BODIES

THE EXHIBITION

TEACHER'S GUIDE

Post-Secondary

Teacher's Guide

Post-Secondary

BODIES...THE EXHIBITION

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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 see the effect that disease and unhealthy life choices have on the body – what happens to the lungs, for example, when people smoke. You will also see 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 understanding 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 Applied Learning Exercises. Next is the Guide to Exhibition Galleries, a road map to follow when you visit the exhibition with your students.

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 or 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.

APPLIED LEARNING EXERCISES

By the time students reach the post-secondary level it is expected that they will be familiar with the basic structure and function of the human body. The following Applied Learning Exercises are designed to expand their knowledge of the body and help them apply what they have learned through the use of practical examples.

For each body system, a selected topic - or topics - will form the focal point for the exercises. Each topic will introduce students to relevant issues or problems that they themselves might have personally encountered or that they might have heard or read about.

Each exercise begins with a series of Questions. The information requested may or may not be familiar based on a students previous course work. It is assumed that some information will have to be found by consulting reference textbooks. After answering these questions, students should have most of the information necessary to complete the Putting-It-All-Together section. Again, some additional reading and reasoning may be needed to complete this section. Students should be encouraged to share their answers with one another explaining the reasoning they used in their development. A final Take Home Message is intended to highlight the significance of each exercise.

The specific structures discussed in these exercises will be referenced to the bodies and specimens displayed in each of the galleries in BODIES...THE EXHIBITION. This will allow students who visit the exhibition to see and understand them from a more educated point of view.

Spinal cord exposed

THE SKELETAL SYSTEM

Bone Health

QUESTIONS

Q1 Describe the different types of bone tissue cells.
Q2 Describe how the organic and inorganic components of bone are formed and organized
Q3 What is the relationship between the processes of ossification and calcification?
Q4 List as many factors as you can that influence these two processes.

PUTTING IT ALL-TOGETHER

A 14 year-old girl lives in an apartment in the city. She does not seem to like outdoor activities. When she is not at school she spends most of her time watching TV, playing video games, drinking soft drinks, eating junk food and talking with her friends on the phone. One afternoon she stumbles, falls and breaks her leg. Although she appears healthy, her doctor - after taking her medical history - tells her that it might take longer for her broken leg to heal than one might normally expect for a young person her age. He also advises her that it is important for her to change her eating habits and, after her leg heals, to get more exercise and definitely spend more time outdoors. Why do you think the doctor felt it necessary to give her this rather unusual prescription and what might be the cause of this longer healing time?

This girl most likely had a low level of calcium in her blood as a result of her lack of vitamin D. Her depressed calcium level will naturally slow the bone healing process because mineralization of new bone lags behind the formation of osteoid by osteoblasts. Vitamin D is required to stimulate the absorption and transport of calcium from the gastrointestinal tract into the blood. The source of vitamin D is either diet or synthesis in the skin upon exposure to UV radiation. The girl's nutrition was poor and she tended to remain indoors away from normal amounts of UV light making lack of vitamin D likely in her case.

TAKE HOME MESSAGE

It is important to take good care of your bones. Good bone health depends on a number of different factors. One of the most important factors necessary for good bone health is an adequate diet containing the normal daily requirement of calcium. UV light is also important because of the effect it has on the skin. So don't be a couch potato! Eat right, spend time out of doors and get adequate amounts of exercise. Your bones will be stronger because of it.

BODIES....THE EXHIBITION
Skeletal Gallery
Cases 1 - 10

THE MUSCULAR SYSTEM

The Achilles Tendon

QUESTIONS

Q1 What type of tissue is a tendon made of?
Q2 Describe the nature of the blood supply to a tendon.
Q3 With what muscle is the Achilles tendon associated?
Q4 To which bone does the Achilles tendon attach?
Q5 What is the function of the Achilles tendon?

PUTTING IT ALL-TOGETHER

A young football player arrives in your office with a suspected torn Achilles tendon. What difficulty would the patient experience that would confirm to you that this diagnosis is correct? Assuming that surgery is necessary to repair the torn tendon, describe to the patient the circumstances surrounding the surgery and his expected time of recovery based on what you know about the Achilles tendon and its function. What advice might you give this player that could potentially minimize future damage to this important tendon?

1. During surgery the foot is plantar flexed (the function of the gastrocnemius muscle) in order to bring the ends of the torn tendon together. The leg and foot are cast to stabilize the repair.
2. The healing process will take approximately 8-10 weeks. Tendons have a very poor blood supply and therefore heal very slowly.
3. Because of the nature of the injury and the length of time it will take to heal, the patient will not be able to put any weight on the foot during the healing process; thus requiring the use of crutches.
4. After the cast is removed, the foot will be in the plantar flexed position (the result of immobilization of the foot without the ability to contract the gastrocnemius muscle). Returning the foot to its normal walking position will take some time. This is usually done by asking the patient to wear a boot-like appliance in which the inside surface of the boot is built up in layers to conform to the plantar flexed position of the foot. Then week-by-week, one layer at a time is removed from the inside surface of the boot until the patient's foot again rests flat on the floor.

TAKE HOME MESSAGE

Protect your Achilles tendon - and all of your other muscle tendons - through regular exercise preceded by a warm-up stretching routine. The slow, controlled stretching of muscle tendons before rigorous exercise is an important way to protect them from tearing. Stretching exercises are important for everyone but particularly for those people who do not engage in regular exercise or for older individuals since tendons become more susceptible to injury under both circumstances.

The Rotator Cuff

QUESTIONS

Q1 Describe the anatomy of a typical movable joint.
Q2 Describe the anatomy of the shoulder joint.
Q3 What movements are permitted at the shoulder joint?
Q4 What structures serve to stabilize the shoulder joint during its different movements?
Q5 What is a bursa? Explain how they aid in movement at a joint like the shoulder.

PUTTING IT ALL-TOGETHER

A 40-year-old amateur tennis player has begun to complain that her right shoulder hurts. The pain is particularly intense when she attempts to serve and has gotten progressively worse over the past 5 or 6 years. It now bothers her so much that it often keeps her from sleeping at night. She goes to see a physician about the problem who discovers that she has some serious muscle weakness in her right shoulder and that the motion in her right arm is more limited than that in her left arm. After examining her, the physician tells her that he believes she has a partial tear of the rotator cuff and that the primary damage is not due to damage to the muscles themselves but is the result of damage to the rotator cuff tendons.

What exactly is the rotator cuff and what does it do? What do you think caused the rotator cuff damage in this particular instance? Why does a rotator cuff injury most commonly affect muscle tendons and why does it seem to occur more frequently as a person ages? Why are the infraspinatus and the teres minor muscles more commonly involved in rotator cuff injuries? What types of rehabilitation exercises would you prescribe for a patient to strengthen their rotator cuff muscles?

1. The rotator cuff consists of four muscles and their tendons that surround (cuff) the shoulder joint and attach the humerus (arm bone) to the scapula. These muscles help raise and rotate the arm. Also, as the arm is raised, they keep the humerus tight in the socket of the scapula.
2. This injury was probably the result of the patient's repetitive overhead tennis serving motion.
3. Rotator cuff injuries most often involve structures with a reduced blood supply. Tendons, being composed almost entirely of non-living collagen fibers, have this type of blood supply. Tendons undergo progressive degeneration as a person ages thus they are more likely to be damaged in an older person.
4. The infraspinatus and teres minor muscles are more commonly involved in rotator cuff injuries because they function to help slow down arm motion at the completion of a particular movement like a tennis serve or the pitching of a baseball.

The Rotator Cuff cont'd

5. Rotator cuff strengthening exercises are done with hand weights – 15 pounds is the absolute maximum. They are done repetitively until fatigue sets in. Exercises include: A) arm curls done with the palm forward and with the palm facing backward B) front lifts of the arm done with both the palm up and the palm down and C) lateral lifts of the arm done in both the upright and in the bent at the waist position

TAKE HOME MESSAGE

The shoulder joint is both elegant and complex. Its design allows us to reach and use our hands in many different positions. While the shoulder joint has great range of motion, it is very stable. This makes the shoulder vulnerable to problems if any parts aren't in good working order. The rotator cuff tendons are the key to the healthy functioning of the shoulder. They are subject to a lot of wear and tear, or degeneration, as we use our arms. Tearing of the rotator cuff tendons is an especially painful injury. A torn rotator cuff creates a very weak shoulder. Most of the time patients with torn rotator cuffs are in the 40's or 50's but these tears can happen at any age.

BODIES....THE EXHIBITION
Muscular Gallery
Cases 11 - 18

THE NERVOUS SYSTEM

Sciatica

QUESTIONS

Q1 Describe the basic structure of a peripheral nerve.
Q2 What are spinal nerves and what is their function?
Q3 Describe the origin of the sciatic nerve from the spinal cord and the course that the nerve takes to enter the lower limb.
Q4 What is the relationship between the sciatic nerve and the common peroneal and tibial nerves?
Q5 Describe the peripheral distribution of these two nerves.

Many people see a physician because they have pain in their lower back or in their lower limbs. In most instances, this pain is the result of some involvement of the sciatic nerve. Injury to the sciatic nerve produces a condition known as sciatica. Sciatica can result from a variety of different causes. Precise localization of the cause of a person's sciatica is important because only then can an appropriate treatment regime be devised and implemented to deal with the condition.

