G6. Inspire Science

Module: Cells and life

Lesson 1: Exploring life

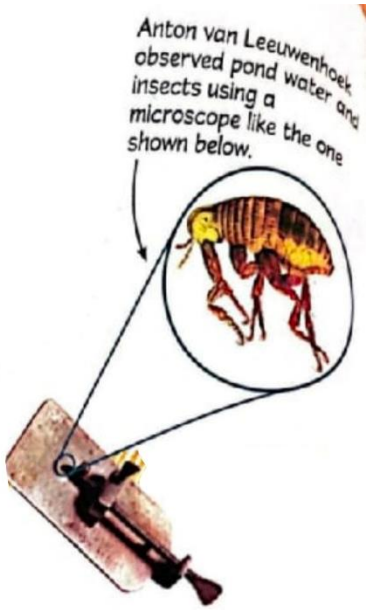
Cells:

we can use microscopes to see cells, it took hundreds of years for scientists to learn about cells.

The invention of microscopes enabled people to see details of living things that they could not see with the unaided eye. **The microscope** was an advance in engineering that enabled people to make important discoveries about living things.

More than 300 years ago, an English scientist named **Robert Hooke** built a microscope. He used that microscope to discover cells.

In the late 1600s, the **Dutch merchant Anton van Leeuwenhoek** made Improvements to the first microscopes. His microscope, had one lens and could magnify an image about **270 times** its original size. This made it easier to view organisms.



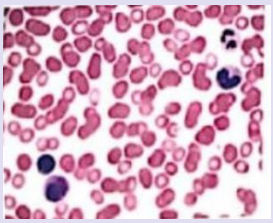
After **Hooke's** discovery, other scientists began making better microscopes and looking for cells in many other places, such as **pond water** and **blood.**

Three important observations about cells made by three different scientists were combined into one theory called the **cell theory**.

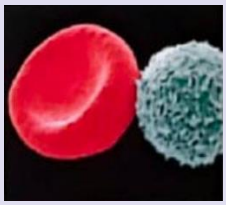
Principles of the Cell Theory:

1. All living things are made up of cells.
2. Cells perform different functions to keep organisms alive.
3. All cells come from preexisting cells through the process of cell division.

<table>
<tr><th>Light microscopes</th><th colspan="2">Electron microscopes</th></tr>
<tr><td rowspan="2">use light and lenses to enlarge an image of mice an object. Light microscopes can enlarge images up to <u>1,500 times</u> their original size, in some cases, the object, must be stained with a dye in order to see any details.

  </td><td colspan="2">use a magnetic field to focus a beam of electrons through an object or onto an object's surface. An electron microscope can magnify an image up to 100,000 times or more.
The two main types of electron microscopes are transmission electron microscopes (TEMs) and scanning electron microscopes (SEMs).</td></tr>
<tr><td>TEMs</td><td>SEMs</td></tr>
<tr><td></td><td>are usually used to study extremely small things such as cell structures. In a TEM, electrons pass through the object and a computer produces an image of the object.

  </td><td>are usually used to study an object's surface. In an SEM, electrons bounce off the object and a computer produces a three dimensional image. of the object.

  </td></tr>
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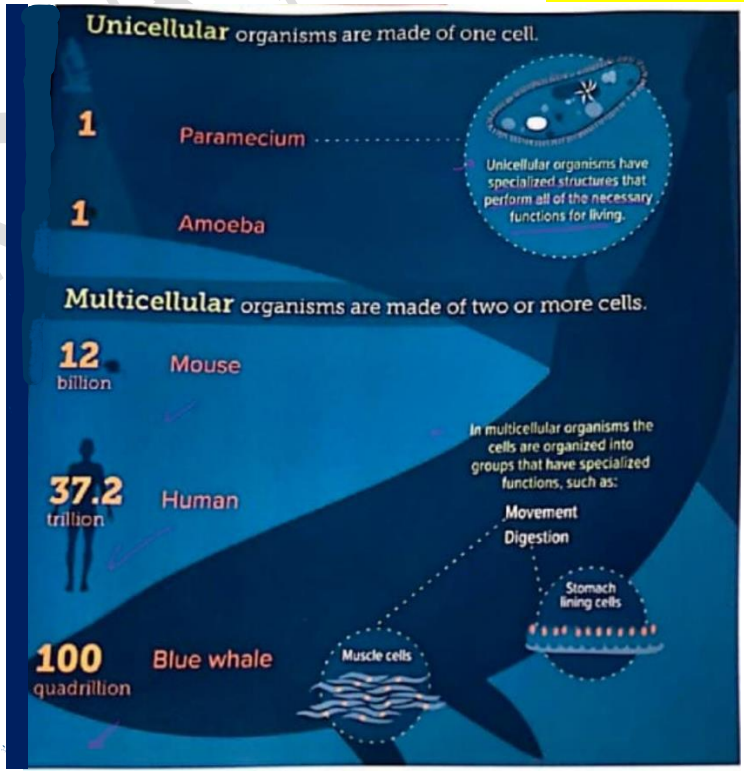
How many cells do living things have?

