

Course	Agricultural Science I
Unit	Introduction to Animal Nutrition
Lesson	Monogastric Digestive System
Estimated Time	50 minutes

Student Outcome

Identify the components and describe the functions of the monogastric animal digestive system.

Learning Objectives

1. Determine which domestic animals have monogastric digestive systems.
2. Identify the components of the monogastric digestive system.
3. Describe the functions that the components of the monogastric system play in digestion.
4. Explain the role of digestive juices and enzymes in the digestion of nutrients.

Grade Level Expectations

SC/LO/2/D/09-11/c SC/LO/2/F/09-11/a

SC/LO/2/D/09-11/d SC/LO/2/F/09-11/d

Resources, Supplies & Equipment, and Supplemental Information

Resources

1. PowerPoint Slides
 - ☐ PPt 1 – Swine Digestive System
 - ☐ PPt 2 – Horse Digestive System
 - ☐ PPt 3 – Dog Digestive System
 - ☐ PPt 4 – Rabbit Digestive System
 - ☐ PPt 5 – Fowl Digestive System - Chicken
 - ☐ PPt 6 – Enzymes in the Monogastric Digestive System
2. Activity Sheets
 - ☐ AS 1 – Swine Digestive System
 - ☐ AS 2 – Dissection of the Monogastric Digestive System
3. *Introduction to Animal Nutrition (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1996.
4. *Introduction to Animal Nutrition Curriculum Enhancement*. University of Missouri-Columbia: Instructional Materials Laboratory, 2003.

Supplies & Equipment

- ☐ A monogastric digestive system can be obtained from a local processing plant. The system should begin at the esophagus and end with the anus. It should be kept frozen until the dissection is performed.
- ☐ Six different colors of Play-Doh

Supplemental Information

1. Internet Sites

- ❑ “Animal Nutrition and Digestion.” Department of Animal Science. University of Vermont. Accessed May 10, 2007, from <http://asci.uvm.edu/course/asci001/digest.html>.
- ❑ Animal Science Publications. MU Extension. University of Missouri-Columbia. Accessed April 12, 2007, from <http://extension.missouri.edu/explore/agguides/ansci/>.
- ❑ “The Horse’s Digestive System.” Hygain. Accessed May 10, 2007, from http://www.hygain.com.au/articles/article_digestivesystem.htm.
- ❑ Tech Information. Merrick’s. Accessed May 10, 2007, from <http://www.merricks.com/tech.html>.

2. Print

- ❑ Campbell, J. R., M. D. Kenealy, and K. L. Campbell. *Animal Sciences: The Biology, Care, and Production of Domestic Animals*. 4th ed. New York: McGraw-Hill Companies, 2003.
- ❑ Frandson, R. D., W. L. Wilke, and A. D. Fails. *Anatomy and Physiology of Farm Animals*. 6th ed. Baltimore: Lippincott Williams and Wilkins, 2003.
- ❑ Kellems, R. O., and D. C. Church. *Livestock Feeds and Feeding*. 5th ed. Upper Saddle River, NJ: Prentice Hall, 2002.

3. Electronic Media



- ❑ *Animal Nutrition Interactive PowerPoints*. University of Missouri-Columbia: Instructional Materials Laboratory, 2006.
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Interest Approach


Put students into small groups. Pass out six different colors of Play-Doh to each group. Instruct the students to “build” a monogastric digestive system using a different color for each major part.

Communicate the Learning Objectives

1. Determine which domestic animals have monogastric digestive systems.
2. Identify the components of the monogastric digestive system.
3. Describe the functions that the components of the monogastric system play in digestion.
4. Explain the role of digestive juices and enzymes in the digestion of nutrients.

Instructor Directions	Content Outline
Objective 1 <i>Animals have either a monogastric or a ruminant digestive system. The following domestic animals have a monogastric digestive system.</i>	Determine which domestic animals have monogastric digestive systems. <ol style="list-style-type: none">1. Swine2. Horse3. Dog4. Rabbit5. Fowl
Objective 2 <i>Ask students what a monogastric digestive system is and discuss their answers. Remind students that while the liver, gall bladder, and pancreas are not a part of the digestive system, they are related organs that play an important role in digestion. Hand out AS 1 and, using PPt 1, identify the parts along with the students. Use PPt 2, PPt 3, PPt 4, and PPt 5 to illustrate the digestive systems of other species.</i>  AS 1 – Swine Digestive System  PPt 1 – Swine Digestive System	Identify the components of the monogastric digestive system. Mammalian digestive system <ol style="list-style-type: none">1. Mouth2. Esophagus3. Stomach4. Small intestine - duodenum, remainder of small intestine5. Large intestine - cecum, colon, rectum6. Anus Fowl digestive system <ol style="list-style-type: none">1. Beak2. Gullet3. Crop4. Glandular stomach (or proventriculus)5. Gizzard (or ventriculus)6. Small intestine7. Ceca8. Large intestine9. Cloaca10. Vent

Instructor Directions	Content Outline
<ul style="list-style-type: none"> <input type="checkbox"/> PPt 2 – Horse Digestive System <input type="checkbox"/> PPt 3 – Dog Digestive System <input type="checkbox"/> PPt 4 – Rabbit Digestive System <input type="checkbox"/> PPt 5 – Fowl Digestive System – Chicken 	
<p>Objective 3</p> <p><i>Each part of the monogastric digestive system has a specific function in the digestion process. Ask students if they know what each function is. When discussing the functions of the parts, use PPt 1 as an illustration.</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> PPt 1 – Swine Digestive System <input type="checkbox"/> PPt 5 – Fowl Digestive System - Chicken 	<p>Describe the functions that the components of the monogastric system play in digestion.</p> <p>Mammalian digestive system</p> <ol style="list-style-type: none"> 1. Parts leading to the small intestine - reduce feed particle size 2. Mouth - teeth grind feed; tongue moves pieces to throat; begins digestion 3. Esophagus - carries pieces 4. Stomach - stores food; continues digestion 5. Small intestine <ol style="list-style-type: none"> a. Duodenum - continues digestion b. Remainder of small intestine - absorbs nutrients into the bloodstream 6. Large intestine - absorbs water and molds indigestible feed wastes into solid form <ol style="list-style-type: none"> a. Cecum - contains microorganisms; functions differently depending on the species, with the enlarged cecum in horses and rabbits allowing microorganisms to ferment roughage and break it down for absorption into the blood b. Colon - absorbs water and forms the feces 7. Parts allowing the exit of the feces <ol style="list-style-type: none"> a. Rectum - carries the feces to the anus b. Anus - passes solid wastes out of the body <p>Fowl digestive system</p> <ol style="list-style-type: none"> 1. Beak - breaks feed down for swallowing 2. Gullet - passes feed to crop 3. Crop - stores feed; softens feed for digestion 4. Glandular stomach - begins digestion 5. Gizzard - feed ground by muscular contractions

Instructor Directions	Content Outline
	<ol style="list-style-type: none"> 6. Small intestine - digests and absorbs feed 7. Ceca - contain bacteria; little role in digestion 8. Large intestine - carries wastes to cloaca 9. Cloaca - junction of reproductive and digestive systems 10. Vent - allows wastes to exit the body
<p>Objective 4</p> <p><i>Ask students what digestion is. Describe the roles of enzymes and digestive juices in digestion.</i></p> <p> PPT 6 – Enzymes in the Monogastric Digestive System</p>	<p>Explain the role of digestive juices and enzymes in the digestion of nutrients.</p> <p>Digestive juices - fluids secreted into the digestive system from glands or tissue; enzymes - substances in the digestive juices that speed up the chemical reactions of digestion</p> <p>Mammalian digestive system</p> <ol style="list-style-type: none"> 1. Saliva - lubricates feed for passage into the digestive system; contains the enzyme amylase, which breaks down starches into sugars 2. Gastric juices <ol style="list-style-type: none"> a. Diluted hydrochloric acid (HCl) - stops the action of amylase b. Gastrin - stimulates the stomach to produce more gastric juices c. Pepsin - enzyme that begins digestion of proteins d. Rennin - enzyme that curdles a protein in milk e. Gastric lipase - enzyme that begins the breakdown of fats f. Mucus - protects the stomach lining from the acidic environment 3. Bile - helps to liquefy fats for absorption 4. Pancreatic juices <ol style="list-style-type: none"> a. Pancreatic lipase - breaks fats down further, aided by bile b. Trypsin - breaks down proteins c. Chymotrypsin - acts on proteins d. Amylase - continues to work on starch 5. Intestinal juices - contain the enzyme peptidase to break down proteins and the enzymes maltase, sucrase, and lactase to work on sugars and starches <p>Fowl digestive system</p> <ol style="list-style-type: none"> 1. Saliva - softens feed for digestion in conjunction with secretions from the crop wall

Instructor Directions	Content Outline
<p>Evaluation: Quiz</p>	<p>Answers:</p> <ol style="list-style-type: none"> 1. Stomach 2. Colon 3. Rectum 4. Mouth 5. Esophagus 6. Anus 7. Cecum 8. Small intestine 9. Duodenum 10. d 11. c 12. a 13. b 14. d 15. b 16. a 17. c 18. a 19. Once the feed enters the digestive system through the beak, it passes through the gullet to the crop. It then enters the glandular stomach, followed by the gizzard. From the gizzard it moves through the small intestine, passes by the ceca, and enters the large intestine. It passes out of the body through the cloaca and vent.

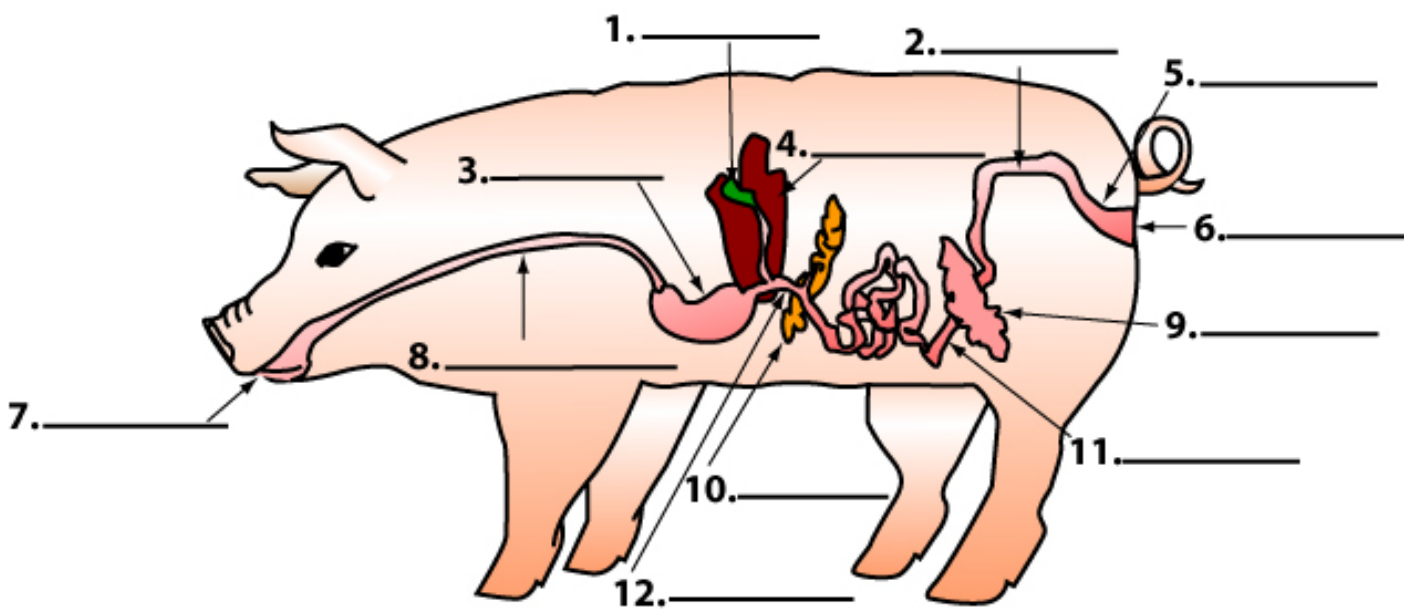
Lesson 1: Monogastric Digestive System

Name: _____

SWINE DIGESTIVE SYSTEM

Objective: Identify the parts of the monogastric digestive system of swine.

