THE CELL
&
MODERN CELL THEORY

THE INTRODUCTION

Imagine shrinking down smaller than the eye can see—so small you could walk right into the building blocks of life. Welcome to the microscopic world of cells! In this unit, you'll explore what makes cells the most important part of every living thing—from tiny bacteria to the tallest trees and even you.

We'll kick things off by uncovering the Cell Theory—the big three ideas that explain how all life is built. Then, we'll zoom in on the two main types of cells: prokaryotic and eukaryotic. One is simple and ancient, while the other is complex and full of compartments (kind of like rooms in a house). You'll learn what sets them apart, and what they still have in common.

Next, we'll take a guided tour through the organelles, the "little organs" that keep cells alive and working. From the nucleus that holds your genetic blueprint, to the mitochondria that power the cell like a battery, each part has a special job. You'll even get to compare plant and animal cells and discover how structures like the chloroplast help plants make their own food!

By the end of this unit, you'll be able to:

- Explain the Cell Theory and why it's so important.
- Compare prokaryotic and eukaryotic cells like a true cell expert.
- Identify the parts of a cell and explain what each one does.

Whether you're solving mysteries about how your body works, or thinking about life on other planets, understanding cells is your first step. Get ready to explore life at its smallest—and most fascinating—level!

VOCABULARY

Vocabulary Word	Definition
autotrophs	
cell	
cell membrane	
cell theory	
cell wall	
chloroplast	
cytoplasm	

VOCABULARY CONTINUED

Vocabulary Word	Definition
eukaryote	
endoplasmic reticulum	
equilibrium	
Golgi bodies	
heterotrophs	
lipid bilayer	
lysosome	

VOCABULARY CONTINUED

Vocabulary Word	Definition
mitochondrion	
nucleus	
organelles	
prokaryote	
ribosome	
vacuole	

THE PHENOMENA

"The Red Frontier"

The hatch of the rover hisses open as you take your first step onto the rusty surface of Mars. Your boots crunch into the orange-red soil as you scan the empty horizon. The silence is unreal—no wind, no birds, just the distant hum of your life support system. You were only supposed to collect rock samples near Olympus Mons, but something strange catches your eye near a cluster of jagged basalt outcroppings.

A dark, pulsating mound sits half-buried in the dust. It's unlike anything in your mission training. The surface shimmers faintly, like it's coated in a thin film of slime, and tiny bubble-like pockets expand and collapse along its side. Is it moving... or are you just imagining it? You quickly pull out your sampling tool and secure a piece in a sterile container. Back in the Mars HAB, you prep your makeshift lab. This could be the discovery of the century—but first, you have to figure out: Is this growth alive?

The 8 Characteristics of Life

To be considered alive, an organism must exhibit all eight of these characteristics:

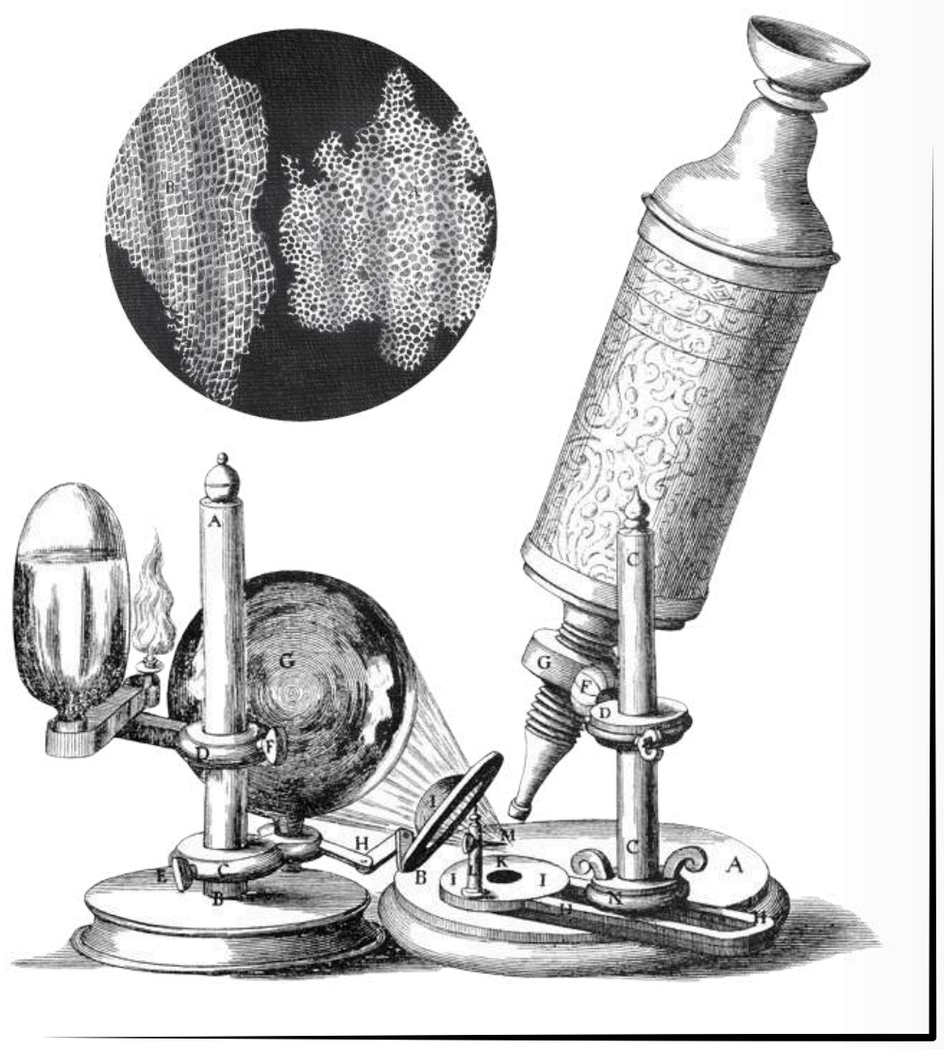
- Made of cells – All living things are made of one or more cells.
- Reproduction – Living things reproduce, either sexually or asexually.
- Based on a universal genetic code (DNA) – Organisms use DNA to pass on traits.
- Growth and development – All living things grow and change over time.
- Obtain and use energy – Living things perform metabolism (chemical reactions to build or break materials).
- Response to environment – Organisms respond to stimuli (light, sound, temperature, etc.).
- Homeostasis – Living things maintain a stable internal environment.
- Evolution/adaptation – Over generations, living things change and adapt to their environments.

In this unit, you'll learn how scientists define what "life" actually is, starting with cell theory—the idea that all living things are made of cells, and all cells come from other cells. Using the strange Mars growth as your mystery case, you'll explore how we use the 8 characteristics of life to decide what counts as living. Get ready to think like an astrobiologist, observe like a cell biologist, and uncover what it really means to be alive.

1. Based on your initial observations, list three characteristics of life you could test in the HAB to help determine if the Mars growth is living. Explain why each one is important.
    - "One characteristic of life I would test is _____ because _____."
    - "Another important characteristic to test is _____. This helps us determine life by _____."
    - "A third characteristic I would investigate is _____ since _____."
2. The Mars growth appears to respond to changes in light and temperature. Which characteristic of life does this suggest, and why does this matter in deciding if it's alive?
    - "The characteristic of life this observation supports is _____."
    - "This matters because living things must be able to _____."
    - "If the growth responds to its environment, it suggests that _____."
3. You break down a piece of the sample and place it under a microscope. Describe what you would be looking for at the cellular level to support the claim that this growth is alive.
    - "Under the microscope, I would look for _____."
    - "If I observe _____, it would support the idea that the growth is made of cells."
    - "According to the Cell Theory, all living things _____, so this evidence would be important."

DISCOVERIES

- In 1665, [ ] used a microscope to examine a thin slice of cork.
  - What he saw looked like [ ]
  - He called these boxes [ ] after the rooms that monks lived in.
- In 1673, [ ] (a Dutch microscope maker), was first to view organisms (living things).
  - Leeuwenhoek used a simple, handheld microscope to view pond water & scrapings from his teeth.
- In 1838, a German botanist named [ ] concluded that all plants were made of cells.
  - Schleiden is a cofounder of cell theory.
- In 1839, a German zoologist named [ ] concluded that all animals were made of cells.
- Schwann also co-founded cell theory.
- In 1855, a German medical doctor named [ ] [ ] observed, under the microscope, cells dividing.
  - He reasoned that all cells come from other pre-existing cells by cell division.



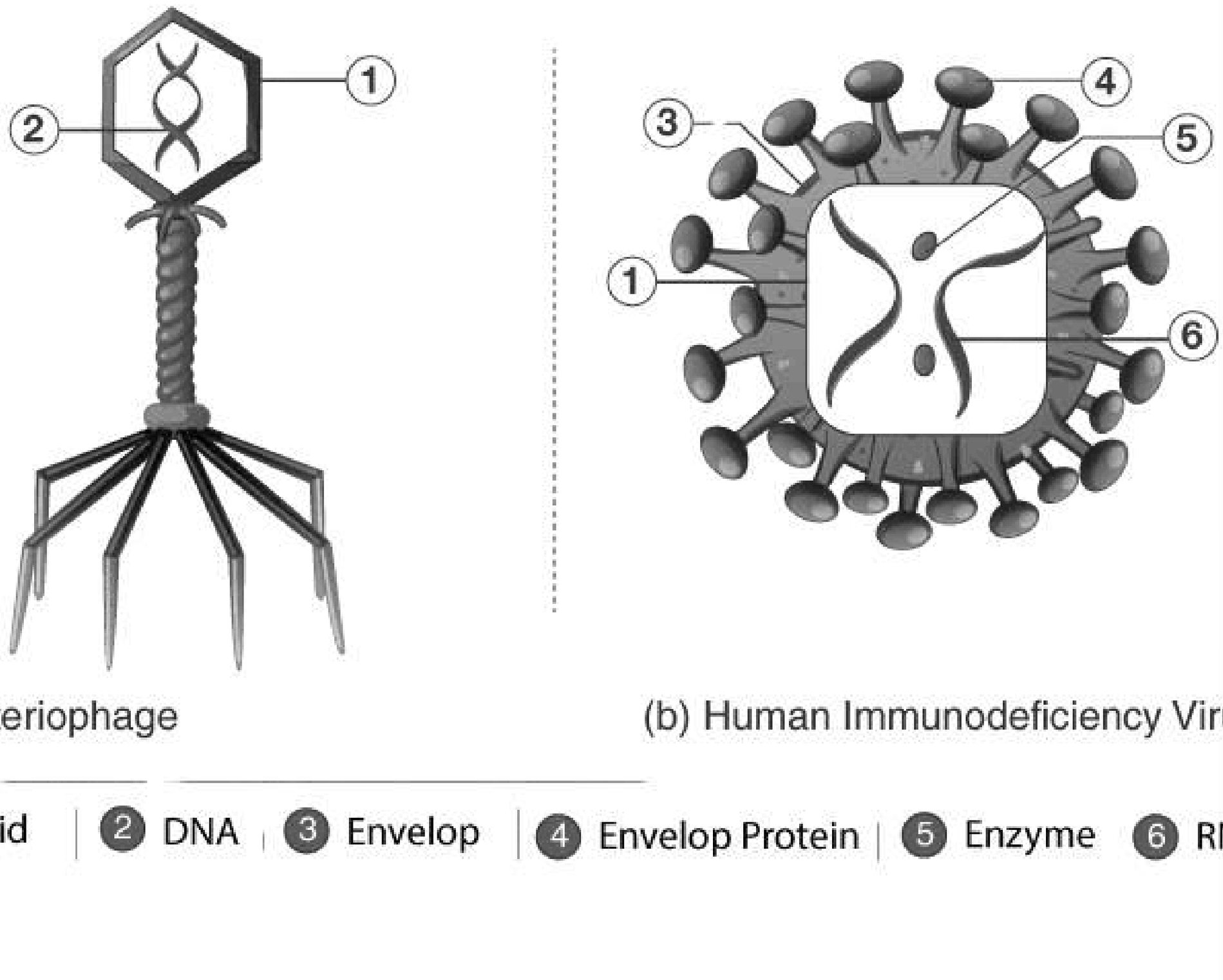
- Three Parts
  a. All living things
  b. Cells are the in an organism (basic unit of life)
  c. Cells come from the reproduction of (cell division)

1. What were some key scientific observations made by Robert Hooke and Antonie van Leeuwenhoek that contributed to the development of the cell theory?
2. How did Matthias Schleiden's work with plants and Theodor Schwann's work with animals contribute to our understanding of cells?
3. Why is Rudolf Virchow's concept of "cellular pathology" considered a crucial step in the development of the cell theory?
4. How did the development of microscopes impact the discovery and study of cells?

