

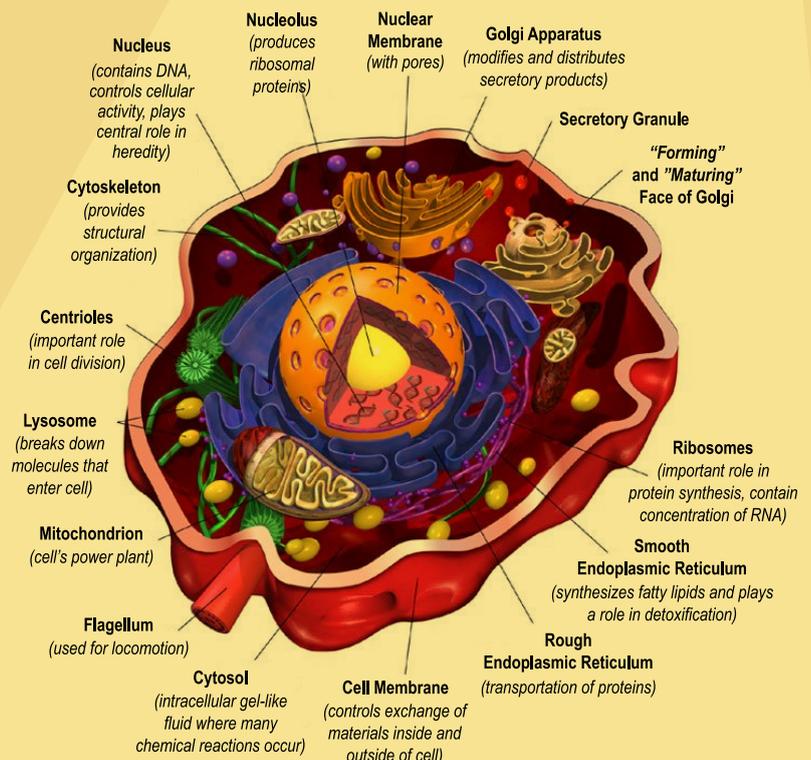


CONNECTING HUMAN BIOLOGY & HEALTH CHOICES

Have you ever wondered about how the human body works? The human body is like a complex machine, with many little parts that work by themselves or with other parts to perform specific functions. Sometimes, it seems like our body has a mind of its own and it embarrasses you. Have you ever passed gas accidentally when other people were around? In most cases, the things that your body does are normal, but it's important to know your body so you can recognize what is normal body behavior and what is not. If there is a problem with how your body works, by recognizing that there is a problem, you can take steps to fix it or get help.

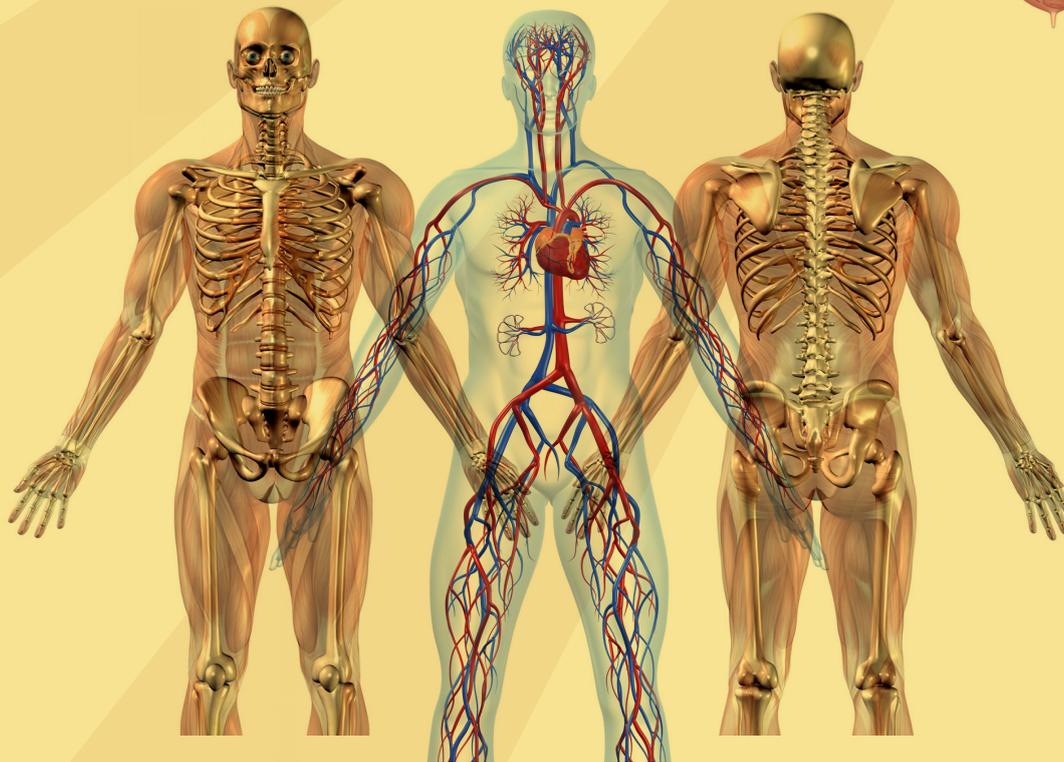
To understand how the body works, it helps to understand how the body is organized. The smallest living unit in any organism is a **cell** and the human body is made up of trillions of them. That is more than **1,000,000,000,000 cells!** Cells are so small you cannot see them without a microscope. Cells are important for many reasons. They produce the energy in your body to do daily activities, or hold the coded instructions for everything from the color of your hair to whether you have freckles or not. Cells differentiate from each other to perform different, important tasks within the body. For example, some cells might become brain cells while others make bone, and red blood cells carry oxygen throughout the body, while white blood cells fight infection.

When a group of cells work together to perform a specific function, they are called **tissue**. There are four types of tissue within the body. The first, **epithelial tissue** protects the body and the organs by forming a protective outer layer. The skin, which is an example of epithelial tissue, is the first line of defense against infections. **Nerve tissue** carries messages from the brain to the rest of your body by sending electrical impulses. The electrical impulses tell the muscles when to contract and affect everything from the beating of your heart to the wiggling of your toes. **Muscle tissue** functions in movement because the muscle cells contract, shorten and relax. Muscle cells know when to contract or shorten because they receive electrical signals from nerve tissue. Finally, **connective tissue** holds the body together, provides support, insulation, and protection. Bones, tendons, and ligaments are all examples of connective tissue.



Organs are two or more types of tissue that work together to perform a specific task. For example, the stomach has all four types of tissue and is responsible for breaking down food. **Organ systems** are formed when two or more organs work together to perform a larger task. The mouth, throat, stomach, large and small intestines, liver, pancreas, and gallbladder all work together, as the digestive system, to process the food we eat so that our cells can absorb the nutrients and convert it into energy.

There are many systems in the body, such as the skeletal, muscular, circulatory, nervous, digestive, immune, respiratory, urinary, and reproductive systems and they all interact with each other every second of our lives. Without these systems, humans would not be able to grow, maintain life, and reproduce. Doing something beneficial for one system (like taking an antibiotic for an ear infection) might cause problems in another (like disrupting the digestive process.) Doctors call these **side effects** and you have to decide if the benefits from the medication are worth the risk of the side effects. Sometimes, the side effects are minor and undetectable;



other times they have very serious consequences. For example, birth control pills lose effectiveness if you are also taking certain antibiotics. That's why it's important to listen carefully to your doctor's and pharmacist's instructions when taking a new medication and tell them about any prescriptions, recreational or street drugs, vitamins, alcohol, etc., that you are taking.

When you take any drug, it may interact negatively with other drugs or substances. A new phenomenon called pharming, involves raiding the medicine cabinets for prescription medications and mixing them with the intent of getting high. Pharming is *extremely* dangerous and potentially fatal. Prescription drugs that are meant to treat a specific condition in an ill person can have the exact *opposite* effect in healthy people because of drug interactions and the effect on internal organs. The effects on the body depend on what was taken, what it was taken with, and in what quantities. Drug interactions can lead to overdose and death.

