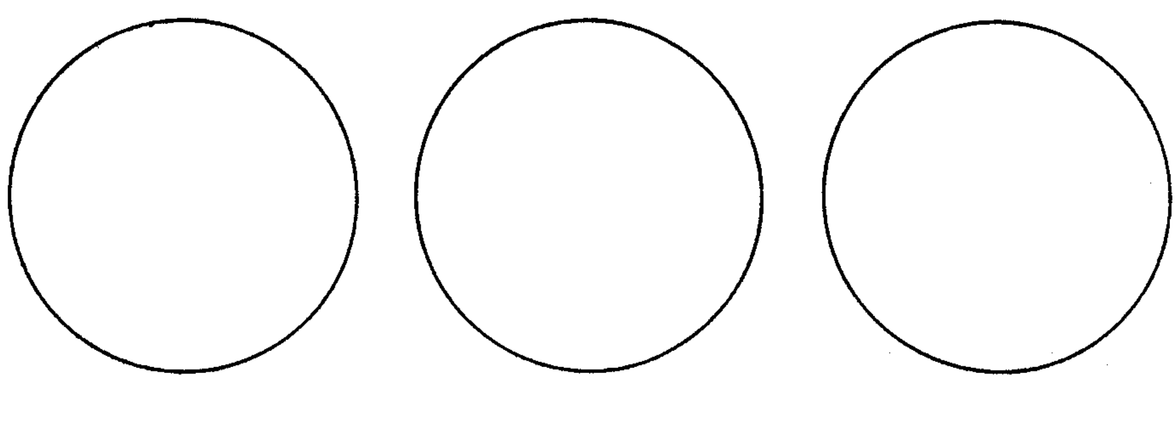
12. Dispose of the liquids and clean your equipment.

<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.



<u>Part III: Analysis</u>

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.

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.

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 532 - D

ANSWERS TO LABORATORY EXERCISE

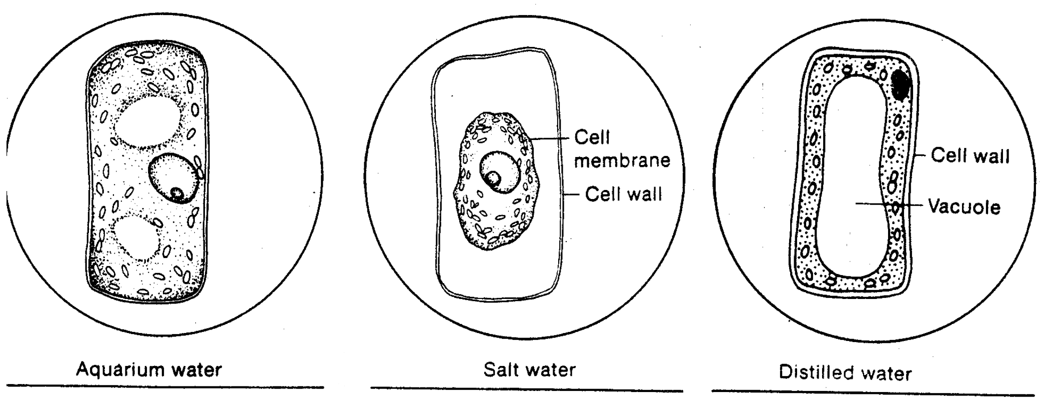
Part I:

(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 532 - 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.

____

____

____

____

____

9. Explain the process of fermentation.

____

____

____

____

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

FUNCTIONS OF THE CELL

AG 532 - 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. Passive transport: Moves molecules from regions of high concentration to regions of lower concentration; Does not require cellular energy

   b. Active transport: 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. Endocytosis: 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. Exocytosis: 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 532 - 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 532 - 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.

D. Smith, G.C., et al., *Laboratory Manual for Meat Science*, 2nd edition, American Press, Boston, Massachusetts, 1978.

ANIMAL TISSUES, SYSTEMS AND ORGANS

AG 532 - 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)

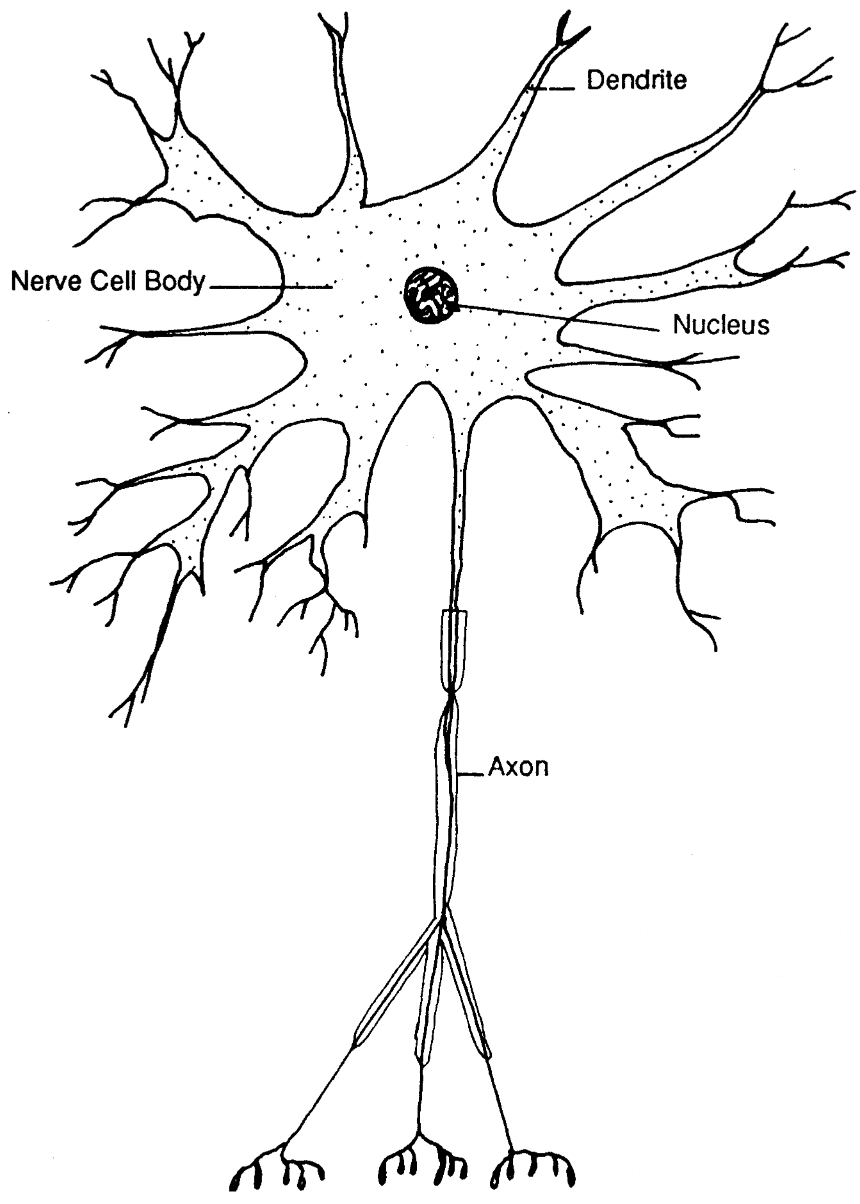
A. Function--Makes the sex cells necessary for producing offspring

B. Major organs

1. Ovaries

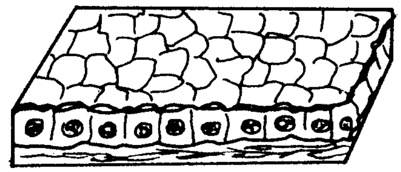
2. Testes

Typical Neuron

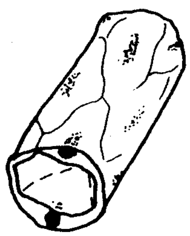


Types of Epithelial Tissue

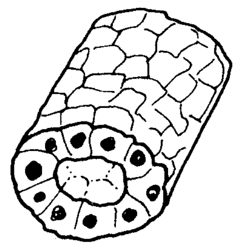
Simple Squamous



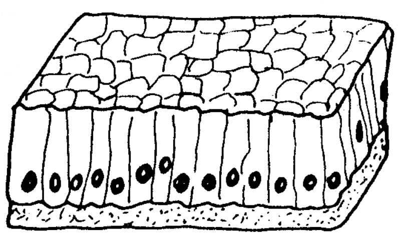
Simple Cuboidal



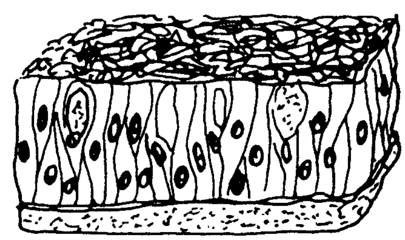
Simple Squamous in Tubular Arrangement



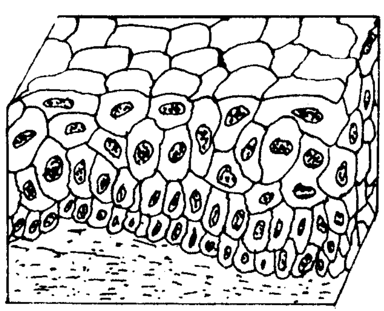
Simple Cuboidal forming a small duct



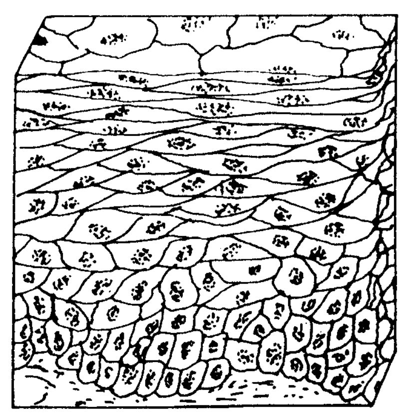
Simple Columnar



Pseudostratified Columnar with Cilia

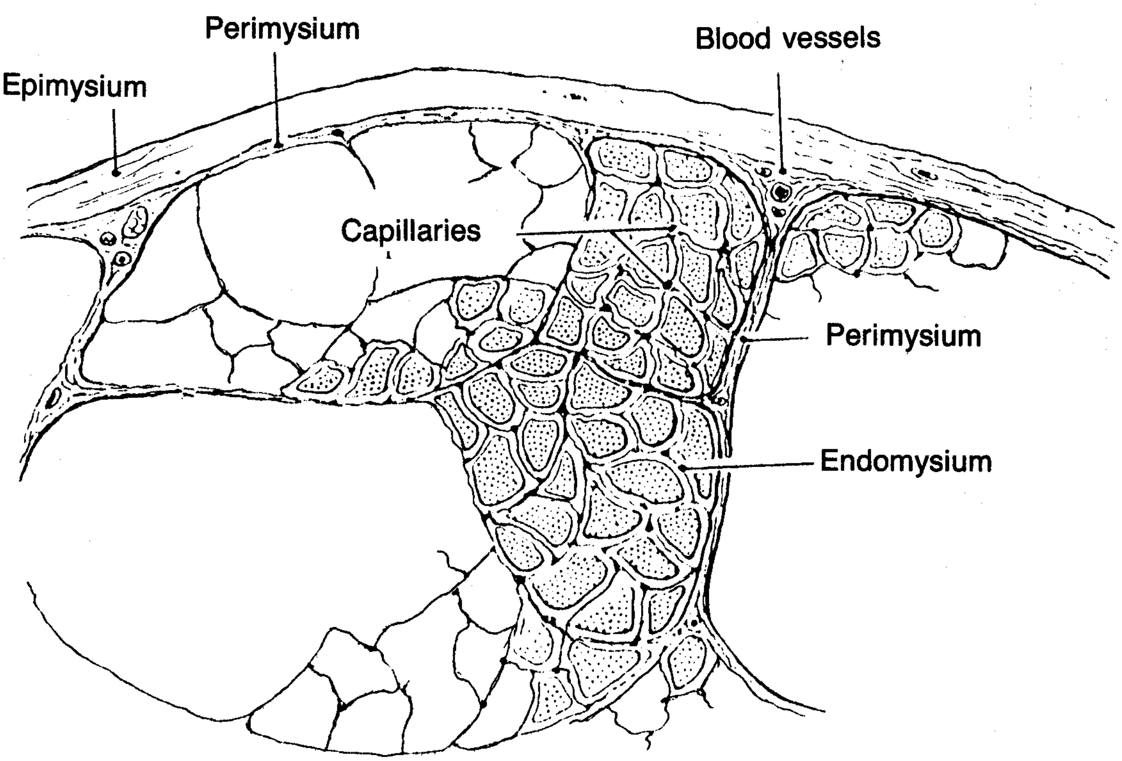


Transitional

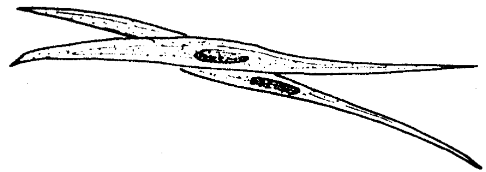


Stratified Squamous (Moist Type)

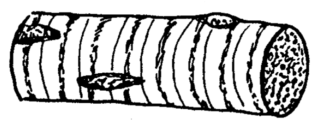
Arrangement of Connective Tissue in a Muscle



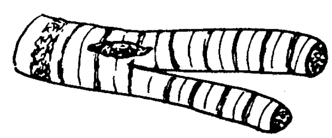
Muscular Tissue



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 532 - 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.

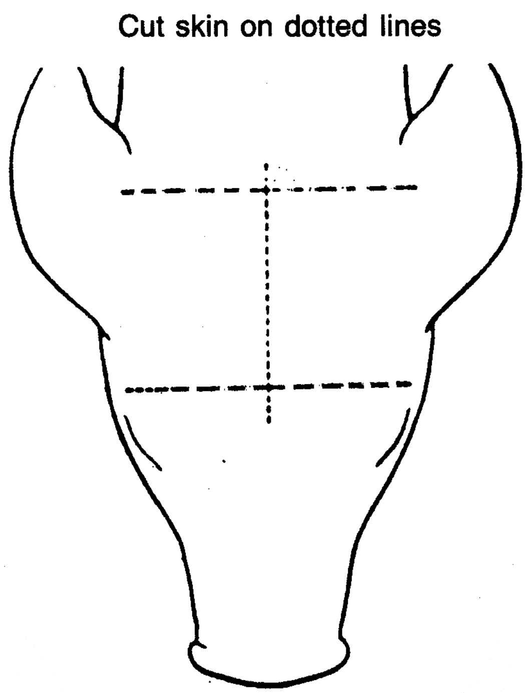


Figure 1

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.

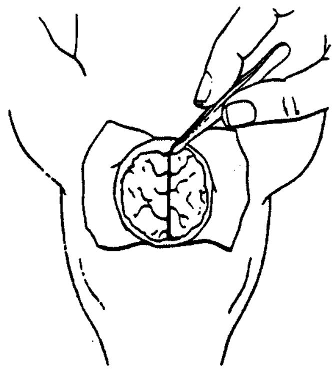


Figure 2

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.

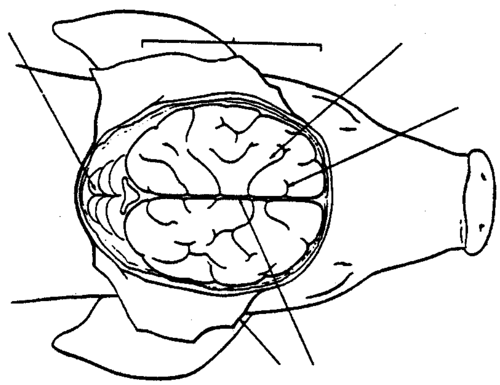


Figure 3

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.

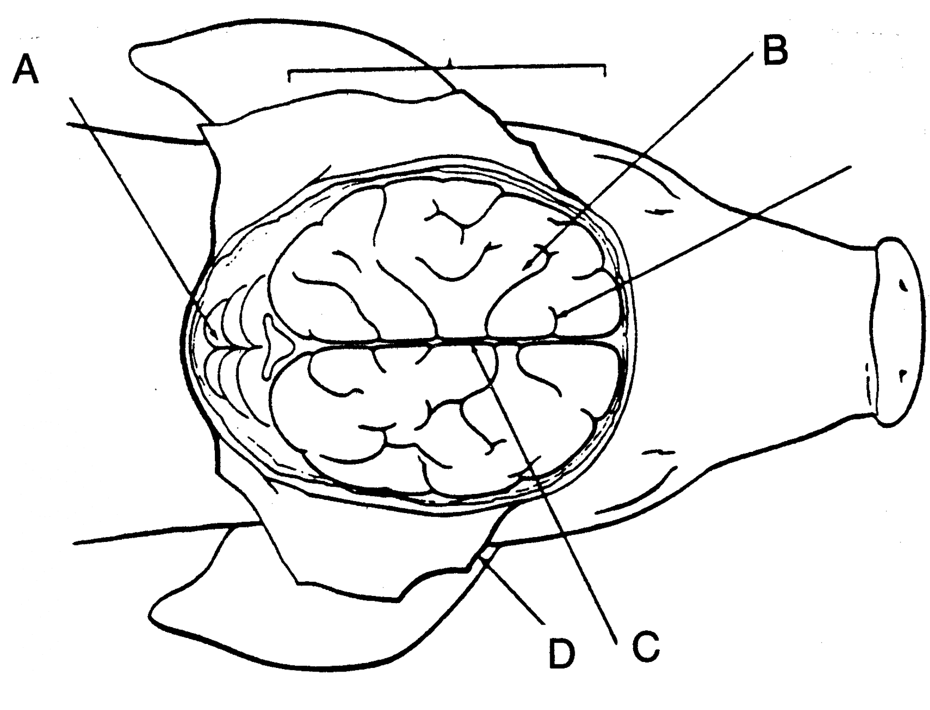
Part II: Analysis

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 532 - 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

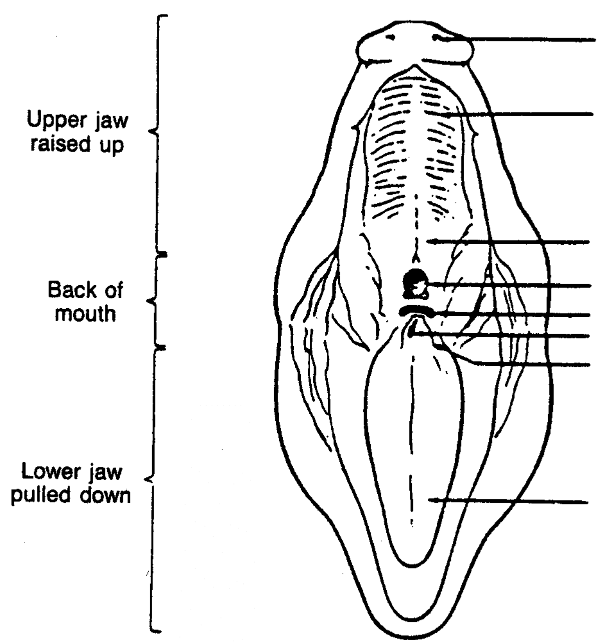


Figure 1

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)

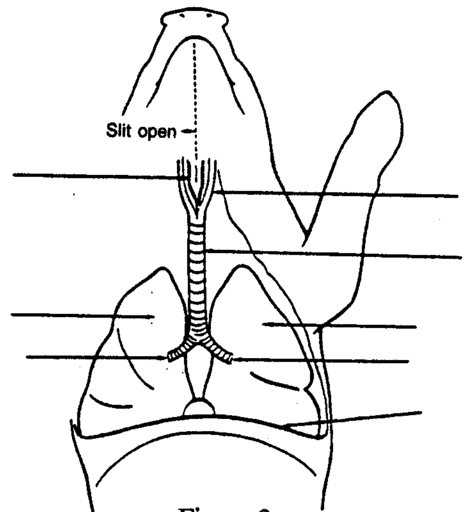


Figure 2

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.

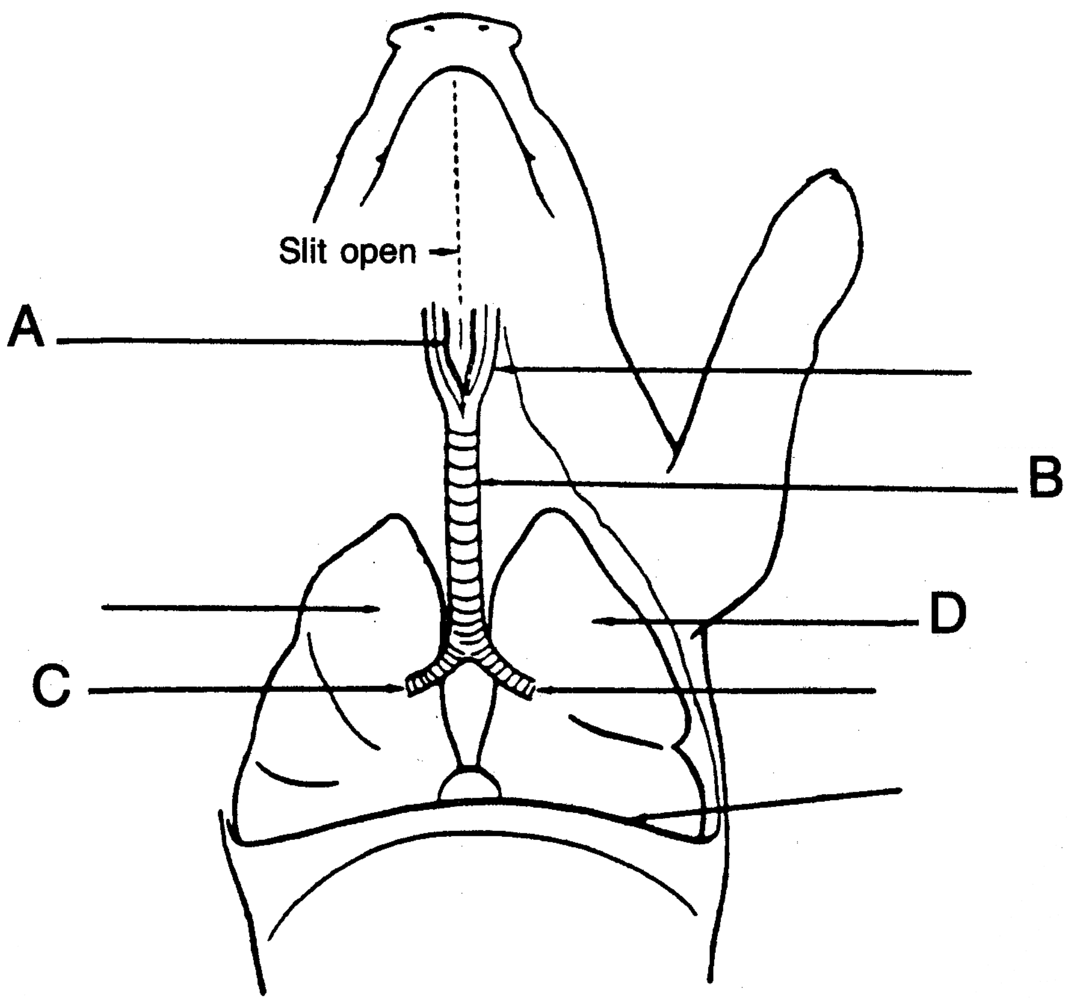
_____Nasopharynx	a.	Muscle below lungs involved in inhalation and exhalation process
_____Epiglottis	b.	Air sacs in lungs
_____Diaphragm	c.	Passageway for air from pharynx to lungs
_____Alveoli	d.	Covers trachea during swallowing

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 532 - 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

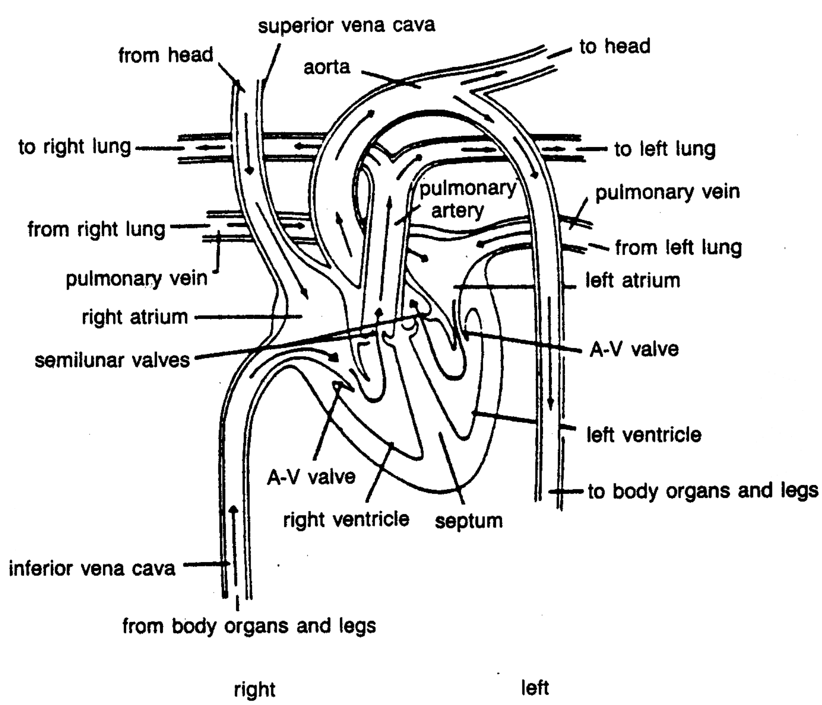


Figure 1

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)	Paper towels
Dissecting pan	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.

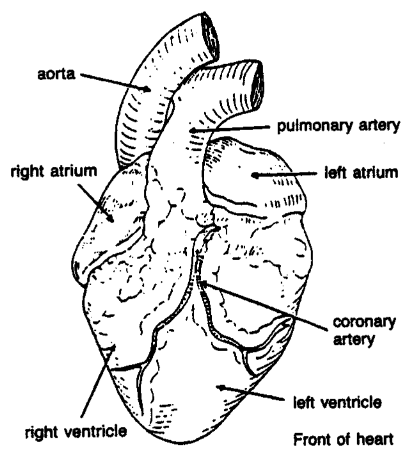


Figure 2

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 ____

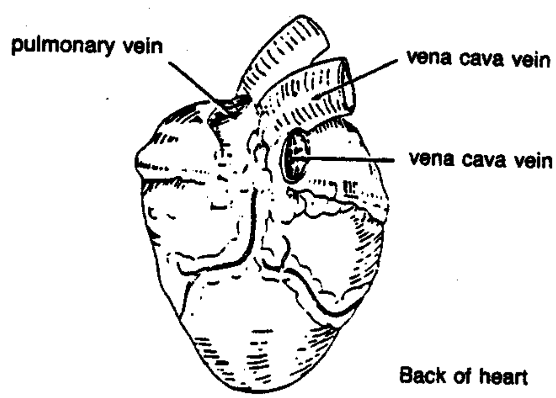


Figure 3

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	______		

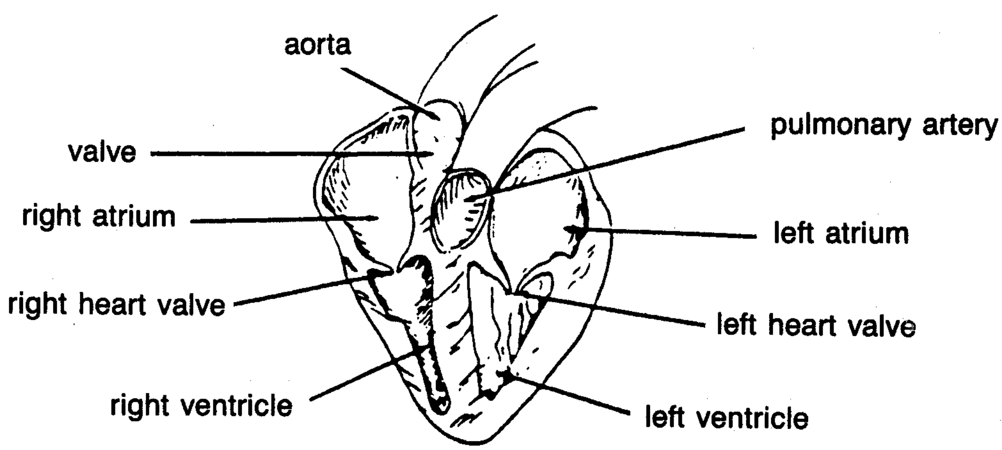


Figure 4

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	____

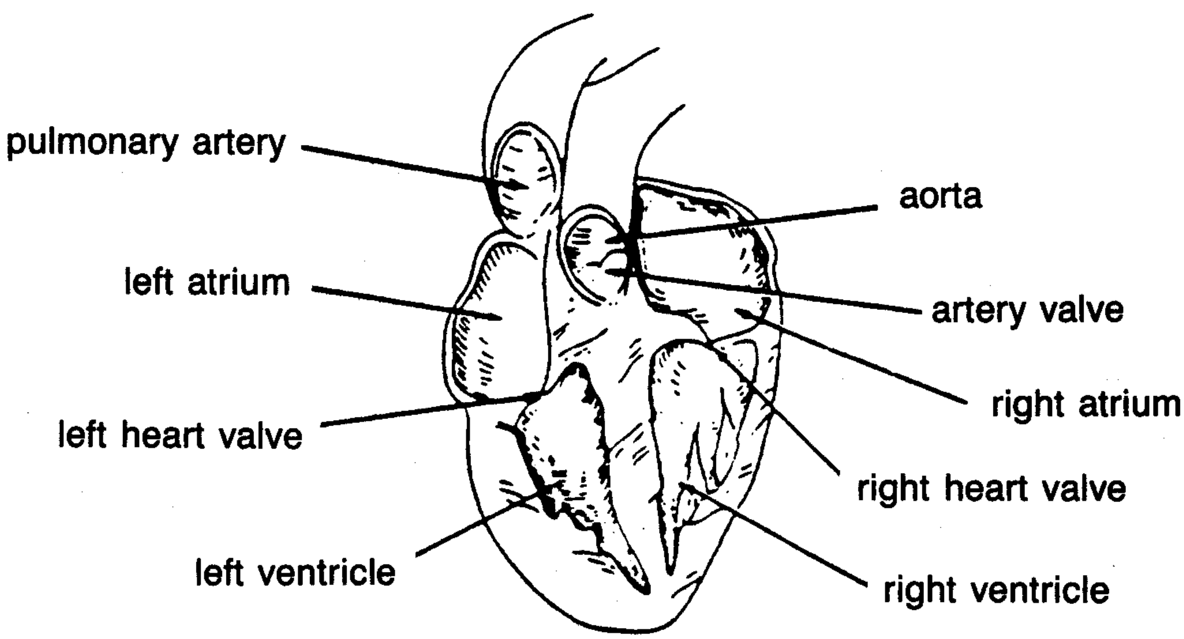


Figure 5

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?

____

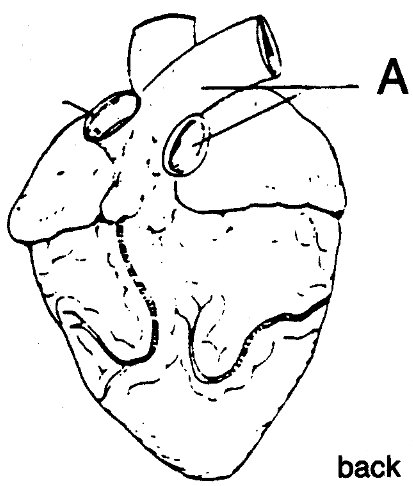
5. Which ventricle pumps blood to the body?

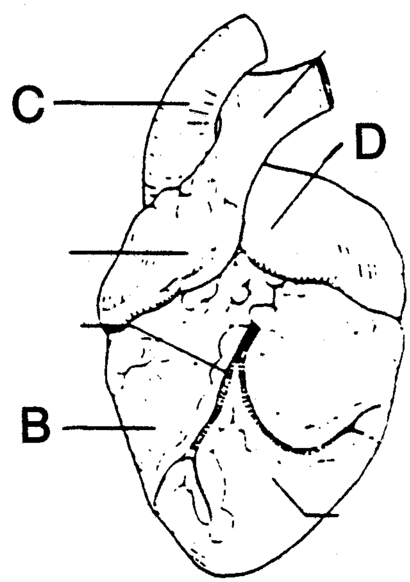
____

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

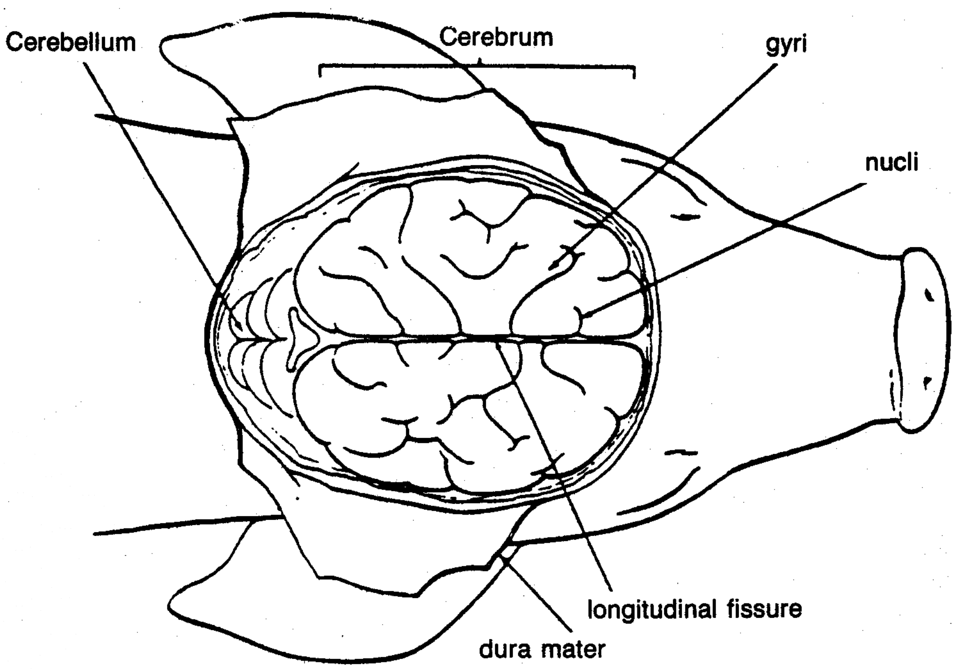
AG 532 - E

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

<u>Lab #2</u>

Part I, II:

Students should have labeled Figure 1 and Figure 2 as you see them below:

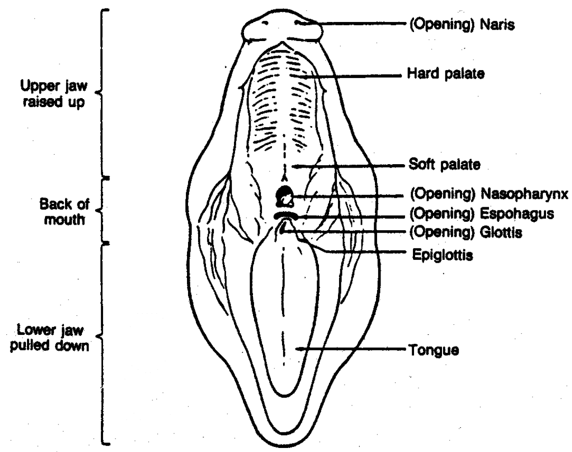


Figure 1

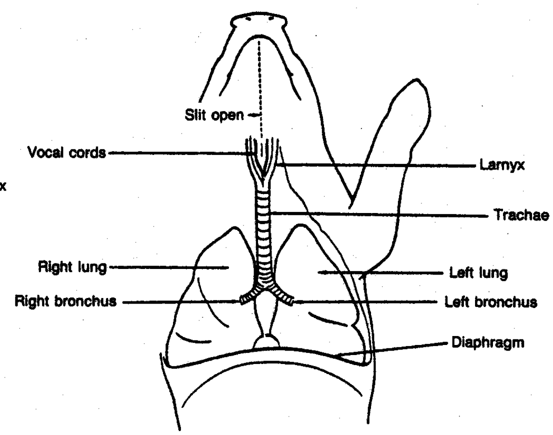


Figure 2

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

<u>Lab #3</u>

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 <u>Ventricle</u>.
3. a. Chamber with the thickest walls is the <u>Ventricle</u>.
   b. <u>Left ventricle</u> 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 532 - 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 532 - 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 toward the cell body; Axon--Nerve fibers connected to the nerve cell body that conduct impulses away 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

INTRODUCTION TO ANIMAL NUTRITION

AG 532 - F

UNIT OBJECTIVE

After completion of this unit, students should be able to discuss the two major feed groups and list the feed components that should be included when balancing a ration. Students should also be able to discuss animal water intake and feed additives in livestock rations. 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. Match terms associated with livestock nutrition to their correct definitions.
2. List, define and give five examples of the two major feed groups generally used in livestock feeding.
3. List the six components of feed that are important when balancing rations for livestock.
4. List the three feed components that provide energy for animals.
5. List the three major minerals needed in livestock rations.
6. Identify the four factors that affect the water intake of animals.
7. Explain why feed additives are used in livestock rations.
8. List eight important by-products of the livestock industry.

