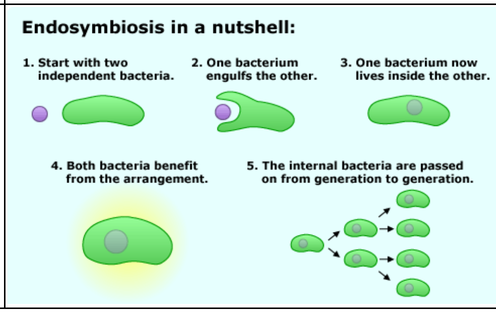
BIOL 112 NOTES

Lecture #1

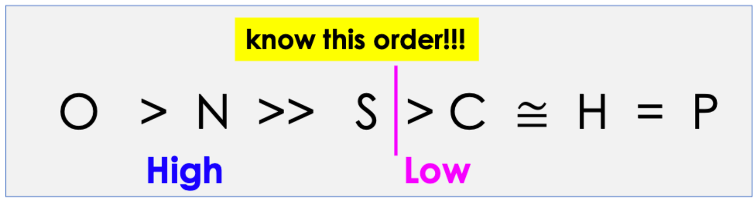
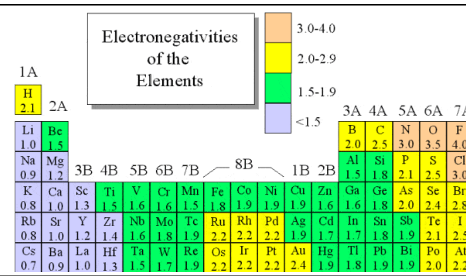
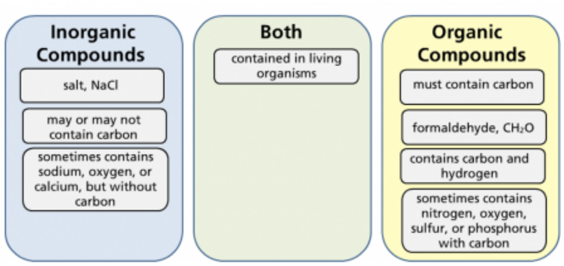
2021/09/08

Questions:	*Answers/Notes:*
What are the differences between eukaryotes and prokaryotes?	**Nucleus**: While eukaryotic cells have a membrane-bound nucleus, prokaryotic cells instead store their genetic information inside an area known as the nucleoid in a thread-like mass of fibres. Eucaryotic cells store most of their DNA inside the nucleus. **Organelles**: Organelles in eukaryotic and prokaryotic cells differ in structure and function. Eucaryotic cells have many more organelles, and their organelles are membrane-bound, such as the nucleus. On the other hand, prokaryotic cells have less complicated organelles that are not membrane-bound, like ribosomes. Eucaryotic organelles are usually more complex, like mitochondria, compared to simpler organelles like ribosomes. **Size**: Eucaryotic cells are much bigger than prokaryotic cells, with eukaryotes ranging from 10 to 100 micrometres and prokaryotes ranging from 1 to 10 micrometres. **Unicellularity/Multicellularity**: All prokaryotes are single-celled or unicellular organisms, while eukaryotic cells can be single or multicellular organisms. **DNA structure**: Eucaryotic DNA is usually found within the nucleus, where it is compactly stored and must pass nuclear pores to create proteins. Prokaryotic cells store their DNA in the cytoplasm, in a region known as a nucleoid. Within the nucleoid, DNA is stored as a mass of fibres in a circular non-chromosomal form. Moreover, in eukaryotes, mitochondrial DNA is stored in the mitochondria, and chloroplast DNA is stored inside chloroplasts, while prokaryotes do not have mitochondria or chloroplasts. Eukaryotes usually have far more DNA than prokaryotes. **Ribosomes**: Ribosomes are organelles that are found in both prokaryotes and eukaryotes. Ribosomes are made of two subunits and function as the site of mRNA translation, otherwise known as the assembly of individual amino acids into proteins or a polypeptide chain. **Reproduction**: Prokaryotes and eukaryotes have significant differences in their reproduction. Most eukaryotes reproduce through sexual reproduction or meiosis, creating offspring with a mix of the parents' genome. Other eukaryotes can reproduce asexually through mitosis, in which two genetically identical daughter cells are produced. Meanwhile, prokaryotes reproduce through binary fission, a process in which DNA is replicated, and the cell splits into two individual daughter cells. Binary vision is an asexual form of reproduction, and there is no mixing of genetic material.
Do all cells replicate? What is an organism?	Not all cells replicate; nerve cells and muscle heart cells remain in G0 indefinitely. An Organism is the entirety of a single living creature, e.g., a human, a bacterium, whereas a cell