"It won't happen to me." Why not you?

When we think about things that may happen in our lives such as disease, it's human nature to think it will not happen to us - it happens to *other* people. We like to believe that we are immune from these types of things, but unfortunately, that isn't always true. They have to happen to someone, so *why not you?*

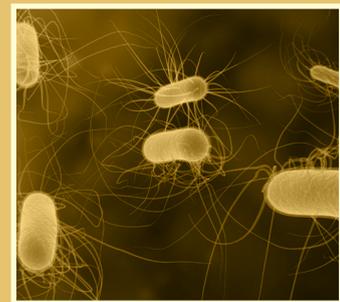
People are living longer than ever, and the likelihood of developing a health condition, contracting an infection, or manifesting a genetic disease increases. The actions and behaviors you take today can have a dramatic effect on your body and to your health both now and in the long-term. That is why knowing about and making health choices are so important!

What makes people sick?

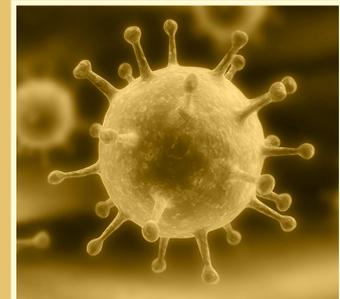
As long as there have been people on earth, people have gotten sick. Throughout the centuries, the diseases and how they affect people have changed because humans have adapted, developed resistance to certain infections, and there have been many advances in medicine. Some illnesses are mild and eventually go away. Other diseases are very serious and can change the way the body works. But what makes people sick? Why can some people be cured, and others cannot?

There are a variety of reasons people develop a disease: exposure to a bacteria or a virus, consuming contaminated water or food, poor nutrition, genetic factors, exposure to certain chemicals, and from environmental factors such as breathing in second-hand cigarette smoke and asbestos.

Bacteria are single-celled organisms and they are normally found inside and outside of the body, except in the blood and spinal fluid. Most bacteria are beneficial, but some bacteria cause disease. Harmful bacteria are often referred to as germs because they cause disease such as ear infections, pneumonia, or strep throat. When bacteria cause infections, antibiotics prescribed by your doctor will typically destroy the harmful bacteria. Antibiotics should only be taken when prescribed by a doctor because one of the side effects is that antibiotics can also destroy the beneficial bacteria in the body. For example, over a hundred species of bacteria live in the large intestine and colon. This type of bacteria helps the body process food and keep harmful bacteria from traveling up the digestive track and harming other parts of the body. When bacteria in the colon and large intestine are disturbed, people can experience symptoms like constipation, gas, or diarrhea. (While gas is a natural by-product of digestion, excessive gas accompanied by other symptoms may require medical treatment.)



Viruses are infectious agents that must live inside a host cell to survive and replicate. As the virus replicates, it will take over more and more cells. Your immune system is responsible for fighting the infection caused by a virus since viruses don't respond to antibiotics. For some viral infections, like HIV, there are anti-viral medications available that help slow the rate of the virus's replication, but they can't kill it.



In many cases, you can avoid catching a bacterial or viral infection or disease by practicing good hygiene. Most germs are spread from person-to-person contact, and even if someone doesn't feel sick, they can still be carrying the infection. To help minimize the spread of germs, **wash your hands** frequently for at least 20 seconds using soap and water. (Sing the "Happy Birthday" song in your head to make sure you have washed long enough and be sure to use warm water and soap!) It's also important to wash your hands after handling raw meat or animals since they can carry organisms that cause disease. Put the toilet lid down before you flush because whatever is in the bowl aerosolizes (mists) onto everything within 6 feet of the toilet. (How close is your toothbrush to the toilet?) Cough or sneeze into the crook of your elbow instead of your hands so you can avoid spreading the germs through the air or via your hands. Always wash your fruits and vegetables and cook meats and eggs thoroughly to kill bacteria on your food.

Fighting Infection

The body is very good at fighting foreign organisms and has many ways to protect you. For example, skin acts as a barrier for organisms trying to enter the body. If something gets in your eye, tears are produced. If you inhale something, you sneeze or cough to expel it. Stomach acids often kill other organisms. Your body makes it very inhospitable for foreign organisms to survive and thrive.

The **immune system** is responsible for protecting us against foreign organisms that do get past the initial line of defense and it is made up of special cells, tissues, and organs that work together to kill foreign invaders. The thymus, spleen, and bone marrow are called lymphoid organs and special infection-fighting cells are stored throughout the body in lymph nodes. If we have an injury or an infection, leukocytes or white blood cells travel through the circulatory and lymphatic systems and surround the infected area. There are three classes of white blood cells: **Macrophages, T-Cells, and B-Cells**. Macrophages and T-Cells surround an infection and break down foreign materials. B-Cells produce **antibodies** that recognize and attach to foreign organisms, preventing it from harming the body. Some antibody producing B-Cells remain in the body after the infection has cleared up and becomes part of the immune system's "memory" against future infections. If your body has B-Cells for certain pathogens, such as chicken pox, your body would be able to destroy it almost immediately if you were re-infected with that particular virus. Resistance to a particular pathogen is called **immunity** and you become immune to a specific pathogen after your body has developed this resistance. One way this is accomplished is through vaccines, which contains small amounts of dead or weakened pathogens that stimulate an immune response in your body and provide future immunity. Due to biomedical research, vaccines are available for many common pathogens. Some diseases, such as polio, have been eradicated or wiped out in the U.S. because of vaccines.

Drug Resistant Bacteria

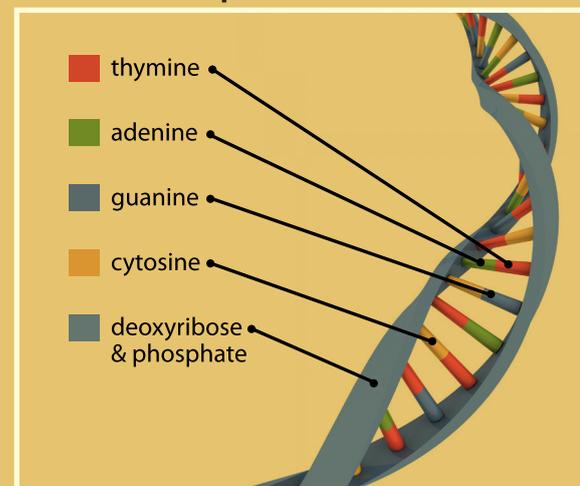
Researchers have developed many different antibiotics that can kill the harmful bacteria that cause many infections. Over the years, bacteria have adapted or changed in order to survive in environments that were designed originally to kill them. These bacteria are called **drug resistant** because they don't respond to typical antibiotics. Drug resistant bacteria are a major problem for the health care community and the entire world because there aren't antibiotics available to treat these new forms of bacteria, such as MRSA (drug resistant staph) or XDR-TB (drug resistant TB). Drug resistant bacteria make it harder to treat diseases that had previously been easy to treat with antibiotics. Without effective antibiotics, someone who is fighting an infection may suffer longer with their illness and some may possibly die. In addition, it will cost a lot more to treat sick people.

One of the reasons bacteria have become drug resistant is because antibiotics have not been used correctly. When a doctor prescribes antibiotics, it's important to follow the directions and take all of the antibiotics so the harmful bacteria are killed off completely instead of possibly becoming stronger, multiplying and re-infecting you after an incomplete dose of antibiotic. Many times, antibiotics are prescribed to treat a viral infection (i.e.: a cold, cough, bronchitis, etc.) rather than a bacterial infection (i.e.: strep throat, ear infection, etc.) Taking antibiotics for a viral infection will not help the infection go away any faster or prevent the spread of illness. Conduct your own internet research to learn more about drug resistant bacteria in humans and animals.

