

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

The green elements are called "trace" elements because they make up less than .05%.

1	2	3	4	5	6	7	8										
H	He	B	C	N	O	F	Ne										
3	4	5	6	7	8	9	10										
Li	Be	B	C	N	O	F	Ne										
11	12	13	14	15	16	17	18										
Na	Mg	Al	Si	P	S	Cl	Ar										
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
87	88	89	104	105	106	107	108	109	110	111	112	113	114	115			
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Uub	Uuq	Uup				
88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu				
90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	Nb	Lr				

Uses of elements

- Carbon is a requirement for all biochemical compounds
- Nitrogen is needed for proteins
- Iron is needed for using oxygen
- <http://www.mil.org/periodic/LifeElement.html>

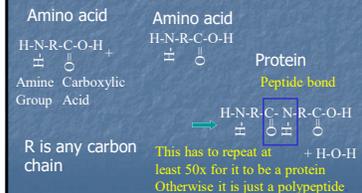
Biochemical Compounds

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

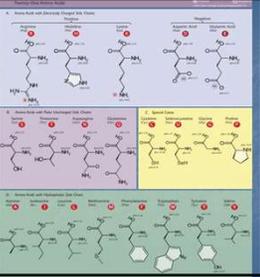
Proteins

- Proteins are polymers made up of monomers called **amino acids**.
- Amino acids have a carboxylic acid end and an amine (NH₂) end.
- Bonding an amine group and carboxylic acid is called a **peptide bond**.

Amino acid to protein



■ 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.

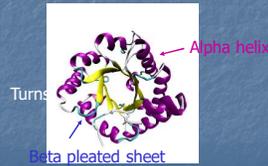
Protein Structure

- 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-cytosine-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 effects the function of the protein.**
- Enzymes are proteins that catalyze certain reactions.
- Enzymes work at specific spots on a protein.

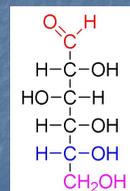
Other functions of proteins

- 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.

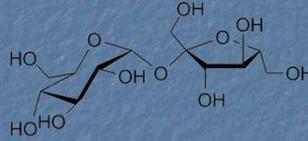
D Glucose



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.

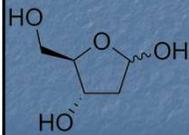
Nucleic Acids

- 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.

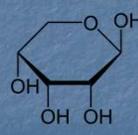
Nucleic acids

- 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

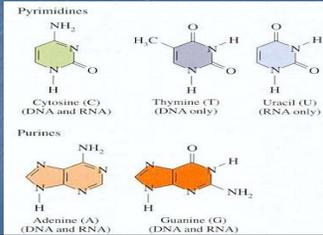
Deoxyribose



Ribose

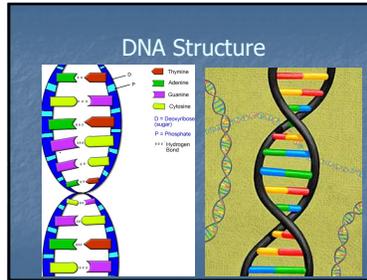


Nitrogen Bases



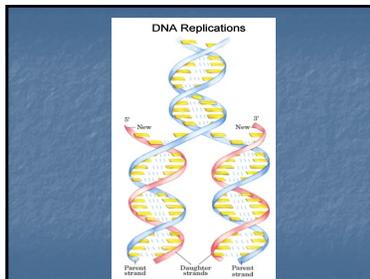
DNA Structure

- DNA forms a double helix structure.
- That is two complementary strands wrapped around one another in a spiral fashion.
- The sugar and phosphate form the backbone, while the bases form 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.



DNA replication

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



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.

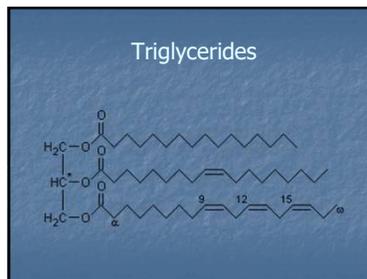
Lipids

- 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.

