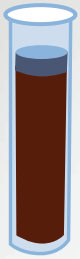
EXPLORE BIOTECHNOLOGY

EXPLORE BIOTECHNOLOGY

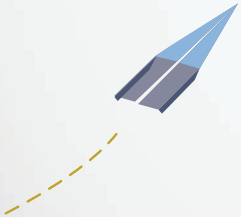


YOUR MISSION:

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

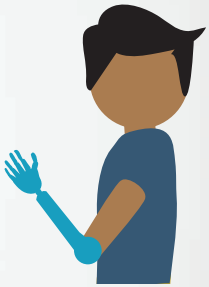
SAFETY CHECK: There's a lot to handle on these exhibits, but make sure students do it safely (no running, no poking each other in the eye, etc.)



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

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

AREA OVERVIEW

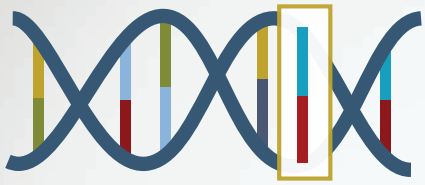


THE AGE OF BIOTECH

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.**

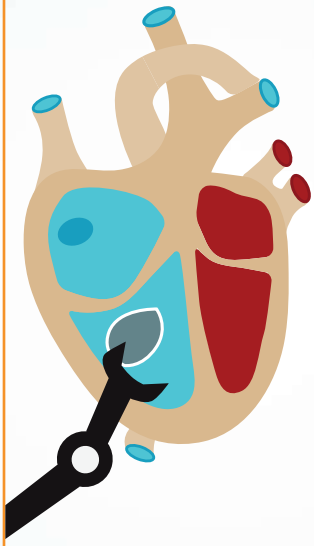
EXPLORE BIOTECHNOLOGY



- 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.

AUGMENTED REALITY (AR) ANATOMY

AREA: BIOTECHNOLOGY

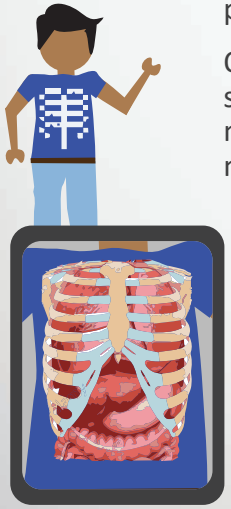
EXHIBIT: AR ANATOMY

SAFETY FIRST: HOW TO USE

- Okay for students to touch.
- Turn on the tablets stored near the mannequin and open the Curiscope Virtuali-Tee app.
- The student holds the tablet about 18 inches away from the T-shirt and points the camera at the printed skeletal pattern. An AR view of the inside of a human body should appear on the screen.
- To reveal other layers, tap on the screen where there are body parts.
- To return to the main screen, tap the leftmost button on the bottom of the screen.

CONCEPT BREAKDOWN

This app uses **AUGMENTED REALITY** (AR), a technology that places a computer-generated image on top of a user's view of the real world. AR is different from **VIRTUAL REALITY** (VR). VR creates a simulated 3D world, while AR places a digital layer of effects over a real picture.



Our bodies are made of lots of different systems working together: skeletal, muscular, digestive, cardiovascular, nervous, and others. Using the AR tool, we can look at each of these systems individually, or see how they interact with each other.

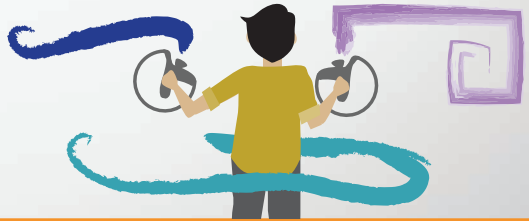
Medical students can use AR to practice their surgical skills. Once they become doctors, they can even use AR with an internal camera to perform on real patients!

RELATE TO REAL LIFE!

Have you played a game where you've captured a creature with your phone? Have you had a computer-generated pet that sat in your hand? If so, you've already used Augmented Reality (AR).

AR technology brings to life many of the most popular games and apps, and is expected to grow in popularity as the technology advances.

Have you painted on a wall using a digital paintbrush? Artists can use AR to paint virtually in 3D, using a headset and controllers.



AREA: BIOTECHNOLOGY

EXHIBIT: AR ANATOMY

AUGMENTED REALITY ANATOMY

QUESTIONS

Why would it help a medical student to use AR to look at the body's systems?