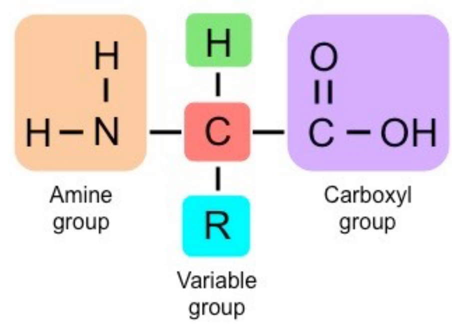
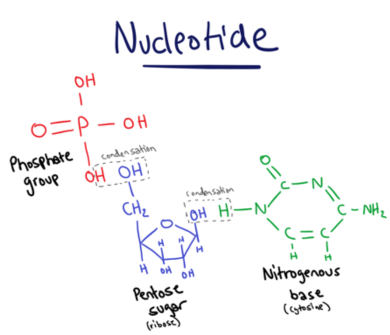
	is the smallest unit of life. For example, a human cell is not an organism, but a yeast cell is both an organism and a cell.	
What is the endosymbiotic theory?		The endosymbiotic theory states that eukaryotic life arose when one cell consumed another smaller cell but did not digest it, leading to a symbiosis between the two organisms.

Biology 112 101

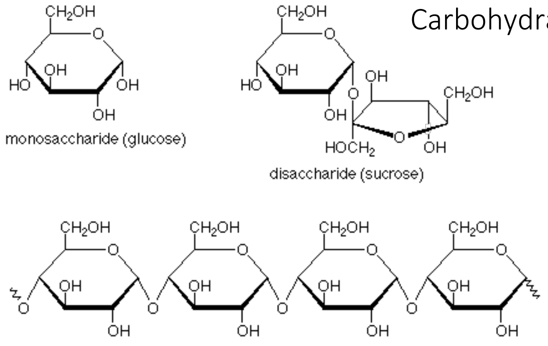
Lecture #2
2021/09/10

Questions:	*Answers/Notes:*
How can electronegative atoms affect electron bond sharing?	Electronegative atoms can affect electron bond pairing by causing an uneven electron distribution, which can affect the polarity of a molecule. A highly electronegative atom such as oxygen can cause the electrons from hydrogen to be drawn to it, creating a polar covalent bond.
What is Electronegativity?	Electronegativity is the tendency of an atom to forcefully attract the electrons of the bond towards itself through electrostatic attraction. 
How can one identify types of molecules?	To identify a polar bond, one must look at the electronegativity of the species involved in the molecule. If there is a difference in electronegativity of more than 0.5, then there will be a polar bond. Hydrophobic molecules are species that are nonpolar and thus have a lower chance of interacting with polar water molecules. Hydrophilic molecules are polar, which means the reaction is spontaneous. Amphipathic refers to molecules that contain both hydrophobic and hydrophilic components.
What is an electronegative chart?	An electronegative chart displays the values of electronegativity for atoms, which allows for an easy comparison of molecules. 
What is an organic molecule?	 Organic molecules are defined as having a C-H bond.