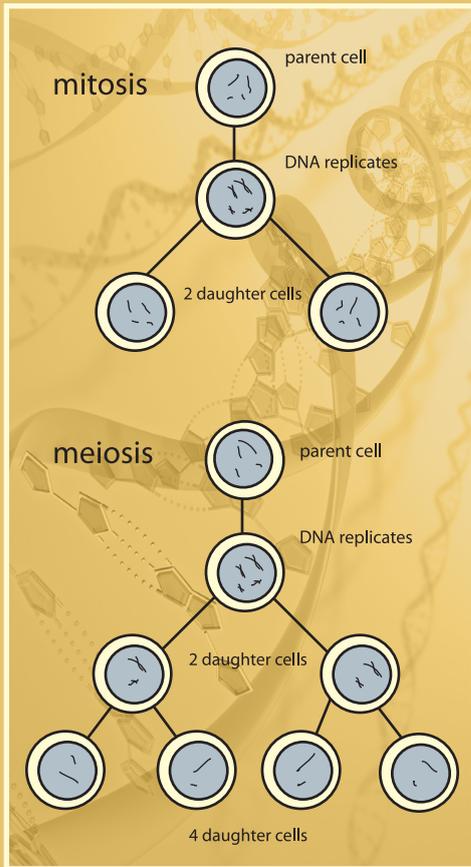
What color are your eyes?

Every organism has DNA inside their cells – including bacteria, plants, insects, animals, and humans. **DNA (deoxyribonucleic acid)** contains the genetic information that determines how an organism will look, grow, develop, reproduce, and repair itself. DNA is found inside the chromosomes, which are located in the cell's nucleus. It's incredibly small and can only be seen under a special, high-powered microscope, like a Transmission Electron Microscope (TEM). DNA is responsible for everything in your body – it determines the color of your eyes, how tall you will grow, how your body digests food, etc. DNA can be compared to the blueprints for building a new house. A builder needs detailed instructions about how to build the house and the blueprints provide information for the dimensions for each room, the size of the windows, the stair location, etc.

DNA The Blueprints for Life



Cell Division - 2 Types



the builder has a question about a specific room, he can go to that section of the blueprints for more detailed information. DNA acts in the same way for it's located inside every cell and provides instructions about how to perform all the body's tasks and functions. Like the builder, cells have the capability of narrowing that information down to look at the sections of the DNA that is relevant only to its function.

Depending on their function, some cells are replaced, while others, like brain cells, live for the duration of your life. Blood cells only live for a couple of weeks and are replaced at a rate of several billion each day. There are two types of cell division: mitosis and meiosis. When the body creates new cells to replace old and damaged cells in the body, they use **mitosis**. During mitosis, all 46 chromosomes are copied inside the parent cell's nucleus, 92 chromosomes total. The parent cell then splits in half and gives one full set of 46 chromosomes to each new daughter cell. The new set of chromosomes should be identical to the original set of chromosomes and there is no intended genetic variation during this process.

Genetic variations can occur during **meiosis**, which is when the body creates reproductive cells called ovum (egg) and sperm. The ovum and sperm each have one set of 23 chromosomes from the parent cell's genetic material. When the egg and sperm combine, they create a full set (46 chromosomes) of DNA for a new organism. Twenty-two of the 23 chromosomes are the same

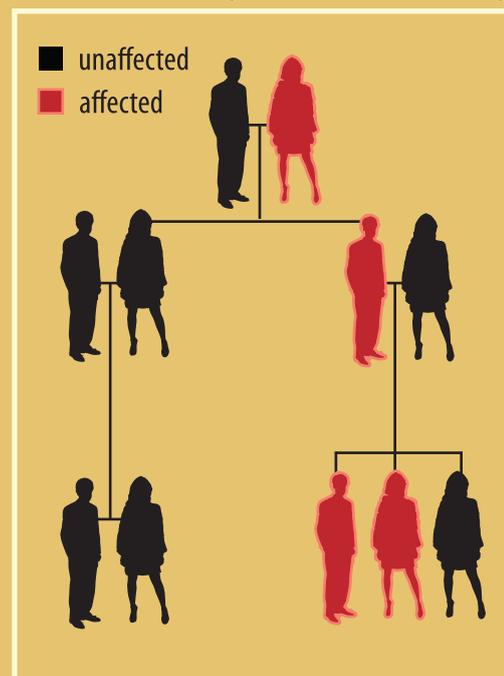
in male and females. The remaining 23rd set of chromosome is different in males and females and it determines the sex of the offspring. Females have two X chromosomes, while males have an X and Y chromosome. The Y chromosome results in a male offspring. Everyone's DNA is unique to them – no two people have the exact same DNA unless they are identical twins (or identical triplets, etc.)

A **gene** is one unit that occupies a specific location on your chromosome. For example, you may have a gene that determines if you have flat feet or not. If one of your parents also has flat feet, you **inherited** that gene. **Heredity** is when one gene is passed from a parent to their offspring. Some genes are dominant and some are recessive. You are more likely to inherit a dominant gene from your parents, and are more likely to manifest it (i.e. brown eyes instead of blue.)

Scientists are trying to gain a better understanding of human genetics through the Human Genome Project. They have determined that there are 20,000 – 25,000 genes in the human body. Each person has two copies of each gene (example: bone composition) that they receive from their parents during fertilization. Ninety-nine percent of the genes are the same in all people. There is only one percent genetic variation and that is what determines unique characteristics such as eye color, dimples, etc.

Sometimes, a problem occurs during meiosis or mitosis and a gene will **mutate** or alter from its natural state. When a gene mutates, it effects how the body works and can cause an abnormal condition, such as a disease or deformity. For example, some people lack the gene that tells the body how to make a specific enzyme called lactase that digests milk products. People who are unable to digest milk products are called lactose intolerant. Some gene mutations like this aren't life threatening, but others can be very serious.

Condition Affecting Members of the Family



GENETIC DISEASES

Some people know that a particular disease runs in their family. If your DNA includes a gene for a particular disease like breast cancer or diabetes, you are considered **genetically predisposed**, or more likely, to develop that disease. If you know your family's medical history, you may be able to make choices that will help control a disease better in the future, or, in the case of Type 2 diabetes, avoid it. It is important to share your family history with your doctors because it helps them to assess your risk for a particular disease, aid in diagnosis, determine what tests to order, and identify a condition they might not have considered previously. They will be also able to recommend lifestyle changes to reduce your risk of developing certain health conditions or diseases. Some common proactive measures you can take to reduce your risk for future health problems include maintain a healthy weight and diet, exercise regularly, refrain from smoking, reduce alcohol intake, and see your doctor regularly.

Disease	Diagnosis
<p>Obesity – occurs when you have too much body fat for your height. It occurs gradually over time as you consume more calories than you use during the day. Obesity may trigger other diseases such as cardiovascular disease, diabetes, arthritis, stroke, gynecologic problems, and some cancers. Losing 5 - 10% of your starting weight can dramatically improve your health.</p>	<p>Ask your doctor to calculate your Body Mass Index (BMI). An adult is considered obese when the BMI is greater than 30. Another method to determine obesity is to measure your waist circumference. Using a tape measure, snugly measure around the waist. Adult men should not have a waist circumference greater than 40", women should be lower than 35".</p>
<p>Heart Disease – any disorder that affects the heart's ability to function normally. Coronary heart disease is the number one killer in the U.S., while stroke is #3. Hypertension (high blood pressure) and atherosclerosis (fatty materials build up along the walls of the arteries causing them to become blocked) are called "silent killers" because there are typically no symptoms. High blood pressure causes your heart to work harder to pump blood throughout your body and atherosclerosis blocks blood for reaching vital parts of your body, such as the heart, brain, and kidneys.</p>	<p>Your doctor will monitor your blood pressure and cholesterol levels. Blood pressure is measured by your systolic and diastolic rates. A normal reading is 120/80. High blood pressure is anything above 140/90. If the systolic rate is between 120-139 and the diastolic rate is between 80-89, you are considered pre-hypertensive. Symptoms of a heart attack include difficulty breathing, chest pain or discomfort, pain or discomfort in the upper body, extreme fatigue, nausea, light headed or dizzy, rapid and irregular heartbeats. If you experience any of these symptoms for more than 5 minutes, immediately dial 9-1-1, as you may be experiencing a heart attack.</p>
<p>Diabetes – a metabolic disease where the body has trouble regulating its blood glucose or blood sugar levels. Your body uses glucose as its main source of fuel with the help of a hormone called insulin. Insulin cells, located in the pancreas, act like a key to unlock the body's cells so glucose can enter the cells and serve as fuel. There are two types of diabetes. Type 1 (childhood diabetes) develops when the body's immune system destroys the pancreatic beta cells that make insulin. Type 2 diabetes develops from insulin resistance when the body cannot make enough insulin. Type 2 diabetes used to be diagnosed in only adults but is becoming more common in adolescents as a result of obesity. Diabetes can damage your eyes, kidneys, and nerves. It can cause heart disease, stroke, and loss of a limb.</p>	<p>Symptoms of diabetes include fatigue, extreme thirst, unexplained weight loss, blurred vision, and frequent urination. Your doctor will perform a blood test to measure the amount of glucose in your blood.</p>
<p>Cancer – a term for a range of diseases where abnormal cells divide without control, and the ability of those cells to invade other tissues is called metastasis. There are more than 100 forms of cancer. One out of every four deaths in the U.S. is due to cancer, making it the second leading cause of death. Half of the men and one third of women in the U.S. will be diagnosed with cancer in their lifetime.</p>	<p>A doctor will discuss with you your family history and any symptoms you may be experiencing. The tests that may be performed during diagnosis vary. Some cancers may be detected through a simple blood test, while other types require x-ray or more invasive tools.</p>

