Biochemistry

Elements in the body

- About 96% of the mass of the human body is made up of 4 elements
- Oxygen 65%
- carbon 18%
- hydrogen 10%
- nitrogen 3%
- The only other elements that make up a significant portion are:
- Calcium 1.5%
- Phosphorus 1.2%

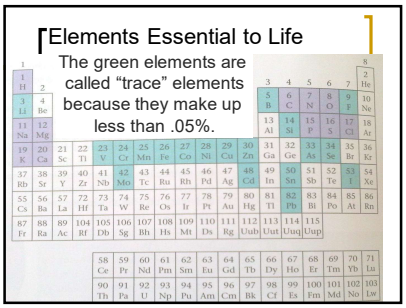
Water

- Of course, the vast majority of the oxygen is found in water.
- Water is essential for life.
- It is what all chemical reactions in the body occur in.
- However, water is not considered a biochemical or organic compound.
- Organisms are not *bonded* to water, instead water is contained within the organism.

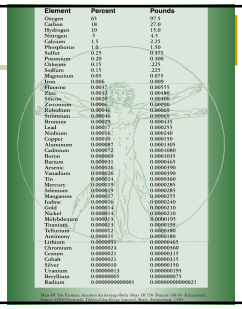
If we remove water…

- Then the human body is made up of
- 37% carbon
- 30% oxygen
- 18% hydrogen
- 6.2% nitrogen
- 3.1% calcium
- 2.5% Phosphorus

Elements Essential to Life



Composition of the human body



Uses of elements

- Carbon is a requirement for all biochemical compounds
- Nitrogen is needed for proteins
- Iron is needed for using oxygen

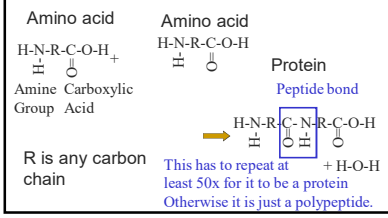
Biochemical Compounds

- These elements are bonded together to form different biochemical compounds.
- Biochemical compounds include:
- Proteins
- Carbohydrates
- Nucleic acids
- Lipids

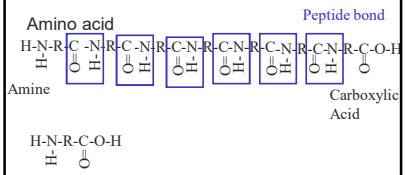
Proteins

- Proteins are polymers made up of monomers called **amino acids**.
- Amino acids have a carboxylic acid end and an amine (NH_2) end.
- Bonding an amine group and carboxylic acid is called a peptide bond.

Amino acid to protein

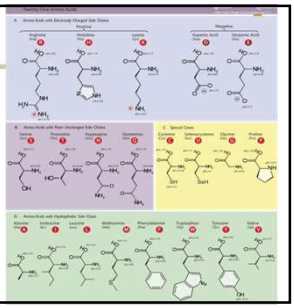


A polypeptide



It still has a carboxylic acid end and amine end so it can keep bonding to more amino acids (infinitely)

- Amino acids



Proteins

- A protein is at least 50 amino acids linked together.
- This makes proteins very large molecules.
- Most have a molar mass between 6000-1,000,000 g/mol.

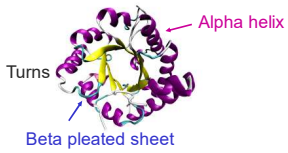
Protein Structure

- Proteins naturally fold into distinct 3-D structures.
- It is based off of a few different aspects.
- Primary structure of proteins is the amino acid sequence.
- 3 letter or one letter abbreviations are used for each amino acid.
- gly-cys-met-asp-
- Glycine-cytoseine-methionine-aspartic acid-

Secondary structures

- The secondary structure is local structures formed throughout the molecule.
- Alpha helix, beta pleated sheet, and turns are common formations.
- Alpha helix is when the molecules start to spiral around.
- Beta pleated sheet is when the molecules take a jagged back and forth formation.
- Turns are when the chain flips directions.

Triose Phosphate Isomerase



Tertiary Structure of proteins

- Tertiary structure- the overall structure of the protein.
- **This greatly affects the function of the protein.**
- Enzymes are proteins that catalyze certain reactions.
- Enzymes work at specific spots on a molecule.

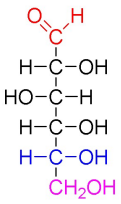
Other functions of proteins

- Structure- Tendons, bones, skin, cartilage, hair, are mainly protein
- Movement- Muscles are mainly protein
- Transport- hemoglobin, a protein, carries oxygen to cells from the lungs
- Protection- antibodies that fight off foreign substances are proteins
- Control- many hormones such as insulin are proteins.

Carbohydrates

- Carbohydrates are second class of biochemical compounds.
- They are commonly polymers made up of monomer units called simple sugars or monosaccharides.
- Simple sugars are ketones or aldehydes with several –OH (hydroxyl) groups attached.