Lecture #3
2021/09/13

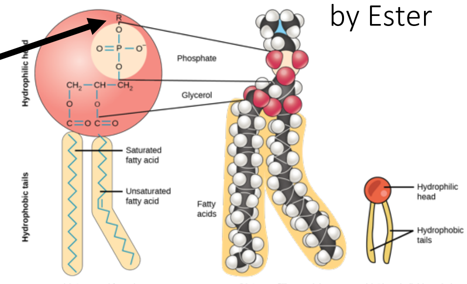
<table>
<tr><th>Questions:</th><th>Answers/Notes:</th></tr>
<tr><td>Where can the four macromolecules be found?</td><td>The four major macromolecules are lipids, carbohydrates, nucleic acids, and proteins. The cell membrane is comprised of lipids; proteins are found throughout the cell body, carbohydrates from the cell wall and serve as an energy source, while nucleic acids can be found in the nucleus/mitochondria/chloroplasts.</td></tr>
<tr><td>What are macromolecules comprised of?</td><td>Macromolecules are comprised of smaller units known as monomers. These units bind together to form overarching structures.
<table>
<tr><th>Macromolecule</th><th>Monomer</th><th>Covalent bond (name)</th></tr>
<tr><td>Protein</td><td>Amino acids</td><td>Peptide bond</td></tr>
<tr><td>Nucleic acid (DNA/RNA)</td><td>Nucleotide</td><td>Phosphodiester bond</td></tr>
<tr><td>Carbohydrate</td><td>monosaccharides (simple sugars)</td><td>Glycosidic bond</td></tr>
<tr><td>Lipid (eg triacylglycerol)</td><td>Fatty acids</td><td>Ester linkage</td></tr>
</table></td></tr>
<tr><td>What are proteins comprised of?</td><td>Proteins are polypeptide chains that are formed from amino acids. Individual amino acids are comprised of an amino group, an alpha carbon, an ‘R’ group or sidechain, a carboxyl group, and alone carbon. The only part of the amino acid which changes is the ‘R’ group or sidechain, which can be substituted with a variety of different molecules, and the interactions between these molecules form proteins. Amino acids are bound together when the amino group combines with the carboxyl end of another amino acid, producing a polypeptide chain.

</td></tr>
<tr><td>What are nucleic acids comprised?</td><td>

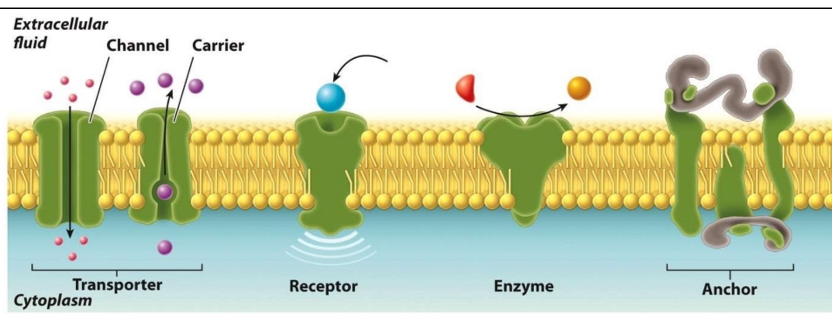
Nucleic acids are formed from individual monomers known as nucleotides. Nucleotides are comprised of a phosphate group, a 5-carbon sugar, and an unspecified nitrogenous base. The four nitrogenous bases are Adeline, Thymine, Guanine and Cytosine. Nucleic acids are formed when nucleotides combine to form chains, with the phosphate group and the 3’ carbon bonding together.</td></tr>
</table>

<table>
<tr><td>What are carbohydrates comprised of?</td><td>


Carbohydrates are comprised of monosaccharides, which form glycosidic bonds with the 4’ end and 1’ end. Carbohydrates store energy and are formed by dehydration synthesis, forming a peptide bond.</td></tr>
<tr><td>What are lipids?</td><td>Lipids are comprised of fatty acids, which are attached by Ester linkages to Glycerol.

