4-H at HOME

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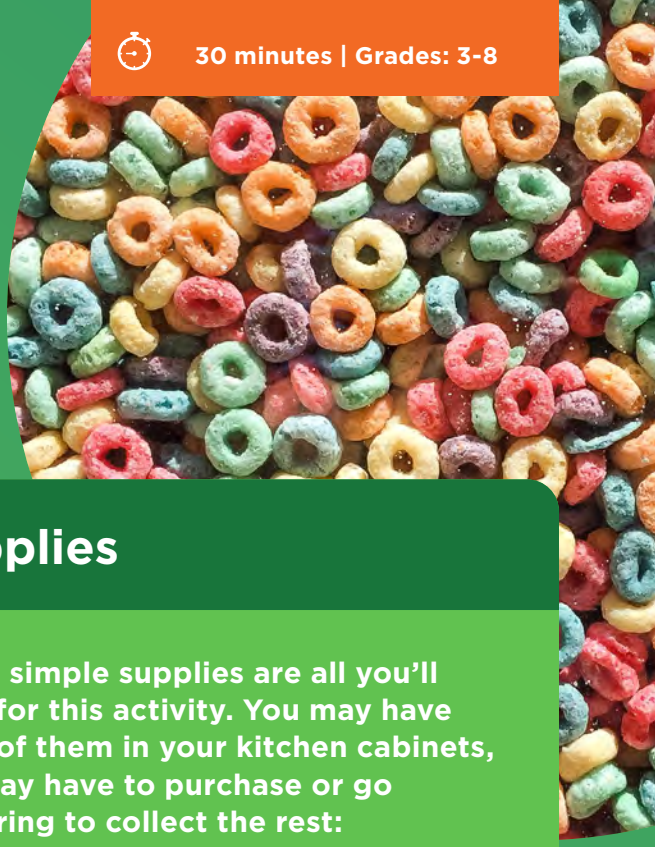
OF COWS AND CHILDREN

Small children need their parents to make their meals and cut them up into right-sized pieces. Guess what? Cows need someone to prepare their meals for them just-so, too.

30 minutes | Grades: 3-8

Of Cows and Children



Small children need their parents to make their meals and cut them up into right-sized pieces. Guess what? Cows need someone to prepare their meals for them just-so, too.

About the Activity

What do kids have in common with cows? Both of them get their food prepared for them by people who make sure they eat a nutritious meal. That's because, just like humans, cows need to eat a proper diet to stay healthy. Many cattle farms have animal nutritionists, who combine different types of feeds for animals to create a diet specific to their nutritional needs. They even make sure the feeds are ground to the appropriate particle size to ensure that the animal gets a consistent bite every time. Kind of like kids!

In this activity, we will use cereal and other materials to see how this concept works for cows.

Grades: 3-8

Topic: Animal Science,
Time: 30 minutes

Supplies

These simple supplies are all you'll need for this activity. You may have most of them in your kitchen cabinets, but may have to purchase or go exploring to collect the rest:

PART 1

- 1 cup each of 3 kinds of breakfast cereals, such as Rice Krispies®, Corn Flakes®, and Cheerios®
- 1 large container with lid (can hold approximately 4 cups)
- Measuring cup
- 3 plastic cups
- 3 plastic sandwich bags
- Optional: Feed samples for observation (corn-whole and/or ground, whole soybeans, soybean meal, pelleted feeds, salt)

PART 2

- 1/2 cup of fine sand
- 1/2 cup of rocks
- 1/2 cup of marbles
- 3 plastic cups
- Water
- Optional: Placemat

Activity Steps

This activity will be broken into two parts to demonstrate why breaking down cattle feed into smaller sizes is important, but at the same time, why it's critical to identify the appropriate particle size is important.

PART 1

1

Pour your grains

In the first part of the activity, we will explore how leaving an animal's feed at full size can encourage it to go for preferential pieces of food. If an animal only eats the food it prefers, it may not receive the full nutritional benefits of its feed. Follow the below steps to explore this concept:

- Add 1 cup of each kind of cereal to a container for a total of 3 or 4 cups.
- Place the lid on the container, and shake the container to mix the cereal together.
- Remove the lid and sort the cereal into plastic cups, one for each type of cereal.

DID YOU KNOW? Cows eat many byproducts, or "waste" feeds, that humans can't eat, such as soybean hulls, sugar beet pulp, bakery waste like bread and cookies, and damaged fruits and vegetables.

2

Time to crush it

Now that you've seen how easy it is to pick-and-choose pieces of cereal at full size, explore what happens when you grind the cereal down into smaller particles:

- Pour each cup of cereal into its own plastic bag.
- Using your hands, crush the contents of the plastic bags into fine particles.
- Add the contents of each plastic bag into the large container. Place the lid on the container and mix again.
- Try to sort the different cereal types out into individual cups.

DID YOU KNOW? Grains can be processed in various ways including cracking, rolling, grinding, steaming, and pelleting. Grinding of feeds results in smaller particle size and often greater digestibility.

PART 2

3

Pour your ingredients

In the second part of the activity, we will observe what can happen when the particle sizes in animal feed are too small:

- Fill Cup 1 with sand, Cup 2 with rocks, and Cup 3 with marbles.
- Carefully pour contents of each cup out onto a flat surface, and try to form a pile of each "ingredient."

Now that you have separated your particles into separate piles, discuss how the small particles (sand) hold their shape better than the large particles (rocks and marbles). Discuss how irregular shaped particles (rocks) hold their shape better than uniformly shaped particles (marbles).

4

Just add water

Now let's take a look at what happens if the particles are too small:

- Separate your ingredients back into their individual cups.
- Add a small amount of water to each cup (approximately 1/8 cup), and mix well.
- Carefully pour the contents of each cup onto a flat surface, and try to form a pile of each "ingredient."

Discuss how adding moisture helps sand hold together even better, but does not help the rocks or marbles. This is an example of how finely ground feed can create handling problems (such as clogging machinery), especially with added moisture.

DID YOU KNOW? Finely ground, starch-based feeds like corn can cause acidosis, which can lead to severe illness, if there is not enough physically-effective fiber in the diet.

30 minutes | Grades: 3-8

Test Your Knowledge

See how much you've learned about feeding beef cattle!

QUESTION 1

True or False: Cows eat many byproducts, or "waste" feeds, that humans can't eat.

a. True
b. False

QUESTION 2

Why is it important to break down and thoroughly mix animal rations:

a. To ensure the animal gets a consistent bite every time.
b. To make sure the animal doesn't only eat preferential foods
c. To make sure the animal receives all it's nutrients
d. All of the above
e. None of the above

QUESTION 3

Which method of breaking down grains encourages proper digestibility?

a. Cracking
b. Rolling
c. Steaming
d. Grinding

QUESTION 4

True or false: Certain finely ground foods can lead to illness in cattle.

a. True
b. False

Reflection Questions

Bonus questions to inspire wonder:

- Which cereal mixture is easier to sort and why?
- Was it easier to form a pile with the sand, rocks, or marbles? Why?
- How did the water (moisture) affect the feed ingredients?
- Do you need to grind all the feed ingredients? If the feed ingredients were not properly ground, what might happen?
- How does formulating rations relate to how we feed other animals? How does this relate to the human diet?
- If you were a beef cattle nutritionist, what do you think the biggest challenge would be?

30 minutes | Grades: 3-8

Investigate & Explore

Take your new knowledge to the next level.

For this bonus activity, all you need is an internet connection and a computer or mobile device. Look up the following information to learn more about particle size and how it translates to creating proper nutrition for animals.

What is the typical particle size for ground corn?

What units are used to measure particle size?

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4-H at HOME

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INCREDIBLE, EXPANDING COW FOOD

See how the amount of moisture held in hay and grass can actually keep cows from eating enough nutrients – and why drying those forages is so important.

Incredible, Expanding Cow Food

—

See how the amount of moisture held in hay and grass can actually keep cows from eating enough nutrients – and why drying those forages is so important.

About the Activity

When you boil pasta at home, you start by dropping dry, hard noodles into a pot of boiling water. By the time they're done cooking, they've softened and grown in size, taking up more space in the pot. Kind of like sponges, which expand when they get wet.

Similar to pasta or sponges, natural forages for cows like hay or fresh grass have moisture inside of them, meaning a cow might eat its fill of them before it's actually consumed enough nutrients for a proper meal. And the amount of moisture can differ from grain to grain.

In this activity, we will use sponges to explore how adding and removing moisture from food sources can impact the amount of nutrients the animal receives.

