Gunther von Hagens'

BODY WORLDS

The Original Exhibition of Real Human Bodies

& The Brain—Our Three Pound Gem

TEACHER AND STUDENT GUIDE

This guide is made possible by the generosity of The Kenneth T. and Eileen L. Norris Foundation.

Contents

Dear Educator,

Welcome to ***BODY WORLDS & The Brain—Our Three Pound Gem: The Original Exhibition of Real Human Bodies***. This guide includes an exhibition overview, links (in colored text), and curriculum to help make your Museum visit an engaging educational experience.

References to California Content and English standards are included where appropriate. Full text of standards is available at **http://www.cde.ca.gov/index.asp**.

If you have questions related to this guide please call the Museum Education Department at 619.255.0311 or email education@sdnhm.org.

About
BODY WORLDS

Gunther von Hagens' ***BODY WORLDS*** exhibitions are the first of their kind. Visitors to ***BODY WORLDS & The Brain—Our Three Pound Gem: The Original Exhibition of Real Human Bodies*** will learn about anatomy, physiology, and health by viewing real human bodies preserved through an extraordinary process called Plastination. More than 200 authentic human specimens are featured in each exhibition—entire bodies as well as separate organs and body cross-sections.

Prepare
Key Concepts

Plastination

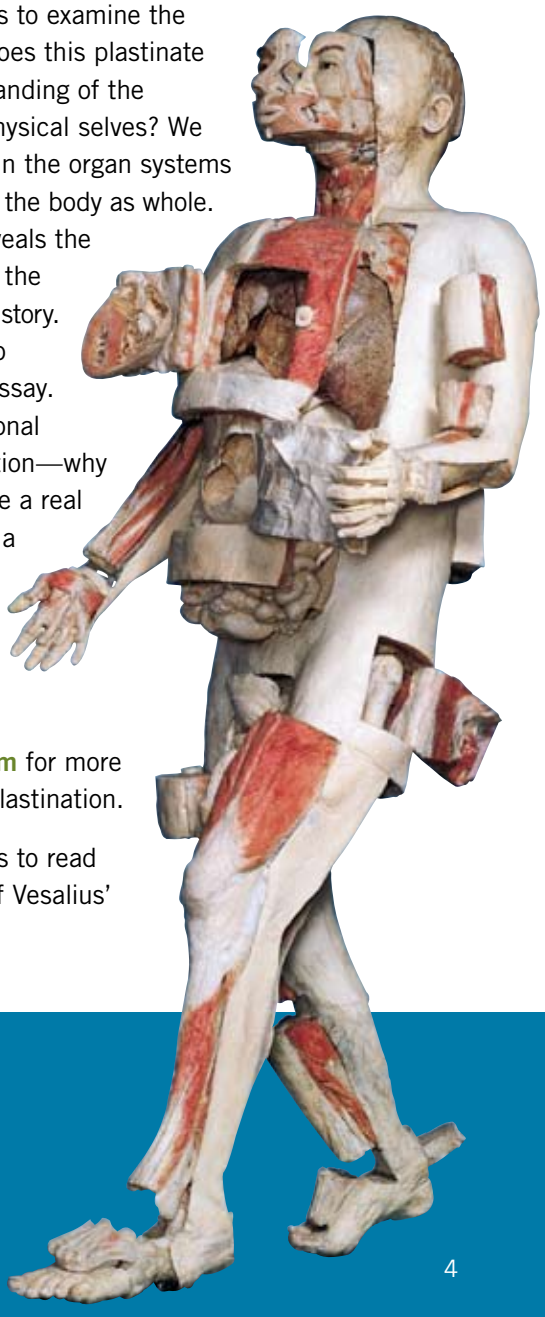
Imagine being able to look inside an actual human body. The plastinated human specimens in ***BODY WORLDS*** provide this exceptional vista. In Plastination, all bodily fluids and fat are removed from the bodies and replaced with silicon rubber and epoxy. The Plastination materials are hardened with gas, light, or heat curing, which provides firmness and durability. Before the specimens are cured, they can be positioned. In this process every single anatomical structure is properly aligned and fixed with the help of wires, needles, clamps, and foam blocks.It takes 1500 hours to transform a body into a whole-body plastinate.

Plastination is a revolutionary process. The idea for this breakthrough came to Dr. Gunther von Hagens sometime before he invented the process in 1977. "By inventing Plastination, I was only trying to solve a problem," von Hagens says. "I wanted to educate my students so they would become better doctors, as I don't think doctors should be poking around inside your body and operating on you if they don't know important things about it." With Plastination, Dr. von Hagens has forever changed traditional anatomy and its audience. ***BODY WORLDS*** allows the viewer to see inside the systems and organs of the human body in detail once known only to the medical professional.

Prior to the Renaissance, human dissection was performed rarely, and usually only as an autopsy to solve a crime. Dissection for the express purpose of discovery was rare and, in many places, a grave sin or crime. During the first half of the 16th century in Italy, bodies began to be opened with a new academic intent— to see and to discover the norms of anatomy and physiology. In 1543, Andrea Vesalius published his book, *On the Fabric of the Human Body*, which described his dissections with exhaustive text and elaborate illustrations. As a result of his work, knowledge of human anatomy began to be based upon empirical evidence instead of suppositions based in folklore or animal anatomy. The discoveries Vesalius made through dissection were the beginnings of modern medical science. The technology of Plastination may again change the way doctors learn. What advances in medical education might this technology provide?

Ask your students to examine the ***Drawer Man***. How does this plastinate expand our understanding of the complexity of our physical selves? We are able to see within the organ systems and yet still imagine the body as whole. The ***Drawer Man*** reveals the interior of the body, the way a book reveals a story. Ask your students to write a persuasive essay. Explain the educational benefits of Plastination—why is it important to see a real body as opposed to a simulation? Would an artificial anatomical man be as effective as the ***Drawer Man***? Visit **www.bodyworlds.com** for more information about Plastination.

