

Unit 2: Biochemistry

Content Outline: Molecules of Life (2.4) – Part 1

- I. **Macromolecules** – “Macro” means “large”
 - A. **Polymers** “poly” means “many”; “mer” means “unit”.
 1. These are *formed* from individual units called **monomers** (“Building Blocks”).
 2. Monomers are linked together by *covalent bonds*. Organisms need these to *stay intact* so the strongest type of bond is used.
 3. These are another example of the theme: Structure = Function.
 - B. Macromolecules are formed by **Dehydration or Condensation Reactions**.
 1. Hydroxyl (OH) is removed from one molecule and Hydrogen (H) is removed from another *This combination forms water*. This orientation of molecules and making of a bond *requires E*.
 2. Enzymes (most are proteins) help *speed up* the rate of the reaction.
 - C. Macromolecules are broken apart into individual monomers by **Hydrolysis reaction**. “lysis” means “split”.
 1. This process *releases E* in the bond breakage.
 2. The process *needs water* (hydroxyl and hydrogen) to *fill the open bonds* on the monomers.
 3. Enzymes speed up the rate of the reaction here too.

- II. **Carbohydrates** “Carbo” refers to Carbon; “hydrate” refers to water.
 - A. These molecules are *mainly sugars*.
 1. **Monosaccharides** (Are the monomers or “building blocks”). “sacch” means “sugar”.
 2. **Disaccharides** – two monosaccharides linked together. “di” means “two”.
 3. **Polysaccharides** (Are the polymers.) – Many sugars linked together.
 - B. The chemical composition is: Carbon = Oxygen; 2x as many hydrogen also present.
 - C. The names usually end with “ose”. Such as Fructose, Glucose, Sucrose.
 - D. These are primary E sources for cells.
 - E. Carbohydrates can also be sources of stored E in cells or organisms.
 1. **Starch** - E storage molecule in plants.
 2. **Glycogen** – E storage molecule in Animals.
 3. **Cellulose** – Structural component of plant cell walls.
 - a. Cellulose is the most abundant organic compound on Earth.
 4. **Chitin** – This is the exoskeleton of some animals and also Fungi cell walls.

- III. **Lipids**
 - A. These macromolecules are fats, oils, waxes, and steroids.
 - B. Most lipids are **hydrophobic** molecules. “Hydro” means “water”; “phobic” means “fear of”.
 - C. Lipids are mainly composed of **Hydrocarbons** (All of the bonded hydrogens cause more energy to be released when they are broken off of the carbon.
 - D. Two Main parts
 1. **Fatty Acid** tails (The Hydrocarbon unit.)
 2. **3 Carbon Glycerol molecule** (alcohol) to hold the whole molecule together.
 - E. Major Types of lipids
 1. **Triglycerols or Triglycerides** – *your basic fat or oil*.
 - a. There are **saturated fats**. These fatty acids are saturated with hydrogen atoms. The molecule has *no open bonds* to put any more Hydrogen on. (These are *solid at room temp*.) (They usually are associated with *animals*.) These are the *bad types of fat* when it comes to our diet.
 - b. There are **unsaturated fats**. These have *double or triple bonds* that “could be broken” to add more Hydrogen to the fatty acid. (These are *liquids* at room temp.) (They usually are from *plants*, such as vegetable oil, sunflower oil, or peanut oil.)
 - c. There are also **Polyunsaturated fats**. These have *numerous double or triple bonds* in the fatty acid portion. (These are also *liquids* at room temp.) (They are also usually from *plants*.)
 - d. **Hydrogenated or Trans fats** (These are oils turned solid by *adding Hydrogen* by breaking the double or triple bonds so in order to *transform* it into a saturated fat)
 2. **Phospholipids**
 - a. These molecules *replace* a single fatty acid with a single Phosphate ion. (This part of the molecule is **Hydrophilic**. “philic” means “lover of” It loves water because the phosphate carries a *negative* charge. Remember water is polar. So the negative phosphate will be *attracted* to the positive hydrogen portion of water.)
 - b. They still have 2 Fatty Acid tails. (These are the **Hydrophobic** portion of the molecule. They carry a neutral charge. Therefore are not attracted to water.)

- c. Phospholipid Bi-layers (having 2 layers) are common for cell and organelle membranes.
- 3. **Waxes**
 - a. These lipids are made by *combining* alcohols with unsaturated oils. Such as girls lipsticks which also have coloring added to make the different shades.
- 4. **Steroids, Hormones, and Cholesterol**
 - a. A steroid has *4 carbon rings with the top ring looking like a house*.
 - b. Cholesterol is also a steroid molecule, but it helps with cell membrane *flexibility*. All membranes need to have some cholesterol to remain flexible. Cholesterol *in excess* is bad for your health though.
- F. Lipids are stored in Adipose Tissue in animals. This can lead to obesity or even Atherosclerosis (Clogged Arteries).

