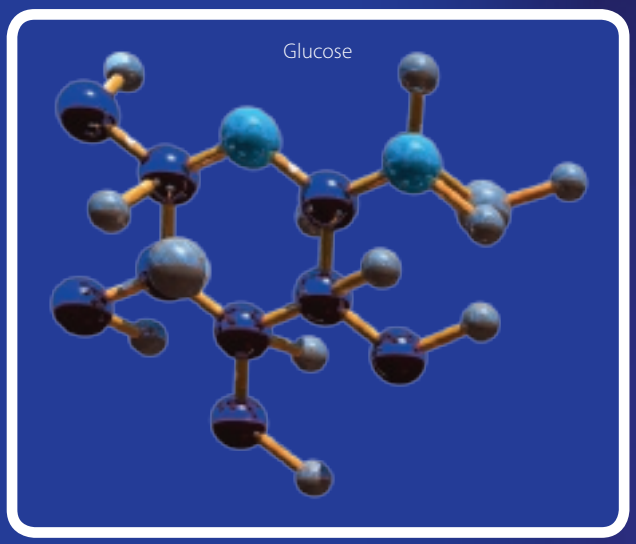
Core Knowledge® SCIENCE

Metabolic Reactions:

How do things inside our bodies work together to make us feel the way we do?


Science Literacy

Science Literacy Student Reader


Glucose


Human Body Systems

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Metabolic Reactions

Science Literacy Student Reader



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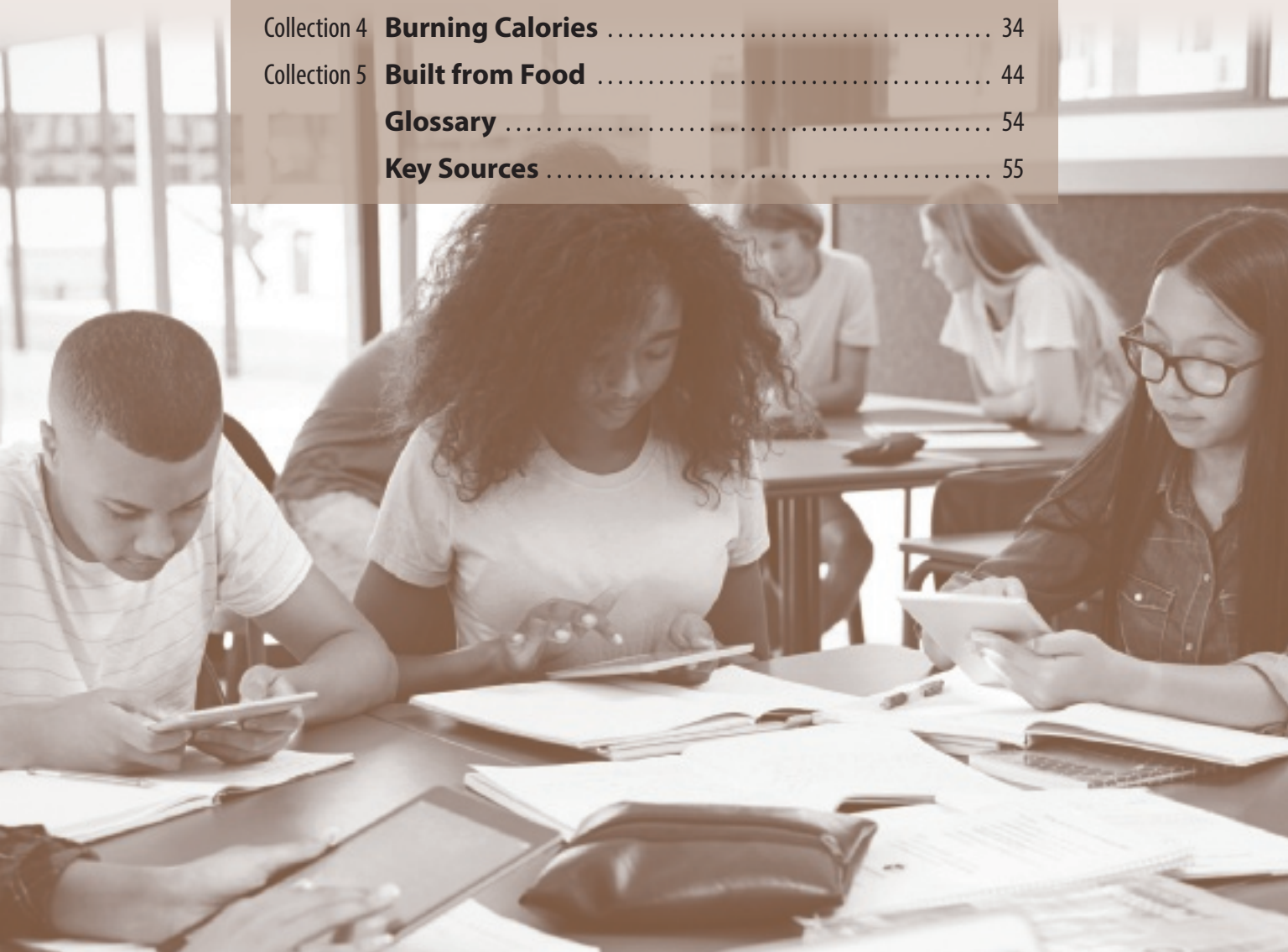
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Metabolic Reactions

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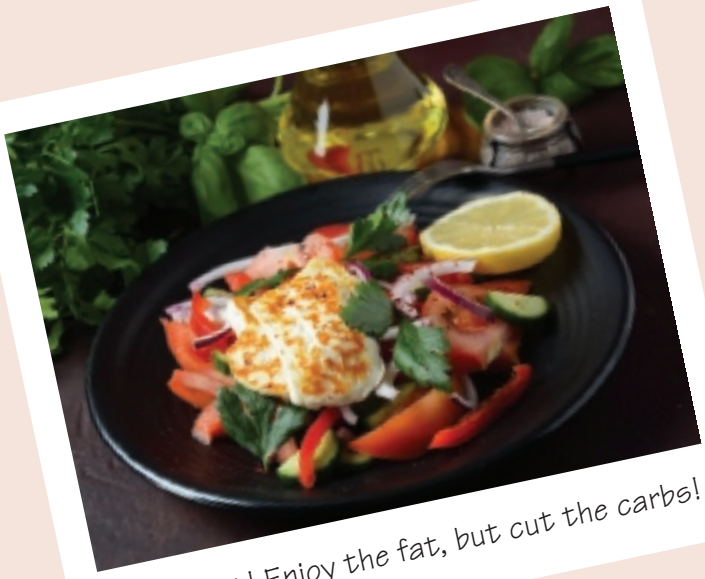
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Put Yourself in This Scene

Everyone needs to eat. Many people love to eat. A lot of people also want to look a certain way. These demands and interests create huge markets for food as well as diets. *Don't eat fat! No, fat is fine, but don't eat meat! No, actually, meat is fine as long as you don't eat carbs*! One day a food seems great for you, and the next day it's not.

It seems like food and diet advertisements are everywhere! How can you know what's true and what's false? How can you apply the information to your own life?



Keto Diet! Enjoy the fat, but cut the carbs!



Go Paleo: Why eating like your Neanderthal ancestor might save your life!



Carb-Loading: A Marathoner's Menu



The Mediterranean Diet

That's what this book is about—scientific literacy, which means knowing how to think about science topics that you read or hear about. Our world has 24–7 news, social media, and too many websites to count. The amount of information we have to sort through is overwhelming, and all the information is not reliable. In the internet age, sources of information are often obscure or not trustworthy. It is good to process information with a healthy degree of skepticism.

We will make our way back to various topics around food and diets by the end of the book. Along the way, the series of reading selections and the writing exercises that go with them will help you flex your mental muscles and sharpen your science literacy skills. The ability to read about science, understand the information, and tell truth from fallacy or misrepresentation is really important. Science literacy helps you as an individual and as a consumer, and it shapes the ways you affect the community in which you live.

The Piscivore's Plate



Get the truth about high-fat diets!



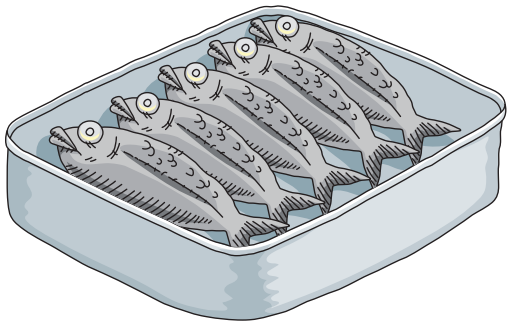
Going Gluten Free?



Good Cholesterol vs. Bad Cholesterol



Fish Oil Fraud?



"Healthy" Body Weight

Determining if someone's weight is healthy or unhealthy isn't as simple as labeling anything over *X* pounds as "overweight" or under *Y* pounds as "underweight." The primary reason for the difficulty is the wide range in height and body types among humans. Some healthy adults are under five feet tall. Others are over seven feet tall. There is weight in simply being taller. Longer bones, wider muscles, and larger organs all add to a person's weight. A seven-foot professional basketball player weighing 250 pounds is likely to be considered neither overweight nor underweight, while a six-foot person who weighs the same could be considered overweight or obese.

To adjust to the differences in body types, the Centers for Disease Control and Prevention (CDC) uses body mass index (BMI) to estimate whether someone's weight is potentially unhealthy.

You can use the table below to see how height and weight yield a BMI measurement. For example, look for the height in inches of a 5'8" person in the first column: 68. Then find the weight, 177, to the right in that row. Move up from that 177 to the top of that column. That number, 27, is the BMI for a 5'8", 177-pound adult.

What does a BMI of 27 mean? The CDC translates the raw numbers into useful information like this:

<18.5 = underweight

18.5–24.9 = normal, healthy weight range

25.0–29.9 = overweight range

30.0+ = obese range

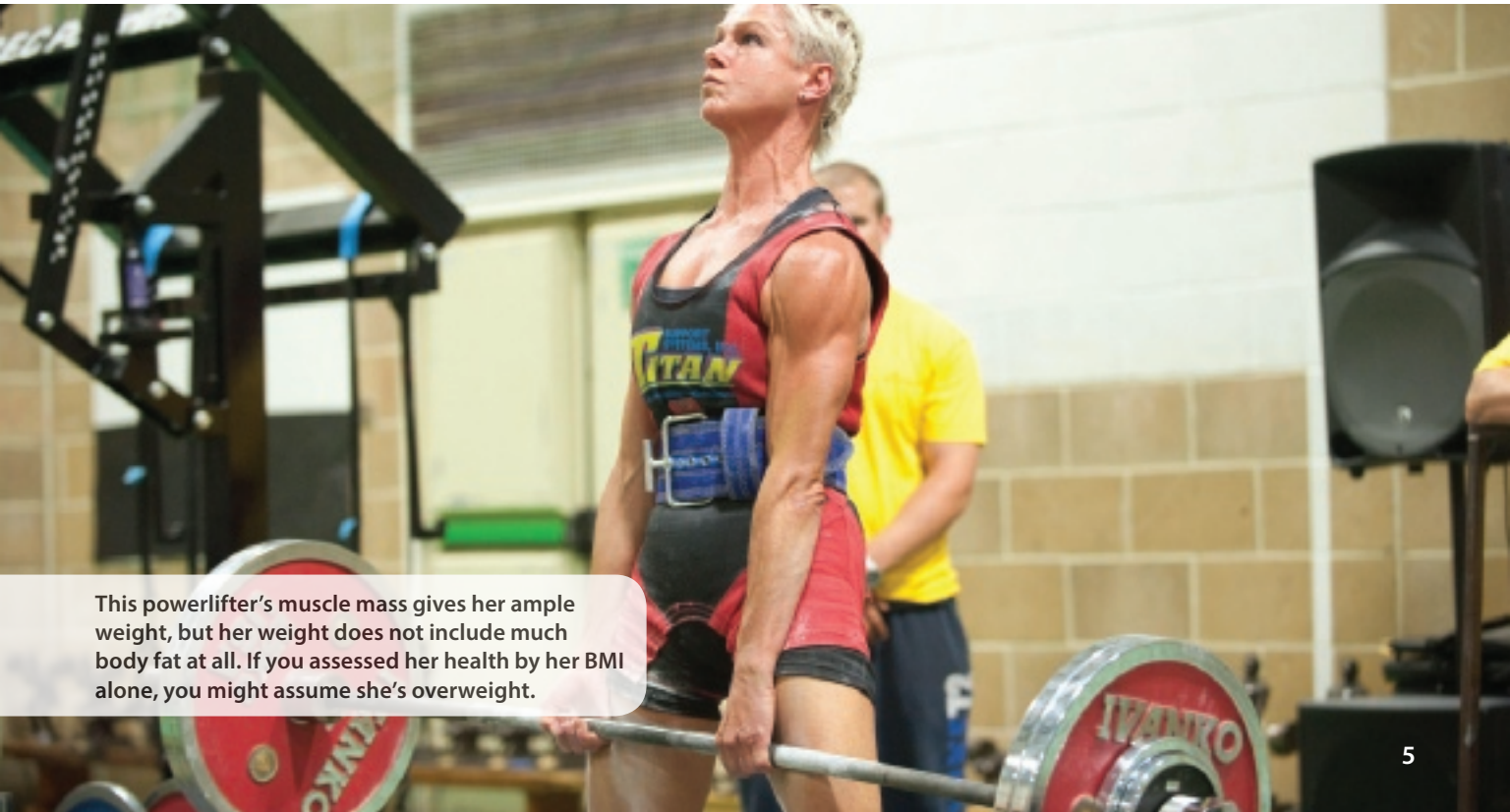
BMI	21	22	23	24	25	26	27	28	29	30	31
Adult Height (inches)	Adult Body Weight (pounds)										
58	100	105	110	115	119	124	129	134	138	143	148
59	104	109	114	119	124	128	133	138	143	148	153
60	107	112	118	123	128	133	138	143	148	153	158
61	111	116	122	127	132	137	143	148	153	158	164
62	115	120	126	131	136	142	147	153	158	164	169
63	118	124	130	135	141	146	152	158	163	169	175
64	122	128	134	140	145	151	157	163	169	174	180
65	126	132	138	144	150	156	162	168	174	180	186
66	130	136	142	148	155	161	167	173	179	186	192
67	134	140	146	153	159	166	172	178	185	191	198
68	138	144	151	158	164	171	177	184	190	197	203
69	142	149	155	162	169	176	182	189	196	203	209
70	146	153	160	167	174	181	188	195	202	209	216
71	150	157	165	172	179	186	193	200	208	215	222
72	154	162	169	177	184	191	199	206	213	221	228

Okay, so an adult BMI of 27 means overweight, right? Well, not exactly. Because BMI calculations are based on average builds, they can be misleading. Muscle is denser than fat, so having a lot of muscle mass might skew a person's BMI upward. Even people with normal BMIs might develop health problems if they have excess fat near major organs in their abdomen. Because of this and other factors, physicians and nutritionists take other measurements of a person's physique to better assess their body mass.