Ask your students to read from a translation of Vesalius'



California Content and English Standards

Grades 5–12 Writing Strategies 1
Grade 7 History and Social Science 7.11
Grades 9–12 Life Sciences Physiology 9
Grades 9–12 Investigation and Experimentation g
Grades 9–12 Historical and Social Science Analysis Skills, Historical Interpretation 3

work at **http://vesalius.northwestern.edu/flash.html** and discuss how individuals like Vesalius and Dr. von Hagens have changed teaching paradigms.

Form and Function

Your body is made up of trillions of cells. These multitudes of cells vary in size, shape, and character according to their functions. These building blocks of life form distinct tissues which are the scaffolds of your varied organs. Your organs function within distinct but coordinated systems such as the locomotive, nervous, respiratory, cardiovascular, digestive, urinary, and reproductive systems. In ***BODY WORLDS*** you will see the intricate relationship between form and function. Plastinates reveal organs and tissue so that we can understand the systems that support and maintain our bodies.

For example, imagine that you had an apple for lunch. How are your organ systems and the apple intersecting? A lacy network of vessels carries oxygenated blood from your heart to every millimeter of your body including the 20 feet of intestines that are metabolizing the apple, and before the apple reached the intestine it was well-masticated by your strong jaw of bone and muscle. This whole network of cooperating systems was directed by your marvelous multi-tasking brain! Examine the ***Exploded Body***. Skin is peeled away from muscle, muscle from bone, and the organs are displayed. This revealed structure of the body is a guide to understanding how its systems function in concert.

Ask your students to investigate the structure and functions of the locomotive, digestive, nervous, and cardiovascular systems. Are there non-biological systems that mimic the forms and functions of these anatomical structures? Find an example of a non-biological system that resembles a system in the body. Sketch the two systems side by side comparing the structure and function of the components.

http://thinkanatomy.com/

http://uimc.discovery-hospital.com/main.php?t=symptom&p=anatomy_explorer

http://www.bbc.co.uk/science/humanbody/

http://www.medtropolis.com/VBody.asp

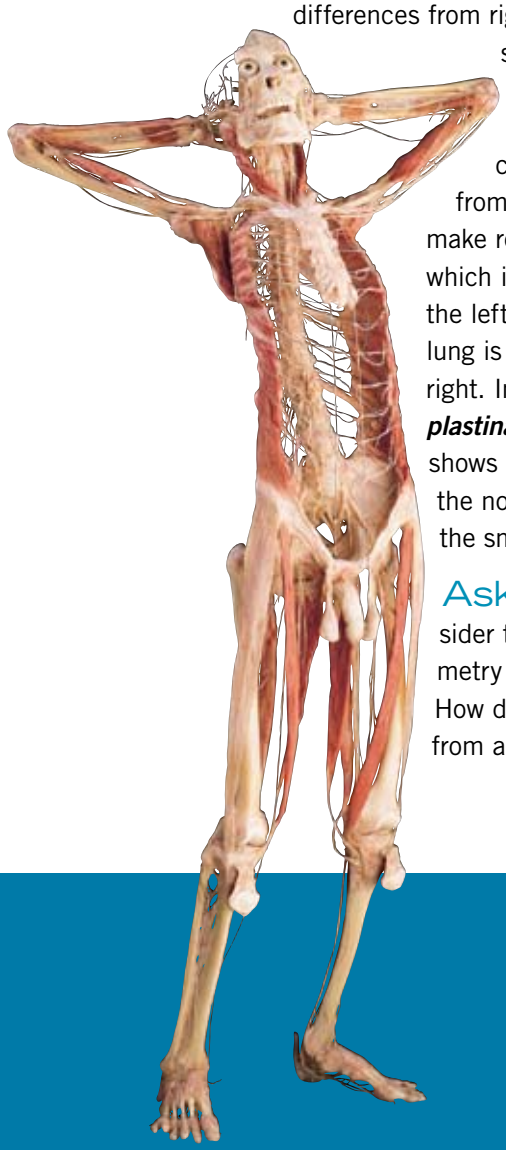
California Content and English Standards

Grades 5–8 Physical Education 4
Grades 5–12 Visual Arts Aesthetic Valuing 4
Grade 5 Life Science 2
Grade 7 Physical Principles in Living Systems 6h
Grades 9–12 Physical Education 1.4

Symmetry and Shape

Your body is a symmetrical and tidily compacted machine. Vertebrates can be divided bilaterally with a vertical line at the spine, and the left and right sides of the body are almost mirror images. You might also imagine yourself as a tube within a tube. Your body wall forms the outer tube and the digestive tract is the inner tube. These symmetries are the legacy of evolution. Take a look at the ***Man at Leisure*** and the ***Muscle Man*** and notice the elegant symmetry of the locomotive and nervous systems.

However, within our tightly packed bodies there are some differences from right to left. The stomach is a j-shaped bag tucked to the left of the liver which crosses the midline from the right. To make room for the heart, which is nestled slightly to the left of midline, the left lung is smaller than the right. Investigate the sets of ***plastinated lungs***. Which pair shows a greater asymmetry; the non-smoker's lungs or the smoker's lungs?



Ask your students to consider the symmetry or asymmetry of ordinary animals. How does a spider differ from a jellyfish? A sea star from a cat? Find out more about symmetry and evolution at **http://evolution.berkeley.edu/evolibrary/article//arthropods_04**.

