BODIES

THE EXHIBITION

TEACHER'S GUIDE

Grades 9 - 12

Teacher's Guide

Grades 9 - 12

BODIES...THE EXHIBITION

800 Pike
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Across from the Convention Center

For school group reservations call
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INTRODUCTION

In BODIES...THE EXHIBITION, you will see 21 bodies dissected to show various systems throughout nine galleries. You will also see over 250 individual organs or parts - some healthy, some diseased. You will observe first-hand the effect that disease and unhealthy life choices have on the body – what happens to the lungs, for example, when people smoke. You will understand how positively *amazing* the body is – how the pulleys, fulcrums and levers we know as muscles, joints and bones let us function continuously without even thinking about it.

BODIES...THE EXHIBITION celebrates the human body and its inter-related systems and functions. By learning how the body works, we believe you can better care for your body and keep it healthy. By studying the systems of the body, you will come away with a new appreciation for life.

BODIES...THE EXHIBITION provides an unprecedented opportunity for learning human anatomy, physiology, and chemistry. BODIES ...THE EXHIBITION enables you and your students to speak with ease about the body, dispelling some preconceived ideas and fears.

This Teacher's Guide is divided into two sections and applies to academic content across the curriculum. First, you will find the Guide to Student Learning with experiential activities aligned to both National Academic Standards and Washington State Academic Content Standards. Next is the Guide to Exhibition Galleries, a road map to follow when you visit the exhibition with your school group.

THE POLYMER PRESERVATION PROCESS

To help you see what a body really looks like on the inside, this exhibition uses real human bodies that have been preserved so they do not decay.

A human specimen is first preserved according to standard mortuary science. The specimen is then dissected to show whatever it is that someone wants to show. Once dissected, the specimen is immersed in acetone, which eliminates all body water. The specimen is then placed in a large bath of silicone, or polymer, and sealed in a vacuum chamber. Under vacuum, acetone leaves the body in the form of gas and the polymer replaces it, entering each cell and body tissue. A catalyst is then applied to the specimen, hardening it and completing the process.

This method of preservation creates a specimen that will not decay. This offers thousands of unique teaching possibilities for educators at all levels, including medical professionals, archeologists and other scientists.

PREPARING TO VISIT THE EXHIBITION

The setting of this exhibition lends itself to a quiet, respectful viewing of specimens. There are nine galleries – skeletal system, muscle system, nervous system, circulatory system, digestive system, reproductive system, an optional fetal gallery, and a gallery that shows how prosthetic joints and surgical tools are used to restore our health. The ninth gallery invites guests to write comments about their exhibition visit and to thumb through age appropriate books on anatomy.

This amazing exhibition features 21 preserved whole human specimens and over 250 organs and partial body specimens. In this exhibition all organs and body systems are on display. BODIES...THE EXHIBITION teaches you about your body from the inside out. Students see diseased and healthy organs and learn about healthy lifestyle choices.

BODIES...THE EXHIBITION allows students to learn about their own bodies and how to take better care of their health. The exhibition enables students to see and understand medical conditions friends and family members face in a whole new way by highlighting pressing health concerns including smoking, cancer, cirrhosis, arthritis and fractures.

Please prepare your students by discussing what they will be seeing - real, preserved specimens of the human body. The specimens have been dissected to specifically illustrate each body system and function. Male and female reproductive organs are visible in most of the full body specimens. *The fetal room is entirely optional. All embryos and fetuses died of natural causes in utero*.

The specimens are preserved through a process called Polymer Preservation. This process is a revolutionary technique in which human tissue is permanently preserved using liquid silicone rubber. This prevents the natural process of decay, making the specimens available for study for an indefinite period of time. Polymer Preservation provides a closer look at the skeletal, muscular, nervous, respiratory, digestive, urinary, reproductive, endocrine and circulatory systems, unveiling the mysteries of the human anatomy. Human specimens are used instead of models to study individual variations and uniqueness.

The exhibition offers a special children's audio tour, comprehensive Teacher's Guides for Grades K-2, 3-5, 6-8 and 9-12 plus a Post-Secondary Guide for advanced students.

Please give a copy to each adult chaperone in your group.

CHAPERONE RESPONSIBILITIES

As a chaperone, you are responsible for helping your students get the most out of this very unique learning experience. While some of you may be part of the teaching team at your school, others may be parent volunteers with a limited background in Biology or Anatomy. The good news is that there are trained docents in white lab coats available to answer questions throughout the galleries in the Exhibition. In addition, there are reference books at the end of the Exhibition that students are welcome to read through and thumb through as needed. Feel free to grab a book or a docent at any time during your tour.

To keep order, you need to stay with your assigned group of students throughout your visit. If you leave a gallery, they leave a gallery. If you are still in a gallery, they are still in a gallery. Please supervise your students in the retail area and in the restrooms as well.

While your students are busy learning, discovering, questioning and reflecting, we ask that you help us reinforce some basic rules of museum etiquette. Keep your voices low. Do not gather at the entrances or exits to the galleries. Do not lean against walls or block the flow of traffic for our other patrons. We have a very strict policy of no photography or cell phone use in the Exhibition. Some of your teachers may have assigned worksheets for students to complete as they move through the galleries. Please remind them not to lean on the glass cases or on the walls to write. They should use a notebook or a clipboard to fill out their papers.

We know that this is a fascinating Exhibition to view, but please know that your top priority is to monitor your students and keep them focused so that they can meet their teachers' expectations when they return to class.

We greatly appreciate your participation in making this a memorable field trip for everyone from your school. Thank you!

BODIES
THE EXHIBITION

SAMPLE PERMISSION SLIP

Permission slips from parents or guardians are required from the teacher for each student who views BODIES...THE EXHIBITION.

By signing this form, you are giving your child permission to view BODIES...THE EXHIBITION on a school fieldtrip with their teacher and chaperones.

Thank you for granting permission so that your son or daughter is able to participate in this unique opportunity to gain a better understanding about their body.

My child, _____, has my
(please print child's name)

permission to view BODIES...THE EXHIBITION with his / her teacher and

chaperones.

_____
Parent or Guardian Name (please print)

_____ _____
Parent or Guardian (signature) Date

TEACHER'S GUIDE to STUDENT LEARNING

SKIN

Let's face it; the world is a tough place. It is nice to have a flexible, self-repairing, multi-sensory suit of armor that shields you from the elements and protects your vital organs from microbial invaders and physical harm. Many people are surprised to learn that skin is an organ. In fact, it is the human body's largest organ.

Specialized cells known as melanocytes produce Melanin, the chemical pigment that gives skin its color. People with light colored skin and dark colored skin have the same number of melanocytes. The only difference between them is the activity level of melanin production. Melanin helps to protect the body from the harmful effects of UV light from the sun.

DID YOU KNOW? Although our skin does help to protect our bodies from UV light, it is important to use sun block rated at SPF 45 or more on exposed areas of your body to prevent sunburn, premature wrinkling and skin cancer.

ACTIVITY: Bacteria Everywhere on Our Skin

Students will compare the amount of bacteria on washed hands vs. unwashed hands.

National Science Standards: Standard A, Science as Inquiry; Standard C, Life Science

MATERIALS (per group of 4 students)

- 2 petri dishes containing nutrient agar
- permanent marker
- incubator (only one needed per class)
- notebook to record results

INTRODUCING THE ACTIVITY

Bacteria are the most common organisms on the face of the earth. From the inside of our intestines to the boiling mud baths of Yellowstone National Park, they are everywhere and affect almost every aspect of our lives. Some consume the oil on our faces (and occasionally create pimples as a result); while others produce the yogurt and cheese we eat. To see just how prevalent bacteria are in our world, let's go hunting!

PROCEDURE

1. Collect two petri dishes containing nutrient agar from your teacher. Label the bottom of one plate "washed" and the bottom of the other plate "unwashed" with the marker.
2. Using the marker, divide both petri dishes into 4 quadrants by marking on the lid. Number the quadrants 1-4. Assign each student a number on the petri dish. Each student will have their own quadrant to test their own bacteria.
3. Starting with the petri dish labeled unwashed, have each student take their right thumb and gently rub their thumb across their section.
4. Have students vigorously scrub their hands with soap for at least 30 seconds.
5. Repeat step 3 using the washed plate. Students should keep the same quadrant number.
6. Put the lids on the petri dishes so the number matches the correct student swab.
7. Store both petri dishes in an incubator at 37° overnight.
8. On the next day, record your observations of what grew and where.

Important! Do not take the lid off any of the petri dishes.

EXPLANATION

Students should see a lower growth of bacteria on the washed plate. Soap will kill lots of the bacteria, but students will still observe some levels of growth. Scrubbing of the hands also removes large amounts of bacteria from the hands.

EXTENSION

1. Was there any growth in each quadrant?
2. How were you able to tell which sections had growth and which sections did not?
3. Which quadrants had more growth on them? Why do you think this is the case?
4. What does the information gained from this experiment tell you about human hygiene?
5. With all these bacteria growing, why do think people aren't sick more often?

Be SunWise

Check out the U.S. Environmental Protection Agency's SunWise Program on how to be protected from overexposure to the sun through a variety of educational programs.

http://www.epa.gov/sunwise/

SKELETAL SYSTEM

If you have ever seen an X-ray taken by a doctor, you probably realize that everyone has a skeleton made up of many bones. In fact, the average adult has about 206 of them – over half of them in your hands and feet. Your skeleton gives your body structure like the girders of a building. The bones of your skeleton also protect your internal organs; such as the heart, brain and lungs.

Many people think that the skull is one big piece of bone, but in truth it is composed of 30 different bones.

Although the bones of our skeleton possess a great deal of resiliency and strength, they can fracture or break. Osteoblasts, bone-forming cells, are instrumental in rebuilding trabeculae (bone framework) in addition to generating new bone cells.

Follow these tips if you want to have strong and healthy bones:

- Protect your skull bones and the brain inside by wearing a helmet whenever you bike, skateboard or roller skate. Also, wearing appropriate gear such as elbow and kneepads will provide extra protection if you fall.

- Strengthen your skeleton by getting plenty of calcium by drinking milk and eating other foods high in calcium. Check out the nutritional labels on the foods you eat.

Joints, made up of ligaments and cartilage, link one bone to another. Joints that do not move are known as fixed joints and can be found connecting the sides and front of the skull. Moving joints allow for a wide range of motions depending on their purpose. Our elbows and knees are examples of hinge joints while our shoulders and hips allow for motion in many different directions.

DID YOU KNOW? What really happens when you crack your knuckles? Joints are the meeting points of two separate bones held together by connecting tissues and ligaments. A thick, clear lubricant (made mostly of carbon dioxide and some nitrogen) called synovial fluid is found between the bones. When you stretch or pull your fingers, bubbles of gas form quickly and burst -- which is why you get that cracking noise.

ACTIVITY: Cervical Vertebrae

Students will be able to identify the cervical vertebrae and understand how easy it is to damage the vertebrae.

National Science Standards: Standard A, Science as Inquiry; Standard C, Life Science

MATERIALS (per group of students)

- 7 rice cakes = vertebrae
- 7 marshmallows = discs
- 2 straws = spine
- thread = nerves
- needles = used to thread the nerves

INTRODUCING THE ACTIVITY

The spine is made up of 33-34 linked bones called vertebrae. Vertebrae have different shapes and sizes, depending on their location in the vertebral column. The vertebral column is divided into the following 5 sections, from top to bottom: cervical, thoracic, lumbar, sacral and coccygeal. Because cervical vertebrae are in your neck, they are more often injured than the other four sections since they are better protected within your body.

The 7 cervical vertebrae rotate, nod, shake and tilt the head. There are 12 thoracic vertebrae that articulate (form joints) with the 12 pairs of ribs. The 5 lumbar vertebrae are the largest and thickest in size because they absorb most of the weight transmitted through the vertebral column. They also transmit forces that help you maintain an erect posture. There are 5 sacral vertebrae that are fused together and form two joints with the pelvic bones – our sacro-iliac joints. The tiny 4 or 5 coccygeal vertebrae are at the very bottom and form our tailbone.

In this activity, students will focus on the cervical vertebrae by creating a model of the spine and simulating a spinal cord injury.

PROCEDURE

1. To soften the rice cakes for piercing by the straw, students must drop several drops of water in the CENTER of the rice cakes.

2. When the rice cakes are soft in the center, assemble the spine by putting the straw through a rice cake and then a marshmallow, alternating until all seven of each are in place. The rice cakes represent the cervical vertebrae and the marshmallows represent the discs.

PROCEDURE: Cervical Vertebrae (cont'd)

3. Thread a needle with black or red thread, and "stitch" through the marshmallow near the upper rice cake with a single thread. Do this for each marshmallow.

4. To simulate someone "breaking their back", collapse the "vertebrae" by bringing your hands together with force, keeping the "spine" between your middle and ring fingers, close to the palms.

EXPLANATION

Most spinal cord injuries result from a pinched, dented, or bruised cord, not an actual "break". The spinal cord is about the same diameter as the thumb and is filled with gel-like material, much like the brain. Because the gel-like filler makes the spinal cord very elastic, it would take a projectile, like a bullet or knife, to actually separate, or sever, the cord.

More often, the cord is damaged by some sort of trauma. When a spinal cord is injured, the cells in the center of the cord die and the cord becomes hollow, leaving a donut rim of tissue on the outside. Without enough cells, the spinal cord cannot function properly to transmit messages from the brain to and from the rest of the body.

EXTENSION

1. Have students compare their results.

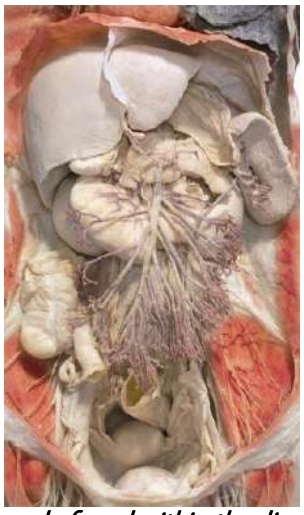
2. Did the "break" occur in the same area with each model? Why or why not?

Spinal cord exposed

MUSCULAR SYSTEM

If all 600 muscles in your body pulled in one direction, you could lift around 25 tons. But lifting things is just one of the jobs our muscles help us do. Muscles pump blood through our body, allow us to smile or frown, and help us to run and jump. The muscular system is made up of three types of muscles:

Smooth muscles. Muscles that work automatically, without conscious thought, are involuntary or smooth muscles. Smooth muscles are made up of smooth muscular tissue. They control the involuntary movements of the internal organs (i.e. blood vessels, bronchi, digestive tract, and uterus). The smooth muscles found in our digestive system help us digest by squeezing food from the esophagus to the rectum using the process called peristalsis. Smooth muscles are capable of staying contracted for long periods of time.



Smooth muscle found within the digestive system

Cardiac muscles. Our hearts are made of cardiac, or myocardium, designed to squeeze blood to all the systems of our body through blood vessels. The cardiac muscle is made up of cardiac fibers laid into spiral bundles. Each cell can contract rhythmically. The entire tissue contracts in a coordinated fashion due to a particular anatomical element from which, "waves" of contraction emanate. These waves spread to the heart, regulating its beat. The cardiac muscle is able to sustain strong and continuous contractions without getting tired.

Cardiac muscle in the ventricular wall

Skeletal muscles. Skeletal muscles, the muscles most people identify with, are voluntary muscles that we control. They make up the musculoskeletal system. Skeletal muscles are made up of striated muscle tissue. They insert into your bones. Skeletal muscles are able to contract with great strength, but they tire easily.

Muscle and bones of the ribcage

Muscle contraction. The act of lifting an object is not a simple process. When we use our muscles for physical movement, we call upon our skeletal muscles. Skeletal muscles contract when the brain sends signals in the form of "action potentials" through the nervous system.

The place where the nerve and muscle meet is called the neuromuscular junction. An electrical signal crosses this junction and triggers the flow of calcium ions causing the myofilaments, fibers made from protein, to slide across one another. When this happens, the sarcomere, a thick filament system that gives cardiac and skeletal muscles their striped appearance, shortens and force is generated.

Billions of sarcomeres shortening cause a contraction of the entire muscle fiber. An energy supply of ATP (adenosine triphosphate), the body's primary energy unit, ensures continued muscle contraction.

DID YOU KNOW? On many television crime shows, investigators are called upon to establish a time of death. Rigor mortis is the stiffening of the body when we die. This happens when our cells – without oxygen from the lungs, impulses from the brain, or nutrients from the blood – no longer produce ATP. Without ATP, the last contractions of the muscle fibers become permanent. Investigators can determine a time of death from body temperature and degree of rigor mortis.

ACTIVITY: Muscle Mania

Through observation, demonstration and brainstorming, students will learn about the three different types of muscles in the human body and their functions.

National Science Standards: Standard A, Science as Inquiry; Standard C, Life Science

MATERIALS (per group of students)

- 3 wooden dowels = humerus (arm bone), radius and ulna (forearm bones).
- 4 small screws (any type will work)
- 5 hinges
- wood glue
- 1 hammer
- 4 long balloons
- markers
- 1 gallon milk jug filled with water – weight approx. 8 lbs
- 1 tape measure

INTRODUCING THE ACTIVITY

Students will demonstrate the specific movements that the three types of muscles (skeletal, cardiac, and smooth) enable us to perform.

Have a student jump up and down to demonstrate skeletal large muscles, frown to demonstrate skeletal small muscles, and eat to demonstrate smooth muscles.

Discuss the continuous beating of the heart (cardiac muscle), and introduce the concept of voluntary (skeletal muscles) and involuntary (cardiac, smooth) control.

Dispel the myth that muscle can "turn into" fat, or fat "into" muscle. Discuss the difference between muscle contraction and relaxation.

PROCEDURE

Muscle groups and functions

1. Construct the arm with bones and muscles using the wooden dowels, hinges, balloons, and screws. Let teams of students work together to connect the hinges to the wooden dowels to resemble an arm. If possible, supply students with a picture of the arm showing the muscle and bone connections.

2. Observe how the bones move.

PROCEDURE: Muscle Mania (cont'd)

3. Attach the balloons (about 50% of air), which represent the muscles, to the screws.

4. Observe how the "muscles" move with the bones.

5. Discuss the difference between origin and insertion.

6. Move the whole apparatus and observe how the muscles look when they contract and relax.

7. Using the model or on yourself, demonstrate the following terms of movement: abduction, adduction, supination, pronation, flexion, and extension.

Muscle fatigue

1. Have students measure each other's bicep muscle, by making a muscle, palpating the boundaries, and measuring between the beginning and the end (origin and insertion) of the muscle boundaries.

2. Chart the measurement in metric.

3. Have each person pick up the gallon jug filled with water.

4. Using the dominant hand, hold the gallon jug by the handle, and lift the jug up and down, keeping the elbow as close to the waist as possible.

5. Do not let the students rest between flexion and extension. Lift in a smooth motion.

6. Muscle fatigue will occur when the person is unable to lift the jug anymore.

7. Record the number of lifts and measure the bicep muscle as in step one. Record the results.

EXPLANATION

We use muscles when we walk across a room, eat and digest an apple, or simply to live. Muscles are attached to bones and move in relationship to the bones.

