THE STORY OF LIFE ON EARTH

Remember the story about the formation of the Earth? The Earth came directly as a piece of the Sun. The sun had spun around and around, spinning off particles which became planets. Earth was one of the planets, a small pearl in the vast, interstellar space. In the beginning, everything was hot and liquid, but in the end, everything settled in its place according to its nature. The Sun, the Earth's mother, was very happy about her little daughter. She was so happy that she looked at the Earth all day long.

But then one day, the sun noticed that things were not going right. Order had been established on Earth in preparation for life, and she saw the danger of chaos returning. The Earth had fought very hard to form rocks, water, and air, but the temperature on Earth was still very hot, about 260 degrees Celsius, which was too hot for life. There was also too much carbon dioxide in the air. We know that carbon dioxide when combined with water, such as rain, makes a weak carbonic acid that can slowly dissolve even rocks.

Because of the continuous heat from the sun, Earth had violent storms and constant rain. The rain and the acid from the atmosphere fell on Earth's rocks, dissolving the rocks and washing the sediment into the ocean water. The ocean became thick with dissolved calcium carbonate from the limestone rocks, and also with the carbon dioxide. Surely nothing would ever be able to live in that thick, poisonous water!

The Sun was in great sorrow because her little daughter was in such trouble. Who was to blame for all this? Who was responsible? Was it the Rocks? Was it the Air? Or was it the Water? We know that each particle received a command about what to do and how to behave, so the Rocks, the Air and the Water must be behaving according to their nature.

Even so, Water was blamed first since it was washing the poisons into the oceans.

"I am not to blame, " said Water. "I am only obeying the commands given to me in the very beginning. If I get hot, I become vapor and rise. If I get cold, I turn into rain and fall.. I am supposed to cover the Earth, but if I get too hot, I must rise; and when I get too cool, I must fall back down as rain. It is the air that carries me up and lets me fall. The air must be responsible."

"I am not to blame either," said Air. "I, too, have been given commands. I am to cover the surface of our mother Earth. I have to rush in when she gets cold. If she gets hot, she pushes me away and makes me go very fast. As I rush over my little sister, Water, she jumps on me for a ride and I have to carry her with me. When we Rocks, they are so tall that I must rise. As I go up, I get cold and tired and have to drop my little sister, Water. She falls back to the Earth as rain. It is the heat that makes me rise, and it is the Rocks that make everything hot. If the Rocks were not so hot, mother Earth would not push me away. The Rocks are to blame for all this."

"It's not fair," cried the Rocks. "The Sun makes us so hot because she looks at us all the time. Water can leave when it gets too hot, and so can Air, but we are stuck here. We cannot move. If the Sun does not stop looking at Earth all day, we will get hotter and hotter. Things will only get worse. The Sun is to blame! If she really loves Earth, she must stop looking at her all the time and give Earth time for herself!

The sun was very sad when she heard this. If it was necessary for her to go away to keep her little daughter Earth alive, she would do it, but first the sun decided to consult with the universal intelligence. The universal intelligence said to the sun, "You cannot go away because the Earth cannot exist without your heat. We must first find a way to purify the water that is so thick with dissolved carbon dioxide and calcium carbonate. Perhaps we can find something that can live in the water."

And so there came to be a jelly-like substance called **protoplasm** (Greek- proto, "first," and plasma, "something molded or formed.") that was in the water. From this protoplasm came simple organisms. Some of them had **chlorophyll** so they could use the sun's light to help make their own food from the carbon dioxide in the water. They were very successful and multiplied and spread throughout the water. These were the blue-green bacteria (cyanobacteria) and green algae. There were other organisms in the water, too, but these did not have chlorophyll and so could not make their own food. They ate some of the algae, which was so plentiful. These first organisms that ate other cells were the protista. They, too, multiplied and spread. Still other organisms used the calcium carbonate in the water to make protective structures. These were the corals. So in this way, slowly the water was being cleansed of the poisonous carbon dioxide and calcium carbonate, as these first simple organisms performed their tasks and spread throughout the water.

The Rocks were still too hot from the ever-watchful sun, and the air still could not carry the water very long, and the rain continued to fall and wash carbon dioxide and calcium carbonate into the water, but gradually the rain began to cool the rocks. As the rocks cooled, the water vapor was able to ride on the discourse, to speak of or to write about the Earth.

This is the **Clock of Eras**. (Show) It represents the history of the Earth. The black part represents the Hadean era, the first story: the formation of the Earth. It is black to signify the unknown of the past. The gray part is the **Precambrian Era**. It represents the second story: the emergence of life. But there are very few words in the Book of Rocks about the these Eras and the few words that are there are hard to read.

How can the rocks tell stories like a book? Well, when Water and Air erode and dissolve Rock, this sediment is carried into the ocean and sinks to the bottom where it settles and hardens together. The, as life dies in the ocean, some of it sinks to the very bottom where it becomes embedded in the sediment of rocks, layer after layer. Each layer is like a page in a book that communicates the progression of life through time. Even signs of raindrops have been found in these layers. The Book of Rocks is still being formed today by the rain and wind. The signs of life that are left in the layers of rock are called **fossils**, from a Latin word that means 'to dig'.

You might think that it would not be very difficult for a geologist to read about the story of life in the Book of Rocks. The bottom layers would contain words about the oldest life, and the top layers would show the newest life. But the layers did not stay in order. There is no permanence to the Earth's crust. Some areas are being folded up and buckled, so the pages of the rocks are pushed out of shape and order. Parts of these folds are pushed down into the hot inner Earth where they melt. The fossils in these layers disappear.