PUTTING IT ALL-TOGETHER

Knowing what you do about the sciatic nerve, list some of the sites where this nerve can be damaged resulting in the symptoms associated with sciatica. How can you tell where the problem in a particular individual might be considering that there are a number of different places where the sciatic nerve might be involved? Why is knowledge of the sciatic nerve important to someone giving intramuscular injections? Why are these injections almost always given when the patient is lying down?

1. A herniated intervertebral disc might impinge on the nerve branches that form the sciatic nerve. The sciatic nerve itself might be compressed where it passes deep to the gluteus and piriformis muscles of the buttocks. Damage can also occur to the common peroneal and tibial branches of the nerve. Damage caused by a tumor can occur at any point along the sciatic nerve or its terminal branches. Damage may also occur as the result of disease in an area adjacent to the nerve; such as the sacroiliac joint.
2. The onset of sciatica that results from a herniated disc is acute (sudden) and often occurs following a stressful physical movement. The pain from such a problem affects the specific nerve roots compressed by the disc, resulting in pain from the buttocks to the hip, posterior thigh, leg, ankle and foot. It could also result in a generalized weakness of many of the muscles whose fibers run in the sciatic nerve. The pain and muscle weakness that results from some involvement of either the sciatic nerve itself or one of its branches tends to be more chronic (less sudden onset). In each case, the

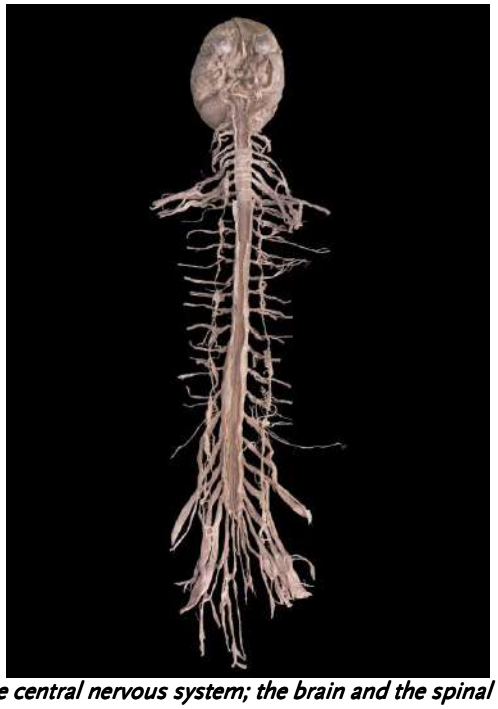
Sciatica cont'd

pain and muscle weakness typically involve only the body areas and the muscles to which each nerve distributes.
3. Involvement of the sciatic nerve itself typically results in pain radiating over the entire area to which the nerve distributes; that is, from the buttocks to the hip, posterior thigh, leg, ankle and foot. Involvement of the common peroneal nerve usually results in pain that is localized down the front and side of the leg and the upper surface of the foot, excluding the little toe. Involvement of the tibial nerve usually results in pain almost exclusively localized to the sole of the foot.
4. The sciatic nerve might be injured if an injection is not given in the proper location. For a person lying down, the safest area is the upper lateral quadrant of the buttocks. An injection given here may still accidentally pierce a nerve if the patient is standing up.

TAKE HOME MESSAGE

The pain that results from involvement of the sciatic nerve can have many different causes. It can occur because of something as simple as a misplaced intramuscular injection or because of the pressure placed on the nerve by tense muscles or a tightened spine. On the other hand, it can also occur because of something much more serious such as cancer, a diseased joint, or a herniated disc. Accurate diagnosis of the cause of sciatica is imperative since it is the key to the development of a proper regimen of treatment.

BODIES....THE EXHIBITION
Nervous System Gallery
Cases 19 - 31



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

THE CIRCULATORY SYSTEM

Fetal Circulation

QUESTIONS

Q1 What is the function of the placenta?
Q2 How is the placenta functionally connected with the fetus?
Q3 What type of blood, oxygenated or un-oxygenated, is found within the umbilical arteries and vein? What other blood vessels show a comparable oxygenation pattern?
Q4 What is meant by the term "blue baby"?

Blood flow through the body is described in terms of several different circulatory routes. One of these routes exists only in the fetus and is known as the fetal circulation. Immediately after a baby is born, the fetal circulatory route is adjusted and two new routes are the formed; the pulmonary circulation route and the systemic circulation route. These adjustments insure that the newborn baby's blood is properly oxygenated and effectively distributed to all of the newborn's cells, tissues and organs.

PUTTING IT ALL-TOGETHER

The fetal circulation route contains two important right-left shunts that are necessary to insure that oxygenated blood reaches all of the developing fetal cells, tissue and organs. Name these important shunts, locate them and describe why each is important for the normal development of the developing fetus. When do each of these shunts close? Why is their closure necessary to the health of the newborn?

1. The foramen ovale is an opening in the interatrial septum of the fetal heart, an opening that allows oxygenated blood returning to the right atrium from the placenta to pass directly into the left atrium. Since the lungs are not functional before birth, the foramen ovale allows blood to bypass the future pulmonary side of the heart (right side) and directly enter the systemic side of the heart (left side) from where it can be directed to the cells, tissues and organs of the fetus. The ductus arteriosus is a small duct that connects the pulmonary trunk with the aorta. It also allows oxygenated blood to pass directly from the pulmonary trunk into the aorta. This allows the small amount of blood leaving the right ventricle to bypass the lungs since they do not begin to function until immediately after birth.
2. The foramen ovale closes immediately after birth while the ductus arteriosus usually closes during the first three weeks of life. When both of these structures close, the normal adult pattern of blood circulation through the heart, the pulmonary and the systemic circulation routes is established. A small depression seen in the interatrial septum of the adult heart, the fossa ovalis indicates the location of what once was the foramen ovale. Similarly, a small fibrous cord seen connecting the pulmonary trunk (the ligamentum arteriosum) is all that remains of the fetal ductus arteriosus.

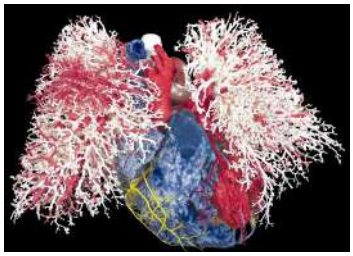
Fetal Circulation cont'd

3. The ductus arteriosus, though small, is very important to the normal development of the heart. Since the heart is made up of cardiac muscle which must contract in order to develop properly, it is necessary for the wall of the developing right ventricle to pump blood even though the lungs to which it normally sends its blood are not functioning. It can do this by pumping blood into the pulmonary trunk from where it is shunted to the aorta thus bypassing the lungs. This allows the right ventricle to develop normally and be ready to function immediately after the baby is born. If the ductus weren't present, the right ventricle would be underdeveloped at birth and not be able to effectively pump blood in its normal fashion. This is why the ductus arteriosus is sometimes called the "exercise channel of the right ventricle."
It is not uncommon for the foramen ovale to not close completely at the time of birth. When this happens, unoxygenated blood returning to the right atrium is shunted directly into the left atrium. This is a problem once the lungs, and not the placenta, assume the responsibility for oxygenating the blood. The consequence of a patent foramen ovale is that a great deal of unoxygenated blood is delivered to the body via the aorta. Since blood rich in carbon dioxide is blue, and not red, it gives a somewhat bluish color to the skin surface. Thus the name "blue baby" is often given to infants that experience this condition. Fortunately this problem is easily repaired surgically. When this is done, the normal pattern of adult circulation is established.

TAKE HOME MESSAGE

After birth, the physician's job is to determine the health of the newborn infant. Visual examination is an important way to assess several different internal developmental problems. The bluish appearance of the skin often indicates a circulatory problem, most often an interatrial heart defect. Such a defect can be life threatening and needs to be surgically repaired. A group of chemicals known as prostaglandins seem to play an important role in maintaining a patent ductus arteriosus during fetal life. This finding has important clinical consequences. It has been shown that an injection of prostaglandins can be used to insure that the ductus arteriosus doesn't close prematurely or to insure that it remains patent to compensate for some other severe heart anomaly, i.e. coartation (narrowing) of the aorta. Likewise, giving prostaglandin inhibitors to a premature baby born can insure that the ductus closes properly which helps establish the normal newborn circulation routes.

BODIES....THE EXHIBITION
Circulatory System Gallery
Cases 32 - 49



Veins and arteries of the heart

THE RESPIRATORY SYSTEM

Cystic Fibrosis

QUESTIONS

Q1 List, in correct order, the respiratory passageways that carry outside air to the lung alveoli.
Q2 Describe the processes by which inspired air is filtered, humidified and warmed.
Q3 Describe how integral membrane proteins, facilitated diffusion, and osmotic gradients influence the movement of materials across the cell membrane.
Q4 What is the function of the exocrine portion of the pancreas?
Q5 What is an autosomal recessive trait?

