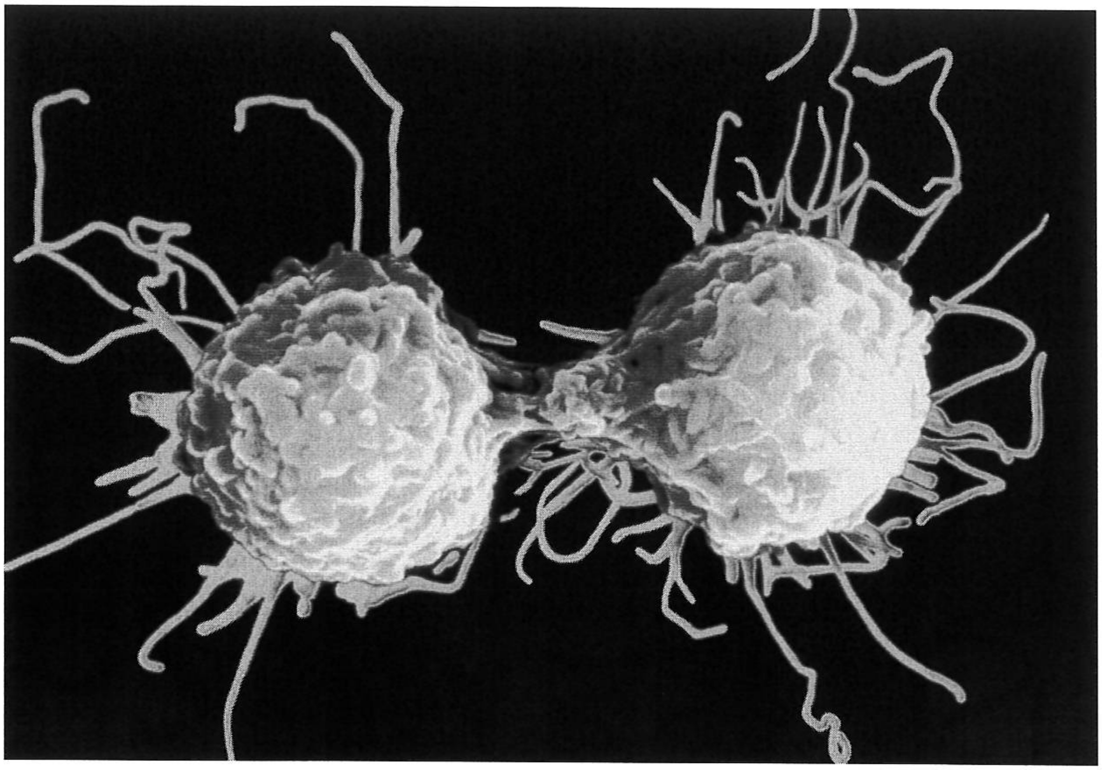


When the body grows or repairs itself, cells divide into more cells.

Growth and Repair

Cellular Growth

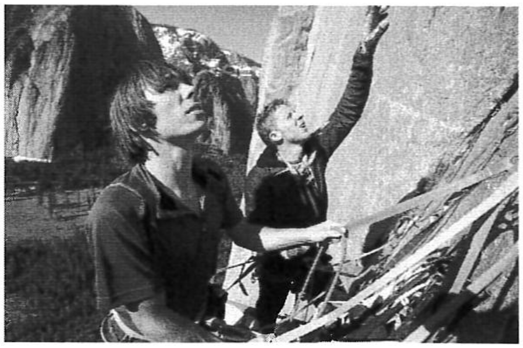
What does it mean to grow? For a body to grow, its systems and organs need to grow, too—and that growth all happens on a tiny scale at the cellular level. Cells are always making new proteins, growing, and dividing to make more cells. This is what makes bodies grow over time. You may not be able to watch a person getting taller, but through a microscope, you could watch his or her cells dividing to make more cells. When millions of healthy cells grow and divide to make millions more cells, the whole body grows.

Repair Is Really Growth

When you're recovering from an injury or just healing from a cut, you're actually growing— at least on a cellular level. The body repairs itself by growing the new cells and cell parts needed to fix damaged ones. Individual cells get old and die, and need to be replaced by new cells. Cellular growth is always happening, even in adults—who may not be getting taller anymore, but still need to grow new cells to replace old ones and repair damaged ones.

What Cells Need for Growth and Repair

To grow and repair themselves, cells combine amino acid molecules to form larger protein molecules. Those new proteins build new cells and cell parts. Growth and repair also require energy, so cells also need glucose and oxygen to release energy for these important functions.



Diego and Gabe prepare to begin climbing after months of training.

The Big Climb

A Story in Large and Small Scale

Diego and Gabe stand by a tree at the bottom of a huge cliff. The rock goes up for hundreds of feet above them. By tomorrow, the brothers plan to be standing at the top, looking back down at this tree. First they'll need to haul themselves, their gear, and all their food and water up the rock. Diego is excited to go on his first overnight climb with his older brother. They'll sleep tonight on a special tent platform part of the way up, then finish the climb to the top tomorrow morning. Diego and Gabe have been planning for this trip for months by training in the gym and outdoors.

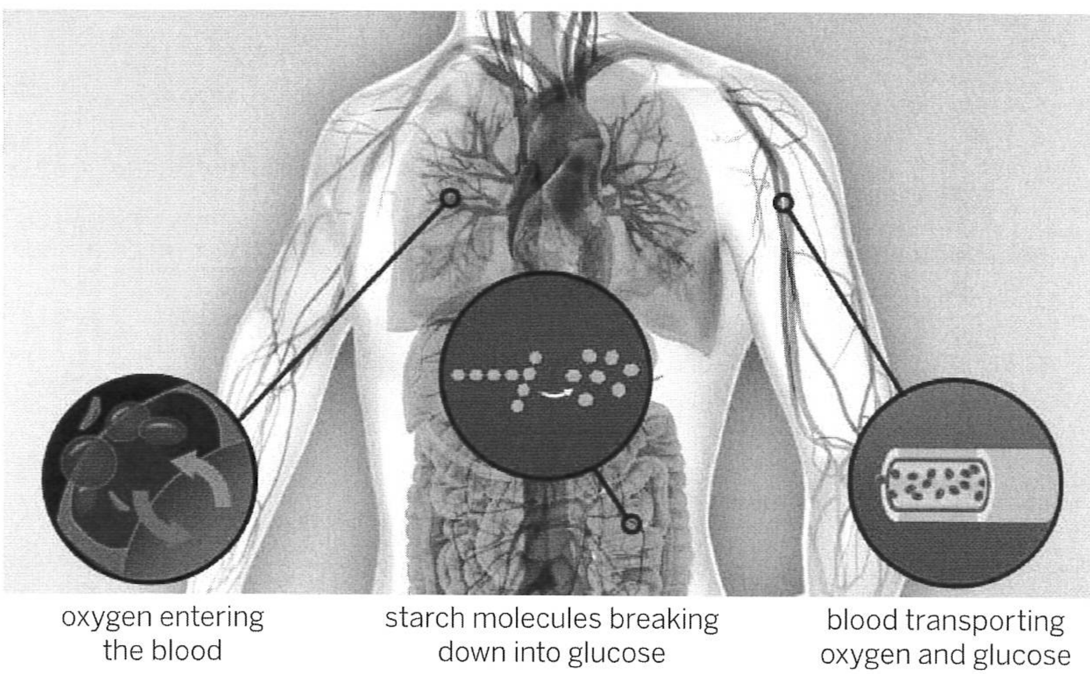
7:46 a.m.: Getting ready

What's happening at a large scale

This morning, Diego and Gabe filled up on big bowls of oatmeal and nuts for breakfast. Their meal had plenty of starch, and some protein as well. Standing at the bottom of the cliff, Diego stretches and takes a deep breath.

