

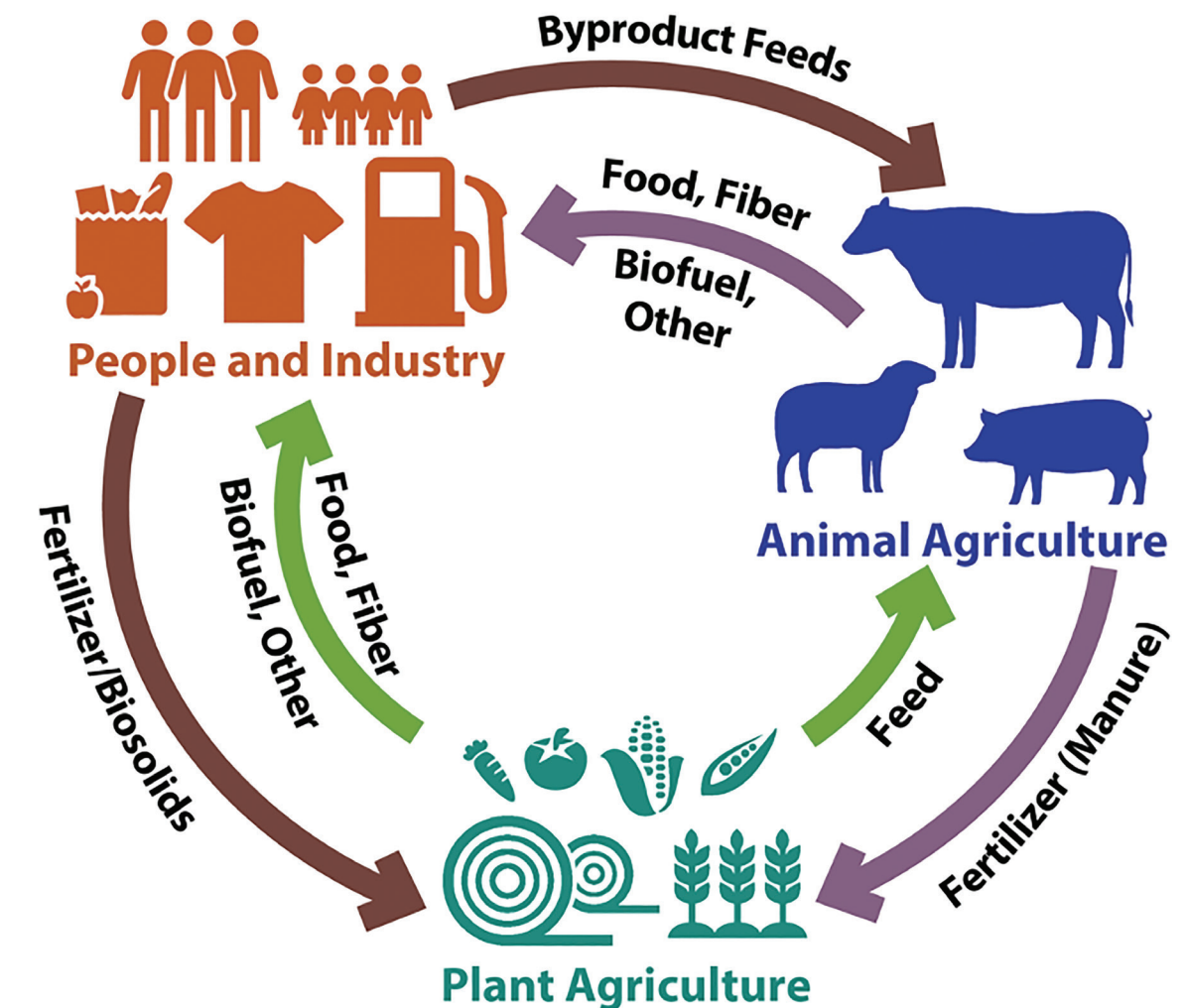


THE FOOD ECOSYSTEM

An **ecosystem** is a biological community where living organisms work together with nonliving parts of their environment, such as weather and landscape, to form a bubble of life. The living parts of an ecosystem are called **biotic** factors and include plants, animals, people, and bacteria. The **abiotic** factors are made up of nonliving components like soil, water, air, and climate. There are many different types of ecosystems.

