KGI KECK GRADUATE INSTITUTE

Science from Home: Workbook for Kids

GRADES 4–8

Developed by Keck Graduate Institute (KGI) students who lead the annual PharmCAMP event.

PharmCAMP is an interactive program designed to introduce students to careers in pharmacy, as well as other science and healthcare fields. This workbook was created to help students explore science through a series of activities from home. Happy learning!

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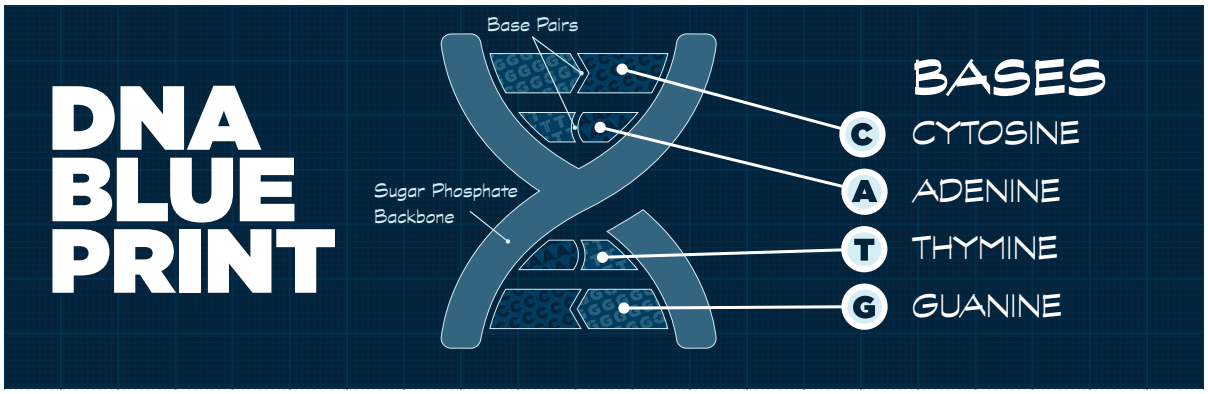
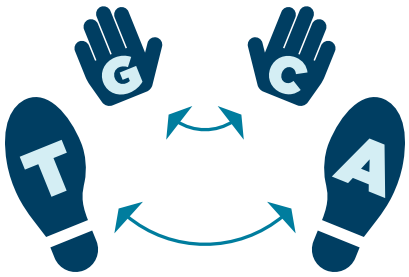
What's up with DNA?

Introduction

Humans have trillions of cells, which together make all of the organs and systems in our bodies. Nearly all cells in the body contain their own copy of DNA. DNA can be found in the center of our cells within the nucleus—a small container that protects the DNA from any harm. Think of DNA as a blueprint that stores codes with instructions for the whole body, so you would certainly want to keep it safe from any damage! The structure of DNA is called a "double helix" because it is composed of two strands, connected to each other.

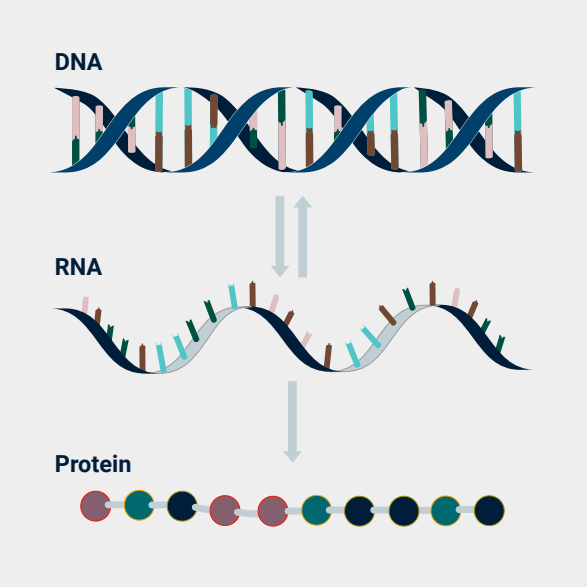


The way the two strands connect is through "bases" which are similar to "letters" in words and sentences. There are four chemical bases that make up DNA. These are thymine (T), adenine (A), guanine (G) and cytosine (C). As the two strands come together, there is always an A opposite a T, and a C opposite a G. It is like your left hand only liking to be opposite your right hand, and your left foot wanting to be opposite your right foot!



The DNA in the nucleus of every cell has about 3,000,000 bases included in 23 separate pieces called "chromosomes." But the information needed to be of use in the cells is a tiny fraction of the whole. In order to get the information from the protected place inside the nucleus, there is a mechanism to "read" the sequences of short portions of DNA, and to provide this information to molecules that act as messengers, and are appropriately called Message RNA (or mRNA). The messenger "reads" a portion of the DNA, transports this information out of the nucleus, and then is used as the basis of a complex process to make proteins. It is the proteins that do the actual chemical work (enzymes), provide much of the structure we have in our bodies (membrane

proteins), transmit information around our bodies (hormones), and fight disease (antibodies).



Proteins are made from about 20 different amino acids that we either make or are in our food. They can be assembled in an enormous number of combinations so that they can have a wide variety of functions. Amino acids are like LEGO™ building blocks—depending on how you put them together, they can form different things such as a house or a car. But it is important to remember that the basic instructions were stored in the DNA, brought outside of the nucleus by a messenger (mRNA) and used as a roadmap to make any of thousands of different proteins.

Activity: DNA Build

Click on the link to participate in this hands-on activity!

https://www.teachengineering.org/activities/view/cub_biomed_lesson09_activity2

What is DNA?

DNA is a molecule that carries the genetic information, or genes, of living things (like you).

These genes determine all of your characteristics by directing cells to make proteins, which determine traits.

DNA has a double helix shape, which is like a ladder twisted into a spiral. The 'rungs' of the DNA ladder are each made of two bases, one base coming from each leg.

When DNA is copied this is called DNA replication. When DNA is copied, mistakes are sometimes made—these are called mutations. Mutations may be bad for the organism, or neutral, or of benefit.

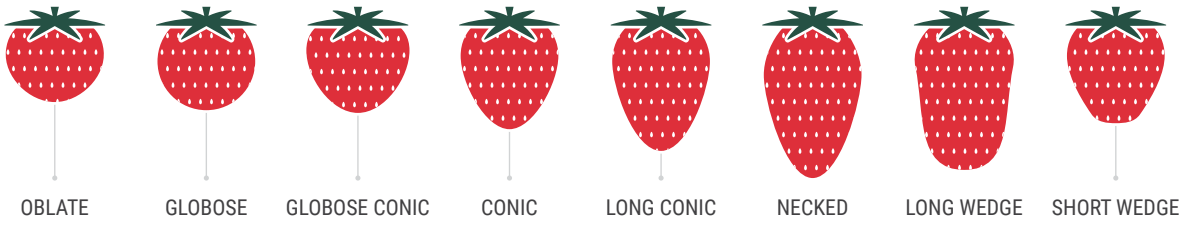
Why do scientists study DNA?

Scientists study DNA to figure out how the instructions stored in DNA help your body to function properly. They can use DNA to make new medicines, genetically modify foods to be resistant to insects, and identify the suspect of a crime by isolating DNA from things left at a crime scene such as hair strands or even fingerprints. They can even use ancient DNA to reconstruct evolutionary histories.

Scientists also study DNA to learn more about other genetic-based diseases and to develop potential new drugs (including gene therapy) to fight these diseases.

Did you know that all living organisms have DNA? Let's extract the DNA from something you have probably eaten–strawberries! Similar to us, strawberries come in all shapes and sizes, which is termed a phenotype. A phenotype is an observable characteristic that is determined by DNA. Look at the many shapes and sizes of the strawberries below. While the vast majority of the DNA sequence of every strawberry is pretty similar, a change in a specific sequence—even resulting in the change of a single protein sequence—can have an effect that you can see.

Strawberries have eight genetically controlled shapes, ranging from the squatty Oblate, round Globose, slightly elongated Globose Conic, heart shaped Conic, Long Conic, Necked, Long Wedge with a slightly flattened bottom, to the Short Wedge that is a squatty wedge.



Activity: DNA extraction

WHY: By extracting and visualizing the strawberry DNA, you will get to see just how large the DNA molecules are and gain an understanding of the vast amount of information contained in DNA.

You will make your own DNA extraction kit from household materials and use it to purify DNA from strawberries.

During DNA extraction, a detergent causes the cell to pop open so that the DNA is released into the liquid solution.

Salt is added to the liquid solution to make the tiny strands of DNA clump together.

After alcohol is added, the DNA can be taken out of the solution.

Materials:

- Gloves (optional)
- Goggles (optional)
- 1 medium strawberry OR ½ large strawberry
- Ziploc bag
- Cheesecloth or coffee filter
- Plastic cup
- Rubber band (to hold cheesecloth or coffee filter)
- Rubbing alcohol (90% isopropanol or higher)
- Salt
- Dishwashing liquid
- Water
- Measuring spoon
- Tweezers (optional)
- Plastic cup
- Rubber band (to hold cheesecloth)
- Rubbing alcohol
- Measuring spoon
- Tweezers (optional)

Pre-experimentation preparation

Chill the rubbing alcohol by either placing the bottle on ice or in the fridge for at least four hours (or overnight) before starting the experiment.

Mix one-half teaspoon of salt, one-third cup of water, and one tablespoon of dishwashing liquid in a glass or small bowl. Set the mixture aside. This is your extraction liquid.

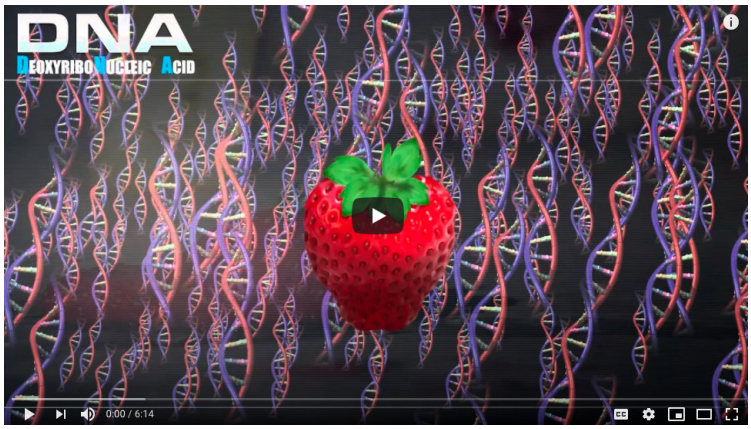
Place cheesecloth (or filter) over the top o a plastic cup, using a rubber band to hold the cheesecloth in place.