What's happening at a small scale

Diego's metabolism is already going strong, even though he hasn't started the climb. The food that Diego ate for breakfast is travelling



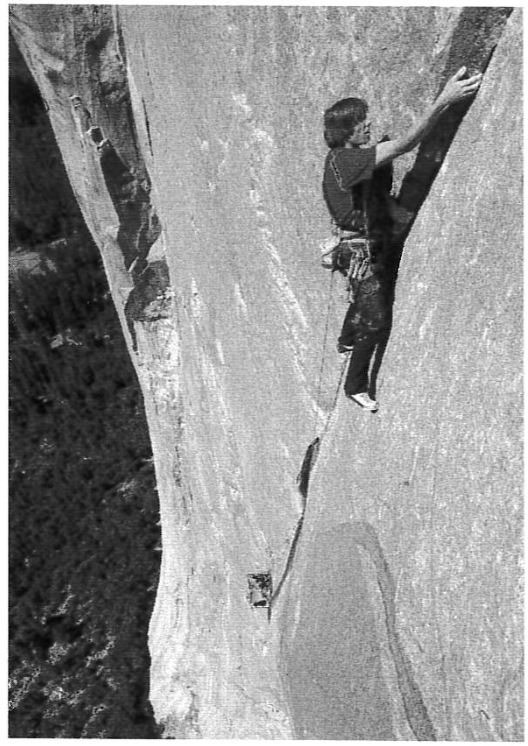
Diego's body uses glucose and oxygen to release the energy he needs to climb.

through his digestive system. Digestive enzymes are breaking down starch molecules from the food into glucose molecules and breaking down protein molecules into amino acid molecules. Some of the molecules are already moving into Diego's blood in his circulatory system. As Diego breathes in, oxygen enters his respiratory system and passes from his lungs into his blood. Diego's cells are going to need these molecules as he climbs the cliff.

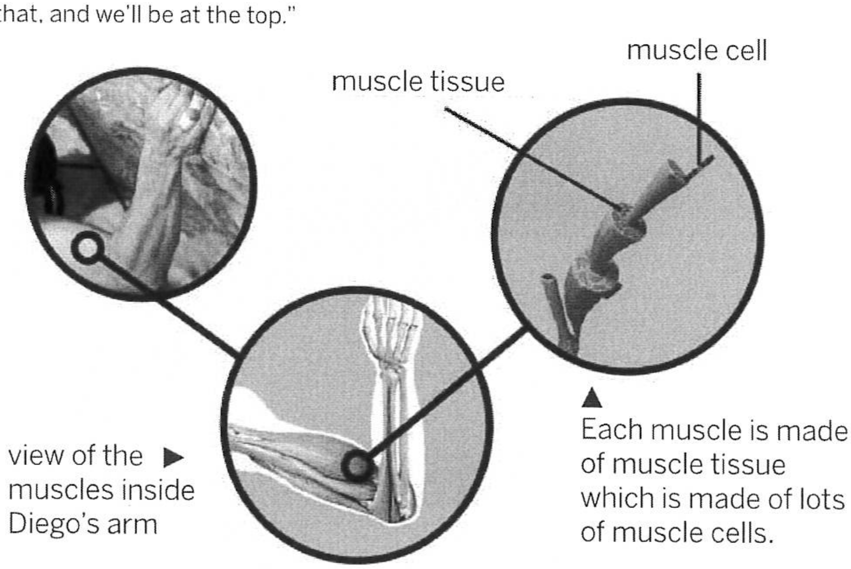
9:13 a.m.: Reaching the first ledge

What's happening at a large scale

Diego starts climbing up toward his brother, who went first and is waiting for him on the first rock ledge. Diego grabs handholds and pulls himself up. He reaches high for a small crack in the rock, and braces himself as he pushes with his legs. His leg and arm muscles feel like they are burning as he climbs up and up. The last move is the hardest, but Diego does it, then sits on the ledge by his brother, breathing hard. "Nice work!" says Gabe, "About twenty more climbs like that, and we'll be at the top."



Diego's muscles work hard as he climbs up the rock wall.

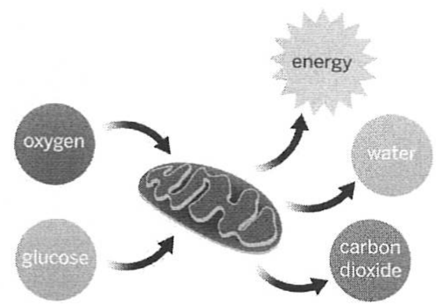


When Diego moves his arm, the muscles in his arm move. When the muscles in his arm move, every cell in his arm muscles moves.

What's happening at a small scale

As Diego reaches for a handhold and pulls himself up, the muscles in his arm pull on his bones to make the movements happen. Diego's muscles are made of muscle tissue, and muscle tissue is made of tiny muscle cells. For Diego's muscles to move, each muscle cell has to move. The movements of billions of muscle cells add up to Diego's move on the rock.

Each muscle cell needs to release energy to move. Energy is released inside parts of the cells called mitochondria. Inside the mitochondria, when glucose molecules and oxygen molecules combine in a chemical reaction called cellular respiration, energy is released. The cells in Diego's muscles bring in oxygen and glucose from his blood. The cells use up these molecules quickly, and they send signals telling his brain they need more. These signals cause Diego to breathe faster and make him start to feel hungry.



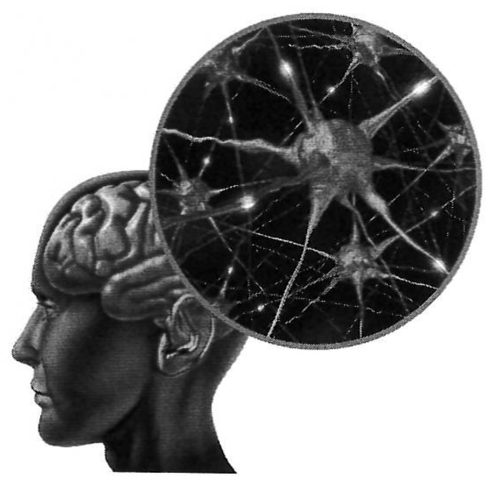
In the mitochondria, glucose and oxygen combine to form carbon dioxide and water, releasing energy. This process is called cellular respiration.