PUTTING IT ALL-TOGETHER

Since Cystic fibrosis is a genetic condition that involves glands found throughout the body, it is a disease that can affect many different organs. Cystic fibrosis is inherited as an autosomal recessive trait. What does this say about the genetic makeup of the parents of an affected individual? What chance does a child born to parents that possess the gene for cystic fibrosis have to be born with the disease? To be born as a carrier of the disease? To be born as a non-carrier of the disease? This disease affects secretions within the lung airways and within the ducts of the pancreas. Describe the process responsible for altered function in both of these organs. How does this disease affect the ability of the pancreas and lung to function normally? Describe what can be done in each instance to help restore normal function.

1. An abnormal gene on one of the autosomal chromosomes (one of the first 22 "non-sex" chromosomes) from each parent is required to cause the disease. People with only one abnormal gene in the gene pair are called carriers but, since the gene is recessive, they do not exhibit the disease. In other words, the normal gene of the pair can supply the function of the gene so that the abnormal gene is described as acting in a recessive manner. Both parents must be carriers in order for a child to have symptoms of the disease. A child who inherits the gene from one parent will be a carrier.
2. The First Law of Mendelian Inheritance is known as the Principle of Segregation. It states that two members of a gene pair (alleles) segregate (separate) from each other in the formation of gametes. Half the gametes carry one allele and the other half carries the other allele. In the case that both parents are carriers of the disease but neither are affected, there is a 25% chance that a child will be born with the disease, a 50% chance that a child will be a carrier of the disease and a 25% chance that a child will be born a non-carrier of the disease.
3. Cystic fibrosis affects chloride transport across cells membranes. People with the disease cannot effectively secrete chloride. This disrupts the essential balance of salt and water that is needed to maintain a normal thin coating of fluid and mucus inside

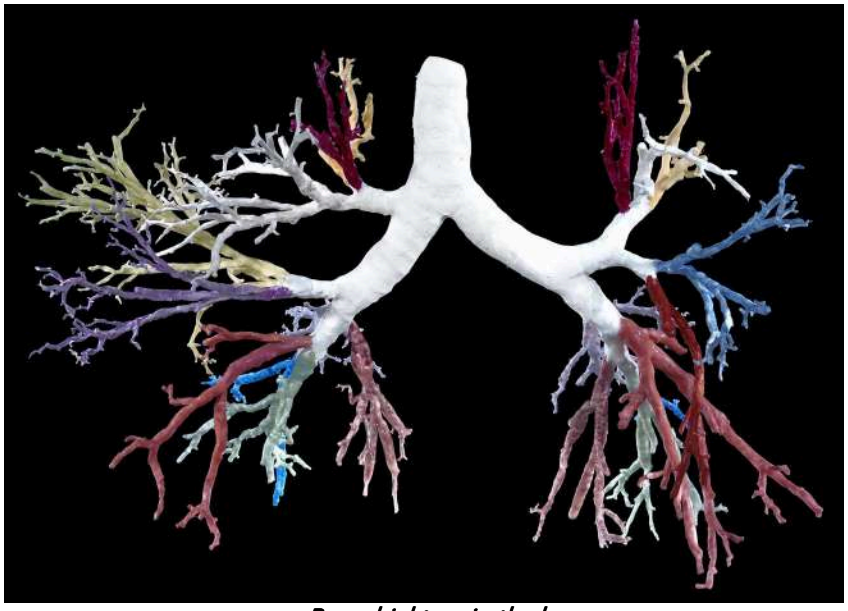
Cystic Fibrosis cont'd

of the lungs, pancreas, and passageways in other organs. The mucus becomes thick, sticky, and hard to move. Normally, mucus in the lungs traps germs which are then cleared out of the lungs. But in cystic fibrosis, the thick, sticky mucus and the germs it traps remain in the lungs and the lungs become infected. In the pancreas, the same process obstructs the pancreatic ducts and leads to a backup of enzymes that can ultimately destroy the pancreas itself.

4. The primary treatment of cystic fibrosis involves agents that break up the thick mucous in the lungs. This includes postural drainage, also called chest physical therapy [CPT]), a procedure that requires vigorous percussion (by using cupped hands) on the back and chest to dislodge the thick mucus from the lungs. Antibiotics are also used to treat lung infections. Cystic fibrosis also can affect the digestive system interfering with the ability of the body to absorb adequate nutrients. To address this problem, people are encouraged to eat an enriched diet and to take both replacement vitamins and pancreatic enzymes.

TAKE HOME MESSAGE

The Cystic Fibrosis Foundation was established in 1955 to raise money for research to find a cure for cystic fibrosis and to improve the quality of life for the 30,000 children and young adults who suffer from the disease. Today there is still no cure for cystic fibrosis but, because of ongoing research, great strides are being made. Whereas 30 years ago, not many people with cystic fibrosis lived past childhood, nowadays many can live well into their 30's.



Bronchial tree in the lung

THE DIGESTIVE SYSTEM

JAUNDICE

QUESTIONS

Q1 What is bile?
Q2 List some of the important functions of bile.
Q3 What does the formation of bile have to do with hemoglobin?
Q4 Describe the path that bile takes as it flows through the liver to the gallbladder.
Q5 What stimulates the release of bile from the gallbladder? How does it eventually reach the duodenum?

PUTTING IT ALL-TOGETHER

A baby is born 2 month prematurely. After being examined by his pediatrician, he is pronounced well enough to go home and does so the following day. Several days later, his mother notices that the white part of his eyes (the sclera) and his skin look yellow. In a panic she calls her pediatrician to ask for advice. Her pediatrician tells her that she believes her son has a case of neonatal jaundice and that there is no need to worry unless his skin color begins to get darker. She explains that under most circumstances the yellowish color will begin to disappear in a few weeks. She suggests that one way to help speed the process is through the use of phototherapy; placing her baby under artificial ultraviolet light while at the same time protecting his eyes. The mother follows this advice and after three weeks time is pleased to see that her baby's skin and eye color have again returned to normal.

What is jaundice and what causes the yellow skin and eye color associated with it? What does jaundice have to do with the liver? Why are babies, especially those born prematurely, so susceptible to developing jaundice? How does the use of artificial light help clear up the problem? What are some of the symptoms of jaundice? What are its major causes?

1. Jaundice, also known as icterus, is not a disease but rather a sign that can occur in many different diseases. Both the yellow skin and the sclera result from high blood levels of the chemical, bilirubin. Bilirubin comes from red blood cells. When red blood cells get old, they are destroyed. Hemoglobin, the iron-containing chemical in red blood cells that carries oxygen, is released from the destroyed red blood cells after the iron it contains is removed. The chemical that remains in the blood after the iron is removed becomes bilirubin.

2. The liver has many functions. One is to produce and secrete bile into the intestines to help digest dietary fat. Another is to remove toxic chemicals or waste products from the blood. Bilirubin is a waste product. After the bilirubin has entered the liver cells, the cells attach other chemicals to the bilirubin and then secrete it into bile. The complex that is secreted in bile is called conjugated bilirubin. The conjugated bilirubin is eliminated in the feces. Bilirubin is what gives feces its brown color. The color of the skin and sclera vary depending on the level of bilirubin. When the bilirubin level is mildly elevated, they are yellowish. When the bilirubin level is high, they tend to be brown.

Jaundice cont'd

3. Neonatal jaundice is associated with increased levels of bilirubin in the baby's blood. In fact, bilirubin levels in the blood become elevated in almost all infants during the first few days following birth and jaundice occurs in more than half. For all but a few infants, elevated bilirubin levels, and the jaundice that results from it, represent a normal physiological phenomenon and do not cause problems. The cause of normal, physiological jaundice is well understood. During life in the uterus, the red blood cells of the fetus contain a type of hemoglobin that is different than the hemoglobin that is present after birth. When an infant is born, the infant's body begins to rapidly destroy the red blood cells containing the fetal-type hemoglobin and replaces them with red blood cells containing the adult-type hemoglobin. This process floods the liver with bilirubin derived from the fetal hemoglobin. The liver in a newborn infant is not mature and its ability to process and eliminate bilirubin is limited. As a result of both the influx of large amounts of bilirubin and the immaturity of the liver, bilirubin accumulates in the blood. Within two or three weeks, the destruction of red blood cells ends. The liver matures and the bilirubin levels return to normal. Artificial light helps break down bilirubin in the skin, changing it into a form that can be eliminated by the baby's kidneys. Newborns with jaundice typically receive phototherapy for several days.

4. Jaundice and cholestasis (the abnormal flow of bile from the liver into the intestine), by themselves, causes few problems except in the newborn. Jaundice can turn the skin and sclera yellow. In addition, stool can become light in color, even clay-colored, because of the absence of bilirubin. The urine may turn dark or brownish in color. This occurs when the bilirubin that is building up in the blood begins to be excreted from the body in the urine. Just as in feces, the bilirubin turns the urine brown. Besides the cosmetic issues of looking yellow and having dark urine and light stools, the symptom that is most frequently associated with jaundice and cholestasis is itching; medically known as pruritus. Pruritus can sometimes be so severe that it causes patients to scratch their skin "raw," to have trouble sleeping, and, rarely, even to commit suicide.