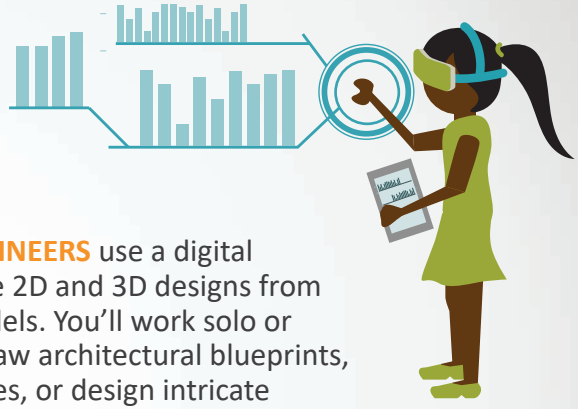
How does the AR experience compare to looking at a 2D drawing or picture?

What other jobs do you think could use AR technology?

When was VR/AR tech invented?

- The very first virtual reality device was created by computer scientist Ivan Sutherland in 1966. The head-mounted device was so heavy that it had to be hung from the ceiling, so the display was nicknamed "The Sword of Damocles."

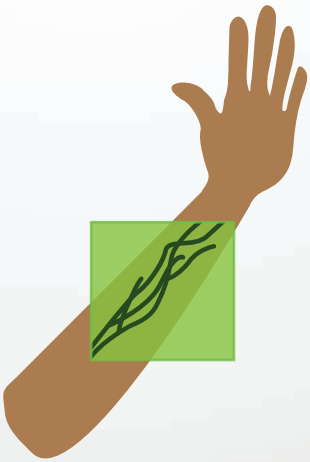
CAREER



3D GRAPHIC ENGINEERS use a digital platform to create 2D and 3D designs from sketches and models. You'll work solo or with a team to draw architectural blueprints, create video games, or design intricate machines.

AVERAGE SALARY: $68,000

ADDITIONAL INFORMATION



Nurses and doctors are using AR technology to help them find veins in their patients' arms, so they can more quickly administer medication through injections.

The screen will show the patient's arm, and overlay digital maps of where the veins should be. This makes getting a shot or an injection a lot easier on the patient.

GENETIC MUTATION

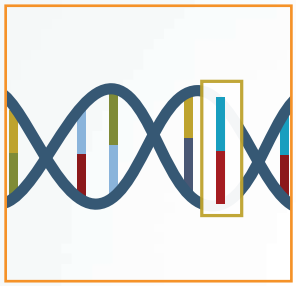
AREA: BIOTECHNOLOGY

EXHIBIT: 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 stipes 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.

AREA: BIOTECHNOLOGY

EXHIBIT: GENETIC MUTATION

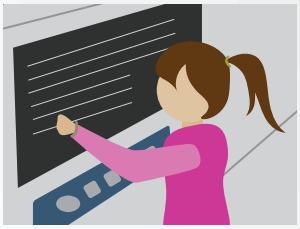
GENETIC MUTATION

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.

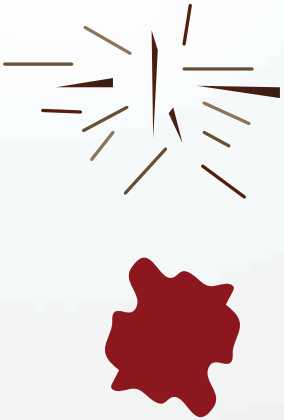
CAREER



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



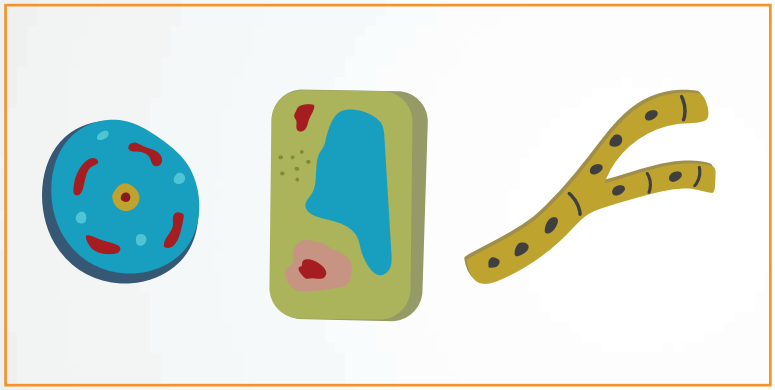
DNA IS USED IN CRIME SCENES to catch criminals. For instance, a robber might leave behind blood or hair, and scientists can identify the robber's DNA profile from that sample. The chance of two unrelated people having the same profile is around one in several billion – unless they are identical twins!

