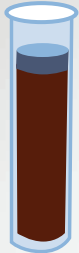


EXPLORE BIOTECHNOLOGY





EXPLORE BIOTECHNOLOGY



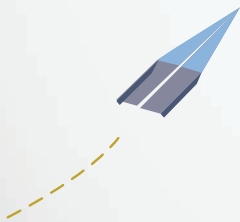
YOUR MISSION:

Get students excited about the invisible world: our cells, our DNA, bacteria. Help students to think big – by thinking really, really small! Encourage them to imagine themselves with a job in this field. They could discover cures, save lives, build robotic prosthetics, print organs on a 3D printer, and more.

ADVICE ON VOLUNTEERING



SAFETY CHECK: There's a lot to handle on these exhibits, but make sure students do it safely (no running, no poking each other in the eye, etc.)

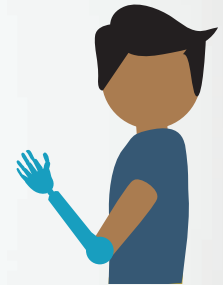


ENCOURAGE EXPLORATION: Ask questions and make sure everyone gets a chance to participate. A little positive feedback goes a long way.

HOW COOL!!

GEEK OUT! You don't have to be an expert. Your curiosity and enthusiasm inspire kids to learn.

AREA OVERVIEW

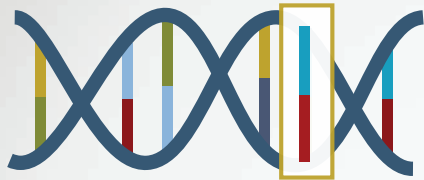


THE AGE OF BIOTECH

If technology creates tools to help humans, then **biotechnology creates tools to empower humans in health, medicine, and wellness.**

This fast-growing field includes the study of the human genome, the design of prosthetics, the improvement of sustainable agriculture, and the development of medicines and nanotechnology. Advances in the biological sciences have made such leaps in recent years that experts predict **the 21st Century may be known as the age of biotechnology.**

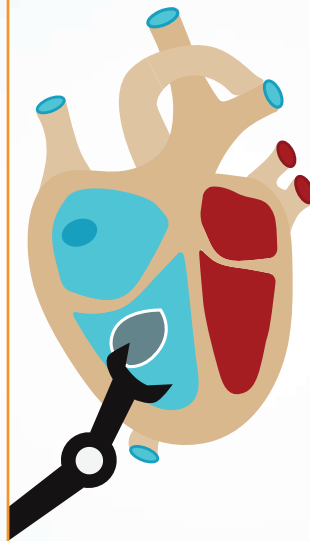
EXPLORE BIOTECHNOLOGY



- Each cell in your body contains about 6 feet of DNA.
- If you could stretch out all the blood vessels in a human body, they would be about 60,000 miles long. That's enough to go around the world twice.
- The strongest bone in your body is the femur (thighbone), and it's hollow.
- The width of your arm span stretched out is usually about the same length as your whole body.
- In one day your heart beats about 115,200 times.

GRAND CHALLENGES

If you could do one thing to make life on Earth better, what would that thing be? Here's a **GRAND CHALLENGE**: according to some of the world's smartest people, this is a challenge that humans will face in the next 100 years. **What would you do to help solve it?**



HOW CAN YOU HELP MAKE BETTER MEDICINE?

The more we understand about how diseases work, the better we can create medicines and procedures to cure these diseases—and maybe even develop ways to prevent the diseases in the first place. For example, nanotechnologists use tiny robots that can work in tiny areas of the body. This can prevent patients from having to undergo invasive surgeries.

JOKES

Did you hear the joke about the germ?

Nevermind, I don't want to spread it around.

Why did the birdie go to the doctor?

To get a tweetment.



CHROMATOGRAPHY



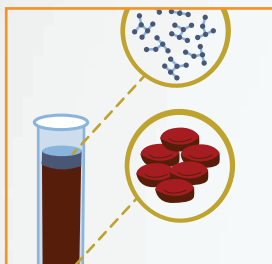
AREA: BIOTECHNOLOGY



SAFETY FIRST: HOW TO USE

- Okay for students to handle.
- Give a student the chance to turn the tube over and watch the particles move. What goes to the bottom? What stays at the top?

