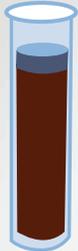


# EXPLORE BIOTECHNOLOGY





# EXPLORE BIOTECHNOLOGY



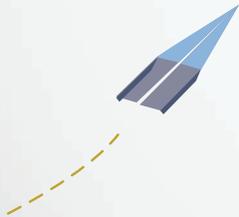
## YOUR MISSION:

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

## ADVICE ON VOLUNTEERING



**SAFETY CHECK:** Look for this symbol in the scripts. Our exhibits are hands-on, but **some require close supervision**. Make sure students explore safely (no running, no poking each other in the eye, etc.) and follow instructions from the facilitator.

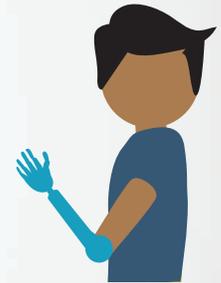


**ENCOURAGE EXPLORATION:** Ask questions about what they see, hear, and feel and make sure everyone gets a chance to participate. A little positive feedback goes a long way.



**GET EXCITED!** 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**.

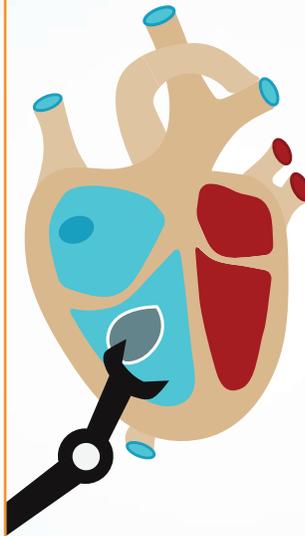
# EXPLORE BIOTECHNOLOGY



- 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 (thigh bone), 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. These microscopic machines 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

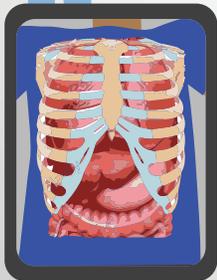


## SAFETY FIRST: HOW TO USE

- 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.

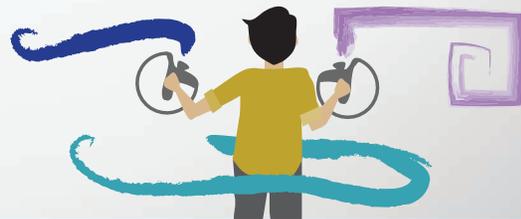
Medical students can use AR to practice their surgical skills. Once they become doctors, they can even use AR with an internal camera to perform on real patients!

## 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.



# 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?**

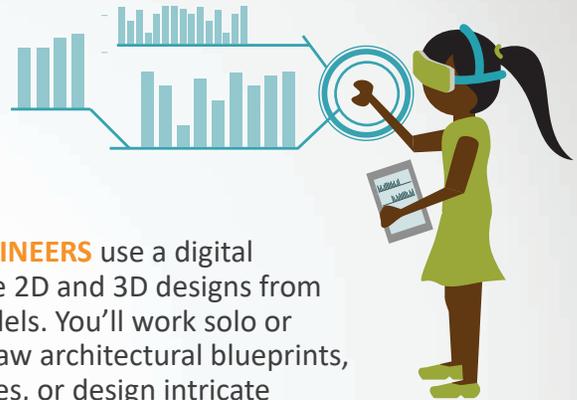
**What other jobs do you think could use AR technology?**

**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."



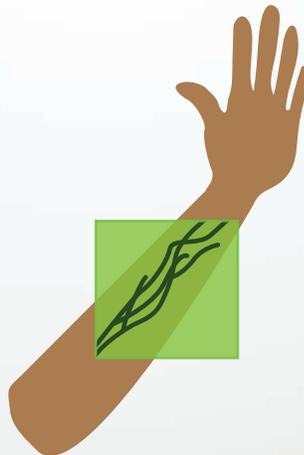
## CAREER



**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

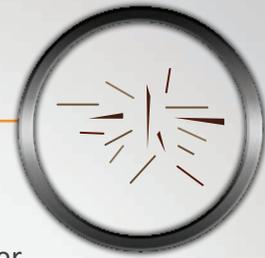
## ADDITIONAL INFORMATION



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.