California Content and English Standards

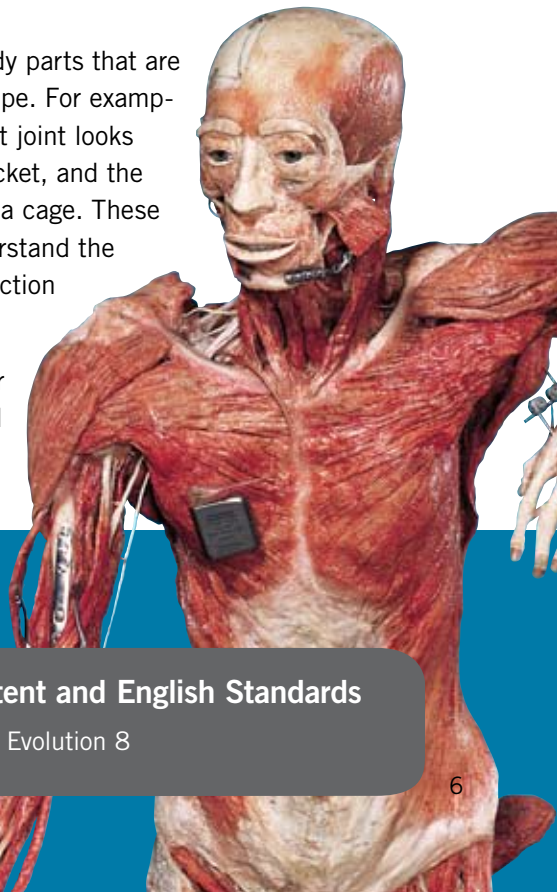
Grade 9–12 Science Evolution 8

Turn your head from right to left. Your neck allows you to pivot your skull. Our ancient ancestors, the fish, do not have necks; their skulls are fused to their shoulders. In the gallery, take a close look at the neck and shoulder musculature of the ***Autopsy Body***. Our necks, and the ability to move our heads independent of our shoulders, are adaptations belonging to the first tetrapods, the pioneer amphibians that moved from sea to land.

Ask your students to visit **http://tiktaalik.uchicago.edu/index.html** and learn about Tiktaalik, the newly discovered prehistoric fish fossil whose neck shows evidence of the evolutionary step between fish and land animal. How does the study of other life forms inform our understanding of our own anatomy?

There are many body parts that are named for their shape. For example, a ball and socket joint looks like a ball and a socket, and the rib cage resembles a cage. These terms help us understand the shape, size and function of each body part.

The ear in particular is filled with several



California Content and English Standards

Grade 9–12 Science Evolution 8

evocatively named bones and organs. The inner ear is also called the *labyrinth* which describes its complicated system of canals. There are also the cochlea, which is Latin for *snail*, and the tympanic membranes or ear drums. In the gallery you will see the *stirrup*, the *hammer* and the *anvil*. These are the ***Auditory Ossicles***, the small bones of the ear. Can you guess which bone belongs to which name?

Sometimes a shape-based name can be misleading. The vestibular system of the ear got its name from early anatomists who judged from its shape that it was a mere vestibule or entrance to the inner ear. We now know that it is an essential sensory organ. It alerts the brain to movement of the head and the conditions of equilibrium for the skeletal muscular system. Take a closer look at the organs of the ear in *Gray's Anatomy* online at **http://www.bartleby.com/107/illus900.html**

Ask your students to search the galleries and find anatomical structures that look like other things. Then ask them to make analogies. The surface of the brain is like the shell of a walnut. The inside of a bone is like a sponge. Learn more about teaching with analogy at **http://www.cdtl.nus.edu.sg/link/mar2004/tm3.htm**

The Three-pound Gem

At first glance your brain looks like nothing more than a lumpish blob, but it is an extraordinary organ of vast complexity. Plastination allows us to take apart the brain and see its separate structures. The brain is divided into two halves separated by a deep groove. A great bundle of nerves connects the communication between the two sides. Nerves stretched like wire run out from the brain down the spine throughout the body to monitor and regulate all functions.

Like a well-run business, this communication system is organized by region. The sensory and motor cortexes keep track of what and where you feel and what and where you move. The brain stem and the cerebellum keep you upright and breathing while the cerebrum directs you in negotiating the world. This thinking part of your brain is divided into four cerebral lobes that manage different parts of your conscious functioning. Your brain is the command center—you see, feel, smell, hear, think, and decide.

Ask your students to study the Skateboarder and discuss what each area of the brain is doing during the execution of this athletic maneuver. To learn more how the brain works visit **http://kidshealth.org/kid/htbw/brain.html** or for advanced study **http://faculty.washington.edu/chudler/introb.html#bb**

California Content and English Standards

Grades 9–12 Life Sciences Physiology 9

California Content and English Standards

Grades 5–8 Physical Education 4
Grade 5 Life Science 2
Grades 9–12 Life Sciences Physiology 9
Grades 9–12 Physical Education 1.4

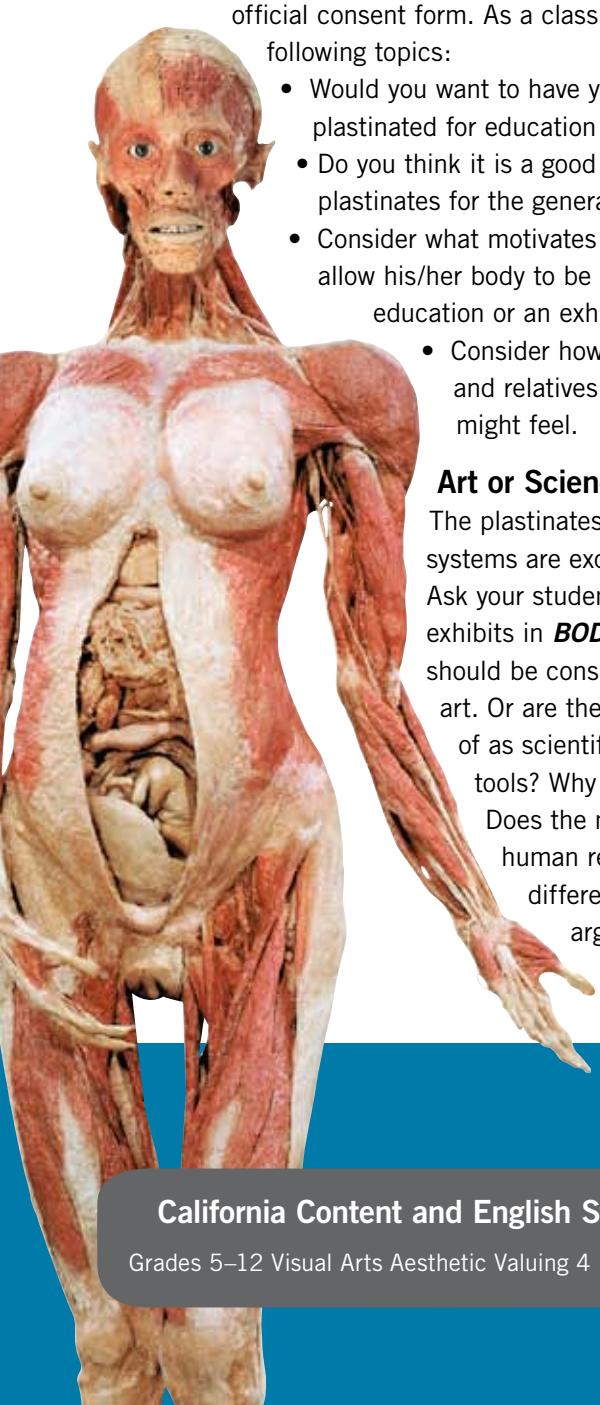
Explore
Classroom Activities

Plastination

Would you do it?