Supplies

These simple supplies are all you'll need for this activity. You may have most of them in your kitchen cabinets:

- 3 sponges (same size and shape)
- 1 cup of water
- Tablespoon measuring spoon
- Food scale (you CANNOT use a bathroom scale)

Tip: If you don't have sponges, paper towels will also work.

Grades: 3-8

Topic: Animal Science, Math
Time: 30 minutes

Activity Steps

Before we start, you should know that growing hay for cows to eat is not as easy as it seems. In fact there are five steps involved:

1. Cutting
2. Drying, or “curing”
3. Raking
4. Baling
5. Storing

In this particular activity, we will explore the importance of the drying process, which involves removing moisture from the hay. This step is instrumental in determining the amount of nutrients the animal actually receives.

For example:

- Fresh forages have a range of 80% to 90% moisture
- Baleage has a range of 50% to 70% moisture
- Hay has less than 20% moisture

The remaining percentage for each forage is known as “dry matter,” which is the part that contains nutrients. Due to the difference in moisture levels and dry matter, a cow may only need to eat 30 pounds of hay to meet daily intake requirements, whereas she needs well over 100 pounds of fresh forage to meet the same requirement.

Continue with the steps to learn how moisture can impact the amount of forage your cattle may eat. You will also learn how to calculate the amount of dry matter -- or grain -- your cattle has consumed when it’s saturated with water from rain, dew, or other moisture sources.

Did you know? Round hay bales usually weigh between 800 and 1,200 pounds. Wow!

Activity Steps

Now, let's start the activity

1

Try some hay math

To know how to feed a cow, you have to be able to crunch some numbers (pun intended). We'll start with the equation for calculating dry matter. We've provided an example below for you to follow and test. Using the equation and example in your worksheet, calculate the dry matter for fresh grass/ pasture and hay. When you have the answer, fill in the blank in the last column for Dry Matter %.

2

Weigh each sponge

Now it's time to experiment! The sponges represent the dry matter in forage. Using the food scale, weigh each dry sponge. This is the dry weight, which we will call X. Record the weight in the chart below.

3

Just add water

Add the following:

- 1 Tbsp of water to the first sponge
- 3 Tbsp to the second sponge
- 5 Tbsp to the third sponge

4

Weigh and record again

Now pretend each sponge is a different type of forage (ie (hay, baleage, or fresh forage). Because they are different, each sponge will absorb a different amount of moisture.

Using the food scale, weigh the sponges wet. This is the wet weight, which we will call Y. Record the weight in the chart below.

5

Wring out the water

Remove as much water from the sponges as possible. You can do this by squeezing, wringing out, or dabbing the sponges. etc. Then, weigh the sponges again. See how close you can get to the initial dry weight. Record the weight in the chart below.

Did you know? Hay that does not dry to the optimum moisture level (15 - 18% moisture) may spoil or spontaneously combust due to heat produced by microbial activity.

5

Calculate the dry matter

To determine dry matter, use the equation in your worksheet.

Notice how all three sponges have similar dry matter content (dry weight), but each sponge -- or type of forage -- has its own moisture amount. Discuss how a larger amount of fresh forage is needed to meet DM needs.

Did you know? Rainfall and humidity significantly impact hay drying time; it usually takes three days of dry, hot weather for hay to cure.

30 minutes | Grades: 3-8

Test Your Knowledge

QUESTION 1

What does the DM stand for in the dry matter calculation?

a. Dry weight
b. Wet weight
c. Dry Matter percentage
d. A&B

QUESTION 2

True or false: Most forages have the same moisture content?

a. True
b. False

QUESTION 3

Excess moisture in hay can:

a. Impact how much your cattle eats
b. Cause the hay to spoil
c. Cause the hay to combust
d. Cause the hay to evaporate
e. A, B, and C

QUESTION 4

Why is the Dry Matter calculation important?

a. It helps to determine the amount of nutrients the animal receives
b. It helps to calculate how much the animal weighs
c. Neither A or B
d. Both A or B

QUESTION 5

True or False: There is no difference between the amount of forage cattle will consume when it's eating dry hay vs. fresh forage in the pasture.

a. True
b. False

Reflection Questions

Bonus questions to inspire wonder:

- Did you know that grass is 80 – 90% moisture? Why do you think this is?
- After squeezing out the water, how close were you able to get to the original dry weight of the sponge?
- How do you think this experiment relates to hay production?
- Why do you think hay or baleage has to wilt/dry before it is stored?
- Why are nutrients adjusted to a dry matter basis?

30 minutes | Grades: 3-8

Investigate & Explore

Take your new knowledge to the next level.

If you have access to a farm or a zoo, see if there is a cow that you can observe. If you don't know or can't find the answers yourself, ask the below questions to the farmer or zookeeper in charge:

- How much does your cow weigh?
- How much does your cow eat?
- If your cow gained another 150 pounds, how would you need to change their feed?

If you aren't able to observe a cow, try answering the above questions with a different type of animal. You can even apply the questions to a pet at home! How would you alter your pet's diet if it started to gain or lose too much weight?

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DETERMINING DRY MATTER WORKSHEET

Equation to calculate dry matter: (Dry weight / wet weight) x 100 = DM %

Example:

Type of Dry Matter	Dry Weight	Wet Weight	Dry Matter %
Example	X	Y	DM%
Fresh Grass / Pasture	18gm	125gm	_____%
Hay	110gm	125 gm	_____%

Why is this calculation important? Rations are calculated on a dry matter basis because it determines the exact amount of nutrients the animal receives.

Type of Dry Matter	Dry Weight	Wet Weight	Weight after wringing out	Dry Matter %
Sponge 1				_____%
Sponge 2				_____%
Sponge 3				_____%

*Answer key: DM fresh grass/pasture=18%; DM hay=88%

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MAKE YOUR BEST COW PASTURE

Is your "cow pasture" equipped to feed cattle? Let's find out!

30 minutes | Grades: 3-8

Make Your Best Cow Pasture

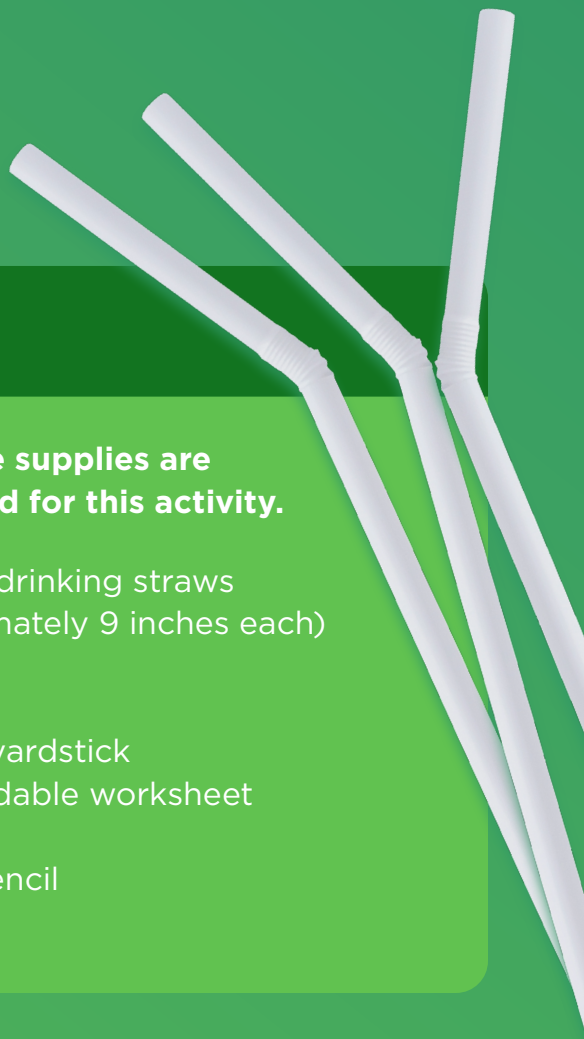
—

Is your "cow pasture" equipped to feed cattle? Let's find out!

About the Activity

Did you know that grasses make up about 26% of the plant life on Earth? And since cows are grazers by nature, it's not surprising that grasses contribute significantly to a cow's diet, especially when they are out in the pasture. But exactly what they eat when they are foraging for themselves may not be as cut-and-dry as when the feed is premeasured.

In this activity, kids you'll learn how to determine if a pasture is right for your cattle and how many it can support.



Supplies

These simple supplies are all you'll need for this activity.

