GRADES 6-12

PATHWAYS

Unlocking the Mysteries of Cells & Proteins

TEACHING GUIDE

About Microscope Technologies, Biological Discoveries, and Research Careers

Visit **scholastic.com/pathways** for additional lessons, videos, and more.

BROUGHT TO YOU BY:





National Institute of General Medical Sciences

MAGAZINES & ACTIVITY

A Closer Look at Scientific Imaging

Discover the stunning images created with advancing microscope technologies. Then have your class create a gallery of colorful scientific illustrations of their own.

Objective

Students will model cell parts and functions, plus learn about technologies used to capture cellular and molecular structures.

NGSS Standards

Grades 6–8 MS-LS1-2. Model a cell's parts and its function.

Grades 9–12 HS-LS1-4. Model the process of mitosis.

HS-PS4-5. Communicate how technological devices use waves to transmit and capture information.

Time

60 minutes

Allow extra work periods to complete scientific illustrations and imaging research projects.

Materials

- ▶ Pin (or image of a pin)
- Pathways student magazine
- Create a Scientific Illustration activity sheet
- Research Imaging Tech activity sheet
- Imaging Resource sheet (bit.ly/imagingresource)

PART A

Hold up a pin. Ask students how many cells they think could fit on its head. Reveal that about 10,000 cells can fit on the head of a pin.

2 Ask: What kinds of challenges might researchers and structural biologists encounter when studying cells, proteins, molecular structures, or their atoms? Prompt for ideas like: size (too small to be seen without the help of imaging technology), appearance (can be translucent or require staining to visualize), and movement (a biological process could be moving too fast to capture, or the requirements of the imaging technology could kill the specimen, stopping the biological process).

Distribute and have students explore the themes in *Pathways* student magazine.

Have students read the main text on pages 2–3. After they read, ask them to quickly sketch one of the imaging processes they read about. In small groups or as a class, have them discuss their sketches and collaborate to deepen their understanding of the processes.

Direct students to complete the caption activity on the last page of the magazine. Have them consider advancements like 3D imaging and time-lapse imaging and make connections to ongoing lessons. For example, how might these techniques



Inside an Imaging Lab

Meet STEM pros who work with exciting imaging technology: scholastic.com/pathways/techlab

compare with static 2D images in helping students better visualize energy production in mitochondria or the process of mitosis?

- **Discuss** the career profiles on the bottom half of the last page. Have students imagine they are a structural biologist or molecular animator with access to highpowered microscopes. Ask: What would you want to study?
- **7 Distribute** and have students complete the Create a Scientific Illustration activity sheet, referring to the Imaging Resource sheet if needed. (You may wish to assign Challenge A for middle schoolers and Challenge B for high schoolers.)
- **B** Hang or compile completed student diagrams for a physical or digital gallery walk. Have students take in and respond to one another's work.
- **Extend** the learning for high school students. Distribute the Research Imaging Tech activity sheet. Once research projects are complete, have students present or share their work in small groups.

ANSWER KEY Caption Challenge in the student magazine: cell; cell division; cytoskeleton; DNA; neuron



Protein Alphabet

Researchers have found a protein in the shape of every letter of the alphabet! Have high schoolers play with the protein alphabet at: **bit.ly/proteinABC** or, for middle schoolers, project and play with the alphabet together as a class!

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.	Create an eye-catching visual aid that helps its viewers better understand the process of mitosis (cell division).
\Rightarrow Draw a diagram of a bacterium or a plant or	<⇒ Diagram the stages of mitosis.
animal cell.	<> "Stain" centrioles, chromosomes,
Stain each component of the cell structure a different color.	centromeres, the nuclear membrane, and the cell membrane different colors.
Create a key to link your chosen stain color with each cell component.	Create a key to link your chosen stain color with each cell component.
Provide a brief explanation of the function of 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?



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.

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

- **T** 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
- \Rightarrow How it can be used to learn more about life or human health
- Types of careers that use this imaging technology

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





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



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

Raman	_
Speciroscopy	
	-

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



Drawing of the first commercialized

confocal microscope:

the tandem

developed by Mojmír Petráň

scanning microscope,

FIG. 2