Cells

Cell as a basic unit of life

In the year 1665, Robert Hooke observed a honeycomb like structure consisting of many compartments in a thin slice of cork. He called these boxes as cells. Cell in Latin means a ‘small room’.

Activity: Observing onion cells

Take a small piece of onion and using forceps (tweezers), peel off the membrane from the underside (the concave side). Lay the membrane flat on the surface of a clean glass slide, and then add one drop of water. Lower a thin glass cover slip or cover glass onto the slide. Make sure there are no air bubbles. Observe the mount created by you in a microscope at low power and at high power.

Repeat the process after adding a dye solution (iodine or methylene blue). Be very careful; these dyes can stain your skin and clothes.
Is the membrane (skin) composed of one cell or many cells?

What is the general shape of these cells?

When is it easier to observe the cells – with or without the dye? What is the role of the dye?

How many cells can you count?

Which parts of the cell can you identify?

Cell Theory

Find out about the contributions of the following scientists to cell theory –

- Zacharias Jansen
- Robert Hooke
- Leeuwenhoek
- Robert Brown

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Activity: Cell Organelles and their functions
Complete the drawings of the plant and animal cells based on the information given below.

- **Cell Membrane** is the outer boundary of the cell that controls the movement of materials in and out of the cell. Found in both plant and animal cells.

- **Cytoplasm** is the fluid within the cell that contains organelles and aids in moving things around in the cell. It is inside the cell membrane surrounding the nucleus. The cytoplasm is made up of about two-thirds water.

- **Nucleus** is one of the larger organelles found in all cells. The nucleus is usually the shape of a sphere and contains the cell's genetic material. It is the control center of the cell. It is found floating in the cytoplasm.

- **DNA** (deoxyribonucleic acid) looks like a twisted extension ladder. It is found in the nucleus and controls everything inside the cell.

- **Mitochondria** contain the energy to power the cell's activities. It changes the energy stored in food compounds into a useful form of food. It is a kidney-bean-shaped organelle floating around the cytoplasm.

- **Endoplasmic reticulum** a network of membranes that stores, separates, and transports substances within the cell. It is like a ribbon floating throughout the cytoplasm.
  - **Smooth endoplasmic reticulum** makes lipids, processes carbohydrates and modifies toxic chemicals in the cell.
  - **Rough endoplasmic reticulum** contains ribosomes on its surface and makes proteins to be secreted by the cell, makes new cell membranes.

- **Ribosomes** are tiny ball-like structures found at the surface of the endoplasmic reticulum. Proteins are formed in the ribosomes.

- **Golgi apparatus** are flat pancake-like sacs where protein molecules are sorted, changed, packaged and distributed throughout the cell.

- **Lysosomes** are small spheres floating around the cytoplasm that contain digestive enzymes to help break down bacteria and viruses within the cell.

- **Vacuole** is a sac that absorbs water, stores proteins, ions and waste products. Vacuoles are large in plant cells and small in animal cells. They provide support for plant cells.

- **Cell wall** is a tough, rigid outer covering that surrounds the cell membrane of plant cells. It protects plant cells and helps the plant keep its shape.

- **Chloroplast** is a green oval-shaped structure that enables plants to make sugars through photosynthesis.

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Plant Cell

Animal Cell

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**Activity: Comparing a cell to a factory**
A cell is like a small factory. Fill in the below table by comparing the activity done by each cell organelle a job in the factory.

<table>
<thead>
<tr>
<th>Cell Organelle</th>
<th>Factory Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipping/Receiving Department</td>
<td></td>
</tr>
<tr>
<td>Chief Executive Officer (CEO)</td>
<td></td>
</tr>
<tr>
<td>Security Guards</td>
<td></td>
</tr>
<tr>
<td>Factory floor</td>
<td></td>
</tr>
<tr>
<td>Assembly line (where workers do their work)</td>
<td></td>
</tr>
<tr>
<td>Workers in the assembly line</td>
<td></td>
</tr>
<tr>
<td>Finishing/packaging department</td>
<td></td>
</tr>
<tr>
<td>Maintenance crew</td>
<td></td>
</tr>
<tr>
<td>Power plant</td>
<td></td>
</tr>
<tr>
<td>Store room</td>
<td></td>
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</tbody>
</table>
Cell membrane
Cell membrane is made up of compounds called proteins and phospholipids. The phospholipids make the basic bag. The proteins are found around the holes and help move molecules in and out of the cell. Phospholipids are in a shape like a head and a tail. The heads like water (hydrophilic) and the tails do not like water (hydrophobic). The tails bump up against each other and the heads are out facing the watery area surrounding the cell. The two layers of cells are called the bilayer.

Functions:

Cell wall
The cell wall is the tough layer that surrounds plant cells. It is located outside the cell membrane and provides these cells with structural support and protection, and also acts as a filtering mechanism. It is made up of cellulose.

Why only plant cells have a cell wall?

Cytoplasm
Cytoplasm is the fluid that fills a cell. The cell organelles are suspended in the cytosol (part of cytoplasm other than the cytoplasm). The cytosol in a cell does more than just suspend the organelles. It uses its dissolved enzymes to break down all of those larger molecules. The products can then be used by the organelles of the cell.

Nucleus
The cell nucleus acts like the brain of the cell. It helps control eating, movement, and reproduction. The nucleus is seen as a big dark spot somewhere in the middle of the cytoplasm.

The nuclear envelope surrounds the nucleus and all of its contents. The nuclear envelope is a membrane similar to the cell membrane around the whole cell. There are pores and spaces for RNA and proteins to pass through while the nuclear envelope keeps all of the chromatin and nucleolus inside.