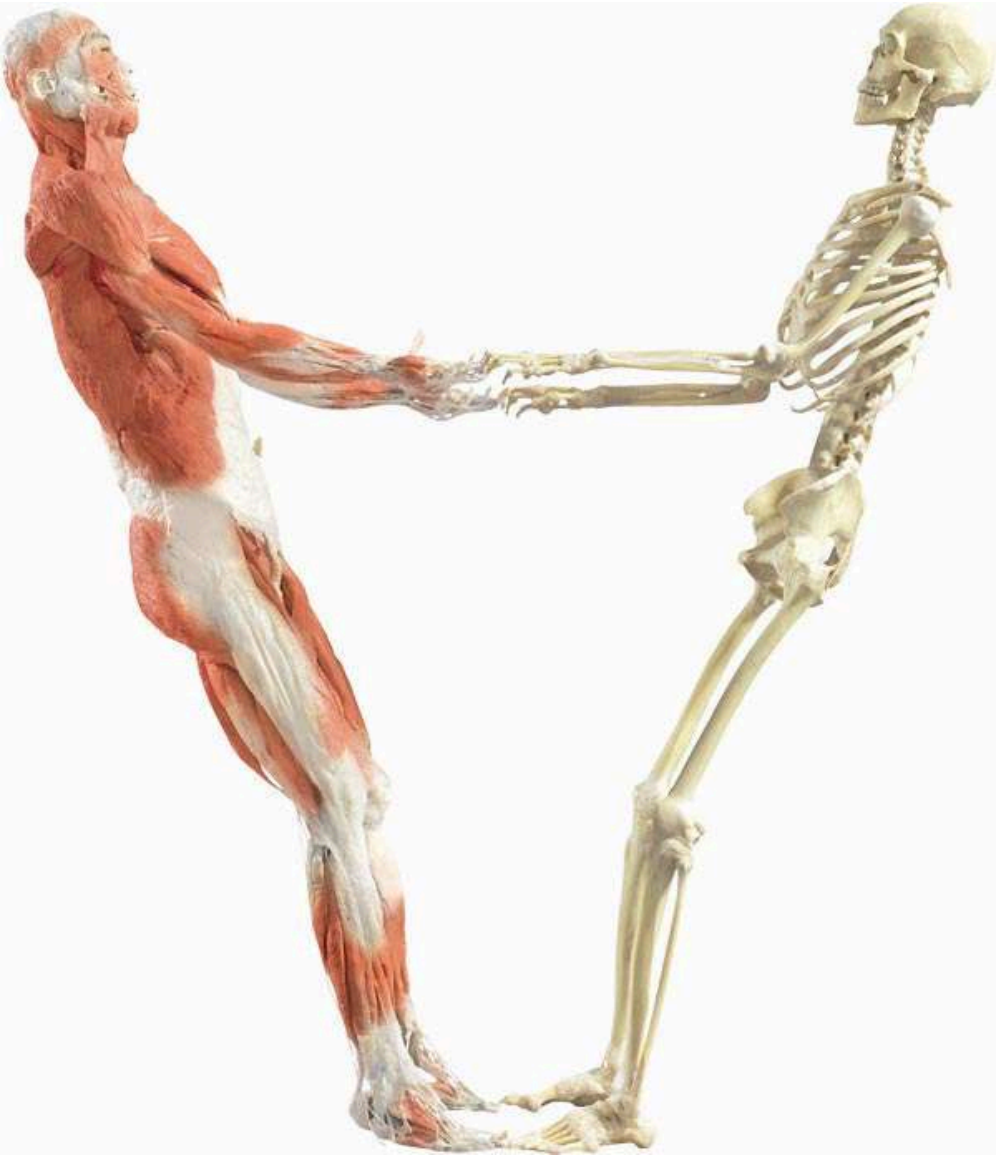
Muscles fatigue and change in size when a person exercises. Muscles increase in size after exercising due to the increased flow of oxygenated blood to the muscles. Muscle size may or may not have anything to do with strength.

EXTENSION

1. Discuss if larger muscles fatigue more or less quickly than smaller muscles? Why? Why not?

2. Have students discuss the change in muscle size before and after exercise.

3. Discuss factors that can make muscles stronger (e.g., diet, general physical condition).



NERVOUS SYSTEM

The nervous system is like the Internet of the human body. It gathers, stores, transfers information, and controls systems throughout the body. The nervous system is designed to prepare and adapt your body to a wide variety of situations and environments.

Your nervous system is divided into the central nervous system, consisting of the brain and spinal cord, and the peripheral nervous system, consisting of all the nerves that move information out into the arms and hands and to the legs and feet.

The autonomic system innervates your organs, things that you do not even think about, like your heart, kidneys and digestive system. The somatic system is made up of motor fibers and sensory fibers. These specialized receptors are for each of the senses.

Seeing. Human vision is based on receiving light with the eyes. The pupil, the dark center of the eye, absorbs the light. The iris, the colored part of your eyes, consists of muscles that control the amount of light the pupil receives. Light passes to the back of the eyeball to the retina through a clear, jelly-like substance known as the vitreous body.

The retina contains two types of photoreceptors to decipher the light -- rods, sensitive to motion and low-light environments like a darkened room, and cones, used to detect fine details and color. Three kinds of cones are used to detect the millions of colors you see everyday. There are cones to detect shades of blue, red, and green. Combined, you see the entire visible light spectrum.

DID YOU KNOW? People who are color-blind have damaged or missing cones.

Hearing. Your ears funnel the vibrations of sound waves that are ultimately passed to extremely small hair cells known as cilia. The movement of the cilia generates impulses to the vestibulocochlear nerve connected directly to the brain stem.

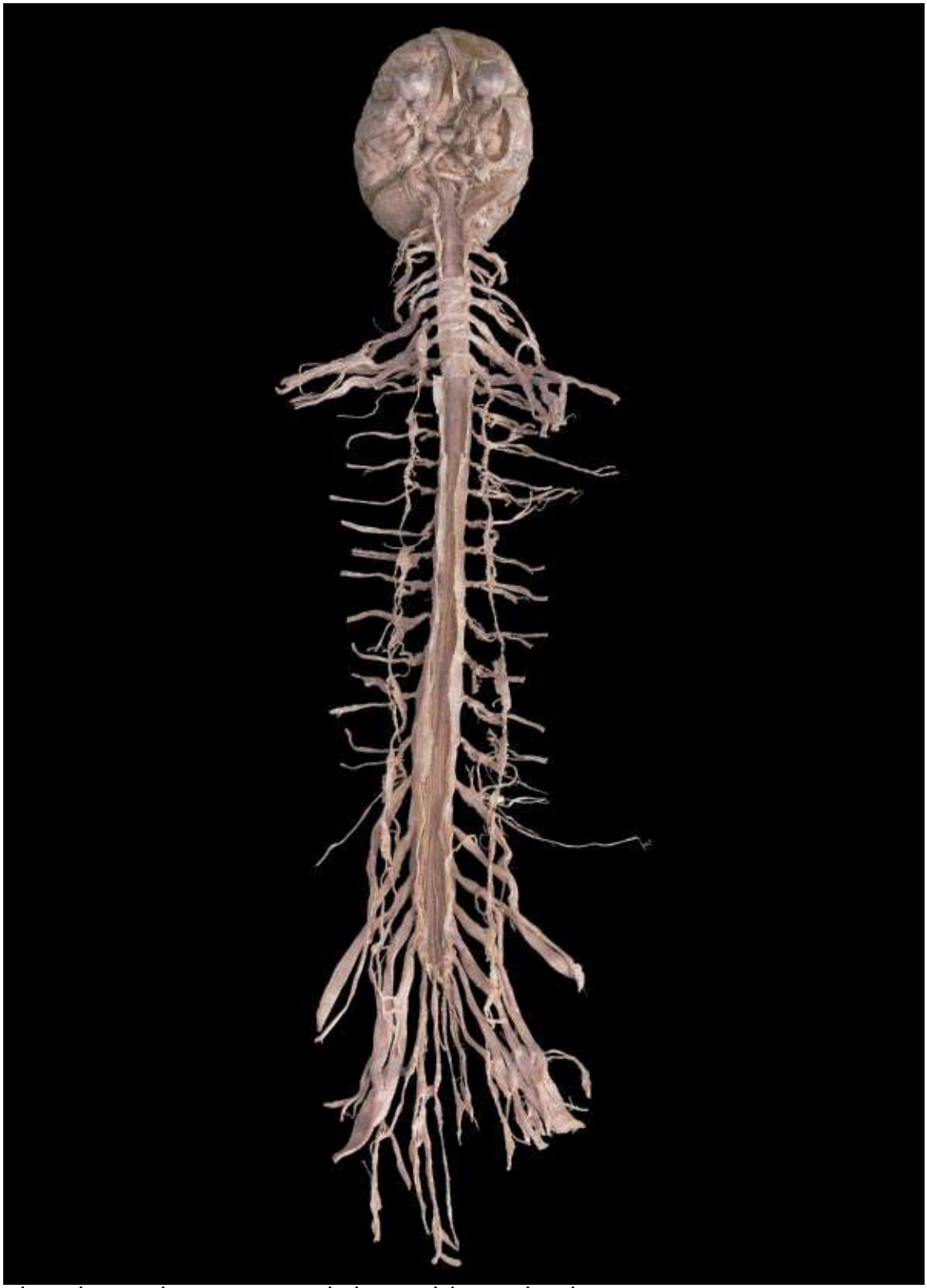
Tasting. Taste buds, which lie in the grooves between the bumps of the tongue, contain chemical sensors, or chemoreceptors, to sense for sweet, sour, bitter, and salty. Taste works best with smell, which is why food does not taste as good when we have colds.

Touching. The skin's dermis, the layer of skin just below the surface, contains specialized nerve receptors used to detect temperature (thermoreceptors), pressure (mechanoreceptors), and pain (nociceptors). The skin's sensory receptors are sensitive enough to detect small temperature changes in a room or minute differences in the thickness of paper.

Smelling. As you breathe in air through your nose, olfactory cells lining the top of the nasal cavity chemically analyze food, plant, or any type of particles by cilia, small sensory hairs. The olfactory cell sends an impulse directly through the olfactory nerve fiber to the brain for interpretation.

DID YOU KNOW? Smell is the only human sense that bypasses the cerebral cortex, used to process what you sense, and sends the olfactory information to the amygdala, the most ancient part of the brain. Scientific studies have found that smell is the best way to recall old memories. Try it out by smelling the same brand of baby food you ate when you were young.

DID YOU KNOW? Nerve impulses travel though the body at speeds of up to 200- 400 miles per hour, providing action within milliseconds.



This is the central nervous system; the brain and the spinal cord.

ACTIVITY: How Sensitive Is My Skin?

Students will determine the relative number of nerve endings located in the skin by using the technique of two-point discrimination.

National Science Standards: Standard A, Science as Inquiry; Standard C, Life Science

MATERIALS (per pair of students)

- 2 sheets large graph paper (1 per student)
- several toothpicks
- 1 ruler

INTRODUCING THE ACTIVITY

Humans learn a great deal about their immediate environment from the sense of touch. The brain is able to determine where the body has been touched and can often identify the object touching the body. Some areas of the skin have more touch receptors in a given area than others.

PROCEDURE

1. Take 2 toothpicks and gently touch the points of the toothpicks on the palm of your lab partners' hand and determine if they can feel one or two points. Start with the toothpicks 6 inches apart from each other. *It is important to touch the tips of the toothpicks to the skin at the same time.*

2. Ask the student how many points he or she feels. If the person feels two points, move the points of the toothpicks closer together – about 4 inches apart, and check again. Continue the procedure until you find the smallest distance the points can be separated for the person to feel the two points instead of one. When the person reports "one point" for the first time, move the two points apart only a few centimeters at a time and try to make a very accurate measurement.

3. When the smallest distance is found, measure and record the distance.

4. Try this experiment on the back of the hand as well as the inside and outside area of your forearm and your fingertips.

5. Record the data and perform the same experiments on the other partner. Use fresh toothpicks when you switch.

EXPLANATION for How Sensitive Is My Skin?

Students find that the ability to tell that two points rather than just one are pressing on the skin depends on two things: (1) the density of skin receptors and (2) the connections that the sensory nerve cells make in the brain.

EXTENSION

1. How do your results compare with those in other groups?

2. Are the two-point distances on different areas of the skin the same – for example, is the measurement on the palm of the hand the same as the measurement on your fingertips?

3. Which skin areas do you think have more receptors; areas that have small two-point distances or large two-point distances? Why do you think so?

4. How does information from sensory receptors in the skin get to the brain?

Nerves innervating the muscles in the hand

CIRCULATORY SYSTEM

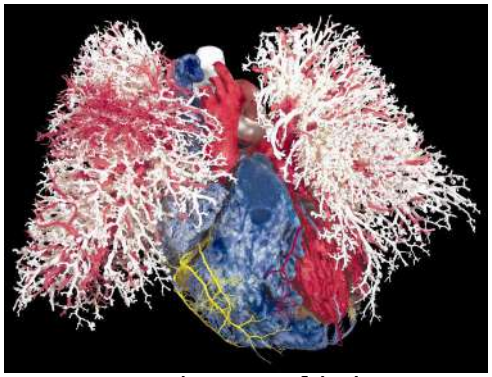
Your circulatory system is like the highway system of your body. Vital nutrients and oxygen are transported in the blood flowing through your arteries. The deoxygenated blood and waste are transported through the veins. You have about 5 quarts of blood traveling continuously throughout your body. Blood is made up of plasma, a liquid, and the following three types of cells:

- Red cells, or erythrocytes, carry oxygen for delivery to all your cells.
- White cells, or leukocytes, function as body police by fighting off bacteria and viruses.
- Platelets, or thrombocytes, are tiny pieces of cells that plug up injured blood vessels and start the clotting process when you get a cut.

Blood cells are created from the stem cells found in the red marrow of the skull, ribs, sternum, spine and pelvis. These stem cells divide and multiply to make various blood cells.

The primary organ of the circulatory system – the heart -- pumps oxygenated blood out through the arteries to all parts of the body. Because the heart is a double pump with four chambers, it also pumps the deoxygenated blood to the lungs to be oxygenated again.

DID YOU KNOW? The rhythmic beating of your heart is controlled by electrical impulses from specialized fibers located at the sinoatrial (SA) node on the back wall of the right atrium. The SA node is also known as a pacemaker. If the SA node has trouble maintaining the cardiac cycle of the blood pumping heart, an artificial pacemaker can be implanted to monitor and correct irregular rhythms.



Veins and arteries of the heart

ACTIVITY: Venous Valves

Students will understand the anatomy of blood vessels and observe the location of the venous valves.

National Science Standards: Standard A, Science as Inquiry; Standard C, Life Science

MATERIALS

- notebook to record data and something to write with

INTRODUCING THE ACTIVITY

The veins are the vessels that transport the blood toward the heart. Therefore, except for the pulmonary veins (which transport oxygenated blood from the lungs to the right auricle of the heart), all of the other veins transport non-oxygenated blood.

Veins hold approximately 50-60% of the total blood volume. The pressure inside of the veins is much lower than the pressure inside of the arteries.

The vena cava (largest vein in the body) collects the venous blood arriving from the trunk and legs. The jugular vein collects blood arriving from the head. The subclavian vein collects the blood arriving from the arms.

PROCEDURE

1. Hold your arm so you can see the veins on the anterior side of the forearm (palm facing up).

2. Place your forefinger on one of the visible veins. Push the finger along the vein toward the shoulder. Leave the finger in place on the vein and look to see if the blood flows back into the vein. Now remove the finger and watch what happens.

3. Place the finger on one of the veins in your arm (preferably the same vein). Push the finger along the vein toward the hand. Leave the finger in place and see if the blood flows back into the vein. Now remove the finger and watch what happens.

EXPLANATION

Veins are sectioned off by semi lunar valves which allow the blood to flow in only one direction -- towards the heart. Veins have a muscular wall which is much thinner and flexible than the walls in the arteries.

EXTENSION for Venous Valves

1. Based on the blood flow observations, predict where the valves are located in the vein in your arm.

2. You may choose to repeat this activity on the veins on the top of the hand.

RESPIRATORY SYSTEM

You don't think about your breathing throughout the day, do you? You might, however, be more aware of your breathing after you finish exercising or running up stairs! Your lungs, the star of your respiratory system, allow you to take air in from your environment and extract vital oxygen transported to all the cells in your body. Once finished with the air, your diaphragm, the muscle that works to inhale and exhale, expels carbon dioxide and other waste out into the environment.

Your lungs are made up of branches of tubes called bronchioles. Each bronchiole is about the same thickness as a hair. At the end of the bronchioles are microscopic air sacs known as alveoli. Alveoli take the oxygen molecules in the air and pass them to the red blood cells to deliver oxygen to the rest of the body.

Although it is up to your lungs to ventilate your body, it is up to *you* to keep harmful chemical fumes and cigarette smoke from damaging your lungs.

DID YOU KNOW? Every year, several hundred people die while thousands are hospitalized from carbon monoxide (CO) poisoning. CO is a colorless, odorless gas produced by the incomplete burning of solid, liquid and gaseous fuels. Carbon monoxide's molecular structure binds very strongly to the hemoglobin in red blood cells. When inhaled, CO asphyxiates the body by preventing oxygen from binding to the red blood cells necessary for respiration. People can prevent CO poisoning by installing CO detectors and attending public awareness programs on the use of fuel-burning appliances.

Healthy lungs

Smoker's lungs

ACTIVITY: Respiratory Physiology – Vital Lung Capacity

Students will be able to explain what vital capacity is and what factors affect it.

National Science Standards: Standard A, Science as Inquiry; Standard C, Life Science

MATERIALS

- 2 liter soda bottle for each group
- 2 foot piece of surgical tubing for each group
- Pan or bucket with volume greater than 2 liters
- Masking tape and markers
- Ruler

INTRODUCING THE ACTIVITY

This activity will give students a better understanding of lung physiology. The vital capacity of the lungs is the maximum volume of air the lungs can hold. You can measure vital capacity with a device called a spirometer. Most spirometers are bulky and expensive, but you can make a simple spirometer by using a 2-liter soda bottle, a piece of tubing and a water bowl.

PROCEDURE

1. First, you must assemble the spirometer. To do this, put about 2-3 inches of water in the bowl. Fill the 2 liter bottle completely and turn it upside down into the bowl being careful not to let any air into the bottle (you might need two people for this).

2. Place one end of the tubing into the bottle. While a partner holds the bottle, inhale as deeply as you can and exhale normally into the bottle. DO NOT blow out all the extra air in your lungs, just exhale as you would in any normal breath. Use the marker to indicate where the air meets the water in the bottle. Measure the amount of the air in the container using a ruler. This measurement is called the "inspiratory reserve".

3. Refill the bottle. Now take a normal breath. After exhaling, blow into the tube all of the extra air still in your lungs. Mark and measure the amount of air in the container as you did in step 2. This measurement is called the "expiratory reserve".

