



# Prokaryotic and Eukaryotic Cells

## Educator Notes

### Learning Objectives

- Students will compare eukaryotic and prokaryotic cells
- Students will compare cell organelles and their functions
- Students will explore specialized parts of the space station and their functions

### Investigation Overview

Students will learn about eukaryotic and prokaryotic cells and how they are similar and different. In the STEMonstrations video, students will explore the parallels between cellular functions and the operations of the International Space Station. Additionally, students will draw and label the parts of the eukaryotic and prokaryotic cells, and create a list of organisms with each cell type.

### Investigation Preparation

The educator should:

- Read through and become familiar with this activity
- Prepare the listed materials

### Introduce the Investigation

To activate prior knowledge, ask students the following questions:

- What is the difference between eukaryotic and prokaryotic cells?
- What is the function of a cell organelle?
- List some parts of the space station. Why do you think the parts are important on the space station?

### Facilitate the Investigation

#### Engage

- Watch the Cell STEMonstrations video found at [STEMonstrations | NASA+](#)
- Have students complete the chart below, except the last column, while watching the STEMonstrations above by briefly describing the organelles' function and listing the part of the space station with a similar function
- Students will share their charts with each other in a Think/Pair Share, discussing the differences in eukaryotic and prokaryotic cells

## Grades 6 to 12

### Suggested Pacing

45 to 60 minutes

### Materials

- ☐ Colored pencils
- ☐ Science Journal
- ☐ Cell Organelle Chart

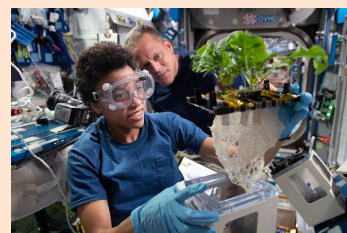
### National STEM Standards

MS-LS1-1

MS-LS1-2

HS-LS1-1

HS-LS1-2



[Cell Biology Tech Demo \(SpaceX-2\)](#)

## Educator Answer Key for the Cell Function Chart

Cell Organelle	Function	Space Station Part	Eukaryotic, Prokaryotic, or Both
<b>Nucleus</b>	Contains genetic material and instructions for cell	Tranquility Module	Both
<b>Cell membrane</b>	Exterior barrier with channels and pores built from protein molecules to allow certain substances to enter or leave the cell	Exterior Barriers	Both
<b>Cytoskeleton</b>	Provides support in the cell and is made of interlinking protein filaments	Truss	Eukaryotic
<b>Cytoplasm</b>	Cell fluid that contains organelles and cytoskeleton and allows intracellular movement	Atmosphere	Both
<b>Vacuoles</b>	A cell's storage spaces for storing cellular material waste and water	Zarya Module	Both
<b>Mitochondria</b>	Powers the cell	Lithium Ion Batteries	Eukaryotic
<b>Golgi Apparatus</b>	Processes and packages proteins in a cell	Cargo Transfer Bags	Eukaryotic
<b>Chloroplasts</b>	Plant cell organelles that convert sunlight in stable forms of energy	Solar Arrays	Eukaryotic
<b>Lysosomes</b>	Breaks down and recycles wastes and pathogens for use in the making of new cellular parts	Recycling System	Eukaryotic

### Explore

- Share the AskNASA video: [What is the International Space Station?](#) and discuss the parts that were in the STEMonstrations video (Solar Arrays, Docking Station, Truss, Zarya Module, Tranquility Module, Recycling System)
- In pairs, students will choose a part of the International Space Station they would like to visit and create a list of five facts using this website: [International Space Station Assembly Elements](#)
- In small groups, students will share the part of the space station they researched

### Explain

- Review eukaryotic and prokaryotic cells, their similarities and differences, and their functions, using the *Background Information and NASA Context sections*
- Students will complete the last column in the chart above to categorize each cell organelle
- Students will draw and label the eukaryotic and prokaryotic cells, draw the International Space Station, and label all three and complete a side by side comparison
- Check student's drawings for accuracy

### Elaborate

- Go over the Cell Biology Lab and the research conducted on the space station using the *Background Information and NASA Context sections*
- Students will research and present on an experiment currently being conducted on station regarding cells and propose another (cell-related) topic they would like to suggest for NASA to further investigate
- Use this website for research: [Space Station Research Explorer on NASA.gov](https://www.nasa.gov/learning/our-work/space-station-research-explorer)
- Students can create a presentation, video, brochure, etc.

### Evaluate

Engage students with the following discussion questions:

- What do prokaryotic and eukaryotic cells have in common?
- What is one example of a prokaryotic cell and a eukaryotic cell?
- List two characteristics of a eukaryotic cell and a prokaryotic cell
- List two parts of the space station that are similar to parts of a cell

### Share






Students will collaborate in small groups to present their research on a chosen space station cell biology experiment.