Your Family History

A recent study showed that Americans believe knowing their family healthy history is important, yet only one-third of Americans have actually gathered this information from their family members. The U.S. Surgeon General has created a website to help you keep track of your family history at <https://familyhistory.hhs.gov/>.

When you begin to research your family history, it's important to explain why you are asking personal questions about their health and assure them that you will protect their privacy. If possible, try to obtain three generations of health history. Ask your family members their birthdates, about any diseases/conditions and the age of onset, and about deceased relatives' ages and cause of death. The most important part of the process is sharing your family history with your doctors. Make sure you keep a copy of your family history for your personal records and update it every few years.

Treatment

Losing weight is a slow and steady process. You should not lose more than 3/4 to 2 pounds per week. You are more likely to lose weight quickly in the beginning. Ask your doctor to help you develop a step program that you can maintain over time. (Example: if you want to lose 20 pounds, your initial goal is 3/4 pound/week. After a few weeks, you can increase weight loss to 1 pound/week.)

Since heart disease is a slow and progressive disease, the first step in treatment is making lifestyle changes. A low-fat, low-sodium, high-fiber diet, regular exercise, reduce alcohol consumption and not smoking greatly reduces the progression of the disease. If diet and exercise alone are not effective, your doctor may prescribe medication to reduce cholesterol and blood pressure. Surgical procedures, such as stents and bypass surgery, are other options to treat blocked arteries.

All diabetics must regulate their diet and exercise to control their disease. Diabetics should eat low-fat, high-fiber, low-sodium diets. They may have sugar in their diet but the key is moderation. Insulin dependent diabetics must check their blood sugar levels many times a day to determine how much insulin they need to control their blood sugar and then inject themselves with the proper dosage. Some diabetics can control their disease with oral medications. If diabetics maintain good blood sugar control, they can minimize the harmful side-effects or avoid them for many years.

Cancer is treated through surgery to remove affected cells, chemotherapy, radiation therapy, and an extensive variety of medications. The approach to treatment is based on the type of cancer, location, and the progression of the disease.

Research

Because obesity is a major risk factor for type 2 diabetes, identifying genes that affect type 2 diabetes holds promise for the detection of individuals at risk, as well as for potential prevention and treatment methods. Mice may provide a valuable tool for identifying genes that regulate body fat. Once these genes are identified, they can be used to develop anti-obesity therapies by targeting the human protein products of these genes. Laboratory primates help researchers study age-related obesity.

Researchers are investigating the root causes of heart disease that may someday bring about preventive measures. More work is needed to learn about the role that cholesterol, hormones, and various dietary substances play in the role of heart disease. Through research with laboratory animals such as rats, rabbits, cats, and mice, scientists have been able to better understand the progression of the diseases and develop new medications to treat hypertension and atherosclerosis.

Although there is no cure for diabetes, over the years researchers have found ways to better control the disease and to lower the risk of complications. Devices like the insulin pump and better blood-testing tools are some of the results of biomedical research. Diabetes research has also included successful transplantation of islet cells (cells that produce insulin) into rats with diabetes, resulting in a cure for the disease in small animals. Scientists are working to translate this procedure for use in humans. There are two potential cures for human patients with diabetes: a pancreas transplant or implanting an artificial pancreas. Future developments may result in an insulin patch, implantable insulin pumps, and a cure based on diabetes-associated stem cell research.

Cancer researchers believe that cancer can be triggered by many factors, such as genetics, diet, lifestyle, occupation, and environmental factors. Various new approaches to cancer treatment are under investigation. Scientists use animals to investigate the causes of cancer, test new treatments, search for and work with new screening and diagnostic tools, and conduct molecular studies that may have a link to cancer. Researchers are looking for ways to destroy cancer cells and to interrupt the growth and spread of cancer cells without harming healthy cells, such as curing some forms of cancer by blocking the blood supply of tumors based on recent success in studies using mice.

Be Proactive

1. Set specific, attainable, and forgiving goals for yourself. Determine how much weight you want to lose in a year and break it down into a weekly goal.
2. Develop an exercise regimen. If you don't like sports, you can go for a walk, do household chores, dance, etc. Exercise for at least 30 minutes, 3 times a week.
3. Decrease your calorie intake. Eat more fruits, vegetables and whole grains, drink more water and watch the sugar. Watch what you drink - beverages can be high in calories.

It is important to discuss with your doctor your family history of heart disease (including hypertension and atherosclerosis). Because there are no obvious symptoms, the only way to know you have the disease is to be regularly tested. Talk with your doctor about taking a low dose aspirin daily and/or vitamin supplements. Maintaining a healthy lifestyle is very important to reduce your risk.

In order to reduce the risk of developing diabetes, it is very important to control your weight, maintain a healthy diet low in sugar and exercise 3-5 times a week for 30 minutes. Research has shown that by losing 5-7% of your body weight, you can either prevent or delay the onset of diabetes. Also, reducing soda intake will help reduce the risk of developing diabetes. Studies have shown that one can of regular soda a day increases your risk by 60%!

To reduce the risk of developing cancer, maintain a healthy weight and a low-fat, high-fiber diet, exercise regularly, do not smoke, and reduce alcohol intake. You should visit the doctor yearly for a physical and discuss any changes to your health. Breast cancer affects 1 out of 8 women in the U.S. and is the second most deadly disease for women after lung cancer. Women should perform a self-breast exam approximately the same time every month. Your doctor may recommend getting a mammogram to look for cancer cells if breast cancer runs in the family. Testicular cancer affects young men between 20 and 39. Men should perform self-testicular exams every month.

INFECTIOUS DISEASES

An infectious disease results from the presence of **pathogens** like viruses, bacteria, fungi, and protozoa within a living system. Unlike genetic diseases, an infectious disease is transmitted from an outside source. This transmission can occur in a number of different ways: respiratory diseases like the flu, tuberculosis, and meningitis are commonly acquired through contact with aerosolized droplets, spread by sneezing, coughing, talking, or kissing (hence the common name of mononucleosis as “The Kissing Disease”). Most of us have immunities to many infectious diseases (like mumps, measles, polio, and tetanus) due to vaccinations.