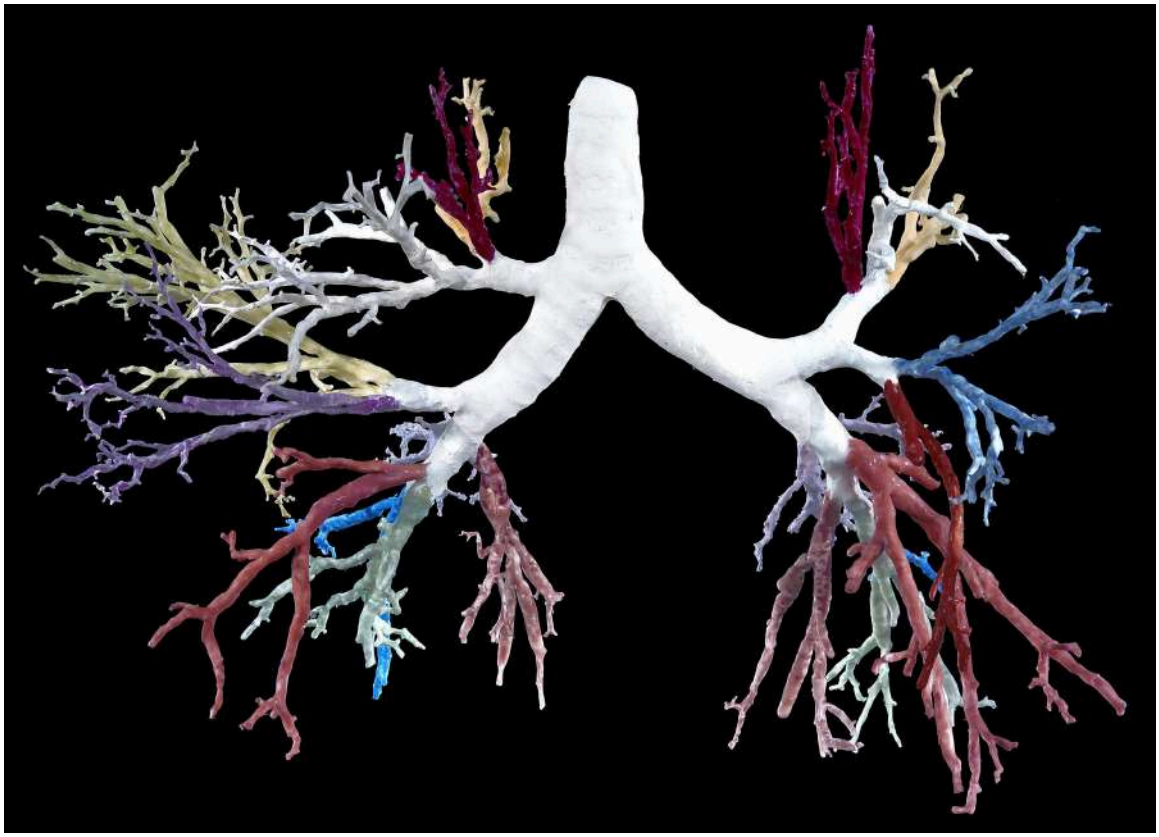
4. Add the two numbers together to get your "vital capacity". This number is the maximum amount of air your lungs can hold.

EXPLANATION for Respiratory Physiology – Vital Lung Capacity

Lung vital capacity is calculated by adding the inspiratory reserve measurement to the expiratory reserve measurement. The vital capacity will differ from student to student due to the size and physical fitness of each student.

EXTENSION

1. Who had the highest "vital capacity" in the group?
2. Was this person tall, short, big, small, male, or female?
3. What do you think makes a person have a large "vital capacity?"



Bronchial tree in the lung

ACTIVITY: Respiratory Physiology -- Acid Base

Students will be able to explain the composition of expired gases and their relative acidity or basicity.

National Science Standards: Standard A, Science as Inquiry; Standard C, Life Science

DANGER!!! Careful supervision is required. Students will use straws to blow bubbles into a poisonous chemical. DO NOT do this experiment unless students can handle this safely! Wear goggles during this lab!

MATERIALS

- small beakers or jars (approximately 250 ml)
- drinking straws
- safety goggles
- phenolphthalein **Note:** Phenolphthalein is an acid/base indicator. It is a pinkish color at low pH (acidic) and turns clear when base is added.

INTRODUCING THE ACTIVITY

The air you breathe out contains carbon dioxide gas (CO_2). This gas is a "base". Normally, the carbon dioxide content of the air you exhale does not contain a huge amount of CO_2, but when you are exercising, the air you breathe out contains much more CO_2. The chemical you will be using to measure the amount of CO_2 you exhale is called "phenolphthalein" (feen-ol-thay-leen).

PROCEDURE

1. Blow normal breaths into the phenolphthalein solution. Count how many exhalations it takes to turn the solution clear.

2. Breathe into a paper bag for 30 seconds. Count number of breaths it takes to turn the solution clear. (use the came amount of phenolphthalein for 2nd measurement)

EXPLANATION

Phenolphthalein is normally pink. When a base is mixed with it, it turns clear. Since CO_2 is a base, when you blow bubbles into the phenolphthalein, the CO_2 you blow out turns the solution clear.

EXTENSION

1. After breathing into the bag, did it take more or fewer breaths to turn the solution clear? Why?

DIGESTIVE SYSTEM

We base our decision on what to eat largely on taste preferences and nutritional habits. Let's follow what happens to our food from the minute we put it into our mouth to the time it comes out the other end.

1. You put food into your mouth. Teeth prepare the food by chewing larger pieces into smaller, easier to swallow ones. Enzymes are added to get a start on breaking down foods chemically.

2. Once your food is chewed, it is pushed into the esophagus and squeezed down using a muscular action called peristalsis.

DID YOU KNOW? The esophagus makes a sharp turn just before it reaches the stomach to keep the stomach contents from returning back through the esophagus. Gastroesophageal reflux disease, more commonly known as acid reflux disease, occurs when acid from the stomach is allowed to flow backward into the esophagus due to a reduction in the angle of the esophagus or an abnormal hole known as a hiatal hernia.

3. Food arriving in the stomach is subjected to highly acidic gastric juices that digest food and kill bacteria. Although the stomach churns and mixes the food, the stomach also acts as a storage compartment slowly changing the food into a gray, oatmeal-like mush known as chyme and passing it into the small intestine.

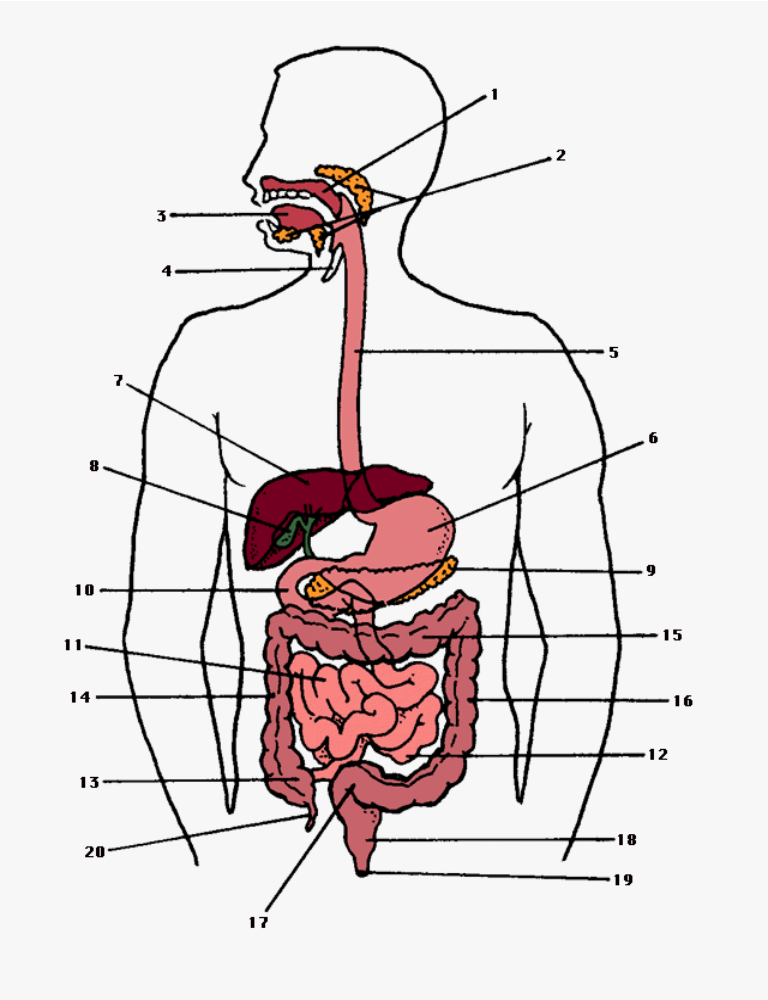
4. As the chyme enters the small intestine, it is mixed with green bile and other digestive juices to help with the absorption of minerals, vitamins, carbohydrates, proteins, and fats. This 26-foot long tube absorbs most of the nutrition from the food we eat.

The small intestines are chemically similar to your brain with neurotransmitters and hormones that sort and analyze foods as they are being digested.

5. Once the chyme makes it through the small intestine, its nutrients have already been stripped and transported to other organs. The fluid remains of the food have their water absorbed by the large intestine.

6. The final step. The nutrient and water remains of the food are stored in the rectum until there is enough to be defecated as feces.

Digestion: 1 palate, 2 salivary glands, 3 tongue, 4 epiglottis, 5 esophagus, 6 stomach, 7 liver, 8 gallbladder, 9 pancreas, 10 duodenum, 11 jejunum, 12 ileum (10, 11, and 12 comprise the small intestine), 13 cecum, 14 ascending colon, 15 transverse colon, 16 descending colon, 17 sigmoid flexure, 18 rectum (13-18 comprise the large intestine), 19 anus, 20 vermiform appendix



DID YOU KNOW? A diet rich in fiber helps digested food move easier though the intestines. Although plant fiber does not provide us nutrition it is important to our digestion and helps to control overeating.

ACTIVITY: Demonstration of Fat Content

Students will explore the various components of the digestive system and demonstrate the physical and chemical processes that work together to break down food into absorbable molecules.

National Science Standards: Standard A, Science as Inquiry; Standard C, Life Science

MATERIALS

- quarter pound hamburger meal with medium fries and 12 oz soda
- blender
- hot plate
- 500 ml container
- 200 ml container
- 100 ml of water
- 2 oven mitts
- 1 wooden spoon
- 1 refrigerator to cool mixture

INTRODUCING THE ACTIVITY

Your digestive system works to break down food into fats, proteins and starch molecules that can be absorbed by your body. Once absorbed, these molecules must be transported via the blood stream to all parts of the body where they serve as fuel.

Food is broken down using the following two methods: (1) hydrolytic, which takes place in the presence of water and (2) enzymatic, where food is broken down using enzymes. These two processes, along with the physical actions of chewing, stomach churning, absorption by the microvilli in the intestine and transportation of nutrients via the bloodstream, make up the digestive system.

During this activity, the complete meal will be blended and a large sample of the meal will be heated. From the heated sample, 100 ml of it will be cooled. Results from the 100 ml sample are representational of the complete meal.

PROCEDURE

1. Preheat the hot plate.

2. Break up food into small pieces and put into blender. Blend at medium speed.

3. Pour part of the blended mush into a 500 ml container.

PROCEDURE for Demonstration of Fat Content (cont'd)

4. Add 100 ml of water to the mush and stir well.

5. Boil the mush mixture gently for 15 minutes.

6. Use oven mitts to protect your hands. Pour the hot mixture into a container. Cool in the refrigerator for 5 minutes.

7. Remove the mixture from the refrigerator. Measure the amount of accumulated fat at the top of the graduated cylinder.

8. Record results.

EXPLANATION

The fat will form a layer at the top and solidify as it cools. You may calculate the percentage of fat in the mush meal by dividing the milliliters of fat by the total milliliters of your sample.

For example, you might find 40 mls of fat out of a total of 100 mls of sample. This would indicate that the total meal contained 40% fat

EXTENSION

1. Have students compare the fat content of foods from different fast food restaurants. Which has the most fat? The least?

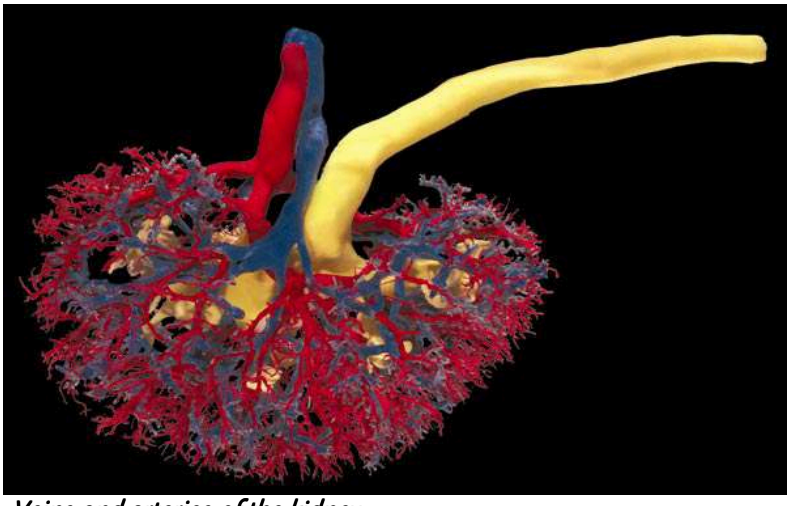
URINARY SYSTEM

The chore of taking out the trash is a dirty job, but someone has to do it. Luckily, we have the urinary system dedicated to removing discarded waste from every cell and system of your body. Although defecation releases feces as the final step of digestion, only our body's urinary system "cleans up" after metabolic or chemical processes in the form of urine.

Urea, the body's main waste product excreted by cells into the bloodstream, has to be removed because it is toxic. Traveling through the bloodstream, urea is filtered out from the blood by the kidneys. Your kidneys, located just below the ribs in the lower back, produce urine by combining the urea with other metabolic waste, salts, ions, and excess water.

The urine is transported via tube-like ureters to the bladder acting like a storage tank. When enough urine has filled the bladder, the brain sends an impulse telling the sphincter to relax (open) and the detrusor muscle to contract allowing the urine to flow from the bladder and down the urethra in the process known as micturition or urination.

DID YOU KNOW? People who do not drink enough water make their urine more concentrated with solutes (which are dissolved particles of waste material, including uric acid). If these solutes crystallize, they can become kidney stones that can damage the lining of a ureter. Small kidney stones can be painfully flushed through the urinary system while larger stones are handled through surgery, shock waves, or ultrasound. There is nothing fun about kidney stones, so drink plenty of water!



Veins and arteries of the kidney

ACTIVITY: Synthetic Urinalysis

Students will test and evaluate synthetic urine samples to learn how different diseases and conditions of the urinary system are diagnosed.

National Science Standards: Standard A, Science as Inquiry; Standard C, Life Science

MATERIALS (per group of students)

- 2 test tubes
- 1 test tube rack
- 1 test tube holder
- small cup filled with Benedict's solution
- small cup filled with Biuret reagent
- safety goggles for everyone in group
- control sample (water and yellow food coloring)
- synthetic urine sample from diabetic patient (water and apple juice)
- synthetic urine sample from patient with damaged kidneys (water, red & yellow food coloring, and albumin)
- notebook to record data

INTRODUCING THE ACTIVITY

Many different tests are used to identify problems with the urinary system. Transparency, color, odor, sugar and protein content are the most common tests.

Transparency: Normal fresh urine samples are transparent. Old samples of urine may be cloudy due to the presence of bacteria growing after the samples were collected. Fresh urine samples that are cloudy may be due to urinary tract infections (bacteria growing inside the urethra) or may indicate the presence of blood cells, pus or fat.

Color. The color of urine depends in part on its concentration. Pale, dilute urine may be the result of drinking large volumes of liquids. It may also indicate diabetes. Dark, concentrated urine may be the result of dehydration or of fever. A smoky-red color may indicate the presence of red blood cells, which can be due to damaged kidneys.

Odor. The normal color of urine may be changed by several factors. A foul odor in fresh urine can indicate the presence of bacteria. A fruity odor indicates the presence of ketones. Ketones are a product of the breakdown of fat, which can occur due to diabetes or starvation.

INTRODUCING the Synthetic Urinalysis Activity (cont'd)

Sugar Content. Sugar may be present in your urine after eating a meal rich in carbohydrates or during periods of stress. However, a consistent finding of sugar in urine may indicate diabetes.

Protein Content. Protein in the urine indicates an abnormal condition known as proteinuria. This condition may result from disease or damage to the kidneys.

PROCEDURE

1. Supply each group of students with different synthetic samples of urine.

2. Have students analyze urine samples for their transparency, color, odor, sugar content, and protein content.

3. Benedict's solution is a deep blue alkaline solution used to test for glucose (sugar) in urine. Biuret's reagent is used to test for proteins in urine.

4. Record the data from the urine tests in your notebook. Work with your group to determine the condition or disease found in the urine samples.

EXPLANATION

Pale, dilute urine with a fruity odor or high sugar content indicates a positive test for diabetes. Smoky-red urine or proteins in the urine could indicate damaged kidneys. Cloudy urine samples usually indicate the presence of bacteria. It is always a good idea to consult your physician if you notice anything unusual.

EXTENSION

1. Have students compare results.

BODIES...THE EXHIBITION **Washington State Standards, EALRs and GLEs**

Level	Content Area	Standards		
K-2	Science	1.1.6 1.2.6 1.2.8 1.3.8	2.1.1 – 2.1.5 2.2.1 2.2.3	3.1.2
	Health/Fitness	1.3 1.4	2.1 2.3	4.1 4.2
3-5	Science	1.2.1 1.2.3 1.2.8 1.3.8 1.3.10	2.1.1 – 2.1.5 2.2.1 2.2.3 2.2.5	3.1.2 3.1.3
	Health/Fitness	1.3 1.4	2.1 2.3	4.1 4.2
6-8	Science	1.1.6 1.2.1 1.2.6 1.2.8 1.3.8	2.1.1 – 2.1.5 2.2.1 – 2.2.5	3.1.1 3.1.2
	Health/Fitness	1.3 1.4	2.1 2.3	4.1 4.2
9-12	Science	1.1.6 1.2.1 1.2.6 1.2.8 1.3.8	2.1.1 – 2.1.5 2.2.1 – 2.2.5	3.1.2 3.1.3
	Health/Fitness	1.3 1.4	2.1 2.2 2.3	4.1 4.2

ORGANIZATION OF THE EXHIBITION

BODIES...THE EXHIBITION is presented, primarily by function and by system, in the following nine galleries:

1. skeletal
2. muscular
3. nervous
4. circulatory
5. respiratory
6. digestive
7. reproductive
8. fetal (optional)
9. treated body

The information in each exhibition gallery is designed to provide answers to the following questions, among others:

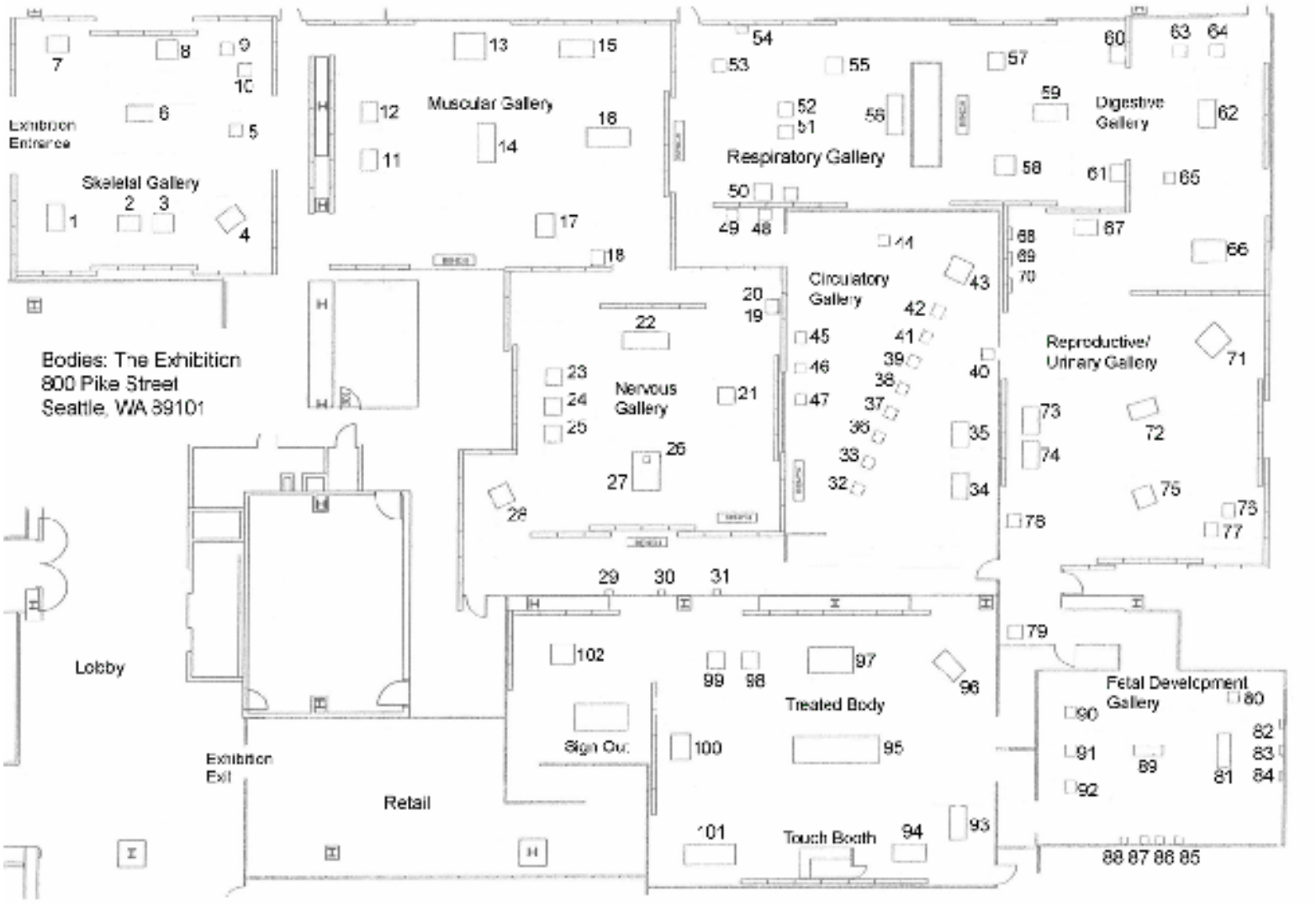
1. What are the systems of the human body?
2. How does each system of the body function?
3. How are the body's systems inter-related?
4. What can be done to improve and extend the life of the body?

