UNIT I - NUTRITION

Lesson 1: Importance of Animal Nutrition to Agriculture

Objective: The student will be able to identify the importance of nutrition in livestock.

Study Questions

1. **What careers are associated with nutrition?**
2. **Who sets the guidelines for nutrition?**
3. **What information is supplied on feed tags, and what is its purpose?**
4. **What is the economic importance of understanding nutrition?**
5. **What are the general functions which nutrients serve in the animal body?**

References

1. Student Reference
2. Transparency Master
   a) TM 1.1: Example Feed Tag

UNIT I - NUTRITION

Lesson 1: The Importance of Animal Nutrition to Agriculture

TEACHING PROCEDURES

A. Review

Review the nutrition unit in Ag Science I core curriculum.

B. Motivation

1. Have students research occupations associated with animal nutrition and their contributions.

2. Who sets the guidelines for livestock requirements? (not the farmer or the feed store) Why are these guidelines necessary?

3. What is a feed tag? What information is provided on a feed tag? Why are these requirements important to a person who feeds livestock?

4. Why is important to understand animal nutrition? How does it affect your everyday life?

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students what careers they view as nutrition careers and what the educational requirements might be.

What careers are associated with nutrition?

a) More than 20% of the U.S. labor force works in an ag-related occupation. Approximately 540,000 are employed in the meat, poultry and dairy production industry. Careers associated with nutrition are numerous. The careers may be directly or indirectly related to nutrition. They include:
   1) Agricultural instructors
   2) Livestock producers/farmers
   3) Nutrition specialists
   4) Feedlot employees/managers
   5) Feed sales reps
   6) Horse trainers
   7) Feed store managers
   8) Veterinarians
   9) Nutrition researchers

b) Most occupations require a college degree or years of experience. More and more areas are requiring a master's degree or more. Today, most feed sales reps are required to have a college degree.

2. Ask the students who sets the guidelines and determines the recommended nutritional requirements. Relate that Missouri uses national NRC guidelines.

Who sets the guidelines for nutrition?

a) The work of research scientists has resulted in greatly improved methods of feeding livestock. Many of the U.S. Agriculture Experiment Stations conduct feeding trials. Results of these experiments relate to the value of feeds and rations under controlled feeding conditions.
b) The National Research Council of the National Academy of Sciences develops the requirements for different livestock species.
c) The respective sets of requirements are available in publications specific to each species. Subcommittees on each specie are formed to review the requirements that were set through years of experimentation.
d) The NRC reviews and/or revises its requirements every several years.

3. Ask the students what information is provided on feed tags.

What information is supplied on feed tags, and what is its purpose?

a) Individual states generally regulate the manufacturing and sale of feeds. However, regulations relating to feed additives are made by the federal government. The Association of the American Feed Control Officials has published the "Uniform State Feed Bill," after which many states pattern their regulations. This results in fairly uniform state guidelines regarding the sale and manufacturing of feed.
b) The feed tag found on a bag of commercial feed is important to the livestock feeder. It contains information about the content of the feed and its proper use. The format and content of the feed tag or label is regulated by state laws.
c) The tag generally contains the following information.
    1) Net weight
    2) Product name and brand name
    3) Guaranteed analysis of the feed
        (a) Minimum percentage of crude protein
        (b) Maximum or minimum percentage of equivalent protein from nonprotein nitrogen
        (c) Minimum percentage of crude fat
        (d) Maximum percentage of crude fiber
        (e) Minimum and maximum percentages of calcium and salt
        (f) Minimum percentage of phosphorus
        (g) Other minerals
        (h) Vitamin content
    4) When drugs are used as an additive, requirements must be met.
        (a) The word "medicated" must be on the label.
        (b) The purpose of the medication must be stated.
        (c) Directions for use and precautionary statements must be included.
        (d) Active drug ingredients must be listed.
d) Certain exemptions on labeling are common.
    1) No mineral guarantee is needed *if* no label claims concerning minerals are made *and* the total mineral content is less than 6.5% of the total contents.
    2) No vitamin information is required when the feed contains no claims concerning vitamins or is not being sold as a vitamin supplement.
    3) Crude protein, crude fat and crude fiber guarantees are not needed if the feed is not intended to furnish these substances or if they are a minor part of the total

ingredients. (For example, in drug premixes, mineral or vitamin supplements and molasses)

e) This general description of feed tag labeling is not intended to be a specific guide for a given state. Instead, the Department of Agriculture in each state establishes committees to set state standards. The feed laws, rules and regulations of each state should be considered to determine specific requirements for that state.

4. Have the students list what they feel are the assets of understanding nutrition.

What is the economic importance of understanding nutrition?

a) Agriculture is the largest industry in the U.S.
   1) The total assets of agriculture exceed one trillion dollars.
   2) Production of livestock is an important part of the total agriculture industry.
   3) About 50% of farm cash receipts comes from the sale of livestock and livestock products.

b) The cost of feed is 50-75% of the total cost of raising livestock.
   1) Careful attention to animal nutrition can help reduce feed costs and thus increase the potential profit from livestock.
   2) The lowest cost feed ration may not be the most profitable. One must also consider feeding efficiency and nutrition value when selecting rations.

c) Estimated feed costs for different species vary somewhat.
   1) Swine = 65-80% of total costs
   2) Poultry = 55-65%
   3) Dairy = 50-60%
   4) Finishing beef cattle = 70%
   5) Finishing lambs = 50%

5. Ask the students how nutrients found in feed help the animal.

What are the general functions that nutrients serve in the animal body?

a) There are three general functions that nutrients serve.
   1) Maintenance--maintain basic life processes without any work or production
      (a) Heat to maintain body temperature
      (b) Energy for vital functions and a minimum amount of movement
      (c) Small amounts of protein, minerals and vitamins
   2) Growth (assimilation of tissue)
   3) Reproduction

b) There are also functions which are specific to the purpose of the animal.
   1) Finishing/fattening for market
   2) Fitting for show
   3) Production
      (a) Meat
      (b) Milk
      (c) Eggs
      (d) Wool and mohair
   4) Work
      (a) Horses
      (b) Movement in environment

F. Other activities

1. Have the students research income for a nutrition-related career.

2. Have a local feed sales rep or feed store manager talk to the class about careers, feed requirements, and the importance of understanding nutrition.

3. Have the students bring in feed tags from feed used at home. Compare and contrast the information listed.

4. Tour an animal nutrition research facility.

G. Conclusion

Nutritionists formulate livestock rations to provide the nutrients needed by animals for maintenance and production. Producers are rarely interested in just maintaining animals, yet the maintenance requirements must be met before animals will provide any productivity.

H. Competency

Identify the importance of nutrition to agriculture.

I. Answers to Evaluation

1. d
2. b
3. c
4. c
5. Maintenance, growth and reproduction
6. Any of the careers listed in the lesson or discussed in class
7. Any of the requirements listed in the lesson

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EVALUATION

Circle the letter that corresponds to the best answer.

1. Who sets the nutritional requirements for domestic animals?

   a. Farmers
   b. University nutrition specialists
   c. Feed manufacturers
   d. National Feed Council

2. Who sets regulations for feed tags?

   a. Feed manufacturers
   b. Individual states
   c. U.S. Department of Agriculture
   d. Feed stores

3. The cost of feed is _____% of the total cost in livestock production.

   a. 10-20
   b. 25-40
   c. 50-75
   d. 100

4. How much of total farm cash receipts do livestock sales make up?

   a. 10%
   b. 25%
   c. 50%
   d. 80%

Complete the following short answer questions.

5. List the three general functions that nutrients serve in the animal.

6. List four careers associated with nutrition.

7. List four items required to be on a feed tag.

Example Feed Tag

NET WEIGHT 50 LBS.

SUPER COW
16% TEXTURED

GUARANTEED ANALYSIS

Crude Protein, not less than	16.0%
Crude Fat, not less than	3.0%
Crude Fiber, not more than	7.5%

INGREDIENTS

Grain Products, Processed Grain By-Products, Plant Protein Products, Animal Protein Products, Cane Molasses, Salt, Calcium Carbonate, Dicalcium Phosphate, Manganese Oxide, Ferrous Sulfate, Copper Sulfate, Magnesium Oxide, Potassium Chloride, Cobalt Carbonate, Zinc Oxide, Ethylenediamine Dihydriodide, Sodium Selenite, Lignin Sulfonate and Sodium Bentonite (pellet binders), Vitamin A Acetate, D-Activated Animal Sterol (source of Vitamin D-3), Vitamin E Supplement, Niacin Supplement, Dried Lactobacillus Acidophilus Fermentation Products, Zinc Methionine.

FEEDING DIRECTIONS

Feed Super Cow 16% Textured as a high-energy supplement to excellent legume hay or haylage or lush legume-grass pasture when used as the only source of roughage for the lactating cow. Feed 1 lb. of this feed for each 2-3 lbs. of milk produced.

Manufactured by
MFA INCORPORATED
Columbia, MO 65201

UNIT I - NUTRITION

Lesson 2: Livestock Digestive Systems

Objective: The student will be able to compare and contrast the different digestive systems in livestock.

Study Questions

1. **How is food digested in a ruminant?**
2. **How is food digested in a nonruminant?**
3. **How is food digested in a modified nonruminant?**
4. **How is food digested in poultry?**

References

1. Student Reference
2. Transparency Masters
    a) TM 2.1: Comparison of Digestive System Parts
    b) TM 2.2: Digestive System Parts of a Ruminant
    c) TM 2.3: Digestive System Parts of a Nonruminant
    d) TM 2.4: Digestive System Parts of an Avian

UNIT I - NUTRITION

Lesson 2: Livestock Digestive Systems

TEACHING PROCEDURES

A. Review

1. Review the previous lesson on the importance of animal nutrition.

2. Reinforce that ruminants include cattle, sheep and goats; nonruminants include swine and humans; modified nonruminants include horses and rabbits; and poultry (avian) include ducks, chickens, and turkeys.

B. Motivation

1. Are there any similarities between human and livestock digestive systems? The human digestive system is very similar to the nonruminant's digestive system (such as swine). They consist of a mouth, esophagus, simple stomach, small intestine, large intestine, and anus. They both use these parts to mechanically and chemically breakdown food for absorption.

2. How long is the digestive tract in humans? How long is the digestive tract in swine? From mouth to anus, the digestive tract in a human is 30 feet in length. The digestive tract in swine is about 80 feet in length. In hogs, this added length permits some absorption in the large intestine, while little or no absorption occurs in the large intestine of humans.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students about the differences between the digestive systems of ruminants and non-ruminants. (A ruminant animal has a four-compartment stomach, where each compartment serves a different function in the digestion of roughage. A nonruminant animal has one stomach, which cannot digest roughage.)

How is food digested in a ruminant?

a) Parts in the ruminant digestive system
   1) Mouth
   2) Esophagus
   3) Rumen
   4) Reticulum
   5) Omasum
   6) Abomasum
   7) Liver
   8) Gallbladder
   9) Pancreas
   10) Duodenum
   11) Small intestine
   12) Colon
   13) Cecum

14) Rectum

b) Functions of digestion in ruminants

1) Mouth--Three physical processes occur in the mouth.
   NOTE: Same functions as nonruminants and modified nonruminants
   (a) Prehension--the act of bringing food into the mouth
   (b) Mastication--the act of chewing food (Saliva is added and enzymatic digestion begins.)
   (c) Deglutition--the act of swallowing
2) Esophagus
   NOTE: Same functions for all classes of livestock
   (a) Pharynx--structure which controls the passage of air and feed
   (b) The passageway for food and water from mouth to stomach
3) Reticulum and rumen
   (a) Microorganisms (bacteria and protozoa) are present to aid in digestion.
   (b) Fatty acids are produced and absorbed.
   (c) Vitamins K, C and B-complex are synthesized.
   (d) Muscular action stirs and mixes food and water, which aids in digestion.
4) Omasum
   (a) Absorbs water
   (b) Aids in grinding of food
   (c) Absorbs volatile fatty acids
5) Abomasum
   (a) This is considered the "true stomach" in of ruminants.
   (b) Digestive juices containing acids and enzymes are added, which increase the moisture content of food.
   (c) A small percentage of feed protein (the hard-to-digest part) is digested here.
6) Pancreas
   NOTE: Same functions as nonruminants, modified nonruminants, and poultry
   (a) Endocrine gland secretes hormones such as insulin and glucagon.
   (b) Exocrine gland secretes fluids necessary for digestion.
7) Liver
   NOTE: Same functions as nonruminants and modified nonruminants
   (a) Secretion of bile, which emulsifies fat
   (b) Vitamin storage
   (c) Detoxification of harmful compounds
   (d) Metabolism of proteins, carbohydrates, and lipids (fats)
   (e) Storage of carbohydrates when needed
   (f) Destruction of red blood cells
   (g) Urea formation
   (h) Formation of plasma proteins
   (i) Inactivation of polypeptide hormones
8) The gallbladder stores bile.
   NOTE: Same functions as nonruminants and avians
9) Duodenum
   (a) Bile and pancreatic fluids are stored here.
   (b) Fats are emulsified here.
   (c) Enzymes in the pancreas aid in breaking down carbohydrates and proteins.
10) Small intestine
   (a) Vitamins and minerals are absorbed into the bloodstream.
   (b) Proteins (80%) are absorbed here.
   (c) Lipids (fats) are also absorbed here.
11) Cecum and colon (large intestine)

(a) Fiber (5 to 15%) is digested in the cecum.
(b) The majority of water is absorbed in the colon, which causes fecal formation.
(c) Mucus is added to feces for lubrication.
(d) The mixture still remains neutral.

2. Ask students about the similarities between the digestive systems of ruminants and nonruminants.

How is food digested in a nonruminant?

a) Parts in the nonruminant digestive system
   1) Mouth
   2) Esophagus
   3) Stomach
   4) Liver
   5) Gallbladder
   6) Pancreas
   7) Duodenum
   8) Small intestine
   9) Colon
   10) Cecum
   11) Rectum

b) Functions of digestion in nonruminants
   1) Mouth--Three physical processes occur in the mouth.
      NOTE: Same functions as ruminants and modified nonruminants
      (a) Prehension--the act of bringing food into the mouth
      (b) Mastication--the act of chewing food (Saliva is added and enzymatic digestion begins.)
      (c) Deglutition--the act of swallowing
   2) Esophagus
      NOTE: Same functions for all classes of livestock
      (a) Pharynx--structure which controls the passage of air and food
      (b) The passageway for food and water from mouth to stomach
   3) Stomach
      (a) Food is mixed with acids and enzymes; this mixture becomes acidic in nature.
      (b) Fats are partially broken down.
      (c) Digestion begins on proteins.
      (d) Carbohydrates move through the stomach at a faster rate than other nutrients.
   4) Pancreas
      NOTE: Same functions as ruminants, modified nonruminants, and poultry
      (a) Endocrine gland function is to secrete hormones such as insulin and glucagon.
      (b) Exocrine gland secretes fluids necessary for digestion.
   5) Liver
      NOTE: Same functions as ruminants and modified nonruminants
      (a) Secretion of bile, which emulsifies fat
      (b) Vitamin storage
      (c) Detoxification of harmful compounds
      (d) Metabolism of proteins, carbohydrates, and lipids (fats).
      (e) Storage of carbohydrates
      (f) Destruction of red blood cells

(g) Urea formation
(h) Formation of plasma proteins
(i) Inactivation of polypeptide hormones

6) The gallbladder stores bile.
NOTE: Same functions as ruminants and avians

7) Duodenum
(a) Food mixture becomes a neutral mixture with the addition of alkaline enzymes.
(b) Emulsification of fats by bile makes fats soluble in water.
(c) Further breakdown of proteins and carbohydrates occurs.

8) Small intestine
(a) Digested nutrients are absorbed into the bloodstream.
(b) Peristalsis is the coordinated contraction and relaxation of smooth muscles to create unidirectional movement of food.

9) Cecum and colon (large intestine)
(a) The cecum has a very limited function but does contain microorganisms.
(b) Water is absorbed in the colon; fecal formation occurs.
(c) Mucus is added to feces to provide lubrication.
(d) The mixture remains neutral.

3. Encourage discussion about the similarities between nonruminants and modified nonruminants. (The only real difference is an active cecum in the modified nonruminant.)

How is food digested in a nonruminant?

a) Parts in the modified nonruminant digestive system
1) Mouth
2) Esophagus
3) Stomach
4) Liver
5) Pancreas
6) Duodenum
7) Colon
8) Cecum
9) Rectum

b) Functions of digestion in modified nonruminants
1) Mouth--Three physical processes occur in the mouth.
NOTE: Same functions as ruminants and nonruminants
(a) Prehension--the act of bringing in food into the mouth
(b) Mastication--the act of chewing food (Saliva is added and enzymatic digestion begins.)
(c) Deglutition--the act of swallowing

2) Esophagus
NOTE: Same functions for all classes of livestock
(a) Pharynx--the structure which controls the passage of air and food
(b) The passageway for food and water from the mouth to the stomach

3) Stomach
(a) Food is mixed with acids and enzymes; this mixture becomes acidic in nature.
(b) Fats are partially broken down.
(c) Digestion begins on proteins.
(d) Carbohydrates move through the stomach at a faster rate than other nutrients.

4) Pancreas

NOTE: Same functions as ruminants, nonruminants, and poultry
(a) Endocrine gland secretes hormones such as insulin and glucagon.
(b) Exocrine gland secretes fluids necessary for digestion.

5) Liver
NOTE: Same functions as ruminants and nonruminants
(a) Secretion of bile
(b) Vitamin storage
(c) Detoxification of harmful compounds
(d) Metabolism of proteins, carbohydrates, and lipids
(e) Storage of carbohydrates
(f) Destruction of red blood cells
(g) Urea formation
(h) Formation of plasma proteins
(i) Inactivation of polypeptide hormones

6) Duodenum
(a) Food mixture becomes a neutral mixture with the addition of alkaline enzymes.
(b) Emulsification of fats by bile makes fats soluble in water.
(c) Further breakdown of proteins and carbohydrates occur.

7) Small intestine
(a) Digested nutrients of concentrates are absorbed into the bloodstream.
(b) Peristalsis is the coordinated contraction and relaxation of smooth muscles to create unidirectional movement of food.