1:17 p.m.: A big decision

What's happening at a large scale

They've made it past the halfway point. Diego pauses to put some chalk on his hands and calls out to Gabe. They've been taking turns leading and following. Now Diego is in the lead, searching for footholds and handholds as he climbs. Diego has to decide where to put the next piece of equipment that will hold their rope. He sees two small cracks in the rock that might work, but he's not sure which is better. If he chooses the wrong one, and he falls, the equipment could come loose, and that would be bad—very bad.

Diego looks closely at the two cracks and feels them with his fingers, trying to decide. It's hard to concentrate. Diego takes a deep breath. He looks again, and now he's sure: the crack on the left is perfect. He puts in the piece of equipment and attaches the rope.



As Diego thinks, cells in his brain send signal molecules back and forth. This takes energy! That's why his brain cells need lots of oxygen for cellular respiration.

What's happening at a small scale

As Diego looks at and feels the rock, signal molecules move from his eye cells to his brain cells and from his finger cells to his brain cells. As Diego thinks, more signal molecules move from one brain cell to another. Each signal takes energy to send. The energy is released by cellular respiration in Diego's cells. Diego might have had trouble concentrating because his brain cells were running low on the glucose or oxygen needed to release energy. Brain cells actually release and use twice as much energy as any other kind of cell in the body! Taking a deep breath brought more oxygen to Diego's brain cells.

6:23 p.m.: Staying warm at night

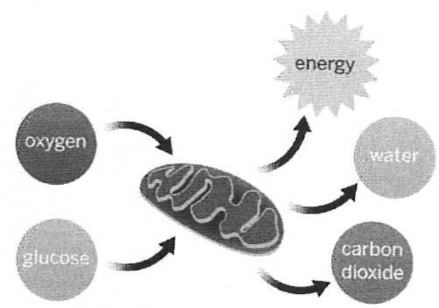
What's happening at a large scale

Diego and Gabe have set up a special tent platform that's attached to the cliff—tonight they'll sleep hundreds of feet up! They are close to the top, but the sun is starting to set and they can't climb in the dark. Diego feels hungrier than he ever has in his life. Who knew instant noodles could taste so good? Now the sun is down and it's cold. Diego and Gabe get into their sleeping bags in their tent. Diego shivers, his whole body shaking. But soon he feels warm and falls asleep, dreaming of ropes and rock.

What's happening at a small scale

As Diego shivers, his muscles shake with tiny movements. These movements warm up his body. Each muscle cell that moves releases energy through cellular respiration. These cells use glucose from his dinner and oxygen from his breath. All night, as Diego sleeps, his metabolism continues to work. His cells don't use as much oxygen and glucose as they did during the day, but they still release energy for pumping blood, digesting the rest of his dinner, keeping warm, repairing small injuries, and even dreaming.

Gabe is shivering just like Diego. Cells all over his body are releasing energy to keep warm, digest his dinner, and do all the other things cells need to do.



All the time, mitochondria in cells all over the body are taking in oxygen and glucose and releasing energy through cellular respiration.

11:34 a.m.: The top

The next day, after a morning of climbing, Gabe and Diego reach the top. They look down at the tree where they started, which now looks as small as a pin. It is a huge accomplishment, and all thanks to invisible actions inside their bodies and cells.

The world of international bicycle racing can be so competitive that some athletes cheat by blood doping.

Blood Doping:

Messing with Metabolism to Win Races

To win international bicycle races, you can't just be in good physical shape—you have to be in AMAZING shape. Your metabolism has to work like a well-oiled machine. The world's top cyclists work to perfect their muscles and body systems so that they process oxygen, glucose, and amino acids better than almost any other humans on Earth.

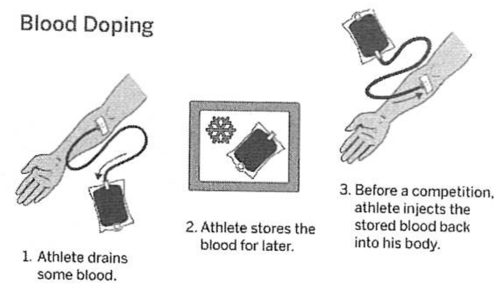
A Cyclist's Metabolism

What's so special about a top cyclist's metabolism? Cyclists' muscle cells contain unusually high numbers of mitochondria, where glucose and oxygen combine to release energy. That means their muscles can release more energy than most people's muscles. To bring in more oxygen, top cyclists breathe hard: up to 75 breaths per minute. To bring in more glucose, they eat lots of carbohydrates, such as starch, even while they're riding! Cyclists often slurp down special gels filled with glucose while they're on their bikes, one hand on the handlebars and the other popping open the gel. To transport these molecules more quickly to their muscle cells, their hearts beat fast: up to 200 beats per minute. A faster heart rate pushes the molecules through the circulatory system more quickly and out to all the cells in the body sooner.

The problem for top cyclists is that even all that isn't always enough to win. Every cyclist in the race is in perfect physical shape, and all of them are looking for an edge to help them win. Sadly, that means some decide to break the rules to help them get ahead . . . not by taking a shortcut on the racecourse or breaking a competitor's bike, but by injecting themselves with extra blood from their own bodies—a practice known as blood doping. Blood doping is banned, meaning it's not allowed in competition, but some cyclists secretly do it to improve their performance. The most famous example of an athlete who used blood doping is Lance Armstrong, who was known as the best cyclist in the world until he admitted to blood doping in 2013.

What Is Blood Doping?

In most cases of blood doping, an athlete drains some of his or her own blood, chills the blood to keep it fresh, and stores it for several weeks or even months. The athlete's body naturally works to replace the lost red blood cells. Then, just before a competition, the athlete injects the stored blood back into his or her body. Injecting blood increases the number of red blood cells in the athlete's body.

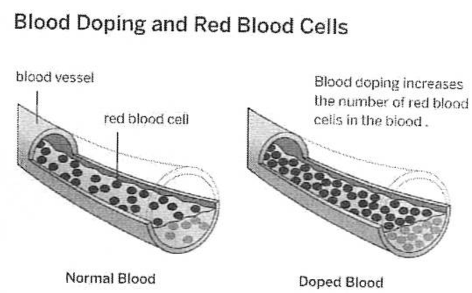


Blood doping requires athletes to remove and store their own blood, then inject it back into themselves later.