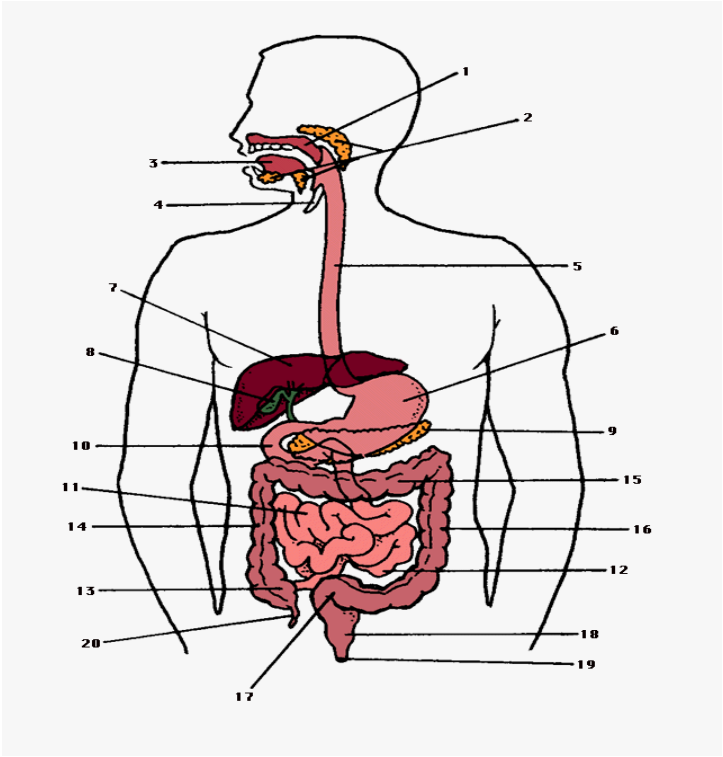
Healthy Liver

5. It is the disease causing the jaundice that causes most problems. There are three different classes of causes for jaundice: Prehepatic, Hepatic and Posthepatic. Prehepatic jaundice occurs when too much bilirubin is being produced for the liver to remove from the blood. For example, patients with hemolytic anemia have an abnormally rapid rate of destruction of their red blood cells. This releases large amounts of bilirubin into the blood. Hepatic jaundice occurs when there is a defect in the liver that prevents bilirubin from being removed from the blood, converted to bilirubin/glucuronic acid (conjugated) or secreted in bile. This can occur in patients with acute and chronic inflammation of the liver caused by hepatitis, cirrhosis caused by poor diet and excessive alcohol consumption, and cancer of the liver (mostly metastatic). Jaundice commonly seen in a newborn baby is another example of hepatic jaundice. Drugs can also cause hepatic jaundice by interfering directly with the chemical processes within the cells of the liver and bile ducts that are responsible for the formation and secretion of bile to the intestine. As a result, the constituents of bile, including bilirubin, are retained in the body. The best example of a drug that causes this latter type of cholestasis and jaundice is estrogen. 3) Posthepatic jaundice occurs when there is a blockage of the bile ducts that decreases the flow of bile and bilirubin from the liver into the intestines. For example, the bile ducts can be blocked by cancers, gallstones, or inflammation of the bile ducts. The decreased conjugation, secretion, or flow of bile that can result in jaundice is referred to as cholestasis: however, cholestasis does not always result in jaundice.

TAKE HOME MESSAGE

10 Ways to Love Your Liver

1) Street drugs can cause serious damage and scar me permanently.
2) Don't drown me in beer, liquor or wine. (If you drink alcohol, have two or fewer drinks per day)
3) Since everything you eat must pass through me, eat a well- balanced, nutritionally adequate diet. If you enjoy foods from each of the four food groups, you will probably obtain the nutrients you need.
4) Cut down on the amount of deep-fried and fatty foods you consume. Doctors believe that the risk of gallbladder disorders; including gallstones, a liver-related disease, can be reduced by avoiding high fat and cholesterol foods.
5) Increase your intake of high-fiber foods; such as fresh fruits and vegetables, whole grain breads, rice and cereals. A high-fiber diet is especially helpful in keeping me healthy.
6) If you are dieting to lose weight, make sure that you are still getting all the vitamins and minerals your body - and I - need to function properly.
7) A regular exercise routine, two or three days a week, will help keep me healthy, too.
8) I have to detoxify what you breathe in, so when you paint a room, or go on a cleaning binge, make sure the room is well ventilated or wear a mask.
9) Teach children what a syringe looks like and tell them to leave it alone. Never, ever, touch a discarded syringe or needle.
10) Use caution and common sense regarding intimate contact. Hepatitis viruses live in body fluids, including blood and seminal fluid.



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

BODIES....THE EXHIBITION
Digestive System Gallery
Cases 62 - 70

THE ENDOCRINE SYSTEM

Goiter

QUESTIONS

Q1 What is the difference between an exocrine gland and an endocrine gland?
Q2 Locate the thyroid gland and describe its relationship to important nearby structures.
Q3 Describe the structure and function of a thyroid follicle.
Q4 What is the functional relationship between the hypothalamus, the pituitary gland and the thyroid gland?
Q5 What is meant by negative feedback? Give an example.

PUTTING IT ALL-TOGETHER

A 35-year-old woman visits her physician complaining of difficulty sleeping at night. She says she falls asleep only to wake up with a choking sensation. She has difficulty sleeping when her neck is flexed to the left; however, with her head propped up on pillows and with her neck flexed to the right, she has no problem sleeping. On examination, her physician finds that the left side of her neck is somewhat swollen. She is diagnosed as having a fairly large goiter.

What is a goiter? Why does the woman have difficulty sleeping when her neck is flexed to the left and why is this condition relieved when her neck is flexed to the right and supported by a pillow? What are some of the additional signs of a goiter? Why do people with a goiter have difficulty breathing? What is the thyroid gland – pituitary gland – negative feedback loop? Use it to explain why a deficiency of iodine in the diet can cause a goiter. What can be done to treat this condition? What condition(s), other than iodine deficiency, can cause a goiter?

1. A goiter is an enlargement of the thyroid gland – it is not cancer.

2. The close relationship between the trachea and the lobes of the thyroid gland commonly results in pressure on the trachea in people with pathological enlargement of the thyroid gland. The left lobe of this woman's thyroid is larger than the right lobe. When she falls asleep and has a tendency to flex her neck laterally to the left, this kinks the trachea over the enlarged left lobe of her thyroid resulting in the chocking sensation she describes. Because the right lobe of her thyroid is not enlarged she finds that, by flexing her neck to the right and sleeping on a pillow, she is able to maintain the patency of the trachea.

Goiter cont'd

3. In addition to a swelling in the neck, signs and symptoms of goiter may include (a) difficulty breathing, (b) a tight feeling in the throat, (c) coughing, (d) hoarseness, and (e) difficulty swallowing. All of these are the result of the close relationship between the thyroid gland, the larynx and the trachea.

4. A hypothalamic releasing hormone (known as thyroid stimulating hormone releasing factor or TSHRF) stimulates cells of the anterior pituitary gland to secrete thyroid-stimulating hormone (TSH). TSH in turn stimulates the thyroid gland to secrete thyroid hormone, a hormone that circulates through the bloodstream to stimulate its target cells to increase their metabolic activity. At the same time, circulating levels of thyroid hormone feed back (negative feedback) to (1) prevent the hypothalamus from producing TSHRF and also to (2) prevent the cells of the anterior pituitary (negative feedback) from producing TSH.

5. Active thyroid hormone (secreted as either triiodothyronine T3 or tetraiodothyronine T4) is necessary to inhibit the production of TSHRF and TSH. When these two hormones are inhibited, the thyroid gland is silenced until the level of active thyroid hormone in the bloodstream falls. When this occurs, TSHRF and TSH are no longer inhibited and both begin to be secreted again in normal amounts by the hypothalamus and the anterior pituitary. This insures that increased amounts of thyroid hormone are synthesized and released from the thyroid gland. When no iodine is available, the thyroid hormone secreted by the thyroid gland lacks this necessary molecule and is rendered non-active. It is important to understand that only active thyroid hormone has the ability to negatively inhibit the production of TSHRF and TSH. Thus, in the presence of non-active thyroid hormone, TRHRF and TSH continue to stimulate the thyroid gland. The long-term consequence of excessive TSHRF and TSH stimulation of the thyroid is overgrowth of the thyroid follicles and enlargement of the thyroid itself.

6. Because we salt everything with iodized salt, iodine deficiency is not a problem in America. In most instances, thyroid hormone replacement therapy is prescribed for iodine deficiency. Hormone replacement inhibits thyroid-stimulating hormone (TSH) and allows the thyroid to recover.

7. Under-activity of the thyroid gland (hypothyroidism) typically causes the thyroid gland to enlarge. Hypothyroidism is almost always due to disease within your thyroid gland that causes a decrease in the production of thyroid hormone. If your thyroid begins to fail, and hormone levels fall below normal, your pituitary gland senses that there is not enough thyroid hormone in the blood. Thyroid function – and sometimes size - increases through the action of thyroid stimulating hormone, which it releases into the bloodstream. The most common cause of low thyroid hormone production is an autoimmune disease called Hashimoto's thyroiditis in which a person's own lymphocytes make antibodies that slowly and gradually disable the hormone-producing cells in their thyroid gland. Excellent tests designed to detect blood TSH level are available to diagnose the condition accurately. Treatment with oral thyroid hormone (thyroxine) usually restores normal thyroid function.