8) Cecum
(a) Quite functional and much larger than most nonruminant animals
(b) Digestion of roughage takes place here.
(c) Contains microorganisms to aid in digestion of roughage

9) Colon
(a) The majority of the water is absorbed in the colon; fecal formation occurs.
(b) Mucus is added to feces to provide lubrication.
(c) The mixture remains neutral.

4. Point out that the digestive system of poultry is considerably different than those of the three groups discussed so far.

How is food digested in poultry?

a) Parts in the avian digestive system
1) Mouth
2) Esophagus
3) Crop
4) Proventriculus
5) Gizzard
6) Liver
7) Gallbladder
8) Pancreas
9) Small intestine
10) Large intestine
11) Ceca
12) Cloaca
13) Vent

b) Functions of digestion in poultry
1) Mouth--*Two* physical processes occur in the mouth.
(a) Prehension--the act of bringing in food into the mouth

(b) Deglutition--the act of swallowing

2) Esophagus
   NOTE: Same functions for all classes of livestock
   (a) Pharynx--the structure which controls the passage of air and food
   (b) The passageway for food and water from the mouth to the crop
3) Crop
   (a) Storage of food
   (b) Mucus is secreted and added to the food, which softens and lubricates it.
4) In the proventriculus, gastric fluids are secreted and added to ingested food.
5) Gizzard
   (a) This muscular organ aids in digestion by mechanically mixing and grinding food.
   (b) Gastric fluids are mixed with food.
6) Pancreas
   NOTE: Same functions as ruminants, nonruminants, and modified nonruminants
   (a) Endocrine gland secretes hormones such as insulin and glucagon.
   (b) Exocrine gland secretes enzymes necessary for digestion.
7) Liver
   (a) Secretion of bile
   (b) Vitamin storage
   (c) Detoxification of harmful compounds
   (d) Metabolism of proteins, carbohydrates, and lipids
   (e) Storage of carbohydrates
   (f) Destruction of red blood cells
   (g) Formation of plasma proteins
   (h) Inactivation of polypeptide hormones
8) The gallbladder stores bile.
   NOTE: Same functions as ruminants and nonruminants
9) Small intestine movements
   (a) Pendular motion--Shortening and lengthening of the intestine create a mixing motion.
   (b) Segmentation contractions--Ringlike contractions at regular intervals create a mixing motion.
   (c) Peristalsis--The coordinated contraction and relaxation of smooth muscles create unidirectional movement of food.
   (d) Digested nutrients are absorbed into the bloodstream.
10) Ceca
   (a) Ceca is the plural form of cecum.
   (b) This blind-ended tube is found at the junction of the small intestine and the large intestine.
11) The colon (large intestine) does not play a significant role in digestion, except for water absorption.
12) In the cloaca, urinary and fecal materials are mixed together before leaving the body through the vent.

F. Other activities

1. Obtain a digestive tract from a slaughter house to show the movement of food through the digestive system.

2. Activities on salivary digestion, gastric digestion, pancreatic digestion, and digestion of fat are available from:

   "Digestive Systems of Domesticated Animals" (#8833-C). *Agriscience 332H: Advanced Animal Science.* College Station, TX: Instructional Materials Service, Texas A&M University, 1990.

G. Conclusion

Understanding livestock digestive systems is critical to success of a producer or another in a related nutrition occupations. The person who can apply nutrition utilization to a situation can greatly improve the profit capability of an operation or business.

H. Competency

Compare and contrast the digestive systems of livestock.

I. Answers to Evaluation

1.	h	10.	d	19.	f
2.	b	11.	b	20.	e
3.	a	12.	g	21.	a
4.	g	13.	d	22.	b
5.	e	14.	c	23.	a
6.	c	15.	i	24.	b
7.	j	16.	k	25.	d
8.	k	17.	a	26.	c
9.	i	18.	j	27.	b
				28.	c

29-46. Refer to TM 2.1 for answers. (section worth 72 points)

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Lesson 2: Livestock Digestive Systems Date_____

EVALUATION

Match parts on the right with functions of the ruminant digestive system on the left.

___ 1.	Where saliva is mixed with food	a.	Abomasum
___ 2.	Where a majority of water is absorbed	b.	Colon
___ 3.	"True stomach"	c.	Duodenum
___ 4.	Detoxification of harmful compounds	d.	Esophagus
___ 5.	Storage of bile	e.	Gallbladder
___ 6.	Emulsification of fats	f.	Large intestine
___ 7.	Where B-complex vitamins are synthesized	g.	Liver
___ 8.	Where minerals are absorbed	h.	Mouth
___ 9.	Location of endocrine and exocrine glands	i.	Pancreas
___ 10.	Where the pharynx is located	j.	Rumen
		k.	Small intestine

Match parts with functions of the poultry digestive system.

___ 11.	Where fecal and urinary materials are mixed	a.	Ceca
___ 12.	Storage of vitamins	b.	Cloaca
___ 13.	Passageway from mouth to crop	c.	Crop
___ 14.	Where food is softened and lubricated	d.	Esophagus
___ 15.	Where insulin is secreted	e.	Gallbladder
___ 16.	Location of pendular motion	f.	Gizzard
___ 17.	Blind-ended tube between small intestine and large intestine	g.	Liver
		h.	Mouth
___ 18.	Where gastric fluids are secreted	i.	Pancreas
___ 19.	Where mixing and grinding of food occurs	j.	Proventriculus
___ 20.	Storage of bile	k.	Small intestine

Circle the letter that corresponds to the best answer.

21. Which describes the coordinated contraction and relaxation of smooth muscles to create unidirectional movement of food?

    a. Peristalsis
    b. Pendular
    c. Segmentation
    d. Mastication

22. In the small intestine of poultry, which mixing movement is caused by shortening and lengthening the intestine?

    a. Peristalsis
    b. Pendular
    c. Segmentation
    d. Mastication

23. In poultry, which mixing movement is caused by ring-like contractions at regular intervals in the intestine?

    a. Segmentation
    b. Mastication
    c. Deglutition
    d. Prehension

24. Which describes the act of chewing food?

    a. Segmentation
    b. Mastication
    c. Deglutition
    d. Prehension

25. Which describes the act of bring food into the mouth?

    a. Segmentation
    b. Mastication
    c. Deglutition
    d. Prehension

26. Where are red blood cells destroyed?

    a. Pharnyx
    b. Pancreas
    c. Liver
    d. Gallbladder

27. Which structure which controls the passage of air and food?

    a. Liver
    b. Pharnyx
    c. Pancreas
    d. Gallbladder

28. Where is urea formed?

a. Pharnyx
b. Pancreas
c. Liver
d. Gallbladder

Place a check in each part of the table that pertains to that class of animal. (The first one has been done for you as an example.)

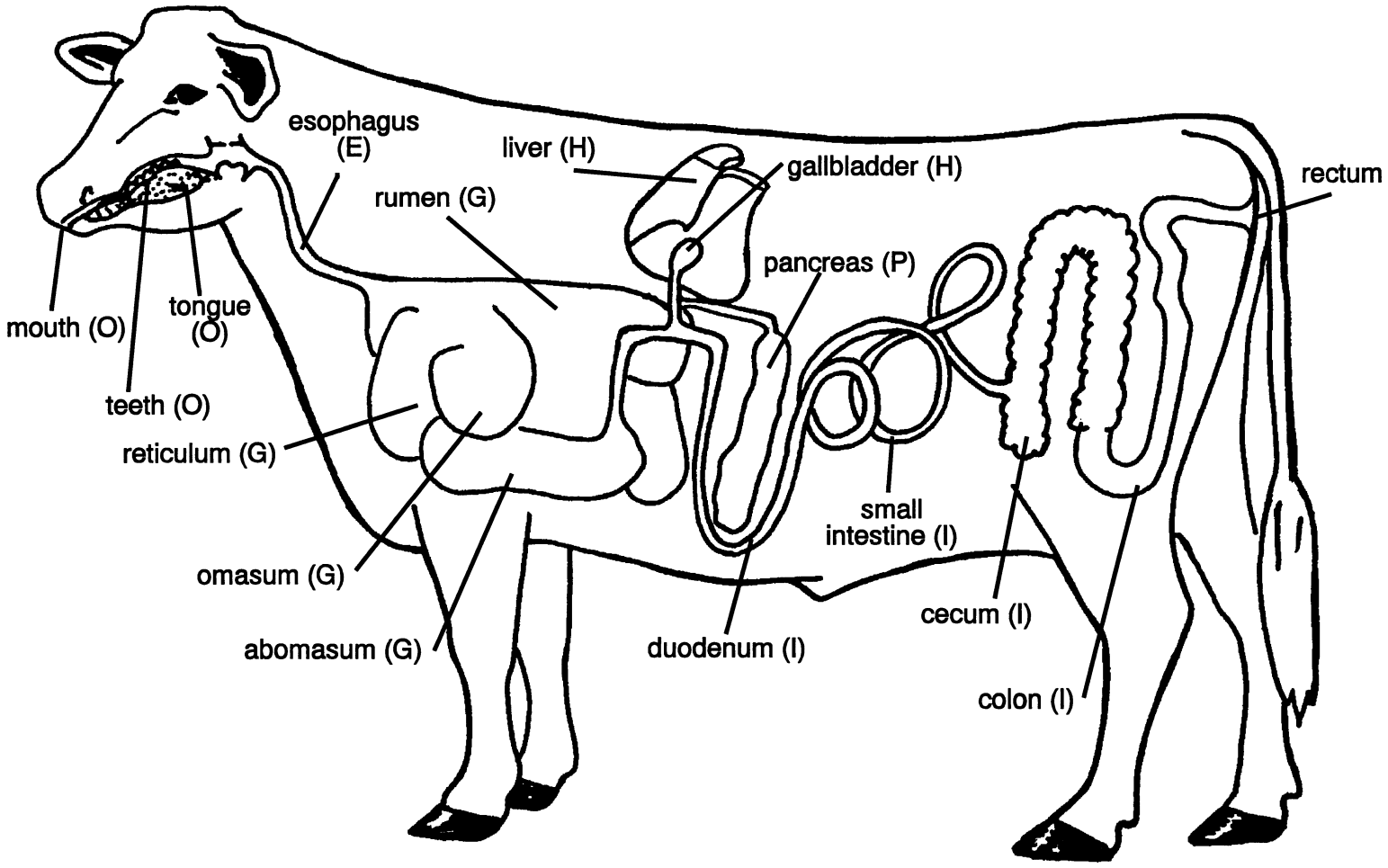
Body part	Ruminants	Nonruminants	Mod. non-ruminants	Poultry (avian)
Oral Mouth	✓	✓	✓	✓
Esophageal 29. Esophagus				
Gastric 30. Rumen				
31. Reticulum				
32. Omasum				
33. Abomasum				
34. Stomach				
35. Crop				
36. Proventriculus				
37. Gizzard				
Pancreatic 38. Pancreas				
Hepatic 39. Liver				
40. Gallbladder				
Intestinal 41. Duodenum				
42. Colon				
43. Cecum				
44. Small intestine				
45. Cloaca				
46. Rectum				

Comparison of Digestive System Parts

NOTE: Shaded areas show that those animals have that part.

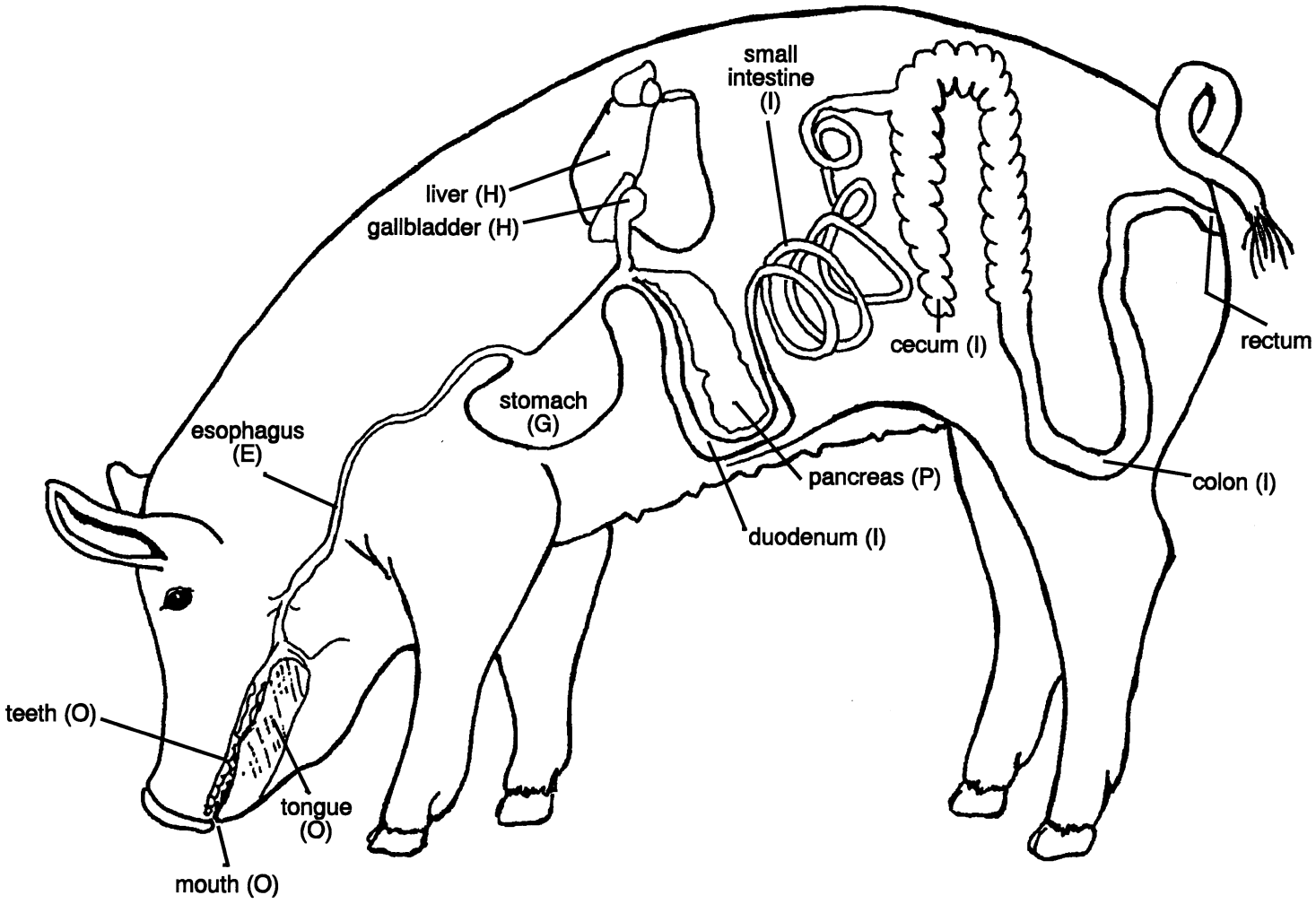
Body part	Ruminants	Non-ruminants	Mod. non-ruminants	Poultry (avian)
Oral Mouth				
Esophageal Esophagus				
Gastric Rumen				
Reticulum				
Omasum				
Abomasum				
Stomach				
Crop				
Proventriculus				
Gizzard				
Pancreatic Pancreas				
Hepatic Liver				
Gallbladder				
Intestinal Duodenum				
Colon				
Cecum/ceca				(ceca)
Small intestine				
Cloaca				
Rectum/vent				(vent)

Digestive System Parts of a Ruminant

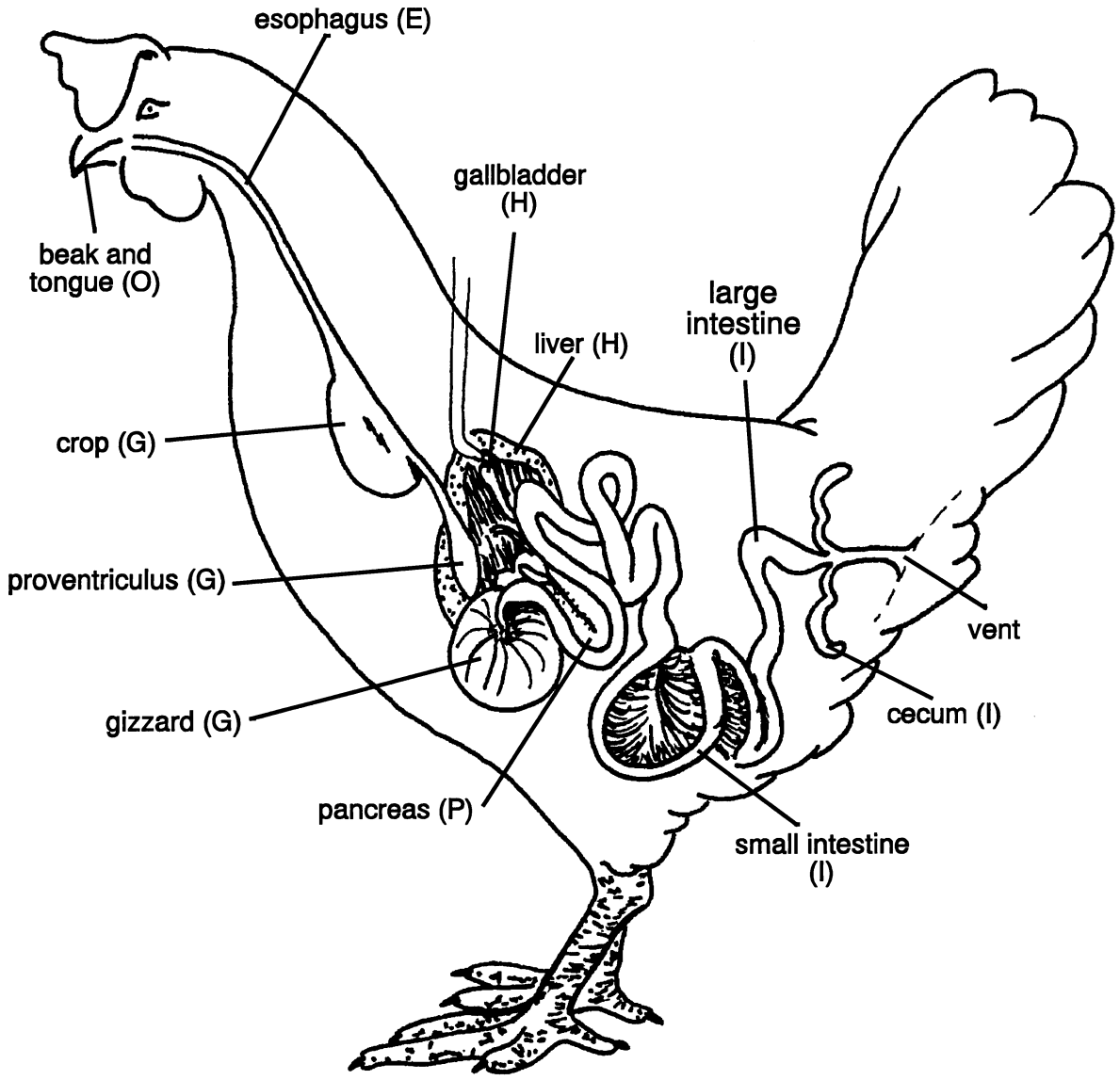


TM 2.2

Digestive System Parts of a Nonruminant



Digestive System Parts of an Avian



UNIT I - NUTRITION

Lesson 3: Energy's Role in Livestock Nutrition

Objective: The student will be able to describe the function of energy in livestock nutrition.

