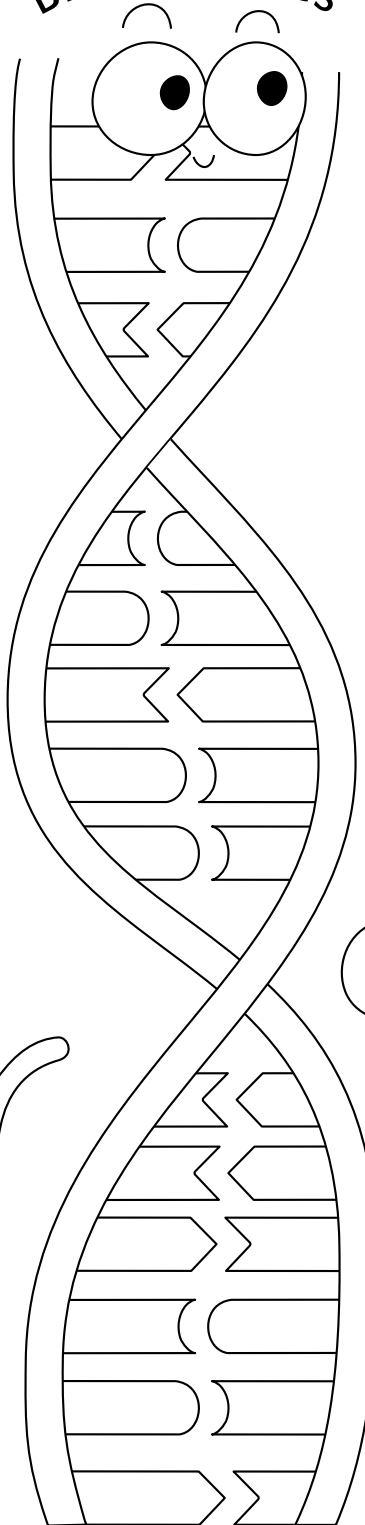
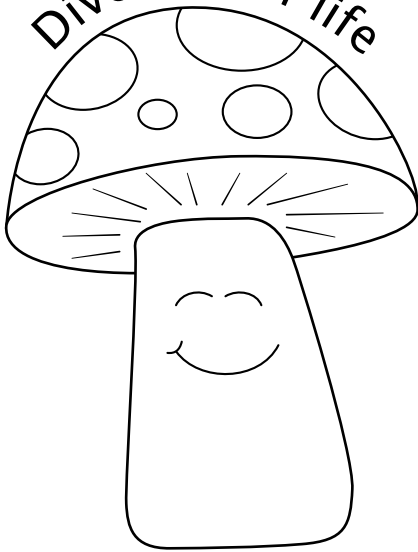


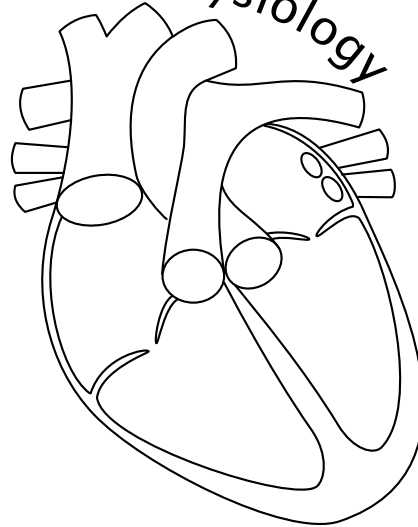
BIOLOGY ONE

Biomolecules

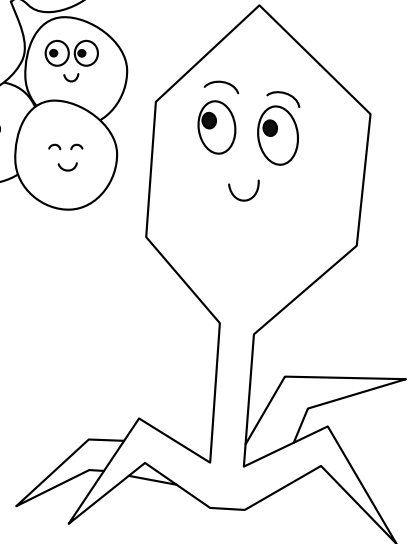
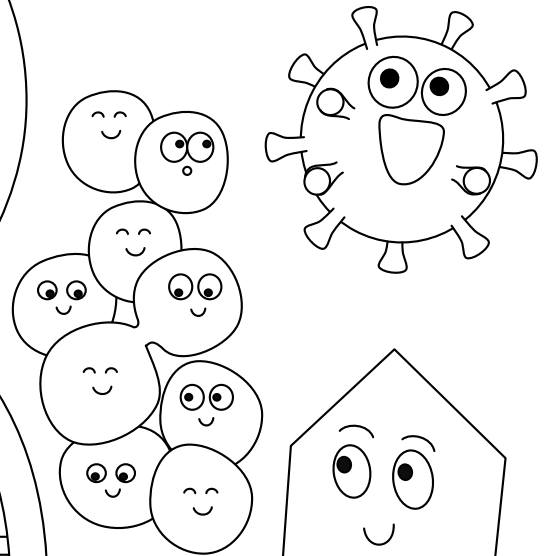
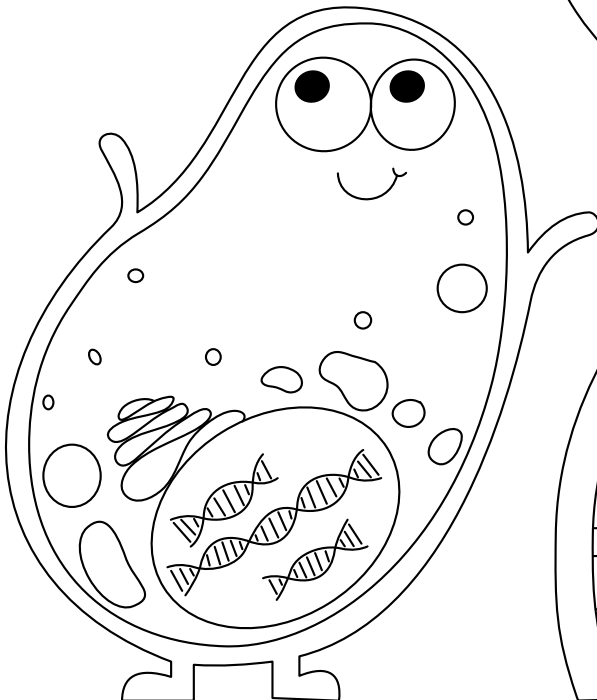
Diversity of life



Physiology



cells



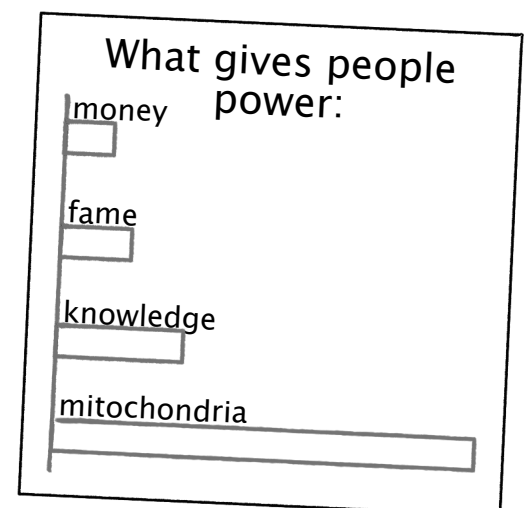
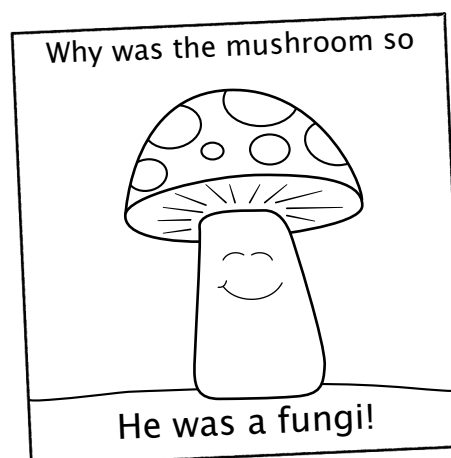
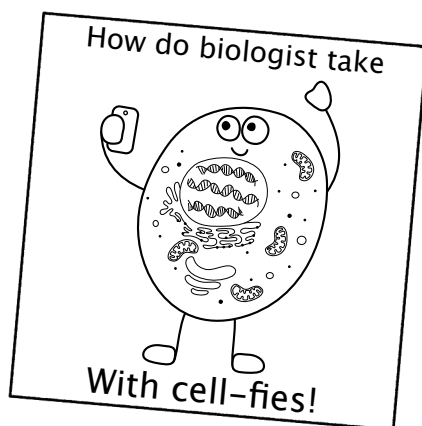
BIOLOGY ONE

