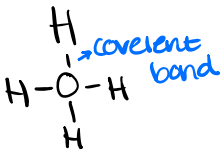
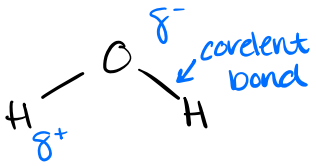
BIOMOLECULES

- Covelent bonds ⇒ electrons shared between atoms



nonpolar covelent bond → can't interact with water (hydrophobic)



polar covelent bond → interacts and forms bonds w/ water (hydrophillic)

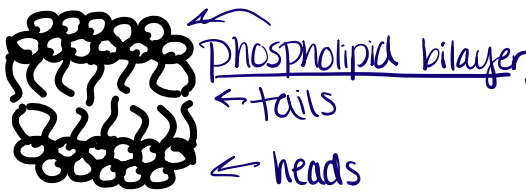
- Polarity: unequal sharing of electrons in covelent bonds
  - ↳ cohesion: ability to stick to itself
  - ↳ adhesion: ability to stick to other things
- amphilphillic: hydrophobic + hydrophillic regions

Carohyarates

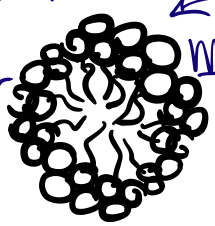
- Composed of hydrogen + oxygen (1:2:1) → carbon bonds to hydroxyl (-OH) and hydrogens (-H), Hydrophillic
- Monosaccharides: simple sugars (1 unit), ex: glucose
- Disaccharides: covelent bonds between two monosaccharides
- Polysaccharides: multiple sugars
  - Glycogen stores sugar
  - Starch: found in plants, and digestion produces energy
  - Cellulose: found in plants, but humans can't digest

LiPids

- contain carbon and hydrogen linked by nonpolar covelent bonds (hydrophobic), 4-carbon ring
- Triglycerides (Fats): one glycerol molecule + 3 fatty acids → each fatty acid links to a carbon in the glycerol backbone
  - Saturated: carbon linked by a single bond to mulitiple hydrogens
  - Unsaturated: contain one or more pairs of carbon linked by double bonds
  - Cis: hydrogen + carbon are on the same side, produced naturally
  - trans: opposite sides, artificially produced → unhealthy
- Phospholipids: lipids containing a phosphate group
  - two fatty acids form the tail (nonpolar), phosphate group forms the head (polar) → amphipathic



Phospholipid bilayer
← tails
← heads



Micelle: single layer of phospholipids function in transport of nonpolar molecules

- Steroids: three 6-carbon rings + one 5-carbon ring
  - Cholesterol: most common, precurser for testosterone, estradiol, cortisol

Amino Acids + Proteins

- Function of a protein is dependent on its 3D structure
  - Primary: sequence of amino acids (determined by peptide bonds within peptide chain)
  - Secondary: folding pattern produced by hydrogen bonds between hydrogen atom in amino group and oxygen atom in carboxyl group
  - tertiary: folding produced by interactions between the R groups of different Amino Acids in the same Polypeptide

- Quaternary: exist only in proteins containing more than 1 polypeptide chain (hemoglobin)

- Fiberous proteins: elongated strands that function in structure or contraction (collagen → in hair + tendons, tropomyosin → muscle cells)
- Globular proteins: irregular, bulky chemical messangers for intercellular communication (receptors → bind chemical messangers, carrier proteins → transport substances in blood, enzymes → catalyze chemical reactions

Nucleic Acids

- Transfer energy and form genetic material of cells
- DNA, RNA, ATP
  - Cytosine + Guanine, Adenine + Thymine (→ replaced by Uracil in RNA)

- Energy in bonds:
  - using energy: making a disaccharide / peptide bond (anabolic reaction, requires energy)
  - releasing energy: breaking down bonds (catabolic reaction)
  - activation energy: minimum amount of energy required to start a reaction
    - presence of enzymes lowers activation energy

Cell Structure

- Phospholipid bilayer
  - Cholesterol molecules can be in the bilayer, if they interfere with the tails, it can cause crystalization
  - Membrane Proteins: imbedded in the bilayer to transport molecules