Molecules of Life – Part 2

- I. **Proteins** (A. K.A. **Polypeptides**) and Enzymes (Enzymes are a *type* of protein.)
- A. Proteins make up greater than 50% of an organisms *dry weight* (referred to as **biomass**).
 - B. This is another important example of the theme: Structure = Function. (These are very large 3-D Molecules.)
 - C. The *monomer* “building blocks” are **Amino Acids** (There are 20 different Amino Acids that can be involved in making proteins. Proteins and enzymes usually have *hundreds* of Amino acids in their structure.)
 - D. Individual Amino Acids (monomers) are bonded together by a **peptide bond**. When we put *many* amino acids together, we get a **polypeptide** or protein.
 - E. Proteins and enzymes are the “work horses” of a cell. They carry out *numerous* functions within cells.
 - F. *Arrangement and Quantity* of Amino acids *affect* the structure and function of that protein or enzyme. (Structure = Function)
 - 1. **Primary Structure** (Represented by the symbol - 1')
 - a. This refers to the *sequence of bonded Amino Acids*. Think “sequence” for Primary structure.
 - b. Fredrick Sanger, in 1948, discovered the first protein Amino Acid sequence. It was for *insulin*.
 - c. *Primary Sequence is really important*; just look at the difference between Sickle-Cell Disease and normal red blood cells. Just changing the SIXTH amino acid in the primary sequence creates this horrible disease. The easy way to remember that it is the SIXTH amino acid that changed, remember the number of the devil 666. Bad number = bad disease.
 - 2. **Secondary Structure** (2')
 - a. **Hydrogen bonds** between neighboring amino acids allow for overlapping and coiling to occur. These help *fold up* the protein into it’s unique shape. It allows for *flexibility* too.
 - 3. **Tertiary Structure** (3') (“Tert” means “third”)
 - ~~3-4.~~ A variety of bonds (covalent~~covalent~~, ionic, hydrogen) between *distant* amino acids causes *large* folds in the protein. These help provide *stability* to the folded protein.
 - 4-5. **Quaternary Structure** (4') “Quarter” means “fourth”
 - a. This is when *two or more polypeptides are woven together*.
 - b. Hemoglobin (Red Blood Cells have four proteins woven together to make it.)
 - c. Think “multiple woven together” for Quaternary structure.
 - G. **Denaturation** (enzyme unfolding)
 - 1. The “*unraveling*” of a protein or enzyme causing it not to function
 - 2. Denaturing can be caused by ph changes, salt concentration changes, and temperature changes.
 - 3. The most common bonds that have been affected during denaturation are the *weak hydrogen bonds* associated with **secondary structure**.

II. Nucleic Acids

- A. *Monomers* are called **Nucleotides**
- B. *Polymers* are called **DNA or RNA**- It depends on the 5 Carbon sugar present in the monomer.
- C. These are the *source* of genes and *hereditary* information primarily.
- D. Two Types
 - 1. **DNA** – This polymer is the “Master Million Dollar Blueprint”.
 - a. It is kept “safe” in the nucleus. (Nucleus is like a vault to keep the DNA in.)
 - 2. **RNA** – This polymer is like a “cheap 10 cent copy” of the “Master Million Dollar Blueprint”. It is *disposable/recyclable*. It makes messenger RNA and other RNA molecules.
- E. **Pyrimidines** (C, T,U)
 - 1. Big name small molecule. (These have *1 Carbon ring* in the Nitrogen base.)
 - 2. “Counting steps **Takes you Up the Pyramid**” is the easy way to remember them.
- F. **Purines** (A, G,)
 - 1. Small name big molecule. (These have *2 Carbon rings* in the Nitrogen base.)
 - 2. “Alabama is **Purely** Greater than Auburn” or “Auburn is **Purely** Greater than Alabama” is an easy way to remember. It just depends on who you like more.
- G. It is always a pyrimidine paired with a purine.
- H. The *sequence determines what protein or enzyme is made*.

1. Example of Structure = Function theme and Emergent Properties theme
2. That is why it is the “*Blueprint*”.

III. DNA Double Helix Structure

- A. James Watson and Francis Crick make the model in 1953.
- B. The two sides are said to be **complementary**. (They fit together perfectly.)
- C. One side has *information to make proteins and enzymes* (The Million Dollar Blueprint); other side is a *protective cap* for the Million Dollar Blueprint. It protects the *sequence* of nucleotides.

IV. Genes and Evolution

- A. The *more* Nucleotide sequence “genes” in common; the *more closely* related the organisms are.
- B. The *fewer* Nucleotide sequence “genes” in common: the *more distantly related* they are.
 1. Time allows for the changes to occur... little time allows for less change or more time allows for greater change.