~ MICROBIOLOGY ~

		Topic	Page(s)
Week 1		<i>Watch the Welcome and Intro videos.</i>	
	Day 1	It's alive! Or is it? <i>Characteristics of living things and why we study biology</i>	6-7
	Day 2	The discovery of the cell Laser Pointer Microscope	8-11
Week 2	Day 3	The Parts of the Cell <i>Meet the organelles. Prokaryotes & Eukaryotes</i>	12-15
	Day 4	Unicellular vs Multicellular life <i>A look at the incredible diversity of cellular life!</i>	16-17
	Day 5	Cell Quiz Show <i>Practice Quiz 1</i>	18-19
		Science Vocabulary Crossword and Word Search	20-21
Week 3	Day 6	Biomolecules <i>The molecules that make living things</i>	22-23
	Day 7	Osmosis! <i>All about cell membranes and why we salt our food</i>	24-26
	Day 8	Proteins and Enzymes <i>A deeper look at enzymes and cell proteins</i>	27-28
Week 4	Day 9	Sugars and Carbohydrates <i>The main source of energy</i>	29
	Day 10	DNA <i>The instructions for the cell</i>	30-31
	Day 11	Extract DNA from fruit <i>Hands on science project</i>	32-35
Week 5	Day 12	Mitosis and cell division <i>How one cell becomes two</i>	36-37
	Day 13	Biomolecules Quiz Show <i>Practice Quiz 2</i>	38-39
	Day 14	Where does energy come from? <i>Eating vs making food</i>	40

*There are 5 projects in the course, each listed in bold in this table of contents.
A supply list for all projects and activities can be found on page 5.*

		Topic	Page(s)
	Day 15	Animals & Fungi <i>Diversity of the consumers</i>	41-42
Week 6	Day 16	Cellular Respiration <i>Making energy in the mitochondria</i>	43-44
	Day 17	Plants <i>The big producers</i>	45-46
Week 7	Day 18	Photosynthesis <i>Making sugars in the chloroplast</i>	47-48
	Day 19	The Single-Celled Archaea <i>The most diverse groups of all</i>	49-50
	Day 20	DIY Petri Dishes <i>Culture your own microorganisms</i>	51-53
Week 8	Day 21	Diversity of Life Quiz Show <i>Practice Quiz 3</i>	54-55
	Day 22	Systems of the human body <i>The body is made of different systems of cells</i>	56-57
	Day 23	What is blood? <i>Introduction to circulatory system and different blood cells</i>	58-60
Week 9	Day 24	Why we need to breathe <i>An introduction to the respiratory system</i>	61-62
	Day 25	How nerves work <i>Introduction to the nervous system and the longest cells!</i>	63-64
	Day 26	There's more of us than you! <i>Introduction to the digestive system and the microbiome</i>	65



		Topic	Page(s)
Week 10	Day 27	The Immune System <i>An introduction to the body's most fascinating system</i>	66-68
	Day 28	How Antibodies Work <i>The basic defenses and fighters against infections</i>	69
	Day 29	You're Allergic to What? <i>How a misbehaving immune system causes allergies</i>	70-71
Week 11	Day 30	What makes things poisonous? <i>What happens when things go wrong in the cell</i>	72-75
	Day 31	Physiology Art <i>Hands on science project</i>	76
	Day 32	Physiology Quiz Show <i>Practice Quiz 4</i>	77
Week 12	Day 33	Most Wanted Microbes <i>An overview of viruses, fungi, bacteria, and parasites</i>	78-80
	Day 34	Pre-industrial Medicine <i>A look at common 16th century treatments</i>	81-82
	Day 35	Scurvy and Trials <i>The evolution of modern medicine</i>	83-85
Week 13	Day 36	The Story of Smallpox <i>How a deadly disease led to the first vaccine</i>	86-89
	Day 37	The Problem with Polio <i>An exercise in understanding and comparing risk</i>	90-91
	Day 38	Elementary Epidemiology <i>Lessons from looking at diseases in large populations</i>	92-95
Week 14	Day 39	Penicillin & the Discovery of Antibiotics <i>How a moldy dish led to medicine</i>	96-97
	Day 40	MRSA and antibiotic resistance <i>How overuse of a good tool is breeding superbugs</i>	98-99
	Day 41	<i>Final Quiz Show</i> <i>And a showcase of Most Wanted Microbe art from students.</i>	100
Appendix		Suggested Microbe List	101
		Most Wanted Microbe Template	102
		Body System Templates	103-106

Have questions, corrections, or suggestions?
Contact jenny@science.mom or serge@science.mom

Project Supply List

Day 2 - Laser Pointer Microscope

- Laser pointer
- Paper clip or plastic pipette
- Tape
- Water from a stream, pond, or pet water dish

Day 11 - Extract DNA from Fruit

- 2 fresh strawberries (or bananas or other fruit)
- ½ cup warm water
- 1 tsp salt
- Plastic bag or bowl and fork
- 2 tsp concentrated dish soap
- Rubbing alcohol (91%)
- Coffee filter
- Jar or cup
- Meat tenderizer (if using the split pea option)
- Blender (if using the split pea option)

Day 21 - DIY Petri Dishes

- 8 oz boiling water
- 1 bouillon cube
- Cotton swabs
- 4 petri dishes (clean containers with lids)
- 1 Tbsp agar (or 1 packet unflavored gelatin)
- 2 tsp sugar
- Permanent marker

Day 30 - Physiology Art Project

- Several pieces of waxed paper or tracing paper
- Pencil
- Markers
- Brads (paper fastener)

Day 33 - Most Wanted Microbe Art Project

- Copies of the most wanted microbe template
- Pencil
- Markers
- Butter knife (optional)
- Ink and napkin (optional)

Other (optional) Activities

Week 6 - Respiration

- 2 Tbsp Yeast
- 2 Balloons
- 2 Water bottles
- Sugar

Week 8 - What is Blood?

- 1/3 c measuring cup
- 6 L of water and two containers
- Timer or stopwatch

Week 9 - Why We Breathe

- 2 balloons
- Plastic bottle with bottom cut off

Week 9 - How Nerves Work

- Ruler

Week 13 - The Problem with Polio

- 2 dice

How to get the most from this course:

This course can be used in a variety of ways! You can participate passively by just watching the videos, or actively by filling out the notes and completing the projects. You can do the entire course at once or participate in one lesson or section at a time.

For BEST learning, we recommend:

- ✓ Read the pages that go with each lesson before watching the video. Take 10-15 minutes to see if you can fill in the blanks.
- ✓ On quiz show days, take the practice quiz before you watch the class!
- ✓ Complete each of the science activities, and then share your work with a family member or friend.
- ✓ Download the answer key for the notes, but don't look at the answers until after you give things a try yourself!

Next Generation Science Standards

This class covers the following Next Generation Science Standards. Often referred to as NGSS, they are the United States education standards for science.