Other infectious diseases are often transmitted and acquired by eating or drinking contaminated food and water. Some infectious diseases may also be spread as a result of contact with a contaminated object like used hypodermic needles,

Disease	Pathogen	Transmission	Symptoms
Food Borne Illness – every year more than 76 million people experience a food borne illness or food poisoning. There are more than 250 known food borne illnesses.	Various bacteria, viruses and parasites	Food may be contaminated during the production process through water or unclean surfaces. Improperly prepared food or food left standing at room temperature for more than two hours increases the risk of developing a food borne illness.	Symptoms can occur just a few hours after eating and include upset stomach, abdominal cramps, fever, nausea, vomiting, diarrhea, and dehydration. Dehydration symptoms include becoming dizzy upon standing, dry mouth or throat, and decrease in urination.
Athlete’s Foot – a very common infection that affects most people at least once in their lives. It most often is found between the toes but it can spread to the sides and soles of the feet.	Fungus	This highly contagious infection is often transmitted in locker rooms, public showers, and gyms.	Itching, stinging or burning between the toes or on the soles of the feet, itchy blisters, cracking and peeling skin on the soles of the feet or between the toes, nails that are thick, crumbly, discolored and are pulling away from the nail bed, and excessive dryness on the soles and bed of the feet.
HIV/AIDS – Human Immuno-deficiency Virus or HIV is the cause of AIDS (Acquired Immunodeficiency Syndrome.) It weakens the immune system to the point that the system has difficulty fighting off infections that a healthy immune system could easily control. AIDS is usually referred to the later stages of the HIV infection. HIV also directly attacks organs such as the kidneys, heart and brain, leading to acute renal failure, disease of the heart muscle, dementia, and degeneration of brain function.	Type of virus called a retrovirus	HIV is transmitted from one infected person to another through blood, semen, vaginal fluids, and breast milk. Activities that permit HIV transmission are unprotected sexual contact, direct blood contact with infected needles and sharp objects (IV drug use, tattoo and body piercing instruments, and blood transfusions), and mother to baby either before or during birth and breast milk.	Two to six weeks after acquiring HIV, some people experience symptoms that are similar to other types of infections, such as fever, headache, and swollen glands. Generally, the symptoms come and go for a few months after infection. Even if you do not have any symptoms, you can still pass the infection on to other people. As the virus reproduces in your body, you may develop other symptoms such as a chronic cough, diarrhea, shortness of breath, and weight loss. Once the viral load increases and destroys white blood cells that help the body fight infection, the immune system is unable to fight off other opportunistic infections. When someone has more than one of these infections and has a low T-cell count, they have AIDS.
Tuberculosis (TB) – an infectious disease caused by the bacterium <i>Mycobacterium Tuberculosis</i> (MTB). TB is most common in the lungs (pulmonary TB) but can also affect the central nervous system (meningitis), lymphatic system, circulatory system (miliary TB), genitourinary system, bones, and joints. The World Health Organization (WHO) states that nearly 2 billion people, one-third of the world’s population, have been exposed to the tuberculosis pathogen and it is one of the four most fatal infectious diseases in the world.	Bacteria	TB is spread by aerosol droplets expelled by people with active TB disease of the lungs when they cough, sneeze, speak, or spit. Transmission can only occur from people with active TB disease. A person with untreated, active TB can infect an estimated 20 other people per year.	TB symptoms include a bad, persistent cough that last more than 3 weeks, weight loss, coughing up blood or mucus, night sweats, fever and chills, and fatigue.

toilet handles, etc. That's why washing your hands is so important! Other diseases like West Nile or malaria involve a "vector" like a mosquito which transmits a disease from one person to another via bites, or a housefly that can pass a disease by landing on feces and contaminating its legs with bacteria, then transferring these bacteria to a food product when it lands on it. Practicing careful food storage and preparation can also control the ingestion of pathogens.

According to the World Health Organization, infectious diseases caused a quarter of all deaths worldwide in 2002. Since infectious diseases come from outside sources, most can be prevented. A healthy body is less likely to become infected after exposure, and good personal judgment and good personal hygiene can eliminate exposure to many infectious agents.

Curable?	Treatment	Prevention	Research
<p>Most cases of food borne illnesses are curable and the body's immune system will fight the infection. However, each year, there are approximately 5,000 deaths as a result of food poisoning.</p>	<p>For most cases, treatment involves increasing your fluid intake and waiting for the source of the infection to pass through the digestive system. For serious illness that includes symptoms such as blood in the stool, high fever, signs of dehydration, and/or prolonged symptoms lasting three days or more, you should seek advice from a doctor.</p>	<p>Keep hot foods hot and cold foods cold. Always wash your hands after using the restroom and before and after handling food. Keep food work surfaces separate. Cooking food to an internal temperature of 160°F will kill most microbes.</p>	<p>Much focus is placed on understanding pathogen transmission and keeping animals used in the food supply uncontaminated. If animals don't become contaminated in the first place, there would not be as much illness in the humans who eat them. Researchers study each pathogen carefully and test various destruction methods, and the effects on human, animal, and plant health.</p>
<p>Often treated with over-the-counter medication. In severe cases, a prescription may be required.</p>	<p>For mild cases, most infections will clear up with an over-the-counter antifungal lotion, spray, powder, or gel. In severe cases, your doctor may prescribe an oral medication to fight the infection.</p>	<p>Always wear foot protection in communal areas, do not wear someone else's shoes, keep your feet dry - especially between the toes, change your socks regularly, and wear well ventilated shoes.</p>	<p>Research studies indicate that athlete's foot is passed from person-to-person through nail and skin contact. Researchers are studying skin cells of family members, looking for a genetic link in the fungal cells. Researchers are also investigating new oral and topical medications to treat the infection.</p>
<p>Currently, there is no cure. However, researchers have discovered that a combination of prescription medications can delay the progression of the virus. People can live with HIV and AIDS for many years.</p>	<p>The number of medications have been developed in the last 15 years to treat HIV/AIDS and the opportunistic infections. Anti-retroviral medications are used for HIV/AIDS. Many of the medications are given in a combination or as a "cocktail." Side effects of the medications can be severe and most are expensive. Your response to the medication is measured by the viral load in your blood.</p>	<p>To reduce your risk of getting HIV/AIDS, do not have unprotected sexual contact - always use a condom with spermicide. You should not have direct blood contact with infected blood through needles and other sharp objects. If using a needle, always use a new needle. Pregnant or nursing women with HIV/AIDS should speak to their doctor about ways to prevent transmitting disease to the baby. Research is being done to develop a microbicide to help protect women from infection during intercourse, but condoms are still the best choice for prevention.</p>	<p>Vaccines have historically been mankind's best weapon against viruses. Scientists study the disease and work toward potential vaccines in many cases with primates because they have a similar strand of the virus, SIV or simian immunodeficiency virus. Several research groups have successfully vaccinated monkeys to reduce the viral load and halt disease progression. This is an important step. If these results can be generalized to humans, vaccines may be used to treat HIV-infected humans.</p>
<p>If not treated properly, TB can be fatal.</p>	<p>To determine if you have TB, your medical caregiver will administer a simple skin test. If you have been exposed to the bacteria, treatment includes taking multiple medications for long period of time, usually six months. It is important to take the medication every day or else the bacteria will remain in the lungs, and you could potentially develop drug-resistant TB.</p>	<p>There is a vaccine for TB but it is not recommended for children in the U.S. because of the low risk of infection. Vaccines should be administered to people at great risk, such as health care workers and children who are continually exposed to TB. If you think you have been exposed to TB, you should immediately see your doctor and be tested. If you or someone you know has TB, it is extremely important that they take all their medication as instructed.</p>	<p>Current research using animal models is underway. Searching for newer forms of antibiotics and effective vaccines, including recombinant tuberculosis vaccine to treat TB and prevent initial infection. The hope is to discover new forms of the vaccines that will eventually eliminate TB but the rise of multi-drug resistant strains of TB (MDR-TB) and the now emerging Extreme Drug Resistance in Tuberculosis (XDR-TB) have significantly hampered this effort.</p>

HEALTH CHOICES

At some point in your life, you have probably heard the saying, “For every action, there is a reaction.” As with many clichés, this one is true. There are consequences to our actions. Some of the consequences are good (i.e. brushing your teeth at least twice a day and prevent cavities) and some are bad (i.e. don’t brush your teeth and you’ll probably get cavities and have bad breath). There is *always* a consequence to our choices and actions. Non-action is also a choice. If you cannot make up your mind about something and procrastinate about making a decision or taking action, you are choosing to do nothing. When we make a choice whether or not to do something, it’s important to consider the consequences first so we make an informed decision. Another cliché is, “Knowledge is power.” Knowing the facts helps you to make smarter decisions. In some cases, knowledge can save your life because it helps you decide whether or not to do something, when to seek help, and what we do in case of an emergency.