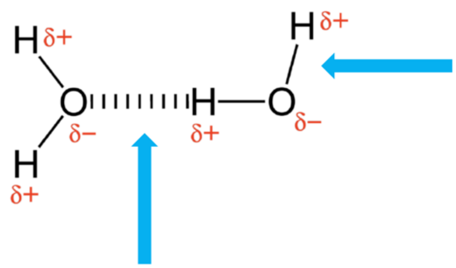
R-Group

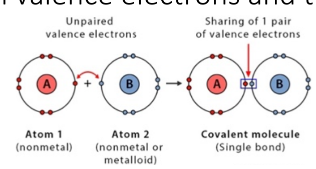


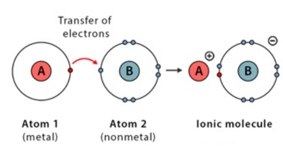
</td></tr>
<tr><td>Why is chemical polarity so important?</td><td>The chemical polarity of a monomer is essential to a cell because the chemical polarities must be similar for a monomer to form. The overarching chain of a macromolecule must have a certain polarity; thus, the individual monomers must have matching polarities, like the way that Legos can only stack on top of each other. In this case, polarity refers to the chemical polarity, not electrostatic polarity.</td></tr>
<tr><td>What has chemical polarity?</td><td>Nucleic acids, proteins, and carbohydrates exhibit polarity since they have two chemically distinct ends. On the other hand, Lipids do not have the same directionality/polarity as other macromolecules since they are not comprised of repeating monomers (fatty acid tails are added to the head group).</td></tr>
<tr><td>What does the fluid mosaic model refer to?</td><td>The fluid mosaic model details the make-up of the cell membrane. There are many diverse components to the cell membrane, and the membrane is dynamic, with lipids and proteins being able to move freely throughout the membrane.</td></tr>
<tr><td>How are phospholipids amphipathic?</td><td>Phospholipids are amphipathic since they have a hydrophilic head and hydrophobic fatty acid tails. Hydrophobic refers to molecules that interact with water (typically polar, charged, make hydrogen bonds, and have ionic interactions), whereas hydrophobic refers to molecules that don’t interact with water (typically nonpolar and have no formal charge).</td></tr>
<tr><td>What are the components of the fluid mosaic model?</td><td>


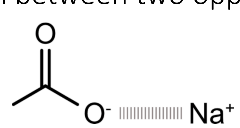
There are many components that make up the fluid mosaic model. The membrane is made of a phospholipid bilayer embedded with proteins. Integral proteins cross through the lipid bilayer, whereas peripheral proteins are associated on either side.</td></tr>
</table>

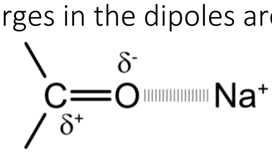
Tutorial #1
2021/09/17

<table>
<tr><th>Questions:</th><th>Answers/Notes:</th></tr>
<tr><td>What are intermolecular and intramolecular bonds?</td><td>


Intermolecular bonds: are formed between atoms or elements within a certain molecule, such as the bonds between hydrogen and oxygen in a water molecule.
Intramolecular bonds: are formed between atoms in differing molecules, such as hydrogen or Van Der Waals Bonds.
</td></tr>
<tr><td>Describe the types of intramolecular bonds?</td><td>
Intramolecular bonds: are formed between atoms in differing molecules, such as hydrogen or Van Der Waals Bonds.
Descriptions:
1. Covalent: sharing of electron pairs between atoms
- Polar/Nonpolar
- Non-metal + Non-mental/Metalloid
- Electrostatic force between valence electrons and the nuclei, specifically the protons


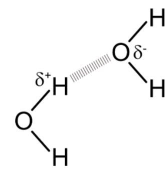
2. Ionic: transfer of electrons between two polarized atoms
- Polar
- Negative ion + Positive Ion
- Electrostatic force between