All specimens in the ***BODY WORLDS*** exhibition are authentic. They belonged to people who declared during their lifetime that their bodies should be made available after their deaths for education. To ensure that donors make the decision willingly, the Institute for Plastination's Body Donation Program requires that all donors sign an official consent form. As a class, discuss the following topics:

- Would you want to have your body plastinated for education or display?
- Do you think it is a good idea to exhibit plastinates for the general public?
- 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.



Art or Science?

The plastinates of the arterial systems are exquisitely made. Ask your students if the exhibits in ***BODY WORLDS*** should be considered works of art. Or are they best thought of as scientific teaching tools? Why or why not? Does the medium, real human remains, make a difference to the argument?

California Content and English Standards

Grades 5–12 Visual Arts Aesthetic Valuing 4

Form and Function

What Does It Take

The whole-body plastinates reveal how human bodies work when people take part in activities. Different displays focus on different systems in the body. 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. Why did you chose to represent this system for this action?

California Content and English Standards

Grades 5–8 Physical Education 4
Grade 5 Life Science 2
Grades 9–12 Life Sciences Physiology 9
Grades 9–12 Physical Education 1.4

Symmetry and Shape

The Divine Proportion

The golden ratio, or divine proportion, is defined as a line which is divided in such a way that the smaller part is to the larger part as the larger is to the whole. This ratio, along with the related Fibonacci series, is sometimes found in nature and in art. Visit these sites to learn more: **http://leonardodavinci.stanford.edu/submissions/clabaugh/history/leonardo.**

http://milan.milanovic.org/math/english/golden/golden2.html

http://mathworld.wolfram.com/GoldenRatio.html

Now consider this ancient aesthetic proportion in relationship to the body.

- Ask your students to look at varied paintings and sculptures of the human form. Which ones do they find most pleasing? How does our sense of beauty and symmetry inform our perceptions of ourselves?
- Take measurements of corresponding body parts, like fingertip to wrist, wrist to elbow and fingertip to elbow, to see if you can truly find the golden ratio on your body.

California Content and English Standards

Grade 6 Math, Statistics, Data Analysis, and Probability 1.2

The Three-pound Gem

Error Message

Try the following brain teasers to experience how sensory data is processed by your nervous system.

- Purchase gourmet jelly beans in a wide selection of flavors. Carefully taste a variety of them and note how distinct they are in flavor. Conduct a second tasting with your nose held completely shut and your eyes closed. The beans still taste sweet, but are the flavors still distinct from each other?
- Draw or paint a shape with thick black lines on plain white paper. Stare at it hard for a full minute. Close your eyes tightly. What do you see?
- Open up a paper clip so that it has two points. Close your eyes and touch the points to your fingertip. Move the points closer together and continue testing your ability to feel two distinct points with your eyes closed. When you can really perceive only one point, measure the distance between the two ends of the paper clip. Try the same experiment on your lips. Even though your fingertips are quite sensitive, you should be able to feel two distinct points at a lesser distance from each other on your lips. Your lips have far more nerve endings. Try the same test on your back and compare the final measurement here to the two previous trials.
- Play more brain-teaser games at **http://faculty.washington.edu/chudler/chgames.html**

California Content and English Standards

Grades 5–8 Physical Education 4
Grade 5 Life Science 2
Grades 9–12 Life Sciences Physiology 9
Grades 9–12 Physical Education 1.4

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 athletes 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 football pitch, basketball or tennis court, riding a bike, or just walking down the street.

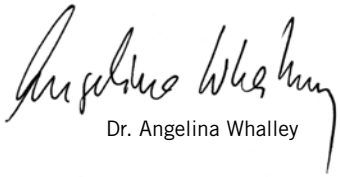
"***Gunther von Hagens' BODY WORLDS: The Original Exhibition of Real Human Bodies***" was developed by a German doctor and anatomist to help people understand how their bodies work by letting them look inside real human bodies.

When you visit with your school or family, you will see exactly how your organs look and what happens to them when certain diseases take over. You will see how smoking destroys lungs, and how bones, muscles and ligaments all work together so you can play sports, dance, or skate.

The activities inside this guide will help you learn more about the human body. Come visit us to see ***BODY WORLDS***. You'll really get to know yourself!

COOL FACT

Dr. Gunther von Hagens invented Plastination in 1977.



Dr. Angelina Whalley

Conceptual Designer for BODY WORLDS and Managing Director of the Institute for Plastination

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 200 real human specimens, including whole-body plastinates, individual organs, organ configurations and transparent body slices. The specimens on display stem from the body donation programme that Gunther von Hagens established in 1983.

The exhibitions allow visitors to see and better understand the long-term impact of diseases, the effects of tobacco consumption and the mechanics of artificial supports such as knees and hips.

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.

What is Plastination?

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

Can't people learn just as much from books or models?

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. They offer people a chance to see the real thing in a safe and informative environment.

Where did the specimens on display come from? Will we know who the plastinates were or how they died?

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 register of more than 9,000 individuals.

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.

Why is it important for the public to see these exhibits?

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 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.

Are these exhibitions appropriate for children?

More than 25 million people, including many children, have seen the ***BODY WORLDS*** exhibitions around the world. We recommend the ***BODY WORLDS*** exhibits for school groups in Key Stage 3 and above. It is important to know in advance that the exhibition includes full-body plastinates with exposed genitals, and plastinates showing pre-natal development (foetuses).

