EDUCATOR GUIDE
Grades 5 – 8

Now on exhibit through January 5, 2020

To book your field trip:
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Contents

- Planning your Visit ................................................................. 5
- Note to Educators ....................................................................... 6
- Frequently Asked Questions .................................................... 8
- Classroom Activities ................................................................. 11
- Exhibition Overview including Human Facts .............................. 25
- Massachusetts Science Standards ............................................. 34
- Additional Resources ................................................................. 35
Planning Your Visit

Before
- Read the Note to Educators and Frequently Asked Questions in this guide.
- Visit the BODY WORLDS website (bodyworlds.com) for a preview.
- It is recommended teachers complete pre-visit activities with students. This will help prepare your students for what they will encounter within the exhibition.
- Discuss the visit with students and explain what they are going to see and why.
- Administer permission forms to parents and guardians.
- Register for our free Teacher Partner Program to take advantage of special benefits, including free access to the Exhibit Halls to preview the exhibit before your field trip.

During
- Bring the Educator Guide with you to the exhibition.
- Seek out Museum staff for answers to your questions about the exhibition.

After
- Complete the suggested activities with your students.
- Consider sharing your students’ reactions to BODY WORLDS.
- Visit some of the websites listed in the additional resources section.
Note to Educators

Dear Educator:

The primary educational goals of Gunther von Hagens’ BODY WORLDS & The Cycle of Life are health science, human anatomy, and physiology. These specimens provide insight into the major systems and organs of the human body. Comparisons of healthy and diseased organs such as a lung from a smoker and non-smoker highlight the benefits of healthy lifestyle choices. In addition, the exhibit conveys powerful lessons about the form, function and beauty of the human body and how everything works together. Students come to understand that people are as unique on the outside as they are on the inside, as each human body is distinctly different from every other. Position, size, shape, and structure of skeleton, muscles, nerves, and organs determine our “interior face.” The authenticity of the real specimens illuminates the “interior face” and through careful observation the miracle of the human body is revealed. To date, more than 48 million people around the world have viewed the BODY WORLDS exhibits.

BODY WORLDS & The Cycle of Life displays specimens preserved using Dr. Gunther von Hagens’ groundbreaking invention of Plastination, a process that replaces the natural fluids in the body with fluid plastics. The use of plastics for preservation means the specimens are odorless and completely dry. Plastination allows the bodies to be fixed into life-like poses, illustrating how our bodies are structured and how they function when performing everyday activities. Students will understand how the body works when it’s healthy and what happens when it breaks down.

Teachers are responsible for distributing and collecting the enclosed parental permission form. By entering the exhibition with your student, you are acknowledging that all of your students have parental permission to view the exhibition. We will not review permission forms, it is not necessary to bring the completed forms on your visit.

Please note that we have ensured that any of our visitors or school groups who do not wish to see BODY WORLDS & The Cycle of Life will still be able to visit the Museum without viewing any part of the exhibition.

Permission Form

Important information to know about the BODY WORLDS & The Cycle of Life exhibition:

The BODY WORLDS exhibits rely on the generosity of body donors, individuals who made declarations of will and gave their legal consent that, upon their death, their bodies could be used for educational purposes in the exhibition. All of the full body plastinates and the majority of the specimens are from these body donors; some specific specimens that show unusual conditions stem from old anatomical collections.

• Most are without skin so you can see the bones, muscles, tendons, nerves, blood vessels and organs. Eyes and genitals of the bodies remain. Written descriptions accompany specimens.

Parent / Guardian Permission Form:
By signing this form, you are acknowledging that your child has permission to view the exhibition with a teacher, school supervisor, or other school representative. If you do not wish for your child to see this exhibition, please ask the teacher to make other arrangements.

Yes, I give (student’s name) permission to view BODY WORLDS & The Cycle of Life.

Parent/Guardian’s name (please print)

Parent/Guardian Signature

Date
Frequently Asked Questions

What is BODY WORLDS?
The BODY WORLDS exhibitions are first-of-their-kind exhibitions through which visitors learn about anatomy, physiology, and health by viewing real human bodies, using an extraordinary process called Plastination, a groundbreaking method for specimen preservation invented by Dr. von Hagens in 1977.

Each exhibition features more than 100 real human specimens, including whole-body plastinates, individual organs, blood vessel configurations, and transparent body slices. The exhibitions also allow visitors to see and better understand the long-term impact of diseases, the effects of tobacco consumption, and the mechanics of artificial supports. To date, more than 48 million people around the world have viewed the BODY WORLDS exhibits.