Body fat percentage can be estimated using calipers or by comparing a person's weight in water and out of water. It can also be estimated by passing a small current of electricity through the body. None of these measurements are foolproof. That is why it's important for a person's perception of their health to be based on a variety of observations, not just one or two numbers.



These calipers measure how much skin and body fat can be pinched at various sites on a person. This measurement yields a rough estimate of body fat percentage.



This powerlifter's muscle mass gives her ample weight, but her weight does not include much body fat at all. If you assessed her health by her BMI alone, you might assume she's overweight.

What Gets Lost in Weight Loss?

Debate: Can a wrestler regain ten pounds by drinking a glass of water?

College soccer teammates Scott, Stephen, and Andy are having dinner after a tough practice. Stephen has gone back to the beverage dispenser multiple times to refill his juice glass. He and his twin brother Andy reminisce about their days as high school wrestlers.

Andy: Stephen, remember when we wrestled how we would lose *so* much weight at practice? Way more than we do in soccer. Seriously, I dropped ten pounds at some practices.

Stephen: Same here. But then we'd go home for dinner. Mom would give us a meal, and we'd drink a glass of water and—bang—all the weight would be back on.

Scott is a science major, and this story is not making sense. The Law of Conservation of Matter seems to have been broken, if Stephen and Andy are to be believed.

Scott: Guys, are you saying your mom made you nine-pound dinners? And you drank one glass of water, and this somehow added up to ten pounds? That's not possible.

Andy and Stephen (in identical-twin unison)**:** It's true!

Scott: No! You can't lose ten pounds and then put that weight back on a few hours later without taking in ten pounds' worth of stuff. You probably had a big meal and drank a gallon of water. A gallon of water is eight pounds by itself!

Stephen: Scott, we know you're a chem major and all, but we wrestled for four years and we know what we're talking about! It was one glass of water, plus dinner!

Scott: Okay, go to Professor Zimmer in your Intro to Chemistry class tomorrow, and ask him if what you're saying is physically possible. If I'm right and you're wrong, you both owe me a tuna melt from the snack bar on Friday after the game. If I'm wrong, I'll eat a pound of raw onions.

Stephen and Andy: You're on! Your breath is going to be *so bad!*

What do you think? Is it possible that the twins gained back all of their weight loss from just one meal and the water?

The next day, in the chemistry building . . .

Stephen: Hi, Professor Zimmer. Please settle a bet. When we wrestled in high school, we would lose ten pounds at practice and then put all that weight back on with dinner and one glass of water. Our friend Scott says we're wrong. What do you think?

Professor Zimmer: I'm sorry, but that's impossible. You would need to ingest some combination of food and drink that adds up to the weight that you had lost. Your body cannot create matter from nothing.

That Friday, the twins each buy Scott a tuna melt on rye. He ate it all in one sitting, adding one pound and three ounces to his body weight!

The quickest but not always the safest way to lose weight is to lose water. The human body is, by mass, about 60% water. That percentage is even higher in infants. Where is all this water? Two-thirds is in cells. The other third is in extracellular fluids, including urine, lymph, and blood plasma, the liquid that carries red and white blood cells throughout the body. Some tissues and organs have more water than others. The brain is about 73% water. For muscles and kidneys, it's 79%. As you might expect, bones are less watery but are still 31% water.

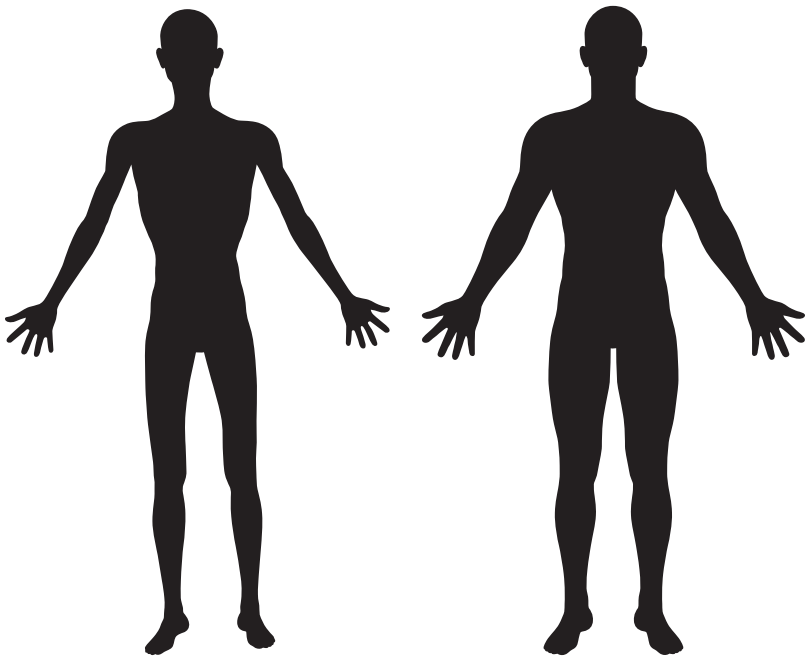
You release water all the time. It's exhaled when you breathe. It seeps out of sweat glands when you're hot or exercising. Your excretory system sends it out of your body when you use the bathroom. A person's weight can fluctuate by pounds within a single day just by increasing the amount of water that leaves the body. A wrestler, for example, might need to "make" or "cut" weight to be eligible for a match. That means the wrestler needs to gain or lose weight in a short period of time to qualify for a certain weight class. A wrestler who needs to lose weight might go for a long run while wearing hot, heavy clothing. Miles later, the wrestler might have sweated and breathed out anywhere from two to ten pounds of water. Some wrestlers take things too far and put their own health at risk to cut weight. Wearing rubber suits during heavy exercise and taking dehydrating drugs are concerns in the sport.



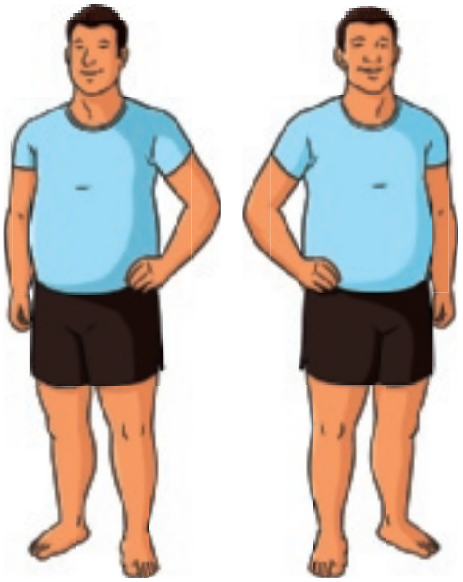
The second way to lose weight is to lose muscle mass, although this takes much more time than losing water weight. Any person can see a decline in the size of their muscles if they are physically inactive for a long period of time. Muscles that are not used will shrink and atrophy. This occurs when the proteins that make up muscle break down faster than the body can make them. Some illnesses can lead to muscle atrophy. A diet that is very low in protein can also make it difficult for a person to maintain their muscle mass, even if they are getting enough food overall.

Some people deliberately gain or lose muscle mass to alter their appearance. In 2005, the actor Christian Bale appeared in two feature films looking very different. To play the lead in the *The Machinist*, Bale lost sixty pounds in just four months by living on a diet of canned tuna and apples. He lost whatever fat he had but also muscle. To bulk up for the role of Batman, Bale gained a hundred pounds, much of it muscle. To do this, he ate protein-rich foods and lifted weights. This kind of rapid loss and gain of weight is not advisable, nor do most people attempt this sort of thing. A doctor carefully monitored these kinds of weight changes.

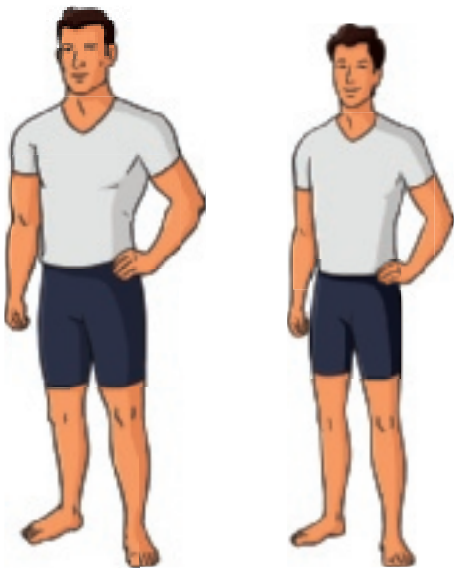
The process of aging can also lead to a loss of muscle mass. After age 30, a person can expect to lose about 5% of their muscle mass per decade. Part of the reason may be a decline in activity, but it's also a function of an older body not being as good at breaking down proteins in foods. To combat the general trend of losing muscle as one ages, it is recommended that people use resistance training (lift weights, use resistance bands, or do body-weight exercises) and consume more protein.



Another way of losing weight is to slowly and safely shed fat. This method is between water weight loss and muscle wasting in terms of speed. Unlike water and muscle, fat is used as an energy source. The key is reducing food intake while maintaining a healthy diet so that your metabolism taps into body fat to get the energy it needs. Diet and exercise, especially resistance training, can lead to a loss of fat and a gain of muscle mass, for a net weight loss that is less than the amount of fat lost.



Starting weight	300 lb	300 lb
Fat loss	100 lb	100 lb
Muscle gain	30 lb	3 lb



Finishing weight	230 lb	203 lb

Word to Know

A *net* total or number is what is left after multiple factors add to or subtract from some kind of amount.

Weight Loss Bunk and Junk

Hey. I'm sick of my flabby thighs. Gonna order this thing. Looks easy enough. Can use while I watch TV. LOL.



My cousins had one of those! I remember them exercising with it.

Did it work? I always thought they looked very fit.

IDK. Let me ask. I'll text you when I hear back.

They said it made their thigh muscles stronger but didn't make their thighs slimmer. Maybe a little more toned?

I figure if the muscles are being worked, the fat that's covering them will be burned.

Makes sense. Maybe I'll see if they still have that contraption.

Bro. I need to turn my two-pack into a six-pack, or maybe even an eight. Too much pizza.

Don't be so hard on yourself. I'd say you have a solid four-pack. Cutting the pizza and other stuff would help.

There's this dude at the gym who has like 2% body fat. He does about 40 minutes of ab work. I think he has a 10-pack. It's like his abs have abs. He might as well be this, but with skin:



I figure if I start with half of what he does, I'll be on the right track.

Can't hurt, I guess. But does that guy ever eat?

Spot the BS

Heads up! There's some **b**ad **s**cience on these pages. The idea that exercising a certain part of your body might lead to fat loss in that same part is a myth. Stored fat must be broken down into glycerol and fatty acids before it can become energy. The bloodstream distributes these by-products far and wide in the body. When the body needs to "burn" fat, any of the body's fat cells can be called into action. How muscular a person appears does depend, to some extent, on muscle mass and tone, but it's largely a function of having very little body fat. Someone can spend hours on abdominal muscle exercises, but if they don't burn off belly fat, those strong abs will not be visible.

Clues About Weight Change

Unexplained weight changes are sometimes a sign that a person's digestive system is not working as it should. Physicians need to see inside the body to diagnose the problem. *Endoscopy* is the use of various technologies to see inside a person's body using cameras or "scopes" of some type. Endoscopies are often prescribed to figure out what might be causing weight loss or to identify the source of bleeding or discomfort in the intestines. As technology advances, more techniques and devices are added to the endoscopic toolkit.

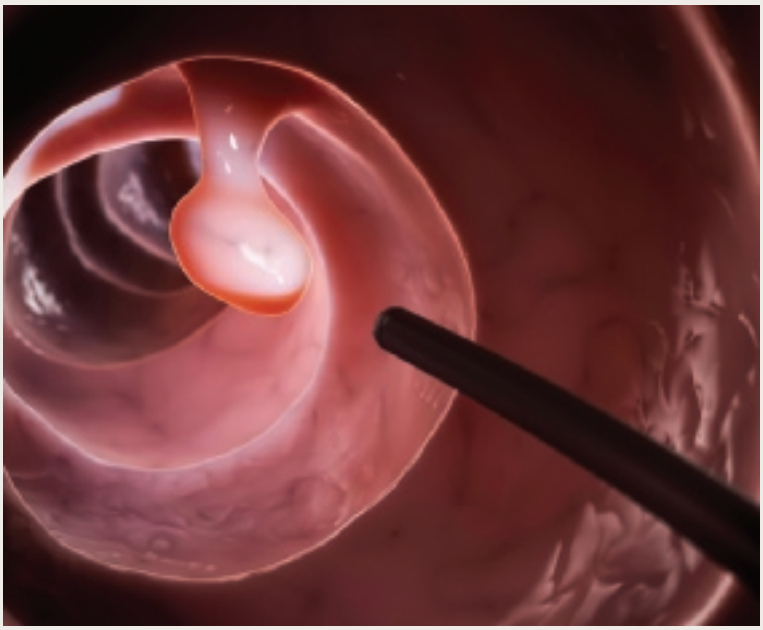
Upper Endoscopy

An upper endoscopy investigates the upper digestive tract. A camera is mounted on a flexible, snakelike tube with a camera and light mounted on the end. Various tools, such as a tiny grasping device, may also be attached to the endoscope. The tube is inserted into the patient's mouth and throat, down into the esophagus, stomach, and first part of the small intestine. Air is pumped into the stomach to make it easier for the endoscope to illuminate and view the inside of the stomach and intestines. Depending on what the physician sees, tissue samples can be taken or minor surgical procedures can be completed, with the endoscope serving as the window into the patient's digestive tract.



