

COW DIGESTION

75 MINUTES

SBI3U, SBI3C, SBI4U,
SCH4U, SCH4C, SVN3M

A high school lesson plan provided by the University of Guelph

This activity will allow students to use their understanding of the digestive systems and increase their knowledge of digestive function of ruminant species. Students will be able to test their knowledge of these biological systems and basic chemistry in this exciting lesson plan.

Curriculum Alignments and Expectations

- Explain using appropriate terminology the anatomy and physiology of the digestive system and the importance of digestion in providing nutrients needed for energy and growth
- Explain the vital roles of microorganisms in the symbiotic relationships with other organisms
- Compare the different classes of organic compounds by describing the similarities and differences in names and structural formulae of the compounds within each class
- Explain the chemical changes that occur during various types of chemical reactions
- Describe the chemical structures and mechanisms of various enzymes and be able to identify functional group structures that define common classes of organic compounds
- Identify gases and particulates that are commonly found in the atmosphere and explain how they affect air quality

Learning objectives

- Apply knowledge of the digestive system
- Discover the differences between ruminants and other species
- Develop understanding of ruminant digestive process and how it relates to the environment by taking part in demonstrations and activities

Assessment Strategies and Success Criteria

- Think-pair-share
- Open-ended questions
- Discussion and debrief
- Quiz
- Peer instructors

Cross Curricular Links

- Career Studies- Communicating with Others and Interpersonal Relations
- Career Studies- Identifying Trends and Opportunities
- Geography – Patterns of Natural and Human Systems

Materials

- Total Mixed Ration (TMR) Sample
- Grain/forage samples
- Baking Soda
- Vinegar
- Cylindrical beakers or jars
- Balloons
- Representation of each part of the cow's digestive system (i.e. construction cut out)
- Complimentary PowerPoint or handout

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TEACHER NOTES

1. Begin by giving a brief reminder of the anatomy and function of the human digestive system.
2. Define “ruminant”. Compare the anatomy of a human digestive system (monogastric) with that of a ruminant. Diagrams are a good visual representation of the differences. This lesson plan focuses on cattle as the ruminant model. Some other examples include sheep, goats, deer, camels, etc.

Note: It is important to clarify that cows (ruminants) do not have 4 stomachs; instead they have 4 compartments to their stomach. This includes the rumen, reticulum, omasum and abomasum. Helpful diagrams can easily be found online.

3. Discuss some examples of what makes up the diet of a cow and how this differs from other species.
 - Forages: Grass and legume plant species (i.e. hays and grasses)
 - Grains: Cereal plant species (i.e. soybean, corn, oats)

Forage species are high in fibre and lower in digestible nutrients whereas grains are very nutrient-dense. Many cattle are raised on pasture as their digestive system is designed to digest fibrous materials. However, several cattle also consume large quantities of grain, for instance in situations in which farmers want their animals to gain weight in a shorter period of time.

Note: Using samples of different feed ingredients can be a fun way to introduce different feed stuff. If possible, contact a local farmer or feed supply to possibly provide samples of ingredients or TMR (total mixed ration).

4. Begin the digestive journey. Define mastication and discuss the role of saliva as a pH buffer and the first step in the digestion process.

Saliva has a pH value of approximately 8.2; therefore it can help neutralize the effects of acid-producing feedstuffs in the rumen.

Fun Fact: A cow can produce between 40 and 150 L of saliva per day! How does this compare to a human? Humans are estimated to produce 0.75 to 1.5 L of saliva per day

5. Activity 1: Super Saliva

Required materials: Vinegar, baking soda, clear container for mixing, balloon (optional)

Mix vinegar (pH of ~3) and baking soda (pH of ~9) to represent feed stuff and the rumen (first compartment of stomach) environment respectively. Observe the rapid neutralization reaction. This is representative of what might happen if saliva did not “buffer” the feed stuff before entering into the rumen. This could cause digestive distress and an increase in gasses produced.

Optional: Use a pop bottle or a container

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with a narrow opening and attached a balloon on top to show the accumulation of gasses during the chemical reaction.

Fun Fact: Cows will belch (eruct) a combination of carbon dioxide and methane from the rumen. Cows will belch 30-50 L of gas per hour to avoid bloating!

6. Define rumination.

Rumination: to regurgitate and chew feed stuff that has already been chewed and swallow again, also known as chewing the “cud”.

This can be a difficult concept when looking at the pathway through the digestive system of the cow. A flow chart can be a great way to show the flow of food during the process of rumination (introduce the concept of the 4 R’s – regurgitation, rechewing, reinspection, reswallowing. These represent the four phases of rumination).

The feedstuff moves from the mouth to the rumen for fermentation and is then moved to the reticulum (second compartment of the stomach) where larger particles will return to the mouth and smaller particles will pass through to the omasum. The abomasum is analogous to the human stomach and is often referred to as the “true stomach” of the ruminant animals

7. Describe fermentation.

Fermentation: A metabolic process in which

organisms (bacteria) convert carbohydrates, such as starch or sugar into an alcohol or acid.

The three main acids produced in ruminants are acetic acid, butyric acid and propanoic acid.

Fun Fact: The rumen is the site of fermentation. There are over 200 different bacteria in the rumen. Every minute, rhythmic muscular contractions assist with moving feedstuffs in and out of the rumen.

8. Activity 2: The Fiber Mat

Required materials: Clear cylindrical container, TMR (total mixed ration)

*Try to source from a local producer. You will need about a handful.

Fill the cylindrical container with water. Put the handful of TMR into the top of the container gently. Observe while the concentrates (i.e. corn silage) sink to the bottom and the larger more fibrous materials stay on the top. This demonstration simulates the organization of feed within the rumen.

9. Discuss the role of the reticulum.

The reticulum is the second compartment of the cow’s stomach. The reticulum is responsible for separating feedstuffs to either be regurgitated or passed into the omasum. The larger particles return to the mouth to be broken down further and the smaller particles travel to the omasum.

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Fun Fact: The reticulum is lined with ridges that form a structure that resembles honeycomb, and is designed to capture large particles and materials that cannot be digested (<http://mandydenelzen.com/the-exploration-of-the-digestion-system-of-a-cattle/>). It also makes for easy identification of the stomach chamber!

10. Continue with the remainder of the organs in the digestive system of a ruminant.

- Omasum: site of water absorption.
- Abomasum: site of protein digestion by gastric juices (very acidic environment).
- Small Intestine: break down and absorption of fatty acids, sugars, amino acids, water.
- Cecum: located at the junction of the small and large intestine. Undigested fiber is broken down here.
- Large intestine: major site of mineral absorption. Secondary site of fermentation.
- Rectum: excretion of undigested feed stuff as waste.

Fun Fact: The abomasum is analogous to the human stomach.

11. Activity 3: The Great Feed Journey

Required materials: Representation of each part of cow's digestive system (i.e. construction cut out)

Test your students' understanding of the overall journey feedstuff will take in the cow's digestive system. Have students represent each part of the ruminant digestive system and ask the class to arrange them in the correct order.

Optional: This can be done in smaller groups or as a class. An example of cut outs you can use in small groups to arrange the digestive system in the correct order is attached.

Additional Resources

- Parish, J., Rivera, J., and H. Boland. (2017, December 17). Understanding the Ruminant Animal Digestive System. Retrieved from <http://extension.msstate.edu/publications/publications/understanding-the-ruminant-animal-digestive-system>

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