Why are there not more women plastinates?

Renaissance anatomists traditionally included more masculine than feminine bodies, since all but the reproductive systems are essentially the same, and the musculature of male bodies is generally more pronounced and illustrates more aspects of the muscle system. However, Dr. von Hagens receives many requests from visitors to see more examples of female anatomy, and has added more female plastinates to the exhibitions.

How long can I stay inside?

You can stay as long as you like, but we recommend allowing about one to two hours. The length of time will vary on how long you want to spend examining each specimen and reading the information provided, and if you use the Audio Guide.

Can I take photographs?

Photography is not allowed in the ***BODY WORLDS*** exhibitions, except by accredited members of the press and media. Unauthorised sketching, recording, filming and/or photogrpahy, including pictures taken with mobile phones, are not allowed.

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.

What is Plastination?

Methods of Plastination explained

Plastination is a relatively simple 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 of the process 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, 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

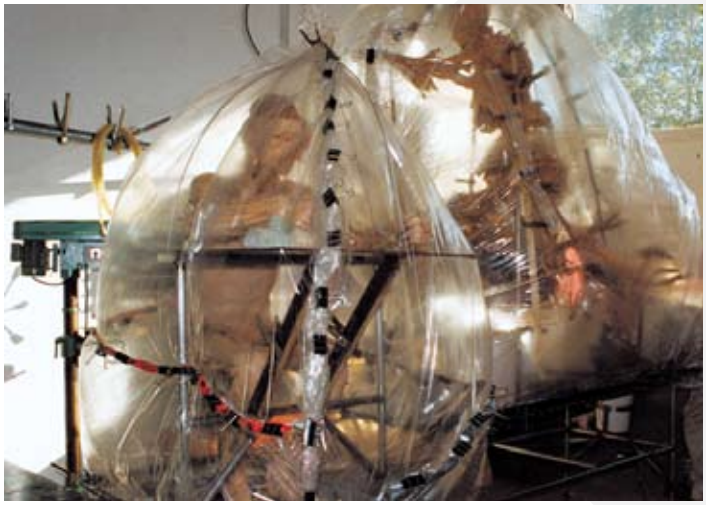
In the first step, the body water and soluble fats are dissolved from the body by placing it into a solvent bath (e.g. an acetone bath).

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.



Specimens plastinated with silicone are cured with a special gas.

Curing (Hardening)

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

Dissection and Plastination of an entire body requires about 1,500 working hours and normally takes about one year to complete.

Sheet Plastination

Sheet Plastination is a special form of Plastination. For this process, the body is deep frozen and cut into slices of 2 to 8 mm in thickness. Instead of silicone, polyester resin or epoxy resin are used for impregnation.

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 a newspaper or magazine, 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.

Interview with Gunther von Hagens

Children Interview Dr. Gunther von Hagens, Creator of BODY WORLDS & Inventor of Plastination

Were you ever scared to work with dead bodies?

Dr. von Hagens: When I was about six years old, I was very sick and nearly died. I was in hospital for many months and became very comfortable in that environment of the sick and dying. The doctors and nurses who cared for me became my heroes and I wanted to be like them. Later when I worked in a hospital as an orderly and then a nurse, (long before I became a doctor), one of my duties was to transport the dead to the morgue. Other workers didn't like this job because it frightened them, but I was never afraid. Being afraid of death is not a good way to live.

Were the people in the exhibit old when they died?
Dr. von Hagens: The people who donated their bodies for Plastination and to educate all of us about health are of various ages. Some were old, but others were young in the prime of their life. Each person is different, not just on the outside but also on the inside. Even after more than 30 years as an anatomist, I have never seen two hearts that look the same.

Where did the idea for *BODY WORLDS* come from?
Dr. von Hagens: When I used to teach anatomy to students in medical school in the 1970s, I had to use illustrated anatomy atlases and picture books to show the organs and body systems. I tried to use real human organs and specimens, but at that time the specimens were preserved in blocks of plastic so you could not touch them, or study the placement of the organs properly. I realised one day that if the plastic was inside the body and not outside it, the specimen would be rigid and easy to grasp, and study and work with. I was only trying to solve a problem, I wanted to educate my students so they would become better doctors, as I don't think doctors should be poking around inside your body and operating on you if they don't know important things about it.