Students are encouraged to work with these questions before they arrive and to form some questions of their own. As a writing exercise, answers may be written in a journal prepared before your visit or upon return to your school.

Upon viewing the exhibition, teachers and students will...

1. appreciate the sanctity and integrity of human life;
2. learn about the anatomy and complex systems of the human body;
3. learn how medical technology enhances one's quality of life;
4. become interested in their own body, how and why it works;
5. appreciate what it takes to care for the human body;
6. discover how daily choices affect the human body's health and well-being;
7. initiate conversations with friends and family about what it takes to sustain a healthy human body;
8. respect the human body in life and death;
9. understand that, regardless of how different we appear to be, the human body and its systems are much the same inside; and
10. explore careers in science, medicine and healthcare.

Floor Plan of BODIES...THE EXHIBITION



TEACHER'S GUIDE TO EXHIBITION GALLERIES

The nine galleries use full-body specimens to teach about the system or systems around which that gallery is designed. In addition, each gallery contains several cases featuring individual organs and sections of the body that relate to these systems. Refer to the floor plan as you review the material; it indicates the location of the cases and specimens. *Please note that all specimens on display are subject to change.*

Take time to view the projected images that appear on the walls of the galleries. These are artists' representations of cells and tissues, enlarged thousands of times!

There are 200 types of cells in the body; 75 trillion cells total.

THE SKELETAL GALLERY

CASE 1

Sphenoid Bone
This butterfly-shaped bone is called the "keystone" of the cranium because it connects with every bone of the skull except the lower jawbone or mandible. The sphenoid bone also contains the sphenoid sinuses, which help lighten the skull and give the voice resonance. As we age, the sphenoid sinuses enlarge and our voices deepen.

Maxilla
The paired maxillary bones form the upper jaw and create the floors of the orbits (eye sockets), as well as the hard palate, or roof of the mouth. If these bones do not join during fetal development, a cleft palate will result, leaving an opening between the mouth and nasal cavity, which creates great difficulty for nursing infants.

Top of Adult Skull

Internal and External Surfaces of the Base of the Skull
These unusual views of the skull allow you to see the complex composition of bone at the base of the skull and the several openings (foramina) that allow blood vessels and nerves to pass into and out of the cranial cavity. The largest of these openings, the foramen magnum, is the point at which the spinal cord connects with the brain. Notice also the zygomatic (cheek) arches on either side of the skull; they provide the bony foundation for the cheeks and are points of attachment for some of the muscles of mastication and facial expression.

Fetal Skull
This specimen demonstrates that the skull is made up of many flat bones, which do not fuse fully before birth. Instead, they are joined by fibrous connective tissue at the fontanelles, or gaps, between them. These fontanelles allow the baby's head to change shape to accommodate its passage through the birth canal. Most bones of the skull fuse into immoveable joints, known as sutures, during the first two years after birth. The mandible (lower jawbone) is the only moveable joint of the adult skull.

CASE 2

Elbow Joint (Hinge joint)

The elbow joint is formed of three bones: the humerus, and the radius and ulna (bones of the forearm). The humerus widens to connect with the radius and ulna, forming the elbow joint. The elbow is a hinge joint, allowing you to flex and extend your forearm. Immediately below the elbow, another joint is formed between the radius and ulna, allowing you to rotate your palm upward (supination) and downward (pronation).

Knee Joint (Hinge Joint)

The knee is the most complex joint in the body. It forms where the convex end of the femur meets the flattened end of the tibia (shinbone). The third bone of the knee, the patella (kneecap), is imbedded within the tendon of a powerful thigh muscle and helps stabilize the knee. The knee joint allows the tibia to move back and forth with some rotation.

Knee Joint Cartilage

The dense cartilage rings, visible at the top of this specimen, are found within every healthy knee joint. Known as menisci, these rings absorb shock and reduce wear to the bone ends. They also deepen the surface of the tibia, making the knee more stable, while allowing for a small amount of rotation. The menisci can sometimes be torn from the bone following a blow to the knee, particularly when the joint is over-rotated or the leg is fully extended. This often results in debilitating pain.

Knee Joint with Sagittal Cut

CASE 3

Hip Joint (Ball and Socket Joint)

One of the strongest and most stable joints in the body, the hip joint, forms where the ball at the head of the femur (thighbone) fits into the acetabulum (socket) of the hipbone. This joint structure allows for rotation, as well as forward, backward, and side-to-side movement. Held in place by five ligaments and tough connective tissue deep in the joint, the hip joint often withstands 400 pounds of force in everyday activity.

Bony Pelvis (Male)

The bony pelvis is a deep, basin-like structure formed of the hipbones and sacrum. It provides a strong and stable support for the spinal column and protects the reproductive organs. In addition, the bony pelvis connects with the bones of the lower limbs at the hip joints. The bones of the pelvis meet in the front at the pubic symphysis, where they are held together by cartilage; this cartilage softens during childbirth, allowing the pelvis to widen.

Fetal Hip Bone

During fetal development the hipbone begins as three separate bones, which are connected by cartilage. These three separate bones do not fully fuse until the age of sixteen. Genetic factors and multiple dislocations during childhood may lead to hip dysplasia, resulting in a shallow acetabulum that affects mechanics of the lower leg.

CASE 4

Bones, Muscles + Cartilage

Perhaps more than any other example in this Exhibition, this specimen shows you how you are held together and upright. This dissection demonstrates the important relationship between the bones of our skeletons and the cartilage and muscle attached to these bones.

CASE 5

Expanded Skull

Bones of the skull are divided into two types: flat bones and irregular bones. The flat bones of the cranium surround and protect the brain. The irregular facial bones form the bony framework of the face, the orbits surrounding the eye, the nasal cavity, and the roof and wall of the mouth.

CASE 6

Atlas and Axis Vertebrae

The first two vertebrae of the spine, the atlas and axis, allow the head to rotate and nod.

Cervical Vertebra

The seven cervical vertebrae are the least robust of the vertebral column, yet are strong enough to support the neck and allow for a wide range of motion.

Thoracic Vertebra

The 12 thoracic vertebrae are slightly larger than the cervical vertebrae; each connects with one of the 12 ribs.

Lumbar Vertebra

The five lumbar vertebrae are the largest and strongest of all the vertebrae. Called the small of the back, they bear the greatest amount of weight and thus provide the greatest amount of support.

Sacrum

The sacrum is composed of five fused vertebrae. It forms part of the bony pelvis and connects with the coccyx or tailbone.

Intervertebral Discs

The intervertebral discs between each vertebra provide mobility and absorb shock. Composed of dense, fibrous cartilage with a pulpy, hydrated core, these discs change shape under pressure as the spine bends and turns. As we age, our discs become less hydrated, causing us to lose height. In a herniated disc, the outer ring tears and some of the pulpy core is lost, leading to compression of and damage to the spinal cord.

The Vertebral Column
Humans are vertebrates, meaning they have an internal bony skeleton, a distinction shared with all mammals as well as fish, amphibians, reptiles, and birds.

The human vertebral column, or spine, typically consists of 33 vertebrae, which support and stabilize the upper body while forming a strong and flexible housing for the spinal cord. In addition, the spine has three natural curves that help it distribute weight and absorb shock.

CASE 7

Sternum (Flat Bone)
The sternum is a flat bone located at the center of your chest. Like the flat bones of the ribs, skull, and pelvis, the sternum acts as armor to protect vital internal organs. One side of this sternum has been cut to reveal the spongy bone within. Spongy bone distributes the force of impact and contains red bone marrow.

Cross Section of Femur Bone (Long Bone)
The ends of the long bones contain spongy bone tissue, which is visible in the cross-section of femur shown here. Spongy bone tissue makes bones lighter and distributes forces over a wider surface area. The outer layer and shafts of the long bones are made of compact bone tissue, which provides protection and support. The centers of the long bones have hollow spaces that contain marrow. Red bone marrow is the site of red blood cell production and creates more than two billion new blood cells per second.

Tibia (Long Bone)
The tibia, or shinbone, is the second longest and second heaviest bone of the body after the femur.

Epiphyseal Line
An epiphyseal line represents the former location of a growth plate. Located at the ends of a bone, the growth plates are the points at which all long bones grow in length. When you reach your height the epiphyseal growth plates disappear and a thin white line is all that remains.

CASE 8

The Whole Skeleton
The skeleton derives its name from the Greek *skeletos*, which means dry. But the bones of the body are anything but dry; they are dynamic organisms that reinvent themselves in response to repeated stress and repair themselves when broken. Visible on this specimen are the bones and joints of the body.

CASE 9

Shoulder with Open Joint Capsule

Like all moveable joints, the shoulder is a synovial joint, meaning its bones are contained within a capsule lined by a synovial membrane. This membrane secretes synovial fluid, a thick liquid that allows for almost frictionless movement within the joint. Synovial fluid is so effective as a lubricant that scientists are trying to duplicate it for use in machinery.

Shoulder Joint

The shoulder joint is formed by the articulation of three bones: the humerus (arm bone), the clavicle (collar bone), and the scapula (shoulder blade). The clavicle acts as a strut, holding the humerus away from the body, while the free floating scapula, held in place only by muscles, allows the humerus a wide range of motion. Although it is strengthened by the tendons of four important muscles (the rotator cuff), the shoulder joint remains relatively unstable. A sudden force can easily dislocate the humerus from its shallow socket and the rotator cuff muscles can be damaged through extreme movements or strenuous exercise.

CASE 10

Auditory Ossicles

Our skulls include the smallest bones in our bodies. Called auditory ossicles (hearing bones), these bones are located within the temporal bones of the skull and have distinct shapes for which they are named. They are the malleas (hammer), the incus (anvil) and the stapes (stirrup). Connected by the smallest moveable joints in the body, these bones transfer sound as vibrations from the eardrum to the inner ear. This efficient structure allows us to hear even the faintest sounds.

Temporal Bone With Auditory Ossicles

This specimen allows you to see deep into the middle ear cavity where the auditory ossicles are located. The eardrum, or tympanic membrane, marks the edge of the middle ear and the beginning of the ossicles, which transfer vibrations to the much smaller oval window at the edge of the inner ear. Two small muscles attach to the ossicles and contract to protect the eardrum and oval window from loud noises. Also visible is the bony labyrinth which helps tell the brain the position of the head, thus helping maintain balance. Diseases of the inner ear may result in hearing loss, tinninitus, or vertigo.

THE MUSCULAR GALLERY

There are more than 600 skeletal muscles in the human body. When muscles are stimulated, the fibers within them contract, or shorten, to cause movement.

Case 11

The Bones of the Foot and Ankle

The 26 bones in the foot have a very similar arrangement to those of the hand, but serve different purposes. While the hand can manipulate delicate objects, the bones of the foot work as a lever to raise the body and transmit thrust when walking and running. The ankle is comprised of a series of gliding joints like the wrist, but it permits a more limited range of motion and thus more stability.

Deep Anatomy of the Foot

The skin and soft tissue have been removed from this specimen to illustrate the ligaments and several of the tendons that insert to the tarsal (ankle) bones. The tarsal bones, their ligaments, and the muscles that attach to them assist in forming the arches of the foot.

In addition, this specimen shows the ligaments and articular cartilages of the metatarsal-phalangeal joints, which are comparable to the knuckles of the hand.

Muscle of the Top of the Foot

The muscles that extend the foot and toes are primarily located on the front of the leg. The supporting tendons of these muscles cross the back of the foot and are held in place by fibrous membranes.

Muscles of the Sole of the Foot

The sole of the foot has four layers of muscles and tendons that keep us balanced when standing or in motion. This dissection clearly reveals the flexor tendons; these fanning shiny cords, visible at the center, allow us to curl the very ends of our toes.

Joints of the Foot

The bones of the foot and ankle make up a complex array of joints, allowing them to: act as a lever to move us forward; to create arches that distribute weight; and to be in close association in order to keep us stable. On this specimen, the top portion of bone has been removed to illustrate the ankle's articular cavities, ligaments, and cartilage. Connected by these small joints and ligaments, the seven tarsal (ankle) bones help form the arch of the foot and allow for complex motion within the ankle.

CASE 12

Bones of the Hand

Joints of the Hand

The carpal, metacarpal, and phalanges of the hand and wrist are connected through multiple small joints that work together to produce the motion of the wrist and fingers. This relationship of bones helps create the fine motions needed to thread a needle or tie a shoelace. If these joints become affected by arthritis—characterized by the breakdown of protective cartilage at the end of the bones—the actions of daily living can become extremely difficult.

Wrist Joint
The eight small bones of the wrist, the carpal bones, create a series of gliding joints that allow for a wide range of movement. They are held together by a dense band of connective tissue that also covers the carpal tunnel. A U-shaped cavity just below the palm, the carpal tunnel is the area through which several tendons and the median nerve pass to the hand. Swelling within the tunnel, caused by repetitious movement, puts pressure on the median nerve and leads to carpal tunnel syndrome, today's high tech malady.

Muscles of Hand Showing Deep Palmar Arch

Muscles of Hand Showing Superficial Palmar Arch

Muscles of the Hand
Nineteen muscles control the movement of the hand. Four of these muscles, the lumbricals, place the hand in writing position; seven others, the interosseous, help perform movements like typing and playing the piano.

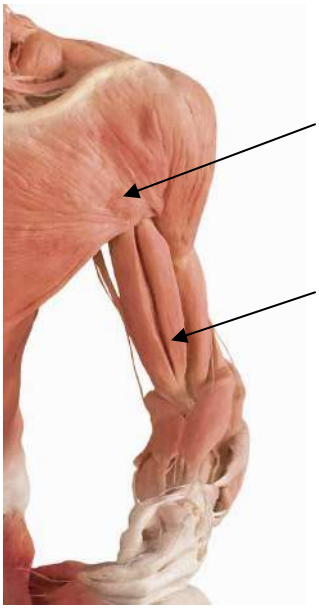
CASE 13

Balance + Muscle Strength
This specimen carrying a football exemplifies the muscular development that can be achieved through exercise and weight training. As they grow, muscles become larger and stronger as the connective tissue around them begins to toughen.

CASE 14

The Skeleton + Its Muscles
This unique presentation, both created from the same specimen, displays the supporting skeleton and the covering of skeletal muscles that were formerly attached to it. These systems would be of no use without the other and each plays an essential role in body movement.

CASE 15



Muscles of the Upper Limb
The numerous muscles of the upper limb constantly work together to perform tasks like writing, lifting, and sipping coffee. These muscles include:

Deltoid. Named for its triangular shape, delta in Greek, the deltoid muscle joins the upper arm to the shoulder. It helps lift the arm away from the side of the body, and allows forward, backward, and side-to-side movement.

Biceps Brachii. The word "biceps" comes from the Latin words bi, meaning two, and cephalon, meaning head. The two heads at one end of the biceps attach to the top of the arm and shoulder. The single head attaches to the forearm.

Supinator and Pronator. These two muscles are named for the actions they perform. Turn your palm upward—that is the supinator muscle working. Turn your palm down—that is the pronator at work. These two muscles are called antagonists because they cause opposite motions.

Muscles of the Lower Limb. The muscles of the lower limb are the largest in the body and make us bipedal and mobile. They include:

Gluteus Maximus. The largest muscle in the body; it helps us keep our balance, and move the thigh.

Quadriceps. This four-headed muscle makes up most of the muscle mass on the front and outside of the thigh and joins into the powerful patellar tendon just above the knee.

Gastrocnemius. One of three muscles that form the prominence of the calf, this large muscle connects to the achilles tendon, the strongest tendon in the body and helps us stand upright.

CASE 16

Muscle Attachments + Layering
This unique dissection of a running man allows you to see the relationship of the body's muscle layers and demonstrates the points at which these layers attach to the skeleton.

CASE 17

Muscle Control + Core Muscles
The dynamic pose of this specimen with a basketball illustrates the body's remarkable agility and balance. This is achieved through the precise control of several skeletal muscle groups working together. It takes 19 muscles to move the hand and the wrist, but not all of those muscles are within the hand. Some of these muscles are located in the forearm and are connected to the hand and fingers via tendons, known as extensors and flexors.

CASE 18

Cardiac Muscle Tissue
Cardiac muscle tissue, which causes the movement of the heart, shares characteristics with both skeletal and smooth muscle. In addition, all cardiac muscle cells are controlled by one nucleus which allows them to contract in unison; essential for a proper heartbeat.

Urinary Bladder
The urinary bladder is a hollow, muscular organ, which stores urine. Its smooth muscles change size, shape, and position according to the amount of urine it contains.

Arterial Wall
The arteries possess strong, elastic walls and include smooth muscle cells. They can quickly expand and contract, ensuring fast and efficient blood flow.

THE NERVOUS SYSTEM GALLERY

The nervous system controls and integrates activities of the body. The central nervous system consists of the brain and spinal cord. The peripheral nervous system consists of the spinal nerves and the cranial nerves. Several peripheral (spinal) nerve networks, called plexi, originate from the spinal cord and branch out to eventually reach the skin and muscles of the upper and lower limbs.

CASE 19

Transparent Section of Cerebrum

CASE 20

Brain Stem

The oldest part of the brain and the continuous link between the upper brain and the spinal cord, the brain stem controls several of the body's most vital functions, including heartbeat and respiration. It is divided into three regions as it ascends from the spinal cord:

Medulla Oblongata. The link to the spinal cord. Controls heartbeat, respiration, and blood pressure, as well as sneezing, coughing and hiccups.

Pons. The bridge between the cerebellum and cerebrum.

Mid-brain. Contains reflex centers for vision, hearing and touch. In threatening situations, these reflex centers immediately respond by closing the eyes, tensing the hearing muscles, or pulling away from danger.

Section of Face showing Trigeminal Nerve

Twelve cranial nerves arise directly from the brain to control and monitor the structures of the face. Nine of these nerves originate from the brain stem; these include the vestibulocochlear nerves that control hearing and balance, the facial nerve that controls the muscles of facial expression, and the trigeminal nerve.