How Blood Doping Works in the Body

Red blood cells carry oxygen from your lungs to every cell in your body, including your muscle cells. The red blood cells fill up with oxygen in the lungs and then are pumped out to the body cells, where they drop off the oxygen before returning to the lungs. Each red blood cell can only carry a certain amount of oxygen. Once your red blood cells are full, you can't get any more oxygen into your blood with that breath, no matter how much air you take in. Blood doping improves the body's ability to carry oxygen by increasing the number of red blood cells in the circulatory system. With more red blood cells, the circulatory system can deliver more oxygen to all the cells of the body. The extra oxygen delivered to the body's cells can increase the rate of cellular respiration, which can help an athlete perform better and for a longer time without becoming tired. This happens because oxygen is necessary for the release of energy in the body.

The body's cells release energy through a chemical reaction called cellular respiration. For cellular respiration to happen, cells need both oxygen and glucose. Oxygen enters the body through the respiratory system and is delivered to all the cells of the body by the circulatory system. At the same time, the circulatory system provides the cells with glucose produced when the digestive system breaks food down. Inside the cells, the glucose and oxygen react to produce carbon dioxide



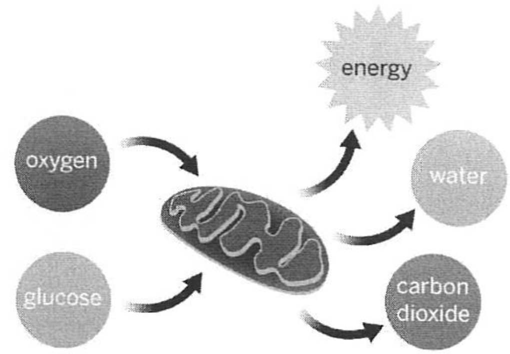
Blood doping increases the number of red blood cells in the body.

and water, and release energy for the body in the process. More oxygen in the body means a faster rate of cellular respiration and increased release of energy.

Catching Blood Dopers

Blood doping is very difficult to detect. Since the body always contains red blood cells, it is difficult to find evidence that an athlete has injected extra red blood cells into his or her bloodstream. One detection method involves testing the age of the red blood cells in a blood sample. The human body constantly produces new red blood cells to replace cells that have died. Blood doping means injecting stored blood, and the red blood cells in stored blood are older than the new red blood cells constantly being produced in the body. A blood sample with an unusually high number of older red blood cells can be evidence of blood doping.

Another method scientists use to detect blood doping is testing the amount of hemoglobin (HEE-moe-globe-in) in the athlete's blood. Hemoglobin is a protein made by the body that carries oxygen in red blood cells. The more red blood cells a person has, the more hemoglobin you'll find in his or her blood. If an athlete has a hemoglobin level that is higher on the day of a race than it was a week before the race, that provides evidence that the athlete might be blood doping. The athlete might even be disqualified from the race if his or her hemoglobin levels are too high.



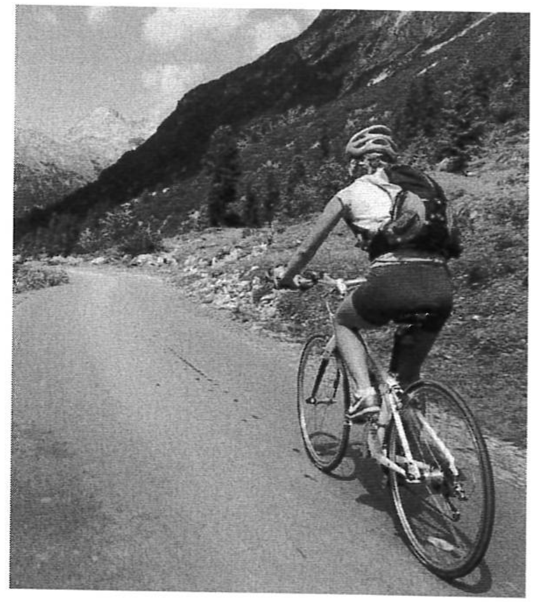
In the parts of the cells called mitochondria, glucose and oxygen combine to make carbon dioxide and water, releasing energy. This is called cellular respiration.

Dangerous Side Effects

One serious potential side effect of blood doping is that increasing the number of red blood cells also increases the thickness of the blood. This unusually thick blood makes the heart work harder and can even cause heart failure.

An Alternative to Blood Doping

There is a legal way for athletes to increase the number of red blood cells in the body: high-altitude training. In the weeks leading up to a competition, some athletes train in the mountains. At high altitude, there is less oxygen in the air than there is at sea level. The athlete's body adjusts to the lack of oxygen by producing more red blood cells: because the body senses that less oxygen is available, it produces more red blood cells so that more oxygen can be picked up with each breath. It takes the body several weeks to adjust and increase the number of red blood cells. High-altitude training takes a longer time than blood doping, but it has the same effect and is not considered cheating. However, high-altitude training may have the same harmful side effect of making blood thicker.



High-altitude training has similar effects to blood doping, but it's legal.

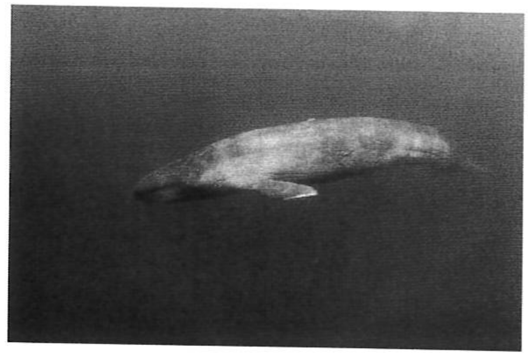
Odd Organisms

and How They Get the Molecules They Need

Some organisms can seem very odd if you look closely at how their body systems work! All organisms need to take in molecules from their environment. However, different organisms may have very different ways of taking those molecules in and getting them where they need to go. For example, in order to take in enough oxygen to supply its huge body during long dives, a blue whale's lungs are almost 5,000 times larger than yours. Grasshoppers don't have lungs at all—they take in oxygen from the air through tiny holes along the sides of their bodies! Trout and other fish use gills instead of lungs, and they take in oxygen directly from the water they live in. Sea sponges and water bears have even stranger body systems. To learn more about blue whales and their amazing body systems, keep reading.

Blue Whale

Imagine that you are swimming next to the largest animal ever to have existed. It's as long as three school buses, weighs between 200,000 and 300,000 pounds, breathes air, and lives in the ocean. This animal is a



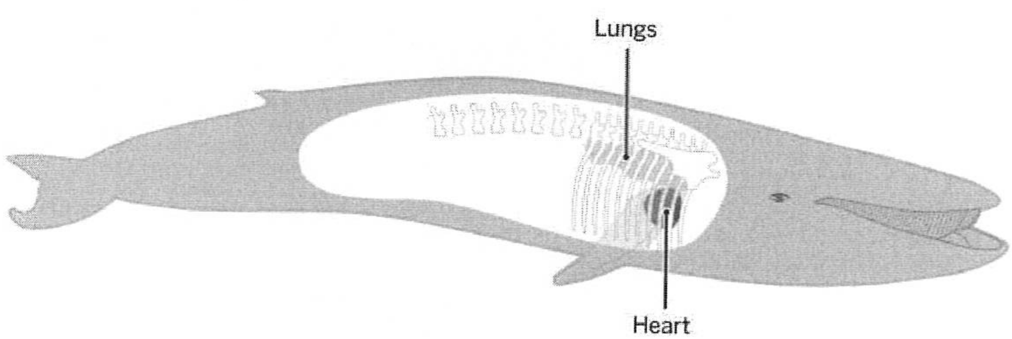
Blue whales are the largest animals on Earth.

blue whale, and its enormous size means that it needs to eat a lot of food and take in a lot of oxygen. Blue whales must dive deep underwater to feed, which means that they spend a lot of time holding their breath. How can a blue whale survive 20 minutes without taking a breath?