Study Questions

1. **What are the basic functions of energy in the body?**
2. **How are carbohydrates and fats related to energy?**
3. **Where are carbohydrates and fats absorbed in the digestive system?**
4. **What are the sources of energy for ruminants and nonruminants?**
5. **What are deficiency and toxic effects of carbohydrates and fats?**

References

1. Animal Science

UNIT I - NUTRITION

Lesson 3: Energy's Role in Livestock Nutrition

TEACHING PROCEDURES

A. Review

1. Review the previous lesson on digestive systems of livestock.

B. Motivation

1. What are two sources of energy? (carbohydrates and fats)

2. What are some signs of energy deficiencies in humans?

   a) Always feeling rundown can be a sign of a lack of carbohydrates and fats.
   b) Insufficient fats in the body cause a lack of fat-soluble vitamins.

3. What are sources of carbohydrates and fats for humans?

   a) Carbohydrates--breads, pasta, sugars, cereals, fresh fruit, starchy vegetables
   b) Fats--dairy products, meats, and oils

4. What are the signs of excess consumption of energy in humans? (Excess carbohydrates are changed to fat and stored in the body as excess body weight. Excess weight causes other problems, such as heart conditions and high blood pressure.)

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students to discuss the functions of energy in the body. Discuss why it is important to understand energy requirements.

   What are the basic functions of energy in the body?

   a) Maintenance of life
      1) Controls basal metabolism, such as beating of the heart, blood pressure maintenance, nerve impulse transmission, breathing, and internal organ work
      2) Keep muscles in state of tension
      3) Supply fuel to maintain body temperature
   b) Growth and production
      1) Fattening
      2) Lactation--milk production
      3) Development of a fetus
      4) Reproduction
      5) Work

2. Ask the students for the two types of energy sources. How do they differ?

How are carbohydrates and fats related to energy?

a) Carbohydrates and lipids (fats and oils) are the major sources of energy in livestock rations.
b) Carbohydrates--most important
    1) Readily available
    2) Easily digested in greatest quantities in most feeds
    3) Generally lower in cost
c) Fats and oils
    1) It is difficult to store feeds high in fat content during warm weather because feeds tend to become rancid (bad odor and flavor).
    2) Feeds become less palatable, and animals are reluctant to eat them.
    3) Fatty feeds may make the animal sick.
d) Carbohydrates are organic compounds made of carbon (C), hydrogen (H), and oxygen (O).
    1) Plants produce carbohydrates by photosynthesis.
        (a) Energy from the sun, plus water and carbon dioxide, produce glucose and oxygen.
        (b) Carbohydrates include:
            (1) Starch
            (2) Sugars
            (3) Hemicellulose
            (4) Cellulose
            (5) Pectins
            (6) Gums
            (7) Lignins
        (c) Most carbohydrates are combinations of saccharides or sugars.
        (d) One way carbohydrates are classified is by the number of molecules of sugars they contain. For example, monosaccharides contain only one sugar molecule.
    2) In digestion, carbohydrates in feed are changed into simpler forms.
        (a) Glucose levels in the bloodstream of animals are maintained at a level of 0.05-0.1 percent concentration.
        (b) Because glucose can be used by all animals, it is the most important sugar found in the body.
    3) Two groups of carbohydrates
        (a) Fiber: contains hard-to-digest hemicellulose, cellulose, and lignin
        (b) Nitrogen-free extract (NFE)
            (1) Includes starches and sugars
            (2) Plants store energy as starch in grain; grains have a high feeding value since starch is easily digested.
    4) Digestion of fiber is related to the presence or absence of bacteria in the digestive system.
        (a) Ruminants
            (1) High bacteria population in the rumen
            (2) Make use of energy from the fiber portion of the ration
            (3) Bacterial action breaks fiber down into volatile fatty acids absorbed through the rumen wall
            (4) Roughage in a ruminant's ration can provide much of the maintenance energy needed by the animal

(b) Nonruminants, modified nonruminants, and avians
(1) No rumen
(2) Low bacteria population in stomach and intestines
(3) Less ability to utilize energy from fiber
(4) For mature breeding animals, increase the level of fiber in the ration to prevent excessive weight gain.
(5) Fiber assures adequate elimination of waste products (keeps animals "regular").

e) Lipids (fats and oils) are made up of carbon, hydrogen, and oxygen.
1) Lipids have higher carbon and hydrogen levels than carbohydrates, but lower oxygen levels.
2) Lipids supply 2.25 times as much energy as an equal amount of carbohydrates.
3) At body temperature, fats are solids and oils are liquids.
4) Fats are composed of two units--fatty acids and glycerol.
(a) Fatty acids consist of a carbon chain, 2-20 carbons in length, which contains a carboxyl group (COOH).
(1) Saturated fatty acids contain carbons attached with all single bonds.
(2) Unsaturated fatty acids contain carbons attached by double bonds. These double bond sites are chemically reactive; as a result, they are less stable than saturated.
(3) As the number of double bonds increases, the melting point of fat is lowered and the fats become softer (oils).
(b) Glycerol is the second constituent of fat.
(c) Fats are formed when one glycerol combines with three fatty acids to form a triglyceride.
5) Rancidity may be a problem with both saturated and unsaturated fats. Oxidative rancidity occurs only in unsaturated fats.
(a) Requires presence of oxygen
(b) Alters flavor, odor, and nutritional value
(c) Favored by moist conditions
(d) Part of hyperoxide formation, which promotes aging and destroys the immune system
(e) Destroys essential fatty acids
(f) Prevented with antioxidants (Vitamin E) and storing fats in cool environment
6) Three fatty acids are considered dietary essential nutrients since they are not synthesized by nonruminant animals. However, these fatty acids are synthesized by microorganisms in the rumen.
(a) Linoleic acid
(b) Linolenic acid
(c) Arachidonic acid
7) Storage of fats in the body
(a) Marbling is fat stored in muscle tissue.
(b) Fat stored in adipose (fatty) tissue contains reserve energy, which can help sustain life for a while if feed supplies are cut off.
8) Uses of fats in feed
(a) Raise energy level
(b) Improve flavor, texture, and palatability
(c) Reduce dustiness
(d) Improve glossiness of hair coat in show animals
9) Guidelines for fat content in feed
(a) Ruminants: no more than 3-5 percent
(b) Nonruminants: no more than 15-20 percent

3. Ask the students for ideas on what happens to nutrients to make them usable by the animal's body. (Refer to Lesson 2, if necessary.)

Where are carbohydrates and fats absorbed in the digestive system?

a) Carbohydrates (ruminants and nonruminants)
   1) Mostly in the small intestine
      (a) Starches and sugars are converted to glucose, fructose, and galactose when digested.
      (b) Crude fiber is converted to short, chained fatty acids or glucose by digestion.
      (c) By osmosis, nutrients pass into the blood capillaries through semipermeable membranes of the digestive tract, then through the liver into the bloodstream.
   2) Some in the large intestine

b) Fats (ruminants and nonruminants)
   1) Fats are digested into fatty acids and glycerols called chyle.
   2) Chyle is absorbed by lacteal (lymphatic vessels) and carried through the lymphatic system.

4. Ask students to list sources of readily available carbohydrates and fats.

What are the sources of energy for ruminants and nonruminants?

a) Grains (major source)
   1) Shelled corn
      (a) Highest energy feed available
      (b) Economical and superior source of energy for livestock
   2) Oats
      (a) Contains 85 percent of the energy of shelled corn
      (b) Higher in crude protein; add fiber and bulk to rations
      (c) Helps maintain rumen functions in ruminants
   3) Barley
   4) Grain sorghum (similar to shelled corn)
   5) Wheat

b) Roughage
   1) Roughage supplies some energy needs in livestock rations but is not a concentrated source.
   2) The value of forages is highly dependent upon time of harvest.
   3) As the plant matures, crude fiber content increases; this lowers the digestibility of the feed.
      (a) Corn silage
      (b) Hay
      (c) Pastures

c) Fats
   1) Feed-grade animal fat is a byproduct of packing, poultry processing, and animal rendering plants.
   2) Animal fat is an economical source of energy used in manufacturing commercially mixed feeds.

5. Ask students to list signs of a lack of energy in an animal's diet.

What are deficiency and toxic effects of carbohydrates and fats?

a) Deficiency symptoms
   1) Slower growth in the young
   2) Delay of onset of puberty
   3) Decrease in milk yield in lactating females
   4) Shortened lactation period
   5) Loss of body weight
   6) Reduced fertility and delayed estrus
   7) Higher mortality rates
   8) Lowered resistance to disease and parasites

b) Toxic effects
   1) Obesity
      (a) Decreased fertility
      (b) Delayed estrus
   2) Ketosis
      (a) Ketosis occurs when an animal has a higher energy demand (such as lactating dairy cattle) and a low supply of carbohydrates.
      (b) To meet the energy demand, the animal increases the metabolism of fats.
      (c) The increased fat metabolism rate overloads the liver with ketone acids.
      (d) Ketone acids can provide energy for muscles but **cannot** provide energy for the brain.
      (e) If the situation is not corrected, glucose blood levels drop so low that the animal collapses, goes into a coma, and dies.
      (f) This often happens to the best milk cows because of high energy requirements.

F. Other activities

1. Have students bring in feed tags from various commercial feeds and compare the energy values.

2. Visit a local feed mill or elevator. Ask the operator to explain how they formulate feeds and determine the energy nutrients to include in them.

3. Have students keep track of the foods they eat for a week, and have them determine which of the foods would be considered energy nutrients.

4. For quick response, feed small animals (especially chickens) different protein levels to see the results.

5. Consider using a kit to demonstrate the solubility and saturation of fats and carbohydrates. Carolina Biological Supply Co. (800/334-5551) has two kits: "Introduction to Properties of Lipids" and "Introduction to Analysis of Carbohydrates."

G. Conclusion

Fuel is supplied to the body by energy nutrients. The major sources of energy in livestock rations are carbohydrates and fats. Energy is used for digestion; absorption of nutrients; breathing; heart action; movement of muscles; production of milk, eggs, wool, and mohair; waste formation and excretion; and to supply heat to maintain body temperature. Some feed energy is lost through the feces, urine, and gases produced in the body. Excess energy not used to sustain life is stored as body fat.

H. Competency

Describe energy's role in nutrition.

I. Answers to Evaluation

1. Maintenance of life; growth and production
2. Carbohydrates and fats
3. Carbon, hydrogen, and oxygen
4. Fiber and nitrogen-free extract (NFE)

5. Three of the following:
   a) Raise energy level of feed
   b) Improve flavor and texture of feed
   c) Reduce dustiness of feed
   d) Improves glossiness of hair coat

6. Carbohydrates are absorbed through the liver and then the bloodstream, while fats are first absorbed through the lymphatic system before entering the bloodstream.

7. d
8. b

UNIT I - NUTRITION Name_____

Lesson 3: Energy's Role in Livestock Nutrition Date_____

EVALUATION

Complete the following short answer questions.

1. What are the basic functions of energy in the body?

   a.

   b.

2. What are the two major sources of energy in the livestock ration?

   a.

   b.

3. What are the three elements that make up the molecules of fats and carbohydrates?

   a.

   b.

   c.

4. What are the two major groups of carbohydrates?

   a.

   b.

5. List three reasons to add fat to a ration.

   a.

   b.

   c.

   d.

6. Explain the main difference between how carbohydrates and fats are absorbed and circulated through the body.

Circle the letter that corresponds to the best answer.

7. Which is a possible toxic effect of carbohydrates and fats?

   a. Slower growth in the young
   b. Decrease in milk yield in lactating females
   c. Shortened lactation period
   d. Lower conception rates

8. Which source of energy contains 85 percent of the energy of shelled corn?

   a. Animal fat
   b. Oats
   c. Grain sorghum
   d. Wheat

UNIT I - NUTRITION

Lesson 4: Protein's Role in Animal Nutrition

Objective: The student will be able to describe the function of protein in animal nutrition.

Study Questions

1. **What are the functions of protein?**
2. **What are amino acids and their role in protein synthesis?**
3. **What are the essential amino acids?**
4. **What are the major symptoms of protein deficiency?**
5. **What are sources of protein?**
6. **What determines which proteins should be used in livestock diets?**

References

1. Student Reference
2. Transparency Masters
   a) TM 4.1: Protein Utilization in the Ruminant
   b) TM 4.2: Barrel Stave Illustration of the Effect of Limiting Amino Acid Supplementation on Milk Production

UNIT I - ANIMAL NUTRITION

Lesson 4: Protein's Role in Animal Nutrition

TEACHING PROCEDURES

A. Review

Review previous lesson on the importance of the nutrient energy in livestock.

B. Motivation

1. What are the signs of protein deficiency in humans? Lack of energy, loss of weight, and tiredness are all signs of protein deficiency in humans. Kwashiorkor is a childhood disease caused by protein deficiency. Symptoms are stunted growth, discolored skin, body sores, and a bulging abdomen. Good protein sources for humans are poultry, fish, dairy products, and dried peas and beans.

2. What are the signs of too much protein in the human diet? Proteins that are not used by the body are converted into body fat, which causes excess amounts of body fat.

C. Assignment

D. Supervised study

E. Discussion

1. See if students know how proteins are used in the body and the purposes they serve.

What are the functions of protein?

a) Functions of proteins in all classes of livestock
   1) Build, repair, and maintain muscles, skin, body tissues, hair, and hooves
   2) Produce body regulators, including enzymes and some hormones
   3) Good source of blood glucose
   4) Provide energy when fed in amounts higher than the body requires
   5) Building blocks in some genetic compounds, including DNA, RNA, and ATP
   6) Used as precursors of some B-complex vitamins

b) Signs of protein deficiencies in livestock
   1) Animal appears thin and has a rough hair coat.
   2) Animals have poor appetites, low digestive efficiencies, and lower production rates.
   3) Animal may die if these deficiencies aren't corrected.

2. Ask students about how amino acids are formed.

What are amino acids and their role in protein synthesis?

a) Definition/functions
   1) Nitrogen compounds that originate from proteins provided in the diet
   2) The bricks and mortar of which muscles, body tissues, skin, and hair are built

b) Amino acids groups
   1) Amino acids are separated into two groups: essential and nonessential amino acids.
   2) There are 23 amino acids; 10 are essential and 13 are nonessential.
   3) All classes of livestock require both groups of amino acids.

c) The role of the amino acids in protein synthesis
   1) Ruminants can synthesize their own amino acids if there is enough nitrogen in the diet.
   2) Non-ruminants must be supplied with essential amino acids in their diet because they cannot synthesize amino acids.
   3) DNA serves as the information center that links amino acids together to form a specific protein with a particular physiological function.

3. Ask students about differences between essential amino acids and non-essential amino acids. Relate the memory aid, "Pvt. Tim Hall," to help students remember amino acids.

What are the essential amino acids?

a) Phenylalanine
b) Valine
c) Threonine
d) Tryptophan
e) Isoleucine
f) Methionine
g) Histidine
h) Arginine
i) Lysine
j) Leucine

4. Ask students if they can tell when an animal is lacking protein in the diet.

What are the major symptoms of protein deficiency?

a) Why symptoms occur in protein synthesis
   1) For a protein to be synthesized, all of the amino acids must be present and available.
   2) If an amino acid is deficient, the protein cannot be made; it must be supplied for the animal.
      EXAMPLE: Corn is deficient in lysine, so lysine must be supplied through another source.

b) Symptoms of amino acid deficiencies
   1) Lack of animal growth
   2) Poor hair coat
   3) Lack of muscling
   4) Lack of energy

5. Discuss the importance of knowing crude protein percentages for feedstuffs.

What are sources of protein?

NOTE: Crude protein is abbreviated CP. The following are book values. Home-raised protein sources should be tested for accurate CP values.

a) Animal protein sources
   1) Feather meal, 87 percent CP
   2) Blood meal, 86 percent CP
   3) Fish meal, 60 percent CP
   4) Poultry byproduct meal, 55 percent CP
   5) Meat scrap, 55 percent CP
   6) Meat and bone meal, 61 percent CP
   7) Dried skim milk, 34 percent CP
   8) Dried whole milk, 25 percent CP

b) Plant protein sources
   1) Sunflower meal, 47 percent CP
   2) Soybean meal, 48 percent CP
   3) Cottonseed meal, 41 percent CP
   4) Rapeseed meal, 37 percent CP
   5) Dehydrated alfalfa meal, 18 percent CP
   6) Alfalfa hay, 15 percent CP
   7) Red clover hay, 13 percent CP
   8) Wheat grain, 12 percent CP
   9) Oat grain, 12 percent CP
   10) Corn grain, 8 percent CP

c) Synthetic sources (N = nitrogen)
   1) Urea is 45 percent N. (Feed only to ruminant animals with a high energy ration.)
   2) Urea is a good source of nitrogen for amino acids.
   3) If the full amount of urea is not used in the rumen, urea toxicity could occur when the byproduct ammonia is produced.