Some of the choices we make are very easy and straight-forward (wear comfortable shoes or the uncomfortable ones). Other choices are very difficult and involved, such as choosing to have sex. As with any decision, it’s important to consider the long-term consequences of your choices and actions, not just the short-term. There can be emotional and physical consequences to consider, such as pregnancy and the risk of a sexually transmitted disease (STD), and long-term health issues. There are more than 20 different types of STDs that affect men and women. Most are curable if caught early but if left untreated can cause permanent damage. For example, if you choose to have unprotected sex and you contract a STD, will it affect your ability to have children in the future? What if you got HIV/AIDS?

Action/Choice	Effect On Body
<p>Smoking – Cigarette smoke contains over 4000 chemicals, including 60 carcinogens (cancer causing substances). Many of the chemicals are considered poisonous to the human body, including tar, carbon monoxide, arsenic, and lead. Nicotine, which is found naturally in the tobacco leaf, is addictive. Smoking is responsible for 87% of lung cancer deaths in the U.S.</p>	<p>Smoking is the single most preventable cause of death in the U.S. Smoking harms nearly every major organ in the human body and causes lung cancer, chronic bronchitis, emphysema, heart and blood vessel disease, stroke, cataracts, cancer in the pancreas, kidney, cervix, stomach, bladder, esophagus, oral cavity, and larynx. It causes pregnancy complications and secondhand smoke causes cancer and other diseases in others. It can contribute to an increased risk of Sudden Infant Death Syndrome (SIDS).</p>
<p>Alcohol – Alcohol abuse is when a person engages in excessive drinking that causes health or social problems but is still in control of how much and how often they drink. Alcoholism is when a person is preoccupied with alcohol and they have no control over how much they consume or they feel they can’t quit. Alcoholism is a chronic and often progressive disease, sometimes resulting in death.</p>	<p>Cirrhosis of the liver, liver damage, reduced testosterone in men, high blood pressure, damage to the heart muscle, diabetes, erectile dysfunction, interruption of menstruation, birth defects, neurological complications, gastrointestinal problems, metabolic imbalance and increased cancer risk - especially of the esophagus, larynx, and colon.</p>
<p>Eating Disorders – Eating disorders are serious but treatable medical illnesses that usually start during the teenage years. People with eating disorders are typically women and girls who are obsessed with food and their weight. Depression, anxiety, and substance abuse usually accompanies an eating disorder. Bulimics over-eat and then purge, usually self-induce vomiting or take laxatives. Anorexics do not maintain normal weight. They refuse to eat enough because they think they are fat, exercise excessively and sometimes purge their food. Binge eaters eat out-of-control.</p>	<p>Eating disorders can cause heart problems including irregular heartbeat, weakened heart muscle, low blood pressure, poor circulation to hands and feet, and heart failure, hair loss, kidney problems, metabolic and hormonal imbalance, reproductive risks, increased risk of diabetes and obesity, and death. Malnutrition occurs when there is a lack of sufficient nutrients to maintain healthy body functions.</p>
<p>Street Drugs – Many street drugs are highly addictive and create feelings of euphoria. Addiction is very hard to break. Ceasing to take regularly used drugs and experiencing unpleasant symptoms is called withdrawal. Someone is considered to be addicted to drugs when they have compulsive behavior, such as cravings and seeking of the drugs, despite negative consequences associated with the drug use. Heroin withdrawal symptoms are the some of the nastiest of the street narcotics.</p>	<p>Most street drugs cause increased blood pressure, heart rate, and amnesia and have a high risk of death due to overdose. Long-term use damages the liver and parts of the brain that are responsible for thought and memory. In addition to the side effects associated with each drug, the method of drug use has specific consequences to the body: IV use - increased risk of contacting hepatitis and/or HIV/AIDS, collapsed veins, and infection at puncture site which could travel through the rest of the body. Smoking - a variety of respiratory problems, including lung cancer. Snorting - collapse of nasal septum. Pregnancy: All drugs taken during pregnancy increase the risk of miscarriage and damage to the baby.</p>

In many of life's decisions, our family and friends can influence us. It's important to consider the consequences and make your own decision. Ask yourself: Is this going to affect my health or those around me? Am I going to regret this? Is it worth the risk? Can I go to jail for doing this? Can I die? How will this hurt me in the future? Will this hurt someone else?

More Choices

We make choices everyday that affect our health. Identify an action that people take that affects the body and conduct your own research. Is the effect on the body permanent? Is there a cure? Are there treatments available? What current research is taking place? The following chart provides some examples.



Curable?	Treatment	Research
<p>The longer you smoke, the more damage is done to the major organs of the body. Some of the damage may be irreversible and problems may not be obvious for many years, such as cancer and emphysema.</p>	<p>Many smokers find it very difficult to quit. While difficult, you CAN quit and drastically improve your health. Depression, anxiety, restlessness, and weight gain are some of the symptoms of nicotine withdrawal. Nicotine replacement therapy (nicotine lozenges, patches, gum, etc.) and medications may help with these symptoms. These symptoms will disappear with time.</p>	<p>Lung cancer is responsible for 1/3 of cancer deaths in the U.S. In women, more deaths are attributed to this disease than breast cancer and all gynecological diseases combined. Since early detection is critical to survival, current studies are comparing the best methods for early detection. Other research is developing new medications and treatments for lung cancer.</p>
<p>Alcoholism is treatable but you may never lose the desire or craving for alcohol. Some of the side affects of excess alcohol consumption are permanent, such as damage to the heart muscle and the liver. Your doctors will need to treat those as separate medical issues.</p>	<p>The first step in treatment is determining whether you are alcohol dependent or not. If you are not physically dependent on alcohol, reducing the amount you consume may be adequate. If you are alcohol dependent, total abstinence may be part of your long-term goal. Treatment involves individual and group counseling. If dependency is severe, a residential treatment program may be necessary to manage the detoxification and withdrawal symptoms. New prescription drugs may also be an option to help reduce cravings.</p>	<p>Animals are used in alcoholism research because they can model the drinking behavior of human alcoholics. Researchers learn how brain chemistry leads to drinking behavior and how alcohol affects organs. Studies with rats are exploring the process of alcohol craving, dependency, tolerance and the genetic basis for these phenomena. Nutritional studies with pigs may lead to specific dietary recommendations that can prevent malnutrition and liver disease from chronic alcoholism.</p>
<p>Someone with an eating disorder can get better by working with a team of doctors, nutritionists and therapists. Depending on the severity of the eating disorder, there may be permanent damage to organs and systems of the body, which may not be discovered for years.</p>	<p>A team of doctors, nutritionists and therapists work together to help you develop healthy eating patterns, obtain and maintain a healthy weight and cope with thoughts and feelings. Counseling is recommended to deal with the underlying issues of the eating disorder. Hospitalization may be necessary. Your doctor may prescribe medicines to fix hormone imbalances or treat depression and/or anxiety.</p>	<p>There are many ongoing research studies that focus on the psychological, behavior, and physical effects of eating disorders. One study seeks to identify the similarities in hormone release in the stomach for anorexia and bulimia patients. Since anorexic women are more likely to suffer broken bones and reduced bone strength, research studies are studying whether or not human growth hormone can help repair the damage caused by anorexia.</p>
<p>While it is possible to kick the addiction, some of the side effects of drug abuse may not appear for many years. Withdrawal symptoms are: intense craving for the drug, agitation, depression, extreme fatigue, angry outbursts, panic attacks, insomnia, diarrhea, "itchy blood," severe muscle and bone pain, nausea/vomiting, shaking, irritability, and lack of motivation.</p>	<p>There are many treatment options available but most include a combination of medications and behavior therapy. The long-term goal of treatment is to have total abstinence and the short-term goal is to reduce the amount of drug abuse and the negative consequences. Withdrawal may be severe but not life threatening. The degree of withdrawal symptoms depends on the type of drug that was misused, quantity taken regularly, and the length of time of drug misuse. Drug addiction is a chronic illness and relapses are possible.</p>	<p>There are many ongoing research studies looking at the short and long-terms effect of street drugs on the body. Studies indicate that cocaine mixed with alcohol is the most common drug related death. Treatment options for addiction is a large area of research. Treatment options may include antidepressant medications to behavioral interventions.</p>

Healthy Body

People come in all shapes and sizes. We get bombarded with images from the TV, magazines, and movies but what is normal and healthy? What is too fat or too skinny? How much is too much or not enough food? Do you really need to exercise? What is healthy and what is not? How concerned should you be - *really*?