1. Living things that are made of only one cell are called **unicellular organisms**.
2. Living things that are made. of two or more cells are called **multicellular organisms**.



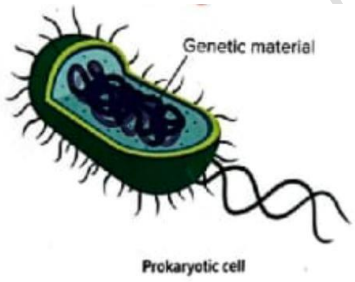
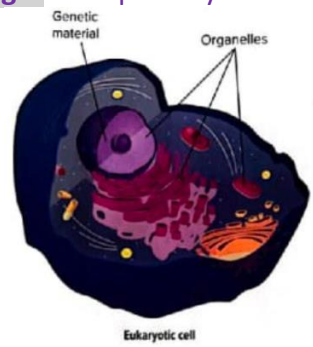
Characteristics of Life:

1. All living things are organized according to different structures that perform different functions.
2. Living things grow and develop, meaning they increase in size and go through changes during their lifespans.
3. Living things create new living things through the process of reproduction.
4. They also respond to changes in their environments, called stimuli.
5. Another characteristic of organisms is **homeostasis**, which is the ability to maintain steady internal conditions.
6. All organisms require energy for everything they do.

What are the different types of cells?

scientists discovered that all cells can be grouped into two categories:

1. **prokaryotic cells** 2. **eukaryotic cells**

prokaryotic cells	eukaryotic cells
All cells contain genetic material	
the genetic material is not surrounded by a lining. prokaryotic cells are **smaller** than eukaryotic cells. Most prokaryotic cells are unicellular organisms and are called **prokaryotes**. Some prokaryotes live in small groups called **colonies**. Some can also live in extreme environments.  Prokaryotic cell	has genetic material that is surrounded by a lining. Every eukaryotic cell also has other structures, called **organelles**, which have specialized functions. Most organelles are surrounded by linings. Eukaryotic cells are usually **larger** than prokaryotic cells.  Eukaryotic cell

Classification:

Organisms are classified according to their cell type- prokaryotic or eukaryotic, as well as other characteristics. All organisms are classified one of three domains-Bacteria, Archaea, or Eukarya and then into one of six kingdoms. Organisms in the Bacteria and Archaea domains are unicellular prokaryotes, while organisms in the Eukarya domain are eukaryotes.

Domains and kingdoms						
Domain	**Bacteria**	**Archaea**	**Eukarya**			
Kingdom	**Bacteria**	**Archaea**	**Protista**	**Fungi**	**Plantae**	**Animalia**
Example						
Characteristics	Bacteria are simple unicellular organisms.	Archaea are simple unicellular organisms that often live in extreme environments,	Protists are unicellular or multicellular and are more complex than bacteria and archaea.	Fungi are unicellular or multicellular and absorb food.	Plants are multicellular and make their own food.	Animals are multicellular and take in their food

Lesson 2: Cell structure and function

What surrounds a cell?

Every cell is surrounded by a protective boundary called a membrane.
The cell membrane is a flexible covering that protects the inside of a cell from the environment outside a cell.