Label the parts of the monogastric digestive system.



Lesson 1: Monogastric Digestive System

Name: _____

DISSECTION OF THE MONOGASTRIC DIGESTIVE SYSTEM

Objective: Identify, locate, and describe the parts and function of the monogastric digestive system.

Activity Length: 1 hour

Materials and Equipment:

Lab coat
Lab gloves (palpation sleeves)
Swine digestive system
Dissecting knife

Procedure:

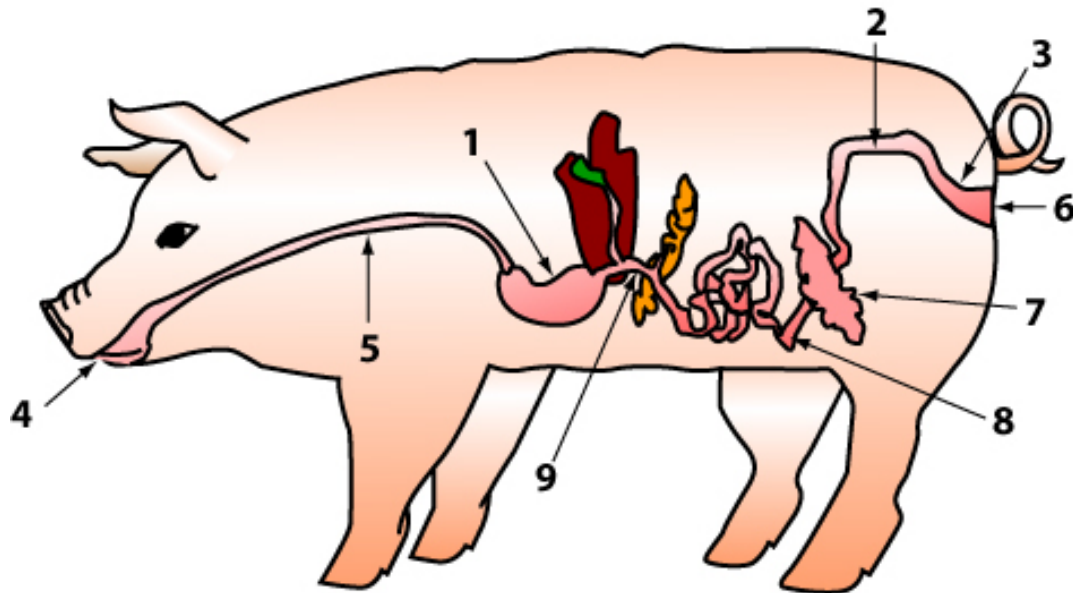
1. After putting on the lab coat and gloves, locate the esophagus and cut between the esophagus and the stomach. Set the esophagus to the side.
2. Find the point where the stomach attaches to the small intestine at the duodenum and separate the two with the knife.
3. Cut open the stomach and examine the interior of the stomach.
4. Locate the place where the small intestine and large intestine join. Separate the small intestine from the large intestine.
5. Look at the small intestine. Identify the duodenum and the rest of the small intestine and cut between the two.
6. Detach the large intestine from the rectum.
7. Sever the cecum and the colon.
8. Separate the rectum and the anus.

Key Questions:

1. What is the monogastric digestive system?
2. What part absorbs the nutrients into the body?
3. What is the path taken by feed through the digestive system?

EVALUATION

From the diagram below, identify the parts of the digestive system of swine and write the name of the part in the corresponding numbered blank.



1. _____

6. _____

2. _____

7. _____

3. _____

8. _____

4. _____

9. _____

5. _____

Circle the letter that corresponds to the best answer.

10. What digestive part stores feed in fowl?

- a. Esophagus
- b. Beak
- c. Small intestine
- d. Crop

11. What part absorbs digestible nutrients into the bloodstream?
- a. Esophagus
 - b. Large intestine
 - c. Small intestine
 - d. Stomach
12. What digestive part serves as an outlet from the body for feces?
- a. Anus
 - b. Cecum
 - c. Colon
 - d. Small intestine
13. Which species does not use teeth to break feed into small particles?
- a. Dogs
 - b. Fowl
 - c. Horses
 - d. Swine
14. Gastric juices contain the enzymes _____ and gastrin.
- a. Amylase
 - b. Trypsin
 - c. Maltase
 - d. Pepsin
15. Where is bile produced to help neutralize acidity in the digestive system?
- a. Duodenum
 - b. Liver
 - c. Mouth
 - d. Pancreas
16. Which enzyme works on starch?
- a. Amylase
 - b. Lipase
 - c. Peptide
 - d. Trypsin

17. Which species uses the cecum to ferment feed?

- a. Dogs
- b. Fowl
- c. Horses
- d. Swine

18. The ceca are found in which species?

- a. Fowl
- b. Horses
- c. Rabbits
- d. Swine

Complete the following short answer question.

19. What is the path taken by feed as it passes through the digestive system of the fowl? Describe the path.

Course	Agricultural Science I
Unit	Introduction to Animal Nutrition
Lesson	Ruminant Digestive System
Estimated Time	90 minutes or 2 50-minute blocks

Student Outcome

Identify the components and describe the functions of the ruminant animal digestive system.

Learning Objectives

1. Determine which livestock species have ruminant digestive systems.
2. Identify the components of the ruminant digestive system.
3. Describe the functions that the components of the ruminant system play in digestion.
4. Explain how feed nutrients are converted into usable nutrients by the ruminant digestive system.
5. Explain why ruminants are better able to utilize forages.

Grade Level Expectations

SC/LO/2/D/09-11/c SC/LO/2/F/09-11/a

SC/LO/2/D/09-11/d SC/LO/2/F/09-11/d

Resources, Supplies & Equipment, and Supplemental Information

Resources

1. PowerPoint Slides
 - ☐ PPt 1 – Digestive System of Cattle
 - ☐ PPt 2 – Digestive System of Sheep
 - ☐ PPt 3 – Ruminant Stomach Compartments
 - ☐ PPt 4 – Three Possible Routes of Feed in Ruminants – Grain Concentrates or Cud
 - ☐ PPt 5 – Three Possible Routes of Feed in Ruminants – Light Grain
 - ☐ PPt 6 – Three Possible Routes of Feed in Ruminants - Forages
2. Activity Sheets
 - ☐ AS 1 – Digestive System of Cattle
 - ☐ AS 2 – Ruminant Digestive System
 - ☐ AS 3 – Monogastric and Ruminant Digestive Systems (Instructor)
3. *Introduction to Animal Nutrition (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1996.
4. *Introduction to Animal Nutrition Curriculum Enhancement*. University of Missouri-Columbia: Instructional Materials Laboratory, 2003.

Supplies & Equipment

- ☐ Cutouts of each part of the ruminant digestive system

Supplemental Information

1. Internet Sites
 - ☐ Bowen, R. "Digestive Anatomy in Ruminants." Colorado State University.

Accessed May 15, 2007, from

http://www.vivo.colostate.edu/hbooks/pathphys/digestion/herbivores/rumen_a_nat.html.

- ❑ Hall, J. B., and S. Silver. Nutrition and Feeding of the Cow-Calf Herd: Digestive System of the Cow. Virginia Cooperative Extension. Accessed May 15, 2007, from <http://www.ext.vt.edu/pubs/beef/400-010/400-010.html>.
 - ❑ Umphrey, J. E., and C. R. Staples. "General Anatomy of the Ruminant Digestive System." University of Florida Institute of Food and Agricultural Sciences. Accessed May 15, 2007, from http://edis.ifas.ufl.edu/BODY_DS061.
2. Print
- ❑ Campbell, J. R., M. D. Kenealy, and K. L. Campbell. *Animal Sciences: The Biology, Care, and Production of Domestic Animals*. 4th ed. New York: McGraw-Hill Companies, 2003.
 - ❑ Frandson, R. D., W. L. Wilke, and A. D. Fails. *Anatomy and Physiology of Farm Animals*. 6th ed. Baltimore: Lippincott Williams and Wilkins, 2003.
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3. Electronic Media
- ❑ *Animal Nutrition Interactive PowerPoints*. University of Missouri-Columbia: Instructional Materials Laboratory, 2006.

References




1. Campbell, J. R., M. D. Kenealy, and K. L. Campbell. *Animal Sciences: The Biology, Care, and Production of Domestic Animals*. 4th ed. New York: McGraw-Hill Companies, 2003.
 2. Frandson, R. D., W. L. Wilke, and A. D. Fails. *Anatomy and Physiology of Farm Animals*. 6th ed. Baltimore: Lippincott Williams and Wilkins, 2003.
 3. Kellems, R. O., and D. C. Church. *Livestock Feeds and Feeding*. 5th ed. Upper Saddle River, NJ: Prentice Hall, 2002.
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Interest Approach

This activity can be done individually, in pairs, or in small groups. Pass out cutouts of each part of the ruminant digestive system. Have the students place the cutouts in the correct orientation and location to “build” a ruminant digestive system.





Communicate the Learning Objectives

1. Determine which livestock species have ruminant digestive systems.
2. Identify the components of the ruminant digestive system.
3. Describe the functions that the components of the ruminant system play in digestion.
4. Explain how feed nutrients are converted into usable nutrients by the ruminant digestive system.
5. Explain why ruminants are better able to utilize forages.