- 6 plastic drinking straws (approximately 9 inches each)
- Tape
- Scissors
- Ruler or yardstick
- Downloadable worksheet
- Printer
- Pen or pencil

Grades: 3-8

Topic: Animal Science, Math
Time: 30 minutes

Activity Steps

In this activity, we are going to calculate two things: species composition and forage yield. **Species composition** can be estimated through visual observation. **Forage yield**, or the total amount of forage available for grazing, can help make decisions about how many cattle a pasture can support.

There are various ways to determine forage mass, but using a grazing stick or pasture ruler is a simple method. Using a frame or quadrant can help with these observations because it breaks a large area into small, measurable pieces. Print out the worksheet, and let's get started!

Create a frame with your straws

1. Cut four of the drinking straws into 3-inch lengths.
2. Tape one, 9-inch straw and one, 3-inch straw together to create a side that is 1-foot long.
3. Repeat Step 2 three more times until you have four foot-long pieces.
4. Tape the four pieces together to form a square. You now have your frame!

Tip: You can use the "bendy" part of the straw as the corner to connect it easier.

Place your frame

Place your frame in a random, grassy location. If you don't have access to a pasture, a yard or a field will do just fine. Toss the frame a short distance in front of you to allow for random sampling.

Take stock of your sample

Observe your grass sample from above to determine the species composition.

- Estimate the following items listed in the chart below to the nearest 5%. Record your observations in the appropriate place in the worksheet.
- Measure the average height of the forage within the frame and record your observations in the appropriate spot in the worksheet.
- Repeat this process three more times, until you have a total of four samples.

Example for measuring species composition:

Figure 2 shows an illustration of a quadrant in a mixed pasture. The pointed plants represent desirable species and the rounded plants represent weeds.

An estimation of species composition here would be 50% desirable species, 40% weeds, and 10% bare ground.

Tip: When measuring the forage for height, it helps to place your hand on top of the forage canopy to determine the height, making sure you are not measuring the tips of the longest pieces. The height should be a representative average of the plant height within the quadrant, which you can determine roughly by laying your hand flatly against the top of the grass.

Activity Steps

(continued...)

Figure 1

Figure 2

Forage Type	Sample percentage *(Round to nearest 5%)*
Desirable forage *(grass and clover)*	50%
Weeds	40%
Bare Ground	10%

DID YOU KNOW?
Incorporating legumes like clover into pastures can improve forage quality and add nitrogen to the soil.

DID YOU KNOW?
In real situations, forage crops are categorized by three criteria:

1. Grass or legume
2. Annual or perennial
3. Warm-season or cool-season.

Calculate forage mass

Use the information in the grass chart in the worksheet Figure 1 to calculate the forage mass in your plot of land.

For illustration purposes, choose whichever species is most common in your pasture/yard.

DID YOU KNOW?
As forage grows and becomes more mature, its yield increases but its quality decreases.

30 minutes | Grades: 3-8

Test Your Knowledge

QUESTION 1

What is forage yield?

a. Species composition
b. The average height of the forage
c. The total amount of forage available for grazing
d. None of the above

QUESTION 2

Why is forage yield important?

a. It can help farmers make decisions about how many cattle a pasture can support.
b. It can help farmers decide if they should feed their cattle weeds.
c. It can help cows eat faster.
d. None of the above.

QUESTION 3

True or False: Species composition is the percentage of various platlife that make up a forage.

a. True
b. False

QUESTION 4

How can you measure species composition?

a. By measuring the average height of the grass
b. Estimating through visual observation
c. Both A and B
d. None of the above

QUESTION 5

Why is species composition important?

a. It helps to determine the nutritional value of the pasture
b. It helps to determine forage yield
c. Neither A or B
d. Both A and B

Reflection Questions

Bonus questions to inspire wonder.

- What does species composition tell you about the condition of your pasture?
- What does canopy height tell you about your pasture?
- Other than straws, what else could be used to create a frame for observing species composition?
- How can you use these measurements to determine the most appropriate number of animals for a pasture?
- What other information about the cattle or grazing system do you need to know to make grazing decisions?

30 minutes | Grades: 3-8

Investigate & Explore

Take what you've learned to the next level to learn more and explore the possibilities.

For this activity, you will need a camera (a camera on a mobile device will do just fine), an internet connection, note cards, and markers.

- Take a photo of one of the weeds you found in the first activity. Research to identify the type.
- Repeat this with other types of weeds, plants, or grasses that you observed.
- Create a set of flashcards that includes five different grasses and five different weeds that are common where you live. To create each flashcard, put the mage on the front and name on the back.
- If you didn't find enough plants for your flashcard set, research additional grasses and weeds that are local to your area, and create flashcards for those.

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CALCULATE FORAGE MASS Worksheet

Table 1

Forage Type	SAMPLE 1 Percentage *(Round to nearest 5%)*	SAMPLE 2 Percentage *(Round to nearest 5%)*	SAMPLE 3 Percentage *(Round to nearest 5%)*	SAMPLE 4 Percentage *(Round to nearest 5%)*	Average Percentage
Desirable forage *(grass and clover)*					
Weeds					
Bare Ground					

Table 2

SAMPLE 1 Height	SAMPLE 2 Height	SAMPLE 3 Height	SAMPLE 4 Height	Average Height

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MAKE A MOO-DEL OF A COW'S STOMACH

Learn how a cow's stomach transforms food into energy.

30 minutes | Grades: 3 - 8

Make a Moo-del of a Cow's Stomach

—

Learn how a cow's stomach transforms food into energy.

About the Activity

Certain animals such as cattle, sheep, and goats are considered ruminant animals. This means that they have a stomach with four different parts – each with its own important job. One of these parts is called the rumen, which uses a special process to break down the fiber from plants and turn them into energy for the animal. Let's learn how this process works!

Supplies

These simple supplies are all you'll need for this activity:

- Empty 20-oz water/soft drink bottle with cap
- 3 tablespoons (or 8 packets) of white granulated sugar
- Packet of active dry yeast or dry quick-rise yeast
- Warm tap water
- 9-inch latex balloon
- Funnel

Grades: 3 - 8

Topic: Animal Science, Biology

Time: 30 minutes

Activity Steps

It is common for people to think that cattle have four stomachs, when actually, they only have one. But, did you know their stomachs do have four separate compartments, and each with their own distinct functions? The rumen, which we will explore today, uses a process called fermentation to transform the grass and hay the animals eat into nutrients. However, this process also produces gasses that are found in the earth's atmosphere, such as methane and carbon dioxide.

Follow the below instructions to see how this process works:

1

Pour and Shake

Add the packet of yeast and 3 tablespoons of sugar to the empty bottle. Next fill the bottle halfway with warm tap water (the water should be warm to the touch). Twist the cap back on your bottle (make sure it's on tight!) and then give the bottle a shake, shake, shake!

DID YOU KNOW? Ruminant animals like cattle, sheep, and goats generally eat greenery that they find in fields or wherever they live. The sugar in your bottle represents the grass and hay the animal may have eaten.

2

Inflate the Balloon with your Bottle

Remove the cap and place a balloon over the open top. Now: Sit back and observe. In a few minutes, the yeast will start eating the sugar, which in turn, will build up enough gas to inflate the balloon. The longer the model is left, the more gas will develop, resulting in a larger balloon.

DID YOU KNOW? The rumen — represented by the bottle in this experiment — is the site of fermentation. In an adult cow, the rumen has a 35-50 gallon capacity.

3

Swirl It Up

After a few minutes, the balloon will stop getting larger. You will need to gently swirl the bottle to mix the contents. This represents a process called rumination that occurs in the animal – also referred to as "chewing cud."

When an animal "chews its cud," it is actually chewing food that it has already swallowed! After the food spends some time in the cow's rumen, it is sent back up to the cow's mouth for extra chewing. Not very appetizing, is it?

DID YOU KNOW? The four compartments of a cow's stomach (or other ruminant animals like sheep and goats) are the:

- **Rumen:** The first compartment that uses fermentation to turn food into gas and fuel.
- **Reticulum:** The second compartment that mimics the rumen, but also moves smaller digested particles into the next compartment of the stomach.
- **Omasum:** This third compartment absorbs nutrients from food and water
- **Abomasum:** Most like a real stomach, this compartment helps prepare for absorption of nutrients in the body.