3. Ion-Ion:
- Polar
- Strong electrostatic attraction between two oppositely charged ions


4. Ion-Permanent Dipole (I-PD):
- Polar
- An ion and a permanent dipole attract each other through electrostatic force
- Partial negative/positive charges in the dipoles are attracted to the ionic charge


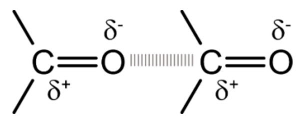
5. Hydrogen bonding (H-bond)
</td></tr>
</table>

- Polar
- Bonds between molecules with hydrogen and highly electronegative atoms
- Only one hydrogen is required



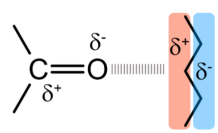
6. Permanent Dipole - Permanent Dipole (PD-PD)

- Polar
- Electrostatic attraction between two polar molecules



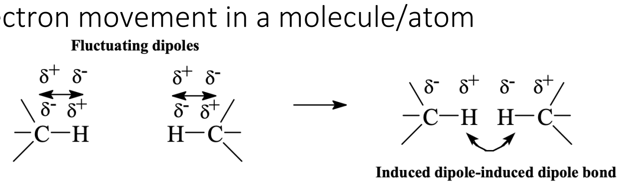
7. Permanent Dipole – Induced Dipole (PD-ID)/Ion-Induced Dipole

- Polar
- A polar molecule induces dipole movement upon a nonpolar molecule by attracting electrons
- Forms from electron movement in a molecule/atom



8. Induced Dipole – Induced Dipole (ID-ID)

- Polar
- An induced dipole induces another dipole, which forms an electrostatic attraction
- Forms from electron movement in a molecule/atom

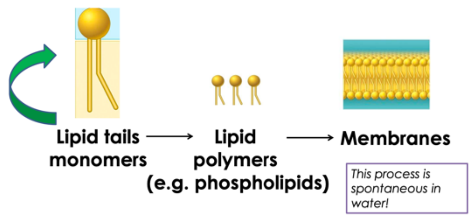


Display the strengths of bonds in order from strongest to weakest.

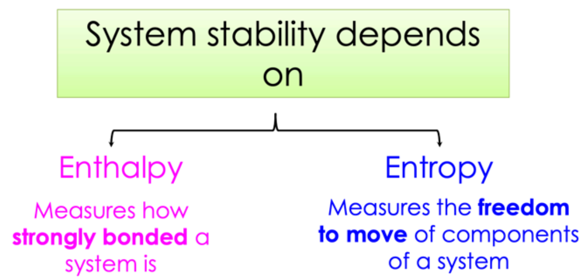
Bond	***Names***	***Charge Distribution***
Covalent	Covalent	Polar/Nonpolar
Ionic	Ionic, electrostatic	Very Polar
Ion-Ion	Electrostatic	Polar
Ion-Permanent Dipole (I-PD)	Van der Waals	Polar
Hydrogen bonding (H-bond) *A special case of PD-PD between hydrogen and a highly electronegative atom*	Hydrogen bond	Polar
Permanent Dipole – Permanent Dipole (PD-PD)	Van der Waals	Polar
Permanent Dipole – Induced Dipole (PD-ID) & Ion-Induced Dipole	Van der Waals	Polar
Induced Dipole – Induced Dipole (ID-ID)	Van der Waals, London forces/dispersion forces	Polar

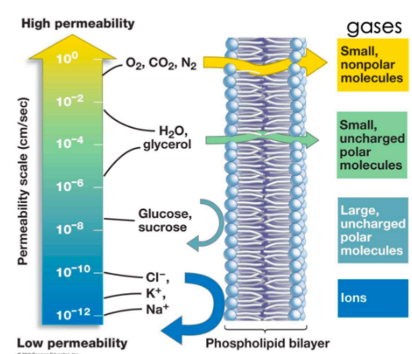
Lecture #4
2021/09/15

<table>
<tr><th>Questions:</th><th>Answers/Notes:</th></tr>
<tr><td>What happens if lipids are placed in water?</td><td>