# DIGITAL MICROSCOPE



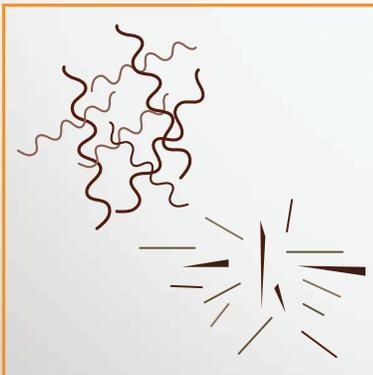
## SAFETY FIRST: HOW TO USE

- Okay for students to touch.
- Instruct students to place the microscope's handheld lens over different samples. The images will be visible on the computer screen.
- To focus the image, slide the band in the middle of the handheld lens.
- Students may also place the lens over their skin, hair, fingernail, and clothes. Use the sanitizing wipes to clean the lens after each group or whenever you feel it's needed.

## CONCEPT BREAKDOWN

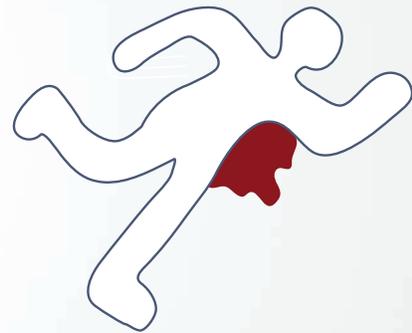


- Using digital microscopes to enlarge objects, scientists can look for clues about how people, animals, and plants live.



- These clues are normally so small you might never notice them, but the differences are clear once they are enlarged.

## RELATE TO REAL LIFE!



Imagine you are a **FORENSIC SCIENTIST** and find a tiny piece of fabric at the scene of a crime. If you can identify the material, you may be able to find the criminal. Was it someone wearing blue jeans, or someone wearing a silk dress? The microscope can tell the difference with only a single thread!

# DIGITAL MICROSCOPE



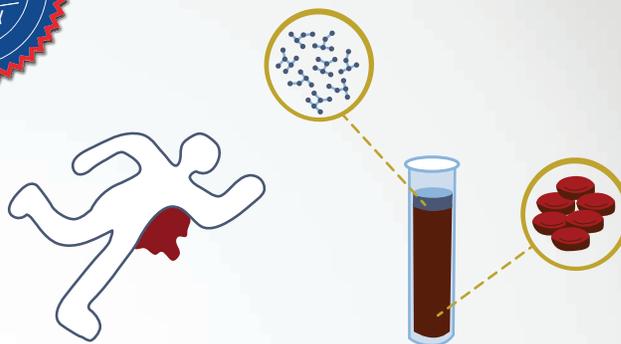
## QUESTIONS

Can you determine which strands came from silk and which came from the hare? How can you tell?

- Microscopes can also be used to examine fingerprints. Look at the lines on your own thumbprint. What patterns can you see?
- If you could look at anything under a microscope, what would it be?



## 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

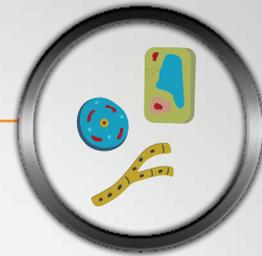
## ADDITIONAL INFORMATION



**HERE'S AN EXPERIMENT TO TRY AT HOME: LOOK AT MONEY!**

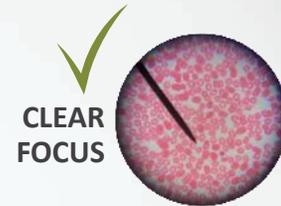
- For example, on the five dollar bill, can you find the names of states above the Lincoln Memorial?
- Can you find the initials "VBD" on a penny?
- What else can you see with a microscope or magnifying glass that you can't see using only your eyes?