MS-LS1-1: Days 4, 5, and 6

Living things are made of cells

MS-LS1-2: Days 3 and 22

The function of a cell as a whole and how the parts of a cell contribute to that function

MS-LS1-3: Days 22, 23, 24, 25, and T

The body is a system of interacting subsystems composed of groups of cells

MS-LS1-6: Days 14, 17, and 18

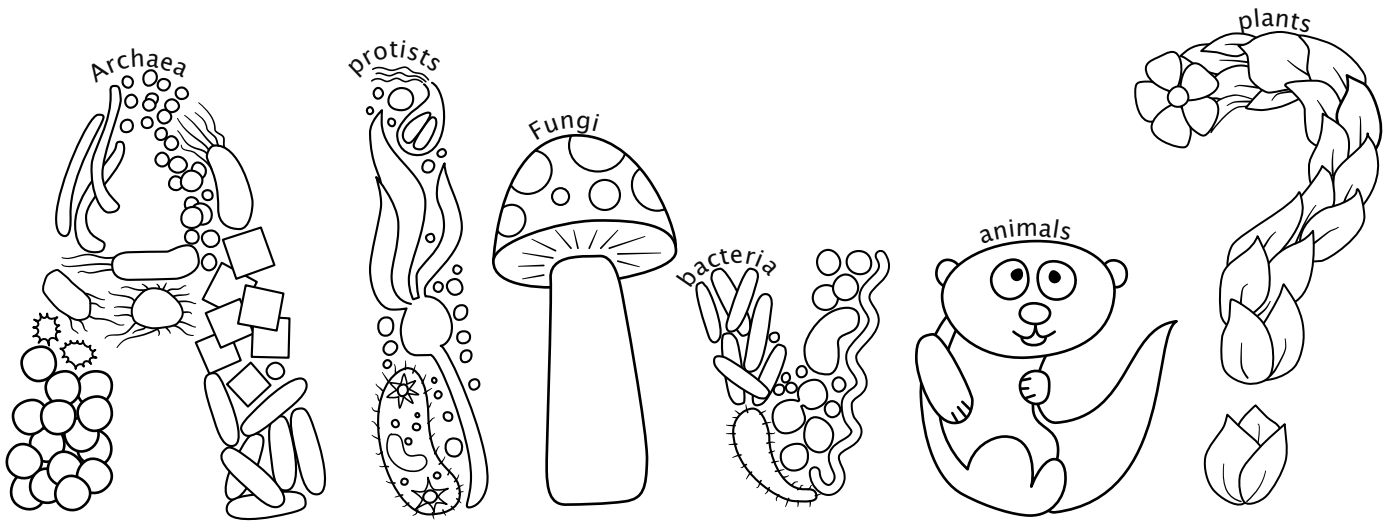
Photosynthesis and its role in cycling matter and the flow of energy in and out of organisms

MS-LS1-7: Days 14, 15, and 16

How food is rearranged through chemical reactions to form new molecules that support growth and release energy

MS-LS1-8: Day 25

Sensory receptors respond to stimuli by sending messages to the brain



What makes something alive? This is not an easy question to answer! Most definitions agree that living things include all the following qualities or abilities:

METABOLISM

HOMEOSTASIS

GROWTH

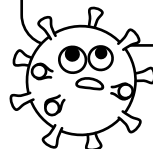
RESPONDS TO STIMULI

MADE OF CELLS

REPRODUCTION

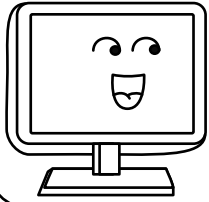
Hey! What about me? I can reproduce.

But only if you take over a host



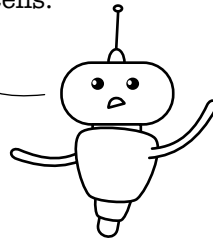
COULD ARTIFICIAL INTELLIGENCE (AI) BE CONSIDERED ALIVE?

We can be programmed to have all of the characteristics of life!



So? Cells shouldn't even be on the list anyway.

Except being made of cells.



The question of whether or not AI is alive is currently being debated, and will be one of the more important questions of the century!

Write down three of the best reasons for each side of the argument and then share your opinion. What do *you* think?

What are 3 arguments for technology or AI to be considered **alive**?

1. _____

2. _____

3. _____

What are 3 arguments for technology or AI to be considered **nonliving**?

1. _____

2. _____

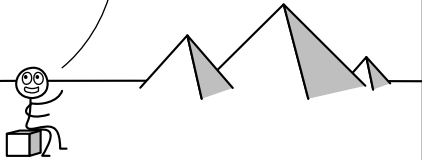
3. _____

What is your opinion?

THE DISCOVERY OF THE CELL

FOR THOUSANDS OF YEARS, PEOPLE KNEW THAT CURVED GLASS MAGNIFIED DETAILS.

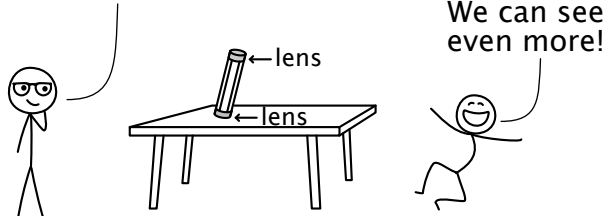
I wrote about it way back in



CLAUDIUS PTOLEMY
Famous philosopher

THEN, IN 1590, TWO GLASS MAKERS CREATED THE FIRST COMPOUND MICROSCOPE.

If we put lenses on both sides of a tube, the objects on the other side



HANS & ZACHARIAS JANSSEN
Dutch glassmakers

THE NEXT CENTURY SAW HUNDREDS OF EXPERIMENTS ON IMPROVING THE MAGNIFICATION OF MICROSCOPES AND MANY PUBLICATIONS ABOUT WHAT WAS OBSERVED UNDER THE LENS.

THE MOST FAMOUS OBSERVATIONS WERE MADE BY ROBERT HOOKE...

Oil lamp burns, creating light

Water flask diffuses the light

Lens to focus light on specimen

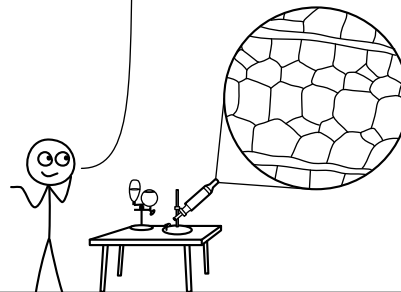
Eye piece

Barrel

Focusing screw

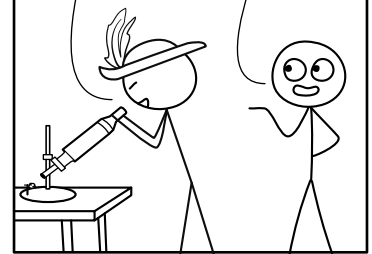
ROBERT HOOKE'S MICROSCOPE 1665

This specimen of cork plant is full of pores! They look like the plain unfurnished rooms of monks.



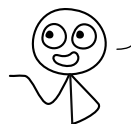
You're right. They do look like empty rooms! What will you call

Cells.

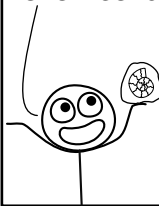


Cells? The same name for empty rooms?

Why not? They look like honeycomb cells



And look! There are even cells in

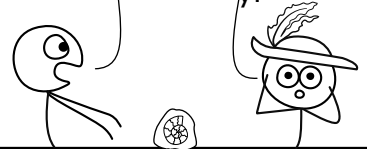


I thought fossils were just rocks.



Rocks that used to be alive!

Blimey!

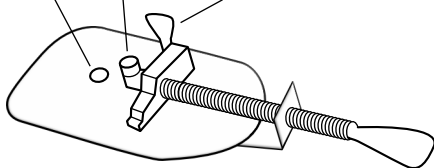


...AND DUTCH SCIENTIST ANTON VON LEEUWENHOEK.