6. Discuss the types of proteins available for feedstuffs. (Use Transparency Masters 4.1 and 4.2.) Using a wooden barrel as an example, describe how the first limiting amino acid influences production. For example, using a barrel with staves cut at different heights, that barrel will hold fluid only to the height of the shortest stave. Similarly, cows will produce milk only to the level of the most limiting nutrient. By providing supplemental rumen-pass protein, we can increase the amount of that limiting amino acid (height of the short barrel stave), thereby increasing milk production.

What determines which proteins should be used in livestock diets?

a) The first step in deciding which proteins to feed **ruminants** is to determine which proteins will be used to feed the microorganisms or "bugs" in the rumen. These microbes can synthesize amino acids from nonprotein nitrogen that nonruminants cannot.
   1) A producer can choose true proteins, such as soybean meal or cottonseed meal. The other option is to feed a nonprotein nitrogen (NPN) feedstuff, such as urea or anhydrous ammonia. These two types of proteins supply nitrogen used by the microbes for protein synthesis.
   2) When using true proteins such as plant protein or animal protein, crude protein does not determine digestibility (amount of protein available to the animal). Crude protein is the total amount of protein available in the feedstuff, but an animal cannot digest all the protein available.
   3) Digestible protein best describes the amount of protein used by the animal.
   4) Price, of course, is another influencing factor.

b) The next consideration is the amount of protein digested by the rumen. Most nonprotein nitrogen feedstuffs are digested and utilized by microbes in the rumen.
   1) In TM 4.1, nonprotein feedstuffs are considered rapidly degraded proteins. Excess amounts of nonprotein nitrogen can result in higher levels of ammonia

in the rumen. Excess rumen ammonia is absorbed into the bloodstream and converted to urea in the liver. The nonprotein nitrogen (rapidly degraded protein) is converted into NH_3 (ammonia), and the excess enters the bloodstream, is transformed into urea in the liver, and leaves the body through the urine. Excess nonprotein nitrogen can result in ammonia toxicity due to high levels of blood ammonia. Only limited amounts of NPN can be used. (Four pounds of urea per cow per day is a safe maximum.)

2) In TM 4.1, bound proteins are the undigestible portions of true proteins. These proteins cannot be digested by the rumen or the small intestine. These proteins are the difference between crude protein and digestible protein. Bound proteins enter and leave the body virtually undigested.
3) There are also true proteins that are considered rapidly degraded proteins. A large part of these proteins are used by microbes in the rumen.
4) The last form of protein is slowly degraded protein. Part of these true proteins are digested in the rumen. Microbes in the rumen use some of them, and the remaining portions escape into the small intestine, where it is digested along with microbial protein and then used for muscle formation and milk production.

c) The last step in classifying feedstuffs is based on rumen digestion.
1) Solubility - Soluble proteins disappear or are digested in two hours or less after entering the rumen. These proteins are classified as "rapidly degraded protein" in TM 4.1. Example sources are urea, alfalfa silage, and anhydrous ammonia. Most of these proteins are used by microbial cells ("bugs").
2) Degradability - Degradable proteins are broken down at a measurable rate over time. The amount of protein digested in the rumen depends on the rate and amount of time spent in the rumen.
   (a) These proteins are classified as "rapidly and slowly degraded proteins" in TM 4.1. These proteins are used by microbial cells and the small intestine.
   (b) Examples are soybean meal and cottonseed meal.
3) Escape or bypass - These proteins bypass or escape rumen digestion. Most of them are digested and absorbed in the small intestine. These proteins are classified as "slowly degraded proteins" in TM 4.1. Examples are fish meal, blood meal, meat and bone meal, and corn gluten meal.
4) Nonprotein feedstuffs cannot supply all the protein necessary in the diet, but true proteins can. Nonprotein feedstuffs must be supplemented with true proteins.
5) TM 4.2 shows the effects of amino acids on milk production. Milk production in dairy cattle is limited by the lowest limiting amino acid (here, lysine).
   (a) In TM 4.2, this animal would only produce 75 lbs. of milk daily because the lysine becomes limiting at this level of milk production.
   (b) TM 4.2 also shows what would happen if the diet was supplemented with a bypass protein high in lysine. When this occurs, lysine is no longer the limiting amino acid; methionine now becomes the limiting amino acid.
   (c) This change results in increased milk production (75 lbs. to 92 lbs. daily). Paying close attention to ration balancing can mean a much more profitable operation.
   (d) This concept of limiting amino acids also applies to nonruminants.

d) Protein digestibility is easier to understand in **nonruminants** because there are no microbial cells to feed and no predigestion before entering the stomach.
1) Table 4.1 in the Student Reference shows the requirements for a growing 100 lb. market hog, as well as the crude protein, digestible protein, and amount of amino acids present in different feedstuffs.
2) A 100 lb. market hog requires a 16 percent crude protein diet. The average 100 lb. hog consumes 4.1 lbs. of feed daily. Of that, 16 percent needs to be crude protein, which is .66 lb. of crude protein. (Remember, this is an estimate.)

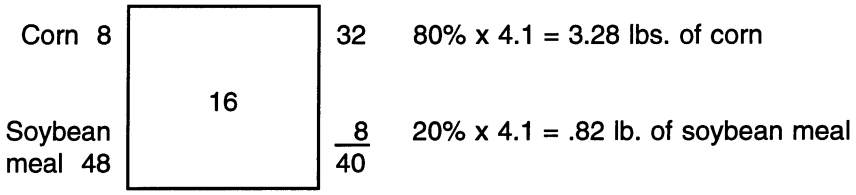
e) To further understand the hog's requirement, look at the bottom line of Table 4.1. It shows that the amino acid requirement for the 100 lb. hog is .019 lb. of isoleucine, .025 lb. of leucine, .031 lb. of lysine, .017 lb. of methionine and cystine, .02 lb. of threonine, and .005 lb. of tryptophan.

1) Use blood meal as an example. It has a crude protein percentage of 86 percent, of which 70 percent can be digested.
EXAMPLE: Of 100 lbs. of blood meal, 86 lbs. are crude protein, while 70 lbs. are usable (digestible) protein. Of the 100 lbs. of blood meal, the total amount of isoleucine is 1.13 lbs. There is .75 lb. of usable (digestible) isoleucine available in 100 lbs. of blood meal. To find out the digestible amount of isoleucine available in 50 lbs. of blood meal, multiply 50 lbs. of blood meal by .0075 digestible isoleucine. (50 x .0075 = .375 lb. of digestible isoleucine)

2) To find the available digestible leucine in 50 lbs. of blood meal, multiply 50 lbs. of blood meal by .0924. (50 x .0924 = 4.62 lbs.)

3) Let's use this information in a real life ration. On the average, a 100 lb. hog eats 4.1 lbs. a day. To find out if the ration below meets the amino acid requirements of this hog, find out the total amount of each feedstuff. In the following ration, 3.28 lbs. of the 4.1 lbs. eaten is corn, and .82 lb. is soybean meal. Usually, lysine is the limiting amino acid in most hog rations. Soybean meal will supply .021 lb. of lysine (.82 lb. x .0255 = .021). The corn supplies .006 lb. of lysine (3.28 x .0018 = .006). The hog requires .031 lb. of lysine; these feedstuffs supply .027 lb. of lysine (.021 + .006). This ration, therefore, is lacking lysine. Remember that all hog rations need vitamins and minerals, which have not been figured in yet. In real life, this ration would be balanced for lysine (not protein) to prevent this deficiency form occurring.

EXAMPLE: Balancing a ration



4) Remember that the 4.1 lbs. eaten daily is an average. In the winter, hogs will eat more than in the summer. To the average producer, using the above ration in the winter wastes money because it includes more amino acids than the hog needs. In the summer, the hog's appetite decreases and its needs are not met because it eats less than 4.1 lbs. a day. Figure 4.1 in the Student Reference shows this difference in eating habits.

5) If using the above ration, packers receive leaner hogs in the winter because hogs are eating more, so their amino acid needs are met, resulting in more muscle. In the summer, when hogs eat less, their amino acid needs are not met and fat is produced instead of muscle.

f) The processing of feedstuffs improves protein digestibility.

1) Compare raw soybeans to heated soybeans on Table 4.1 in the Student Reference. Crude protein remains about the same, but the digestibility of heated soybeans jumps up seven percent.

2) This concept also applies to digestibility of amino acids.

F. Other activities

1. "Litmus Milk Test," *Digestive System of Domesticated Animals (#8833-C).* Agriscience 332H: Advanced Animal Science. College Station, TX: Instructional Materials Service, Texas A & M University, 1990.

2. Compare feather meal (87% CP) and milk. Discus amino acid balances of the two.

3. Students can finish figuring the rest of the amino acids for the example ration to see if the ration is balanced. Or, they can make up a new ration with a new concentrate to see how closely the new ration meets the 100 lb. hog's amino acid requirements.

G. Conclusion

Understanding protein's role in nutrition is economically important because protein is one of the more expensive components in ration development.

H. Competency

Describe protein's role in nutrition.

I. Answers to Evaluation

1. a
2. c
3. b
4. b
5. a, b, c, e, g, h, i (question worth 10 points)
6. c, d, e, h (question worth eight points)
7. a, d, e, f, h (question worth eight points)

UNIT I - NUTRITION Name_____

Lesson 4: Protein's Role in Animal Nutrition Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which is true regarding amino acids?

   a. There are 10 essential and 13 nonessential amino acids.
   b. Amino acids are carbon compounds that originate from plant proteins.
   c. Non-ruminant animals can synthesize their own amino acids.
   d. Ruminants do not synthesize their own amino acids.

2. Which is *false* regarding proteins?

   a. Proteins are used in genetic compounds, such as DNA.
   b. Proteins are essential for body regulators, including enzymes and hormones.
   c. Urea can be fed to non-ruminant animals.
   d. When too much protein is used in the diet, the excess becomes fat.

3. Of the following plant proteins, which has the highest CP value?

   a. Cottonseed meal
   b. Sunflower meal
   c. Alfalfa hay
   d. Oat grain

4. Which is the information center that links amino acids together to form a specific protein the animal can use?

   a. Brain
   b. DNA
   c. RNA
   d. Stomach

Complete the following multiple answer questions.

5. Which are considered essential amino acids? (Check all that apply.)

____ a.	Arginine	____ f.	Valeucine
____ b.	Threonine	____ g.	Histidine
____ c.	Lysine	____ h.	Phenylalanine
____ d.	Lousine	____ i.	Isoleucine
____ e.	Valine	____ j.	Isocine

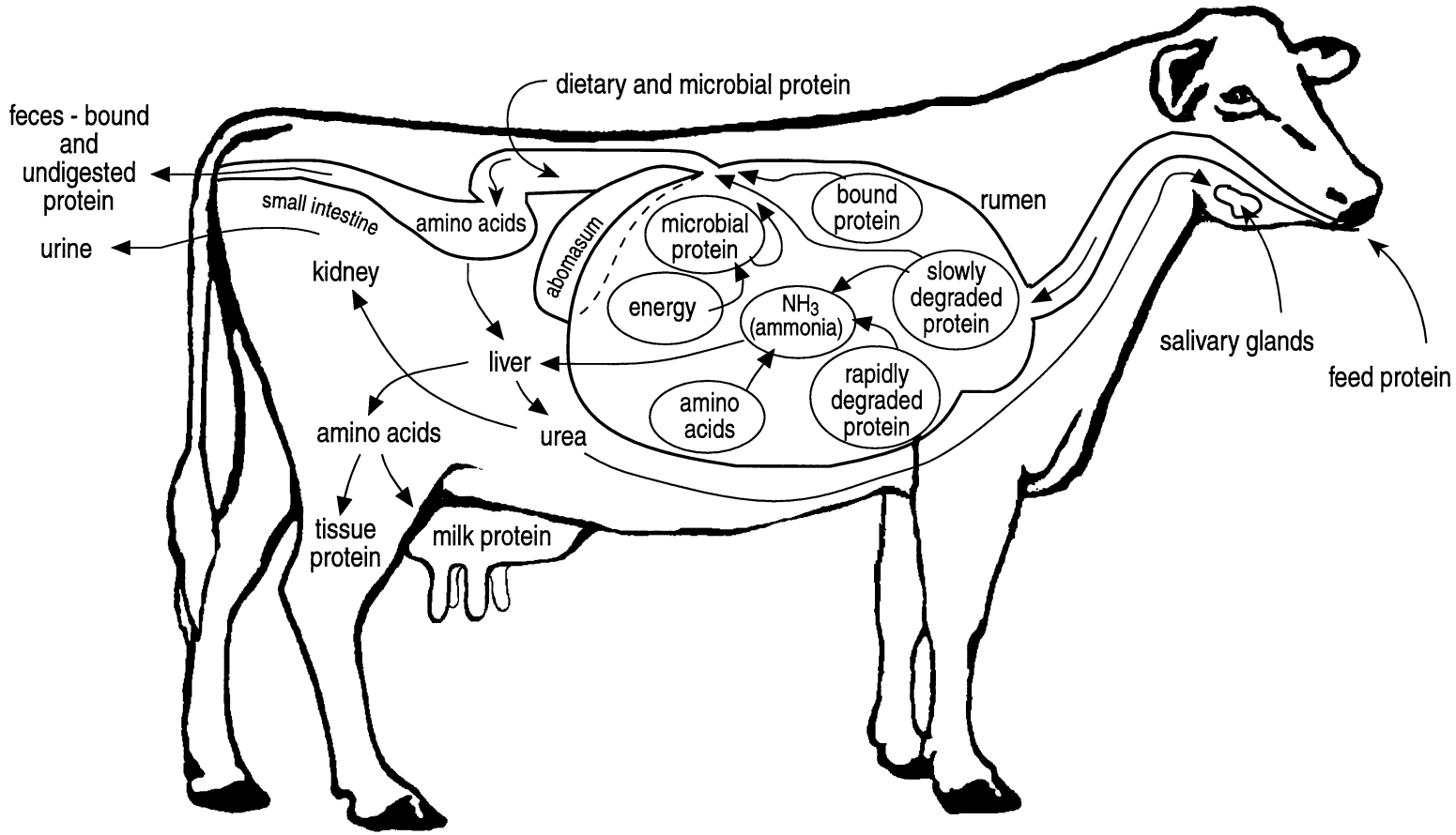
6. Mark with a check the symptoms of protein deficiency.

a. ___ Increased eye watering
b. ___ Hearing loss
c. ___ Poor hair coat
d. ___ Lack of energy
e. ___ Poor growth
f. ___ Poor appetite
g. ___ Diarrhea
h. ___ Lack of muscling

7. What factors need to be considered when determining amount of protein to be fed in a ruminant's diet?

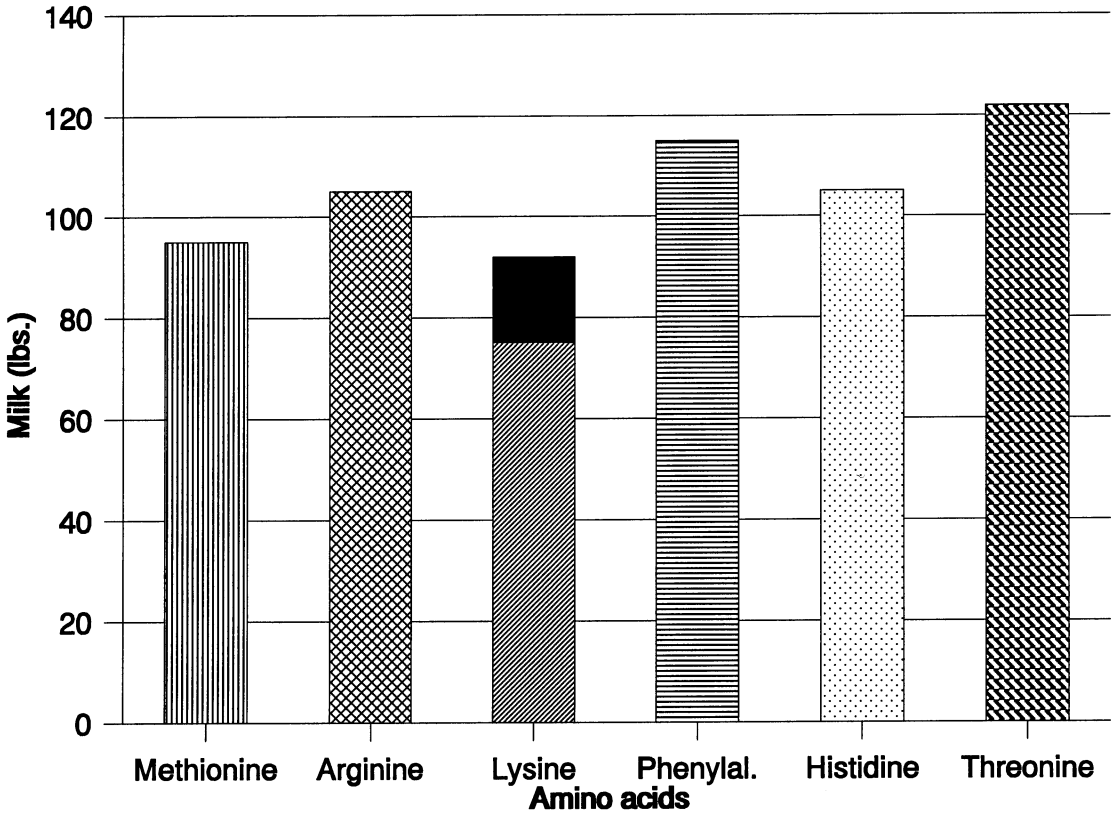
a. ___ Amount of nonproteins fed
b. ___ Mineral content of protein
c. ___ Vitamin content of protein
d. ___ Amount of true proteins fed
e. ___ The limiting amino acid
f. ___ Protein digestibility
g. ___ Energy level in the protein
h. ___ Price of the protein

Protein Utilization in the Ruminant



TM 4.1

Barrel Stave Illustration of the Effect of Limiting Amino Acid Supplementation on Milk Production



Darkest section shows effects of supplemental rumen-bypass lysine.

