Chapter 7: Cell Structure and Function

Class	Biology

TABLE OF CONTENTS

7.1 — Life is Cellular

The Discovery of the Cell

In the 1500s, the microscope was invented to enhance smaller things into larger images.

Robert Hooke studied a cork under a microscope and found empty chambers, which he called *“cells”*.

Anton van Leewenhoek used a microscope to find organisms in ponds, water, and his mouth.

- Called them *bacteria*

> **Cells** are the basic unit of life.

Cell Theory

- Matthias Schleiden concluded that all plants are made of cells.
- Theodor Schwann concluded that all animals are made of cells.
- Rudolf Virchow concluded that new cells are only birthed from existing cells.

Those discoveries became the **cell theory**.

- All living things are made of cells.

- Cells are the basic units of structure and function in living things.
- New cells are produced from existing cells

Microscopes

- Use lenses to magnify the image of an object by focusing light or electrons

Compound Light Microscopes

- Allows light to pass through a specimen
- Uses two lenses to form a picture

Objective Lens → above the specimen

- Enlarges the image of the specimen
- Most microscopes have multiple objective lenses

Ocular Lens → magnifies the image further

Light microscopes can produce clear images to a magnification to ~1000 times.

Since cells are transparent, they must be stained to be clearly viewed.

Electron Microscopes

- View smaller things than light microscopes can

Transmission Electron Microscopes → explore cell structures and large proteins

- Sample must be cut ultrathin to be viewed
- Electrons pass through thin samples → flat and 2D images

Scanning Electron Microscopes → 3D images of a specimen’s surface

- Doesn’t need to be in thin slices

Electron microscopy must be used in a vacuum.

Prokaryotes & Eukaryotes

All cells contain a form of genetic information.

- All surrounded by a **cell membrane**

Cells have two categories based on whether or not they have a nucleus.

Nucleus: a large membrane-enclosed structure that contains genetic material in the form of DNA

- Controls the cell's activities

Eukaryotes: cells that enclose their DNA in nuclei

- Larger and more complex

Prokaryotes: cells that don't enclose their genetic material in nuclei

- Smaller and simpler

7.2 — Cell Structure

▼ Labeling Practice

https://learnful.ca/index.php/h5p/21/embed

https://learnful.ca/index.php/h5p/22/embed

Two main parts of the cell: *nucleus* and *cytoplasm*

- Cytoplasm of a prokaryote is just the interior

Organelles: specialized structures in cells

- Similar to “organs” of the human body

The Nucleus

- Control center of the cell

Nucleus → contains all the cell’s DNA and the coded instructions for making proteins and other molecules

- Prokaryotic cells lack a nucleus

The nucleus is surrounded by the nuclear envelope.

- Thousands of nuclear pores to things can enter and exit the nucleus

Chromosomes → carry the cell’s genetic material

- Found in the nucleus
    - Spread throughout the nucleus in the form of *chromatin* (thread-like form of chromosomes)

Nucleolus: small, dense region inside the nucleus

- Site of ribosome assembly

Support & Storage Organelles

Vacuoles store water, salts, proteins, and carbohydrates.

- Plants have a singular, large vacuole

Vesicles store and move materials through the cell and in and out of the cell.

Lysosomes: small organelles that break down lipids, carbohydrates, and proteins into smaller molecules to be used by the rest of the cell

- Uses enzymes
- Found in both plant and animal cells
- Dysfunction in lysosomes can cause a variety of diseases

The Cytoskeleton

- gives the cell its shape and internal organization (maintains cell shape)
    - Uses protein filaments
    - Can also help in material transport

Microfilaments: threadlike structures made up of a protein called actin

- Form extensive networks in cells
- Produce a tough framework
- Helps cells to move

Microtubules: hollow structures made of proteins (*tubulins*)

- Maintain cell shape
- Important in cell division
    - Form the mitotic spindle to separate chromosomes
- Build cilia and flagella to assist in cell movement

Centrioles → also formed from *tubulins*

- Organize cell division
- Not in plant cells

Protein-Building Organelles

One main focus on cells is *protein production and distribution*.

- Synthesized from ribosomes

Ribosomes: small particles of RNA found throughout the cytoplasm in all cells

- Follow coded instructions from the DNA

Endoplasmic Reticulum (ER): an internal membrane system where lipids, proteins, and other materials are synthesized

- **Rough Endoplasmic Reticulum** → involved in protein synthesis
  - Ribosomes on the surface make it look “rough”
- **Smooth Endoplasmic Reticulum** → synthesize lipids & detoxify drugs
  - No ribosomes on their surface
  - Help in synthesizing carbohydrates

Golgi Apparatus: stack of flattened membranes that modifies, sorts, and packages proteins and other materials from the ER for storage

- Receives materials in vesicles

Energy-Producing Organelles

> All living things require **energy**.

Chloroplasts → capture energy from sunlight and convert it into food containing chemical energy

- Process is called *photosynthesis*
- Contains *chlorophyll* (a green pigment)

Mitochondria → convert chemical energy from food into compounds that can be used by cells

- Has an inner and outer membrane

Chloroplasts and mitochondria have their own DNA.

- Suggests that they were once independent organisms

Cellular Boundaries

Cell Wall: strong layer that supports and encases the cell

- Most prokaryotes and plants have cell walls
- Allow certain molecules to pass through

All cells contain *cell membranes*.

