Warm Up Exercise

• Please take a moment to complete the KWL sheet that you picked up as you came in.

• When you finish, complete the pre-lab questions for the lab that we will do later today.
Cell Theory

- All living things are made of cells.
- Cells are the basic unit of structure and function in living things.
- All cells come from pre-existing cells.
Eukaryotic vs. Prokaryotic Cells

- Eukaryotic cells contain DNA in the nucleus. Prokaryotic cells contain DNA in a concentrated region called the nucleoid.
The Cell Membrane

- **Cell Membrane** (aka: Plasma Membrane)- regulates what enters and leaves the cell and provides protection and support.

- Cell membranes are composed of a **phospholipid bilayer**- a double layer sheet that provides a flexible structure and forms a strong barrier between the cell and its surroundings.

- The phospholipid bilayer is embedded with diverse proteins that aid the cell in transportation across the membrane.
CELL MEMBRANE

- Outside of Cell
- Cell Membrane
- Inside of Cell (cytoplasm)
- Protein channel
- Proteins
- Carbohydrate chains
- Lipid bilayer
As you decrease the cell size, you increase the surface area to volume ratio, which increases the efficiency of transport across the cell membrane.
Surface Area to Volume Ratio

**Red Blood Cells**

<table>
<thead>
<tr>
<th>Surface area increases while total volume remains constant</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Total surface area</th>
<th>6</th>
<th>150</th>
<th>750</th>
</tr>
</thead>
<tbody>
<tr>
<td>[sum of the surface areas (height × width) of all box sides × number of boxes]</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Total volume</th>
<th>1</th>
<th>125</th>
<th>125</th>
</tr>
</thead>
<tbody>
<tr>
<td>[height × width × length × number of boxes]</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
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<tr>
<th>Surface-to-volume (S-to-V) ratio</th>
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<th>1.2</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>[surface area ÷ volume]</td>
<td></td>
<td></td>
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</table>

Animal Cell

Plant Cell
Warm Up Exercise

• What does cell theory say?
• Where is the DNA stored in a prokaryote?
Nucleus: Information Central

- **Nucleus** contains DNA which includes most of the genes in the cell. The nucleus is surrounded by the nuclear envelope.
  - The nuclear envelope is also a lipid bilayer.
**Nucleus: Information Central**

- **Chromosomes** - structures that carry genetic information (DNA). Each chromosome contains one long DNA molecule.
  - Each eukaryotic species has a distinct number of chromosomes.
- **Chromatin** - the DNA and protein making up chromosomes.
- **Nucleolus** - helps synthesize ribosomes.
Ribosomes: Protein Factory

- **Ribosomes** - carry out protein synthesis.
  - Ribosomes exist as either free ribosomes (suspended in cytoplasm) or bound ribosomes (attached to the Rough ER or nuclear envelope)
Endoplasmic Reticulum: Biological Factory

- **Endoplasmic Reticulum** - an internal membrane system in the cell.
- **Smooth ER** - lacks ribosomes. Functions lipid synthesis and detoxification.
- **Rough ER** - has ribosomes on surface. Continuous with the nuclear envelope.
Golgi Apparatus: Shipping and Receiving

- **Golgi Apparatus** modifies, sorts, and packages proteins and other materials from the endoplasmic reticulum for storage in the cell, or for secretion outside of the cell.

* cis face (*“receiving” side of Golgi apparatus*)

* trans face (*“shipping” side of Golgi apparatus*)
**Lysosomes: Digestive Compartments**

- **Lysosome** - contains enzymes used to digest molecules.
  - Phagocytosis - “cell eating” - lysosome digesting food
  - Autophagy - lysosome breaking down damaged organelles.
Vacuoles: Storage Centers

- **Vacuole** - saclike structures that store materials such as water, salts, proteins, and carbohydrates.
  - In many plant cells, there is a large, central vacuole filled with liquid.
Mitochondria: Chemical Energy Supercenter