The trigeminal nerve, exposed on this specimen, supplies nerve impulses to the skin on the face and scalp, the teeth, the mucous membranes in the nose, mouth, and eye, and to the muscles of mastication (chewing). The trigeminal nerve is mainly composed of sensory nerves. It allows you to feel your skin stretch when you open your mouth wide and is the reason you can feel the texture of the foods you eat. A branch of the trigeminal nerve is also very important to dentists: it is the nerve they numb before dental procedures such as drilling.

Brain Stem with Trigeminal Nerve

CASE 21

Nerves

The intricate nerves of the head are dissected here, as are the nerves that control digestion and respiration. The opened cranial cavity of the back of this specimen reveals the unique blood flow within the brain.

CASE 22

The Central and Peripheral Nervous System
This remarkable dissection offers a nearly complete view of the central and peripheral nervous systems. The brain and spinal cord are clearly visible as are all the spinal nerves. At the base of the spinal cord you can see the lumbar enlargement and the cauda equina —dozens of nerve rootlets that branch from the spinal cord. In addition, both the lumbosacral and the brachial plexi are visible, as are several of the cranial nerves that innervate the face and head.

Like the brain's protective membranes, three layers of the meninges surround the spinal cord. The outer fibrous layer of the meninges is called the dura mater, while the inner and most delicate layer is called the pia mater. An intermediate layer is called the arachnoid because the fibers within it resemble a spider's web.

The specimen is also displayed with its eyes and optic nerves. The size of the eyes does not change between infancy and adulthood, thus children's eyes are large in comparison to their brains and skulls giving them that wide-eyed look.

CASE 23

The Cerebellum
The cerebellum is the cauliflower-shaped organ at the base of the brain. Meaning "little brain" in Latin, the cerebellum controls equilibrium and regulates our muscular movements. It is because of your cerebellum that you are able to stand on one foot, button your shirt, and walk smoothly through this exhibition.

Cerebral Dura Mater with Whole Brain
The brain is surrounded by three meninges, or protective membranes, which supply it with blood and nutrients. The tough and fibrous outer layer, called the dura mater, is shown here. It supports the brain and divides the cranial cavity into smaller compartments.

Insular Lobe

Hippocampus

CASE 24

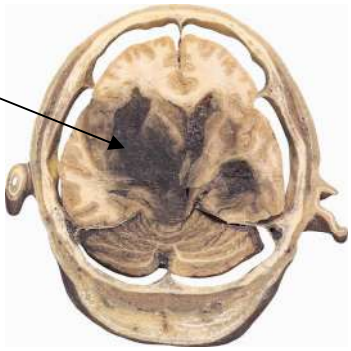
Brain Ventricles and Cerebrospinal Fluid
Inside the brain are an interconnected series of hollow spaces called ventricles that are filled with cerebrospinal fluid. Made within the ventricles, this water-like fluid circulates between the layers of the meninges, cushioning the brain and spinal cord, and removing their wastes. The cerebrospinal fluid is continuously produced, circulated and reabsorbed. If a blockage prevents the cerebrospinal fluid from circulating, the ventricles can enlarge, putting pressure on the brain. This condition is known as hydrocephalus (water on the brain).

Cerebrum with Hydrocephalus

Stroke

The brain requires a massive and continual blood supply. If this blood supply is interrupted, even for a few minutes, brain tissues will begin to die.

This is the case with stroke. It is caused by a blockage (thrombosis) or rupture in one or more of the brain's blood vessels. In the case of a rupture, a broken vessel fills part of the brain with blood, increasing pressure, and causing further tissue death. Those with high blood pressure and arteriosclerosis are at the greatest risk. Symptoms of stroke include paralysis, language and vision impairment. There are 600,000 new cases of stroke annually in the United States. The brain section in this case is an example of a large-scale debilitating stroke.



Top view of cross section of the head

Thrombosis (Blockage of Cerebral Artery)

CASE 25

Half Brain Showing Location of Pituitary Gland

Pituitary Gland

Known as the master gland, the pituitary plays a very important role in the functioning of the glands in the endocrine system. It secretes the hormones that control all the other glands of this delicate and essential system, which influences every cell, organ, and function of our body.

Thyroid Gland

The largest of the endocrine glands, the thyroid, is located just below the voice box. It produces hormones that regulate body metabolism. In certain cases, the thyroid becomes overactive, increasing metabolism and raising blood pressure. Those with this condition, known as Grave's Disease, often appear to have very large eyes. Grave's disease is often treated by removal or destruction of the thyroid. The thyroid hormone is then replaced with a synthetic hormone that is taken daily. In other cases, the thyroid is under-active causing lethargy and weight gain. This, too, is regulated with synthetic hormones.

Thymus Gland

The thymus gland lies underneath the top of the breastbone. A very important gland during childhood and puberty, the thymus produces T-lymphocytes (T-cells), white blood cells responsible for immunity. T-cells help recognize and destroy invading bacteria, viruses, abnormal cells, and foreign tissue. Experiments done on animals have shown that if the thymus is removed before birth, the animal's immune system cannot recognize foreign tissue and cannot fight off cancer cells.

Thyroid Cancer

Thyroid cancer is both a rare clinical disease and a rare cause of death; the gland is more often affected by a benign tumor known as an adenema. These tumors can occur in any age group, but occur more commonly in young adults. Until recently, adenomas were surgically removed upon their discovery to prevent cancerous change. However, current research suggests that the risk of cancerous changes is slight, allowing physicians time to monitor adenomas before deciding upon surgery.

CASE 26

The Whole Brain
The brain is the mysterious organ of the central nervous system and is essential for all bodily functions. Weighing only 2.6 pounds on average, it contains billions of nerve cells, which are in constant communication with each other and the body. Some brain cells make connections with over 10,000 others in a split-second.

CASE 27

The Brain
The exposed brain of this seated figure offers an excellent view of the main organ of the central nervous system, which controls everything we do; every thought, action and emotion. As the main conduit between the brain and the body, the spinal cord transmits millions of nerve impulses per second at speeds exceeding 270 miles per hour.

CASE 28

Creativity + Bodily Control
This specimen of a musical conductor illustrates the nearly countless number of tasks the brain executes, from the most basic to the highly complex. The thickest and longest nerve in the body, the sciatic nerve, is also visible on this dissection.

THE CIRCULATORY SYSTEM GALLERY

Every drop of blood in the body passes through the heart once each minute.

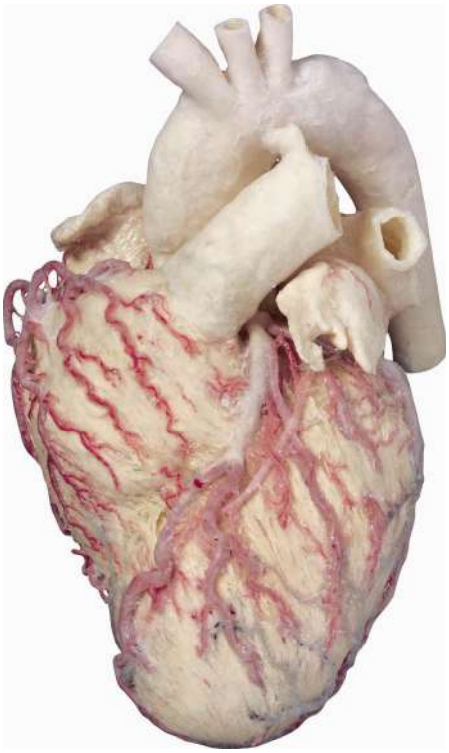
CASE 29
Heart

CASE 30
Chambers of the heart

CASE 31
Heart with Visible Cardiac Valves

CASE 32
The blood vessels of the heart

Case 33
Casting Specimen of Pancreas and Spleen



CASE 34
Arteries of the upper Limb
Arteries and veins of upper Limb

CASE 35
Arteries of the lower Limb
Arteries and veins of the lower Limb

CASE 36
Artery of the Jejunum

CASE 37
Blood Vessels of the Ileum

CASE 38
Arteries of the Stomach

CASE 39
Arteries of the Ileum

CASE 40
The arteries of the thoracic wall

CASE 41
The blood vessel of the iliocecal junction

CASE 42
Arteries of the kidney

CASE 43

Blood Vessels
This specimen was prepared using a special casting method. The blood vessels were first injected with a colored polymer. Once the polymer hardened, the remaining body tissue was removed by a corrosive chemical to reveal the intricate matrix of the blood vessels.

CASE 44
Arteries of the head with skull

CASE 45
The bronchial tree and pulmonary veins

CASE 46
Casting specimen of associated heart and lungs

CASE 47
Bronchial Tree and Pulmonary Artery

CASE 48
The venous valves

THE RESPIRATORY GALLERY

CASE 49

Spleen

Located high in the left side of the abdomen, the spleen helps form blood in a developing fetus and, though not essential to an adult, continues to filter blood and fight disease throughout life. Red blood cells squeeze through narrow pores within the spleen and older, more brittle, cells are destroyed here. The spleen also contains the largest concentration of lymphatic tissue in the body and assists the immune system in isolating and destroying harmful organisms.

Megalosplenia (Enlarged Spleen)

Because the spleen acts as a filter for the blood and the immune system, it may become enlarged due to infections or diseases of the blood. The most common cause of enlargement is malaria, a disease endemic to mosquito-infested tropical and sub-tropical areas, which affects the body's red blood cells. The Epstein-Bar virus, which causes mononucleosis, also leads to swelling of the spleen. If the spleen ruptures due to infection, it must be removed in emergency surgery. Removal of the spleen may lead to a weakened immune system.

CASE 50

Smoker's Lungs with Heart

These shrunken and darkened lungs illustrate the tar build-up and disease that often accompanies cigarette smoking. The tars in tobacco permeate and blacken lung tissue. The accumulation of smoking debris within the lungs leads to the breakdown of the alveoli, greatly decreasing the surface area of the lung and depriving every organ in the body, including the heart, of much needed oxygen.

Section of Lung with Emphysema

Emphysema comes from the Greek word for inflation and refers to an over-extension of the alveoli. This inflation occurs as the thin walls of the alveoli rupture if they are obstructed. The lungs may be obstructed by many different types of debris, but the most common is debris from cigarette smoking. As lung tissue continues to deteriorate, it begins to fill with fluid, leading to a near-permanent state of pneumonia resulting in a chronic cough, loss of appetite, and fatigue.

Lung with Cancer

Bronchogenic carcinoma of the lung most often starts in one of the air passageways and not in the lung tissue itself. These cancers can go undetected for some time and often develop into advanced diseases before they are discovered. Early symptoms include a dry, irritated cough and the slow onset of breathlessness. The leading cause of lung cancer is chronic cigarette smoking.

Lobe of Lung with Cancer

Because the lungs are naturally divided into independent segments, one portion of the lung may be removed without affecting breathing in other regions. In the case of lung disease or cancer, surgeons often remove the compromised section of lung, hoping to keep the disease from spreading. This specimen came from a surgery in which a portion of lung was removed to save the individual's life.

CASE 51

Lungs and Heart of Fetus

During fetal development, oxygen is delivered to the fetus via the umbilical cord. The lungs are not used until birth when the infant takes its first breath.

Healthy Lungs and Heart

These healthy lungs show some dark pigmentation, the normal amount of discoloration resulting from the inhaled pollutants in our air. Special cells within the lungs sweep these pollutants out of the airway and deposit them in the lung tissue, allowing oxygen and carbon dioxide to be exchanged normally.

CASE 52

Tuberculosis of Small Intestine

Tuberculosis of the small intestine is thought to begin when bacteria is coughed up and swallowed. Because it is resistant to gastric acid, the bacteria enters the small intestine and becomes lodged in lymphoid tissue. This can lead to erosion of the intestinal lining.

Tuberculosis of Kidney

Tuberculosis of the kidneys arises almost always from a blood-borne spread of tuberculosis from the lungs. In advanced stages of tuberculosis, the kidney becomes a hollow sac-like structure. Occasionally, the original site of infection (e.g., the lungs) will heal, but the kidney will remain infected. Renal tuberculosis can lead to death either from uremia (kidney failure) or from chronic wasting and loss of kidney function from the uncontrolled tuberculosis infection.

Section of Lung with Tuberculosis

Pulmonary Tuberculosis

CASE 53

Cancer of the Larynx

Although it is not common form of cancer, carcinoma of the larynx occurs directly upon the vocal cords. This accounts for the progressive hoarseness and difficulty swallowing associated with this cancer. When they do occur, however, tumors of the larynx have a high mortality rate.

Front of Larynx

Back of Larynx

Vocal Cords

The lower segment of the larynx contains the vocal cords, two ligaments of elastic tissue covered with gathered mucous membrane that enable speech. We speak by pushing air from the lungs into the larynx and vibrating the vocal cords; the closer the vocal cords draw together, the higher the pitch of your voice. The tongue and lips convert the vocal cords' vibrations into speech.

Segmental Bronchi

As its name suggests, the bronchial tree branches into smaller and smaller segments as it enters the lungs. These branches eventually end at one of millions of alveoli where carbon dioxide is exchanged for oxygen. The lung is actually divided into only 20 segments. These segments are functionally separate regions in the lungs, which receive their own blood supply and can continue to operate if another segment is removed. This is nature's way of insuring that breathing will continue if other parts of the lung become diseased.

Alveoli

The bronchial tree ends in air sacs, or alveoli, that branch out like clusters of grapes. Only one cell thick, the walls of the alveoli are in direct contact with the capillary walls of the pulmonary veins. It is across this fragile membrane that life-supporting gas exchange occurs; here carbon dioxide is diffused from the bloodstream and exhaled, while oxygen is absorbed into the bloodstream and circulated to every organ in the body. The lungs contain approximately 300 million of these alveoli that, if stretched out, would cover half a football field.

CASE 54

The Respiratory System

The respiratory system consists of a number of successive, interconnected, structures (air passageways) that begin in the nose and end in millions of alveoli deep in the lungs. The conducting division of the respiratory system includes the nasal cavity, nasopharynx, larynx, trachea, bronchi, and bronchioles, which cleanses, humidifies, and directs the air we breathe into the lungs. In most instances, the walls of the conducting division contain cartilage, which prevents the air passageways from collapsing.

Once inhaled, air enters the respiratory division of the respiratory system. It passes into the alveoli where oxygen and carbon dioxide are exchanged across a thin blood-air membrane: red blood cells absorb oxygen from the inhaled air and release carbon dioxide that is then exhaled.

CASE 55

The Mediastinum

The central portion of the thoracic cavity is called the mediastinum, a thick partition that contains the heart, esophagus, trachea, and the thymus gland. It lies in the midline of the chest, dividing it into two smaller compartments: the pleural cavities that hold the lungs.

Diaphragm

The diaphragm, visible at the top of this specimen, is essential for life. This strong, flat muscle divides the thoracic and abdominal cavities and is the main muscle used in breathing. When at rest, the diaphragm forms a high dome; when the diaphragm contracts, the dome moves towards the abdomen creating a vacuum, expanding the chest cavity, and making room for outside air. The average adult takes 15 breaths per minute; babies take 40.

CASE 56

Respiration + Circulation

This dissection of a man throwing a baseball displays many of the body's major arteries. In particular, it demonstrates the delicate interior architecture of the lungs.

THE DIGESTIVE GALLERY

CASE 57

Muscles of Mastication, the Tongue and Taste Buds

Digestion of food begins in the mouth, with the teeth and tongue. The teeth tear, bite, and grind food (mastication), mixing it with saliva. The tongue moves food between the teeth to assist with chewing and swallowing. When food is swallowed, a cartilaginous flap of tissue, called the epiglottis, closes off the airway to prevent us from choking. Food then enters the esophagus, a ten-inch long muscular tube, where it is transported to the stomach by peristalsis (muscular contractions).

Taste buds lie between the grooves on the surface of the tongue and tell the brain what the body is ingesting and what enzymes it needs to break it down. Each person has between 2000 and 5000 taste buds, with women generally having more than men

Muscles of Mastication

Pharynx

The pharynx is commonly known as the throat. It is the passage for air and food, and contains the larynx (voice box). Its opening from the mouth is protected by the tonsils, which have open pits to catch bacteria and viruses. The pharynx also contains the epiglottis, a leaf-shaped flap of tissue just behind the tongue that prevents food or liquid from entering the airway when swallowing.

Section of Head Showing Location of Parotid Gland

The Ducts of the Parotid Gland

These delicate glands carry saliva from the parotid gland, the largest of all salivary glands, and deliver it into the mouth. Saliva begins breaking down carbohydrates in food as soon as it enters your mouth. The major ducts of the parotid gland open into both sides of the mouth opposite the upper second molars. Because it they are constantly being bathed by saliva, the upper second molars often accumulate more plaque than any of the other teeth within the mouth.

CASE 58

Normal Gallbladder

The gallbladder attaches to the lower surface of the liver and stores bile, a greenish-brown fluid that is essential for digestion. Bile breaks down fats and also helps carry certain toxic wastes created by the liver out of the body.

Adenocarcinoma of the Gallbladder

Cancer of the gallbladder is a common disease in the gastrointestinal tract. In its early stages, the cancer has few symptoms, but later symptoms include pain, nausea, vomiting, intolerance to fatty foods, jaundice, and weight loss. The lack of early symptoms often leads to a delayed diagnosis and a low curability rate for the disease. Only 20 percent of such cancers are surgically treatable.

The Liver

The heaviest single organ in the body, weighing close to 3.5 pounds (1.58 kilograms) in an average adult, the liver serves several metabolic functions. It produces bile, key to the proper digestion of fats, stores vitamin A, and creates several proteins essential to blood flow and clotting. The liver also receives glucose-rich blood returning from the digestive tract. It converts much of this glucose into glycogen, the sugar your body's cells use for energy.

Cirrhosis of the Liver

Along with storing sugars, the liver also removes and destroys ingested toxins, including alcohol, drugs, and microbes. Improper diet that often accompanies alcohol and drug abuse can lead to the death of liver cells and to their replacement by scar tissue. This disease is known as cirrhosis and is visible on this specimen. Other diseases, such as liver cancer and hepatitis, can severely damage the liver as well. A liver transplant is often the only way to treat these conditions.

Canal System of Liver

This special dissection reveals the hepatic portal venous system, one of the pathways that blood takes through the liver. This pathway receives blood from the capillaries of the small intestine and delivers the absorbed nutrients in that blood to the sinusoidal capillaries of the liver for processing.

Healthy Liver

Liver Cancer

The liver is a common site for secondary cancers to occur because of its high blood flow. Tumors arising in the colon, pancreas, stomach, lung or breast can spread to the liver as their cells become more prevalent in the blood.

On this specimen, you can clearly see cancer's devastating effects in two ways: cancer cells both destroy the liver's healthy cells and take much needed blood for their own growth. On this specimen, you can see the larger blood vessels that correspond to the tumor's development in the liver.

CASE 59

The Stomach

In the stomach, three layers of muscle churn partially digested food with powerful gastric juices, turning the food into a paste-like substance and killing many bacteria that might otherwise bring disease to the body.

Stomach with Rugae

The stomach contains many rugae (folds), which expand to create more surface area as the stomach fills with food. Cells within the rugae produce both mucus and digestive juices. We feel full from eating when nerve receptors in the stomach tell the brain that the stomach has stretched to capacity. Ignoring this feeling can lead to overeating and destructive weight gain.

Stomach and Duodenum

After food is broken down in the stomach, it enters the duodenum, a one-foot long, C-shaped section at the beginning of the small intestine. Here food is mixed with bile from the liver and enzymes from the pancreas to further digest it into carbohydrates, nucleic acids, proteins, and fats--the four nutrients needed for life. These nutrients are then absorbed into the bloodstream as the digested food travels through the small intestine. The pancreas also plays a vital role in controlling blood sugar levels in the body, secreting the hormone insulin when blood sugar levels are high and the hormone glucagon—a sugar the body uses for energy—when they are low.