Instructor Directions	Content Outline
Objective 1 <i>Animals have either a monogastric or a ruminant digestive system. The following domestic animals have a ruminant digestive system.</i>	Determine which livestock species have ruminant digestive systems. <ol style="list-style-type: none">1. Cattle2. Sheep
Objective 2 <i>Ask what the parts of the ruminant digestive system are. Point out the importance of the related organs – the liver, gall bladder, and pancreas – in digestion. Hand out AS 1 and, using PPt 1, identify the parts along with the students. Use PPt 2 to illustrate the digestive system of sheep.</i>  AS 1 – Digestive System of Cattle  PPt 1 – Digestive System of Cattle  PPt 2 Digestive System of Sheep	Identify the components of the ruminant digestive system. Ruminant digestive system <ol style="list-style-type: none">1. Mouth2. Esophagus3. Four stomach compartments<ol style="list-style-type: none">a. Rumenb. Reticulumc. Omasumd. Abomasum4. Small intestine<ol style="list-style-type: none">a. Duodenumb. Remainder of small intestine5. Large intestine<ol style="list-style-type: none">a. Cecumb. Colonc. Rectum6. Anus

Instructor Directions	Content Outline
<p>Objective 3</p> <p><i>Ask students what the functions of the main parts of the ruminant digestive system are. Discuss the functions.</i></p>	<p>Describe the functions that the components of the ruminant system play in digestion.</p> <p>Ruminant digestive system</p> <ol style="list-style-type: none"> 1. Mouth – allows feed to enter the digestive system <ol style="list-style-type: none"> a. Tongue – in cattle, grabs grass and other feeds to bring them into the mouth; moves feeds to the throat b. Teeth – bottom teeth cut grass against top dental pad; back upper and lower teeth chew cud and other feeds 2. Esophagus – transports feed back and forth from mouth to the stomach 3. Stomach compartments <ol style="list-style-type: none"> a. Rumen (paunch) – helps break feed down b. Reticulum (honeycomb) – forces roughage back to the mouth for rumination and further breaks down the feed c. Omasum (manyplies) – absorbs some water and nutrients d. Abomasum (true stomach) – similar to the monogastric stomach; site where digestive juices with acids and enzymes are added, moisture increases, and protein is partially digested 4. Small intestine <ol style="list-style-type: none"> a. Duodenum – continues digestive process b. Remainder of small intestine – absorbs digested nutrients into the bloodstream 5. Large intestine <ol style="list-style-type: none"> a. Cecum – plays a minor role in the breakdown of roughage b. Colon – absorbs water and forms wastes into feces; also absorbs some nutrients c. Rectum – stores feces before elimination 6. Anus – the opening through which undigestible solid wastes exits from the body
<p>Objective 4</p> <p><i>Ask students how a ruminant is able to convert feed into nutrients.</i></p>	<p>Explain how feed nutrients are converted into usable nutrients by the ruminant digestive system.</p> <p>Ruminant stomach compartments</p> <ol style="list-style-type: none"> 1. The rumen and reticulum have microorganisms that help break down feed.

Instructor Directions	Content Outline
<p>☐ PPt 3 – Ruminant Stomach Compartments</p>	<ol style="list-style-type: none"> a. Bacteria break down the sugars and starches in feed concentrates and young forages and ferment fiber feed parts. b. Protozoa aid in the storage of available sugars and starches as well as forming some protein and fermenting fiber. c. Fungi play an unclear role in fiber digestion. <ol style="list-style-type: none"> 2. In the rumen, sugar, starches, and fiber are converted into fatty acids. 3. Fatty acids are absorbed in the omasum. 4. Other nutrients are broken down by the digestive juices and enzymes in the abomasum. 5. The breakdown of nutrients in the abomasum and the small intestine is similar to the monogastric digestive system.
<p>Objective 5</p> <p><i>Ask students what parts of the ruminant digestive system enable it to digest forages efficiently. Discuss why ruminants are better able to utilize forages. Compare different routes of feed. AS 3 can be used as an alternative to instructor lecture to teach the structure and function of the monogastric and ruminant digestive systems.</i></p> <p>📄 AS 2 – Ruminant Digestive System</p> <p>📄 AS 3 – Monogastric and Ruminant Digestive Systems (Instructor)</p> <p>☐ PPt 4 – Three Possible Routes of Feed in Ruminants – Grain Concentrates or Cud</p>	<p>Explain why ruminants are better able to utilize forages.</p> <ol style="list-style-type: none"> 1. The rumen has microorganisms to help break down forages. 2. Forages move from the rumen to the reticulum. 3. If forages need to be broken down more, the reticulum pumps the cud up to the mouth to be chewed. 4. When swallowed, the cud enters the reticulum and then passes to the omasum and abomasum.

Instructor Directions	Content Outline
<div data-bbox="180 218 591 331">  PPt 5 – Three Possible Routes of Feed in Ruminants – Light Grain </div> <div data-bbox="180 375 548 489">  PPt 6 – Three Possible Routes of Feed in Ruminants – Forages </div>	
<p data-bbox="155 550 321 581">Application:</p> <div data-bbox="180 594 607 667">  AS 1 – Digestive System of Cattle </div> <div data-bbox="180 1201 607 1274">  AS 2 – Ruminant Digestive System </div>	<p data-bbox="662 550 894 581">Answers to AS 1</p> <ol data-bbox="662 590 894 1171" style="list-style-type: none"> 1. Esophagus 2. Mouth 3. Reticulum 4. Rumen 5. Omasum 6. Abomasum 7. Gall bladder 8. Liver 9. Pancreas 10. Rectum 11. Anus 12. Colon 13. Cecum 14. Small intestine 15. Duodenum <p data-bbox="662 1224 1187 1255">Answers to “Key Questions” on AS 2</p> <ol data-bbox="662 1264 1471 1690" style="list-style-type: none"> 1. Rumen, reticulum, omasum, abomasum 2. Abomasum 3. Hay enters the mouth and passes through the esophagus and reticulum and into the rumen. The hay next enters the reticulum again, and if it is not fully broken down, it is pumped back up through the esophagus to be chewed as cud. After chewing, the cud is swallowed and enters the reticulum. The hay then passes on to the omasum, abomasum, and small intestine. Finally, it passes through the large intestine and out of the body through the anus. <p data-bbox="662 1738 878 1770">Other activities</p> <ol data-bbox="662 1778 1458 1927" style="list-style-type: none"> 1. Perform a dissection of a ruminant digestive system. Contact a processing plant to obtain a ruminant digestive system. Keep it frozen until the dissection is performed.

Instructor Directions	Content Outline
	2. Take students on a field trip to see a fistulated cow.
Closure/Summary	Unlike the monogastric digestive system, the ruminant digestive system found in cattle and sheep includes four compartments. These compartments utilize forages efficiently, converting them into usable nutrients for the animal.
Evaluation: Quiz	<p>Answers:</p> <ol style="list-style-type: none"> 1. Esophagus 2. Rumen 3. Rectum 4. Mouth 5. Omasum 6. Anus 7. Reticulum 8. Colon 9. Abomasum 10. Duodenum 11. Cecum 12. Small intestine 13. c 14. b 15. a 16. b 17. d 18. Forages 19. Ground concentrate or cud

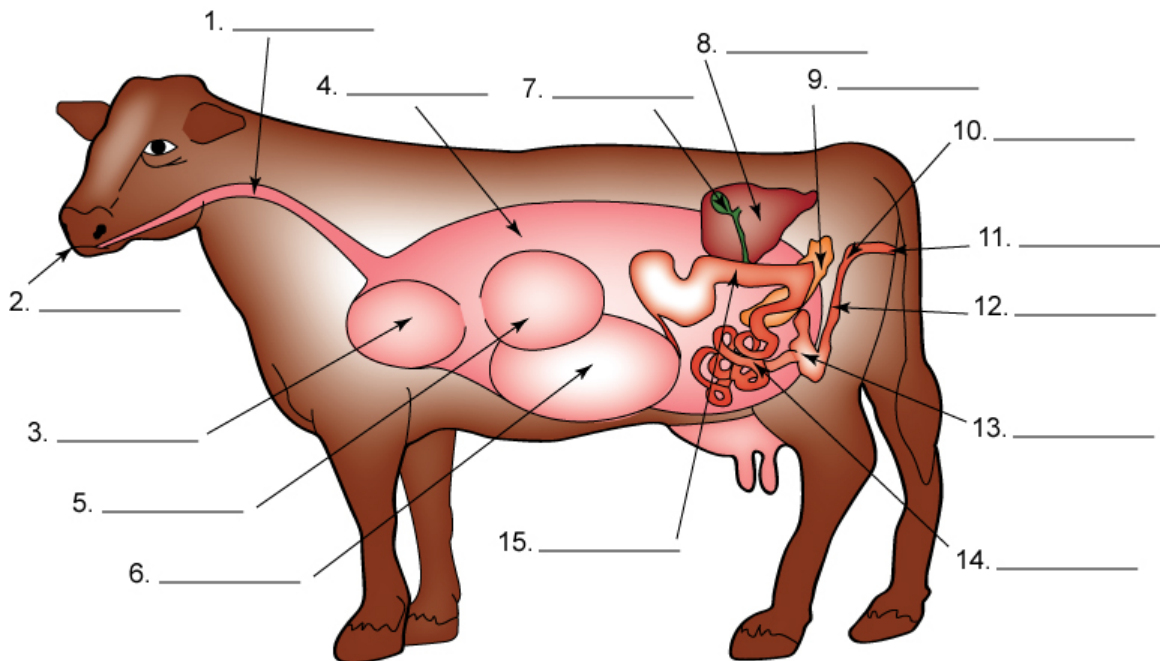
Lesson 2: Ruminant Digestive System

Name: _____

DIGESTIVE SYSTEM OF CATTLE

Objective: Identify the parts of the ruminant digestive system in cattle.

Label the parts of the ruminant digestive system.



Lesson 2: Ruminant Digestive System

Name: _____

RUMINANT DIGESTIVE SYSTEM

Objective: Identify the parts of the ruminant digestive system and their functions.

Activity Length: 30 minutes

Procedure:

NOTE: Your instructor may have you work in groups.

1. Choose one of the following parts:

Mouth	Abomasum
Esophagus	Small intestine
Rumen	Large intestine
Reticulum	Anus
Omasum	

2. Research and write down the functions of each part. Students researching the esophagus should also be able to describe the path taken by grain in the digestive system, while those students researching the function of the anus should be able to describe the path taken by forages.
3. Line up in order starting with the mouth and ending with the anus. The person who is representing the mouth is responsible for ensuring the correct order.
4. After lining up, name the part and describe its functions based on your research.
5. The students who have researched the paths taken by grain and forages should describe them.

Key Questions:

1. What are the four compartments of the stomach?

2. What digestive part is known as the true stomach?
3. What is the path taken by hay as it passes through the ruminant digestive system?

Lesson 2: Ruminant Digestive System

Name:_____

MONOGASTRIC AND RUMINANT DIGESTIVE SYSTEMS

Objective: Illustrate the monogastric and ruminant digestive systems.

Activity Length: 45 minutes

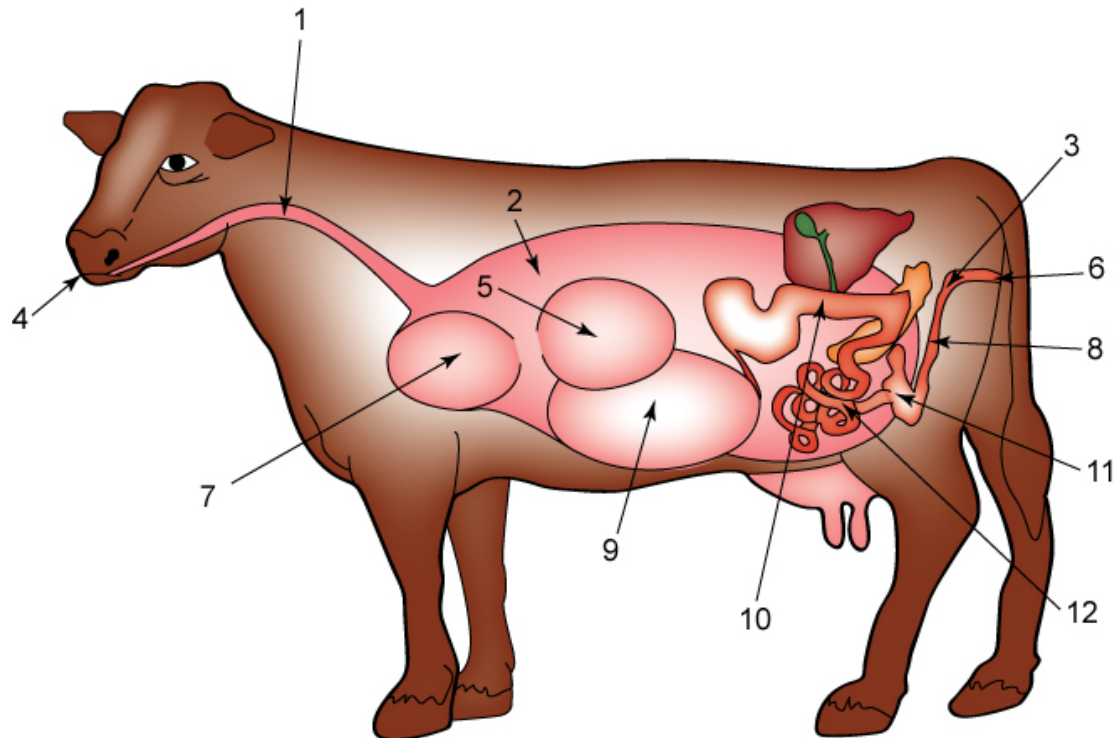
Procedure:

NOTE: This activity may be used as an alternative to instructor lecture to teach the structure and function of the monogastric and ruminant digestive systems.