Getting Oxygen from the Air

Like humans, blue whales breathe air. Whales can't get oxygen from the water, so they have to hold their breath underwater, transporting oxygen through their respiratory systems. Whales breathe air into their lungs, which are lined with blood vessels called capillaries. Because whales are so big and because one breath of air has to last them a long time, the lungs of a blue whale are very large—nearly

Blue Whale Respiration



Blue whales are mammals, and must breathe oxygen from the air.

5,000 times bigger than a human's lungs! Capillaries allow oxygen to enter the whale's blood, which carries it to the heart. The heart pumps the blood through the circulatory system, bringing oxygen to all the cells of the body. Cells use the oxygen for cellular respiration and must get rid of carbon dioxide produced during the cellular respiration reaction. The carbon dioxide goes into the circulatory system, where blood moves it to the heart and then to the lungs, where it will be breathed out.

Food for Energy Release

Just like humans, blue whales need energy to live and grow. Whales get the molecules they need to release energy from the air they breathe and the food they eat. Blue whales eat krill, a type of tiny animal that looks similar to a shrimp. Krill are high in fat and protein. To get enough food to maintain such large bodies, blue whales eat thousands of pounds of krill a day. The blue whale does not have teeth; instead, it has a part in its mouth that acts like a filter to keep the krill in and spit water out. The swallowed krill pass through the whale's digestive system. In the stomach, acids and enzymes begin to break them down. This partially digested food is then broken down into amino acids and molecules from fats, which are absorbed in the small intestine.

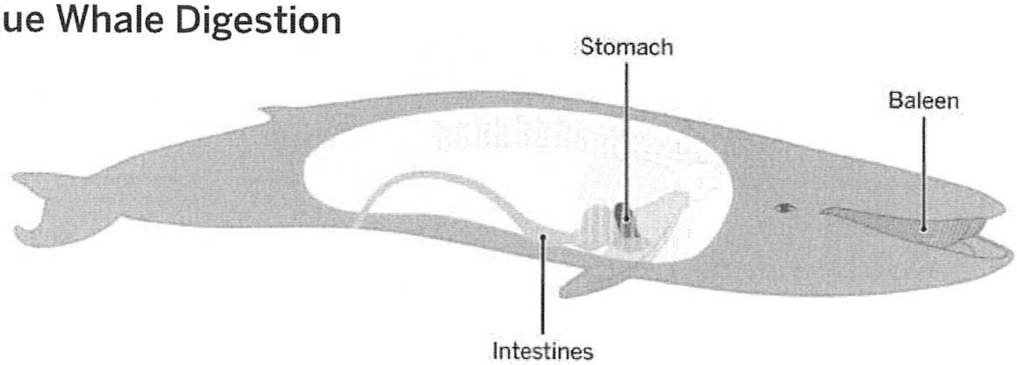
Bringing Matter to Cells

Since whales cannot breathe underwater, but spend most of their time there, their circulatory systems have adapted to the lack of oxygen. When a blue whale goes on a long dive, its heart slows down so it uses less oxygen. If the heart were pumping fast, it would quickly use up all of the oxygen stored in the lungs.

Another way blue whales use less oxygen underwater is by decreasing blood flow to certain parts of the body. Since the brain always needs molecules from blood for energy, blood temporarily stops flowing to less important organs, such as those in the digestive tract, and to the muscles of the tail fins and flippers.

Although whales can hold their breath longer than humans can, they still need oxygen and food, which they break down into molecules that can be used to release energy. Despite the many physical differences between blue whales and humans, our cells still have the same survival needs.

Blue Whale Digestion



Blue whales digest their food and use oxygen and molecules from the food to release energy.

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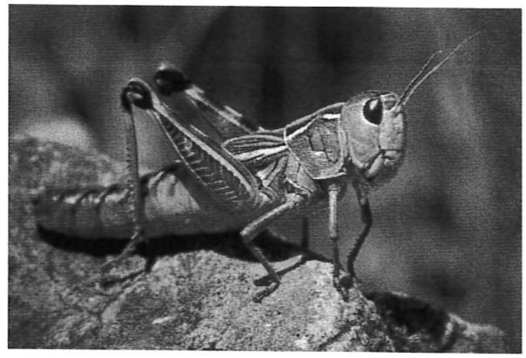
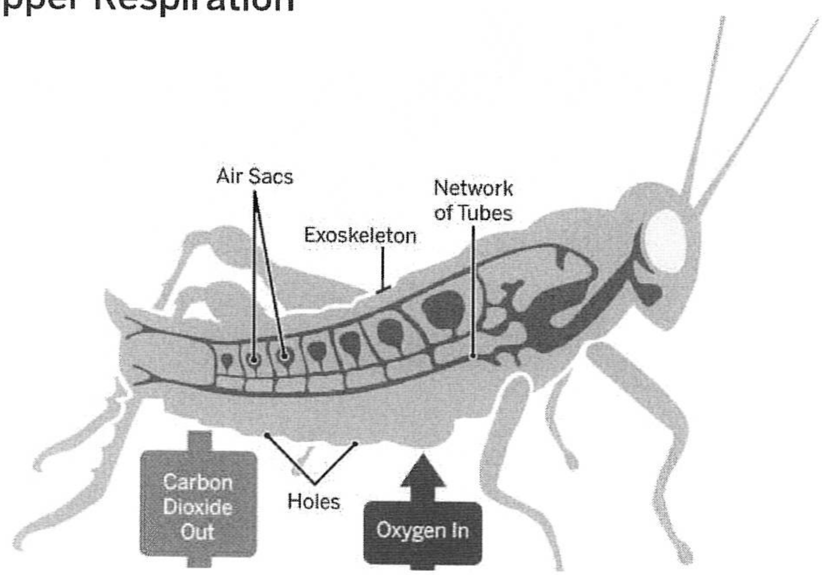


Grasshoppers can jump very high in comparison to their small size.

Grasshopper

Imagine being able to jump 180 feet into the air over and over again. If you were a human-sized grasshopper, you could—but you'd also need to eat twice your body weight in food every day! Like you, grasshoppers get glucose and oxygen from food and air and use those molecules to perform cellular respiration, which releases energy in their cells. It's this reaction that gives grasshoppers the energy they need to jump so high, so often.