[USE PICTURE THAT JENNIFER HERNANDEZ SENT HERE]

Instructions

1. After putting on your goggles and gloves (optional), place the strawberry into the Ziploc bag along with the extraction liquid. Remove as much air from the bag as possible and seal the bag.
2. Gently mash the strawberry in the sealed bag with your fingers for about 5 minutes to form a mush. Try to avoid forming soap suds and tearing the bag.
3. Open the bag and carefully pour the mush onto the cheesecloth, holding down the cheesecloth with one hand, and gently pat down the mush using a spoon with your other hand to strain the liquid.
4. Carefully remove the cheesecloth from the cup and dispose of the strawberry solids left on top of the cheesecloth along with it.
5. Have a parent help you pour 10 mL (2 teaspoons) of COLD rubbing alcohol into the strawberry liquid inside the cup.
6. Observe what happens! (Do not shake the cup—keep it as still as possible).
7. GENTLY swirl 1–2 times using a spoon or chopstick.
8. The solid that forms in the liquid is DNA! Carefully spoon out DNA or use tweezers.

DNA Extraction Video: `bit.ly/DNA-extraction`



Did you know?
Genetic counselors and genomic data scientists are two jobs where you can study DNA every day! Visit page 35 for a list of recommended courses to take in high school and college to lead to this career path.

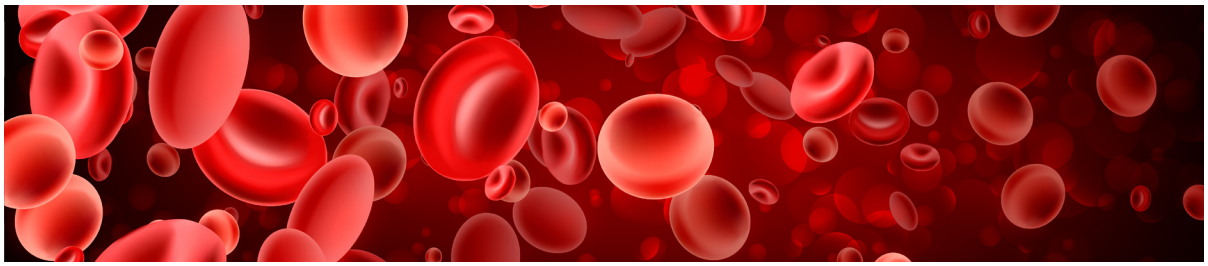
We'd love to celebrate your progress!

Snap a photo and use `#KGIworkbook` so we can share your activity.

Getting Air: Oxygenation via Blood and Lungs

Introduction

Blood is made up of several types of cells.



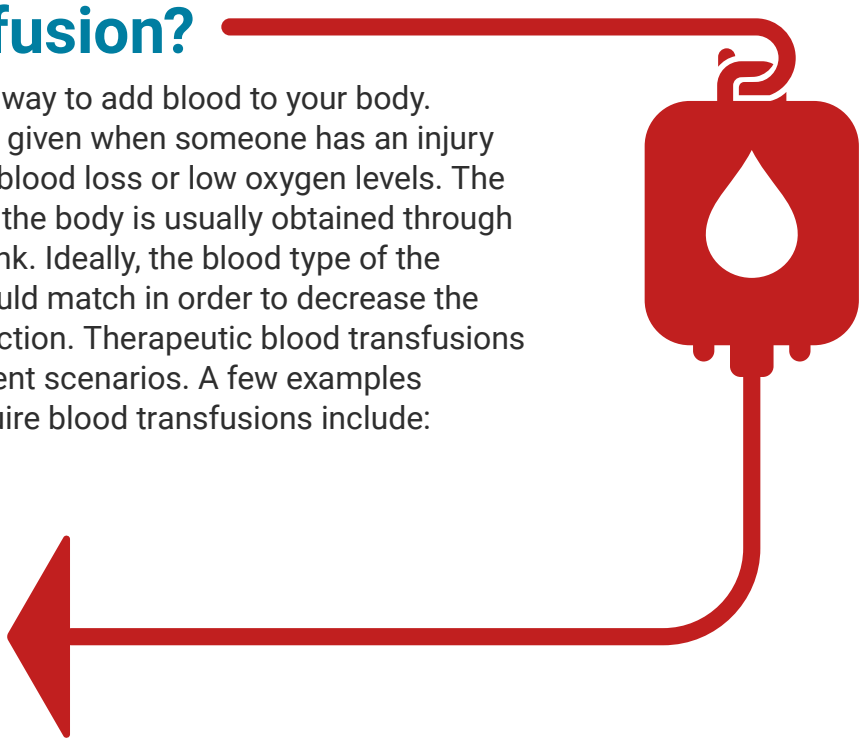
Red blood cells (also called erythrocytes) transport oxygen to other cells in the body. Our lungs breathe in oxygen from the air. Red blood cells contain a protein called hemoglobin, which carries oxygen. The oxygenated blood (blood carrying oxygen) is pumped to the rest of our body through our heart. Our muscles and organs (including your brain) need oxygen in order to function. Both the heart and lungs work together to help transport the red blood cells carrying oxygen to our body.

Red blood cells contain proteins on the outside of the cell called surface proteins. These proteins carry antigens, which distinguish a specific blood type or group. There are 4 different human blood types: A, B, AB, and O. Blood type A contains A antigens, blood type B contains B antigens, blood type AB contains both A and B antigens, and blood type O does not contain either A or B antigens. When a person donates blood, the recipient has to be given the right type of blood to make sure that they do not have antibodies against antigens in the donated blood. Type AB blood contains both A and B antigens and is commonly called the “universal recipient” since it does not have antibodies against either antigen A or B. Type O blood does not have any antigens on its surface. In addition, the body recognizes Rh (Rhesus) factors, which is another group of surface antigens. A person that is Rh positive contains the main Rh surface antigen. Rh negative refers to someone that does not have the Rh antigen. Together A and B antigens and the Rh factor helps to identify your specific blood type. Because it does not have A, B, or Rh antigens, O negative blood is sometimes called the “universal donor” because it can be given to anyone, regardless of blood type.

The diagram below illustrates which types of blood could be given to recipients with the four possible blood types in the ABO blood grouping system. Note that recipients with blood type O can only receive blood type O and recipients with blood type AB can receive all four types.

		BLOOD DONOR			
		O	A	B	AB
RECIPIENT	O	✓	✗	✗	✗
	A	✓	✓	✗	✗
	B	✓	✗	✓	✗
	AB	✓	✓	✓	✓

Why would someone need a blood transfusion?



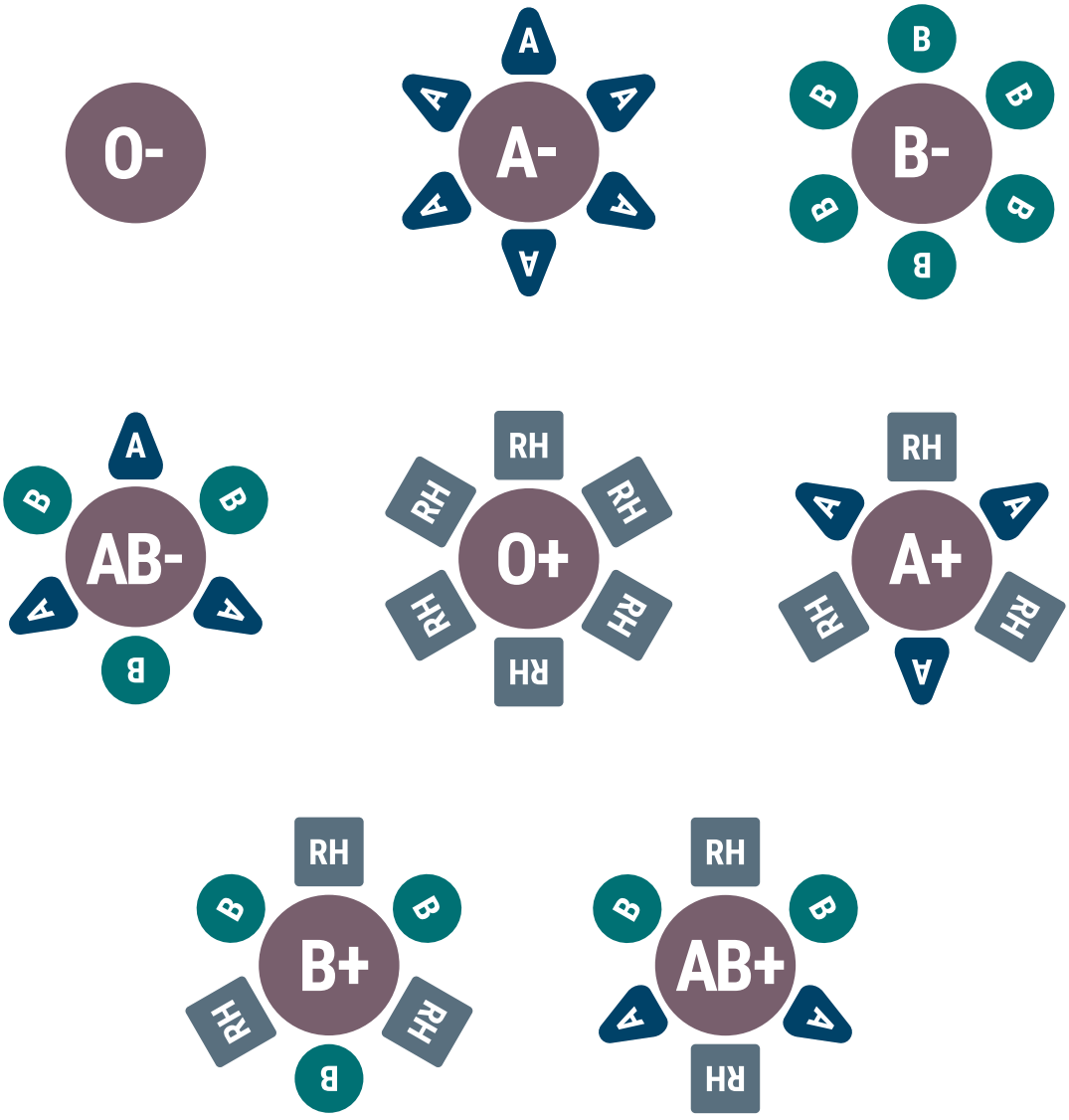
A blood transfusion is a way to add blood to your body. Transfusions are usually given when someone has an injury or illness that results in blood loss or low oxygen levels. The blood that is added into the body is usually obtained through donations to a blood bank. Ideally, the blood type of the donor and recipient should match in order to decrease the chance of a harmful reaction. Therapeutic blood transfusions are given in many different scenarios. A few examples of cases that might require blood transfusions include:

- Anemia
- Sickle cell disease
- Cancer
- Bleeding disorders
- Trauma resulting in blood loss
- Surgery

What happens if the blood doesn't match?

There are different ways in which blood groups can have reactions. A transfusion reaction occurs if blood donated from one person does not match the blood type of the recipient. Symptoms that occur immediately during a transfusion reaction may include: fever and chills, breathing difficulties, muscle aches, nausea, chest pain, abdominal or back pain, blood in the urine, and liver failure. Symptoms of a rejected blood transfusion can occur anywhere from during the transfusion to a few days after the transfusion.