Colonoscopy

A lower endoscopy is known as a colonoscopy. The endoscope that is used is similar to the one used in an upper endoscopy. It is inserted through the anus and rectum and then maneuvered through the U-shaped colon after air is pumped in to give the colonoscope's camera a broader view of the interior of the colon. If an unusual growth is found, a sample can be taken, and in some cases the growth is fully removed. Such growths can develop into colon cancer. For this reason, colonoscopies are now prescribed to most middle-aged adults as a preventive screening.



Capsule Endoscopy

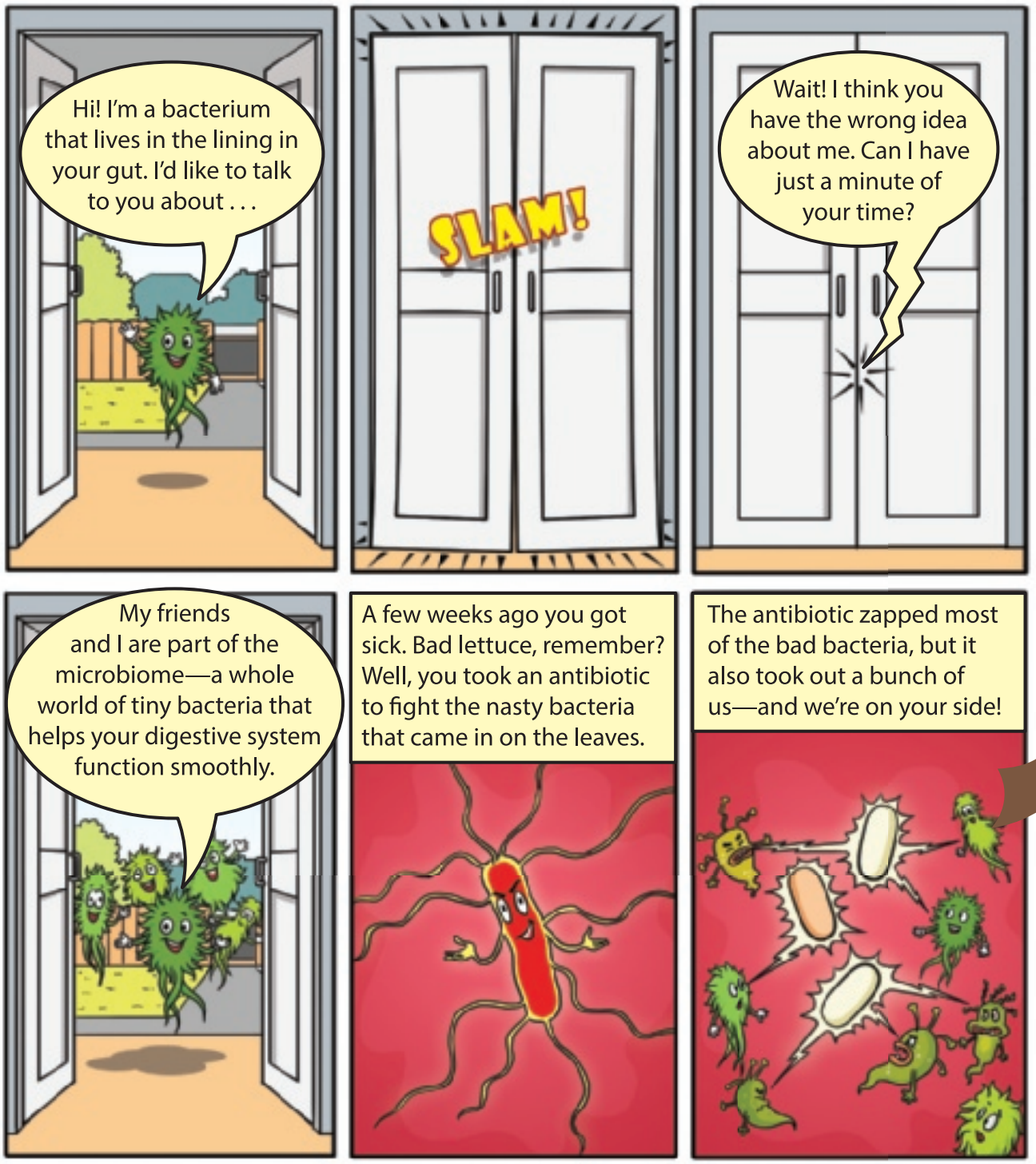
Endoscopic surgery probably sounds quite unpleasant to you. Fortunately, a less invasive procedure is now possible thanks to the invention of the capsule endoscope. This is a wireless, pill-shaped camera that can be swallowed by the patient. It takes hundreds or thousands of photographs inside the digestive tract. The capsule does not need to be retrieved. Instead, the image files are sent wirelessly to a recorder worn by the patient for about eight hours as the capsule works its way through the patient. The recorder is returned to the physician for analysis of the images, and the capsule is eventually excreted.



Connection

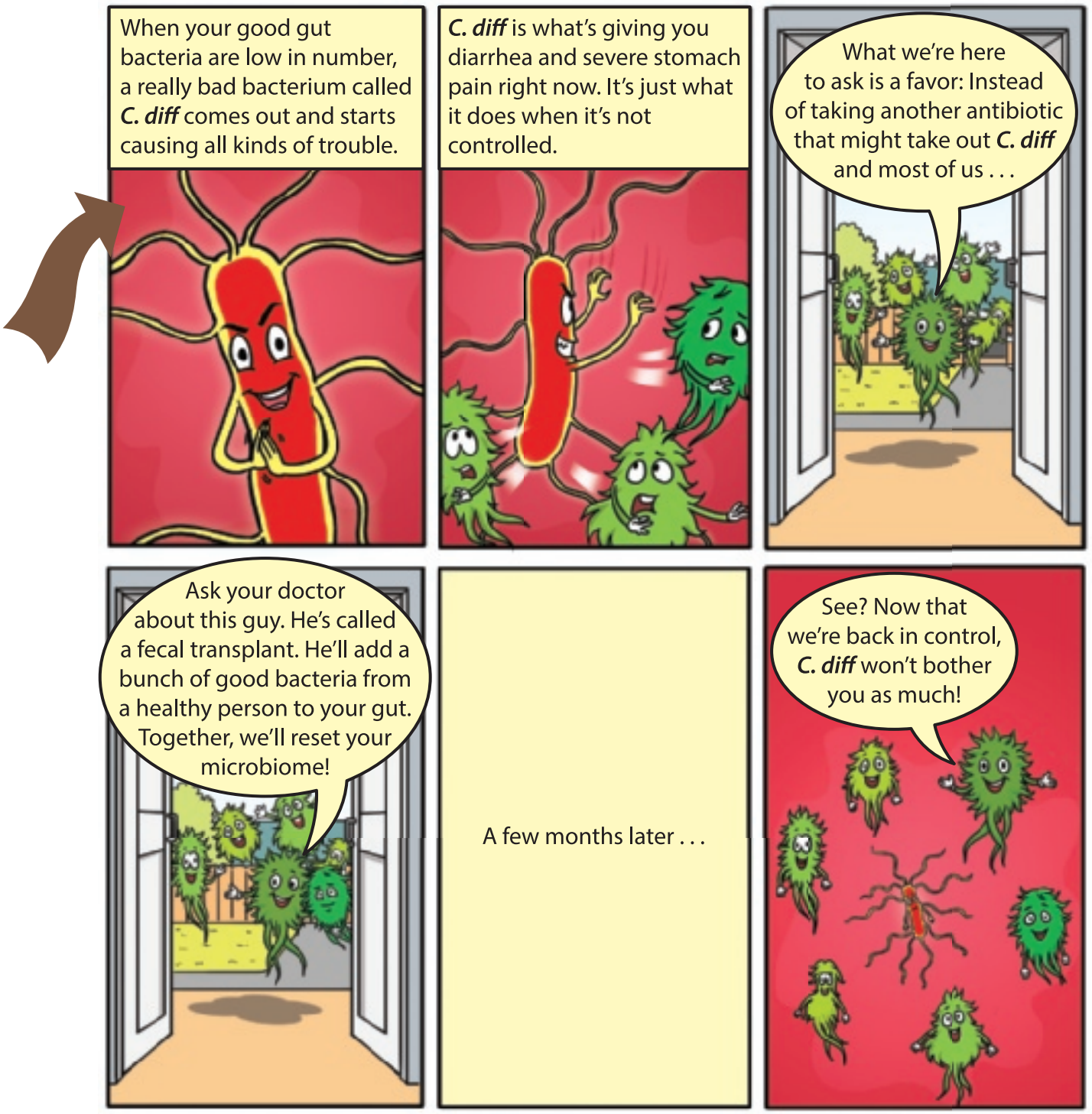
The capsule endoscope is one of many modern digital cameras made possible by advances in small-scale lenses, microchips, and high-capacity memory cards. Each of these are vital components. Wireless technology allows the capsule endoscope to be disposable.

Microbiome Balance



Word to Know

A *biome* is a large, natural community of organisms that occupies a habitat.



Poop Science





North Atlantic right whales are endangered. In a race to save this species, scientists collect their poop, which is orange and greasy and easy to spot on the ocean surface. Small samples are then analyzed for hormones that indicate whether the whale was stressed, hungry, or well-fed.

Another large ocean animal, the whale shark, releases plumes of poop that are twenty feet long. Shark researchers think that analyzing samples of shark poop can help them know exactly what these animals are eating, which in turn can reveal where they have been.



Mammal poop is often called *scat.* Scientists can tell from the scat in an area which animals live there. From this sample of bear scat, a researcher can extract DNA to study the local population. The scat can also tell what the bear's been eating. Hard seeds in the scat mean the bear has been eating berries. Fish bones might indicate the bear gorged on salmon.

Sometimes the study of animal poop mixes with the study of rock and Earth's history. The island nation of Nauru in the center of the Pacific Ocean is made of limestone, the remains of an ancient coral reef. The island also has large amounts of phosphate. The phosphate accumulated on the island over thousands of years because of bird poop that became fossilized. Because phosphate is a very effective fertilizer, Nauru was strip-mined of this resource—80 million tons of it—leaving the landscape scarred and degraded.







Paleontologists can learn about the diets of ancient animals, including dinosaurs, by studying fossilized feces called *coprolites*.

Insects poop, too. Their poop is called *frass*. Some insects use frass to signal to others of their kind that it's time to mate. Others use their own poop to help their young. When a female stink bug lays her eggs, she excretes a layer of frass on them. When the young hatch from the eggs, they eat the poop and get helpful gut bacteria from the mother.



Civets are small, catlike mammals native to Asia and Africa. Most are omnivores, meaning they eat both plants and animals. A plant product consumed by one type of civet is the fruit of coffee plants. The seeds, or beans, inside coffee fruits are slightly altered by the chemicals in the digestive system of the civet and then pooped out. Beans are plucked from the scat of wild civets and sold for very high prices. The coffee made from these beans is less acidic than normal coffee. Unfortunately, in some cases civets are being captured and held in cages, with coffee fruit as their only food, to produce this special coffee.



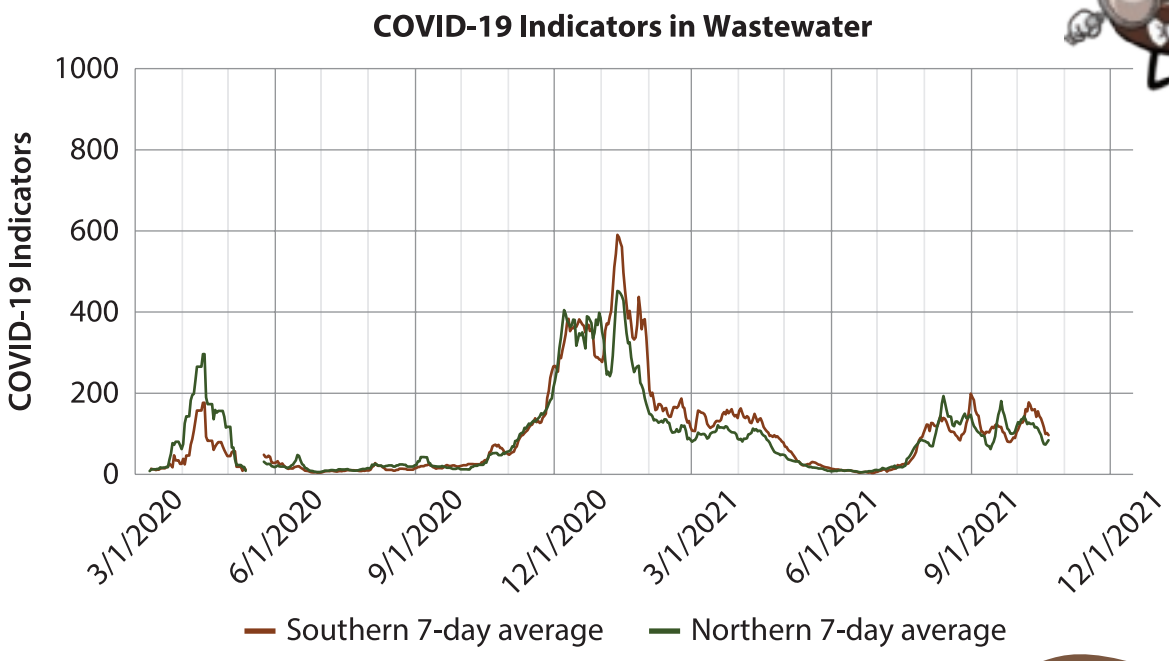


Earthworms are important for developing and maintaining soil all over the world. In one acre of land, earthworms produce tons of worm poop, called *castings*. The castings recycle nutrients back into the soil. Some people keep a worm composting box in their yard. Adding worms turns decomposing banana peels and coffee grounds into rich compost for gardening.