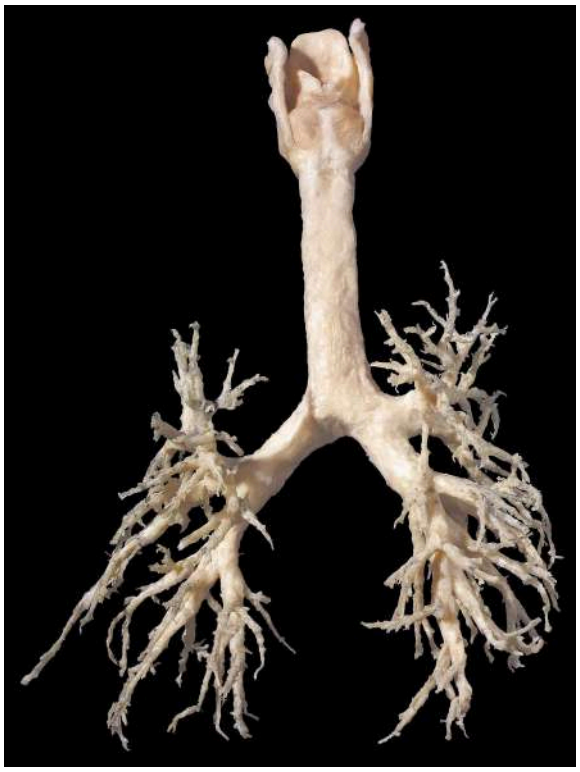
Goiter cont'd

TAKE HOME MESSAGE

Your thyroid is that little glandular butterfly in your neck that you're not exactly sure what it is or why it's there. It wasn't even described in the scientific literature until 1656 when Thomas Wharton made a distinction between it and the larynx. For the next 200 years, its function – the regulation of the body's metabolism - was completely unknown.

You can take care of your thyroid and prevent a goiter very simply. Just make sure you get enough iodine in your diet. One fifth of the world's population, 1 billion people, have diets that are deficient in iodine. People in these areas commonly have thyroid enlargement. In European countries, and many other developed countries, iodine intake has only risen to normal levels in recent years. In the past, particularly in the Great Lakes region of the United States, many people developed goiters because of a lack of iodine in their diet due to the soil used to grow edible crops. This dietary iodine deficiency was eliminated early in the last century with the addition of iodine to salt (iodized salt) and the presence of iodine in milk and bread products.

BODIES....THE EXHIBITION
The Nervous System Gallery
Case 25



Larynx, Trachea, and Bronchial Tree

THE URINARY SYSTEM

Kidney Stones

QUESTIONS

Q1 Where are the kidneys located within the body?
Q2 What are the main functions of the kidneys?
Q3 What path does urine take from the time it enters a minor calyx of the kidney until it leaves the body?
Q4 What is visceral pain and what way(s) does it differ from somatic pain?
Q5 How is visceral pain normally experienced?

PUTTING IT ALL-TOGETHER

A man calls his physician early one morning to report that he was struck with a very bad pain on the left side of his back after dinner the night before. The pain built up in about 5 minutes to a severity that he had never experienced before. The pain was so bad, in fact, that he became nauseous and vomited. After this, he felt that some of the pain had gone away. He thought that a bad virus or something he ate had upset his stomach. But the pain kept him awake all that night and, in his opinion, did not seem to get much better since it first began. After listening to the man's symptoms, his physician tells him that he thinks he is suffering from a kidney stone.

What are kidney stones? Why do kidney stones cause so much discomfort? How do kidney stones form? Although the chemical composition of kidney stones may vary, what is the most common type of kidney stone? What are some of the causes of kidney stones?

What signs and symptoms are commonly used to diagnose a kidney stone? What is the key in a consideration of this man's problem? What are some of the risk factors for developing kidney stones? What role, if any, does diet play in the development of kidney stones? How are kidney stones treated?

1. Kidney stones are hardened mineral deposits that tend to form in the kidneys or upper urinary tract when your urine becomes too concentrated. This causes minerals - and other substances in the urine - to form crystals on the inner surfaces of your kidneys. Over time, these crystals may combine to form a small, hard mass or stone.

2. Small stones can cause some discomfort as they pass out of the body. Regardless of size, stones may pass out of the kidney or become lodged either within the kidney (within the calyces or renal pelvis) or within the ureters that carry urine from the kidney to the bladder. These stones cause severe pain that begins in the lower back and radiates to the side or groin. A lodged stone can block the flow of urine causing distention and pressure to build in the affected ureter and kidney. This increased pressure results in stretching and spasm causing severe pain.

Kidney Stones cont'd

3. Kidney stones form when there is either a high level of calcium (hypercalciuria), oxalate (hyperoxaluria), or uric acid (hyperuricosuria) in the urine; a lack of citrate in the urine; or insufficient water in the kidneys to dissolve waste products. The kidneys must maintain an adequate amount of water in the body to remove waste products. If dehydration occurs, high levels of substances that do not dissolve completely (e.g., calcium, oxalate, uric acid) may form crystals that slowly build up into kidney stones.

4. Approximately 75% to 85% of all kidney stones are calcium stones. These stones are usually a combination of calcium and oxalate, a compound that occurs naturally in some fruits and vegetables. The most common cause of calcium stone production is excess calcium in the urine - a condition known as hypercalciuria. Excess calcium is normally removed from the blood by the kidneys and excreted in the urine. In hypercalciuria, excess calcium builds up in the kidneys and urine where it combines with other waste products to form stones. Low levels of citrate, high levels of oxalate and uric acid, and inadequate urinary volume may also cause calcium stone formation.

5. Calcium stones are composed of calcium that is chemically bound to either oxalate or phosphate. Of these, calcium oxalate is more common. Calcium phosphate stones typically occur in patients with metabolic or hormonal disorders. Increased intestinal absorption of calcium, excessive hormone levels (hyperparathyroidism), and renal calcium leak (kidney defect that causes excessive calcium to enter the urine) can cause hypercalciuria. Prolonged inactivity also increases urinary calcium and may cause stones.

6. You're not likely to have signs and symptoms unless a kidney stone is either quite large, is causing a blockage, is associated with an infection or is being passed. Then the most common symptom is an intense, colicky pain that may fluctuate in intensity over periods of 5 to 15 minutes. The pain usually starts in your back or your side, just below the edge of your ribs. As the stone moves down the ureter towards your bladder, the pain may radiate to your groin. If the stone stops moving, the pain may stop too. Other signs and symptoms may include: the presence of blood in the urine (dark urine), nausea and vomiting, a persistent urge to urinate and fever and chills, if an infection is present.

7. The key finding is this instance is the abrupt onset of the man's excruciating urinary tract pain. When a part of the collecting system of the upper urinary tract (this consists of the calyces, renal pelvis and ureter) becomes distended, the intensity of visceral pain that is evoked is primarily a measure of the rate of distention. Therefore, the abrupt onset of excruciating pain is suggestive of an acute high rate of distention of some part of the upper urinary collecting system.

Kidney Stones cont'd

8. Several factors increase the risk for developing kidney stones; including inadequate fluid intake and dehydration, reduced urinary flow and volume, certain chemical levels in the urine that are too high (e.g., calcium, oxalate, uric acid) or too low (e.g., citrate), and several medical conditions. Anything that blocks or reduces the flow of urine (e.g., urinary obstruction, genetic abnormality) also increases the risk. Medical conditions such as excessive parathyroid hormone, which causes calcium loss (hyperparathyroidism), gout (caused by excessive uric acid in the blood), high blood pressure (hypertension), inflammation of the colon causing chronic diarrhea, dehydration, plus chemical imbalances (colitis) and urinary tract infections are also risk factors.

9. Diet plays an important role in the development of kidney stones, especially in patients who are predisposed to the condition. A diet that is high in sodium, fats and protein (meat, chicken and fish) and low in fiber (fruits, vegetables and whole grains) may increase a person's risk of developing kidney stones. High doses of vitamin C can result in high levels of oxalate in the urine (hyperoxaluria) and increase the risk for kidney stones. Oxalate is found in berries, vegetables (e.g., green beans, beets, spinach, squash, and tomatoes), nuts, chocolate, cranberries and tea.

10. Treatment depends on the size and type of stone, the underlying cause, the presence of urinary infection, and whether the condition recurs. Stones 4 mm and smaller (less than 1/4 inch in diameter) pass without intervention in 90% of cases; those 5 – 7 mm do so in 50% of cases; and those larger than 7 mm rarely pass without intervention. When surgery is necessary, the most commonly used procedure for treating kidney stones is called extracorporeal shock wave lithotripsy (ESWL). It uses shock waves to break the stones into tiny pieces that are then passed in your urine. If possible, the kidney stone is allowed to pass naturally. The patient is instructed to strain their urine to obtain the stone(s) for analysis. It is important to analyze the chemical composition of kidney stones to determine how to prevent recurrent stone formation. Dietary changes may be required and fluid intake should be increased. Patients with stones must increase their urinary output. Generally, 2000 cc of urine per day (slightly more than 1/2 gallon) is recommended and patients should drink enough water to produce this amount of urine. Dietary calcium should not be severely restricted. Reducing calcium intake often causes problems with other minerals (e.g., oxalate) and may result in a higher risk for calcium stone disease.