Credit: Jim Spain, Dairy Science Extension, University of Missouri-Columbia, 1994

UNIT I - NUTRITION

Lesson 5: Minerals' Role in Animal Nutrition

Objective: The student will be able to describe the function of minerals in animal nutrition.

Study Questions

1. **What basic minerals are required for proper animal nutrition?**
2. **What are the functions, deficiency and toxicity symptoms, and sources of macro-minerals?**
3. **What are the functions, deficiency and toxicity symptoms, and sources of micro-minerals?**

References

1. Student Reference

UNIT I - NUTRITION

Lesson 5: Minerals' Role in Animal Nutrition

TEACHING PROCEDURES

A. Review

Review the previous lesson on the role of protein in nutrition.

B. Motivation

1. What are some symptoms of mineral deficiencies in humans? What are the roles that minerals play in human nutrition? Deficiencies in calcium and phosphorus cause improper bone growth. Osteoporosis is caused by a lack of calcium. Deficiencies in magnesium cause major kidney malfunctioning and severe diarrhea. Shortages of sodium, chlorine, and potassium are rare, but in cases of severe diarrhea, burns, and vomiting, these minerals need to be replaced.

2. What happens if minerals are taken in excessive amounts by humans? In most cases, the human body will get rid of any excess amounts of minerals. Except for sodium, it is very difficult to consume too many minerals. (Sodium is connected to high blood pressure and fluid retention in the body.)

C. Assignment

D. Supervised study

E. Discussion

1. Ask students to discuss the minerals they know that are recommended for animals.

What basic minerals are required for proper animal nutrition?

a) Minerals are a group of inorganic elements needed by livestock for production and maintenance.
   1) Because they are inorganic, minerals cannot be synthesized by animals or microorganisms.
   2) If a particular mineral is needed, it must be provided in the diet in a form that can be digested, absorbed, and used in metabolism.
   3) Rations must be formulated so that a mineral imbalance does not occur.

b) Dissolved minerals are absorbed into the bloodstream through villi in the small intestine. Leftover minerals are absorbed directly into the bloodstream through capillaries in the wall of the large intestine.

c) Minerals are classified according to the dietary concentration needed to fulfill the animal's requirements.
   1) Macro- and micro-minerals are both important, but macro-minerals are needed in larger amounts. Macro-minerals are:
      (1) Calcium (Ca)
      (2) Salt--sodium chloride (NaCl)
      (3) Phosphorus (P)
      (4) Magnesium (Mg)
      (5) Potassium (K)

2) Trace or micro-minerals
   (1) Sulfur (S)
   (2) Chromium (Cr)
   (3) Cobalt (Co)
   (4) Copper (Cu)
   (5) Fluorine (F)
   (6) Iodine (I)
   (7) Iron (Fe)
   (8) Manganese (Mn)
   (9) Molybdenum (Mo)
   (10) Selenium (Se)
   (11) Silicon (Si)
   (12) Zinc (Zn)

d) General functions of minerals
   1) Filling in soft bone and teeth cells to make a cell that is hard and rigid
   2) Cell structure and integrity
   3) Part of organic compounds such as proteins, amino acids, carbohydrates, and fats
   4) Control the location of body water through osmotic pressure
   5) Provide an acid-base balance, which regulates the pH of body fluids at about 7.0
   6) Coenzymes that activate enzymes
   7) Necessary components of hormones
   8) Essential part of blood, body fluids, and some secretions in the body
   9) Egg production

e) Some minerals, such as arsenic, cadmium, mercury, and lead, are toxic to animals.

2. Discuss the functions of the required macro-minerals and what happens when enough minerals are not consumed.

What are the functions, deficiency and toxicity symptoms, and sources of macro-minerals?

a) Calcium (Ca)
   1) Major functions
      (1) Bone and teeth formation and maintenance
      (2) Approximately 99 percent of the body's calcium present in bones and teeth
      (3) Nerve function
      (4) Muscle contraction
      (5) Blood coagulation
      (6) Essential for milk production and for forming eggshells in poultry
   2) Deficiency symptoms
      (1) Rickets in youth
      (2) Osteoporosis in adults
      (3) Milk fever in dairy cows
      (4) Thin-shelled eggs, drop in egg production, and lowered hatchability in poultry
   3) Major interrelationships/toxicities
      (1) The calcium-to-phosphorus ratio is important.
      (2) Vitamin D is critical because a deficiency of vitamin D in the ration prevents the proper utilization of calcium.
      (3) Excess Ca reduces the absorption and utilization of Zn.
      (4) Excess Mg decreases Ca absorption, replaces Ca in the bones, and increases Ca excretion.

4) Good sources for animals
   (1) Oyster shells
   (2) Limestone
   (3) Protein supplements of animal origin
   (4) Legume forages, such as alfalfa or clover hay
   (5) Milk
   (6) Bonemeal

   NOTE: Only 20-30 percent of Ca in the average ration is absorbed from the intestinal tract and taken into the bloodstream.

b) Salt (sodium chloride, NaCl)
   1) Major functions
      (1) Salt helps maintain osmotic pressure in body cells, upon which depends the transfer of nutrients to the cells and the removal of waste materials.
      (2) Sodium (Na) is associated with muscle contraction and is important in making bile, which aids in the digestion of fats and carbohydrates.
      (3) Chlorine (Cl) is required for the formation of hydrochloric acid in the gastric juice, which is vital to protein digestion.
   2) Deficiency symptoms
      (1) Reduced growth and efficiency of feed utilization in growing animals
      (2) Reduced milk production and weight loss in adults
      (3) Lowered reproduction (infertility in males and delayed sexual maturity in females)
      (4) Craving for sodium, evidenced by behavior such as drinking urine or licking the ground
      (5) In laying hens, lowered production, loss of weight, and cannibalism
   3) Major interrelationships/toxicities
      (1) Salt toxicity, which is accentuated by low water intake, readily occurs in nonruminants. It is characterized by a staggering gait, blindness, and other nervous disorders.
      (2) Salt toxicity rarely occurs in ruminants.
      (3) Salt-starved ruminants can overeat if given unlimited access to salt, causing digestive disturbances or death.
   4) Good sources for animals
      (1) Salt given free choice
      (2) Salt added to the ration at a level of 0.25-0.50 percent

c) Phosphorus (P)
   1) Major functions
      (1) Bone and teeth formation and maintenance
      (2) Component of phospholipids, which are important in lipid transport and metabolism, as well as cell-membrane structure
      (3) Milk secretion
      (4) Energy metabolism
      (5) A component of RNA and DNA
      (6) Constituent of several enzyme systems
      (7) Affects conversion of carotene into vitamin A
      (8) Utilization of vitamin D
   2) Deficiency symptoms
      (1) Rickets in young
      (2) Osteoporosis in adults
      (3) Poor appetite
      (4) Breeding problems
      (5) Reduced egg production in hens
      (6) Poor utilization of vitamins A and D

3) Major interrelationships/toxicities
   (1) The Ca-P ratio is important.
   (2) Sufficient Vitamin D is necessary for P assimilation and utilization.
   (3) Excess Ca and Mg cause a decrease in P absorption.
   (4) P is more efficiently absorbed than calcium; about 70 percent of ingested phosphorus is absorbed.
   (5) Excess P may result in lameness and spontaneous fracture of long bones.
   (6) High P has a laxative effect.
4) Good sources for animals
   (1) Adequate level of vitamin D
   (2) Most cereal grains and their by-products (notably wheat bran)

d) Magnesium (Mg)
1) Major functions
   (1) Essential for normal skeletal development
   (2) Constituent of bones and teeth
   (3) Enzyme activator
   (4) Involved in activating certain enzyme systems and in protein digestion
   (5) Relaxes nerve impulses
   (6) Serves as a ruminant alkalizer and buffer
2) Deficiency symptoms
   (1) Vasodilation, with resulting reduction in blood pressure (shown by the flushing of the skin)
   (2) Hyperirritability
   (3) Grass tetany, characterized by loss of appetite, convulsions, staggering, and death
   (4) Decreased utilization of phosphorus
3) Major interrelationships/toxicities
   (1) Excess Mg upsets calcium and phosphorus metabolism.
   (2) Added Mg can cause a zinc deficiency.
4) Good sources for animals
   (1) Magnesium sulfate or oxide
   (2) Mixed with feed or in a commercial mineral

e) Potassium (K)
1) Major functions
   (1) Major cation (positively charged ion) in intracellular fluid, where it is involved in osmotic pressure and acid-base balance
   (2) Relaxes the heart muscle
   (3) Involved in secretion of insulin
   (4) Involved in carbohydrate metabolism and protein synthesis
2) Deficiency symptoms
   (1) Reduced growth
   (2) Unsteady gait
   (3) General muscle weakness
   (4) Diarrhea
   (5) Enlargement of the heart and kidneys, followed by death
   (6) May occur in dry lot finishing cattle or sheep on a high-concentrate ration
3) Major interrelationships/toxicities
   (1) Excessive levels of potassium interfere with magnesium absorption.
   (2) The resulting magnesium deficiency results in failure to retain potassium, leading to potassium deficiency.
   (3) Excessive salt intake depletes the body's potassium.
4) Good sources for animals--generally adequate in most animal rations

3. Ask the students about the functions of micro-minerals. What happens when too little (or too much) is fed?

What are the functions, deficiency and toxicity symptoms, and sources of micro-minerals?

a) Sulfur (S)
   1) Major functions
      (1) Sulfur is required as a component of sulfur-containing amino acids cystine and methionine.
      (2) A component of biotin, sulfur is important in lipid metabolism.
      (3) As a component of coenzyme A, sulfur is important in energy metabolism.
      (4) Sulfur is a component of hair, wool, and feathers.
   2) Deficiency symptoms
      (1) There is reduced and slowed growth, primarily due to not meeting the sulfur amino acid requirement for protein synthesis.
      (2) Sheep that are fed nonprotein nitrogen without sulfur supplements show reduced wool growth. (Wool contains about 4 percent sulfur.)
   3) Major interrelationships/toxicities--none
   4) Good sources for animals
      (1) Forages, especially legumes which are harvested in the earlier growth stages, should contain enough sulphur for ruminants.
      (2) Nonruminants should be provided sulfur-containing proteins.

b) Chromium (Cr)
   1) Major functions
      (1) Glucose metabolism
      (2) Activator of certain enzymes
      (3) Stabilizer of nucleic acids
      (4) Stimulation of the synthesis of fatty acids and cholesterol in the liver
   2) Deficiency symptoms
      (1) Impaired glucose tolerance
      (2) Disturbance of lipid and protein metabolism
   3) Supplements not generally needed

c) Cobalt (Co)
   1) Major functions
      (1) Essential for vitamin B_{12} synthesis
      (2) Used by rumen microorganisms in the growth of rumen bacteria
   2) Deficiency symptoms
      (1) Symptoms similar vitamin B_{12} deficiency are shown in cattle and sheep.
      (2) Ruminants grazing in cobalt-deficient areas show loss of appetite, reduced growth, and loss in body weight, followed by emaciation, anemia, and eventually death.
   3) Major interrelationships/toxicities
      (1) Related to vitamin B_{12}
      (2) Toxicity not likely
   4) Good sources for animals
      (1) Commercial minerals
      (2) Poultry by-product meal, soybean meal, and molasses

d) Copper (Cu)
   1) Major functions
      (1) Along with iron and vitamin B_{12}, necessary for hemoglobin formation
      (2) Essential in enzyme systems
      (3) Essential for hair development and pigmentation
      (4) Essential for lactation and reproduction

2) Deficiency symptoms
   (1) Fading hair coat
   (2) Severe diarrhea
   (3) Abnormal wool growth and straight, hairlike fibers
   (4) Condition known as swayback in newborn lambs
   (5) Nutritional anemia
3) Major interrelationships/toxicities
   (1) Excess copper is toxic; it accumulates in the liver, and death may result, especially in sheep.
   (2) Cu is involved in iron metabolism.
4) Good sources for animals
   (1) Trace-mineralized salt containing copper sulfate
   (2) Commercial minerals
5) Additional comments
   (1) A variable store of copper is located in the liver and spleen.
   (2) Milk is low in copper; therefore, young animals raised solely on milk may develop anemia.
   (3) Do not supply sheep with commercial minerals containing copper; it may be lethal because copper accumulates in bodies and does not metabolize.

e) Fluorine (F)
1) Major function--necessary for sound bones and teeth
2) Deficiency symptoms--uncommon
3) Major interrelationships/toxicities
   (1) Large amounts of calcium, aluminum, or fat will lower the absorption of fluorine.
   (2) High dietary Ca depresses F uptake in bone
   (3) Since fluorine is a cumulative poison, toxic effects may not be noticed for some time.
   (4) High levels result in enlarged bones; softening, mottling, and irregular wear of the teeth; roughened hair coat; delayed maturity and less efficient utilization of feed.
4) Good sources for animals--supplements not needed

f) Iodine (I)
1) Major functions
   (1) Iodine is needed by the thyroid gland to make thyroxin.
   (2) Thyroxin controls the rate of body metabolism or heat production.
2) Deficiency/toxicity
   (1) Goiter (big-neck) in humans, calves, lambs, and goats; stillbirths and weak young; hairless pigs and wool-less lambs at birth
   (2) No satisfactory treatment for animals that have developed pronounced iodine deficiency symptoms
   (3) Enlargement of the thyroid gland (goiter) is nature's way of trying to make enough thyroxin when there is insufficient iodine in the diet.
   (4) Long-term chronic intake of large amounts of iodine reduces the thyroid uptake of iodine.
3) Good sources for animals
   (1) Calcium iodate
   (2) Iodized salt
   (3) Whey and molasses

g) Iron (Fe)
1) Major functions
   (1) Constituent of hemoglobin, the iron-containing compound that transports oxygen in the blood
   (2) Plays a role in cellular oxidation

2) Deficiency symptom--iron-deficient anemia in nursing pigs in confinement
3) Major interrelationships/toxicities
   (1) Copper is required for proper Fe metabolism.
   (2) Too much iron interferes with phosphorus absorption.
4) Good sources for animals
   (1) Iron dextran given orally or by injection to young pigs
   (2) Leafy portions of plants
   (3) Legumes
   (4) Trace-mineralized salt
5) Additional comments
   (1) Iron is stored in the liver, spleen, and kidneys.
   (2) Young animals are born with a store of iron, but milk is low in iron. Therefore, if young animals continue on milk for a long time, particularly under confined conditions, anemia will likely develop.

h) Manganese (Mn)
1) Major functions
   (1) Essential for normal bone formation and growth of other connective tissues
   (2) Blood clotting
   (3) Synthesis of fatty acids
2) Deficiency symptoms
   (1) Poor growth
   (2) Lameness, shortening, and bowing of the legs, and enlarged joints
   (3) Swollen and stiff joints
   (4) Impaired reproduction
   (5) Slipped tendons in poultry
   (6) Pinkeye
3) Major interrelationships/toxicities
   (1) Excess Ca and P decrease absorption.
   (2) Mn is not toxic in moderate excesses.
4) Good sources for animals
   (1) Trace-mineralized salt
   (2) Rice, wheat, and hay

i) Molybdenum (Mo)
1) Major functions
   (1) Component of three different enzyme systems involved in the metabolism of carbohydrates, fats, proteins, and iron
   (2) Stimulates action of rumen organisms
2) Deficiency symptoms--none
3) Major interrelationships/toxicities
   (1) Utilization is reduced by excess copper sulfate and tungsten.
   (2) Molybdenum is related to uric acid formation in poultry and microbial action in ruminants.
   (3) Toxic levels of Mo interfere with copper metabolism.
   (4) Mo toxicity results in severe scours and loss of condition.
4) Good sources for animals--no supplementing of normal rations necessary

j) Selenium (Si)
1) Major functions
   (1) Protects tissue against certain poisonous substances, such as arsenic, cadmium, and mercury
   (2) Involved in vitamin E absorption and retention
   (3) Prevents degeneration and fibrosis of the pancreas in chicks

2) Deficiency symptoms
   (1) Nutritional muscular dystrophy (called white muscle disease in calves) or stiff lamb disease in sheep
   (2) Liver damage in swine
3) Major interrelationships/toxicities
   (1) Excess selenium consumption results in blind staggers, lameness, anemia, excess salivation, grinding of the teeth, and blindness.
   (2) Excess in poultry results in reduced egg production and deformities such as lack of eyes and deformed wings and feet.
4) Good sources for animals
   (1) Marine by-products, such as seaweed and kelp
   (2) Cereal grains and wheat by-products

k) Silicon (Si)
1) Major function--necessary for normal growth and skeletal development of chicks
2) Deficiency symptoms
   (1) Slow growth
   (2) Skeletal deformities, especially in the skull
3) Good sources for animals--present in large amounts in soil and plants
4) Additional comments--On purified diets, the addition of silicon has increased the growth rate of chicks.

l) Zinc (Zn)
1) Major functions
   (1) Needed in normal skin, bones, hair, and wool
   (2) Component of several enzyme systems
   (3) Gives bloom to the hair coat
2) Deficiency symptoms
   (1) Loss of appetite
   (2) Stunted growth
   (3) Poor hair or feather development
   (4) Rough and thickened skin in swine (parakeratosis)
3) Major interrelationships/toxicities
   (1) Excess calcium reduces the absorption and utilization of zinc.
   (2) Excess zinc interferes with copper metabolism and may cause anemia.
4) Good sources for animals
   (1) Fish meal
   (2) Corn gluten feed and meal
   (3) Poultry by-products
   (4) Added to trace-mineralized salt

F. Other activities

1. Have students bring in tags from various commercial mineral mixes and compare the amounts and types of minerals that are present.

2. Invite a nutrition specialist or feed representative talk about the importance of minerals in an overall nutrition plan.

