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_anat.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.
   - ❑ 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.

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.

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 *Animals have either a monogastric or a ruminant digestive system. The following domestic animals have a ruminant digestive system.*	**Determine which livestock species have ruminant digestive systems.** 1. Cattle 2. Sheep
Objective 2 *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.* 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 1. Mouth 2. Esophagus 3. Four stomach compartments a. Rumen b. Reticulum c. Omasum d. Abomasum 4. Small intestine a. Duodenum b. Remainder of small intestine 5. Large intestine a. Cecum b. Colon c. Rectum 6. Anus

Instructor Directions	Content Outline
Objective 3 *Ask students what the functions of the main parts of the ruminant digestive system are. Discuss the functions.*	**Describe the functions that the components of the ruminant system play in digestion.** Ruminant digestive system 1. Mouth – allows feed to enter the digestive system 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 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 a. Duodenum – continues digestive process b. Remainder of small intestine – absorbs digested nutrients into the bloodstream 5. Large intestine 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
Objective 4 *Ask students how a ruminant is able to convert feed into nutrients.*	**Explain how feed nutrients are converted into usable nutrients by the ruminant digestive system.** Ruminant stomach compartments 1. The rumen and reticulum have microorganisms that help break down feed.

Instructor Directions	Content Outline
☐ PPt 3 – Ruminant Stomach Compartments	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. 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.
Objective 5 *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.* ☐ AS 2 – Ruminant Digestive System ☐ AS 3 – Monogastric and Ruminant Digestive Systems (Instructor) ☐ PPt 4 – Three Possible Routes of Feed in Ruminants – Grain Concentrates or Cud	**Explain why ruminants are better able to utilize forages.** 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
PPt 5 – Three Possible Routes of Feed in Ruminants – Light Grain PPt 6 – Three Possible Routes of Feed in Ruminants - Forages	
Application: AS 1 – Digestive System of Cattle	Answers to AS 1 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
AS 2 – Ruminant Digestive System	Answers to "Key Questions" on AS 2 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. Other activities 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	Answers: 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