Each period in the *Clock of Eras* starts from the beginning of the formation of mountains and lasts until the mountains are completely eroded. When the mountains are eroded and flat, the sea invades the land. When the climate gets cold, the water is locked into ice and retreats from the land. If all the ice that exists today were to become melted, the sea level would be 200 meters higher than it is now, and all except the highest mountains would be under water.

The pages of the Book of Rocks about the **Paleozoic Era** are easier to read. Paleozoic means 'ancient life'. It is colored blue because life lived in the water. All phyla of invertebrates were represented: sponges, sea anemones, jellyfish, worms, arthropods, mollusks, and echinoderms. Then the first vertebrate, the fish, appeared, followed by amphibians and reptiles once plants moved onto the land.

The **Mesozoic Era**, in brown, is dominated by the dinosaurs, reptiles that lived on land, in the water, and in the air. Mesozoic means 'middle life'. Small birds and mammals developed also. The dinosaurs became extinct at the end of the Mesozoic Era.

The **Cenozoic Era**, in green, is dominated by mammals. Cenozoic means 'new life'. At first, some mammals were extremely large. They finally developed into the mammals we know today. About 3 - 4 million years ago, humans appeared.

The Story of Life on Earth, one of the six great stories of Montessori, was given by Mario M. Montessori at the Washington Montessori Institute Advanced Course in 1979.

BIOLOGY
THE STUDY OF LIVING ORGANISMS

In our first discussions with children about living organisms, we discuss those features of life that we can see with our eyes (e.g.- a plant grows, a lizard moves).

We generally focus on plants and animals because these categories of life forms can be observed without technological aides. Observation is the foundation of scientific inquiry. The initial lesson of "Living/ Non-Living" relies on what the children can observe. We have devised a list of criteria for determing if something is living in order to provide a framework for thinking about the requirements of living organisms. We reiterate criteria of "living" (Move, Respire, Sense, Grow, Reproduce, Excrete, Feed) with the children throughout the various biology lessons.

Keep in mind that there is no definitive list for what constitutes life. For example, most forms of life require oxygen or carbon dioxide, but not all.[1] Some scientists argue that viruses are living even though they do not have cells.[2] However, From our observations, we can organize and categorize information.[3]

The scientific study of living organisms began with that which is observable to the human eye. Aristotle, the philosopher and naturalist during Classical Athens, is the father of biology. He approached the study of living organisms systematically, describing his observations of the natural world around him. The Artistotle compiled these features of animals he observed in his seminal *History of Animals.* Aristotle dissected animals in order to understand their internal parts. His On the Parts of Animals outlines standards for evaluating observations. Artistole sets forth a method of inquiry that holds true for science today: "we may first grasp the differences and the attributes belonging to all animals. After we do this, we must attempt to discover the causes. For it is natural to carry out the investigation in this way, beginning with the inquiry into each thing; for from these inquiries it becomes clear both about which things the demonstration hould be and from which things it should proceed."[4]

Artistole further outlines his method: first clarify the differences and attributes to be demonstrated before going on to find the causes. He correlated structure to function. For example, the qualities of a particular bird's beak suits the task of its foraging.

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1 "Oxygen-Free Animals Discovered-A First," National Geographic, by Ker Than. April 17, 2010.

2 Villarreal, Luis P. "Are Viruses Alive?" Scientific American, 8 Aug. 2008, www.scientificamerican.com/article/are-viruses-alive-2004/.

3 The first Next Generation Science Standards cross-cutting concept is "Patterns": "Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them."

4 (HA I 6, 491a7–14)

Aristotle, and his disciple, categorized all living things into two categories: plants and animals. These categories remained the standard through the mid-19th century.

In 1866, through the use of the newly invented microscope, scientists could observe single-celled eukaryotes and prokaryotes. Since these organisms could not be categorized as either plant or animal, the Protist Kingdom was proposed. The microscope allowed scientists to understand life on a cellular level. Cell theory was developed.

Cell theory states that:

1. All living organisms are composed of one or more cells;
2. The cell is the basic unit of life;
3. All cells arise from pre-existing cells.

With the invention of the electron microscope, scientists could see the molecular structure of cells, ultimately leading to an understanding of genetic material. Cell theory was further refined to include an understanding of cells containing DNA.

As scientists have deepened our understanding of life on this molecular level, they have simultaneously enabled an understanding of the vast timeline of life. With genetic information of a cell, we can construct a map of genetic relationships among organisms. We call this the *Tree of Life*.

LIVING AND NON-LIVING

Material:

- An assortment of objects representing living organisms and non-living things gathered by the children or the adult
- Labels with the words 'Living' and 'Non-living'
- An assortment of pictures representing living organisms and non-living things

Presentation:

1. Lay out the labels 'Living' and 'Non-living' at the top of a large carpet.
2. Ask the children to find objects and place them under the labels.
3. Discuss with the children the reasons for the placement of the objects.
4. Move any objects that the children decide are placed in the incorrect place.
5. Discuss the characteristics of living and non-living things.

A discussion about the features of living organisms provides an opportunity to review concepts introduced in botany and zoology. Here are some common **characteristics of living things that the children may observe and remember from botany and zoology.**

- All living things require energy and chemicals. Energy is obtained from food and water.
- All living things take in oxygen.
- All living things must release carbon dioxide. This is excretion. (Excretion should not be confused with egestion which is the removal from the body of substances with no food value that have passed unused through the digestive systems)
- All living things maintain equilibrium (homeostasis). For example, when we are in a hot tub, our body works to maintain the same internal temperature.
- All living things are sensitive to their environments and are capable of responding to external stimuli. For example, if you approach a wild animal, it will move away; a plant moves towards the sunlight. We, humans, are sensitive to light, sound, touch, taste, smell, and temperature.
- All living things transport substances within themselves For example, we transport oxygen through our circulatory system and plants transport water through their stems.
- All living things grow. For example, a seed grows into a plant, children grow into adults.
- All living things reproduce. Our parents produced us!
- We are going to distill all of these observations into the following criteria:

1. **Move:** in some way, even if it is just to grow
2. **Respire:** the release of energy
3. **Sense:** be able to sense and respond to external stimuli

4. **Grow:** develop new cells
5. **Reproduce:** procreate to produce more of its kind
6. **Excrete:** eliminate chemicals or matter that is not reusable
7. **Feed:** obtain energy and nutrients in some way

Although these characteristics are shared by all living things, the manner in which these processes are carried out vary widely from one group to another.