The diagram below shows the surface antigens present for each of the blood types. A person's blood contains antibodies for surface antigens that are NOT present in that person's blood type.



Why does a reaction happen?

When blood type from a donor is not compatible, the body will recognize the surface antigens as foreign and attack them. Antibodies are made by the immune system in response to recognition of new surface antigens, which will destroy the newly transfused blood. For example, in the diagram above, O- blood does not contain any surface antigens. Giving someone with O- blood type a transfusion containing A, B, or Rh antigens would result in antibodies that attack the transfused blood. This reaction could cause a very dangerous reaction in the recipient, called hemolysis. This could lead to kidney failure, irregular heart rhythms, and organ system failures.

More information on blood typing: `bit.ly/blood-typing`

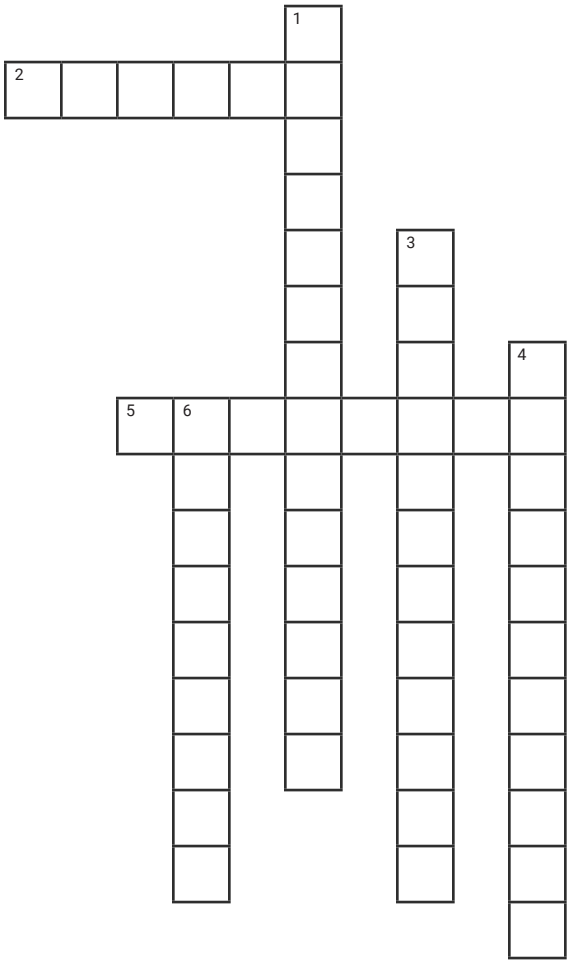
Review question:

A patient arrives at the hospital after an accident that caused a lot of blood loss. This person is in need of a blood transfusion. The person's family is able to tell the emergency medical technician, doctors, nurses, and pharmacist taking care of her that her blood type is A+. Which of the blood types below would be safe to give to this patient?

AB+ | **A-** | **B+**

If you were thinking, A-, you are on the right track! Since A+ blood does not contain B surface antigens, giving this person any blood that has B surface antigens would cause an immune response leading to antibodies attacking the transfused blood.

Activity: Crossword puzzle



Down:

1. Type O blood is considered an_____
3. Another term for red blood cells
4. Getting a blood _____with the wrong blood type may cause a reaction.
6. A dangerous reaction that can occur if blood groups don't match

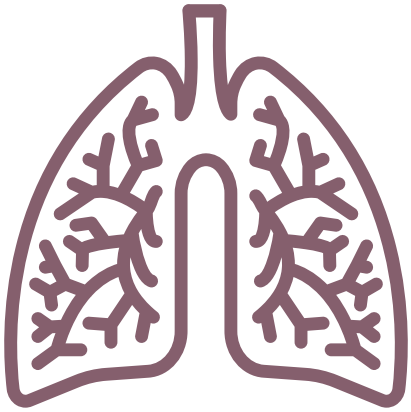
Across:

2. Red blood cells help transport this to the body
5. Determines if a blood type is positive or negative

Career options
Understanding how the lungs function is an important part of being a doctor, physician assistant, or nurse! Visit page 36 for a list of recommended courses to take in high school and college to lead to this career path.

Answers on page 39

Activity: The Lungs



Remember that our lungs help us breathe, and it is important to keep them healthy. Lungs oxygenate blood, or add oxygen to blood, that gets pumped around our body from the heart to provide oxygen that is necessary for your muscles and important organs to work. Lung diseases make it more difficult to provide oxygen to these vital organs in the body (including the brain and heart). Smoking commonly causes a lung disease called chronic obstructive pulmonary disease (COPD). COPD is a chronic inflammatory disease that can cause an obstruction in the airways, making it difficult to breathe. This brief experiment will show us how smoking affects our lungs.

Materials

- 2 straws
- 1-liter clear plastic bottle (can be done with a smaller clear plastic bottle)
- 4 balloons
- Duct tape (or any strong tape)
- Play dough or clay

Instructions:

1. To set up our lung experiment, carefully cut the bottom off the clear plastic bottle.
2. For the healthy “lung,” tape one balloon end tightly around a straw so there are no air leaks.
3. For the “lung” affected by smoking, you will actually need to put a balloon inside of another balloon and then duct tape it to a straw (see the link below for photo and video examples).
   This represents how smoking damages the elasticity of the lung’s tissue.
4. Once you have inserted the two straws with attached “lungs” into the bottle opening, take a small lump of clay and connect/seal the straws to the bottle opening. Make sure to seal them tightly so there are no air holes.
5. Push some clay down inside the straw of the unhealthy “lung” to mimic the blockage that smoking can cause.
6. Cut the bottom off a balloon, tie it off, and wrap the cut end around the bottom opening of your clear bottle.
   We had several balloons break due to the sharp plastic edges of the bottle so if

this occurs you can simply add a layer of duct tape around the bottle to cover the sharp edges and then wrap your balloon around the bottom opening of the bottle.

7. Once your balloon is set in place, add one final layer of duct tape around the edges to help hold the balloon in place.

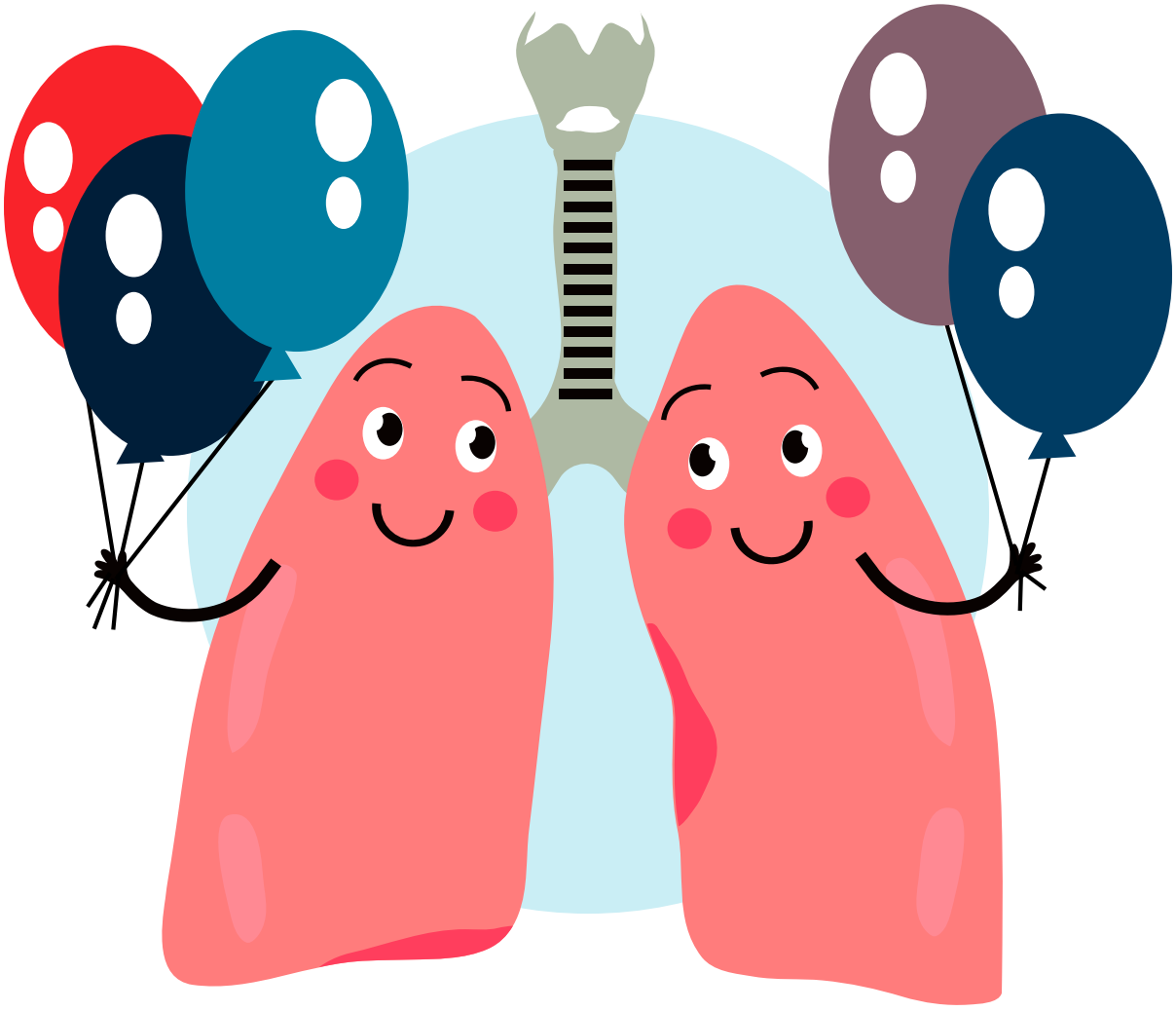
   When you tug on the bottom balloon piece you will immediately notice that the suction created inside the bottle will help the healthy "lung" to inflate more easily than the damaged "lung," which struggles to inflate properly.

   You can also use the link below to see a video and photo examples of the instructions.

   bit.ly/make-lungs

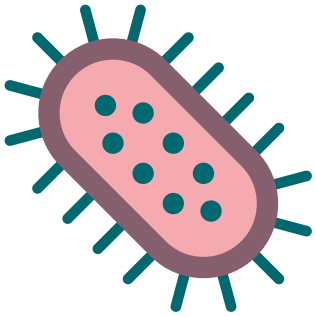
Proud of how the activity turned out?

Take a quick picture and share it on social media with #KGIworkbook.



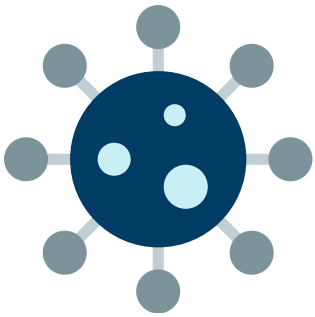
Fighting Microorganisms: Protecting Ourselves with Antibiotics and Vaccines

What are bacteria?