Human poop can be analyzed to determine whether someone carries parasites. Sewage from a city can be analyzed for signs of communicable diseases. The COVID-19 virus, for example, can be detected and measured in sewage. At the Deer Island Treatment Plant near Boston, Massachusetts, sewage from Boston and nearby towns is processed so the water can be recycled. Samples of this water were tested for the presence of the virus. The graph shows sample data. Peaks on the graph correlate with when the numbers of known COVID-19 cases were highest in the Boston area.





Feed Conversion Ratios

Raising animals to produce meat, milk, or other products can be a good way to make a living, but it requires an investment in land, food, and other costs. You need to have some idea of how much you'll need to put into each animal to get the desired amount of product out of it. Feed is a big component of that calculation. One way that farmers think about this is to use a feed conversion ratio, or FCR. A low ratio means the animal's digestive system is very good at converting its food into growth or production of the desired human food product, whether that's the flesh of the animal or it's something else, such as milk. The table provides FCRs for some animals that are raised for human consumption. FCRs are based on dry feed weights. For example, dry hay rather than wet grass is measured to calculate the FCR of cattle.



Grass-fed cattle need lots of space to graze in summer. In winter, they feed on straw and grain. Much of the fibrous food they consume comes out as manure.

Animal	Feed type	Product	FCR
Cattle	grasses, grain	meat	6:1
		milk	8:1
Pig	fruits, vegetables, grains	meat	1:1 as piglet; 3.5:1 when in 200-pound range or above
Lamb	grain, soybeans, grasses	meat	4.5:1
Chicken	grain, fruit, vegetables, insects	meat	2:1
		eggs	2:1
Rabbit	grasses	meat	3:1
Atlantic salmon	fishmeal (fish oil and other fish parts)	meat	1.5:1
Catfish	soybean pellets	meat	2:1
Crickets	fruit, vegetables, grain	whole cricket	1:1



A piglet's metabolism is so efficient that it adds almost as much mass to its body as it takes in. The piglet's mother, on the other hand, has a higher FCR.



A lamb fed concentrated, manufactured feed has a low FCR. If the lamb were to graze on grass, the FCR would be many times higher.

Connection

There are other costs in farming. Cattle eat a lot of food and need space, but they also emit a lot of methane—a powerful greenhouse gas—and consume a lot of water. Salmon farming requires pens to contain them if the farm is in the ocean or large, constructed pools if the farm is on land.



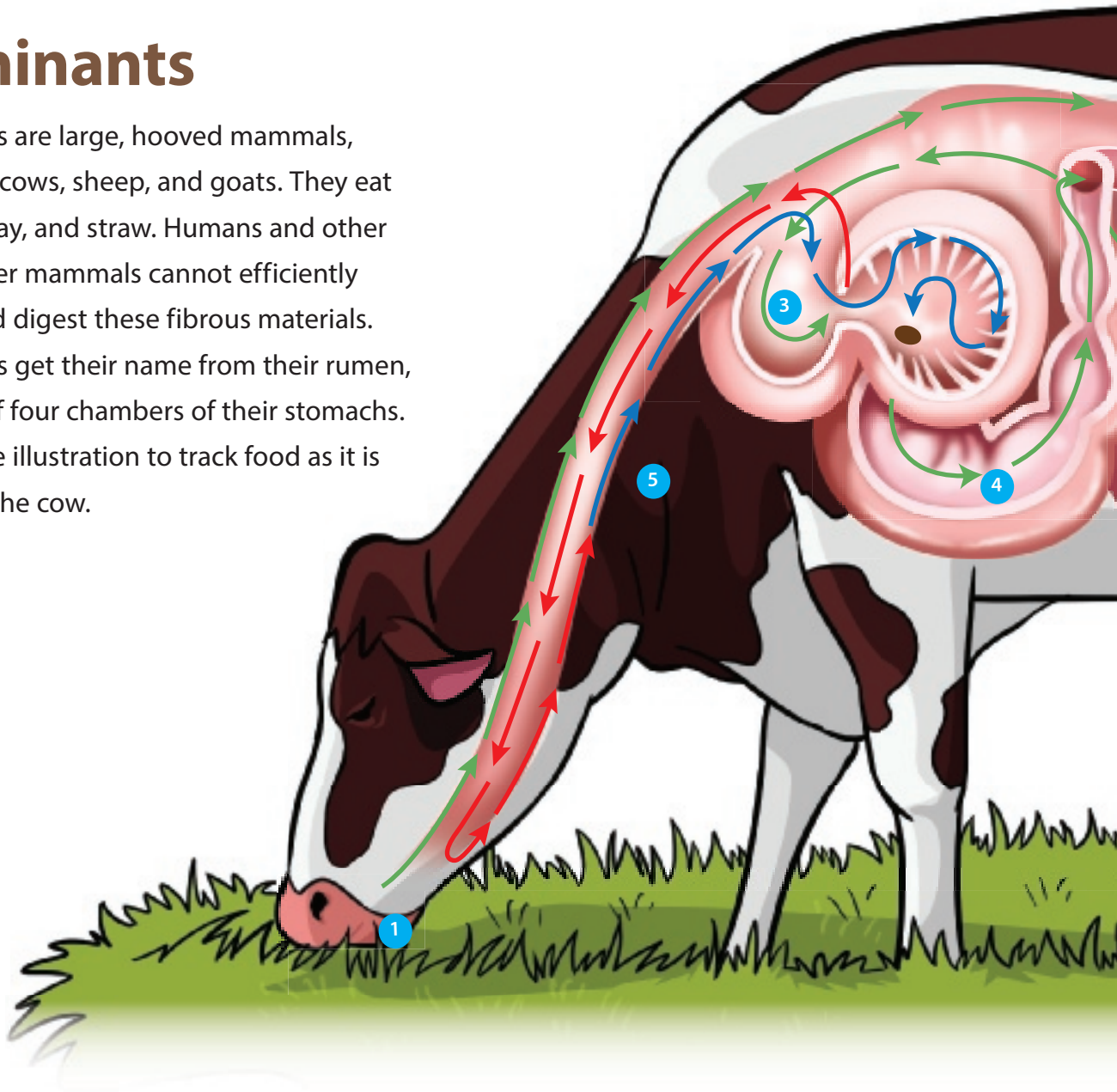
The FCR for farmed Atlantic salmon is very low. However, this is based on a concentrated fish feed made of fishmeal and fish oil processed from other fish. For wild salmon, the FCR is closer to 4:1.



Crickets can be farmed by providing them with a habitat and grain or other plant matter to eat. An FCR of 1:1 makes the cricket one of the most efficient animals to raise. There is great interest in adding more insects to the human diet because of the low FCRs and the high protein content of insects.

Ruminants

Ruminants are large, hooved mammals, including cows, sheep, and goats. They eat grasses, hay, and straw. Humans and other many other mammals cannot efficiently ingest and digest these fibrous materials. Ruminants get their name from their rumen, the first of four chambers of their stomachs. Follow the illustration to track food as it is eaten by the cow.



1. Large teeth chop and grind plant matter into smaller pieces. Very large amounts of saliva begin the chemical digestion of the food.

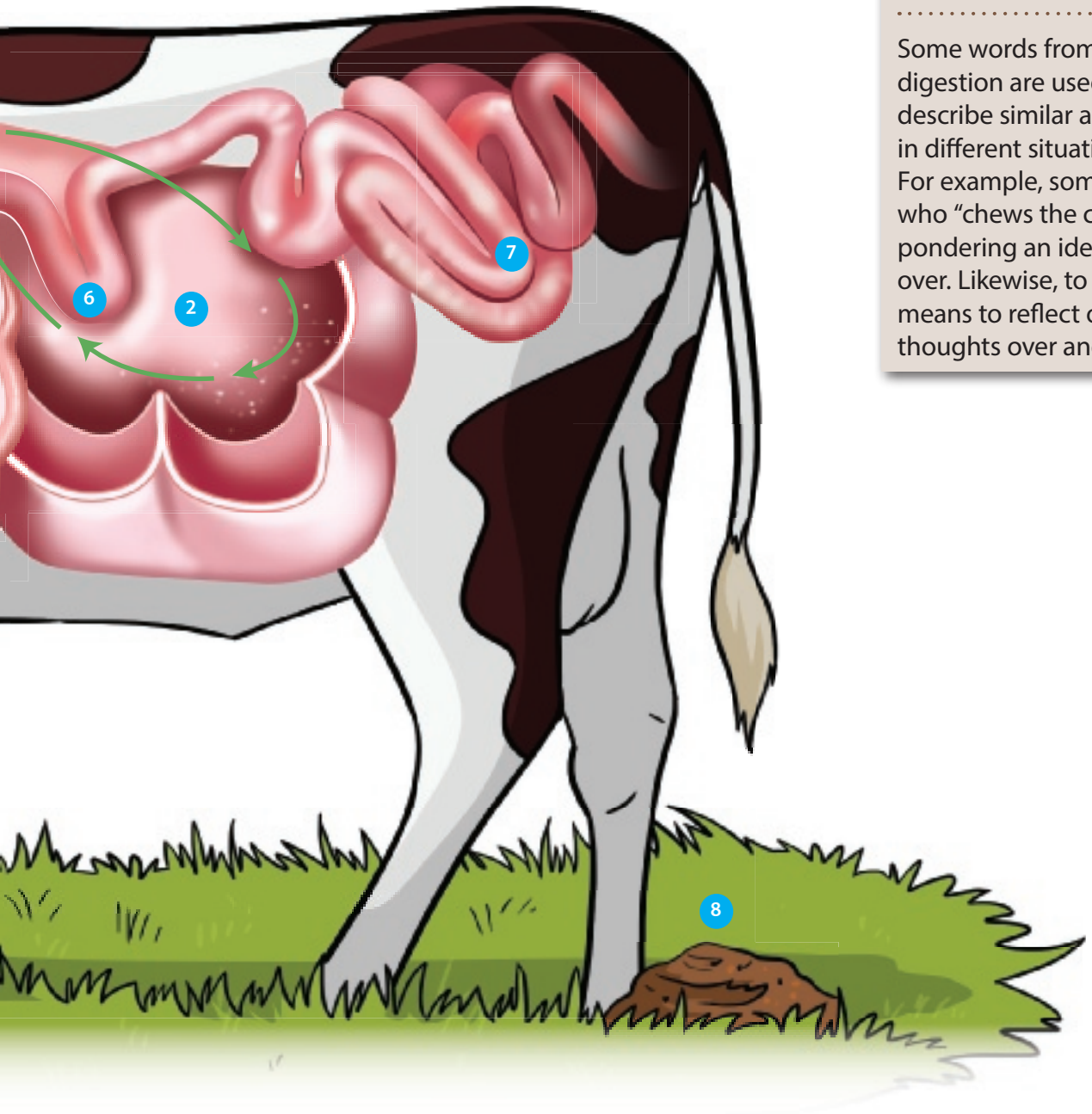
2. Food moves through the esophagus to the rumen, the largest chamber of the stomach. A large cow can hold about 95 liters of material in its rumen. Microbes in the rumen help break down the thick cell walls of the plant matter in the cow's food. The muscular rumen contracts, churning the material softer. Gases produced by the microbes' activity accumulate near the top of the rumen. Older, heavier material sinks to the bottom. Tiny projections called papillae absorb nutrients released by the food.

3. The rumen sends some partially digested material to the next chamber, called the reticulum. The rumen and reticulum are mostly open to each other, like a kitchen and dining room connected by an open doorway.

4. Older, softer material in the rumen goes to the third chamber of the stomach, called the omasum. The omasum is lined with leaflike projections that absorb water from this material.

Connection

Some words from ruminant digestion are used to describe similar actions in different situations. For example, someone who "chews the cud" is pondering an idea over and over. Likewise, to "ruminate" means to reflect on thoughts over and over.



5. From the reticulum, material can be sent back up the esophagus to the mouth. There it is chewed more and digested further by the saliva. This is called "chewing cud." If you see a ruminant chewing when it hasn't eaten in a while, it is probably chewing cud. The saliva in the mouth helps neutralize the acid in the cud.

6. Next is the abomasum, or the "true stomach." It introduces acidic juices and enzymes to break down the food even further. This is similar to what the human stomach does.

7. The food is passed through the small intestine, where most of the nutrients are absorbed. The rest moves into the large intestine. Here, microbes draw out more nutrients to be absorbed. The large intestine also absorbs water. The indigestible material is sent on to the rectum, where it becomes feces that are expelled through the anus.

8. The large volumes of food eaten by ruminants result in large volumes of feces, called manure.

Digestive Aid Advertisements

Gas Away

Tired of feeling like you can't enjoy the foods you love most because of painful, embarrassing gas? Do your clothes feel too snug as you're digesting lunch at your desk? Put this in the past with ***Gas Away!*** Our specially formulated digestive aid, developed by Harvard University PhD Jason Hegger, contains alpha-galactosidase, an enzyme that helps break down complex molecules consisting of sugar and fat. Gas Away gives your gut just the right amount of this key enzyme so it can digest beans and other foods that might otherwise give you gas. Go ahead and have that hot dog and plate of baked beans. Just one Gas Away is all you need!