Grasshopper Respiration



Grasshoppers don't have lungs; instead, they take air in through tiny holes on the outsides of their bodies.

Getting Oxygen Without Lungs

Grasshoppers need to take in oxygen molecules and get them to their cells, just as humans do. However, the system that moves oxygen around in the grasshopper body is very different from the one that does the same in humans—grasshoppers don't have lungs, and they don't carry oxygen in their blood. Oxygen enters the body through tiny holes in the grasshopper's abdomen and travels to the cells in the body through a complex network of tubes.

Converting Food Into Glucose

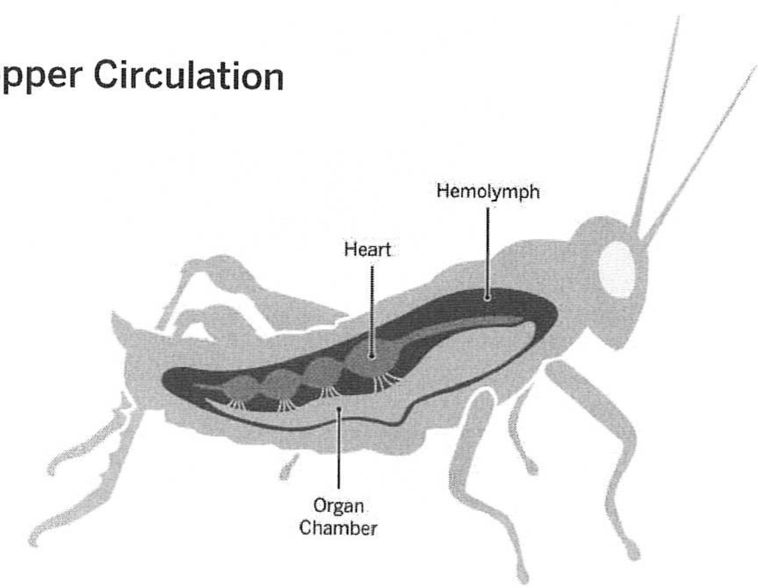
What do grasshoppers eat? Grass, of course! Grass is mostly made of a substance called cellulose. Humans eat cellulose, too: we call it fiber. However, humans can't actually digest cellulose: it passes through our digestive systems without breaking down. Grasshoppers, on the other hand, have enzymes that can break down cellulose into glucose. Although grasshoppers and humans have different organs in their digestive systems, those organs share the function of converting food into glucose and then sending the glucose into the circulatory system, where it's carried to cells all over the body.

Bringing Matter to Cells

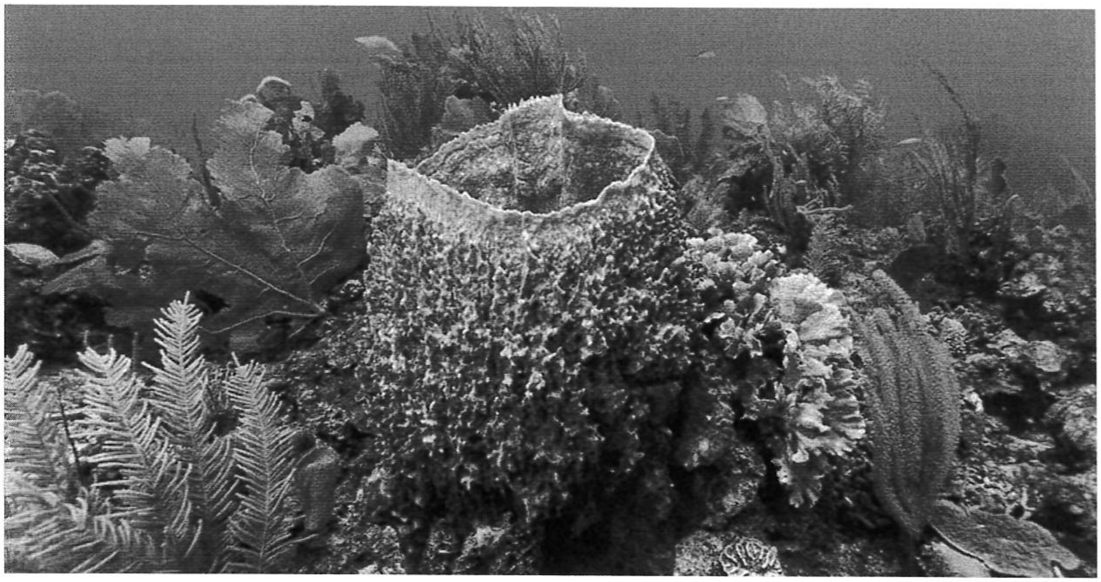
Like you, a grasshopper has a circulatory system for carrying molecules to its cells. However, a grasshopper's circulatory system is very different from a human's circulatory system. Your circulatory system is filled with blood. Instead of blood, grasshoppers have a different fluid called hemolymph. Human blood is always contained within blood vessels and pumped through the body by the heart. Instead of a single heart and many blood vessels, grasshoppers have a single tube that runs down the top of the body, with several hearts inside it. The blood-like hemolymph simply fills up the space surrounding a grasshopper's organs, bringing glucose to the cells. The main function of a grasshopper's circulatory system is to carry glucose and other nutrients. It doesn't have to carry oxygen the way a human circulatory system does, because oxygen enters through holes in the grasshopper's body and goes directly to the cells.

Grasshoppers obtain oxygen and glucose differently than humans do, but the resulting chemical reaction is the same—cellular respiration occurs, releasing energy.

Grasshopper Circulation



A grasshopper has multiple hearts in its circulatory system.



Some sponges are barrel-shaped and can grow large enough for a human to fit inside.

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Sea Sponge

Did you know that you can use a sea creature to clean your house? For hundreds of years, people used the skeletons of animals called sea sponges, which had been brought up from the sea floor and dried, to clean up spills and scrub their houses—and both the name and the shape stuck! Most of the sponges we use today are made in factories, but they are modeled after the sponges found on the bottom of the ocean.

Sea sponges come in all shapes and sizes, from very tiny to large enough to fit an entire human inside! They're very simple creatures, though: a sponge doesn't have a respiratory system, a digestive system, or a circulatory system. Instead, sponges rely on the flow of water through their bodies to bring them food and oxygen and carry waste away. Most sponges are shaped like tubes, with one end stuck to a rock, coral reef, or the sea floor. They bring water in through pores, or small holes, on the outsides of their bodies, and release it from the top of the tube. As the water flows through, the sponge takes what it needs and gets rid of what it doesn't.

Getting Oxygen from the Water

Just like you, sea sponges need oxygen to survive. Instead of breathing oxygen from the air, sponges take in oxygen directly from the water they live in. The water has oxygen molecules dissolved in it. Water enters the sponge through tiny pores and is spread through the body by whip-like structures called flagella. Wherever it goes, the water carries oxygen molecules to the sponge's cells.

