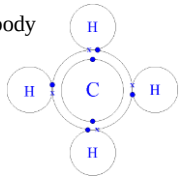
ORGANIC CHEMISTRY

CHEMISTRY OF CELLS

- 11 elements make up all organisms
- C, O, N, H: 96% weight of human body
- Organic compounds: contain C
- Inorganic compounds: no C



Bonding and Structural Formulas

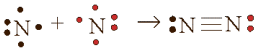
H and He: 2 valence electrons to complete outer shell

All other elements: 8 valence electrons to complete outer shell

Single Bonds

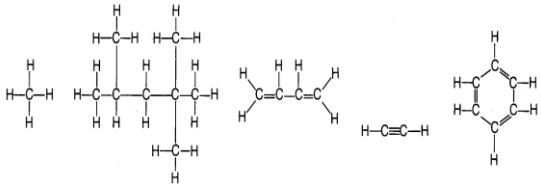
Double Bonds

Triple Bonds



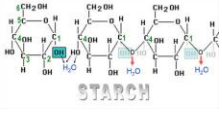
Carbon Structural Formations

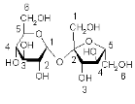
Chains
Branches
Rings



Polymerization: process of forming large compounds from small compound

monomer: single unit
dimer: two monomers
polymer: three or more monomers
macromolecules: extremely large polymers





4 Classes of Organic Compounds (biomolecules)

1. Carbohydrates
2. Lipids
3. Proteins
4. Nucleic Acids

CARBOHYDRATES

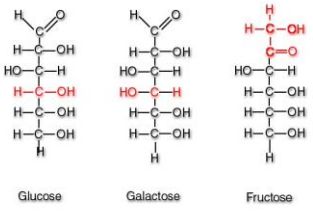
(saccharo / Latin or Greek /sweet or sugar)

- composed of C : H : O

- function: energy and structure

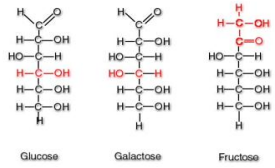
Isomers

Compounds that have same chemical formula but differ in the arrangement of groups around the carbon atoms

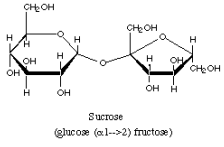


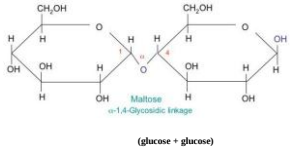
Types of Carbohydrates

1. **Monosaccharides**: ($C_6H_{12}O_6$)
   - 1 : 2 : 1 ratio
   - A. **glucose** – most important : used for energy
     - all di/polysaccharides broken down into glucose
   - B. **galactose** – milk
   - C. **fructose** – fruits

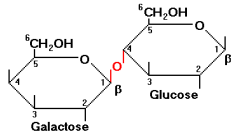


2. **Disaccharides:** ($C_{12}H_{22}O_{11}$) two monosaccharide units
   - A. **sucrose** – table sugar
   - B. **maltose** – malt sugar (beer)

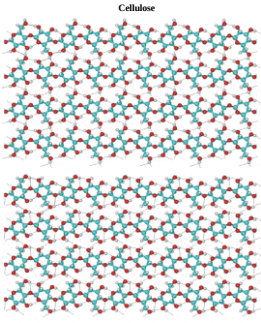




   - C. **lactose** – milk sugar



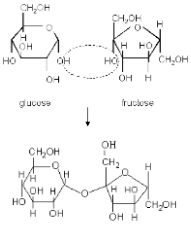
3. **Polysaccharides** : very large saccharide chains (poly / Greek many)
   - A. **starch** – energy storage for plants
     - 100's of glucose molecules
   - B. **glycogen** – energy storage for animals (muscles and liver)
   - C. **cellulose** – structure for plant stems
     - wood and bark
     - cell walls of plants