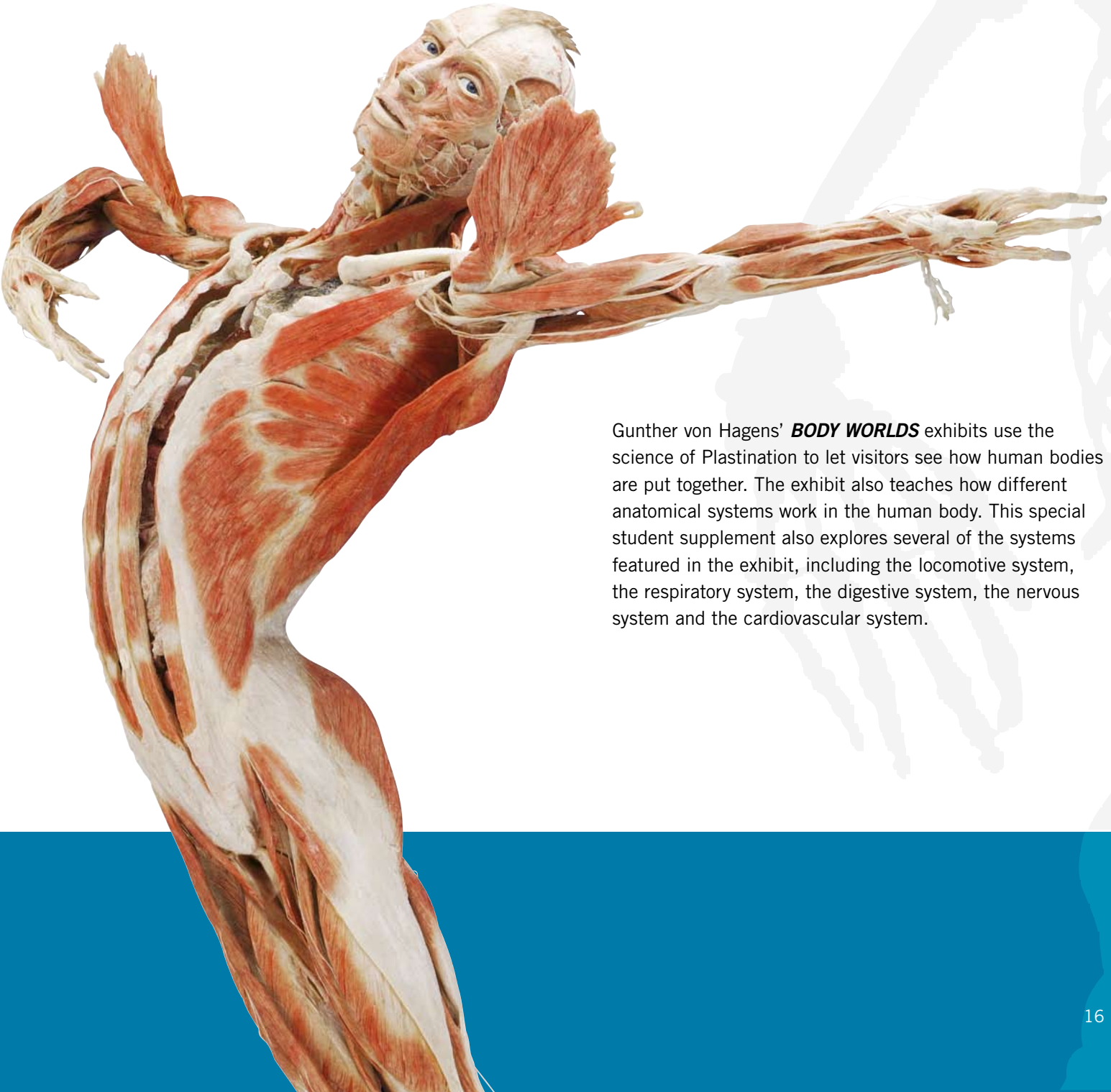
But something very unusual began to happen after I began to plastinate organs and specimens. The janitors and secretaries and office workers at the university began to stop by the lab; they were fascinated by the plastinates. This was when I began to think of anatomy for lay people, which is what ***BODY WORLDS*** is. It is very different from anatomy for medical professionals because it has to be interesting and dynamic and not scary to look at.

How long does it take to prepare the bodies for display?
Dr. von Hagens: Plastination takes a very long time. A whole-body can take up to 1,500 hours to prepare. At the moment I am working on plastinating an elephant which had died in a German zoo. This will take more than three years.

What happens to the skin once it is removed from the bodies?
Dr. von Hagens: Each body is an anatomical treasure, human remains must be handled carefully and respectfully. All human remains are cremated and buried.

How do you get people to donate their bodies?
Dr. von Hagens: I have never sought body donation. People offer their bodies for Plastination for several reasons: they want to leave a legacy for future generations, they don't like the effects of decay and decomposition that take place after death, or they don't like traditional burials.

Exhibition Overview including Human Facts



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

The Locomotive System

Makes motion happen

The locomotive system 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 is made up of bones and cartilage. Bone is made mostly of calcium, which is why it is important to drink calcium-rich food to keep your bones strong.

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 haemoglobin 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.

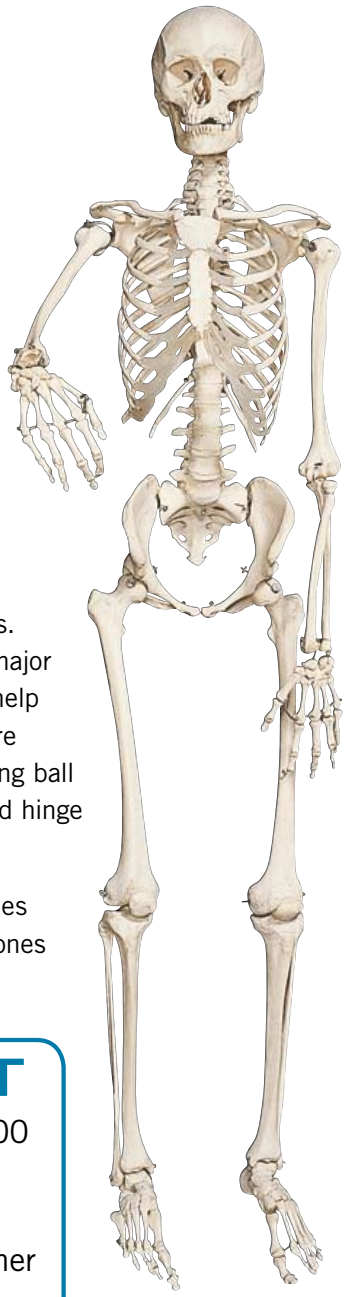
Muscles and bones are connected by tendons, which are similar to ropes. When a muscle contracts, it pulls the tendon, which then tugs on the bone, and everything moves.

Although it may seem easy to do something like throw a ball, it's actually complicated when looked at inside the body. To make the motion of throwing, many muscle groups in the shoulders, arms, chest, abdomen and even legs must be used! Each of these groups must work together with nerves in order for motion to occur. And all this happens in a fraction of a second!

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. Joints 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.



COOL FACT

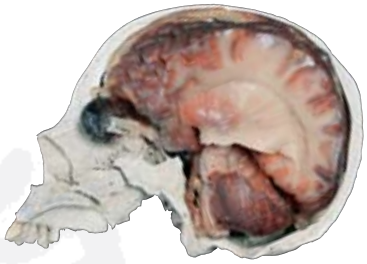
At birth, humans have 300 bones. As a baby grows, however, many of the smaller bones fuse together so that adults have just 206 bones.

Learn with BODY WORLDS

The bones of the human skeleton give the body both strength and structure. A strong and healthy skeleton is important for every person for both work and recreation. Think of three things that you do every day that involve the use of certain bones.

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 controls the system. 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 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!

COOL FACT

The nervous system carries messages from the brain to other parts of the body at more than 100 kilometers per hour.

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.