ARE VIRUSES ALIVE?

What is living? Viruses

- Viruses are ____
  - They have some properties of life but not others
  - Viruses ____
  - They can't maintain a constant internal state (____).
  - Disease-causing, nonliving particle.
  - Composed of an inner core of ____
  - Enclosed by one or two ____
  - Reproduces only in ____



(a) Bacteriophage

(b) Human Immunodeficiency Virus

1 Capsid | 2 DNA | 3 Envelop | 4 Envelop Protein | 5 Enzyme | 6 RNA

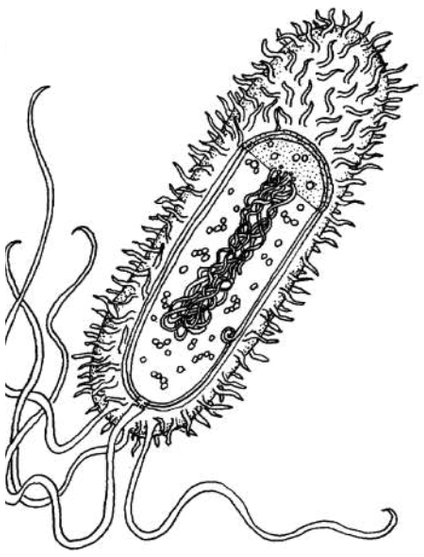
- Factors Affecting Cell Size
  - [ ] (plasma membrane surface) is determined by multiplying length times width (L x W)
  - [ ] of a cell is determined by multiplying length times width times height (L x W x H)
  - Therefore, Volume increases FASTER than the surface area
    - When the surface area is no longer great enough to get rid of all the wastes and to get in enough food for

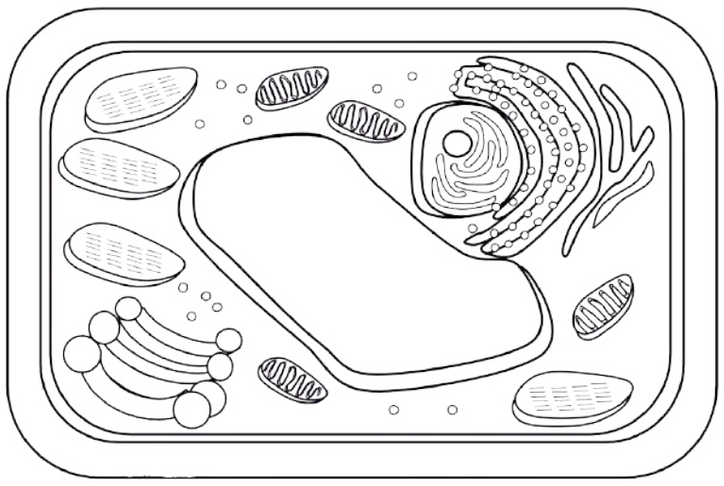
BASIC CELLULAR STRUCTURE

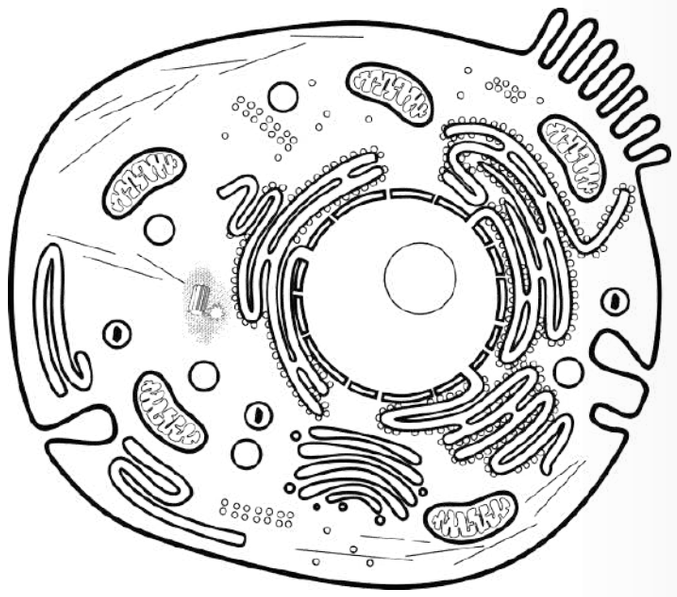
[ ] are cells that have a nucleus and membrane-bound [ ]

- Includes protists, fungi, **plants**, and **animals**
- More complex type of cells
- Contain 3 basic cell structures:
  - [ ]
  - [ ]
  - [ ]
- Once they get too large, then the cell must [ ]
- Therefore, the cells of an organism are close in size

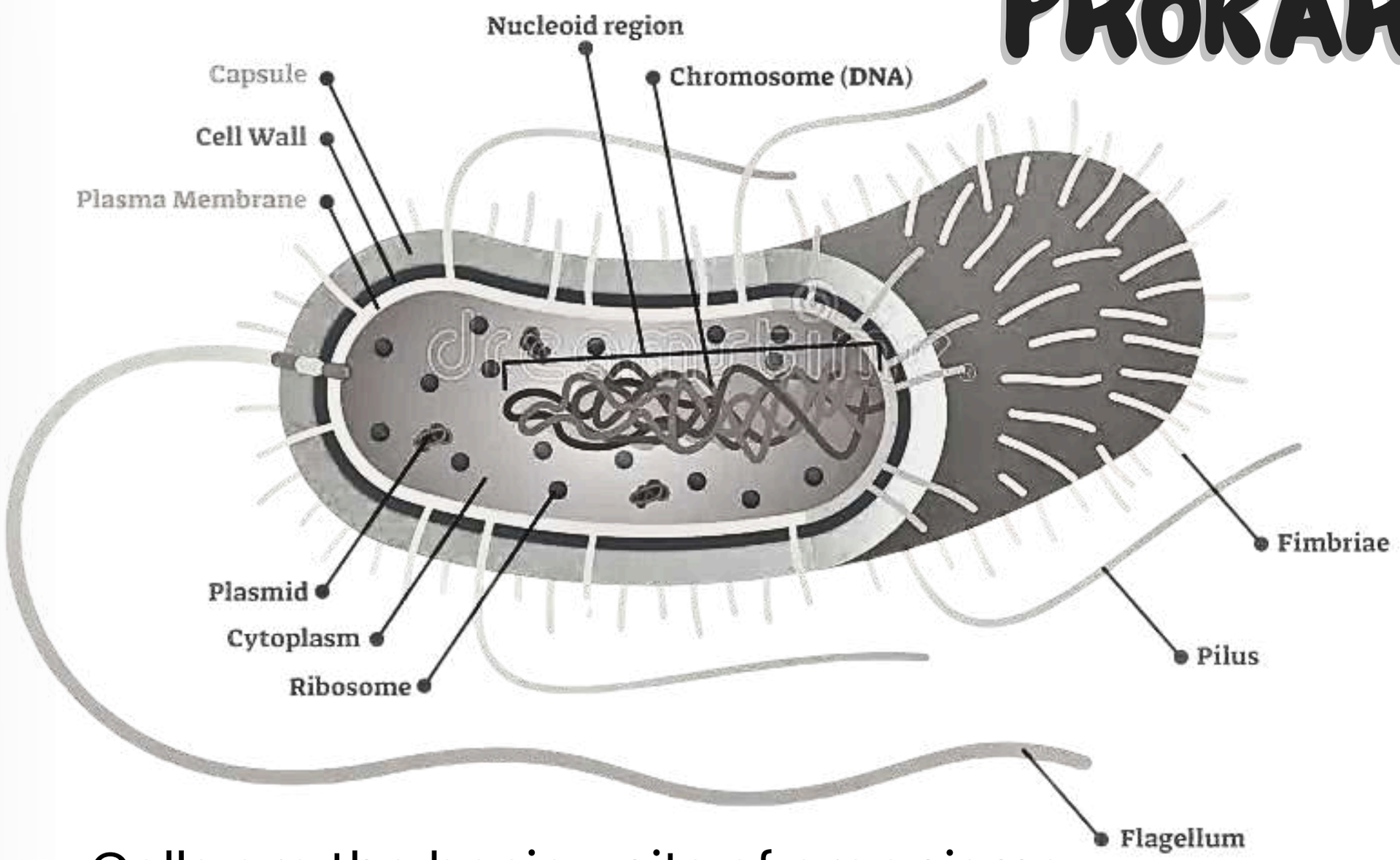
1. What are the main things that make eukaryotic cells different from other cells, like prokaryotic cells?
2. How do parts of eukaryotic cells surrounded by membranes, called organelles, make these cells more complex?
3. What are some important parts inside eukaryotic cells, and what jobs do they do?
4. How did finding the nucleus inside eukaryotic cells help us understand them better?
5. What do mitochondria and chloroplasts do in eukaryotic cells, and how are their jobs different?