Kidney Stones cont'd

TAKE HOME MESSAGE

If you've ever passed a kidney stone, you're not likely to forget the experience — it can be excruciatingly painful. What's more, kidney stones are increasingly common. One in 10 Americans will have at least one kidney stone some time in their life. Not all kidney stones cause symptoms. They're often discovered when a person has an X-ray for an unrelated condition or when they seek medical care for problems such as blood in their urine or recurring urinary tract infections. The pain becomes agonizing only when a stone breaks loose and begins to work its way down from the kidneys to the bladder. Most small kidney stones pass into the bladder without causing any permanent damage. Still, it's important to determine the underlying cause in order to prevent more stones from forming. In many cases, simply drinking more water and making a few dietary changes can prevent kidney stones.

Veins and arteries of the kidney

BODIES....THE EXHIBITION
Digestive System Gallery
Case 67

THE MALE REPRODUCTIVE SYSTEM

Benign Prostatic Hypertrophy (BPH)

QUESTIONS

Q1 Where is the prostate gland located within the body?
Q2 What is the relationship between the following: the prostate gland and the urethra; the prostate gland and the urinary bladder; and the prostate gland and the rectum?
Q3 What hormonal relationship exists between the testes and the prostate?
Q4 What are prostate specific antigens?
Q5 What is the function of the prostate gland?

PUTTING IT ALL-TOGETHER

During his annual physical exam, a 60 year-old man mentions to his physician that over the past 6 months he has noticed some pain when attempting to urinate. He indicates that he has also had trouble starting and stopping and has been experiencing urgency (a sudden desire to urinate), dysuria (difficulty with urination) and nocturia (excessive urination at night). After doing a digital rectal exam, conducting a prostate specific antigen (PSA) blood test and getting the results of a rectal ultrasound, his physician determines that he is suffering from benign enlargement of the prostate - more commonly known as benign prostatic hypertrophy or BPH.

Describe the manner in which the prostate grows. What causes the prostate gland to enlarge as a person ages? How does an enlarged prostate gland interfere with urination? What affect does an enlarged prostate gland have on the urinary bladder? What are the primary symptoms of BPH? Why is a prostate specific antigen (PSA) test done as part of a man's prostate health examination? What is the relationship between BPH and prostate cancer?

1. As a man matures, the prostate gland goes through two main periods of growth. The first occurs early in puberty, when the prostate doubles in size. At around age 25, the gland begins to grow again. This second growth phase often results, years later, in benign enlargement of the gland known as benign prostatic hypertrophy (BPH). Though the prostate continues to grow during most of a man's life, problems do not usually arise until the later years. BPH rarely causes symptoms before age 40, but more than half of men in their sixties and as many as 90 percent in their seventies and eighties have some symptoms of BPH.

BPH cont'd

2. The cause of BPH is not well understood. No definite information on risk factors exists. It has been known for some time that BPH occurs mainly in older men and that it doesn't develop in men whose testes were removed before puberty. For this reason, it is believed that factors related to aging and the testes may spur the development of BPH. Throughout their lives men produce testosterone, an important male reproductive hormone, and small amounts of estrogen, a female reproductive hormone. The prostate converts testosterone to a more powerful androgen, dihydrotestosterone (DHT). DHT stimulates cell growth in the tissue that lines the prostate gland (the glandular epithelium) and is the major cause of the rapid prostate enlargement that occurs between puberty and young adulthood. DHT is a prime suspect in prostate enlargement in later adulthood.

Male Reproductive System

Some estrogen is always present in men. But as they age, the amount of active testosterone in their blood decreases; leaving a higher proportion of estrogen. Studies have suggested that BPH may occur because the higher amount of estrogen within the gland increases the activity of substances that promote cell growth.

Recently, it has been suggested that BPH may develop as a result of "instructions" given to cells early in life. According to this theory, BPH occurs because cells in one section of the gland follow these instructions and "reawaken" later in life. These "reawakened" cells then deliver signals to other cells in the gland, instructing them to grow or making them more sensitive to hormones that influence growth.

3. The prostate surrounds a portion of the male urethra, the canal through which urine passes out of the body. As the prostate enlarges, the layer of tissue surrounding the gland stops it from expanding causing it to press against the urethra like a clamp on a garden hose.

4. As the prostate enlarges, the wall of the urinary bladder also becomes thicker and more irritable. The bladder now begins to contract even when it contains small amounts of urine, causing more frequent urination. Eventually the bladder weakens and loses the ability to empty itself completely. The narrowing of the urethra and the partial emptying of the bladder both cause many of the problems associated with BPH.

5. Many symptoms of BPH stem from obstruction of the urethra and gradual loss of bladder function resulting in incomplete emptying of the bladder. The symptoms of BPH vary, but the most common ones involve changes or problems with urination; such as a hesitant, interrupted, weak stream, urgency and leaking or dribbling, and more frequent urination - especially at night. The size of the prostate does not always determine how severe the obstruction or the symptoms will be. Some men with greatly

BPH cont'd

enlarged glands have little obstruction and few symptoms while others, whose glands are less enlarged, have more blockage and greater problems.

6. PSA is a protein enzyme produced by cells of the prostate gland that prevents semen from solidifying. To rule out cancer as a cause of urinary tract symptoms, a prostate specific antigen (PSA) blood test is often recommend. Although considered to be a diagnostic test, levels of PSA in a man's blood do not actually confirm the presence of malignant tumors. In addition to cancer, high PSA levels may be traced to BPH, infections, or inflammation of the gland. Some men have naturally high blood levels of the enzyme and perfectly healthy prostates. High levels of PSA indicate cancer in about a third of all cases. Presently, in men age 50 and older, a PSA blood test is normally performed in conjunction with a digital rectal exam to evaluate the health of the prostate gland. However, much remains unknown about the interpretation of PSA levels; including the test's ability to discriminate cancer from benign prostate conditions and the best course of action following a finding of elevated PSA.

7. Although some of the signs of BPH and prostate cancer are the same, having BPH does not seem to increase the chances of getting prostate cancer. Nevertheless, a man who has BPH may have undetected prostate cancer at the same time or may develop prostate cancer in the future. For this reason, it is recommended that all men over 40 have a rectal exam once a year to screen for prostate cancer.

TAKE HOME MESSAGE

The prostate is a walnut-sized gland that forms part of the male reproductive system. This gland is made of two lobes, or regions, enclosed by an outer layer of tissue. It is located in front of the rectum and just below the bladder, where urine is stored. Scientists do not know all the functions of the prostate. One of its main roles, though, is to squeeze fluid into the urethra as sperm move through during sexual climax. This fluid, which helps make up semen, energizes the sperm and makes the vaginal canal less acidic. Many people feel uncomfortable talking about the prostate, since the gland plays a role in both sex and urination. Still, prostate enlargement is as common a part of aging as gray hair. As life expectancy rises, so does the occurrence of BPH. In the United States in 2000, there were 4.5 million visits to a physician for BPH. It is important that men (of any age) tell their doctor about any urinary tract problems they may be experiencing since urinary tract infections can result in serious medical problems. In 8 out of 10 cases, urinary tract problems in men over the age of 60 suggest BPH, but they also can signal other more serious conditions that require prompt treatment. These conditions, including prostate cancer, can be ruled out only by a doctor's exam.

BODIES....THE EXHIBITION
Reproductive System Gallery
Case 78

THE FEMALE REPRODUCTIVE SYSTEM

Placenta Previa

QUESTIONS

Q1 Where does implantation of a fertilized ovum normally take place?
Q2 What does the word "ectopic" mean? What is an ectopic pregnancy?
Q3 Where and how is the placenta normally formed?
Q4 What is the placental barrier and what is its function?
Q5 List as many functions of the placenta as you can.

PUTTING IT ALL-TOGETHER

A 40 year-old woman, pregnant for the fourth time, calls her obstetrician during the later part of her second trimester to report some minor painless vaginal bleeding. Ultrasound shows that she has placenta previa (PP) and that it is marginal. Her doctor tells her not to be alarmed but insists that she have a follow-up ultrasound early in her third trimester to again check on the location of her placenta. In the meantime he tells her that, if she experiences any additional vaginal bleeding, an immediate ultrasound will be done to find out what's going on.

What is PP? How is PP usually diagnosed? What normally happens during the course of a woman's pregnancy when she is diagnosed as having PP? What are the risks/complications of PP for the mother and her baby? What factors determine a woman's risk for developing PP?

1. Placenta previa is a condition in which the placenta develops ectopically, low down in the uterus next to or covering the cervix. The placenta is the pancake-shaped organ, normally located near the top of the uterus (fundus), which supplies the developing embryo and fetus with nutrients through the umbilical cord. Placenta previa is not usually a problem early in pregnancy; but if it persists into later pregnancy, it can cause serious bleeding. In some instances, this can lead to an uncontrolled hemorrhage that may even put the lives of the mother and baby in danger. Should this happen, delivery is normally done by caesarean section - or C-section. If the placenta covers the cervix completely, it is called a complete or total previa. If it is right on the border of the cervix, it is called a marginal previa. The term partial previa is sometimes used to describe a placenta that covers part of the cervical opening once the cervix starts to dilate. If the edge of the placenta is within 2 centimeters of the cervix, but not bordering it, it is called a low-lying placenta. The location of the placenta is normally checked during mid-pregnancy.