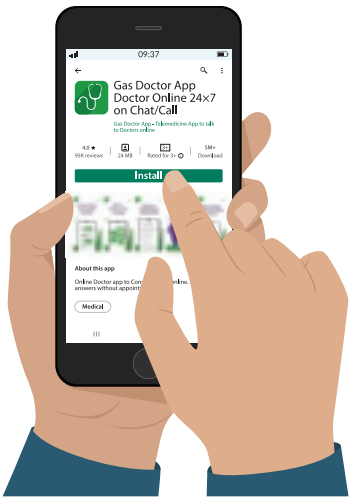


Hey, kids! Do you ever get a tummy ache after eating pizza or ice cream? Does drinking a tall glass of milk seem to cause you to run to the bathroom a lot? You might be one of the millions of people whose tummy has trouble digesting dairy products. What your tummy needs is **Lactasty**. This is a gum that you can chew before eating or drinking foods that contain lactose. Lactose is a type of sugar in milk and foods made from milk that your tummy has a tough time digesting. Lactasty gum contains lactase, which deals with the lactose. Even better, Lactasty tastes great! It comes in five fruity flavors and has no sugar. Good for your tummy and good for your teeth! Ask your parents if you can give Lactasty a try today!



The Gas Doctor

Let's face it: It's almost impossible to prevent flatulence. But in those important moments, don't you wish you could? **The Gas Doctor** can give you that power. This noninvasive device is a thin, adhesive membrane that can be placed on the inside of clothing. It has a patented filter to eliminate offensive odors. More amazing, its tiny microprocessor detects severe flatulence and immediately sends a signal to your mobile device. No one will be the wiser. To charge the Gas Doctor, simply place it on your mobile device's induction charger, and it is ready for another day's work in just five minutes! Order the Gas Doctor, and download the app today!



ALOE LOVELY

The aloe vera plant has magical properties. To treat a sunburn, cut through the plant and rub its soothing gel on your skin. Did you know aloe can also cure what ails you on the inside? It's true! Aloe juice has been used as a general digestive aid for centuries. All we've done is make it taste better. In fact, it tastes divine! One six-ounce can of **Aloe Lovely** can set up your digestive system for smooth sailing all day long. Have another can if you're going to indulge in spicy food. Make Aloe Lovely a part of your daily routine!



Spot the BS

Heads up! There's some **b**ad **s**cience on this page, mostly in the form of vague or unbelievable claims. Which of the advertisements seem to be based on science and reality? Which ones are more difficult to believe?

Consider the Source

Digestive aids and dietary supplements are not regulated by the Food and Drug Administration (FDA). This means various products containing known or unknown substances can be manufactured, packaged, and labeled as "dietary supplements" without claims on the packaging or in advertisements being proven or tested. It also means the FDA is not investigating whether these products might be causing harm, let alone doing what they claim.

Digestive System Products



Cheese is made by adding rennet to heated milk. Rennet is a set of enzymes made in the four-chambered stomachs of ruminants, such as goats and cows. Rennet causes a protein in milk, casein, to form clumps called *curds*. The curds can be removed and treated by aging, salting, and flavoring to make cheese.

Many people love to eat sausage. Not as many people like to know how sausage is made. The natural "casing" for sausage is the long flexible, cleaned-out small intestines of pigs and other animals.





Insulin is a hormone that regulates how much **glucose**, or sugar, is in the blood. The pancreas produces insulin, but in diabetics the production of insulin is ineffective. Insulin can be extracted from other animals such as cattle and pigs for use in humans. It is also manufactured using genetically modified bacteria. Insulin can be injected when needed, or it can be pumped in automatically from a belt-mounted insulin pump.



The liver of the basking shark can weigh several thousand pounds. Because liver is rich in useful oils, this species has been heavily fished. A liver from the shark could be squeezed to yield hundreds of gallons of oil. This oil could be burned to light lamps or refined into different lubricants. Liver oil from fish is, in general, considered a healthy food due to a high concentration of vitamins D and A. However, overfishing can reduce the numbers of certain species to dangerously low numbers.

Intestines are made of smooth muscle, which is a very elastic type of muscle. When the intestines are dried, the elasticity is preserved and turned into a very tough, long-lasting, wirelike material. Natural gut, made of cow intestines, is sometimes used to make strings for tennis racquets, guitars, and other products. Most modern racquet strings are made from synthetic materials.



Connection

The phrase "how the sausage gets made" is used in the context of something that might be unpleasant, often as a way of avoiding hearing how something is actually made or taken care of. This phrase comes from the production of sausage, which involves not only ground-up animal flesh but squeezing that meat and fat into casings made of animal intestines.

Vocabulary

glucose, n. a simple sugar molecule, $C_6H_{12}O_6$

Lactose Intolerance

Out and About with Seojun

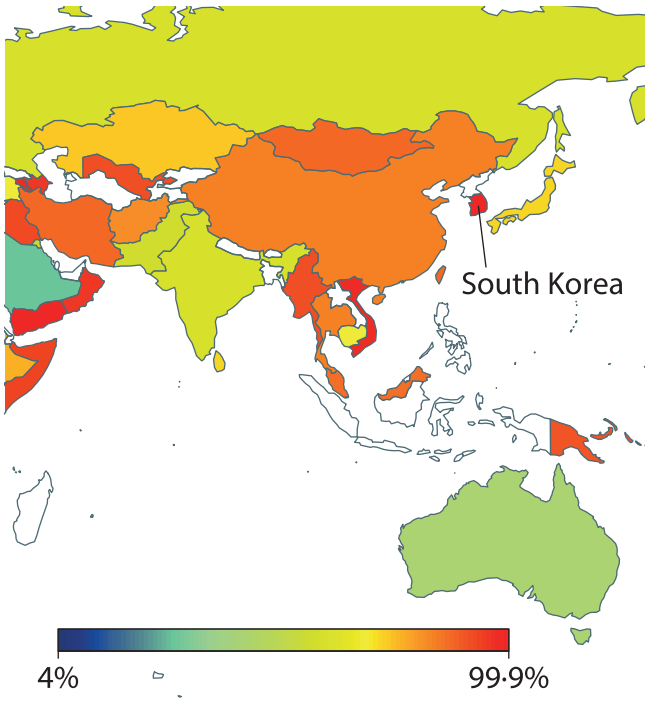
A Food and Travel Blog

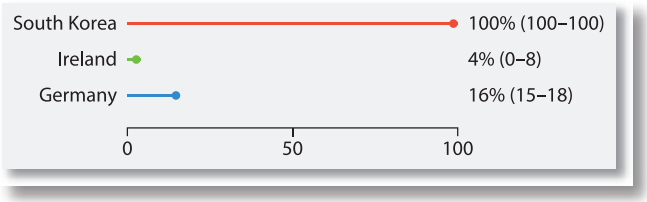
I love pizza. Nothing is quite as satisfying as a slice with fresh mozzarella from Leo's on Houston Street. It's my favorite thing about living in New York. The problem is, if I have more than one slice, my digestive system rebels. This happens with ice cream, too, or any dairy products. My gastroenterologist friend Adam says I'm probably lactose intolerant. In medical speak, I suffer from lactose malabsorption. What does that mean? Here's the text Adam sent me about it:

> Lactose is a sugar found in dairy milk. Humans and other mammals' digestive systems have an enzyme called *lactase* that breaks lactose into two simpler sugars: glucose and galactose. Glucose is the basic sugar your cells need. Remember cellular respiration from Bio 101? Glucose is a big player in that. Babies have lots of lactase, but as some humans get older, their systems make less lactase. This causes that lactose to flow through the intestines without being absorbed as those simpler sugars. It can turn into a kind of breeding ground for bacteria in your large intestines. When those bacteria act up, you can get diarrhea, bloating, and nausea. Meanwhile, it's actually another type of bacterium in the small intestines that produces some of the lactase. So, in a sense, it's all about bacteria.

I got curious about whether I might be lactose intolerant because of my genes. It seems to run in my extended family, half of whom are from South Korea. I looked around for articles about lactose malabsorption in different populations. I found an article in the science journal *Lancet* that reviewed hundreds of studies to find some patterns. The first thing I'll share from that study is this map that shows the percentage of people who live in areas that are lactose intolerant.

Take a look at the percentage for South Korea on the map. Just one word: *eek!*





So, I'm guessing some of my lactose intolerance might come from my mom's genes. I also looked on the map at Ireland and Germany, where my dad's genes come from. The numbers are way lower there, meaning the Irish and Germans might be able to eat more cheese and drink plenty of milk than people from other parts of the world.

Scientists think the gene associated with lactase production probably became more common over time in Europe as people became reliant on milk for survival. It makes sense. Someone migrating from Pacific Islands wouldn't have had access to dairy cows. There would be no benefit to having a tolerance for lactose. In Europe, if your family had a cow and there wasn't much to eat, you could at least have milk and other dairy products. If ingesting those gave your family a better chance of survival, then the tolerance for lactose in that area might become more common over time. Natural selection at work!

Adam says I should just take a lactase tablet before I go down to Leo's for a slice. I'll give that a try. Right about now sounds good.

Consider the Source

This blog doesn't appear to be written by a scientist, but the writer does include information from a friend who is a doctor specializing in the digestive system, and the blog cites a specific study from a well-known journal on medical topics.

Stones, Clay, and Plastic

Gastroliths

Gastroliths (Latin for "stomach rocks") are small pieces of rock that some animals ingest on purpose, despite the fact that these stones cannot be digested.

Birds use gastroliths, which in the case of birds are called gizzard stones, to help them break food into smaller pieces. Because birds have beaks and lack teeth, they swallow large pieces of food. Ahead of their stomach is a muscular organ called the gizzard, which squeezes the stones against swallowed pieces of food. This functions almost like a toothed mammalian mouth, grinding the food into smaller pieces that are then more easily digested.

Some marine animals, such as the whale and sea lion, have gastroliths but lack gizzards. One theory is that the dense stones help these animals remain neutrally buoyant in the water—that is, they won't float too much or sink too much, allowing them to better control their bodies as they swim and dive. Another theory is that they simply ingest the stones by accident when feeding on prey on the sea floor.



Eat Dirt

Some animals eat dirt. And we're not just talking earthworms. Mountain gorillas consume soil to absorb vital iron, which promotes the development of red blood cells. Elephants eat clay when they don't get enough salt from their food. Even some humans eat clay based on the theory that the positively charged particles of clay attract particles of toxins, which tend to be negatively charged, in the stomach. The clay then carries the toxins out of the digestive system. This "detox" effect is seen in parrots, which ingest clay along with seeds and fruit that are slightly toxic on their own. Chimpanzees and baboons appear to do the same thing for the same reason. Eating clay lets these animals expand their diets.



Plastic Pollution

Plastic is so abundant on Earth's surface, and often mismanaged, that it now ends up in the stomachs of many organisms that ingest it because it resembles food. Whales, sea turtles, and sea birds are especially vulnerable to this problem. Plastic bags can resemble the jellyfish that turtles hunt. Plastic cigarette lighters have been found in the nests of albatrosses. Presumably they were carried there by the parents to feed the young as though they are food. Many albatross chicks die as a result of all the plastic they consume.



Post-Surgery Diary

August 4, 2021

I'm so sick of being sick! It seems like every other day I'm either vomiting or having diarrhea—or both. I've lost so much weight that my clothes feel like they're hanging on my body. I'm a coatrack. I went to Mom and Pop's for a cheeseburger, but an hour later it seemed like half the meal came out the front end and then the rest came out the other end. It's tiring. The tension and nausea take all the pleasure out of eating. Dr. Cho is confident that when he removes my gallbladder, I will feel better within days and these symptoms will go away in time. We'll see.

August 6, 2021

I head in for surgery tomorrow. It's odd to think about an organ being removed from my body, as though it's not important. I guess that's why they call others, like the heart, "vital organs" while the gallbladder is optional? Ha ha. Dr. Cho says the gallbladder certainly helps, mostly by controlling when and how much bile gets into the small intestine to break down fats in food. Bile can still get from where it's made in the liver to the small intestine if the gallbladder isn't in between, but the process isn't as well controlled. I will probably have a harder time digesting fats after the surgery.

August 12, 2021

The surgery went well, Dr. Cho said. The incisions from the surgery are healing nicely, but I feel the stiches pulling when I cough. I have to be careful. It's amazing that they can insert a few tiny cameras into someone's belly and use a few thin surgical tools to remove an entire organ. Having open surgery would have meant a longer stay in the hospital and much bigger scars. I still feel full from having gas pumped into my abdomen so Dr. Cho had more space in which to see and work with his tools. But laparoscopic surgery is definitely the way to go. For a few days, my diet is just rice and some poached chicken and other super bland stuff.



An image from my surgery

August 17, 2021

I tried a cheeseburger today. It wasn't a complete disaster—no vomiting—but I did have some diarrhea. I guess I will have to keep track of what portions of certain foods, especially fatty foods, are okay and what is too much. Without my gallbladder there to regulate the flow of bile, I basically have to hope that the balance of bile and fat is okay.

August 29, 2021

Increasing the amount of fiber in my diet has helped. I thought it would lead to more diarrhea, but it actually helps soak up bile and gives my large intestines something to build on. I can handle a burger made of lean beef, but I skip the cheese now. Other fatty foods I'm learning to live without include ice cream, ham-and-cheese omelets, and some of the greasier dishes. It's also been helpful to eat small meals so that a relatively steady flow of bile is running into a steadier flow of food in my small intestine.

What's a Calorie?

Talk of calories can get confusing. In science and nutrition, a calorie, with a lowercase *c*, is the amount of heat required to raise the temperature of one gram of pure water by one degree Celsius. In everyday experience a calorie is a very small amount.

To discuss the calories in foods, it makes more sense to use a larger unit. When you read "Calories" on a food label on a food wrapper, it's actually a kilocalorie, or a thousand small-c calories.

$$\frac{1 \text{ calorie}}{\text{gram}} = \frac{1 \text{ kilocalorie}}{\text{kilogram}} = \frac{1 \text{ Calorie}}{\text{kilogram}}$$

Be alert though! People often use the word calorie when they really mean Calorie.