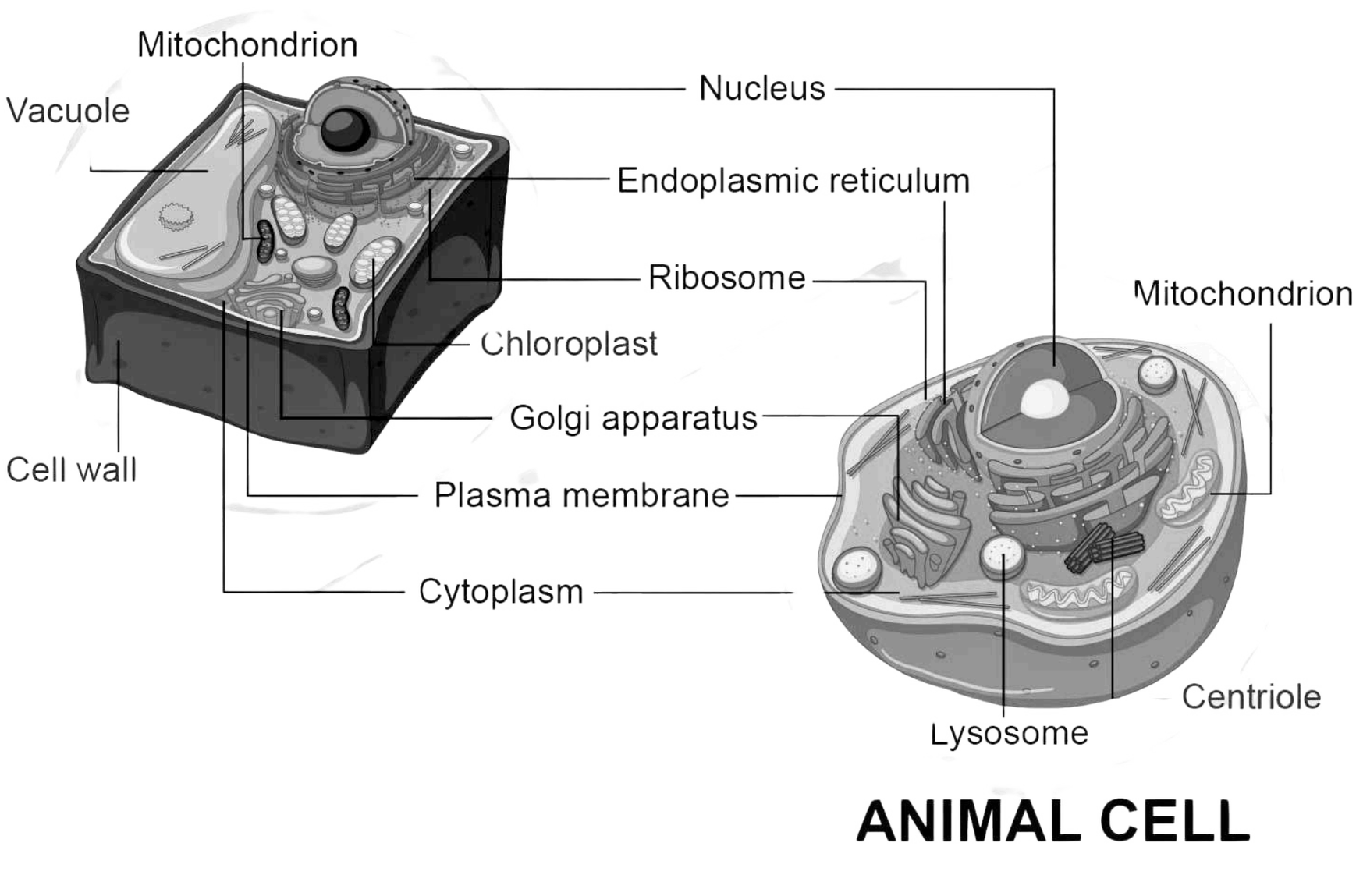
PROKARYOTE



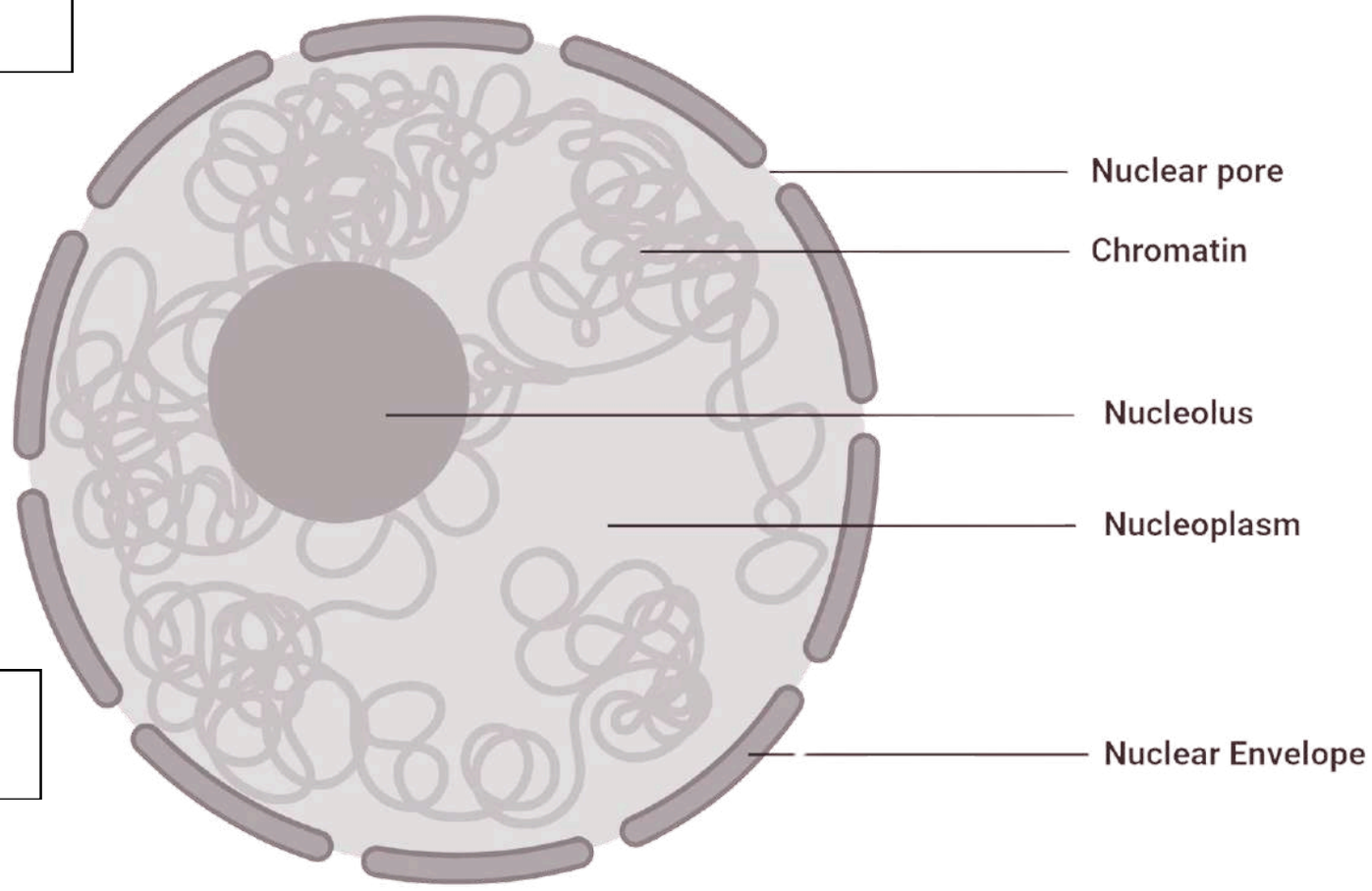
- Cells are the basic units of organisms
- Cells can only be observed under microscope
- Basic types of cells:
  - [ ]
  - [ ]
- Although ALL living things are made of cells, organisms may be:
  - [ ] – composed of one cell
  - [ ]- composed of many cells that may organize into tissues, etc.
- Cells may be [ ]
  - Prokaryotes include [ ] & lack a [ ] or membrane-bound structures called [ ]
  - Prokaryotes have:
    - [ ] that contains the DNA
    - [ ] & [ ]

1. What makes prokaryotic cells different from other cells, and how are they unique?
2. How do prokaryotic cells look inside, and what parts do they have that help them function?
3. How do prokaryotic cells make more of themselves, and what are plasmids?
4. Can you name some places where we find prokaryotic cells, and what are they like?
5. How do prokaryotic cells get energy, and what do ribosomes do for them?

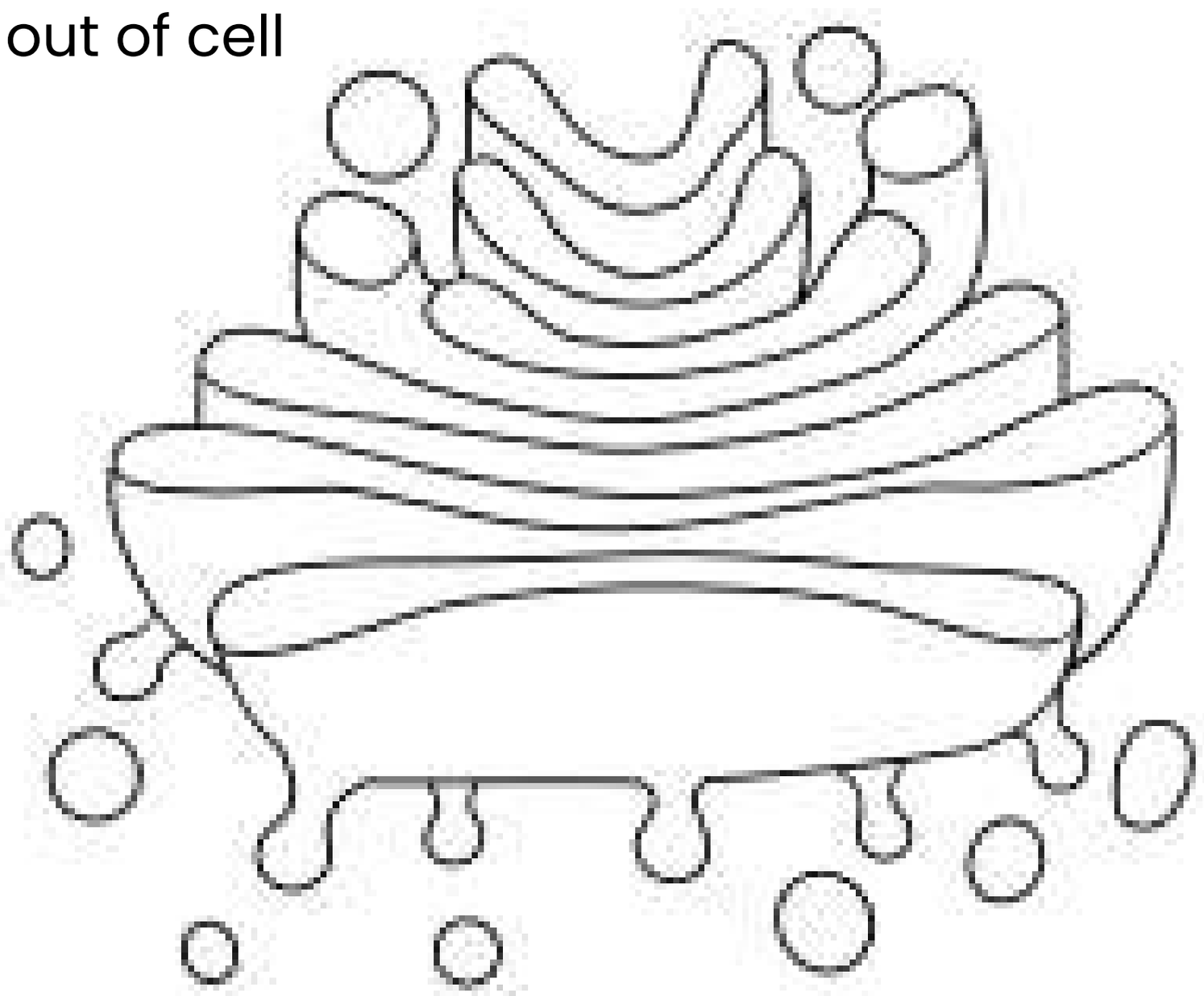
EUKARYOTES - "TRUE NUCLEUS"



- Characteristics:
- Very small (Microscopic)
- Perform various functions for a cell
- Found in the
- May or may not be
-
  - the normal activities of the cell
  - Contains the DNA in
  - Bounded by a nuclear envelope (membrane) with pores
  - Usually the largest organelle
  - Each cell has a fixed number of chromosomes that carry genes
  - control cell characteristics
  - **located in the nucleus.**
- The
  - Inside nucleus
  - Cell may have 1 to 3 nucleoli
  - Disappears when cell divides
  - Makes that make proteins



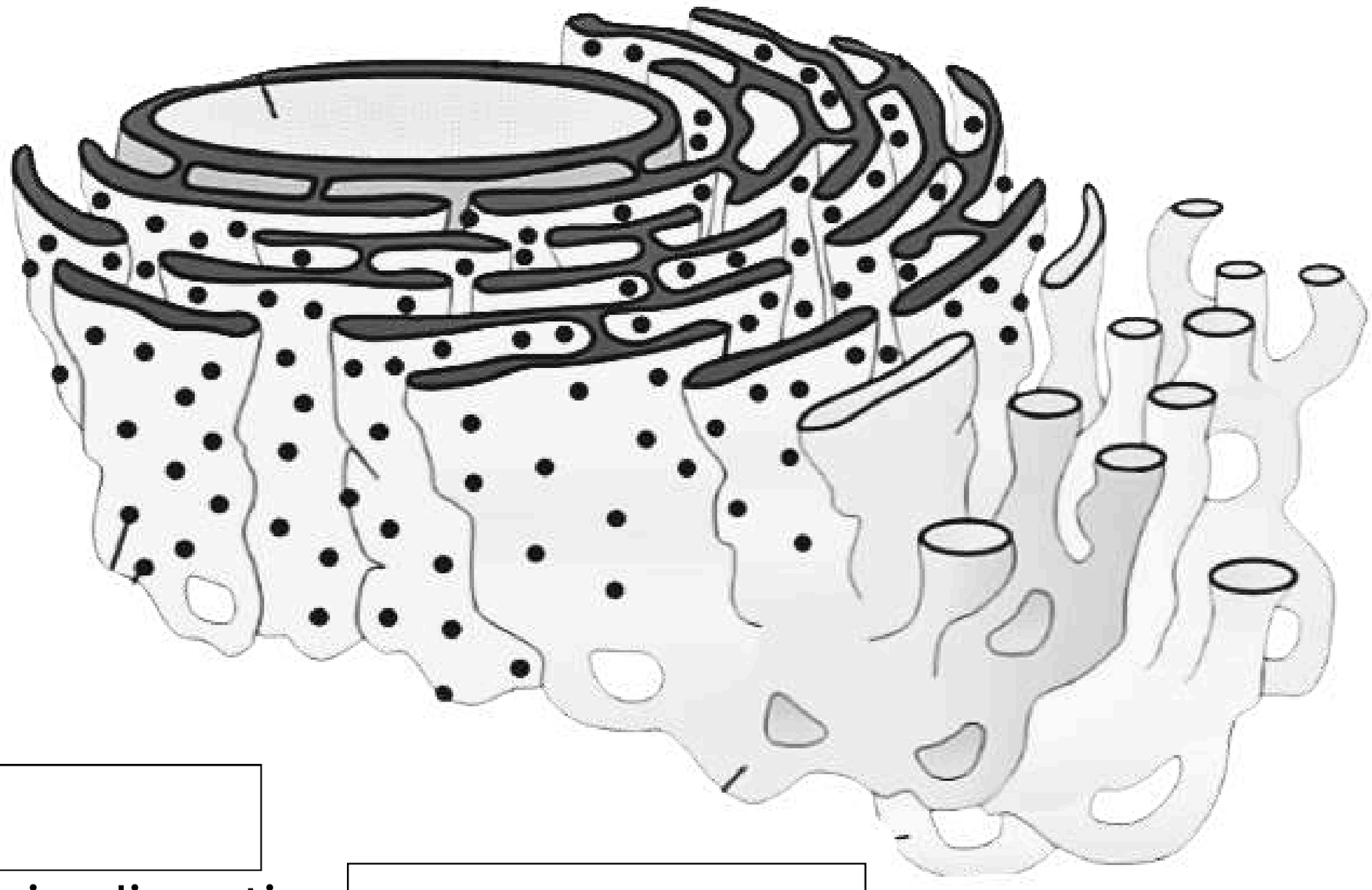
- [ ]
  - Stacks of flattened sacs.
  - Have a shipping side ( ) and receiving side (face).
  - Receive made by ER.
  - Transport with modified proteins pinch off the ends
  - molecules from ER for or out of cell



