**Brief Description:**

Students will examine why ruminant animals can eat only green leafy plant materials (graze) and live healthy lives as opposed to humans that cannot graze.

**Objectives:** Students will be able to:
1. Define the term ruminant.
2. Identify feed ingredient sources.
3. Describe the importance of ruminant animals.

**Life Skills:**
1. Communicating and Relating to Others
2. Understanding Systems
3. Acquiring, Analyzing, and Using information
4. Working with Groups

**Time:**

1 hour session

**Materials:**

- Copies of *Feed Ingredient* activity sheet for each student
- Plastic bag for each group
- Hay
- White paper (4 sheets per group)
- Construction paper (2 sheets per group)
- Markers/colored pencils (one set per group)
- Art supplies
- Stapler and staples
- Reference books

**Preparation:**

- Make double-sided copies of the *Feed Ingredients* activity sheet for each student.
- Obtain and put hay in plastic bags to pass around as samples.
- Gather supplies needed to make the menus.
- Secure reference books or arrange class time in the school library.
**Background:**

**Ruminant Nutrition vs. Monogastric Nutrition**

*Nutrition* is the process of obtaining food to sustain life or promote growth. *Digestion* is the process of breaking down material (food) for use in the body. There are different types of digestive systems. These systems are capable of digesting certain materials. The two systems are ruminant and non-ruminant (monogastric).

**Ruminant**

Ruminant animals possess a stomach with four compartments (rumen, reticulum, omasum, abomasum). The rumen contains microorganisms that are capable of breaking down foods high in fiber (grasses, hays). Ruminant animals are capable of regurgitating (causing partially digested food to come back up to the mouth) their food for further chewing. Food is also fermented in the rumen. Animals like cattle, sheep, goats and deer are ruminants.

Knowing the four compartments of the stomach and their functions are important in understanding the nutritional requirements of ruminant animals.

**Rumen:** The rumen is the largest compartment; it holds about 30-60 gallons of feed and water. Its major function is to allow the microorganisms that line the wall of the compartment to ferment the plant materials. The microorganisms break down plant cellulose and lignin into amino acids.

**Reticulum:** The reticulum is often called the honeycomb; it moves the feed back to the cow's mouth for her to re-chew as a part of digestion. This is called "chewing her cud".

**Omasum:** The omasum is the size of a basketball; its job is to absorb water.

**Abomasum:** The abomasum is "the true stomach." True digestion with stomach acids occurs here and sends materials and nutrients on to the small intestine. This is the largest compartment a calf has. The other compartments develop as a calf grows.
Non-ruminant (monogastric)
Non-ruminant animals have a stomach with only one compartment. These animals are not capable of digesting materials high in fiber. Cats, swine, dogs, birds and humans are all monogastrics. Horses are also non-ruminants but they have a slightly different system. Horses and rabbits possess a pouch called a cecum that functions similarly to the rumen in ruminants. Microbial digestion of fibrous materials occurs in the cecum.

Nutrients are chemical compounds that are necessary for normal growth and maintenance. The nutrients that are required by animals include:

Carbohydrates
Carbohydrates are the number one source of energy and heat for human bodies and the bodies of other animals. Simple carbohydrates are sugars, like cane sugar, honey, beet sugar and molasses. Complex carbohydrates are starches like grains (corn, wheat, and oats). Plant materials like grass, hay or silage (fermented, high moisture forage stored under anaerobic conditions) also contain some carbohydrates.

Fats and Oils
Fats or oils (lipids) are the most concentrated source of energy. Lipids are necessary for energy, cell membrane structure, and are a component of some hormones. Fat is stored in our bodies to protect vital organs. It is deposited under the skin where it helps insulate the body and prevent heat loss. Oils are liquid fats. Lipids can come from animal sources like lard, milk, animal fat, or fish oils. Lipids can also come from the germ of the seeds of plants. Corn oil, soybean oil, and peanut oil are examples.

Minerals
Minerals help maintain healthy bones, teeth and blood. They are also involved in chemical reactions and skeletal structure. Mineral blocks (for animal to lick) or supplements added to the feed are sometimes used in providing animals with an adequate intake of minerals. Examples used in feedstuffs are limestone, oyster shells, salt and bone meal.
Proteins
Proteins are made up of amino acids and are responsible for structure (muscle); antibody and blood formation; and are needed for the formation of enzymes and hormones. They are needed to build and repair body cells. Protein can be changed to carbohydrates and fats. When you do not eat enough carbohydrates, proteins will be changed to carbohydrates for energy. When you eat too much protein, the extra amount will be changed into fat that is stored in your muscles. Sources of protein include meat, chicken, seafood, eggs, milk, cheese, nuts, dried beans and peas for humans. Some examples commonly used for cattle are soybean meal, peanut meal, meat and bone meal, blood meal, fishmeal and dried milk. Ruminants can also obtain all of their protein needs from grazing or consuming leafy plant material.

Vitamins
Vitamins are necessary for growth and normal functioning of the body. Vitamins help prevent disease and keep animals in proper condition. B vitamins and vitamin E are the most common supplements in pet or livestock management. Examples of these supplements in ruminant feedstuffs include yeast, fish oil, wheat germ oil and alfalfa meal.

Water
Water is not considered a nutrient, per se, in animal nutrition, although it is the most essential of all compounds. It is a part of every cell. Water is needed to regulate body temperature, to carry nutrients to all parts of the body, and to carry waste out of the body. Water absorbs heat produced during digestion, cools the body, helps dissolve materials and lubricates the digestive system. Water is part of the body's waste products.