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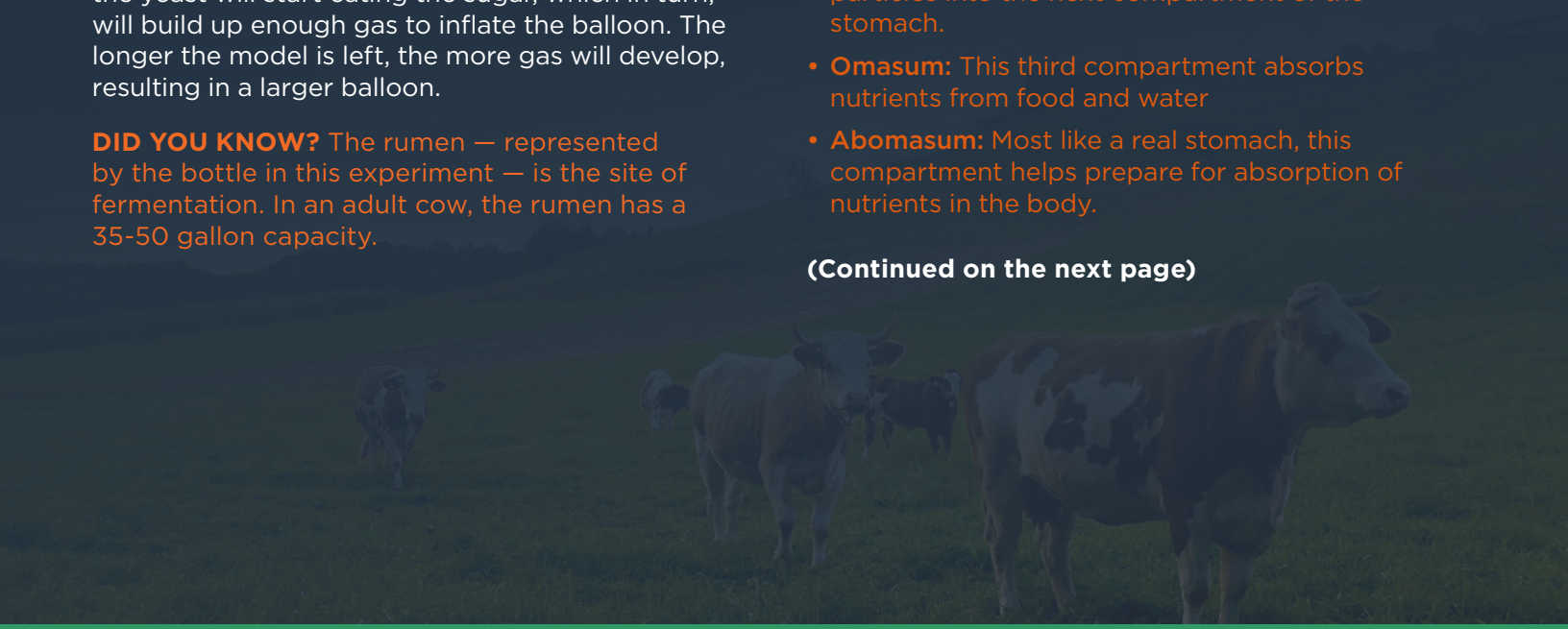

Activity Steps (Continued)

4

Review Your Results

Review the parts of the "mock" rumen and what they represent.

- **Water bottle** = Rumen
- **Yeast** = Micro-organisms or "bugs"
- **Sugar** = Plants that the animals eat
- **Gas in balloon** = Methane and carbon dioxide

DID YOU KNOW? The rumen is the home of many micro-organisms, such as bacteria and protozoa. These "bugs" are what use fermentation to break down the fiber from plants and turn them into energy for the animal.

Bonus Activity

Try the above experiment again, but this time, let's mix things up a bit! The first time you repeat the experiment, try doubling the amount of sugar. Before placing the balloon on top, try predicting what the outcome will be. Did the outcome turn out as you expected?

Now try the experiment with a larger water bottle! Did the size of the bottle affect the amount of gas in your balloon?

30 minutes | Grades: 3 - 8

Test Your Knowledge

See how much you've learned about the inner workings of a cow's stomach!

QUESTION 1

True or false? A cow has four stomachs.

a. True
b. False

QUESTION 2

A cow's stomach uses a process called _____ to turn hay and grass into nutrients.

a. Chewing cud
b. Fermentation
c. Swirling
d. Rumen

QUESTION 3

True or false? Micro-organisms help to break down food into energy.

a. True
b. False

QUESTION 4

What is not one of the four compartments of a cow's stomach?

a. Rumen
b. Omasum
c. Abomasum
d. Rumination

QUESTION 5

Fermentation works to produce a variety of things, including:

a. Nutrients for the animal
b. Methane
c. Carbon dioxide
d. All of the above

Reflection Questions

Bonus questions for your journal:

- What was your initial reaction to learning that cows have "bugs" in their stomach?
- How does a human digestive system compare to beef cattle's digestive system?
- Some farms use automatic feeders with computers/robots. What are some ways computers and robots could be used on your farm?
- Why is it important to understand the digestive system of a ruminant animal?

30 minutes | Grades: 3 - 8

Investigate & Explore

Take your new knowledge to the next level.

We've talked a lot about fermentation during this activity. That's because without it, cows wouldn't be able to properly digest their food and absorb the nutrients that keep them healthy.

- With this in mind, why do you think it's so important for cattle and other animals in our food system to have four stomachs?
- Why do you think humans don't eat grass like cows?

The next time you see cows or sheep or goats out and about, look at them closely. Are they chewing? And, if so, are they chewing what they just plucked off the ground, or does it look like maybe they're chewing their own cud?

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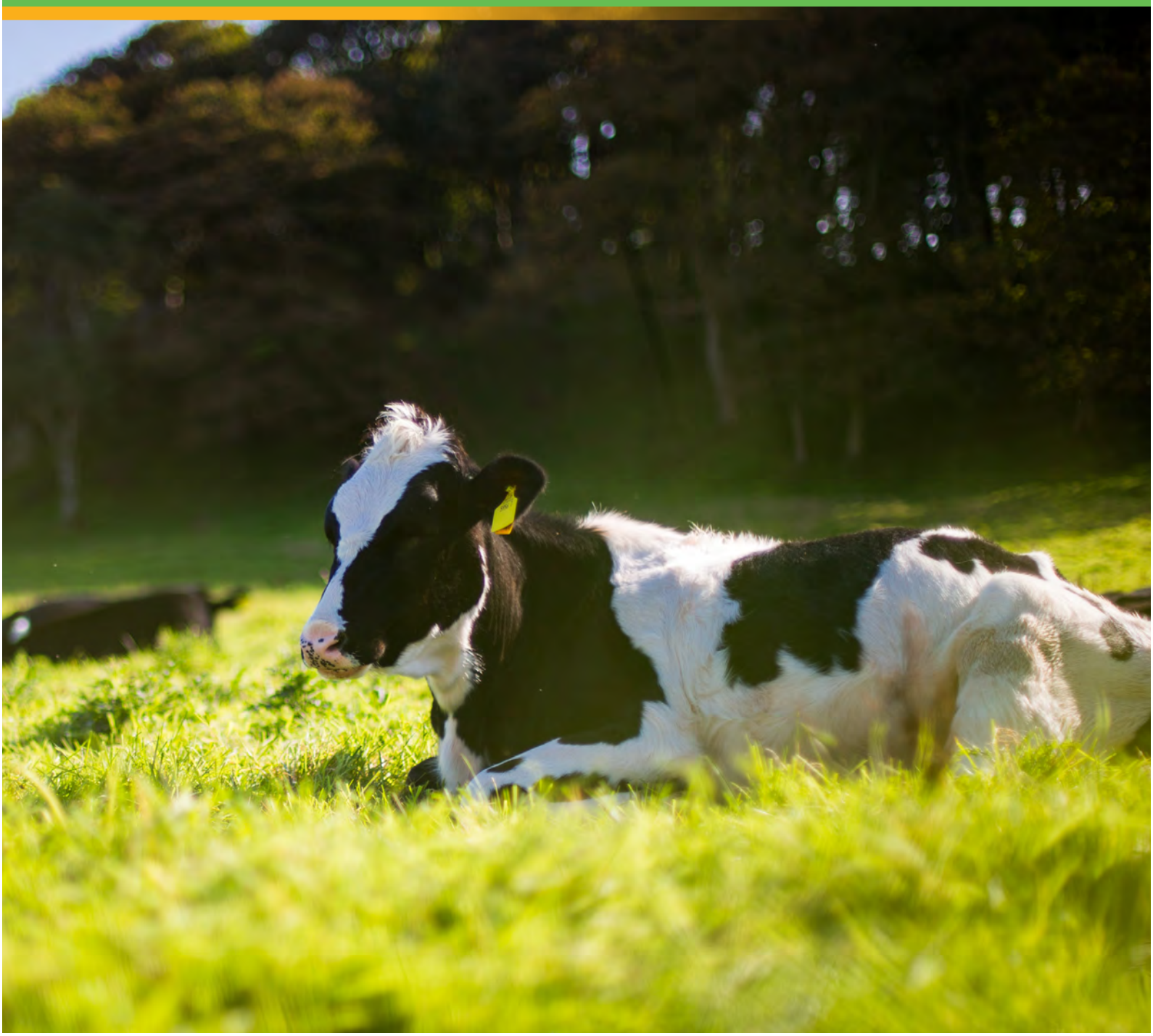
HELPFUL STOMACH BUGS?