INTRODUCTION TO ANIMAL NUTRITION

AG 532 - F

SUGGESTED ACTIVITIES

I. Suggested activities for the 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--Classification of Concentrates

2. TM 2--Classification of Roughages

3. TM 3--Feed Components for Balancing Rations

4. TM 4--Energy Feed Components

E. Test

F. Answers to test

III. Unit references

A. Barrick, Kirby R., Harmon, Hobart L. *Animal Production and Management*. McGraw-Hill Book Company, New York, 1988.

B. Bundy, Clarence E., Diggins, Ronald V., Christensen, Virgil W. *Livestock and Poultry Production,* 5th edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1982.

C. Gillespie, James R. *Animal Nutrition and Feeding*. Delmar Publishers, Inc., Albany, New York, 1987.

INTRODUCTION TO ANIMAL NUTRITION

AG 532 - F

INFORMATION SHEET

I. Terms and definitions

A. Digestion--Process of breaking down and dissolving feeds so that the body can absorb them

B. Absorption--Passing of food materials from the digestive system into the body after they are digested and dissolved

C. Enzyme--Protein compound which brings about changes in other organic compounds without being changed or broken down itself

D. Hormone--Internal body secretion that regulates various body processes

E. Mastication--Grinding or chewing of food to aid in digestion

F. Metabolism--Sum of all physical and chemical changes which take place within an organism

(Note: This process includes both material and energy changes.)

G. Excretion--Removal of water and waste material from the body

H. Regurgitation--Process by which food eaten by a ruminant is carried from the second stomach and the rumen into the gullet, and then forced up to the mouth for chewing

I. Feces--Manure; undigested material and wastes expelled at the end of the digestive tract

J. Pancreatic juice--Clear, watery fluid with an alkaline reaction secreted by the pancreas; aids in feed breakdown

K. Bile--Thin, yellowish brown or greenish liquid secreted by the liver

L. Ruminant--Animal with four stomach compartments

M. Monogastric--Animal with one stomach compartment

N. Rumination--Regurgitating and rechewing previously swallowed food

O. Nutrient--Single class of foods or group of like foods that aids in the support of life; actually becomes a part of the body cells

P. Growth stimulant--Increases growth rate and feed efficiency, but does not become a part of the body cell

Q. Antibiotic--Substance which helps prevent or control certain diseases in animals

R. Cellulose--Carbohydrate portion of the cell wall; livestock cannot digest cellulose unless it is first broken down by microorganisms

S. Thrifty--Vigorous and healthy

II. Two major feed groups in livestock feeding (Transparencies 1,2)

A. Concentrates (Transparency 1)

1. Feeds that are low in fiber and high in total digestible nutrients

2. Examples:

a. Grains--Corn, oats, barley, wheat, rye

b. Oil meals--Soybean meal, cottonseed meal, linseed meal

c. Molasses--Cane, beet

d. Grain by-products--Wheat bran, wheat standard middlings

e. Animal products--Meat scraps, tankage, fish meal, dried dairy products

B. Roughages (Transparency 2)

1. Feeds high in fiber; low in total digestible nutrients

2. Examples

a. Green roughages--Roots, grasses, tubers

b. Dry roughages

(1) Hays--Grasses and legumes

(2) Hulls--Peanut and cottonseed

(3) Straw--Oat, wheat, barley, rice

c. Silage--Corn, sorghum, grass

III. Important feed components for balancing rations (Transparency 3)

A. Carbohydrates

B. Lipids

C. Protein

D. Minerals

E. Vitamins

F. Water

IV. Energy feed components (Transparency 4)

A. Carbohydrates

B. Lipids

C. Excess protein

V. Major minerals in livestock rations

A. Calcium

B. Phosphorus

C. Salt (sodium chloride)

VI. Factors affecting water intake

A. Kind of feed consumed

B. Amount of feed consumed

C. Environmental temperature

D. Activity level of animal

VII. Feed additives are used in livestock rations

A. To promote growth

B. To increase rate of gain

C. To improve feed conversion

D. To reduce disease level

VIII. Important by-products of the livestock industry

A. Hooves, horns

1. Glue

2. Gelatin

B. Inedible fats

1. Cosmetics

2. Waxes

3. Soaps

4. Lubricants
5. Printing ink

C. Extracts from endocrine glands

1. Insulin--Diabetes treatment
2. Cortisone--Rheumatoid arthritis treatment
3. Thromboplastin--Coagulant (used in surgery)

D. Others

1. Perfumes
2. Fertilizers
3. Candles
4. Lanolin
5. Glycerine

Classification Of Concentrates

OIL MEALS

- Soybean
- Cottonseed
- Linseed
- Peanut

MOLASSES

- Cane
- Beet

GRAIN BY-PRODUCTS

- Wheat bran
- Wheat standard middlings

ANIMAL PRODUCTS

- Meat scraps
- Tankage
- Fish meal
- Dried dairy products

GRAINS

- Barley
- Wheat
- Corn
- Milo
- Oats

Classification Of Roughages

GREEN ROUGHAGES

Roots

Grasses

Tubers

DRY ROUGHAGES

Hays—
Grass and Legume

Hulls—
Peanut and Cottonseed

Straw—
Oat, Wheat,
Barley, and Rice

SILAGE

Corn

Sorghum

Grass

FEED COMPONENTS FOR BALANCING RATIONS

Carbohydrates

Lipids

Protein

Minerals

Vitamins

Water

ENERGY FEED COMPONENTS

CARBOHYDRATES

LIPIDS

EXCESS PROTEIN

INTRODUCTION TO ANIMAL NUTRITION

AG 532 - F

UNIT TEST

Name ______________________________________ Score ___________________________________

1. Match the terms associated with livestock nutrition to the correct definitions. Place the correct number on the right in the blank provided.

_____a.	Protein compound which brings about changes in other organic compounds without being changed or broken down itself	1. Digestion
_____b.	Carbohydrate portion of the cell wall; livestock cannot digest this unless it is first broken down by microorganisms	2. Absorption
_____c.	Manure; undigested material and wastes expelled at the end of the digestive tract	3. Enzyme
_____d.	Grinding or chewing of food to aid in digestion	4. Hormone
_____e.	Thin, yellowish brown or greenish liquid secreted by the liver	5. Mastication
_____f.	Sum of all physical and chemical changes which take place within an organism	6. Metabolism
_____g.	Process of breaking down and dissolving feeds so that the body can absorb them	7. Excretion
_____h.	Process by which food eaten by a ruminant is carried from the second stomach and the rumen into the gullet and then forced up to the mouth for chewing	8. Regurgitation
_____i.	Internal body secretion that regulates various body processes	9. Feces
_____j.	Removal of water and waste material from the body	10. Pancreatic juice
_____k.	Clear, watery fluid with an alkaline reaction; aids in feed breakdown	11. Bile
_____l.	Passing of food materials from the digestive system into the body after they are digested and dissolved	12. Ruminant
_____m.	Animal with four stomach compartments	13. Thrifty

_____n.	Animal with one stomach compartment	14.	Rumination
_____o.	Substance which helps prevent or control certain diseases in animals	15.	Nutrient
_____p.	Regurgitating and rechewing previously swallowed food	16.	Growth stimulant
_____q.	Increases growth rate and feed efficiency, but does not become a part of the body cell	17.	Antibiotic
_____r.	Single class of foods or group of like foods that aids in the support of life; actually becomes a part of the body cells	18.	Cellulose
_____s.	Vigorous and healthy	19.	Monogastric

2. List, define and give five examples of the two major feed groups generally used in livestock feeding.

   a. Major feed group ____

      Definition ____

      ____

      Examples ____

      ____

   b. Major feed group ____

      Definition ____

      ____

      Examples ____

      ____

3. List the six components of feed that are important when balancing rations for livestock.

   a. ____

   b. ____

   c. ____

   d. ____

   e. ____

   f. ____

4. List the three feed components that provide energy for animals.

   a.____________________

   b. ____________________

   c.____________________

5. List the three major minerals needed in livestock rations.

   a.____________________

   b. ____________________

   c.____________________

6. Identify the four factors that affect the water intake of animals.

   a.____________________

   b. ____________________

   c.____________________

   d. ____________________

7. Explain why feed additives are used in livestock rations.

8. List eight important by-products of the livestock industry.

   a.____________________

   b. ____________________

   c.____________________

   d. ____________________

   e.____________________

   f.____________________

   g. ____________________

   h. ____________________

INTRODUCTION TO ANIMAL NUTRITION

AG 532 - F

ANSWERS TO TEST

1.

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

2. a. Concentrates: Feeds that are low in fiber and high in total digestible nutrients

   Grains--corn, oats, barley, wheat, rye; Oil meals--soybean meal, cottonseed meal, linseed meal; Molasses--cane, beet; Grain by-products--wheat bran, wheat standard middlings; Animal products--meat scraps, tankage, fish meal, dried dairy products

   b. Roughages: Feeds high in fiber; low in total digestible nutrients

   Green roughages--roots, grasses, tubers; Dry roughages--Hays (grasses and legumes); Hulls (peanut and cottonseed); Straw (oat, wheat, barley, rice); Silage (corn, sorghum, grass)

3. Carbohydrates; Lipids; Protein; Minerals; Vitamins; Water

4. Carbohydrates; Lipids; Excess protein

5. Calcium; Phosphorus; Salt (sodium chloride)

6. Kind of feed consumed; Amount of feed consumed; Environmental temperature; Activity level of animal

7. To promote growth; To increase rate of gain; To improve feed conversion; To reduce disease level

8. Answer should include eight of the following:

   Glue; Gelatin; Cosmetics; Waxes; Soaps; Lubricants; Printing ink; Insulin; Cortisone; Thromboplastin; Perfumes; Fertilizers; Candles; Lanolin; Glycerine

DIGESTION IN ANIMALS

AG 532 - G

UNIT OBJECTIVE

After completion of this unit, students should be able to define terms associated with animal digestion and name the kinds of digestive systems. Students should also be able to describe the liver's function and ruminant regurgitation. 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 the terms associated with animal digestion.
2. Name the three kinds of digestive systems and give an example of an animal with each type.
3. Match the parts of the monogastric digestive system to their correct description and function.
4. Match the digestive enzymes with their function.
5. Describe the functions of the liver.
6. Describe the difference between the digestive system of the horse and the swine.
7. List the four major compartments of the ruminant stomach and describe the function of each.
8. Describe regurgitation in the ruminant and tell how it relates to the digestive process.
9. List the major microorganisms found in the rumen and describe their function.
10. Match the parts of the avian digestive system to their correct description and function.
11. Describe the process of absorption.
12. Describe the process of metabolism.
13. Explore the digestive system of a pig.

DIGESTION IN ANIMALS

AG 532 - G

SUGGESTED ACTIVITIES

I. Suggested activities for the 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. Discuss and demonstrate laboratory exercise.
- 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--Simple Monogastric Digestion System
    2. TM 2--Ruminant Digestion System
    3. TM 3--Digestive System of a Pig
    4. TM 4--Digestive System of a Horse
    5. TM 5--Digestive System of a Chicken
- E. Laboratory exercise
    1. LE 1--Digestive Systems in Swine
- F. Answers to laboratory exercise
- G. Test
- H. Answers to test

III. Unit references

A. Barrick, Kirby R., Harmon, Hobart L. *Animal Production and Management*. McGraw-Hill Book Company, New York, 1988.

B. Bundy, Clarence E., Diggins, Ronald V., Christensen, Virgil W. *Livestock and Poultry Production,* 5th edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1982.

C. Gillespie, James R. *Animal Nutrition and Feeding*. Delmar Publishers, Inc., Albany, New York, 1987.

DIGESTION IN ANIMALS

AG 532 - G

INFORMATION SHEET

I. Terms and definitions

A. Ruminant--Animal with four distinct compartments in its stomach, which swallows unchewed food, regurgitates it, chews it thoroughly and then swallows it again

B. Nonruminant (monogastric)--Animal with single stomach which swallows food after chewing and does not regurgitate

C. Rumination--Process in which a ruminant will lie down to chew its cud after its rumen is filled

D. Nutrient--A chemical element or compound needed to support the life of the animal

II. Types of digestive systems (Transparencies 1, 2)

A. Monogastric (nonruminant) (Transparency 1)--Swine, horses, dogs, bears, humans

B. Avian--Chickens, turkeys

C. Ruminant (Transparency 2)--Cattle, sheep, goats, deer, elk

III. Parts of monogastric digestive system

A. Mouth

1. Tongue, teeth, salivary glands

2. Functions--Assists animal in taking in food, breaks food down into smaller particles, mixes with saliva

B. Esophagus

1. Passageway between mouth and stomach

2. Moves food along by series of voluntary muscle contractions

C. Stomach

1. Stores ingested food

2. Muscular movement breaks down ingested food

3. Secretes digestive juices

D. Small intestine

1. Primary site of digestion and absorption of carbohydrates, fats and proteins

2. Sections

a. Duodenum

(1) Receives bile from the gallbladder to help break fats down into usable forms of energy

(2) Receives enzymes from pancreas to help break down carbohydrates and proteins

b. Jejunum and ileum--Active in absorption of digested nutrients

E. Large intestine

1. Sections

a. Cecum

b. Colon

c. Rectum

2. Functions

a. Absorbs water from undigested material

b. Causes fecal formation

c. Adds mucus for lubrication of digestive tract

F. Anus

1. Final part of digestive tract

2. Passageway for feces to outside of the body

IV. Digestive enzymes and functions

A. Salivary amylase--Changes starch to maltose

B. Maltase--Changes maltose to glucose

C. Hydrochloric acid--Stops action of salivary amylase

D. Pepsin--Breaks down protein into polypeptides

E. Rennin--Curdles the casein of milk

F. Gastric lipase--In young animals, acts on fat to form fatty acids and glycerol

G. Trypsin, Chymotripsin, Carboxypeptidase--Further breakdown of proteins

H. Pancreatic lipase--Breaks down fats into fatty acids, glycerol and monoglycerides

I. Pancreatic amylase--Changes starch to maltose

J. Sucrase--Changes sucrose to glucose and fructose

K. Lactase--Changes lactose to glucose, fructose and galactose

L. Cellulase--Acts on cellulose to form volatile fatty acids

V. Functions of the liver--Produces bile and secretes it into the small intestine to help emulsify fats and acts as a solvent for fatty acids

VI. Differences in horse and swine digestive systems (Transparencies 3, 4)

A. Saliva

1. Swine saliva contains the enzymes amylase and maltase

2. Horse saliva contains no enzymes

B. Horses can't usually regurgitate food after it reaches the lower half of the esophagus (it contains an involuntary muscle, so the horse has no control over it at this point)

C. Horses do not have a gallbladder, so bile is secreted directly into the duodenum from the liver. In swine, bile goes to the duodenum from the gallbladder

D. Horses have both a small colon and a large colon; swine have only one colon

D. Horses can consume large amounts of roughage because of the presence of bacteria in the cecum and colon

VII. Compartments of the ruminant's stomach

A. Rumen

1. Storage

2. Soaking

3. Physical breakdown and mixing

4. Fermentation of ingested feedstuffs

B. Reticulum--Acts as a screening device

C. Omasum

1. Reduces food particle size

2. Absorbs water from injected feedstuff

3. Absorbs fatty acids

D. Abomasum

1. Secretes enzymes

2. Partially digests microbial protein

VIII. Ruminant regurgitation

A. Process of forcing the feed back into the mouth for chewing

B. Allows ruminants to eat large quantities of roughage at once, then chew it for digestion later

C. Feed comes up from the rumen; after being thoroughly chewed, it passes into the reticulum and then the omasum

IX. Microorganisms in the rumen

A. Bacteria

1. Digest and ferment readily available carbohydrates

2. Digest and ferment the cellulose and hemicellulose part of the feed

B. Protozoa

1. Store readily available carbohydrates

2. Produce protozoal protein

3. Ferment cellulose material

X. Avian digestive system (Transparency 5)

A. Mouth

1. Tongue--Helps push feed into gullet

2. Gullet--Feed passes through to the crop

3. Crop

    a. Saliva and secretions soften the food

    b. Storage area for food

B. Stomach

1. Digestive juices mix with feed

2. Pepsin starts breakdown of proteins to amino acids

C. Gizzard--Grinds the feedstuffs

D. Small intestine

1. Most of the digestion takes place here

2. Digestive juices break nutrients down to simple forms

E. Ceca

1. Blind pouches, with some bacteria, filled with soft, undigested feed

2. Water sometimes absorbed from feedstuff

3. Little digestion occurs

F. Large intestine

1. May absorb water from the feedstuff

2. Very little digestion

G. Cloaca--Site where undigested food and urine meet

H. Vent--Feces passed out of body

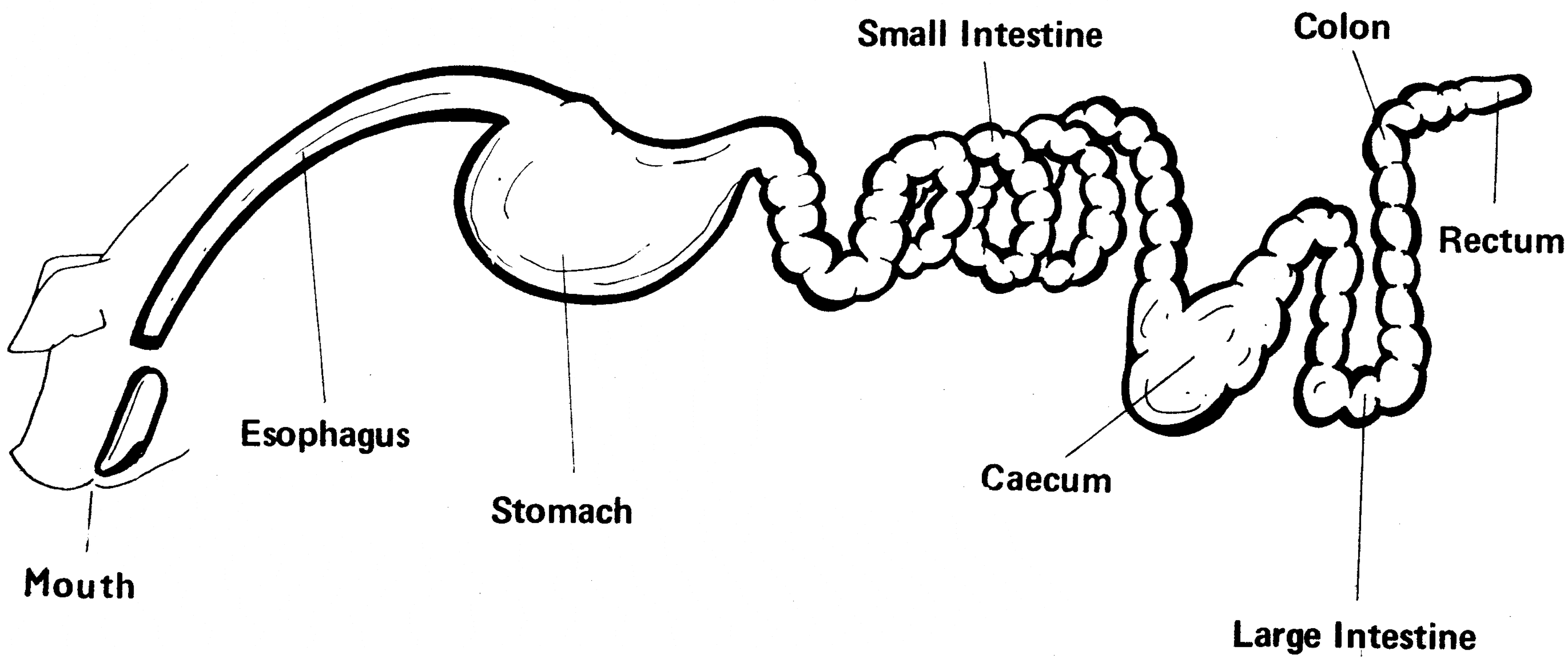
XI. Absorption--Process of taking nutrients from the digested feed into the blood and lymph systems. Nutrients are then distributed to the cells and tissues of the body where they are utilized in the animal's metabolism

A. Nonruminants--Most absorption takes place from small intestine

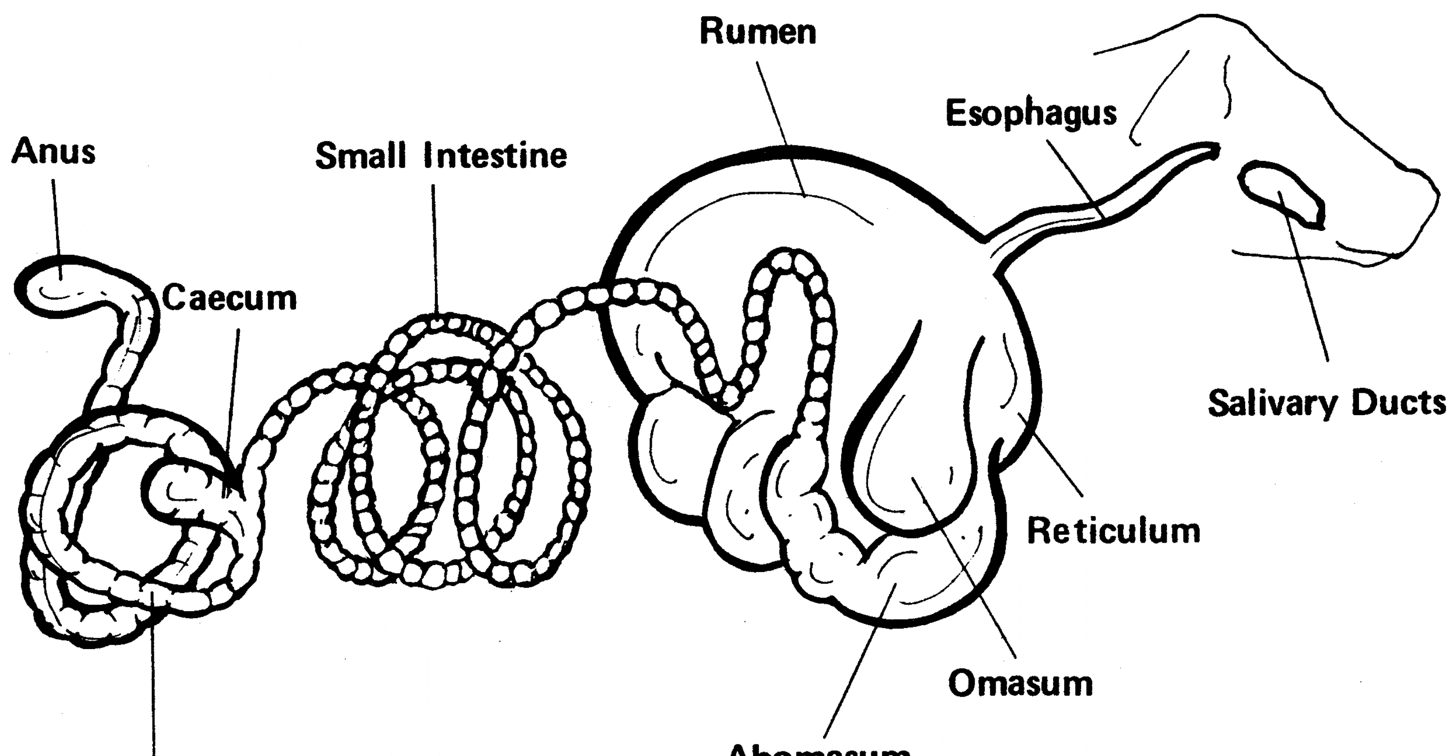
B. Ruminants--Some absorption through wall of rumen

XII. Metabolism--The sum of the chemical and physical changes continually occurring in living organisms and cells utilizing nutrients after they are absorbed from the digestive system

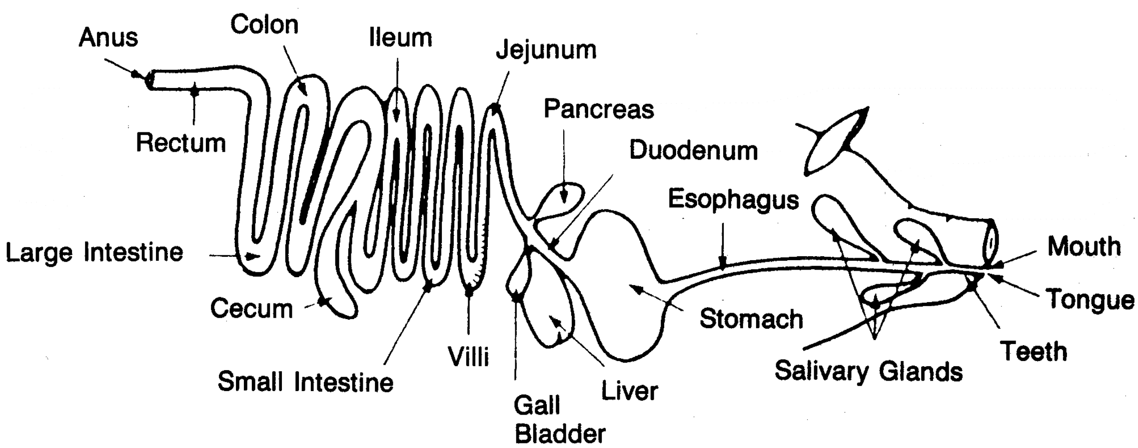
Simple Monogastric Digestion System



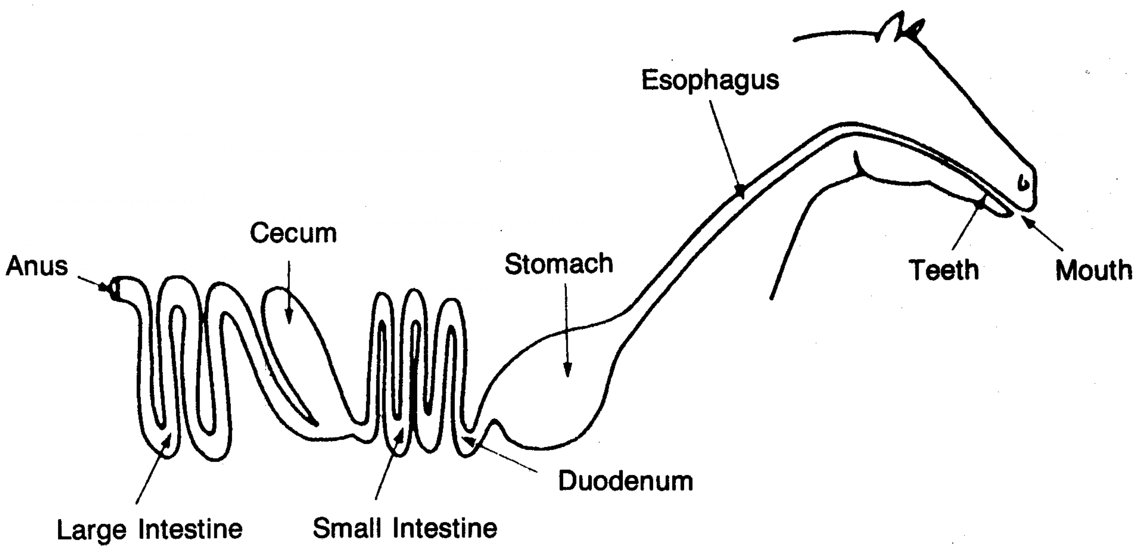
Ruminant Digestion System



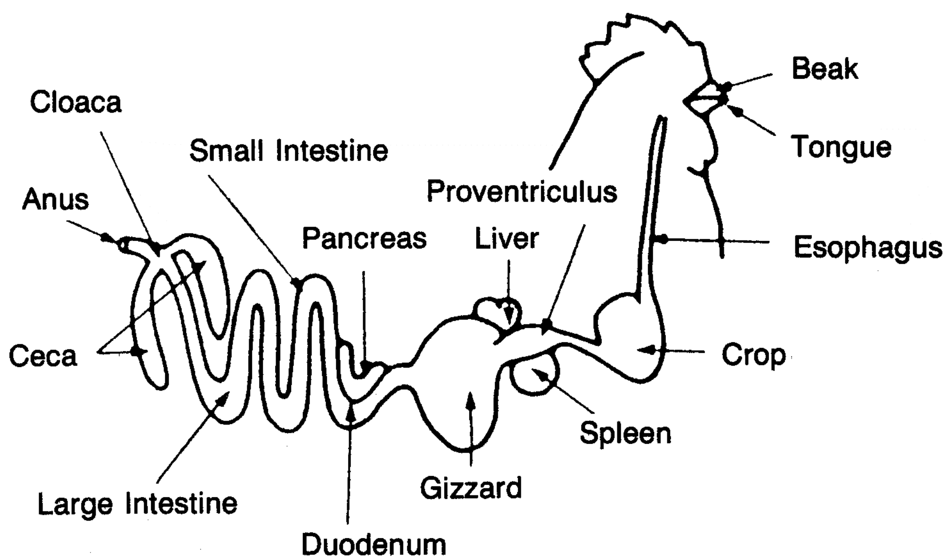
Digestive System of a Pig



Digestive System of a Horse



Digestive System of a Chicken



DIGESTION IN ANIMALS

AG 532 - G

LABORATORY EXERCISE #1--DIGESTIVE SYSTEMS IN SWINE

Name ______________________________________ Score ___________________________________

Introduction

It is not easy to study the digestive organs of a human. However, anatomy of the human digestive system can be studied by examining the digestive system of a pig, an animal similar to a human. A pig resembles a human both internally and externally in many ways.

The pigs you will dissect are called fetal pigs. Fetal pigs have not been born. They were removed from their mother's reproductive tract before birth. Evidence that they are fetal can be seen by examining the stomach area for the attached umbilical cord.

It is important that directions for dissection be followed EXACTLY. Do not remove any organ or structure unless you are directed to do so.

Before beginning the dissection, let's discuss the function of the parts of the digestive system we'll be studying. The *salivary glands*, produce the enzyme amylase which converts carbohydrates to double sugars. The *esophagus* carries food from the throat to the stomach. The *stomach* begins protein digestion; produces pepsin, hydrochloric acid and rennin. The *liver* produces bile. The *gall bladder* stores bile for the liver. The *pancreas* produces several enzymes (trypsin for protein digestion, lipase for fat digestion, and amylase for carbohydrate digestion) and insulin. The *small intestine* allows for the transfer of digested food to the bloodstream and produces enzymes. The *large intestine* reabsorbs water from food and returns it to the bloodstream.

Materials needed

Fetal pig	Plastic bag
Scissors	Water
Razor blade (single-edge)	Dissecting pan

Part I: Procedure

Note: Although this investigation is designed to examine the digestive system parts, structures from other systems will be identified in the process. The parts which belong to the digestive system are in italics.

1. Determine if your pig is male or female. Both sexes have a double row of nipples along the ventral body surface. Therefore, these structures will not help you determine sex. A male pig has a small genital opening on the ventral (stomach) body surface below the area where the umbilical cord enters. A female pig has a vaginal opening next to the *anus*. These two openings are found under the pig's tail. A male pig has only the anal opening.

   The sex of our pig is ____

2. With scissors, remove the skin in the neck and head region of your pig as shown in Figure 1.

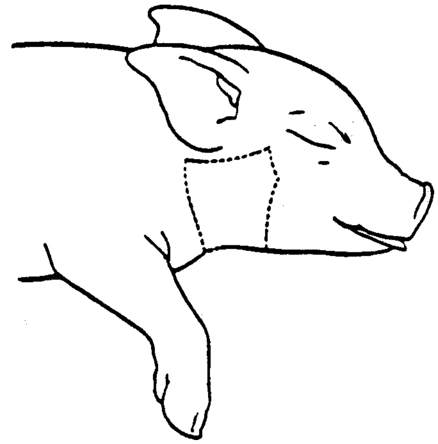


Figure 1

Be sure to remove only skin tissue. Push aside or remove the muscle and connective tissue if necessary.

Use the diagram titled Figure 2 and the directions below to locate the *parotid salivary gland*, the *submaxillary salivary gland* and *Wharton's duct.*

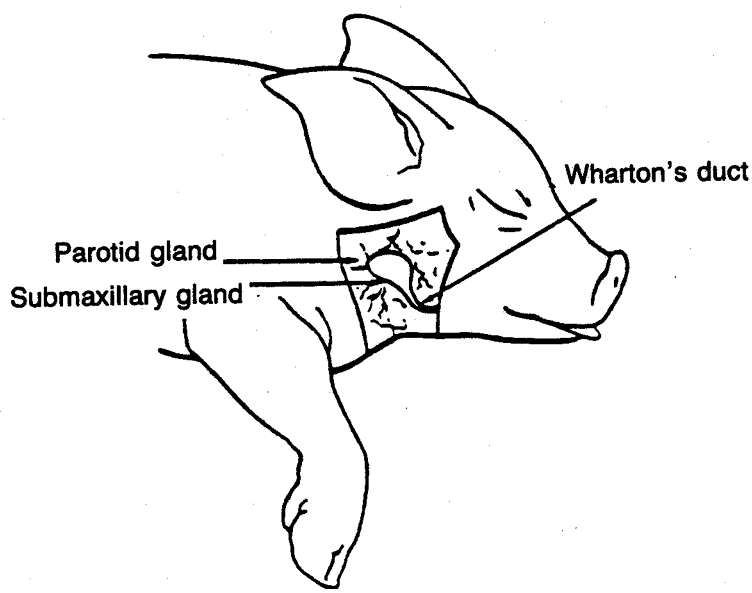


Figure 2

Under the muscle are rough or coarse flat tissues. The larger of the tissues is the *parotid salivary gland.* This gland is very difficult to locate; it is okay if you cannot find it.