Follow-Up Work:

1. The children may research the chemicals that animals excrete.. (Animals excrete carbon dioxide, ammonia, urea, uric acid, and creatine.
2. The children can list which parts of the human body are involved in "sense." (
3. The children can review the systems of the human body are involved with "feed."

BIOLOGY
CLASSIFYING AND ORGANIZING

Just as young children sort shapes and sizes, our elementary children must learn to sort increasingly complex material. Central to biology is taxonomy, the science of classifying organisms. Classifying begins with observation. The next step is articulating the variable that is the basis for the grouping. For example, each "block" of the knobbed cylinders has one or more variables that guides the proper arrangement: diameter and height. Through botany and zoology in lower elementary, the children have been exposed to information that can form the basis for observing similarities and differences among organisms. Some plants flower, some do not; some animals lay eggs, other give live births.

Scientists have created groupings in more complex ways, but the underlying process is the same. The classification systems that we present are the Three Domains and the Five Kingdoms.

The Three Domains classifies life forms into the structure of the cell (prokaryote/ eukaryote) and the chemical processes of the cell (archaea/ bacteria). Unlike bacteria, organisms in the archaea domain do not have peptidoglycan in their cell walls. There are several other metabolic differences that reflect genetic differences.

The Kingdoms can be presented as either 5 or 6, depending on whether Archaea and Bacteria are assigned their own kingdom or grouped together as, simply, the Prokaryote Kingdom. This is a classification issue; undoubtedly, in our lifetime, further research will support new classification systems. The important concept is that living organisms can be classified based on various criteria. Artistotle classified the living world into plants and animals based upon movement (plants do not move, animals move). We have a vastly deeper understanding of our living world and, therefore, have a complex classification system.

Material:

pictures of a bat, birds (e.g.- owl, hawk, pigeon), and other creatures that can fly
pictures of a dolphin, fish and other creatures that live and swim in the water

Group Presentation: Key Experience

1. Say, "There are many ways to categorize things in the world."
2. Place the images of the bat and bird next to each other. Ask, "What do these two animals have in common?" Discuss the physical features. Discuss how they move. "Both of these animals fly."
3. "Place the images of the dolphin and the fish next to each other. Ask, "What do these two animals have in common?" Discuss. Discuss how they move. "Both of these animals live in the water." Discuss where they live. "Both of these animals live in the water."

4. Say, "We can divide all living organisms into those that fly and those that do not fly. We can divide all living organisms into those that live in the water and those that do not live in the water."
5. Say, "We are categorizing animals that we can see based on how they move in the world."

Follow Up Activities:

1. The children can make side-by-side columns of the characteristics of plants and animals in terms of movement, respiration, sense, growth, reproduction, excretion and feeding.

PROKARYOTIC AND EUKARYOTIC CELLS

Introduction for the Children:

We have discussed what we can observe with our eye. Now we introduce what we can see with the help of magnification. Through the use of the microscope, scientists discovered that all living organisms are composed of cells. Do you remember in our botany and zoology curriculum we learned about the plant and animal cell? Understanding cellular structure and function is fundamental to biology. Our bodies are composed of animal cells.

With even deeper magnification, the microscope revealed to scientists that some organisms are unicellular. Even more startling was the discovery that some organisms have no nucleus! Scientists grouped living organisms into two groups: those that have a nucleus (eukaryote) and those that do not have a nucleus (prokaryotes). Remember, prokaryotes are so small that they are not observable to the naked eye!

Cell theory states that:

1. All living organisms are composed of one or more cells;
2. The cell is the basic unit of life;
3. All cells arise from pre-existing cells.

The Three Domains are based on cellular differences.

THE PROKARYOTIC CELL

Material:

- The Prokaryotic Cell Nomenclature

Group Presentation: Key Experience

1. Some of the children are given the definition and picture cards. They discuss the parts and prepare a play, putting the parts of the prokaryotic cell together. They perform the play for the other children.
2. Say, "We have categorized everything in the universe into two categories, living and non-living." Review.
3. Say, "Now we will categorize all living organisms into two different categories by the structure of their cells." Ask the children if they can name some living organisms.
4. Say, "The cell of a living organism is the smallest part of the organism that carries on life processes for the organism and that gives structure to the organism. Some organisms are single-celled. The single cell carries on all the life processes for the organism. Some organisms are many-celled and different cells perform different functions for the whole organism.

   There are two kinds of cells. The prokaryotic cell does not have the center of the cell, called the nucleoid, separated from the rest of the cell by a membrane. The nucleoid contains the hereditary material, DNA. The organisms that have the prokaryotic cell are all the bacteria.

