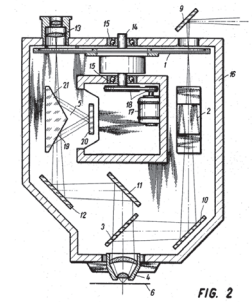
Research Imaging Tech

Learn more about the imaging technologies researchers use to make basic science and structural biology breakthroughs. Plus, explore some of the educational and career pathways that have led researchers to their areas of study.



Drawing of the first commercialized confocal microscope: the tandem scanning microscope, developed by Mojmír Petráň

1 / SELECT the imaging technology of your choice or one from the list below.

- ❒ Confocal Laser Scanning Microscope
- ❒ Scanning Electron Microscope
- ❒ Scanning Tunneling Microscope
- ❒ Cryo-Electron Microscope
- ❒ Lattice Sheet Microscope
- ❒ Fluorescence Microscope
- ❒ X-Ray Crystallography
- ❒ Raman Spectroscopy
- ❒ Nuclear Magnetic Resonance (NMR) Spectroscopy
- ❒ Cryo-Electron Tomography
- ❒ Digital Scientific Illustration or Animation (3D or 4D Modeling)

2 / CONDUCT research to find out:

- ⇨ **How the technology works**
- ⇨ **Which fields of study it's used in**
- ⇨ **The imaging result it produces** (example: 3D model, molecular-level resolution, etc.)
- ⇨ **Examples of specific images it has produced**
- ⇨ **Major milestones or discoveries associated with the technology or its advancement**
- ⇨ **How it can be used to learn more about life or human health**
- ⇨ **Types of careers that use this imaging technology**

3 / PACKAGE and PRESENT your research findings using the method of your choice:

Create a handy **user manual** or **guide**, with images.

Write a **blog post** or design an informative **webpage**.

Storyboard or create a **short video** for presentation to your class.

Write a **journal entry** or **letter** to yourself or a friend.

Confocal microscope drawing: United States Patent and Trademark Office.

Name _____

Create a Scientific Illustration

Staining is a technique biologists can use to better visualize cells, their components, and their functions under a microscope. Researchers can "label" parts of biological specimens with different dyes to add *color* (in microscopes that use light) or *contrast* (in microscopes that use electrons). A few examples of staining:

- ***Crystal violet*** **can be used to tint cell walls purple.**
- ***Nile blue*** **can stain a cell's nucleus blue.**
- ***Green fluorescent protein*** **(GFP) can be used to label organelles and proteins a glowing green.**

In addition, when scientists combine photos to create a 3D model of a specimen, they may add color to the illustration (known as colorizing) to help viewers differentiate the parts.

Colorizing Cells

Give the colorizing concept a try for yourself. On a separate piece of paper, complete challenge A or B.
Optional: Access the Imaging Resource at **bit.ly/imagingresource** to check out brightly colored examples of staining and colorizing.

CHALLENGE A	CHALLENGE B
Create an eye-catching visual aid that helps its viewers understand the function of a cell and the ways parts of cells contribute to its function. ⇨ **Draw** a diagram of a bacterium or a plant or animal cell. ⇨ **"Stain"** each component of the cell structure a different color. ⇨ **Create** a key to link your chosen stain color with each cell component. ⇨ **Provide** a brief explanation of the function of each cell component.	**Create an eye-catching visual aid that helps its viewers better understand the process of mitosis (cell division).** ⇨ **Diagram** the stages of mitosis. ⇨ **"Stain"** centrioles, chromosomes, centromeres, the nuclear membrane, and the cell membrane different colors. ⇨ **Create** a key to link your chosen stain color with each cell component. ⇨ **Provide** a brief, written explanation for each stage of the process.

Think About It

1. What are the advantages of adding color to an image of a microscopic specimen?

_____

_____

2. What are the limitations of looking at single, static photographs of cells to understanding biological processes?

_____

_____

The Colorful World of Imaging Technology

Check out some of the ways color and contrast can help scientists better visualize tiny specimens, and how this research can help human health!

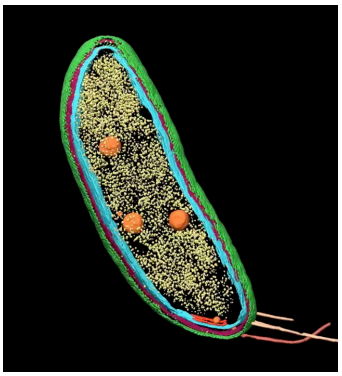
Staining and Colorizing Specimens

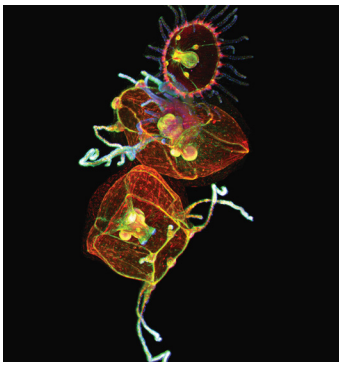
Cryo-ET image before and after colorizing

Specimen: Caulobacter bacterium

Color key: In the second image, cell membranes are highlighted in red and blue, protein shell in green, ribosomes in yellow, and storage granules in orange.