A smaller, more compact triangular salivary gland lies beneath the parotid. This gland is the *submaxillary salivary gland.* A third gland is also present, but is not easily observable.

Salivary ducts lead from the glands toward the animal's mouth. One main duct is *Wharton's duct*. It carries saliva from the salivary glands to the mouth.

3. Open the pig's mouth. The mouth region, or oral cavity, has structures associated with digestion.

   The *tongue* is used to mix food and push it into the pharynx. The surface of the tongue is rough because of the presence of taste buds. Taste buds are sometimes called papillae.

   The roof of the mouth is called the palate. The front portion is the hard palate. The portion toward the back of the mouth is the soft palate.

   The pharynx joins the *esophagus* at the rear of the mouth. It is the tube that connects the throat to the stomach. Do not worry if you cannot see the esophagus at this time, we will observe it again later in the experiment.

   Teeth may or may not be evident in your pig. Rub your finger along the pig's gums to determine if teeth are beginning to emerge through the gum. You may or may not find *teeth* depending upon the age of your pig.

   Does your pig have teeth? ____

4. Position your pig so that its ventral surface (stomach) is up and its head away from you. See Figure 3.

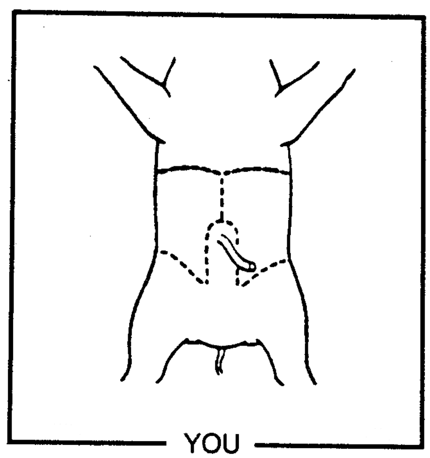


Figure 3

5. Using scissors, cut through the skin and muscle along the lines designated in Figure 3. DO NOT remove the umbilical cord. Now, open the abdominal cavity by pulling the ribs up and out (like opening the shutters of a window).

   If your pig has a brown liquid within the abdominal cavity, rinse out the cavity with tap water over a sink.

6. From the descriptions which follow and what you view on your fetal pig, label the liver, large intestine, small intestine, diaphragm, umbilical cord, umbilical blood vessels, and the urinary bladder on the diagram titled Figure 4.

The *liver* is a large, lobed, brown organ occupying the top portion of the abdominal cavity.

The tightly coiled mass of thick, dark greenish, tubelike tissue is the *large intestine.*

The *small intestine* is the less tightly coiled mass of thin tubelike tissue which can be spread apart more easily.

Above the pig's liver is a thin muscle called the diaphragm. It separates the abdominal cavity from the thoracic (chest) cavity.

7. Pull the umbilical cord down between the hind legs of your pig.

The umbilical cord just after entering the pig's body divides into two blood vessels. These two vessels are called the umbilical blood vessels. They lie on each side of a flat structure called the urinary bladder.

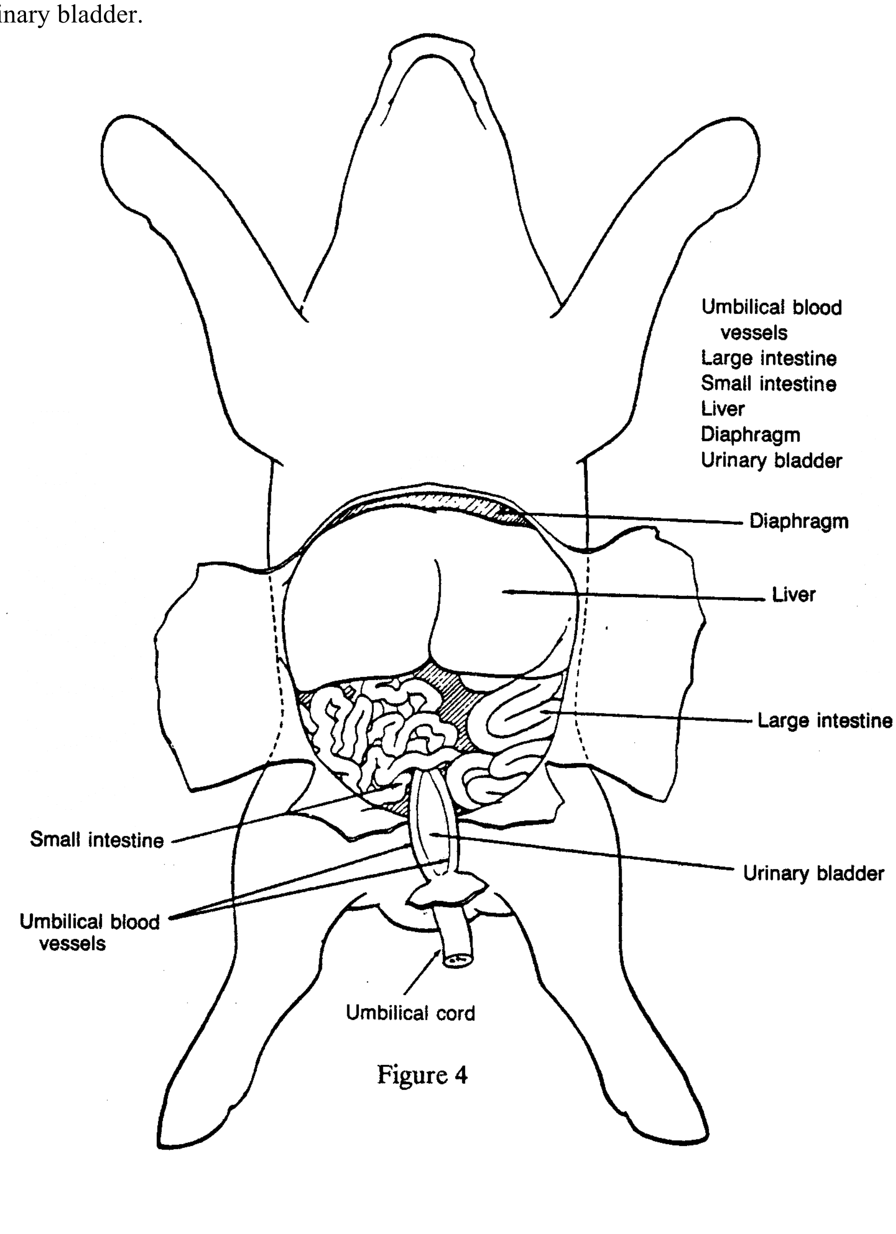


Figure 4

8. From the descriptions which follow and what you view on your fetal pig, label the gall bladder, bile duct, stomach, esophagus, spleen, pancreas, duodenum, cecum, rectum and anus on the diagram titled Figure 5.

9. Raise your pig's liver and push the intestines toward the left with your fingers. Organs not previously visible should now be revealed.

   A saclike structure attached to the underside of the liver is the *gall bladder.* It is usually green and is partly embedded in the liver.

   Leading from the gall bladder and extending along the underside of the liver is a thin tube called the *bile duct*.

   Directly below the liver on the right (the pig's left side) is a large pouch. This is the *stomach*.

   Leading into the top portion of the stomach is the *esophagus*. It appears to be rather short because it passes upward behind the liver.

   Attached along the right edge of the stomach is a round, reddish organ. It is the *spleen*.

   A rough or coarse organ lying directly below and extending along the underside of the stomach is the *pancreas*.

   Extending from the stomach toward the left side (pig's right) is a tube which is the beginning section of the small intestine. This is the *duodenum*. Both the pancreas and the gall bladder empty digestive chemicals into this structure. The bile duct which leads from the gall bladder to the duodenum should be visible. The duct leading from the pancreas is small and difficult to locate.

   At the junction between the small and large intestine is a small, fingerlike projection. This structure is the *cecum*.

10. Push the intestines as far to your left as possible. Also pull the urinary bladder and umbilical cord down.

    A tube leading from the large intestine out of the abdominal cavity toward the pig's tail is the rectum.

    The opening of the rectum to the outside of the animal's body is the *anus*.

11. Locate the *anus* directly under the pig's tail. (Remember that female pigs have a vaginal opening in the same area as the anus.)

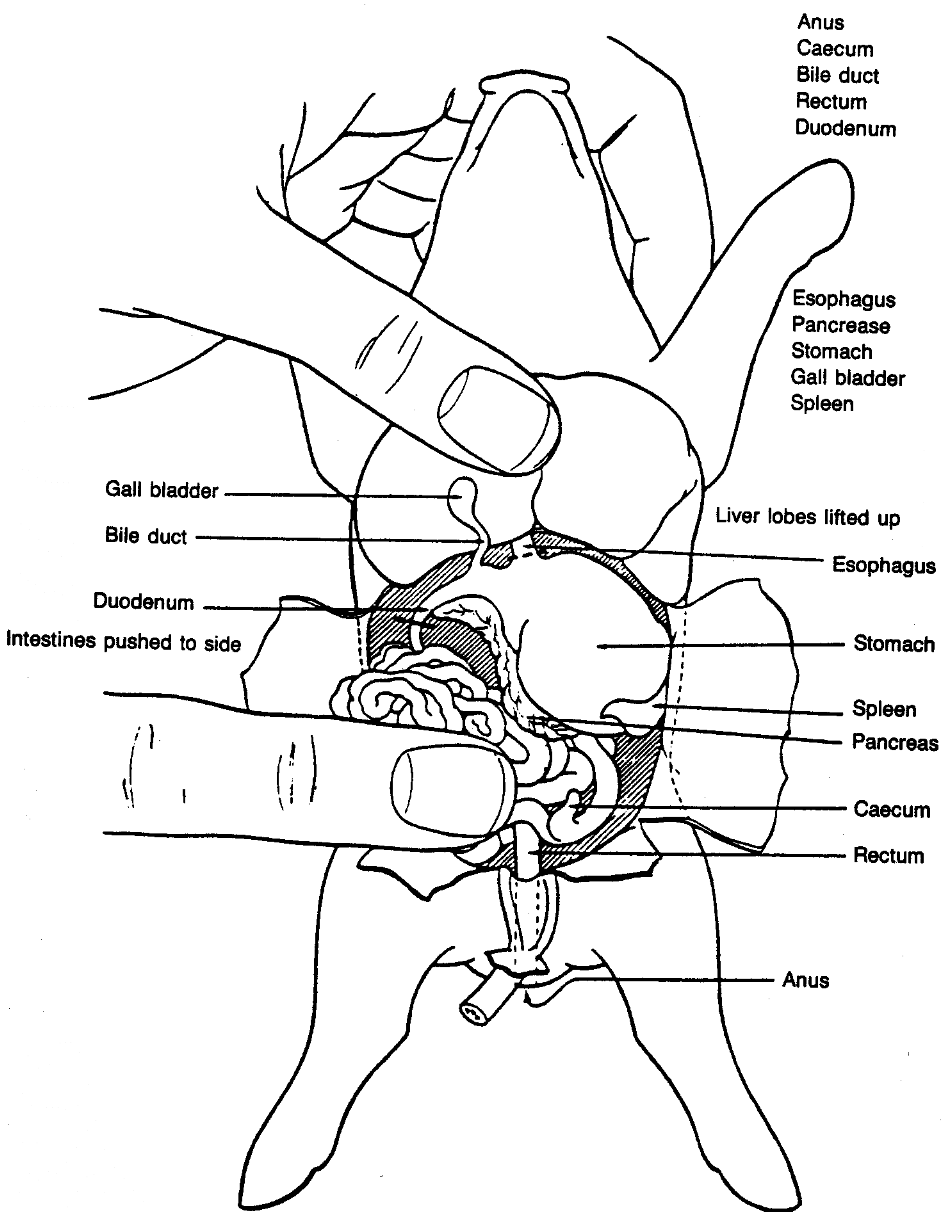


Figure 5

12. Place your pig in a plastic bag and put it where your teacher directs. DO NOT allow the pigs to dry out. Retain any liquid which collects or is found in the bag.

<u>Part II: Analysis</u>

1. The parts of the digestive system which food passes through are listed below. A one was placed next to the mouth and a nine next to the anus. Place the number which corresponds to the order in which the food travels through the system next to the remaining parts.

   __1__Mouth

   _____Small intestine

   _____Stomach

   _____Throat

   _____Rectum

   _____Duodenum

   _____Large intestine

   _____Esophagus

   __9__Anus

2. Match the part of the digestive system to its function.

_____Esophagus	a.	Produces bile
_____Stomach	b.	Reabsorbs water from food to blood
_____Liver	c.	Carries food from throat to stomach
_____Pancreas	d.	Produces insulin
_____Large intestine	e.	Begins protein digestion

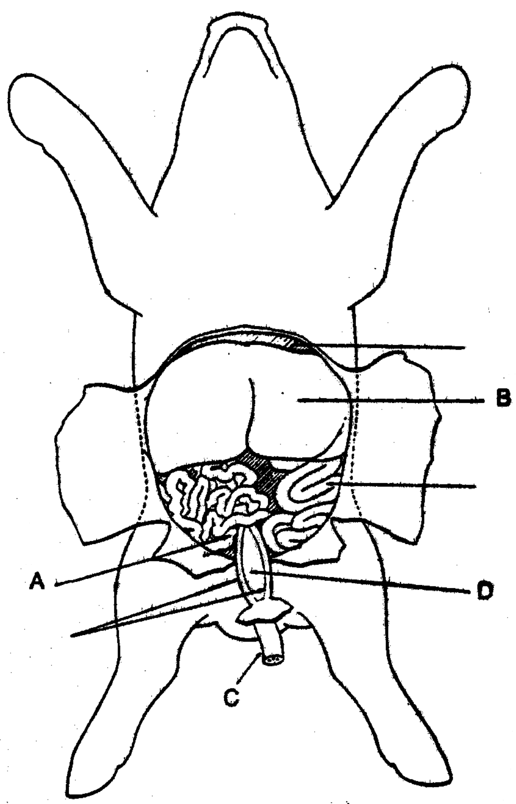
3. Using the diagrams on the next two pages, identify the parts labeled A through H.

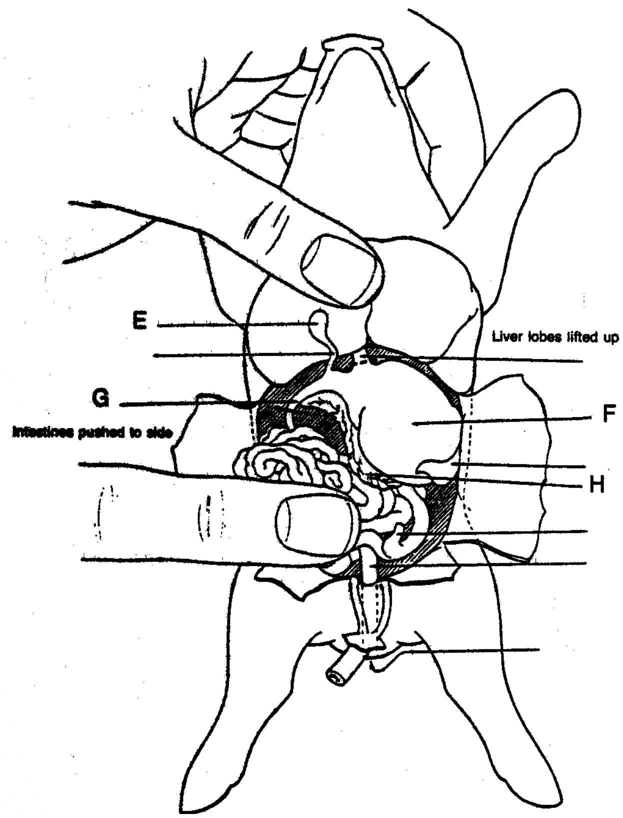
A. ______________________ B. ______________________

C. ______________________ D. ______________________

E. ______________________ F. ______________________

G. ______________________ H. ______________________





DIGESTION IN ANIMALS

AG 532 - G

ANSWERS TO LABORATORY EXERCISE

Part II: Analysis

1. 1, 6, 4, 2, 8, 5, 7, 3, 9

2. c, e, a, d, b

3. A. Small intestine
   B. Liver
   C. Umbilical cord
   D. Urinary bladder
   E. Gall bladder
   F. Stomach
   G. Duodenum
   H. Pancreas

DIGESTION IN ANIMALS

AG 532 - G

UNIT TEST

Name ______________________________ Score ______________________________

1. Define the terms associated with animal digestion.

   a. Ruminant ______________________________

   ____

   ____

   b. Nonruminant (monogastric) ______________________________

   ____

   ____

   c. Rumination ______________________________

   ____

   ____

   d. Nutrient ______________________________

   ____

   ____

2. Name the three kinds of digestive systems and give an example of an animal with each type.

   a.______________________________

   Example: ______________________________

   b. ______________________________

   Example: ______________________________

   c.______________________________

   Example: ______________________________

3. Match the parts of the monogastric digestive system to their correct description and function. The numbers may be used more than once; choose the most specific answer.

_____a. Passageway between mouth and stomach

_____b. Muscular movement breaks down ingested food

_____c. Causes fecal formation

_____d. Receives enzymes from pancreas to help break down carbohydrates and proteins

_____e. Secretes digestive juices

_____f. Assists animal in taking in food, breaks food down into smaller particles, mixes with saliva

_____g. Moves food along by series of voluntary muscle contractions

_____h. Receives bile from the gallbladder to help break fats down into usable forms of energy

_____i. Final part of digestive tract

_____j. Absorbs water from undigested material

_____k. Primary site of digestion and absorption of carbohydrates, fats and proteins

_____l. Stores ingested food

_____m. Made up of three sections: cecum, colon and rectum

_____n. Active in absorption of digested nutrients; section of small intestine

_____o. Passageway for feces to outside of the body

_____p. Made up of the tongue, teeth and salivary glands

_____q. Adds mucus for lubrication of digestive tract

_____r. Made up of the duodenum, jejunum and ileum

1. Mouth
2. Esophagus
3. Stomach
4. Small intestine
5. Duodenum
6. Jejunum
7. Large intestine
8. Anus

4. Match the digestive enzymes with their function. There may be more than one correct answer. Be sure to include all correct answers.

_____a.	Changes maltose to glucose	1. Salivary amylase
_____b.	Further breakdown of proteins	2. Maltase
_____c.	Breaks down protein into polypeptides	3. Hydrochloric acid
_____d.	Changes starch to maltose	4. Pepsin
_____e.	Acts on cellulose to form volatile fatty acids	5. Rennin
		6. Gastric lipase
_____f.	Changes lactose to glucose, fructose and galactose	7. Trypsin, Chymotripsin Carboxypeptidase
_____g.	Breaks down fats into fatty acids, glycerol and monoglycerides	8. Pancreatic lipase
_____h.	Curdles the casein of milk	9. Pancreatic amylase
_____i.	Changes sucrose to glucose and fructose	10. Sucrase
_____j.	In young animals, acts on fat to form fatty acids and glycerol	11. Lactase
_____k.	Stops action of salivary amylase	12. Cellulase

5. Describe the functions of the liver.

____

____

____

6. Describe the difference between the digestive system of the horse and the swine.

____

____

____

____

____

____

____

7. List the four major compartments of the ruminant stomach and describe the function of each.

a.____

____

b. ____

____

c.____

____

d. ____

____

8. Describe regurgitation in the ruminant and tell how it relates to the digestive process.

____

____

____

9. List the major microorganisms found in the rumen and describe their function.

a.____

____

b. ____

____

10. Match the parts of the avian digestive system to their correct description and function. The numbers may be used more than once; choose the most specific answer.

_____a.	Grinds the feedstuffs	1.	Mouth
_____b.	Most of the digestion takes place here; digestive juices break nutrients down to simple forms	2.	Tongue
_____c.	Feces passes out of body	3.	Gullet
_____d.	Blind pouches, with some bacteria, filled with soft, undigested feed	4.	Crop
_____e.	Site where undigested food and urine meet	5.	Stomach
_____f.	Digestive juices mix with feed	6.	Gizzard
_____g.	Helps push feed into gullet	7.	Small intestine
_____h.	Storage area for food	8.	Ceca
_____i.	Pepsin starts breakdown of proteins to amino acids	9.	Large intestine
_____j.	Feed passes through to the crop	10.	Cloaca
_____k.	Saliva and secretions soften the food	11.	Vent
_____l.	Made up of the tongue, gullet and crop		

11. Describe the process of absorption.

____

____

____

____

12. Describe the process of metabolism.

____

____

____

____

DIGESTION IN ANIMALS

AG 532 - G

ANSWERS TO TEST

1. a. Ruminant--Animal with four distinct compartments in its stomach, which swallows unchewed food, regurgitates it, chews it thoroughly and then swallows it again
   b. Nonruminant (monogastric)--Animal with single stomach which swallows food after chewing and does not regurgitate
   c. Rumination--Process in which a ruminant will lie down to chew its cud after its rumen is filled
   d. Nutrient--A chemical element or compound needed to support the life of the animal

2. a. Monogastric (nonruminant)--Swine, horses, dogs, bears, humans
   b. Avian--Chickens, turkeys
   c. Ruminant--Cattle, sheep, goats, deer, elk

3.

a. 2	g. 2	m. 7
b. 3	h. 5	n. 6
c. 7	i. 8	o. 8
d. 5	j. 7	p. 1
e. 3	k. 4	q. 7
f. 1	l. 3	r. 4

4.

a. 2	e. 12	i. 10
b. 7	f. 11	j. 6
c. 4	g. 8	k. 3
d. 1, 9	h. 5	

5. Produces bile and secretes it into the small intestine to help emulsify fats and acts as a solvent for fatty acids

6. Saliva: Swine saliva contains the enzymes amylase and maltase; Horse saliva contains no enzymes; Horses can't usually regurgitate food after it reaches the lower half of the esophagus (it contains an involuntary muscle, so the horse has no control over it at this point); Horses do not have a gallbladder, so bile is secreted directly into the duodenum from the liver. In swine, bile goes to the duodenum from the gallbladder; Horses have both a small colon and a large colon; swine have only one colon; Horses can consume large amounts of roughage because of the presence of bacteria in the cecum and colon

7. a. Rumen--Storage; soaking; physical breakdown and mixing; fermentation of ingested feedstuffs
   b. Reticulum--Acts as a screening device
   c. Omasum--Reduces food particle size; absorbs water from injected feedstuff; absorbs fatty acids
   d. Abomasum--Secretes enzymes; partially digests microbial protein

8. Process of forcing the feed back into the mouth for chewing; Allows ruminants to eat large quantities of roughage at once, then chew it for digestion later; Feed comes up from the rumen; after being thoroughly chewed it passes into the reticulum and then the omasum

9. Bacteria: Digest and ferment readily available carbohydrates; Digest and ferment the cellulose and hemicellulose part of the feed
Protozoa: Store readily available carbohydrates; Produce protozoal protein; Ferment cellulose material

10.

a. 6	e. 10	i. 5
b. 7	f. 5	j. 3
c. 11	g. 2	k. 4
d. 8	h. 4	l. 1

11. Process of taking nutrients from the digested feed into the blood and lymph systems. Nutrients are then distributed to the cells and tissues of the body where they are utilized in the animal's metabolism: Nonruminants--Most absorption takes place from small intestine; Ruminants--Some absorption through wall of rumen

12. The sum of the chemical and physical changes continually occurring in living organisms and ells utilizing nutrients after they are absorbed from the digestive system

ENERGY NUTRIENTS

AG 532 - H

UNIT OBJECTIVE

After completion of this unit, students should be able to list the essential nutrients and describe the energy nutrients. Students should also be able to describe energy needs of animals and discuss carbohydrates in the animal diet. 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 associated with energy.
2. List the six essential nutrients.
3. List the three nutrients that are the major sources of energy in livestock rations.
4. List the five categories of energy nutrient sources.
5. List the six functions of the energy nutrients.
6. List nine symptoms of energy deficiencies in the ration.
7. Describe "upper critical temperature" and "lower critical temperature" and explain how animals react to each condition.
8. List seven factors which affect critical temperatures.
9. Describe the energy needs of animals for milk production, pregnancy and work.
10. Name the most important energy nutrient and explain why it is the most important.
11. List the carbohydrates that are the most easily digested, and those that are the hardest to digest.
12. List the most important compound sugar in the animal's body.
13. Identify the parts of the plant that store the most easily digested carbohydrates.
14. Describe the digestion of fiber.
15. Compare the amount of energy supplied by fats and oils as compared to carbohydrates.
16. List three essential fatty acids.

ENERGY NUTRIENTS

AG 532 - H

SUGGESTED ACTIVITIES

I. Suggested activities for the 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--Essential Nutrients

      2. TM 2--Major Energy Nutrients

      3. TM 3--Sources of Energy Nutrients

      4. TM 4--Functions of Energy Nutrients

      5. TM 5--Symptoms of Energy Deficiencies

      6. TM 6--Factors Affecting Critical Temperatures

      7. TM 7--Essential Fatty Acids

   E. Test

   F. Answers to test

III. Unit references

A. Barrick, Kirby R., Harmon, Hobart L. *Animal Production and Management*. McGraw-Hill Book Company, New York, 1988.

B. Bundy, Clarence E., Diggins, Ronald V., Christensen, Virgil W. *Livestock and Poultry Production,* 5th edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1982.

C. Gillespie, James R., *Animal Nutrition and Feeding*. Delmar Publishers, Inc., Albany, New York, 1987.

ENERGY NUTRIENTS

AG 532 - H

INFORMATION SHEET

I. Terms and definitions

A. Calorie--Measures the amount of heat energy required to raise the temperature of one gram of water from $14.5^{o}C$ to $15.5^{O}c$

B. Kilocalorie (Kcal)--1,000 calories

C. Megacalorie (Mcal)--1,000,000 calories

D. Gross energy (GE)--Total amount of heat released when a substance is completely oxidized in a bomb calorimeter under 25 to 30 atmospheres of oxygen

E. Digestible energy (DE)--Gross energy of the feed consumed minus the gross energy excreted in the feces

F. Metabolizable energy (ME)--Gross energy of the feed consumed minus the energy in the feces, urine and gaseous products of digestion

G. Heat increment (HI)--The portion of the metabolizable energy which is used for digestion or metabolism of absorbed nutrients into body tissues

H. Net energy (NE)--The metabolizable energy minus the heat increment

I. Basal metabolism--The heat production of the animal while it is at rest and not digesting food

J. Maintenance requirement--Amount of energy needed for no body weight change and normal activities

II. Essential nutrients (Transparency 1)

A. Carbohydrates

B. Fats

C. Proteins

D. Minerals

E. Vitamins

F. Water

III. Major energy nutrients (Transparency 2)

A. Carbohydrates

B. Fats

C. Oils

IV. Sources of energy nutrients (Transparency 3)

A. Grains or grain by-products

1. Shelled corn
2. Corn and cob meal
3. Ground snapped corn
4. Corn starch and corn oil
5. Oats
6. Oat groats
7. Barley
8. Wheat
9. Wheat bran
10. Wheat middlings and shorts
11. Grain sorghum
12. Rye
13. Hominy feed
14. Rice bran

B. Forages

1. Corn silage
2. Straws
3. Corn stover
4. Pastures

C. By-products

1. Dried citrus pulp

2. Dried beet pulp

3. Potato meal

4. Sweet potatoes

5. Dried bakery product

6. Dried whey

D. Animal fats

E. Molasses

V. Functions of energy nutrients (Transparency 4)

A. Maintenance of life in the animal (basal metabolism)

B. Keep muscles in state of tension

C. Maintain body temperature

D. Growth

E. Production

F. Development of fetus

VI. Symptoms of energy deficiencies (Transparency 5)

A. Slower growth in young

B. Delayed puberty

C. Decreased milk production

D. Shorter lactation period

E. Weight loss

F. Reproductive problems (reduced fertility, delayed estrus)

G. Loss in wool quality and quantity

H. Higher death loss

I. Less resistance to diseases and parasites

J. Poor condition and weakness

K. Hypoglycemia

L. Loss of subcutaneous fat

M. Reduced levels of blood glucose, calcium and sodium

VII. Critical temperature

A. Lower critical temperature--Temperature below the thermoneutral zone when animals show symptoms of cold stress

1. Animals increase metabolic heat production

2. Gradual physiological adjustments over time (e.g. thicker hair coat)

B. Upper critical temperature--Temperature above the thermoneutral zone when animals show symptoms of heat stress

1. Animal lowers feed intake to reduce rate of metabolic heat production

2. Evaporation through skin surface or respiratory tract

C. Factors affecting critical temperatures (Transparency 6)

1. Housing conditions

2. Age

3. Breed

4. Stage of lactation

5. Level of nutrition

6. Time after feeding

7. Length of time exposed to temperature change

8. Number of animals in group

9. Amount of hair or thickness of wool

VIII. Animal energy needs

A. Milk production

1. Energy needs double (net energy)

2. Energy deficiency limits milk production (after body fat used)

B. Pregnancy

1. Additional energy for development of fetus

2. Maintain animal in healthy condition (not thin or fat)

C. Work

1. Provide energy above maintenance needs

2. Factors affect needed energy (e.g. amount of work being done, condition of animal, etc.)

IX. Carbohydrates are the most important energy source

A. Readily available

B. Easily digested in greatest quantities

C. Usually lower cost

X. Carbohydrates

A. Most easily digested--Sugars

B. Hardest to digest

1. Cellulose

2. Lignin

XI. Glucose is the most important compound sugar in animal body

XII. Parts of the plant where the most easily digested carbohydrates are found

A. Seeds

B. Roots

C. Tubers

XIII. Fiber digestion

A. Fiber cells contain hemicellulose and cellulose--Hard for animal to digest

B. Requires a lot of energy--Inefficient energy source

XIV. Fats and oils supply about 2.25 times as much energy as the same weight of carbohydrates supplies

XV. Essential fatty acids (Transparency 7)

A. Linoleic

B. Linolenic

C. Arachidonic

ESSENTIAL NUTRIENTS

Carbohydrates

Fats

Proteins

Minerals

Vitamins

Water

MAJOR ENERGY NUTRIENTS

CARBOHYDRATES

FATS

OILS

SOURCES OF ENERGY NUTRIENTS

Grains or grain by-products

Forages

By-products

Animal fats

Molasses

FUNCTIONS OF ENERGY NUTRIENTS

Basal Metabolism

Muscle Tension

Body Temperature

Growth

Production

Fetal Development

SYMPTOMS OF ENERGY DEFICIENCIES

Slower growth in young

Delayed puberty

Decreased milk production

Shorter lactation period

Weight loss

Reproductive problems

Wool quality and quantity loss

Higher death loss

Less disease and parasite resistance

Poor condition

Weakness

Hypoglycemia

Subcaneous fat loss

Reduced levels of glucose

Reduced levels of calcium

Reduced levels of sodium

FACTORS AFFECTING CRITICAL TEMPERATURE

Housing Conditions

Age

Breed

Stage of Lactation

Level of Nutrition

Time After Feeding

Length of Time Exposed to Temperature Change

Number of Animals in Group

Amount of Hair/Thickness of Wool

ESSENTIAL FATTY ACIDS

LINOLEIC

LINOLENIC

ARACHIDONIC

ENERGY NUTRIENTS

AG 532 - H

UNIT TEST

Name ______________________________ Score ______________________________

1. Define terms associated with energy.

   a. Calorie ____

   ____

   b. Kilocalorie (Kcal) ____

   ____

   c. Megacalorie (Mcal) ____

   ____

   d. Gross energy (GE) ____

   ____

   e. Digestible energy (DE) ____

   ____

   f. Metabolizable energy (ME) ____

   ____

   g. Heat increment (HI) ____

   ____

   h. Net energy (NE) ____

   ____

   i. Basal metabolism ____

   ____

   j. Maintenance requirement ____

   ____

2. List the six essential nutrients.

   a.____

   b. ____

   c.____

   d. ____

   e.____

   f.____

3. List the three nutrients that are the major sources of energy in livestock rations.

   a.____

   b. ____

   c.____

4. List the five categories of energy nutrient sources.

   a.____

   b. ____

   c.____

   d. ____

   e.____

5. List the six functions of the energy nutrients.

   a.____

   b. ____

   c.____

   d. ____

   e.____

   f.____

6. List nine symptoms of energy deficiencies in the ration.

   a.____

   b. ____

c.____________________

d. ____________________

e.____________________

f.____________________

g. ____________________

h. ____________________

i. ____________________

7. Describe "lower critical temperature" and "upper critical temperature" and explain how animals react to each condition.

   a. Lower critical temperature ____________________

   b. Upper critical temperature ____________________

8. List seven factors which affect critical temperatures.

a.____________________

b. ____________________

c.____________________

d. ____________________

e.____________________

f.____________________

g. ____________________

9. Describe the energy needs of animals for milk production, pregnancy and work.

   a. Milk production ______________________________

   ____

   b. Pregnancy ______________________________

   ____

   c. Work ______________________________

   ____

10. Name the most important energy nutrient and explain why it is the most important.

    ____

    ____

11. List the carbohydrates that are the most easily digested, and those that are the hardest to digest.

    a. Easy to digest ______________________________

    b. Hard to digest ______________________________

12. List the most important compound sugar in the animal's body.

    ____

13. Identify the parts of the plant that store the most easily digested carbohydrates.

    a. ______________________________

    b. ______________________________

    c. ______________________________

14. Describe the digestion of fiber.

    ____

    ____

    ____

15. Compare the amount of energy supplied by fats and oils as compared to carbohydrates.

    ____

    ____

16. List three essential fatty acids.

a.______________________________

b. ______________________________

c.______________________________

ENERGY NUTRIENTS

AG 532 - H

ANSWERS TO TEST

1. a. Calorie--Measures the amount of heat energy required to raise the temperature of one gram of water from 14.5^{O}C to 15.5^{O}C
   b. Kilocalorie (Kcal)--1,000 calories
   c. Megacalorie (Mcal)--1,000,000 calories
   d. Gross energy (GE)--Total amount of heat released when a substance is completely oxidized in a bomb calorimeter under 25 to 30 atmospheres of oxygen
   e. Digestible energy (DE)--Gross energy of the feed consumed minus the gross energy excreted in the feces
   f. Metabolizable energy (ME)--Gross energy of the feed consumed minus the energy in the feces, urine and gaseous products of digestion
   g. Heat increment (HI)--The portion of the metabolizable energy which is used for digestion or metabolism of absorbed nutrients into body tissues
   h. Net energy (NE)--The metabolizable energy minus the heat increment
   i. Basal metabolism--The heat production of the animal while it is at rest and not digesting food
   j. Maintenance requirement--Amount of energy needed for no body weight change and normal activities

2. Carbohydrates; Fats; Proteins; Minerals; Vitamins; Water

3. Carbohydrates; Fats; Oils

4. Grains or grain by-products; Forages; By-products; Animal fats; Molasses

5. Maintenance of life in the animal (basal metabolism); Keep muscles in state of tension; Maintain body temperature; Growth; Production; Development of fetus

6. Answer should include nine of the following:

   Slower growth in young; Delayed puberty; Decreased milk production; Shorter lactation period; Weight loss; Reproductive problems (reduced fertility, delayed estrus); Loss in wool quality and quantity; Higher death loss; Less resistance to diseases and parasites; Poor condition and weakness; Hypoglycemia; Loss of subcutaneous fat; Reduced levels of blood glucose, calcium and sodium

7. a. Lower critical temperature--Temperature below the thermoneutral zone when animals show symptoms of cold stress: Animals increase metabolic heat production; Gradual physiological adjustments over time (e.g. thicker hair coat)
   b. Upper critical temperature--Temperature above the thermoneutral zone when animals show symptoms of heat stress: Animal lowers feed intake to reduce rate of metabolic heat production; Evaporation through skin surface or respiratory tract

8. Answer should include seven of the following:

   Housing conditions; Age; Breed; Stage of lactation; Level of nutrition; Time after feeding; Length of time exposed to temperature change; Number of animals in group; Amount of hair or thickness of wool

9. a. Energy needs double (net energy); Energy deficiency limits milk production (after body fat used)
   b. Additional energy for development of fetus; Maintain animal in healthy condition (not thin or fat)
   c. Provide energy above maintenance needs; Factors affect needed energy (amount of work being done, condition of animal)

10. Carbohydrates; Readily available; Easily digested in greatest quantities; Usually lower cost

11. a. Sugars
    b. Cellulose, Lignin

12. Glucose

13. Seeds; Roots; Tubers

14. Fiber cells contain hemicellulose and cellulose; Hard for animal to digest
    Requires a lot of energy; Inefficient energy source

15. Fats and oils supply about 2.25 times as much energy as the same weight of carbohydrates supplies

16. Linoleic; Linolenic; Arachidonic

PROTEIN

AG 532 - I

UNIT OBJECTIVE

After completion of this unit, students should be able to discuss sources and functions of protein and urea toxicity. Students should be able to discuss protein quality and the biological value of protein. 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 associated with protein in animal nutrition.
2. List six examples each of animal proteins and vegetable proteins.
3. List six functions of protein.
4. Describe urea toxicity and its causes.
5. Describe the use and list five sources of nonprotein nitrogen.
6. List the three parts of the plant in which most of the protein is stored.
7. Describe digestible protein.
8. Explain the difference between essential and nonessential amino acids.
9. Explain what determines a high quality of protein.
10. Describe protein quality as it relates to formulating rations for ruminant and nonruminant animals.
11. Identify at what three stages of the animal's life the protein requirements are the greatest.
12. Explain the relationship between protein deficiency and energy nutrition.
13. Explain what causes protein to be available in a ration.
14. Describe the biological value of protein.