3. Obtain videos to show abnormalities in animals. Contact Creative Educational Videos, PO Box 65265, Lubbock, TX 79424 (800/922-9965) for:

   a) Cattle Abnormalities (26 min., #2010108WIS15002Q)
   b) Sheep Abnormalities (24 min., #2010108WIS15000Q)
   c) Swine Abnormalities (26 min., #2010108WIS15001Q)

G. Conclusion

At least 18 mineral elements are needed by animals. Those needed in large amounts are referred to as major or macro-minerals, while those needed in small amounts are called trace or micro-minerals. Minerals are required for the development of bones and teeth, as well as for many other functions in the body. Deficiencies cause lower production and poor gains, but rarely cause diseases or death. Commercial feeds and mineral mixes are the most common sources of minerals in livestock rations. Minerals can be mixed in complete feeds or fed free choice.

H. Competency

Describe minerals' role in nutrition.

I. Answers to Evaluation

1. a
2. h
3. g
4. f
5. d
6. i
7. e
8. b
9. j
10. i
11. a
12. g
13. d
14. f
15. h

16. Any four of the following:
    a. Filling in soft bone and teeth cells to make a cell that is hard and rigid
    b. Cell structure and integrity
    c. Part of organic compounds such as proteins, amino acids, carbohydrates, and fats
    d. Control the location of body water via osmotic pressure
    e. Provide an acid-base balance, which regulates the pH of body fluids at about 7.0
    f. Coenzymes that activate enzymes
    g. Necessary components of hormones
    h. Essential part of blood, body fluids, and some secretions in the body
    i. Egg production

17. Sodium = Na
    Potassium = K
    Magnesium = Mg
    Copper = Cu
    Iron = Fe

18. Small intestine and large intestine

UNIT I - NUTRITION Name_____

Lesson 5: Minerals' Role in Animal Nutrition Date_____

EVALUATION

Match the following minerals on the right with their corresponding functions on the left.

___ 1.	Bone and teeth formation; nerve function; muscle contraction and blood coagulation.	a.	Calcium
___ 2.	Helps maintain osmotic pressure in body cells; required for muscle contraction; required for making bile and hydrochloric acid	b.	Copper
___ 3.	Relaxes the heart muscle and is involved in the secretion of insulin	c.	Fluorine
___ 4.	Component of RNA and DNA	d.	Iodine
___ 5.	Needed by the thyroid gland to produce thyroxin	e.	Iron
___ 6.	Needed for normal skin, bones, hair, and feathers	f.	Phosphorus
___ 7.	Constituent of hemoglobin; plays a role in cellular oxidation	g.	Potassium
		h.	Salt
		i.	Zinc

Match the following minerals on the right with their correct deficiency symptom(s) on the left.

___ 8.	Emaciation, anemia, and eventually death in ruminants	a.	Calcium
___ 9.	Rough and thickened skin in swine (parakeratosis)	b.	Cobalt
___ 10.	Stunted growth and skeletal deformities in chicks	c.	Fluorine
___ 11.	Tetany or milk fever in cows	d.	Iodine
___ 12.	Enlargement of the heart and kidneys	e.	Iron
___ 13.	Goiter (enlargement of the thyroid gland)	f.	Manganese
___ 14.	Lameness, swelling of the joints, and fragility of the bones	g.	Potassium
___ 15.	White muscle disease in calves and stiff lamb disease in sheep	h.	Selenium
		i.	Silicon
		j.	Zinc

Complete the following short answer questions.

16. List four general functions of minerals.

    a.

    b.

    c.

    d.

17. Give abbreviations for the following minerals.

    a. Sodium =

    b. Potassium =

    c. Magnesium =

    d. Copper =

    e. Iron =

18. Where minerals are absorbed?

UNIT I - NUTRITION

Lesson 6: Vitamins' Role in Animal Nutrition

Objective: The student will be able to describe the function of vitamins in livestock nutrition.

Study Questions

1. **What basic vitamins are required?**

2. **What are the functions, deficiency symptoms, and important sources of fat-soluble vitamins?**

3. **What are the functions, deficiency symptoms, and important sources of B complex vitamins?**

4. **What are the functions, deficiency symptoms, and important sources of other water-soluble vitamins?**

References

1. Student Reference

UNIT I - NUTRITION

Lesson 6: Vitamins' Role in Animal Nutrition

TEACHING PROCEDURES

A. Review

Review previous lesson on the role of minerals in animal nutrition.

B. Motivation

1. What are some vitamin deficiencies found in humans? What are the functions of vitamins in human nutrition? Deficiencies of vitamin A cause night blindness, rough skin, stunted growth, and eyes that are light sensitive. Deficiencies of vitamin D cause improper usage of calcium and phosphorus, which can result in rickets. Deficiencies of vitamin E are very rare. Severe vitamin K deficiency causes hemorrhaging. A lack of vitamin C causes loss of appetite, soreness of joints, bleeding gums, bruising, and scurvy. In humans and dogs, a lack of folic acid can result in a sore, red tongue, disturbance of the digestive tract, and poor growth.

2. What happens if vitamins are taken in excessive amounts by humans? Extra amounts of vitamins are discarded by the body, but there are extreme cases for each vitamin. Too much vitamin C may cause diarrhea. Too much vitamin K or E may be toxic. Excessive vitamin D may result in severe damage to kidneys, lungs, and bones. Too much vitamin A may cause fatigue, headaches, vomiting, and nausea.

3. What are some similarities between swine and humans? How are the nutrient requirements the same? Both swine and humans cannot produce B-complex vitamins. These vitamins must be provided in their diet.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students to discuss why vitamins are important and what vitamins are required for good nutrition.

What basic vitamins are required?

a) General definition
   1) Vitamins are a feedstuff component distinct from carbohydrates, fat, protein, minerals, and water.
   2) They are essential for development of tissues and the growth and maintenance of the animal.

b) Classification by solubility
   1) Fat-soluble vitamins
      (a) Stored in the animal's fat tissue
      (b) Enable livestock to survive on vitamin-deficient diets for lengths of time without deficiency symptoms.
      (c) Includes:
         (1) Vitamin A

(2) Vitamin D
(3) Vitamin E
(4) Vitamin K

2) Water-soluble vitamins
   (a) Stored within the animal for only 2-4 days
   (b) Must be contained in the diet
   (c) Includes:
      (1) Inositol
      (2) Niacin
      (3) Vitamin C
      (4) B_1 (thiamine)
      (5) B_2 (riboflavin)
      (6) B_3 (pantothenic acid)
      (7) B_6 (pyridoxine)
      (8) B_{12}
      (9) Biotin
      (10) Choline
      (11) Folic acid
      (12) Para-aminobenzoic acid (PABA)

c) General sources for all vitamins
   1) Protein supplements
   2) Mineral premixes
   3) Feed tags show the guaranteed minimum and maximum percentages of calcium, minimum percentage of phosphorus, and minimum and maximum percentages of salt in the feed.
   4) Vitamins are usually added to mixed rations or provided free choice.

d) Arsenic, cadmium, lead, and mercury are all toxic to livestock. Prevent contamination of feed by these elements.

2. Discuss with students the functions of the various required vitamins that dissolve in fat.

What are the functions, deficiency symptoms, and important sources of fat-soluble vitamins?

a) Vitamin A
   1) Major functions
      (a) Eyesight maintenance (formation of visual purple in the eye for night vision)
      (b) Essential for body growth, bone growth, and normal tooth development
      (c) Epithelial tissue maintenance in respiratory, urogenital, and digestive tracts, and the skin
   2) Deficiency symptoms
      (a) Night blindness and potential blindness
      (b) Stunted growth or loss of weight and loss of appetite
      (c) Nervous incoordination as shown by a staggering gait
      (d) Unsound teeth and rough, dry skin
      (e) Sterility in males and females
      (f) Wobbly gait in chicks
      (g) Reduced egg production and hatchability in hens
   3) Good sources for animals
      (a) Vitamin A can be provided as a synthetic vitamin or as carotene.
      (b) Major sources of carotene are:
         (1) Leafy green hays, not over one year old
         (2) Grass silage

(3) Lush green pastures
(4) Whole milk
(5) Dehydrated alfalfa meal
(6) Yellow corn

4) Additional comments
   (a) Vitamin A itself is only present in animals. Plants contain the precursor, carotene.
   (b) Animals can store considerable amounts of vitamin A. Young animals suffer from deficiency sooner because of their greater requirements and reduced storage ability.
   (c) Vitamin A and carotene are readily destroyed by oxidation, thus resulting in considerable losses in processing and storing (such as in making and storing hay).

b) Vitamin D
   1) Major functions
      (a) Aids in the assimilation and utilization of calcium and phosphorus
      (b) Necessary for the normal bone development of animals, including the bone in the fetus
      (c) Promotes sound teeth
   2) Deficiency symptoms
      (a) Rickets in young
      (b) Osteoporosis in adults
      (c) Tetany, which is characterized by muscle twitching, convulsions, and low serum calcium
      (d) Poor eggshells and lowered hatchability in hens
   3) Good sources for animals
      (a) Sunlight
      (b) Sun-cured hays
   4) Additional comments
      (a) When animals are exposed to direct sunlight, the ultraviolet light in the sunlight penetrates the skin and produces vitamin D from traces of certain cholesterol in the tissues.
      (b) Tissue storage is very limited.
      (c) The vitamin D requirement is less when the proper balance of calcium and phosphorus exists.

c) Vitamin E
   1) Major functions
      (a) Antioxidant
      (b) Essential for the integrity of red blood cells
      (c) Essential in cellular respiration, primarily in heart and skeletal muscle tissue
      (d) Regulator in the synthesis of DNA and vitamin C
   2) Deficiency symptoms
      (a) Muscular dystrophy (stiff-limb disease in lambs and white muscle disease in calves)
      (b) Reproductive failure
      (c) Poor hatchability in hens
   3) Good sources for animals
      (a) Rice polishings
      (b) Wheat germ meal
      (c) Alfalfa meal
      (d) Green grass
      (e) Early cut hay

4) Additional comments
   (a) Vitamin E is widely distributed in all natural feeds.
   (b) Utilization of vitamin E depends on adequate selenium.

d) Vitamin K
   1) Major function--essential for blood clotting
   2) Deficiency symptoms
      (a) Prolonged blood clotting time
      (b) Generalized hemorrhages
      (c) Death, in severe cases
   3) Good sources for animals
      (a) Green pastures
      (b) Well-cured hays
      (c) Fish meal
      (d) Usually widely distributed in normal farm rations
      (e) Synthesized by all classes of farm animals

      NOTE: A well-known enemy of vitamin K is dicoumarol, which is present in moldy sweet clover hay.

3. Discuss with students the functions of the various B vitamins, which are water-soluble. Do they have similarities?

What are the functions, deficiency symptoms, and important sources of B complex vitamins?

a) Biotin
   1) Major functions
      (a) Required in many reactions in the metabolism of carbohydrates, fats, and proteins
      (b) Serves as a coenzyme for transferring CO_2 from one compound to another
      (c) Serves as a coenzyme for the production of energy
   2) Deficiency symptoms
      (a) Pigs exhibit spastic hind legs, cracks in the feet, dermatitis, and lower feed efficiency.
      (b) Hatchability is severely reduced in hens.
   3) Good sources for animals
      (a) Synthetic biotin
      (b) Alfalfa meal
      (c) Black strap molasses
      (d) Green forages
      (e) Soybean meal
   4) Ordinary farm rations probably contain ample biotin, or farm animals synthesize all they need.

b) Choline
   1) Major functions
      (a) Involved in the prevention of fatty livers
      (b) Involved in transmitting nerve impulses
      (c) Involved in the metabolism of fat
   2) Deficiency symptoms
      (a) Poor growth and fatty livers in most species
      (b) Slipped tendons in chickens and turkeys
      (c) In swine, abnormal gait in growing pigs and reproductive failure in adult females
   3) Good sources for animals
      (a) Soybean lecithin

(b) Yeast
(c) Canola meal
(d) Fish meal

4) Additional comments
(a) With a high-protein diet, enough choline is synthesized from certain precursors and amino acids.
(b) Deficiency symptoms are more visible as the protein content is lowered.

c) Folic acid

1) Major functions
(a) Involved in combining single carbon units into larger molecules
(b) Related to vitamin B_{12} metabolism
(c) Formation of many essential amino acids

2) Deficiency symptoms
(a) In chicks, reduced growth and depigmentation of colored feathers
(b) Lower egg production and hatchability

3) Good sources for animals
(a) Synthetic folacin
(b) Wheat germ
(c) Soybean meal
(d) Alfalfa hay
(e) Cottonseed meal

d) Vitamin B_1 (thiamine)

1) Major functions
(a) Coenzyme in energy metabolism
(b) Functioning of the peripheral nerves
(c) Maintains normal appetite
(d) Maintains muscle tone
(e) Maintains healthy mental attitude

2) Deficiency symptoms
(a) Utilization of thiamin is hindered by high fat diets.
(b) Reduced appetite, anorexia, and loss in weight
(c) Slower heartbeat and enlargement of the heart
(d) Lowered body temperature
(e) Lowered egg production in hens

3) Good sources for animals
(a) Dietary source of vitamin B_1 needed for all animals but ruminants
(b) Cereal grains
(c) Green, leafy hay
(d) Commercial vitamin premixes

e) Riboflavin (vitamin B_2)

1) Major functions
(a) Promotes growth and functions in the body as a constituent of several enzyme systems
(b) Important in carbohydrate, fatty acid, and amino acid metabolism

2) Deficiency symptoms
(a) Stunted growth
(b) Periodic moon blindness in horses
(c) Reproductive failure in the sow
(d) Slow growth, anemia, diarrhea, and abnormal gait in the young pig
(e) Curled toe paralysis in birds

3) Good sources for animals
(a) Synthetic riboflavin
(b) Milk
(c) Alfalfa hay

(d) Green pastures

4) Additional comments
   (a) Grains are poor sources of riboflavin.
   (b) Many common rations, especially swine and poultry rations, are borderline or deficient in riboflavin.
   (c) Riboflavin is destroyed by light or heat.

f) Vitamin B_3 (pantothenic acid)
   1) Major functions
      (a) B_3 is a component of coenzyme A, which is required for energy metabolism.
      (b) Coenzyme A is required by the cells in the biosynthesis of fatty acids.
   2) Deficiency symptoms
      (a) All species exhibit reduced growth, loss of hair, and enteritis.
      (b) Signs of deficiency in calves are a rough coat, dermatitis, anorexia, and loss of hair around the eyes. (Mature ruminants synthesize vitamin B_3 in the rumen.)
   3) Good sources for animals
      (a) Yeast
      (b) Whey
      (c) Alfalfa meal
   4) Additional comments
      (a) Grain is very deficient in vitamin B_3.
      (b) Of all the B vitamins, B_3 is most likely to be deficient under dry lot conditions.
      (c) Vitamin B_3 is commonly added to commercial swine and poultry rations.

g) Vitamin B_6 (pyridoxine)
   1) Major functions
      (a) Coenzyme in protein and nitrogen metabolism
      (b) Involved in red blood cell formation and in absorption of amino acids
      (c) Involved in carbohydrate and fat metabolism
   2) Deficiency symptoms
      (a) All species exhibit convulsions.
      (b) Pigs show anorexia and poor growth.
      (c) Chicks experience stunted growth and abnormal feathering.
      (d) Hens show lowered egg laying and hatchability.
   3) Good sources for animals
      (a) Green pasture
      (b) Wheat
      (c) Alfalfa hay
   4) Additional comments
      (a) B_6 is synthesized in the rumen of cattle and sheep and perhaps in the cecum of the horse.
      (b) Normally, animal rations are not lacking in vitamin B_6.

h) Vitamin B_{12}
   1) Major functions
      (a) B_{12} functions as a coenzyme in a variety of metabolic reactions.
      (b) B_{12} is necessary for the maturation of red blood cells.
   2) Deficiency symptoms
      (a) Generally, there is stunted growth.
      (b) Pigs show uncoordinated hind leg movements, and there is reproductive failure in sows.
      (c) Eggs from B_{12} deficient hens do not hatch.
   3) Good sources for animals
      (a) Synthetic B_{12}

(b) Protein supplements of animal origin
(c) Fermentation products

4) Additional comments
(a) Ruminants synthesize B_{12} in the rumen.
(b) B_{12} is apt to be lacking in swine and breeder poultry rations.

i) Para-aminobenzoic acid (PABA)

1) Major functions
(a) Essential part of the folacin molecule
(b) Essential growth factor for certain microorganisms

2) Deficiency symptoms are not demonstrated in animals.

3) Good sources for animals
(a) Synthetic PABA
(b) Lecithin
(c) Soybean meal
(d) Peanut meal

4) PABA is abundantly synthesized in the intestines.

4. Discuss with students the functions of other water-soluble vitamins, besides the B complex. Do they have similarities?

What are the functions, deficiency symptoms, and important sources of other water-soluble vitamins?

a) Inositol

1) Major functions
(a) In combination with choline, it prevents hardening of the arteries and protects the heart.
(b) Inositol helps reduce blood cholesterol.

2) Deficiency symptoms are not demonstrated in animals.

3) Good sources for animals
(a) Synthetic inositol
(b) Yeast
(c) Liver meal

4) Additional comments
(a) Widely distributed in animal feeds
(b) Synthesized in the intestines

b) Niacin

1) Major functions
(a) Constituent of two coenzymes, which are necessary in cell respiration
(b) Necessary to release energy from carbohydrates, fats, and protein

2) Deficiency symptoms
(a) Often, there is reduced growth and appetite.
(b) Swine have diarrhea, vomiting, dermatitis, unthriftiness, and ulcerated intestines.
(c) Chicks show poor feathering and scaly dermatitis.

3) Good sources for animals
(a) Synthetic niacin
(b) Meat and bone meal
(c) Green alfalfa

4) Additional comments
(a) Niacin is a dietary essential for pigs, chickens, and humans.
(b) It is synthesized in the digestive tract of ruminants. Mature ruminants do not need dietary niacin under most conditions because of rumen bacteria.

(c) Niacin that is present in most cereal grains is not available to pigs and other simple-stomached animals.

c) Vitamin C (ascorbic acid)
   1) Major functions
      (a) Necessary for collagen formation
      (b) Absorption and movement of iron
      (c) Metabolism of fats and lipids and cholesterol control
      (d) Sound teeth and bones
      (e) Strong capillary walls and healthy blood vessels
      (f) More needed in periods of stress
   2) Deficiency symptoms
      (a) Scurvy--swollen, bleeding, and ulcerated gums
      (b) Loosening of teeth
      (c) Weak bones
   3) Good sources for animals
      (a) Vitamin C
      (b) Citrus pulp
      (c) Well-cured hay
      (d) Green pasture
   4) Ordinary rations and body synthesis provide adequate vitamin C.