What is the purpose of the exhibition?
The BODY WORLDS exhibitions aim to educate the public about the inner workings of the human body and show the effects of poor health, good health, and lifestyle choices. They are also meant to create interest in and increase knowledge of anatomy and physiology among the public.

Could I learn just as much from books or models of human anatomy?
Real human bodies show the details of disease and anatomy that cannot be shown with models. They also allow us to understand how each body has its own unique features, even on the inside. Visitors are drawn to real specimens in a way that they are not to plastic models. One of the special features of museums and science centers is that they offer people a chance to see the real thing in a safe and informative environment.

What is Plastination?
Invented by scientist and anatomist Dr. Gunther von Hagens in 1977, Plastination is the groundbreaking method of halting decomposition and preserving anatomical specimens for scientific and medical education. Plastination is the process of extracting all bodily fluids and soluble fat from specimens, replacing them through vacuum forced impregnation with reactive resins and elastomers, and then curing them with light, heat, or certain gases, which give the specimens rigidity and permanence.

Where did the specimens on display come from?
The BODY WORLDS exhibitions rely on the generosity of body donors; individuals who bequeathed that, upon their death, their bodies could be used for educational purposes in the exhibitions. Currently, the Institute for Plastination has a donor roster of more than 18,000 individuals; 2,200 are already deceased.

All of the whole body plastinates and the majority of the specimens are from these body donors; some specific specimens that show unusual conditions come from old anatomical collections and morphological institutes. As agreed upon by the body donors, their identities and causes of death are not provided. The exhibitions focus on the nature of our bodies, not on providing personal information.

Why are the plastinates posed the way they are?
The poses of the plastinates have been carefully thought out and serve educational aims. Each plastinate is posed to illustrate different anatomical features. For instance, the athletic poses illustrate the use of muscle systems while playing sports. The poses allow the visitor to relate the plastinate to his or her own body.
Will I be able to touch any of the plastinates?
While you will be able to get very close to the plastinates, as a rule, visitors are not allowed to touch them.

Are these exhibitions appropriate for children?
More than 48 million people, including young children, have viewed the BODY WORLDS exhibitions around the world. It is important to note that the exhibition includes full-body plastinates with exposed genitals. We recommend the BODY WORLDS exhibits for school groups in grades 5 and up.

Why is it important for the public to see these exhibits?
We believe that when people understand more about how the body works and how it can break down, they are more likely to choose healthy and sustainable lifestyles. We also hope it will inspire visitors to learn more about the life sciences. Knowledge about what the human body looks like and how it functions is basic life science information that should be available to everyone.

How long can I stay inside the exhibits?
You can stay as long as you like, but we recommend allowing yourself about one to two hours. The length of time will vary on how long each visitor wishes to examine each specimen and read the information provided.

Are food and drink permitted in BODY WORLDS?
Food and drink are not permitted in the exhibit galleries. The policy helps to protect the BODY WORLDS plastinates.

Classroom Activities
These classroom activities can be used as either pre-visit activities to prepare students for BODY WORLDS & The Cycle of Life or as post-visit activities to help debrief them. As you know your students best, please modify these activities to suit your class’ needs.

Make a Breathing Model

Materials:
- 1 clear plastic cup
- 1 plastic drinking straw
- 1 small round balloon
- 1 large round balloon
- 2 rubber bands
- 1 small ball of plasticine
- 1 pair of scissors

![Diagram of a breathing model]
Preparation and Method:

1. Insert the straw into the neck of the small balloon. Wrap the rubber band around the balloon neck and the end of the straw to make an airtight seal. (You should still be able to blow up the balloon through the straw).

2. Punch a small hole in the bottom of the cup. Enlarge it so that the free end of the straw can just be pushed through from inside the cup.

3. Seal around the straw and the hole using the plasticine.

4. Cut off the bottom half of the large balloon and stretch it over the opening of the cup. Use the other rubber band to hold it in place.

Observation:

The straw represents the trachea, the cup represents the chest, the small balloon represents the lungs, and the stretched balloon represents the diaphragm. When you pull on the middle of the diaphragm (simulating breathing in), the lungs will increase in size. When you release the diaphragm, the lungs will decrease in size.

Explanation:

When you pull on the middle of the diaphragm, this increases the volume of the “chest cavity” and lowers the air pressure inside. The higher pressure of air outside then pushes air into the “lungs” through the “trachea.” To exhale air, the diaphragm is allowed to return to its resting point, reversing the process.