Why study this? By studying this bacterium, scientists learn more about asymmetric cell division—an important factor in our understanding of human disease and the growth of tumors.



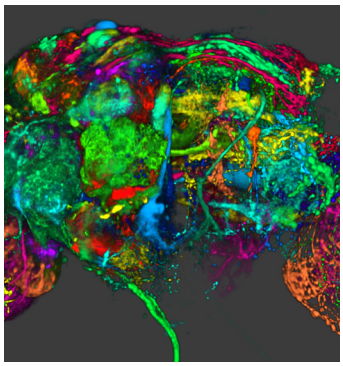


Light sheet fluorescence microscope

Specimen: Jellyfish

Color key: Nervous system is stained green. Musculature is stained red. Cell nuclei are stained blue.

Why study this? By studying jellyfish tissues, scientists learn more about the evolution of animals, including humans!



Confocal microscope + fluorescence

Specimen: Fruit fly brain

Color key: To create this digital, 3D color-coded map, scientists labeled the brain's parts with fluorescence, then captured and combined thousands of photos.

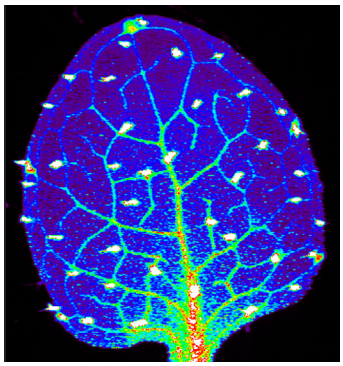
Why study this? By studying the brain of fruit flies, researchers aim to learn more about the functions and structures of the human brain.

Scanning electron microscope

Specimen: Leg muscle

Color key: Blood vessels are colorized pink (with red blood cells at the bottom). The light brown marks the extracellular matrix (ECM), made up of molecules like proteins that physically support the muscle.

Why study this? Disruption of the ECM is associated with many muscle disorders. Scientists hope to learn more about how the ECM functions and how muscle disorders can be treated.



X-ray fluorescence technology

Specimen: Leaf

Color key: The levels of zinc in the leaf from lowest to highest are marked in blue, green, red, and white.

Why study this? Zinc is required for the function of more than 300 enzymes in the human body. With a goal of improving human health, researchers are investigating how plants distribute zinc to find ways of increasing the zinc content of crops.

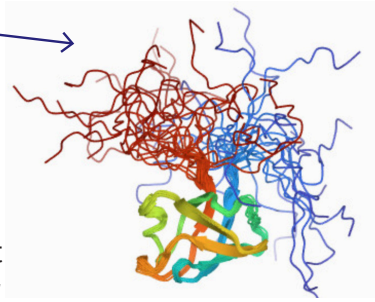
images courtesy of NIGMS.

VOCABULARY LIST

BIOLOGY

DNA *(noun):* the molecule found in cells that carries instructions for cell structure and processes in the body. DNA contains genes that are passed on from parents to offspring and give living things their inherited characteristics. The letters *DNA* stand for **d**eoxyribo**n**ucleic **a**cid.

enzyme *(noun)*: a type of protein found in animals and plants that speeds up chemical reactions by reducing the amount of energy needed for the reactions to proceed.



gene *(noun)*: a small section of DNA that contains instructions, usually for making a specific protein.

mitochondrion *(noun;* plural is mitochondria*)*: an organelle (part of a cell) that converts food and oxygen into energy to fuel the cell.

neuron *(noun)*: a cell within the nervous system that transmits information to other nerves, muscles, or gland cells.

proteins *(noun)*: large, complex molecules that are essential for all life processes, playing a key role in the structure, function, and regulation of the body's cells, tissues, and organs.

RNA *(noun)*: the molecule that delivers a copy of the instructions in DNA so that cells can produce proteins according to the instructions. The letters *RNA* stand for **r**ibo**n**ucleic **a**cid.

TAKE IT FURTHER

Choose five vocabulary words that you think will be hardest to remember, then write a paragraph with them (nonfiction or fiction).

IMAGING

crystallize *(verb):* to cause a material to organize into a crystal form in which its atoms or molecules are arranged in a highly ordered structure.

diffraction *(noun)*: the slight bending of light, or other waves (like X-rays), when passing around something in its path.

electron *(noun)*: a particle that orbits the nucleus of an atom and carries a negative electrical charge.

fluorescence *(noun)*: light that a substance (like a protein) first absorbs and then emits (gives off).

imaging *(noun)*: techniques used by scientists that make cellular, molecular, and atomic structures and processes visible.

laser *(noun)*: a very narrow beam of light, or a device that uses the vibrations of atoms or molecules to generate light.

light microscope *(noun)*: a type of microscope that uses light rays and curved glass lenses to magnify a specimen; also known as an optical microscope.

specimen *(noun)*: a sample or example of something that is used for scientific study.

structural biologist *(noun)*: a scientist who studies how biological molecules are built. Using a variety of imaging techniques, structural biologists view molecules in three dimensions to see how they are assembled, how they function, and how they interact.