- [ ]
  - Network of hollow membrane tubules
  - Connects to nuclear envelope & cell membrane
  - Functions in Synthesis of cell products & Transport
  - Two kinds of ER ---ROUGH & SMOOTH
    - [ ]

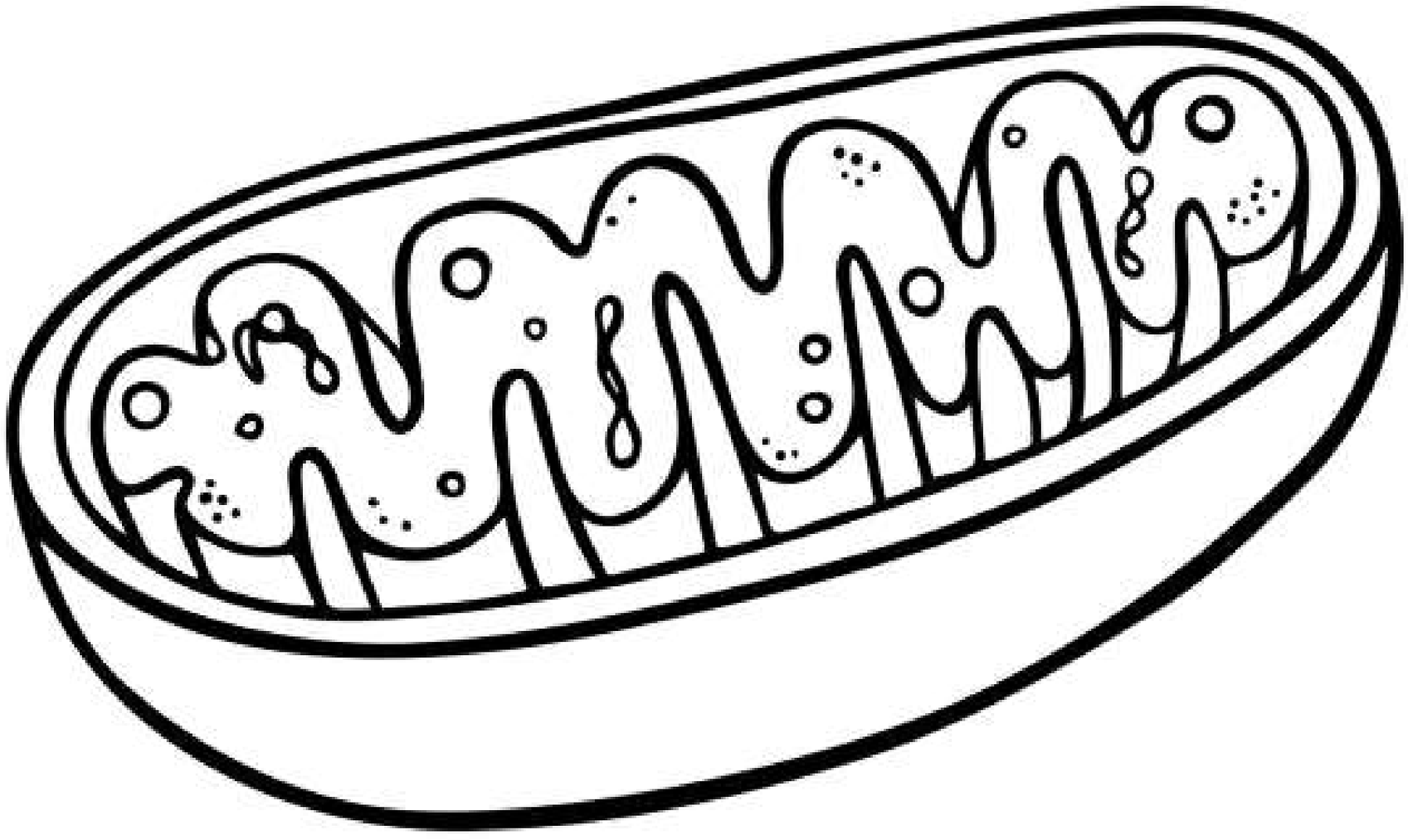
- Have [ ] on its surface.
- Makes membrane [ ] and proteins for [ ] out of the cell.

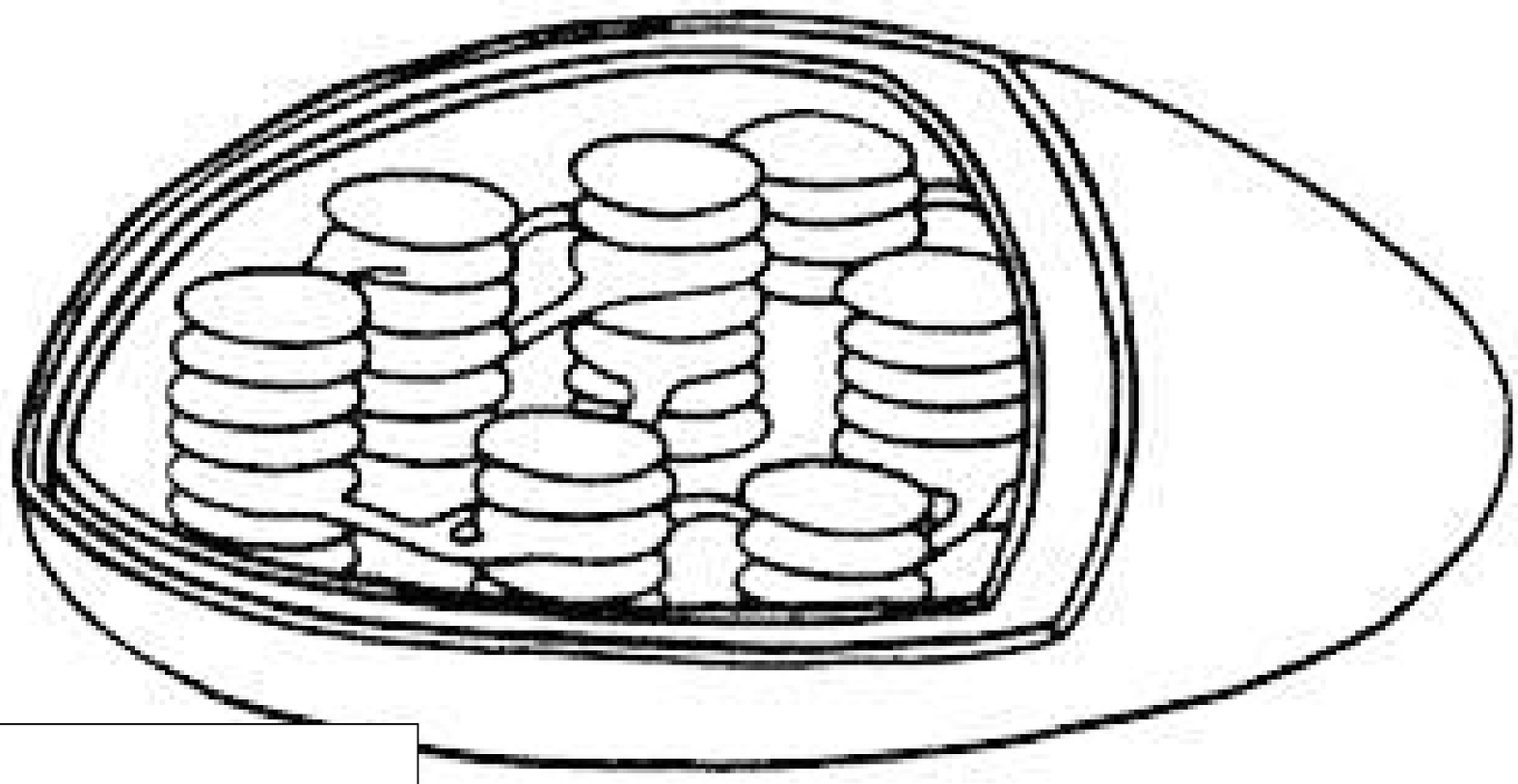
- [ ] ER lacks [ ] on its surface.
  - Is attached to the ends of a rough ER.
  - Makes cell products that are used inside the cell.
  - Makes membrane [ ] (steroids).
  - Regulates [ ] (muscle cells).
  - Destroys toxic substances ([ ]).



- [ ]
  - Contain digestive [ ]
  - Break down food, bacteria, and worn out cell parts for cells
  - Cells take in food by [ ]
  - Lysosomes digest the food & get rid of wastes
  - Programmed for cell death ([ ])
  - Lyse ([ ]) & release enzymes to break down & recycle cell parts)

-
  - Powerhouse" of the cell.
  - Generate cellular energy ( ) Surrounded by a double membrane.
  - Folded inner membrane called (increases surface area for more chemical reactions).
  - Interior called
  - Breaks down to release energy (ATP).
    - Active cells like have more mitochondria.
    - Both cells have mitochondria.
    - Site of
    - Has its own DNA.
    - Mitochondria come from cytoplasm in the egg cell during fertilization. You inherit your mitochondria from your mother!

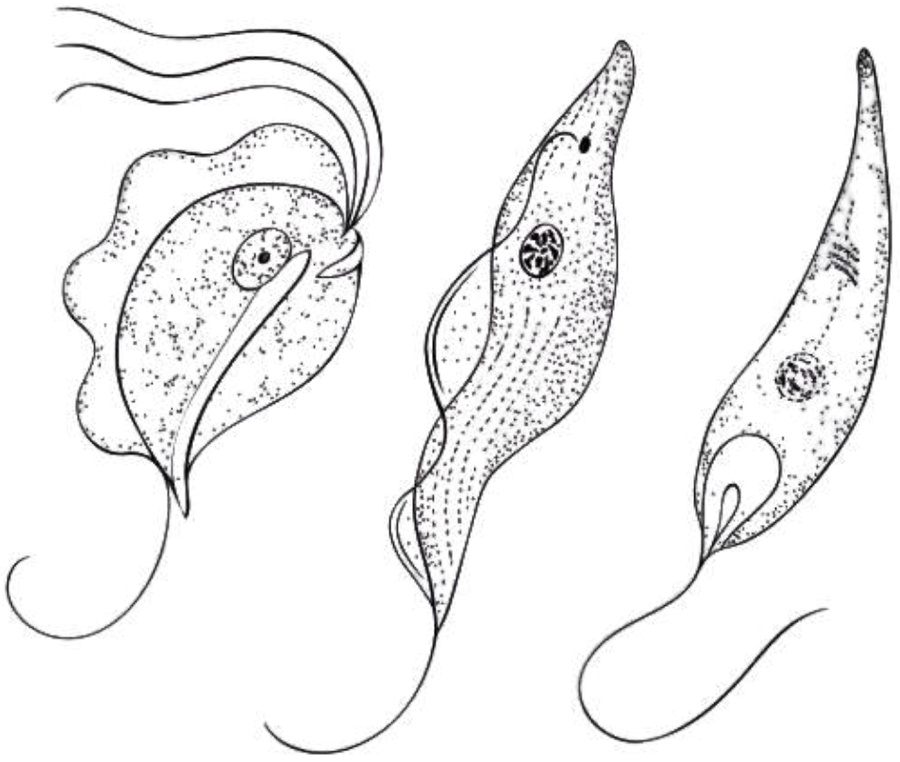


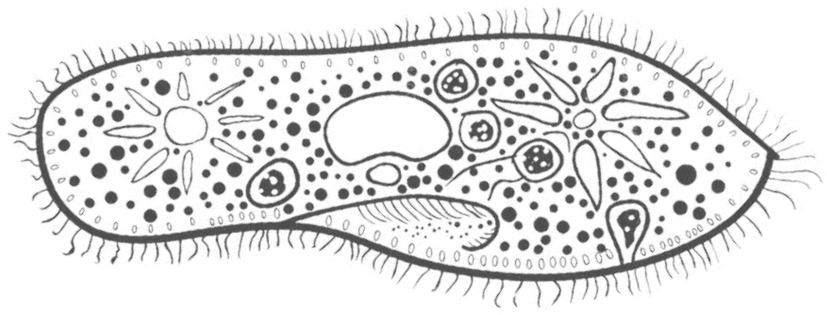


- [ ]
  - Found only in [ ] (organisms containing chlorophyll).
  - Contains its own DNA.
  - Contains enzymes & [ ] for [ ]
  - Never in [ ] or [ ] cells.
  - Surrounded by a double membrane.
    - Outer membrane smooth.
    - Inner membrane modified into sacs called [ ]
    - Thylakoids in stacks are called [ ] and are interconnected.
    - [ ] – gel like material surrounding thylakoids.