Food for Cellular Respiration

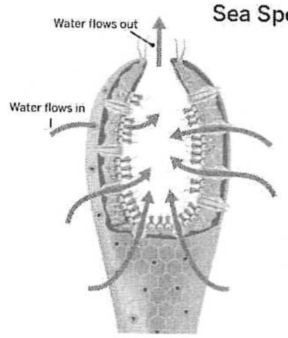
Sponges stay in one place, and can't move to go find food—which means their food has to come to them. Like everything else they need, sponges get their food from the water that flows through them. The water carries tiny bits of food, which the sponge filters out as the water passes through it. Cells in the sponge's body break the food down into glucose molecules. Then the cells can use the glucose molecules, along with the oxygen molecules they took in from the water, for cellular respiration. Through cellular respiration, the cells release the energy they need in order to function.

Bringing Matter to Cells

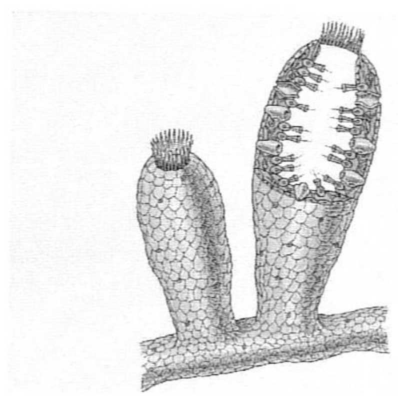
Sea sponges don't have circulatory systems. Many of a sea sponge's cells get all the molecules they need directly from the seawater that flows through the sponge. However, some cells deep inside the sponge's body don't come into direct contact with seawater, and those cells need help getting glucose. Special cells in the sponge's body actually take glucose to the cells that can't filter food directly from the water.

The bodies of humans and sea sponges don't have very much in common—but both are animals, both need oxygen and glucose to stay alive, and both have bodies that make sure their cells get the molecules they need.

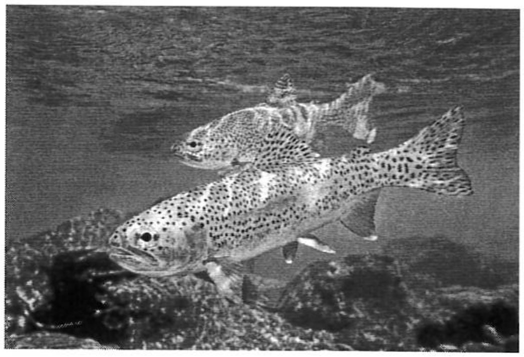
Sea Sponge Anatomy



Sea sponges take in water through holes near their bases and let it flow out through their tops.



The cells that line the insides of sea sponges catch food from the water that passes through them.



Trout are fish that live mainly in rivers and lakes.

Odd Organisms

and How They Get the Molecules They Need

Some organisms can seem very odd if you look closely at how their body systems work! All organisms need to take in molecules from their environment. However, different organisms may have very different ways of taking those molecules in and getting them where they need to go. For example, in order to take in enough oxygen to supply its huge body during long dives, a blue whale's lungs are almost 5,000 times larger than yours. Grasshoppers don't have lungs at all—they take in oxygen from the air through tiny holes along the sides of their bodies! Trout and other fish use gills instead of lungs, and they take in oxygen directly from the water they live in. Sea sponges and water bears have even stranger body systems. To learn more about trout and their amazing body systems, keep reading.

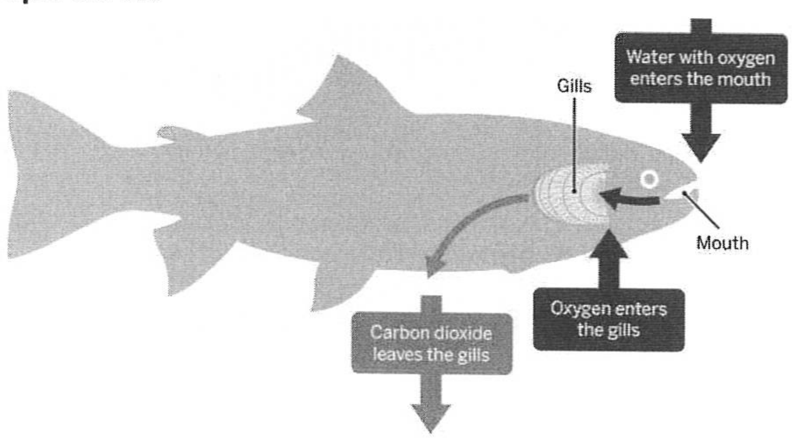
Trout

How is a human like a trout? After all, humans walk on dry land and breathe air through lungs, while trout swim underwater and don't have lungs at all. Still, both humans and trout must take in food and oxygen to release energy through cellular respiration. Humans get oxygen from the air, but trout live underwater—so where does their oxygen come from?

Getting Oxygen from Water

Trout need oxygen to survive and release energy, but they can't get it from the air. So how do they get oxygen underwater? Most water has oxygen dissolved in it—the oxygen isn't visible, but it's there, and fish can use it. Fish have gills that serve the same purpose as lungs do in humans: exchanging gases. They open their mouths and take in water containing oxygen. This water passes through the gills, which absorb oxygen from the water and send it into

Trout Respiration



Trout take in oxygen from water using organs called gills.

the blood. The blood carries oxygen to every cell in the body.

Food for Cellular Respiration

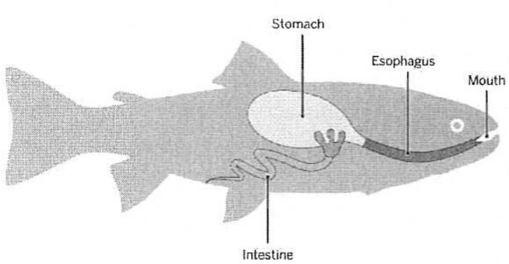
Like humans, trout eat many different things, and their digestive systems break food down into smaller molecules they can use. The trout diet includes bugs, worms, plants, and other fish. Trout get some glucose for cellular respiration from starch in the plants they eat: the glucose from the plants reacts with oxygen in the trouts' cells to release energy. Trout can also break down fats from the bodies of animals they eat into molecules that can be used to release energy. Food enters the trout's body through the mouth, then moves into the esophagus. Trout don't chew their food with teeth, but their esophaguses can stretch to allow large pieces of food to pass through. In the trout's stomach, enzymes and acid begin to break food down. At the end of the stomach, there are several small tubes that produce more enzymes that convert the food into glucose. The breakdown of food is completed in the intestine. There, glucose and other molecules pass through the walls of the intestine and into the circulatory system.

Bringing Matter to Cells

The circulatory system of a trout is similar in many ways to a human circulatory system. Just like you, a trout has a heart that pumps blood, carrying glucose and oxygen molecules through a network of blood vessels and capillaries. In both trout and humans, blood vessels also carry away the carbon dioxide that is produced in the process of cellular respiration.