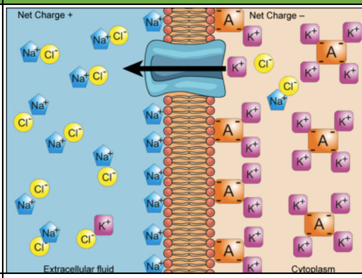


The formation of a phospholipid bilayer is spontaneous in water. The hydrophilic head groups face outwards towards the water, while the inside is comprised of nonpolar hydrophobic fatty acids. This process, known as molecular self-assembly, is when molecules form 3-dimensional configurations with outside interference. The formation of a phospholipid bilayer is energetically and entropically favourable, and the change in gibes free energy is less than zero.</td></tr>
<tr><td>What is stability? How does a spontaneous reaction occur?</td><td>The stability of a system depends on enthalpy and entropy. Enthalpy measures the bond strength of a system, whereas entropy measures the freedom of movement of components. Energetically favourable processes are spontaneous, and reaction components move from stable to more stable. Energetically unfavourable processes are not spontaneous, require an input of energy to force components to move from more to less stable. However, the favourability of a reaction does not indicate the reaction rate.


</td></tr>
<tr><td>What is the lipid bilayer?</td><td>The lipid bilayer is a selectively permeable barrier, meaning that certain molecules can move across it by Diffusion. This allows cells to maintain homeostasis. Small, neutral, nonpolar molecules can easily pass through the lipid bilayer, while larger, charged, polar molecules are unable to pass through easily. Ions are usually unable to get through the membrane, as they have a charge and are surrounded by water molecules in a hydration shell, which makes the total area larger. Water can pass through the membrane, but it does so at a slow rate.


</td></tr>
</table>

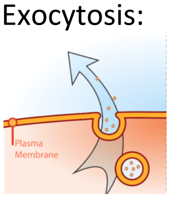
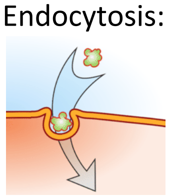
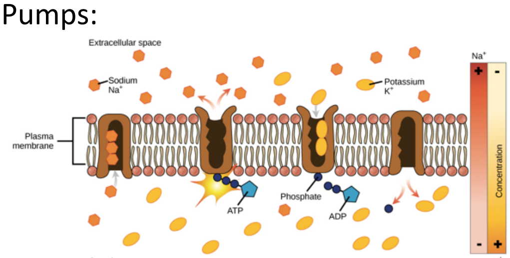
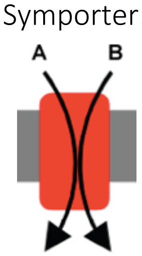
Lecture #5
2021/09/20

<table>
<tr><th>Questions:</th><th colspan="2">Answers/Notes:</th></tr>
<tr><td>What is a concentration gradient?</td><td>
</td><td>A concentration gradient is a difference in the concentration of molecules of a certain substance when compared to a differing area. For example, one area may have a higher concentration of Na^+, while another area may have a higher K^+ concentration.</td></tr>
<tr><td>What are the types of Transport? How do they function?</td><td colspan="2">There are two types of membrane transport: Passive Transport and Active Transport.

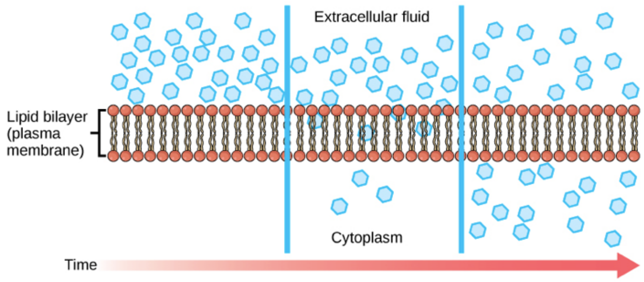
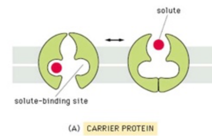
Passive Transport/Diffusion: requires no outside energy and is conducted with the help of a concentration gradient. Molecules are constantly entering and leaving the cell, but only the net movement of molecules is measured.
<ol type="a">
Simple Diffusion: molecular movement through the lipid bilayer by Diffusion due to osmosis.
Facilitated Diffusion: a protein transporter is used to bypass the lipid bilayer. There are two types of facilitated Diffusion: channel and carrier proteins.