Make a Stethoscope to Listen to your Heart and Guts

You can listen to your own heart and intestines with a homemade stethoscope.

Materials:

- scissors
- small plastic funnel
- plastic tubing
- 3-way hose connector (from hardware store)
- clear tape
- stopwatch
- notepad
- pen

Plastic funnel
Rubber band
3-way hose connector
Plastic tubing
Preparation and Method:

1. Carefully cut three lengths of tubing, each about 12 inches long. Tape the funnel to the end of one of the tubes. Push the other end of this tube and one end of each of the other tubes into the hose connector. Use tape to make sure that they fit snugly.

2. Ask a classmate to do something active such as running for one minute. Since the sounds that you are listening for are very faint, you must do these activities in a quiet room. Now ask your classmate to hold the funnel over his or her chest and hold the tube ends to your ears, do not push them in. Count the number of heartbeats in one minute—this is their heart rate.

Observations and Explanation:

Sometimes you can hear sounds from your stomach and intestines. While you are digesting your food, faint gurgling sounds may be heard as the organs squeeze food along. Listen over different parts of the abdomen to try to hear some of these sounds. The stomach makes much louder sounds when it is empty compared to when it is full. These result from the squeezing around of air bubbles and stomach juices.

How Blood Travels through the Body:

Directions: Fill in the blanks below with these words. Each word may only be used once.

<table>
<thead>
<tr>
<th>Aorta</th>
<th>Inferior vena cava</th>
<th>Veins</th>
<th>Atrium</th>
<th>Food</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capillaries</td>
<td>Arteries</td>
<td>Ventricle</td>
<td>Superior vena cava</td>
<td>Vein</td>
</tr>
<tr>
<td>Capillary</td>
<td>Oxygen</td>
<td>Circulatory system</td>
<td>Blood vessels</td>
<td></td>
</tr>
</tbody>
</table>

A system of _____________ carries blood through the body. These vessels include _____________, _____________, and ___________. These vessels and the heart make up the _______________. Let’s follow that droplet of blood through the blood vessels. When it leaves the left _______________ of the heart, it goes into the _______________. This vessel is the largest artery in the body. Soon after leaving the heart, this vessel branches, so the droplet could move into the smaller arteries leading to the head or arms. Let’s assume this droplet travels down toward the legs. The largest artery divides to carry blood to each leg. This droplet of blood goes into one of the branches. From here, the blood travels in smaller and smaller arteries until it reaches the very end of the big toe. The blood vessel here is so small it cannot be seen by the naked eye. This tiny vessel is a _______________. At this point, the droplet nourishes the cells next to this tiny vessel and takes away the waste products.

Now that the blood has given up its _______________ and _______________, it must return to the heart. It moves into a larger blood vessel called a _______________. This droplet joins other blood going back to the heart. The blood vessels become larger and larger and finally they all join one large blood vessel that receives all blood from the lower part of the body. This blood vessel is called the _______________. Another large blood vessel called the _______________ collects blood from the head and arms. Both then separately enter the right _______________ of the heart.
A system of blood vessels carries blood through the body. These vessels include arteries, veins, and capillaries. These vessels and the heart make up the circulatory system. Let’s follow that droplet of blood through the blood vessels. When it leaves the left ventricle of the heart, it goes into the aorta. This vessel is the largest artery in the body. Soon after leaving the heart, this vessel branches, so the droplet could move into the smaller arteries leading to the head or arms. Let’s assume this droplet travels down toward the legs. The largest artery divides to carry blood to each leg. This droplet of blood goes into one of the branches. From here, the blood travels in smaller and smaller arteries until it reaches the very end of the big toe. The blood vessel here is so small it cannot be seen by the naked eye. This tiny vessel is a capillary. At this point, the droplet nourishes the cells next to this tiny vessel and takes away the waste products.

Now that the blood has given up its oxygen and food, it must return to the heart. It moves into a larger blood vessel called a vein. This droplet joins other blood going back to the heart. The blood vessels become larger and larger and finally they all join one large blood vessel that receives all blood from the lower part of the body. This blood vessel is called the inferior vena cava. Another large blood vessel called the superior vena cava collects blood from the head and arms. Both then separately enter the right atrium of the heart.

Myself in Numbers

Here, the students discover how diversely and, at the same time, how similarly people are built. With this aim, the students take various measurements of themselves or their classmates.

