

Grass to Glass – Amazing Dairy Cows

Purpose: Students learn how the complex digestive system of dairy cows allows these animals to eat grass and other forages to produce milk for humans to drink.

Time: 60 min

Level: 3-6

Materials:

- Diagram of a ruminant digestive system
- Attached Grass to Glass cards
- Attached Answer cards

Vocabulary

Cow – Female member of the cattle family that has had a calf. After she has had a calf, she will start producing milk.

Heifer – Female member of the cattle family that has not had a calf

Bull – Male member of the cattle family

Steer – Male member of the cattle family that has been castrated. Steers are usually raised for beef.

Calf – young born to a cow. Females are called heifers and males are called bulls



Minnesota Science Standards and Benchmarks

3.4.1.1.1 Compare how the different structures of plants and animals serve various functions of growth, survival and reproduction.

5.4.1.1.1 Describe how plant and animal structures and their functions provide an advantage for survival in a given natural system.

6.1.3.1.1 Describe a system in terms of its subsystems and parts, as well as its inputs, processes and outputs.

Minnesota Social Studies Standards and Benchmarks

4.2.3.3.1 Define the productivity of a resource and describe ways to increase it.

Background

Cattle, whether they are raised for beef or dairy production, utilize a complex digestive system to utilize nutrients from grass and other forages to produce meat and milk for humans to consume. Cattle are able to survive and thrive on grassy plains areas because the structures of their digestive system are able to break down the cell wall and cellulose in grass that cannot be broken down and utilized by the human digestive system.

All cattle are classified as ruminants which have four compartments to their stomach. Before food enters the stomach compartments the animal uses its tongue and mouth to grab grass and other vegetation and swallow it in large chunks. These large particles enter the first two compartments – the rumen and reticulum – where microbes work to digest plant materials. The rumen and reticulum are two separate parts of the digestive system but they are connected by a large opening between which food passes constantly. They work together to break down plant material through fermentation, releasing nutrients important to milk production. If some of the plant particles are too large the animal regurgitates a ball of food called a bolus or cud, which it then rechews. This is called “chewing the cud” and many cattle will chew their cud for 8-10 hours each day.

Once the particles are small enough they will be swallowed again and enter the third stomach called the omasum. The omasum absorbs water and nutrients and passes the food to the fourth stomach the abomasum. The abomasum works like the human stomach-secreting strong acid and enzymes to break down any undigested food.

The food is further broken down, nutrients absorbed and waste consolidated as it passes through the small and large intestines. The nutrients released by these organs of the digestive system are carried through the cow’s body by the bloodstream. Some nutrients are delivered to the udder where they are transformed into milk. Unused material is passed from the cow in the form of manure. Rich in minerals and organic material, manure makes an excellent fertilizer for green

grass. Not only does the cow provide us with nutritious milk, but it also can fertilize the fields it eats to produce more milk.

(From Project Seasons, Shelburne Farms, Shelburne, VT)

Procedure

Before completing this activity, print out the attached Grass to Class cards and Answer cards. Cut them out and tape or display the answer cards around your classroom.

1. Ask the students for their impressions of the saying “You are what you eat.”
 - a. Show students some sod or a patch of grass and discuss what would happen if they ate only grass. Help students come to the conclusion that our digestive system cannot break down grass to get any nutrients from it.
 - b. Now show students a glass/container of milk. Ask students what happens when they eat milk. Help them come to the conclusion that milk is easily digestible and provides important nutrients to us.
 - c. Finally, ask the students how milk is connected to grass. Help them discover that dairy cattle are able to transform grass and other forages that are unusable by humans into milk that is packed with nutrients for humans.
2. Divide the class into nine groups. Explain that each group will represent a part of the cow involved in transforming green grass to the milk we drink. Review the definition of a **Cow** if necessary. Also provide details from the Background Information and /or a diagram of a ruminant digestive system if you would like.
3. Pass out a Grass to Glass card to each group. Ask the students to read their cards with their group very carefully.
4. Ask students to view the cards displayed around the room and select the answer card that lists their identity. Before making their selection, encourage groups to share the information on their Grass to Glass cards with other groups. Point out that important clues are found on cards other than the one they received. *Answer Key = C-1, A-2, I-3, G-4, B-5, F-6, D-7, H-8, E-9*
5. Now ask the groups to put their answer cards and props into the sequence of the grass to glass story. Remind the class that two end products are formed, so that at some point the sequence will branch. *Answer Key = 1. Mouth, 2. Rumen, 3. Reticulum, 4. Omasum, 5. Small Intestine, 6a. Large Intestine, 6b. Blood Stream, 7b Udder*
6. Review the sequence giving each group a chance to describe and demonstrate their role in the milk making process. Then enjoy a glass of milk!