80 Calories is actually 80,000 calories..

Why does talk of nutrition and metabolism involve a measure of heat in the first place? Much of the matter you ingest as food ends up being "burned" by your body. There is no spark or flame involved, but the chemical reaction that occurs during cellular respiration is a kind of burning. Carbon, which arrives at your body's cells in a molecule of glucose, combines with oxygen to become carbon dioxide. This reaction gives off heat, and the carbon dioxide is removed from your body as a gas. When you exhale air, you are emitting carbon dioxide. Meanwhile, your body is warm because of the glucose being "burned" in your cells.



A sugar cube will burn if it's set on fire. The sugar molecules react with oxygen, producing heat and carbon dioxide. In your cells, the breakdown of sugar happens in a series of complex chemical reactions that release a small amount of heat.

High-Calorie Foods to Keep You Going on the Trail

If you're going on a long hike, you need to consume more food than you would sitting at home. For an adult, that means you need at least 3,000 calories per day, unless you're looking to lose weight. It isn't feasible to carry around rich, perishable foods like rib-eye steak or ice cream—too hard to keep cold. In general you'll want to pack light, and that means dry foods. This is what makes a high-calorie trail mix so important for a long hike. The goal when making a trail mix bar should be 100 calories per ounce. Here are some tips to get there:

- Seeds such as sunflower and sesame have about 165 calories per ounce.
- Dried fruits offer almost 100 calories per ounce.
- Fats have the most potential calories per ounce: 255. This is twice as much as what can be burned from an ounce of protein or carbohydrates (often called ***carbs***). Macadamia nuts and pecans top out at 200 calories per ounce. Brazil nuts, walnuts, and hazelnuts aren't far behind. Almonds, cashews, and pistachios are at 160.
- Combine all the above with some oats into your hiking food.





Diet Pills:

From FDA-Approved to Mystery Mail Orders

A variety of drugs are designed to help people lose weight, each using a different approach. Many are approved by the Food and Drug Administration (FDA). Some must be prescribed by physicians, but there are also FDA-approved over-the-counter medications for weight loss. One FDA-approved drug reduces fat absorption of the food you eat by about 25%. Side effects include loose bowel movements, abdominal pain, and gas. Other over-the-counter weight loss medications are not FDA approved. They are generally appetite suppressants or stimulants.

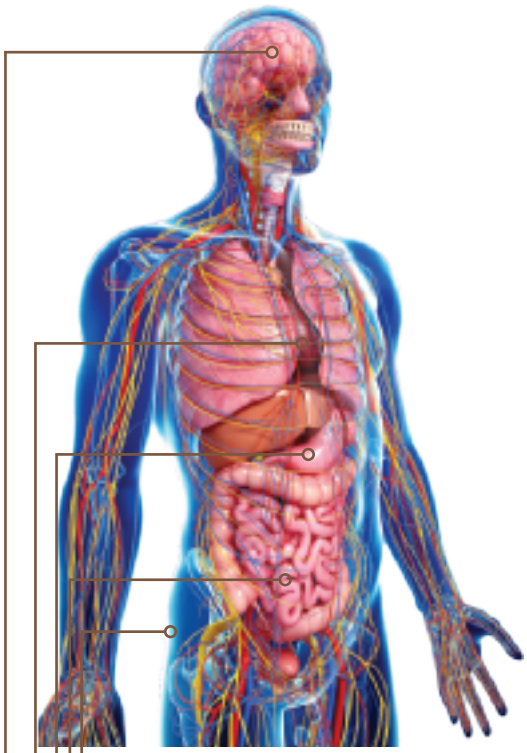
Stimulants in particular are often included, sometimes without warning, in diet pills that promise the user that they will "burn fat" or "lose 30 pounds in 30 days." They can provide an energized feeling that can inspire more fat-burning physical activity. Unfortunately, stimulants can be harmful to the body. Caffeine, for example, which is what gives coffee its energizing effect, can lead to insomnia, nervousness, and dehydration.

Nowadays, many over-the-counter "supplements" can be bought through the mail or online. Buyers should be *very* careful: The exact ingredients of these products are often unknown and may be harmful.

Word to Know

An *over-the-counter* substance is one that can be purchased without a prescription from a doctor. The term comes from how people can select items at a store and put them on a checkout counter along with other items. A prescription drug is held behind the counter and requires a doctor's approval.

Ways Diet Pills Work



- Suppressing a person's appetite (The person feels less hungry, which should lead to less eating, resulting in the loss of body fat.)
- Reducing how well your digestive system absorbs fat
- Reducing cravings and depression, both of which can lead to overeating and a sedentary lifestyle
- Increasing the person's metabolism by stimulating activity in different body systems and raising their heart rate
- Increasing amounts of brain chemicals that tell you you're full or not hungry

Best Fat Burners for 2022!

If you're overweight or simply want to shed a few pounds, we have assembled a list of the three best fat-burning, over-the-counter supplements of 2022.

1. Lipoway—Best Overall, Editor's Choice

2. Caffeind—Best Fat Burner for Active Men

3. Metablaster—Best Deal

There's a lot of bad information out there about weight loss techniques, diet pills, and how the metabolism actually works. We've cut through the nonsense to provide straightforward reviews of the three best fat-burning supplements that are on the over-the-counter market today.



Lipoway is engineered to increase the activity of your skeletal muscle cells. This means you won't have digestive system side effects, because your digestive organs are not made of skeletal muscle. Likewise, no heart problems, as cardiac muscle isn't affected. The increased rate of activity among your skeletal muscles will burn calories and lead to burning fat. The key ingredient in Lipoway is a special blend of herbs. Click here to buy now!

Caffeind is a high-dose, tasty lozenge that contains 18 milligrams of pure caffeine extracted from green tea. If you're looking for a big boost of energy before a workout or game, Caffeind is your friend. Click here to buy now!



Metablaster is available in bottles of 100 pills or more, with free shipping! Its formula is based on a molecule modeled on the stimulant derived from the coca plant, which has been used in Peru for centuries. Fat burning is almost an afterthought because you will barely be able to contain your energy. Metablaster will make you ready to take on the world! Click here to buy now!

Sponsored by ActiLoss, makers of Lopiway, Caffeind, and Metablaster.

Spot the BS

Heads up! There's some **b**ad **s**cience in the "sponsored content" on this page, which is a fancy way of saying "advertisement." What are the signs that the drugs being advertised may not be safe or regulated?

Hunting for Calories

July 11, 2022

I'm on a small vessel off a sandy island near Cape Cod. Several great whites patrol the shallow green water of the Atlantic. On shore, several hundred gray seals are lounging in the sun, tending their pups and digesting their meals of striped bass and bluefish. The sharks are here for the seals. This week alone I've witnessed five predations. The seal population was almost nonexistent for many years, but since the 1990s it has been rebuilding. The dinner bell for great whites was rung. Tagging studies and aerial surveys suggest that there may be as many as 500 great whites in these waters every summer and fall. A seal with a mass of about 300 kilograms is a huge meal for a shark. Seal blubber is rich in energy, and seal muscle, bone, and organs are a bounty of protein. They are a fitting meal for great whites, which can reach five or six meters in length and several thousand kilograms in mass. From here, white sharks migrate south for the winter, where they feed more on fish. However, if they find a whale carcass on the way, this is another all-you-can-eat buffet that can help fuel the sharks' migration from Cape Cod to Florida.



September 27, 2022

Great day observing brown bears! The grizzly bears of coastal areas of Alaska are known as brown bears. They are the same species, but the coastal bears have access to more protein, so their coat is darker, and they are larger than grizzlies. Salmon come into the bays and rivers in summer, presenting the bears with a massive source of protein. However, these bears still get 75% of their food from plants. It's less protein, but in large quantities it gives plenty of sugar that can be converted to fat. Today, I watched a mother and her cub grazing on berries for hours.

All that food would tip the scale at about 50 pounds per day. This is key to building up large stores of body fat to keep them alive during the winter, when they hibernate for six to eight months. While the days are warm and long, they will eat whatever they can find, including grasses, bugs, or dead animals. During the summer binge, they will put on three to six pounds per day. Adult males swell to over 1,000 pounds by the fall, and females top out at about 600. It's been great to see these beautiful omnivores again, six years removed from writing my PhD dissertation on their foraging behavior.

Consider the Source

The writer is a wildlife biologist who has a great deal of experience and knowledge of large predators, including the grizzly bear. How does reading this person's field notes differ from, say, a magazine article written by a nonscientist?



Carb Loading

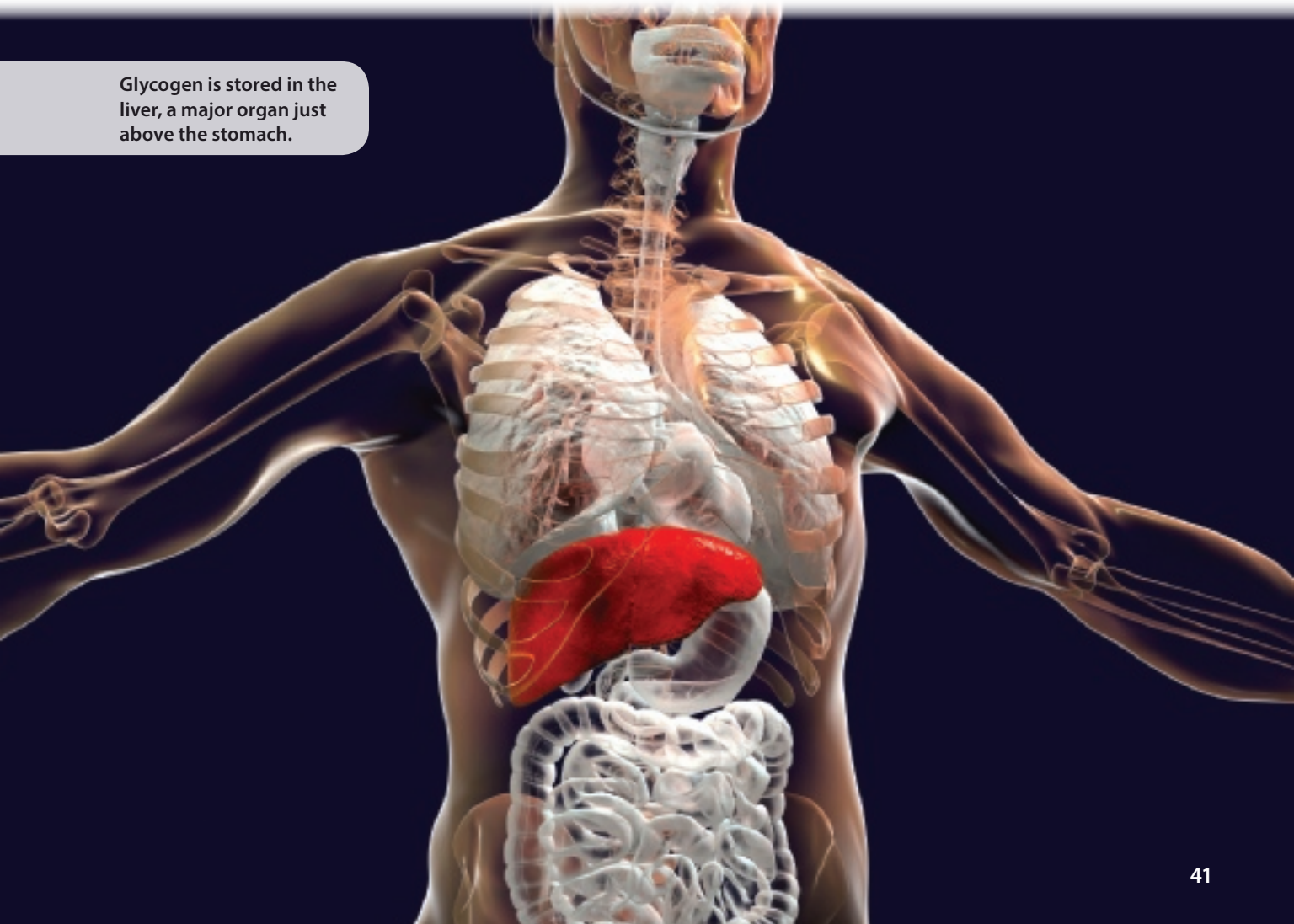


When you're on the go—or in the middle of a marathon—you can't stop for a plate of pasta. And you don't want to chug a one-liter energy drink just to get the boost and salts your body needs. What you need is FruGoo, a special formula of maltodextrin and fructose extracted from citrus fruits, with sodium to replenish what you've sweated out and caffeine to help carry you through the tape and onto the winner's podium! FruGoo can fit in your pocket or be handed off by your support crew as you take on heartbreak hill. If chased by water, FruGoo maintains its stickiness, so it breaks down and is digested at the right rate in your gut.

Glycogen and Fat: The Flash Fire and the Slow Burn

Imagine a person about to embark on a calorie-demanding physical activity, such as playing a three-game basketball tournament or running a marathon. They're going to be getting most of their energy from two sources: glycogen, which is a sugar stored in the liver after the various sugars in food are digested, and body fat. Glycogen is the more readily available of the two. You can think of this as dry, seasoned firewood that is chopped into kindling and ready to ignite. Fat is more like damp logs of wood. It will burn, but it needs to be chopped and will not burn as quickly. Glycogen is "stacked" neatly in the liver and in muscles, while fat is dispersed throughout the body.

Eating high-fat food before rigorous exercise or a long race is not wise. Fat does not burn as quickly as sugar, despite being higher in energy per ounce. Fat can also cause indigestion—the last thing you want while playing a game or running a race.



Glycogen is stored in the liver, a major organ just above the stomach.

Max Out on Carbs

It's not important to take in many more calories than usual when you "load" for competition. In fact, if you eat too much, your body will end up storing some of that energy as slow-burning fat. What matters most is that what you ingest is efficiently digested and, as much as possible, stored as glycogen. This is why, in the days before an event, many athletes "carb load," meaning they eat meals heavy on complex carbohydrates—another word for sugar molecules that are larger than glucose and fructose. Pasta, rice, oats, beans, bread, waffles, and fruit juice are good examples. Whole fruit can be excellent, too, but it includes a lot of fiber. You do not want to be thinking about where to find a bathroom in the middle of a race!