Exercises:

1. Use a soft tape measure and take the following measurements:
   - Height
   - Length of foot
   - Outstretched arm length
   - Forearm length
   - Circumference of the head
   - Width of chest
   - Width of waist
   - Height of highest point your fingers can reach

2. Produce a large poster with a table into which all students can enter their results.

3. Compare the results.

4. Lie on a large piece of cardboard. Ask a classmate to draw your silhouette on the cardboard. Now turn yourself 90° on the same piece of cardboard and get someone to draw your silhouette once again. What do you notice?

5. In the exhibition, look for a similar plastinate and compare it with your picture on the piece of cardboard!
The Mind of the Inventor

Gunther von Hagens is the creator of Plastination. For more than 40 years, he has worked in this field, inventing various methods to make possible something completely new. He describes what he does as follows:

During the 40 years I have worked on plastination, I have produced a whole host of individual inventions. I am always being asked how I think up such ideas and how I take each of them forward. How I come up with inventions relating to the development of Plastination corresponds to the four usual stages of invention: identifying the problem, analyzing it, working out solutions and, finally, putting them into practice.

1. Identifying the problem:

I basically question everything. Even good things can be improved upon, as “good” can always be made “better.” So, in inventing Plastination, I realized there was one key problem. Saturating specimens in synthetic substances had to be an improvement on the usual practice up to that point of laying them in blocks of synthetic material.

2. Analyzing the problem:

I try not only to identify the problem at hand, but also to imagine what additional questions it could provoke. Part of that process involves studying manuals, textbooks, literature on patents and company brochures, as well as regularly visiting trade shows.

3. Solving the problem:

I am never completely satisfied with any solution. Instead, I always follow a number of trains of thought; you should allow three to five possible solutions to compete for a while. It is also important not to fix on one particular solution too early. When I am pursuing the beginnings of a solution, I have complete faith in the fact that the solution I am working on will succeed, even if, from a purely factual point of view, that is rubbish. You have to keep returning to the problem and factoring in your own mistakes. When discussing possible solutions with experts, I often evaluate them in the following way: the more emotional it would be to reject a given solution, the more likely it is to be revolutionary and, in principle, possible.

Putting the solution into practice:

At this stage, studying company brochures and visiting trade shows is again important. You cannot afford not to be constantly improving your technical knowledge and repeatedly thinking through possible ways of putting ideas into practice. So I spend almost all my time thinking about Plastination: even before getting up, when thinking about my plans for the day in the shower, while driving, when doing the shopping. Only through this can the blancmange mould become the skull, the meat slicer a machine to slice up the brain, the machine that turns chips a machine that turns brain sections, the price tag holder in the shop window the clips for the plates that flatten plastinated sections, and the aquarium pump a sprayer for gas hardening techniques. This process of adapting and exploiting established technology is the lifeblood of invention. I often try the impossible or the downright ludicrous. Often it is in trying out nonsensical ideas that I have crucial thoughts. So I permit myself mistakes or even make them on purpose. The strangest experiments, mistakes and accidents lead to inventions.

Exercises:

1. Read the above text. Pick out the individual steps of an invention. Present them graphically on a sheet of paper or on a poster. Use the following symbols:

Of course you can also use or invent your own symbols!

2. List what Gunther von Hagens uses for his inventions:

a. Logic
b. Imagination
c. ...
d. 
e. f. g. h.

3. Put the areas you named in number 2 onto a small “Thought Map.” You can decide how big to make it. Then briefly describe what view of the human thought process underpins an inventor’s work.
Stomach:

1. Write the biography of a stomach (from beginning to end)
2. While doing so, think about its consequences for the body.
3. Draw pictures to accompany your biography to make a poster.

The route that food takes:

1. Name the organs displayed in the illustration that are involved in digestion.
2. Summarize the functions of individual sections of the gastro-intestinal tract. Fill in the table:

<table>
<thead>
<tr>
<th>ORGAN</th>
<th>FUNCTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouth</td>
<td>Reducing the food pieces in size, insalivation, starch digestion, transportation of the food pulp through the esophagus</td>
</tr>
<tr>
<td>Stomach</td>
<td>Collection, mixing, gastric juice is added here, killing of bacteria, digestion of proteins</td>
</tr>
<tr>
<td>Small intestine</td>
<td>Juice from the liver and the stomach’s salivary glands are added, digestion of the three basic materials (carbohydrates, proteins and fat), absorbing into the blood</td>
</tr>
<tr>
<td>Colon</td>
<td>Removal of water, transportation of the indigestible remnants, expulsion through the anus</td>
</tr>
</tbody>
</table>

**ANSWER KEY**

The route that food takes
Welcome
A letter from BODY WORLDS

Dear Students,

Have you ever watched a professional basketball player seem to float in air as he or she leaps up to dunk the ball in the basket? Or maybe you watched skiers and skaters competing at the Olympics, and wondered “How did they do that?”