PROTEIN

AG 532 - I

SUGGESTED ACTIVITIES

I. Suggested activities for the 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--Protein Sources: Animal Proteins

2. TM 2--Protein Sources: Vegetable Proteins

3. TM 3--Functions of Protein

4. TM 4--Nonprotein Nitrogen Sources

5. TM 5--Protein Storage in Plants

E. Test

F. Answers to test

III. Unit references

A. Barrick, Kirby R., Harmon, Hobart L. *Animal Production and Management.* McGraw-Hill Book Company, New York, 1988.

B. Bundy, Clarence E., Diggins, Ronald V., Christensen, Virgil W. *Livestock and Poultry Production,* 5th edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1982.

C. Gillespie, James R. *Animal Nutrition and Feeding*. Delmar Publishers, Inc., Albany, New York, 1987.

PROTEIN

AG 532 - I

INFORMATION SHEET

I. Terms and definitions

- A. Proteins--Long and complex organic compounds that are formed when amino acids are combined with each other into polymers
- B. Crude protein--All the nitrogenous compounds found in a feed
- C. Digestible protein--Ration's approximate amount of protein available for use by the animal
- D. Amino acids--Organic compounds containing one or more alpha-amino groups that form the building blocks of proteins
- E. Limiting amino acid--Essential amino acid present in lowest amount in the feed
- F. Urea--Nonprotein nitrogen compound containing carbon, oxygen, nitrogen and hydrogen

II. Protein sources

- A. Animal proteins
  - 1. Animal by-products (Transparency 1)
    - a. Tankage and meat scraps
    - b. Meat and bone scraps
    - c. Blood meal
    - d. Fish meal
  - 2. Dairy products and by-products
    - a. Skim milk and buttermilk
    - b. Dried skim milk and buttermilk

B. Vegetable proteins (Transparency 2)

1. Seed by-products

a. Soybean meal

b. Soybeans

c. Cottonseed meal and cake

d. Linseed meal

e. Peanut meal

f. Corn gluten meal

2. Legume roughages

a. Dry roughages

b. Silage

c. Pasture

III. Protein functions (Transparency 3)

A. Develop and repair body organs and tissues

B. Milk, wool and egg production

C. Fetus development

D. Enzyme and hormone construction

E. Immune antibodies development

F. Hereditary DNA transmission

IV. Urea toxicity

A. Ammonia in urea can be toxic

1. Microbes in rumen must fully utilize

2. Combine with carbon dioxide in liver

B. Causes

1. Too little readily fermentable carbohydrates in ration

2. Urea level exceeds 1/3 total protein nitrogen in ration

V. Nonprotein nitrogen (Transparency 4)

A. Sources

1. Urea

2. Biuret

3. Ammoniated molasses

4. Ammoniated beet pulp

5. Ammoniated cottonseed

B. Use

1. Provide nonprotein nitrogen source

2. Addition of ammonia

a. Improves silage preservation

b. Improves digestibility of low quality roughages

VI. Protein storage in plants (Transparency 5)

A. Leaves

B. Petioles

C. Seeds

VII. Digestible protein--The amount of protein in a feedstuff that can actually be digested by an animal

VIII. Amino acids

A. Essential amino acids--Those amino acids that cannot be produced by the body of the animal and must be acquired through the feed intake

B. Nonessential amino acids--Those amino acids that are produced by the body of the animal

IX. Quality of protein

A. A high quality protein has a good balance of the essential amino acids

B. In nonruminants, amino acid content of the protein is more important than the percent of protein in the feed

C. In ruminants, need to protect protein quality from ruminal degradation (treating the protein with heat or chemicals before feeding will help with this)

X. Stages of greatest protein requirements

A. Young animals

B. Animals in gestation

C. Animals in lactation

XI. Protein deficiency effects on energy nutrition--Chronic protein deficiency depresses appetite which causes reduced feed intake, causing combined deficiency of both protein and energy

XII. Availability of protein--Determined by the balance of amino acids. Essential amino acids are required in the ration in definite proportions. Even if there is a surplus of essential amino acids, they can only be used to the extent that the one in shortest supply is available (limiting amino acid)

XIII. Biological value of protein

A. Measured by percent of digestible protein retained by animal for use

B. Compare protein intake with excreted protein

C. Good quality protein has a high biological value

D. Good balance of essential amino acids

E. Animal protein feeds usually higher than plant proteins

PROTEIN SOURCES: ANIMAL PROTEINS

ANIMAL BY-PRODUCTS

Tankage and meat scraps

Meat and bone scraps

Blood meal

Fish meal

DAIRY PRODUCTS AND BY-PRODUCTS

Skim milk and buttermilk

Dried skim milk and buttermilk

VEGETABLE PROTEINS

SEED BY-PRODUCTS

Soybean meal

Soybeans

Cottonseed meal and cake

Linseed meal

Peanut meal

Corn gluten meal

LEGUME ROUGHAGES

Dry roughages

Silage

Pasture

PROTEIN FUNCTIONS

Develop and repair body organs and tissues

Milk, wool and egg production

Fetus development

Enzyme and hormone construction

Immune antibodies development

Hereditary DNA transmission

NONPROTEIN NITROGEN

SOURCES

Urea

Biuret

Ammoniated molasses

Ammoniated beet pulp

Ammoniated cottonseed

PROTEIN STORAGE IN PLANTS

Leaves

Petioles

Seeds

PROTEIN

AG 532 - I

UNIT TEST

Name ______________________________ Score ______________________________

1. Define the following terms associated with protein in animal nutrition.

   a. Proteins ______________________________

   ____

   b. Crude protein ______________________________

   ____

   c. Digestible protein ______________________________

   ____

   d. Amino acids ______________________________

   ____

   e. Limiting amino acid ______________________________

   ____

   f. Urea ______________________________

   ____

2. List six examples each of animal and vegetable proteins.

   Animal proteins

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

   f. ______________________________

Vegetable proteins

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

3. List six functions of protein.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

4. Describe urea toxicity and its causes.

____

____

____

____

5. Describe the use and list five sources of nonprotein nitrogen.

____

____

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

6. List the three parts of the plant in which most of the protein is stored.

   a. ______________________________

   b. ______________________________

   c. ______________________________

7. Describe digestible protein.

   ____

   ____

   ____

8. Explain the difference between essential and nonessential amino acids.

   ____

   ____

   ____

   ____

9. Explain what determines a high quality of protein.

   a. ______________________________

   b. ______________________________

   c. ______________________________

10. Describe protein quality as it relates to formulating rations for ruminant and non-ruminant animals.

   ____

   ____

   ____

11. Identify at what three stages of the animal's life the protein requirements are the greatest.

   a ______________________________

   b. ______________________________

   c. ______________________________

12. Explain the relationship between protein deficiency and energy nutrition.

13. Explain what causes protein to be available in a ration.

14. Describe the biological value of protein.

PROTEIN

AG 532 - I

ANSWERS TO TEST

1. a. Proteins--Long and complex organic compounds that are formed when amino acids are combined with each other into polymers
   b. Crude protein--All the nitrogenous compounds found in a feed
   c. Digestible protein--Ration's approximate amount of protein available for use by the animal
   d. Amino acids--Organic compounds containing one or more alpha-amino groups that form the building blocks of proteins
   e. Limiting amino acid--Essential amino acid present in lowest amount in the feed
   f. Urea--Nonprotein nitrogen compound containing carbon, oxygen, nitrogen and hydrogen

2. Answer should include six of each of the following:

   Animal proteins: Tankage and meat scraps; Meat and bone scraps; Blood meal; Fish meal; Skim milk and buttermilk; Dried skim milk

   Vegetable proteins: Soybean meal; Soybeans; Cottonseed meal and cake; Linseed meal; Peanut meal; Corn gluten meal; Dry roughages; Silage; Pasture

3. Develop and repair body organs and tissues; Milk, wool and egg production; Fetus development; Enzyme and hormone construction; Immune antibodies development; Hereditary DNA transmission

4. a. Ammonia in urea can be toxic: Microbes in rumen must fully utilize; Combine with carbon dioxide in liver

   b. Causes: Too little readily fermentable carbohydrates in ration; Urea level exceeds 1/3 total protein nitrogen in ration

5. Use: Provide nonprotein nitrogen source; Addition of ammonia; Improves silage preservation; Improves digestibility of low quality roughages

   Sources: Urea; Biuret; Ammoniated molasses; Ammoniated beet pulp; Ammoniated cottonseed

6. Leaves; Petioles; Seeds

7. The amount of protein in a feedstuff that can actually be digested by an animal

8. Essential--Those amino acids that cannot be produced by the body of the animal, and must be acquired through the feed intake; Nonessential--Those amino acids that are produced by the body of the animal

9. A high quality protein has a good balance of the essential amino acids

10. In ruminants, need to protect protein quality from ruminal degradation (treating the protein with heat or chemicals before feeding will help with this); In non-ruminants, amino acid content of the protein is more important than the percent of protein in the feed

11. Young animals; Animals in gestation; Animals in lactation

12. Chronic protein deficiency depresses appetite which causes reduced feed intake, causing combined deficiency of both protein and energy

13. Determined by the balance of amino acids. Essential amino acids are required in the ration in definite proportions. Even if there is a surplus of essential amino acids, they can only be used to the extent that the one in shortest supply is available

14. Measured by percent of digestible protein retained by animal for use; Compare protein intake with excreted protein; Good quality protein has a high biological value; Good balance of essential amino acids; Animal protein feeds usually higher than plant proteins

MINERALS

AG 532 - J

UNIT OBJECTIVE

After completion of this unit, students should be able to describe the functions of minerals and their deficiency and toxicity symptoms. Students should also be able to list the major and trace minerals needed by livestock. 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 minerals, major minerals and trace minerals in livestock nutrition.
2. Identify minerals as major minerals or trace minerals.
3. List three functions of calcium.
4. List three deficiency symptoms of calcium.
5. List three sources of calcium.
6. List two toxicity symptoms of calcium.
7. State the calcium-phosphorus ratio that must be kept in the feed for proper utilization of both minerals.
8. List three functions of phosphorus.
9. List three deficiency symptoms of phosphorus.
10. List three sources of phosphorus.
11. List three functions of salt.
12. List three deficiency symptoms of salt.
13. List two sources of salt.
14. List the cause and two symptoms of salt toxicity.
15. List three functions of potassium.
16. List three deficiency symptoms of potassium.
17. List two sources of potassium.
18. List two toxicity symptoms of potassium.
19. List three functions of magnesium.

20. List two deficiency symptoms of magnesium.
21. List two sources of magnesium.
22. List three functions of sulfur.
23. List two deficiency symptoms of sulfur.
24. List two sources of sulfur.
25. List two functions of iron.
26. List the deficiency symptom of iron.
27. List two sources of iron.
28. List three functions of manganese.
29. List three deficiency symptoms of manganese.
30. List a source of manganese.
31. List three functions of copper.
32. List three deficiency symptoms of copper.
33. List two symptoms of copper toxicity.
34. List three functions of zinc.
35. List three deficiency symptoms of zinc.
36. List a source of zinc.
37. List two functions of molybdenum.
38. List two toxicity symptoms of molybdenum.
39. List two functions of selenium.
40. List two deficiency symptoms of selenium.
41. List two sources of selenium.
42. List two toxicity symptoms of selenium.
43. List two functions of cobalt.
44. List three deficiency symptoms of cobalt.
45. List two sources of cobalt.
46. List the function of iodine.

47. List two deficiency symptoms of iodine.

48. List two sources of iodine.

49. List two functions of fluorine.

50. List two sources of fluorine.

51. List two toxicity symptoms of fluorine.

52. List the three minerals most likely to be deficient.

53. List the two most common sources of minerals in livestock rations.

MINERALS

AG 532 - J

SUGGESTED ACTIVITIES

I. Suggested activities for the 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--Major Minerals

2. TM 2--Trace Minerals

3. TM 3--Calcium: Functions and Deficiency Symptoms

4. TM 4--Phosphorus: Functions and Deficiency Symptoms

5. TM 5--Salt: Functions and Deficiency Symptoms

6. TM 6--Potassium: Functions and Deficiency Symptoms

7. TM 7--Magnesium: Functions and Deficiency Symptoms

8. TM 8--Sulfur: Functions and Deficiency Symptoms

9. TM 9--Iron: Functions and Deficiency Symptom

10. TM 10--Manganese: Functions and Deficiency Symptoms

11. TM 11--Copper: Functions and Deficiency Symptoms

12. TM 12--Zinc: Functions and Deficiency Symptoms

13. TM 13--Molybdenum: Functions and Toxicity

14. TM 14--Selenium: Functions and Deficiency Symptoms

15. TM 15--Selenium Toxicity

16. TM 16--Cobalt: Functions and Deficiency Symptoms

17. TM 17--Iodine: Function and Deficiency Symptoms

18. TM 18--Fluorine: Functions and Toxicity

E. Test

F. Answers to test

III. Unit references

A. Barrick, Kirby R., Harmon, Hobart L. *Animal Production and Management*. McGraw-Hill Book Company, New York, 1988.

B. Bundy, Clarence E., Diggins, Ronald V., Christensen, Virgil W. *Livestock and Poultry Production,* 5th edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1982.

C. Gillespie, James R. *Animal Nutrition and Feeding*. Delmar Publishers, Inc., Albany, New York, 1987.

MINERALS

AG 532 - J

INFORMATION SHEET

I. Animal minerals

A. Inorganic substances that animals need in small amounts

B. Major (macro)--Needed in larger amounts (Transparency 1)

1. Calcium (Ca)
2. Phosphorus (P)
3. Sodium (Na)
4. Chlorine (Cl)
5. Potassium (K)
6. Sulfur (S)
7. Magnesium (Mg)

C. Trace (micro)--Needed in smaller amounts (Transparency 2)

1. Iron (Fe)
2. Copper (Cu)
3. Zinc (Zn)
4. Iodine (I)
5. Cobalt (Co)
6. Manganese (Mn)
7. Molybdenum (Mo)
8. Selenium (Se)
9. Silicon (Si)
10. Fluorine (F)
11. Chromium (Cr)

II. Mineral functions, deficiency symptoms, sources and toxicity

A. Calcium (Transparency 3)

1. Functions

a. Bone and teeth development

b. Essential for lactating animals and laying hens

c. Nerve and muscle function

d. Maintain acid-base balance of body fluids

2. Deficiency symptoms

a. Rickets

b. Broken bones

c. Slow growth

d. Milk fever

3. Sources

a. Grains, grain by-products, straw, dried manure, grasses, protein supplements from plants

b. Forages (grasses, legumes)

c. Fish meal, milk, citrus pulp

4. Calcium toxicity

a. Decreased absorption of other minerals

b. Calcification of soft body tissues

c. Kidney stone formation

(Note: The calcium-phosphorus ratio in the feed must be kept between 1:1 to 2:1for proper utilization of both minerals.)

B. Phosphorus (Transparency 4)

1. Functions

a. Bone and teeth growth and development

b. Appetite

c. Milk and egg production

d. Reproduction

e. Conversion of carotene to vitamin A

f. Vitamin D utilization

2. Deficiency symptoms

a. Lameness

b. Stiffness of joints

c. Lowered appetite

d. Reduced rate of gain

e. Breeding problems

3. Sources

a. Feeds such as wheat bran, meat scraps, tankage, fish meal, dried skim milk

b. Legume and grass pastures

c. Cereal grains and by-products

d. Mineral supplements

C. Salt (sodium and chlorine) (Transparency 5)

1. Functions

a. Maintain osmotic pressure in body cells

b. Maintain neutral pH level in body tissues

c. Muscle and nerve activity

d. Formation of hydrochloric acid in digestive juices

2. Deficiency symptoms

a. Lack of appetite

b. Unthrifty appearance

c. Reduced growth

d. Lowered reproduction

e. Eating soil

3. Sources

   a. Hay salt (loose)

   b. Salt block

4. Toxicity

   a. Cause--Restricted water with salt intake

   b. Symptoms--Staggering gait, blindness, nervous disorder, hypertension

D. Potassium (Transparency 6)

1. Functions

   a. Osmotic pressure

   b. Maintain acid-base balance of body fluids

   c. Muscle activity

   d. Carbohydrate digestion

2. Deficiency symptoms

   a. Slow growth rate

   b. Reduced feed consumption

   c. Muscle weakness

   d. Diarrhea

3. Sources

   a. Forages

   b. Grains and concentrates

4. Toxicity

   a. Diarrhea

   b. Tremors

   c. Heart failure

E. Magnesium (Transparency 7)

1. Functions

a. Activate enzyme systems in body

b. Proper maintenance of nervous system

c. Carbohydrate digestion

d. Utilization of zinc, phosphorus and nitrates

e. Normal skeletal development

2. Deficiency symptoms

a. Muscle spasms and convulsions

b. Hyperirritability

3. Sources

a. Most rations contain enough

b. Can be mixed with salt or supplement

c. If diet is low, magnesium will be pulled from bones

F. Sulfur (Transparency 8)

1. Functions

a. Amino acids make-up

b. Lipid metabolism

c. Carbohydrate metabolism

d. Energy metabolism

2. Deficiency symptoms

a. Unthriftiness

b. Slow growth

3. Sources

a. Forages--Especially legumes

b. Water

G. Iron (Transparency 9)

1. Functions

   a. Hemoglobin formation

   b. Oxidation of nutrients in cells

2. Deficiency symptom--Anemia

3. Sources

   a. Grains

   b. Forages

   c. Trace-mineralized salt with iron

H. Manganese (Transparency 10)

1. Functions

   a. Utilization of phosphorus

   b. Assimilation of iron

   c. Reduction of nitrates

   d. Amino acid and cholesterol metabolism

   e. Synthesis of fatty acids

2. Deficiency symptoms

   a. Swollen and stiff joints

   b. Abnormal bone development

   c. Sterility

   d. Delayed estrus

   e. Reduced ovulation

   f. Abortion

   g. Deformed, weak or dead offspring

   h. Appetite loss, slow gain

   i. Rough hair coat

   j. Pinkeye

3. Sources

   a. Trace-mineralized salt

   b. Most rations are sufficient

I. Copper (Transparency 11)

1. Functions

   a. Hemoglobin formation

   b. Activate some enzyme systems

   c. Hair development and pigmentation

   d. Wool growth

   e. Bone development

   f. Reproduction

   g. Lactation

2. Deficiency symptoms

   a. Severe diarrhea

   b. Slow growth (caused by anemia)

   c. Swelling of joints

   d. Bone abnormalities

   e. Weakness at birth

   f. Breathing difficulty

   g. Lack of muscle coordination

   h. Sudden death

3. Sources--Most livestock feeds have more than needed

4. Toxicity

   a. Levels--Above 50 ppm

   b. Symptoms--Anemia, jaundice

J. Zinc (Transparency 12)

1. Functions

a. Normal development of skin, hair, wool, bones and eyes

b. Prevent parakeratosis

c. Promote healing

d. Enzyme systems

e. Protein synthesis

f. Metabolism

g. Insulin

2. Deficiency symptoms

a. Parakeratosis (rough, thick skin in swine)

b. Thick skin on neck, muzzle, back of ears (cattle)

c. Slow wound healing

d. Poor appetite, slow growth

e. Swelled hocks and knees, stiff gait

f. Inflammation of nose and mouth tissues

3. Source--Trace-mineralized salt

K. Molybdenum (Transparency 13)

1. Functions

a. Enzyme xanthine oxidase

(1) Milk

(2) Body tissues

(3) Uric acid (poultry)

b. Stimulates rumen organisms

2. Source--Most normal rations are adequate

3. Toxicity

    a. Diarrhea

    b. Poor growth

    c. Loss of hair color

    d. Bleached mucous membranes

    e. Lameness

    f. Joint abnormalities

    g. Osteoporosis

    h. Death

L. Selenium (Transparency 14)

1. Functions

    a. Vitamin E absorption

    b. Part of enzyme glutathione peroxidase

2. Deficiency symptoms

    a. White muscle disease

    b. Retained placenta in ruminants

    c. Low fertility in ruminants

    d. Diarrhea

3. Sources

    a. Selenium injections

    b. Roughages

    c. Mixed into ration (not authorized by FDA for all animals)

4. Toxicity (Transparency 15)

    a. Acute--Intake of accumulator plants over short period

        (1) Labored breathing

        (2) Abnormal movement and posture

(3) Prostration

(4) Diarrhea

(5) Death

b. Chronic--Blind staggers--intake of limited amount of accumulator plants over a longer period of time

(1) Impaired vision

(2) Wandering

(3) Stumbling

(4) Death

c. Chronic alkali disease--Intake of grains or grasses with more than 5 mg selenium/K over a long period

(1) Liver cirrhosis

(2) Lameness

(3) Hoof malformations

(4) Hair loss

(5) Emaciation

M. Cobalt (Transparency 16)

1. Functions

a. Synthesis of vitamin B_{12}

b. Rumen bacteria growth

2. Deficiency symptoms

a. Poor appetite/general malnutrition

b. Weakness

c. Anemia

d. Slow growth

e. Decreased fertility

f. Lower wool and milk production

3. Sources
    a. Legumes
    b. Grasses
    c. Ration supplement

N. Iodine (Transparency 17)
    1. Function--Thyroxine production
    2. Deficiency symptoms
        a. Goiter
        b. Weak or dead offspring
        c. Offspring born without hair
        d. Infected navels at birth
    3. Sources
        a. Iodized salt
        b. Ration supplement

O. Fluorine (Transparency 18)
    1. Functions
        a. Prevent cavities
        b. Slow down osteoporosis
    2. Deficiency is rare; supplementing the ration is not recommended
    3. Sources
        a. Water
        b. Forages
    4. Toxicity (an accumulative poison)
        a. Tooth enamel loss
        b. Uneven, excessive wearing of teeth
        c. Bones--thick, soft, weak
        d. Lameness

e. Poor appetite, poor gains, weight loss

f. Rough hair coat

g. Lowered milk production

III. Minerals most likely to be deficient

A. Salt (sodium and chlorine)

B. Calcium

C. Phosphorus

IV. Most common sources of minerals in livestock rations

A. Commercial feeds

B. Mineral mixes

MAJOR MINERALS

Calcium

Phosphorus

Sodium

Chlorine

Potassium

Sulfur

Magnesium

TRACE MINERALS

Iron

Copper

Zinc

Iodine

Cobalt

Manganese

Molybdenum

Selenium

Silicon

Fluorine

Chromium

CALCIUM: FUNCTIONS AND DEFICIENCY SYMPTOMS

FUNCTIONS

Bone and teeth development

Lactation

Nerve and muscle function

Maintain acid-base balance of body fluids

DEFICIENCY SYMPTOMS

Rickets

Broken bones

Slow growth

Milk fever

PHOSPHORUS: FUNCTIONS AND DEFICIENCY SYMPTOMS

FUNCTIONS

Bone and teeth growth and development

Appetite

Milk and egg production

Reproduction

Conversion of carotene to vitamin A

Vitamin D utilization

DEFICIENCY SYMPTOMS

Lameness

Stiffness of joints

Lowered appetite

Reduced rate of gain

Breeding problems

SALT: FUNCTIONS AND DEFICIENCY SYMPTOMS

FUNCTIONS

Maintain osmotic pressure in body cells

Maintain neutral pH level in body tissues

Muscle and nerve activity

Formation of hydrochloric acid in digestive juices

DEFICIENCY SYMPTOMS

Lack of appetite

Unthrifty appearance

Reduced growth

Lowered reproduction

Eating soil

POTASSIUM : FUNCTIONS AND DEFICIENCY SYMPTOMS

FUNCTIONS

Osmotic pressure

Acid-base balance of body fluids

Muscle activity

Carbohydrate digestion

DEFICIENCY SYMPTOMS

Slow growth rate

Reduced feed consumption

Muscle weakness

Diarrhea

MAGNESIUM : FUNCTIONS AND DEFICIENCY SYMPTOMS

FUNCTIONS

Activate enzyme systems in body

Proper maintenance of nervous system

Carbohydrate digestion

Utilization of zinc, phosphorus and nitrates

Normal skeletal development

DEFICIENCY SYMPTOMS

Muscle spasms and convulsions

Hyperirritability

SULFUR : FUNCTIONS AND DEFICIENCY SYMPTOMS

FUNCTIONS

Amino acids make-up

Lipid metabolism

Carbohydrate metabolism

Energy metabolism

DEFICIENCY SYMPTOMS

Unthriftiness

Slow growth

IRON : FUNCTIONS AND DEFICIENCY SYMPTOM

FUNCTIONS

Hemoglobin formation

Oxidation of nutrients in cells

DEFICIENCY SYMPTOM

Anemia

MANGANESE : FUNCTIONS AND DEFICIENCY SYMPTOMS

FUNCTIONS

Utilization of phosphorus
Assimilation of iron
Reduction of nitrates
Amino acid and cholesterol metabolism
Synthesis of fatty acids

DEFICIENCY SYMPTOMS

Swollen and stiff joints
Abnormal bone development
Sterility
Delayed estrus
Reduced ovulation
Abortion
Deformed, weak or dead offspring
Appetite loss, slow gain
Rough hair coat
Pinkeye

COPPER: FUNCTIONS AND DEFICIENCY SYMPTOMS

FUNCTIONS

Hemoglobin formation
Activate some enzyme systems
Hair development and pigmentation
Wool growth
Bone development
Reproduction
Lactation

DEFICIENCY SYMPTOMS

Severe diarrhea
Slow growth (caused by anemia)
Swelling of joints
Bone abnormalities
Weakness at birth
Breathing difficulty
Lack of muscle coordination
Sudden death

ZINC : FUNCTIONS AND DEFICIENCY SYMPTOMS

FUNCTIONS

Normal development of skin, hair, wool, bones and eyes

Prevent parakeratosis

Promote healing

Enzyme systems

Protein synthesis

Metabolism

Insulin

DEFICIENCY SYMPTOMS

Parakeratosis (rough, thick skin in swine)

Thick skin on neck, muzzle, back of ears (cattle)

Slow wound healing

Poor appetite, slow growth

Swelled hocks and knees, stiff gait

Inflammation of nose and mouth tissues

MOLYBDENUM : FUNCTIONS AND TOXICITY

FUNCTIONS

Enzyme xanthine oxidase
Stimulates rumen organisms

TOXICITY

Diarrhea
Poor growth
Loss of hair color
Bleached mucous membranes
Lameness
Joint abnormalities
Osteoporosis
Death

SELENIUM : FUNCTIONS AND DEFICIENCY SYMPTOMS

FUNCTIONS

Vitamin E absorption

Part of enzyme glutathione peroxidase

DEFICIENCY SYMPTOMS

White muscle disease

Retained placenta in ruminants

Low fertility in ruminants

Diarrhea

SELENIUM TOXICITY

ACUTE

Labored breathing
Abnormal movement and posture
Prostration
Diarrhea
Death

CHRONIC

Impaired vision
Wandering
Stumbling
Death

CHRONIC ALKALI DISEASE

Liver cirrhosis
Lameness
Hoof malformations
Hair loss
Emaciation

COBALT : FUNCTIONS AND DEFICIENCY SYMPTOMS

FUNCTIONS

Synthesis of vitamin B_{12}

Rumen bacteria growth

DEFICIENCY SYMPTOMS

Poor appetite/general malnutrition

Weakness

Anemia

Slow growth

Decreased fertility

Lower wool and milk production

IODINE : FUNCTION AND DEFICIENCY SYMPTOMS

FUNCTION

Thyroxine production

DEFICIENCY SYMPTOMS

Goiter

Weak or dead offspring

Offspring born without hair

Infected navels at birth

FLUORINE : FUNCTIONS AND TOXICITY

FUNCTIONS

Prevent cavities

Slow down osteoporosis

TOXICITY (AN ACCUMULATIVE POISON)

Tooth enamel loss

Uneven, excessive wearing of teeth

Bones - thick, soft, weak

Lameness

Poor appetite, poor gains, weight loss

Rough hair coat

Lowered milk production

MINERALS

AG 532 - J

UNIT TEST

Name ______________________________ Score ______________________________

1. Define minerals, major minerals and trace minerals in livestock nutrition.

   a. Minerals ______________________________

   ____

   b. Major minerals ______________________________

   ____

   c. Trace minerals ______________________________

   ____

2. Identify minerals as major minerals or trace minerals by placing an "M" for major or a "T" for trace in the blanks provided.