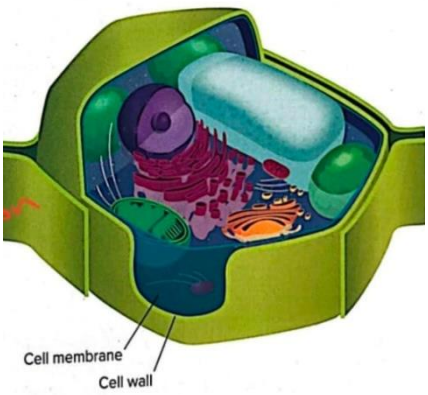
Cell Membrane:

The cell membrane surrounds the cytoplasm.
The **cytoplasm** is a fluid inside a cell that contains salts and other molecules.
another important role of cell membranes is to control the movement of substances into and out of cells. A cell membrane is **semipermeable**. This means it allows only certain substances, like nutrients and wastes, to enter or leave a cell.

Cell Wall:

Plant cells, fungal cells, bacteria, and some types of protists have cell walls.

A **cell wall** is a stiff structure outside the cell membrane.



Function:

1. A cell wall protects a cell from attack by viruses and other harmful.
2. A cell wall helps maintain the cell's shape and gives structural support.

How does cell size affect the transport of materials?

Nutrients, oxygen, and other materials enter and leave a cell through the cell membrane, the size of a cell affect the ransport of these materials throughout the cell.

Math connection A ratio is a comparison of two numbers, such as surface area and volume. If a cell were cube shaped, you would calculate surface area by multiplying its length (ℓ) by its width (w) by the number of sides (6).
You would calculate the volume of the cell by multiplying its length (f) by its width (w) by its height (h). To find the surface-area-to-volume ratio of the cell, divide its surface area by its volume.

Surface area = ℓ x w x 6

Volume = ℓ x w x h

$$\frac{\text{Surface area}}{\text{Volume}}$$

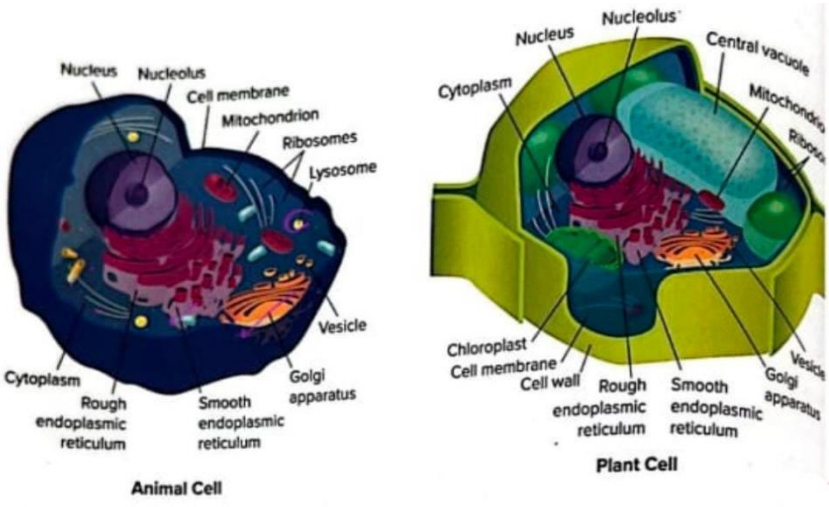
In the table below, surface area to volume ratios are calculated for cells that are 1 mm and 4 mm per side. Notice how the ratios change as the cell's size increases.

		
Length	**1mm**	**4mm**
Width	**1mm**	**4mm**
Height	**1mm**	**4mm**
Number of Sides	**6**	**6**
Surface Area	**1mm x 1mm x6 = $6mm^2$**	**4mm x 4mm x6 = $96mm^2$**
Volume	**1mm x 1mm x 1mm = $1mm^3$**	**4mm x 4mm x4mm = $64mm^3$**
Surface-area-to-volume ratio	$\frac{6mm^2}{1mm^3} = \frac{6}{1}$ **Or 6:1**	$\frac{96mm^2}{64mm^3}$ $\frac{1.5}{1}$ **Or 1.5:1**

Surface Area and Volume

The movement of nutrients, waste material, and other substances into and out of a cell is important for survival. For this movement to happen**, the area of the cell membrane must be large compared to its volume**. **The area** of the cell membrane is the cell's surface area. **The volume** is the amount of space inside the cell. As a cell grows both its volume and its surface area increase, **The volume** of a cell **increases faster than** its **surface area**.
If a cell were to keep growing, it would need large amounts of nutrients and would produce large amounts of waste material, the surface area of the cell's membrane would be **too small** to move enough nutrients and wastes through it for the cell to survive.