Another way to think of an ecosystem is a complex network of interconnected parts. Every factor in an ecosystem depends on every other factor, either directly or indirectly. A change to one factor of an ecosystem can affect the other parts.

Are you part of an ecosystem? The answer is YES! Humans and the food we eat is an ecosystem. Animal agriculture and plant agriculture



Food ecosystem chart adapted from a research article by Robin R. White and Mary Beth Hall entitled "Nutritional and greenhouse gas impacts of removing animals from U.S. agriculture".

provide nearly all the products we rely on every day. Agriculture provides raw materials used for food, fiber, **biofuel**, and many other nonfood

byproducts. The environment and climate affect the plants and animals produced in the ecosystem.

Climate and Greenhouse Gases

Over millions of years, earth's climate has changed, both warming up and cooling down. Changes in climate impact the food ecosystem. **Weather** is a specific event, like a snowstorm or hot day, that happens over a few hours, days, or weeks. **Climate** is the average weather of a given location over a period of time, generally 30 years. Climate is the big picture.

The earth is heated by the sun. **Greenhouse gases** trap the sun's heat in the atmosphere. This is called the **greenhouse effect**. Trapping some heat is a good thing. It makes the earth a comfortable place to live and allows animal and plant agriculture to exist. Human activities are causing more greenhouse gases to be released into the atmosphere, changing earth's natural greenhouse effect. Too many greenhouse gases traps more and more heat, causing the earth to warm up.

Nearly all human activity contributes to releasing greenhouse gases. The U.S. Environmental Protection Agency, or EPA, tracks greenhouse gas emissions to measure the amount of these gases produced annually. The data and chart below represent the total U.S. greenhouse gas emissions by sector in 2019. *Using this information, can you fill in the chart labels?*

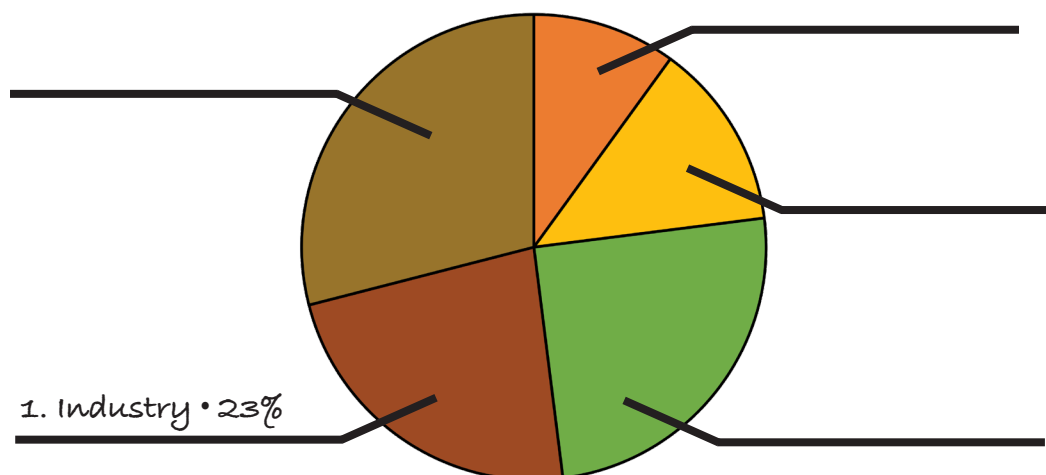
Transportation • 29% – Burning fossil fuel for our cars, trucks, ships, and planes

Electricity • 25% – Most of our electricity is produced by burning fossil fuels, much of which is coal and natural gas

Industry • 23% – Burning of fossil fuels for energy and certain chemical reactions necessary to produce the goods from raw materials

Commercial and Residential • 13% – Burning fossil fuels to heat homes and businesses, using products that contain greenhouse gases, and the handling of waste