Fat is necessary for a healthy body because it stores energy reserves for the cells, protects internal organs, and helps regulate the body's temperature. When someone consumes more calories (energy) than the body can use,



extra energy is stored as fat in **adipose (fat) cells**. As the body stores more fat, the fat cells grow bigger and bigger. If a significant amount of weight is gained, the body will produce more fat cells for fat storage. When a person loses weight, they lose the fat inside the cells and they shrink but the number of fat cells stays the same. It's hard to keep weight off because the body has already done the hard work and created the fat cells, which are eagerly waiting to store more fat.

Oftentimes, people step on the scale to determine if they are at a healthy body weight. This is misleading because muscle weighs more than fat. Very muscular people, such as athletes, may weigh more than other people but it does not mean they are unhealthy or obese.

Women's bodies are designed to have a higher body fat percentage than men – about 5% more. Estrogen, a hormone in women's bodies, stimulates cells to store more fat in order to protect the woman and her fetus during pregnancy. Women tend to carry fat in the hips, breasts, waist, and buttocks. If a woman's body fat percentage becomes too low, her body may stop producing the appropriate levels of hormones her body needs. Low hormones can interrupt the menstrual cycle and lead to bone loss. Women's bodies need some fat to work properly. On the other hand, too much fat can lead to obesity and cause an increased rate of cancer and infertility. Men have more lean muscle mass than women and less body fat. When men gain weight, they tend to gain it in the chest, abdominal, and buttock areas.

Hormones & Sleep

The endocrine system regulates your metabolism, growth and controls the reproductive systems, tissue function, and moods by releasing hormones from glands. Without hormones, your body would not know when to perform a certain function. Hormones are chemicals that travel through the blood vessels from cell to cell carrying messages. They tell the cells to perform a particular task.

Sleep is important to managing your weight because lack of sleep triggers the body to produce a hormone called ghrelin, which stimulates hunger. When you get enough sleep, your body will produce another hormone called leptin, which suppresses your appetite. In addition, lack of sleep can affect how your body tolerates glucose (blood sugar) and how your body stores energy from food.

Sleep is necessary for survival because it allows the body to repair itself. Research studies indicate that a loss of a few hours of sleep cause reduced cognitive ability and difficulty performing tasks. Long-term sleep deprivation weakens the immune system, increases the risk of cardiovascular disease, impairs motor skills, suppresses growth hormones, and disrupts hormones that regulate metabolism and appetite, which can lead to obesity and diabetes. Studies with rats have shown that their neurological processes are disrupted and they die if deprived of sleep for more than 17 hours.

During the next week, keep track of how much sleep you get each night and what you eat and drink and how much during the day. Did you get tired during the day? Did you eat because you were hungry or because you were feeling sleepy? What did you learn from tracking your sleep and food intake?

Your Role in Having a Healthy Body

Choosing to have a healthy lifestyle can be very challenging because you have to make constant decisions. Some decisions are easier to make and follow through with than others. During the day, try to remember the following tips:

- **Exercise regularly.** Physical activity is important in building healthy bones and joints, improving the health of the heart, lungs, and muscles, and reducing the risk of disease such as colon cancer and diabetes. It also reduces stress, anxiety, and depression. You should exercise for at least 30 minutes 3-5 times per week.
- **Don't smoke.** Smoking is the single most preventable cause of death in the U.S. Smoking harms nearly every major organ in the human body and causes a variety of disease, including lung cancer. The longer you smoke, the more damage is done.
- **Always wear a seat belt.** Car accidents are the leading cause of death for adolescents and the number one cause of head and spinal cord injury. Buckle up every time you get in the car.
- **Always wear sunscreen.** Skin cancer is the most common form of cancer in the U.S. and the incidence rate is increasing in people under 50 (including teens.) Studies have shown that wearing SPF 15 sunscreen or higher may help reduce the chance of developing skin cancer by 40%. Check your skin regularly for any changes in the size, shape, color, or feel of birthmarks, moles, or spots. Report any changes to your doctor. Stay out of the sun when it is at its strongest (10AM-4PM). Wear a hat and sunglasses with UV protection, and always avoid sunlamps or tanning booths.
- **Get enough sleep.** People need at least eight hours of sleep per day, but most Americans get less. Sleep allows the body to reset itself to optimal performance levels. If you don't receive enough sleep, your body will compensate for that deficiency and will try to get more energy from food by stimulating your appetite.
- **Don't abuse drugs.** Unless your doctor approves or prescribes you a medication, you should not take any type of drug because it may negatively affect how your body works. For example, some drugs may cause memory loss, liver damage, or death, especially if combined with other medications, drugs, or alcohol.
- **Practice good hygiene.** Infectious diseases can spread very easily from one person to another and practicing good hygiene will help prevent the spread of disease. Washing your hands frequently and thoroughly, not sharing a toothbrush or a drinking glass, and coughing or sneezing into the crook of your elbow instead of your hands, is enough to prevent the spread of a cold or other illness.
- **Eat nutritious foods.** You need to eat enough so your body has enough energy for the day's activities but consuming extra calories will not give you extra energy. When you have low energy, eat a piece of fruit, crackers, or cheese instead of candy, a brownie, or soda. While your body will metabolize the sugar in candy faster, blood sugar levels for energy will plummet faster so that you will "crash" faster. Eating a piece of fruit or crackers takes longer for your body to metabolize and will give you energy for a longer length of time.
- **Dieting.** Many popular diets are misleading and can be very dangerous. Your body needs carbohydrates, proteins, and fats (healthy fats in small amounts) to work properly. Nutrients are in food and avoiding one food group (example: carbohydrates) or not eating anything at all can be very damaging to your body. Your body relies on various nutrients to maintain blood chemistry, the health of your bones, immune system, and organs. For example, your body converts carbohydrates into glucose, which your brain uses for energy. If you eliminate carbohydrates from your diet, your body will break down protein (muscle) to feed the brain, resulting in muscle loss and a weakened body. To lose weight safely, you need to moderately reduce your calorie intake (no more than 25% of your total calorie intake) and exercise 30 minutes three to five times a week.
- **Don't use steroids.** Bodybuilders and athletes often use anabolic steroids in high doses to build muscle mass and improve athletic performance. The side effects vary from very minor to very serious, including death. Research studies indicate that steroid use in adolescents may stunt growth because the bones are still growing. Long-term research shows that many of the effects of steroid use do not appear until later in life, such as cancer and heart disease.

Famous People

In the U.S., the physical appearance of famous people receives a lot of attention. Identify three famous people that you think are under-weight, over-weight, and at a healthy weight. Why did you identify these people? Did you notice any trends? Are they male or female? Are they young or old? How does the media perceive these people?

Scientific Inquiry

What is science? Science is asking and seeking answers to questions about the world and about our bodies. The knowledge that scientists have gained over the centuries is like a stack of building blocks because they are able to ask harder and harder questions as they learn. For example, when you were beginning to read, you struggled with the alphabet. After you mastered the alphabet, you began to read sentences, then paragraphs, and eventually books.

Scientists are curious and creative. Scientists are also very observant and skeptical. When scientists address a new question, they use their knowledge and experience to look at the question from different perspectives. They interact with each other; ask lots of questions; and perform experiments in their search for answers. By asking questions and trying to find answers, scientists have learned much about how the human body works, to treat the sick, make new medications, develop medical devices like pacemakers or prosthetic limbs, and perform new surgical procedures, etc.