F. Other activities

1. Have students formulate a nutrition plan for various species, include the necessary vitamin supplements that would be needed, and justify the need.

2. Have a nutrition specialist speak to the class about the importance of vitamins in a ration.

G. Conclusion

Vitamins are organic compounds essential for life but needed only in trace amounts. Sixteen vitamins have been identified as essential in animal nutrition. They are classified by their solubility--either fat-soluble or water-soluble. Fat-soluble vitamins can be stored in the body, reducing the need for dietary sources. Water-soluble vitamins are not generally stored in the body and need to be supplied in the animal's diet. Vitamins play a vital role in various functions of the body's system and are an important part of the animal's overall nutrition.

H. Competency

Describe vitamins' role in nutrition.

I. Answers to Evaluation

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

11. Fat-soluble and water-soluble. Fat-soluble vitamins can be stored in the body, whereas water-soluble vitamins cannot. Therefore, the water-soluble vitamins must be supplied in the diet on daily basis.

UNIT I - NUTRITION Name_____

Lesson 6: Vitamins' Role in Animal Nutrition Date_____

EVALUATION

Match each vitamin on the right with the appropriate function on the left.

___ 1. Aids in assimilation and use of calcium and phosphorus; promotes normal bone development

___ 2. Essential for blood clotting

___ 3. Prevents night blindness; necessary for the maintenance of epithelial tissue

___ 4. Involved in red blood cell formation and in absorption of amino acids

___ 5. Maintains normal appetite, muscle tone and healthy mental attitude

___ 6. Component of coenzyme A; required for energy metabolism and of acyl carrier protein (ACP)

___ 7. Promotes growth and functions in the body as a constituent of several enzyme systems; is important in carbohydrate, fatty acid, and amino acid metabolism

___ 8. Necessary for cell respiration and in energy release from carbohydrates, fats, and protein

___ 9. Necessary for collagen formation and for iron absorption and movement

___ 10. Serves as a coenzyme for transferring CO_2 from one compound to another

a. Vitamin A

b. Vitamin K

c. Vitamin C

d. Vitamin B_6

e. Niacin

f. Biotin

g. Vitamin B_3 (pantothenic acid)

h. Vitamin B_2 (riboflavin)

i. Vitamin B_1 (thiamin)

j. Vitamin D

k. Vitamin B_{12}

Complete the following short answer question.

11. What are the two ways in which vitamins are classified?

Explain the differences between these ways.

UNIT I - NUTRITION

Lesson 7: Water's Role in Animal Nutrition

Objective: The student will be able to understand the function of water in animal nutrition.

Study Questions

1. **What is the function of water?**
2. **What are daily requirements for water?**
3. **What is water toxicity, and what are its symptoms?**
4. **What happens if there is an inadequate water supply?**

References

1. Student Reference

UNIT I - NUTRITION

Lesson 7: Water's Role in Animal Nutrition

TEACHING PROCEDURES

A. Review

Review previous lesson on vitamins' role in animal nutrition.

B. Motivation

Why is water important to the human body? What happens when the human body is lacking water? Water makes up 50-75 percent of a human's weight. It helps in digestion, cell growth, chemical reactions, body temperature regulation, joint lubrication, and body structure and shape. Lack of water can cause kidney failure, fever, increased pulse rate, and flushed skin.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students why water is so vital in the lives of humans. How many of these functions apply to livestock?

What is the function of water?

a) Important part of the body fluids
   1) Lubricates joints
   2) Lubricates eyes
   3) Acts as a cushion for nerves
   4) Helps conduct sound in the ear
   5) Helps dilute toxic substances, such as urea, and carry them through the digestive system (Urea is harmless to the urinary tract if it is diluted in water.)

b) Important part in the circulatory system
   1) Transfers heat from one part of the body to another, like a car radiator
   2) Cools the animal's body since animals do not have sweat glands to keep cool them like humans (They use evaporation of water to cool the body.)

c) Important part in gas exchange in the body
   1) Water vapor is mixed with other gases and expelled during respiration.
   2) Water is used in body temperature regulation.

d) Acts as a carrier in the mouth
   1) Carries chemicals in food to taste buds for the animal's recognition
   2) Aids in maintaining an animal's body shape
   3) Used in metabolism, digestion, and absorption of nutrients in the animal
   4) Essential in the bloodstream to carry and transport nutrients throughout the animal's body
   5) Aids in the elimination of waste products in the animal, usually in the urine and fecal material

2. See if students know what determines daily water requirements in livestock. Discuss which conditions change an animal's need for water.

What are daily requirements for water?

a) Daily requirements for livestock depend on the following:
   1) Species
   2) If the animal is lactating, since milk consists of 87 percent water
   3) Age, because younger animals require more water and have higher water content in their bodies
   4) Environmental temperature (Consumption increases when environmental temperatures increase.)
   5) The amount of exercise the animal gets (Water consumption increases as the animal becomes more active.)
   6) Moisture content of diet (Feeds with higher moisture content decrease the animal's free consumption.)
   7) Environmental humidity (As humidity increases, so does water consumption.)
   8) Level and kind of production of the animal (such as gestating, lactating, wool or meat producing)
   9) Mineral content of the animal diet (As the mineral content of the diet increases, so do the water requirements.)

b) Average daily requirements of livestock
   1) Beef cattle
      (a) Growing cattle
         (1) 100 lbs. = 1.5 gallons
         (2) 400 lbs. = 5 gallons
         (3) 800 lbs. = 7 gallons
      (b) Mature, fattening cattle = 9 gallons
      (c) Lactating = 10-15 gallons
   2) Lactating dairy cattle
      (a) Average production = 12-25 gallons
      (b) Heavy production = 35+ gallons
   3) Growing sheep
      (a) 20 lbs. = .5 gallon
      (b) 50 lbs. = .4 gallon
      (c) 150-200 lbs. = 1+ gallons
   4) Growing swine
      (a) 50 lbs. = 1+ gallons
      (b) 100 lbs. = 1.5+ gallons
   5) Mature swine
      (a) Pregnant = 5+ gallons
      (b) Lactating = 6+ gallons

c) Sources of water
   1) For drinking
      (a) Drinking water must be fresh, clean, and provided at all times for the animal's use.
      (b) Moisture in feed provides some water.
      (c) Fresh green pastures are 80 percent moisture.
      (d) Green cut forages, such as silage, have 65-75 percent moisture.
      (e) Dry harvested forages, such as hay, are 15 percent moisture.
      (f) Many grains, such as corn, have 10-15 percent moisture.
   2) From body metabolism
      (a) Some water is produced when fats, proteins, and carbohydrates are digested and metabolized.

(b) This source is impractical when figuring the animal's needs.

3. Ask students if they have ever heard of water toxicity. How do they know if an animal has acquired water toxicity?

What is water toxicity, and what are its symptoms?

a) Water toxicity is dehydration accompanied by concentration of sodium and other ions in the brain cells that cause cerebral edema if:
   1) Thirsty animals are suddenly given fresh water.
   2) Dehydrated body tissues can't overcome the sudden overdose of water that the animal tries to drink to overcome its thirst.
   3) Toxicity is more common in calves or young animals because they try to drink 35-50 percent of total body water within a half hour period.

b) Symptoms of water toxicity
   1) Hemoglobinuria (red urine)
   2) Diarrhea
   3) Irregular heart beat
   4) Body hair stands on end
   5) Excessive salivation
   6) Extended position of the head and neck
   7) Fluids collecting in soft tissues under the skin; appears as apparently swollen eyelids
   8) Nervousness
      (a) Animal's walk appears unstable.
      (b) Excessive licking and rubbing occur.
   9) Coma, then death

c) Guidelines for treatment of water toxicity
   1) Administer saline or hypertonic glucose intravenously to remove excess water from body tissues.
   2) Give animal salt water.
   3) Be especially observant of animals if there was a lack of water for a long time.
   4) It takes 4-6 hours for water toxicity to be fatal.

4. Ask students what happens when there is insufficient water for humans. Is it the same for livestock?

What happens if there is an inadequate water supply?

a) Occurrences in animals with low water intake
   1) Lack of appetite (eats less feed)
   2) Blood thickens
   3) Weight loss
   4) Reduction in performance and production
   5) Possible death by dehydration

b) Normal body functions that can increase water intake
   1) If animal develops scours or diarrhea, more water is needed. Water is lost because of a digestive disturbance.
   2) Through respiration, moist air is exhaled during respiration.
   3) When excess body heat leaves the animal's body through moist air, water is lost.

F. Other activities

Check with Extension and/or public health department employees for proper water sampling methods. Students can bring in water samples yearly for testing by Extension personnel. Contact the public health department for litmus paper testing (nitrogen) availability.

G. Conclusion

Understanding the roles of nutrients is vital for the management of livestock. A deficiency in one or more nutrients can cause severe losses in the production of livestock. Water is critical in maintaining all animal body functions; understanding this concept will lead to success as a livestock producer.

H. Competency

Describe the role of water in nutrition.

I. Answers to Evaluation

1. a
2. c
3. a

4. Six of the following:
   a) Lubricates joints
   b) Lubricates eyes
   c) Acts as a cushion for nerves
   d) Helps conduct sound in the ear
   e) Helps dilute toxic substances carry them through the digestive system
   f) Transfers heat from one part of the body to another
   g) Cools the animal's body by evaporation since animals do not have sweat glands to keep cool them like humans
   h) Mixes with other gases and expelled during respiration
   i) Used in body temperature regulation
   j) Carries chemicals in food to taste buds for the animal's recognition
   k) Aids in maintaining an animal's body shape
   l) Used in metabolism, digestion, and absorption of nutrients in the animal
   m) Essential in the bloodstream to carry and transport nutrients
   n) Aids in the elimination of waste products in the animal

5. Two of the following:
   a) Administer saline or hypertonic glucose intravenously to remove excess water from body tissues.
   b) Give animal salt water.
   c) Be especially observant of animals if there was a lack of water for a long time.

6. Two of the following:
   a) If animal develops scours or diarrhea
   b) Through respiration
   c) When excess body heat leaves the animal's body through moist air

UNIT I - NUTRITION Name_____

Lesson 7: Water's Role in Animal Nutrition Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which is NOT a symptom of water toxicity?

   a. Tail extension
   b. Coma
   c. Diarrhea
   d. Swollen eyelids

2. How long does it take for water toxicity to be fatal?

   a. 45 minutes
   b. 1-2 hours
   c. 4-6 hours
   d. 8 hours

3. Which is true regarding water?

   a. Water acts as a cushion for nerves within the body.
   b. Water produced by body metabolism is important in figuring an animal's water needs.
   c. Decreased environmental humidity increases the animal water consumption.
   d. Increased appetite is a sign of inadequate water supply.

Complete the following short answer questions.

4. List six functions of water.

   a.

   b.

   c.

   d.

   e.

   f.

5. List two treatments for water toxicity.

   a.

   b.

6. List two normal body functions that can increase water intake.

   a.

   b.

UNIT I - NUTRITION

Lesson 8: Environmental Effects on Nutrition

Objective: The student will be able to determine the environmental effects on animal nutrition.

Study Questions

1. **What is included in the animal's environment?**
2. **Identify weather factors that affect nutrition requirements and how animals react to them.**
3. **What are other factors affecting nutrition needs, and how do animals react?**
4. **How do feed requirements and production yields vary with temperature?**

References

1. Student Reference

UNIT I - NUTRITION

Lesson 8: Environmental Effects on Nutrition

TEACHING PROCEDURES

A. Review

Review previous lesson on water's role in animal nutrition.

B. Motivation

How does the environment affect human nutrient requirements? Wind chill, humidity, wind, and temperature strongly affect environmental conditions. Both hot and cold environments increase nutrient intake because it takes more calories to maintain body functions. Health, stress, and physical activity changes human nutrient requirements. How does the environment affect animal nutrient requirements? The same four environmental factors affect animal nutrient requirements--weather, stress, health, and nutrition.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students what factors are included in the animal's environment that can affect digestion and nutritional needs.

What is included in the animal's environment?

a) Everything surrounding and affecting the growth, development, and production of animals
b) Involves nutrition, space requirements, light, relative humidity, air temperature and velocity, wet bedding, dust, ammonia buildup, odors, and manure disposal
c) Factors with the most impact on nutritional needs
    1) Nutrition
    2) Weather and facilities/shelter
    3) Health
    4) Stress

2. Ask students to discuss what changes in the weather affect the nutritional needs of animals.

Identify weather factors that affect nutrition requirements and how animals react to them.

a) Weather is the "state of the atmosphere with respect to heat or cold, wetness or dryness, calm or storm, clearness and cloudiness." (Webster's dictionary)
b) Animals have a thermo-neutral (comfort) zone.
c) Extreme weather can cause wide fluctuations in animal performance.
d) An animal's requirements increase as temperature, humidity, and wind exceed or fall short of its comfort zone. These three factors influence an animal's heat loss, as well.
e) Animals adapt to cold weather by using various heating mechanisms.
    1) Increased insulation from hair growth and more fat

2) Increased thyroid activity
3) Seeking protective shelter and warming sunshine
4) Huddling together
5) *Consuming more feed, which increases the heat increment and warms the animal
6) *Increasing activity

NOTE: The most important heating mechanisms are noted with an asterisk (*).

f) Animals adapt to hot weather by using the following cooling mechanisms.
1) Moisture vaporization (from the skin and lungs)
2) Avoidance of the sunshine
3) Depression of thyroid activity
4) Loafing

g) Heat production (metabolism) is plotted against ambient temperature to depict the relationship between chemical and physical heat regulation.

h) Rain reduces feed intake by 10-30 percent and mud by 5-30 percent, depending upon its depth and the amount of bedded area.

i) There are several ways in which animals cope with inclement weather.
1) Environmentally controlled buildings
2) Adaptation
(a) Brahman cattle are more heat tolerant.
(b) British breeds, such as Herefords, are more cold tolerant.
3) Increased or decreased nutrient needs

3. Have students discuss factors, other than the weather, that change nutrient requirements of animals.

What are other factors affecting nutritional needs, and how do animals react?

a) Gestation
1) Nutrient requirements for pregnant females are most critical during the last trimester, when the developing fetus grows most.
2) Especially critical are nutrient requirements for young females during their first pregnancy. Poor nutrition at this stage will result in a poorly developed fetus and poor growth of the mother.

b) Lactation
1) Milk production requires a liberal supply of energy, protein, minerals, and vitamins in the ration.
2) After giving birth, feed requirements increase tremendously because of milk production.
3) A female suckling young needs approximately 50 percent greater feed allowance than during the pregnancy period.

c) Stress
1) Any environmental factor that is counter-productive to an animal's well-being, either external or internal
2) The more the stress, the more nutrition that is needed
3) Kinds of stress
(a) Excitement
(b) Presence of strangers
(c) Changing animals that are together
(d) Crowding
(e) Disease
(f) Hauling
(g) How animals are handled
(h) Weaning

4) Handling that reduces stress
   (a) Preconditioning (started on feed, vaccinated, etc.) before weaning
   (b) Proper handling during vaccinations, movement, and hauling

d) Health
   1) In the U.S., animal diseases and parasites decrease animal productivity by 15-20 percent.
   2) Improper nutrition has some involvement in up to 85 percent of cases treated by veterinarians.

e) Muddy lots
   1) Mud increases scours and other diseases in newborn animals; in older animals, it reduces production and feed efficiency.
   2) Studies show that mud can reduce finishing cattle gains *and* increase the feed required per pound of gain by as much as 10-35 percent. (California Agricultural Experiment Station)
   3) These problems can be minimized by proper management.
      (a) Lots that are properly located and constructed for proper drainage
      (b) Mounds that are 6-12 feet high as a dry place on which cattle can lie
      (c) Lessening the number of cattle in the lots during the muddy seasons

4. Ask the students how nutritional requirements might change when animals are subjected to any of the above factors.

How do feed requirements and production yields vary with temperature?

a) Dairy cows
   1) The optimum temperature for the production of milk is 55-64˚F.
   2) Temperatures below optimum
      (a) Reduction of water intake
      (b) Approximately 35 percent increase in feed intake (down to -4˚F)
      (c) Corresponding decrease in milk yield
      (d) Can be corrected by increasing the proportion of concentrate in the diet (20 percent roughage/80 percent concentrate) and providing shelter
      (e) Better maintained milk yields with higher concentrate levels
   3) Temperatures above optimum cause:
      (a) Increase in water intake
      (b) Decrease in feed intake at 77-81˚F, with greater decrease above 85˚F
      (c) Decrease in dry-matter intake
      (d) Corresponding decrease in milk yield
      (e) At 95˚F, milk yield reduced as much as 33 percent
      (f) Impact of environmental extremes reduced by using confined housing for lactating dairy cows

b) Beef cattle
   1) The temperature range of 59-77˚F is considered optimum.
   2) Variations from this range change feed intake.
      (a) At 77-95˚F, feed intake depressed 3-10 percent
      (b) At 41-59˚F, feed intake increased 2-5 percent
      (c) At 23-41˚F, feed intake increased 3-8 percent
      (d) At 5-25˚F, feed intake increased 5-10 percent
      (e) Below 5˚F, feed intake increased 8-25 percent
   3) During cold weather, increase the amount of roughage for cattle on restricted feed intake.
   4) With cattle on full feed, increasing the amount of roughage during cold weather can actually *decrease* the amount of energy available.

c) Sheep
   1) There is little data available that describes the interaction of temperature and feed intake for sheep.
   2) Sheep can tolerate colder climatic extremes than other animals.
   3) The length of the fleece and the level of feeding affect feed intake as temperatures change.
   4) Sheep need higher energy intake during cold stress. This can be done economically by increasing the roughage in the ration.
   5) During hot weather, decrease the roughage; this lowers the amount of heat produced by digesting the feed.

d) Swine
   1) A temperature range of 64-70˚F is considered optimum for growing/finishing swine.
   2) For each 1.8˚F of temperature drop, the feed requirement increases 1-1.4 oz. daily.
   3) Heavier hogs are more sensitive to hot weather than lighter hogs.

e) Poultry
   1) Laying hens can adjust to a fairly wide range of temperatures. When the temperature change occurs, feed intake will change temporarily and then return to approximately the level before the temperature change.
   2) Adequate drinking water is more critical to maintaining growth or production in poultry. Compared to water intake at 70˚F, water intake is doubled at 90˚F and is 2.5 times greater at 98˚F.