Building and Breaking Organic Molecules

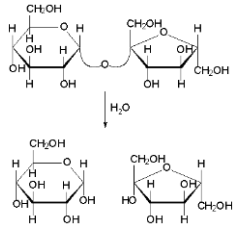
Dehydration synthesis/ Condensation

chemically joining two molecules with loss of H2O



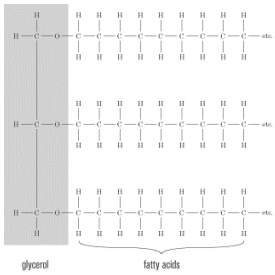
Hydrolysis

splitting of polysaccharide into monosaccharide units with consumption of water

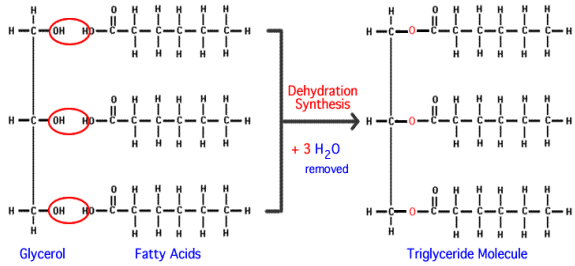


LIPIDS (fats)

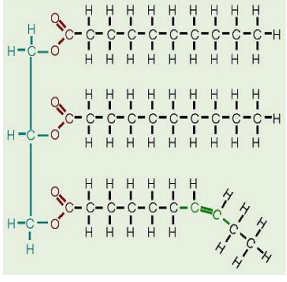
- waxy or oily compounds
- ratio of H to C is > 2:1
- functions:
  - energy storage
  - membrane formation (phospholipids)
  - chemical messengers (sterols/steroids)



Formation of a Triglyceride via Dehydration Synthesis



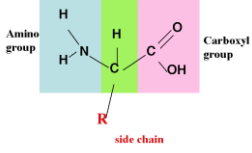
Types of Lipids



- **Saturated** - solid at RT
  - max number of H bonds with C (saturated with bonds)
- **Unsaturated** - liquid at RT
  - double bonds between C
- **Polyunsaturated** - many double bonds between C
  - cooking oils

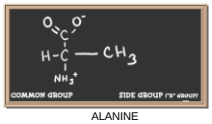
PROTEINS

- most important of biomolecules
- composed of C, O, H, and N
- functions:
  1. structure, growth , repair
  2. carrier molecules
  3. enzymes- initiate chemical reactions
  4. immunity- antibodies
  5. receptors- initiate and receive messages between cells
- structure:
  amino acids: building blocks

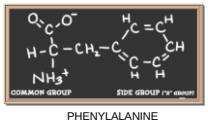


NH2 amino group (base)
COOH carboxyl group (acid)
R functional group (determines a.a.)

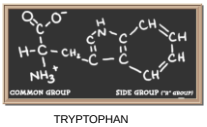
Amino Acid R Groups



ALANINE



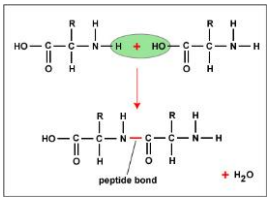
PHENYLALANINE



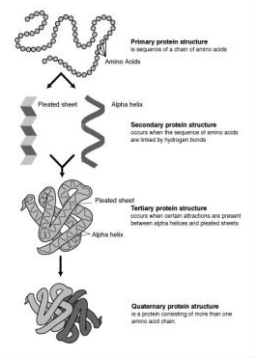
TRYPTOPHAN

Peptide Bond

- **Covalent bond** between two amino acids
- **Dehydration synthesis** reaction
- H from amino group bonds with OH (hydroxyl) of another amino acid
- water molecule is removed

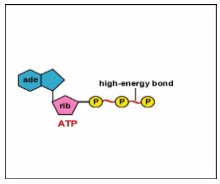


Protein Shapes



Nucleic Acids

- composed of C, O, H, N plus P
- very large molecules
- polymers of nucleotides



ATP (adenosine triphosphate)

- Single nucleotide with two extra energy storing phosphate groups.
- energy from broken down food is stored temporarily in ATP
- cells need ATP to function

Nucleic Acids

DNA: master molecule of organisms

RNA: involved in protein synthesis

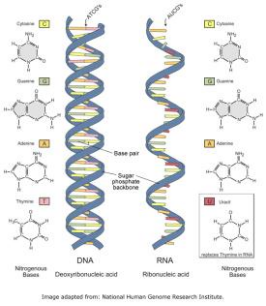


Image adapted from: National Human Genome Research Institute.