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Grass to Glass C While out grazing in the field cows use me to grab some grass and swallow it whole! Then they moo-ve onto the next green, grassy spot. Later the cow burps up a ball of food called a bolus or cud, which it then chews and rechews. Cows can spend up to eight hours a day chewing their cud or ruminating. The food is then ground up and mixed with their white foamy saliva. The saliva acts like an antacid to keep the acidity level in the first compartment of the stomach - the RUMEN - just right for digestion. **What am I? How do I begin the digestive process?**

Grass to Glass A I am a very large organ and can hold up to 25 gallons of food. Most of the vegetation a cow eats comes to me looking much like it did when it was grown in the field. I work like a large fermentation vat along with my partner in digestion, the RETICULUM. We have a whole colony of microscopic organisms living inside us that breaks down the plant fibers without oxygen! My muscles work to mix, moisten, churn and blend the food with these microbes. Important nutrients are then released and absorbed by the blood stream. They are a major energy source for the cow and are important in milk production. **What am I? What is my role in digestion?**

Grass to Glass I I am a team player in digestion. Food comes to me from the RUMEN and I mix it with more microbes. We work together and pass food back and forth. Important nutrients are also absorbed through my walls into the bloodstream. To keep moo-ving through the digestive tract, food must measure up. If it can fit through the opening to the next organ in line, it is on its way. If not, lumps the size of tennis balls are formed and sent back, one at a time, to the mouth for more chewing and processing. Whenever you see a cow burp, a bolus or cud is on its way to be rechewed. **What am I? What is my role in digestion?**

Grass to Glass G I have a small opening that lets me be selective about the size of food particles entering me. Once inside, the food is further mixed and softened. Water and minerals are absorbed from the food through my walls and pass into the bloodstream. The rest of the food moves to the true stomach or ABOMASUM. **What am I? How do I function?**

Grass to Glass B I am often called the true stomach and I work much like your stomach does. I contain special enzymes and acids that completely break down the food that comes to me from the OMASUM. Here more nutrients are released, absorbed through my walls, and passed into the bloodstream. **What am I? What is my role in the digestive process?**

Grass to Glass F The true stomach sends digested food and waste my way. More nutrients and water are released and absorbed through my walls into the bloodstream. I expand and contract to moo-ve the leftovers along my twisting path to my large neighbors and relatives, the CECUM and LARGE INTESTINE. **What am I ? How do I function?**

Grass to Glass D The SMALL INTESTINE passes the leftovers to me. These are fermented by bacteria in the CECUM and any remaining nutrients and water are absorbed through my walls into the bloodstream. I expand and contract to moo-ve the remaining unusable material to the end of the line. It comes out as cow manure, rich in minerals and organic matter. Manure is used to fertilize grass that can then be turned into more milk. **What am I? What is my role in digestion?**

Grass to Glass H I take all the nutrients absorbed from the RUMEN, RETICULUM, OMASUM, ABOMASUM and SMALL INTESTINE, and carry these throughout the cow's body. Think of me as a mass transit system, powered by a strong muscular pump that keeps nutrients moving continuously along. In a mother cow, I deliver important nutrients to the UDDER where they are used to make milk. **What am I? What is my main function?**

Grass to Glass E When a cow has a calf I kick into action to feed him or her. The BLOODSTREAM delivers nutrients through tiny capillaries to each of my four chambers. The milk making alveoli within these chambers use the nutrients to form milk, drop by drop. It takes 50-70 hours for a cow to turn grass into milk. The milk is stored here until it is needed. Then intensive hormone and nerves within me trigger a series of responses making this milk available to whoever massages my teats, either the calf or dairy famer's equipment. The average dairy cow in Minnesota produces 19,400 pounds of milk in her lactation period (average = 305 days). That's nearly 2,255 gallons of milk. **What am I? What do I do?**

Answer 1 I am the **MOUTH**, I grab food with my tongue, grind it up with my single set of bottom teeth and buffer it with my saliva.

Answer 2 I am the **RUMEN**. I blend and churn food with bacteria which break it down through a process called fermentation. Important nutrients are then released and absorbed by the bloodstream.

Answer 3 I am the **RETICULUM**. I also mix food with more bacteria and release important nutrients which are absorbed by the bloodstream. Food must be below a certain size before it can pass on to the next stomach component. If it is too big, cud is formed and sent back to the mouth to be re-chewed.

Answer 4 I am the **OMASUM**. My small entrance limits the size of food particles that can enter me. I further mix and blend the food and absorb water and minerals.

Answer 5 I am the **ABOMASUM**. With my special enzymes and acids I further breakdown the food, releasing more nutrients. The nutrients are then absorbed through my walls into the bloodstream.

Answer 6 I am the **SMALL INTESTINE**. I absorb remaining nutrients and pass them into the bloodstream. By expanding and contracting I move leftovers along my long twisting path.

Answer 7 I am the **LARGE INTESTINE** and **CECUM**. I expand and contract to keep unusable food moving along. The **CECUM**, a small pouch like extension, with its associated bacteria, ferments the leftovers one last time and any remaining nutrients and water are absorbed. The final product is manure, an important fertilizer.

Answer 8 I am the **BLOODSTREAM**. My heart pumps blood, which carries important nutrients throughout the cow's body.

Answer 9 I am the **UDDER**. I make and store milk until the calf or farmer milks it out of my teats.