- Made up of a double-layered sheet called a *lipid bilayer*

Lipid Bilayer → gives cell membranes a flexible structure that forms a strong barrier between the cell and its surroundings

- Regulates what enters and leaves the cell
- Also protects and supports the cell

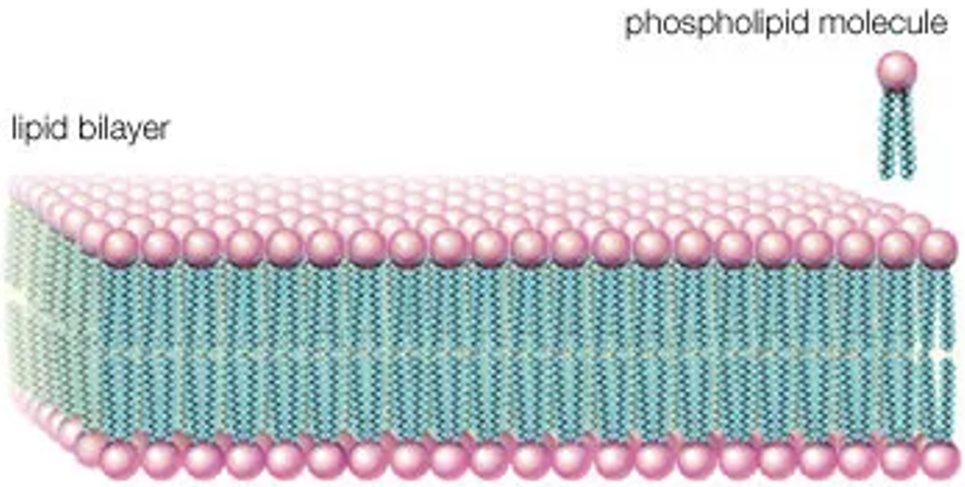
Properties of Lipids

- Oily fatty acid chains attached to chemical groups that have strong interactions with water

Hydrophobic End → away from water

Hydrophilic End → attracted to water

- 2 layers form a **bilayer**



The Fluid Mosaic Model

Protein molecules can be embedded in the lipid bilayers

- Float around the bilayer → *fluid mosaic*

The proteins help to move materials across the bilayers.

Membranes are **permeable** to something if the object can pass through it.

Membranes are **impermeable** to something if the object cannot pass through it.

Membranes are **selectively permeable** if some substances can pass through and some can't.

- Called *semipermeable membranes*

7.3 — Cell Transport

Passive Transport

> Every living cell exists in a liquid environment.

- The cell membrane must keep the cell's internal conditions relatively constant.

    - Regulates the movement of substances from one side to another

Diffusion

- Particles move from areas of higher concentration to areas of lower concentration

Diffusion is the driving force between movement of substances across a membrane.

- Substances move through a membrane until both sides are equal (*equilibrium*)
    - Even after equilibrium is reached, particles still move but since they are in equal directions, equilibrium is maintained.

Passive Transport: the movement of molecules across the cell membrane without using cellular energy

Facilitated Diffusion

Proteins in the cell membranes act as **channels** for certain substances to pass through.

- Channels facilitate the diffusion of certain substances

Facilitated Diffusion: process in which molecules that cannot directly pass through the cell membrane pass through specific protein channels

- Fast and specific
- Doesn’t require any energy

Osmosis

It is difficult for water to pass through the cell membrane because the interior of the lipid bilayer is hydrophobic.

- **Aquaporins:** proteins embedded in the cell membrane that allow water to pass through

Osmosis: diffusion of water through a selectively-permeable membrane

- Molecules moves from areas of higher concentration to area of lower concentration
- The molecules that move are water molecules

Before osmosis, there is a **hypertonic** side (more concentrated with sugar) and a **hypotonic** side (less concentrated with sugar).

- After osmosis, the solutions will be **isotonic** (same amount of solute).

Osmotic Pressure: force that causes *hypertonic solutions* to shrink and *hypotonic solutions* to swell

- Changes the size of a cell's vacuoles
- Only if the cell comes in contact with fresh water

Active Transport

Active Transport: movement of materials against a concentration difference

- Requires energy
- Generally carries out by protein pumps

Bulk Transport

Larger molecules and clumps of material can be transported across the cell membrane.

Endocytosis

- Taking material *into* the cell by folding in the cell membrane
  - Forms vesicles to contain the material
  - Ex. **phagocytosis** → cells engulfing material, **pinocytosis** → cells taking up liquid from the environment and forming vacuoles

Exocytosis

- Release of large amounts of material
    - Vesicle membrane fuses with the cell membrane
        - Forces contents out of the cell

7.4 — Homeostasis & Cells

Maintaining Homeostasis in Individual Cells

Single cells can be organisms.

Homeostasis: relatively-constant internal physical and chemical conditions

- Individual cells *grow*, *respond to environmental stimuli*, *transform energy* and *reproduce* to maintain homeostasis.

Unicellular organisms can be either prokaryotic or eukaryotic.

Maintaining Homeostasis in Multicellular Organisms

> The cells of multicellular organisms **specialize themselves** for particular tasks and **communicate** to maintain homeostasis.

Levels of Organization

1. Cells
2. **Tissues:** groups of similar cells that perform particular functions
3. **Organs:** groups of tissues
4. **Organ Systems:** groups of organs that work together to perform a specific function

Different levels of life in multicellular organisms allow for homeostasis to be maintained.

Cellular Communication

- Cells communicate with *chemical signals*
    - Speed up or slow down activities in the cells that receive them

Certain cells form **cellular junctions** to neighboring cells.

- Cellular junctions are connections between cells (allows for direct communication)
    - Cells require **receptors** to receive the direct communication