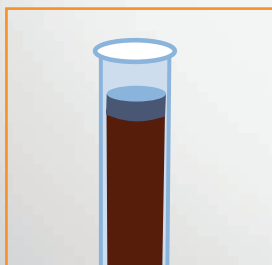
CONCEPT BREAKDOWN



- A compound is a mixture made of two or more elements.
- **Chromatography** is the separation of a compound into its separate parts.
- This allows scientists to understand the “recipe” or parts of a compound and then to change it.



- For instance, a doctor can use chromatography to study blood or urine samples. The presence or absence of different chemicals can be a clue about what’s causing a patient’s illness
- Filters like this tube sort chemicals by size. It can take some time for all the different molecules to settle.



- Heavier molecules will settle at the bottom of the tube. Lighter molecules, such as gas, will rise to the top.
- A centrifuge can do the same sorting more quickly by spinning molecules at high speed.

RELATE TO REAL LIFE!

What happens when you shake a bag of trail mix? Lighter pieces like cereal rise to the top, while heavier pieces like chocolate or peanuts sink to the bottom.

A coffee machine is another example of chromatography. The filter has holes that are large enough to let water pass through, but too small for the coffee grounds to pass through. If you put very finely ground coffee in your coffee maker, more of it will pass through the filter, and your coffee will be thick like mud!

EXHIBIT: CHROMATOGRAPHY

CHROMATOGRAPHY



QUESTIONS

What are other examples of compounds, or mixtures, that can be studied through chromatography?

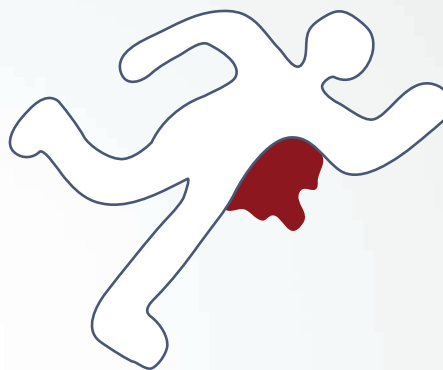
Water, blood, urine, air, crude oil, soup, paint, peanut butter – anything that has more than one ingredient! Air, for instance, is a mixture of different gases.

What are other ways to separate molecules?

You can use magnets to pull out metal; you can use evaporation to pull out water.



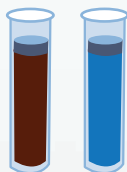
CAREER



Crime scenes can be full of clues of every shape and size, both large and small. **FORENSIC SCIENTISTS** study hair, blood, and skin cells to help investigators solve crimes.

AVERAGE SALARY: \$46,000

ADDITIONAL INFORMATION



As a **CRIMINAL INVESTIGATOR**, you can use chromatography to find clues (like poison or drugs) in a blood sample.

As a **WATER QUALITY SCIENTIST**, you can use chromatography to find out what's in your water (like algae or fertilizer runoff) and make sure it's safe to drink.

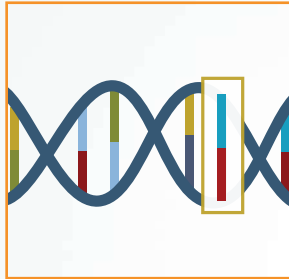
GENETIC MUTATION



SAFETY FIRST: HOW TO USE

- Okay for students to handle.
- Give each student the chance to look at each panel, then slide the panels to identify the areas that don't match.

CONCEPT BREAKDOWN



- DNA sequences, like the ones shown on these panels, contain a lot of information about a person.
- For instance, these panels can tell you that this person is a male with black hair and brown eyes, and that he has a genetic mutation that will make him more likely to go bald.
- A genetic mutation is a change in the DNA sequence.
- Genetic mutations can be inherited, caused by environmental factors, or caused by a mistake as the DNA copies itself during cell division.
- Some mutations can prevent disease. Other mutations can cause disease.
- Some mutations are helpful. For instance, some scientists believe that zebras developed stripes as natural sunscreen.