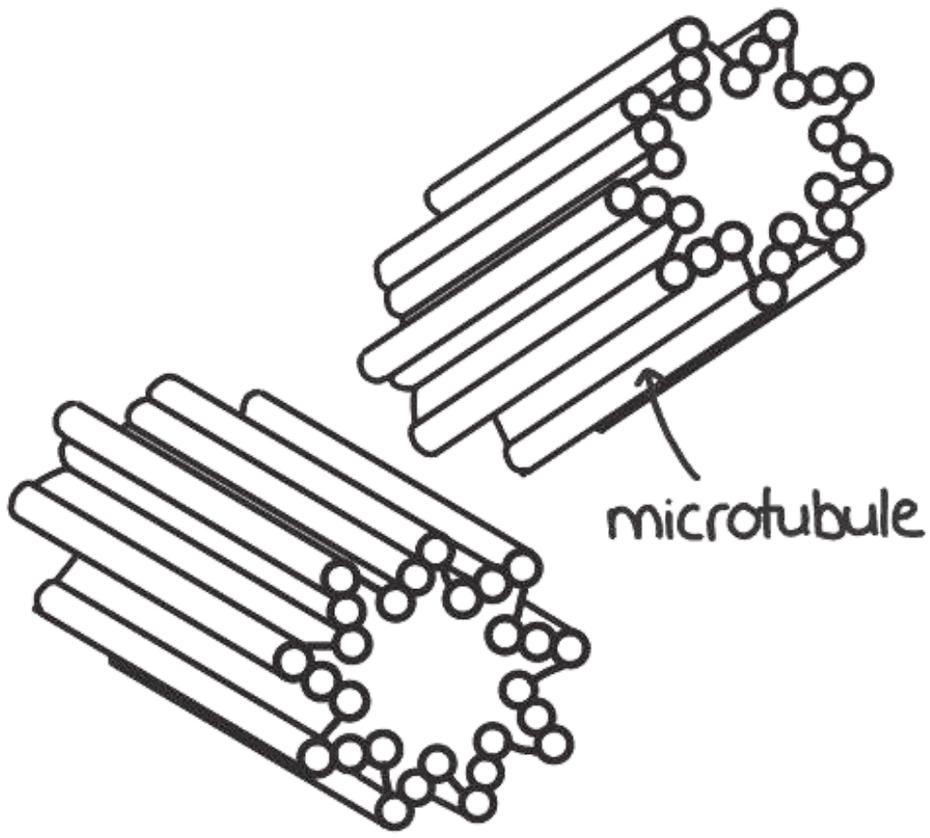
- [ ]
  - Made of proteins and rRNA.
  - [ ] for cell.
  - Join amino acids together to make proteins.
  - Process is called [ ]
  - Can be attached to
    - [ ]
    - Can be free (unattached) in the cytoplasm.

-
  - Made of protein tubes called microtubules.
  - Microtubules arranged (9 + 2 arrangement).
  - Functions- moving cells, moving fluids, or small particles across the cell surface.
  - are shorter and more numerous on cells.
  - are longer and fewer (usually 1-3) on cells.

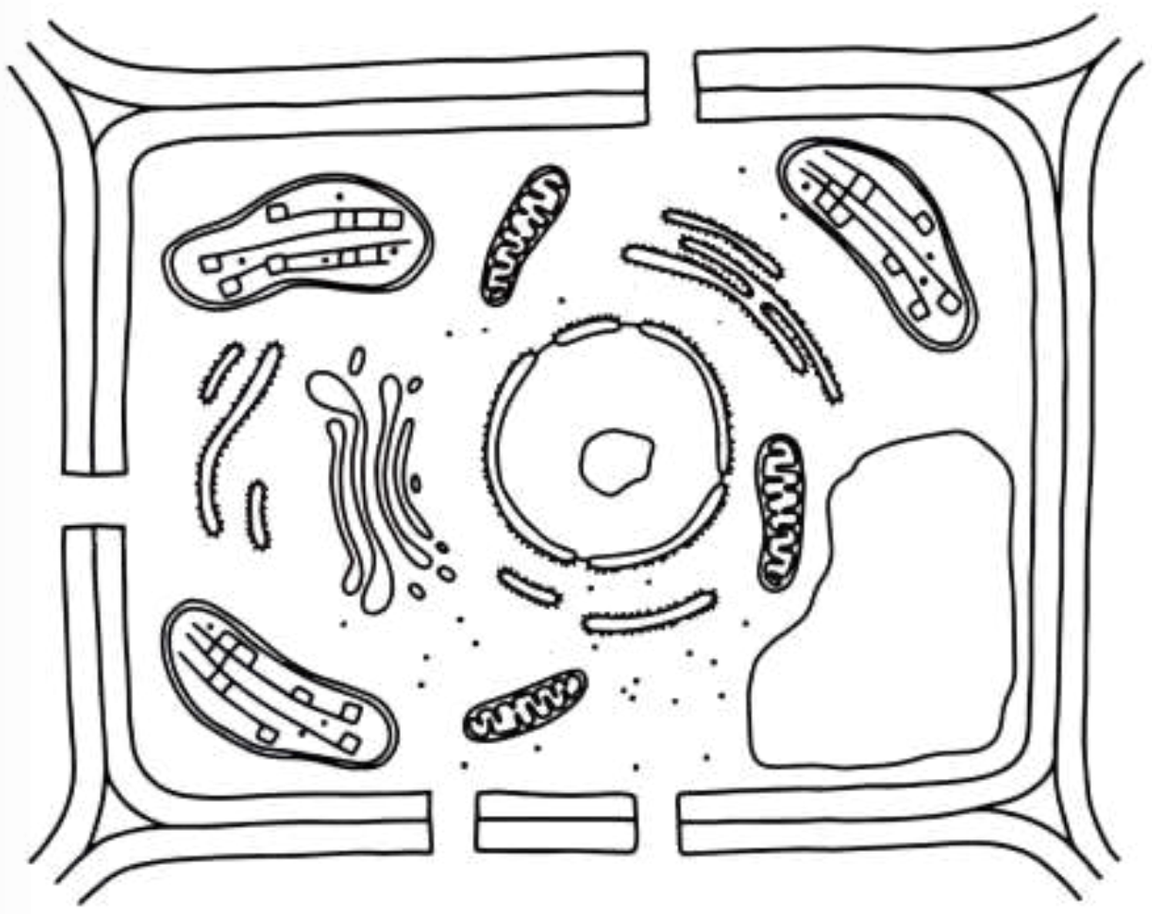


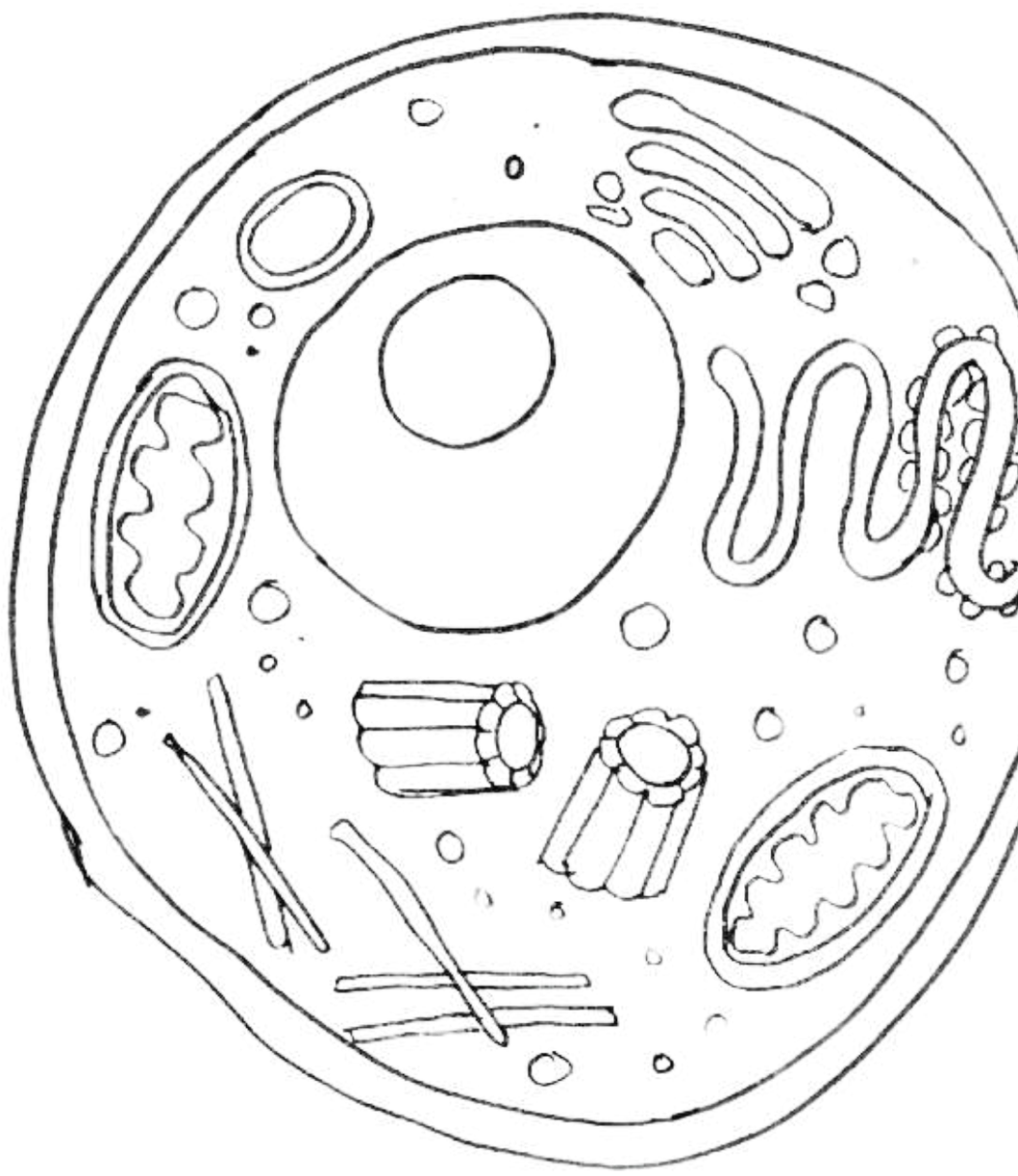


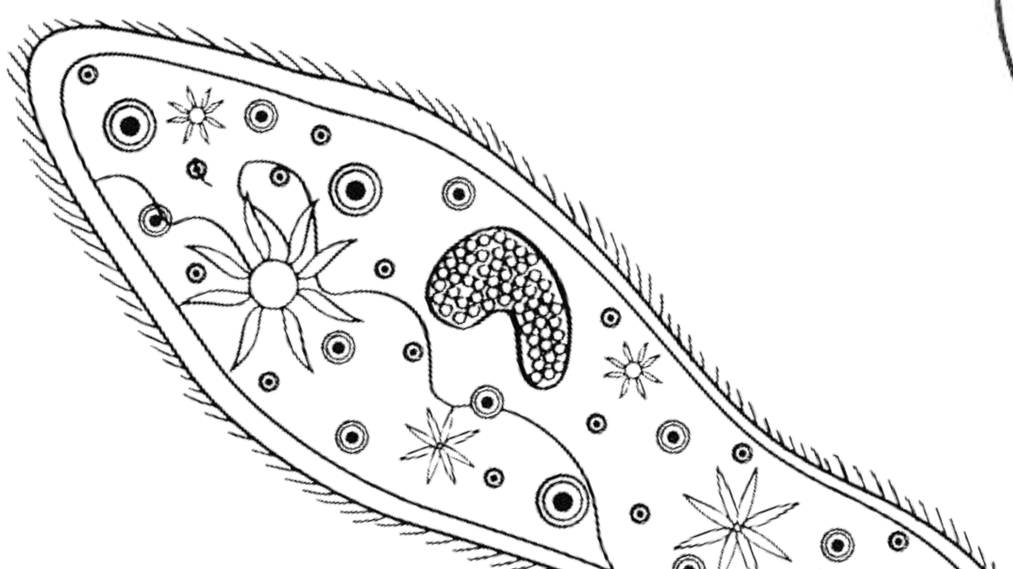
-
  - Found only in
  - Paired structures near the nucleus.
  - Made of a bundle of microtubules.
  - Appear during forming a
  - Help to pull chromosome pairs to opposite ends of the cell.