# MICROSCOPE & CELLS



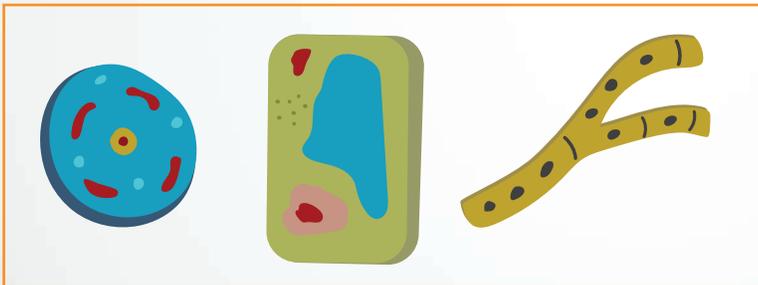
## SAFETY FIRST: HOW TO USE

- At the start of your volunteer shift, check the focus on the blood cells. If it is out of focus, have the Trailblazer Facilitator remove the cover and adjust the microscope. Examples of how it may look:



- Students should look into the microscope. They may not adjust the focus.
- Ask students to guess what they see on screen and help them understand cells.

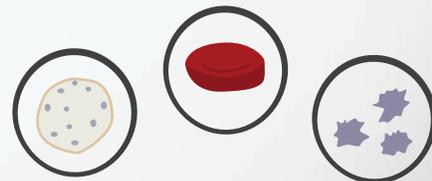
## CONCEPT BREAKDOWN



- 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 things: 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 problems like infection or anemia.

# MICROSCOPE & CELLS

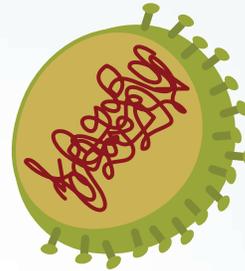


## QUESTIONS

- **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 (10x, 20x, 40x, 100x, or even 1000x).



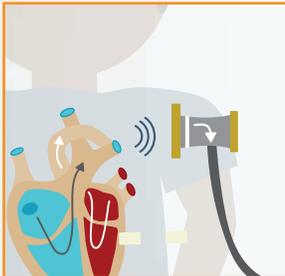
# STETHOSCOPE



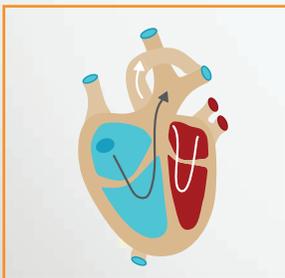
## SAFETY FIRST: HOW TO USE

- Okay for students to touch.
- Ask students to clean the earpieces with the medical wipes before placing them in their ears.
- Ask the students to listen to their heartbeat through the stethoscope. What does it sound like?

## CONCEPT BREAKDOWN



- A stethoscope can be used to listen to the internal sounds of a body, like the sounds that the lungs and heart make, and the sound of blood flowing through arteries and veins.



- A normal heartbeat makes a **lub-dub** sound. What actually makes the sound? There are two sets of valves in your heart that open and close to control the flow of blood. The **lub-dub** is the sound of these valves opening and closing.

## RELATE TO REAL LIFE!



How does a stethoscope work? Just like your eardrums, the stethoscope has a surface that is a lot like the skin of a drum that picks up sound vibrations. The difference is that it picks up vibrations from whatever it is placed against.

Those sounds then travel through tubes into the ears of the doctor or whoever is wearing the stethoscope. The earpieces of the stethoscope help to block out other sounds in the room.