Not all bacteria are created equal. Learn how different stomach bugs can help a cow digest its dinner.



30 minutes | Grades: 3-8

Helpful Stomach Bugs?

Not all bacteria are created equal. Learn how different stomach bugs can help a cow digest its dinner.

About the Activity

When we think about bacteria, it's common to think of different illnesses and how these microorganisms can make us sick. But did you know not all bacteria are bad? In this activity, you will learn about different types of bacteria (and other types of microorganisms) in a cow's stomach that help transform its food into fuel.

Supplies

These simple supplies are all you'll need for this activity.

- 1 can of modeling clay (e.g. Play-doh®)
- Large sponge
- Scissors
- Glue stick
- 5-6 Pipe cleaners
- Table tennis (ping pong) ball
- Cotton twine (10 foot)

Grades: 3-8

Topic: Animal Science, STEM, Biology

Time: 30 minutes

Activity Steps

The rumen is the first of four sections in a cow's stomach, and it has a very important job – to transform its food into energy. It does this with the help of many microorganisms, including bacteria, protozoa, and fungi.

Each microorganism carries out different functions and digests different types of nutrients. In this activity, we learn about each type of microorganism and how they help to aid in digestion.

1

Build your bacteria

While we typically think about germs when we hear the word "bacteria," there are also good forms of it that can help animals stay healthy! For cattle, bacteria are important to help digest fiber, starch, and sugars. Bacteria also help to transform food into nutrients.

A couple different examples of common rumen bacteria are Ruminococcus flavefaciens and Streptococcus bovis. We are going to use Play-doh® to build our bacteria.

Break the Play-doh® into 12 separate pieces.

Using your hand and the table, roll out 8-10 small balls. Use the remaining pieces to roll out a couple of long tubes.

Once you are done rolling your shapes, clump 3-4 of the small balls together. You have now made a model of rumen bacteria.

Each small ball of Play-doh® represents a single bacteria. These bacteria can make different formations by forming chains and clumps.

DID YOU KNOW? Bacteria are typically considered bad regarding food safety. But certain bacteria that are found in the stomach can actually play a positive role in processing food (not only in animals, but in people too).

2

Cut your pipe cleaner protozoa

Protozoa are the largest microorganisms that can be found in a cow's rumen, but there aren't as many of these as bacteria. However, they are super large – 40 times larger than the bacteria we talked about! While their role in the rumen is not completely clear, they do aid in digestion, and will actually feed on different types of bacteria, too – yikes!

To create a model of this powerful protozoa, grab your pipe cleaners, scissors, and sponge.

Cut 5-6 pipe cleaners into varying shorter lengths; anywhere from 2-6 inches is good.

Stick the pipe cleaner pieces into one end of the sponge. Curve the tops of the pipe cleaners slightly at the end.

You have now made a model of a rumen protozoa. The sponge represents the body of the protozoa, which also contains the "mouth." The mouth allows it to consume and digest nutrients and bacteria inside the rumen. The pipe cleaners represent cilia around the mouth.

DID YOU KNOW? Without rumen microorganisms, cattle would not be able to digest grasses, leaves, and sticks from their own grazing. Instead, they would have to eat oats and other grain-based feeds, similar to pigs and horses.

3

Have fun with fungi

Fungi – yes, cows produce actual fungi in their stomach to help digest their food – make up about 8 percent of the total mass of the rumen. They only work in an oxygen-free environment. Fungi produce enzymes that are important in the digestion of fiber that the animal eats. This digestion leads to an increase in the energy available to other rumen microorganisms.

Grab your twine, ball, scissors, and glue to get started.

Cut 8-10 pieces of twine, each 10- to 12-inches long.

Cut another piece of twine, this time only 2-inches long. Use this piece to tie the longer strands together on one end.

Glue the tied end of the twine strands to the ball and allow a few minutes to dry.

You now have a model of rumen fungi. The ball represents the main body of the fungi while the twine strands represent the flagella that helps the fungi move around in the rumen. A couple examples of common rumen fungi are Aspergillus and Anaeromyces.

DID YOU KNOW? Rumen fermentation results in volatile fatty acids, which are the main source of energy for the cow. This rumen fermentation gives cattle the ability to turn lower-quality feeds into high quality meat and milk.

30 minutes | Grades: 3-8

Test Your Knowledge

See how much you've learned about the inner workings of a cow's stomach.

QUESTION 1

What types of microorganisms can you find in a cow's rumen?

a. Bacteria
a. Protozoa
a. Fungi
a. All of the above

QUESTION 2

True or False: Not all bacteria is bad.

b. True
c. False

QUESTION 3

Why are rumen microorganisms important?

a. They help transform cattle's food into energy
a. They protect the grass after the cow eats it
a. They eat the bacteria
a. None of the above

QUESTION 4

True or False: microorganisms help to break down food into energy.

b. True
c. False

QUESTION 5

True or False: Fungi need oxygen to work.

d. True
e. False

Reflection Questions

Bonus questions to inspire wonder:

- What was your reaction to learning about the different types of microorganisms -- also referred to as "bugs" -- in the cow's stomach? How will learning about stomach bugs in cattle help you to do a better job feeding your beef cattle in the future?
- What is the role of the microorganisms in the digestive process?
- If beef cattle did not have rumen microorganisms, how would you feed them differently?
- Are there other things you can think of in your life that are beneficial to some areas and bad in other areas?

30 minutes | Grades: 3-8

Investigate & Explore

Take your new knowledge to the next level.

When we talk about the science of farming and raising animals, we tend to use a lot of big words. This can be confusing! And that's okay!
Now, practice some of these new words you've learned about cow digestion! You might want to grab a grownup for support, and use a dictionary or the internet to look up the below words.

Once you find each word, think or talk about how each one relates to farming and the process of digestion in the rumen.

- Fermentation
- Cellulose
- Hemi-cellulose
- Enzymes
- Forages

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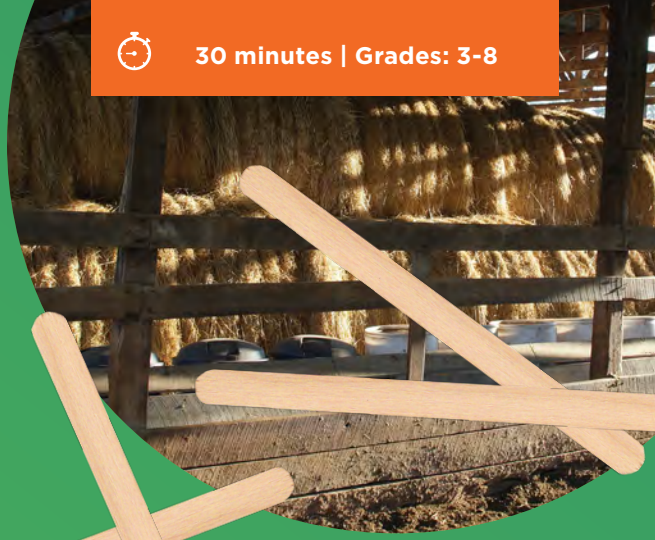
LET'S BUILD A HAY BARN

Learn to properly protect your hay from nature's challenges.

30 minutes | Grades: 3-8

Let's Build a Hay Barn



Learn to properly protect your hay from nature's challenges.

About the Activity

When we think of an animal farm, a cow grazing in the grass or roaming in the fields may come to mind. This is because grazing is the least expensive way for farmers to provide nutrients to beef cattle, which are prone to eating grass and hay. When winter comes around, and the ground freezes over, what are they supposed to eat? In this activity, you will build your own hay barn to help protect your cattle's food source from weather and pests year-round.