1. Divide the class into groups of two or three students.
2. Have one student from each group draw a folded slip of paper from a container to determine what species each group will draw.
3. Have each group draw the outline of the animal and its digestive system.
4. The parts of the digestive system should be labeled.
5. After all the groups have completed their drawings, have the members of each group do a presentation in which they describe each of the parts of the digestive system and its function to the class.

EVALUATION

From the following diagram, write the names of the parts of the ruminant digestive system in the corresponding numbered spaces.



1. _____

7. _____

2. _____

8. _____

3. _____

9. _____

4. _____

10. _____

5. _____

11. _____

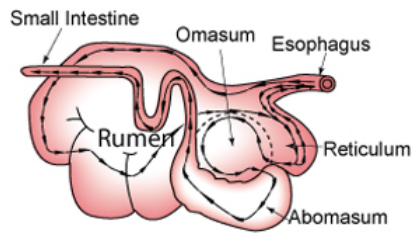
6. _____

12. _____

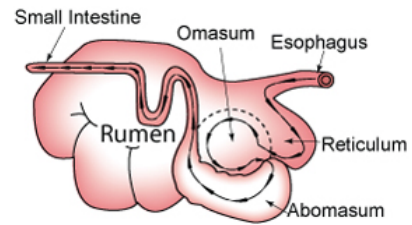
Circle the letter that corresponds to the best answer.

13. Which part of the digestive system acts like a pump to force the cud back to the mouth?
- a. Abomasum
 - b. Esophagus
 - c. Reticulum
 - d. Rumen
14. Which part absorbs water from the digested material?
- a. Esophagus
 - b. Large intestine
 - c. Rumen
 - d. Small intestine
15. The _____ acts very similar to the monogastric stomach when converting feed into usable nutrients.
- a. Abomasum
 - b. Omasum
 - c. Reticulum
 - d. Rumen
16. Which of the following helps the ruminant to break down forages?
- a. Amylase
 - b. Bacteria
 - c. Hydrochloric acid
 - d. Pepsin
17. Which two species have a ruminant digestive system?
- a. Sheep and horses
 - b. Rabbits and sheep
 - c. Horses and cattle
 - d. Cattle and sheep

For each picture, name the type of feed that would be passed through the ruminant digestive system.



18. _____



19. _____

Course	Agricultural Science I
Unit	Introduction to Animal Nutrition
Lesson	The Importance of Meeting Nutritional Needs
Estimated Time	90 minutes or 2-50 minute blocks

Student Outcome

Identify the importance of meeting the nutritional needs of animals.

Learning Objectives

1. Describe what a nutrient is.
2. Determine the six basic nutrients and describe their functions.
3. Describe the importance of meeting the nutritional needs of an animal.

Grade Level Expectations

SC/LO/2/D/09-11/b

Resources, Supplies & Equipment, and Supplemental Information

Resources

1. PowerPoint Slides
 - ☐ PPt 1 – Nutrient Requirements for a Cow through Life Stages
2. Activity Sheets
 - ☐ AS 1 – Nutrient Recommendations (Instructor)
 - ☐ AS 1 – Nutrient Recommendations (Student)
3. *Introduction to Animal Nutrition (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1996.
4. *Introduction to Animal Nutrition Curriculum Enhancement*. University of Missouri-Columbia: Instructional Materials Laboratory, 2003.

Supplies & Equipment

- ☐ Photos of different species of livestock with nutrient deficiencies

Supplemental Information

1. Internet Sites
 - ☐ Animal Science Publications. MU Extension. University of Missouri-Columbia. Accessed April 12, 2007, from <http://extension.missouri.edu/explore/agguides/ansci/>.
 - ☐ Livestock and Forages Publications. Cooperative Extension Service. University of Arkansas. Accessed June 1, 2007 from <http://www.aragriculture.org/livestock/publications.htm#Beef%20Cattle%20Nutrition>.
2. Print
 - ☐ Kellems, R. O., and D. C. Church. *Livestock Feeds and Feeding*. 5th ed. Upper Saddle River, NJ: Prentice Hall, 2002.
 - ☐ National Research Council. *Nutrient Requirements of Beef Cattle*. 7th Ed. Washington D.C.: National Academy Press, 2000.

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- ❑ National Research Council. *Nutrient Requirements of Dairy Cattle*. 7th Ed. Washington D.C.: National Academy Press, 2001.
 - ❑ National Research Council. *Nutrient Requirements of Horses*. 6th Ed. Washington D.C.: National Academy Press, 2007.
 - ❑ National Research Council. *Nutrient Requirements of Poultry*. 9th Ed. Washington D.C.: National Academy Press, 1994.
 - ❑ National Research Council. *Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids, and New World Camelids*. 1st Ed. Washington D.C.: National Academy Press, 2006.
 - ❑ National Research Council. *Nutrient Requirements of Swine*. 10th Ed. Washington D.C.: National Academy Press, 1998.
3. Electronic Media
- ❑ *Animal Nutrition Interactive PowerPoints*. University of Missouri-Columbia: Instructional Materials Laboratory, 2006.
-

Interest Approach


Show pictures of various species with nutrient deficiencies. Ask the students if they can identify the problems.

Communicate the Learning Objectives

1. Describe what a nutrient is.
2. Determine the six basic nutrients and describe their functions.
3. Describe the importance of meeting the nutritional needs of an animal.

Instructor Directions	Content Outline
<p>Objective 1</p> <p><i>Ask what a nutrient is. Discuss the definition of nutrients and where they originate.</i></p> <p>NOTE: AS 1 may be used as an alternative format to teach objectives 1 and 2, or it can be completed after the discussion of these objectives.</p>	<p>Describe what a nutrient is.</p> <ol style="list-style-type: none">1. Elements or chemical compounds that support the life processes of an animal2. Allow animals to maintain bodily functions by entering cells of the body and fueling their growth and function3. Found in water, grain, roughage, and other food substances taken into the digestive system through the mouth
<p>Objective 2</p> <p><i>Ask what the six basic nutrients are. Describe the nutrients and their functions.</i></p>	<p>Determine the six basic nutrients and describe their functions.</p> <p>Water – contains hydrogen and oxygen</p> <ol style="list-style-type: none">1. Plays a role in biochemical reactions, including respiration, digestion, and assimilation2. Transports nutrients3. Transports wastes4. Regulates body temperature5. Gives the body its form <p>Proteins – contain carbon, hydrogen, oxygen, and nitrogen; may contain iron, phosphorus, and sulfur</p> <ol style="list-style-type: none">1. Develop and repair body organs and tissues like muscles, nerves, skin, hair, hooves, and feathers2. Used to produce milk, wool, and eggs3. Develop the fetus4. Generate some enzymes and hormones5. Form a part of DNA <p>Carbohydrates (sugar, starch, and fiber) – contain carbon, hydrogen, and oxygen</p> <ol style="list-style-type: none">1. Provide energy that powers muscle movement

Instructor Directions	Content Outline
	<p>required for exercise and essential functions, such as breathing, digestion, and beating of heart</p> <ol style="list-style-type: none"> 2. Produce body heat 3. Stored as body fat <p>Fats – contain carbon, nitrogen, and oxygen</p> <ol style="list-style-type: none"> 1. Function as a valuable energy source 2. Provide body heat 3. Carry some vitamins <p>Minerals – inorganic elements</p> <ol style="list-style-type: none"> 1. Supply materials for building skeleton and teeth 2. Form a part of body regulators, such as enzymes and hormones <p>Vitamins – organic substances that are fat- or water-soluble</p> <ol style="list-style-type: none"> 1. Regulate the digestion, absorption, and metabolism of nutrients 2. Regulate the formation of new cells 3. Regulate development of vision, bones, hair, feathers, skin, and muscles 4. Help protect against diseases 5. Develop and maintain the nervous system
<p>Objective 3</p> <p><i>Ask why animals might have different nutrient requirements at different times. Discuss those differences.</i></p> <p><input type="checkbox"/> PPt 1 – Nutrient Requirements for a Cow through Life Stages</p>	<p>Describe the importance of meeting the nutritional needs of an animal.</p> <p>Maintenance</p> <ol style="list-style-type: none"> 1. Must be met before any other nutrient needs are met 2. Keep the body functioning with no weight gain or loss and no production 3. Amount of feed needed to maintain the animal depends on body size <p>Lactation</p> <ol style="list-style-type: none"> 1. Fats and carbohydrates – supply energy vital for lactation 2. Protein 3. Water 4. Minerals – calcium and phosphorus needed during lactation 5. Vitamins – A, B-complex, and D (if indoors) are needed when a female is lactating

Instructor Directions	Content Outline
	<p>Conception and gestation</p> <ol style="list-style-type: none"> 1. Ensures good fetal growth, particularly for increased nutrient needs of fetus in last trimester 2. Needed because female requires additional nutrients to maintain itself and fetus <p>Growth and development</p> <ol style="list-style-type: none"> 1. Fats and carbohydrates – supply energy source 2. Protein – builds muscles and produces bone and connective tissues 3. Minerals – requires calcium and phosphorus for bone growth 4. Vitamins – requires higher quantities, especially D <p>Health – nutrients needed to carry out vital bodily functions; animal must be healthy to be most productive</p>
<p>Application:</p> <p> AS 1 – Nutrient Recommendations</p>	<p>Answers to AS 1</p> <p>Define the problem: What is causing the cows to be open and very thin?</p> <p>Possible Causes, Related Facts, and Accept/Reject Causes</p> <p>Water deficiency Components: Hydrogen and oxygen Functions: Plays a role in biochemical reactions, including respiration, digestion, and assimilation. Transports nutrients. Maintains body temperature. Gives body its form and carries body waste. Reject</p> <p>Protein deficiency Components: Essential and non-essential amino acids, containing carbon, hydrogen, oxygen, and nitrogen. Sometimes include iron, phosphorus, and sulfur. Functions: Develops and repairs body organs and tissues like muscles, nerves, skin, hair, hooves, and feathers. Produces milk, wool, and eggs. Develops the fetus and generates enzymes and hormones. Forms a part of DNA. Reject</p>