ENERGY AND CHEMICAL REACTIONS

- All organisms need energy to carry on life processes

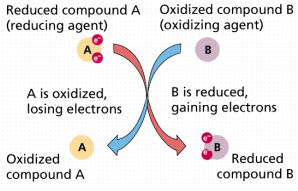
Energy: the ability to move or change matter (to do work)

- Energy can be stored or released by chemical reactions (bonds are broken)

ENERGY AND CHEMICAL REACTIONS

Oxidation/ Reduction Reactions (Redox): reactions in which electrons are transferred between atoms

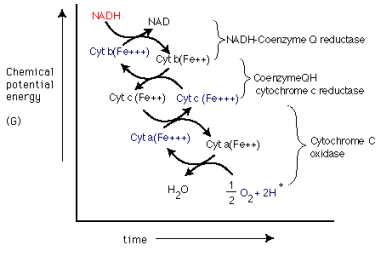
- **Oxidation**: loss of electrons atom becomes positively charged
- **Reduction**: gain of electrons atom becomes negatively charged



Biochemical pathway

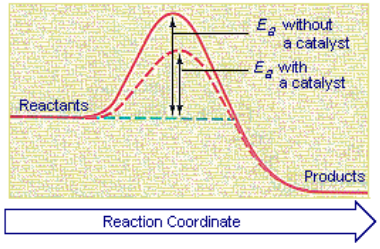
products of one reaction are used as reactants of next reaction

- due to redox reactions

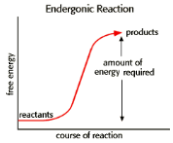


ENERGY AND CHEMICAL REACTIONS

Activation energy: amount of energy needed to start a reaction



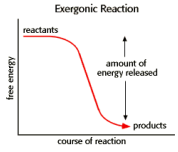
Types of Reactions



1. **Endothermic/ Endergonic**: absorbs energy

   Product moves to a higher energy state

   Ex: ice → water



2. **Exothermic/ Exergonic:** releases energy

   Product moves to a lower energy state

   Ex: steam → water

Catalyst: substance that speeds up chemical reaction without being changed or used up

Lowers **activation energy**

Enzyme: biological catalyst (ends in "ase")

- **globular proteins**

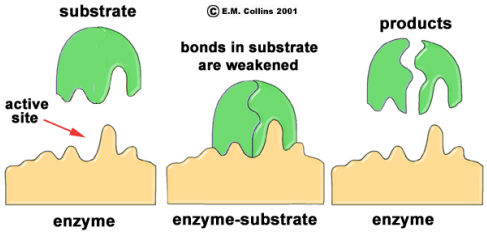
- **specific catalytic action**

  Ex: lipase: lipids
  lactase: lactose
  amylase: starch → glucose

- needed to maintain **homeostasis**

Enzyme Mode of Action Models

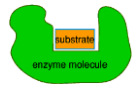
Lock and Key Model



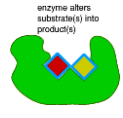
Enzyme Model of Action Models

Induced Fit Model

1. Enzyme has pocket (active site) in structure.



2. Only one substrate fits into the active site of enzyme molecule.



3. Enzyme active site changes shape to fit substrate (induced fit).
   Chemical reactions occur and new products are made.

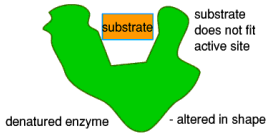
4. New products are released.
   Enzyme returns to original shape to be used again.

Enzyme animation

Factors that affect enzyme activity

1. temperature: (humans 35 – 40*C)
2. pH: (humans 6 – 8)

DENATURED ENZYME



denatured enzyme animation