Well, our bodies are pretty amazing. And the more we learn about ourselves and how our bodies work, the better we can take care of ourselves and others. And, the healthier we will be—making us better on the ice rink, basketball or tennis court, jumping hurdles, or just walking down the street.

Gunther von Hagens’ BODY WORLDS & The Cycle of Life was developed by a German doctor and anatomist to help people understand how their bodies work by letting them look inside real human bodies. When you visit with your school or family, you will see exactly how your brain and your heart look and what happens to them when certain diseases take over. You will see how smoking destroys your lungs, and how your bones, muscles and ligaments all work together so you can shoot baskets, dance, or figure skate.

The activities inside this guide will help you learn more about the human body. Then come visit us to see BODY WORLDS & The Cycle of Life. You’ll really get to know yourself!

Gunther von Hagens’ BODY WORLDS exhibits use the science of Plastination to let visitors see how human bodies are put together. The exhibits also teach how different anatomical systems work in the human body. This special student supplement explores several of the systems featured in BODY WORLDS & The Cycle of Life, including the locomotive system, the respiratory system, the digestive system, the nervous system, and the cardiovascular system.

Exhibition Overview

Dr. Angelina Whalley
Conceptual Designer for BODY WORLDS and President and CEO of the Institute for Plastination
The Locomotive System

Makes motion happen

The locomotive system is the system in the body that makes movement possible. It consists of the bones that make up the skeleton, the joints that hold the bones together and the muscles that contract and relax to actually make you move.

The skeleton is the framework of the body, and it is made up of bones and cartilage. Bone is made mostly of calcium, which is why it is important to drink milk to keep your bones strong. Milk is a food that is rich in calcium.

Inside the bone is sponge-like matter called bone marrow. This makes bones light so people can move easily, but strong enough to support body weight. Bone marrow also produces red and white blood cells. Red blood cells have hemoglobin and carry oxygen. White blood cells produce antibodies to attack bacteria, infections and diseases.

The skeleton has many jobs. It provides protection to internal organs, it supports the body and gives it its shape, and it provides a place for muscles to attach.

Bones are important to almost every movement we make. Bones couldn’t move a pencil, though, without help from muscles. Muscles consist of cells that contract. Muscles and bones are connected by tendons, which are something like ropes. When a muscle contracts, it pulls the tendon, which then tugs on the bone, and everything moves.

Voluntary muscles are used when you throw a ball. These are the muscles we can control. People also have involuntary muscles, which we cannot control, such as the heart and the stomach. Another important part of the locomotive system are the joints. They are positioned between major bones that come together and help you to move and bend.

There are different kinds of joints, including ball and socket joints in the hips and hinge joints at the knees and elbows. Joints are surrounded by capsules containing fluid that help the bones move smoothly.

The Nervous System

The messenger and the boss

The nervous system is the system of the body that controls movements, thoughts, and emotions throughout the body. Without it, you wouldn’t be able to function!

There are two parts to the nervous system: the central nervous system and the peripheral nervous system.

The central nervous system includes the brain and the spinal cord. They work together with nerves to send messages back and forth between the brain and the rest of the body.

The brain is the boss. It has five parts: the cerebrum, the cerebellum, the brain stem, the pituitary gland, and the hypothalamus.

The cerebrum is the biggest part of the brain and controls thoughts, language, and voluntary muscles, which are the muscles you can control. You also use the cerebrum when you think hard in school and when you need to remember things.

The cerebellum is a lot smaller than the cerebrum, but still very important. It controls balance, movement, and coordination. If it weren’t for the cerebellum, you wouldn’t be able to stand without falling!

The brain stem connects the rest of the brain to the spinal cord. It’s the part in charge of major things that keep you alive like breathing, blood pressure, and digesting food. Unlike the cerebrum, the brain stem controls the involuntary muscles—the ones that work without you thinking about it, such as the heart and stomach.

The tiny pituitary gland produces and releases hormones into the body—hormones like those that help you grow and change.

Finally, the hypothalamus regulates your body temperature, your emotions and hunger and thirst.

The brain has many jobs, but it needs help from nerves and the spinal cord too. Every action you do happens because your brain, your nerves, and your spinal cord work together.