_____a. Iron

_____b. Iodine

_____c. Calcium

_____d. Potassium

_____e. Magnesium

_____f. Molybdenum

_____g. Zinc

_____h. Sulfur

_____i. Copper

_____j. Phosphorus

_____k. Manganese

_____l. Fluorine

_____m. Cobalt

_____n. Chlorine

_____o. Silicon

_____p. Chromium

_____q. Sodium

_____r. Selenium

3. List three functions of calcium.

   a.______________________________

   b. ______________________________

   c.______________________________

4. List three deficiency symptoms of calcium.

   a.____

   b. ____

   c.____

5. List three sources of calcium.

   a.____

   b. ____

   c.____

6. List two toxicity symptoms of calcium.

   a.____

   b. ____

7. State the calcium-phosphorus ratio that must be kept in the feed for proper utilization of both minerals.

   ____

8. List three functions of phosphorus.

   a.____

   b. ____

   c.____

9. List three deficiency symptoms of phosphorus.

   a.____

   b. ____

   c.____

10. List three sources of phosphorus.

   a.____

   b. ____

   c.____

11. List three functions of salt.

    a.____

    b. ____

    c.____

12. List three deficiency symptoms of salt.

    a.____

    b. ____

    c.____

13. List two sources of salt.

    a.____

    b. ____

14. List the cause and two symptoms of salt toxicity.

    Cause ______________________________________

    a.____

    b. ____

15. List three functions of potassium.

    a.____

    b. ____

    c.____

16. List three deficiency symptoms of potassium.

    a.____

    b. ____

    c.____

17. List two sources of potassium.

    a.____

    b. ____

18. List two toxicity symptoms of potassium.

a.__________

b. __________

19. List three functions of magnesium.

a.__________

b. __________

c.__________

20. List two deficiency symptoms of magnesium.

a.__________

b. __________

21. List two sources of magnesium.

a.__________

b. __________

22. List three functions of sulfur.

a.__________

b. __________

c.__________

23. List two deficiency symptoms of sulfur.

a.__________

b. __________

24. List two sources of sulfur.

a.__________

b. __________

25. List two functions of iron.

a.__________

b. __________

26. List the deficiency symptom of iron.

    ____

27. List two sources of iron.

    a. ______________________________

    b. ______________________________

28. List three functions of manganese.

    a. ______________________________

    b. ______________________________

    c. ______________________________

29. List three deficiency symptoms of manganese.

    a. ______________________________

    b. ______________________________

    c. ______________________________

30. List a source of manganese.

    ____

31. List three functions of copper.

    a. ______________________________

    b. ______________________________

    c. ______________________________

32. List three deficiency symptoms of copper.

    a. ______________________________

    b. ______________________________

    c. ______________________________

33. List two symptoms copper toxicity.

    a. ______________________________

    b. ______________________________

34. List three functions of zinc.

a.____

b. ____

c.____

35. List three deficiency symptoms of zinc.

a.____

b. ____

c.____

36. List a source of zinc.

____

37. List two functions of molybdenum.

a.____

b. ____

38. List two toxicity symptoms of molybdenum.

a.____

b. ____

39. List two functions of selenium.

a.____

b. ____

40. List two deficiency symptoms of selenium.

a.____

b. ____

41. List two sources of selenium.

a.____

b. ____

42. List two toxicity symptoms of selenium.

a.______________________________

b. ______________________________

43. List two functions of cobalt.

a.______________________________

b. ______________________________

44. List three deficiency symptoms of cobalt.

a.______________________________

b. ______________________________

c.______________________________

45. List two sources of cobalt.

a.______________________________

b. ______________________________

46. List the function of iodine.

____

47. List two deficiency symptoms of iodine.

a.______________________________

b. ______________________________

48. List two sources of iodine.

a.______________________________

b. ______________________________

49. List two functions of fluorine.

a.______________________________

b. ______________________________

50. List two sources of fluorine.

a.______________________________

b. ______________________________

51. List two toxicity symptoms of fluorine.

a.____

b. ____

52. List the three minerals most likely to be deficient.

a.____

b. ____

c.____

53. List the two most common sources of minerals in livestock rations.

a.____

b. ____

MINERALS

AG 532 - J

ANSWERS TO TEST

1. a Inorganic substances that animals need in small amounts
   b. Minerals needed in larger amounts
   c. Minerals needed in smaller amounts

2.

a.	T	j.	M
b.	T	k.	T
c.	M	l.	T
d.	M	m.	T
e.	M	n.	M
f.	T	o.	T
g.	T	p.	T
h.	M	q.	M
i.	T	r.	T

3. Answer should include three of the following:

   Bone and teeth development; Essential for lactating animals and laying hens; Nerve and muscle function; Maintain acid-base balance of body fluids

4. Answer should include three of the following:

   Rickets; Broken bones; Slow growth; Milk fever

5. Answer should include three of the following:

   Grains, grain by-products, straw, dried manure, grasses, protein supplements from plants; Forages (grasses, legumes); Fish meal, milk, citrus pulp

6. Answer should include two of the following:

   Decreased absorption of other minerals; Calcification of soft body tissues; Kidney stone formation

7. 1:1 to 2:1

8. Answer should include three of the following:

   Bone and teeth growth and development; Appetite; Milk and egg production; Reproduction; Conversion of carotene to vitamin A; Vitamin D utilization

9. Answer should include three of the following:

   Lameness; Stiffness of joints; Lowered appetite; Reduced rate of gain; Breeding problems

10. Answer should include three of the following:

    Feeds such as wheat bran, meat scraps, tankage, fish meal, dried skim milk; Legume and grass pastures; Cereal grains and by-products; Mineral supplements

11. Answer should include three of the following:

    Maintain osmotic pressure in body cells; Maintain neutral pH level in body tissues; Muscle and nerve activity; Formation of hydrochloric acid in digestive juices

12. Answer should include three of the following:

    Lack of appetite; Unthrifty appearance; Reduced growth; Lowered reproduction; Eating soil

13. Hay salt (loose); Salt block

14. Cause--Restricted water with salt intake; Symptoms--Staggering gait, blindness, nervous disorder, hypertension

15. Answer should include three of the following:

    Osmotic pressure; Maintain acid-base balance of body fluids; Muscle activity; Carbohydrate digestion

16. Answer should include three of the following:

    Slow growth rate; Reduced feed consumption; Muscle weakness; Diarrhea

17. Forages; Grains and concentrates

18. Answer should include two of the following:

    Diarrhea; Tremors; Heart failure

19. Answer should include three of the following:

    Activate enzyme systems in body; Proper maintenance of nervous system; Carbohydrate digestion; Utilization of zinc, phosphorus and nitrates; Normal skeletal development

20. Muscle spasms and convulsions; Hyperirritability

21. Answer should include two of the following:

    Most rations contain enough; Can be mixed with salt or supplement; If diet is low, magnesium will be pulled from bones

22. Answer should include three of the following:

    Amino acids make-up; Lipid metabolism; Carbohydrate metabolism; Energy metabolism

23. Unthriftiness; Slow growth

24. Forages--Especially legumes; Water

25. Hemoglobin formation; Oxidation of nutrients in cells

26. Anemia

27. Answer should include two of the following:

    Grains; Forages; Trace-mineralized salt with iron

28. Answer should include three of the following:

    Utilization of phosphorus; Assimilation of iron; Reduction of nitrates; Amino acid and cholesterol metabolism; Synthesis of fatty acids

29. Answer should include three of the following:

    Swollen and stiff joints; Abnormal bone development; Sterility; Delayed estrus; Reduced ovulation; Abortion; Deformed, weak or dead offspring; Appetite loss, slow gain; Rough hair coat; Pinkeye

30. Answer should include one of the following:

    Trace-mineralized salt; Most rations are sufficient

31. Answer should include three of the following:

    Hemoglobin formation; Activate some enzyme systems; Hair development and pigmentation; Wool growth; Bone development; Reproduction; Lactation

32. Answer should include three of the following:

    Severe diarrhea; Slow growth; Swelling of joints; Bone abnormalities; Weakness at birth; Breathing difficulty; Lack of muscle coordination; Sudden death

33. Anemia; Jaundice

34. Answer should include three of the following:

    Normal development of skin, hair, wool, bones and eyes; Prevent parakeratosis; Promote healing; Enzyme systems; Protein synthesis; Metabolism; Insulin

35. Answer should include three of the following:

    Parakeratosis; Thick skin on neck, muzzle, back of ears (cattle); Slow wound healing; Poor appetite, slow growth; Swelled hocks and knees, stiff gait; Inflammation of nose and mouth tissues

36. Trace-mineralized salt

37. Enzyme xanthine oxidase (milk, body tissues, uric acid); Stimulates rumen organisms

38. Answer should include two of the following:

    Diarrhea; Poor growth; Loss of hair color; Bleached mucous membranes; Lameness; Joint abnormalities; Osteoporosis; Death

39. Vitamin E absorption; Part of enzyme glutathione peroxidase

40. Answer should include two of the following:

    White muscle disease; Retained placenta in ruminants; Low fertility in ruminants; Diarrhea

41. Answer should include two of the following:

    Selenium injections; Roughages; Mixed into ration (not authorized by FDA for all animals)

42. Answer should include two of the following:

    Labored breathing; Abnormal movement and posture; Prostration; Diarrhea; Death; Impaired vision; Wandering; Stumbling; Liver cirrhosis; Lameness; Hoof malformations; Hair loss; Emaciation

43. Synthesis of vitamin B_{12}; Rumen bacteria growth

44. Answer should include three of the following:

    Poor appetite/general malnutrition; Weakness; Anemia; Slow growth; Decreased fertility; Lower wool and milk production

45. Answer should include two of the following:

    Legumes; Grasses; Ration supplement

46. Thyroxine production

47. Answer should include two of the following:

    Goiter; Weak or dead offspring; Offspring born without hair; Infected navels at birth

48. Iodized salt; Ration supplement

49. Prevent cavities; Slow down osteoporosis

50. Water; Forages

51. Answer should include two of the following:

    Tooth enamel loss; Uneven, excessive wearing of teeth; Bones--Thick, soft, weak; Lameness; Poor appetite, poor gains, weight loss; Rough hair coat; Lowered milk production

52. Salt (sodium and chlorine); Calcium; Phosphorus

53. Commercial feeds; Mineral mixes

VITAMINS, FEED ADDITIVES AND WATER

AG 532 - K

UNIT OBJECTIVE

After completion of this unit, students should be able to list vitamin sources, vitamins essential in animal nutrition and the chemical elements found in vitamins. Students should also be able to describe the functions of vitamins, feed additives and water. This knowledge will be demonstrated by completion of an assignment sheet 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. Define vitamins.
2. Define and list the essential fat soluble vitamins.
3. Define and list the essential water soluble vitamins.
4. Define feed additives.
5. List three uses of feed additives.
6. List four types of feed additives and two functions of each.
7. List the sources of vitamins.
8. Select the B complex vitamins.
9. List two ways vitamins may be supplied other than through natural feed sources.
10. List two functions and three deficiency symptoms of vitamin A.
11. List two functions and two deficiency symptoms of vitamin D.
12. List the function and two deficiency symptoms of vitamin E.
13. List the function and deficiency symptom of vitamin K.
14. List the function and two deficiency symptoms of B vitamins including B_1, B_2, niacin, pantothenic acid and biotin.
15. List two functions and two deficiency symptoms of vitamin B_6.
16. List the function and two deficiency symptoms of vitamin B_{12}.
17. List two functions and two deficiency symptoms of vitamin C.
18. List six functions of water.

19. Discuss the relationship between age and fat content of the body and the percent of water it contains.

20. In addition to drinking water, list the other sources of water for an animal.

21. List ten factors that affect an animal's water consumption.

22. List the typical water intakes for swine, beef cattle, dairy cattle and horses.

23. List six ways that an animal loses water from its body.

24. List four symptoms of water deprivation in livestock.

25. Compile information on livestock nutrient deficiencies in the local area.

VITAMINS, FEED ADDITIVES AND WATER

AG 532 - K

SUGGESTED ACTIVITIES

I. Suggested activities for the instructor

   A. Make transparencies and any necessary copies of materials.

   B. Provide students with objectives and discuss.

   C. Provide students with information and discuss.

   D. Provide students with assignment sheet.

   E. Discuss assignment sheet.

   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--Essential Vitamins

      2. TM 2--Vitamin A: Functions and Deficiency Symptoms

      3. TM 3--Vitamin D: Functions and Deficiency Symptoms

      4. TM 4--Vitamin E: Function and Deficiency Symptoms

      5. TM 5--Vitamin B_6: Functions and Deficiency Symptoms
      Vitamin B_{12}: Function and Deficiency Symptoms

      6. TM 6--Vitamin C: Functions and Deficiency Symptoms

      7. TM 7--Functions of Feed Additives

      8. TM 8--Functions of Water

      9. TM 9--Factors Affecting Water Consumption

      10. TM 10--Symptoms of Water Deprivation

E. Assignment sheet

1. AS 1--Compile Information on Livestock Nutrient Deficiencies in the Local Area

F. Test

G. Answers to test

III. Unit references

A. Barrick, Kirby R., Harmon, Hobart L. *Animal Production and Management*. McGraw-Hill Book Company, New York, 1988.

B. Bundy, Clarence E., Diggins, Ronald V., Christensen, Virgil W. *Livestock and Poultry Production,* 5th edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1982.

C. Gillespie, James R. *Animal Nutrition and Feeding*. Delmar Publishers, Inc., Albany, New York, 1987.

VITAMINS, FEED ADDITIVES AND WATER

AG 532 - K

INFORMATION SHEET

I. Vitamins (Transparency 1)

- A. Organic compounds, needed in small amounts, that are essential for good health
  - 1. Required for normal growth and maintenance of life
  - 2. Function as catalysts in metabolic processes
- B. 16 essential vitamins
  - 1. Fat soluble (or fat solvent soluble)
    - a. Can be stored in the body, reducing the need for daily supplementation
    - b. Vitamins A, D, E, K
  - 2. Water soluble
    - a. Not usually stored in the body, must supplement on regular basis
    - b. Vitamin C, B complex vitamins
- C. Contain carbon, hydrogen, oxygen

II. Feed additives

- A. Products used in animal nutrition that are not "normal" nutrients
- B. Uses
  - 1. Greater feed efficiency
  - 2. More rapid gains
  - 3. Higher production
- C. Types
  - 1. Antibiotics and antibacterials
  - 2. Hormones

3. Anthelmintics

4. Miscellaneous additives

III. Vitamin sources

A. B complex vitamins--Ruminants synthesize in rumen, feed supplement for swine and poultry

B. Vitamin A--Fresh green forages, yellow corn

C. Vitamin D--Sun-cured forages, irradiated yeast

D. Vitamin E--Whole grains, green forages, good quality hay

E. Vitamin K--Green leafy feeds, fish meal

F. Vitamin C--Supplement in feed

IV. B complex vitamins

A. Thiamine (B_1)

B. Riboflavin (B_2)

C. Pantothenic acid

D. Pyridoxine (B_6)

E. Niacin

F. Choline

G. Biotin

H. Folic acid

I. B_{12}

J. Inositol

K. Para-aminobenzoic acid

V. Vitamin supplementation

A. Natural feed sources

B. Vitamin premixes

C. Injection

VI. Vitamin functions and deficiency symptoms

A. Vitamin A (Transparency 2)

1. Functions

a. Aids in disease resistance

b. Necessary for building new cells

c. Prevents night blindness

2. Deficiency symptoms

a. Slow growth

b. Night blindness

c. Poor reproductive efficiency

d. Rough hair coat

B. Vitamin D (Transparency 3)

1. Functions

a. Necessary for animal to be able to use calcium and phosphorus

b. Aids in skeletal development

2. Deficiency symptoms

a. Rickets--Bone deformities

b. Swelling of joints

C. Vitamin E (Transparency 4)

1. Function--Necessary for reproduction

2. Deficiency symptoms

a. Infertility

b. Stiffening of muscles

(Note: This is called white muscle disease in cattle.)

D. Vitamin K

(Note: Vitamin K deficiency normally only occurs in poultry.)

1. Function--Necessary for blood clotting

2. Deficiency symptom--Hemorrhages

E. B vitamins including B_1, B_2, niacin, pantothenic acid and biotin

1. Function--Helps in the release of energy from foods

2. Deficiency symptoms

a. Retarded growth

b. Diarrhea, vomiting and goose stepping in swine

F. Vitamin B_6 (Transparency 5)

1. Functions

a. Helps form red blood cells

b. Helps break down protein into usable form for the body

2. Deficiency symptoms

a. Convulsions

b. Retarded growth

G. Vitamin B_{12} (Transparency 5)

1. Function--Helps form red blood cells

2. Deficiency symptoms

a. Retarded growth

b. Reproductive failure

H. Vitamin C (Transparency 6)

1. Functions

a. Aids in iron absorption

b. Helps form substances between the body cells in teeth, bones and soft tissue

c. Aids in healing

2. Deficiency symptoms

   a. Loose of appetite

   b. Loose teeth

   c. Swollen and bleeding gums

VII. Functions of feed additives (Transparency 7)

A. Antibiotics

1. Growth stimulation
2. Reduce disease problems and infections
3. Improve shell quality
4. Improve gains and feed efficiency

B. Hormones

1. Suppress estrus
2. Increase gains and feed efficiency

C. Anthelmintics

1. Control stomach worms
2. Control intestinal worms

D. Miscellaneous

1. Coccidiostats--Prevent poultry coccidiosis
2. Thyroprotein--Control metabolism rate
3. Poloxaline--Prevent bloat

VIII. Feed additive regulations

A. With the increasing public concern of chemicals and additives, regulations are changing and becoming more strict

B. For up-to-date information

1. *Feed Additive Compendium*, published yearly by: Miller Publishing Company, 2501 Wayzata Boulevard, Minneapolis, Minnesota 55440.
2. *Code of Federal Regulations*, Title 21, from the Food and Drug Administration (contains approval of antibiotics and other animal drugs). Updated yearly. Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

3. *Federal Register*, contains continuous updates of the *Code of Federal Regulations*. Monthly subscription available from Superintendent of Documents.

C. Many additives can be used within certain levels and for specific species or types

D. With many additives, must discontinue use within specified time of marketing animal

IX. Functions of water (Transparency 8)

A. Digestion and metabolism biochemical reactions

B. Nutrient and waste transport

C. Body temperature regulation

D. Fills cells (turgor pressure) to give body form

E. Fluids in body

F. Lubrication

G. Milk production

X. Water in the body

A. Fat replaces water

1. Younger animals have higher percent water (in relation to their weight) than older animals

2. Fat animals have lower percent water (in relation to their weight) than thinner animals

B. Percentages of water in the body

1. Newborn calf 70%

2. 1,000 lb steer 50%

XI. Animal water sources

A. Drinking water

B. Metabolic breakdown of carbohydrates, fats and proteins from feed

C. Feed

XII. Factors affecting water consumption (Transparency 9)

A. Species

B. Breed

C. Body size

D. Rate of gain

E. Age

F. Pregnancy

G. Lactation

H. Activity

I. Diet

J. Feed intake

K. Watering frequency

L. Humidity

M. Ambient temperature

N. Water's mineral content

XIII. Daily average water consumption

A. Swine

1. .5 - 1.3 gallons of water per 2.2 lbs dry feed

2. 1.8 - 5.3 gallons water per 220 lbs body weight

B. Beef cattle

1. .8 - 2.1 gallons water per 2.2 lbs dry feed

2. Higher consumption level at higher temperatures

C. Dairy cattle

1. Nonlactating--.8 - 4.1 gallons water per 2.2 lbs dry feed

2 Lactating--.55 - 1.0 gallons water per 2.2 lbs of milk produced <u>in addition</u> to the amount needed for maintenance

D. Horses

1. .5 - 1.0 gallons water per 2.2 lbs dry matter

2. Increases 15 - 20% with increase of ambient temperature

XIV. Body water losses

A Urine

B. Feces

C. Sweat

D. Lungs

E. Milk production

F. Egg production

XV. Water deprivation symptoms (Transparency 10)

A. Reduced feed intake

B. Upset digestive system

C. Reduced production

D. Starvation

ESSENTIAL VITAMINS

FAT SOLUBLE

Vitamin A

Vitamin D

Vitamin E

Vitamin K

WATER SOLUBLE

Vitamin C

B Complex Vitamins

VITAMIN A: FUNCTIONS AND DEFICIENCY SYMPTOMS

FUNCTIONS

Disease resistance

Building of new cells

Prevents night blindness

DEFICIENCY SYMPTOMS

Slow growth

Night blindness

Poor reproductive efficiency

Rough hair coat

VITAMIN D: FUNCTIONS AND DEFICIENCY SYMPTOMS

FUNCTIONS

Necessary for animal to be able to use calcium and phosphorus

Aids in skeletal development

DEFICIENCY SYMPTOMS

Rickets--Bone deformities

Swelling of joints

VITAMIN E: FUNCTION AND DEFICIENCY SYMPTOMS

FUNCTION

Is necessary for reproduction

DEFICIENCY SYMPTOMS

Infertility

Stiffening of muscles

(Note: This is called white muscle disease in cattle.)

VITAMIN B_6: FUNCTIONS AND DEFICIENCY SYMPTOMS

FUNCTIONS

Helps form red blood cells

Helps break down protein into usable form for the body

DEFICIENCY SYMPTOMS

Convulsions

Retarded growth

VITAMIN B_{12}: FUNCTION AND DEFICIENCY SYMPTOMS

FUNCTION

Helps form red blood cells

DEFICIENCY SYMPTOMS

Retarded growth

Reproductive failure

VITAMIN C: FUNCTIONS AND DEFICIENCY SYMPTOMS

FUNCTIONS

Aids in iron absorption

Helps form substances between the body cells in teeth, bones and soft tissue

Aids in healing

DEFICIENCY SYMPTOMS

Loss of appetite

Loose teeth

Swollen and bleeding gums

FUNCTIONS OF FEED ADDITIVES

ANTIBIOTICS

Growth stimulation

Reduce disease problems and infections

Improve shell quality

Improve gains and feed efficiency

HORMONES

Suppress estrus

Increase gains and feed efficiency

ANTHELMINTICS

Control stomach worms

Control intestinal worms

MISCELLANEOUS

Coccidiostats--Prevent poultry coccidiosis

Thyroprotein--Control metabolism rate

Poloxaline--Prevent bloat

FUNCTIONS OF WATER

Digestion and metabolism biochemical reactions

Nutrient and waste transport

Body temperature regulation

Fills cells (turgor pressure) to give body form

Fluids in body

Lubrication

Milk production

FACTORS AFFECTING WATER CONSUMPTION

Species

Breed

Body size

Rate of gain

Age

Pregnancy

Lactation

Activity

Diet

Feed intake

Watering frequency

Humidity

Ambient temperature

Water's mineral content

SYMPTOMS OF WATER DEPRIVATION

Reduced feed intake

Upset digestive system

Reduced production

Starvation

VITAMINS, FEED ADDITIVES AND WATER

AG 532 - K

ASSIGNMENT SHEET #1--COMPILE INFORMATION ON LIVESTOCK NUTRIENT DEFICIENCIES IN THE LOCAL AREA

Name ______________________________ Score ______________________________

Nutrients in feeds vary from one area to the next because of climate, soil and management differences. Knowing which nutrients may be deficient in your area is important for successful livestock feeding and ration formulation.

Using local resource people such as farmers, ranchers, feed store personnel and county extension agents, determine which nutrients are most likely to be deficient for the various types of livestock in your community. List these nutrients and then list the most likely sources for supplementing them. Finally, write the symptoms which would indicate a deficiency in that nutrient.

Livestock species: ______________________________

Nutrients that may be deficient	Sources	Deficiency Symptoms

Livestock species: ______________________________

Nutrients that may be deficient	Sources	Deficiency Symptoms

VITAMINS, FEED ADDITIVES AND WATER

AG 532 - K

UNIT TEST

Name ______________________________ Score ______________________________

1. Define vitamins.

____

____

2. Define and list the essential fat soluble vitamins.

____

____

3. Define and list the essential water soluble vitamins.

____

____

4. Define feed additives.

____

____

5. List three uses of feed additives.
   a.______________________________
   b. ______________________________
   c.______________________________

6. List four types of feed additives and two functions of each.

   a.______________________________

      1.______________________________

      2.______________________________

b. ______________________________

1. ______________________________

2. ______________________________

c. ______________________________

1. ______________________________

2. ______________________________

d ______________________________

1. ______________________________

2. ______________________________

7. List the sources of vitamins.

a. B complex vitamins ______________________________

____

b Vitamin A ______________________________

____

c Vitamin D ______________________________

____

d Vitamin E ______________________________

____

e Vitamin K ______________________________

____

f. Vitamin C ______________________________

____

8. Select the B complex vitamins by placing an "X" in the blank of those that are B complex vitamins.

_____a. Riboflavin

_____b. B_{12}

_____c. Thyroxin

_____d. Niacin

_____e. Thiamine

_____f. Chlorine

_____g. Fluorine

_____h. Biotin

_____i. Para-aminobenzoic acid

_____j. Amino acids

_____k. Pantothenic acid

_____l. Inositol

_____m. Ascorbic acid

_____n. Pyridoxine

_____o. Beta-tocopherol

_____p. Folic acid

_____q. Choline

9. List two ways vitamins may be supplied other than through natural feed sources.

   a.____

   b. ____

10. List two functions and three deficiency symptoms of vitamin A.

    Functions:

    a.____

    b. ____

    Deficiency symptoms:

    a.____

    b. ____

    c.____

11. List two functions and two deficiency symptoms of vitamin D.

Functions:

a.____

b. ____

Deficiency symptoms:

a.____

b. ____

12. List the function and two deficiency symptoms of vitamin E.

Functions ____

____

Deficiency symptoms:

a.____

b. ____

13. List the function and deficiency symptom of vitamin K.

Functions ____

____

Deficiency symptoms ____________________________________

14. List the function and two deficiency symptoms of B vitamins including B_1, B_2, niacin, pantothenic acid and biotin.

Functions ____

____

Deficiency symptoms:

a.____

b. ____

15. List two functions and two deficiency symptoms of vitamin B_6.

Functions:

a.____

b. ____

Deficiency symptoms:

a.____

b. ____

c.____

16. List the function and two deficiency symptoms of vitamin B_{12}.

Functions ____

____

Deficiency symptoms:

a.____

b. ____

17. List two functions and two deficiency symptoms of vitamin C.

Functions:

a.____

b. ____

Deficiency symptoms:

a.____

b. ____

18. List six functions of water.

a.____

b. ____

c.____

d. ____

e.____

f.____

19. Discuss the relationship between age and fat content of the body and the percent of water it contains.

____

____

____

20. In addition to drinking water, list the other sources of water for an animal.

a. ______________________________

b. ______________________________

21. List ten factors that affect an animal's water consumption.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

j. ______________________________

22. List the typical water intakes for swine, beef cattle, dairy cattle and horses.

a. Swine ______________________________

____

b. Beef cattle ______________________________

____

c. Dairy cattle ______________________________

____

d. Horses ______________________________

____

23. List six ways that an animal loses water from its body.

a.______________________________

b. ______________________________

c.______________________________

d. ______________________________

e.______________________________

f.______________________________

24. List four symptoms of water deprivation in livestock.

a.______________________________

b. ______________________________

c.______________________________

d. ______________________________

VITAMINS, FEED ADDITIVES AND WATER

AG 532 - K

ANSWERS TO TEST

1. Organic compounds, needed in small amounts, that are essential for good health; Required for normal growth and maintenance of life; Function as catalysts in metabolic processes; Contain carbon, hydrogen and oxygen

2. Can be stored in the body, reducing the need for daily supplements; A, D, E, K

3. Not usually stored in the body, must supplement on regular basis; C, B complex vitamins

4. Products used in animal nutrition that are not "normal" nutrients

5. Greater feed efficiency; More rapid gains; Higher production

6. Answer should include two functions for each feed additive.

   a. Antibiotics and antibacterials: Growth stimulation; Reduce disease problems and infections; improve shell quality; Improve gains and feed efficiency

   b. Hormones: Suppress estrus; Increase gains and feed efficiency

   c. Anthelmintics: Control stomach worms; Control intestinal worms

   d. Miscellaneous: Coccidiostats--Prevent poultry coccidiosis; Thyroprotein--Control metabolism rate; Poloxaline--Prevent bloat

7. a. B complex vitamins--Ruminants synthesize in rumen, feed supplement for swine and poultry
   b. Vitamin A--Fresh green forages, yellow corn
   c. Vitamin D--Sun-cured forages, irradiated yeast
   d. Vitamin E--Whole grains, green forages, good quality hay
   e. Vitamin K--Green leafy feeds, fish meal
   f. Vitamin C--Supplement in feed

8. a, b, d, e, h, i, k, l, n, p, q

9. Vitamin premixes; Injection

10. Functions (should include two of the following): Aids in disease resistance; Necessary for building new cells; Prevents night blindness

    Symptoms (should include three of the following): Slow growth; Night blindness; Poor reproductive efficiency; Rough hair coat

11. Functions: Necessary for animal to be able to use calcium and phosphorus; Aids in skeletal development

    Symptoms: Rickets; Swelling of joints

12. Function--Necessary for reproduction
    Symptoms: Infertility; Stiffening of muscles

13. Function--Necessary for blood clotting
    Deficiency symptom--Hemorrhages

14. Function--Helps in the release of energy from foods
    Symptoms: Retarded growth; Diarrhea, vomiting and goose stepping in swine

15. Functions: Helps form red blood cells; Helps break down protein into usable form for the body
    Symptoms: Convulsions; Retarded growth

16. Function--Helps form red blood cells
    Symptoms: Retarded growth; Reproductive failure

17. Functions (should include two of the following): Aids in iron absorption; Helps form substances between the body cells in teeth, bones and soft tissue; Aids in healing
    Symptoms (should include two of the following): Loss of appetite; Loose teeth; Swollen and bleeding gums

18. Answer should include six of the following: Digestion and metabolism biochemical reactions; Nutrient and waste transport; Body temperature regulation; Fills cells (turgor pressure) to give body form; Fluids in body; Lubrication; Milk production

19. Younger animals have higher percent water (in relation to their weight) than older animals; Fat animals have lower percent water (in relation to their weight) than thinner animals; Newborn calf's weight is 70% water; A 1,000 lb. steer's weight is 50% water

20. Metabolic breakdown of carbohydrates, fats and proteins from feed; Feed

21. Answer should include ten of the following:

    Species; Breed; Body size; Rate of gain; Age; Pregnancy; Lactation; Activity; Diet; Feed intake; Watering frequency; Humidity; Ambient temperature; Water's mineral content

22. a. Swine: .5 - 1.3 gallons of water per 2.2 lbs dry feed; 1.8 - 5.3 gallons water per 220 lbs body weight

    b. Beef cattle: .8 - 2.1 gallons water per 2.2 lbs dry feed; Higher consumption level at higher temperatures

    c. Dairy cattle: Nonlactating--.8 - 4.1 gallons water per 2.2 lbs dry feed; Lactating--.55 - 1.0 gallons water per 2.2 lbs of milk produced in addition to the amount needed for maintenance

    d. Horses: .5 - 1.0 gallons water per 2.2 lbs dry matter; Increases 15 - 20% with increase of ambient temperature

23. Urine; Feces; Sweat; Lungs; Milk production; Egg production

24. Reduced feed intake; Upset digestive system; Reduced production; Starvation

CLASSIFICATION AND USE OF FEEDS

AG 532 - L

UNIT OBJECTIVE

After completion of this unit, students should be able to discuss the feed classes and describe the effect of nutrition on reproduction. Students should also be able to discuss maintenance rations and explain how production affects animal nutrient requirements. 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 briefly tell the difference between the two general classes of feeds used for animal nutrition.
2. List the six descriptors used in determining international feed names.
3. List the eight feed classes.
4. Identify the class of livestock that is fed urea and other nonprotein nitrogen sources.
5. Describe how nutrition affects reproduction in livestock.
6. Describe nutrient needs of young, growing animals as compared to more mature animals.
7. Define maintenance ration.
8. Describe the three functions of a maintenance ration.
9. Explain why the amount of an animal's body surface is more closely related to its maintenance needs than to its weight.
10. Explain how milk production affects the nutrient requirements of an animal.
11. Explain how wool and mohair production affects the nutrient requirements of sheep and goats.
12. Describe the effect of work on nutrient requirements of horses.

CLASSIFICATION AND USE OF FEEDS

AG 532 - L

SUGGESTED ACTIVITIES

I. Suggested activities for the 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--Classification of Concentrates

2. TM 2--Classification of Roughages

3. TM 3--Determining International Feed Names

4. TM 4--Feed Classes

E. Test

F. Answers to test

III. Unit references

A. Barrick, Kirby R., Harmon, Hobart L. *Animal Production and Management*. McGraw-Hill Book Company, New York, 1988.

B. Bundy, Clarence E., Diggins, Ronald V., Christensen, Virgil W. *Livestock and Poultry Production,* 5th edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1982.

C. Gillespie, James R. *Animal Nutrition and Feeding*. Delmar Publishers, Inc., Albany, New York, 1987.

CLASSIFICATION AND USE OF FEEDS

AG 532 - L

INFORMATION SHEET

I. The two general feed classes

A. Concentrates (Transparency 1)

1. High in energy (TDN and NFE)

2. Low in crude fiber (CF)

3. Include the following: cereal grains; soybean and cottonseed meal; corn gluten; wheat bran

4. May be high or low in protein content

(Note: Concentrates high in protein are usually called protein supplements protein concentrates.)

B. Roughages (Transparency 2)

1. High in crude fiber (over 18%); bulky

2. Low in energy (40% NFE)

3. Include the following: hay; pasture; silage

4. May be high or low quality

(Note: A high quality hay has less than 30% fiber and more than 15% protein.)

II. Determining international feed names (Transparency 3)

A. Feed origin

B. Part consumed

C. Processes and treatments before fed

D. Maturity stage (roughages)

E. Cutting or crop (roughages)

F. Grade or quality designations

III. Eight feed classes (Transparency 4)

   A. Dry forages and roughages

      1. Cut, cured, more than the 18% CF or more than 35% dry basis

      2. Low in net energy per unit weight

   B. Pasture, range plants and forages fed fresh

   C. Silages--Ensiled forages only

   D. Energy feeds

      1. Less than 20% protein; less than 18% CF

      2. Grain, milk by-products, roots, etc. (not ensiled)

   E. Protein supplements--More than 20% protein

   F. Mineral supplements

   G. Vitamin supplements--Includes ensiled yeast

   H. Additives--Antibiotics, coloring material, flavors, hormones, medications

IV. Ruminants are fed urea and other nonprotein nitrogen sources

V. Nutrition and reproduction

   A. High quality ration for sperm production and semen quality

   B. Over-fat males may become sterile

   C. Pregnant females need best nutrition for last third of gestation (fetus growing most)

   D. Poor nutrition for first pregnancy females results in poorly developed fetus and poor growth of mother

VI. Young, growing animals have greater nutritional needs than mature animals

   A. Nutritional deficiencies show up more quickly and seriously

   B. Nutrients needed in larger quantities

      1. Quality protein--Rapid muscle growth

      2. Sufficient TDN--Growth and final size

3. Mineral requirements
    a. Rickets (mineral or vitamin deficiency)
    b. Weak bones (calcium or phosphorus deficiency)
    c. Anemia (iron deficiency)

VII. Maintenance ration

A. Maintains basic life processes without work or production being done

B. Functions

1. Supply heat to maintain body temperature
2. Supply energy for vital functions and a minimum amount of movement
    a. Heart, lungs and other internal organs
    b. Muscle tension for lying, standing, etc.
3. Supply small amounts of proteins, vitamins and minerals

C. Amount of body surface more closely related to maintenance than weight

1. Animal weighing 1,000 lbs does not require the same TDN in maintenance ration as two 500 lb animals (major heat loss from body surface radiation and conduction--1,000 lb animal does not have as much body surface as the two 500 lbs animals)
2. Weight of internal organs, glands, etc. is proportionate to body surface instead of weight
3. Weight is a factor in determining activity maintenance requirements since heavier animals require more energy for standing and moving

VIII. Nutrient requirements and production

A. Milk production

1. Requires liberal supply of TDN, protein, minerals and vitamins
2. Quantity produced affects level of nutrients needed; heavier milkers require more nutrients than light milkers

B. Wool and mohair production

1. High protein level (wool and mohair have high protein content; deficiency results in fiber weak spots and reduced production)
2. Higher TDN requirements

C. Work production of horses

1. TDN requirements increase as amount of work increases
2. Protein, mineral, vitamin requirements increase slightly
3. Higher nutrient needs for young, growing horses

Classification Of Concentrates

OIL MEALS

Soybean
Cottonseed
Linseed
Peanut

MOLASSES

Cane
Beet

GRAIN BY-PRODUCTS

Wheat bran
Wheat standard middlings

ANIMAL PRODUCTS

Meat scraps
Tankage
Fish meal
Dried dairy products

GRAINS

Barley
Wheat
Corn
Milo
Oats

Classification Of Roughages

GREEN ROUGHAGES

Roots

Grasses

Tubers

DRY ROUGHAGES

Hays—
Grass and Legume

Hulls—
Peanut and Cottonseed

Straw—
Oat, Wheat,
Barley, and Rice

SILAGE

Corn

Sorghum

Grass

DETERMINING INTERNATIONAL FEED NAMES

Feed origin

Part consumed

Processes and treatments before fed

Maturity stage (roughages)

Cutting or crop (roughages)

Grade or quality designations

FEED CLASSES

Dry forages and roughages

Pasture, range plants, fresh forages

Silages

Energy feeds

Protein supplements

Mineral supplements

Vitamin supplements

Additives

CLASSIFICATION AND USE OF FEEDS

AG 532 - L

UNIT TEST

Name ______________________________ Score ______________________________

1. List and briefly tell the difference between the two general classes of feeds used for animal nutrition.

   a.______________________________

   ____

   ____

   b. ______________________________

   ____

   ____

2. List the six descriptors used in determining international feed names.

   a.______________________________

   b. ______________________________

   c.______________________________

   d. ______________________________

   e.______________________________

   f.______________________________

3. List the eight feed classes.

   a.______________________________

   b. ______________________________

   c.______________________________

   d. ______________________________

   e.______________________________

   f.______________________________

g. ______________________________

h. ______________________________

4. Identify the class of livestock that is fed urea and other nonprotein nitrogen sources.

____

5. Describe how nutrition affects reproduction in livestock.

a. ______________________________

____

b. ______________________________

____

c. ______________________________

____

d. ______________________________

____

6. Describe nutrient needs of young, growing animals as compared to more mature animals.

____

____

____

____

7. Define maintenance ration.

____

____

8. Describe the three functions of a maintenance ration.

a. ______________________________

____

b. ______________________________

____

c.____

9. Explain why the amount of an animal's body surface is more closely related to its maintenance needs than to its weight.

a.

b.

c.

10. Explain how milk production affects the nutrient requirements of an animal.

a.

b.

11. Explain how wool and mohair production affects the nutrient requirements of sheep and goats.

a.

b.

12. Describe the effect of work on nutrient requirements of horses.

a.

b.

c.