Sample holder

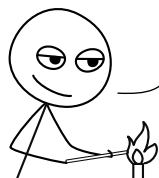
Lens

Focus knob

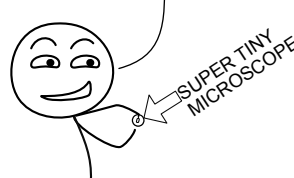


LEEUVENHOEK'S MICROSCOPE 1676

I made incredibly tiny lenses by melting, grinding, and



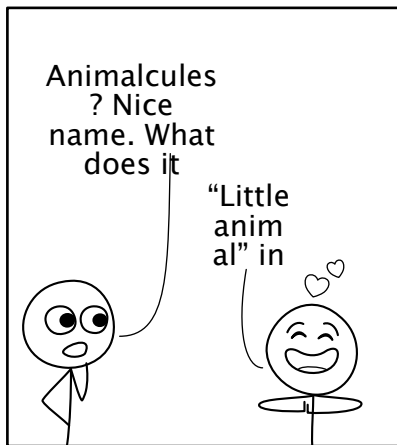
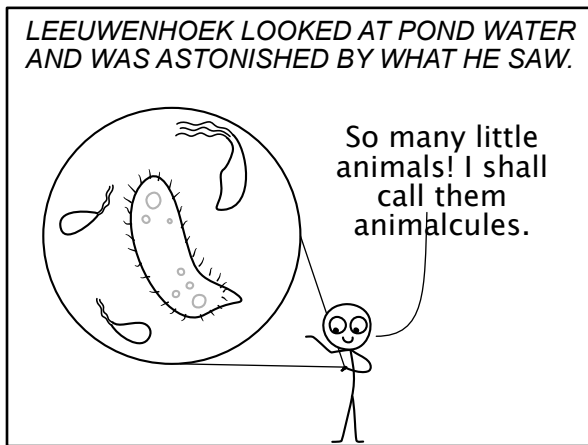
There is only one lens in this microscope, but the quality is so good I can see with



My microscope has better magnification than Hooke's!



CONTINUED ON NEXT PAGE...



OVER THE NEXT 200 YEARS, MICROSCOPES BECAME POWERFUL ENOUGH TO SEE ATOMS AND WE DISCOVERED HOW THE PARTS OF CELLS WORKED!

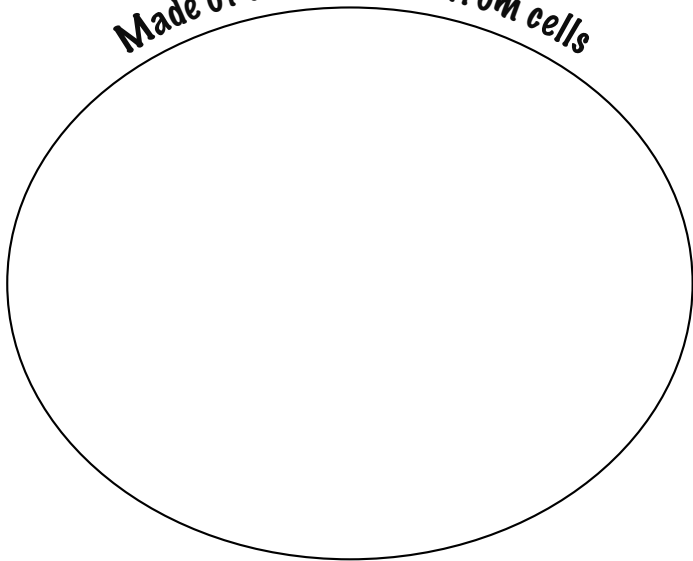
Your notes:

_____	_____
_____	_____
_____	_____
_____	_____

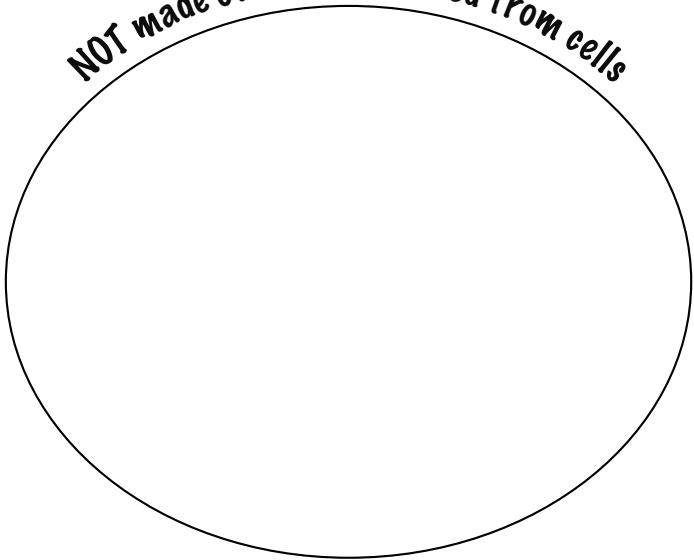
IS IT MADE OF CELLS OR NOT? Write the words below in the correct oval:

- | | | | | | | |
|--------|--------|-------|----------|---------|--------|---------|
| salt | tomato | wood | cement | mold | sand | cabbage |
| pepper | water | onion | platypus | plastic | yogurt | grass |

Made of cells or came from cells



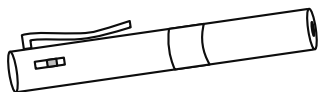
NOT made of cells or derived from cells



Hands-on Science Project

LASER POINTER MICROSCOPE

MATERIALS:



Laser Pointer



Paperclip



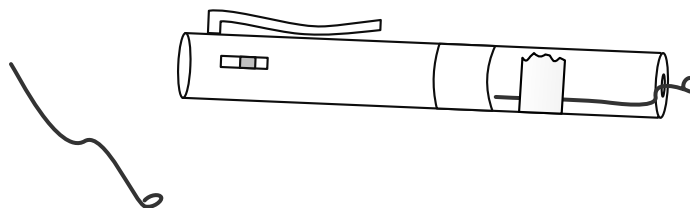
Tape



Water from a pond, dog dish, aquarium, or other source that will have microbial life.

SAFETY WARNING

NEVER POINT A LASER BEAM AT ANYONE'S EYES. LOOKING DIRECTLY AT A LASER BEAM CAN PERMANENTLY DAMAGE YOUR EYES.



1. Straighten out a large paper clip and then bend one end so that it forms a small loop.

2. Test the loop to be sure that it holds a water droplet. When you dip it in water and then lift it out again, a drop of water should stay inside the loop. If the loop does not hold water then bend it again and make it smaller.

3. Attach the paperclip to the laser pointer with tape so that the loop is directly in the path of the beam.

4. Carefully dip the wire loop into a water source that will have bacteria and other microbial life. Pond water, aquarium water, or water from a pet drinking dish are all good choices.

5. Shine the laser toward a white surface. For best results, conduct this activity in a darkened room.

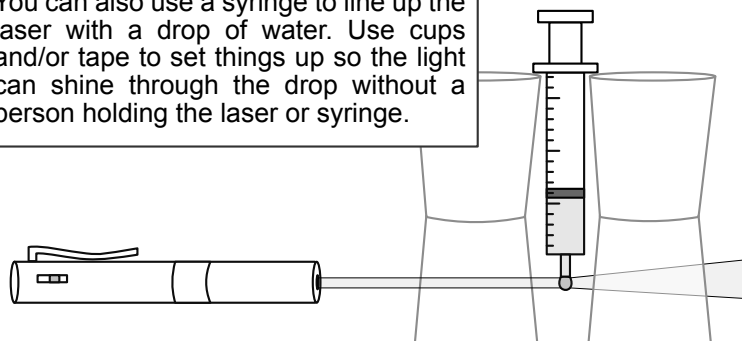
6. Observe your results and experiment with different sources of water.

SAFETY TIP

WASH YOUR HANDS AFTER HANDLING SAMPLES OF WATER THAT COULD CONTAIN MICROBES.

AN ALTERNATIVE APPROACH:

You can also use a syringe to line up the laser with a drop of water. Use cups and/or tape to set things up so the light can shine through the drop without a person holding the laser or syringe.



For BEST results

Choose a source of water that is chlorine free and exposed to sunlight.



Observe multiple drops of water from different sources.

Set up the laser in a dark room and shine it on a flat white surface.

Arrange the laser so that no one is touching it. The less it moves, the better you'll see the microbes in the water.

Adjust the distance between the laser and flat white surface to see which distance gives you the best view.

WHICH SOURCE OF WATER HAD THE MOST MICROBES?

It's time to go exploring! Gather some clean containers or plastic bags and collect water from several sources. If using the paper clip method, be sure to use different paper clips OR to clean your paperclip before testing each sample. If you gather a saliva sample, do NOT put the paperclip in your mouth! Spit into a container and sample the saliva from there. Before you gather your samples, make a prediction about which water will have the most microbes. Then, after observing each sample put a **check mark** by the type of water that had microbes, and a **zero** by water that was microbe-free. Put a **double check mark** by the water that had the MOST microbes. Write NA if you didn't test that type of water.

YOUR PREDICTION:

The water with the most microbes will be _____.