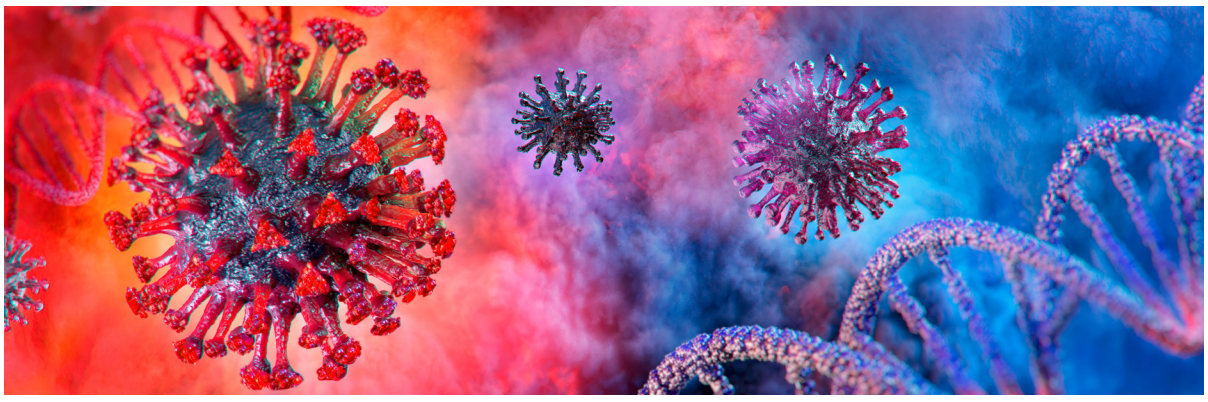
Bacteria are tiny microscopic organisms that come in different shapes and sizes, and can be found almost anywhere. Bacteria are unicellular organisms, also known as prokaryotes, since they lack a nucleus. There are helpful and harmful bacteria. Helpful bacteria help us with digestion, our immune system, and our overall health. Harmful bacteria can cause infections, such as: food poisoning, stomach ulcers, and pneumonia.

What is a virus?



A virus is a non-living agent that causes infections. Viruses are smaller than bacteria (submicroscopic), and they need to be in a living organism to grow. Viruses are present almost anywhere and are estimated to outnumber bacteria by a factor of ten. Some examples of viral infections include the common cold, the flu, and chicken pox.

In regard to current events, SARS-CoV-2, the virus that causes COVID-19, causes an upper respiratory tract infection. SARS-CoV-2 belongs to the coronavirus family, which originated in the 1960's.

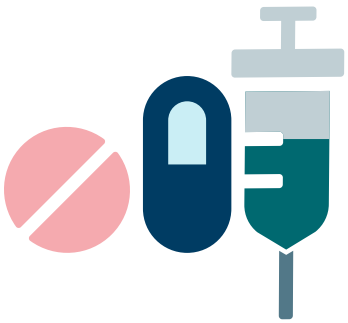


The common cold virus is also part of the coronavirus family. The slight changes in SARS-CoV-2 compared to the common cold virus is what makes SARS-CoV-2 deadlier. SARS-CoV-2 is mainly spread by close contact from small droplets spread from person to person and through surfaces. The most common signs and symptoms include cough, difficulty breathing, fever, and fatigue, but asymptomatic people, or people without symptoms, can still spread the virus to others. Older people and people with underlying health conditions are at the most risk for a severe infection. SARS-CoV-2 has caused a pandemic, affecting millions of people globally; thus, it is important to take preventative measures like wearing masks, frequent hand washing, and social distancing to prevent the spread of COVID-19. These preventative measures can help keep ourselves and our communities healthy.

What happens when we are sick?

When we are sick, our body tries to protect itself from invaders, such as bacteria and viruses. As our bodies are trying to fight off the infection, we might experience a fever, a cough, or feel really tired. Oftentimes, viruses and bacteria spread through touching surfaces and close contact with an infected person. It is important to stop the transmission of the virus or bacteria so that more people do not get sick. In order to stop the spread of the disease, it is important to wash our hands well and often, stay home if sick, wear a face covering, and use a tissue when coughing or sneezing.

Antibiotics and vaccines



Antibiotics only work on bacteria and not on viruses. This is because antibiotics target things like the cell wall of bacteria, which is something viruses lack. Antibiotics are powerful medicines that keep a bacterial infection from getting worse by either killing the bacteria or by making it difficult for bacteria to continue growing and multiplying. When an antibiotic is prescribed by a doctor, it is important to follow the instructions and take every dose, even if you start to feel better. This is important to get rid of the bacteria and prevent them from coming back with a stronger infection in the future. It is also important not to share antibiotics with someone else, because different people are prescribed different medications by their doctor depending on their symptoms and type of bacteria causing their infection.

There are numerous vaccines that help protect us from infections. Vaccines usually come in the form of a shot and are given before we have the infection to help stop us from getting sick. There are vaccines that protect us from bacteria, such as the meningitis and tetanus vaccines. There are also vaccines that protect us from viruses, such as the seasonal flu vaccine and chickenpox vaccine. It is important to get these vaccines to prevent us from getting sick and spreading diseases to others.

Activity: Make a virus

Materials:

- Printer so that you can print all four pages of this document: `bit.ly/make-virus`
- Coloring materials
- Scissors
- Paper
- Glue

Instructions for Making the Adenovirus

1. Cut out the virus on the solid lines.
2. Pre-fold on all the dotted lines. Make sure your folds are crisp and neat. The crisper and neater your folds, the better your model will look.
3. Begin gluing joints. Start with just one or two, and press and hold them for at least 10 seconds. Then clip them (if you wish) and let them dry for another minute or so. After a minute or two, these joints should be adhered well enough to be able to go to other joints. If you are assembling two viruses at once, you could do a few joints on one, then switch to the other one while the first one dries.
4. Be very patient as you assemble the virus. Patience is the key. When you get to the last flap and can no longer get your fingers on the inside to press and hold, just pull the glue flaps out enough so that they apply a little pressure to the inside of the figure, then glue and hold the flap in place for a minute or two. A little patience with holding it will pay off. The glue sets in just a minute or two, and you can put the figure aside to finish drying by itself.
5. If you would like to decorate your virus when you are finished, we recommend a light coat of spray paint.

Instructions for Making the T2 Virus:

1. Cut out the three body parts that are printed on the paper, cutting on the solid lines.
2. Pre-fold on the dotted lines. Once again, make sure your creases are sharp and accurate.
3. Assemble the two halves of the upper body before trying to connect them. Connecting them can be a little tricky, but it is definitely possible. Once again, patience is the key.
4. Roll the long, skinny lower part and glue along the glue tab. Make sure to cut the pieces on the end.
5. Glue the long “neck” onto the body.
6. Cut the stems in half, so you have six identical pieces. Put a fairly generous amount of white glue in and around one end of them (no more than an inch) and stick them up into the bottom of the neck. Let this dry for as long as possible before twisting legs out into position.
7. You don’t need to decorate the T2, but if you want to, we recommend a light coat of spray paint. Don’t use too much wet paint. If the paper gets soggy, the figure will bend and sag.

Metabolic Syndrome—What's That?

Metabolic syndrome is a group of conditions that increase your risk of diabetes and heart disease. A few of these conditions are:

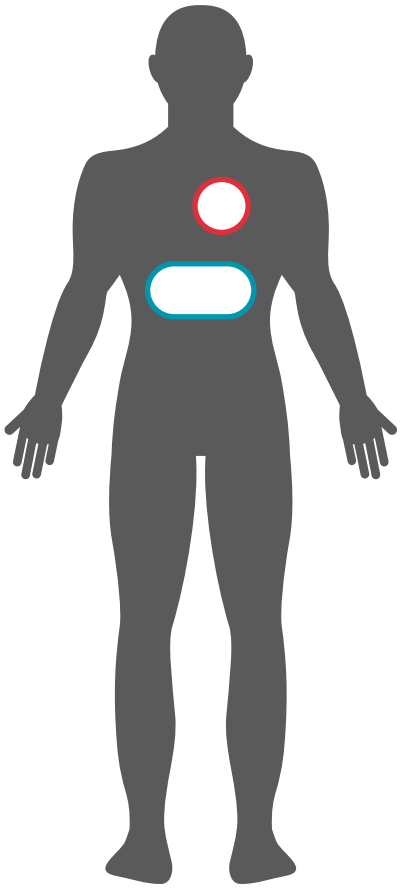
- High blood sugar
- High blood pressure
- Low HDL ("good cholesterol") and high triglycerides
- High body mass index and waist circumference

The main cause of metabolic syndrome is being overweight. This leads to insulin resistance, which is the leading cause of type 2 diabetes, which will be explained later. Insulin resistance and inflammation are the main leading factors in metabolic syndrome. Typically, risk factors include the following:

- Lack of physical activity
- Unhealthy diets that are high in sugar
- Family history of metabolic syndrome

Knowing the risk factors will help in deciding how to prevent metabolic syndrome. Preventable measures include positive changes to lifestyle. Follow the list below for some ideas on how to live have a healthy lifestyle:

- Eat a healthy diet to fuel your body and maintain a healthy weight.
- Exercise for at least 30 minutes per day.
- Do not smoke or vape to help keep your heart and lungs healthy.



Activity: Metabolic syndrome match

This worksheet section will look at two organs that are affected by metabolic syndrome and its diseases.

1. **The Pancreas** is affected by diabetes.
2. **The Heart** is affected in heart disease.

Place the number of the corresponding organ inside the correct location in the body. ***Tip: Match the colors!***

Introduction to Diabetes

Diabetes is a health condition that can affect people of any age. It is not something you catch, like the flu, but something that develops inside your body. The following worksheet will take you through what diabetes is and how to prevent some types. At the end, there are fun exercises with a special treat!

What is diabetes?

Diabetes is a disease that affects how the body uses glucose, the scientific term for sugar. Sugar is used in the body as a main source of fuel. This means every cell in your body needs glucose to keep running properly. When a person is deemed diabetic, this means that their blood sugar level is higher than normal.

How does glucose fuel the body?

Glucose comes from the food we eat. It gets absorbed into our bloodstream after digestion, then triggering the pancreas to produce the hormone insulin, which is made by the pancreas. Insulin tells cells of the body to uptake glucose from the blood stream and use it as energy inside the cell or converted to fat for storage.

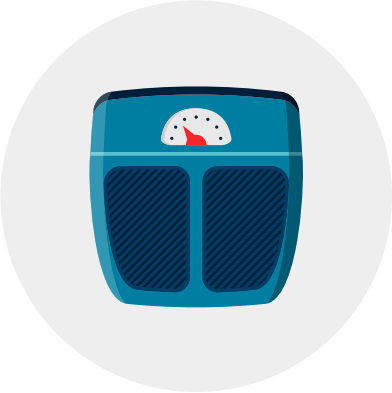
Glucose levels in the blood are measured by a glucose meter (glucometer). By comparing the measurement to standard, healthy levels, we can determine how well the pancreas is functioning. Glucose levels also give information about our overall health status. High glucose levels can be an early indication of diabetes.