CLASSIFICATION AND USE OF FEEDS

AG 532 - L

ANSWERS TO TEST

1. a. Concentrates: High in energy (TDN and NFE); Low in crude fiber (CF); Include the following: cereal grains, soybean and cottonseed meal, corn gluten, wheat bran; May be high or low in protein content

   b. Roughages: High in crude fiber (over 18%); bulky; Low in energy (40% NFE); Include the following: hay, pasture, silage; May be high or low quality

2. Feed origin; Part consumed; Processes and treatments before fed; Maturity stage (roughages); Cutting or crop (roughages); Grade or quality designations

3. Dry forages and roughages; Pasture, range plants and forages fed fresh; Silages--Ensiled forages only; Energy feeds; Protein supplements--More than 20% protein; Mineral supplements; Vitamin supplements--Includes ensiled yeast; Additives--Antibiotics, coloring material, flavors, hormones, medications

4. Ruminants

5. High quality ration for sperm production and semen quality; Over-fat males may become sterile; Pregnant females need best nutrition for last third of gestation (fetus growing most); Poor nutrition for first pregnancy females results in poorly developed fetus and poor growth of mother

6. Young, growing animals have greater nutritional needs than mature animals; Nutritional deficiencies show up more quickly and seriously; Nutrients needed in larger quantities

7. Maintains basic life processes without work or production being done

8. Supply heat to maintain body temperature; Supply energy for vital functions and a minimum amount of movement (Heart, lungs and other internal organs; Muscle tension for lying, standing, etc.); Supply small amounts of proteins, vitamins and minerals

9. Animal weighing 1,000 lbs does not require the same TDN in maintenance ration as two 500 lb animals (major heat loss from body surface radiation and conduction--1,000 lb animal does not have as much body surface as the two 500 lbs animals); Weight of internal organs, glands, etc. is proportionate to body surface instead of weight; Weight is a factor in determining activity maintenance requirements since heavier animals require more energy for standing and moving

10. Requires liberal supply of TDN, protein, minerals and vitamins; Quantity produced affects level of nutrients needed; heavier milkers require more nutrients than light milkers

11. High protein level (wool and mohair have high protein content; deficiency results in fiber weak spots and reduced production); Higher TDN requirements

12. TDN requirements increase as amount of work increases; Protein, mineral, vitamin requirements increase slightly; Higher nutrient needs for young, growing horses

NUTRIENT QUALITY AND ANALYSIS

AG 532 - M

UNIT OBJECTIVE

After completion of this unit, students should be able to discuss factors that affect feed quality and the Van Soest method of forage analysis. Students should also be able to discuss the importance of digestion trials in determining the value of a feedstuff and feeding trials in developing rations. 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 associated with nutrient quality and analysis.
2. List eight factors that affect feeding value of feeds.
3. List the six components into which a feedstuff is separated by proximate analysis.
4. Describe the method of proximate analysis for each of these six components.
5. List four limitations of using proximate analysis to determine feed value.
6. List the four major feed components.
7. List four factors that affect moisture content of feed.
8. Describe and give examples of how feeds may be converted from one composition basis to another:
   a. Convert dry matter nutrient values to an as-fed basis.
   b. Convert as-fed nutrient values to a dry matter basis.
   c. Convert dry matter weight of a feed to an equivalent as-fed weight.
9. Explain why the Van Soest method of forage analysis is sometimes used.
10. Describe the Van Soest method of forage analysis.
11. Explain why digestion trials are of importance when determining the value of a feedstuff, and how the trials are conducted.
12. Describe how net energy values of feed may be determined.
13. List and briefly describe three other measures of feed value.
14. List three methods used to determine feed value.
15. Explain why feeding trials are of value in developing rations.

16. List the seven major provisions found in most state feed laws.

17. List information found on feed tags.

18. Convert values from a dry matter basis to an as-fed basis and vice versa.

NUTRIENT QUALITY AND ANALYSIS

AG 532 - M

SUGGESTED ACTIVITIES

I. Suggested activities for the 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.

E. Discuss and demonstrate assignment sheets.

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--Feed Composition

2. TM 2--Commercial Feed Tag

E. Assignment sheet

1. AS 1--Convert Values From a Dry Matter Basis to an As-fed Basis and Vice Versa

F. Answers to assignment sheet

G. Test

H. Answers to test

III. Unit references

A. Barrick, Kirby R., Harmon, Hobart L. *Animal Production and Management*. McGraw-Hill Book Company, New York, 1988.

B. Bundy, Clarence E., Diggins, Ronald V., Christensen, Virgil W. *Livestock and Poultry Production,* 5th edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1982.

C. Gillespie, James R. *Animal Nutrition and Feeding*. Delmar Publishers, Inc., Albany, New York, 1987.

NUTRIENT QUALITY AND ANALYSIS

AG 532 - M

INFORMATION SHEET

I. Terms and definitions

A. Composition--The way something is made up or put together

B. Concentrates--Feed high in total digestible nutrients and low in fiber

C. Roughages--Feed high in fiber and low in total digestible nutrients

D. TDN--Total digestible nutrients; percentage of all digestible matter in a feed except minerals

E. NFE--Nitrogen-free extract; contains the sugars and starches

(Note: NFE is what is left in the feed after water, ash, fiber, crude protein and fat have been removed.)

F. Ash--Non-organic part of the feed; minerals

G. Protein--Nutrient made up of chains of amino acids which contain nitrogen; "building blocks" of muscles

H. Amino acids--Basic unit of protein; protein quality is determined by what kind and how many amino acids it contains

I. Essential amino acid--Amino acid which an animal cannot manufacture in large enough amounts to meet its needs; must be supplied in feed

J. Crude protein--Calculated protein based on nitrogen content

K. Digestible protein--Amount of protein that actually can be digested by an animal

(Note: Most digestion trials have been performed on ruminants and digestible protein information is therefore not as valid for monogastrics.)

L. Tankage--Ground meat and bone by-products; used as a protein supplement

M. Carbohydrate--Nutrient that supplies most of the energy needs; easily digested and absorbed but is not stored in the body

N. Fat--Stored energy

O. Lignin--Indigestible component of fiber

P. Feed grains--Grains used in animal feeds as opposed to food grains which are used for humans

Q. As-fed--Feed containing the amount of water it usually contains when fed to the animal

(Note: Nutrient content is calculated as a percentage of the feed containing the water, as-fed, or as a percentage of the feed minus the water, dry matter.)

R. Dry matter--Feed left after the water has been removed

S. Organic matter--Substance from living organisms

T. Palatability--Flavor of the feed

U. Maintenance level--Level at which nutrients are meeting an animal's basic needs but does not provide any energy for production or weight gain

V. Silage--Feed that is stored without drying and becomes fermented; usually stored with 60% to 67% moisture content

W. CWT--Hundred weight or 100 pounds

II. Factors affecting feeding value of feeds

A. Time of harvest

(Note: Forages are more nutritious when harvested early.)

B. Harvesting and storage conditions

(Note: Silage preserves more of the plant nutrients than other forms of feed.)

C. Soil conditions

D. Palatability

E. Fiber and lignin content

F. Form

(Note: Finer feeds are consumed more readily, but are usually not as digestible since they stay in the digestive tract a shorter time.)

G. Type of animal

Example: Ruminants can use roughages much more effectively than non-ruminants

H. Amount being fed

(Note: An animal's ability to effectively utilize feeds is best at maintenance levels and decreases as the animal approaches full feed.)

III. Separation of feedstuff by proximate analysis

A. Water

1. Oven-dry sample, weigh

2. Formulas

$$\text{Percent water} = 100 \times \frac{\text{Weight loss}}{\text{original weight}}$$

$$\text{Percent dry matter} = 100 \times \frac{\text{Weight of dried sample}}{\text{original weight}}$$

Percent water = 100 - percent dry matter

B. Crude protein

1. Kjeldahl process--Chemical analysis to determine nitrogen content

2. Proteins average 16% nitrogen

3. Nitrogen content x 6.25 = crude protein content

4. Formula

$$\text{Percent crude protein} = 100 \times \frac{\text{Crude protein in sample}}{\text{weight of sample}}$$

C. Crude fat

1. Portion of feed sample soluble in ether

2. Contains true fat, fat soluble vitamins (A, D, E and K), free fatty acids, sterols, xanthrophyll, phospholipids, chlorophyll, lecithin, resins, volatile oils and waxes

3. Sample oven-dried, ether used to extract sample, remaining material weighed

4. Formula

$$\frac{\text{Weight of crude fat}}{\text{Weight of original sample}} \times 100 = \text{percent crude fat}$$

D. Crude fiber

1. Consists of cellulose, insoluble hemicellulose and lignin

2. Steps in determining content

a. Boil in sulfuric acid then sodium hydroxide

b. Filter

c. Dry

d. Weigh

e. Heat in furnace to oxidize the crude fiber

f. Weigh material left (ash)

3. Formula

$$\frac{\text{Weight of crude fiber}}{\text{Weight of original sample}} \times 100 = \text{percent crude fiber}$$

E. Ash

1. Contains inorganic (mineral) content of feed

2. Steps

a. Weigh sample

b. Heat

c. Weigh

3. Formula

$$\frac{\text{Weight of ash}}{\text{Weight of original sample}} \times 100 = \text{percent ash}$$

F. Nitrogen-free extract (NFE)

1. Contains easily digested carbohydrates (sugars, starches, organic acids) and the more soluble cellulose, hemicellulose and lignin

2. Formula

100 - (% of water + % of crude fiber
+ % of crude fat
+ % of crude protein + % of ash) = % of nitrogen-free extract

IV. Proximate analysis to determine feed value has limitations since it gives no indication of:

A. Palatability

B. Toxicity

C. Digestibility

D. Nutritional value

V. Composition of feed (Transparency 1)

(Note: The amounts of the following may change drastically from one feed to the next.)

A. Water

B. Dry matter

1. Ash--Minerals

2. Organic matter

a. Protein

(Note: All protein contains nitrogen and is made up of chains of amino acids.)

b. Carbohydrates

(1) Crude fiber (cellulose)

(2) Nitrogen-free extract

(a) Simple sugar

(b) Compound sugar

(c) Starch

c. Vitamins

d. Fat

VI. Moisture content of feed varies with:

A. Form of the feed

B. Growth stage when harvested

C. Time in storage

D. Storage conditions

VII. As-fed data is calculated on the basis of average amount of moisture in feed as it is used on the farm

VIII. Air-dry usually means as-fed or 90% dry-matter basis

IX. 100% dry-matter basis data is calculated on basis of <u>all</u> moisture removed from feed

X. Converting between dry matter and as-fed values

(Note: Nutrient values will either be on a dry matter or as-fed basis. Before balancing a ration all values must be converted to either one or the other. It is often easier to balance the ration using dry matter figures and only convert to an as-fed basis after the ration is balanced. Part "C" explains how to do this.)

A. Converting dry matter nutrient values to an as-fed basis--Multiply nutrient percentage by the percentage of dry matter in the feed

Example: Hay = 85% dry matter (15% moisture)
Hay = 19% crude protein on a dry matter basis

.19 x .85 = .1615 or 16.15% protein on an as-fed basis

B. Converting as-fed nutrient values to a dry matter basis--Divide percentage of nutrient by percentage of dry matter in the feed

Example: Hay = 85% dry matter (15% moisture)
Hay = 16.15% protein on an as-fed basis

.1615 ÷ .85 = .19 or 19% protein on a dry matter basis

C. Converting dry matter weight of a feed to an equivalent as-fed weight--Divide the dry matter weight of the feed by the feed's normal percentage of dry matter

Example: You have calculated that your heifers need 9 pounds of dry matter.

You are feeding them hay and grain which have a dry matter content of 86%.

9÷.86 = 10.47 lbs.

You would need to feed 10.47 lbs. of feed to provide them with sufficient dry matter

XI. Van Soest forage analysis

A. Use--Gives a more accurate analysis of the crude fiber and NFE content in roughages than proximate analysis

B. Method

1. Boil feed sample in neutral detergent solution for 1 hour; filter. Separates into:

a. Neutral detergent solubles (NDS)--Lipids, sugars, starches and proteins

b. Neutral detergent fiber (NDF)--More insoluble material found in the cell wall (cellulose, lignin, silica, hemicellulose and some protein)

2. Acid detergent lignin procedure--To determine amount of lignin present

    a. Determine amount of acid detergent fiber (ADF) present (cellulose, lignin, silica)

    b. Hemicellulose content = NDF - ADF

    c. ADF is digested in sulfuric acid, then filtered

    d. Residue--Wash, dry, weigh, burn to ash

    e. Ash = Silica; weight loss from burning = Lignin present

3. NDF and NDS--Percentages of dry matter in roughage

4. About 12.9% dry-matter intake is passed through body in the feces

XII. Digestion trials

A. Important in determining the value of a feedstuff

B. Nutrients in the ration are of no value to the animal if they are not digested

C. Analysis of feed is made to determine the percentage of each nutrient present; then feces is analyzed to determine the percentage of the nutrient passed through the animal

XIII. Net energy value--True value of a feed

A. Measure amount of energy lost by animal

1. Direct calorimetry

    a. Animal confined in insulated chamber

    b. Heat losses measured

2. Indirect calorimetry

    a. Measure O_2 and CO_2 exchange as animal breathes

    b. Respiratory quotient (RQ)--Ratio of CO_2 produced to O_2 used. Gives indication of which nutrient is being metabolized

B. Measure amount of energy retained by animal

1. Comparative slaughter method

    a. Slaughter control group

    b. Determine body composition (carcass density)

    c. After experiment, slaughter rest of animals

d. Determine body composition

e. Difference in calorie content is amount of energy stored in the gain on the animal

2. More effective with growing and fattening animals

XIV. Measures of feed value

A. Net energy

B. Palatability

1. How well the animal likes the feed and how readily it eats it

2. Factors affecting palatability

a. Taste

b. Odor

c. Appearance

d. Texture

e. Feed temperature

C. Digestive disturbances--Some kinds of feeds cause problems in animal's digestive system. For example: lush, standing alfalfa can cause bloat in cattle

D. Other considerations

1. Feed variety

2. Match amount of bulk in diet to particular group of animals

a. Young animals and nonruminants--Less bulk than mature animals and ruminants

b. Market animals--Less bulk than breeding animals

XV. Methods used to determine feed value

A. Cost per unit weight

B. Cost per unit weight of TDN

C. Cost per unit weight of protein

XVI. Feeding trials

A. Conducted by U.S. Agricultural Experiment Stations

B. Results relate to feed and ration value under controlled feeding conditions

C. Valuable for determining practical farm rations

XVII. Major provisions in most state feed laws

A. Feed manufacturer registration

B. Labeling requirements

C. Prohibited acts

D. Definitions of misbranding and alterations of feed

E. Schedule of inspection fees and reports

F. Inspection, sampling and analysis procedures

G. Violation penalties

XVIII. Information on feed tags (Transparency 2)

A. Minimum of ________________% crude protein

B. Minimum of ________________% crude fat

C. Maximum of ________________% fiber

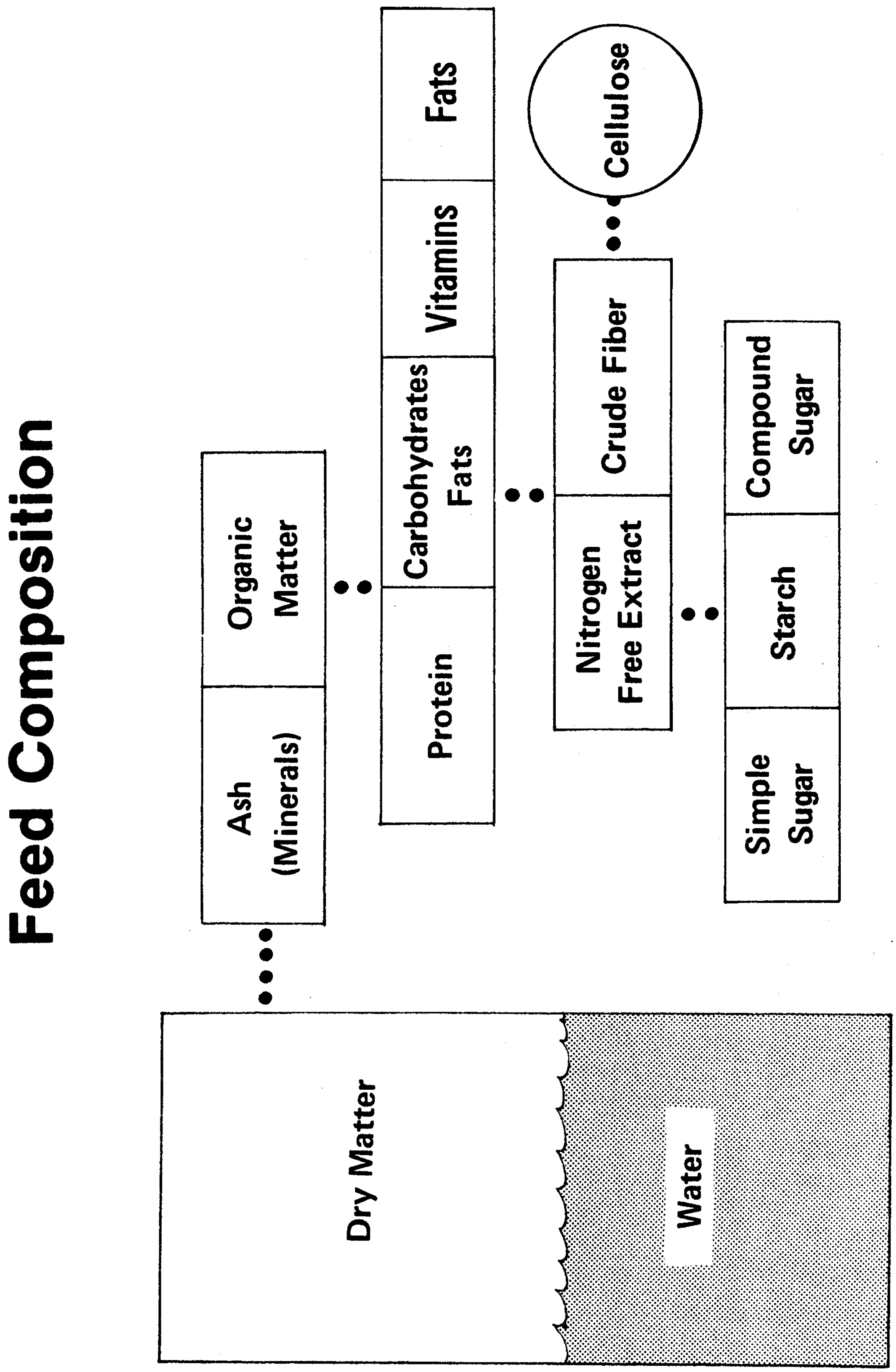
D. Ash content

E. Mineral content

(Note: This is only included if the feed contains a significant amount of minerals.)

F. Ingredients

(Note: This is not always included.)



Feed Composition
Dry Matter
Water
Ash (Minerals)
Organic Matter
Protein
Carbohydrates Fats
Vitamins
Fats
Nitrogen Free Extract
Crude Fiber
Cellulose
Simple Sugar
Starch
Compound Sugar

Commercial Feed Tag

50 Pounds (Net) B & D BRAND SPECIAL CATTLE CUBES

GUARANTEED ANALYSIS

Crude Protein not less than .... 20.00 Percent
Crude Fat not less than .... 2.50 Percent
Crude Fiber not more than .... 14.00 Percent

INGREDIENTS: Composed of grain products, plant protein products, processed grain by-products, animal protein products, dehydrated alfalfa meal (preserved with ethoxyquin), mixed screenings 10%, rice mill by-products 10%, cane molasses, calcium carbonate, defluorinated phosphate salt, and TRACES of manganous oxide, zinc oxide, ferrous sulphate, copper sulphate, calcium iodate, and cobalt carbonate. (Total added mineral ingredients less than 5%.)

Manufactured by

FEEDING DIRECTIONS: A cattle supplement for winter range.

NUTRIENT QUALITY AND ANALYSIS

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ASSIGNMENT SHEET #1--CONVERT VALUES FROM A DRY MATTER BASIS TO AN AS-FED BASIS AND VICE VERSA

Name ______________________ Score ______________________

Complete the following chart by converting the values as needed.

Feed	Dry Matter %	Dry Matter Basis		As-Fed Basis	
		%C.P.	%TDN	%C.P.	%TDN
Beet pulp	91	10	_____	_____	65.5
Rye	89	_____	_____	11.9	75.7
Wheat	89	14.3	88	_____	_____
Linseed meal	91	_____	81	35.3	_____
Alfalfa hay	91.2	13.6	_____	_____	45.6
Alfalfa silage	35	_____	57	5.6	_____

Feed	Dry Matter %	Pounds of Dry Matter	Pounds of Actual Feed Needed
Corn silage	28	3	____________
Beet molasses	77	2	____________
Barley straw	88.2	8	____________
Dent corn	89	13	____________

NUTRIENT QUALITY AND ANALYSIS

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ANSWERS TO ASSIGNMENT SHEET

Feed	Dry Matter %	Dry Matter Basis		As-Fed Basis	
		%C.P.	%TDN	%C.P.	%TDN
Beet pulp	91	10	72	9.1	65.5
Rye	89	13.4	85	11.9	75.7
Wheat	89	14.3	88	12.7	78.3
Linseed meal	91	38.8	81	35.3	73.7
Alfalfa hay	91.2	13.6	50	12.4	45.6
Alfalfa silage	35	16	57	5.6	20

Feed	Dry Matter %	Pounds of Dry Matter	Pounds of Actual Feed Needed
Corn silage	28	3	10.7
Beet molasses	77	2	2.6
Barley straw	88.2	8	9.1
Dent corn	89	13	14.6

NUTRIENT QUALITY AND ANALYSIS

AG 532 - M

UNIT TEST

Name ______________________________ Score ______________________________

1. Define the following terms associated with nutrient quality and analysis.

   a. Composition ______________________________

   ____

   b. Concentrates ______________________________

   ____

   c. Roughages ______________________________

   ____

   d. TDN ______________________________

   ____

   e. NFE ______________________________

   ____

   f. Ash ______________________________

   ____

   g. Protein ______________________________

   ____

   h. Amino acids ______________________________

   ____

   i. Essential amino acid ______________________________

   ____

   j. Crude protein ______________________________

   ____

k. Digestible protein ______________________________

____

l. Tankage ______________________________

____

m. Carbohydrate ______________________________

____

n. Fat ______________________________

____

o. Lignin ______________________________

____

p. Feed grains ______________________________

____

q. As-fed ______________________________

____

r. Dry matter ______________________________

____

s. Organic matter ______________________________

____

t. Palatability ______________________________

____

u. Maintenance level ______________________________

____

v. Silage ______________________________

____

w. CWT ______________________________

____

2. List eight factors that affect feeding value of feeds.

   a.____

   b. ____

   c.____

   d. ____

   e.____

   f.____

   g. ____

   h. ____

3. List the six components into which a feedstuff is separated by proximate analysis.

   a.____

   b. ____

   c.____

   d. ____

   e.____

   f.____

4. Describe the method of proximate analysis for each of the six components listed in #3.

   a.____

   ____

   b. ____

   ____

   c.____

   ____

   d. ____

   ____

e.____

f.____

5. List four limitations of using proximate analysis to determine feed value.

   a.

   b.

   c.

   d.

6. List the four major feed components.

   a.

   b.

   c.

   d.

7. List four factors that affect moisture content of feed.

   a.

   b.

   c.

   d.

8. Describe and give examples of how feeds may be converted from one composition basis to another.

   a. Convert dry matter nutrient values to an as-fed basis.

b. Convert as-fed nutrient values to a dry matter basis.

____

____

____

____

____

c. Convert dry matter weight of a feed to an equivalent as-fed weight.

____

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____

____

9. Explain why the Van Soest method of forage analysis is sometimes used.

____

____

____

10. Describe the Van Soest method of forage analysis.

a.____

____

____

b. ____

____

____

c.____

____

____

d. ____

____

____

11. Explain why digestion trials are of importance when determining the value of a feedstuff, and how the trials are conducted.

____

____

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____

____

12. Describe how net energy values of feed may be determined.

a. ____

____

____

____

____

b. ____

____

____

____

____

13. List and briefly describe three other measures of feed value.

a. ____

____

b. ____

____

____

c. ____

____

____

14. List three methods used to determine feed value.

a. ____

b. ____

c. ____

15. Explain why feeding trials are of value in developing rations.

a. ____

____

b. ____

____

16. List the seven major provisions found in most state feed laws.

a. ____

b. ____

c. ____

d. ____

e. ____

f. ____

g. ____

17. List information found on feed tags.

a. ____

b. ____

c. ____

d. ____

e.____

f.____

NUTRIENT QUALITY AND ANALYSIS

AG 532 - M

ANSWERS TO TEST

1. a. Composition--The way something is made up or put together
   b. Concentrates--Feed high in total digestible nutrients and low in fiber
   c. Roughages--Feed high in fiber and low in total digestible nutrients
   d. TDN--Total digestible nutrients; percentage of all digestible matter in a feed except minerals
   e. NFE--Nitrogen-free extract; contains the sugars and starches
      (Note: NFE is what is left in the feed after water, ash, fiber, crude protein and fat have been removed.)
   f. Ash--Non-organic part of the feed; minerals
   g. Protein--Nutrient made up of chains of amino acids which contain nitrogen; "building blocks" of muscles
   h. Amino acids--Basic unit of protein; protein quality is determined by what kind and how many amino acids it contains
   i. Essential amino acid--Amino acid which an animal cannot manufacture in large enough amounts to meet its needs; must be supplied in feed
   j. Crude protein--Calculated protein based on nitrogen content
   k. Digestible protein--Amount of protein that actually can be digested by an animal
   l. Tankage--Ground meat and bone by-products; used as a protein supplement
   m. Carbohydrate--Nutrient that supplies most of the energy needs; easily digested and absorbed but is not stored in the body
   n. Fat--Stored energy
   o. Lignin--Indigestible component of fiber
   p. Feed grains--Grains used in animal feeds as opposed to food grains which are used for humans
   q. As-fed--Feed containing the amount of water it usually contains when fed to the animal
   r. Dry matter--Feed left after the water has been removed
   s. Organic matter--Substance from living organisms
   t. Palatability--Flavor of the feed
   u. Maintenance level--Level at which nutrients are meeting an animal's basic needs but does not provide any energy for production or weight gain
   v. Silage--Feed that is stored without drying and becomes fermented; usually stored with 60% to 67% moisture content
   w. CWT--Hundred weight or 100 pounds

2. Time of harvest; Harvesting and storage conditions; Soil conditions; Palatability; Fiber and lignin content; Form; Type of animal; Amount being fed

3. Water; Crude protein; Crude fat; Crude fiber; Ash; Nitrogen-free extract (NFE)

4. a. Water:

   Oven-dry sample, weigh

   $$\text{Percent water} = 100 \times \frac{\text{Weight loss}}{\text{original weight}}$$

$$\text{Percent dry matter} = 100 \times \frac{\text{Weight of dried sample}}{\text{original weight}}$$

Percent water = 100 - percent dry matter

b. Crude protein:

Nitrogen content x 6.25 = crude protein content

$$\text{Percent crude protein} = 100 \times \frac{\text{Crude protein in sample}}{\text{weight of sample}}$$

c. Crude fat:

Sample oven-dried, ether used to extract sample, remaining material weighed

$$\frac{\text{Weight of crude fat}}{\text{Weight of original sample}} \times 100 = \text{percent crude fat}$$

d. Crude fiber:

Boil in sulfuric acid then sodium hydroxide; Filter; Dry; Weigh; Heat in furnace to oxidize the crude fiber; Weigh material left (ash)

$$\frac{\text{Weight of crude fiber}}{\text{Weight of original sample}} \times 100 = \text{percent crude fiber}$$

e. Ash:

Weigh sample; Heat; Weigh;

$$\frac{\text{Weight of ash}}{\text{Weight of original sample}} \times 100 = \text{percent ash}$$

f. Nitrogen-free extract (NFE):

100 - (% of water + % of crude fiber
+ % of crude fat
+ % of crude protein + % of ash) = % of nitrogen-free extract

5. Palatability; Toxicity; Digestibility; Nutritional value

6. Answer should include four of the following:

Water; Dry matter; Ash--Minerals; Organic matter; Protein; Carbohydrates; Vitamins; Fat

7. Form of the feed; Growth stage when harvested; Time in storage; Storage conditions

8. a. Multiply nutrient percentage by the percentage of dry matter in the feed

Example: Hay = 85% dry matter (15% moisture)
Hay = 19% crude protein on a dry matter basis

.19 x .85 = .1615 or 16.15% protein on an as-fed basis

b. Divide percentage of nutrient by percentage of dry matter in the feed

Example: Hay = 85% dry matter (15% moisture)
Hay = 16.15% protein on an as-fed basis

.1615 ÷ .85 = .19 or 19% protein on a dry matter basis

c. Divide the dry matter weight of the feed by the feed's normal percentage of dry matter

Example: You have calculated that your heifers need 9 pounds of dry matter. You are feeding them hay and grain which have a dry matter content of 86%.

9 ÷ .86 = 10.47 lbs.

You would need to feed 10.47 lbs. of feed to provide them with sufficient dry matter

9. Gives a more accurate analysis of the crude fiber and NFE content in roughages than proximate analysis

10. Answer should include the following information:

a. Boil feed sample in neutral detergent solution for 1 hour; filter. Separates into neutral detergent solubles (NDS) and neutral detergent fiber (NDF)

b. Acid detergent lignin procedure--To determine amount of lignin present: Determine amount of acid detergent fiber (ADF) present; Hemicellulose content = NDF - ADF; ADF is digested in sulfuric acid, then filtered; Residue--Wash, dry, weigh, burn to ash; Ash = Silica; weight loss from burning = Lignin present

c. NDF and NDS--Percentages of dry matter in roughage

d. About 12.9% dry-matter intake is passed through body in the feces

11. Nutrients in the ration are of no value to the animal if they are not digested; Analysis of feed is made to determine the percentage of each nutrient present; then feces is analyzed to determine the percentage of the nutrient passed through the animal

12. a. Measure amount of energy lost by animal: Direct calorimetry; Indirect calorimetry

c. Measure amount of energy retained by animal: Comparative slaughter method; More effective with growing and fattening animals

13. Answer should include three of the following:

a. Net energy

b. Palatability--How well the animal likes the feed and how readily it eats it

c. Digestive disturbances; Some kinds of feeds cause problems in animal's digestive system

d. Feed variety; Match amount of bulk in diet to particular group of animals

14. Cost per unit weight; Cost per unit weight of TDN; Cost per unit weight of protein

15. Results relate to feed and ration value under controlled feeding conditions; Valuable for determining practical farm rations

16. Feed manufacturer registration; Labeling requirements; Prohibited acts; Definitions of misbranding and alterations of feed; Schedule of inspection fees and reports; Inspection, sampling and analysis procedures; Violation penalties

17. Minimum percent crude protein and crude fat; Maximum percent fiber; Ash content; Mineral content; Ingredients

METABOLISM OF NUTRIENTS FOR MAINTENANCE, HEALTH AND PRODUCTION

AG 532 - N

UNIT OBJECTIVE

After completion of this unit, students should be able to explain the importance of a balanced ration and describe the general principles for formulating a ration. Students should also be able to describe the steps in balancing a ration and use the Pearson's Square or algebraic equations to balance rations. This knowledge will be demonstrated by completing 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. Define terms associated with nutrient metabolism.
2. Explain why a balanced ration is important in livestock feeding.
3. List and describe three general principles for formulating a ration.
4. Match the most major feed grains to their characteristics.
5. Name the three most common methods of preparing grains.
6. List three methods used to determine value of feed.
7. Describe the procedure for determining dry matter content of a feed.
8. List the six general principles for ration selection.
9. Convert values from a dry matter basis to an as-fed basis and vice versa.
10. Balance a ration for protein using the Pearson's Square method.
11. Balance a ration using the trial-and-error method.
12. Describe two advantages and two limitations of using computers for ration balancing.
13. Describe how urea should be used as a protein supplement in ruminants to achieve maximum benefits, without causing harm to the animal.
14. Discuss the proper use of growth stimulants and the role they play in the animal's development.
15. List the six nutrients needed by the cell protoplasm.
16. Discuss the functions of the cell protoplasm.

METABOLISM OF NUTRIENTS FOR MAINTENANCE, HEALTH AND PRODUCTION

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SUGGESTED ACTIVITIES

I. Suggested activities for the 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.

   E. Discuss and demonstrate assignment sheets.

   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--Using Pearson's Square

      2. TM 2--Pearson's Square

   E. Handout

      1. HO 1--Average Composition of Common Feeds

      2. HO 2--(continued)

      3. HO 3--(continued)

   F. Assignment sheets

      1. AS 1--Convert Values From a Dry Matter Basis to an As-fed Basis and Vice Versa

      2. AS 2--Balance a Ration for Protein Using the Pearson's Square Method

      3. AS 3--Balance a Ration Using the Trial-And-Error Method

G. Answers to assignment sheets

H. Test

I. Answers to test

III. Unit references

A. Barrick, Kirby R., Harmon, Hobart L. *Animal Production and Management*. McGraw-Hill Book Company, New York, 1988.

B. Bundy, Clarence E., Diggins, Ronald V., Christensen, Virgil W. *Livestock and Poultry Production,* 5th edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1982.

C. Gillespie, James R. *Animal Nutrition and Feeding*. Delmar Publishers, Inc., Albany, New York, 1987.

METABOLISM OF NUTRIENTS FOR MAINTENANCE, HEALTH AND PRODUCTION

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INFORMATION SHEET

I. Terms and definitions

   A. Ration--Amount of feed given to an animal to meet its needs during a 24 hour period

   B. Diet--The ration fed to an animal without reference to a specific time period

   C. Balanced ration--A ration that provides the nutrient needs of the animal in the proper proportions

II. Importance of balanced ration in livestock feeding

   A. Maintenance

   B. Growth

   C. Fattening

   D. Efficient production

      1. Meat

      2. Milk

      3. Eggs

      4. Wool

   E. Reproduction

   F. Work

III. Ration formulation

   A. Economical

      1. Feed is 50 - 80% total cost of livestock production

      2. Homegrown feeds less expensive

   B. Palatability

      1. No poisonous plants

      2. Feeds animal will eat

C. Nutritional requirements

1. Balanced diet

2. Balance of roughages and concentrates for species and age

3. Micronutrients and feed additives

a. Only recommended amounts

b. Mix thoroughly

IV. Characteristics of major feed grains

A. Corn

1. Most important livestock grain

2. High in TDN

3. Low in protein

B. Barley

1. Most commonly used in the western United States

2. Comparable to corn in feed value

C. Oats

1. Lower in TDN but higher in protein than corn

2. Bulkier than corn

(Note: This bulk helps keep digestive systems working properly.)

D. Wheat

1. Similar in TDN to corn with more protein

2. Usually more expensive than other grains

3. Should not be over 50% of the ration for cattle as it ferments faster in the rumen than other grains

E. Grain sorghums

1. Slightly lower in energy but higher in protein than corn

2. Must be ground for maximum digestibility

F. Rye

1. Least palatable of all grains

2. Should be limited to not over 25% of ration

V. Common methods of preparing grains

A. Grinding

B. Rolling

C. Pelleting

VI. Methods used to determine value of a feed

A. Cost per unit weight

B. Cost per unit weight of TDN

C. Cost per unit weight of protein

VII. Determining dry matter content of a feed

A. Finely grind a feed sample and weigh

B. Dry sample in oven

C. Weigh sample again, divide by the first weight and multiply by 100; this answer is the percentage dry matter of the feed

(Note: Do not forget to subtract the weight of the container each time the sample is weighed.)

Example:	4.1 lb	Original weight of feed and container
	- .1 lb	Weight of container
	4.0 lb	Original weight of feed
	3.5 lb	Weight of feed and container after drying
	-.1 lb	Weight of container
	3.4 lb	Weight of feed after drying

(3.4÷4) x 100 = 85% dry matter in feed

VIII. Ration selection

A. Homegrown feeds when possible

B. Feed supplements

1. Additional protein, vitamins, minerals

2. Compare on basis of cost per pound of crude protein content

C. Transportation costs

D. Suitability of feed

E. Changing prices over period of time

F. Availability of the feed

IX. Trial-and-error method of balancing a ration

A. Look up nutrient requirements of the animal

B. Write down an estimated ration; provide necessary dry matter

(Note: This will become easier with experience. Knowledge of feeds available and an idea of what is reasonable is important.)