   The eukaryotic cell has a double nuclear membrane, the nuclear envelope, to separate the hereditary material, DNA, from the rest of the cytoplasm. The organisms that have the eukaryotic cell are the protists, the fungi, the plants, and the animals."
5. Show the children a raw egg. Break open the egg so that the yolk remains intact. Say, "The nucleus of the eukaryotic cell is like the egg yolk. There is a membrane that confines the DNA inside the nucleus." Break the membrane around the egg yolk. "The prokaryotic cell is like this broken egg yolk. There is no membrane to confine the DNA to one position in the cell."
6. Discuss the parts of the prokaryotic cell:
   A. The Prokaryotic Cell - The prokaryotic cell was the first cell on earth. The prokaryotic cell is simpler in structure and smaller than the eukaryotic cell. The prokaryotic cell does not have a nuclear membrane. The word prokaryote means 'before the nucleus'. The prokaryotic cell

performs all the functions necessary for the cell to live without special organelles.

Greek: pro - before karyon - kernel, nucleus

B. The capsule - The capsule surrounds the entire cell. The capsule is a jelly-like slimy outer layer of the cell. The capsule is made of carbohydrates and proteins. The capsule of pathogenic bacteria allows the bacteria to attach to specific host tissues. The function of the capsule is to protect the cell. The capsule is found in many prokaryotes but not all prokaryotes.

C. The cell wall - The cell wall surrounds the entire cell. If the prokaryote cell has a capsule the cell wall is located under the capsule. The functions of the cell wall are to support and to protect the cell. The cell wall is made of special carbohydrates and proteins.

D. The cell membrane - The cell membrane surrounds the entire cell. The cell membrane is surrounded by the cell wall. The function of the cell membrane is to hold the cell together. Another function of the cell membrane is to control substances that enter and leave the cell. The cell membrane is sometimes called the plasma membrane.

E. The cytoplasm - The cytoplasm is made of all the cell contents outside the nucleoid and inside the cell membrane. The function of the cytoplasm is to contain the ribosomes and the nucleoid. The cytoplasm contains no membrane-bound organelles.

Greek: cyto - cell plasma - substance of a cell

F. The ribosomes - The ribosomes are located in the cytoplasm. The function of the ribosomes is to make protein for the cell. The ribosomes are smaller and more numerous than in the eukaryotic cell.

G. The Inclusions - The inclusions are located in the cytoplasm. The function of the inclusions is to store granules of compounds such as glycogen present in many prokaryotes.

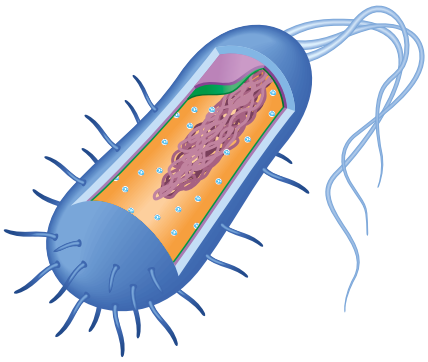
H. The nucleoid - The nucleoid is located within the cell membrane and is surrounded by cytoplasm. The function of the nucleoid is to direct the function of the ribosomes and to divide the cell. The nucleoid contains a single circular or continuous molecule of the hereditary material, DNA. DNA determines what the cell will become. The nucleoid does not have a membrane to separate it from the cytoplasm.

I. The pill - The pili are small hairlike projections coming from the outer surface of the cell wall of some bacteria. Pili help the bacteria attach to other cells and surfaces. Without pili, bacteria would have difficulty attaching to other cells and surfaces. Pili are like Velcro.

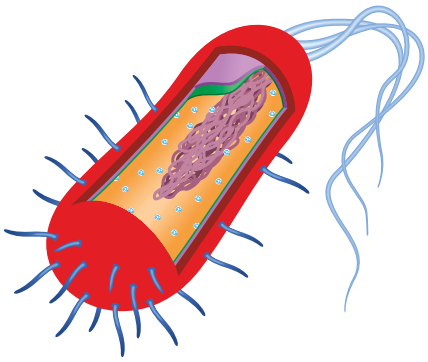
J. The flagellum - The flagellum is attached to the outside of the cell wall. The function of the flagellum is to move the cell through liquids. The flagellum is a whip-like structure that pushes the cell through liquids. The flagellum is composed of a protein called flagellin. The flagellin is arranged into chains and wound into a triple helix with a hollow central core. The flagellum grows at the tip

7. "Is the prokaryote cell living or non-living?"
8. "The prokaryote cell makes up the group of living organisms in the Archaea and Bacteria Kingdoms, the bacteria."
9. Allow the children to draw or in other ways render what they observe.
10. Lay out the pictures of the prokaryotic cell in order from left to right.
11. Distribute the labels for the children to match to the pictures.
12. Distribute the definitions for the children to read and to match to the pictures.
13. Display the wall chart.
14. Check the definitions with the booklet.
15. Place the classified nomenclature, the booklet, and the wall chart on the shelf.
16. **Follow-up activities** for the children:
    A. Match the picture and the label (simple nomenclature).
    B. Match the picture, the label, and the definition cards (classified nomenclature).
    C. Make a booklet of the parts of the prokaryotic cell. The children write the definitions in their own words.
    D. Make a chart of the parts of the prokaryotic cell.
    E. Research to gain more information on the prokaryotic cell.
    F. Examine microscope slides of the prokaryotic cell.
    G. Use playdough, seeds, and string to make a model of the prokaryotic cell. Label the parts.
17. This presentation is typically covered over several group presentation periods.