How does diabetes affect glucose?

There are two main types of diabetes, conveniently named type 1 diabetes and type 2 diabetes. With each type, insulin does not function properly and glucose is not transported into the cells from the bloodstream. This dysfunction leaves a lot of glucose in the blood. Without treatment, high or low blood sugar levels can make people very sick and lead to negative long-term health consequences.

- With Type 1 Diabetes, the body cannot make insulin because cells of the pancreas are treated as invaders and are destroyed.
- With Type 2 Diabetes, the body makes insulin, but it does not work well (the body does not respond to insulin correctly).

Can diabetes be prevented?



Only type 2 diabetes can be prevented. Type 1 diabetes happens early in life when you are young and is related to genetic inheritance. Neither type of diabetes is contagious. The good news is that both forms of diabetes are impacted by lifestyle choices and making positive health choices can help prevent complications with diabetes.

You can stay healthy by making healthy food choices. Here is a list of some healthy food choices:

- Vegetables
- Whole-grain cereal and bread products
- Lean meat
- Fiber
- Yogurt
- Fruit

You want to limit food choices that are high in fat, salt, and sugar because these can lead to an unhealthy weight. This includes sugary snacks and sodas. Instead, you can try the following options:

- Unsweetened iced tea
- Homemade sweet treats

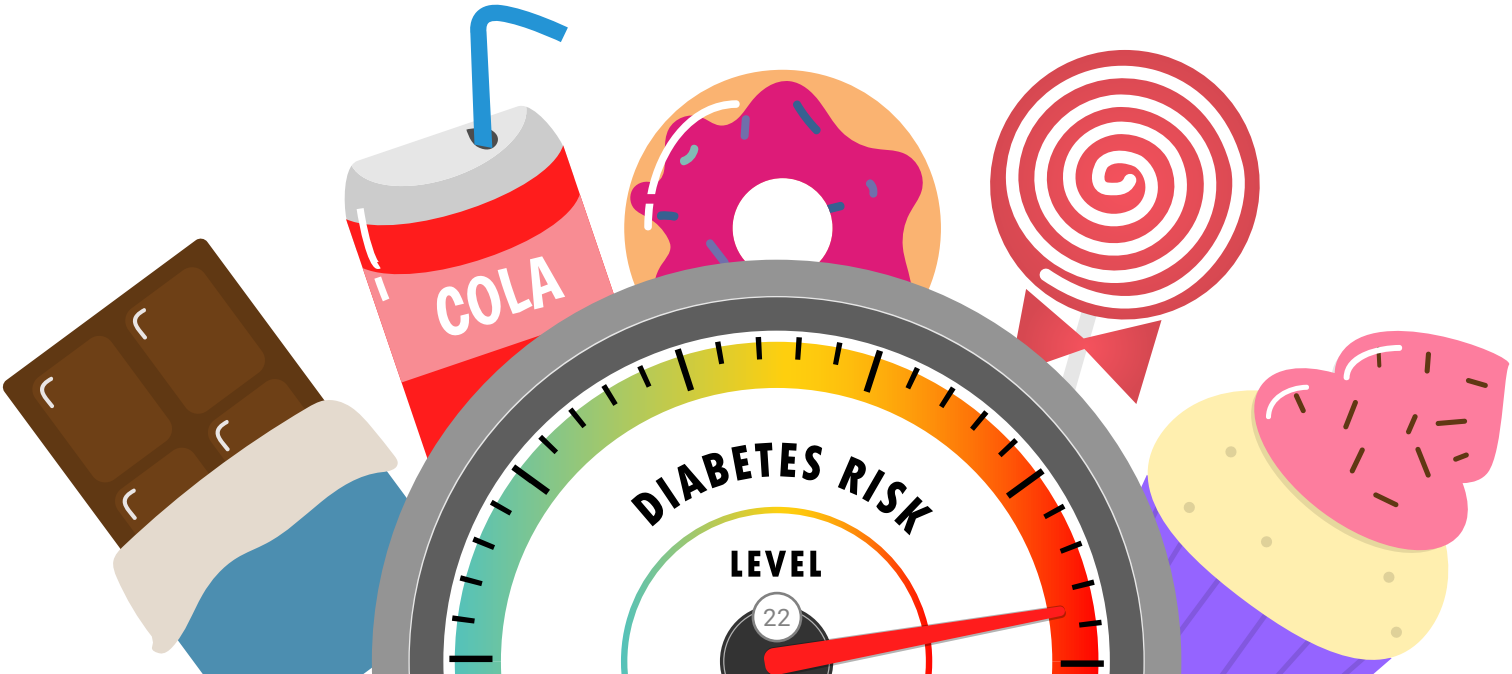
With homemade treats, you can control how much sugar you use and the type of sweeteners that are used. Remember, everything is okay in moderation. A good diet and daily exercise will help to maintain a healthy weight and prevent type 2 diabetes from happening later in life.

Are you interested in helping your community?
Becoming a pharmacist means you will have opportunities to advise patients on how to avoid or treat diabetes and other health conditions. Visit page 37 for a list of recommended courses to take in high school and college to lead to this career path.

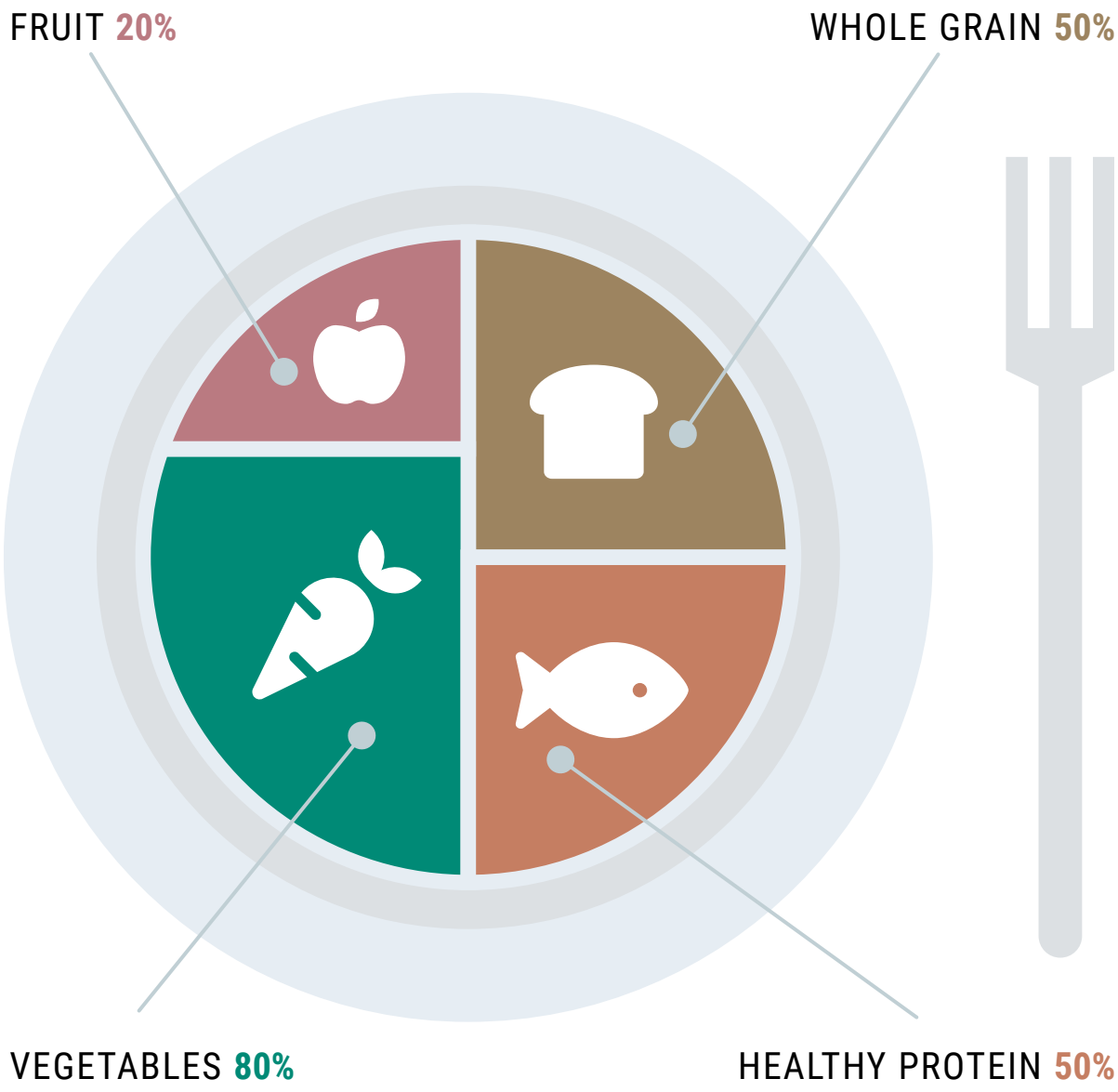
Activity: Diabetes quiz

1. Which type of diabetes is preventable?
    a. Type 1 diabetes
    b. Type 2 diabetes
2. What is the scientific name for sugar?
    a. Fat
    b. Carbs
    c. Glucose
    d. Cellulose
3. What is sugar used for in the body?
    a. Energy
    b. Sleep
4. True or False: in type 1 diabetes, the pancreas cannot make insulin.
5. True or False: in type 2 diabetes, the pancreas can make insulin, but the insulin does not work correctly in the body.

Answers on page 39



Activity: Healthy Plate



It is your turn to make dinner for the family! It is important to stay healthy to prevent diabetes. Fill the plate with healthy food you would serve. Take a look at bit.ly/diabetes-meal-planning and bit.ly/kids-plate-meals to learn more about making a healthy plate.

Tips: Start by sectioning your plate. Create a list of foods you love. Add one food from each food group to the plate.

Additional resource: My Plate poster bit.ly/my-plate-my-wins

Making a healthy snack: Sweet treats

This section will explore how to make a couple of healthy sweet treats. The activity will explain how to measure, followed by how to combine measured ingredients.

Things to think about:

- How much sugar can I eat? For children, that is 6 teaspoons or less of added sugar total per day. Don't forget that there are added sugars in many foods, not just sweets.
- Want a healthy alternative to sodas and energy drinks? Try homemade fruit smoothies with no sugar added. Sweet treats are delicious and can be eaten in moderation. Choose homemade treats with measured amounts of sugar or natural sweeteners over packaged candy or cookies

Activity: Make a healthy smoothie

Materials

- Variety of fruit cut into smaller pieces
  You can use bananas, berries, peaches, kiwi, or any combination of fruit that is tasty!
- Ziploc bag
- Blender
- Choice of liquid base
  Low-fat yogurt, low-fat milk, or fruit juice without added sugar. A healthy non-dairy option is unsweetened soy milk or unsweetened almond milk.
- Ice cubes
  If you like, you can use frozen fruit (with no sugar added) instead of ice.
- Cups to enjoy smoothie in
- Extras
  You can add veggies, like spinach, for a healthy way to include a serving of veggies and vitamins.