C. Calculate levels of digestible protein and TDN provided by the ration

D. Alter ration to correct deficiencies; adjust for TDN first

(Note: Remember that grains can help bring up TDN content and protein supplements can be substituted to increase protein content.)

E. Recalculate and continue changing ration until it meets the necessary requirements

Example: You want to balance a ration for a 550 lb beef heifer to gaining 1.5 lb per day. Nutrient requirements and feeds available are listed in the tables below.

(Note: All feed nutrients are on a dry matter basis unless otherwise noted.)

Animal Requirements

Dry matter	14.25	lb
Crude protein	1.36	lb
TDN	9.10	lb
Calcium	.037	lb
Phosphorus	.033	lb

Feed	Dry Matter %	Crude Protein %	TDN %	Calcium %	Phosphorus %
	Chemical composition - dry matter basis				
Orchardgrass hay	89.7	9.7	57	.45	.37
Corn silage	27.9	8.4	70	.28	.21
Corn	89.0	10.0	91	.02	.35
Soybean meal	89.0	51.5	81	.36	.75
Limestone	---	---	--	38.00	---

You decide to try an all-roughage ration to get by as cheaply as possible. You decide you have enough silage to feed about 4 lb a day per animal (dry matter basis). You therefore decide on the following:

Orchardgrass	10.25 lb (Dry matter requirement of 14.35 lb - 4 lb silage)
Silage	4.00 lb

Make calculations:

	Dry matter--lb	Protein--lb	TDN--lb
Orchardgrass	10.25	.99	5.84
Silage	4.00	.34	2.80
Totals	14.25	1.33	8.64
Requirements	14.25	1.36	9.10

Add corn and decrease hay to raise TDN

	Dry matter--lb	Protein--lb	TDN--lb
Orchardgrass	8.85	.86	5.04
Silage	4.00	.34	2.80
Corn	1.40	.14	1.27
Totals	14.25	1.34	9.11
Requirements	14.25	1.36	9.1

Substitute soybean meal for a small amount of the corn to raise protein level

	Dry matter--lb	Protein--lb	TDN--lb
Orchardgrass	8.85	.86	5.04
Silage	4.00	.34	2.80
Corn	1.34	.13	1.22
Soybean meal	.06	.03	.05
Totals	14.25	1.36	9.11
Requirements	14.25	1.36	9.1

Check calcium and phosphorus content to insure a 1 to 1 or greater ratio

	Calcium	Phosphorus
Orchardgrass	.04	.033
Silage	.011	.008
Corn	--	.005
Soybean meal	---	---
Totals	.051	.046
Requirements	.037	.033

Ratio is 1.1 to 1 and is okay; limestone does not need to be added

Convert to actual feed needed

	Dry Matter %	Dry Matter lb	Feed lb
Orchardgrass	89.7	8.85	9.9
Silage	27.9	4	14.3
Corn	89.0	1.34	1.5
Soybean meal	89.0	.06	.067

(Note: The trial-and-error method can be very tedious and time consuming, especially as more feeds are added to the ration. One way to speed up the process is to calculate the amount the nutrient needs to be increased and divide it by the net gain made by the substitution. For example, orchardgrass has 57% TDN and corn has 91%. In our first ration we had 8.64 lb of TDN and needed 9.1 lb or an addition of .46 lb (9.1 - 8.64). By dividing .46 by 34% we get 1.35 lb, which is the amount of corn we must substitute for orchardgrass to get the desired TDN. Use of computers is another way to greatly speed this process.)

X. Using Pearson's Square to balance rations for protein (Transparencies 1, 2)

(Note: This method does not balance the other nutrients needed in the ration and is therefore most valuable when used for making substitutions of protein concentrates when formulating rations.)

A. Determine percentage of protein required in ration

B. Place in center of square

C. Place protein supplement and its percent protein in the lower left-hand corner

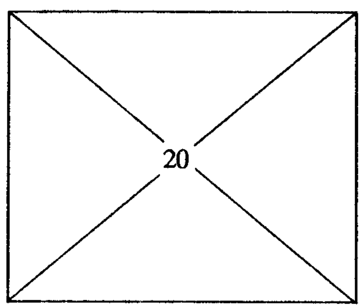
D. Place the other feed and its percent protein in the upper left-hand corner

E. Subtract diagonally, the smaller number from the larger

F. Resulting answers are the parts of feed and parts of supplement needed in ration

Example: **<u>Parts</u>**

Barley 11.5% **21 Barley**



Cottonseed meal 41% **<u>8.5</u> Cottonseed meal**

29.5 Total

F. Determine percentage of each by dividing the parts of each by the total parts and multiplying by 100

Example:

	Parts	Total Parts		Percent in Ration
Barley	21 %	29.5 x 100	=	71.2%
Cottonseed meal	8.5 %	29.5 x 100	=	28.8%

XI. Using computers for balancing rations

A. Advantages

1. Computers can balance rations with many different feeds in a very short time

2. Computers can include feed cost as a consideration when balancing rations with very little extra operator effort

3. Feed and price substitutions can be made quickly

B. Limitations

1. Computers must still be supplied with accurate feed analyses, animal nutrient requirements and limitations on amounts of certain feeds

(Note: Feeds vary widely in nutrient content and animal nutrient requirements will depend on production goals, animal condition, environmental factors, etc.)

2. Computer may not be able to consider other factors which could affect the particular situation

Example: Some feeds may not mix well in certain proportions; feed price may change with amount of feed bought; individual animals may require additional nutrients

XII. Urea as a protein supplement

A. Supplying no more than one-third total protein requirement

B. Add gradually to get animals accustomed to it

C. Mix in thoroughly

D. Use less urea in low-energy rations

XIII. Growth stimulants

A. Increase animal's ability to produce food for human consumption

B. Improve growth rate and feed efficiency

C. Proper use

1. Read and follow all label directions

2. Obtain accurate diagnosis before using drugs to treat diseased animals

3. Wear recommended protective clothing, if any

4. Read and follow all feeding instructions

    a. Recommended dosage

    b. Milk restrictions from treated animals

    c. Pre-slaughter withdrawal times

5. Use proper sanitation procedures and equipment when administering drugs

6. Store drugs in original containers; properly dispose of any unlabeled containers

7. Keep all drugs away from children and animals

XIV. Proper nutrition and the cell protoplasm

A. Nutrients needed by the cell protoplasm

1. Carbohydrates

2. Lipids

3. Proteins

4. Vitamins

5. Minerals

6. Water

B. Functions of cell protoplasm

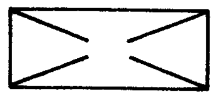
1. Provide materials for cell growth and maintenance

2. Provide materials to regulate essential chemical reactions

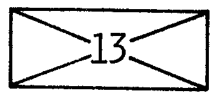
3. Provide materials to break down for energy release

Using Pearson's Square

Step No. 1

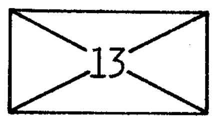


Step No. 2



Milo 8.5

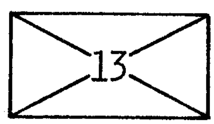
Step No. 3 and 4



C.S.M. 32.2

Milo 8.5 — 19.2 parts of Milo

Step No. 5



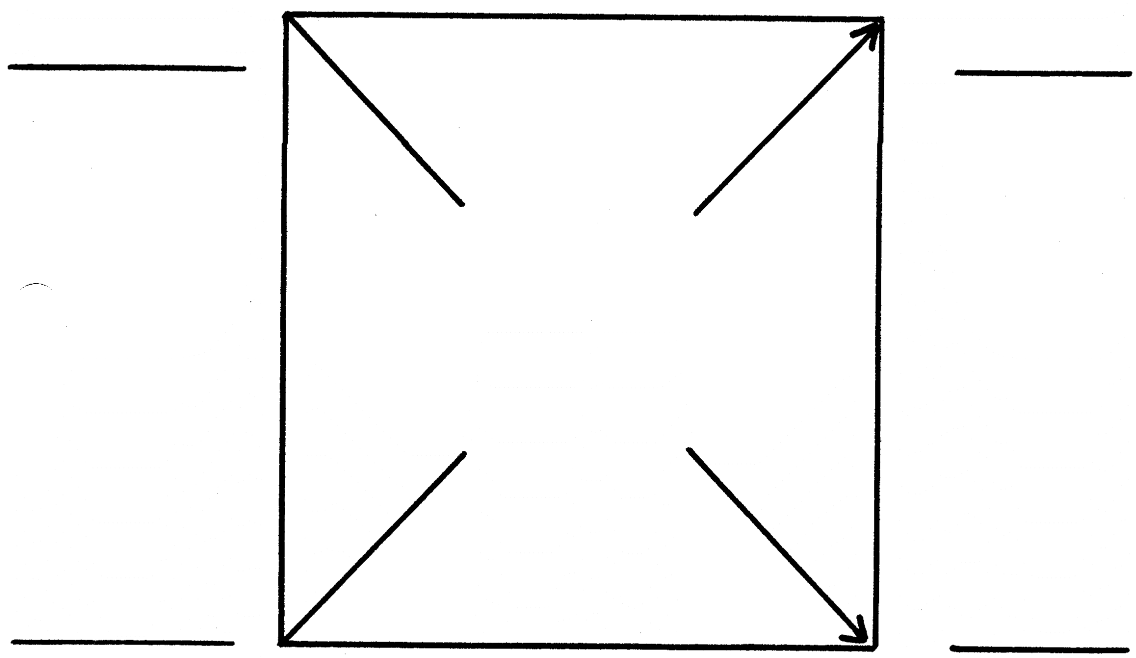
C.S.M. 32.2 — 4.5 parts of C.S.M.

Total parts in mixture 23.7

Step No. 6 — Milo $19.2 \div 23.7 = .81 \times 100 = 81\%$

Cottonseed Meal $4.5 \div 23.7 = .19 \times 100 = 19\%$

Pearson's Square



Average Composition Of Common Feeds

Dry Basis

The following tables list average nutrient and mineral values for some common feedstuffs. To convert dry matter values in the tables to as-fed values, multiply the nutrient value (dry basis) by the percent dry matter (oats 12.4% crude protein on a dry basis x .89% dry matter = 11% crude protein on an as-fed basis). Adapted by David A. Yates, Extension Animal Scientist, University of Wyoming.

Feedstuffs	Dry matter	Dry matter basis: Crude protein	Energy: TDN	Energy: NE_m	Energy: NE_g	Crude fiber	Ca	P	IU/lb.
	(%)	(%)	(%)	Mcal/lb.		(%)	(%)	(%)	
Low protein concentrates									
Barley grain	89.0	13.0	83	.97	.64	5.6	.09	.47	—
Beet pulp	91.0	10.0	72	.73	.47	20.9	.75	.11	—
Beet pulp w/ molasses	92.0	9.9	74	.92	.61	17.4	.61	.11	—
Beet molasses	77.0	8.7	89	.93	.62	—	.21	.04	—
Brewers dried grains	92.0	28.1	66	.64	.38	16.3	.29	.54	—
Corn distillers grains	92.0	29.5	84	.90	.60	13.0	.10	.40	—
Corn, dent, #2	89.0	10.0	91	1.04	.67	2.2	.02	.35	360
Ground ear corn	87.0	9.3	90	1.01	.63	9.2	.05	.31	—
Milo	89.0	12.4	80	.84	.56	2.2	.04	.33	—
Oats	89.9	13.2	76	.79	.52	12.4	.11	.39	—
Rye	89.0	13.4	85	.93	.62	2.2	.07	.38	—
Sugar cane molasses	75.0	4.3	72	.87	.54	—	1.19	.11	—
Turnip roots	9.3	14.0	84	.89	.60	11.8	.64	.22	—
Wheat	89.0	14.3	88	.98	.64	3.4	.06	.41	—
Wheat bran	89.0	18.0	70	.70	.44	11.2	.16	1.32	—
High protein concentrates									
Cottonseed meal									
Expeller	94.0	43.6	78	.82	.54	12.8	.17	1.28	—
Solvent	91.5	44.8	75	.77	.50	13.1	.17	1.31	—
Linseed meal									
Expeller	91.0	38.8	81	.86	.58	9.9	.48	.98	—
Solvent	91.0	38.6	76	.79	.52	9.9	.44	.91	—
Meat and bone meal	94.0	53.8	72	.73	.47	2.0	11.25	5.39	—
Rapeseed meal									
Expeller	93.6	39.6	74	.76	.50	14.6	.64	1.04	—
Solvent	90.3	43.6	69	.69	.43	15.3	.44	1.00	—
Safflower									
Expeller	91.0	21.7	57	.55	.25	34.1	.25	.78	—
Solvent	91.8	23.3	55	.53	.22	35.2	.37	.92	—
Soybean meal									
Expeller	90.0	48.7	85	.94	.62	6.7	.30	.70	—
Solvent	89.0	51.5	81	.88	.59	6.7	.36	.75	—
Sunflower									
Expeller	93.0	44.1	70	.70	.44	14.0	.46	1.12	—
Solvent	93.0	50.3	65	.64	.38	11.8	—	—	—

Average Composition Of Common Feeds (cont.)

Feedstuffs	Dry matter	Dry matter basis							
		Crude protein	Energy			Crude fiber	Ca	P	IU/lb.
			TDN	NE_m	NE_g				
	(%)	(%)	(%)	(Mcal/lb.)		(%)	(%)	(%)	
Dry roughages									
Alfalfa hay									
Late vegetative	84.5	19.4	59	.57	.28	28.5	1.43	.26	31,600
Early bloom	90.0	18.4	57	.55	.25	29.8	1.25	.23	23,200
Mid-bloom	89.2	17.1	55	.53	.22	30.9	1.35	.22	6,000
Full bloom	87.7	15.9	53	.51	.18	33.9	1.28	.20	6,800
Mature	91.2	13.6	50	.49	.13	37.5	—	—	—
Alfalfa dehydrated									
20% protein	92.0	21.8	61	.60	.36	23.0	1.79	.31	40,000
17% protein	93.0	19.2	62	.60	.31	26.0	1.43	.26	32,000
15% protein	93.0	16.3	61	.60	.29	28.0	1.32	.24	20,000
Barley hay	87.3	8.9	57	.56	.26	26.4	.21	.30	—
Barley straw	88.2	4.1	41	.46	.06	42.4	.34	.09	—
Bluegramma hay	90.0	4.1	47	—	—	34.0	.21	.08	—
Bluegrass hay	93.4	11.6	55	.53	.22	28.9	.30	.29	—
Bluestem-mature	71.3	4.5	46	.45	.05	34.0	.40	.11	—
Bromegrass hay	89.7	11.8	52	.50	.16	32.0	—	—	—
Clover hay									
Alsike	87.9	14.7	60	.59	.30	29.4	1.31	.25	34,000
Landino	91.2	23.0	61	.60	.31	19.2	1.38	.40	29,200
Red	87.7	14.9	59	.57	.28	30.1	1.61	.22	6,800
Ground corn cobs	90.4	2.8	47	.48	.11	35.8	.12	.04	—
Cottonseed hulls	90.3	4.3	41	.47	.09	47.5	.16	.10	—
Fescue hay, meadow	88.5	10.5	54	.52	.20	31.2	.50	.36	—
Intermountain native hay	92.9	9.1	51	.50	.14	30.1	.57	.17	—
Oat hay	88.2	9.2	61	.60	.32	31.0	.26	.24	18,400
Oat straw	90.1	4.4	52	.50	.16	41.0	.83	.10	—
Orchardgrass hay	88.3	9.7	57	.55	.25	34.0	.45	.37	6,000
Rye straw	88.9	3.0	31	.34	.00	47.6	.29	.10	—
Sagebrush big (stem cured)		9.4	—	—	—	—	.67	.18	2,800
Sagebrush fringed									
Mid-bloom	43.2	8.5	62	.60	.33	26.5	—	—	—
Mature	50.0	6.0	53	.51	.18	31.7	—	—	—
Saltgrass desert (grazed)	75.0	5.9	64	.63	.36	29.7	.16	.09	—
Sedge hay	90.2	10.3	50	.49	.13	30.9	—	—	—
Sorghum sudangrass hay	88.9	12.7	59	.57	.29	28.9	.56	.31	—
Sweetclover hay	87.2	16.3	57	.55	.25	32.2	1.77	.26	—
Timothy hay									
Late vegetative	88.6	12.3	62	.61	.33	32.9	.66	.34	—
Early bloom	87.7	8.7	59	.57	.28	33.2	.60	.26	—
Mid-bloom	88.4	8.5	57	.56	.26	33.5	.41	.19	9,600
Late bloom	88.0	8.3	55	.53	.22	32.4	.38	.18	1,600
Wheat									
Hay	85.9	7.5	66	.65	.39	27.8	— —	—	20,400
Straw	90.1	3.6	48	.47	.09	41.5	.77	.08	400
Wheatgrass, crested									
Early vegetative	31.0	23.6	67	.66	.40	34.0	.46	.35	78,850
Early bloom	42.0	11.0	58	.56	.27	30.0	—	—	—
Full bloom	50.0	9.8	55	.53	.22	30.0	.39	.28	27,900
Mature	60.0	5.7	52	.50	.16	36.0	.29	.17	13,700
Silages									
Alfalfa									
Immature	35.0	21.5	63	.62	.35	26.0	1.79	.30	12,000
Early bloom	35.0	18.4	57	.61	.28	30.0	1.45	.23	8,000
Mid-bloom	35.0	15.9	57	.55	.25	34.0	1.28	.20	5,000
Full bloom	35.0	13.6	55	.53	.21	38.0	1.25	.20	2,000
Beet, sugar (tops)	21.0	12.7	54	.52	.19	13.0	2.32	.20	—
Corn, well-eared	28.0	8.4	70	.71	.45	26.0	.28	.21	—
Oats	32.0	9.7	59	.58	.29	32.0	.37	.30	21,727
Milo	29.0	7.3	57	.55	.26	26.0	.25	.18	—
Sorghum, sudangrass	23.0	10.2	59	.58	.29	34.0	.64	.22	—

Average Composition Of Common Feeds (cont.)

Average mineral content of selected foodstuffs on an as-fed basis.

Feedstuff	As-fed basis Calcium (%)	Phosphorus (%)	Magnesium (%)	Potassium (%)
	Minerals			
Bone meal steamed	30.5	14.0	.67	.19
Limestone	34.0	——	2.06	.12
Magnesium carbonate	——	——	25.20	——
Magnesium oxide	——	——	60.30	——
Magnesium sulfate	——	——	10.00	——
Oyster shell	38.0	——	——	.09
Phosphate, deflourinated rock	34.0	16.0	——	.09
Phosphate, diammonium	——	20.0	——	——
Phosphate, dicalcium	24.0	19.0	——	——
Phosphate, monocalcium	16.0	25.0	——	——
Phosphate, monosodium	——	22.5	——	——
Phosphate, sodium tripoly	——	30.0	——	——
Phosphoric acid	——	32.0	——	——
Potassium sulfate	——	——	——	45.00
Potassium chloride	——	——	——	50.00

*Table values are from National Research Council's "Nutrient Requirements of Beef Cattle" No. 4, fifth revised edition, 1976, and Nebraska Neb Guide G74-145 "Average Composition of Common Feeds (Dry Basis)" by Paul Q. Guyer.

METABOLISM OF NUTRIENTS FOR MAINTENANCE, HEALTH AND PRODUCTION

AG 532 - N

ASSIGNMENT SHEET #1--CONVERT VALUES FROM A DRY MATTER BASIS TO AN AS-FED BASIS AND VICE VERSA

Name ______________________________ Score ______________________________

Complete the following chart by converting the values as needed.

Feed	Dry Matter %	Dry Matter Basis		As-Fed Basis	
		% C.P.	% TDN	% C.P.	% TDN
Beet pulp	91	10	_____	_____	65.5
Rye	89	_____	_____	11.9	75.7
Wheat	89	14.3	88	_____	_____
Linseed meal	91	_____	81	35.3	_____
Alfalfa hay	91.2	13.6	_____	_____	45.6
Alfalfa silage	35	_____	57	5.6	_____

Feed	Dry Matter %	Pounds of Dry Matter	Pounds of Actual Feed Needed
Corn silage	28	3	______________
Beet molasses	77	2	______________
Barley straw	88.2	8	______________
Dent corn	89	13	______________

METABOLISM OF NUTRIENTS FOR MAINTENANCE,
HEALTH AND PRODUCTION

AG 532 - N

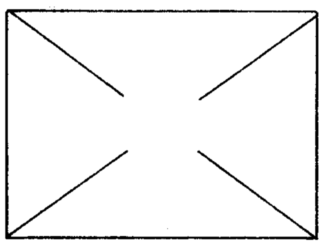
ASSIGNMENT SHEET #2--BALANCE A RATION FOR PROTEIN
USING THE PEARSON'S SQUARE METHOD

Name ______________________________ Score ______________________________

Balance the following rations for protein by calculating the parts of the feeds needed and the percentage of the ration they would make up.

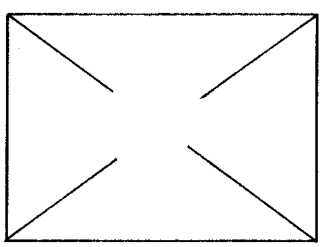
(Note: All figures are given on an as-fed basis.)

1. You want 25% protein in the ration. Your feeds are tankage -- 50.6% protein and barley-- 11.6% protein.



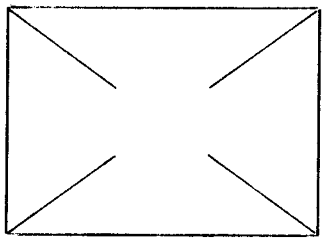
	Parts	**Percentage**
Barley	_____	_________
Tankage	_____	_________
Totals	_____	_________

2. You want 17% protein in the ration. Your feeds are milo -- 11% protein and soybean meal -- 43.8% protein.



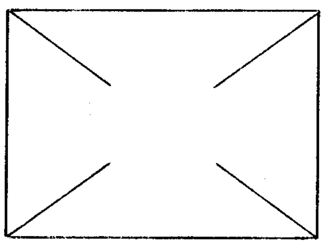
	Parts	**Percentage**
Milo	_____	_________
Soybean meal	_____	_________
Totals	_____	_________

3. You want 20% protein in the ration. Your feeds are alfalfa hay -- 16.6% protein and sunflower -- 41% protein.



	Parts	Percentage
Alfalfa hay	____	______
Sunflower	____	______
Totals	____	______

4. You want 14.2% protein in the ration. Your feeds are sweetclover hay -- 14.2% protein and sunflower -- 41% protein.



	Parts	Percentage
Sweetclover hay	____	______
Sunflower	____	______
Totals	____	______

METABOLISM OF NUTRIENTS FOR MAINTENANCE, HEALTH AND PRODUCTION

AG 532 - N

ASSIGNMENT SHEET #3--BALANCE A RATION USING THE TRIAL-AND-ERROR METHOD

Name ______________________________ Score ______________________________

Using the feeds listed, balance a ration for dry matter, protein and total digestible nutrients for a dairy cow having the nutrient requirements listed in the chart. Figure nutrient requirements on a dry matter basis and then convert them to an as-fed basis as the final step after balancing the ration. Limit silage to 5.4 lb of dry matter.

(Note: As an extra challenge, figure out how much 20-24% Ca-18% P supplement you should add to meet the calcium and phosphorus requirements.)

Requirements for a high producing 1,300 to 1,400 lb cow

Dry Matter	Crude Protein	TDN	Calcium	Phosphorus
42-45 lb	7.5-7.9 lb	30-31 lb	.28-.32 lb	.21-.22 lb

Worksheet (dry matter basis--lb)

Feeds (dry matter basis)	Dry Matter-lb	Crude Protein-lb	TDN-lb
Alfalfa 17% CP, 56% TDN			
Corn silage 8% CP, 66% TDN	5.4		
Corn 10.2% CP, 91% TDN			
Protein supplement 49% CP, 86% TDN			
Totals			

Converting to as-fed basis:

Feeds	Dry Matter Content	Pounds of feed actually needed
Alfalfa	89.2	______________
Corn silage	28	______________
Corn	89	______________
Protein supplement	90	______________

METABOLISM OF NUTRIENTS FOR MAINTENANCE, HEALTH AND PRODUCTION

AG 532 - N

ANSWERS TO ASSIGNMENT SHEETS

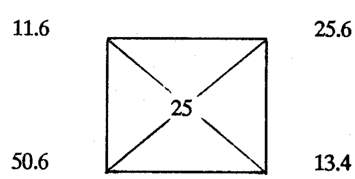
Assignment Sheet #1

Feed	Dry Matter %	Dry Matter Basis		As-Fed Basis	
		% C.P.	% TDN	% C.P.	% TDN
Beet pulp	91	10	72	9.1	65.5
Rye	89	13.4	85	11.9	75.7
Wheat	89	14.3	88	12.7	78.3
Linseed meal	91	38.8	81	35.3	73.7
Alfalfa hay	91.2	13.6	50	12.4	45.6
Alfalfa silage	35	16	57	5.6	20

Feed	Dry Matter %	Pounds of Dry Matter	Pounds of Actual Feed Needed
Corn silage	28	3	10.7
Beet molasses	77	2	2.6
Barley straw	88.2	8	9.1
Dent corn	89	13	14.6

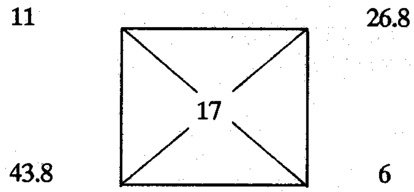
Assignment Sheet #2

1.



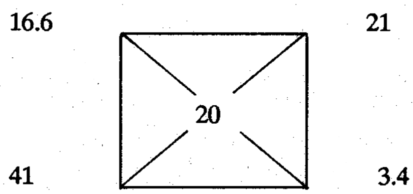
	Parts	%
Barley	25.6	65.6%
Tankage	13.4	34.4%
Totals	39.0	100%

2.



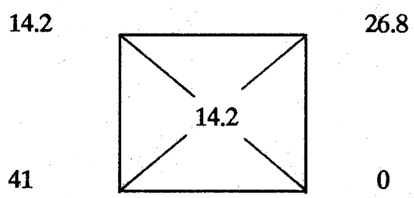
	Parts	%
Milo	26.8	81.7%
Soybean meal	6.0	18.3%
Totals	32.8	100%

3.



	Parts	%
Alfalfa hay	21.0	86.1%
Sunflower	3.4	13.9%
Totals	24.4	100%

4.



	Parts	%
Sweetclover hay	26.8	100%
Sunflower	0	0%
Totals	26.8	100%

Assignment Sheet #3--Answer should be similar to the following:

	Dry Matter-lb	Crude Protein-lb	TDN-lb
Alfalfa	16.1	2.74	9.0
Corn silage	5.4	.43	3.6
Corn	15.0	1.53	13.6
Protein supplement	5.9	2.89	5.1
Totals	42.4	7.59	31.3

As-fed Basis	Pounds of feed actually needed
Alfalfa	18.05
Corn silage	19.3
Corn	16.85
Protein supplement	6.56

Extra credit:

20-24% Ca-18% P = .47 lb

METABOLISM OF NUTRIENTS FOR MAINTENANCE, HEALTH AND PRODUCTION

AG 532 - N

UNIT TEST

Name ______________________________ Score ______________________________

1. Define terms associated with nutrient metabolism.

   a. Ration ______________________________

   ____

   b. Diet ______________________________

   ____

   c. Balanced ration ______________________________

   ____

2. Explain why a balanced ration is important in livestock feeding.

   a.______________________________

   b. ______________________________

   c.______________________________

   d. ______________________________

   e.______________________________

   f.______________________________

3. List and describe three general principles for formulating a ration.

   a.______________________________

   ____

   b. ______________________________

   ____

   c.______________________________

   ____

4. Match the most major feed grains on the right to their characteristics.

   (Note: Some grains may be used more than once.)

_____a.	Most common in western United States	1.	Rye
_____b.	Should not be over 50% of cattle rations	2.	Wheat
_____c.	Most important grain	3.	Corn
_____d.	Lower in TDN, higher in protein and bulkier than corn	4.	Oats
_____e.	Must be ground for maximum digestibility	5.	Grain sorghums
_____f.	Least palatable of all grains	6.	Barley
_____g.	Usually the most expensive grain		
_____h.	Should be limited to not over 25% of ration		

5. Name the three most common methods of preparing grains.

   a.____

   b. ____

   c.____

6. List three methods used to determine value of feed.

   a.____

   b. ____

   c.____

7. Describe the procedure for determining dry matter content of a feed.

   a.____

   ____

   b. ____

   ____

   c.____

   ____

8. List the six general principles for ration selection.

a.____

b. ____

c.____

d. ____

e.____

f.____

9. Convert values from a dry matter basis to an as-fed basis and vice versa. Convert the following values as indicated.

Sedge hay has 90% dry matter and has 50% TDN on a dry matter basis.

a. Percentage of TDN on an as-fed basis

____

Crested wheatgrass has 31% dry matter and has 7.3% protein on an as-fed basis.

b. Percentage of protein on a dry matter basis

____

Alsike clover has an 88% dry matter content. You have calculated a need for 20 lb of dry matter in the feed.

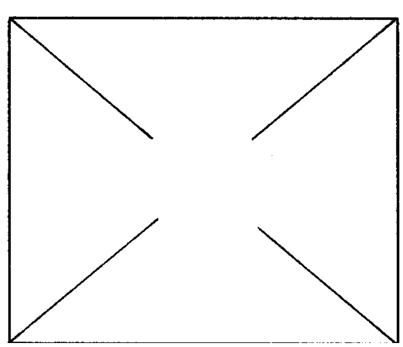
c. Pounds of clover hay needed (as-fed basis)

____

10. Balance a ration for protein using the Pearson's Square method.

Amount of protein desired in ration = 17%

Feeds available: Timothy hay -- 10% protein
Rapeseed meal -- 39%



a. Parts of Timothy hay ____________________

b. Parts of rapeseed meal ____________________

c. Total parts ____________________

d. Percentage of Timothy hay ____________________

e. Percentage of rapeseed meal ____________________

11. Describe two advantages and two limitations of using computers for ration balancing.

Advantages

a.____

b. ____

Limitations

a.____

b. ____

12. Describe how urea should be used as a protein supplement in ruminants to achieve maximum benefits, without causing harm to the animal.

a.____

b. ____

c.____

d. ____

13. Discuss the proper use of growth stimulants and the role they play in the animal's development.

a.____

b. ____

c.____

d. __________

e. __________

f. __________

g. __________

14. List the six nutrients needed by the cell protoplasm.

a. __________

b. __________

c. __________

d. __________

e. __________

f. __________

15. Discuss the functions of the cell protoplasm.

a. __________

____

b. __________

____

c. __________

____

METABOLISM OF NUTRIENTS FOR MAINTENANCE,
HEALTH AND PRODUCTION

AG 532 - N

ANSWERS TO TEST

1. a. Ration--Amount of feed given to an animal to meet its needs during a 24 hour period
   b. Diet--The ration fed to an animal without reference to a specific time period
   c. Balanced ration--A ration that provides the nutrient needs of the animal in the proper proportions

2. Maintenance; Growth; Fattening; Efficient production; Reproduction; Work

3. a. Economical: Feed is 50 - 80% total cost of livestock production; Homegrown feeds less expensive
   b. Palatability: No poisonous plants; Feeds animal will eat
   c. Nutritional requirements: Balanced diet; Balance of roughages and concentrates for species and age; Micronutrients and feed additives

4. a. 6 d. 4 g. 2
   b. 2 e. 5 h. 1
   c. 3 f. 1

5. Grinding; Rolling; Pelleting

6. Cost per unit weight; Cost per unit weight of TDN; Cost per unit weight of protein

7. Finely grind a feed sample and weigh; Dry sample in oven; Weigh sample again, divide by the first weight and multiply by 100; this answer is the percentage dry matter of the feed

8. Homegrown feeds when possible; Feed supplements; Transportation costs; Suitability of feed; Changing prices over period of time; Availability of the feed

9. a. 45% b. 23.5% c. 22.7 lb

10. a. 22 d. 76%
    b. 7 e. 24%
    c. 29

11. Answer should include at least two advantages and two limitations.

    Advantages
    Computers can balance rations with many different feeds in a very short time; Computers can include feed cost as a consideration when balancing rations with very little extra operator effort; Feed and price substitutions can be made quickly

Limitations

Computers must still be supplied with accurate feed analyses, animal nutrient requirements and limitations on amounts of certain feeds; Computer may not be able to consider other factors which could affect the particular situation

12. Supplying no more than one-third total protein requirement; Add gradually to get animals accustomed to it; Mix in thoroughly; Use less urea in low-energy rations

13. Read and follow all label directions; Obtain accurate diagnosis before using drugs to treat diseased animals; Wear recommended protective clothing, if any; Read and follow all feeding instructions; Use proper sanitation procedures and equipment when administering drugs; Store drugs in original containers; properly dispose of any unlabeled containers; Keep all drugs away from children and animals

14. Carbohydrates; Lipids; Proteins; Vitamins; Minerals; Water

15. Provide materials for cell growth and maintenance; Provide materials to regulate essential chemical reactions; Provide materials to break down for energy release

ENVIRONMENT AND NUTRITION

AG 532 - O

UNIT OBJECTIVE

After completion of this unit, students should be able to define terms related to environment and nutrition and describe how animals maintain body heat balance. Students should also be able to describe the effect of temperature on feed efficiency and explain beneficial diet adjustments to high and low temperatures. This knowledge will be demonstrated by completing 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 the term effective ambient temperature.
2. Describe how animals maintain body heat balance.
3. Define the term thermoneutral zone.
4. Define the terms upper critical temperature and lower critical temperature and discuss their significance for livestock producers.
5. Explain why large ruminants have lower critical temperatures than other farm animals.
6. Explain how animals generally react when they pass the upper critical temperature.
7. Discuss the effects of temperature on forage quality and intake.
8. List the three major sources of water for livestock.
9. List three major ways livestock lose water.
10. Describe the effect temperature has on feed efficiency.
11. Explain why the efficiency of egg production increases during periods of high temperature.
12. Explain what adjustments in diet may be beneficial when temperatures are above or below the thermoneutral zone.

ENVIRONMENT AND NUTRITION

AG 532 - O

SUGGESTED ACTIVITIES

I. Suggested activities for the 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--Factors Affecting Critical Temperatures

      2. TM 2--Livestock Water Sources

      3. TM 3--Body Water Losses

   E. Test

   F. Answers to test

III. Unit references

   A. Barrick, Kirby R., Harmon, Hobart L. *Animal Production and Management*. McGraw-Hill Book Company, New York, 1988.

   B. Bundy, Clarence E., Diggins, Ronald V., Christensen, Virgil W. *Livestock and Poultry Production,* 5th edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1982.