Marathon Meal Planning

How should you eat for a sports event? Marathon runners and nutritionists have this down to a science. Follow the timeline to see how it can be done.

Vocabulary

carbohydrate, n. a type of compound occurring in foods and living tissues that is broken down to release energy for the organism to use



2 or 3 Days Before the Event

Switch up your diet so it's 85–95 percent carbs. Try to eat after running, as the muscles will be craving more glycogen, and they will store whatever they don't burn through after the training run.

The Morning of the Event

Eat a relatively small meal of carbs. Include some simple sugars for an immediate boost of energy.

The Night Before the Event

Have a carb-heavy meal, but don't stuff yourself. Eat a little earlier than usual so your body has more time to digest those carbs and stash them in your muscles as molecules of glycogen.

During the Event

Downing another carb-heavy meal during the event is not practical, and at this point it's too late to use any glycogen produced by digesting an in-race meal. Instead, consume small, concentrated simple sugars, especially glucose and fructose. These can be ingested in gel form or in sports beverages. Caffeine can provide extra energy and alertness, which might help you finish the race strong.



Nutrition, Growth, and Disease

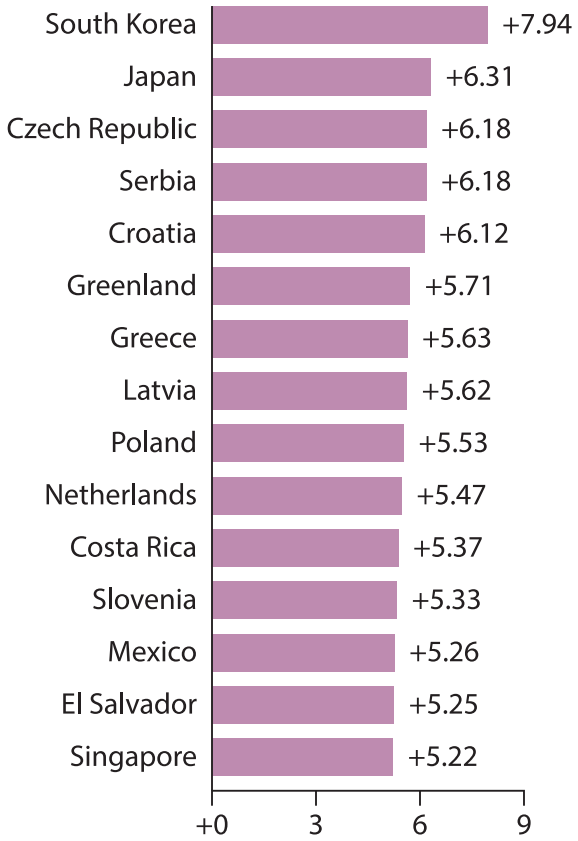
"You are what you eat." That old adage means you and your body are affected by the foods you consume. Carbohydrates, fats, proteins, and vitamins are important for growth and development. A shortage in a key nutrient can result in malnutrition, which in turn can lead to health problems. Proper nutrition also involves not taking in too much of things that can lead to health problems. Overeating itself can lead to health issues, as can eating the wrong things. Adult height in humans is, in general, determined by two factors: genetics and nutrition. Some countries have taller people, and others have shorter people, largely due to genetic factors. The role of nutrition in a person's height can be more important than most people realize. Over the last century, the average adult height of both males and females has soared in China, South Korea, and Japan as more foods became available. In recent decades, war, poverty, and **malnutrition** have not been as prevalent in these countries, and their economies have improved dramatically. As a result, children have grown up with nutritious, balanced diets, and their heights, relative to their parents and grandparents, are much greater. In South Korea, 18-year-old women are an average of eight inches taller than they were a century ago.

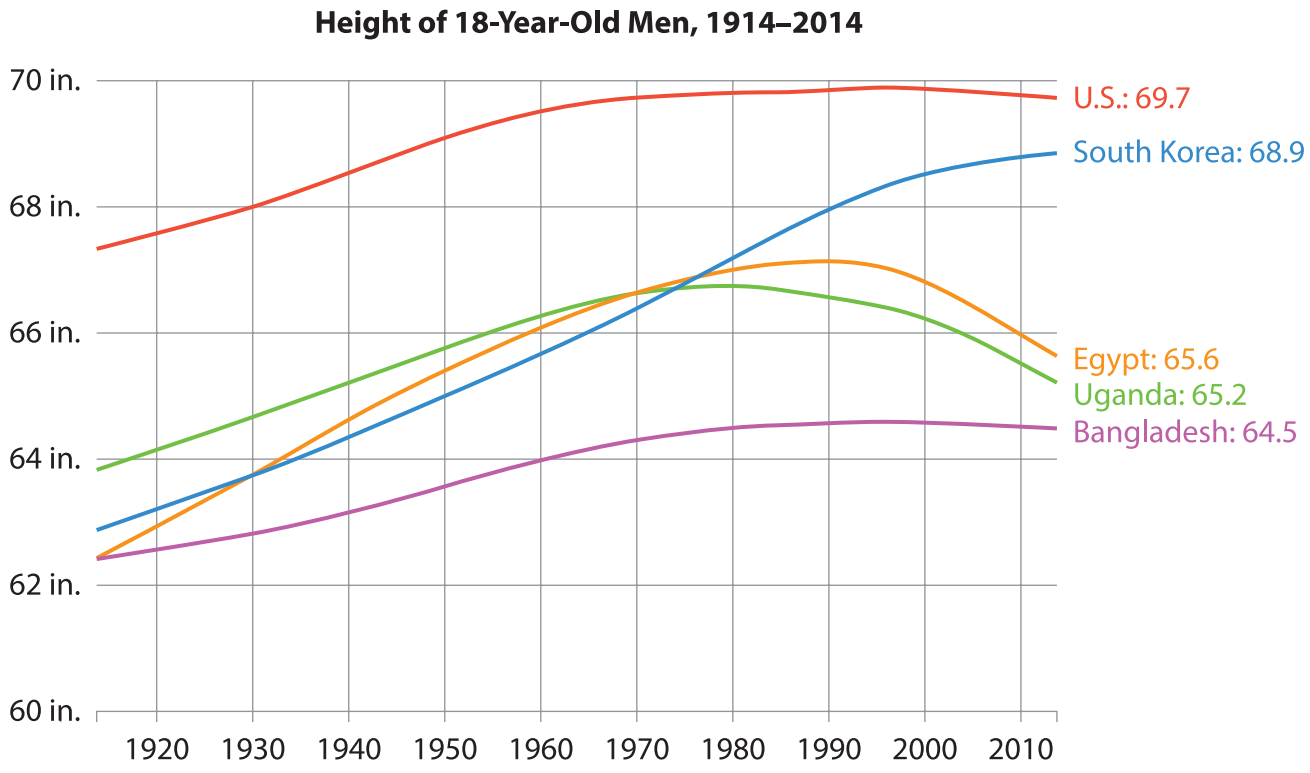
The reverse is also true. Wars and other calamities in the 20th century had significant effects on agriculture, fishing, and food availability. When times were tough, people had limited diets. Many people did not reach the heights they might have if they had not been malnourished.

Heights for men have increased in many countries, too. South Korean 18-year-old men are now nearly as tall as the average American 18-year-old man. In some places, such as Egypt and Uganda, average height climbed for half a century but then declined. This is likely the effects of conflict, poverty, and malnutrition.

In the United States, some scientists think a slight decline in average male height is due to a decline in nutrition, with too many Americans eating processed foods featuring "empty" calories and not enough of the key nutrients we need, such as calcium, which is key for bone development. Other scientists think that the dip in height could be due to immigration, with people from countries that have shorter average heights affecting the overall gene pool in the United States, leading to a slight decline in height.

18-Year-Old Women: Greatest Gains In Height in Inches (1914–2014)





Vocabulary

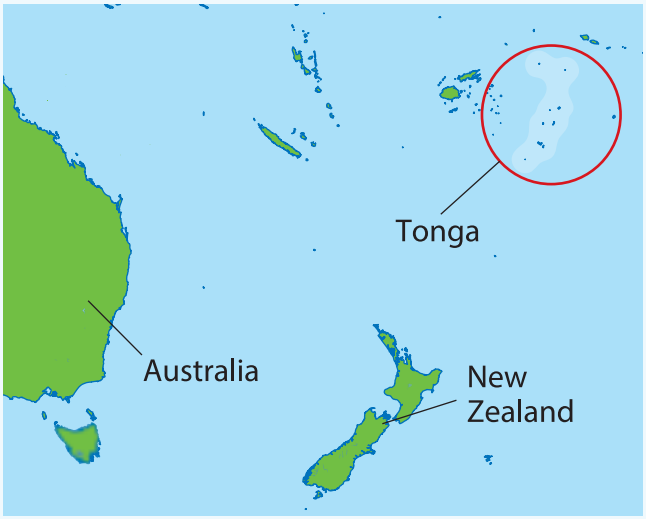
malnutrition, n. a condition caused by a lack of sufficient nutrients in the body; can also refer to overnutrition, meaning too much of some nutrients are being consumed

Dig into Data

The graph shows the average 18-year-old male height over a century for five specific populations. Both Bangladesh and the United States have seen slight declines in height in recent years, but the causes of those declines might not be the same. Bangladesh has had serious poverty and malnutrition for many years. Its slight decline in height could be due to food insecurity rather than a change in the gene pool of its population.

Word to Know

The term *food insecurity* means a general lack of access to safe, nutritious food for normal growth and development. This can range from mild (difficulty obtaining quality food) to severe (not eating at all for a day or more).



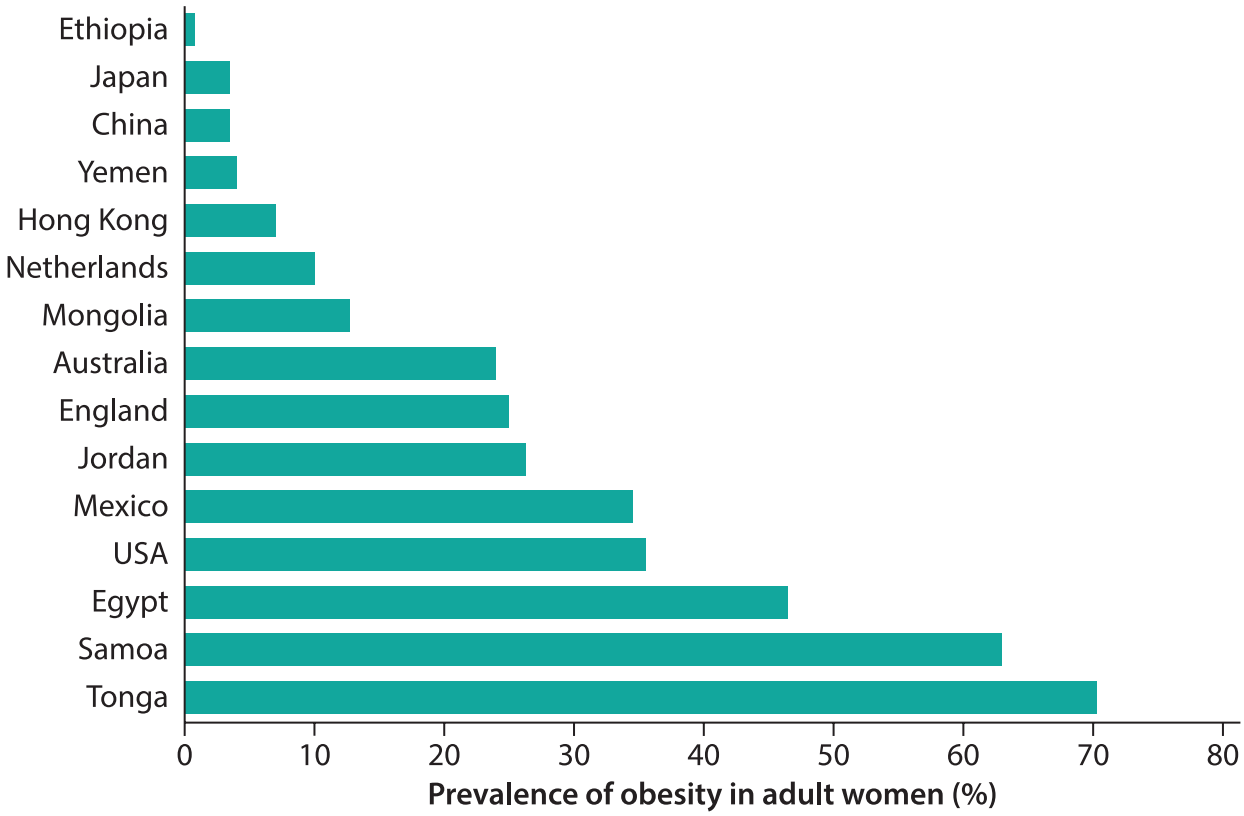
Nomuka, Ha'apai, Tonga
November 25, 2021

A typical quiet Sunday here in Tonga. My neighbors, Sione and Malama, brought me a big plate of lunch. There's a bit of taro leaves, fried taro with pork, a spoon of raw fish with coconut milk, and a big chunk of smoked octopus, which was rehydrated in coconut milk. Basically—protein, lots of carbs, and a little bit of leafy greens. The paradox of food here is that there's plenty of it but too much of some types and not enough of other types. People here and throughout much of the Pacific are genetically tall. This can mask some of the malnutrition that I see, because people generally seem to be well fed. There's no shortage of calories on these islands.