- **Mitochondria** - site of cellular respiration.
- **Cellular Respiration** - the process that uses $O_2$ to generate ATP by extracting energy from food.
Chloroplast: Light Energy Capturer

- **Chloroplast** - found in plants and algae - the site of photosynthesis. Contain the green pigment chlorophyll.
Cells have three different structures that aide in their movement:

- **Cilia** - hair-like projections from the cell that allow for movement.
- **Flagella** - a whip-like structure that helps to propel the cell in an aqueous environment. (commonly found on bacteria)
- **Pseudopodia** - "false feet" that allow cells to crawl or move.
Warm Up Exercise

• Describe the protein’s path through the cell, starting with the mRNA molecule that specifies the protein.
• What sets the limit on how big or how small a cell is?
Cytoskeleton

- **Cytoskeleton** - the supporting structure that gives cells their shape and internal organization.
  - The cytoskeleton is a network of protein filaments that help the cell to maintain its shape. The cytoskeleton is also involved in movement.
- **Microfilaments** - threadlike structures made of a protein called actin.
- **Microtubules** - hollow structures made up of tubulin. They help maintain cell shape and help with mitosis/meiosis.
- **Centrioles** are also formed from tubulin.
  - Centrioles are only found in animal cells.
Cell Wall

- Cell walls lie outside of the cell membrane.
- Most cell walls are made of carbohydrates and protein. Plant cell walls are composed mostly of cellulose, a tough carbohydrate that can provide rigidity to the plant.
- The main function of the cell wall is to provide support and protection to the cell.
- **Plasmodesmata**—perforations in the plant cell wall that allows cytoplasm to be continuous between neighboring plant cells.
Fluid Mosaic Model

- **Fluid Mosaic Model** - membrane is a fluid structure with a “mosaic” of various proteins embedded in or attached to a phospholipid bilayer. (lipids and proteins are amphipathic)
Membrane Proteins

- **Integral Proteins** - penetrate the hydrophobic interior of the lipid bilayer. (Ex: integrins)
  - Most of these are **transmembrane proteins** which span the entire membrane.

- **Peripheral Proteins** - loosely bound to the surface of the membrane. Not embedded at all.
Membrane Proteins

• Classes of Transport Proteins
  • **Channel Proteins** - provide a channel for hydrophilic molecules to move through.
  • **Carrier Proteins** - bind to molecules and shuttle them across the membrane.
Warm Up Exercise

• Explain the difference between channel proteins and carrier proteins.
• Describe in detail one function of a membrane protein.
**Diffusion**

- **Diffusion** - movement of molecules of any substance until they spread out evenly in the available space (equilibrium).
  - Diffusion is a spontaneous process, needing no energy input.
  - **Rule of Diffusion**: in the absence of a force, a substance will diffuse from high concentration to low concentration.
Diffusion

- A substance diffuses down its own concentration gradient, unaffected by the concentration of other substances.
- Diffusion is a form of **passive transport** - movement that does not require the cell to use energy.

(b) Diffusion of two solutes
Osmosis

- **Osmosis** - the diffusion of water. Water diffuses from the region of lower solute concentration (higher free water concentration) to the area of higher solute concentration (lower free water concentration) - until equilibrium is reached.
  - Osmosis is a method of passive transport.
**Osmotic Terms**

- **Isotonic**- concentration inside cell and outside cell are the same. (water in = water out)
- **Hypertonic**- concentration outside the cell is greater than inside the cell. (water leaves)
- **Hypotonic**- concentration outside the cell is less than inside the cell. (water enters)
Osmosis

- **Osmoregulation** - the control of solute concentrations and water balance.
Facilitated Diffusion

- **Facilitated Diffusion** - protein channels in the cell membrane facilitate (or help) the diffusion of molecules across the cell membrane.
  - Still requires movement from an area of higher concentration to lower concentration.
  - Does not require energy.
  - Frequently involves polar molecules.
Warm Up Exercise