Small Intestine with Mesentery

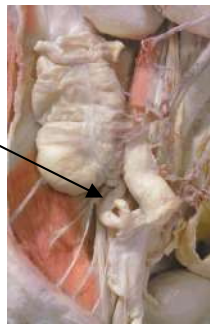
The small intestine attaches to the body wall with a connective tissue called mesentery. It wraps around the intestine like a sling and holds it in place. Blood vessels, visible as dark lines on this specimen, travel through the mesentery to reach the intestine, carrying oxygen and nutrients to the intestine and wastes and absorbed molecules away from it.

Section of Small Intestine

The small intestine performs most of the digestion and absorption of nutrients in the digestive tract. Over ten feet long, it contains several million villi and microvilli. These microscopic, finger-like projections reach into the hollow spaces of the intestine and increase the small intestine's surface area over one thousand times. Through these projections, digested molecules pass into the bloodstream and are carried to the liver for further processing.

Cecum and Vermiform Appendix

The cecum marks the very beginning of the colon (large intestine). Unlike the walls of the small intestine, which have permanent folds, the colon's inner wall is smooth. The small piece of tissue at the bottom of this specimen is the vermiform (worm-like) appendix. Once needed by our ancestors when they ate rougher foods, it is now an evolutionary relic.



Section of Colon

The colon (large intestine) is the end of the digestive tract. It converts digested food into feces for excretion. Digested food moves through the colon by peristalsis (muscular contractions) in the colon walls. In some cases, due to stress, the walls in one area of the colon contract more intensely, causing discomfort and flatulence, a condition known as irritable bowl syndrome or spastic colon.

Rectum and Anal Canal

As it leaves the lower portion of the colon, undigested food and other body waste pass into the rectum where they are stored until the body discards then as feces through the anal canal. The rectum and the lower portion of the colon are sometimes the site of constipation, which occurs when the feces hardens and becomes too dry to pass out of the anal canal. This is generally caused by lack of exercise plus insufficient fiber and liquid in the diet.

Gastric Cancer Invading the Spleen
Cancerous tissue in the stomach lining results in a breakdown of the stomach's rugae, which are then replaced by hard, smooth cells. While gastric cancer may feel much like an ulcer, it can be fatal if not treated. The best way to detect stomach cancer is through the use of a long flexible tube called an endoscope, which is swallowed by the patient allowing physicians to examine the lining of the stomach. Milk, fresh vegetables, vitamin C and frozen foods all appear to reduce the risk of stomach cancer.

CASE 60

The Whole Viscera
The vital organs of respiration, digestion, circulation, and reproduction are contained within the body's thoracic, abdominal, and pelvic cavities. They are aligned within us in an amazing, compact, and efficient relationship, performing hundreds of functions simultaneously, while continuously maintaining and remaking themselves.

CASE 61

The Alimentary System (Digestive Tract)
A fibro-muscular tube that runs from mouth to anus, the digestive tract is one of the world's most efficient dis-assembly lines. It uses a combination of mechanical and chemical processes to break down the foods we eat, converting them to nutrients the body can use for fuel. Once swallowed, food moves through the digestive tract by the process of peristalsis, waves of muscular contractions that propel food from the esophagus to the rectum. On average, it takes 24 hours for food to pass through the canal.

CASE 62

The Vital Organs
This dissection provides a rare view into the compact and complex relationships that exist between many of the body's major organs. This specimen was cut into right and left halves along the midline of the body.

CASE 63

Gastric Polyps
Polyps, benign tumors that develop in the digestive tract, can signify changes in the tissue that may lead to cancer. They are very small and usually develop singly. Polyps occurring in large numbers are termed polyposis.

Ascariasis
Ascariasis is an infection caused by the parasitic roundworm *Ascaris lumbricoides.* Poor sanitation and poor personal hygiene are contributing factors to this disease. Early signs of its presence include lack of appetite, fatigue, and weight fluctuations. Adult worms live in the intestine and when infestation is great can cause abdominal discomfort, intestinal obstructions, and malnutrition. As part of their life cycle, larval worms migrate through the lungs of their host causing a cough and discomfort while breathing. Effective medications are available, but in severe cases surgery may be necessary to clear internal blockages.

The relationship of liver, stomach, pancreas, and spleen
This view of the close positioning between the stomach, liver, spleen, and pancreas helps demonstrate how each organ depends upon the other during the process of digestion.

CASE 64

Greater Omentum
The greater omentum secures and supports the stomach and part of the small intestines, supplying them with nerves and blood vessels. A connective tissue, it is also one of the areas where the body stores fat. The omentum is known as the "guardian of the abdominal cavity" because it contains cells that help guard against infections.

CASE 65

Aorta with Atherosclerosis
Atherosclerosis (hardening of the arteries) develops when plaques (fatty deposits) form in the lining of the arteries. These plaques narrow the affected blood vessels, sometimes causing aneurysms, a bulge on the aorta, which may rupture. Smoking and high cholesterol increase the risk for this disease. Atherosclerosis is the main cause of death in developed nations.

Normal Aorta
The aorta is the largest artery in the body. It carries oxygenated blood away from the heart and branches into many smaller arteries that supply the head, neck, and arms, as well as the organs in the chest, abdomen, pelvis, and legs. Like all arteries, the aorta has thick and muscular walls that can expand or contract to accommodate the volume of blood passing through them. The health of the arteries' walls is a contributing factor to blood pressure.

CASE 66

Adipose Tissue
This specimen displays the distribution of fat in an overweight female. Excess weight aggravates conditions such as high blood pressure and diabetes. The greatest health risk posed by obesity is a shortened life span.

THE REPRODUCTIVE AND URINARY SYSTEM GALLERY

CASE 67

The Kidneys
These specimens reveal some of the kidney's inner structure, including the renal artery, which delivers blood for filtering, and the renal cortex where the actual filtration of blood occurs. The hollow space within the kidney is the renal sinus. It marks the beginning of the ureters, which carry urine drop by drop to the bladder.

The whole kidney specimen also exhibits an adrenal gland. Located on top of the kidneys, the adrenal glands produce hormones that influence metabolism and the body's response to stress. These hormones are sometimes called adrenaline after the gland that creates them.

Horseshoe Kidney
The term "horseshoe kidney" refers to a condition in which both kidneys are fused in early embryonic life giving them the appearance of a horseshoe. A fairly common condition, it occurs in approximately one of every 400 births. The kidneys will continue to function under this condition, but may suffer from a lack of blood supply. Those with a horseshoe kidney sometimes have other genetic disorders of the skeletal, digestive, and cardiovascular systems.

Left and Right Kidneys
This unique specimen exhibits a double ureter on its right kidney. A double ureter does not seem to affect the amount of urine that flows to the bladder.

Blood Vessels of Kidney
This special dissection reveals the amazing network of blood vessels within the kidneys. Blood enters the kidney through the renal artery (visible in the center of this specimen) and passes into ever-smaller blood vessels until it reaches one of over one million nephrons (filtering units). Here great pressure forces blood and proteins through a fine membrane leaving waste materials, water, electrolytes, and salts behind.

Filtered blood returns to the body, while the captured material moves toward the bladder. However, most of the water, electrolytes and salts are re-absorbed into the bloodstream before they reach the bladder. If this did not occur, we would produce almost 50 gallons of urine per day. In your lifetime, however, you will urinate 12,000 gallons.

Kidney with Hydronephrosis
Hydronephrosis is a condition that develops when the normal flow of urine leaving the kidney is somehow obstructed. When such an obstruction occurs, urine backs up into the kidney causing it to swell. If the condition progresses unchecked, it can eventually destroy the kidney tubules. When both kidneys are affected, total kidney failure may result.

Cross Section of Kidney

Kidney Cancer (Carcinoma of the Kidney)
Very little is known about the causes of kidney cancer, but it is very rare for it to occur in both kidneys. Research has shown that cigarette smoking increases the risk of developing cancer of the kidney, as does exposure to cadmium, asbestos and lead paints. Diabetes, obesity, chronic kidney failure, and high blood pressure, may also increase the risk of developing cancer of the kidney. Those with a family history of kidney cancer should be checked regularly for this disease.

CASE 68
Transverse Section of Thorax at Level of Lung

CASE 69
Transverse Section of Abdomen at Level of Liver

CASE 70
Transverse Section of Abdomen at Level of Kidney

Male sperm are the smallest cells in the human body.

CASE 71

The Male Body
This specimen exhibits the organs of the male reproductive system.
Female Reproductive and Urinary Systems

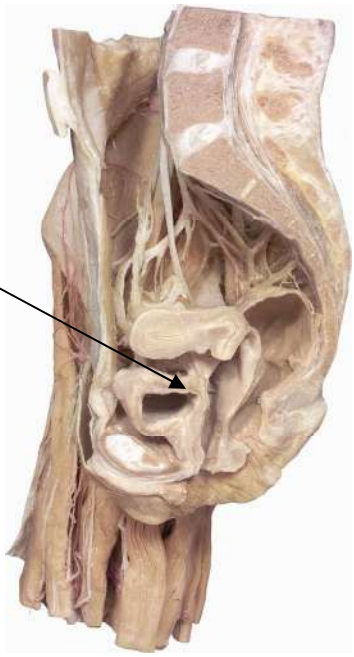
CASE 72

Symmetry
This specimen helps us understand the relationship between the surface of the body and the bones and organs beneath it.

CASE 73

The female reproductive systems stores, releases, and incubates the egg, or female sex cell, which creates new human life when joined with a male sperm cell.

1. Ovaries. Contain more than 250,000 ova, or eggs. All the eggs an ovary will ever have are present at birth. Alternating between left and right, ovaries release an egg each month by a process called ovulation.
2. Uterine (Fallopian) Tubes. Capture the egg when it is breaks through the wall of the ovary and transport it to the uterus. Most pregnancies begin in the uterine tubes.
3. Uterus (Womb). The site where a fertilized egg implants and develops. It has a blood-rich lining that is shed each month (menstruation), if fertilization does not occur.
4. Cervix. Lower portion of the uterus that opens into the vagina. It softens prior to delivery for easier passage of the fetus into the birth canal. Cervical cancer is one of the most common cancers in women and can often be detected with a yearly Pap test.
5. Vagina (Birth Canal). A fibro-muscular tube that connects the uterus and external genitalia. It is capable of expanding during delivery to allow for easier childbirth.
6. External Genitalia. Consists of several protective folds of skin that surround the openings of the vagina and urethra. One of these folds corresponds to the male scrotum, while another surrounds the clitoris, the female equivalent of the male penis.



Female Urogenital System

Median-Sagittal Section of Female Pelvic Cavity

Superior View of Female Pelvic Cavity

The Female Internal Genital Organs (With IUD)

CASE 74

The Male Reproductive and Urinary Systems

The male reproductive system creates and delivers sperm, the male sex cell, which when joined with the egg or female sex cells, causes fertilization. Its organs include:

1. Testis (Testicle). Where sperm and hormones are produced. They are contained within the scrotum outside of the main body cavity because they best produce sperm at 2 degrees below normal body temperature.
2. Spermatic Cord. Carries sperm out of the testes. It also contains the testicular artery and the cremaster muscle, which lifts the testes closer to the body in cold weather.
3. Seminal Vesicle. Small glands that lie behind the urinary bladder, which secrete most (75 percent) of the seminal fluid.
4. Prostate Gland. A single gland, shaped like an inverted pyramid; it surrounds the urethra as it leaves the urinary bladder. Its secretions account for approximately 25 percent of the seminal fluid.
5. Penis. Contains erectile tissue and a portion of the urethra, which carries urine and seminal fluid out of the body.
6. This specimen also exhibits one of the adrenal glands. Located on top of the kidneys, the adrenal glands produce hormones that influence metabolism and the body's response to stress. These hormones are sometimes called adrenalin after the gland that creates them.

Male Urogenital System

Superior view of Male Reproductive System

Median-Sagittal Section of Male Pelvic Cavity

The Cavenous Body of Penis

CASE 75

The Female Body

This specimen illustrates features of the female reproductive system. Women have a bell-shaped pelvis and wider hips to assist in childbirth.

Female eggs are the largest cells in the human body.

CASE 76

The Breasts with Glandular Milk Ducts

Breast Cancer
Breast cancer affects approximately five per cent of the female population and is thought to be caused by high estrogen levels. These tumors can go undetected for some time because they are usually not painful. Because the later stages of breast cancer can be extremely fatal, women over 50, or with a family history of breast cancer, should have a yearly mammography to detect the disease in its earliest stages when it is highly treatable.

CASE 77

Teratoma
Teratomas are rare tumors composed of multiple tissues such as skin, teeth, and hair that develop in abnormal locations. Such abnormalities within the ovary (dermoid teratomas) mainly occur during reproductive life and sometimes develop during pregnancy. In almost all cases, these teratomas are curable.

Dermoid Cyst of Frontal Lobe
A dermoid cyst is a type of teratoma, a benign tumor that originates from some of the cells that later form the skin. These tumors most often occur close to the body's midline, sometimes growing in the spine and, rarely, in the midline of the brain. Dermoid cysts in the brain and spine are sometimes found in children who have experienced episodes of meningitis. Treatment normally involves their surgical removal.

Ovarian Cyst
Ovarian cysts are relatively common and can occur in females of all ages. These hollow fluid-filled structures are usually small and asymptomatic. Complications can occur, however, including an enlarged ovary, a disturbed menstrual cycle, damaged ovarian blood supply, and infertility.

Intramural Uterine Fibroid
A fibroid within the uterus is a benign tumor consisting of a sphere of muscle and fibrous tissue. It may occur in the uterine smooth muscle (intramural) or within the uterine lining (submucosal).

CASE 78

Benign Prostatic Hyperplasia
The prostate gland secretes some of the fluids that create semen. As men age, the prostate may increase up to five or six times its normal size, a condition known as benign prostatic hyperplasia. This sometimes leads to an obstructed urinary flow, as was the case with this specimen, which also resulted in swelling of the urinary bladder. While enlargement of the prostate does not lead to cancer of the prostate, men over 50 should have regular screening for prostate cancer.

Prostate and Seminal Vesicles
Shaped like an inverted pyramid, the prostate gland supplies semen with 25 percent of its fluid, mainly an alkaline solution that neutralizes the vagina's acidity allowing sperm to live. The urethra passes through the prostate and carries both sperm and urine out of the body.

The seminal vesicles are coiled tubes at either side of the prostate through which sperm pass before reaching the prostate. Here sperm mixes with a fructose-based secretion, which provides 60 percent of the fluid that creates semen.

CASE 79

Blood Vessels of Placenta

NOTE: If you wish to tour The Fetal Development Gallery, continue with the exhibition notes. If you do not wish to view the Fetal Development Gallery, please turn to Page 67 of this guide.

OPTIONAL: THE FETAL GALLERY

NOTE: All embryos and fetuses died of natural causes in utero.

CASE 80

Placenta (fetal side)
The placenta acts as a lung for the developing fetus receiving deoxygenated fetal blood from the fetus and delivering oxygen-rich blood to it.

Placenta (Uterine Side)
The placenta forms within the wall of the uterus from a combination of uterine and fetal tissue. There is no mixing of embryonic and maternal blood in the placenta. Instead, all exchange between these two separate circulations takes place across a very thin cellular barrier. However, the placental barrier cannot stop harmful chemicals. If such substances are ingested during the embryonic period, they can cause birth defects and have other serious consequences on the process of normal development.

CASE 81

Fetus (9 weeks)
Fetus (13 weeks)
Fetus (16 weeks)
Fetus (24 weeks)

CASE 82
Transparent Fetal Section

CASE 83
Transparent Fetal Section

CASE 84

Transparent Fetal Section

CASE 85

Fetal Bone Development (20 weeks)

CASE 86

Fetal Bone Development (16 weeks)

CASE 87

Fetal Bone Development (14 weeks)

CASE 88

Fetal Bone Development (12 weeks)

CASE 89

Embryonic and Fetal Development

The 40 weeks of in utero development are divided into two extended time periods; the embryonic period that runs through the end of the eighth week; and the fetal period, which extends from the ninth week until birth. The embryonic period is characterized by the development of the body's organs and, while the fetal period is characterized primarily by their increased growth.

Embryo (8 weeks)
Embryo (7 weeks)
Embryo (5 weeks)
Embryo (4 weeks)
Embryo (18 days)

CASE 90

Visceral Hernia

A visceral hernia occurs when some or all of the fetus' digestive organs form outside the body.

CASE 91

Anencephalia

Anencephaly occurs when the "cephalic" or head end of the embryo's neural tube fails to close between the third and fourth week of development. This results in the absence of a major portion of the brain, skull, and scalp. Infants with this disorder are born without a forebrain, the front, thinking and coordinating part of the brain. The remaining brain tissue is often exposed - not covered by bone or skin. The cause of anencephaly is unknown. Although it is thought that a mother's diet and vitamin intake may play a role, scientists believe that many other factors are also involved. Recent studies have shown that the addition of folic acid (vitamin B9) to the diet of women of childbearing age may significantly reduce the incidence of neural tube defects.

CASE 92

Bifid Spine
Spina Bifida develops during the first month of pregnancy. It is a congenital defect in which the embryo's spinal column does not fuse properly, leaving the spinal cord and its protective membranes vulnerable. In some extreme cases, the spinal cord and nerves are exposed at birth. While surgery can repair the opening after birth, the resulting nerve damage is permanent and may lead to paralysis of the lower limbs. With proper care, most children with spina bifida live well into adulthood.

THE TREATED BODY GALLERY

CASE 93

Vertebrates
Humans are vertebrates, a category of animals with an internal bony skeleton. Whales also belong to this class, as do fish, amphibians, reptiles, and birds. Although each type of vertebrate is unique, all have a head, ribs, and a vertebral column with a tail—or remainder of one. In this case are examples of the similarities between the human and the whale's bony structure.

Whale Vertebra
Human Vertebra
Human Costal Bone
Whale Costal Bone

CASE 94

Carcinoma of the Esophagus
Carcinoma of the esophagus accounts for about five percent of all visceral carcinomas found in men, and occurs most often after the age of 50. There are few symptoms in the early stages of the disease and tumors can grow unchecked until they begin to block the esophagus. Because the survival rate is low (less than ten percent), early detection is crucial.

Cancer of the Rectum
Colon cancer frequently occurs at either end of the colon—in the area of your right hip where the colon begins, or near the rectum where it ends. Cancers near the rectum are often detected earlier than those deeper in the colon. Early detection is the key to surviving colon cancer. The most effective method of detection is colonoscopy, in which a fiber optic camera is used to inspect the entire length of the colon. Physicians recommend that anyone over 50 receive a colonoscopy every 3-5 years.

Purulent Osteomyelitis of Tibia
Osteomyelitis is a bone infection often caused by bacteria called Staphylococcus Aureus. Both the bone and the bone marrow are often simultaneously affected. While any bone in the body can be affected, the common sites of localization are the long tubular bones. Bones can become infected in several ways, both via blood-borne bacteria and through direct infection, which occurs after a cut or severe fracture. A bone also may become infected when its blood supply is disrupted. This can happen in older people with atherosclerosis, narrowing of the blood vessels, or in association with diabetes. Most infections of this kind occur in the toes or feet.

Larynx with Multiple Polyps
Polyps are the most common type of benign tumor affecting the larynx and are usually found on the true vocal cords. They often develop in heavy smokers or in individuals, such as singers, who impose great strain on their larynx. In singers these polyps are frequently referred to as "singer's nodes." Because of their location, they characteristically cause changes in the voice and progressive hoarseness. Though benign, polyps must be closely monitored to ensure they do not become malignant.