Instructions

It is important to measure to make sure you do not go over daily serving sizes.

1. Place fruit into blender.
2. Add 1 cup of liquid base (can be non-dairy).
3. Add one-half cup of yogurt (optional).
4. Add ice.
5. Blend until everything is mixed to the consistency you prefer.
6. Pour into glass and enjoy.

Don't be afraid to play with different fruit flavor combinations (or even add vegetables, like spinach)!

Activity: Make ice cream in a bag

Materials

- Sugar or sugar alternative
- Half-and-half or non-dairy milk (unsweetened almond or coconut milk are good healthy choices)
- Vanilla extract
- Salt (different types of salts, such as table salt or rock salt, will all work, but may give slightly different results)
- 4 cups of ice
- 1 small, sealable bag, such as a sandwich-sized Ziploc
- 1 gallon-size sealable bag
- Oven mitts or a small towel

Instructions

1. Fill each small sealable bag with the following (use a measuring spoon and cup):
    - one tablespoon of sugar
    - one-half cup of half-and-half (or unsweetened almond or coconut milk)

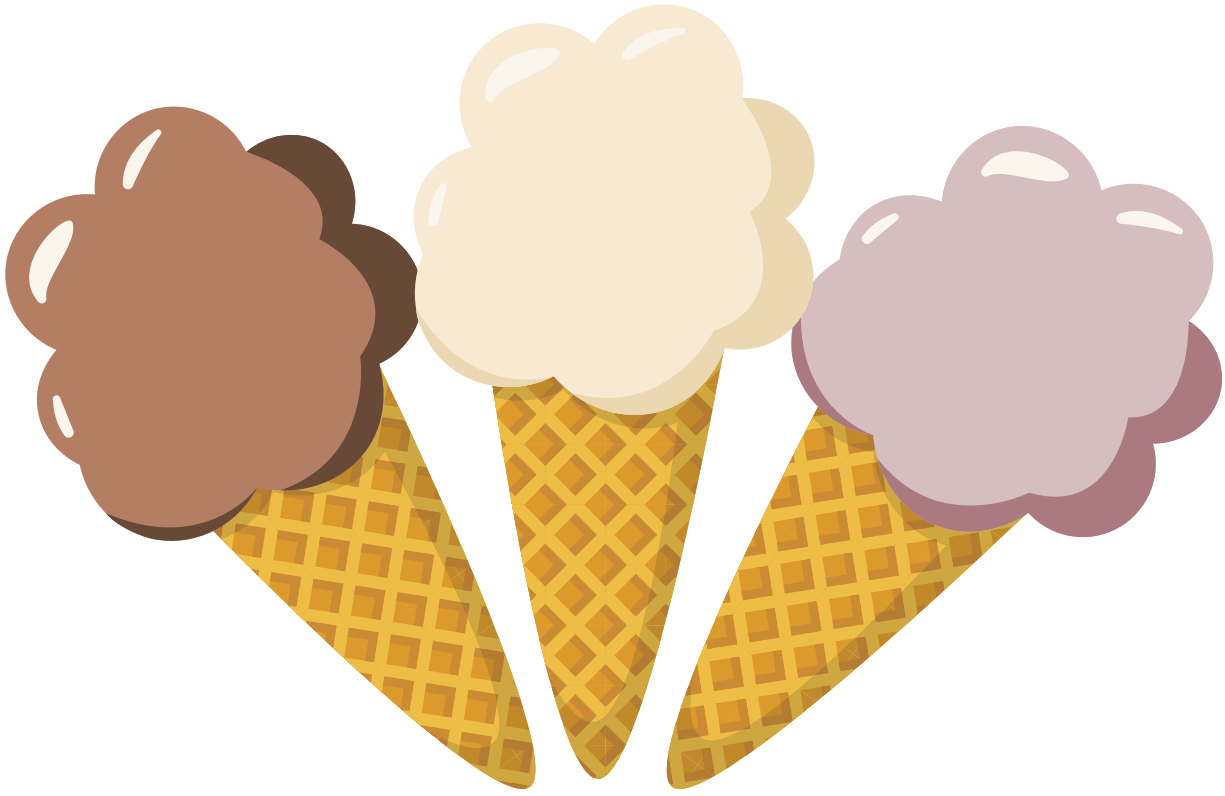
- one-quarter teaspoon of vanilla extract

2. Seal the small bag well and place to the side.
3. Next, add four cups of ice cubes to the gallon-sized bag (large).
    - Now, add one-half cup of salt to the gallon-sized bag of ice.
4. Then, place one of the small bags (that you already prepped and placed to the side) inside the large bag.
    - Be sure both bags are sealed.
5. Now for the oven mitts!
    - If you do not have oven mitts, wrap the large bag in a small towel.
6. While wearing the mitts (or with the bag wrapped in the towel), shake the bag vigorously for 5 minutes.
    - As you shake the bag, look and feel the smaller bag. Notice the change in consistency. It is going from liquid to solid.
7. Once the contents of the small bag are no longer liquid, you are done.

   You have made ice cream!!!

Proud of how the activity turned out?

Take a quick picture and share it on social media with #KGIworkbook.



Cardiovascular Disease

Introduction

The heart is a muscle. It is located near the middle of your chest, though it tilts slightly to the left. The heart is significant because it pumps oxygenated blood, or blood that carries oxygen, throughout your entire body. It is only the size of your fist, but it works hard to keep you alive. It is important to keep your heart healthy to protect it from cardiovascular disease.

What is cardiovascular disease?

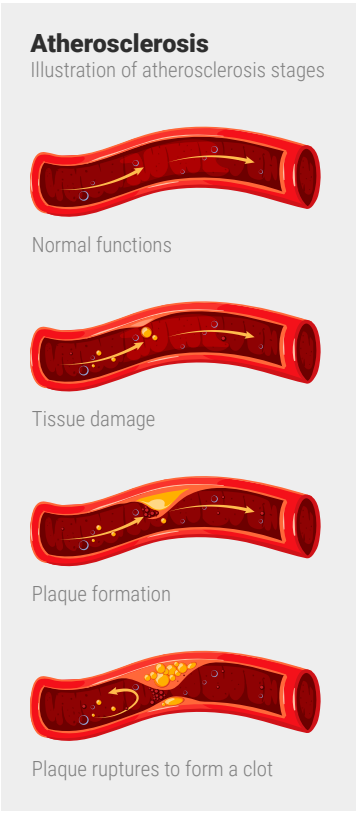
Cardiovascular disease, or heart disease, describes a set of conditions that affect your heart and blood vessels.

One form of heart disease is atherosclerosis. Atherosclerosis is a buildup of "plaque" made of cholesterol, minerals, and fat in the arteries. This plaque buildup starts to block the transport of blood to important organs, including the heart.

Cholesterol is a waxy, fatty molecule that forms many important hormones. Remember that there are two different types of cholesterol. HDL (high-density lipoproteing) is called "good" cholesterol because it helps get rid of extra cholesterol in your body. LDL (low-density lipoprotein) is called "bad" cholesterol because it can build up in the arteries and form plaques. An improper balance of cholesterol can lead to life threatening diseases such as:

- **Heart Attack**: This happens when blood is blocked from reaching the heart.
- **Stroke**: This happens when blood is blocked from reaching the brain.

Cardiovascular disease mainly affects older people, but can affect younger people, especially when there are risk factors. Want to help your family members or relatives understand the signs and symptoms of heart disease? Let them know that there are many tests to see if they have heart disease. For example, a stress test shows how the heart responds in stressful conditions. One sign to pay attention to is called angina, or severe and constant chest pain.



What causes heart disease?

There are many risk factors that can lead to heart disease. Some of these risk factors include:

- Being overweight
- Smoking (includes cigarettes, smokeless tobacco, vaping)
- Not exercising
- Diabetes, especially when not controlled
- Inherited genetic factors

Most of these risk factors can be changed with healthy habits. Smoking exposes you to a lot of chemicals that can hurt your lungs and heart. This makes it harder to pump oxygenated blood throughout the body. Making healthy lifestyle choices includes exercising regularly, having a balanced diet and not putting harmful chemicals into your body.

Now that you have read a little about heart disease, it is important to make good, healthy choices every day. Share this information with your friends and family. Try doing a fun physical activity together like biking or hiking and make a healthy meal to share.

Activity: Cardiovascular quiz

1. Cardiovascular disease is also known as_____disease.
2. A heart attack happens when blood is blocked from reaching the_____.
3. A stroke happens when blood is blocked from reaching the_____.
4. Which of the following is not a risk factor for heart disease?
   a. Healthy lifestyle choices
   b. Smoking
   c. Overweight
   d. Vaping
5. True or False: Risk factors for heart disease can be preventable.
6. True or False: The lungs pump oxygenated blood throughout the body.

Taking a break?

Share a photo on social media and use #KGIworkbook so we can see your progress!

Answers on page 39

The heart

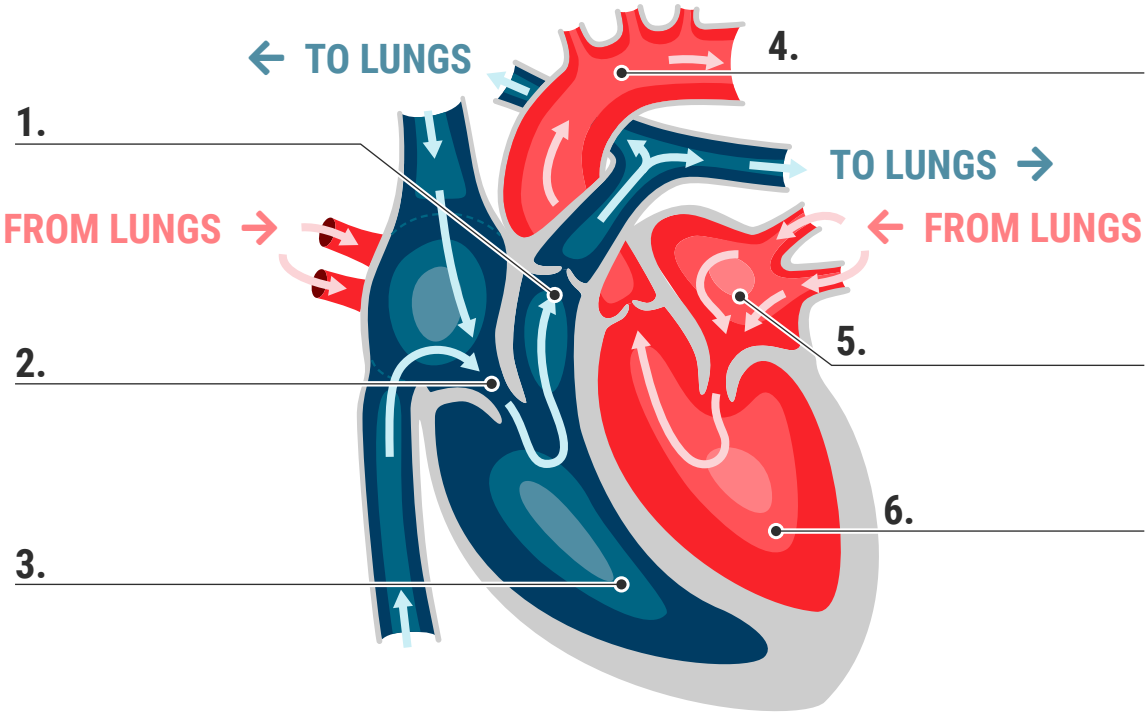
The heart is a very important muscle in your body. It is important to understand how it works. The following activities will help build your understanding of how the heart works.