   C. Gillespie, James R. *Animal Nutrition and Feeding*. Delmar Publishers, Inc., Albany, New York, 1987.

ENVIRONMENT AND NUTRITION

AG 532 - O

INFORMATION SHEET

I. Effective ambient temperature (EAT)--The combined effects of air temperature, humidity, precipitation, wind and heat radiation affecting efficiency of energy use by farm animals

II. Animals attempt to maintain body heat balance

- A. Feed intake
- B. Metabolism
- C. Heat dissipation

III. Thermoneutral zone

- A. The range of effective ambient temperatures in which an animal does not have to increase normal metabolic heat production to offset heat loss to the environment
  1. Range that animal is most comfortable
  2. Greatest feed efficiency
  3. No temperature stress
- B. Varies with livestock species
- C. Can shift

IV. Critical temperatures

- A. Lower critical temperature
  1. Temperatures below the thermoneutral zone at which animals show symptoms of cold stress
  2. Large ruminants have lower critical temperatures
     - a. Produce a lot of metabolic heat
     - b. Small surface area relative to total body mass
     - c. Large amount insulative tissue

B. Upper critical temperature

1. Temperatures above the thermoneutral zone at which animals show symptoms of heat stress

2. Animals respond by reducing feed intake to lower rate of metabolic heat production

C. Factors affecting critical temperatures (Transparency 1)

1. Housing conditions

2. Age

3. Breed

4. Stage of lactation

5. Nutrition level

6. Time after feeding

7. Time exposed to temperature change

8. Number of animals in herd

9. Hair or wool thickness

V. Temperature effects on forage quality and intake

A. Quality

1. Higher temperature

a. Mature faster

b. Higher cell wall content

2. Higher cell wall content reduces quality and digestibility

B. Intake

1. Temperature

a. Feed intake generally increases with decreased temperatures

b. Feed intake generally decreases with increased temperatures

2. Feed intake lowers with reduced digestibility

VI. Livestock water sources (Transparency 2)

A. Drinking water

B. Metabolic breakdown of carbohydrates, fats and proteins from feed

C. Feed

VII. Body water losses (Transparency 3)

A. Urine

B. Feces

C. Sweat

D. Lungs

E. Milk production

F. Egg production

VIII. Temperature and feed efficiency

A. Both upper and lower critical temperatures reduce feed efficiency relative to growth and fattening

B. Temperature affects rates of feed intake and maintenance energy requirements

IX. Increased egg production from increased temperatures

A. Layers utilize body tissue to produce eggs during periods of reduced feed intake caused by higher temperatures

B. Increased use of body fat as an energy source (as opposed to utilization of energy from the diet)

X. Diet adjustments for critical temperatures

A. Lower critical temperatures

1. Lactating dairy cows--Provide more concentrate in ration

2. Beef cattle--Increase roughage in restricted diets

3. Sheep--Increase roughage (higher energy)

4. Swine--Additional feed

5. Poultry--Increase feed

B. Upper critical temperatures

1. Lactating dairy cows--Provide more concentrate in ration

2. Beef cattle--High fiber diet; decrease of maintenance energy requirements for TDN

3. Sheep--Feed less roughage, add dry pulp and increase amount of fat

4. Swine--Add fat to diet, increase percent protein

5. Poultry--Increase crude protein by 25%

FACTORS AFFECTING CRITICAL TEMPERATURES

* **Housing conditions**
* **Age**
* **Breed**
* **Stage of lactation**
* **Nutrition level**
* **Time after feeding**
* **Time exposed to temperature change**
* **Number of animals in herd**
* **Hair or wool thickness**

LIVESTOCK WATER SOURCES

- **Drinking water**
- **Metabolic breakdown from feed**
  - **Carbohydrates**
  - **Fats**
  - **Proteins**
- **Feed**

BODY WATER LOSSES

Urine

Feces

Sweat

Lungs

Milk Production

Egg Production

ENVIRONMENT AND NUTRITION

AG 532 - O

UNIT TEST

Name ________________________ Score ________________________

1. Define the term effective ambient temperature.

____

____

____

____

2. Describe how animals maintain body heat balance.

a. ____

b. ____

c. ____

3. Define the term thermoneutral zone.

____

____

____

____

4. Define the terms upper critical temperature and lower critical temperature.

a. Upper critical temperature ____

____

____

____

b. Lower critical temperature ____

____

____

____

5. Explain why large ruminants have lower critical temperatures than other farm animals.

   a.____

   b. ____

   c.____

6. Explain how animals generally react when they pass the upper critical temperature.

7. Discuss the effects of temperature on forage quality and intake.

8. List the three major sources of water for livestock.

   a.____

   b. ____

   c.____

9. List three major ways livestock lose water.

   a.____

   b. ____

   c.____

10. Describe the effect temperature has on feed efficiency.

   a.____

   b. ____

11. Explain why the efficiency of egg production increases during periods of high temperature.

   a.____

b. ____

____

12. Explain what adjustments in diet may be beneficial when temperatures are above or below the thermoneutral zone.

Lower critical temperature

a. Lactating dairy cows ____

____

b. Beef cattle ____

____

c. Sheep ____

____

d. Swine ____

____

e. Poultry ____

____

Upper critical temperature

a. Lactating dairy cows ____

____

b. Beef cattle ____

____

c. Sheep ____

____

d. Swine ____

____

e. Poultry ____

____

ENVIRONMENT AND NUTRITION

AG 532 - O

ANSWERS TO TEST

1. The combined effects of air temperature, humidity, precipitation, wind and heat radiation affecting efficiency of energy use by farm animals

2. Feed intake; Metabolism; Heat dissipation

3. The range of effective ambient temperatures in which an animal does not have to increase normal metabolic heat production to offset heat loss to the environment (Range that animal is most comfortable; Greatest feed efficiency; No temperature stress)

4. a. Upper critical temperature: Temperatures above the thermoneutral zone at which animals show symptoms of heat stress

   b. Lower critical temperature: Temperatures below the thermoneutral zone at which animals show symptoms of cold stress

5. Produce a lot of metabolic heat; Small surface area relative to total body mass; Large amount insulative tissue

6. Animals respond by reducing feed intake to lower rate of metabolic heat production

7. a. Quality: Higher temperature; Mature faster; Higher cell wall content; Higher cell wall content reduces quality and digestibility

   b. Intake: Feed intake generally increases with decreased temperatures; Feed intake generally decreases with increased temperatures; Feed intake lowers with reduced digestibility

8. Drinking water; Metabolic breakdown of carbohydrates, fats and proteins from feed; Feed

9. Answer should include three of the following:

   Urine; Feces; Sweat; Lungs; Milk production; Egg production

10. Both upper and lower critical temperatures reduce feed efficiency relative to growth and fattening; Temperature affects rates of feed intake and maintenance energy requirements

11. Layers utilize body tissue to produce eggs during periods of reduced feed intake caused by higher temperatures; Increased use of body fat as an energy source (as opposed to utilization of energy from the diet)

12. <u>Lower critical temperature</u>

   a. Lactating dairy cows--Provide more concentrate in ration
   b. Beef cattle--Increase roughage in restricted diets
   c. Sheep--Increase roughage (higher energy)
   d. Swine--Additional feed
   e. Poultry--Increase feed

<u>Upper critical temperature</u>

a. Lactating dairy cows--Provide more concentrate in ration
b. Beef cattle--High fiber diet; decrease of maintenance energy requirements for TDN
c. Sheep--Feed less roughage, add dry pulp and increase amount of fat
d. Swine--Add fat to diet, increase percent protein
e. Poultry--Increase crude protein by 25%

RELATIONSHIP BETWEEN NUTRITION AND ANIMAL PRODUCTS

AG 532 - P

UNIT OBJECTIVE

After completion of this unit, students should be able to describe the importance of proper nutrition for milk production and for the composition of milk. Students should also be able to discuss sources of animal protein and list animal sources for various vitamins. 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. Explain the importance of proper nutrition in the laying hen as related to egg shell quality and yolk composition.
2. Describe the importance of proper nutrition for milk production.
3. Describe the importance of proper nutrition on the composition of milk.
4. Explain the effects of feed odors on animal product quality.
5. List the components and their percentages of lean muscle.
6. List seven factors that describe the value of animal fat in the human diet.
7. Distinguish between saturated and unsaturated fats.
8. List three animal products that are good sources of both calcium and phosphorus.
9. Discuss sources of animal protein, quality determination and why they are better than plant proteins.
10. List two animal products low in carbohydrates and two high in carbohydrates, and which contain lactose.
11. Indicate the only natural source for vitamin B_{12}.
12. List four animal product sources of vitamin A.
13. List three animal product sources of vitamin B.
14. List the animal product that is a good natural source for vitamin D.
15. Complete a chart to compare the nutritive content of beef sirloin steak and chicken breast in protein content, saturated fat, unsaturated fat, cholesterol and calories.
16. Discuss animal products in the American diet.

RELATIONSHIP BETWEEN NUTRITION AND ANIMAL PRODUCTS

AG 532 - 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. Invite a nutritionist in to talk about the value of animal products in the American diet.

   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--Lean Muscle

      2. TM 2--Value of Animal Fats in the Human Diet

      3. TM 3--Comparing Nutritive Content of Beef Sirloin Steak and Chicken Breast

      4. TM 4--Animal Products in the American Diet

   E. Test

   F. Answers to test

III. Unit references

   A. Campbell, John R. and Lasley, John F., *The Science of Animals That Serve Mankind*. McGraw-Hill Book Company, New York, 1975.

   B. Romans, John R.; Jones, Kevin W.; Costello, William J.; Carlson, C. Wendell; and Ziegler, P. Thomas., *The Meat We Eat*, 12th Edition, Interstate Printers and Publishers, Inc., Danville, Illinois, 1975.

RELATIONSHIP BETWEEN NUTRITION AND ANIMAL PRODUCTS

AG 532 - P

INFORMATION SHEET

I. Effects of nutrition in egg production

   A. Sufficient quantities of proteins and lipids needed for yolk formation

   B. Sufficient calcium and phosphorus needed for egg shell quality

II. Nutrition and milk production

   A. Nutrient requirements must be met for high production

      1. Energy nutrients (60-70%)

      2. Crude protein (12-22%)

      3. Supplements (salt, calcium and phosphorus)

   B. Feed quantity should match each cow's level of production and stage of lactation

III. Nutrition and milk composition

   A. Cows on high concentrate and low forage rations often secrete milk with low fat content

   B. In the ruminant, acetate is the principle precursor of milk fatty acids and the high concentrate/low forage ration results in reduced production of acetate in the rumen

IV. Feed odors and animal product quality--Odors from feed consumed by the cow will be carried into her milk

   Example: If a cow eats wild onions in the pasture, her milk will be onion flavored

V. Components and percentages of lean muscle (Transparency 1)

A.	Protein	20%
B.	Water	72%
C.	Fat	7%
D.	Ash	1%

VI. Value of animal fats in the human diet (Transparency 2)

A. Highly digestible

B. Supply energy

C. Supply needed fatty acids

D. Carry the fat soluble vitamins

E. Protection and insulation for the human body

F. Adds palatability to the lean in meat (generates flavor and aroma)

G. Aids in calcium digestion

VII. Saturated fats and unsaturated fats

(Note: The chemical difference lies in the existence of double bonds between the carbon atoms in the fatty acids.)

A. Saturated fats

1. Carbon valance satisfied with hydrogen

2. Higher melting points

3. Hard

B. Unsaturated fats

1. Lacks a hydrogen to satisfy the carbon valance

2. Soft and oily

3. Lower melting points

4. Considered "better" in human diet (cholesterol)

VIII. Animal product sources of calcium and phosphorus

A. Calcium--Milk is the best

B. Phosphorus

1. Dairy products

2. Beef

3. Chicken

4. Lamb

5. Liver

6. Pork
7. Turkey

C. Calcium and phosphorus
1. Milk
2. Milk products
3. Fish

IX. Animal proteins

A. Excellent sources
1. Meat
2. Milk
3. Eggs

B. Quality determined by ability to support growth and maintenance

C. Superior to plant proteins--better balanced in essential amino acids

X. Carbohydrates in animal products

A. Poor sources
1. Meat
2. Eggs

B. Excellent sources
1. Honey--Contains more carbohydrates than any other animal product
2. Milk--Only substance in nature that contains the sugar lactose (37% in cow's milk)

XI. Vitamins supplied by animal products

A. Vitamin A
1. Cheese
2. Eggs
3. Milk
4. Some organ meats

B. B vitamins--meat

1. B_1--eggs, milk

2. B_2--eggs, milk

3. Animal products are the only natural source for vitamin B_{12}

C. Vitamin D--eggs (other products are fortified)

Example: Milk

XII. Nutritive content of meat (per 100 grams) (Transparency 3)

Meat	Protein	Saturated Fat	Unsaturated Fat	Cholesterol	Calories
Ground beef (10% fat)	27.2 g	7.1 g	17.3 g	94 mg	272
Beef sirloin steak	26.8 g	8.4 g	20.2 g	87 mg	297
Chicken breast	29.8 g	2.2 g	7.8 g	84 mg	197
Broiler drumstick	25.3 g	2.9 g	10.6 g	83 mg	195
Roasted duck	19.0 g	9.7 g	28.4 g	84 mg	337
Leg of lamb	26 g	6.6 g	15 g	92 mg	244
Lamb loin chop	27 g	9.1 g	20 g	97 mg	215
Pork ham	28.3 g	3.8 g	11.0 g	94 mg	220
Bacon (3 slices)	30.5 g	17.4 g	49.2 g	85 mg	576
Pork sausage	19.7 g	10.9 g	31.1 g	83 mg	369
Turkey	28.1 g	2.8 g	9.7 g	82 mg	208
Veal cutlet	27.1 g	4.8 g	11.1 g	101 mg	216

XIII. Animal products in the American diet (Transparency 4)

A. Provide 75% dietary protein, calcium, phosphorus and riboflavin

B. Provide 50% fat and niacin

C. Provide 40% iron, vitamin A and riboflavin

D. Provide 7% dietary carbohydrates

E. Provide 33% food energy

LEAN MUSCLE

20 % Protein

72 % Water

7 % Fat

1 % Ash

VALUE OF ANIMAL FATS IN THE HUMAN DIET

Highly digestible

Energy supply

Fatty acids supply

Carry fat soluble vitamins

Body protection and insulation

Palatability

Calcium digestion

COMPARING NUTRITIVE CONTENT OF BEEF SIRLOIN STEAK AND CHICKEN BREAST

	Beef Sirloin Steak	Chicken Breast
Protein	26.8g	29.8g
Saturated fat	8.4g	2.2g
Unsaturated fat	20.2g	7.8g
Cholesterol	87.0mg	84.0mg
Calories	297.0	197.0

ANIMAL PRODUCTS IN THE AMERICAN DIET

PROVIDE:

75 %........................ Protein

Calcium

Phosphorus

Riboflavin

50 %........................ Fat

Niacin

40 %........................ Iron

Vitamin A

Riboflavin

7 %........................ Carbohydrates

33%........................ Food energy

RELATIONSHIP BETWEEN NUTRITION AND ANIMAL PRODUCTS

AG 532 - P

UNIT TEST

Name ______________________ Score ______________________

1. Explain the importance of proper nutrition in the laying hen as related to egg shell quality and yolk composition.

   a.____

   ____

   b. ____

   ____

2. Describe the importance of proper nutrition for milk production.

   ____

   ____

   ____

   ____

3. Describe the importance of proper nutrition on the composition of milk.

   ____

   ____

   ____

   ____

4. Explain the effects of feed odors on animal product quality.

   ____

   ____

5. List the components and their percentages of lean muscle.

   a.______________________________

   b. ______________________________

   c.______________________________

   d. ______________________________

6. List seven factors that describe the value of animal fat in the human diet.

   a.______________________________

   b. ______________________________

   c.______________________________

   d. ______________________________

   e.______________________________

   f.______________________________

   g. ______________________________

7. Distinguish between saturated and unsaturated fats by placing an "S" by the saturated fats and a "U" by the unsaturated fats.

   _____a. Soft and oily

   _____b. Higher melting points

   _____c. Considered "better" in human diet

   _____d. Lacks a hydrogen to satisfy the carbon valance

   _____e. Carbon valance satisfied with hydrogen

   _____f. Hard

   _____g. Lower melting points

8. List three animal products that are good sources of both calcium and phosphorus.

   a.______________________________

   b. ______________________________

   c.______________________________

9. List three sources of animal protein, and discuss quality determination and why they are better than plant proteins.

   a.____

   b. _______________________________________

   c.____

10. List two animal products low in carbohydrates and two high in carbohydrates. Identify which is the only substance in nature that contains the sugar lactose.

    Low in carbohydrates: ______________________________

    High in carbohydrates: _____________________________

    Source of lactose: ________________________________

11. List the only natural source for vitamin B_{12}.

12. List four animal product sources of vitamin A.

    a.____

    b. _______________________________________

    c.____

    d. _______________________________________

13. List three animal product sources of vitamin B.

    a.____

    b. _______________________________________

    c.____

14. List the animal product that is a good natural source for vitamin D.

15. Complete the following chart to compare the nutritive content of 100 grams of beef sirloin steak and 100 grams chicken breast in protein content, saturated fat, unsaturated fat, cholesterol and calories. Write the correct values in the blanks.

	Beef Sirloin Steak	Chicken Breast
Protein	26.8 g	________
Saturated fat	________	________
Unsaturated fat	________	7.8 g
Cholesterol	87 mg	________
Calories	________	________

16. Discuss animal products in the American diet.

____

____

____

____

____

RELATIONSHIP BETWEEN NUTRITION AND ANIMAL PRODUCTS

AG 532 - P

ANSWERS TO TEST

1. Sufficient quantities of proteins and lipids needed for yolk formation; Sufficient calcium and phosphorus needed for egg shell quality

2. Answer should include the following information:

   a. Nutrient requirements must be met for high production: Energy nutrients (60-70%); Crude protein (12-22%); Supplements (salt, calcium and phosphorus)
   b. Feed quantity should match each cow's level of production and stage of lactation

3. Cows on high concentrate and low forage rations often secrete milk with low fat content; In the ruminant, acetate is the principle precursor of milk fatty acids and the high concentrate/low forage ration results in reduced production of acetate in the rumen

4. Odors from feed consumed by the cow will be carried into her milk

5. a. Protein--20%
   b. Water--72%
   c. Fat--7%
   d. Ash--1%

6. Highly digestible; Supply energy; Supply needed fatty acids; Carry the fat soluble vitamins; protection and insulation for the human body; Adds palatability to the lean in meat; Aids in calcium digestion

7.

a. U	e. S
b. S	f. S
c. U	g. U
d. U	

8. Milk; Milk products; Fish

9. Sources: Meat; Milk; Eggs; Quality determined by ability to support growth and maintenance; Superior to plant proteins--Better balanced in essential amino acids

10. Low in carbohydrates: Meat; Eggs
    High in carbohydrates: Honey; Milk
    Sources of lactose: Milk

11. Animal products

12. Cheese; Eggs; Milk; Some organ meats

13. Meat; Eggs; Milk

14. Eggs

15.

	Beef Sirloin Steak	Chicken Breast
Protein	26.8 g	29.8 g
Saturated fat	8.4 g	2.2 g
Unsaturated fat	20.2 g	7.8 g
Cholesterol	87 mg	84 g
Calories	297	197

16. Answer should include the following information:

    Provide 75% dietary protein, calcium, phosphorus and riboflavin; Provide 50% fat and niacin; Provide 40% iron, vitamin A and riboflavin; Provide 7% dietary carbohydrates; Provide 33% food energy

RELATIONSHIP BETWEEN NUTRITION AND REPRODUCTION

AG 532 - Q

UNIT OBJECTIVE

After completion of this unit, students should be able to discuss flushing and describe the relationship of reproductive problems and overfeeding or underfeeding. Students should also be able to discuss lactating dairy cows and describe the nutrient requirements associated with lactation. 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 three reproductive benefits which are derived from flushing.
2. Describe the rations needed for swine and sheep to derive the benefits of flushing.
3. List eight reproductive problems encountered from deficient nutritional levels.
4. List three reproductive problems that result from overfeeding.
5. List two reproductive problems caused by a sodium deficiency.
6. List four reproductive problems caused by a manganese deficiency.
7. List two reproductive problems caused by a copper deficiency.
8. List two reproductive problems caused by a selenium deficiency.
9. List the reproductive problem caused by a cobalt deficiency.
10. List the reproductive problem caused by an iron deficiency.
11. Describe how the nutrient levels required for reproduction change as each animal species proceeds through pregnancy.
12. Describe the differences in nutrient requirements between growing and mature animals as related to reproductive efficiency.
13. Indicate the most critical nutrient for lactating animals.
14. Indicate the minimum level of fiber needed in the ration of lactating dairy cows and why it is needed.
15. Describe how proper nutrition during pregnancy will prevent postpartum diseases and ailments in the offspring.
16. Describe the role of antibiotics in animal rations during gestation.
17. Describe how sires (boars, bulls and rams) should be fed for best reproductive performance.

18. Describe all the nutrient requirements associated with lactation.

19. Describe the importance of the calcium-phosphorus ratio to reproductive performance.

20. List the recommended protein and energy requirements for pullets and hens of the egg laying species.

RELATIONSHIP BETWEEN NUTRITION AND REPRODUCTION

AG 532 - Q

SUGGESTED ACTIVITIES

I. Suggested activities for the instructor

   A. Make 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 sheets

   D. Test

   E. Answers to test

III. Unit references

   A. Barrick, Kirby R., Harmon, Hobart L. *Animal Production and Management*. McGraw-Hill Book Company, New York, 1988.

   B. Bundy, Clarence E., Diggins, Ronald V., Christensen, Virgil W. *Livestock and Poultry Production,* 5th edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1982.

   C. Gillespie, James R. *Animal Nutrition and Feeding*. Delmar Publishers, Inc., Albany, New York, 1987.

RELATIONSHIPS BETWEEN NUTRITION AND REPRODUCTION

AG 532 - Q

INFORMATION SHEET

I. Flushing

   A. Reproductive benefits

      1. Increases number of young born by increasing ovulation

      2. Helps bring females into heat about the same time

      3. Increases chance of conception

   B. Rations

      1. Swine

         a. Well-balanced, plenty of proteins, minerals, vitamins and forages

         b. 12 - 14% protein

         c. Gilts--2 - 2 1/2 lb feed per 100 lb of live weight

         d. Sows--1 1/2 lb feed per 100 lb of live weight

      2. Sheep

         a. Move to abundant pasture; or

         b. Full feed of good quality legume hay; or

         c. 1/2 - 3/4 lb corn, barley, oats or sorghum grain

II. Reproductive problems

   A. Deficient nutritional levels

      1. Delayed puberty

      2. Abortion

      3. Retained placenta

      4. Infertility/sterility

      5. Silent heat (protein deficiency)

      6. Irregular heat cycles (phosphorus deficiency)

      7. Reduced sperm production

8. Reduced sperm quality

B. Overfeeding

1. Infertility/sterility

2. Birthing problems

3. Reduced sperm production

III. Mineral deficiencies cause reproduction problems

A. Sodium

1. Infertile males

2. Delayed sexual maturity in females

B. Manganese

1. Sterility

2. Delayed estrus

3. Reduced ovulation

4. Abortion

5. Deformed young

6. Young born weak or dead

C. Copper

1. Abortion

2. Young born weak

D. Selenium

1. Retained placenta

2. Low fertility

E. Cobalt--Decreased fertility

F. Iron--Young born weak or dead

IV. Nutritional requirement changes during gestation

- A. Beef and dairy cattle
  - 1. Maintenance ration at beginning of gestation
  - 2. Increase amount of feed and nutrients during last trimester
    - a. 2/3 fetal growth takes place
    - b. Feed for 1/2 - 1 lb/day average daily gain
- B. Sheep
  - 1. Maintenance ration in early gestation
  - 2. 1/2 - 1 1/2 lb/day gain during last 4 weeks
- C. Swine
  - 1. First 75 days gestation--2 1/2 - 3 1/2 lb/day of 12 - 14% protein ration
  - 2. Last 35 - 40 days gestation--increase to 5 - 6 lb/day

V. Young, growing, breeding animals require higher nutrient levels than mature breeding animals because they need the nutrients to continue their growth to maturity as well as to support growth of the fetus

VI. Energy nutrients are the most critical for lactating cows

VII. Fiber for lactating dairy cows

- A. Necessary to maintain milkfat percentage in milk
- B. Ration should provide a minimum of 15% crude fiber

VIII. Proper nutrition during pregnancy reduces postpartum diseases and offspring sickness because:

- A. Mother is in better condition, healthier
- B. Offspring are larger, healthier

IX. Antibiotics fed during gestation

- A. Increases number of pigs born alive
- B. Reduces lamb mortality

X. Feeding sires for reproductive performance

- A. Boars
  1. Overweight decreases sex drive
  2. 4 - 5 lb/day balanced ration
- B. Bulls
  1. Feed just enough to keep in healthy, vigorous condition
  2. Yearlings--1 1/2 lb grain/day to breed 10 - 15 cows
  3. Two year olds--3/4 lb grain/day
  4. Mature--Feed same as cows if in good condition; 5 - 6 lb grain a day if thin
- C. Rams
  1. Too thin
     - a. Lack strength
     - b. Add 1 - 1 1/2 lb grain mix
  2. Too fat--Lack vigor
  3. Winter--3 1/2 - 5 lb hay; 1 1/2 lb concentrate daily

XI. Lactation nutrient requirements

- A. 60 - 70% total digestible nutrients
- B. 15% crude fiber
- C. 12 - 22% crude protein
- D. Concentrate mix
  1. 1/2 - 1% mineralized salt
  2. 1 - 2% calcium-phosphorus supplement

XII. The calcium-phosphorus ratio is important for proper utilization of phosphorus and manganese, which affect reproductive performance

XIII. Poultry protein and energy requirements

A. Laying hens

1. 15% protein supplement

2. 65% energy producing feeds (corn, oats, barley, wheat, etc.)

B. Pullets

1. First 6 weeks--18-20% protein

2. 6-14 weeks--14-16% crude protein

3. 14-20 weeks--12-14% crude protein with energy level (ME) of 1200-1400 Kcal/lb

RELATIONSHIP BETWEEN NUTRITION AND REPRODUCTION

AG 532 - Q

UNIT TEST

Name ______________________________ Score ______________________________

1. List three reproductive benefits which are derived from flushing.

   a.______________________________

   b. ______________________________

   c.______________________________

2. Describe the rations needed for swine and sheep to derive the benefits of flushing.

   Swine

   a.______________________________

   b. ______________________________

   c.______________________________

   Sheep

   a.______________________________

   b. ______________________________

   c.______________________________

3. List eight reproductive problems encountered from deficient nutritional levels.

   a.______________________________

   b. ______________________________

   c.______________________________

   d. ______________________________

   e.______________________________

   f.______________________________

g. ______________________________

h. ______________________________

4. List three reproductive problems that result from overfeeding.

a.______________________________

b. ______________________________

c.______________________________

5. List two reproductive problems caused by a sodium deficiency.

a.______________________________

b. ______________________________

6. List four reproductive problems caused by a manganese deficiency.

a.______________________________

b. ______________________________

c.______________________________

7. List two reproductive problems caused by a copper deficiency.

a.______________________________

b. ______________________________

8. List two reproductive problems caused by a selenium deficiency.

a.______________________________

b. ______________________________

c.______________________________

9. List the reproductive problem caused by a cobalt deficiency.

____

10. List the reproductive problem caused by an iron deficiency.

____

11. Describe how the nutrient levels required for reproduction change as each animal species proceeds through pregnancy.

Beef and dairy cattle

a.____

b. ____

Sheep

a.____

b. ____

Swine

a.____

b. ____

12. Describe the differences in nutrient requirements between growing and mature animals as related to reproductive efficiency.

____

____

____

____

13. Indicate the most critical nutrient for lactating animals.

____

14. Indicate the minimum level of fiber needed in the ration of lactating dairy cows and why it is needed.

____

____

15. Describe how proper nutrition during pregnancy will prevent postpartum diseases and ailments in the offspring.

a.____

b. ____

16. Describe the role of antibiotics in animal rations during gestation.

    a.____

    b. ____

17. Describe how sires (boars, bulls and rams) should be fed for best reproductive performance.

    a. Boars____________________________________

    b. Bulls ____________________________________

    c. Rams____________________________________

18. Describe all the nutrient requirements associated with lactation.

    a.____

    b. ____

    c.____

    d. ____

19. Describe the importance of the calcium-phosphorus ratio to reproductive performance.

20. List the recommended protein and energy requirements for pullets and hens of the egg laying species.

    <u>Laying hens</u>

    a.____

    b. ____

Pullets

a.____

b. ____

c.____

RELATIONSHIP BETWEEN NUTRITION AND REPRODUCTION

AG 532 - Q

ANSWERS TO TEST

1. Increases number of young born by increasing ovulation; Helps bring females into heat about the same time; Increases chance of conception

2. Swine: Well-balanced, plenty of proteins, minerals, vitamins and forages; 12 - 14% protein; Gilts--2 - 2 1/2 lb feed per 100 lb of live weight; Sows--1 1/2 lb feed per 100 lb of live weight

   Sheep: Move to abundant pasture; Full feed of good quality legume hay; 1/2 - 3/4 lb corn, barley, oats, or sorghum grain

3. Delayed puberty; Abortion; Retained placenta; Infertility/sterility; Silent heat (protein deficiency); Irregular heat cycles (phosphorus deficiency); Reduced sperm production; Reduced sperm quality

4. Infertility/sterility; Birthing problems; Reduced sperm production

5. Infertile males; Delayed sexual maturity in females

6. Answer should include four of the following:

   Sterility; Delayed estrus; Reduced ovulation; Abortion; Deformed young; Young born weak or dead

7. Abortion; Young born weak

8. Retained placenta; Low fertility

9. Decreased fertility

10. Young born weak or dead

11. a. Beef and dairy cattle: Maintenance ration at beginning of gestation; Increase amount of feed and nutrients during last trimester; 2/3 fetal growth takes place; Feed for 1/2 - 1 lb/day average daily gain

    b. Sheep: Maintenance ration in early gestation; 1/2 - 1 1/2 lb/day gain during last 4 weeks

    c. Swine: First 75 days gestation--2 1/2 - 3 1/2 lb/day of 12 - 14% protein ration; Last 35 - 40 days gestation--Increase to 5 - 6 lb/day

12. Young, growing, breeding animals require higher nutrient levels than mature breeding animals because they need the nutrients to continue their growth to maturity as well as to support growth of the fetus

13. Energy nutrients

14. Necessary to maintain milkfat percentage in milk; Ration should provide a minimum of 15% crude fiber

15. Mother is in better condition, healthier; Offspring are larger, healthier

16. Increases number of pigs born alive; Reduces lamb mortality

17. a. Boars: Overweight decreases sex drive; 4 - 5 lb/day balanced ration

    b. Bulls: Feed just enough to keep in healthy, vigorous condition; Yearlings--1 1/2 lb grain/day to breed 10 - 15 cows; Two year olds--3/4 lb grain/day; Mature--Feed same as cows if in good condition; 5 - 6 lb grain a day if thin

    c. Rams: Too thin--Lack strength; Add 1 - 1 1/2 lb grain mix; Too fat--Lack vigor; Winter--3 1/2 - 5 lb hay; 1 1/2 lb concentrate daily

18. 60 - 70% total digestible nutrients; 15% crude fiber; 12 - 22% crude protein; Concentrate mix: 1/2 - 1% mineralized salt; 1 - 2% calcium-phosphorus supplement

19. The calcium-phosphorus ratio is important for proper utilization of phosphorus and manganese, which affect reproductive performance

20. Laying hens: 15% protein supplement; 65% energy producing feeds (corn, oats, barley, wheat, etc.)

    Pullets: First 6 weeks--18-20% protein; 6-14 weeks--14-16% crude protein; 14-20 weeks--12-14% crude protein with energy level (ME) of 1200-1400 Kcal/lb

AG. 532 ZOOLOGY / SCIENCE OF ANIMAL NUTRITION

R. Scientific Method Term Project

Based on: Idaho Science Content Guide and Framework. Grades 9 - 12.
Standard II. Science Themes. Goal C. Models, Scale, and Structure.

Goal. Understand and be able to use a chart-model to explain animal needs according to breed for successful stock production.

Performance Objectives. All students will:

- Create a model to assist in the determination of watering, feeding, and housing a breed given a set of actual requirements based on breed type.
- Apply the model to real circumstances.

Progress Indicators. All students will:

- Determine a type of model (i.e., mechanical or computer-generated) to create which would assist a breeder in the management of livestock for production.
- Create a model featuring one livestock type and several common breeds showing their requirements for watering, feeding and housing according to the breed selected.
- Make the model easily understood and simple to use.
- Document the scientific methods of the project:

  - ♦ **State the Problem.** Write a statement describing the project and its purpose.
  - ♦ **Gather Information.** Research the livestock type chosen, the various breeds, and their watering, feeding and housing requirements. Document the literature or other sources used to make these determinations.
  - ♦ **Form an Hypothesis.** Write a statement which states how the model could be applied in real circumstances; i.e. what problems the model might solve.
  - ♦ **Collect Data through Experimentation.**

    - ◊ Choose a model type and develop the model.
    - ◊ Test the model on at least three people to determine the model's understandability and simplicity of use.
    - ◊ Record the responses of the test group.

  - ♦ **Analyze Data and Form a Conclusion.** Determine if the model needs revision according to the test group's responses and adjust accordingly. The model should reflect the original purpose as stated in the problem statement and the application as stated in the form of an hypothesis.
  - ♦ **Report Results.** Present the entire project methodology including the test group results and the model in usable form in the form of a poster presentation (a short

interactive presentation displaying the steps of the research and the results, allowing a hands-on demonstration of the model's application).

SCIENTIFIC METHOD MATRIX

AG. 532 ZOOLOGY / SCIENCE OF ANIMAL NUTRITION

ACTIVITIES MEETING GOALS PER STANDARD

IDAHO K-12 SCIENCE CONTENT GUIDE AND FRAMEWORK

Standard I. Habits of the Mind	Goal A. Science Processes
Digestion in Animals	
Digestive Systems in Swine	X
Nutrient Quality and Analysis	
Convert Values from a Dry Matter Basis to an As-fed Basis and Vice Versa	X
Metabolism of Nutrients for Maintenance, Health and Production	
Convert Values from a Dry Matter Basis to an As-fed Basis and Vice Versa	X
Balance a Ration for Protein Using the Pearson's Square Method	X
Balance a Ration Using the Trial-and-Error Method	X
Standard I. Habits of the Mind	**Goal B. Values**
Vitamins, Feed Additives and Water	
Compile Information on Livestock Nutrient Deficiencies in the Local Area	X

AGRICULTURAL SCIENCE AND TECHNOLOGY CURRICULUM
SCIENTIFIC METHOD MATRIX

AG. 532 ZOOLOGY / SCIENCE OF ANIMAL NUTRITION

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
Digestion in Animals							
Digestive Systems in Swine	X						
Vitamins, Feed Additives and Water							
Compile Information on Livestock Nutrient Deficiencies in the Local Area		X					
Nutrient Quality and Analysis							
Convert Values from a Dry Matter Basis to an As-fed Basis and Vice Versa	X						
Metabolism of Nutrients for Maintenance, Health and Production							
Convert Values from a Dry Matter Basis to an As-fed Basis and Vice Versa	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
Metabolism of Nutrients for Maintenance, Health and Production							
Balance a Ration for Protein using the Pearson's Square Method	X						
Balance a Ration Using the Trial-and-Error Method	X						