☐

Water from the kitchen sink.

☐

Water from a natural outdoor source that looks clean like a lake or river.

☐

Water from a natural outdoor source that looks dirty or scummy like a puddle, swamp, or pond.

☐

A drop of saliva.

☐

Water from a pet's water dish.

☐

Water from the tank (not the bowl!) of a toilet.

☐

Other: _____

YOUR RESULT:

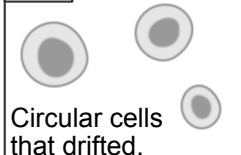
The water with the most observed microbes was _____.

WHICH OF THESE DID YOU OBSERVE USING YOUR LASER POINTER MICROSCOPE?

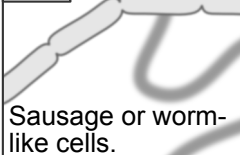
Check all that apply.

☐

Clean water with no microbes.

☐


Circular cells that drifted.

☐


Sausage or worm-like cells.

☐


A swimmer! A cell that is moving itself through the water rather than drifting.

☐


Something with a tail or flagella.

Your notes:

The Parts of a Cell

FILL IN THE BLANKS USING THESE WORDS:

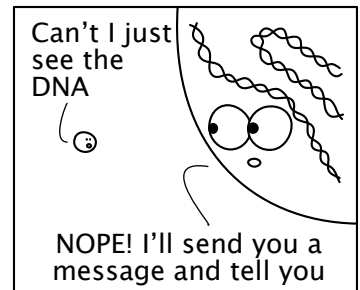
DNA	proteins	living	organelles
plasma membrane	dead	cytoplasm	diversity

The cells that Robert Hooke saw in the bark of a cork tree were actually _____. This is why they looked so empty. _____ cells contain several important parts or _____ that help them survive. Ribosomes build _____. If the cell has a nucleus, it contains the _____. Mitochondria or chloroplasts are involved in digesting or creating food for the cell, and all of this activity is contained within a cell wall or _____. The liquid inside a cell is called the _____. Not every type of cell will contain all of these parts. There is incredible _____ between different types of cells!

DRAW LINES TO CONNECT THE NAME & DESCRIPTION WITH THE CORRESPONDING PICTURE

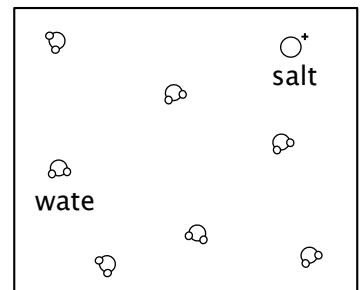
Cytoplasm

The liquid inside the cell.
It's mostly water.



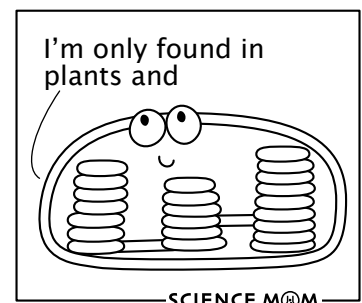
Nucleus

Keeps the DNA separate
from the rest of the cell.



Chloroplast

Uses CO₂ and sunlight to
create sugars.



Plasma Membrane

Keeps the cytoplasm inside the cell.

Cell Wall

Keeps the cytoplasm inside the cell.

Flagella

Helps the cell move. Works like a little paddle or tail to push it through the water.

Ribosome

The thing that makes the proteins.

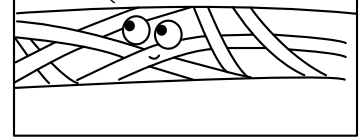
DNA

The instructions for making proteins and other stuff for the cell.

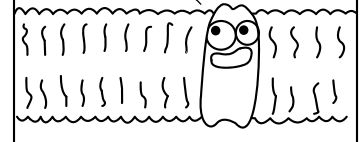
Mitochondria

Uses oxygen and sugar to create energy for the cell.

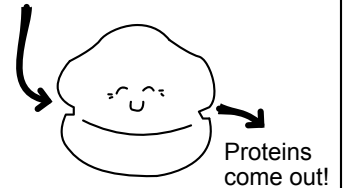
I'm even stronger than a cell



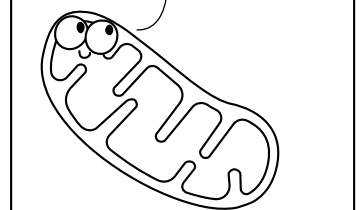
No one gets past me!
Except the stuff I want to get past.



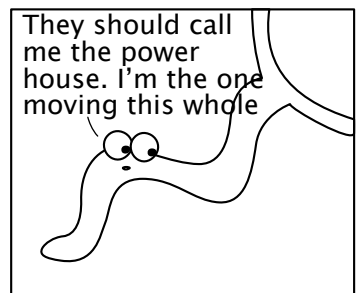
Instructions from DNA go in.



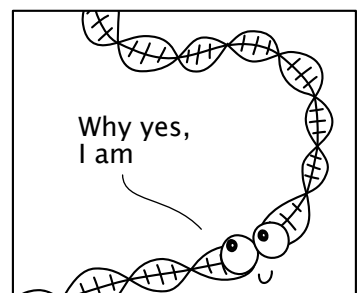
They call me the powerhouse of the



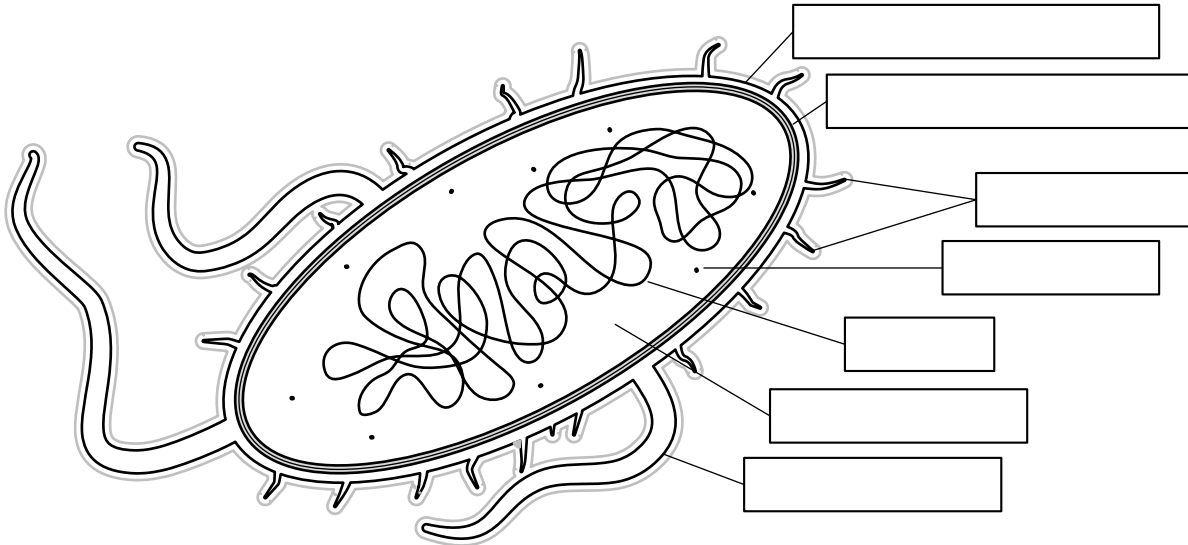
They should call me the powerhouse. I'm the one moving this whole



Why yes, I am



PROKARYOTIC CELLS



Example: *Salmonella*
Size: 2-5 Microns long

FILL IN THE LABELS ABOVE
USING THESE WORDS:

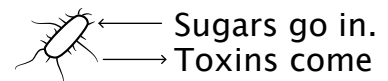
CYTOPLASM	CELL WALL	PLASMA MEMBRANE	DNA	CILLIA
		FLAGELLUM	RIBOSOME	

Your notes:

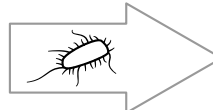
IS SOMETHING AS SMALL AS A SALMONELLA
BACTERIUM REALLY ALIVE? LET'S CHECK:

Metabolism ✓

IT EATS FOOD AND PRODUCES WASTE.