RELATE TO REAL LIFE!



How did the zebra get its stripes? A zebra's stripes are encoded in its DNA, or genetic sequence. But DNA can change over time. In another thousand years, if the sun is shining even more brightly, how do you think the zebra's stripes will change?

Have you ever heard of color-blindness? This is a mutation in humans that means some people can't see as many colors. Scientists believe a tiny percentage of women in the world have the opposite kind of mutation, which lets the eye see more colors than most people.

GENETIC MUTATION



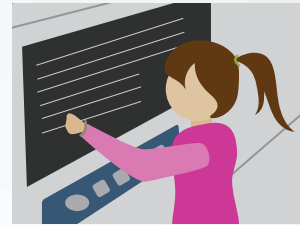
QUESTIONS

What else can we learn from studying DNA?

- We can learn whether a person is likely to develop a disease (like cancer or diabetes).
- We can learn the gender of an unborn baby.
- We can learn about a person's ancestry – where their family roots are.



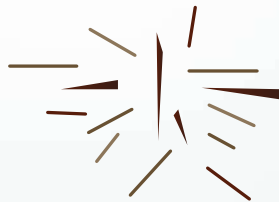
CAREER



COMPUTER SCIENCE SKILLS make you valuable in any field: for example, in a biotech laboratory that uses computers to analyze DNA, an airport that needs software to manage air traffic, or a movie studio that produces special effects through computers.

AVERAGE SALARY: \$76,000

ADDITIONAL INFORMATION



DNA IS USED IN CRIME SCENES to catch criminals. For instance, a robber might leave behind blood or hair, and scientists can identify the robber's DNA profile from that sample. The chance of two unrelated people having the same profile is around one in several billion – unless they are identical twins!

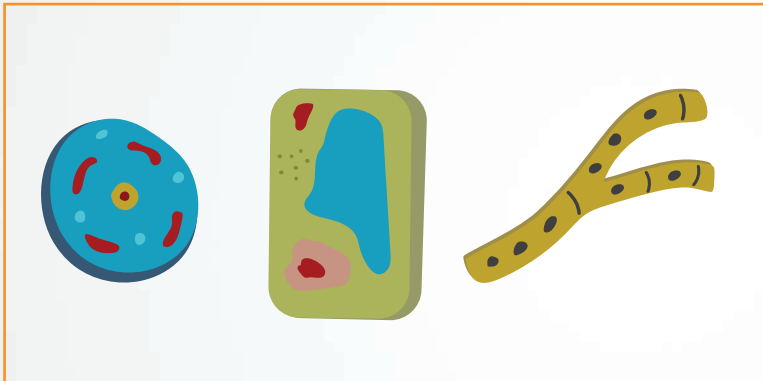
MICROSCOPE & CELLS



SAFETY FIRST: HOW TO USE

- Students may look into the microscope. They should not adjust the focus by turning any knobs.
- Ask students to look at the screen to see a magnified view of what is on the slide in the microscope. Describe what they are looking at (for instance, human saliva or blood).

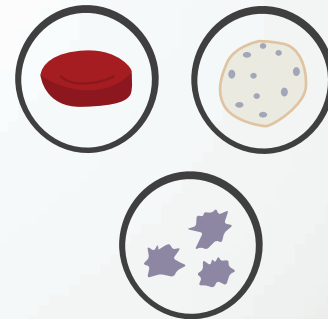
CONCEPT BREAKDOWN



- What do a fruit fly, an apple, and your best friend have in common? They – and you! – are all made of cells.
- Cells are tiny collections of protoplasm enclosed inside a membrane. They contain the proteins and acids that when put together make a fruit fly, an apple, or you.
- Cells are too small to be seen by the human eye.
- The microscope is one way to magnify these cells so that you can see them.

RELATE TO REAL LIFE!

There's a lot happening in the world that we can't see. Tools like the digital microscope give us a view of all kinds of activities: the little creatures that live on your skin, for instance, or all the little particles that make up the wall of this trailer.



A **LAB TECHNICIAN** can examine your blood to look for signs of disease like infection or anemia.

