Chapter 3 • Study Guide

Cells: The Living Units

BIOL 2111 • Human Anatomy & Physiology I

Cell membranes

Cell membranes are **semi-permeable** or **selectively permeable.**
Membrane proteins may be **enzymes, receptors**, or **transport** proteins.

The structure of water affects the **structure** of **cell membranes**
Water is **polar. Polar molecules** are **relatively charged** at **one end,** but they do **not** have the **strong charge** like **ions.**
Some molecules are **hydrophilic.** They are **polar** or have a strong **charge** that interacts with water. Some molecules are **hydrophobic**. They are **nonpolar** and they do not have a charge to interact with water. When **hydrophobic molecules** are introduced into water, they **clump together**. Hydrophobic molecules will clump together the way **salad oil** lipids will spontaneously **clump** in **water.**

The **most common** molecule in cell membranes is **phospholipids.**
Phospholipids are similar to triglycerides (the storage form of fat)
They have **two hydrocarbon tails** and a **variable polar head group**.
The **hydrocarbon tails** are **hydrophobic** so they turn away from water.
The **polar head group** has a partial charge so it is **hydrophilic** and will interact with water**.**

Phospholipids in water **spontaneously** form a **lipid bi-layer**. The two layers of phospholipids orient with their **polar head groups facing** the **aqueous** cytoplasm and intercellular fluid. The hydrocarbon tails turn away from water and form a **hydrophobic layer**. **Cell membranes** are a **fluid mosaic**. They are **fluid lipid bi-layers** interspersed with **proteins**.

Small, nonpolar molecules **diffuse** across cell membranes very easily. **Carbon dioxide** and **oxygen** are **small** and **nonpolar. Water diffuses more slowly** because it is **polar,** but it is **so small** that it **diffuses easily. Glucose** is **nonpolar,** but it is **so large** that it **diffuses slowly. Ions diffuse** very **slowly** across the hydrophobic layer of fatty acid tails in the cell membrane.

Below is a list of molecules beginning with those that diffuse most easily and ending with those that diffuse very slowly.

- **Carbon dioxide and oxygen**
- **Water**
- **Glucose**
- **Sodium – all ions diffuse very poorly**

Diffusion and **osmosis**
Unless there is a barrier to movement, molecules will **spread** until they **fill** the available space. They move from areas of high concentration to areas of low concentration. That is, they move down a **concentration gradient**. For example, coke or tea poured into warm water will quickly color the whole container. An open perfume bottle will fill a room with scent.
Many solutes in the body are **salts** that **dissociate** into **ions**. **Ions** do **not diffuse freely** through cell membranes, but **water does.**
The concentration of water in a solution increases as solute concentration decreases. **Water** will diffuse down its concentration gradient**. Diffusion** of **water** is called **osmosis.**

A **hypotonic** solution has a **lower solute concentration** than the cytoplasm of cells. **Water** is **more concentrated** outside the cell and **will move** into the cells. If the **kidneys** increase **return** of **salts** to the **blood stream**, **water** will **flow** into the **blood** and increase blood pressure. Remember that **water follows salt.**
An **isotonic** solution has the **same concentration** of solutes as cytoplasm of cells. There is no **net** movement of water into or out of the cell. Water can flow into and out of the cell, but it does not flow in one direction more than the other.
A **hypertonic** solution has a **higher concentration** of solutes than the cytoplasm of cells. Water will move out of the cell. You can not satisfy your thirst with sea water because it is hypertonic to cells.

Because it is **fluid,** a **cell membrane** can pinch off to **form vesicles** (tiny membrane-enclosed vessels) and then **reseal** itself.