Responds to Stimuli



Will move toward a
wetter and better
environment

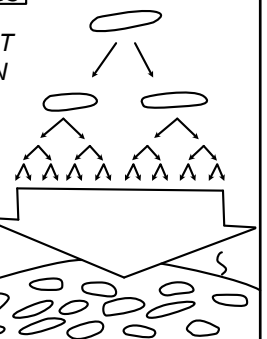
WHEN IT FINDS A GREAT LOCATION IT FORMS A **BIOFILM**,
A COLONY OF CELLS STUCK TOGETHER WITH SLIME.



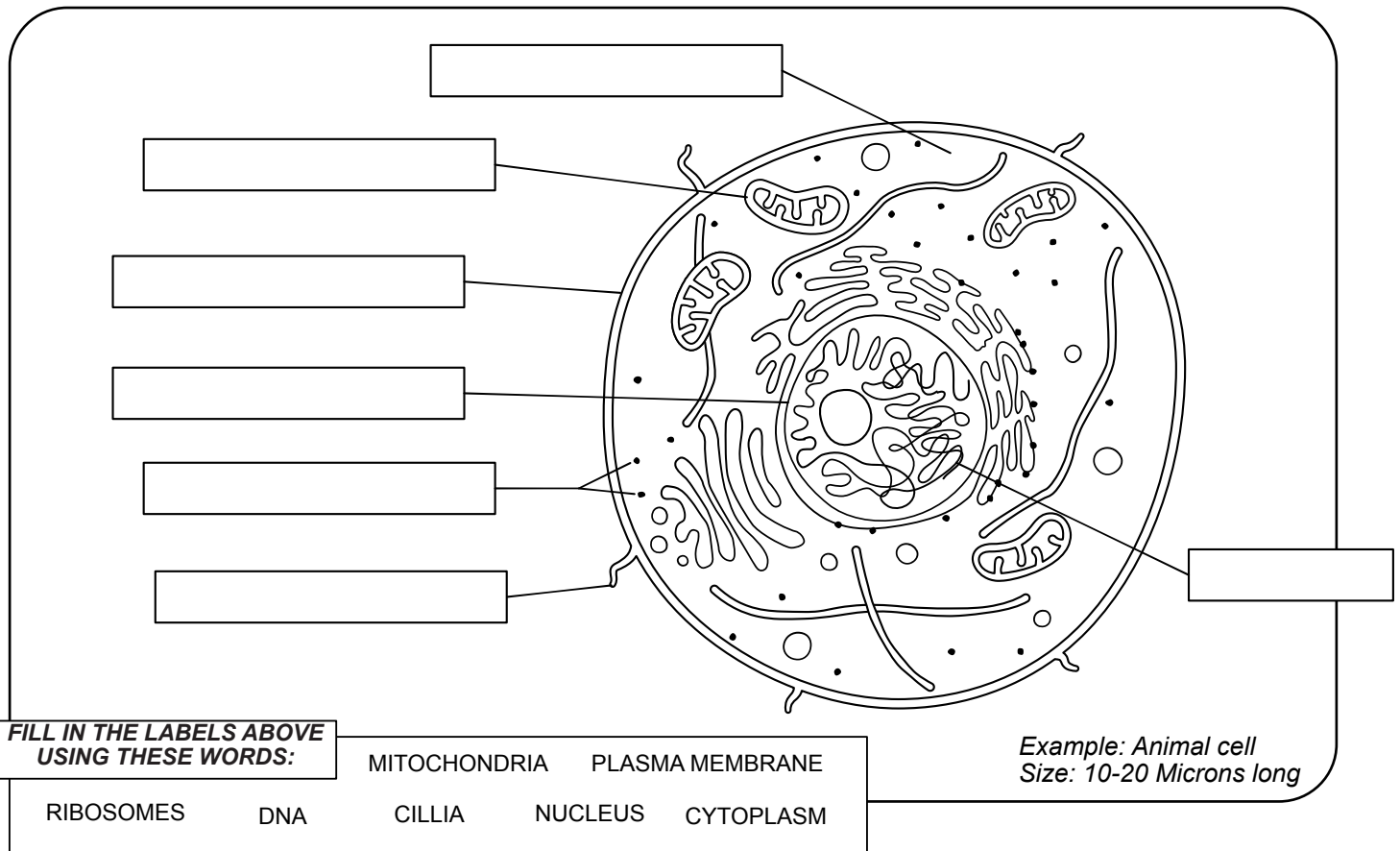
Ha ha! They'll never
get rid of us now!
Team work makes
the dream work!

Growth ✓ Reproduces

THIS IS WHY YOU HEAR ABOUT
SALMONELLA "OUTBREAKS" IN
FOOD. FIRST YOU HAVE ONE,
THEN TWO... THEN MILLIONS.



EUKARYOTIC CELLS



Your notes:

Eukaryotic cells can have incredibly different shapes and parts, but they will always contain:



A NUCLEUS which holds the DNA



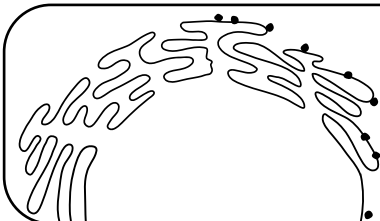
MITOCHONDRIA which provide energy



MEMBRANE which surrounds the cell



RIBOSOMES which make proteins

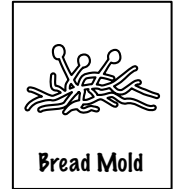
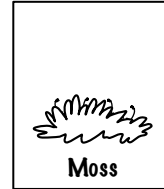
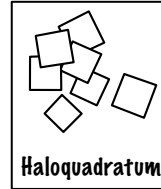
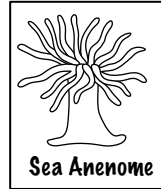
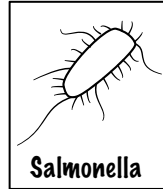
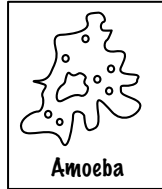


BONUS ORGANELLE!

What is the crazy-shaped thing around the nucleus with ribosomes stuck to it? It's called the **endoplasmic reticulum** and it helps make proteins. We won't be talking about it more in this class, but of all the organelles, it has one of the coolest names!

Cellular Life

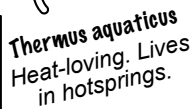
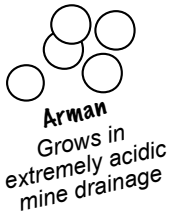
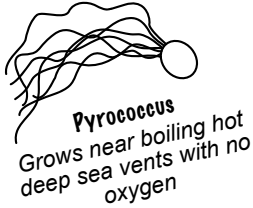
Can you place each of these organisms in their matching category?



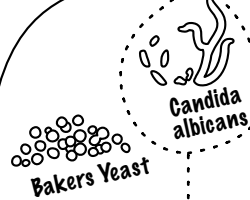
Unicellular

Multicellular

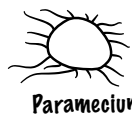
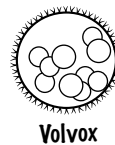
ARCHAEA



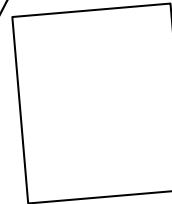
FUNGI



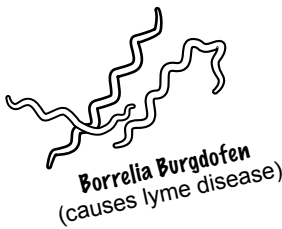
PROTISTS



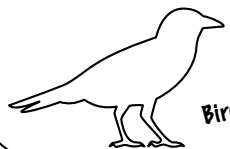
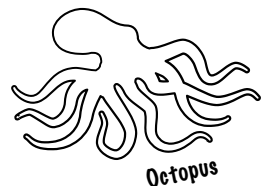
PLANTS



BACTERIA



ANIMALS



Taxonomy is the study of classifying groups of organisms based on shared characteristics. Classification systems have changed a lot in recent years thanks to the ability to compare DNA sequences. We'll learn more about taxonomy in Biology 2.

Five misclassified marvels

Scientists group things into categories to better understand them, but some organisms don't exactly fit! This page is dedicated to five organisms that people often mistake for something else. One is already filled out as an example. Choose 4 more from these lists to fill in the remaining blocks!