Check out this video by Kids Health to review how the heart works:
bit.ly/video-heart-works

After the video,
label the heart in the activity below.

Activity: Label the heart

Instructions: Label the parts of the heart and circle the valves.



- Left Ventricle
- Left Atrium
- Pulmonary Artery
- Right Ventricle
- Right Atrium
- Aorta

Answers on page 39

Cardiovascular Word Search

Q A Z W S X E D C B U F V T G B O Y P H S N C U W J K M D I
Z K T L O P Q A Z R S X E D C R F V T G P B Q Y U H X N P U
I J X M R I P O I A Y W S X E D C R U F V T G K L M Z X C V
X Z W S X E D C R I F U Y P Q A Z W S X E D C X E D C R U Q
R I U Y P Q A Z W N X G B I P O I U Y T R E W P Q A Z W S C
V T G B I P O I U Y T C R A Z W S X E C C R F I P O I U Y R
E D C R A Z W S X E D I P O I U Y T R A W Q A X N C R U F T
M R I P O I U Y T R E E D C R U F V T R B O Y Z X Z W S X N
S X E D C R U F V T G G B O Y P H S N D U W J C R I U Y T J
V T G B O Y P H S N C C R F V T G P B I Y U H F L T G B O I
E D C R F V T G P B Q W Q A S D F G H O K L M X E U C R F X
R E W Q A S D F G H J B O Y P H S N C V X E D T R E N Q A S
T G B O Y P H S N C S R F V T G P B Q A P Q A C R U F G T G
D O R F V T G P B Q O Q A S D F G H J S I P O Z W S X E S C
E X Q A S D F G P J R V T E P B Q Y U C X N C I U R T R H W
R Y V T G P B Q Y R H S D F X H J K L U Z X Z S X I D C E F
Q G S D F G H J K L E Z X Z W E X N I L O I U Y T S E W A A
O E P H S N C S X E D V R I U Y R J E A C R U F V K G B R Y
Q N Z W S H E D C R U F E T G B O C G R O Y P H S N C U T J
Z K T L O P E A Z W S X E N C R F X I R F V T G P B Q Y U H
I J X M R I P A I U Y T R E T Q A S W S A S D F G H J K L M
Q A Z W S X E D L R U F V T G A O Y P O E P H S N C S X E D
Z K T L O P Q A Z T S X E D C R B V T F V T G P B Q O P Q A
I J X M R I P O I U H W S X E D C L U A S D F G H J R I P O
X Z W S X E D C R U F Y Y P Q A Z W E T G P B Q Y U H X N C
R I U Y P Q A Z W S X G B I P O I U Y D F G H J K L M Z X Z
V T G B I P O I U Y T C R A Z W S X E S X E D C R U F V T G
E D C R A Z W S X E D I P O I U Y T R O P Q A Z W S X E D C
D C R F V T G P B Q O Q A S D I J X M R I P O I U Y T R E W
V T G B O Y P H S N C C R F V T G P B Q Y U H F V T G B O I

- Brain
- Cardiovascular
- Exercise
- Healthy
- Risk
- Heart
- Lungs
- Oxygen
- Preventable

Proud of how the activity turned out?

Take a quick picture and share it on social media with #KGIworkbook.

Answers on page 39

Learn About Important People in the History of Science and Healthcare

Rosalind Franklin (1920–1958), PhD Chemistry

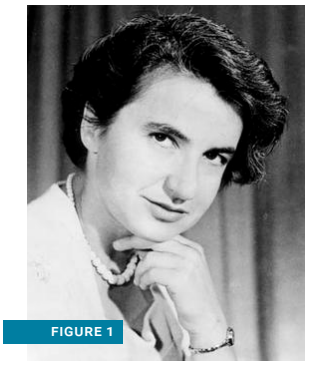


FIGURE 1

Franklin was an English chemist and biophysicist in the 19th century. She used her skill in X-ray crystallography, which takes X-ray images of small biomolecules, to research the structure of DNA. In 1953, Watson and Crick used data from Franklin to formulate their hypothesis of DNA as a double helix structure. As one of two women scientists working at King's College London, Franklin faced exclusion and lack of recognition throughout her career. The data that led to the discovery of DNA was used without Franklin's permission, and her contribution to the discovery was not included in the original paper by Watson and Crick. She died from ovarian cancer before the Nobel Prize was awarded to her male colleagues in 1962.

Jennifer Doudna (1964–present), PhD Biochemistry

FIGURE 2

Doudna is an American biochemist and researcher. She was a leader in developing a new molecular technique called CRISPR-mediated genome editing. The CRISPR revolution opened up the field of genome editing with applications in therapeutic medicine, preventing infectious disease and improving crop yields. Doudna holds many prestigious awards in biological sciences, and currently serves as the Li Ka Shing Chancellor Chair Professor in the Department of Chemistry and the Department of Molecular and Cell Biology at the University of California, Berkeley.

Charles Richard Drew (1904–1950), MD, PhD

FIGURE 3

Drew is known as the “father of the blood bank” for his contributions to preserving blood and developing the mobile blood bank. His work saved thousands of lives in World War II and is still in practice by the American Red Cross today. Drew faced challenges from racism and segregation growing up in Washington, which led to pursuing a medical degree at McGill University in Montreal, Canada. Drew excelled in medical school, and went on to pursue a doctorate in medical research at Columbia University. During a fellowship, Drew and his supervisor discovered a way to preserve blood and secured funding to set-up an experimental blood bank. While serving as assistant director for the Red Cross pilot program for mobile blood donations, Drew openly criticized the Red Cross policy of denying blood donations from Black people. This unscientific and racist policy was only changed after Drew’s death in 1950. After leaving the Red Cross in 1941, Drew worked as the Head of the Department of Surgery and Chief of Surgery at Freedmen’s Hospital with a mission to advance the training and position of young African American surgeons in the United States, and spoke out against exclusions of Black medical professionals from medical societies and organizations.

Ivan F. Gonzalez-Cancel (1960–present), MD

FIGURE 4

Gonzalez-Cancel is a cardiovascular and heart transplant surgeon in Puerto Rico. He grew up in Bayamon and Toa Baja, Puerto Rico, and completed medical school at the Universityof Puerto Rico School of Medicine. Gonzalez-Cancel faced adversity as a Latino man pursuing a career as a surgeon. He overcame obstacles to join the Cardiovascular Surgery faculty at the University of Alberta in Canada, and completed a fellowship in Heart and Lung Transplant at the University of Pittsburgh in the USA. He is credited with performing the first heart transplant surgery in Puerto Rico in 1999, and has since performed 125 heart transplants in Puerto Rico with one of the highest success rates in the country.

Marie M. Daly (1921–2003), PhD Chemistry

FIGURE 5

Daly was an American biochemist and the first Black woman to receive a PhD in Chemistry in the United States. She was born in 1921 in Queens, New York, to a family that loved reading and valued education. Daly went on to complete her BS at Queens College and MS at New York University. In 1944, she accepted a place in the doctoral program at Columbia University. After earning a PhD. in the science of digestion, Daly went on to study the causes of heart attacks and how diet can affect the circulatory system. Throughout her career in science, Daly was involved in efforts to promote students of color in STEM graduate programs.

Figure 1: *By Jewish Chronicle Archive/Heritage-Imageshttp://www.britannica.com/EBchecked/topic-art/217394/99712/Rosalind-Franklin, Fair use, https://en.wikipedia.org/w/index.php?curid=24959067*

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Figure 3: *By Associated Photographic Services, Inc - National Library of Medicine: http://profiles.nlm.nih.gov/ps/retrieve/ResourceMetadata/BGBBCT: Year supplied: ca. 1949Original Repository: Howard University. Moorland-Spingarn Research Center. Charles R. Drew Papers, PD-US, https://en.wikipedia.org/w/index.php?curid=47837720*

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Figure 5: *By Queens College Silhouette Yearbook - Immediate source: http://philosophyofscienceportal.blogspot.com/2010/04/marie-maynard-daly1st-african-american.html mirror of https://www.sciencehistory.org/historical-profile/marie-maynard-daly, Public Domain, https://commons.wikimedia.org/w/index.php?curid=56922705*

KGI

Want to Learn More About Exciting Careers in Biotechnology and Healthcare?

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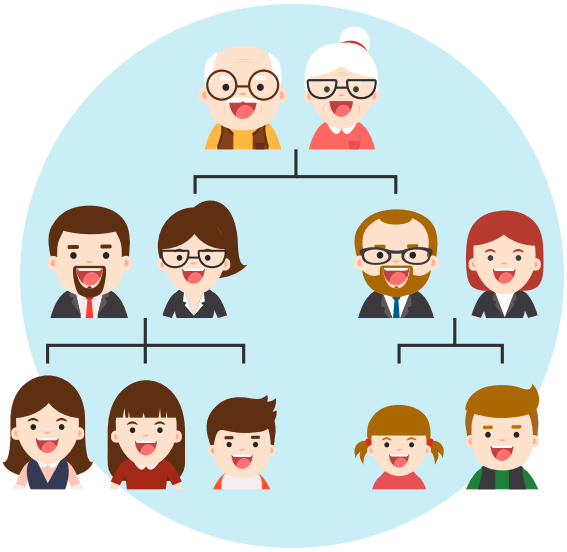
Visit ebook.kgi.edu to access the free resource.

Recommended courses to pursue a career as a genetic counselor or genomic data scientist

High School



- Biology
- Chemistry
- Foreign Language (Spanish or Mandarin)
- Speech/public speaking/debate
- Health
- Psychology
- Computer programming
- Physics
- Pre-Calc

Community College / Undergraduate

Biology (~1 year)

Chemistry (~1 year)

Genetics (1 semester+)

Biochemistry (1 semester)

Social sciences (psychology, communication studies, sociology, anthropology) (2 classes)

Statistics (1 semester)

Embryology

Bioethics

Anatomy

Physiology

Epidemiology

Organic chemistry

Communication

Options After Undergraduate Degree

MS in Human Genetics and Genetic Counseling `kgi.edu/msgc`

MS in Human Genetics and Genomic Data Analytics `kgi.edu/msgda`

Recommended courses to pursue a career as a doctor, physician assistant, or nurse

High School

- Statistics
- Biology
- Chemistry
- Physics
- Pre-Calc or higher
- Foreign Language (Spanish)

Community College/ Undergraduate

- Organismal Biology and Cellular Biology with lab (1 full year of biology)
- Inorganic Chemistry with lab (2 semesters)
- Organic Chemistry with lab (2 semesters OR 1 semester of organic chemistry and 1 semester of biochemistry)
- Human Anatomy (1 semester)
- Human Physiology (1 semester)
- Intro Psychology or Sociology or Anthropology (1 semester)
- Foreign Language (Spanish)
- Ethics/Bioethics (1 semester)
- Miscellaneous upper division biology (i.e., molecular, genetics, micro, histology, virology, etc.)