Supplies

These simple supplies are all you'll need for this activity.

- Cardboard
- Straws
- Cotton balls
- Cotton swabs
- Toothpicks
- Craft sticks
- Tape
- Index cards
- Scissors

Grades: 3-8

Topic: Animal Science, STEM, Crafting

Time: 30 minutes

Activity Steps

Let's Build a Hay Barn–

Hay is the main source of food for beef cattle in the winter. Farmers will typically produce hay during the summer, and then store it as a winter food source for when grazing is not possible. Hay can be made into large round bales that weigh anywhere between 600-1,500 pounds, or into smaller square bales that weigh 40-140 pounds.

Regardless of size, protection is key. Important considerations for hay barns include creating complete protection from the weather to avoid heat and moisture, minimizing access to pests, storage capacity, and a firm foundation. With this in mind, let's design a hay barn for your beef cattle!

1

Take a few minutes to think about a barn you may have seen during a visit to a farm, a school field trip, or on a drive with your family – or your own, if you have one! If needed, do an internet search for pictures of hay barns. After you have an idea what you want your barn to look like, sketch out your building plan.

DID YOU KNOW? Weather can damage up to 10-30 percent of hay that is not properly stored in a barn. This is why proper storage is important – storing hay in a barn can prevent farmers from wasting resources and losing money.

2

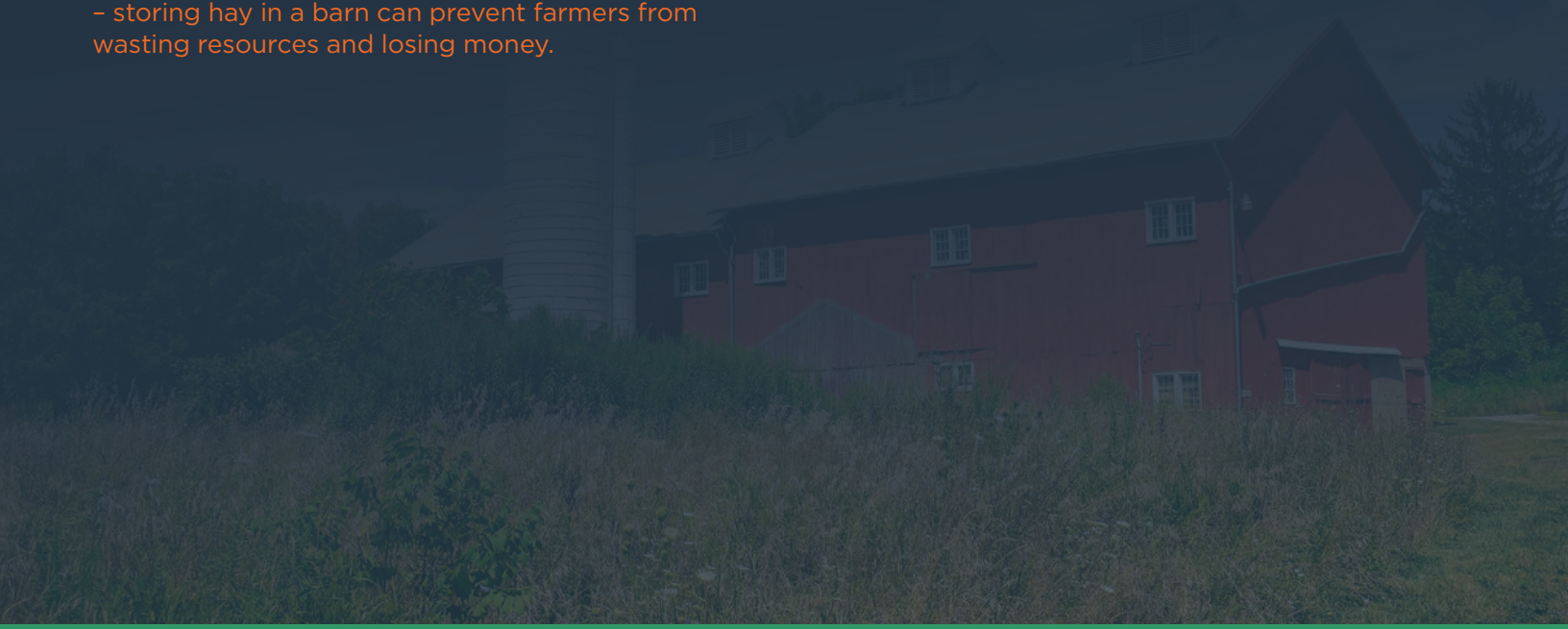
Once you have your plan, build your hay barn using the supplies listed above.
Tip: While you are welcome to be creative, keep in mind that you want your barn to have a strong foundation. Using sticks to build the framework of your barn is one way to create a strong base and walls.

DID YOU KNOW? Hay is the main type of winter feed for beef cattle.

3

After you finish building your barn, place cotton balls inside the barn to get an idea of how much hay your barn will store.

DID YOU KNOW? Another method of preserving hay for winter feeding is through haylage or baleage. In this system, hay is mowed and then wrapped in plastic for storage before it has been dried.



30 minutes | Grades: 3-8

Test Your Knowledge

See how much you've learned about making a hay barn!

QUESTION 1

True or False? It is a good idea to store hay outside in the winter.

a. True
b. False

QUESTION 2

Hay barns help to protect cattle food sources from:

a. Moisture
b. Pests
c. A&B
d. None of the above

QUESTION 3

True or False? A strong foundation is important for the structure of your barn.

a. It will shed or molt the old skin
b. It will transform into a butterfly or moth
c. The old skin will adjust to the new body
d. It will turn into a cocoon or chrysalis

QUESTION 4

Haylage or Baleage is the process of_____.

a. Freezing hay
b. Mowing hay and leaving it outside
c. Mowing hay and wrapping it in plastic
d. Mowing hay and wrapping it in string

QUESTION 5

True or False? Hay bales range in size, but overall, they are really heavy!

a. True
b. False

Reflection Questions

Bonus questions to inspire wonder:

- What was challenging as you created your barn into a model from your sketch?
- Based on what you have learned, what would you change about your model?
- What purposes does a barn serve?
- How are homes and buildings similar to a barn and how are they different?
- It takes a long time to plan and build a hay barn in real life. What are some other things in your own life that require a planning process before you can implement them?

30 minutes | Grades: 3-8

Investigate & Explore

Take your new knowledge to the next level.

While building our hay barn, we learned how the structure and foundation of our design plays a role in protecting our resources. This is true for many different types of buildings. Even though different buildings may not look alike, they can still have similar purposes. For example, whether we are talking about our homes, schools, barns, or a community center, they each provide a safe space for certain types of activities.

With this in mind, take a walk around your neighborhood. Be sure to bring a grownup with you. As you go out into the world, take the time to look at the buildings around you. What are some features you noticed when looking at other buildings that might improve the usefulness of your barn model? What features may help to improve your barn's structure and foundation?

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FEED A COW!

In this activity, you'll learn how to prep and parcel a pretend meal for your animals.

30 minutes | Grades: 3-8

Feed a Cow!

In this activity, you'll learn how to prep and parcel a pretend meal for your animals.

About the Activity

Water, vitamins, minerals, protein. Sound familiar? Similar to humans and pets, it's important for beef cattle to ingest all the nutrients that provide a balanced diet. From corn to cottonseed, there are many different feeds and forages from which to choose.

In this activity, you'll learn how different grains – also referred to as feeds and forages – can support a healthy cattle diet, and how to measure out a proper meal for our cattle.

Supplies

These simple supplies are all you'll need for this activity. You may have most of them in your kitchen cabinets:

- 1 cup peanuts (substitute with popcorn or pretzels if allergies are a concern)
- ½ cup chocolate chips
- 1 tbsp. (or small bag) raisins
- 1½ cup + 1 tbsp. sunflower seeds
- 3 sandwich-size plastic bags
- Sharpie
- Measuring cups
  - ½ cup
  - 1 cup
- Measuring spoons
  - 1 tablespoon

Grades: 3-8

Topic: Animal Science, Math
Time: 30 minutes

Activity Steps

Most beef cattle will feed on forages for a majority of their nutrition needs throughout their lives. However, cattle also have other nutritional needs, such as energy-based foods, protein, vitamins, and minerals. Before you begin to measure out feed mixtures for cattle, let's explore the various types of nutritional elements you will add into each mixture.