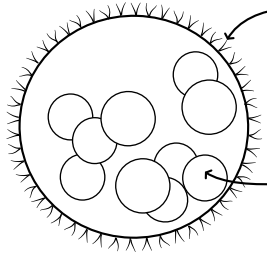
Plant or Fungus? *Caloplaca marina* (Orange Sea Lichen), *Sarcodes sanguinea* (Snow Flower), *Monotropa uniflora* (Ghost Pipe), or *Clathrus archeri* (Octopus Stinkhorn);

Animal or Plant? *Diploria labyrinthiformis* (Brain Coral), *Xestospongia muta* (Giant barrel sponge), *Elysia chlorotica* (Emerald Elysia), or *Pseudocolochirus violaceus* (Sea Apple)

What in the world? *Caulerpa taxifolia*, *Acetabularia*, and *Volvox*.

Volvox!

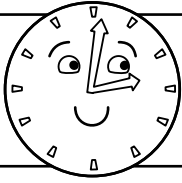
Volvox barberi
An algae colony made of thousands of cooperating cells!



Thousands of cells arrange themselves so that they form a sphere with with flagella facing out.

The Daughter colonies inside have their flagella facing toward the inside and will turn themselves inside out when they grow up!

The first people who wrote about volvox thought it was a tiny animal, perhaps related to a jellyfish!



Quiz Time!

Answer the questions to
see what you learned
About cellular life!

- 1 Which of these is the best simple definition for the word homeostasis?
 - A. The ability to regulate internal conditions.
 - B. The ability to use energy.
 - C. The ability to reproduce.
 - D. The ability to respond to a stimulus.
- 2 What are two characteristics of living things?
_____, _____
- 3 When did humans invent a microscope that can see structures inside a cell that are smaller than the wavelength of light (< 500 nanometers)?
 - A. 1665
 - B. 1850
 - C. 1903
 - D. 1951
- 4 No cell is large enough to be viewed without the help of a microscope.
 - A. True
 - B. False
- 5 Which type of cell has a nucleus?
 - A. Prokaryotic
 - B. Eukaryotic
- 6 Fungi are plants, but plants are not fungi.
 - A. True
 - B. False
- 7 Which domains of life have both single-celled and multi-celled organisms?
 - A. Only protists
 - B. Archaea and eubacteria
 - C. Fungi and protists
 - D. Only archaea
 - E. Only fungi
- 8 Which of the following are prokaryotic?
 - A. Bacteria and archaea
 - B. Fungi, animals, and plants
- 9 Protists are which type of cell?
 - A. Prokaryotic
 - B. Eukaryotic
- 10 A cell can only have one nucleus.
 - A. True
 - B. False
- 11 The average prokaryotic cell is _____ than the average eukaryotic cell.
 - A. 2 to 5 times smaller
 - B. 20 to 100 times smaller
 - C. More than 1,000 times smaller
- 12 Which organelle is responsible for making proteins in the cell?
 - A. Mitochondria
 - B. Ribosome
 - C. Plasma membrane
 - D. Endoplasmic reticulum
- 13 Which of the following are made of cells?
 - A. Wood
 - B. Plastic
 - C. Tomato
 - D. Polyester fabric
- 14 Which organelle uses oxygen and sugar to create energy for the cell?
 - A. Mitochondria
 - B. Chloroplast
 - C. Nucleus
 - D. Flagella
- 15 Which of the following statements is true?
 - A. Some living things are too small to see.
 - B. Animals are made of prokaryotic cells.
 - C. Fungi contain chloroplasts.
 - D. Every cell has a nucleus.
- 16 Which organelle is only found in plants or protists?
 - A. Chloroplasts
 - B. Mitochondria
- 17 Eukaryotic cells are bigger than prokaryotic cells.
 - A. True
 - B. False

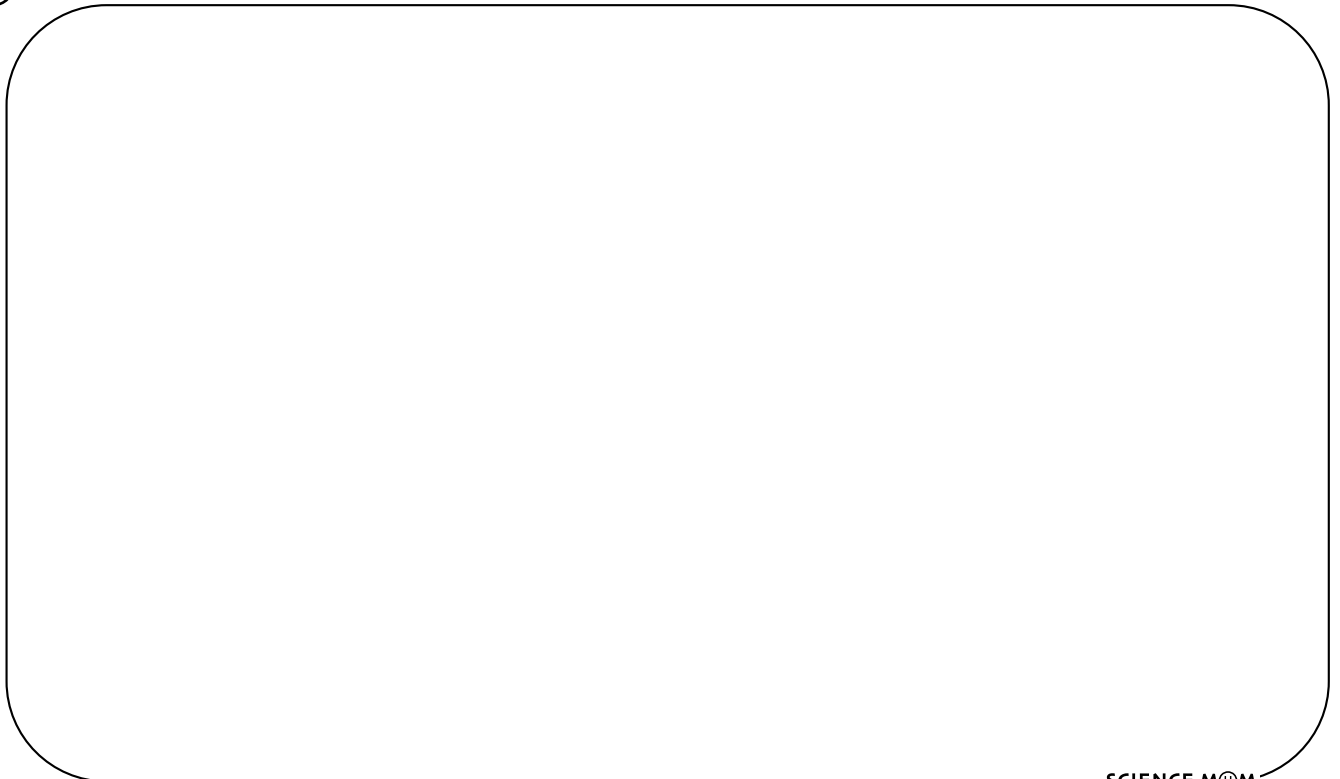
18 Which of these is the best simple definition for the word metabolism?

- A. The ability to regulate internal conditions
- B. The ability to use energy
- C. The ability to reproduce
- D. The ability to respond to a stimulus

19 Draw a simple bacterial cell. Label the plasma membrane, cell wall, DNA, ribosomes, and flagella.



20 Draw a simple animal cell. Label the plasma membrane, DNA, ribosomes, mitochondria, and nucleus.



Cellular Word Search

There are a lot of new words to learn when studying biology. Repetition is the best way to learn them, and word games can be part of that! Find each of the hidden words in the word-search. The words can run in any direction: horizontal or diagonal, and the letters might go left to right or right to left!