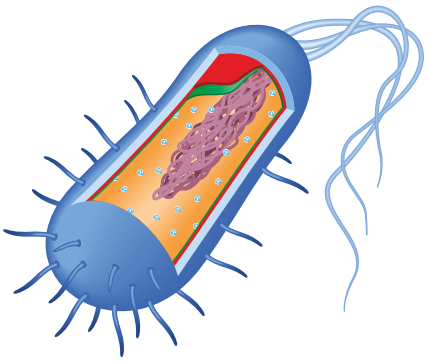
THE PROKARYOTIC CELL



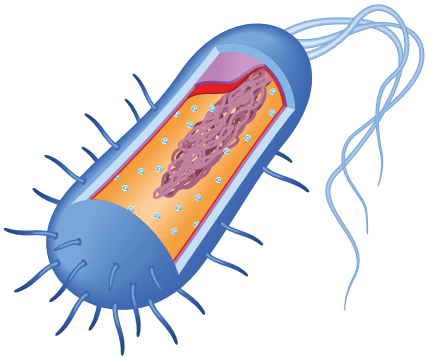
The Prokaryotic Cell



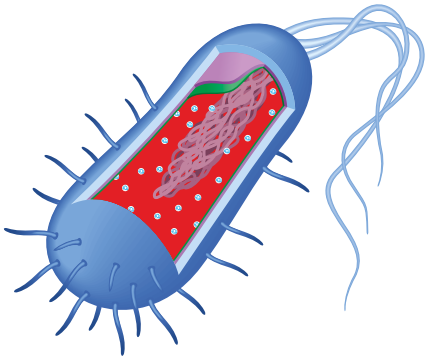
The Capsule



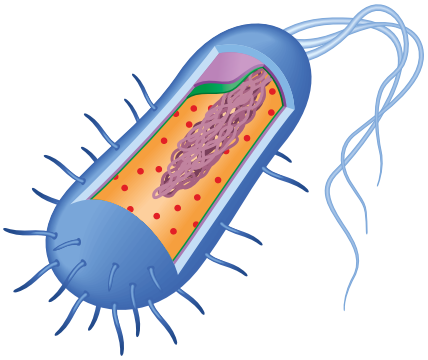
The Cell Wall



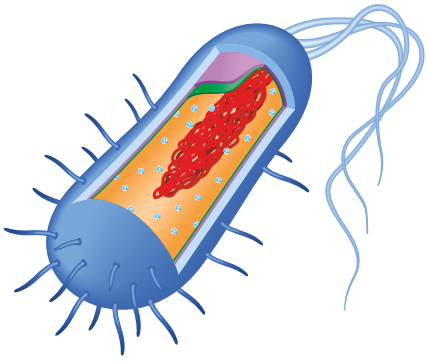
The Cell Membrane



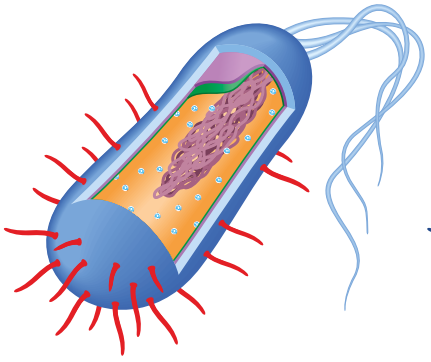
The Cytoplasm



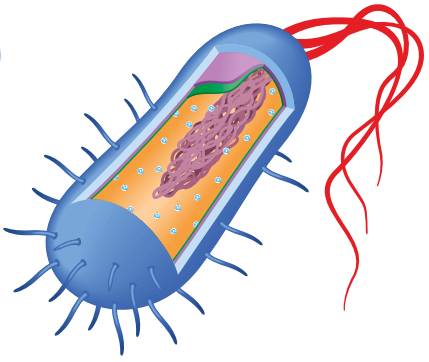
The Ribosomes



The Nucleoid



The Pili



The Flagellum

THE EUKARYOTIC CELL

Material:

- The Eukaryotic Cell Nomenclature

Group Presentation: Key Experience

1. Some of the children are given the definition and picture cards. They discuss the parts and prepare a play, putting the parts of the eukaryotic cell together. They perform the play for the other children.
2. Say, "We have categorized everything in the universe into two categories, living and non-living." Review.
3. Say, "Now we will categorize all living organisms into two different categories by the structure of their cells." Review the prokaryotic cell.
4. Say, "The cell of a living organism is the smallest part of the organism that carries on life processes for the organism and that gives structure to the organism. Some organisms are single-celled. The single cell carries on all the life processes for the organism. Some organisms are many-celled and different cells perform different functions for the whole organism.

   There are two kinds of cells. The prokaryotic cell does not have the center of the cell, called the nucleoid, separated from the rest of the cell by a membrane. The nucleoid contains the hereditary material, DNA. The organisms that have the prokaryotic cell are all the bacteria. The eukaryotic cell is larger and has many more parts inside. It has internal membranes that compartmentalize the functions of the cell. The double nuclear membrane, the nuclear envelope, separates the hereditary material, DNA, from the rest of the cytoplasm, and organelle membranes separate the organelles from the rest of the cytoplasm. The organisms that have the eukaryotic cell are the protists, the fungi, the plants, and the animals."
5. Show the children a raw egg. Break open the egg so that the yolk remains intact. Say, "The nucleus of the eukaryotic cell is like the egg yolk. There is a membrane that confines the DNA inside the

nucleus." Break the membrane around the egg yolk. "The prokaryotic cell is like this broken egg yolk. There is no membrane to confine the DNA to one position in the cell."