The peripheral nervous system is composed of the nerves and neurons that go outside the central nervous system to operate the body’s limbs and organs. It is here that everything gets connected.
The Respiratory System

Oxygen in, carbon dioxide out

The organs of the respiratory system work together along with other body systems to ensure the cells of the body receive the oxygen they need to live. When you breathe in, the muscles of your chest expand. Your diaphragm lowers and creates lower air pressure in your lungs than in the world outside. This causes air to enter through the nose or mouth. Once air enters, it travels past your esophagus, sometimes called the “food pipe,” and is moistened as it goes down the trachea, or “windpipe,” into the lungs. As the air enters the lungs, the lungs expand outward.

Once inside the lungs, the air travels through tubes called bronchi into smaller tubes called bronchioles, which get smaller and smaller until they reach alveoli, which are sacs about the size of a grain of sand. It is through the walls of the alveoli that the oxygen in the air you breathe enters the body’s blood, which flows past the alveoli. The blood receives the oxygen and in return passes carbon dioxide into the alveoli.

The cells of your body need oxygen to live, and carbon dioxide is the waste of things the cells do. Your red blood cells are designed to carry the oxygen to the cells, and take the carbon dioxide away. Smoking, as we all know, makes the lungs less healthy, and can lead to death.

One of the reasons for this is that smoking makes little structures called cilia stop working. Cilia move within the lungs to help clear things out that enter the lungs. Smoking disables or even kills them. Then harmful particles stay in the lungs. Another bad effect of smoking is that chemicals from cigarettes will build up in the lungs, and the delicate alveoli can become thickened, swollen, and unable to exchange oxygen and carbon dioxide with the blood in a healthy way. This condition leads to emphysema.

Think about it

Plants take the carbon dioxide that we release and use it, creating oxygen, which we need. We in turn take oxygen and turn it into carbon dioxide, which plants need. This is what is called a symbiotic relationship—one that is good for both organisms. Try to think of other ways in which humans interact with nature in symbiotic relationships.

The Cardiovascular System

The body’s great pump

Images of hearts are often used to symbolize romance or love. But actually—and more importantly—the heart is the central organ of the cardiovascular system, and it doesn’t look much like the drawings found on Valentine’s Day.

Cardio means heart, and the cardiovascular system is essential to our survival. The cardiovascular system is sometimes referred to as the circulatory system because it’s responsible for the circulation of blood through the body.

It consists of the heart, which is a muscular pumping device, and a closed system of vessels called arteries, veins, and capillaries. The cardiovascular system’s vital role is to provide a continuous and controlled movement of blood through the thousands of miles of microscopic capillaries that reach every tissue and cell in the body. Human survival depends on the circulation of blood to the organs, tissues, and cells of your body. Arteries carry blood enriched with oxygen away from the heart, and veins carry blood that has used up its oxygen back to the heart. Through the heart and lungs, the blood gets a fresh supply of oxygen and delivers it to the rest of the body.

Learn with BODY WORLDS

A healthy respiratory system makes it possible for people to live active lives. Smoking causes problems for the respiratory system. Make a list of five reasons why you shouldn’t smoke.

Learn with BODY WORLDS

The cardiovascular system is a delicate system and can be affected by many things. Fats and cholesterol, for example, can slow or even block the flow of blood in the body. Fats and cholesterol enter the body through foods people eat, and that is one reason people are encouraged to limit the amount of fatty or oily foods they eat. Think of ten fatty foods and ten healthier options. For example, you may think of a doughnut as a fatty food and toast as an alternative.
The Digestive System
Converting food into energy

The body’s digestive system converts the food you eat into the energy you need to live. The journey through your digestive system is a long one. It starts in the mouth, where teeth grind and tear the food into small pieces. Saliva then wets and softens the food and begins to dissolve carbohydrates. Once the food is properly mashed and wet, it is pushed by muscle action into the pharynx, or throat, and down the esophagus, which leads to the stomach.

When food reaches the stomach it is properly mashed and wet, it is pushed by muscle action into the pharynx, or throat, and down the esophagus, which leads to the stomach.

The small intestine has a large surface area because it contains villi. These are tiny little structures like very short hairs that stick out into the small intestine. Through the walls of the villi nutrients from food pass into the bloodstream. The bloodstream carries the nutrients to your cells so they can live.

Once all the useful nutrients have been taken from food in the small intestine, the unusable parts pass into the large intestine, or colon. In the large intestine, water is extracted from the waste and the material hardens into feces. The feces are passed out of the body when you go to the bathroom.