What organelles are involved in the transport of materials?



1. Ribosomes:

Amino acid molecules made up of **carbon**, **hydrogen**, **oxygen**, **nitrogen**, and **sometimes sulfur**, join together to form long chains called **proteins**.

Some proteins help cells communicate with each other while others transport substances inside cells. Proteins are made on small structures called ribosomes. Unlike other cell organelles, a ribosome is not surrounded by a membrane.

2. Endoplasmic Reticulum:

Ribosomes can be attached to a weblike organelle called the **endoplasmic reticulum**.

The ER spreads from the nucleus throughout most of the cytoplasm. Endoplasmic reticulum with ribosomes on its surface is called **rough endoplasmic reticulum**, Rough ER is the site of protein production.

ER without ribosomes is called **smooth ER**. Smooth ER is important because it helps remove harmful substances from a cell.

3. Vacuoles

Vacuoles are organelles that store food, water, and waste material.

A typical plant cell usually has one large vacuole. Some animal cells have many small vacuoles. A plant cell's vacuole may take up half of the cell's size. **This vacuole** enables the plant to stay rigid and supported when filled with water.

4. The Golgi Apparatus

Proteins are prepared for their specific jobs or functions by an organelle **called the Golgi apparatus**.

Then the Golgi apparatus packages the proteins into tiny, membrane bound, ball like structures called **vesicles**.

Vesicles are organelles that transport substances from one area of a cell to another area of a cell. Some vesicles in an animal cell are called lysosomes. Lysosomes contain substances that help break down and recycle cellular components.

What powers cellular activity?

5. Mitochondria

powers the cell through chemical reactions. Mitochondria are found in both plant and animal cells. It has two membranes to increase the surface area for these reactions to occur. Mitochondria are a vital part of cellular respiration.

Cellular respiration is a series of reactions that convert the energy in food molecules into a usable form of energy called ATP.

6. Powering Plant Cells

plant cells contain organelles called **chloroplasts**.

Chloroplasts are organelles that use light energy and make food-a sugar called glucose-from water and carbon dioxide in a process called **photosythesis**.

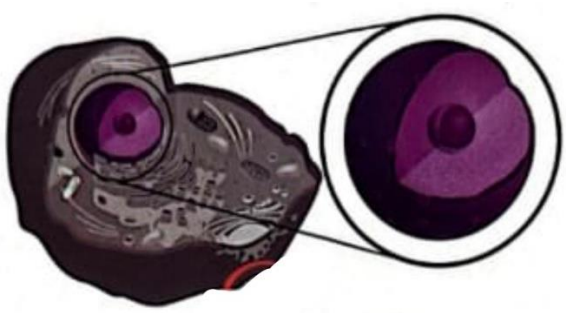
What controls all of this activity?

7. Nucles

The largest organelle inside most eukaryotic cells is the nucleus.

The nucleus is the part of a eukaryotic cell that directs cell activities and contains important cellular information stored in DNA.

DNA is organized into structures called **chromosomes**. The DNA of each cell carries Information that provides instructions for making all the proteins a cell requires.

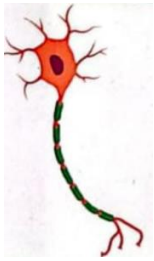


In addition to chromosomes, the nucleus contains proteins and an organelle called the nucleolus.

8. Nucleolus

The nucleolus makes ribosomes, organelles that are involved in the production of proteins. The nucleus controls all cell activity by directing protein synthesis.Proteins are needed for almost every function in the body.

What can different cells do?

	Red blood cells
	Xylem cell
	Neurin cell

Types of Cells and Structures

Cells in the body can be incredibly diverse, as you just saw.

1. **Red blood** cells are disk-shaped, which helps them move through blood vessels so that they can carry oxygen throughout the body.
2. **Xylem cells** are tubelike cells that transport water from the roots to the leaves of plants.
3. **The neuron** is a cell found in many animals that transmits impulses from different parts of the body.

Each cell is unique but works with other cells as body functions are carried out.