Produce is pretty limited and very seasonal. Pineapples are everywhere for a few weeks in summer (January), and we eat so many of them that our gums hurt. There are a few citrus trees, too. But outside of the season, there aren't many foods rich in viatmin C. Dairy milk is basically nonexistent. Many people here suffer from diabetes. Something about the Tongan people's genetic disposition toward being on the larger side, plus the influx of empty-calorie foods such as soda and packaged snacks, seems to have made Tonga one of the epicenters for diabetes, which they call *mahaki suka*, for "sugar disease." Insulin is not really an option, and people don't have the means to monitor their blood sugar levels. As a result, a lot of the more severe symptoms of diabetes are not uncommon here.

Malama's uncle got a cut on his toe a month ago, and because he is diabetic and his case is basically unmanaged, it looks like his toe might need to be amputated. I see other amputees around the island. It's tough to see, especially knowing that this disease can be better managed with the right medicine and know-how. Well, this diary entry reminds me to finish writing a grant proposal to fund some educational programs in Nomuka's primary school. For next year, I'm hoping to start a small seaweed farm, which could help reduce food insecurity here.

Diego Ruiz



Diabetes and Obesity

In much of the world, there is a connection between obesity and diabetes. In some countries such as Tonga, being large has culturally signified wealth and good health. Large feasts are common, and it can be considered rude to turn down a meal when offered. Being overweight or obese is common in Tonga. In fact, the prevalence of obesity in Tongan women is among the highest in the world, according to a 2011 global survey.

Being physically large and even having greater than average weight is not necessarily a sign of poor health. Many large people are perfectly healthy. Even genetically larger people can have bad health. But with more Tongans adopting a more sedentary work life while also adding imported foods to their carbohydrate-rich diets, **diabetes** has become common in Tonga. In a 2014 survey conducted in Tonga, more than one in three adults had diabetes, a disease that makes the body unable to properly regulate the level of sugar in the blood. The same survey found that 73% of the population consumed fewer than five servings of fruit and vegetables per day and 24% had a low level of physical activity.

Prevalence of Diabetes and Obesity in the Kingdom of Tonga, 2014

	Diabetes		Obesity (BMI >30)	
Age Group	**Men**	**Women**	**Men**	**Women**
25–44	24.5%	29.4%	57.6%	77.3%
45–64	40.7%	56.9%	56.2%	78.2%
25–64	**29.7%**	**38.6%**	**57.2%**	**77.6%**

Vocabulary

diabetes, n. a disorder in which the body does not produce enough of the hormone insulin, resulting in large amounts of sugar in the blood and urine

All-World Eating Team

Animals ingest and digest food in a wide variety of ways. Meet our all-world eating team, representing different branches of the animal section of the tree of life, and some of the many ways in which animals feed.



Team: Bivalve Mollusks
Player name: Green Mussel

Green mussels are found in the western Pacific Ocean in temperate waters. They are filter feeders, meaning they draw in seawater and filter out tiny pieces of plankton, which are sent to their stomach. The filter feeding of mussels and other bivalves can help make water clearer. Mussels do not move. Their meals are "delivery only." They thrive in places with currents of cool, nutrient-rich water. They can be farmed by placing large numbers of small mussels in cages tied to lines.



Team: Echinoderms
Player name: Ochre Sea Star

Ochre sea stars are found along the West Coast of the United States, from California to Alaska. This sea star feeds on mussels by prying open the mussel's two shells and then sticking its stomach inside the shell to digest the soft mussel flesh. It basically eats its prey from the inside out.



Team: Snakes
Player name: Olive Python

The olive python is a constrictor that lives in Australia. It uses its long, strong body to wrap around and squeeze large prey until they are unable to breathe. After the prey is killed, the python unlatches it jaws and swallows the prey whole. It can take days for the prey to be digested. During this time, the python can have a hard time moving around. Talk about food coma!



Team: Insects
Player name: Housefly

Some flies bite by jabbing a needle-like proboscis into their prey. The common housefly skips this unpleasantness by doing something that one could consider quite rude: vomiting digestive enzymes onto its food and then using its proboscis and tongue to slurp up the partially digested material.



Team: Cartilaginous Fishes
Player name: Cookiecutter Shark

The cookiecutter shark approaches larger marine animals and uses its scoop-like jaws, which are armed with very sharp teeth, to take single bites that, most often, do not do much damage to these larger animals. The cookiecutter shark then swims away to digest its meal and find a new one. Swordfish, tuna, whales, dolphins, and other large open-ocean species are often seen with cookiecutter scars.



Team: Cartilaginous Fishes
Player name: Smalltooth Sawfish

The smalltooth sawfish's snout is long and toothed. The sawfish swings its saw from side to side to stab its prey. Once the prey is mortally wounded, the sawfish swims over the prey and swallows it. This species can reach 18 feet in length.



Team: Marsupials
Player name: Numbat

The numbat is not a bat. It is a marsupial native to Australia. While it is also called the banded anteater, it doesn't like to eat ants. It eats thousands of termites a day, though, thanks to its long sticky tongue that can burrow into termite mounds and nests. Numbats get so much water from their termite meals that they do not need to drink water.



Team: Bony Fishes
Player name: Monkfish

The monkfish is a wide-mouthed anglerfish that spends much of its time on the ocean floor, waiting for prey to be attracted to a small lure that flips back and forth on its head. When a prey organism is in the right position, the monkfish opens its mouth so quickly that a vacuum is produced, sucking in the prey. The jaws slam shut, and needlelike teeth help keep the prey from escaping. Monkfish can swallow fish that are about the same size as they are, thanks to a wide mouth and a baggy stomach cavity.

Digesting Protein

HF Holly Farrell

Gross! I just saw someone in a video about the meat industry say that the average American's colon has five pounds of rotting meat stuck inside by the time they're forty! This alone makes me want to swear off beef forever.

SW Shana Whitaker

I know, right? I've heard this elsewhere and it's just about the grossest thing I can imagine. Now I know why people are doing these juice cleanses and other things to detox their guts.

PF Paul Farrell

Wait a second. I've heard this before. Wasn't this in a movie? Like, a fictional Hollywood movie? I just can't place it.

MR Marty Reed

"Beverly Hills Cop." Judge Reinhold's character says something like this, though I don't think he says the meat is "rotting." Still gross, though. I remember because you and I went to get burgers after seeing this in the theater when we were 17, and I had second thoughts about eating beef that night.

PF Paul Farrell

Ha! That's it! Yes! Thanks, it was killing me trying to remember.

HF Holly Farrell

Well, based on what my dad's friend wrote above, now I'm wondering if the video I watched was just repeating some line from a movie or if the movie was stating an actual fact. Anybody out there know a gastroenterologist?

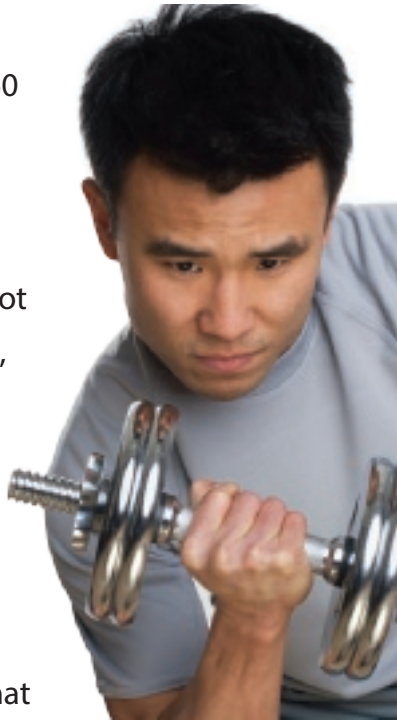
SW Shana Whitaker

@ Peter Benoit

PB Peter Benoit

Looks like I'm needed for another debunking of the "five pounds of meat" thing. It is indeed a myth. Protein-rich foods do not just sit there in your gut. If they did, you would feel it and it would not feel good at all. Things that go into your guts end up moving out, either as poop or through different metabolic processes. These metabolic processes move nutrients through the body and cycle most of them out over time, though often in different forms. There is a limit on how much protein your body can digest, but that doesn't mean undigested protein just stays in your colon. Please consider this myth busted, and if you see this pop up elsewhere on social media, please bust it yourselves!

Maximum Protein for Adding Muscle Mass

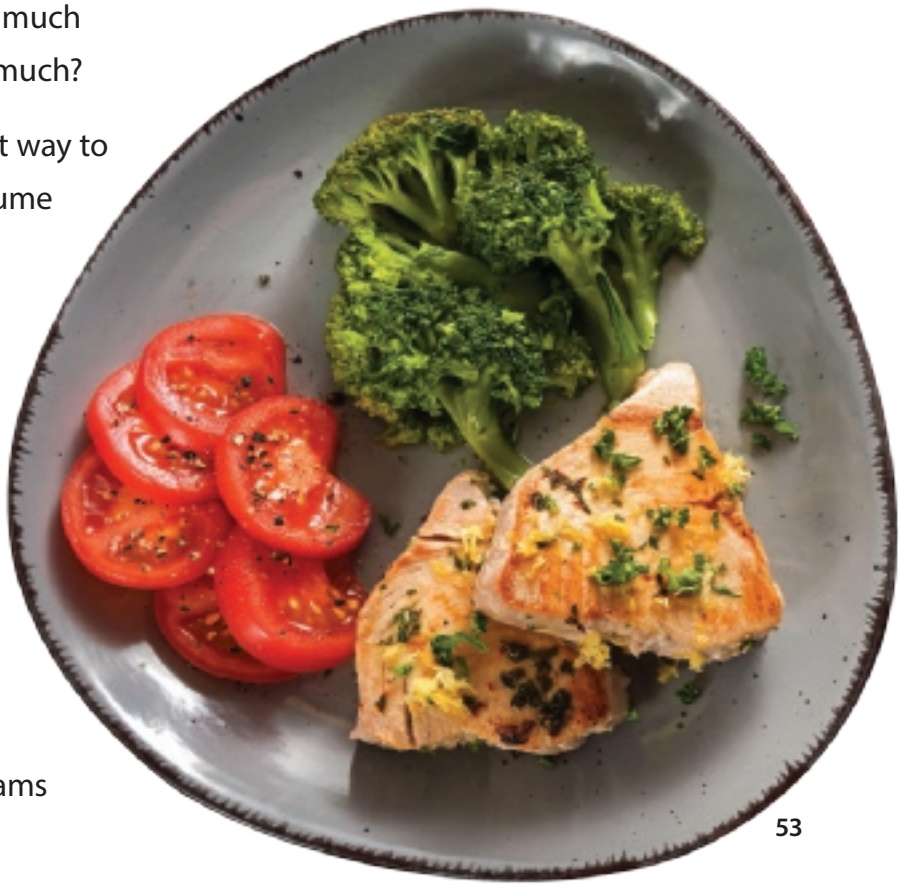


When people want to pack on lean muscle, they tend to eat a lot of protein, but they don't always do it in the right way. Ideally, protein would be ingested and digested at a very steady rate, but that's not realistic. We tend to eat meals, not tiny spoonfuls of protein powder every fifteen minutes. It's easy to overeat protein in a given meal, and a lot of that protein just isn't going to turn into muscle. Some might pass through you undigested if you've eaten so much that your intestines and enzymes can't handle it all. And some of the absorbed protein will be oxidized, or "burned," for energy or converted to urea, which leaves the body as urine.

So, what's the best approach? How much protein is neither too little nor too much?

Recent studies suggest that the best way to maximize muscle growth is to consume 0.55 grams of protein per kilogram of body weight per meal, across a minimum of four meals, to get to a daily intake of 2.2 grams per kilogram per day. For a person weighing 50 kilograms who wants to gain a lot of lean muscle mass, this means they should eat 110 grams of protein in a day, spread equally across four meals. If the proportions get way off—50 grams at lunch and the other 60 grams spread out over three other meals—it's likely that half of the lunchtime protein will not be used to build muscle, while the intake of protein during the other three meals will be slightly less than optimal.

It's important to note that regular ingestion of more than 3.5 grams of protein per kilogram of body weight can be unhealthy. There is no need to consume that much, anyway.



Glossary

biome. n, a large, natural community of organisms that occupies a habitat

body mass index (BMI), n. a ratio of weight to height used to classify body weight in ranges of less than, within, or greater than ideal for health

calipers, n. a instrument for measuring the thickness of a material or the width of an opening

calorie, n. the amount of heat required to raise one gram of water one degree Celsius. One Calorie equals 1,000 calories.

carbohydrate, n. a type of compound occurring in foods and living tissues that is broken down to release energy for the organism to use

cholesterol, n. a waxy substance found in blood and cells

colonoscopy, n. a procedure for examining the colon using a flexible optical instrument

diabetes, n. a disorder in which the body does not produce enough of the hormone insulin, resulting in large amounts of sugar in the blood and urine

endoscopy, n. a procedure for viewing an area or part of the body internally via video with a minimally invasive instrument

feed conversion ratio (FCR), n. the relationship between the amount of food fed to livestock and the amount of weight the animals gain

food insecurity, n. a general lack of access to safe, nutritious food for normal growth and development

gastrolith, n. a small stone that aids digestion in the gizzard of certain types of animals

gizzard, n. a muscular part of the stomach of some animals that grinds food with grit

glucose, n. a simple sugar molecule, $C_6H_{12}O_6$

gluten, n. a family of proteins found in wheat and certain other grains

insulin, n. a hormone, produced in the pancreas, that regulates the amount of glucose in the blood

kilocalorie, n. the amount of heat required to raise one kilogram of water one degree Celsius

lactose, n. a sugar present in milk, $C_{12}H_{22}O_{11}$

malnutrition, n a condition caused by a lack of sufficient nutrients in the body; can also refer to overnutrition, meaning too much of some nutrients are being consumed

net, adj. identifying a total or number that indicates what is left after certain factors add to or subtract from a starting amount

over-the-counter, adj. a health-related or medicinal substance that can be purchased without a prescription from a doctor

prevalence, n. a condition of being common

rennet, n. an enzyme produced in the stomachs of ruminants

ruminant, n. one of a number of large, hoofed, grazing mammals that predigest plant-based food in a specialized stomach

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