Instructor Directions	Content Outline
	<p>Carbohydrate Deficiency Components: Carbon, hydrogen, and oxygen in sugars, starches, and fiber Functions: Provides energy for bodily functions, such as breathing, digestion, and exercise. Produces body heat. Stored as body fat. Accept</p> <p>Fat deficiency Components: Same as carbohydrates but supplies 2.25 times more energy. Functions: Serves as an energy source. Provides body heat. Carries some vitamins. Reject</p> <p>Mineral deficiency Components: Inorganic elements that are macro- or micro-minerals. Macro-minerals are Ca, P, Na, K, Cl, Mg, and S. Micro-minerals are Fe, I, Cu, Co, Fl, Mn, Zn, Mo, Se. Functions: Supply materials for building skeleton and teeth. Form a part of body regulators, such as enzymes and hormones. Reject</p> <p>Vitamin deficiency Components: Organic substances that are either fat- or water-soluble. Fat-soluble vitamins are A, D, E, and K. Water-soluble vitamins are C and B-complex. Functions: Regulate digestion, absorption, and metabolism of nutrients. Regulate the development of vision, bone, hair, feathers, skin, and muscles. Regulate the formation of new cells, protect against diseases, and develop and maintain the nervous system. Reject</p> <p>Decision/Recommendation: A carbohydrate deficiency is the cause of the problem. Brandon's family should increase carbohydrate levels in the feed ration.</p>

Instructor Directions	Content Outline
	<p>Other activities</p> <ol style="list-style-type: none"> 1. Show students pictures of animals suffering from nutrient deficiencies to familiarize them with the effects of deficiencies.
<p>Closure/Summary</p>	<p>Nutrients are elements or chemical compounds that support the life processes of the animal. There are six basic nutrients – water, protein, carbohydrates, fats, vitamins, and minerals. Each nutrient has a specific function and may be important for health and maintenance, conception/ gestation, lactation, and growth/development.</p>
<p>Evaluation: Quiz</p>	<p>Answers:</p> <ol style="list-style-type: none"> 1. c 2. d 3. a 4. d 5. d 6. c 7. a 8. b 9. d 10. b 11. During gestation the female needs nutrients to maintain itself and the fetus. The last trimester requires the most nutrients since it is a period of great growth. The additional nutrient requirements for the female are equal to those of the young animal after birth. During lactation, the female needs protein, vitamins, minerals, fats, and carbohydrates. Protein and fats and carbohydrates are vital for producing milk. Minerals are needed for calcium and phosphorus. Vitamins A and B-complex are also needed, along with Vitamin D (if indoors). 12. Nutrients are important for animal health because they are needed to carry out vital bodily functions. An animal must be healthy in order to be at its most productive.

Lesson 3: The Importance of Meeting Nutritional Needs

NUTRIENT RECOMMENDATIONS

Activity Length: 30 minutes

Procedure:

1. Hand out AS 3.1 (Student). Have students read the problem and answer any questions. Make sure that the students recognize the symptoms of the nutrient deficiency.
2. Ask the students what they need to decide to help Brandon. Help them recognize that the decision to be made is what is causing Brandon's cows to be open and very thin.
3. Use the student reference and provide a supervised study period to fill in the chart.
4. After the supervised study time has expired, ask the students what a nutrient is. Discuss the definition of a nutrient.
5. Have a student write one possible cause of the deficiency on the chalkboard with the related facts. Discuss that possibility. Repeat for each item until all the possible causes are explained.
6. Have students fill in the accept/reject column and decide on a solution and recommendation.

Lesson 3: The Importance of Meeting Nutritional Needs

Name: _____

NUTRIENT RECOMMENDATIONS**Objective:** Identify and recommend a nutrient solution for Brandon's cows.

Read the case study below. Then fill in the table to help identify the problem. In the "Related Facts" column, list both the components of the nutrient and its functions. Write "accept" or "reject" in the third column to indicate the cause of the problem. Then answer the question.

Brandon's family has a cow-calf operation, and he has a few cows of his own as an SAE project. They have a total of one hundred cows, which were bred to calve in March. Recently they were pregnancy checked, and Brandon and his family learned that 40 percent of the cows were not bred. The cows are being fed fescue hay, and all the cows seem to be eating, but they are still extremely thin. Brandon calls the veterinarian, who reviews his health program and takes samples from the animals. The vet says that the cows are healthy. Brandon is concerned and talks to his FFA advisor, extension specialist, and feed dealer. They suggest that the problem could be related to a nutrient deficiency. Brandon needs advice about what to do.

Possible Causes	Related Facts	Accept/Reject Cause
Water deficiency		
Protein deficiency		
Carbohydrate deficiency		
Fat deficiency		

Possible Causes	Related Facts	Accept/Reject Cause
Vitamin deficiency		
Mineral deficiency		
Decision/Recommendation: What is Brandon’s problem? How can the problem be solved?		

EVALUATION

Circle the letter that corresponds to the best answer.

1. What are elements or chemical compounds that support life processes called?
 - a. Feed
 - b. Grass
 - c. Nutrients
 - d. Roughage

2. Which nutrient is composed of hydrogen and oxygen and maintains body temperature?
 - a. Carbohydrates
 - b. Fat
 - c. Mineral
 - d. Water

3. Which two nutrients are used for energy?
 - a. Fats and carbohydrates
 - b. Fats and protein
 - c. Protein and minerals
 - d. Vitamins and carbohydrates

4. Which of the following is a carbohydrate?
 - a. Calcium
 - b. Amino acids
 - c. Fatty acids
 - d. Sugar

5. If a cow cannot see properly, in which nutrient may the cow be deficient?

- a. Fat
 - b. Minerals
 - c. Protein
 - d. Vitamins
6. Which nutrient develops and repairs body organs and tissues?
- a. Carbohydrates
 - b. Minerals
 - c. Protein
 - d. Vitamins
7. Which of the following are macrominerals?
- a. Calcium and potassium
 - b. Chlorine and copper
 - c. Cobalt and phosphorus
 - d. Iodine and zinc
8. Fats have the same components as carbohydrates but provide _____ times more energy.
- a. 2.00
 - b. 2.25
 - c. 2.50
 - d. 2.75
9. When are nutrients needed to sustain body functions with no weight gain or loss?
- a. Gestation
 - b. Growth and development
 - c. Health and maintenance
 - d. Maintenance
10. When are additional nutrients needed for building muscles, bone, and connective tissue?

- a. Conception
- b. Growth and development
- c. Health
- d. Lactation

Complete the following short answer questions.

11. What are the nutrient needs of the sow during gestation? What are its nutrient needs during lactation?

12. Why are nutrients important for animal health?

Course	Agricultural Science I
Unit	Introduction to Animal Nutrition
Lesson	Meeting Nutritional Needs of Animals
Estimated Time	50 minutes

Student Outcome

Identify how the nutritional needs of animals may be met.

Learning Objectives


1. List the sources of information on nutritional requirements.
2. Describe the steps necessary to meet the nutritional needs of animals.
3. Identify sources of nutrients.

Grade Level Expectations

SC/ST/1/C/09-11/a

Resources, Supplies & Equipment, and Supplemental Information

Resources

1. Activity Sheets
 -  AS 1 – Identifying Nutritional Requirements
2. *Introduction to Animal Nutrition (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1996.
3. *Introduction to Animal Nutrition Curriculum Enhancement*. University of Missouri-Columbia: Instructional Materials Laboratory, 2003.

Supplemental Information

1. Internet Sites
 - ☐ Animal Science Publications. MU Extension. University of Missouri-Columbia. Accessed May 10, 2007, from <http://extension.missouri.edu/explore/agguides/ansci/g02051.htm>.
 - ☐ Animal Science Publications. MU Extension. University of Missouri-Columbia. Accessed April 12, 2007, from <http://extension.missouri.edu/explore/agguides/ansci/>.
 - ☐ Animals & Animal Products. U.S. Department of Agriculture. Accessed April 12, 2007, from <http://www.csrees.usda.gov/nea/animals/animals.html>.
 - ☐ Applied Animal Management. Purdue University. Accessed May 10, 2007, from <http://ag.ansc.purdue.edu/nielsen/www245/lecnotes/Nutrition.html>.
 - ☐ DiCostanzo, Alfredo. Stocker/Backgrounder Nutrition. U of M Extension. University of Minnesota. Accessed May 10, 2007, from http://www.extension.umn.edu/Beef/components/homestudy/stocker_lesson4.pdf.
 - ☐ MyPyramid.gov. USDA. Accessed May 10, 2007, from <http://www.mypyramid.gov/>.

2. Electronic Media


- ❑ *Animal Nutrition Interactive PowerPoint*s. University of Missouri-Columbia: Instructional Materials Laboratory, 2006.
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Interest Approach

Ask students to quickly list the foods they eat for meals and snacks during a typical day. Have them try to identify the types of nutrients found in each food. Then inform students of the nutritional requirements for humans. Allow them to compare these requirements to their lists. Make a comparison between the human nutritional requirements and the students' diets and the management by producers of an animal's diet to meet its nutritional needs.

Communicate the Learning Objectives

1. List the sources of information on nutritional requirements.
2. Describe the steps necessary to meet the nutritional needs of animals.
3. Identify sources of nutrients.

Instructor Directions	Content Outline
Objective 1 <i>Ask students where information can be obtained about nutritional requirements. Discuss the information each source provides.</i>	List the sources of information on nutritional requirements. <ol style="list-style-type: none">1. University Extension agricultural publications and livestock and dairy specialists2. Textbooks on animal nutrition3. Feed companies and dealers4. National Research Council
Objective 2 <i>Discuss the steps that should be taken to meet the nutritional needs of an animal. Ask the students to explain the importance of each of the steps.</i>  AS 1 – Identifying Nutritional Requirements	Describe the steps necessary to meet the nutritional needs of animals. Find information sources on the nutritional needs of animals and the nutrient content of feeds. Next, identify the particular animal's nutritional needs <ol style="list-style-type: none">1. Identify the life stage of the animal2. Determine the animal's weight and the size of its frame.3. Determine the desired performance (rate of gain).4. Look up all the nutritional requirements of the animal using this information. Identify the nutrients available in a feed. <ol style="list-style-type: none">1. Identify the feeds that may be used.2. Choose a version of a particular feed.3. Look up the nutrients provided by that specific feed. Match the feed to the animal's nutritional requirements to meet its needs. This is accomplished by balancing a ration.