F. Other activities

1. Have the class chart the various weather factors including precipitation, wind, temperature, and humidity for a length of time (week, month, etc.). Then, for a specific species, identify changes that would need to be made in feeding, handling, etc., according to the changes in weather.

2. Have the students further research animal behaviors. Have them choose a species or a behavior to write papers that describe the behavior, affect on the animal, and ways to adjust or handle the situations that occur.

G. Conclusion

Livestock nutrient requirement tables are generally based on the assumption that no environmental stress is present. Feed and nutritional requirements need adjusting for changes in the animal's environment. Efficiency of nutrient use is affected by the weather, stress, health, and facilities.

H. Competency

Describe environmental effects on nutrition.

I. Answers to Evaluation

1. Three of the following:
   Nutrition, weather and facilities/shelter, health, stress

2. Four of the following:
   a. Increased insulation from growth of hair and more subcutaneous fat
   b. Increase in thyroid activity
   c. Seeking protective shelter and sunshine

d. Huddling together
e. Consumption of more feed
f. Increasing activity

3. Three of the following:
   a. Moisture vaporization
   b. Avoidance of the sunlight (seeking shade)
   c. Depression of thyroid activity
   d. Loafing (decreased activity and production)

4. Three of the following: gestation, lactation, stress, health, muddy lots

5. Two of the following:
   a. Mounds
   b. Proper drainage
   c. Decreased number in the lot

6. d
7. a
8. c

UNIT I - NUTRITION Name_____

Lesson 8: Environmental Effects on Nutrition Date_____

EVALUATION

Complete the following short answer questions.

1. List three of the four factors that affect nutritional needs the most.

   a.

   b.

   c.

2. Name four of the heating mechanisms employed by animals during cold weather.

   a.

   b.

   c.

   d.

3. Name three cooling mechanisms employed by animals during hot weather.

   a.

   b.

   c.

4. Name three factors, other than the weather, that affect nutritional requirements.

   a.

   b.

   c.

5. Give two ways in which the stress of a muddy lot can be alleviated.

   a.

   b.

Circle the letter that corresponds to the best answer.

6. Which class of livestock can adjust to widely ranging temperature variations?

   a. Dairy
   b. Beef
   c. Swine
   d. Poultry

7. For milk production, which is the optimum temperature range for dairy cattle?

   a. 55-64°F
   b. 59-77°F
   c. 64-70°F
   d. 70-77°F

8. Which is the optimum temperature range for finishing swine?

   a. 55-64°F
   b. 59-77°F
   c. 64-70°F
   d. 70-77°F

UNIT I - NUTRITION

Lesson 9: Formulating and Balancing Rations

Objective: The student will be able to formulate a ration for livestock at the teacher's discretion.

Study Questions

1. **What are the general principles in formulating a ration?**
2. **What are the steps in balancing a ration?**
3. **What are eight essentials to balancing a ration?**

References

1. Student Reference
2. Activity Sheet
   a) AS 9.1: Formulating Rations

UNIT I - NUTRITION

Lesson 9: Formulating and Balancing Rations

TEACHING PROCEDURES

A. Review

Review Pearson Square computation from Agricultural Science core curriculum.

B. Motivation

Ask the students how they decide what foods to eat during a given day. Are there guidelines about fixing certain foods together for a meal? (Yes--Food Pyramid)

C. Assignment

D. Supervised study

E. Discussion

1. Ask students what they believe are the components of a good livestock ration. How do you decide what feed to use in a feeding program?

What are the general principles in formulating a ration?

a) Diet must meet the nutritional needs of the animal.
   1) Nutrient requirements are listed in tables usually available from the National Research Council.
   2) Balanced rations have nutrient allowances that are only 1-3 percent below the animal's requirement.

b) Diets must include a minimum level of dry matter for proper digestive tract functioning.

c) Diets are commonly balanced to meet the protein, energy, calcium, phosphorus, and vitamin A requirements for the animal.
   1) Protein
      (a) The amount of protein in the diet can be measured by crude protein (CP) or digestible protein (DP) content.
      (b) In diets balanced for nonruminants, essential amino acids must be considered.
      (c) Protein is an expensive part of the diet; using unneeded amounts raises the cost of the ration excessively.
   2) Energy
      (a) Four measures of energy are commonly used when formulating diets.
         (1) Digestible energy (DE)
         (2) Total digestible nutrients (TDN)
         (3) Metabolizing energy (ME)
         (4) Net energy (NE)
      (b) Energy provided in the diet should not be more than about five percent above requirements because animals are limited in the total amount of energy they can use.

3) Minerals
   (a) Calcium (Ca) and phosphorus (P) are the two minerals generally needed in larger amounts.
   (b) The ratio of Ca to P should be between 1:1 and 2:1.
   (c) There are usually enough minerals provided in the ingredients used or by the addition of trace-mineralized salt.
4) Vitamins
   (a) A vitamin supplement is usually added to the ration to meet the vitamin needs of the animal.
   (b) Always add a vitamin supplement to a gestation ration.
   (c) Sheep and cattle fed low-quality legume hay during pregnancy might exhibit symptoms of vitamin deficiency.

d) Cost of nutrients
   1) The cost per pound of each nutrient must be considered when developing least-cost rations for maximum efficiency.
   2) Energy and protein nutrients are the major ones to consider when making nutrient cost comparisons.

2. Ask the students how they would decide on a ration's components. Ask students what characteristics are important to consider when balancing a ration.

What are the steps in balancing a ration?

a) Identify the kind, age, weight, and function of the animal for which the ration is being formulated.
b) Consult a table of nutrient requirements to determine the nutrient needs of the animal.
c) Choose the feeds to be used in the ration and consult a feed composition table to determine the nutrient content of the selected feeds.
d) Calculate the amounts of each feed to use in the ration.
   1) Pearson square
   2) Algebraic equations
   3) Computer programs
e) Check the ration formulated against the needs of the animal. Be sure it meets the requirements for vitamins and minerals.
f) Check the cost of the nutrients in the ration to determine if this is the most economical, practical ration.

3. Ask the students about what they feel are essentials to a good ration.

What are the eight essentials to balancing a ration?

a) Nutrients in the ration should be balanced. Faster gains, less expense, and more profits are realized when feeding balanced rations.
b) The ration should contain a variety of feeds. This variety generally increases the palatability of the ration and makes it easier to balance the nutrients.
c) The ration should be fresh and appealing. Livestock consume more of a fresh ration, thus increasing productivity.
d) A ration should be palatable (agreeable to the taste).
e) The ration should be bulky; one containing a bulky feed (ground oats, beet pulp, etc.) usually is more desirable.
f) A ration should be slightly laxative. A laxative ration usually improves efficiency.
g) The ration should be economical. Low-cost, high-quality rations keep the producer in business.

h) The ration should be suited to the animal. Digestive systems are different among species. Cattle and sheep can consume large quantities of roughage, while poultry and swine rations must consist of largely concentrates.

F. Other activities

1. In conjunction with the activity sheet, use raw ingredients to make feed.

2. Computer programs

a) Stallings, Charlie, et. al. *DAIR4* (IBM dairy and beef program). Blacksburg, VA: Virginia Tech. (Can be downloaded from Agriculture Electronic BBS, 573/882-8289, system operator 573/882-4827)
b) *Taurus* (IBM cattle ration program). University of California-Davis, 1990.
c) *Apollo* (IBM swine ration program). University of California-Davis, 1990.

3. Show the slides, *Horse Feeding and Nutrition* (AG SL 23), available from the Missouri Vocational Resource Center.

G. Conclusion

This lesson will help students understand and compute basic nutritional needs for different classes of livestock. For growth to occur, every one of the five nutrients (protein, energy, minerals, vitamins, and water) must be present in sufficient quantity.

H. Competency

Formulate a ration for different classes of livestock.

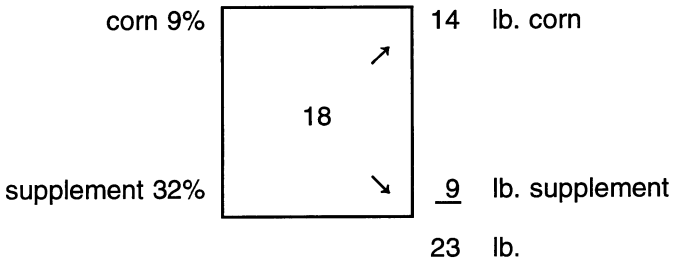
I. Answers to Evaluation

1. d
2. b
3. a
4. a, c, d, e (question worth eight points)
5. a, b, c, e, f, g (question worth eight points)

J. Answers to Activity Sheet 9.1

1. Example using problem 1 and the Pearson Square

Step 1: Construct a square with percent crude protein in the center of the square. Put the two feed ingredients in the corners on the left side. Diagonally subtract the smaller number from the larger number (18 - 9 = 9 and 32 - 18 = 14). Add the two remainders together (9 + 14 = 23).



Step 2: Write the "9" and "14" on the square. Therefore, in 23 lbs. of feed, there are 14 lbs. of corn and 9 lbs. of supplement.

Step 3: To determine the ton mixture, divide by 2000 lbs. to calculate the percentage of each feed in the mixture. Round to one decimal place.

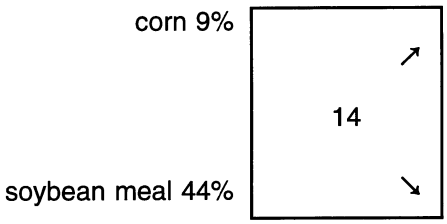
$^{14}/_{23}$ = .608 or 61% x 2000	=	1217.4	lbs. of corn
$^{9}/_{23}$ = .391 or 39% x 2000	=	782.6	lbs. of supplement
		2000.0	lbs. (ton)

Step 4: Check the mixture for protein content.

1217.4 lbs. of corn x .09	=	109.6
782.6 lbs. of supplement x .32	=	250.4
		360.0

Step 5: To get a 100 lb. ration from the 2000 lb. figures, divide by 20 (360 ÷ 20 = 18%). This ration is balanced for crude protein only. The ration must be checked for energy, minerals, and vitamins. Adjustments must be made to meet animal requirements and to be a complete, balanced ration.

2. *Step 1:* 14 - 9 = 5 and 44 - 14 = 30; 5 + 30 = 35



30 lb. corn
5 lb. soybean meal
35 lb.

Step 2: In 35 lbs. of feed, there are 30 lbs. of corn and 5 lbs. of soybean meal.

Step 3:

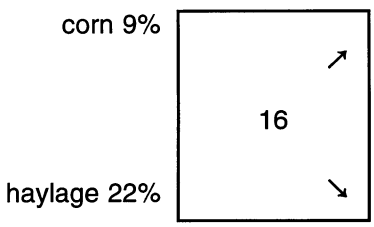
$^{30}/_{35}$ = .857 or 86% x 100	=	85.7	lbs. of corn
$^{5}/_{35}$ =.142 or 14% x 100	=	14.3	lbs. of soybean meal
		100.0	lb. ration

Step 4: Check the mixture for protein content.

85.7 lbs. of corn x .09	=	7.71
14.3 lbs. of soybean meal x .44	=	6.29

14%. This ration is balanced for crude protein.

3. *Step 1:* 16 - 9 = 7 and 22 - 16 = 6; 6 + 7 = 13



6 lb. corn
7 lb. haylage
13 lb.

Step 2: In 13 lbs. of feed, there are 7 lbs. of corn and 6 lbs. of haylage.

Step 3:

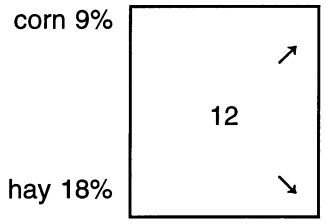
$^{7}/_{13}$ = .538 or 54% x 4000	=	2153.8	lbs. of corn
$^{6}/_{13}$ = .461 or 46% x 4000	=	1846.2	lbs. of haylage
		4000.0	lbs.

Step 4: Check the mixture for protein content.

2153.8 lbs. of corn x .09	=	193.84
1846.2 lbs. of haylage x .22	=	406.16
		600.00

Step 5: 600 ÷ 40 = 15%. Ration is balanced for crude protein.

4. *Step 1:* 12 - 9 = 3 and 18 - 12 = 6; 6 + 3 = 9



6	lb.	corn
3	lb.	hay
9	lb.	

Step 2: In 9 lbs. of feed, there are 6 lbs. of corn and 3 lbs. of hay.

Step 3:

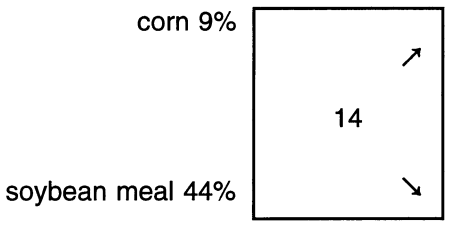
$^{6}/_{9}$ = .666 or 67% x 500	=	333.33	lbs. of corn
$^{3}/_{9}$ = .333 or 33% x 500	=	166.66	lbs. of supplement
		499.99	(500) lbs.

Step 4: Check the mixture for protein content.

333.33 lbs. of corn x .09	=	29.99
166.66 lbs. of hay x .18	=	29.99
		59.98 (60)

Step 5: 60 ÷ 5 = 12%. This ration is balanced for crude protein only.

5. *Step 1:* 14 - 9 = 5 and 44 - 14 = 30; 30 + 5 = 35



30	lb.	corn
5	lb.	soybean meal
35	lb.	

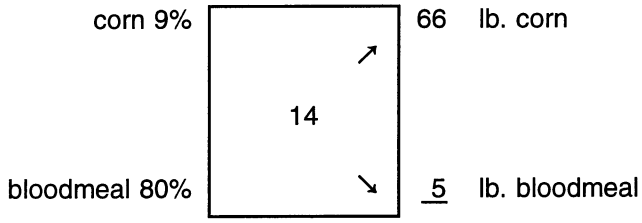
Step 2: In 35 lbs. of feed, there are 30 lbs. of corn and 5 lbs. of soybean meal.

Step 3: $^{30}/_{35}$ = .859 or 86% x 800 = 685.7 lbs. of corn
$^{5}/_{35}$ = .142 or 14% x 800 = 114.3 lbs. of soybean meal
800.0 lbs.

Step 4: Check the mixture for protein content.
685.7 lbs. of corn x .09 = 61.71
114.3 lbs. of soybean meal x .44 = 50.29
112.0

Step 5: 112 ÷ 8 = 14%. This ration is balanced for crude protein only.

6. *Step 1:* 14 - 9 = 5 and 80 - 14 = 66; 66 + 5 = 71



Step 2: In 71 lbs. of feed, there are 66 lbs. of corn and 5 lbs. of bloodmeal.

Step 3: $^{66}/_{71}$ = .929 or 93% x 10,000 = 9295.8 lbs. of corn
$^{5}/_{71}$ = .070 or 7% x 10,000 = 704.2 lbs. of bloodmeal
10,000.0 lbs.

Step 4: Check the mixture for protein content.
9295.8 lbs. of corn x .09 = 836.62
704.2 lbs. of bloodmeal x .80 = 563.36
1399.98

Step 5: 1400 ÷ 100 = 14%. This ration is balanced for crude protein only.

UNIT - NUTRITION Date_____

Lesson 9: Formulating and Balancing Rations Name_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. What two minerals are needed in the greatest quantities in most livestock rations?

   a. Zinc and boron
   b. Zinc and phosphorus
   c. Boron and calcium
   d. Calcium and phosphorus

2. Amino acids have the greatest influence when figuring a ration for which type of livestock?

   a. Ruminants
   b. Nonruminants
   c. Modified nonruminants
   d. Avians

3. Energy provided in the diet or ration should not exceed what percentage over the animal's requirements?

   a. Five
   b. Eight
   c. Ten
   d. Twenty

Complete the following multiple answer questions.

4. Check the physical traits needed to formulate a ration.

____ a.	Age	____ f.	Hair color
____ b.	Height	____ g.	Conformation score
____ c.	Weight	____ h.	Polled or horned
____ d.	Type of livestock	____ i.	Breed
____ e.	Level of production	____ j.	Environmental conditions

5. Check the essentials for balancing a ration

____ a.	Cost	____ e.	Slightly laxative
____ b.	Palatability	____ f.	Match type of animal
____ c.	Feedstuff variety	____ g.	Low-cost, high-quality ration
____ d.	Cheapest possible ration	____ h.	Fewest number of ingredients

Lesson 9: Formulating and Balancing Rations Name_____

FORMULATING RATIONS

Complete the following short answer questions. State whether each ration is balanced for crude protein.

1. Formulate an 18 percent protein ration for a 100 lb. hog. Feedstuffs used are corn at 9 percent and a 32 percent protein supplement. Figure a 1 ton ration.

2. Formulate a 14 percent protein ration for a 180 lb. hog. Feedstuffs used are corn @ 9 percent protein and soybean meal at 44 percent protein. Figure a 100 lb. ration.

3. Formulate a dairy 16 percent protein ration for a 1200 lb. lactating cow using the feedstuffs of 22 percent protein in alfalfa haylage and 9 percent protein in corn. Figure a 2 ton ration.

4. Formulate a dairy 12 percent protein ration for a 1200 lb. dry cow using 18 percent protein in alfalfa hay and 9 percent protein in corn. Figure a 500 lb. ration.

5. Formulate a sheep 14 percent protein ration for an 80 lb. market lamb using feedstuffs of 9 percent protein in corn and 44 percent protein in soybean meal. Figure an 800 lb. ration.

6. Formulate a 14 percent protein ration for an 800 lb. beef steer using 9 percent protein corn silage and 80 percent protein in bloodmeal. Figure a 5 ton ration.