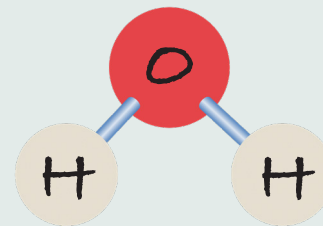
Agriculture • 10% – Emissions from crop and livestock production for food



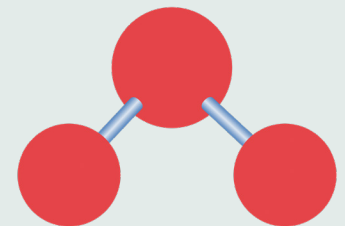
What are the Greenhouse Gases?

The main greenhouse gases and their molecular structures are diagrammed below. *Can you label each of the atoms that make up the different molecules of gases? Use the example to help get you started.*

WATER VAPOR – H₂O



OZONE - O₃



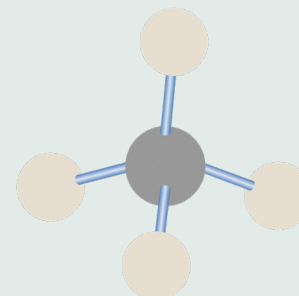
CARBONDIOXIDE – CO₂



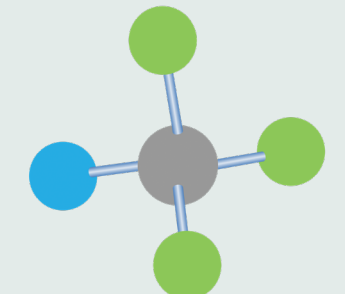
NITRUS OXIDE - N₂O



METHANE - CH₄



**CHLOROFLUOROCARBONS
- CFCs (1 C; 3 Cl; 1 F)**



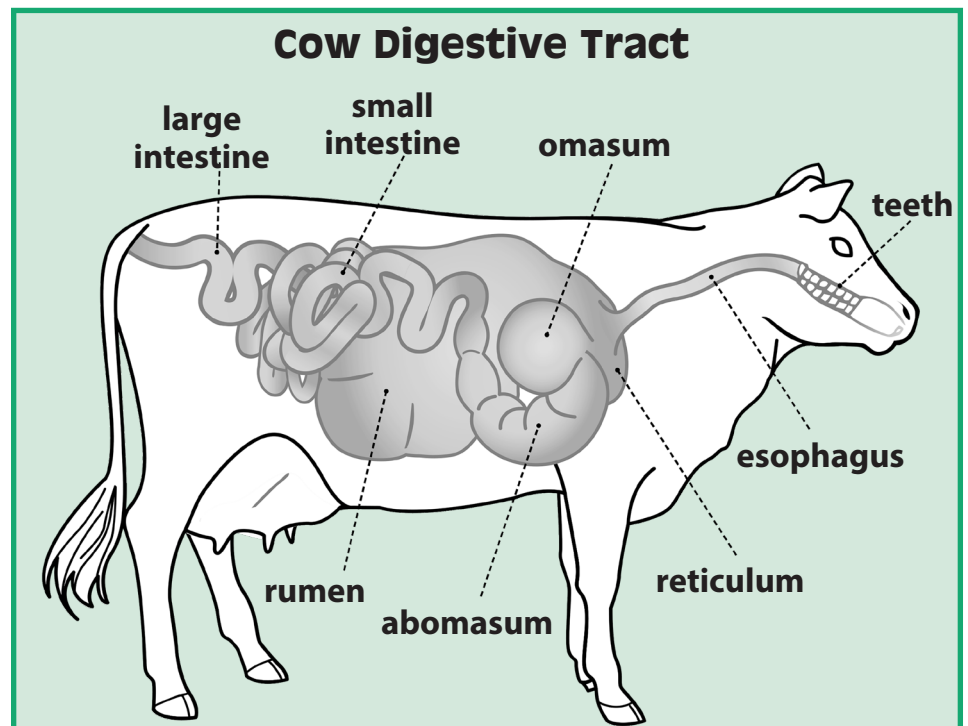
What About Cow Burps?