Endocytosis
Some of the **cell membrane** enters the **cell,** forming a **vesicle.**
Some **leukocytes endocytose pathogens** such as **bacteria.**

Exocytosis-
Some of the **cell membrane** leaves the **cell** as a **vesicle.** The **thyroid** uses **exocytosis** to deliver **thyroid hormone** to the **blood.**

Cell junctions
Cells vary in how tightly they are joined to each other. They may be so tightly bound they can exclude some molecules. T**ight junctions** of the digestive tract keep out digestive enzymes and hydrochloric acid.
Desmosomes connect cells by protein "rivets" that are joined by long filaments of proteins. Desmosomes help **distribute forces** across cells, for instance, in the **heart.**
Gap junctions are **protein channels** that **connect cells** and **facilitate rapid communication** and **coordinated activity.** Gap junctions are found in the **brain, heart** and **smooth muscle.**

Cytoplasm is all the contents within the cell membrane except the nucleus.

Cytoskeleton
Intermediate filaments- these are supporting, immobile filaments that have a twisted linear structure. Intermediate filaments are associated with desmosomes.
One of the fibers of the cytoskeleton is also a major component of muscles **- actin. Actin** is used for **amoeboid movement** or **movement** of **skeletal muscles** and during **cell division** to form a **cleavage furrow** (a belt-like structure that squeezes a cell into two new cells).

Microtubules
Microtubules organize organelles within the cell and form the **spindle** along which **chromosomes** move during **cell division. Microtubules** are used to **move organelles** such as **mitochondria** around the cell. Especially in **axons** which can be very long, **proteins** made in the cell body and **mitochondria** are transported by microtubules**. Cilia** move by movement of **motor proteins** along **microtubules.**

ATP – Stores **energy for** use in **biochemical reactions**. The "A" is for **adenine** which is one of the purines. The **three phosphates** have strong **negative charges** and **repel** each other. ATP is like a **tight spring** that has been pushed down. As soon as you **release** the **last phosphate**, energy is released. Usually, only the last phosphate is removed in a reaction. So the cell has a **pool** of **ADP** to use to make **more ATP**. ATP catalyzes reactions by releasing the last phosphate. **Enzymes attach** this **phosphate** to another **molecule**, making it **more reactive.**

Mitochondria

> **Mitochondria replicate** themselves. Metabolically active cells have **more mitochondria.**
> **ATP** is made on the **folds** of the **inner membrane.** The **number** of folds **increases** as more ATP is needed.
> Some **proteins** are made in **mitochondria** for their own use only.
> Some **proteins** are **imported** to mitochondria from a cell's cytoplasm
> **Mitochondria** are **inherited** from the **mother** and **human lineages** can be **traced** by looking at mitochondrial DNA. Mitochondria may once have been free-living organisms.

The **nucleus** is the site of DNA – the genes that contain the code for making proteins. **Histones organize** DNA and **affect** which **genes** are **expressed.** The nucleus has a double membrane that includes **pores** for transport. **Ribosomal subunits** are made in the **nucleolus** within the **nucleus. mRNA** is made in the **nucleus. Ribosomes and mRNA** are **exported** from the nucleus. **Enzymes** for making new DNA and mRNA must be **imported** into the nucleus.
The nucleus has a **double membrane.** The **outer** membrane is **continuous** with the **endoplasmic reticulum**.

Endoplasmic reticulum is a system of membranes that are an **extension** of the outer **nuclear membrane.**
Smooth ER is a site of **detoxification** and **lipid synthesis**. **Smooth ER increases** in the **liver** when **toxins** are present**.**
Rough ER membranes are rough because **ribosomes** translating proteins are present and give the membrane a rough appearance in photomicrographs.
Ribosomes – protein factories of RNA and protein that hold mRNA and act as catalysts for protein translation.

Golgi – shipping department adds an "**address**" to proteins that directs them to their destination in the cell and in the body. This "address" or signal is usually **glycoprotein.** One type of **hemophilia** is caused by a f**ailure** of the **Golgi** to put an "address" on clotting factors.

Lysosomes – contain a wide range of **digestive enzymes** and digest **old organelles**. Lysosomes arise by budding off the Golgi.

Peroxisomes – Oxygen forms free radicals and these oxygen free radicals are converted to **hydrogen peroxide** in **peroxisomes**. **Catalases** convert the toxic **hydrogen peroxide** to **water**. Leukocytes use hydrogen peroxide to destroy bacteria.