6. Discuss the parts of the eukaryotic cell:
   A. The Eukaryotic Cell - The eukaryotic cell is larger and more complex than the prokaryotic cell. The eukaryotic cell contains a nucleus. The nucleus is separated from the rest of the cell by a membrane. The eukaryotic cell contains organelles that perform the functions necessary for the cell to live. All plants, animals, fungi, and many protista are made of eukaryotic cells. Eukaryote means true nucleus.
      Greek: eu - true karyon - kernel, nucleus
   B. The cell wall - The cell wall is the outermost covering of the cell. The cell wall functions to support, to protect, and to give shape to the cell. Fungi cells have cell wall which is rigid, and made of chitin. Plant cells have a cell which is rigid, and made of cellulose. Animal cells do not have a cell wall. Some protista have a cell wall and some protista do not have a cell wall..
   C. The cell membrane - The cell membrane is under the cell wall. The cell membrane surrounds the entire cell. The cell membrane functions to hold the cell together. The cell membrane also functions to control the substances that enter and leave the cell.
   D. The cytoplasm - The cytoplasm consists of the cell contents inside the cell membrane and outside the nucleus. The cytoplasm contains the cytosol, the cytoskeleton and the organelles. The cytoplasm is about 80% water.
      Greek: cyto - cell plasma - staff
   E. The cytosol - The cytosol is a gelatin-like, watery fluid. The cytosol contains salts, minerals, and organic molecules. The organelles within the cytoplasm are suspended in cytosol.
   F. The cytoskeleton - The cytoskeleton is located throughout the cytosol. The cytoskeleton is a network of long protein strands consisting of microfilaments and microtubules. The cytoskeleton functions to maintain the shape and the size of the cell. The smaller microfilaments contribute to cell movement and the contraction of muscle cells. The larger microtubules aid in the movement of chromosomes during cell division.
   G. The organelles - The organelles are mitochondria, ribosomes, endoplasmic reticulum, vacuoles, Golgi Apparatus, smooth endoplasmic reticulum, rough endoplasmic reticulum. The organelles are suspended in the cytoplasm. Each organelle has a particular function that supports the life processes within the cell. Each organelle has its own membrane surrounding it. The membrane protects and contains the organelle.

H. The mitochondria - The mitochondria are organelles in the cytoplasm. The mitochondria function to make energy for the cell and, in plants, to make protein. The mitochondria make the energy for the cell by combining oxygen with the sugar molecules, breaking down the sugar, and releasing energy. The mitochondria have their own DNA.

Greek mitos – thread chondrion – grain

Greek: mitos - thread chondrion - grain

I. The ribosomes - The ribosomes are organelles in the cytoplasm. The ribosomes function to make proteins for the cell. Some ribosomes move freely in the cytoplasm. Other ribosomes are attached to the endoplasmic reticulum. The ribosomes that move freely provide proteins to the cytoplasm and its contents. The ribosomes that are attached to the endoplasmic reticulum provide proteins for organelle membranes, and proteins for export outside the cell.

J. The vacuoles - The vacuoles are organelles in the cytoplasm. The vacuoles function to store food, water, enzymes, and/or metabolic wastes. The vacuoles are sometimes very large. The vacuole is surrounded by the vacuolar membrane.

K. The Golgi Apparatus - The Golgi Apparatus is an organelle in the cytoplasm. The function of the Golgi Apparatus is to make carbohydrates needed for the cell, and to make the molecules needed for the cell wall. The Golgi apparatus is a network of flattened sacs with membranes. The plant cell has smaller and more numerous sacs than the animal cell. The Golgi sacs are separate in the plant cell.

L. The lysosomes - The lysosomes are organelles in the cytoplasm. The function of the lysosomes is to digest worn out cell molecules. The lysosomes are small, spherical sacs of digestive enzymes. The lysosomes digest molecules such as proteins, carbohydrates, lipids, RNA, DNA, old organelles, and foreign substances such as bacteria and viruses. Lysosomes serve some of the same functions as the vacuoles in the plant cell.

M. The endoplasmic reticulum - The endoplasmic reticulum is an organelle in the cytoplasm. The endoplasmic reticulum is an elaborate network of sacs and tubes. The endoplasmic reticulum membranes connect to the outer border of the nuclear membrane. Part of the function of the endoplasmic reticulum is to provide passageways and to transport molecules throughout

the cytoplasm. The endoplasmic reticulum contains both rough and smooth membranes.

N. The rough endoplasmic reticulum - The rough endoplasmic reticulum has ribosomes embedded in the outer membrane. The rough endoplasmic reticulum collects proteins made by the ribosomes. The rough endoplasmic reticulum also transports the ribosomes within the cell.

O. The smooth endoplasmic reticulum - The smooth endoplasmic reticulum is a continuation of the rough endoplasmic reticulum. The smooth endoplasmic reticulum transports proteins, makes lipids, processes carbohydrates, and modifies toxic chemicals. Buds are formed off the ends of the smooth endoplasmic reticulum. The buds transport the proteins and the lipids to the Golgi apparatus and to the cell membrane.

P. The nucleus - The nucleus is located in the center of the cell. The two functions of the nucleus are to divide the cell, and to direct the processes of the organelles. The nucleus contains the hereditary material, DNA. DNA determines what the cell will become. The nucleus is surrounded by the nuclear membrane that separates the nucleus from the cytoplasm. The nucleus contains the nucleolus and chromatin.

Q. The nuclear membrane - The nuclear membrane surrounds the nucleus. The nuclear membrane is a membrane made of two layers. The nuclear membrane contains many nuclear pores. The nuclear pores are tiny holes that allow the passage of RNA and protein from the nucleus into the cytosol. The nuclear membrane is also named the nuclear envelope because it has two layers.

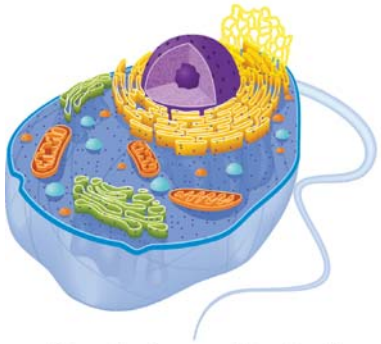
R. The nucleolus - The nucleolus is located in the nucleus of the cell. The function of the nucleolus is to make ribosomes for transport to the cytosol. The nucleolus is a dense, granular, spherical structure inside the nucleus. The nucleolus is made of protein and DNA packed tightly together.