Animal Feeds
Animal feeds are classified as either roughages or concentrates. Roughages are feedstuffs that are high in fiber and low in energy. Roughage includes grasses and hays. Ruminants are capable of utilizing roughages because they have microorganisms that can breakdown the tough components of fiber. Monogastrics do not have a rumen nor the microorganisms to break down the fiber, and therefore, cannot efficiently use roughages. Concentrates are feedstuffs that are low in fiber and high in energy. These generally consist of grains, animal and plant by-products. The diet of monogastrics mainly consists of concentrates such as corn or soybean meal. Horses are capable of utilizing roughages due to the microbial digestion that takes place in the cecum.
Animals eat different types of foods. Because of this, animals are divided into three different groups: herbivores, carnivores, or omnivores.

**Herbivores**
Consume only plant materials; horses and cattle.

**Carnivores**
Consume only flesh or animal tissue; cats, dogs, lions, and tigers.

**Omnivores**
Consume plant and animal tissue; humans, bears, and raccoons.

There are many other factors that affect an animal's nutritional needs. Palatability (flavor, texture, overall acceptability of taste) is very important to an animal's interest in food. The age or production state of the animal is also important. Young animals have different requirements than mature animals. Animals that are pregnant (gestating) or producing milk (lactating) have higher protein requirements than non-pregnant or non-lactating animals. Also, animals that are working (horses, dogs) have different protein and energy requirements as well.

The condition of the feed is important because feed that is moldy or rotten will not be acceptable to the animal. The health of the animal will affect its interest in food. Sick animals will not eat as much as healthy animals. All of these factors affect an animal's nutritional level.

**Minimizing Waste**
Cattle eat many food by-products that are considered inedible for humans. The cottonseed hulls, cottonseed, old bread and candy, and citrus pulp are examples that would fill landfills if they were not eaten by cows. Cows are some of the world’s best recyclers.
**Introduction:**
1. Ask the class:
   *Have you ever wondered how it is possible for a cow to eat grass when humans cannot? Most people never ask that question but it will become increasingly important as the world's human population continues to grow.*
2. Explain that the digestive systems of cows and humans are very different. Cows are **ruminants**, which means they have a four-compartment stomach. In one compartment, called the rumen, there are millions of tiny microorganisms. The microbes digest the cellulose of plants. Cows and their rumen microbes have a good relationship. The microbes digest cellulose for the cows, and the cows provide a home for the microbes. Cows like to eat coarse, fibrous foods. They eat a lot of grass and hay. They also like to eat feeds that have ingredients such as soybean meal, cottonseed hulls, citrus pulp, and cracked corn. Cows even eat baked goods and candy every once in awhile. Do any of these ingredients sound like something you have eaten recently? You may not know it yet, but cows are great recyclers. They like to eat what humans throw away. Today, we will compare the diets of cows and humans. Humans are simple stomached animals and are not able to break down cellulose. It passes through our systems as roughage. We cannot survive by grazing as ruminants can.
3. Ask the students to list the animals that are grazers or browsers (eat shrubs or trees). Explain that some of these animals are ruminants, some like horses and zebras are ruminant-like animals without a rumen. Their fermenting vat is their cecum (this is the human appendix). While they can digest fiber, they are not as efficient at it as ruminants.

**Activity:**
1. Divide students into groups of four.
2. Pass out a hay sample to each group. If hay is not available long stems of grass will do.
3. Instruct the students to examine the hay for color, texture, and smell.
4. Ask the following questions:
   *What is the color of the hay? *(light green, slightly yellow or golden brown)*
   *What is the texture of the hay? *(coarse, flexible stalks of dried grass or legumes such as alfalfa)*
   *Why are cows able to eat hay? *(They have microbes in their rumen to digest the cellulose.)*
5. Have students put away hay samples.
6. Pass out a *Feed Ingredient* worksheet to each student. The students should work in their groups to complete the worksheet.
7. Answer any questions and review the worksheet when everyone is finished.
8. Pass out blank paper, construction paper, markers/crayons, and art supplies to each group.
9. Instruct the students to create a menu specializing in “cow cuisine”. They should use the *Feed Ingredient* worksheet to help them plan the meals.
10. Have each group share their favorite meal from the menu when everyone is finished.
11. Discuss the information with the class by asking these questions:
    "What does the term ruminant mean?* (An animal that has a four-compartment stomach, able to digest cellulose because of microbes in the rumen.)"
    *Why is it important for cows to eat food processing waste such as citrus pulp?* (Because if cows did not eat it, there would be a lot of additional garbage.)
    *Which feed ingredient do humans use or eat the most of everyday? (Answers will vary.)*
    "What was the most creative “cow cuisine” meal read from the menus? (Answers will vary.)"

**Alternatives or Variations:**
1. Have students research to identify the names and functions of the four compartments of the ruminant stomach using library resources. Instruct students to draw a diagram of the ruminant digestive system, label the compartments, and trace the digestive process of feed.
2. Ask students what stomach compartment of the ruminant has the same function as a human stomach? (Abomasum)
3. Have students research the human digestive system using library resources. What type of digestive system does a human have? (Monogastric)
4. Instruct students to list some other ruminants and monogastrics. They will find this information in the reference books. Write their suggestions on the board.

**Evaluation Options:**
1. Have the students write an essay as to why ruminants are important in the global food system. It may be from the perspective of other animals or humans.
2. Assign a group evaluation for their cooperative completion of the assignment.
3. Have the students create a food web for beef products that includes the items from this lesson as cattle feed.