- membrane carbohydrates: covelently bonded to membrane lipids or proteins → form glycocalyx (protective layer that holds cells together)

- Structure of the Nucleus
  - contains the nucleus (transmission + expression of DNA + genetic info for RNA + protein synthesis), nucleolus (where rRNA is synthesized), and chromatin (DNA and histones)
  - nuclear envelope → small gaps (nuclear pores) that allow movement between the nucleus and cytoplasm
- Contents of the cytosol
  - stores energy in triglycerides or glycogen in masses called inclusions
  - molecules that will be secreted are stored in vesicles (membrane bound sacs)
- Structure of membranous Organelles
  - Endoplasmic Reticulum
    - rough: continuous with the nuclear pore, synthesis of secretory proteins
    - smooth: lipid synthesis, stores calcium
  - Golgi Apparatus: packages proteins
  - Mitochondria: contains its own DNA, ATP production
  - Lysosomes: breakdown old organelles, endocytosis → cells engolfing particles
  - Peroxisomes: contains detoxifying enzymes
- Structure of nonmembranous organelles
  - Ribosomes: composed of rRNA and proteins, consists of small + large subunit that join in the cytosol in protein synthesis
  - Vaults: protein + rRNA, located in cytoplasm or nucleus, function is unknown
  - Centrioles: hold bundles of protein filaments, each cell has two ⊥ to each other, involved in the development

- Cytoskeleton: actin microfilaments found in microbrilli (cellular protrusions)

Cell-to-cell Adhesions

- Tight Junctions: found in epithelial tissue for molecular transport, contain occludins (integral proteins)
- Desmosomes: provides strength to cells, plaque is formed by glycoproteins, Cadherins → protein filaments
- Gap Junctions: allow muscles to contract as a unit. Connected by connexons.

Protein Synthesis

- Genetic code: in all animal species, a codon can code for 1 or more amino acid
- Gene: portion of DNA that codes for a protein
- Genome: collection of genes in a species
- Genetic code: only the template strand contains DNA code, triplet (3 bases) codes for 1 amino acid, a codon (in mRNA) is complementary + codes for the same amino acid
- **Transcription**: DNA is converted into mRNA in the nucleus
  1) initiation: RNA polymerase binds to promoter sequence of DNA → causes DNA strands to seperate
  2) elongation: nucleotides to mRNA strand starting from 5' to 3'
  3) termination: introns (excess bases) are removed, and exons (remaining coding segments) are joined together (splicing), CAP is added to 5' and poly A tail is added to 3' end to protect the mRNA from degrading in the cytoplasm
- **Translation**: mRNA is converted into protein in the ribosomes

- tRNA carries the appropriate amino acid to the ribosome, contains anticodons complementary to mRNA codon
- ribosome alligns mRNA and tRNA to form a polypeptide

1) initiation: initiation factors bind to the CAP, charged tRNA binds to mRNA at the A site
2) another tRNA binds to the mRNA and peptidyl transferase, an enzyme in the ribosome, catalyzes a peptide bond between the amino acids
3) once the amino acids are connected, the tRNA is released from the P site, and that process is repeated until the stop codon is reached

Cell division: mitosis

- Interphase
  - G_0: cell carries out normal functions, G_1: increased rate of protein synthesis, S: DNA replication occurs, chromosomes copy in pairs, G_2: rapid protein synthesis, cell doubles in size
- Mitosis
  - Prophase: chromatin pairs condense, each chromosome pair (chromatid) is linked by the centromere. Centriole pairs move to polar sides of cell and mitotic spindle develops
  - Prometaphase: nuclear envelope breaks down, chromosomes are linked to the spindle fibers
  - Metaphase: Chromosomes are alligned at the middle of the cell
  - Anaphase: chromatid pairs seperate, and the chromosomes move along mitotic spindle to opposite poles of the cell
  - Telophase: new nuclear envelopes develope on each side of the cell, chromosomes condense to chromatin, mitotic spindle breaks down
- Cytokinesis: division of the cytoplasm by cleavage

- Protein synthesis: DNA $\xrightarrow[\text{in nucleus}]{\text{transcription}}$ mRNA $\xrightarrow[\text{in ribosomes}]{\text{translation}}$ Protein
- Plasma membrane: separates ECF from ICF, keeps components of the cell together