• Explain the difference between osmosis and diffusion.
• What is facilitated diffusion?
• What is the rule of diffusion regarding concentration gradient?
Active Transport

- **Active Transport** - moves solute from low to high concentration. Requires energy (usually ATP). Uses carrier proteins.
  - Active transport allows a cell to have an internal concentration different from its surroundings.
- **Sodium-Potassium Pump** - an example of active transport that exchanges Na⁺ for K⁺ across the plasma membrane.
Passive transport

Diffusion

Facilitated diffusion

Active transport

ATP
Membrane Potential – the difference in charge across the cell membrane. (ranges from -50 to -200 mV)

- The inside of the cell is negative relative to the outside.
- This favors transport of cations into the cell and anions out of the cell.
Endocytosis/Exocytosis

- **Exocytosis** - the secretion of large molecules by the fusion of vesicles with the plasma membrane. Requires energy.
- **Endocytosis** - cell takes in molecules by forming new vesicles from the plasma membrane.
  - Phagocytosis - cell eating
  - Pinocytosis - cell drinking
  - Receptor-Mediated Endocytosis
Warm Up Exercise- Clickers

• Despite difference in size and shape, all cells have cytoplasm and a
  • Cell wall
  • Cell membrane
  • Mitochondrion
  • Nucleus
• The movement of water molecules across a selectively permeable membrane is known as
  • Exocytosis
  • Phagocytosis
  • Osmosis
  • Pinocytosis
• A substance that moves across a cell membrane without using the cell’s energy tends to move
  • Away from equilibrium
  • Away from the area where it is less concentrated
  • Away from the area where it is more concentrated
  • Toward the area where it is more concentrated.
Warm Up Exercise

• Please complete the cell movement graphic organizer you picked up as you came in.
Unicellular vs. Multicellular Organisms

- **Unicellular Organism** - organism with 1 cell.
  - Do everything a multicellular organism can do (grow, respond to environment, transform energy, reproduce, etc).
  - Outnumber multicellular organisms.

- **Multicellular Organisms** - have many cells.
  - Depend on communication and cooperation among specialized cells.
  - Require **Cell Specialization** - where cells develop in different ways that allow them to perform unique tasks.
Levels of organization in a multicellular organism are:

- **Cells** - the basic unit of living things.
- **Tissues** - groups of similar cells that perform a particular function.
- **Organs** - groups of tissues working together.
- **Organ Systems** - a group of organs that work together to perform a specific function.
Major Tissue Types

- **Epithelial** - includes glands and tissues that cover the interior and exterior body surfaces.
- **Connective** - provides support for the body and connects all body parts.
- **Nervous** - transmits nerve impulses throughout the body.
- **Muscle** - enables the body to move.
Levels of Organization

Muscle cell

Smooth muscle tissue

Stomach

Digestive system
Using what you know about the ways muscle moves, predict which organelles would be most common in muscle cells.
Warm Up

• What are the levels of cellular organization?
• What are the four major tissue types?
Stem Cells

- **Stem Cells** - an unspecialized cell that can reproduce indefinitely and under appropriate conditions, differentiate into specialized cells.
Bacterial Cells

- DNA is found in a concentrated, non-enclosed region called the nucleoid.
- Contains ribosomes for protein synthesis.
- Has three exterior layers: capsule, cell wall, and plasma membrane.
- Contain flagella to help with locomotion.
- Many bacterial cells also contain pili, which help them attach onto other surfaces.
Nerve Cells (Neurons)

- Most of the neurons’ organelles, including the nucleus, are found in the cell body.
- Nerve signals are received by the dendrites, transmitted through the cell body, down the axon, and onto other neurons.
Nerve Cells (Neurons)
Nerve Cell (Neuron)
Blood Cells

- Red blood cells carry oxygen, and remove carbon dioxide from all tissues in the body.
- White blood cells are to fight infection.
- Platelets are for blood clotting.