- ____
  - Fluid filled sacs for ____
  - Small or absent in animal cells.
  - Plant cells have a large ____
  - No vacuoles in bacterial cells.
    - Can store ____, Water Vacuole
    - wastes, ____
  - ____ Vacuole
    - Found in unicellular protists like ____
    - ____ water intake by pumping out excess (homeostasis).
    - Keeps the cell from lysing (bursting).







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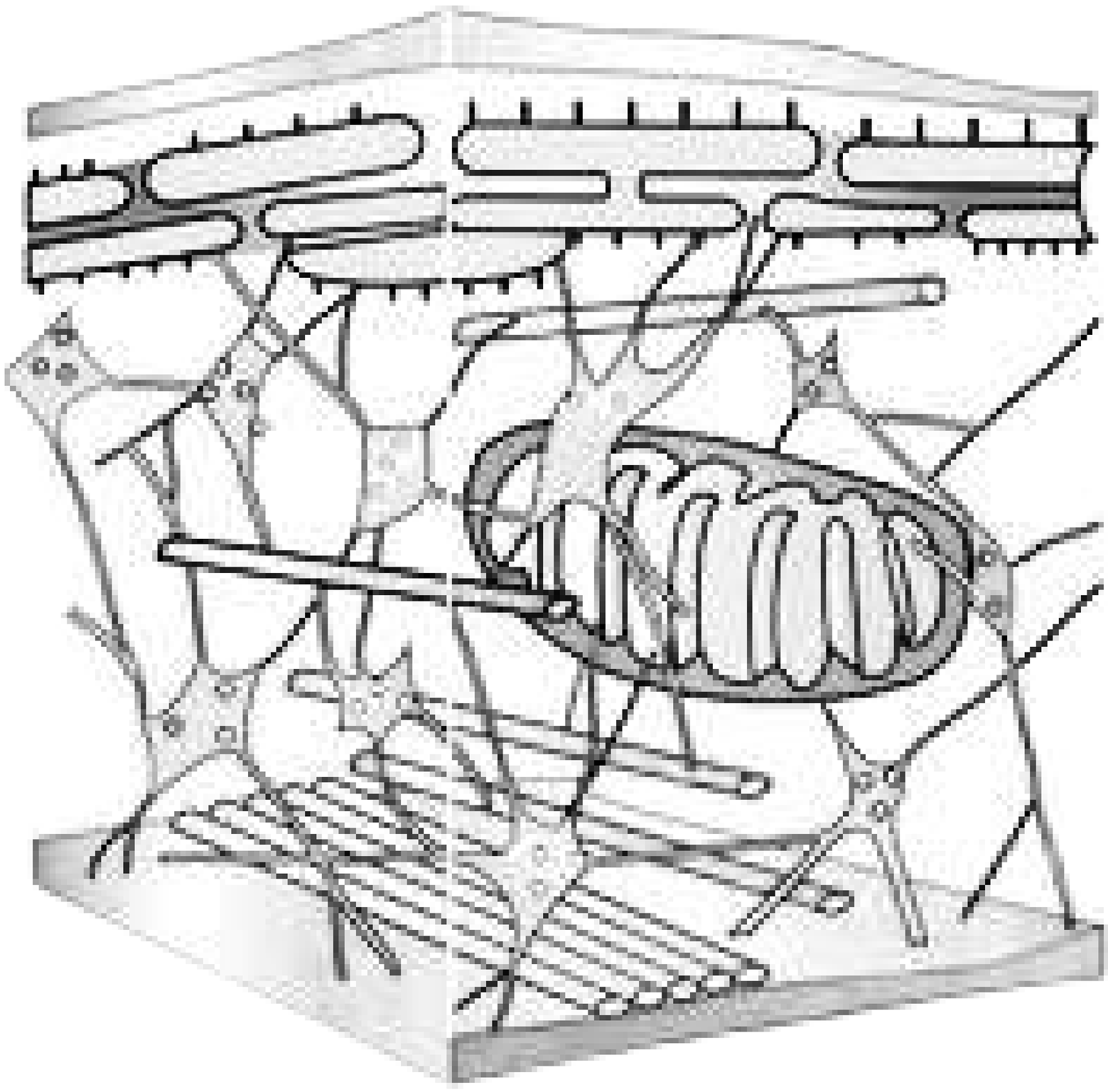
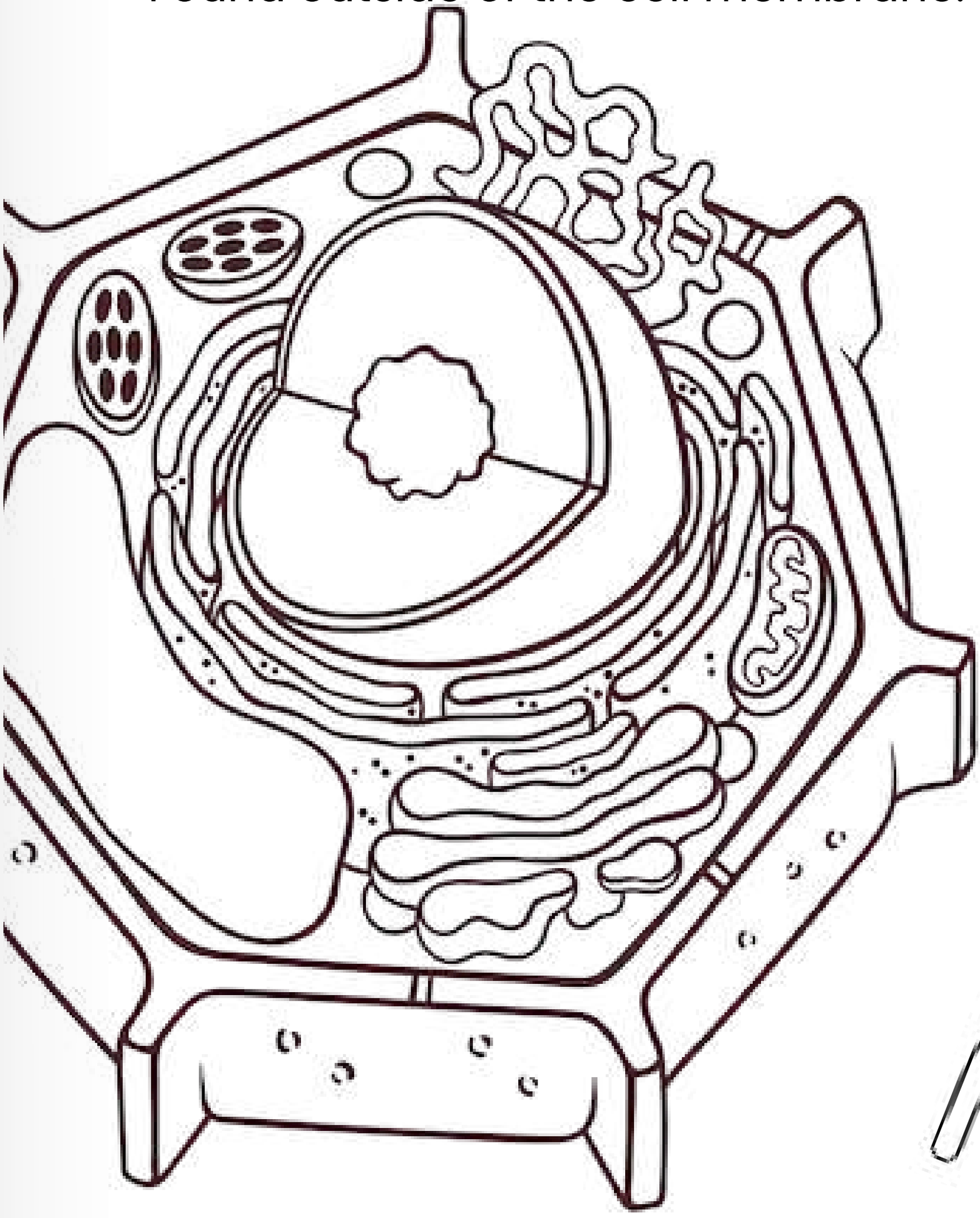
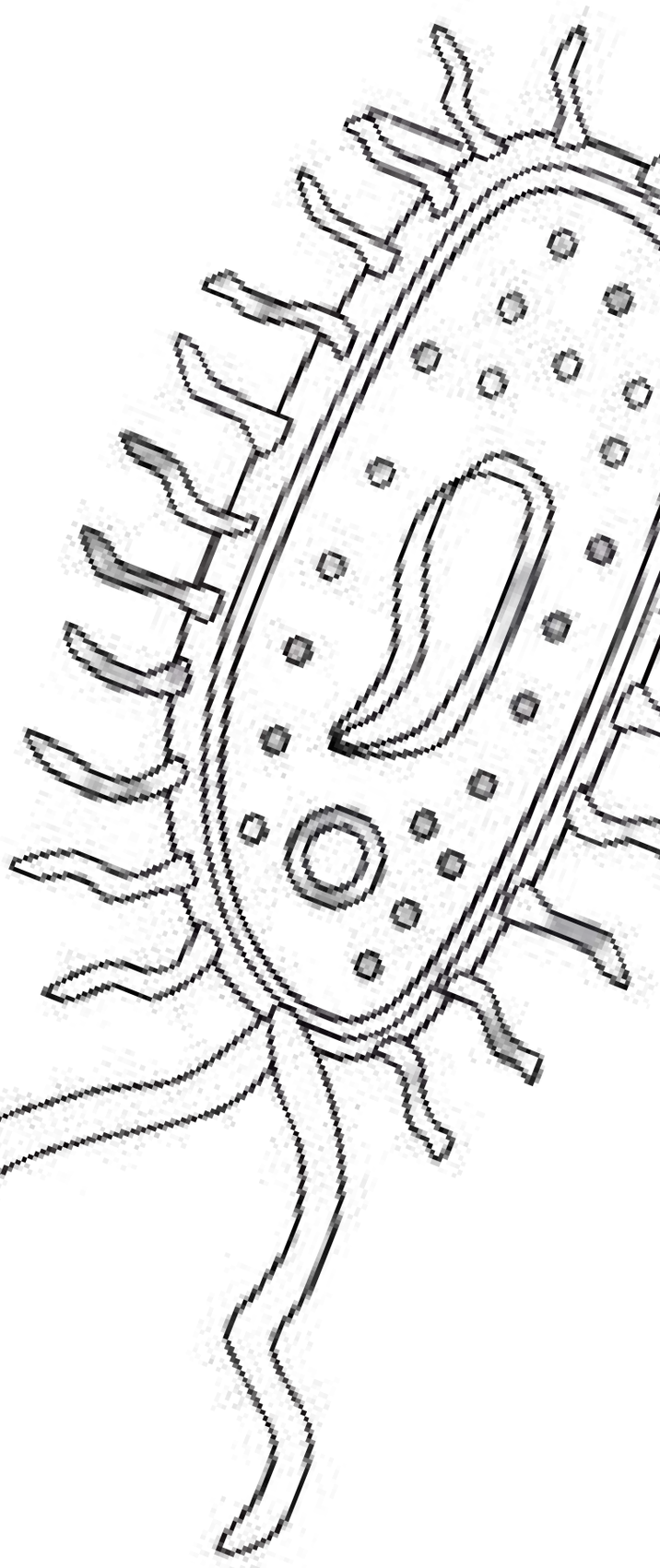
  - Jelly-like substance enclosed by cell membrane.
  - Provides a for chemical reactions to take place.
  - Contains to carry out specific jobs
  - Found in ALL
-
  - Helps cells maintain
  - Also help move organelles around.
  - Made of
  - Microfilaments are threadlike & made of
  - Microtubules are tube-like & made of