Sometimes, scientists will ask a question about one thing and find an answer to a completely different question. For example, a drug that was developed to treat Alzheimer's disease has been proven to kill breast cancer stem cells in laboratory studies. This investigational drug may someday be used in the battle against breast cancer. (The American Cancer Society estimates that in 2008 there will be 182,460 new cases of invasive breast cancer (Stages I-IV) among women in the U.S., with 40,480 deaths.) In Canada, researchers found that when sildenafil (the active ingredient in Viagra) is given to mice that have a rodent version of Duchenne muscular dystrophy (MD), it improved their heart performance. More research needs to be done, but some day patients suffering from MD may be given sildenafil to prevent or delay the development of heart failure, a common cause of death among patients with muscular dystrophy.

Science starts with curiosity and by asking questions, which leads to research and experiments. Scientists follow the **Scientific Method**, a universally accepted process familiar to scientists all over the world. Other scientists, who may live on the other side of the world and speak a different language, can still verify the results. If everyone follows the same steps, there is consistency in the procedures and in the results. The Scientific Method is practiced in all fields of science: astronomy, biology, anthropology, geology, etc.

The generally accepted steps for the Scientific Method are:

1. Have a question that you want to answer
2. Determine what you already know
3. Begin your investigation by observing and recording the results (**Observation**)
4. Create a hypothesis or a possible answer to your question (**Hypothesis**)
5. Perform an experiment to see if your hypothesis is correct and record the results (**Experiment**)
6. Analyze the data you have gathered from your observation and experiment and try to identify patterns or trends that might exist. Was your hypothesis correct? If you don't have enough information to make a conclusion or answer your question, you may have to modify or repeat your experiment. Many scientists will make or revise their hypothesis based on the results of their experiment. (**Data Analysis & Conclusion**)
7. Scientists share the results of their scientific investigation with other scientists and the community through scientific journals, conferences, and the media. They will also share their data and procedures with other scientists to either verify their results and/or to help find a solution to a common question such as finding a cure for Alzheimer's disease. (**Share Results**)

Scientists conduct biomedical research when they ask questions about living systems (the body) and the causes of diseases and chronic conditions in humans and animals conduct biomedical research. They expand the available knowledge (the building blocks) to discover new ways to prevent sickness and poor health. Scientists also develop beneficial products, medications, and procedures to treat and cure diseases and conditions that cause illness and death in ourselves, our families and friends, our pets, farm animals, and wildlife.



Biomedical research and development is very lengthy and costly process because there are many phases or levels to the research. People in the biomedical research field say that research goes from the “Bench top to the Bedside” which means that it begins in a laboratory, working with single cell organisms like bacteria or cell cultures, and ends at the patient’s bedside. Experiments with bacteria, cells, tissues, and organ cultures are done in laboratories and is called **in vitro research**. **Ex vivo research** is experimentation done in or on living cells or tissues taken from an organism and cultured in a laboratory, outside the organism. The living cultured cells serve as models of the whole organism, reducing the need for **in vivo research**, which are experiments performed in or on the living tissue of the whole body. **Pre-clinical** trials and clinical trials are examples of **in vivo** research. Pre-clinical trials involve animal models that assist researchers in furthering knowledge about more effective methods for diagnosing, treating, and curing diseases that affect humans and animals. Animal models are critical because they help scientists evaluate efficacy (how effective a new drug is) and safety (what are the side-effects). Animals are biologically similar to humans and are susceptible to many of the same disease and health problems, the U.S. government requires that researchers conduct pre-clinical tests with animals during the more advanced stages of biomedical research before new drugs, devices, and treatments are allowed to be tested on humans during clinical trial phase. **Clinical trials** take place in a hospital or clinical setting, and involve informed human volunteers to gauge the safety and effectiveness of drugs, procedures, or medical devices. Human studies can only begin after exhaustive studies and regulatory evaluation, including pre-clinical trials, have been conducted.



Every major medical advance in the past century has depended upon animal research. The list is almost endless, but some examples are:

- Vaccines against polio, diphtheria, mumps, measles, rubella, and smallpox
- Open heart surgery and the development of artificial blood and blood vessels
- Kidney, liver, heart, lung, and pancreas transplantation
- Antibiotics, anti-depressants, and medications for ulcers, mental illness, arthritis, asthma, epilepsy, and high blood pressure
- The use of insulin to treat diabetes
- Medications to control asthma
- Treatment for many forms of cancer including leukemia, lymphoma, breast cancer, and Hodgkin's disease
- Advances in vaccines and therapies for HIV/AIDS

The government and the biomedical research industry make sure that research requiring animals is very closely monitored and is done humanely. Veterinarians look after the animals and make sure that they are being properly cared for. Good animal care is necessary for good science to happen. The majority of animals needed for scientific discovery are rats, mice, and other rodents that are bred specifically for laboratory research and have never lived outside the laboratory. Researchers avoid the use of animals in research whenever possible and continue to search for and use alternatives methods whenever possible. They practice the **3Rs (Reduction, Refinement and Replacement)**. Reduction refers to methods that result in fewer animals being used to acquire the needed information. Refinement concerns the manner in which the animals are used and includes more effective anesthetics, enrichment activities for the animals, and species appropriate housing. Finally, replacement means using research methods that don't require an animal, such as computer models.

Biomedical research is a growing and never-ending area of study. As scientists learn more about how the body works, how diseases interact, etc., some questions are answered, but new questions and new areas of inquiry just as quickly arise. Science builds upon itself. For example, a hundred years ago, scientists were learning about how arteries worked, now scientists are developing drugs that will prevent arteries from clogging and are exploring the possibility of artificial arteries.



Perform an Experiment

Listed below are steps for an experiment that you can do on your own or with a partner:

1. Using a marker, divide a cutting board into six equal sections and label them #1-6. Using gloves, wipe a piece of lunchmeat all over the surface of the cutting board, wiping evenly. Leave out over night.
2. Using 6 containers with lids, fill with sterile bottle water, 10% bleach mix (mix 1 part bleach with 9 parts water), 70% rubbing alcohol (mix 7 parts rubbing alcohol with 3 parts water), Lysol, antibacterial soap, and Pine-Sol.
3. Predict which disinfectant will work the best.
4. (Using a clean cotton ball each time), cleanse each section of the cutting board with each of the solutions.
5. Using a new clean cotton ball for each section, swipe each section and then wipe on a clean agar gel Petri Dish. Label and cover each Petri Dish and place in a warm place for 2 days until bacteria colonies are visible.
6. Count the number of colonies on each Petri Dish and record your observations. If you have a digital camera, take a picture of each dish.
7. Graph your results and compare the different disinfections.
8. Compare your predictions with your original conclusion with what actually happened.

Biomedical Research Careers

Depending on your interests and the field of science you like best, there are many career options in biomedical research! It is a huge field and requires a team of people that come from different backgrounds and specialties. Such a team might include medical doctors, veterinarians, computer scientists, statisticians, engineers, research technicians, and a variety of scientists working together to study the biological processes of diseases in order to develop an effective treatment or possible cure.

Just as careers in biomedical research cover a wide range of positions and fields, jobs can be found around the world in a variety of work environments. There are positions in research corporations, biotech firms, colleges and universities, pharmaceutical companies, hospitals and medical schools, military and government agencies, veterinary schools, non-profit associations, and voluntary health organizations.

Learn More about Biomedical Research

Knowing more about biomedical research can help you choose the specific area of your future career! Conduct your own research on the Internet. Some key words that will help you with your online search are: **life science careers, biomedical research careers, biomedical research, medicine + research, laboratory animal science, preclinical research, drug development process, or biotechnology.**

If you are interested in a career in biomedical research, what should you do to prepare? For some research positions, you can start right out of high school, while others need specific training, certification, or a college degree, and still others require education beyond the four-year college degree. Whether you plan on a career right out of high school, or a career that requires a college or an advanced degree, make sure you have good grades, a strong background in the sciences and math, and good writing and communication skills. Visit the California Society for Biomedical Research's (CSBR) career page (www.ca-biomed.org/csbr/careers.php) to learn more about specific jobs, level of education needed, and activities to prepare you for a career in biomedical research.



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