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).

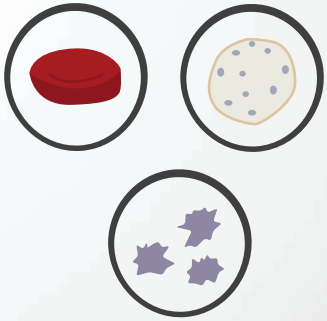
CONCEPT BREAKDOWN



- 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.

AREA: BIOTECHNOLOGY

EXHIBIT: MICROSCOPE & CELLS

AREA: BIOTECHNOLOGY

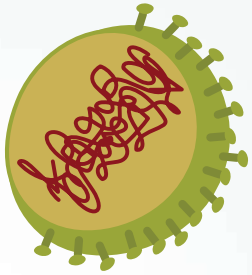
EXHIBIT: MICROSCOPE & CELLS

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



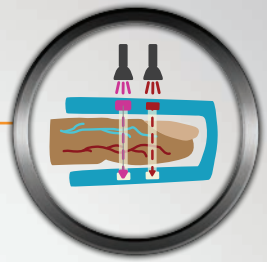
MICROBIOLOGISTS work with tiny ("micro") organisms like bacteria, viruses, algae, and fungi. Their work can help stop diseases from spreading, help farmers grow healthy plants, and much more!

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



AREA: BIOTECHNOLOGY

EXHIBIT: PULSE OXIMETER

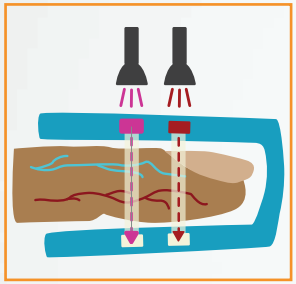
STUDENTS CAN TOUCH

SAFETY FIRST: HOW TO USE

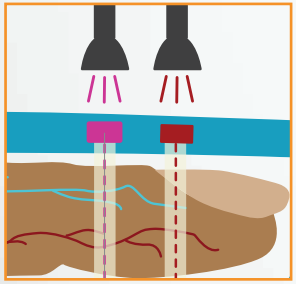
Have each student close the oximeter around their finger and hold their hand below their heart. The device reports the percentage of oxygen in their blood and their heart rate.

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.

AREA: BIOTECHNOLOGY

EXHIBIT: PULSE OXIMETER

PULSE OXIMETER

QUESTIONS

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

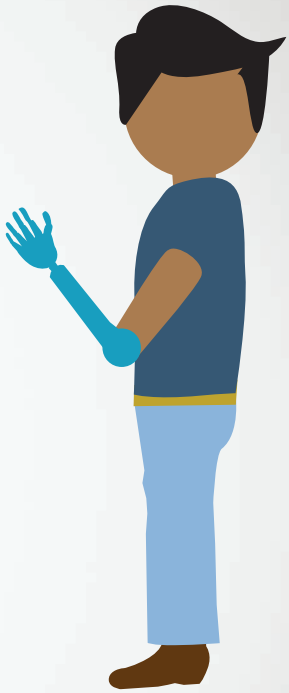
- All the tissues in your body need oxygen to survive.
- If the oxygen supply is interrupted, your brain may be damaged, affecting all parts of your body.

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

AREA: BIOTECHNOLOGY

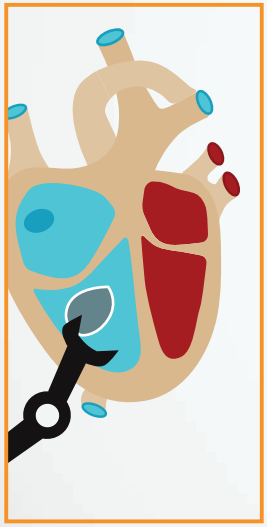
EXHIBIT: ROBOTIC SURGERY

STUDENTS CAN TOUCH

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.

AREA: BIOTECHNOLOGY

EXHIBIT: ROBOTIC SURGERY

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

AVERAGE $90,000 SALARY

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.

Facebook.com/TAMESTEM

Twitter.com/TAMESTEM

#DRIVINGSTEM

Texas Alliance for Minorities in Engineering

Schedule your own Trailblazer experience:

TAME.ORG/TRAILBLAZER