Chromatin is made of DNA, RNA, and nuclear proteins. DNA and RNA are the nucleic acids inside of the cell. When the cell is going to divide, the chromatin becomes very compact. It condenses. When the chromatin comes together, you can see the chromosomes.
Through a microscope, the nucleolus looks like a nucleus inside of the nucleus. It is made of RNA and protein.

**Do all cells have a nucleus?**

**Differentiate between eukaryotic and prokaryotic cells.**

<table>
<thead>
<tr>
<th>Eukaryote</th>
<th>Prokaryote</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Eukaryote" /></td>
<td><img src="image" alt="Prokaryote" /></td>
</tr>
<tr>
<td>Nucleus</td>
<td>Free DNA</td>
</tr>
</tbody>
</table>

**Endoplasmic reticulum**

The ER functions as a packaging system. It works closely with the Golgi apparatus, ribosomes and RNA. It creates a network of membranes found through the whole cell.

There are two types of endoplasmic reticulum – Rough ER and Smooth ER.

**Differentiate between Rough ER and Smooth ER.**

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Cells

Ribosomes
Cells make proteins that are used as enzymes or as support for other cell functions. Ribosomes are the protein builders or the protein synthesizers of the cell. They are like construction guys who connect one amino acid at a time and build long chains.

Ribosomes are found floating in the cytoplasm (cytosol) or on the endoplasmic reticulum.

Golgi apparatus
Golgi apparatus is another packaging organelle like the endoplasmic reticulum (ER). It was named after Camillo Golgi, an Italian biologist. It is pronounced ‘GOL-JI’. The Golgi complex gathers simple molecules and combines them to make molecules that are more complex. It then takes those big molecules, packages them in vesicles and either stores them for later use or sends them out of the cell. They also build lysosomes – the digestion machines of cells.

For what work was Camillo Golgi awarded the noble prize?

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Mitochondria
Mitochondria are known as the powerhouses of the cell. They are organelles that act like a digestive system that takes in nutrients, breaks them down, and creates energy for the cell. The process of creating cell energy is known as cellular respiration. Most of the chemical reactions involved in cellular respiration happen in the mitochondria.

Mitochondria have two membranes (not one as in other organelles). The outer membrane covers the organelle and contains it. The inner membrane folds over many times (cristae). That folding increases the surface area inside the organelle. Many of the chemical reactions happen on the inner membrane of the mitochondria. The increased surface area allows the small organelle to do as much work as possible.

Mitochondria had their own DNA and ribosomes and are therefore able to make some of their own proteins.

Mitochondria are only found in eukaryotic cells.

Checkpoint
Why would your heart cells have more mitochondria than your eye cells?

Lysosomes
Lysosomes hold enzymes that were created by the cell. The purpose of the lysosome is to digest things. A lysosome is basically a specialized vesicle that holds a variety of enzymes. The enzyme proteins are first created in the rough endoplasmic reticulum. Those proteins are packaged in a vesicle and sent to the Golgi apparatus. The Golgi then does its final work to create the digestive enzymes and pinches off a small, very specific vesicle. That vesicle is a lysosome. From there the lysosomes float in the cytoplasm until they are needed.

Why lysosomes are also called as the ‘Demolition Squads’ or Suicide Bags?

Plastids
Plastids are double membrane structures present only in plant cells. They are two types –

1. Chloroplasts (colored plastids)
2. Leucoplasts (white or colorless plastids)
Chloroplasts
Chloroplasts are the food producers of the cell. They are only found in plant cells. Every green plant you see is working to convert the energy of the sun into sugars. They create sugars, and the byproduct of that process is the oxygen that we breathe. That process happens in the chloroplast. Mitochondria work in the opposite direction and break down the sugars and nutrients that the cell receives.

Functions:

Checkpoint
How do mitochondria and chloroplasts differ?

Vacuoles
Vacuoles are storage bubbles found in cells. They are found in both animal and plant cells but are much larger in plant cells. Vacuoles might store food or any variety of nutrients a cell might need to survive. The structure of vacuoles is fairly simple. There is a membrane that surrounds a mass of fluid. In that fluid are nutrients or waste products. Plants may also use vacuoles to store water. Those tiny water bags help to support the plant.

Vacuoles also play an important role in plant structure. Those vacuoles gain and lose water depending on how much water is available to the plant. A drooping plant has lost much of its water and the vacuoles are shrinking. It still maintains its basic structure because of the cell walls. When the plant finds a new source of water, the vacuoles are refilled and the plant regains its structure.

Diffusion
If you enter a train or a bus where would you like to stand – in a crowded place with lot of people or a place with having less people?
Similarly in a solution, the particles of a solute try and spread out evenly throughout the solution.

Diffusion describes the spread of particles through random motion from regions of higher concentration to regions of lower concentration.

**Osmosis**

**Activity**
Requirements: Dried raisins, grape, salt and water.

Take some water in a beaker and put some dried raisins in it. Prepare a solution of salt in another beaker and put some grapes in it. **What do you observe after a couple of hours?**

**Why did the raisins swell while the grapes shrunk?**
Definition

Osmosis:
Osmosis is the movement of solvent molecules through a semi-permeable membrane into a region of higher solute concentration, aiming to equalize the solute concentrations on the two sides.

Hypotonic solution:

Isotonic solution:

Hypertonic solution:

Checkpoint
What would happen if you placed a cucumber in distilled water? Distilled water is 100% pure water.
Why would you dehydrate if you drank salt water?