Osteogenic Sarcoma of Femur
Bone is constantly regenerating itself, but in the case of osteogenic sarcoma, bone cells grow out of control. This type of bone cancer occurs most often in the lower end of the femur. A highly malignant cancer, osteogenic sarcoma is most common in young adults.

Hodgkin's Disease Involving Perigastric Nodes
Hodgkin's disease is a malignant form of cancer that affects the lymph nodes. Hodgkin's sarcoma is the most malignant form of the disease, one that usually leads to death within two years. This form of the disease is most frequent in the middle-aged and elderly and affects males and females equally. It usually manifests with the sudden enlargement of groups of lymph nodes. The disease then spreads to all lymph nodes of the body, particularly those of the GI tract, lung, liver, spleen, pancreas, and bones. It can also affect the central nervous system. Symptoms usually follow a rapid course of progressive weakness and weight loss.

Squamous Cell Carcinoma of Leg
A squamous cell carcinoma of the skin is a form of skin cancer, which is usually the result of long term sun damage to the skin. It enlarges slowly and steadily, sometimes invading neighboring tissue and can also spread to distant parts of the body. If not removed completely, the cancer can go deep into the skin and metastasize to the internal organs causing death. Anyone with a substantial history of sun exposure can develop squamous cell carcinoma. But people who have fair skin, light hair, and blue, green, or gray eyes are at highest risk. Those whose occupations require long hours outdoors or who spend extensive leisure time in the sun are in particular jeopardy.

CASE 95

Transverse Human Sections
These body sections came from one specimen. They show you in actuality what magnetic resonance imaging techniques (MRI) "see" when they scan a human body.

MRI uses a magnetic field created by powerful electromagnets to stimulate hydrogen atoms in the body. These atoms then give off radio signals that are collected by a special scanner and turned into images that look remarkably like the body segments you see here. Transverse body segments such as these, as well as the vertical segments elsewhere in this gallery, can assist physicians as they study relational anatomy, which is essential to reading MRI images.

CASE 96

Medical Prostheses + Surgical Tools
This specimen illustrates techniques used to heal or replace damaged bones, as well as the surgical tools that assist these techniques. Bone has the amazing ability to mend itself when broken. Optimal healing occurs when the broken ends of a bone are properly aligned.

CASE 97

Form + Function
The pose of this specimen illustrates the dynamic beauty of the human body. You can see how the body's operating systems and its supporting organs contribute to the way the body functions with grace and agility.

CASE 98

Aneurysm of Descending Aorta
Blood vessels, both arteries and veins, are susceptible to a variety of different diseases. One of the most striking results of all forms of vascular disease is the formation of an aneurysm. An aneurysm is a localized abnormal dilation of any vessel. Aneurysms may occur in any artery and vein of the body, but are most common and most significant in the aorta. Aortic aneurysms produce serious clinical disease and often cause death by rupture. One of the most common causes of aortic aneurysms is arteriosclerosis.

Cardiac Malformation
In the adult cardiovascular system, the heart is a double pump, delivering blood to the body and lungs. In the developing fetus, however, blood does not receive oxygen from the lungs, but via the umbilical cord and the placenta. For this reason, the heart of a fetus has an opening between its two upper chambers, bypassing the flow of blood to the lungs. Known as the foramen ovale, this opening in the heart wall closes shortly after birth. If it fails to close, deoxygenated blood is returned to general circulation, which makes a baby look blue and deprives it of the oxygen it needs to develop. Openings in the heart can now quickly be corrected through surgery.

Pulmonary Congestion

Mitral Stenosis
Enlarged Heart Cardiomyopathy (Mitral Stinosis)

The mitral heart valve controls blood flow from the heart to the body.

CASE 99

Cerebral Abscess
If the brain becomes infected by a bacteria or fungus, white blood cells will quickly attack the invader and try to contain it. The resulting pus and inflammation can lead to a brain abscess as with this specimen.

Congenital Deformity of Brain

The Brainstem
The brainstem consists of the midbrain, pons, and medulla oblongata. It is overlaid by the cerebellum and is continuous with the spinal cord through the foramen magnum at the base of the skull. Neurological functions located in the brainstem include those necessary for survival (breathing, digestion, heart rate, blood pressure) and for arousal (being awake and alert). Most of the cranial nerves come from the brainstem. The brainstem is the pathway for all fiber tracts passing up and down from peripheral nerves and spinal cord to the highest parts of the brain, in particular to the cerebral hemispheres.

Brain Section with Glioma

The nervous system consists of two different types of cells: nerve cells, which conduct nerve impulses, and neuroglia, which support nerve cells. Neuroglia means "nerve glue". The name is appropriate because these cells are responsible for holding neurons in place. In addition, neuroglia cells protect the nerve cells and produce myelin, which insulates nerve fibers, aiding in the conduction of nerve impulses. Despite all of their supporting roles, neuroglia are also the cells in the brain that can grow out of control and create very invasive brain tumors known as gliomas.

CASE 100

Inside + Out

Each of us is physically unique, from the shade of our skin to the size and shape of our organs.

CASE 101

Skin

Skin acts as a protective shield. The heaviest and largest organ of the body, weighing approximately 11 pounds and covering over 2 square yards, it is comprised of two layers: the dermis and the epidermis. The inner layer, the dermis, contains our nerve receptors, blood vessels, hair follicles, and sweat and oil glands. The blood vessels in the dermis nourish skin cells and help us maintain a constant body temperature, dilating when we are hot and constricting when we are cold. Sweat glands also keep us from overheating, coating the skin with moisture that takes away heat when it evaporates. Oil glands keep the layers of the skin supple, especially the outer layer, the epidermis.

The epidermis is composed of mature skin cells that conjoin and harden, providing our first line of defense, protecting us from dehydration, dampness, radiation, and millions of microbes each day. Our nails and hair are derived from the epidermis. Skin cells regenerate rapidly and are shed constantly; much of the dust in your home comes from these cells.

CASE 102

Your Body

STUDENT GUIDE

Welcome to BODIES...THE EXHIBITION.

Each gallery in this Exhibition represents a different system of the body. Within each system you will view both full bodies and individual organs that support the structure and function of that system. You will see first-hand some of the many things you have been studying in your Science, Anatomy and Biology classes.

Take your time going through the Exhibition. Read and see all that you can. Take notice of the plaques on the walls as they contain valuable information.

Remember that you are viewing real human bodies. Be respectful of them, your classmates and the other guests in the Exhibition. You will be assigned to a specific chaperone before you begin your tour. Keep your voices low and stay with your chaperone throughout each of the galleries. Also, you must turnoff your cell phones. Please be aware that food, drink and/or cameras are not allowed at any time. If you are completing a class assignment, we ask that you do not lean on the glass cases to write. Docents are available throughout the galleries to answer your questions.

You may be surprised to see that the full body specimens are displayed out in the open. You can view them as close as you like but please do not touch any of the bodies. The Interactive Desk at the end of the Exhibition offers you the opportunity to hold a human brain, feel the weight of a real liver and touch other organs from the body.

If you are interested in looking at the items in the retail store, please stay with your chaperone. The same is true for restroom breaks. Some of the more popular items in the store for students (from $4 - $20) include shirts, key rings and magnets; and for teachers ($10 -$40) you will find mugs, Anatomical Flip Books and poseable skeletons.

Enjoy your remarkable journey through the human body.

WHAT STUDENTS WANT TO KNOW

Where do the bodies come from?

The bodies in this Exhibition are those of people from China who died of natural causes with no next of kin. Chinese law, like American law, allows that, after a period of time during which no relative or next of kin can be located, unclaimed bodies can be legally given to a medical school who then has permission under the law to use them for an educational or research purpose while seeing to it that issues related to dignity and respect are carefully adhered to. Detailed information about the identities and personal histories of the bodies is strictly confidential.

What is Polymer Preservation?

Polymer Preservation, the process used to preserve the specimens for BODIES...THE EXHIBITION, is a revolutionary technique in which human tissue is permanently preserved using liquid silicone rubber. This prevents the natural process of decay, making the specimens available to study for an indefinite period of time.

How does it work?

Anatomists fix a specimen with chemicals to temporarily halt the decaying process. Then they dissect it to expose important structures.

All of the water is removed from the specimen by replacing it with acetone.

The specimen is placed into a liquid silicone mixture within a vacuum chamber. Under vacuum, the acetone becomes a gas that is completely replaced by the polymer mixture.

Lastly, the silicone polymer is hardened. The end result is a dry, odorless, permanently preserved specimen containing no toxic chemicals. It retains the look of the original but functions as if it were rubber.

How long does it take to complete the preservation process?

Preparation time varies; a small organ may take only a week while a full body specimen may take up to one year to prepare.

The Skeletal System

1. What makes bones lighter and distributes force over a wide surface area?
    a. Marrow
    b. Spongy bone tissue
    c. Compact bone tissue
    d. Cartilage

2. What is the name for the soft spot on the infant's skull?
    a. Ischium
    b. Foramina
    c. Fontanelle
    d. Vertebrae

3. What is the difference in the total number of fetal bones and the total number of adult bones?
    a. 94
    b. O
    c. 4
    d. 206

4. Which of these is an auditory ossicle?
    a. Malleas
    b. Anvil
    c. Stapes
    d. All of the above

5. The 2 types of bones found in the skull are the
    a. tarsus and metatarsal.
    b. scapula and clavicle.
    c. sphenoid and temporal.
    d. zygomatic and maxillary.

6. An example of a ball and socket joint is your
    a. Shoulder
    b. Neck
    c. Elbow
    d. Toe

7. Explain why infants have more bones than adults.

8. Describe the function of the auditory ossicles.

9. Name the three kinds of joints.

10. Describe the specific range of motion for the three kinds of joints.

The Muscular System

1. The muscles of the heart can squirt blood _____ feet.
    a. 2
    b. 100
    c. 16
    d. 30

2. The tongue is made up of _____ muscles.
    a. 2
    b. 100
    c. 16
    d. 30

3. About how many muscles are there in the human body? _____
    a. >600
    b. <600
    c. 1000
    d. 60

4. What are the names of the types of muscle tissue?
    a. Voluntary and involuntary
    b. Cardiac, smooth, and skeletal
    c. Motor, core, and dynamic
    d. Supinator and pronator

5. What is the largest muscle in the body?
    a. Heart
    b. Gluteus maximus
    c. Sartorius
    d. None of the above

6. How many muscles control the movement of the hand?
    a. 4
    b. 7
    c. 21
    d. 24

7. When a muscle is not used and it grows smaller, that is called
    a. Muscular atrophy
    b. Contraction
    c. Teres major
    d. Sternocleidomastoid

8. What is the difference between the supinator muscle and the pronator?

9. Explain the difference and give examples of voluntary and involuntary muscles.

10. Think about how much liquid you drink during the day and compare that to the size of the bladder. How does it hold so much fluid?

The Nervous System

1. The brain weighs _____ pounds.
    a. 0.6
    b. 2.6
    c. 12.6
    d. 6

2. Girls' brains account for 2.5% of their body weight. Boys' brains account for ____%.
    a. 3
    b. 2.5
    c. 2
    d. 1.5

3. What are the longest cells in the body?
    a. Axons
    b. Spinal
    c. Dendrite
    d. Autonomic

4. What is the longest nerve in the body?
    a. Peripheral
    b. Neuron
    c. Cranial
    d. Sciatic

5. The function of the cerebellum is to control _____.
    a. equilibrium and muscular movement
    b. vital body functions, such as breathing and digestion
    c. connections between the right and left hemispheres
    d. All of the above

6. What is Dura Mater?
    a. Autonomic nerves that regulate the body's fight response.
    b. Outer covering of the brain and spinal column.
    c. Area of the lumbosacral plexus.
    d. The anterior root of the spinal nerve.

7. What protects the spinal cord?
    a. Vagus nerve
    b. Medulla oblongata and cerebellum
    c. Skull and foramen magnum
    d. Meninges and vertebrae

8. Describe Carpal Tunnel Syndrome.

9. Describe the "pathway" used to innervate your pinky finger.

10. What causes a stroke? Describe the brain specimen that has had the stroke.

The Circulatory System

1. There are _____ miles of blood vessels in the human body.
    a. 60
    b. 600
    c. 6,000
    d. 60,000

2. When you feel your pulse, you are feeling a ____.
    a. vein
    b. artery
    c. ventricle
    d. alveolus

3. No cell in the body lies more than a few ____ from one of the body's blood vessels.
    a. feet
    b. inches
    c. centimeters
    d. millimeters

4. What happens in your circulatory system once every minute?
    a. Every drop of blood passes through the heart.
    b. Every platelet becomes a white blood cell
    c. Filaments of fibrin enmesh red blood cells as part of the clotting process.
    d. None of the above.

5. What prevents blood from flowing backwards?
    a. Veins have valves
    b. The dorsal venous arches
    c. Lymphocytes
    d. Ventricles

6. Of the 100% of the body's blood supply, how much is required by the brain?
    a. 0%
    b. 10%
    c. 20%
    d. 40%

7. Your heart is about the same size as your
    a. head.
    b. fist.
    c. tongue.
    d. foot.

8. Describe the corrosion casting process used to prepare these specific specimens.

9. What is the difference between the red and blue vessels?

10. What area of the head and skull has the greatest concentration of vessels? Why do you think this is the case?

The Respiratory Gallery

1. A pack of cigarettes takes _____ off your life.
    a. 2 hours and 20 minutes
    b. 7 minutes and 20 seconds
    c. 2 years
    d. no time

2. What are the small ends of the bronchial tree that branch out like clusters in direct contact with capillary walls of the pulmonary veins?
    a. Diaphragm
    b. Lobes
    c. Alveoli
    d. Trachea

3. The only organ in the body that can float on water:
    a. the spleen.
    b. the heart.
    c. the lungs.
    d. the kidneys.

4. How many breaths do we take every minute?
    a. About 40 for babies and 15 for adults
    b. About 50
    c. About 40 for adults and 15 for babies
    d. About 10

5. What is the connection between the respiratory and circulatory systems?
    a. Oxygen from the respiratory system is absorbed into the bloodstream.
    b. The blood carries the oxygen to every organ in the body.
    c. Both a. and b.
    d. None of the above.

6. What is exchanged for oxygen in the lungs?
    a. Carbon monoxide
    b. Water
    c. Pulmonary arteries
    d. Carbon dioxide

7. What part of the respiratory system pushes and pulls the lungs to draw air in and out?
    a. Superior vena cava
    b. Thoracic cavity
    c. Bronchial tree
    d. Diaphragm

8. Compare the quality of the two sets of lungs found in this gallery.

9. Explain this statement made over 4000 years ago by the Chinese physician, Hwang Ti: "The heart is the king and the lungs are its ministers."

10. Why do you think the bronchial tree segments are functionally separate regions in each lung?

The Digestive Gallery

1. What large organ is also the second heaviest organ of the body, after the skin?
    a. Stomach
    b. Lungs
    c. Brain
    d. Liver

2. How long does it take for food to be absorbed in your small intestine?
    a. 4-8 seconds
    b. 2-4 hours
    c. 3-5 hours
    d. 10 hours-several days

3. What causes cirrhosis of the liver?
    a. Improper diet
    b. Alcohol
    c. Drug abuse
    d. All of the above

4. Where does the digestive tract begin?
    a. Mouth
    b. Esophagus
    c. Stomach
    d. Colon

5. What happens to the rugae when the stomach fills with food?
    a. The pancreas secretes juices into the gallbladder.
    b. They expand to create more surface area.
    c. It produces bile.
    d. Arteries harden.

6. What conditions are aggravated by excess adipose tissue?
    a. High blood pressure
    b. Diabetes
    c. Arthritis
    d. All of the above.

7. What "extra" piece attached to the large intestine serves no discernible purpose and can be removed?
    a. Spleen
    b. Appendix
    c. Duodenum
    d. Gall bladder

8. How do we know when we have eaten enough?

9. How is the surface area of the small intestine increased?

10. What is the "recipe" for digestion?

The Reproductive Gallery

1. How many eggs, or ova, are contained in the ovaries?
    a. More than 250,000
    b. About 2,500
    c. Less than 250
    d. 25

2. When a woman goes into labor what hormone allows the pelvis to widen?
    a. Estrogen
    b. Relaxin
    c. Testosterone
    d. Embryonic

3. In your lifetime, you will produce _____ gallons of urine.
    a. 120
    b. 1,000
    c. 12,000
    d. 1,200,000

4. What procedure can detect breast cancer in its early stages when highly treatable?
    a. Mammogram
    b. Pelvic cavity
    c. Lymphatic system
    d. None of the above

5. What are the parts of the urinary system?
    a. Ovary, uterine tubes, and kidneys
    b. Small intestine, kidneys, and urethra
    c. Ureter, bladder, and prostate
    d. Kidney, ureters, and bladder

6. How many sperm are released with each ejaculation?
    a. Less than 20
    b. About 200
    c. About 100,000
    d. More than 2 million

7. How much blood per minute do your kidneys filter? Make a comparison to an everyday object of the same size. (For example, is it like a gallon of milk? A can of soda?)

8. Describe how the urine gets from the kidneys to the bladder.

9. What is the function of the prostate gland?

10. What is the function of the fallopian tubes?

Fetal Gallery

This assignment is optional depending on your level of sensitivity to this part of the Exhibition. Please write 1 – 2 paragraphs on your reaction to this gallery.

The Treated Body Gallery

Describe the steps of the Polymer Preservation Process.

Look at the discus thrower. List what has been done to repair this body so that it is in working condition.

Explain how the specimen with sliced sections demonstrates an MRI.

Discussion and Reflection

Take some time to record your reflections about your experience at BODIES...THE EXHIBITION. You should fill at least the back of this page or use separate paper.

1. What was your first reaction when you entered the Exhibition? How did your reactions change by the time you got to the end, if they changed at all?
2. How did the bodies look different from what you've seen in textbooks?
3. Which gallery did you react to the strongest? Which gallery was most memorable? Why?
4. List 5 things you saw that you learned about in class.
5. List 5 things you saw that you never heard of before and found interesting.
6. What are 3 questions you still have about the human body and want answered when we return to class?
7. Would you recommend this Exhibition to other people? Why or why not?

Answer Key

Skeletal

1. b
2. c
3. a
4. d
5. c
6. a
7. The skull bones fuse with age.
8. malleus = hammer, incus = anvil, stapes = stirrup; connected by the smallest movable joints in the body, these bones transfer sound vibrations from the surface of the eardrum to the inner ear
9. hinge, ball & socket, pivot
10. hinge allows the joint to swing in 2 directions; ball & socket allows some rotation as well as back/forth and side to side; pivot allows left to right movement

Muscular

1. d
2. c
3. a
4. b
5. b
6. c
7. a
8. They are opposite, or antagonistic, because they work in opposite motions.
9. voluntary: movements under your control, quadriceps; involuntary: muscles that work without any direction from you, heart
10. The bladder is a hollow muscular organ that stores urine. Its smooth muscles change size, shape, and position according to the amount of urine it contains. It contracts to empty itself.

Nervous

1. b
2. c
3. a
4. d
5. a
6. b
7. d
8. numbness and pain in the thumb and middle finger, occurs when tendons become inflamed and press on the median nerve where it passes though the carpal tunnel to the wrist
9. brain to spinal cord through brachial plexus to ulnar nerve to little finger
10. blockage or rupture in one or more blood vessels, blood supply to the brain is interrupted' stroke brain has black areas

Circulatory

1. d
2. b
3. d

4. a
5. a
6. c
7. b
8. Blood vessels are injected with a colored polymer, which then hardens. The remaining body tissues are then chemically removed to reveal the matrix that transports blood.
9. blue for veins, red for arteries
10. face, eyes/nose/mouth

Respiratory

1. a
2. c
3. c
4. a
5. c
6. d
7. d
8. healthy, pinkish white lung vs. smokers black lungs
9. The lungs serve the heart by bringing it oxygen, like the ministers served the king. The lungs also surround the heart.
10. It is nature's way of ensuring that breathing will continue if other parts of the lung become damaged.