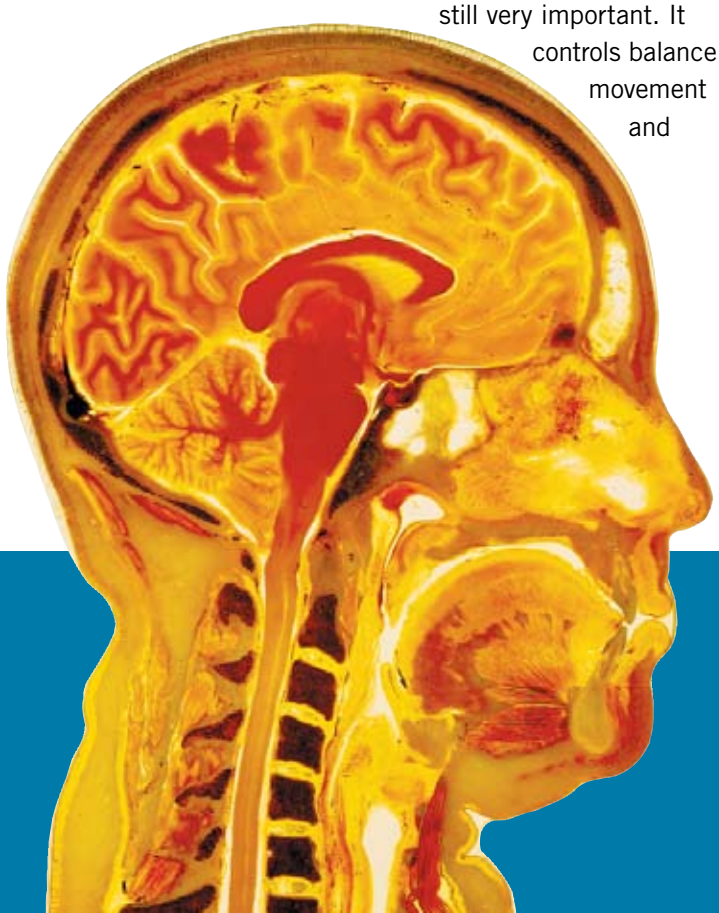
The tiny pituitary gland produces and releases hormones into the body–hormones like those that help you grow and change.

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 nervous system includes millions and millions of neurons, which are microscopic cells. When you do something, messages travel from the neurons to your brain. 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.

Next time you take a test, drink a glass of water, laugh or do anything at all, thank your nervous system. Actually, you can thank it right now since it just helped you read this!



Learn with BODY WORLDS

The nervous system carries messages to the brain that make it possible for the body's five senses to work. The five senses are touch, taste, hearing, sight and smell. Explore the five senses by writing about one of your favorite things for each sense.
For example you may enjoy listening to music, because it helps you concentrate. This relates to your sense of hearing.

The Respiratory System

Oxygen in, carbon dioxide out

The organs of the respiratory system work together, along with other body systems, to ensure that 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 'foodpipe,' 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.

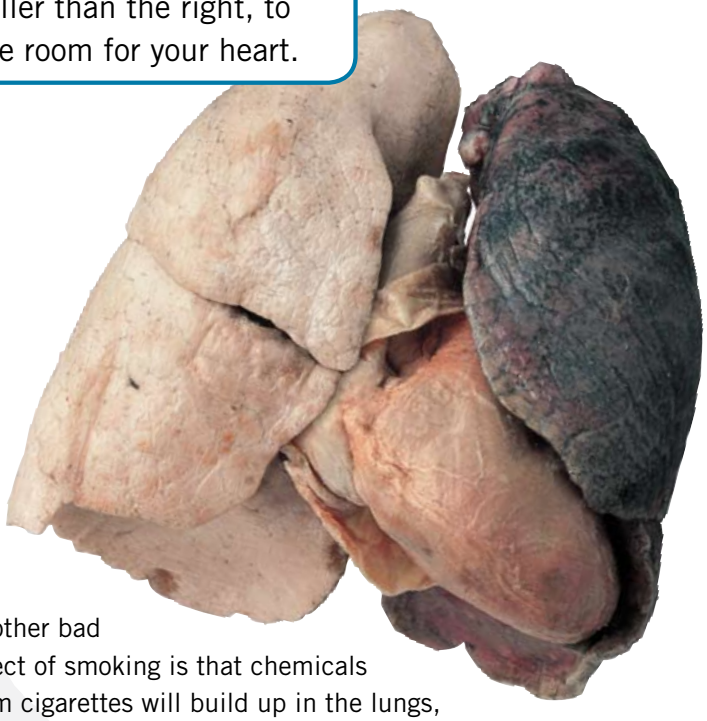
It is through the walls of the alveoli that the oxygen in the air you breathe enters the body's blood, which flows past the alveoli. The blood receives the oxygen, and in return passes carbon dioxide into the alveoli.

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 little workers that 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.

COOL FACT

Your left lung is a bit smaller than the right, to leave room for your heart.



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.

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 people shouldn't smoke.