S. The chromatin - The chromatin is located in the nucleus of the cell. Chromatin is composed of DNA and protein. The chromatin is responsible for the process of cell division. Cell division happens when the DNA is first split and then filled in with paired molecules. The cell divides with the same DNA structure in each cell.

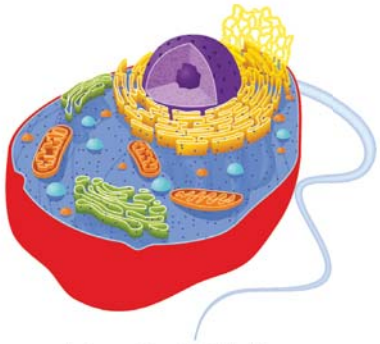
T. The flagellum - The flagellum is a continuation of cell membrane. The flagellum functions to move the cell through liquids. The flagellum is made of nine pairs of microtubules arranged around two microtubules. The flagellum moves materials over the cell surface. Cilia function similarly to flagella. The flagellum is named undulipodium.
Greek: undulipodium - swinging foot

7. Say, "Is the eukaryotic cell living or non-living?"
8. Say, "The eukaryotic cell makes up the groups of living organisms in four of the five kingdoms. Do you remember what they are?" "The Prokaryote, Protista, Fungi, Plant, and Animal Kingdoms."
9. Allow the children to draw or otherwise render what they observe.
10. Lay out the picture cards of the eukaryotic cell in order from left to right.
11. Distribute the labels for the children to match to the pictures.
12. Distribute the definitions for the children to read and to match to the pictures.
13. Display the wall chart.
14. Check the definitions with the booklet.
15. Place the classified nomenclature, the booklet, and the wall chart on the shelf.
16. **Follow-up activities** for the children:
    A. Match the picture and the label (simple nomenclature).
    B. Match the picture, the label, and the definition cards.
    C. Make a booklet of the parts of the eukaryotic cell. The children write the definitions in their own words.
    D. Make a chart of the parts of the eukaryotic cell.
    E. Research to gain more information on the eukaryotic cell.
    F. Examine microscope slides of the eukaryotic cells. Draw pictures.
    G. Compare and contrast the prokaryotic and eukaryotic cells.
    H. Use playdough, seeds, and string to make a model of the eukaryotic cell. Label the model.
17. This presentation is typically covered over several group presentation periods.