# STETHOSCOPE



## QUESTIONS

### What's a heart murmur?

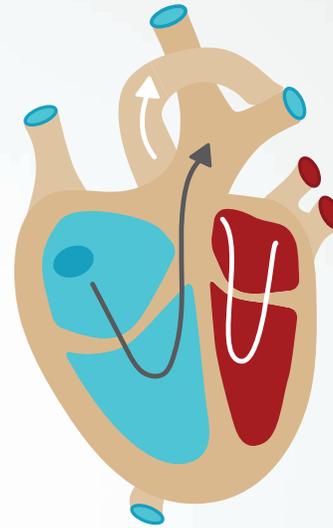
- A heart murmur is a sound that's made when the heart valves aren't working quite right. For example, if the heart valves don't close completely, some blood can leak back through the valve, making a whooshing, rasping, or blowing sound called a murmur.

### What is blood pressure?

- Blood pressure is just what it sounds like: it's a measurement of how much pressure blood puts on the walls of the blood vessels. If your blood pressure is high, this means that your heart has to work harder to push the blood around your body.



## CAREER



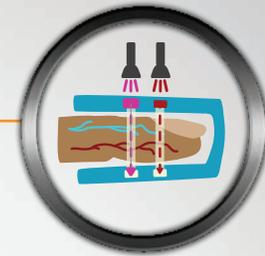
**CARDIOLOGISTS** are like mechanics for hearts, figuring out what parts aren't working and how to fix or replace them.

**AVERAGE SALARY:** \$400,000

## ADDITIONAL INFORMATION

Before **STETHOSCOPES** were invented, in the 19th century, doctors listened for heartbeats the old-fashioned way: by putting their ears against their patient's chest!

# PULSE OXIMETER

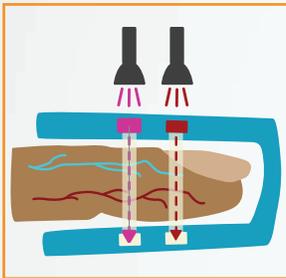


## SAFETY FIRST: HOW TO USE

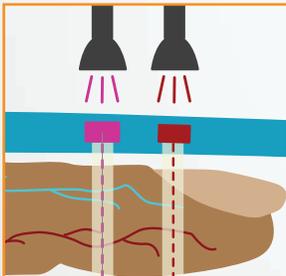
Have each student close the oximeter around their finger and hold their hand below their heart. The device reports the percentage of oxygen in their blood and their heart rate.

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 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 other kinds like white blood cells, 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?**

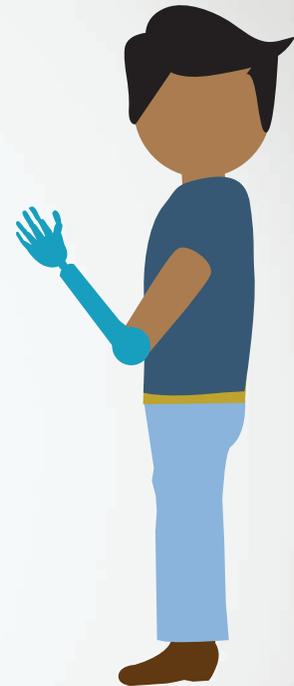
- First, you breathe it in. About 21% of the air we breathe is oxygen.
- Your lungs pull the air into the alveoli (air sacs of the lung), and then send oxygen through the body through the arteries.



## 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 heart muscle contracting and the valves closing and opening to push blood from one chamber to another.

# DIGITAL THERMOMETER



## SAFETY FIRST: HOW TO USE

- Okay for students to touch with supervision.  
**SAFETY NOTE: Do not allow the students to aim the thermometer near anyone's face. The infrared light can cause damage to eyes.**
- Have each student aim the thermometer sensor at a spot of bare skin on their arm or hand and read the temperature.

## CONCEPT BREAKDOWN



- The body temperature of a healthy adult human should be around **98.6 °F** (or 37.0 °C).
- Don't be alarmed if the temperature is not right at **98.6 °F**. Your body temperature varies throughout the day, depending upon where you are and how active you are.
- The thermometer works by capturing and measuring the invisible infrared energy naturally emitted from all objects. It offers an easy and safe method to instantly measure surface temperatures of objects which are difficult or dangerous to touch.