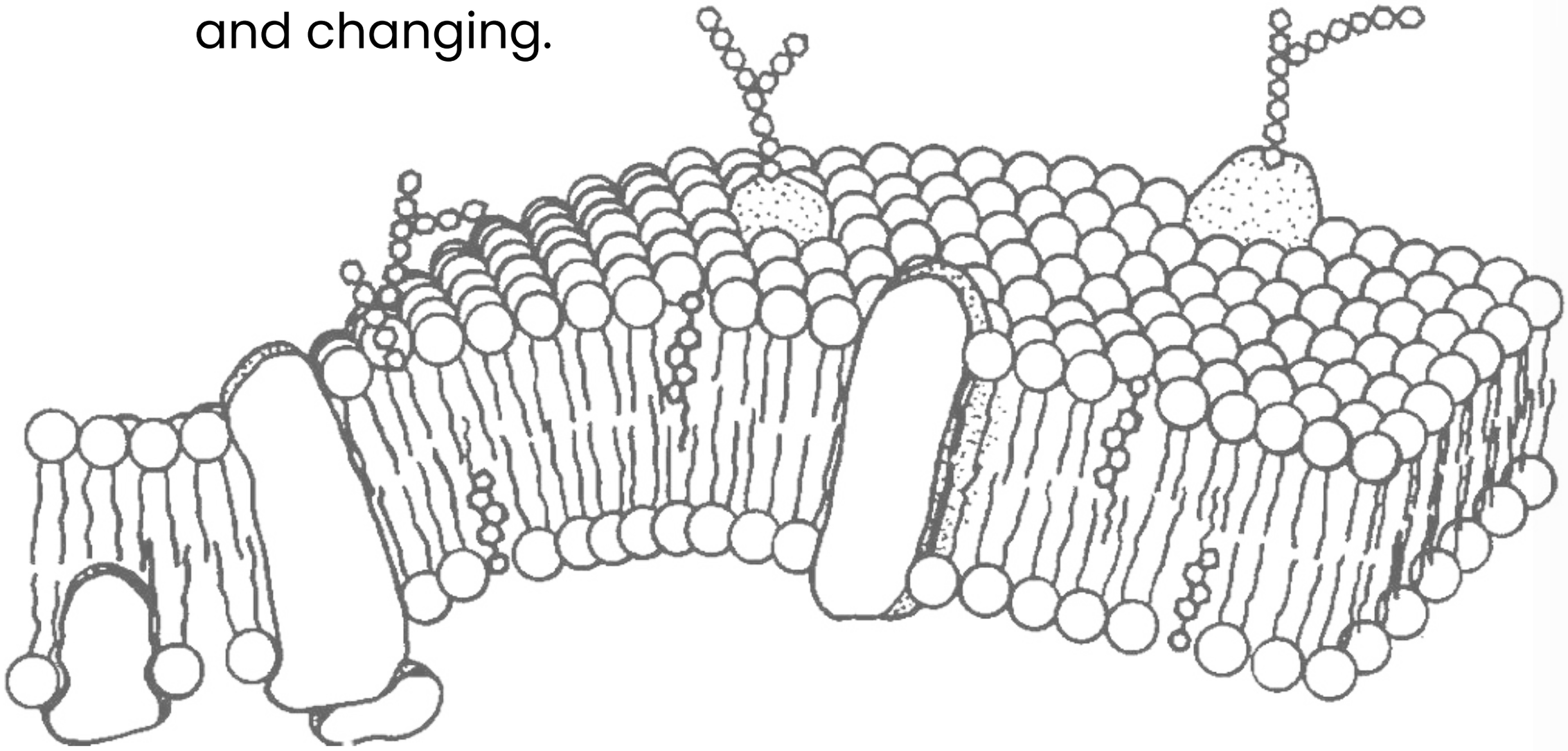


-
  - layer.
  - Found in
  - Made of cellulose in plants.
  - Made of in bacteria.
  - Made of chitin in Fungi.
  - the cell.
  - Found outside of the cell membrane.





-
  - Composed of a double layer of and proteins.
  - Surrounds outside of
  - Controls what enters or leaves the cell.
  -
  - The cell membrane is
  - Molecules in cell membranes are constantly moving and changing.



1. What are the tiny parts inside all cells called, and what do they do?
2. How do these parts work together to keep the cell alive and help it do its job?
3. Can you name some of these parts and explain what each one does?
4. Why are these parts important for the cell's survival and function?
5. How do these parts differ in cells that are simpler, like bacteria, compared to more complex cells, like plants and animals?

SUMMARY

1. What are the three main parts of the cell theory?
    - Sentence Starter: The three parts of the cell theory are…
2. What is the main difference between prokaryotic and eukaryotic cells?
    - Sentence Starter: Prokaryotic cells do not have a _____, but eukaryotic cells do.
3. What does the nucleus do?
    - Sentence Starter: The nucleus…
4. What does the mitochondrion (mitochondria) do?
    - Sentence Starter: The mitochondria…
5. What is the job of the cell membrane?
    - Sentence Starter: The cell membrane…
6. Why are viruses not considered living?
    - Sentence Starter: Viruses are not living because…
7. What do viruses need in order to reproduce?
    - Sentence Starter: Viruses must…
8. What are the 8 characteristics of living things?
    - Sentence Starter: Living things all…

RESOURCES

Amoeba Sisters. (2017, October 26). Characteristics of life [Video]. YouTube. https://www.youtube.com/watch?v=cQPVXrV0GNA

RicochetScience. (2015, January 18). Prokaryotic vs. eukaryotic cells [Video]. YouTube. https://www.youtube.com/watch?v=RQSMCmWB1s

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Dr Matt & Dr Mike. (2019, March 12). The cell and organelles [Video]. YouTube. https://www.youtube.com/watch?v=tUDLMni7R_E

the cell

Cell theory

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Membrane-bound?

PRO- KARYOTE

B4 - NUCLEUS

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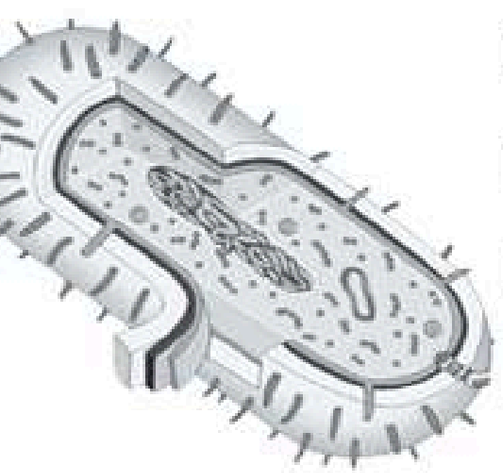

EU- KARYOTE

TRUE

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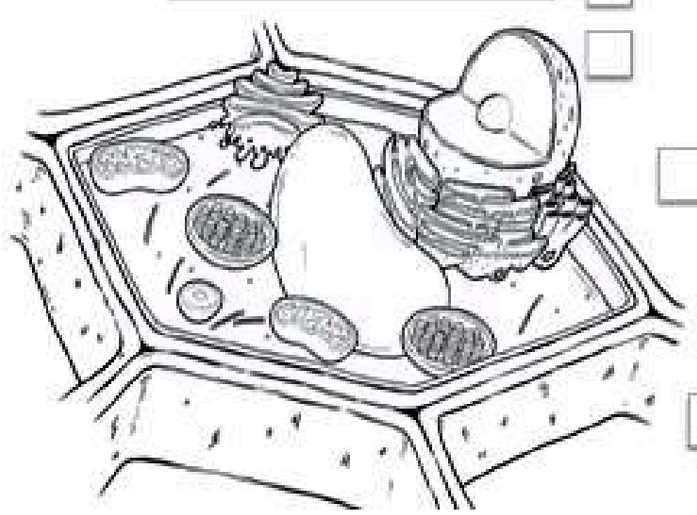

Characteristics of LIFE

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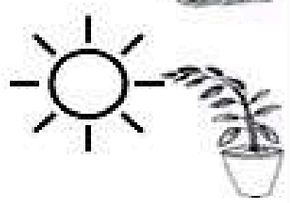
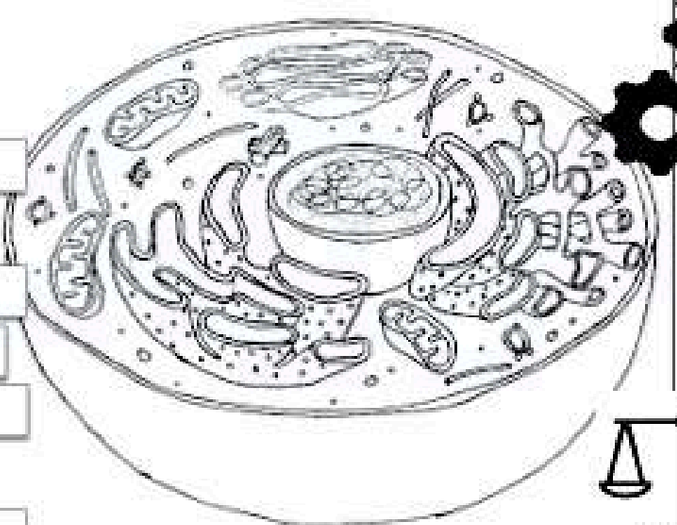
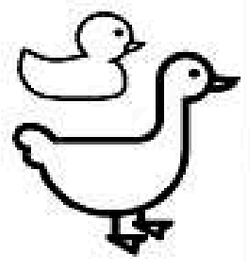
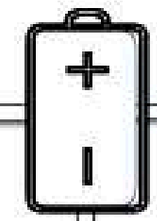
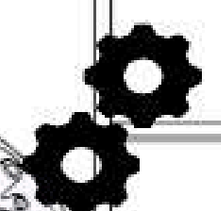