Options After Undergraduate Degree

- Postbac Premedical Certificate `kgi.edu/ppc`
- Postbac Pre-PA Certificate `kgi.edu/ppa`
- Master of Business and Science `kgi.edu/mbs`
- Master of Science in Applied Life Sciences `kgi.edu/ms`
- Master of Science in Translational Medicine `kgi.edu/mstm`

Recommended courses to pursue a career as a pharmacist

High School

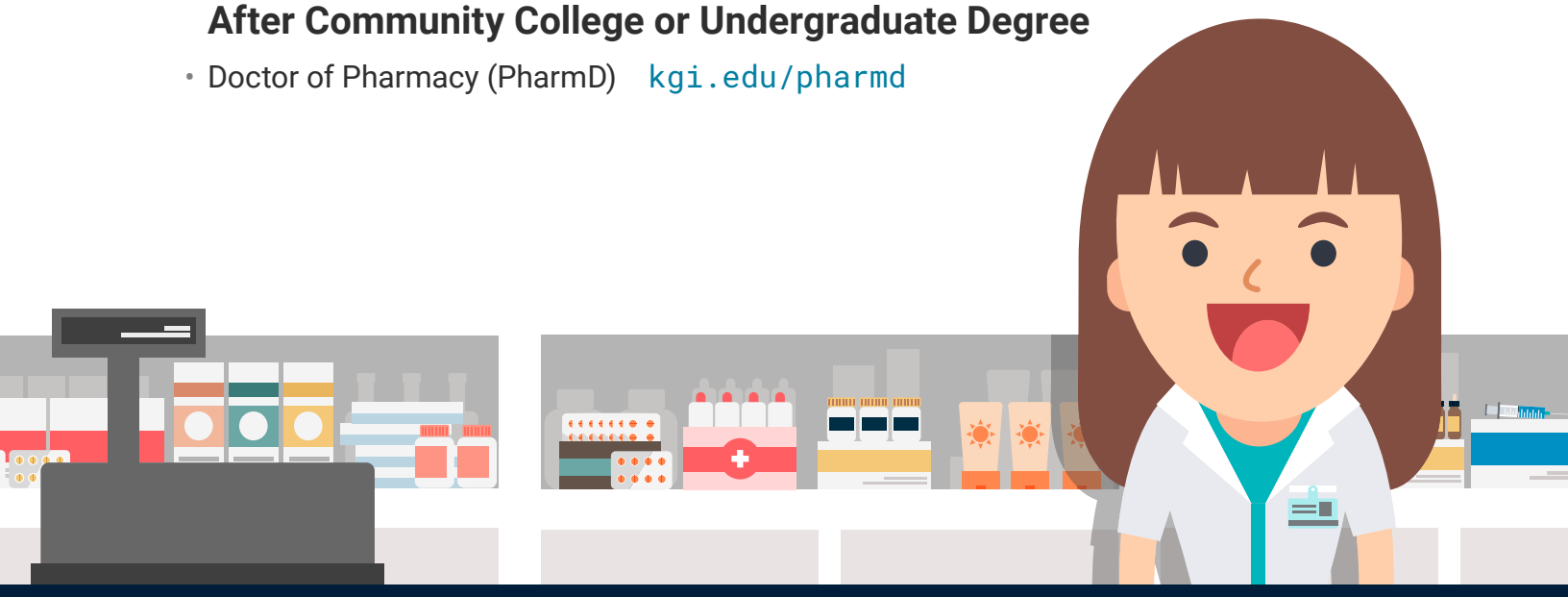
- Statistics
- Chemistry
- Biology
- Physics
- Pre-Calc or higher
- Foreign Language (preferably Spanish)

Community College / Undergraduate

- Biology w/lab
- Inorganic Chemistry w/lab
- Organic Chemistry w/lab
- Biochemistry
- Human Anatomy
- Human Physiology
- Foreign Language (preferably Spanish)
- Microbiology
- Biostatistics

After Community College or Undergraduate Degree

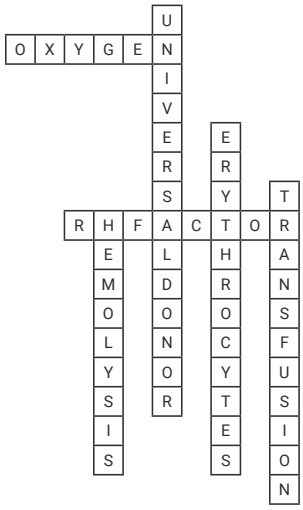
- Doctor of Pharmacy (PharmD) kgi.edu/pharmd



How to pay for college

1. **FAFSA**
   This is the most important first step to take when figuring out how to pay for college to fill out the Free Application for Federal Student Aid, or FAFSA.
2. **Scholarships**
   Scholarships offer money for college that does not need to be paid back. They often cover a specific area of study, interest, qualification, or achievement, and are funded by many different providers. You can also use resources like FastWeb and CollegeBoard to find scholarships.
3. **Grants**
   Grants, like scholarships, do not need to be repaid. They may come in the form of private grants from your institution, state funds, or federal funds like the Pell Grant.
4. **Work-Study**
   A work-study program provides part-time employment opportunities while you're in school. Available to undergraduate, graduate, and professional students, work-study helps those with financial need pay tuition costs, fees, or other costs like room and board.
5. **Federal Student Loans**
   Borrowing money is also one of the most common methods of paying for school. Federal loans, which are issued by the government, are categorized into two types for undergraduate students: direct subsidized (based on financial need) and direct unsubsidized loans (not based on financial need).
6. **Private Student Loans**
   These are provided by banks, credit unions, and private lenders. With private student loans you can borrow up to 100% of your cost of attendance which can include tuition, fees, room & board, and other college costs.

Key
Crossword Activity, Page 12



Key
Quiz, Page 22

1. B
2. C
3. A
4. True
5. True

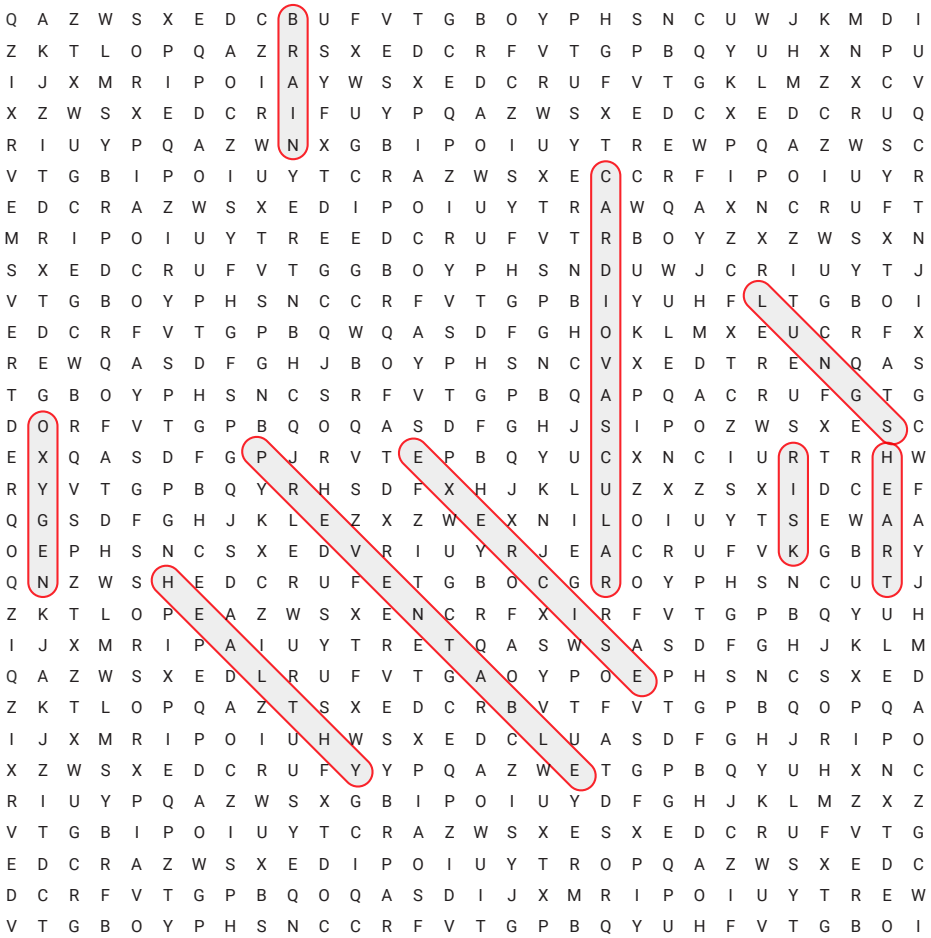
Key
Quiz, Page 28

1. Heart
2. Heart
3. Brain
4. A
5.True
6. False

Key
Quiz, Page 29

1. Pulmonary Artery
2. Right Atrium
3. Right Ventricle
4. Aorta
5. Left Atrium
6. Left Ventricle

Key
Cardiovascular Word Search, Page 30



KGI

ABOUT KECK GRADUATE INSTITUTE (KGI)

KGI, A MEMBER OF THE CLAREMONT COLLEGES, IS A RECOGNIZED LEADER IN BIOTECHNOLOGY AND HEALTHCARE EDUCATION. KGI OFFERS INNOVATIVE POSTGRADUATE DEGREES AND CERTIFICATES THAT INTEGRATE LIFE AND HEALTH SCIENCES, BUSINESS, PHARMACY, ENGINEERING, AND GENETICS, WITH A FOCUS ON INDUSTRY PROJECTS, HANDS-ON INDUSTRY EXPERIENCES, AND TEAM COLLABORATION.

WITH AN ENTREPRENEURIAL APPROACH AND INDUSTRY CONNECTIONS, KGI PROVIDES PATHWAYS FOR STUDENTS TO BECOME LEADERS WITHIN HEALTHCARE AND THE APPLIED LIFE SCIENCES. KGI CONSISTS OF FOUR SCHOOLS: HENRY E. RIGGS SCHOOL OF APPLIED LIFE SCIENCES, SCHOOL OF MEDICINE, SCHOOL OF PHARMACY AND HEALTH SCIENCES, AND THE MINERVA SCHOOLS AT KGI.