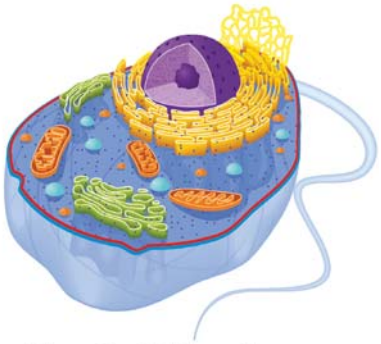
THE EUKARYOTIC CELL #1



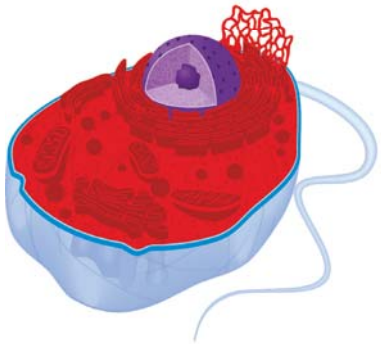
The Eukaryotic Cell



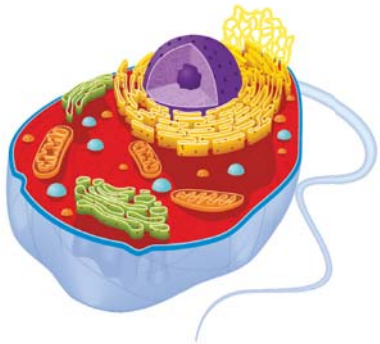
The Cell Wall



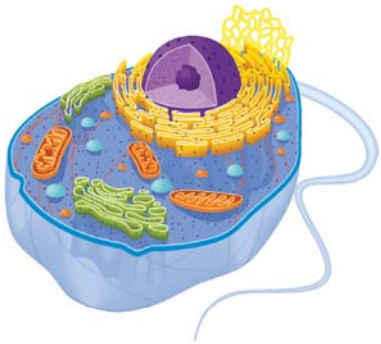
The Cell Membrane



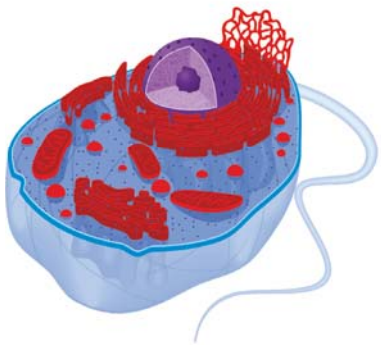
The Cytoplasm



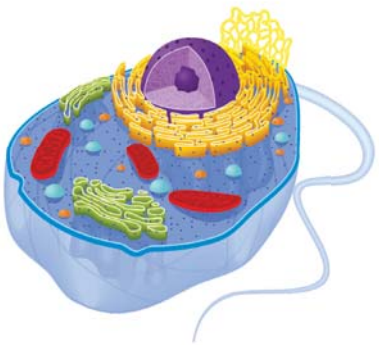
The Cytosol



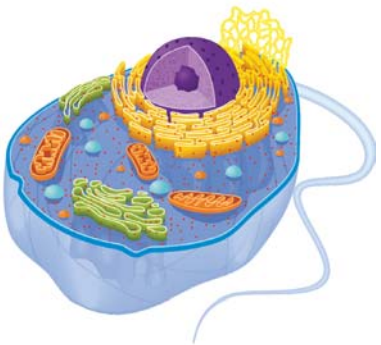
The Cytoskeleton



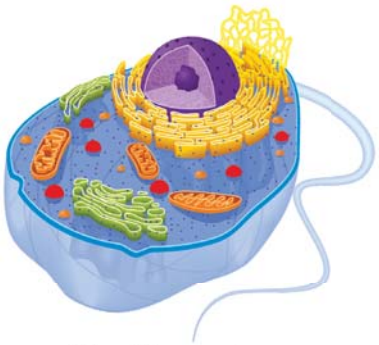
The Organelles



The Mitochondria

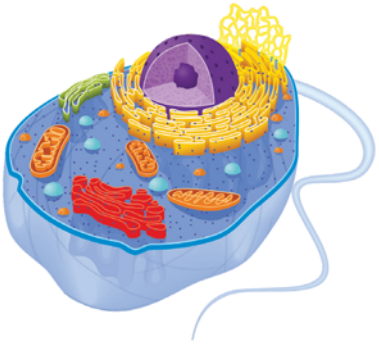


The Ribosomes

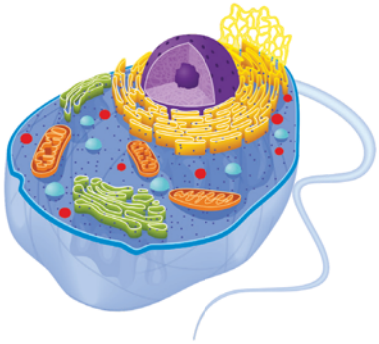


The Vacuoles

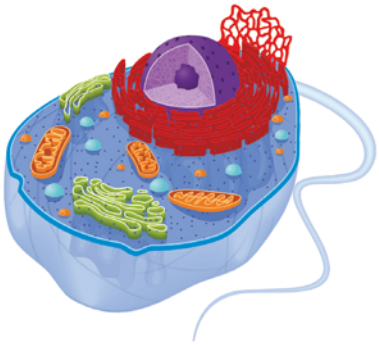
THE EUKARYOTIC CELL #2



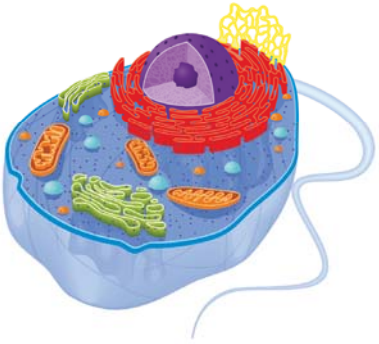
The Golgi Apparatus



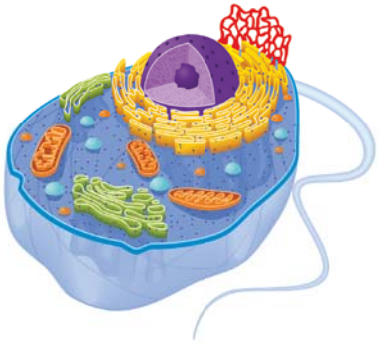
The Lysosomes



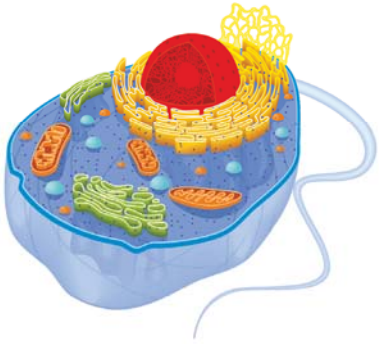
The Endoplasmic Reticulum



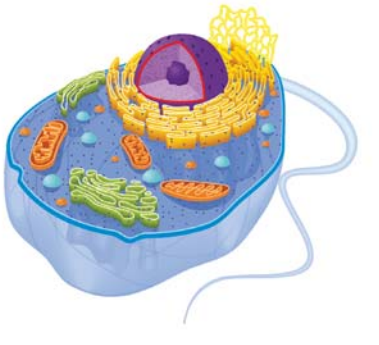
The Rough Endoplasmic Reticulum



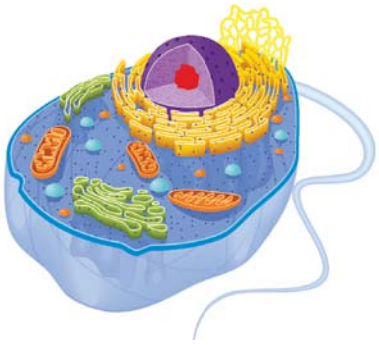
The Smooth Endoplasmic Reticulum



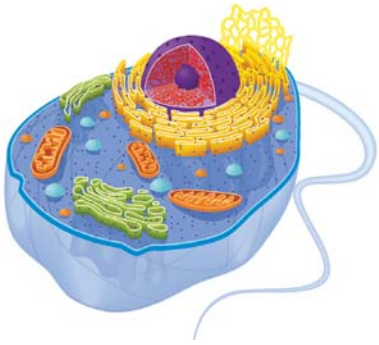
The Nucleus



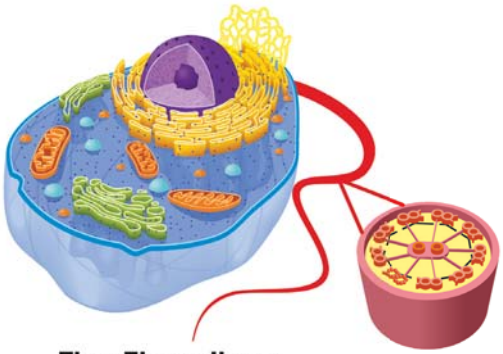
The Nuclear Membrane



The Nucleolus



The Chromatin



The Flagellum