## RELATE TO REAL LIFE!



Why does the doctor take your temperature when you're not feeling well? Your temperature is an indicator of whether your body is fighting an infection.

The normal temperature for a human body is **98.6 °F**. When you get a fever, that means your body has identified a potential infection, and it's turning up the heat to **100 °F** or higher to drive that infection out. Doctors can help treat high fevers.

# DIGITAL THERMOMETER



## QUESTIONS

### Who's warmer, you or your dog?

- Your dog is warmer. The normal body temperature of a dog is between **101** and **102.5°F**. If you're cold, hug a dog!

### Who's warmer, you or a snake?

- That depends on where the snake is. Snakes are cold-blooded, which means their body temperature depends on their environment (and not that they are icy to the touch). Snakes can raise their body temperature by sunning themselves, or lower their body temperature by slithering into the shade. On average, most snake species try to maintain a body heat of **86°F**.



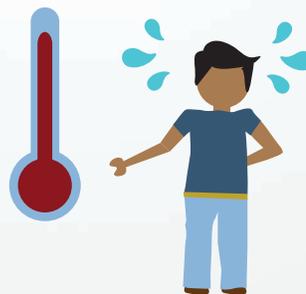
## CAREER



**VETERINARIANS** diagnose, treat, and research the injuries and illnesses of pets, livestock, and other animals.

**AVERAGE SALARY:** \$95,000

## ADDITIONAL INFORMATION



Telling a lie can make your temperature go up! Researchers in Spain found that telling a lie can increase face temperature around the nose and in the muscles in the corner of the eye. They found this out using thermographic photography, which can take pictures of temperature variations. They called this phenomenon the "**PINOCCHIO EFFECT.**"

# CT SCANS & X-RAYS



## SAFETY FIRST: HOW TO USE

- For display only
- Explain the concept of X-rays, then ask students to try to identify bones, muscle, and metal implants. What body parts are being X-rayed?

## CONCEPT BREAKDOWN



- X-rays are a lot like the light we see—both are forms of energy called electromagnetic radiation.
- X-rays are even more energetic than light waves! These energy rays are so powerful, they can go through skin, organs, and other body parts.
- Bone, fat, muscle, or tumors absorb X-rays at different levels, so they look **DARKER** or **LIGHTER** on the X-ray film.
- Because bones are so dense, they absorb the most X-rays and cast a “shadow” on the film. The shadow is very useful in medicine, because you can see inside the body without surgery. Using a special machine like a camera, the shadow can be saved like a photograph.
- What is a CT scan? If an X-ray image is a slice of bread, then a CT scan is the whole loaf: it combines flat X-ray images to create a 3D picture. That makes it useful for seeing inside complex body parts, like the brain.

## RELATE TO REAL LIFE!

What is X-ray vision? It’s a way to see inside of things. Doctors use X-rays to look at broken bones or find tumors. Dentists use X-rays to see if your teeth have cavities. Airport security machines use X-rays to find items in suitcases that might be dangerous. And astronomers use X-rays to explore the universe!



# CT SCANS & X-RAYS



## QUESTIONS

Can you tell what these images show?

- The right image is a CT scan of a head. Look for the eye sockets, lenses in the eyes and nasal cavities.
- The X-ray on the left is a femur, or thigh bone. It's the largest bone in the human body. Note the titanium plate that is screwed into the bone to repair a break. You can also see a hip replacement.

What would you guess the age is of this patient and why?

- The patient was 89 years old, female, with a hip replacement and broken femur.

## CAREER



**AVERAGE SALARY:** \$105,000

### NUCLEAR ENGINEERS

design, create, and improve cutting-edge technology that examine organs and tissues inside the body in gentle, non-invasive ways like with X-rays and CT scans.

## ADDITIONAL INFORMATION



What does the **"X" IN X-RAY** stand for? It's a mystery! The engineer Wilhelm Roentgen, who accidentally discovered the X-ray in 1895, wasn't sure why it worked, so he called it "X". The name stuck.

# 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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