Digestive helpers
The pancreas, liver, and gallbladder are all organs that do things important to the digestive system. The pancreas makes enzymes that help digest proteins, fats, and carbohydrates. The liver makes bile, which helps the body absorb fat. Bile is stored in the gallbladder until it is needed. Enzymes and bile travel into the small intestine through ducts. Interestingly, people don’t really need the gallbladder. If it is removed, the bile just flows right into the small intestine and does its job.

COOL FACT
Your mouth makes about half a quart of saliva each day, and you produce a total of about seven quarts of digestive juices.

When food reaches the stomach it is mixed and broken down further by acids the stomach produces. The stomach protects itself from these acids by secreting a layer of mucus that lines the inside of the stomach.

Some things, such as water and sugars, can be absorbed right out of the stomach and into the bloodstream. The things that need more digestion have further steps ahead of them. When the stomach has made the food a liquid, the food passes through a valve into the small intestine.

Learn with BODY WORLDS
The digestive system breaks down the food that supplies the human body with energy. What foods would you eat if you needed energy for sports or active recreation? Pick five foods you think would be good sources of energy. Then pair off and research your foods. Were they all healthy choices for getting the energy you needed?

Art in Science
The beauty of the body

This knowledge is important, even if artists choose to represent the human form in abstract ways rather than realistic representation. In the BODY WORLDS exhibits, Gunther von Hagens has positioned human figures to reveal how the body is put together and how it performs different tasks. He also has presented human figures in ways that highlight different body systems.

A group display called “The Blood Vessel Family,” for example, reveals the human form through its network of blood vessels. The scientific choices he has made give visitors a new way to understand how human bodies work. At the same time, he has revealed how beautiful the form and systems of the human body are.

As visitors go through the exhibits, they learn the science and biology of anatomy. They also get to experience the artistic qualities of anatomy. This gives the exhibits appeal to all students, not just those in science classes.

Learn with BODY WORLDS
Understanding how the body works is important in many professions. Think about what you may want to be when you grow up and write a short sentence or paragraph explaining what about anatomy is important in the job and why.

Think like an artist
Like Gunther von Hagens, artists sometimes like to focus on one aspect of a figure. In art, this may be done by emphasizing one feature of a person or showing the subject from an unusual angle or perspective. Explore this idea by thinking about someone in your family. Reflect on what this person is like or what you admire about him or her. Then think about what you would focus on if you were to portray this person in a work of art. Draw a sketch of your artwork and explain your ideas to the class.

Photos as Art
Newspaper photographers often are asked to take photo portraits of people in the news. These portraits often could be considered photographic artworks. Look through the news and features sections of the newspaper for several days and clip photos portraying people. Pick the one you like the most and explain to the class what makes the portrayal effective or artistic in your eyes. Finish by giving the photo a title and explain it to classmates.

Sports Anatomy
Coaches need to know how to evaluate the physical skills and talents of players. These talents often are based on anatomy. Pick an athlete you admire. Then think about the different body systems explored in this guide. Write out which systems contribute most to the success of this athlete.
Would You Do It? 
Thoughts about Plastination and your body

All specimens in Gunther von Hagens’ BODY WORLDS exhibits are authentic. They belonged to people who declared during their lifetime that their bodies should be made available after their deaths for the instruction of doctors and the education of the public.

“BODY WORLDS is most of all a collaboration between the donors and myself, and all those who view the exhibits,” von Hagens says. “All of humanity owes the donors a great deal, for without them, there would be no BODY WORLDS.”

To ensure that donors make the decision willingly, von Hagens’ Institute for Plastination requires that all donors sign an official consent form. In the form, the donors must declare that they have made the decision “freely and voluntarily” to donate their body “for the purpose of anatomical research and education…and for students and especially for the general public.”

In addition, they must check off answers to specific questions that have been raised by plastination so there is no doubt they fully understand their decision.

“I agree for my body to be used for any purposes, provided it is to do with medical instruction of doctors and the education of the general public.”

“I agree for my body to be used for education…for students and especially for the general public.”

“I agree that lay people be allowed to touch my plastinated body” in some exhibits.

Donors to the Institute for Plastination have the option to donate all useable organs to save lives before their bodies are plastinated.

Or “I agree that my plastinated body can be used for the medical enlightenment of laypeople, and, to this end, exhibited in public (e.g. in a museum).” Or “I agree that my body can be used for an anatomical work of art.