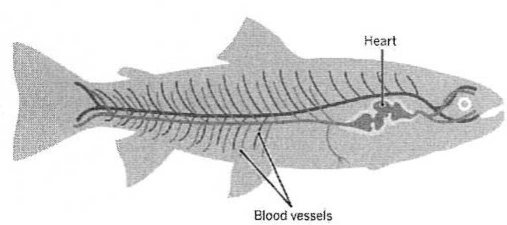
Trout obtain oxygen and glucose differently than humans do, but the end result is the same: cellular respiration occurs in the cells and energy is released.

Trout Digestion

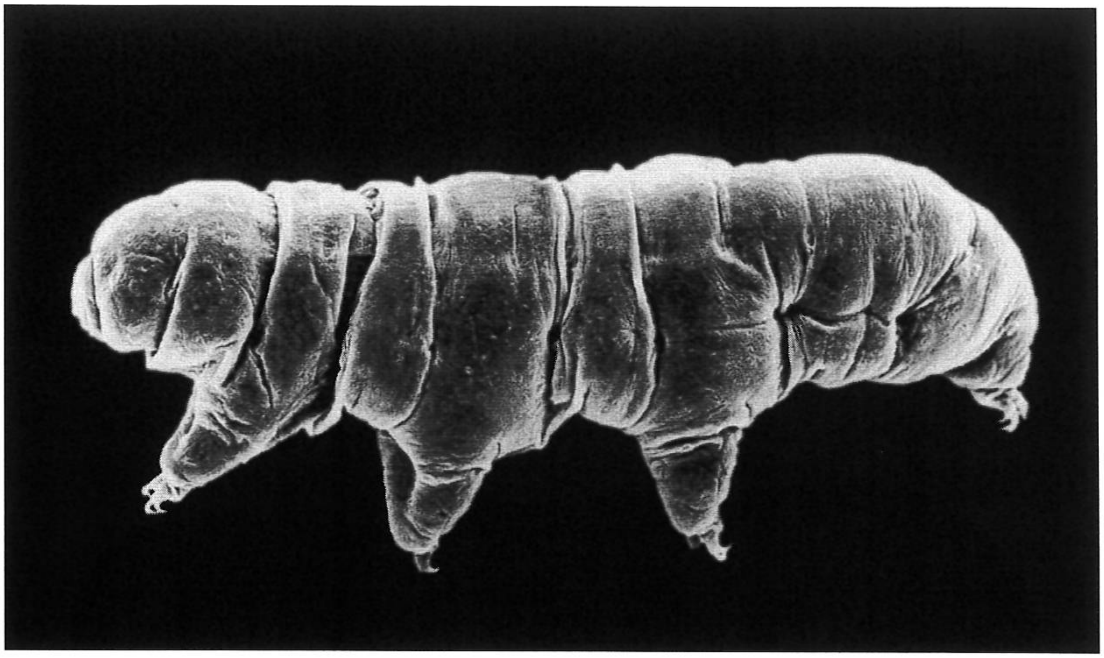


Trout eat bugs, worms, plants, and other fish, and their digestive systems break down their food into smaller molecules they can use.

Trout Circulation



The circulatory system of a trout carries oxygen and glucose to all its body cells, just as a human circulatory system does.



Water bears got their name because they look and move a little like tiny bears.

Odd Organisms

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Water Bear

If you were to think of the toughest animal you could imagine, what would it be? Maybe a huge animal with large claws and sharp teeth? What about a tiny animal with no teeth and no lungs that moves slowly and eats algae and bacteria? This animal may not sound tough, but it can withstand pressure, heat, and cold that would kill any other living organism. What animal is this? A water bear! When conditions are tough, and there is no oxygen, water, or food available, water bears go into a state of hibernation called the tun (toon) stage. During this time, cellular respiration stops almost completely and the water bear does not move or react to its environment—but it can come back to life as soon as conditions return to normal.

Getting Oxygen from the Water

Water bears don't have respiratory systems. Instead, the water bear's body simply absorbs oxygen directly from the water it lives in. Water contains dissolved oxygen. Water bears can live wherever there is water, even in tiny amounts, like under leaves on damp soil. Humans have lungs and respiratory systems because we are too big to let oxygen just float into our bodies the way water bears do. Even though water bears get oxygen in a different way than humans do, we both need oxygen for the same reason: to release energy through cellular respiration.

Getting Glucose from Food

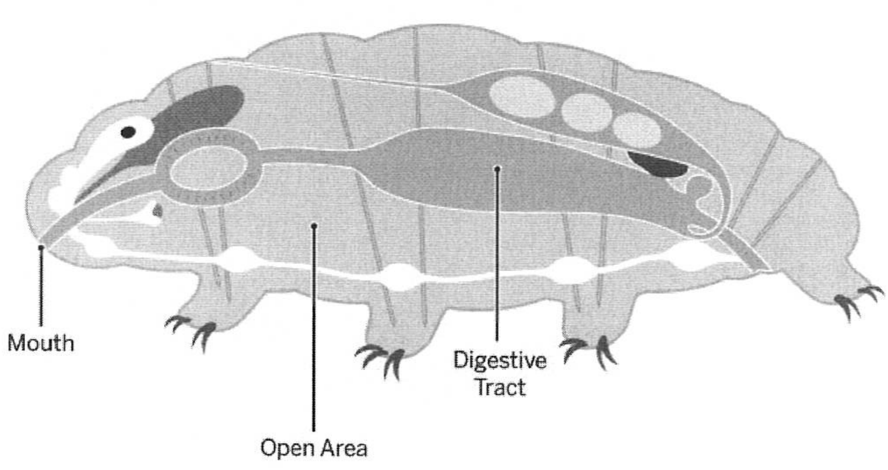
Different species of water bears eat different things, like moss, algae, bacteria, and very small animals. The water bear has a simple digestive system. It uses its tube-shaped mouth to poke through the cell membranes of the microorganisms it eats. Then it sucks the fluid from inside the cell. This food matter supplies water bears with amino acids and the glucose they need for cellular respiration.

Getting Matter to Cells

We humans need a circulatory system to make sure all of our cells get the molecules they need, but it's simpler for water bears to get molecules to their cells. A human body has about 10,000,000,000,000 (ten trillion) cells, while the body of a water bear only has about 40,000 cells. With such a small number of cells, water bears don't need circulatory systems: they get matter to their cells in a different way. The water bear moves a little bit like an inchworm, and it uses special squeezing muscles to move around. As the water bear moves, it also moves body fluids through an open area that's surrounded by every cell in the water bear's body. Oxygen, glucose, and amino acids get to every cell in the water bear's body through that open area.

The water bear has adapted to the way its environment sometimes dries up, but it can only do this by extreme hibernation. When they are not hibernating, water bears still need glucose and oxygen to live. Despite the many differences between water bears and humans, we need oxygen and glucose for the same reason: cellular respiration.

Water Bear Anatomy



Water bears have simple body systems that absorb oxygen directly from water and transport matter to their cells.