Placenta Previa cont'd

Female Reproductive System

2. A diagnosis of PP is usually made when there is painless bleeding during the third trimester. Bleeding from the vagina during the second or third trimester may be the first sign of PP, although in many cases there are no signs at all. However, there is a 10% false positive diagnosis rate usually because of the bladder being overfull. There is also a 7% false negative rate typically caused from missing the PP that is located behind the baby's head. Other reasons to suspect a PP include; premature contractions, abnormal presentation (breech, transverse, etc.) and a uterus that measures larger than it should according to dates. If any bleeding occurs, it is not wise to do a vaginal exam until an ultrasound has ruled out a PP.

3. What happens after a woman is diagnosed with PP depends on how far along in her pregnancy she is and how much bleeding she is experiencing. Bleeding normally occurs when the cervix begins to thin out or dilate (even a little), disrupting the blood vessels in that area. It is usually painless, can start without any warning and range from spotting to extremely heavy bleeding. If a woman's bleeding is severe, she may have to deliver right away, even if her baby is still premature. If bleeding is very heavy, transfusions may be necessary until the fetus is mature enough for delivery. Steroid injections may also be used to speed fetal lung development. Ultimately, the goal is to try to keep the pregnancy going until at least 36 weeks, at which point the baby may be delivered by cesarean to reduce the risk of massive hemorrhage. If the condition is diagnosed after the 20th week of pregnancy (in the second trimester), and a woman is not experiencing any bleeding, there is little need to panic. Only about 10 percent of women who have PP noted on ultrasound at mid-pregnancy still have the condition when they deliver their baby. Resolution of the problem occurs because the placenta is likely to "migrate" farther from the cervix during the later stages of pregnancy. Since the placenta is implanted in the uterus, it doesn't actually move, but it can end up farther from the cervix as the uterus expands. Also, as the placenta itself grows, it's likely to grow toward the richer blood supply in the upper part of the uterus.

A placenta that completely covers the cervix is more likely to stay that way than one that is bordering it (marginal) or nearby (low-lying). But such a placenta may still move away from the cervix. If an ultrasound reveals that the placenta is still covering, or too close to the cervix, a woman is usually monitored through regular ultrasounds. She must watch carefully for any sign of vaginal bleeding. She is usually put on "pelvic rest," which means no intercourse for the rest of her pregnancy, and advised to take it easy and avoid activities such as strenuous housework or heavy lifting that might provoke bleeding. It is uncommon for bleeding to occur until the later part of the second trimester and, about half the time, it doesn't begin until the baby is nearly full-term (37 weeks). If a woman has bleeding and is Rh negative, she is usually given a shot of Rh immune globulin; unless the baby's father is also Rh negative. No matter when a woman delivers her baby, it has to be via cesarean section. With a complete PP, the placenta blocks the baby's way out. Even when the placenta borders the cervix,

Placenta Previa cont'd

a C-section is advised because of the possibility that profuse bleeding might occur if the cervix is dilated during a vaginal delivery.

4. Having PP increases a woman's risk of heavy bleeding (life-threatening hemorrhage) not only during pregnancy but also during and after delivery. After delivery of both the baby and the placenta (the afterbirth), a woman is normally given Pitocin or other medications. This causes the uterus to contract, which helps stop the bleeding from the area where the placenta was implanted. But when a woman has PP, the placenta is implanted in the lower part of the uterus. This part of the uterus, because its wall contains far less smooth muscle, doesn't contract as well as the upper part and thus its contractions are not as effective at stopping the bleeding. Women who have PP are also more likely to have a placenta that attaches directly to the uterine smooth muscle and doesn't separate easily at delivery, a condition known as placenta accreta. Placenta accreta normally occurs in 1 of 2,500 births, but a woman's chance of having placenta accreta increases significantly (approximately 1 in 10) if she has PP when her baby is delivered. Placenta accreta may cause severe bleeding. A hysterectomy to control the bleeding, in addition to a blood transfusion, may be required. Complications to the baby include; intrauterine growth retardation due to poor placental perfusion and, because of a slightly increased risk of intrauterine growth restriction, intrauterine hypoxia and an increased incidence of congenital anomalies.

5. There are a few predisposing factors that can increase a woman's risk for developing PP. Some of these include; chronic cigarette smoking, cocaine abuse, advanced maternal age, increased parity (number of pregnancies), pregnancies that involve twins or higher-order multiples, previous cesarean sections and previous uterine surgery (independent of the type of incision).

TAKE HOME MESSAGE

The placenta develops within the wall of the uterus to functionally connect the mother and fetus. During pregnancy, it transports maternal nourishment and removes fetal wastes. Fetal blood and maternal blood do not mix within the placenta. Instead, an ultra-thin membranous barrier allows the passage of respiratory gasses, and certain select molecules, from one bloodstream to the other. Toxins and other harmful substances, however, can also pass through this thin membrane. Thus, a pregnant woman must carefully watch what she ingests and what she breathes!

An ectopic pregnancy develops when implantation occurs in a place outside of the uterus or in an abnormal place within the uterus. One such abnormal place is low down on the uterine wall at a point where the uterine cervix opens into the vagina. This condition is called PP. Placenta previa occurs in only about 1 in 250 pregnancies. When it does occur, however, it results in some significant and often life-threatening consequences. Therefore, understanding the condition is necessary so that it is not taken lightly and the right steps are followed to ensure that nothing tragic happens to either the mother or her baby.

BODIES....THE EXHIBITION
Reproductive System Gallery
Case 73

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:

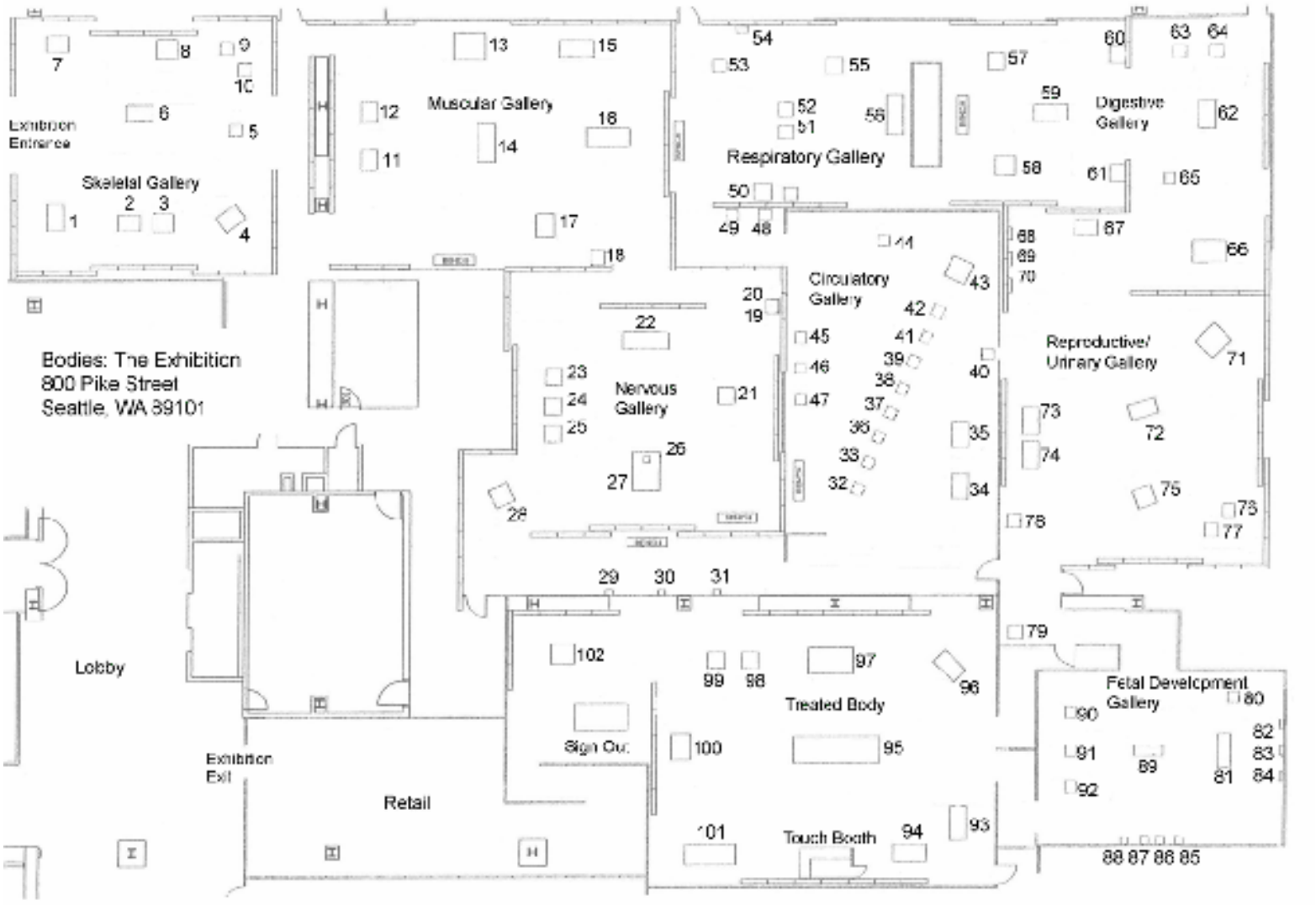
1. What are the systems of the human body?
2. How does each system of the body function?
3. How are the body's systems inter-related?
4. What can be done to improve and extend the life of the body?