Instructor Directions	Content Outline
<p>Objective 3</p> <p><i>List the nutrients and ask students what the sources of each of the six nutrients are. Discuss each source. Display some of the nutrient sources as visual aids.</i></p>	<p>Identify sources of nutrients.</p> <ol style="list-style-type: none"> 1. Water - Fresh water and feeds, which contain water 2. Protein - Amino acids in animal tissues, grains, and legumes 3. Carbohydrates - Sugars, starches, and fibers in grain and forages 4. Fats - Fatty acids in animal tissues, fats, and grains 5. Vitamins - Grass, sun-cured hay, and commercial feeds 6. Minerals - Plant and animal tissues and commercial feeds
<p>Application:</p> <p> AS 1 – Identifying Nutritional Requirements</p>	<p><i>Answers are based on the University of Missouri Extension agricultural publications, using the Missouri recommended allowances.</i></p> <p>Answers to AS 1</p> <ol style="list-style-type: none"> 1. <ol style="list-style-type: none"> a. 14.4% b. 85% c. 11.8 lbs. 2. <ol style="list-style-type: none"> a. 1 lb. b. 18% c. 0.7% d. 1.10% 3. <ol style="list-style-type: none"> a. 8.2% b. 0.28% c. 16.8 lbs. 4. <ol style="list-style-type: none"> a. 14% b. 0.6% c. 0.9% d. 0.65% 5. <ol style="list-style-type: none"> a. 7% b. 0.18% c. 18.1 lbs. d. 48.8%

Instructor Directions	Content Outline
	<p>Other activities</p> <ol style="list-style-type: none"> 1. Have students do research to determine the nutrients provided by different feeds.
Closure/Summary:	<p>Many sources of information about the nutrients in feed and the nutritional requirements of animals are available. Once sources are found, the animal's needs and then the feed nutrients should be identified. The two must be matched to meet the animal's needs. The necessary nutrients may be supplied to an animal through many different feed sources.</p>
Evaluation: Quiz	<p>Answers:</p> <ol style="list-style-type: none"> 1. a 2. c 3. d 4. d 5. a 6. d 7. c 8. d 9. Answers may include any three of the following: University Extension livestock and dairy specialists and agricultural publications, textbooks, feed dealers and companies, National Research Council. 10. a. Find information sources on the nutritional needs of animals and the nutrient content of feeds. b. Identify the animal's nutritional needs. c. Identify the nutrients available in feed. d. Match the feed to the animal's nutritional requirements to meet its needs.

Identifying Nutritional Requirements

Objective: Identify the nutritional requirements of animals.

Using University of Missouri Extension Guides or other sources, answer the following questions to identify the nutritional requirements of animals.

1. A 500-pound medium-framed steer has an ADG of 3.0.
 - a. What is the percent protein?_____
 - b. What percent of TDN is needed?_____
 - c. How much dry matter is needed?_____
2. What are the recommended allowances for a 25 to 45 pound growing swine?
 - a. What is the expected daily gain?_____
 - b. How much crude protein is needed?_____
 - c. What is the total phosphorus needed?_____
 - d. What percent lysine is needed in the diet?_____
3. An 800-pound pregnant yearling heifer in the last third of pregnancy has an ADG of 0.9.
 - a. How much protein is required?_____
 - b. What is the calcium requirement?_____
 - c. How much dry matter should she intake?_____
4. What are the nutritional needs of a lactating sow?
 - a. What is the crude protein requirement?_____
 - b. How much valine is needed?_____
 - c. What is the calcium requirement?_____
 - d. What percent lysine is needed?_____

5. What are the nutritional requirements of a dry, pregnant, mature cow in the middle third of pregnancy weighing 1000 pounds?
- a. What is the percent protein required? _____
 - b. How much calcium is required? _____
 - c. What is the dry matter intake? _____
 - d. What is the TDN? _____

Name _____

Date _____

EVALUATION

Circle the letter that corresponds to the best answer.

1. What is the first step to be taken in meeting an animal's nutritional needs?
 - a. Find sources of information on the animal's needs and on feeds.
 - b. Match the feed to the animal's nutritional requirements.
 - c. Identify that animal's needs.
 - d. Identify the feed nutrients provided.
2. In which step are the animal's weight and size considered?
 - a. Find sources of information on the animal's needs and on feeds.
 - b. Identify that animal's needs.
 - c. Match the feed to the animal's nutritional requirements.
 - d. Identify the feed nutrients provided.
3. Which of the following is not a part of identifying the animal's nutritional needs?
 - a. Determining the desired performance
 - b. Identifying the life stage of the animal
 - c. Determining the animal's weight and frame size
 - d. Identifying the animal's breed
4. Which nutrient may be provided by a pond?
 - a. Carbohydrates
 - b. Fats
 - c. Proteins
 - d. Water
5. Carbohydrates are found in _____.
 - a. Grain
 - b. Animal tissues
 - c. Fats
 - d. Fresh water

6. A good source of vitamins is _____.
- a. Animal tissue
 - b. Fats
 - c. Grain
 - d. Sun-cured hay
7. Legumes are an important source of _____.
- a. Carbohydrates
 - b. Fats
 - c. Protein
 - d. Vitamins
8. Minerals may be supplied to the animal through _____ and _____ tissues.
- a. Fat, legume
 - b. Fat, animal
 - c. Grain, plant
 - d. Plant, animal

Complete the following short answer questions.

9. What are three sources of information on nutritional requirements?
- a.
 - b.
 - c.
10. What are the four general steps followed in meeting an animal's nutritional needs?
- a.
 - b.
 - c.
 - d.

Course	Agricultural Science I
Unit	Introduction to Animal Nutrition
Lesson	Balancing a Ration
Estimated Time	60 minutes

Student Outcome

Demonstrate the procedure for balancing a ration for crude protein.

Learning Objectives

1. List why a balanced ration is important for nutrition.
2. Demonstrate how a ration is balanced.
3. Identify the factors that influence the ingredients used to balance a ration.

Grade Level Expectations

Resources, Supplies & Equipment, and Supplemental Information

Resources

1. PowerPoint Slide
 - ❑ PPt 1 – Pearson Square Method
2. Activity Sheet
 - 📄 AS 1 – Balancing Rations
3. *Introduction to Animal Nutrition (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1996.
4. *Introduction to Animal Nutrition Curriculum Enhancement*. University of Missouri-Columbia: Instructional Materials Laboratory, 2003.

Supplemental Information

1. Internet Sites
 - ❑ Bohnert, David, and David Chamberlain. *Beef Cattle Nutrition Workbook*. Oregon State University Extension Service. Accessed May 10, 2007, from <http://oregonstate.edu/dept/EOARC/about/home/scientists/documents/DWB26.pdf>.
 - ❑ Lalman, David L., and Homer B. Sewell. *Rations for Growing and Finishing Beef Cattle*. MU Extension. University of Missouri-Columbia. Accessed May 9, 2007, from <http://extension.missouri.edu/explore/agguides/ansci/g02066.htm>.
 - ❑ Milk Standardization Calculator for Confirming That Pearson Square Calculations Are Correct. Dairy Science and Food Technology. Accessed May 10, 2007, from <http://dairyscience.info/pearson.asp>.
 - ❑ Pearson Square Calculator. Agri-Publications, Inc. Accessed May 10, 2007, from <http://www.agdownload.com/html/P00091.asp>.
 - ❑ Pearson Square (interactive lesson). Smart Farm. Accessed May 10, 2007, from <http://www.farmschool.com/smartfarm/tools/pearson.php>.
 - ❑ Spreadsheets for calculating rations. Accessed May 10, 2007, from <http://agebb.missouri.edu/download/index.htm>.
 - ❑ Wagner J., and T. L. Stanton. *Formulating Rations with the Pearson Square*. CSU

Cooperative Extension. Colorado State University. Accessed May 10, 2007, from <http://www.ext.colostate.edu/PUBS/livestk/01618.html>.

2. Electronic Media

- ❑ *Animal Nutrition Interactive PowerPoints*. University of Missouri-Columbia: Instructional Materials Laboratory, 2006.
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Interest Approach

- ❑ Ask students what they think would happen if they ate only bread for every meal. What effect would it have on their health? How could they correct this problem? Compare this example to meeting the nutritional needs of a cattle herd. Ask students what would happen if cattle were fed only carbohydrates. Then ask how using a balanced feed ration could improve the herd.
- ❑ The following example from Dr. Dan Netermeyer can be used to illustrate the importance of putting together a ration that not only has the necessary nutrients but also includes quality ingredients. The ration has 10 percent protein, 6.5 percent fat, 2.4 percent fiber, and 68 percent moisture, but it consists of 4 pairs of worn-out work shoes, 1 gallon of waste oil, 1 pail of crushed coal, and 68 pounds of water (from "OK, Feed Prices Are High, but Watch How You Save," *Today's Farmer*, February 1996, p. 18).

Communicate the Learning Objectives

1. List why a balanced ration is important for nutrition.
2. Demonstrate how a ration is balanced.
3. Identify the factors that influence the ingredients used to balance a ration.

Instructor Directions	Content Outline
Objective 1 <i>Ask students what a balanced ration is. Discuss the importance of balancing a ration.</i>	List why a balanced ration is important for nutrition. <ol style="list-style-type: none">1. Meets the nutrient needs for health and each life stage2. Prevents nutritional deficiencies3. Promotes maximum growth and production
Objective 2 <i>Ask students what the methods of balancing a ration are. Discuss the methods. Use PPt 1 to illustrate how to use the Pearson Square method by doing an example balancing a ration for crude protein. If available, a computer method may also be used.</i> ❑ PPt 1 – Pearson Square Method	Describe methods used to balance a ration. Computer programs <ol style="list-style-type: none">1. They are able to check whether multiple nutrients in a ration are balanced at one time.2. The computer does all figuring.3. It requires complete information.4. The operator needs to have a knowledge of nutrition. Trial and error method <ol style="list-style-type: none">1. A combination of feeds is selected.2. The nutrient content is calculated and compared to the animal's nutritional needs.3. The process is repeated if its needs are not met.4. This method meets all the nutritional needs of the animal. Pearson square method <ol style="list-style-type: none">1. This method balances for only one nutrient at a time;

Instructor Directions	Content Outline
	<p>it is mostly used for protein.</p> <ol style="list-style-type: none"> 2. Draw a square. 3. Write the percent of the nutrient required by the animal in the middle of the square. 4. Write the percent nutrient of each of the two feed items on its own corner on the left side. 5. Find the diagonal differences and place the results on the right corners. Always subtract the smaller number from the larger. 6. Add the two values and place the total at the bottom. 7. Find the percentage of the ingredients by dividing the diagonal difference of each feed ingredient by the total. 8. Find the number of pounds of each feed ingredient used by multiplying the percentage by the total number of pounds in the ration. 9. Check to ensure that other nutritional requirements are met.
<p>Objective 3</p> <p><i>Ask students what factors influence the choice of ingredients used to balance the ration. Discuss the factors. Have students complete AS 1 on balancing rations and least cost.</i></p> <p><input type="checkbox"/> AS 1 – Balancing Rations</p>	<p>Identify the factors that influence the ingredients used to balance a ration.</p> <p>Least cost - The goal is to get the desired performance at the least cost to the producer.</p> <ol style="list-style-type: none"> 1. Balance a ration to determine the amount of each feed ingredient used. 2. Find the total cost for each ration by multiplying the amount of each ingredient by its cost and adding to find the total cost. 3. Compare the costs of balanced rations using different ingredients. 4. Choose the ration with the least cost. <p>Ingredient availability - Geographical areas have different available feeds, depending on what is grown there and the manufacturing byproducts that are available.</p>
<p>Application:</p> <p><input type="checkbox"/> AS 1 – Balancing Rations</p> <p><i>Answers are based on University of Missouri Extension agricultural publications, using the Missouri recommended allowances.</i></p>	<p>Answers to AS 1</p> <ol style="list-style-type: none"> 1. Corn - 87 lbs. Supplement - 13 lbs. 2. Soybean meal - .74 lbs. 3. Grain sorghum - 897 lbs. Supplement - 103 lbs.