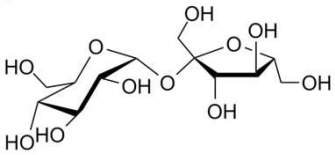
D Glucose



Bonding

- These sugars normally bend around to form rings.
- Then they link together.
- Two sugars bonded together are called a disaccharide.
- Sucrose (common table sugar) is a disaccharide of glucose and fructose.

Sucrose



Polysaccharides

- Polysaccharides are large molecules made of many simple sugars.
- Starch is the main fuel reservoir in plants.
- Cellulose is the main structural component for plants.
- Both are polysaccharides, but because of different types of bonds, humans are only capable of digesting starch not cellulose.

Glycogen

- Animals, and humans, store carbohydrates as glycogen.
- These are large polysaccharide molecules that are broken down into simple sugars as you need them.

Carbohydrates Uses

- In animals, carbohydrates are used as fuel sources.
- Plants uses carbohydrates as both a fuel source and structural support.

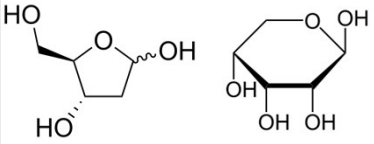
Nucleic Acids

- The biochemical polymer that stores and transmits genetic information in a cell is a polymer called deoxyribonucleic acid, DNA.
- DNA carries the instructions for making a specific protein.
- Ribonucleic Acid, RNA is needed to translate and copy DNA.

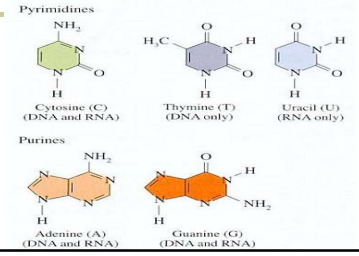
Nucleic acids

- Nucleic acids are polymers made up of nucleotides.
- A nucleotide consists of a nitrogen containing base, a 5 carbon sugar, and a phosphate group.
- In DNA, the sugar is deoxyribose. In RNA the sugar is ribose.
- Phosphate is PO_4^{2-}
- The bases are one of 5 organic compounds

Deoxyribose Ribose



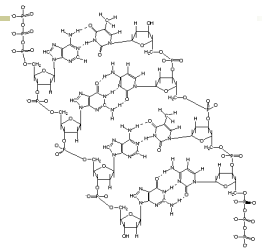
Nitrogen Bases



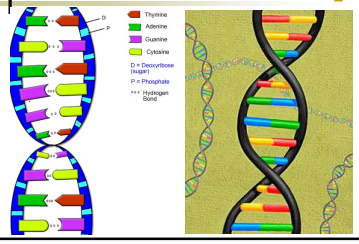
DNA Structure

- DNA forms a double helix structure.
- That is two complementary strands wrapped around one another is a spiral fashion.
- The sugar and phosphate form the backbone, while the bases from the rungs.
- The strands are complementary because the bases must always be matched up.
- Adenine and thymine will form a stable hydrogen bond.
- Guanine and cytosine will also form a stable hydrogen bond.
- These bases must always be matched up.

Piece of DNA



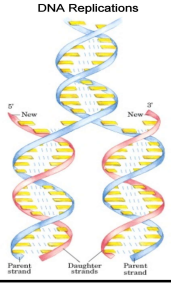
DNA Structure



DNA replication

- When DNA replicates it unwinds and complementary bases
- Adenine – Thymine
- Guanine- Cytosine
- Are added to a new daughter strand.

DNA Replications



Protein synthesis

- DNA is instructions for building a protein.
- The DNA is decoded by messenger RNA, mRNA.
- mRNA then carries the information to the ribosome of a cell.
- Transfer RNA, tRNA, then adds specific amino acids in order to build the protein.

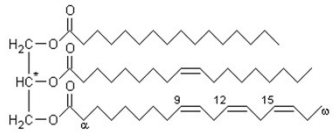
Lipids

- Lipids are biochemical compounds defined by being insoluble in water.
- There are 4 classes of Lipids:
- Fatty Acids
- Waxes
- Phospholipids
- Steroids

Fatty Acids

- Fatty acids are carboxylic acid chains.
- Vegetable oil and animal fats are triglycerides.
- Triglycerides- esters of glycerol bound to 3 fatty acids
- The primary function of triglycerides is storage of energy.
- These fats can be saturated (with hydrogen)
- They can also be unsaturated, meaning they have double bonds decreasing the amount of hydrogen.

Triglycerides



Phospholipids

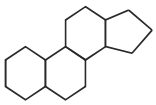
- Phospholipids are similar to triglycerides but only have 2 fatty acids instead of 3.
- They also have a phosphate group attached to the glycerol.
- Phospholipids are needed in cell membranes.

Waxes

- Waxes are long carbon chain esters.
- They are solids at room temperature.
- They provide water proof coatings on leaves.
- They are used in crayons, lip stick, candles, and a variety of other things.

Steroids

- Steroids are a class of lipids that have a characteristic 4 carbon rings linked together.



Common Steroids

- Cholesterol- starting material for many steroid molecules. A buildup of cholesterol in the arteries has been linked to heart attacks
- Testosterone- male sex hormone
- Progesterone/Estrogen- female sex hormones
- Cortisone- reduces inflammation pain and swelling