- Energy: Energy is used by cattle for growth, respiration, and maintaining body temperature. Beef cattle primarily create energy through the intake of carbohydrates and fats.

- Protein: Protein aids in digestion, growth promotion, and immune response. While specific feeds can help aid this, a cow's digestion process also helps with this on its own. Through a special form of digestion, cattle can also produce a type of protein -- called microbial protein -- from living organisms that already exist in their stomachs. You may have learned about this process in a prior activity.

- Fiber: Fiber is the roughage or bulk part of the diet that passes through the body largely undigested by the animal. This roughage/fiber is needed by cattle to ensure proper function in the rumen, which is a part of the cow's stomach that uses a special process to convert fiber into energy.

- Vitamins: Vitamins are organic substances that are essential for body tissues, but are needed in very small amounts. A cow's digestion process will help to produce these.

- Minerals: Minerals are inorganic substances that are essential for many body processes. Most cattle are provided a mineral mixture with various types of minerals at different stages of production.

DID YOU KNOW? Grain-based feeds like corn are primarily used in feedlots. When selecting these feeds and forages, consider:

- How well the animal will eat the feed

- How available the nutrients are in that feed

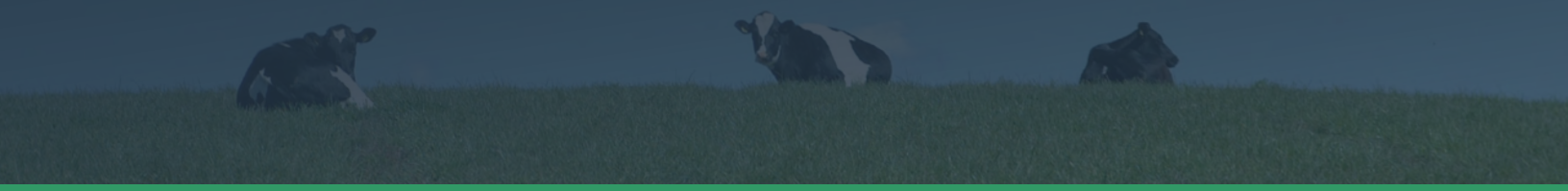
- Are there any toxicity concerns that can affect the final feed mixture?

Now that you've learned about how different types of nutrients contribute to a cow's health and digestion, you can start mixing your own feed mixtures.

MAKE RATION 1: TYPICAL FEEDLOT FEED MIXTURE

- Take one of the plastic sandwich bags and write "feedlot" on the bag with your Sharpie.

- Follow the measurements in the chart on the next page. Using your measuring cups and measuring spoons, portion out the appropriate amount of each food item into the bag.



Nutrient	Percentage	Food item	Represents	Amount
Energy	60%	Peanuts/Pop-corn/Pretzels	Corn/Soybean Hulls	½ cup + 2 tbsp.
Protein	24%	Chocolate chips	Cottonseed meal/ Soybean meal/ Corn gluten feed	¼ cup
Fiber	14%	Sunflower seeds	Forages/Soybean hulls/Cottonseed hulls	2 tbsp.
Minerals	2%	Raisins	Mineral mix	1 tsp.

DID YOU KNOW? Specialized mineral mixtures are typically provided to cattle and adjusted for their needs and specific stage of production. So even though the amount of raisins you've included in each bag is the same, maybe there are still some differences you can still try to find some differences. Consider putting larger raisins in the typical feedlot mixture, or more wrinkly raising in a different mixture to fine-tune your "minerals."

MAKE RATION 2: TYPICAL WEANED CALF FEED MIXTURE

- Take one of the plastic sandwich bags and write "weaned calf" on the bag with your Sharpie.
- Follow the measurements in the chart below. Using your measuring cups and measuring spoons, portion out the appropriate amount of each food item into the bag.

Nutrient	Percentage	Food item	Represents	Amount
Energy	20%	Peanuts/Pop-corn/Pretzels	Corn/Soybean Hulls	3 tbsp.
Protein	10%	Chocolate chips	Cottonseed meal/ Soybean meal/ Corn gluten feed	2 tbsp.
Fiber	68%	Sunflower seeds	Forages/Soybean hulls/Cottonseed hulls	½ cup + 3 tbsp.
Minerals	2%	Raisins	Mineral mix	1 tsp.

DID YOU KNOW? Total Digestible Nutrients – also called TDN – is the common measure of energy in beef cattle feeds.

MAKE RATION 3: TYPICAL MID-GESTATION COW FEED MIXTURE

- Take one of the plastic, sandwich-size bags and write “mid-gestation” on the bag with your Sharpie.
- Follow the measurements in the chart below. Using your measuring cups and measuring spoons, portion out the appropriate amount of each food item into the bag.

Nutrient	Percentage	Food item	Represents	Amount
Energy	10%	Peanuts/Pop-corn/Pretzels	Corn/Soybean Hulls	2 tbsp.
Protein	10%	Chocolate chips	Cottonseed meal/ Soybean meal/ Corn gluten feed	2 tbsp.
Fiber	78%	Sunflower seeds	Forages/Soybean hulls/Cottonseed hulls	3/4 cup
Minerals	2%	Raisins	Mineral mix	1 tsp.

DID YOU KNOW? Though not part of the feed mixtures you’ve created, water is one of the most essential nutrients for cattle. Water plays a major role in digestion, transport of nutrients throughout the body, helps with excretion of waste products, and also helps to regulate body temperature. It is vitally important to ensure that all cattle have free access to clean, fresh water at all times.

30 minutes | Grades: 3-8

Test Your Knowledge

See how much you've learned about feeding beef cattle!

QUESTION 1

What nutrient is important for cows that you won't find in a feed mixture:

a. Fruit
b. Water
c. Corn
d. Soybeans
e. None of the above

QUESTION 2

True or false: Forages are a primary source of nutrition for beef cattle:

a. True
b. False

QUESTION 3

What types of nutrients are a part of the diet for beef cattle?

a. Energy
b. Protein
c. Fiber
d. Vitamins and Minerals
e. All of the above
f. A, B, and C only.

QUESTION 4

True or false: Grain-based feeds are primarily used in feedlots.

a. True
b. False

QUESTION 5

True or False: Cattle in all stages of life eat the exact same feed.

a. True
b. False

Reflection Questions

Bonus questions to inspire wonder:

- What difficulties did you face while making the feed mixes with the different ratios of ingredients?
- What is the purpose of supplying beef cattle with specific types of feeds and forages?
- Discuss the functions of each of the different nutrients. Does this impact how you feed your own beef cattle? If, so why?
- Sometimes, we have to eat foods that we don't really like to get specific nutrients from them. What are some foods you eat to provide your body with nutrients even though you may not like those foods?
- What careers might be of interest to you relative to feeding beef cattle?

30 minutes | Grades: 3-8

Investigate & Explore

Take your new knowledge to the next level.

Grain-based feeds like corn are primarily used in feedlots, but lately, discussions have risen that promote alternative ways to provide those forages through regenerative farming practices.

Take a visit to a local farm or zoo, and observe what type of feed the cows are grazing on. With permission from your grownup, ask the animal caretaker what types of feed the cattle eats. Find out:

- Are the cattle receiving nutrients from a feedlot diet? A grass-fed diet? Or an alternative diet?
- Are there other potential ways to feed cattle in addition to mixing forages?
- What types of rations or nutrients benefit each animal?