Instructor Directions	Content Outline
	<ol style="list-style-type: none"> 4. Yellow dent corn - 836 lbs. Supplement - 164 lbs. 5. Answers will vary depending on the current prices for grain sorghum, yellow dent corn, and supplement. <p>Other activities</p> <ol style="list-style-type: none"> 1. Visit a local COOP, feed mill, or Extension service. Have an employee demonstrate balancing a ration using their computer program.
Closure/Summary:	<p>A ration needs to be balanced to provide the proper amounts and proportions of nutrients for an animal. It is important to balance a ration to meet the animal's nutritional needs for health and the requirements of each life stage, to prevent nutritional deficiencies, and to promote maximum growth and production. Many methods may be used to balance a ration, such as computer programs, trial and error, and the Pearson Square method. Least cost and ingredient availability are factors to consider when balancing a ration.</p>
Evaluation: Quiz	<p>Answers:</p> <ol style="list-style-type: none"> 1. c 2. a 3. b 4. b 5. c 6. Corn - 857 lbs. Supplement - 143 lbs. 7. Answers will vary depending on current prices for corn, wheat, and supplement.

Lesson 5: Balancing a Ration

Name: _____

Balancing Rations

Objective: Balance rations for protein using the Pearson Square method.

Balance the following rations using the Pearson Square method. Round to the nearest pound or dollar. Use sources to obtain any additional information needed to balance the rations.

1. A bred gilt requires a 13% protein ration. Corn with 9% protein and supplement with 40% protein is used in the ration. Find the number of pounds of corn and supplement needed to make a 100 lb. ration.

Corn _____

Supplement _____

2. A 1400-pound cow in the second trimester of pregnancy needs 6.9% protein. She is given 23.3 lbs. of feed, most of which is mature smooth brome hay at 5.5% protein. How many pounds of soybean meal should the cow be given to make sure that she receives 6.9% protein? The soybean meal has 49.6% protein.

Soybean meal _____

3. A lactating sow with a litter is fed high protein grain sorghum and a supplement with 40% protein. Find the number of pounds of high protein grain sorghum and supplement in a 1000 lb. ration.

Grain sorghum _____
Supplement _____

4. A lactating sow with a litter is fed yellow dent corn and a supplement with 40% protein. Find the number of pounds of corn and supplement in a 1000 pound ration.

Corn _____
Supplement _____

5. Using current prices, calculate the prices of the rations in Problems 3 and 4. Determine which ration has the least cost and should be fed to the lactating sow.

Cost of Problem 3 _____
Cost of Problem 4 _____
Which should be fed? _____

EVALUATION

Circle the letter that corresponds to the best answer.

1. A ration is balanced to prevent _____.
 - a. Growth and development
 - b. Health
 - c. Nutritional deficiencies
 - d. Production

2. A balanced ration needs to meet the animal's specific nutritional requirements for a life stage such as _____.
 - a. Lactation
 - b. Deficiency
 - c. Production
 - d. Proportion

3. Which method balances for only one nutrient at a time?
 - a. Computerized method
 - b. Pearson Square method
 - c. Trial and error method
 - d. Two-Two method

4. What are the two factors that influence the types of ingredients used in a ration?
 - a. Animal growth and least cost
 - b. Least cost and ingredient availability
 - c. Balancing method and ingredient availability
 - d. Nutrient requirements and animal growth

5. In balancing a ration, ingredient availability for producers depends on _____.
 - a. Animal needs
 - b. Least cost
 - c. Location
 - d. Proportions

Using the Pearson Square method, balance the following rations. Round to the nearest pound.

6. A sow needs a 14% crude protein ration. Corn and a supplement are fed, with 9% protein in corn and 44% in the supplement. Calculate how many pounds of corn and supplement are needed in a 1000 pound ration.

Corn _____

Supplement _____

Use the Pearson Square method to balance the rations. Calculate the cost of each ration. Show the work for balancing both rations and calculating the cost of each.

7. A feeder pig weighs 40 pounds and needs 18% protein. Corn with 9% protein is used in one ration and wheat with 11.4% is used in the other ration. Supplement with 40% protein is used in both rations. Use current prices for corn, wheat, and supplement to calculate total cost. (There are approximately 56 pounds of corn and 60 pounds of wheat in a bushel.)

Which ration has the lowest cost? _____

Agricultural Science I

Curriculum Guide: *Introduction to Animal Nutrition*

Unit Objective:

Students will demonstrate an understanding of proper animal nutrition by comparing and contrasting two similar animal feeds and presenting their findings in a brief written summary.

Show-Me Standards: 1.8, SC4

Reference:

Introduction to Animal Nutrition. University of Missouri-Columbia, Instructional Materials Laboratory, 1996.

Students may use additional outside sources to complete this activity.

Instructional Strategies/Activities:

- Students will engage in study questions in lessons 1 through 5.
- Students will complete AS 3.1, Nutrient Recommendations; AS 4.1, Identifying Nutritional Requirements; and AS 5.1, Balancing Rations.
- Additional activities that relate to the unit objective can be found under the heading “Other Activities” in the following locations: p. 74 and p. 84.

Performance-Based Assessment:

Each student will locate two different animal feeds. Both feeds should be designed to meet the same nutritional requirements of the same type of animal. Students will compare and contrast the feeds on the basis of key nutrients and fiber, main ingredients, and appearance and present their findings in a brief written summary.

Assessment will be based on the overall content and presentation of the summary.

**Introduction to Animal Nutrition
Instructor Guide**

The instructor should assign the performance-based assessment activity at the beginning of the unit. Students will work toward completing the activity as they progress through the unit lessons. The assessment activity will be due at the completion of the unit.

1. Have students locate two different animal feeds. Both feeds should be designed to meet the same nutritional requirements of the same type of animal.
2. Have students compare and contrast the feeds and present their findings in a brief written summary. Have students compare and contrast the feeds in the following ways.
 - ☐ Key nutrients and fiber: What is the percentage of crude protein, crude fat, and crude fiber in the feed?
 - ☐ Main ingredients: What are the top five ingredients?
 - ☐ Appearance: What is the general texture and appearance of the feed? For example, is the feed pelleted? Is it dry or does it include molasses? Can any ingredients be identified, such as rolled oats?
 - ☐ Based on the appearance of the feed and information from the feed tag, which feed would you choose and why?
3. Students should write the summary in complete sentences and use correct spelling, grammar, and punctuation.
4. Have students turn in the feed tags from their feeds along with their written summary.
5. The final assessment score will be based on the overall content and presentation of the written summary.

**Introduction to Animal Nutrition
Student Handout**

1. Locate two different animal feeds that are designed to meet the same nutritional requirements of the same type of animal.
2. Compare and contrast the feeds using the points below.
 - ☐ Key nutrients and fiber: What is the percentage of crude protein, crude fat, and crude fiber in the feed?
 - ☐ Main ingredients: What are the top five ingredients?
 - ☐ Appearance: What is the general texture and appearance of the feed? For example, is the feed pelleted? Is it dry or does it include molasses? Can any ingredients be identified, such as rolled oats?
 - ☐ Based on the appearance of the feed and information from the feed tag, which feed would you choose and why?
3. Present your findings in a brief written summary. Use complete sentences and correct spelling, grammar, and punctuation.
4. Turn in the tags from the feeds along with your written summary.
5. Your final assessment score will be based on the overall content and presentation of your written summary.

Agricultural Science I

Introduction to Animal Nutrition Scoring Guide

Name _____

Assessment Area	Criteria	0 Points	1 Point	2 Points	3 Points	4 Points	Weight	Total
Thoroughness	Addresses key nutrients and fiber, main ingredients, and appearance; information is complete	Failed	Poor	Fair	Good	Excellent	X 11.25	
Accuracy	Facts are accurate; evaluation of feeds is correct; explanations are persuasive	Failed	Poor	Fair	Good	Excellent	X 11.25	
Presentation	Well organized; no spelling, grammar, or punctuation errors	Failed	Poor	Fair	Good	Excellent	X 2.5	
TOTAL								

Final Assessment Total _____/100 pts.

Comments:

APPENDIX A

Table 2 Requirements of Breeding Cattle (Nutrient Concentration in Dry Matter)

Wt ^a lbs.	ADG lbs.	DM ^b lbs.	Prot ^c %	NE ^d _m Mcal/lb	NE ^d _g Mcal/lb	TDN %	Ca %	P %
Pregnant Yearling Heifers - Last Third of Pregnancy								
700	0.9	15.3	8.4	0.52	NA	55.4	0.27	0.20
700	1.4	15.8	9.0	0.60	0.34	60.3	0.33	0.21
700	1.9	15.8	9.8	0.70	0.43	67.0	0.33	0.21
750	0.9	16.1	8.3	0.52	NA	55.1	0.27	0.19
750	1.4	16.6	8.9	0.60	0.33	59.9	0.32	0.21
750	1.9	16.6	9.5	0.69	0.42	66.5	0.37	0.23
800	0.9	16.8	8.2	0.51	NA	54.8	0.28	0.20
800	1.4	17.4	8.8	0.59	0.33	59.6	0.33	0.21
800	1.9	17.5	9.3	0.69	0.42	66.1	0.35	0.21
850	0.9	17.6	8.2	0.51	NA	54.5	0.26	0.20
850	1.4	18.2	8.6	0.59	0.32	59.3	0.30	0.21
850	1.9	18.3	9.1	0.68	0.41	65.7	0.34	0.22
900	0.9	18.3	8.1	0.51	NA	54.3	0.26	0.20
900	1.4	19.0	8.5	0.58	0.32	59.1	0.30	0.21
900	1.9	19.2	9.0	0.68	0.41	65.4	0.32	0.21
950	0.9	19.0	8.0	0.50	NA	54.1	0.27	0.20
950	1.4	19.8	8.4	0.58	0.32	58.9	0.29	0.21
950	1.9	20.0	8.8	0.67	0.40	65.1	0.32	0.21
Dry pregnant mature cows - Middle third of pregnancy								
800	0.0	15.3	7.1	0.42	NA	48.8	0.17	0.17
900	0.0	16.7	7.0	0.42	NA	48.8	0.18	0.18
1000	0.0	18.1	7.0	0.42	NA	48.8	0.18	0.18
1100	0.0	19.5	7.0	0.42	NA	48.8	0.19	0.19
1200	0.0	20.8	6.9	0.42	NA	48.8	0.19	0.19
1300	0.0	22.0	6.9	0.42	NA	48.8	0.20	0.20
1400	0.0	23.3	6.9	0.42	NA	48.8	0.20	0.20
Dry pregnant mature cows - Last third of pregnancy								
800	0.9	16.8	8.2	0.51	NA	54.5	0.26	0.20
900	0.9	18.2	8.0	0.50	NA	54.0	0.27	0.21
1000	0.9	19.6	7.9	0.50	NA	53.6	0.26	0.20
1100	0.9	21.0	7.8	0.49	NA	53.2	0.26	0.21
1200	0.9	22.3	7.8	0.49	NA	52.9	0.26	0.21
1300	0.9	23.6	7.7	0.48	NA	52.7	0.26	0.21
1400	0.9	24.9	7.6	0.48	NA	52.5	0.26	0.21
Two-year-old heifers nursing calves - First 3-4 months postpartum - 10 lb milk/day								
700	0.5	15.9	11.3	0.67	0.40	65.1	0.36	0.24
750	0.5	16.7	11.0	0.66	0.40	64.4	0.34	0.24
800	0.5	17.6	10.8	0.66	0.39	63.8	0.34	0.24
850	0.5	18.4	10.6	0.65	0.38	63.2	0.33	0.23
900	0.5	19.2	10.4	0.64	0.37	62.7	0.32	0.23
950	0.5	20.0	10.2	0.63	0.37	62.3	0.31	0.23
1000	0.5	20.8	10.0	0.62	0.36	61.9	0.31	0.23

From *Nutrient Requirements for Growing and Finishing Beef Cattle (G2067)*, University Extension, University of Missouri-Columbia

APPENDIX B

TABLE 2 Requirements for Growing and Finishing Beef Cattle (Nutrient Concentration in Diet Dry Matter).