Digestive

1. b
2. c
3. d
4. a
5. b
6. d
7. b
8. Nerve receptors in the stomach send a message to the brain telling it that the rugae are already stretched out far enough.
9. with villi (or microvilli)
10. Ingest, chew (10-30 times), swallow (4 seconds), churn (2-4 hours), absorb (3-5 hours), compact (10 hours-several days), eliminate

Reproductive & Urinary

1. a
2. b
3. c
4. a
5. d
6. d
7. about 2 liters of blood, or 3 pints; about the size of a big soda bottle
8. Urine travels by muscular contractions through the ureters one drop at a time to the bladder where it is stored.
9. supplies semen with 25% of its fluid—mainly an alkaline solution that neutralizes the vagina's acidity, allowing the sperm to live
10. transports egg cells from the ovaries to the uterus

Treated Body

Preservation Process:

1. the human specimen is temporarily preserved to stop decay
2. the specimen is dissected to feature specific systems and structures
3. the dissection is immersed in acetone to evacuate all body water
4. dehydrated, the specimen is placed in a silicone polymer bath and sealed in a vacuum chamber
5. under vacuum, the acetone leaves the body in gas form, replaced by silicone polymer
6. the silicone polymer hardens in curing
7. the permanently preserved specimen is ready for study

Treated body varies by specimen, can include:

- knee, rotator cuff, clavicle joint, hip replacements;
- disc fusion
- wrist immobilization
- surgical spreader
- replaced skull section
- femur stabilized
- plates and screws implanted in jaw

MRI:

Explanation should include concept of how magnetic resonance allows the body to be seen in “layers.”

Glossary for BODIES...THE EXHIBITION

Alveoli: al-'vē-ə-ləs: a small cavity or pit: as a: a socket for a tooth b: an air cell of the lungs c: an acinus of a compound gland d: any of the pits in the wall of the stomach into which the glands open

Antagonist Muscle: a muscle that contracts with and limits the action of an agonist with which it is paired

Appendix: narrow blind tube usually about three or four inches (7.6 to 10.2 centimeters) long that extends from the cecum in the lower right-hand part of the abdomen, has much lymphoid wall tissue, normally communicates with the cavity of the cecum, and represents an atrophied terminal part of the cecum

Artery: any of the tubular branching muscular- and elastic-walled vessels that carry blood from the heart through the body

Articulation: a joint between bones or cartilages in the vertebrate skeleton that is immovable when the bones are directly united, slightly movable when they are united by an intervening substance, or more or less freely movable when the articular surfaces are covered with smooth cartilage and surrounded by an articular capsule

Atrium: an anatomical cavity or passage ; *especially* **:** a chamber of the heart that receives blood from the veins and forces it into a ventricle or ventricles

Autonomic Nervous System: part of the vertebrate nervous system that innervates smooth and cardiac muscle and glandular tissues and governs involuntary actions (as secretion, vasoconstriction, or peristalsis) and that consists of the sympathetic nervous system and the parasympathetic nervous system -- called also *vegetative nervous system*

Birth Canal: the channel formed by the cervix, vagina, and vulva through which the mammalian fetus is expelled during birth

Bone Marrow: a soft highly vascular modified connective tissue that occupies the cavities and cancellous part of most bones and occurs in two forms: a: a whitish or yellowish bone marrow consisting chiefly of fat cells and predominating in the cavities of the long bones

Bone: one of the hard parts of the skeleton of a vertebrate

Bronchi: either of the two primary divisions of the trachea that lead respectively into the right and the left lung

Bronchial Tree: bronchial tree: the bronchi together with their branches

Bronchiole: ˈbräŋ-kē-ˌōl: a minute thin-walled branch of a bronchus

Cardiac Muscle Tissue: named because it is found in the heart. Cells are joined to one another by intercalated discs which allow the "synchronization" of the heartbeat. Cardiac muscle is branched, striated muscle.

Cartilage: a usually translucent somewhat elastic tissue that composes most of the skeleton of vertebrate embryos and except for a small number of structures (as some joints, respiratory passages, and the external ear) is replaced by bone during ossification in the higher vertebrates

CAT Scan: a sectional view of the body constructed by computed tomography

Cecum: ˈsē-kəm: a cavity open at one end (as the blind end of a duct); *especially*: the blind pouch at the beginning of the large intestine into which the ileum opens from one side and which is continuous with the colon

Central Nervous System: the part of the nervous system which in vertebrates consists of the brain and spinal cord, to which sensory impulses are transmitted and from which motor impulses pass out, and which supervises and coordinates the activity of the entire nervous system

Cervix: a constricted portion of an organ or part: as a: the narrow lower or outer end of the uterus b: the constricted cementoenamel junction on a tooth

Colon: the part of the large intestine that extends from the cecum to the rectum

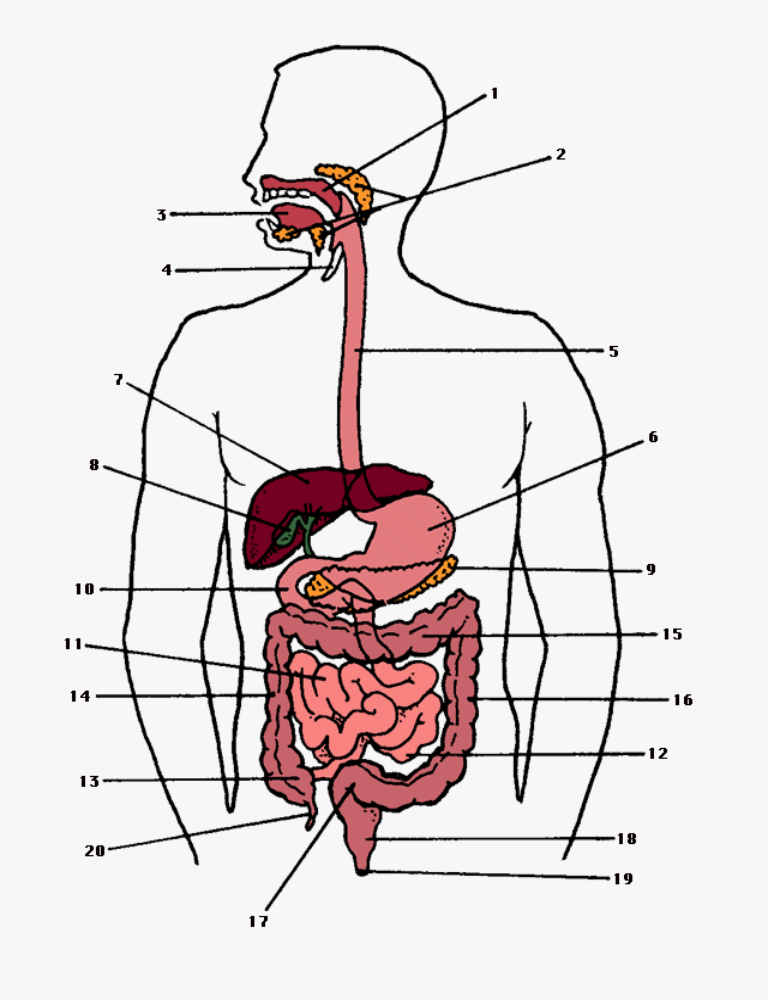
Compact Bone Tissue: The compact noncancellous portion of bone that consists largely of concentric lamellar osteons and interstitial lamellae

Conchae: ˈkäŋ-kə: the largest and deepest concavity of the external ear

Contraction: kən-ˈtrak-shən: the shortening and thickening of a functioning muscle or muscle fiber

Diaphragm: a body partition of muscle and connective tissue ; *specifically* **:** the partition separating the chest and abdominal cavities in mammals

Digestion: 1 palate, 2 salivary glands, 3 tongue, 4 epiglottis, 5 esophagus, 6 stomach, 7 liver, 8 gallbladder, 9 pancreas, 10 duodenum, 11 jejunum, 12 ileum (10, 11, and 12 comprise the small intestine), 13 cecum, 14 ascending colon, 15 transverse colon, 16 descending colon, 17 sigmoid flexure, 18 rectum (13-18 comprise the large intestine), 19 anus, 20 vermiform appendix



Duodenum: d(y)ü-ə-ˈdē-nəm: the first, shortest, and widest part of the small intestine that in humans is about 10 inches (25 centimeters) long and that extends from the pylorus to the undersurface of the liver where it descends for a variable distance and receives the bile and pancreatic ducts and then bends to the left and finally upward to join the jejunum near the second lumbar vertebra

Epididymus: ep-ə-ˈdid-ə-məs:a system of ductules that emerges posteriorly from the testis, holds sperm during maturation, and forms a tangled mass before uniting into a single coiled duct which comprises the highly convoluted body and tail of the system and is continuous with the vas deferens

Foramen (Foramina): fə-ˈrā-mən: a small opening, perforation, or orifice

Glial Cells: glē-əl: of, relating to, or comprising neuroglia

Gray Matter: neural tissue especially of the brain and spinal cord that contains cell bodies as well as nerve fibers, has a brownish gray color, and forms most of the cortex and nuclei of the brain, the columns of the spinal cord, and the bodies of ganglia

Ilium: il-ē-əm: the dorsal, upper, and largest one of the three bones composing either lateral half of the pelvis that in humans is broad and expanded above and narrower below where it joins with the ischium and pubis to form part of the acetabulum

Internal Respiration: the exchange of gases (as oxygen and carbon dioxide) between the cells of the body and the blood by way of the fluid bathing the cells

Jejunum: ji-ˈjü-nəm: the section of the small intestine that comprises the first two fifths beyond the duodenum and that is larger, thicker-walled, and more vascular and has more circular folds and fewer Peyer's patches than the ileum

Ligament: a tough band of tissue that serves to connect the articular extremities of bones or to support or retain an organ in place and is usually composed of coarse bundles of dense white fibrous tissue parallel or closely interlaced, pliant, and flexible, but not extensible

Liver: a large very vascular glandular organ of vertebrates that secretes bile and causes important changes in many of the substances contained in the blood which passes through it (as by converting sugars into glycogen which it stores up until required and by forming urea), that in humans is the largest gland in the body, weighs from 40 to 60 ounces (1100 to 1700 grams)

MRI: magnetic resonance imaging -- a noninvasive diagnostic technique that produces computerized images of internal body tissues and is based on nuclear magnetic resonance of atoms within the body induced by the application of radio waves

Neuroglia: neu·ro·glia: supporting tissue that is intermingled with the essential elements of nervous tissue especially in the brain, spinal cord, and ganglia, is of ectodermal origin, and is composed of a network of fine fibrils and of flattened stellate cells with numerous radiating fibrillar processes

Neuron: one of the cells that constitute nervous tissue, that have the property of transmitting and receiving nervous impulses

Ovary: one of the typically paired essential female reproductive organs that produce eggs and in vertebrates female sex hormones, that occur in the adult human as oval flattened bodies about one and a half inches (four centimeters) long suspended from the dorsal surface of the broad ligament of either side, that arise from the mesonephros, and that consist of a vascular fibrous stroma enclosing developing egg cells

Pancreas: pa^{n}-krē-əs: a large lobulated gland that in humans lies in front of the upper lumbar vertebrae and behind the stomach and is somewhat hammer-shaped and firmly attached anteriorly to the curve of the duodenum with which it communicates through one or more pancreatic ducts and that consists of (1) tubular acini secreting digestive enzymes which pass to the intestine and function in the breakdown of proteins, fats, and carbohydrates; (2) modified acinar cells that form islets of Langerhans between the tubules and secrete the hormones insulin and glucagon; and (3) a firm connective-tissue capsule that extends supportive strands into the organ

Peripheral Nervous System: the part of the nervous system that is outside the central nervous system and comprises the cranial nerves excepting the optic nerve, the spinal nerves, and the autonomic nervous system

Peristalsis: per-ə-ˈstȯl-səs: successive waves of involuntary contraction passing along the walls of a hollow muscular structure (as the esophagus or intestine) and forcing the contents onward

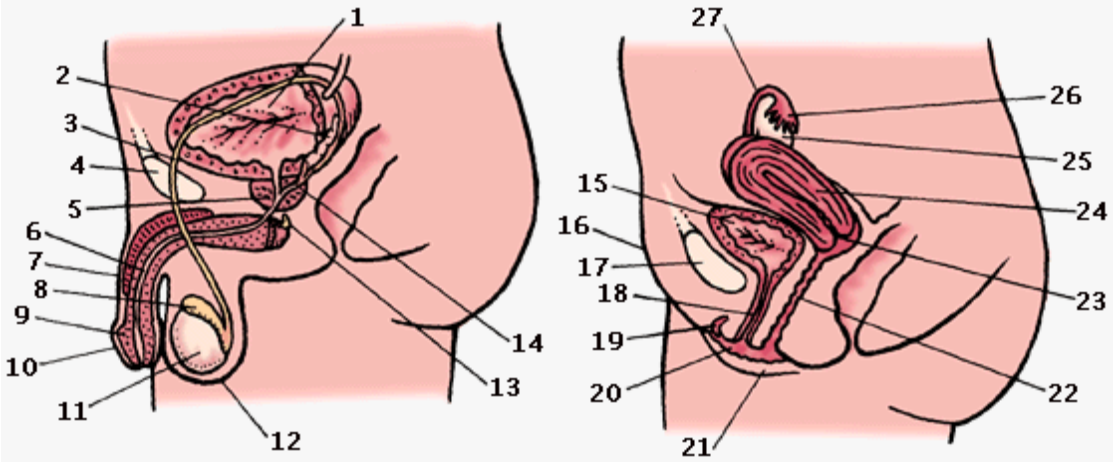
Placenta: the vascular organ in mammals except monotremes and marsupials that unites the fetus to the maternal uterus and mediates its metabolic exchanges through a more or less intimate association of uterine mucosal with chorionic and usually allantoic tissues permitting exchange of material by diffusion between the maternal and fetal vascular systems but without direct contact between maternal and fetal blood and typically involving the interlocking of fingerlike vascular chorionic villi with corresponding modified areas of the uterine mucosa

Prime Mover: a muscle that on contracting is automatically checked and controlled by the opposing simultaneous contraction of another muscle -- called also agonist muscle

Prostate: a firm partly muscular partly glandular body that is situated about the base of the mammalian male urethra and secretes an alkaline viscid fluid which is a major constituent of the ejaculatory fluid

Prosthesis: an artificial device to replace or augment a missing or impaired part of the body

Reproductive System: left male, right female. 1 bladder, 2 seminal vesicle, 3 vas deferens, 4 pubic symphysis, 5 prostate, 6 urethra, 7 penis, 8 epididymis, 9 glans penis, 10 foreskin, 11 testis, 12 scrotum, 13 Cowper's gland, 14 ejaculatory duct, 15 bladder, 16 mons pubis, 17 pubic symphysis, 18 urethra, 19 clitoris, 20 labia minora, 21 labia majora, 22 vagina, 23 cervix, 24 uterus, 25 ovary, 26 fimbria, 27 fallopian tube



Rugae: rü-gə: an anatomical fold or wrinkle especially of the viscera -- usually used in plural <the *rugae* of an empty stomach>

Seminal Vesicle: either of a pair of glandular pouches that lie one on either side of the male reproductive tract and that in human males secrete a sugar- and protein-containing fluid into the ejaculatory duct

Skeletal Muscle Tissue: attached to bones by tendons, is associated with the body's voluntary movements. Skeletal muscle is striated muscle. Unlike cardiac muscle, the cells are not branched.

Smooth Muscle Tissue: muscle tissue that lacks cross striations, that is made up of elongated spindle-shaped cells having a central nucleus, and that is found in vertebrate visceral structures (as the stomach and bladder) as thin sheets performing functions not subject to conscious control by the mind and in all or most of the musculature of invertebrates other than arthropods

Spongy Bone Tissue: Bone in which the spicules form a latticework, with interstices filled with embryonic connective tissue or bone marrow.

Synapse: the place at which a nervous impulse passes from one neuron to another

Synergist Muscle: an organ (as a muscle) that acts in concert with another to enhance its effect

Tendon: a tough cord or band of dense white fibrous connective tissue that unites a muscle with some other part, transmits the force which the muscle exerts, and is continuous with the connective-tissue epimysium and perimysium of the muscle and when inserted into a bone with the periosteum of the bone

Testes: typically paired male reproductive gland that usually consists largely of seminiferous tubules from the epithelium of which spermatozoa develop, that corresponds to the ovary of the female and in craniate vertebrates develops from the genital ridges of the embryo, and that in most mammals descends into the scrotum before the attainment of sexual maturity and in many cases before birth

Trabeculae: trə-ˈbek-yə-lə: one of a pair of longitudinally directed more or less curved cartilaginous rods in the developing skull of a vertebrate that develop under the anterior part of the brain on each side of the pituitary gland and subsequently fuse with each other and with the parachordal cartilages to form the base of the cartilaginous cranium

Trachea: tra·chea: the main trunk of the system of tubes by which air passes to and from the lungs that is about four inches (10 centimeters) long and somewhat less than an inch (2.5 centimeters) in diameter, extends down the front of the neck from the larynx, divides in two to form the bronchi, has walls of fibrous and muscular tissue stiffened by incomplete cartilaginous rings which keep it from collapsing, and is lined with mucous membrane whose epithelium is composed of columnar ciliated mucus-secreting cells

Turbinates: any of three thin bony plates on the lateral wall of the nasal fossa on each side with or without their covering of mucous membrane: a separate curved bony plate that is the largest of the three and separates the inferior and middle meatuses of the nose -- called also *inferior concha, inferior nasal concha, inferior turbinate, inferior turbinate bone, maxilloturbinal*

Urethra: the canal that in most mammals carries off the urine from the bladder and in the male serves also as a genital duct

Uterine Tube: (fallopian tube) either of the pair of tubes that carry the eggs from the ovary to the uterus

Uterus: an organ in female mammals for containing and usually for nourishing the young during development previous to birth that consists of a greatly modified and enlarged section of an oviduct or of the two oviducts united, that has thick walls consisting of an external serous coat, a very thick muscular coat of smooth muscle, and a mucous coat containing numerous glands, and that during pregnancy undergoes great increase in size and change in the condition of its walls -- called also *womb*

Vas Deferens: a sperm-carrying duct especially of a higher vertebrate that in humans is a small but thick-walled tube about two feet (0.6 meter) long formed by the union of the vasa efferentia, is greatly convoluted in its proximal portion, begins at and is continuous with the tail of the epididymis, runs in the spermatic cord through the inguinal canal, and descends into the pelvis where it joins the duct of the seminal vesicle to form the ejaculatory duct

Vein: any of the tubular branching vessels that carry blood from the capillaries toward the heart and have thinner walls than the arteries and often valves at intervals to prevent reflux of the blood which flows in a steady stream and is in most cases dark-colored due to the presence of reduced hemoglobin

Ventricle: cavity of a bodily part or organ: as **a :** a chamber of the heart which receives blood from a corresponding atrium and from which blood is forced into the arteries **b :** one of the system of communicating cavities in the brain that are continuous with the central canal of the spinal cord, that like it are derived from the medullary canal of the embryo, that are lined with an epithelial ependyma, and that contain a serous fluid **c :** a fossa or pouch on each side of the larynx between the false vocal cords above and the true vocal cords below

White Matter: neural tissue that consists largely of myelinated nerve fibers, has a whitish color, and underlies the gray matter of the brain and spinal cord or is gathered into nerves