The Cardiovascular System

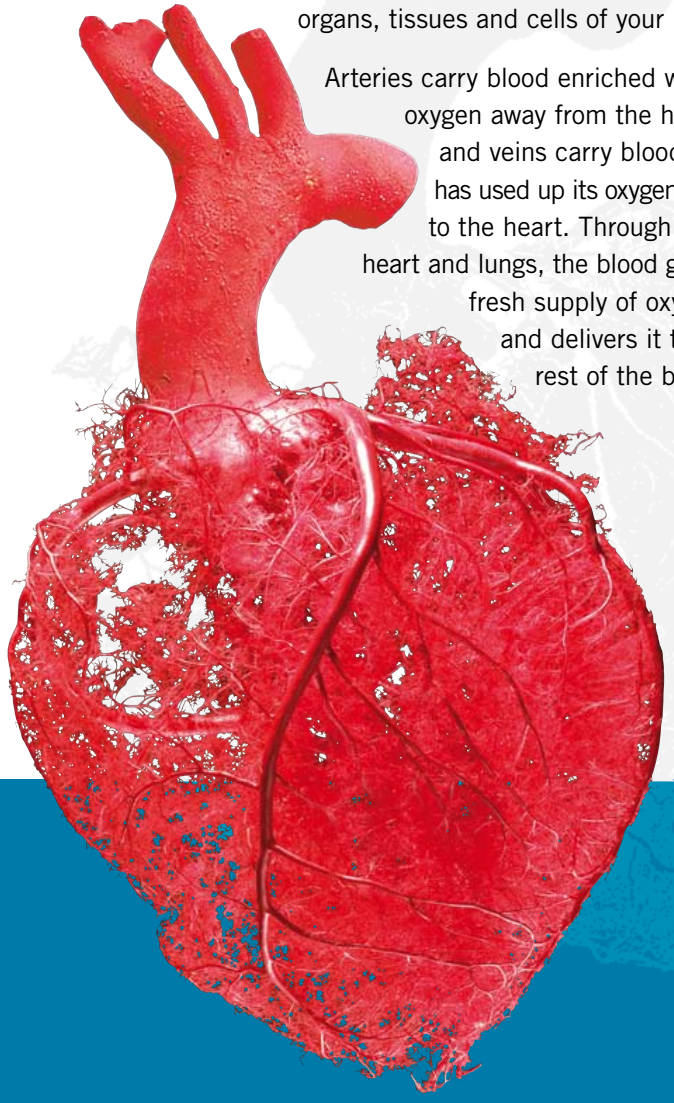
The body's great pump

The heart is the central organ of the cardiovascular system and it doesn't look much like the drawings found on Valentines. 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.

COOL FACT

At every stage of life, your heart is about the size of the fist you make when you close your hand.

Twenty major arteries make a path through the tissues of the body. Then they branch out into smaller vessels called arterioles. These branch further into the capillaries, most of which are thinner than a hair – some so tiny, in fact, that only one blood cell can move through at a time.

Once the blood in capillaries delivers oxygen and nutrients, it picks up carbon dioxide and other waste. Then blood moves back through wider vessels, called venules. These eventually join to form veins, which deliver the blood back to your heart to pick up oxygen.

If all the vessels of this network were laid end to end, they would extend about 60,000 miles, far enough to circle the Earth more than twice!

Because all the tissues in the body rely on it, the cardiovascular system appears early in developing embryos—in the fourth week after fertilisation—and reaches a functioning state long before any other major organ system.

Learn with BODY WORLDS

The cardiovascular system is delicate 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 as food, 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 for food. 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 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.

COOL FACT

Your mouth makes about litre of saliva each day, and you produce a total of about seven litres of digestive juices.

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.

The small intestine has a large surface area because it contains villi. Villi 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 faeces. The feces are passed out of the body when you go to the toilet.

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.

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?

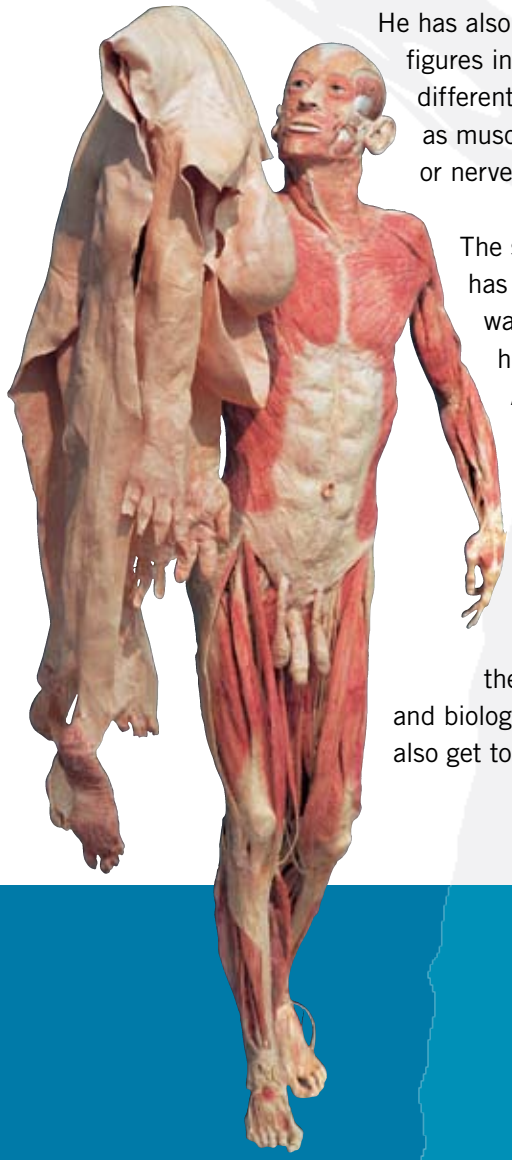
Art in Science

The beauty of the body

BODY WORLDS exhibitions teach us a lot about the science and anatomy of the human body. They also teach about the form and art of the human body.

Studies of anatomy have always been an important part of art education. Artists who know how the human body is put together, and how its muscles work, are better able to portray people in painting, sculpture and other art forms. This knowledge is important, even if artists choose to represent the human form in abstract ways.

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 has also presented human figures in ways that highlight different body systems, such as muscles, internal organs or nerves and blood vessels.



The scientific choices he has made give us 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.

Think like an artist

Artists sometimes like to focus on one aspect of a figure. In art, this may be done by emphasising 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 an artwork. Draw a sketch of your artwork and explain your ideas to the class.

Photography 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 for several days and cut out 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.

Learn with BODY WORLDS

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

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 exhibit," 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 … 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 research or training" reads one example.

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.

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

Talk about it

As a class, discuss whether you would want to have your body, or the body of a relative, plastinated for education or display. Then discuss whether you think it is a good idea to exhibit plastinates for the general public. To ease discussion, you can set up a "For Chair" and an "Against Chair" to sit in at the front of the room when offering your opinion.

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 what you might learn—or did learn—about your own body from viewing the ***BODY WORLDS*** exhibits.

COOL FACT

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

Learn with BODY WORLDS

After holding the class discussion, summarise the general feelings of the class in a news story of the style found on the front page of a newspaper. 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?

www.bodyworlds.com

Institute for Plastination