MICROSCOPE & CELLS

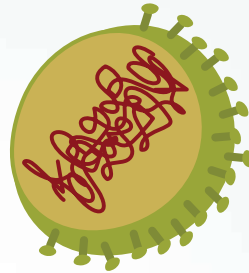


QUESTIONS

- **How many cells are in one human body?** About 37 trillion, not including the millions of microbes that live on your skin.
- **How on earth did someone figure that out?** It was way harder than guessing how many jellybeans are in a jar. Jellybeans are all the same size and they take up the same amount of space. Cells have lots of different sizes and densities. Some, like blood cells, are packed in tight. Others, like skin cells, have more space between them. Researchers figured out the different kinds of cells, then looked at the different volumes and densities, and then added them all up.



CAREER



MICROBIOLOGISTS work with tiny ("micro") organisms like bacteria, viruses, algae, and fungi. Their work can help stop diseases from spreading, help farmers grow healthy plants, and much more!

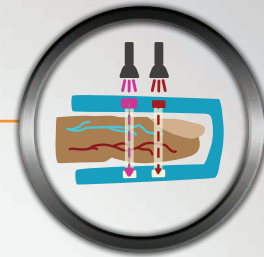
AVERAGE SALARY: \$66,000

ADDITIONAL INFORMATION



Microscopes are tubes that are packed with lenses. Lenses are curved pieces of glass that bend light rays passing through them. A simple microscope is a magnifying glass, which can usually magnify an object 5-10x. Compound microscopes use multiple lenses for even more magnification (10, 20, 40, 100, or even 1000x).

PULSE OXIMETER

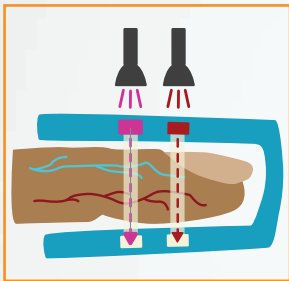


SAFETY FIRST: HOW TO USE

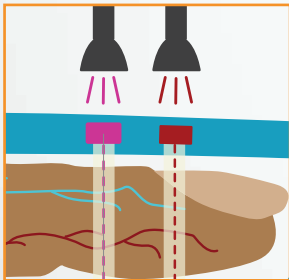
Have each student close the oximeter around their finger and hold their hand below their heart. The device reports the percentage of oxygen in their blood and their heart rate.

If their reported levels don't fall in the normal range on the posted charts, don't worry. These devices may not be completely accurate.

CONCEPT BREAKDOWN



- A pulse oximeter measures two things: your pulse (how many times your heart beats per minute) and how much oxygen is in your blood.



- The oximeter sends **red light** and **infrared light** through a translucent part of your body, like your fingertip or your ear, to see how much of the light gets through your blood. (Translucent means light can go through it.)



- If someone's blood is bright red, it's carrying lots of oxygen, which usually means that they are breathing fine.
- If someone's blood is darker, they may have a breathing or respiratory problem like asthma.

RELATE TO REAL LIFE!

Your blood is like a river: it's a transportation system that carries basic elements like oxygen and essential chemicals to wherever they are needed in the body. Red blood cells, or hemoglobin, do the work of carrying the oxygen to every cell in your body.

There are about 5 million red blood cells in a single drop of your blood. Compare that number to the amount of people living in the Houston area in 2010—almost 6 million!

Your blood also picks up waste and delivers it to the part of the body that is responsible for getting rid of it.

Blood is mostly made up of red blood cells, but it also carries white blood cells, which are your body's defenders against germs and infection.

PULSE OXIMETER



QUESTIONS

Why is it so important to have oxygen in your blood?

- All the tissues in your body need oxygen to survive.
- If the oxygen supply is interrupted, your brain may be damaged, affecting all parts of your body.

How does oxygen get to all the parts of your body?