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.

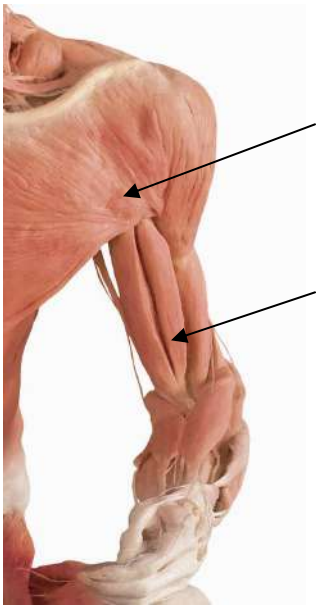
CASE 13

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

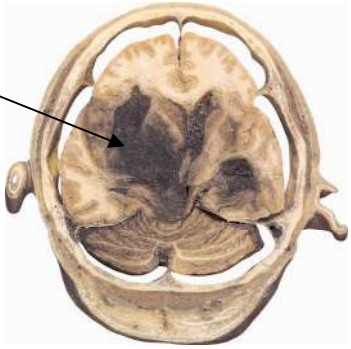
Inside the brain are an interconnected series of hollow spaces called ventricles that are filled with cerebrospinal fluid. Made within the ventricles, this water-like fluid circulates between the layers of the meninges, cushioning the brain and spinal cord, and removing their wastes. The cerebrospinal 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.

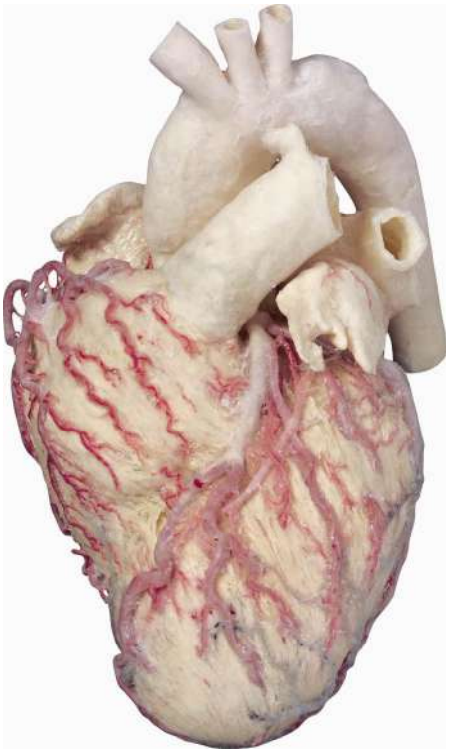
CASE 29
Heart

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

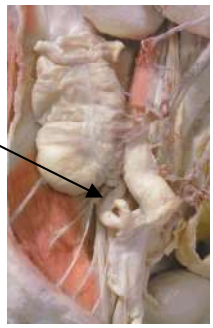
The small intestine attaches to the body wall with a connective tissue called mesentery. It wraps around the intestine like a sling and holds it in place. Blood vessels, visible as dark lines on this specimen, travel through the mesentery to reach the intestine, carrying oxygen and nutrients to the intestine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

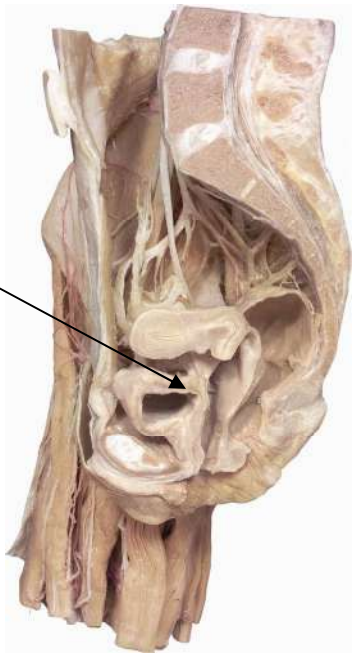
CASE 72

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 62 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

Glossary for BODIES...THE EXHIBITION

Alveoli: al-ˈvē-ə-lə*s*: 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

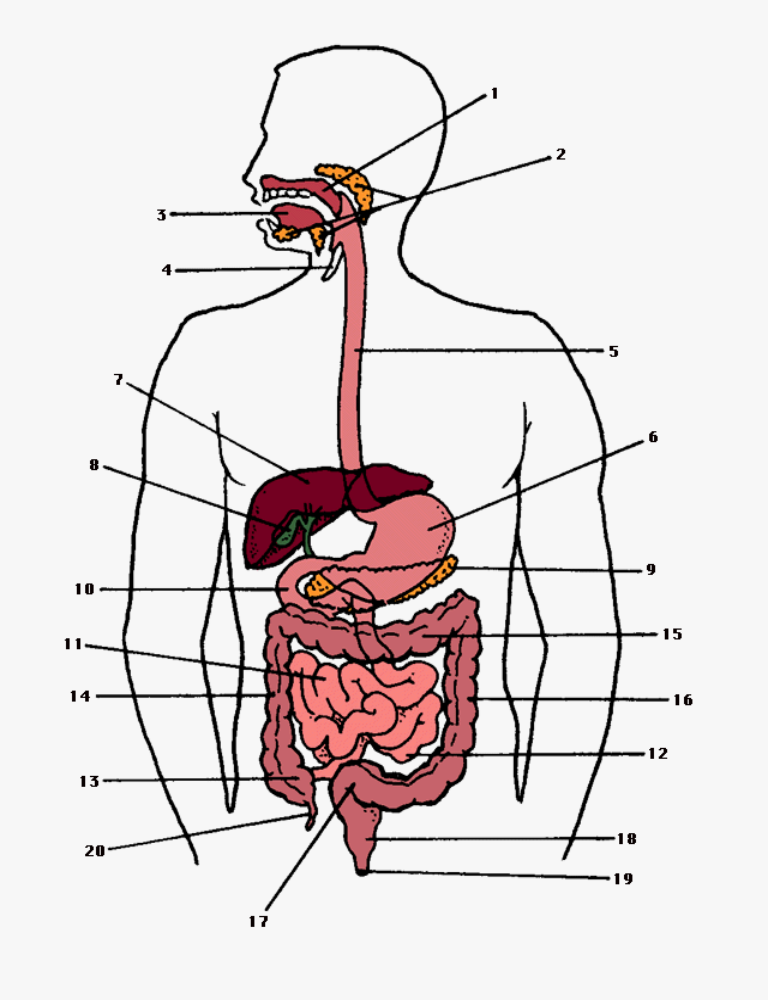
Compact Bone Tissue: The compact noncancellous portion of bone that consists largely of concentric lamellar osteons and interstitial lamellae

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

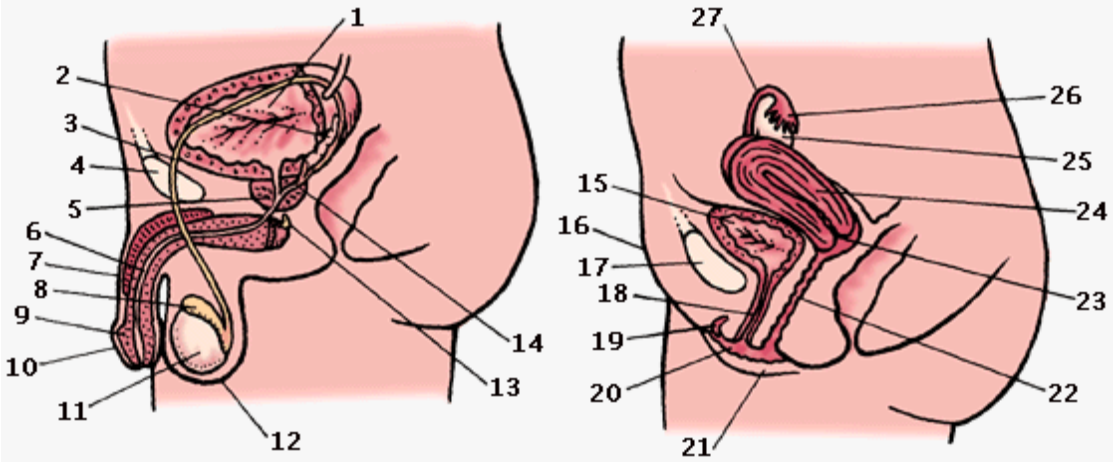
Placenta: the vascular organ in mammals except monotremes and marsupials that unites the fetus to the maternal uterus and mediates its metabolic exchanges through a more or less intimate association of uterine mucosal with chorionic and usually allantoic tissues permitting exchange of material by diffusion 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