Beef cattle, dairy cattle, and sheep are **ruminants**, which means they have a specialized digestive tract. Deer, elk, and bison are also ruminants. Their stomachs have four compartments. The largest compartment is the **rumen**. The rumen contains microbes that allow these animals to digest carbohydrates from their feed and break them down into glucose. Glucose is fermented into several compounds, one of which is **enteric methane**, a greenhouse gas. This methane is produced in the rumen through the digestive process and then expelled through the animal's mouth. BURP!

Farmers and ranchers are concerned about methane production and have been working to reduce emissions. In fact, enteric methane emissions from cattle have decreased 34% since 1975. Changing the animal's diet, by adding corn and a small amount of fat to the feed, can lower enteric methane. Certain supplements given to animals in very small amounts can also change the fermentation process and reduce methane.

BEEF AND DAIRY CATTLE PRODUCE ONLY 2% OF TOTAL GREENHOUSE GAS EMISSIONS IN THE U.S.

Livestock, especially ruminants like beef, dairy, and sheep, play a key role in the food ecosystem. The four compartments of their stomach give them the ability to consume and gain nutritional value from feeds that other animals or humans cannot consume. Ruminant animals can **upcycle** human-inedible **byproduct** feeds like corn stalks, leftover grains from biofuel production, and unattractive or unused fruits and vegetables. They convert these by-product feeds into high-quality, high-protein products in the form of beef, lamb, milk, milk products like cheese, and other items we use in our daily lives. These byproduct feeds might otherwise go into landfills.



Fill in the blank with the correct part of the cow digestive tract.

1. Tear and chop food: teeth
2. Muscle contractions force food through this tube and into the stomach: _____
3. Good bacteria help the cow digest food and provide protein and energy: _____
4. Brings the undigested feed back up the esophagus in the form of cud, to be re-chewed: _____
5. Folds regulate flow of partially digested food to the fourth chamber: _____
6. Prepares the nutrients that are present for absorption in the small intestine: _____
7. A tube-like structure that absorbs nutrients into the bloodstream: _____
8. Removes water and minerals from the undigested matter and forms solid waste that can be excreted: _____



Undeniably Dairy

All food production is part of the food ecosystem. The environment plays an important role in that ecosystem. Farmers and ranchers work to minimize the negative effects that food production can have on the environment. Let's learn more about how dairy farmers in Colorado and across the U.S. are reducing their environmental footprint.

Colorado is home to 186,000 dairy cows. Of the state's top foods produced, dairy ranks second (behind beef cattle) with an estimated 4.8 billion pounds of milk produced each year.

Thanks to increasingly modern and new dairy farming practices, the environmental impact of producing one gallon of milk has shrunk significantly. This is because dairy farmers have better management practices improving cow comfort, cow health and nutrition, and breeding.

The dairy community is committed to conserving natural resources and making further progress. By 2050, they have set these goals: 1) Become carbon neutral or better; 2) Optimize water use; and 3) Improve water quality and soil health.

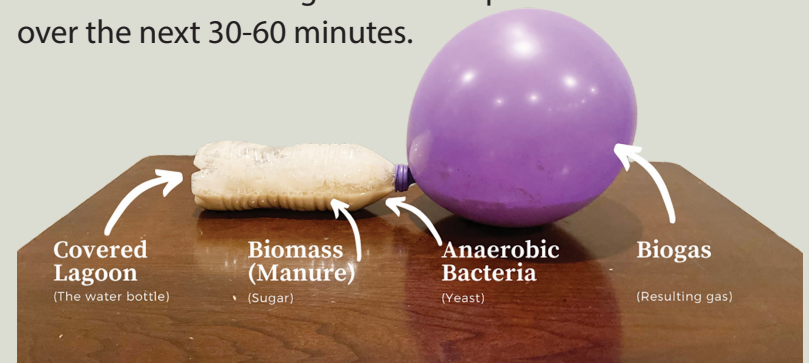
Improvements in Environmental Impact of U.S. Dairy Production		
	1944 to 2007	2007 to 2017
Water use	65% less	30% less
Land use	90% less	21% less
Carbon footprint	63% less	19% less