## Extensions

Review the Photosynthesis STEMonstrations to study the effects of microgravity on plant growth: [STEMonstrations: Photosynthesis | NASA+](https://www.nasa.gov/learning/our-work/stemonstrations-photosynthesis)

## Assessment

### Rubric for 5E Instructional Model

5E Step	Novice (0)	Apprentice (1)	Journey person (2)	Expert (3)	Level of student knowledge (Score)
 <b>Engage</b>	Student does not identify any prior knowledge or connections to previous learning experiences	Student identifies irrelevant or inaccurate prior knowledge or connections to previous learning experiences	Student identifies one example of relevant and accurate prior knowledge or connection to previous learning experience	Student identifies two or more examples of relevant and accurate prior knowledge or connections to previous learning experiences	
 <b>Explore</b>	Student does not participate in brainstorming discussion	Student participates in brainstorming discussion (asks questions, for example) but does not contribute possible hypotheses, solutions, or tests	Student contributes at least one possible hypothesis, solution, or test to brainstorming	Student contributes at least one possible hypothesis, solution, or test to brainstorming and an alternative or improvement to another student's idea	
 <b>Explain</b>	Student does not provide explanation of observations	Student provides an explanation of observations that is inaccurate, incomplete, or lacks evidence	Student provides an accurate, complete explanation of observations based on evidence	Student provides an accurate, complete explanation of observations based on evidence and supplements their reasoning with either evidence or evidence-based explanations from others	
 <b>Elaborate</b>	Student does not draw reasonable conclusions based on evidence	Student draws reasonable conclusions but does not utilize scientific terminology or evidence	Student draws reasonable conclusions utilizing scientific terminology and evidence	Student draws reasonable conclusions utilizing scientific terminology as well as evidence and can make reasonable predictions based on those conclusions	
 <b>Evaluate</b>	Student does not demonstrate understanding of concept or can only repeat provided definitions	Student demonstrates an understanding of concept by providing definitions or explanations in their own words, drawings, models, etc.	Student demonstrates an understanding of concept by applying it to new questions or by analyzing new evidence	Student demonstrates an understanding of concept by explaining how evidence caused their knowledge to progress over time or by proposing new ways to use their new knowledge (such as follow-up experiments)	

## Reference

[NASA Astrobiology Institute](#)

[International Space Station Facts and Figures - NASA](#)

[International Space Station Lithograph](#)

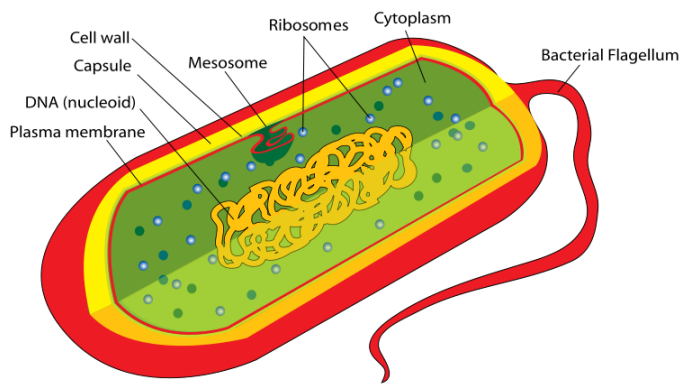
[Space Station Research Explorer](#)

[Space Cell Biology - NASA](#)

[Prokaryotes Are So Over: Pace Makes the Case | News | Astrobiology \(nasa.gov\)](#)

## Background Information and NASA Context

### Eukaryotic and Prokaryotic Cells

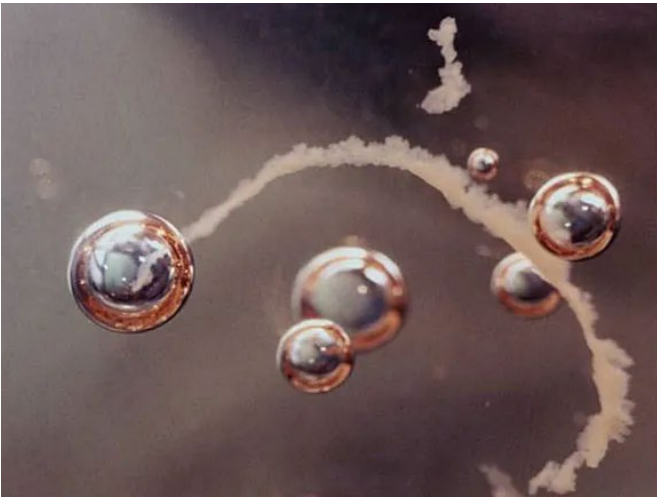


Prokaryote Cell

When scientists first started to classify life, they designated everything as either an animal or a plant. But, as new forms of life were discovered and our knowledge of life on Earth grew, they added new categories called 'Kingdoms.' There eventually came to be five Kingdoms in all — Animalia, Plantae, Fungi, Protista, and Bacteria.