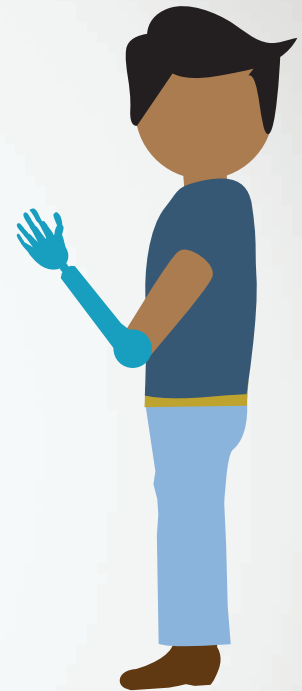
- First, you breathe it in. About 21% of the air we breathe is oxygen.
- Your lungs pull the air into the alveoli (air sacs of the lung), and then send oxygen through the body through the arteries.



CAREER

BIOMEDICAL ENGINEERS

design, create and improve medical devices like prosthetics, bioengineered skin, and 3D-printed artificial organs.



AVERAGE SALARY: \$87,000

ADDITIONAL INFORMATION



- It takes less than a minute for a blood cell to do a complete lap of your body. That's pretty fast!
- A 'heartbeat' is the sound of the valves closing as the heart pushes blood from one chamber to another.

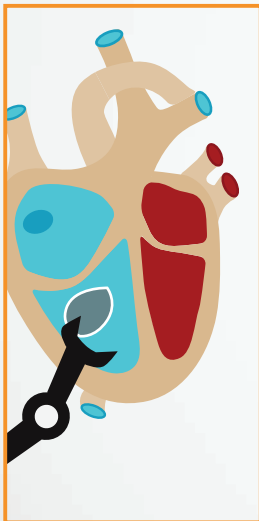
ROBOTIC SURGERY



SAFETY FIRST: HOW TO USE

- Okay for students to handle.
- Explain the controls to the students (how to go forward, backward, down, up, grab, etc.)
- Give each student no more than 30 seconds to try to remove the liver without touching the patient.
- If you hear a click and see a red light, wait a couple seconds for the green light before continuing.

CONCEPT BREAKDOWN

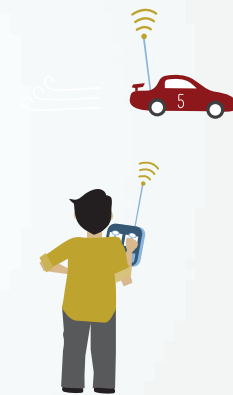


- Robots are already building cars and vacuuming floors. But did you know they also perform surgery?
- Tools like the da Vinci surgical robot and the Cyberknife help doctors perform major operations without having to make big cuts in the patient.
- One cut is made for a lighted camera so that the surgeon can see what she or he is doing. Another cut is made for the robotic tool.



- Become a surgeon and you can direct a remote-control robot to help a wounded soldier on the other side of the world, and soon, you may be able to stitch up an astronaut on the space station.

RELATE TO REAL LIFE!



Just what is a robot? A robot is a machine designed by humans to do specific tasks, like vacuum the floor, assemble a car or perform surgery. By that definition, WALL-E or R2D2 are one kind of robot, and a washing machine is another, and a self-driving car is a third kind.

ROBOTIC SURGERY



QUESTIONS

- Once we make robots who will do all the work for us, what will humans do?
- Can we design robots to have a conscience?
- If a robot has a conscience, is it still a robot?
- If a robot causes an accident, who is to blame: the robot, or the designer of the robot?



CAREER

ROBOTICS ENGINEERS design, construct and program robots to do things for humans that are difficult, repetitive, or dangerous, like explore distant planets or lift heavy debris to rescue someone after an earthquake.

AVERAGE SALARY: \$90,000



ADDITIONAL INFORMATION

A team of MIT researchers has designed a printable origami robot that measures about a centimeter from front to back. It folds itself up from a flat sheet of plastic when heated, and then can swim, climb an incline, traverse rough terrain, and carry a load twice its weight. The robot's motions are controlled by external magnetic fields.

THANK YOU!

Thank you for inspiring students and encouraging them to explore careers in STEM. We could not do this work without you, and we truly appreciate your support.

If you took photos today and plan to post to social media about your experience, please consider tagging the TAME State Office. We would like to recognize your hard work and may share images and stories on TAME.org or with our corporate partners who help bring this experience to different communities around Texas.



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