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RUMINATE ON RUMINANT DIGESTION

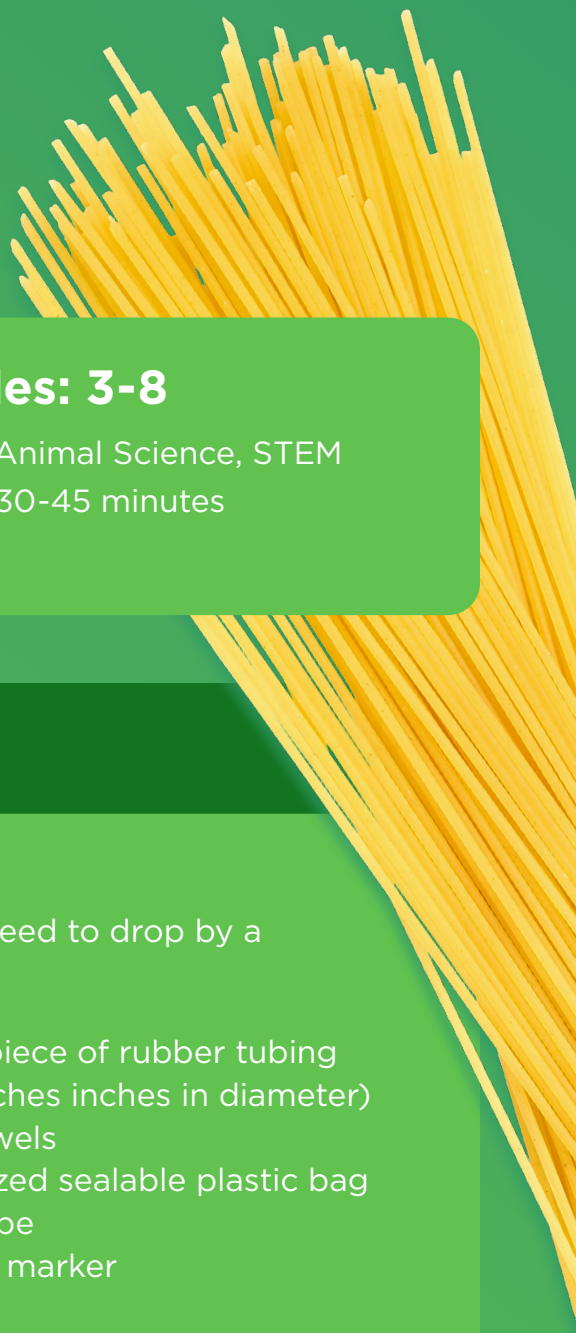
In this activity, kids will experiment with different mixtures to replicate how ruminant digestion works

Ruminate on Ruminant Digestion

In this activity, kids will experiment with different mixtures to replicate how ruminant digestion works

About the Activity

The digestive tract of ruminant animals, such as cows, sheep, and goats, differs from that of other animals because instead of the single-chamber stomach that humans have, it has four. These chambers help to ferment and break down food, and eventually absorb nutrients. Pop rocks and soda aren't the healthiest of snacks, but in this activity you are going to use them to replicate the digestive system of a cow.



Grades: 3-8

Topic: Animal Science, STEM
Time: 30-45 minutes

Supplies

These simple supplies are all you need for this activity.

You may have most of them in your house, but you may need to drop by a convenience store for others.

- 3 large, mixing bowls
- Angel hair pasta (a dime- to nickel-sized stack of dry pasta)
- ½ cup of water
- 1 large funnel
- 1 pack of pop rocks
- 1 potato masher
- A single, 12 oz-can of lemon-lime soda
- 1 sponge
- A 10-inch piece of rubber tubing (1 to 1.5 inches inches in diameter)
- 2 paper towels
- A gallon-sized sealable plastic bag
- Masking tape
- Permanent marker
- Stapler
- Scissors

Activity Steps

The purpose of this activity is to review parts of ruminant digestion and the function. Participants will create a representation of the ruminant digestive system.

Before we start, you should know that a cow's stomach has four separate compartments to aid in digestion, each with their own unique function:

- **Rumen:** The first and largest compartment holds large amounts of forage and water, and is where the fermentation and breakdown of feed occurs with the help of rumen microbes. Rumen contractions help mix the feed/forage and water.
- **Reticulum:** This is the second compartment, which catches heavy items and aids in regurgitation for "chewing cud."
- **Omasum:** The omasum filters particles based on size into the fourth compartment.
- **Abomasum:** This is the "true stomach" of ruminant animals, and contains stomach acid.

Now, let's get started:

Step 1: Cook and drain the pasta

You don't need to cook the entire package. To measure out your pasta, make a circle (or the "OK sign") with your first finger and thumb, and tighten it up until the opening is the size of a dime or nickel. Fill the opening with dry pasta. Next, cook the pasta to the box's specifications. Most noodles cook in about 8-12 minutes in boiling water. Drain the water once the pasta has cooked.

Step 2: Label your mixing bowls

Put a piece of masking tape on each mixing bowl. Using your marker, label your mixing bowls as "Container 1," "Container 2," and "Container 3"

Step 3: Create your tube

You will use your plastic bag, stapler, and scissors to create the rubber tube (see pictures below).

- Lay the bag flat on the table.
- Roll the zippered-edge down until there is about 1 to 1.5 inches of space left at the bottom.
- Staple down the rolled section along the edge.
- Using your scissors, trim the short sides of the bag open to form the tube.

Step 4: Add ingredients to your mixing bowls

- Add ½ cup of water and the cooked pasta into Container 1, and mix slightly. This is the "ingesta."
- Add the pop rocks to Container 2.
- Add the lemon -lime soda to Container 3.

Activity Steps

(continued...)

DID YOU KNOW?
Even though your noodles may be cooling off, if they were to be digested by a real cow, they may go through another warming up period. The rumen environment has a pH range of 5.5 to 7.0 and the temperature range of 98 to 104 degrees Fahrenheit.

Step 5: Move your "feed" from the rumen to the omasum

Using the funnel, pour your ingesta from Container 1 through your tubing. You may need to use your hands to squeeze the ingesta through the tubing and into Container 2. Swirl the ingesta around Container 2 so that the pop rocks are mixed into it.

DID YOU KNOW?
The inside of the rumen is covered with small, finger-like projections called papillae (pa-pil-la), which increase the surface area to aid in absorption of nutrients.

Step 6: Create your cud

This may get a bit messy!

- Using the funnel, pour the mixture from Container 2 back into the tubing.
- Use your hands to squeeze the mixture through the tubing and back into Container 1.
- Crush the pasta into tiny pieces with your potato masher to officially make your cud.

DID YOU KNOW?
A cow will chew its cud for up to eight hours per day.

Step 7: Move the cud into the stomach

Now your cud is going to go through a major part of digestion:

- Using the funnel, pour the cud (mixture in Container 1) through the tubing. Again, you may need to use your hand to squeeze "cud" back through tubing into container 2, which is the omasum.
- Pour the cud, which is now in the omasum in Container 2, through the strainer into Container 3, which has the lemon-lime soda.

DID YOU KNOW?
The breakdown of feed by rumen microbes is a relatively slow process. Fiber particles remain in the rumen for 20 to 48 hours as they are broken down by bacteria.

Step 8: Move your cud through the intestines

After the feed is digested in the abomasum, it moves through the small and large intestines where nutrients and water are absorbed. Any undigested material in a ruminant animal will become excreta or manure. To see how this works, slowly pour the remaining cud (mixture from Container 3) onto your sponge and let the liquid absorb. Allow approximately 1 minute to absorb.

Step 9: Rid the digestive tract of waste

Collect solid pieces off the sponge and place the sponge on the paper towel to absorb water.

30-45 minutes | Grades: 3-8

Test Your Knowledge

See how much you've learned about feeding beef cattle!

QUESTION 1

What are the four compartments of a cow's stomach?

a. Rumen, fermentation, omasum, and abomasum
b. Rumen, omasum, abomasum, and intestines
c. Rumen, reticulum, omasum, and abomasum
d. Container 1, Container 2, Container 3, sponge

QUESTION 2

Which compartment aids in the regurgitation of cud?

e. Reticulum
f. Intestines
g. Omasum
h. Pop rocks
i. None of the above

QUESTION 3

Which compartment is the cow's "true stomach"?

j. Rumen
k. Omasum
l. Abomasum
m. Intestines
n. None of the above

QUESTION 4

How long do fiber particles remain in the rumen to be broken down by bacteria?

o. 5 hours
p. 20 to 48 hours
q. More than 48 hours
r. 30 minutes

QUESTION 5

True or False: Undigested material in a cow becomes excreta or manure.

a. True
b. False

Reflection Questions

Bonus questions to inspire wonder.

- What are the four compartments of the ruminant stomach?
- What is the function of the microbes in the rumen?
- Why did you move content from Container 2 into Container 1 and then back into Container 2?
- Why is a healthy and functioning digestive system important for your beef cattle herd?
- Have you ever had a toy break from not playing with it the right way? If so, what happened to your toy at that time? What do you think happens if part of a beef cattle's digestive system stops working? What process would you follow to correct the problem?

30-45 minutes | Grades: 3-8

Investigate & Explore

Take what you've learned to the next level to learn more and explore the possibilities.

Think about the last time you had a stomach ache. What happened? How did it make you feel? How long did it take for you to feel better? Now think about what might happen to a cow if it's digestive tract was not working properly? What might happen if the feed was not broken down enough?

Let's revisit our activity, and try it again, but this time, try skipping a step in the "digestion" process after you have set up your ingredients. What happened?

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