The five Kingdoms were generally grouped into two categories called Eukarya and Prokarya. Eukaryotes represent four of the five Kingdoms (animals, plants, fungi, and protists). Eukaryotes are organisms whose cells have a nucleus — a sort of sack holding the cell's DNA. Animals, plants, protists, and fungi are all eukaryotes because they all have a DNA-holding nuclear membrane within their cells.

The cells of prokaryotes, on the other hand, lack this nuclear membrane. Instead, the DNA is part of a protein-nucleic acid structure called the nucleoid. Bacteria are all prokaryotes.



## Space Cell Biology

The Space Cell Biology (SCB) Laboratory, located at NASA's Johnson Space Center in Houston, Texas, is a facility that performs conditional 2D cell culture as well as 3D tissue engineering in a variety of bioreactors. In the 1980s, NASA discovered how to use microgravity to improve tissue culture technology and developed a method to model 3D conditions in a ground-based rotating bioreactor. Tissue types previously grown in the rotating bioreactor at NASA include skin, muscle, bone, cartilage, heart, pancreas, liver, prostate, and many others.

The primary functions of the SCB Laboratory are to create tissue models to explore solutions to health risks encountered during human spaceflight, support payload experiments conducted in the International Space Station National Laboratory, and enable external investigators interested in using 3D culture for their research. The SCB Laboratory personnel train astronauts in basic cell biology concepts and techniques to prepare them for future biological research experiments on the International Space Station. Experiments conducted aboard the space station continue to validate the findings of ground-based research using the NASA Rotating Bioreactor. Some experiments aim to determine the effects of microgravity on cells, while other experiments use microgravity as a unique environment in which to create 3D tissue structures we use in research studies.



## International Space Station

The International Space Station is larger than a six-bedroom house with six sleeping quarters, two bathrooms, a gym, and a 360-degree bay window. Five space agencies, including NASA, Roscosmos, ESA (European Space Agency), JAXA (Japan Aerospace Exploration Agency), and CSA (Canadian Space Agency), have contributed to the station's assembly. An international crew of seven people live and work while traveling at a speed of five miles per second, orbiting Earth about every 90 minutes. Sometimes more are aboard the station during a crew handover. Through Expedition 60, the microgravity laboratory has hosted nearly 3,000 research investigations.



# Prokaryotic & Eukaryotic Cells Student Worksheet

## Your Investigation

### Engage

Your educator will show you the STEMonstrations Cell Organelles Video.

- Complete the Cell Function Chart below by briefly describing the organelles' function and list the part of the space station that has a similar function; then, share finished charts with a partner

### Explore

Your educator will show the AskNASA video: [What is the International Space Station?](#)

- In pairs, you will choose a part of the space station you would like to visit and create a list of five facts using this website: [International Space Station Assembly Elements - NASA](#)
- In small groups, share the part of the space station you researched

### Explain

- In your journals, you will draw and label the eukaryotic and prokaryotic cells and the space station and compare them
- Complete the last column on the Cell Function Chart
- Your educator will go over the similarities and differences between the three

### Elaborate

- Research and present on an experiment conducted on the space station regarding cells, and propose another (cell-related) topic you would like to suggest for NASA to further investigate
- Use this website for research: <https://www.nasa.gov/mission/station/research-explorer/>
- Create a presentation, video, brochure, etc.

### Evaluate

Answer the following questions in your science journals:

- What do prokaryotic and eukaryotic cells have in common?
- What is one example of a prokaryotic cell and a eukaryotic cell?
- List two characteristics of a eukaryotic cell and a prokaryotic cell
- List two parts of the space station that are similar to parts of a cell

### Share

- Share research presentations with the class



International Space Station



NASA astronaut Shane Kimbrough sets up a microscope.

### Career Corner

Lynn Margulis pushed the boundaries of knowledge in many fields in astrobiology. She was the first female principal investigator of NASA's Exobiology Program.

Learn more: [Margulis | Heroes | Astrobiology \(nas.gov\)](#)

## Cell Function Chart

Complete the Function and Space Station Part columns while watching the video.

Cell organelle	Function	Space Station Part	Eukaryotic, Prokaryotic, or Both
Nucleus			
Cell membrane			
Cytoskeleton			
Cytoplasm			
Vacuoles			
Golgi apparatus			
Lysosomes			
Chloroplasts			
Mitochondria			