Chapter 5

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August 26, 2020

- There are four main macromolecules:
    1. Carbohydrate
    2. Lipids
    3. Proteins
    4. Nucleic Acids
- Proteins are the most complex out of the four molecules
- There are two forms of macromolecules:
    1. Monomer − The smallest unit of a macromolecule
    2. Polymer − A larger molecule made up of smaller monomers
- Dehydration Synthesis − Two hydrogen and one oxygen are removed from smaller molecules, allowing bonds to form more complex molecules
- Hydrolysis − Reverse of Dehydration Synthesis, -lysis ending means breaking. Water is required for this
- Carbohydrates:
    1. These are sugars and starches
    2. Monomers made up of C, H, and O (1:2:1 ratio)
    3. Short-term energy storage and structures
    4. Monomer − Monosaccharides
        (a) Examples: Glucose, Galactose, & Fructose
        (b) Combination of two forms Disaccharides, created through dehydration synthesis (Glucose + Glucose = Maltose, Glucose + Fructose = Sucrose, Glucose + Galactose = Lactose)

5. Polymer − Polysaccharide
    (a) Glucose polymers have two main functions: Energy Storage for short term, amylose in plants and glycogen in animals, and Structural support, mostly in plants, as cellulose
    (b) Starch vs Cellulose − Starches are alpha linked, whereas cellulose is beta linked
6. Herbivores:
    (a) Termites − Symbiotic relationship with a protist, which lives in the termite's gut. This protist digests cellulose
    (b) Ruminants − Cows are an example. Cows have bacteria that break down the cellulose, while the cow keeps regurgitating it
    (c) Caecophores − Bunnies are an example. They process the cellulose by eating some of their cecal (pre-fecal) matter, as the cellulose is only partly digested before it comes out
7. Chitin − A modified polysaccharide that exits in fungi, arthropod exoskeletons, and dissolving stitches

- Lipids:

1. Exist as fats, oils, and waxes
2. Made up with C, H, O
3. Used for long-term storage and insulation
4. No polymers
5. Three groups: Triglycerides, Phospholipids, and Steroids
    (a) Triglycerides are made of one glycerol & 3 fatty acids
    (b) Triglycerides are connected by dehydration synthesis three times
    (c) Saturated Fat − No double bonds between carbons
    (d) Unsaturated Fat − At least one double bond (kinked), this influences the properties of the lipid. Unsaturated stay liquid at room temperature.
    (e) Phospholipids are a modified version of the triglyceride, but with a phosphate rather than a fatty acid
    (f) Phospholipids have a polar and non-polar region
    (g) Big part of cell membranes, arranged in a bi-layer
    (h) Steroids are made up of cholesterol and some types of hormones
    (i) Steroids' structures are shaped as fused rings
    (j) Have a variety of functions (functional groups)

- Proteins:

1. The most complex biomolecule

2. Made up of C, H, O, N, & a little S
3. Used in all life functions
4. Monomer: Amino Acids (joined together by peptide bonds)
   (a) Built of amino (NH_2) group and Carboxyl group, attached to a central alpha carbon, and R group
   (b) R group defines the amino acid (without it, they are all the same)
   (c) N-terminus, the end of the amino group, connects to the C-terminus, the end of the carboxyl group
5. Polymer: Protein (Polypeptide)
   (a) Primary Structure − The sequence of amino acids in one polypeptide chain
   (b) Happens when peptide bonds between amino acids
   (c) Secondary Structure − A regular, repeating 3D structure found in all polypeptide chains
   (d) Alpha Helix and Beta-Pleated Sheet
   (e) Happens when hydrogen bonds between atoms in the CN backbone of the polypeptide (no R-groups involved)
   (f) Tertiary Structure − The specific 3D shape of a particular polypeptide chain (the conformation)
   (g) Happens when there is interaction between two R-groups of different atoms in cell
   (h) Quaternary Structure − The specific 3D shape of any protein that is made up of more that one polypeptide chain (many are). The only "Optional" level of structure
   (i) The overall structure when multiple chains form a functional protein
6. Different types of proteins:
   (a) Storage Proteins − Store amino acids
   (b) Hormonal Proteins − Responsible for coordination of an organisms activities
   (c) Structural Proteins − Support structures
   (d) Defensive Proteins − Protect against disease (by holding antibodies)
   (e) Transport Protein − Transports substances
   (f) Receptor Proteins − Response of cell to chemical stimuli
   (g) Contractile and Motor Proteins − Responsible for movement
   (h) Enzymatic Proteins − Selective acceleration of chemical reactions
7. Sickle Cell Anemia − An example of the relationship between protein structure and organismal physiology. Hemoglobin carries oxygen in red blood cells. This anemia is caused by the replacement of glutamic acid with valine. Valine is hydrophobic, so the cell moves away from water, instead of glutamic acid, which is hydrophilic
8. Denaturation − Change in the structure of a protein. Denatured proteins do not work well. Denaturing may be caused by heat, pH imbalance, etc