The Power of Poop

Did you know animal manure can be turned into useful energy? That's thanks in part to digesters, which help dairy and pig farmers make animal poop into something we can all use. Micro-organisms break down organic materials like cow and pig manure in a process called **anaerobic digestion**. This happens in a closed tank, where there's no oxygen, called a digester. On a dairy or pork farm, digesters come in a range of sizes and styles. In the digester, bacteria break down the manure, creating **biogas**. The biogas can be used for electricity, heat, compressed natural gas, and even vehicle fuel. Digesters can also create other materials, or **byproducts**, like fertilizers, compost, or even comfortable cow bedding.

Use the following steps to create a small-scale model to demonstrate the science that is taking place in a methane digester:

1. Add 1 and 1/2 cups of warm water to an empty water bottle. This represents the manure from pigs and cattle that is flushed from the barn to covered lagoons.
2. Add 3 tablespoons of yeast and 3 tablespoons of sugar.
3. Mix the water, yeast, and sugar together and place a balloon over the end of the bottle. Anaerobic bacteria (represented by yeast) are mixed with the manure, resulting in a biogas that can be used to power generators and create renewable electricity.
4. Observe the changes that take place over the next 30-60 minutes.



Let's Talk Pork

Are pork producers protecting the environment? YOU BET! Like all Americans, pork producers are concerned about safeguarding the nation's resources for future generations.

Of the 10% of greenhouse gas emissions from agriculture in the U.S., animal production is only responsible for small amount of that total. Pork farmers were responsible for about one-third of one percent or 0.33%.

Pigs are **monogastric** animals, which means they have one stomach. Their food is not fermented in the rumen as in beef cattle, dairy cattle, and sheep.

Pig farmers measure manure output on farms to preserve air and water quality, keeping farms safe and pigs healthy. Remember our food ecosystem diagram on the cover? Fertilizer in the form of manure from animal agriculture



**IN THE PAST 60 YEARS, PORK PRODUCERS
HAVE REDUCED THE PORK INDUSTRY'S
ENVIRONMENTAL FOOTPRINT BY USING LESS.**

75.9% LESS LAND

25.1% LESS WATER

7% LESS ENERGY

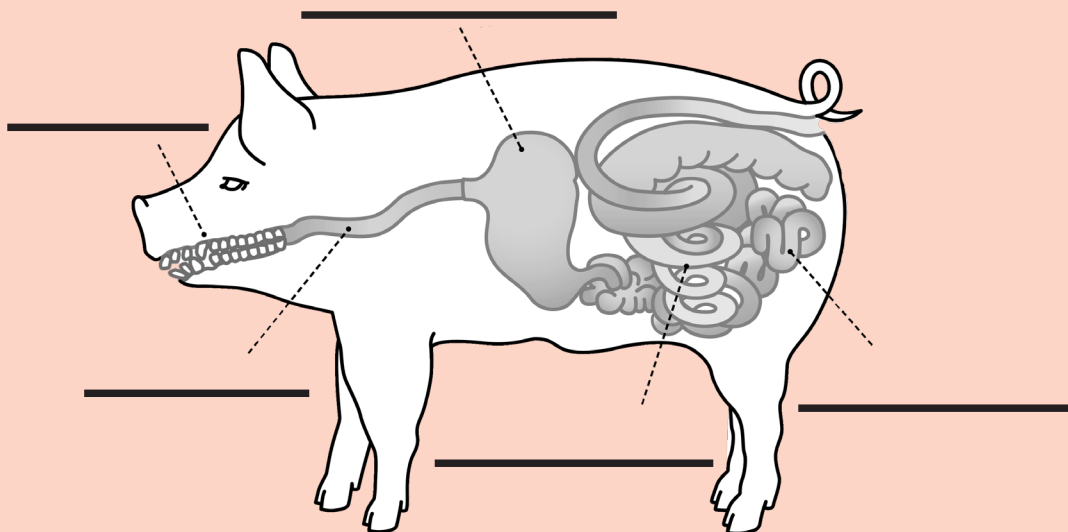
7.7% FEWER CARBON EMISSIONS

benefits plant agriculture. These plants or crops are a feed source for pigs, sheep, beef and dairy cattle. Manure is an effective, organic nutrient source for sustainable crop production.