Or “I agree that lay people be allowed to touch my plastinated body” in some exhibits.

In your discussion:
- Consider what motivates a donor to allow his/her body to be plastinated for education or an exhibit.
- Consider how the friends and relatives of a donor might feel.
- Imagine that a member of your immediate family wanted to be plastinated.
- Consider how you would feel— or did learn—about your own body from viewing the BODY WORLDS & The Cycle of Life.

COOL FACT
Plastination takes a very long time. A whole body can take up to 1,500 hours to prepare.

What Is Plastination?
The method of plastination explained

Plastination is a process designed to preserve the body for educational and instructional purposes. Plastination, like many revolutionary inventions, is simple in concept:

Embalming and Anatomical Dissection
The first step involves halting decay by pumping formalin into the body through the arteries. Formalin kills all bacteria and chemically stops the decay of tissue. Using dissection tools, the skin as well as fatty and connective tissues are removed in order to prepare the individual anatomical structures.

The Plastination process itself is based on two exchange processes:

Removal of Body Fat and Water
In the first step, the body water and soluble fats are dissolved from the body by placing it into a solvent bath (e.g., an acetone bath).

Forced Impregnation
This second exchange process is the central step in plastination. During forced impregnation, a reactive polymer, e.g., silicone rubber, replaces the acetone. To achieve this, the specimen is immersed in a polymer solution and placed in a vacuum chamber. The vacuum removes the acetone from the specimen and helps the polymer to penetrate every last cell.

Positioning
After vacuum impregnation, the body is positioned as desired. Every single anatomical structure is properly aligned and fixed with the help of wires, needles, clamps, and foam blocks.

Curing (Hardening)
In the final step, the specimen is hardened. Depending on the polymer used, this is done with gas, light, or heat.

Learn with BODY WORLDS
The BODY WORLDS exhibits reveal how human bodies work when people take part in activities like sports, dance, chess, or teaching. Different displays focus on different systems in the body. In today’s paper, find a photo of a person involved in an activity that interests you. Think about what the body has to do for that activity. Then write a paragraph describing what part or system of the body you would like to show if you could create a plastinate in action.

Learn with BODY WORLDS
After holding the class discussion, summarize the general feelings of the class in a news story. How did the members of the class feel about plastination? Talk about how newspaper reporters must weigh all information before making a general conclusion. Then compare summaries written by different members of the class. How similar were they? What were some differences? What was the source of those differences?

Learn with BODY WORLDS
Cooperate with a classmate to complete the following activity. Imagine that the two of you are a team of plastinators, preparing plastinates for an exhibit. From viewing the exhibits, what questions do you have? Then compare summaries written by different members of the class. How similar were they? What were some differences? What was the source of those differences?
Massachusetts Health and Science Standards

The Museum of Science provides a field trip destination that allows teachers and students to reinforce Massachusetts Health and Science Standards. Use of the materials in this guide in combination with a field trip to BODY WORLDS & The Cycle of Life will help you link learning experiences to the following content standards.

Grades 5 – 8

**Health**
1.6. Identify the stages of the human life cycle (from prenatal through late adulthood).
1.7. Explain the function of human body systems and how body systems work together.
1.8. Describe the influence of health habits on growth and development.
1.9. Apply skills that increase immediate peak functioning of body systems (vigorous exercise, eating nutritious foods, adequate rest).

**Science**
6. MS-LS1.3. Construct an argument supported by evidence that the body systems interact to carry out essential functions of life.
8. MS-LS1.5. Construct an argument based on evidence for how environmental and genetic factors influence the growth of organisms.

Grades 9 – 12

**Health**
1.11. Describe the impact of behavior and environment on failure of body systems (nervous, muscular, skeletal, circulatory, respiratory, endocrine, and excretory systems).
1.12. Describe the growth patterns and body changes within human beings throughout the life cycle (from prenatal through late adulthood), including critical periods in growth and development.
1.13. Describe how both heredity (including congenital factors) and the environment influence growth and development.

**Science**
HS-LS1-2. Develop and use a model to illustrate the key functions of animal body systems, including (a) food digestion, nutrient uptake, and transport through the body; (b) exchange of oxygen and carbon dioxide; (c) removal of wastes; and (d) regulation of body processes.

Additional Resources

**National Institutes of Health—The Visible Human Project**

**US Department of Agriculture Choose My Plate.gov Games:**
[choosemyplate.gov/games](http://choosemyplate.gov/games)

**Kids Health Organization**
[kidshealth.org](http://kidshealth.org)