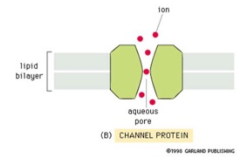
Channel Proteins: proteins embedded inside the lipid bilayer which provide a hydrophilic passageway for molecules such as water. Channel proteins can be open or closed, are usually selective for certain types of ions, and are only able to transport smaller molecules.
Carrier Proteins: gated transport mechanism which transports specific types of molecules and undergo conformational changes. They have open and closed formations.

Active Transport: movement against a concentration gradient that requires an input of energy (usually ATP).
<ol type="a">
Primary Active Transport: chemical energy is used to move molecules against the concentration gradient directly. In Sodium-Potassium pumps, Adenosine Triphosphate is used to move sodium and potassium ions against a concentration gradient.
Secondary Active Transport: energy from electrochemical gradients is used to move certain molecules. High concentrations of other molecules are used to prime a shared carrier protein (cotransporter), which moves the desired molecule to its correct area.

</td></tr>
<tr><td>Describe Primary and Secondary Active Transport.</td><td colspan="2">
<table>
<tr><th colspan="5">Active Transport:</th></tr>
<tr><td colspan="3">Primary:</td><td colspan="2">Secondary:</td></tr>
<tr><td>Exocytosis:

</td><td>Endocytosis:
</td><td>Pumps:

</td><td>Symporter:

</td><td>Antiporter:

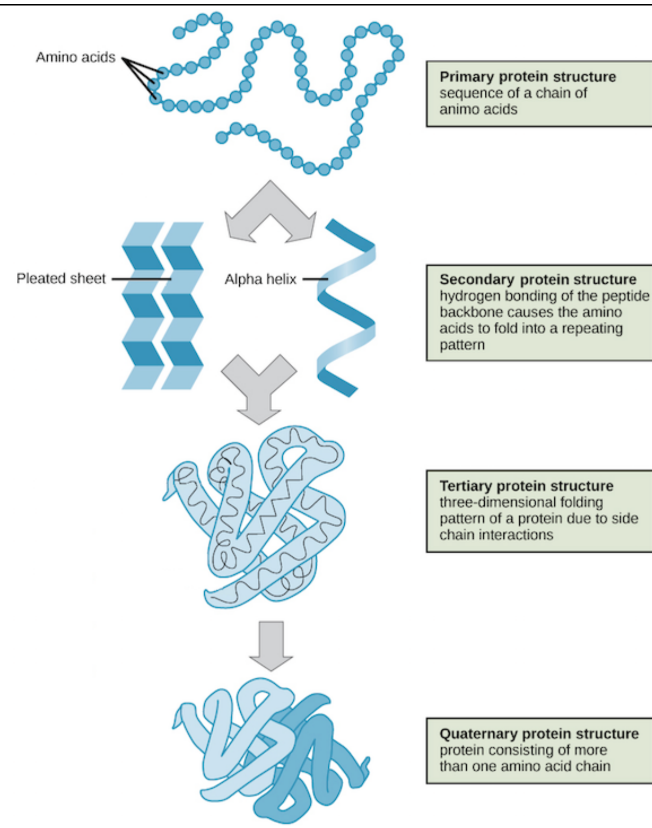
</td></tr>
</table></td></tr>
</table>

<table>
<tr><td rowspan="3">Detail Simple and Facilitated Diffusion.</td><td colspan="3">Passive Transport (Uniport: one-way movement):</td></tr>
<tr><td>Simple Diffusion:</td><td colspan="2">Facilitated Diffusion:</td></tr>
<tr><td>Osmosis:

</td><td>Carrier Protein:


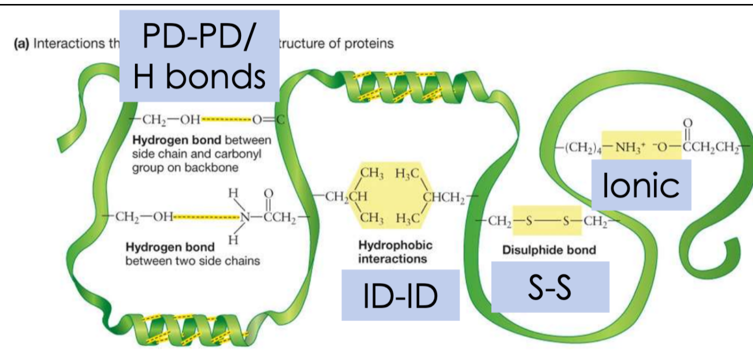
Carrier proteins bind a solute on one side and deliver it to the other side through a change in shape.
Cells can also transport macromolecules across the membrane</td><td>Channel Protein


Channel proteins form tiny hydrophilic pores in the membrane and the specific molecules pass through by diffusion from high to low concentration. Most are ion channels</td></tr>
</table>

Lecture #6
2021/09/22

<table>
<tr><th>Questions:</th><th>Answers/Notes:</th></tr>
<tr><td>What types of bonds hold proteins together, and at what level?</td><td>Types of Bonds for structure levels:
<table>
<tr><th>Levels of structure</th><th>Covalent bonds between backbone atoms?</th><th>Covalent bonds between R groups?</th><th>Non-covalent bonds between backbone atoms?</th><th>Non-covalent bonds between backbone & R groups?</th><th>Non-covalent bonds between R groups?</th></tr>
<tr><td>Primary</td><td>☑</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Secondary</td><td>☑</td><td></td><td>☑</td><td></td><td></td></tr>
<tr><td>Tertiary</td><td>☑</td><td>☑</td><td>☑</td><td>☑</td><td>☑</td></tr>
<tr><td>Quaternary</td><td>☑</td><td>☑</td><td>☑</td><td>☑</td><td>☑</td></tr>
</table></td></tr>
<tr><td>What are chaperone proteins?</td><td>Chaperone proteins are a group of proteins that help with the folding, assembly and unfolding of proteins.</td></tr>
<tr><td>What makes up the structure of proteins?</td><td>
</td></tr>
<tr><td>How are proteins formed?</td><td>Proteins are created by combining amino acids with peptides bonds that are formed through dehydration synthesis. The connected proteins are known as aminoacyl resides, and H_2O is lost for each peptide bond. Proteins have chemical polarity, with the sequences always written from the N —> C direction (amino [N-terminus] to carboxyl end [C-terminus]). For example, N-aa1-aa2-C, where the ‘aa1’ and ‘aa2’ are amino acids.</td></tr>
<tr><td>What is denaturization?</td><td>The protein unfolds, and the bonds break/dissipate due to non-covalent interactions, which causes the protein to break. Changes in pH, temperature can cause denaturing of proteins.</td></tr>
</table>

Lecture #7
2021/09/27

Questions:	*Answers/Notes:*
Transport proteins are what type?	Transport proteins span the entirety of the lipid bilayer, and thus are transmembrane proteins.
What are the types of bonds which hold proteins together?	
How can denature be slowed?	If a protein has strong bonds (interactions), it will be harder to denature, if a protein has weak interactions, it is harder to denature. Net strength is measured; one strong bond is weaker overall when compared 1,000 weak bonds. However, strong bonds don't necessary correlate to usefulness, as very strong bonds can make a protein, such as an enzyme, unable to be used (strong bonds may block binding sites).
How do side chains with more molecular groups effect proteins	Side chains with more molecular groups can increase the total number of interactions, which can cause the strength of a bond to decrease, since more interactions can interfere with the bond.