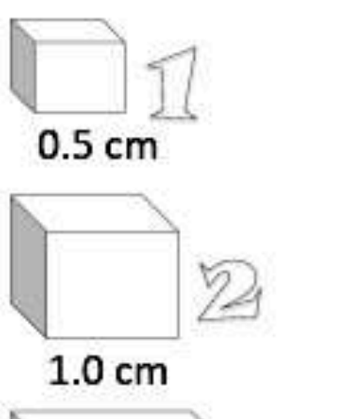








cell size

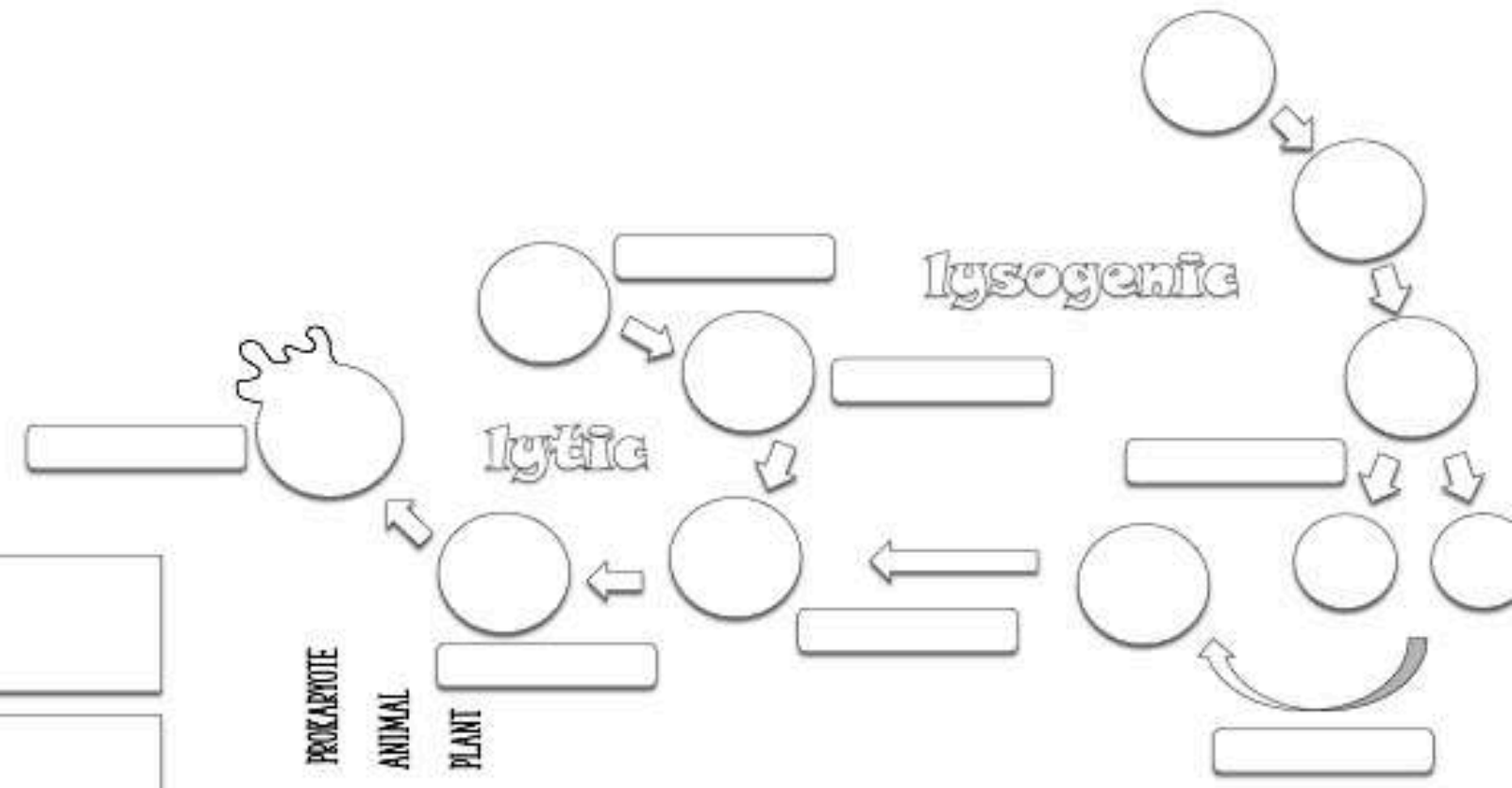


Cell #	Vol – cm^3	Surface Area – cm^2	Ratio
1			
2			
3			

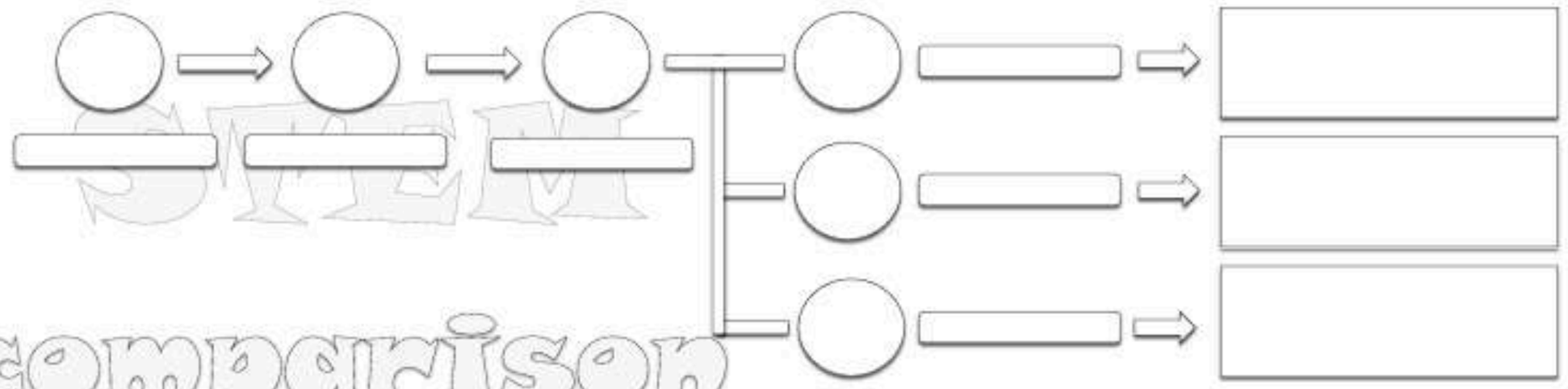
- [ ] THIS RATIO IS AN IMPORTANT RATIO BECAUSE...
- [ ] THE LARGER THE CELL...

Viruses

- [ ]
- [ ]
- [ ]
- [ ]
- [ ]
- [ ]

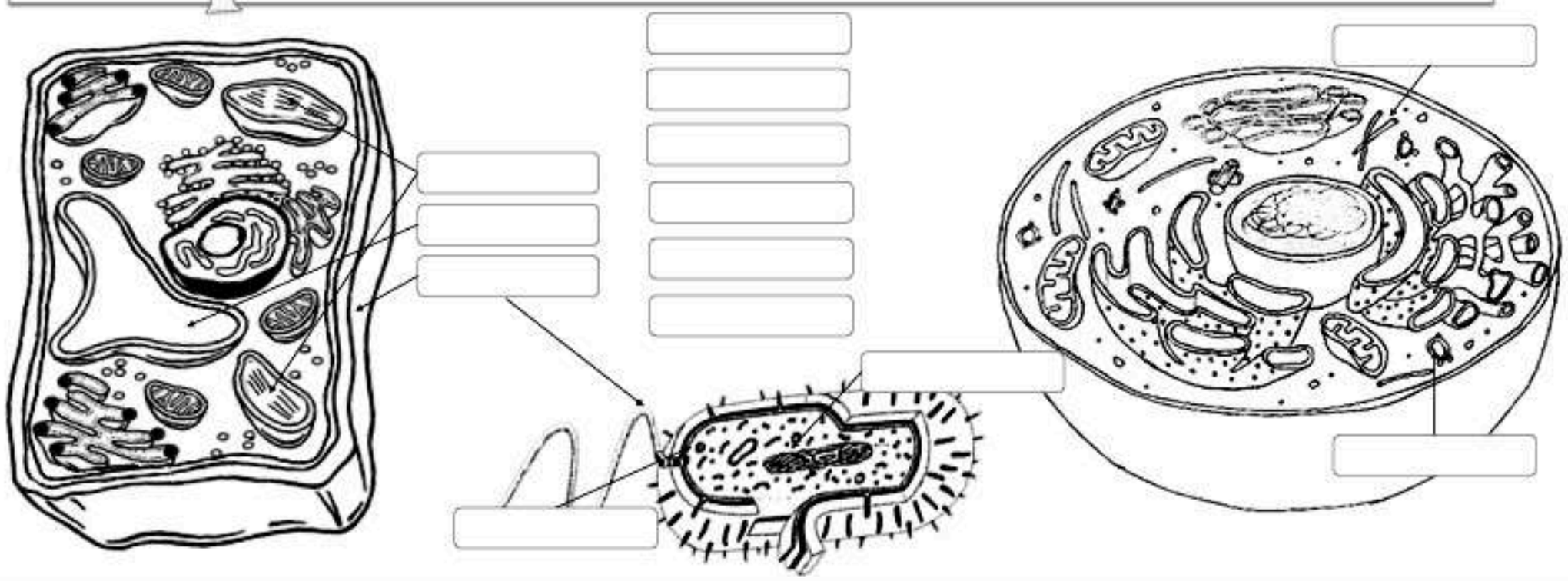


differentiation

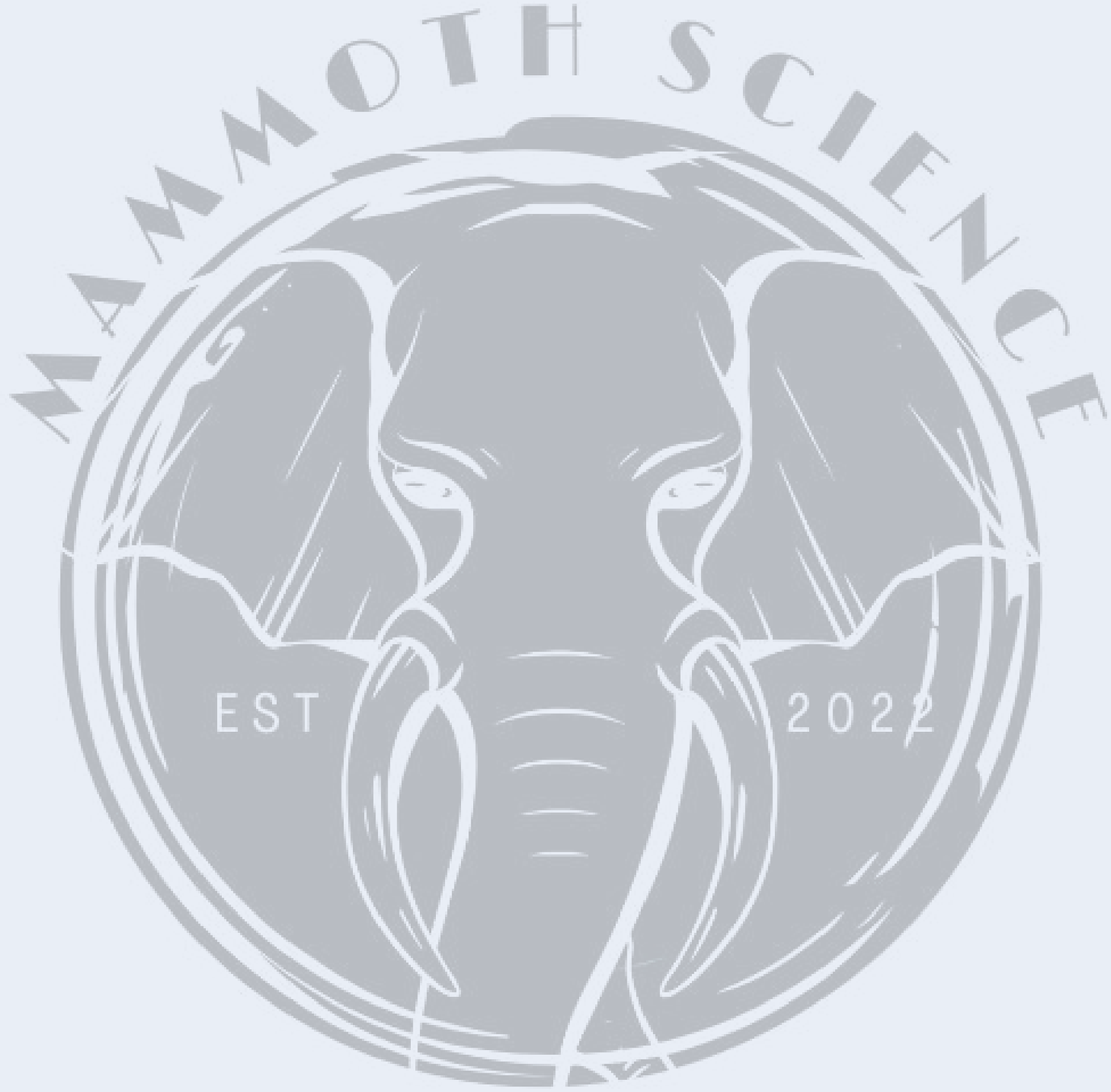


STEM

comparison



			ORGANELLE	DESCRIPTION
			CELL WALL	
			CELL MEMBRANE	
			NUCLEUS	
			CYTOPLASM	
			MITOCHONDRIA	
			ROUGH ER	
			RIBOSOMES	
			GOLGI BODY	
			CHLOROPLAST	
			VACUOLES	
			LYSOSOMES	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2022