Wt ^a lbs.	ADG lbs.	DM ^b lbs.	Prot %	NE _m Mcal/lb	NE _g Mcal/lb	TDN %	Ca %	P %
Medium-frame steer calves								
300	0.5	7.8	9.6	0.50	0.25	54.0	0.31	0.20
	1.0	8.4	11.4	0.57	0.31	58.5	0.45	0.24
	1.5	8.7	13.2	0.64	0.38	63.0	0.58	0.28
	2.0	8.9	14.8	0.70	0.44	67.5	0.72	0.32
	2.5	8.9	16.7	0.79	0.51	73.5	0.87	0.37
	3.0	8.0	19.9	0.95	0.64	85.0	1.13	0.47
400	0.5	9.7	8.9	0.50	0.25	54.0	0.27	0.18
	1.0	10.4	10.3	0.57	0.31	58.5	0.38	0.21
	1.5	10.8	11.5	0.64	0.38	63.0	0.47	0.25
	2.0	11.0	12.7	0.70	0.44	67.5	0.56	0.26
	2.5	11.0	14.2	0.79	0.51	73.5	0.68	0.30
	3.0	10.0	16.6	0.95	0.64	85.0	0.86	0.37
500	0.5	11.5	8.5	0.50	0.25	54.0	0.25	0.17
	1.0	12.3	9.5	0.57	0.31	58.5	0.32	0.20
	1.5	12.8	10.5	0.64	0.38	63.0	0.40	0.22
	2.0	13.1	11.4	0.70	0.44	67.5	0.47	0.24
	2.5	13.0	12.5	0.79	0.51	73.5	0.56	0.27
	3.0	11.8	14.4	0.95	0.64	85.0	0.69	0.32
600	0.5	13.2	8.2	0.50	0.25	54.0	0.23	0.18
	1.0	14.1	9.0	0.57	0.31	58.5	0.28	0.19
	1.5	14.7	9.8	0.64	0.38	63.0	0.35	0.21
	2.0	15.0	10.5	0.70	0.44	67.5	0.40	0.22
	2.5	14.9	11.4	0.79	0.51	73.5	0.46	0.24
	3.0	13.5	12.9	0.95	0.64	85.0	0.57	0.29
700	0.5	14.8	7.9	0.50	0.25	54.0	0.22	0.18
	1.0	15.8	8.6	0.57	0.31	58.5	0.27	0.18
	1.5	16.5	9.2	0.64	0.38	63.0	0.31	0.20
	2.0	16.8	9.8	0.70	0.44	67.5	0.34	0.21
	2.5	16.7	10.5	0.79	0.51	73.5	0.40	0.22
	3.0	15.2	11.7	0.95	0.64	85.0	0.49	0.26
800	0.5	16.4	7.7	0.50	0.25	54.0	0.22	0.17
	1.0	17.5	8.3	0.57	0.31	58.5	0.24	0.19
	1.5	18.2	8.8	0.64	0.38	63.0	0.28	0.19
	2.0	18.6	9.2	0.70	0.44	67.5	0.31	0.20
	2.5	18.5	9.8	0.79	0.51	73.5	0.35	0.21
	3.0	16.8	10.8	0.95	0.64	85.0	0.42	0.25

From *Nutrient Requirements for Beef Breeding Animals (G2068)*, University Extension, University of Missouri-Columbia

APPENDIX C

Table 1. Nutrient Requirements and Allowances for Growing Swine

National Research Council					Missouri Recommended Allowances				
10-25	25-45	45-110	110-230	Live Weight (lbs)	10-25	25-45	45-110	110-230	
.55	1.0	1.54	1.80	Expected Daily Gain (lbs)	.55	1.0	1.54	1.80	
Percent in diet					Percent in diet				
20	18	15	13		20	18	16	14	
.80	.70	.60	.50	Crude Protein	.90	.80	.75	.65	
.65	.60	.50	.40	Calcium	.80	.70	.65	.55	
.50	.40	.25	.10	Phosphorus (Total)	.50	.40	.25	.10	
.31	.25	.22	.18	Arginine	.31	.25	.22	.18	
.65	.53	.46	.38	Histidine	.65	.53	.46	.38	
.85	.70	.60	.50	Isoleucine	.85	.70	.60	.50	
1.15	.95	.75	.60	Leucine	1.25	1.10	.80	.65	
.58	.48	.41	.34	Lysine	.60	.50	.41	.35	
.94	.77	.66	.55	Methionine + cystine	.94	.77	.66	.55	
.68	.56	.48	.40	Phenylalanine + tyrosine	.70	.60	.50	.45	
.17	.14	.12	.10	Threonine	.20	.18	.15	.13	
.68	.56	.48	.40	Tryptophan	.68	.56	.48	.40	
				Valine					

Missouri Recommended Nutrient Addition Per Ton

Nutrient	Unit	Additions per ton	
		Grower Rations	Finisher Rations
Sodium	lb	5	5
Chlorine		-	-
Iron	g	100	60
Zinc	g	100	60
Manganese	g	16	8
Copper	g	10	6
Iodine	g	.27	.18
Selenium*	g	.27	.27
Vitamin A	Mil.I.U.	5	3
Vitamin D	Thou.I.U.	500	300
Vitamin E	Thou.I.U.	20.0	10
Vitamin K	g	2.0	1.0
Riboflavin	g	4.0	2.0
Niacin	g	30	8
Pantothenic acid	g	16	8
Choline	g	200	100
Vitamin B ₁₂	mg	25	12.5

*Maximum legal limit (.3 ppm)

From *Nutrient Requirements of Swine and Recommendations for Missouri (G2320)*, University Extension, University of Missouri-Columbia

Table 2. Nutrient Requirements of Breeding Swine: Percentage or Amount Per Pound of Diet

National Research Council			Missouri Recommended Allowances		
Bred Gilts & Sows Young & Adult Boars		Lactating Gilts & Sows	Bred Gilts & Sows Young & Adult Boars		Lactating Gilts & Sows
Percent in diet			Percent in diet		
12	13		13	14	
.75	.75	Crude Protein	.90	.90	
.60	.60	Calcium	.80	.80	
—	.4	Phosphorus	—	.4	
.15	.25	Arginine	.15	.25	
.30	.39	Histidine	.30	.39	
.30	.48	Isoleucine	.30	.48	
.43	.60	Leucine	.5	.65	
.23	.36	Lysine	.23	.36	
.45	.70	Methionine + cystine	.45	.70	
.30	.43	Phenylalanine + tyrosine	.35	.45	
.09	.12	Threonine	.11	.13	
.32	.60	Tryptophan	.32	.60	
		Valine			

Missouri Recommended Nutrient Additions Per Ton

Nutrient	Unit	Breeding Stock Ratios
Salt	lb	10
Iron	g	100
Zinc	g	100
Manganese	g	16
Copper	g	10
Iodine	g	.27
Selenium	g	.27
Vitamin A	Mil.I.U.	5.0
Vitamin D	Thou.I.U.	500
Vitamin E	Thou.I.U.	25
Vitamin K	g	2.0
Riboflavin	g	5.0
Niacin	g	30.0
Pantothenic acid	g	18.0
Vitamin B ₁₂	mg	25.0
Biotin	mg	200
Folacin	mg	300

APPENDIX D

Table 1. Composition of Feeds Commonly Used in Beef Cattle Ration (As Fed Basis)

Use with NRC Table 1 in UMC Guides 2067 and 2068

	Dry Matter %	Crude Protein %	NEm Mcal/lb	NEg Mcal/lb	TDN %	Fat %	Crude Fiber %	Calcium %	Phos- phorus %	Potas- ium %	Sodium %	Sulfur %	Zinc PPM
Concentrates													
Barley	88.0	11.9	0.83	0.56	74	1.8	5.0	0.04	0.33	0.41	0.03	0.15	17
Brewers Grains, Dried	92.0	27.1	0.63	0.38	61	6.6	13.2	0.30	0.51	0.08	0.21	0.29	28
Corn													
Yellow Dent #2	88.0	8.9	0.90	0.62	79	3.7	1.9	0.02	0.31	0.33	0.02	0.12	14
Corn & Cob Meal	87.0	7.8	0.80	0.54	72	3.2	8.2	0.06	0.23	0.46	0.02	0.14	12
Corn Gluten Feed	90.0	23.0	0.83	0.56	75	2.2	8.7	0.32	0.74	0.58	0.95	0.21	65
Distillers Grain Corn	94.0	22.0	0.90	0.49	81	9.2	11.4	0.10	0.40	0.17	0.09	0.43	33
Hominy Feed	90.0	10.4	0.99	0.68	85	6.9	6.0	0.05	0.51	0.59	0.08	0.03	3
Molasses													
Beet	78.0	6.6	0.68	0.45	62	0.2	0.0	0.13	0.02	4.73	1.15	0.47	14
Cane	75.0	4.4	0.58	0.37	54	0.1	0.0	0.75	0.08	2.88	0.17	0.35	23
Cane, Dried	94.0	9.7	0.70	0.44	66	0.8	6.3	1.03	0.14	3.38	0.19	0.43	31
Oats													
Grain	89.0	11.8	0.75	0.49	69	4.8	10.8	0.06	0.34	0.39	0.07	0.20	37
Mill By Product	89.0	7.1	0.34	0.00	29	2.3	22.3	0.11	0.21	0.53	--	0.21	--
Groats	90.0	15.9	0.95	0.65	85	6.2	2.5	0.07	0.43	0.35	0.05	0.20	0
Sorghum													
Grain (8-10% Protein)	87.0	8.8	0.81	0.55	73	3.0	2.3	0.03	0.31	0.33	0.01	0.11	16
Grain (10%+ Protein)	88.0	11.0	0.81	0.55	73	2.1	2.3	0.04	0.32	0.33	0.01	0.11	16
Rice													
Bran	91.0	12.7	0.67	0.43	64	14.4	11.8	0.07	1.53	1.73	0.04	0.18	30
Mill By-Product	91.0	6.4	0.39	0.00	38	5.2	29.1	0.36	0.56	--	--	--	--
Soybean Hulls	91.0	11.0	0.67	0.42	65	1.9	36.5	0.54	0.19	1.16	0.01	0.08	--
Wheat													
Bran	89.0	15.2	0.66	0.42	62	3.9	10.1	0.12	1.23	1.39	0.04	0.22	94
Hard Winter	88.0	12.7	0.87	0.60	77	1.6	2.5	0.04	0.38	0.43	0.02	0.13	38
Soft Winter	88.0	11.4	0.88	0.61	78	1.6	2.1	0.04	0.38	0.40	0.01	0.11	42
Mids	89.0	16.4	0.65	0.45	61	4.4	7.3	0.12	0.88	1.01	0.17	0.18	103
Shorts	88.0	16.4	0.69	0.40	64	4.6	6.8	0.09	0.80	0.93	0.03	0.19	109

From *Feed Composition Tables (G2051)*, University Extension, University of Missouri-Columbia