In addition, pig farmers are using wind turbines, methane digesters, and solar panels to power their farms. Some farmers are now carbon negative and can supply energy to the

power grid for use by others in their region. Farmers also dedicate a portion of their land for natural vegetation called buffer strips and tree windbreaks. These improve air, soil, and water quality and provide wildlife habitat.

Can You Write in the Labels for the Parts of the Pig Digestive Tract?



Teeth: Tear and chop food.

Esophagus: Muscle contractions force food through this tube and into the stomach.

Stomach: Muscles mix the food with acids and enzymes, breaking it into smaller, more digestible pieces.

Small Intestine: A tube-like structure that absorbs nutrients into the bloodstream.

Large Intestine: Removes water and minerals from the undigested matter and forms solid waste that can be excreted.



Colorado Sheep and Wool

There are more than 80,000 family farmers and ranchers caring for over 6 million sheep throughout the United States. Lamb is produced in every state in the country. Colorado ranks third in the country for sheep and wool production. Fresh, local lamb is available year-round.

Before it makes it to your plate, American lamb is raised by farmers and ranchers who care for the land, their animals, and their local communities. Sheep are a natural, low-cost way to protect the environment. Sheep have pointed hooves which break up the soil so seeds can find a place to grow. They eat woody and broadleaf plants as well as tall weeds and grasses. The U.S. Forest Service uses sheep in firefighting. Fires need fuel to burn. Sheep eat the underbrush, or fuel, in forests and other areas. This means there is less fuel to burn in the fire and makes fires easier to control. Controlled livestock grazing is used to improve habitats for wildlife.

Sheep produce wool, a **renewable resource** because it grows back every year. Sheep must have their wool removed once a year because they do not shed it like other animals shed their hair. This process is called **shearing**. Shearing does not harm the sheep. Wool is a natural fiber that has many uses and benefits.

Protecting Sheep from Predators

If unprotected, sheep are vulnerable to many predators such as coyotes, foxes, wolves, mountain lions, bears, and domestic dogs. Sheep are vulnerable to predators because they are defenseless. They have no way of protecting themselves. Sheep run when something frightens them. Their only protection is to stay together in a group.

Livestock protection dogs are used to protect sheep from wild animals. The protection dogs stay with the sheep day and night and scare wild animals away. Some livestock protection dogs are the Akbash, Great Pyrenees, and Anatolian Shepherds. Without these protection dogs, thousands of sheep and lambs would be injured or killed by predators in the U.S. every year. Sheep producers are required to follow state and federal laws that protect the overall predator population, but can remove the offending predator that is attacking the sheep.

Everything But the Moo, Oink, and Baaa

When we think of animal agriculture, we often think of cattle, pigs, and sheep being raised for food. But animals are used for more than meat, and they play a huge role in our everyday lives, even when we have no clue.

Animals provide different chemicals, compounds and materials that can be used to make everyday items.

These items are called **byproducts**. A byproduct is something produced in the process of making the main product. For instance, about 99 percent of an animal can be used for meat and more. Now that is ensuring nothing goes to waste! Here are seven sometimes surprising ways animals contribute to our lives.

1. Clothing - One of the most visible uses is in our clothes and shoes. Animals give us leather, wool, and other fabrics to wear. They also show up in our upholstery and other home décor.

2. Cosmetics and Beauty Products - Animals play a big role in many of our daily beauty regimens. Collagen, lanolin, keratin, and hyaluronic acid all come from animals. These components can help smooth and strengthen our skin, hair, and nails.