METABOLISM

MEMBRANE

RIBOSOME

MITOCHONDRIA

DEOXYRIBONUCLEIC ACID

CYTOPLASM

NUCLEUS

CHLOROPLAST

FLAGELLA

ARCHAEA

PROKARYOTIC

UNICELLULAR

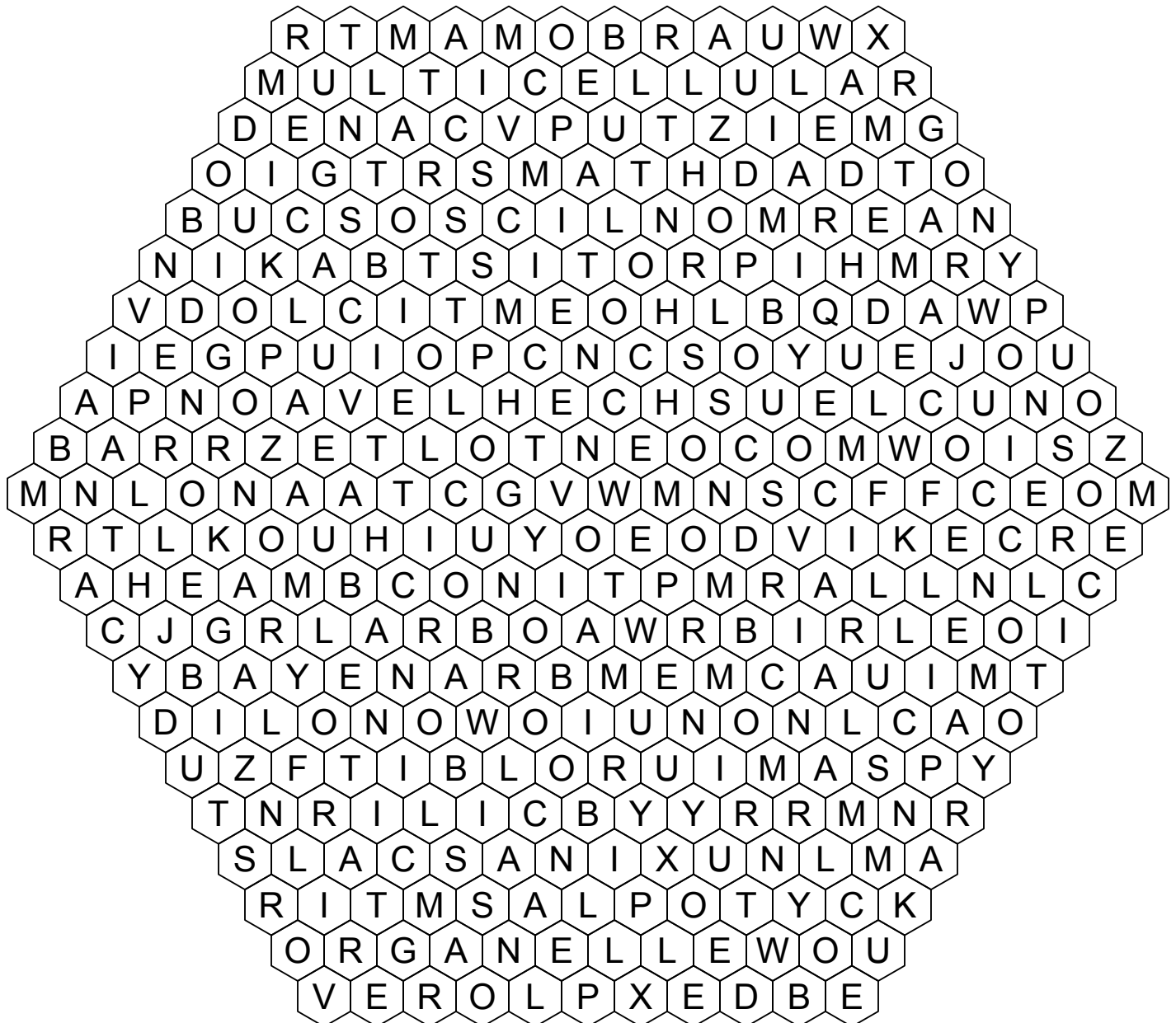
MULTICELLULAR

EUKARYOTIC

PROTIST

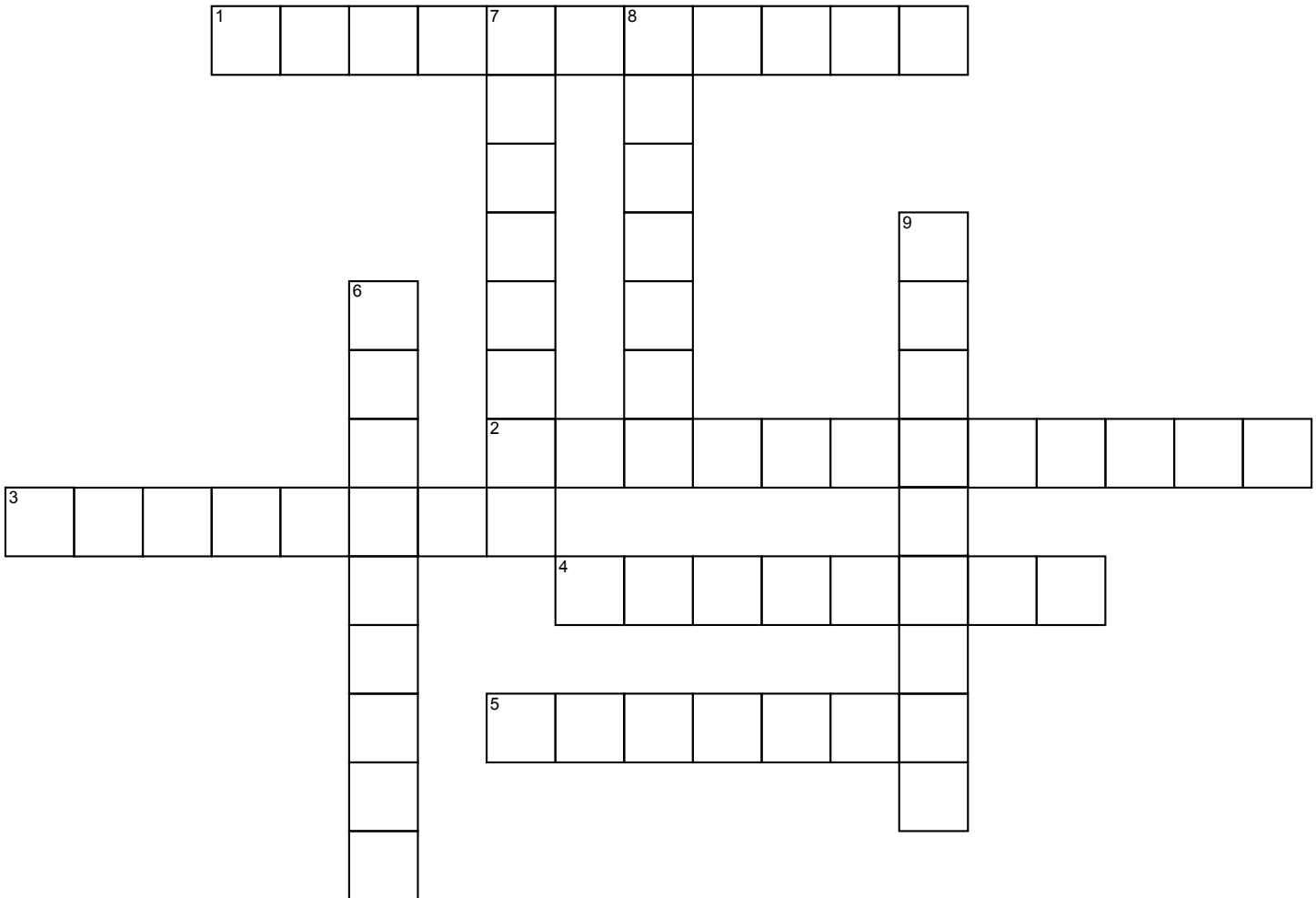
CILLIA

ORGANELLE



Biology Crossword

Use the clues below to fill in the crossword puzzle.



Horizontal Words

1. The organelle that performs photosynthesis.
2. The 'powerhouse' of the cell.
3. Keeps the cell intact by surrounding the cell.
4. A tail that some cells use to travel through fluid.
5. The central feature of most plant, fungus, or animal cells.

Vertical Words

6. A structure within a living cell.
7. Organelles that assist the function of DNA, very common throughout the cell.
8. An organism that is eukaryotic but not a fungus, animal, or plant.
9. Contains all of the organelles.