3. Sports Equipment - You've probably heard the term "pigskin" for a football. The nickname traces back to the late 1800s, when certain animal

parts were used to make balls. However, today footballs are made from rubber or leather, which are also used in other sporting equipment like baseball gloves.

4. Jelly and Gummy Candy -

These are just a couple of examples of things we eat that use gelatin, which comes from animals. Gelatin is known for its jelly-like consistency. Gelatin is made from collagen and can also be used for medicinal purposes to make capsule casings for pills.

5. Medicine - Chemicals produced by animals can be used in our medications. Animals also provide materials to help make valves for grafts, including for human hearts, and to treat burns!

6. Adhesives - Collagen has adhesive properties and is often used to make glue for woodworking and even sandpaper (where the coarse and smooth papers must be tightly bonded). Another animal byproduct - casein - is a milk protein often used to make cheese, but it can also be used in glue, paint, and materials to repair our teeth.

7. Plastic - Stearic acid is used in a variety of products, including plastic. Stearic acid has a waxy texture and is treated for use in PVC products as well as plastic bags. (Tallow, which is used in candles and cosmetics, contains stearic acid.)

True or False?

Do the products listed below come from animal agriculture? Write true next to the products you think come from cattle, pigs, or sheep and false next to the ones that you don't think come from these animals.

- _____ 1. Heart valves
- _____ 2. Paints
- _____ 3. Chewing gum
- _____ 4. Paper
- _____ 5. Cosmetics
- _____ 6. Wood fence boards
- _____ 7. Salt
- _____ 8. Deodorant
- _____ 9. Instrument strings
- _____ 10. Fertilizer
- _____ 11. Plastics
- _____ 12. Rubber
- _____ 13. Footballs
- _____ 14. Bacon
- _____ 15. Carrots
- _____ 16. Yarn
- _____ 17. Baseballs
- _____ 18. Lamb chops
- _____ 19. Concrete
- _____ 20. Artists' brushes
- _____ 21. Pork chops
- _____ 22. Drum heads

Meat and Milk Are Nutrient Dense

Animals can utilize nutrients and energy from food that humans cannot digest. Beef cattle, dairy cattle, pigs, sheep, and other animals convert and utilize energy to produce food (meat and milk) that humans benefit from. Meat and milk are **nutrient dense** meaning they provide more nutrients our bodies need than they provide in **calories**. These foods are full of protein along with essential vitamins and minerals. Many of the nutrients found in meat and milk cannot be found in other foods.

Beef provides our bodies with essential nutrients like protein for muscle strength, vitamin B12 for brain function and energy, zinc for a strong immune system, and iron to carry oxygen to all parts of the body. There are more than 38 cuts of beef that are considered lean. This means they contain less than 10 grams of total fat, 4.5 grams or less of saturated fat, and less than 85 grams of cholesterol per every 3 ounce serving.



Confetti Beef Tacos
Find this recipe and more at BeefItsWhatsforDinner.com

Lamb is naturally nutrient rich. It's packed with many essential nutrients. Lamb is an excellent source of protein, zinc, selenium, riboflavin, niacin, vitamin B12, and vitamin B6. Eating lamb supports a strong immune system. On average, a 3 ounce serving of lamb is lean and has only 160 calories.



Philly Cheesesteak Lamb Sliders Find this recipe and more at AmericanLamb.com

Pork has many beneficial nutritious qualities. Pork is naturally low in sodium and a good source of potassium - two nutrients that when eaten together can help regulate blood pressure. Pork is also packed with protein, making it easy to include in a health-forward and balanced diet. Both the pork tenderloin and pork sirloin roast meet the criteria to be considered lean.



Grilled Pork Tenderloin Skewers Find this recipe and more at Pork.org

Dairy products like milk, cheese, and yogurt each contain 13 essential nutrients your body needs. They contain protein, calcium, and vitamin B12. These nutrients help muscle, bones and teeth, and the nervous system stay strong and healthy. Also, protein, zinc, selenium, and vitamins A and D are found in every cup of milk and help support a healthy immune system.



Best Grilled Cheese
Find this recipe and more at USDairy.com



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