

Chemistry of Life(Organic Chemistry)

Carbon skeletons:

- Are the "backbone" of organic molecules
- Consist of carbon atoms bonded covalently together
- There are four main types:

1) CARBOHYDRATES

2) LIPIDS

3) NUCLEIC ACIDS

4) PROTEINS

Monomers:

- A single unit(molecule)
- Building blocks that can hook together to form
MACROMOLECULES(polymers)

Polymers:

- large molecules made up of many monomers

CARBOHYDRATES

- Composed of Carbons, Hydrogens, and Oxygen atoms
- They are "sugars" in their simplest form
- They are **HYROPHILIC** because they are **POLAR**

STRUCTURE OF CARBOHYDRATES:

- The monomers of carbohydrates are simple sugars
 - 1) MONOSACCHARIDES: one sugar molecule
 - 2) DISACCHARIDES: two sugar molecules
 - 3) POLYSACCHARIDES: many sugar molecules

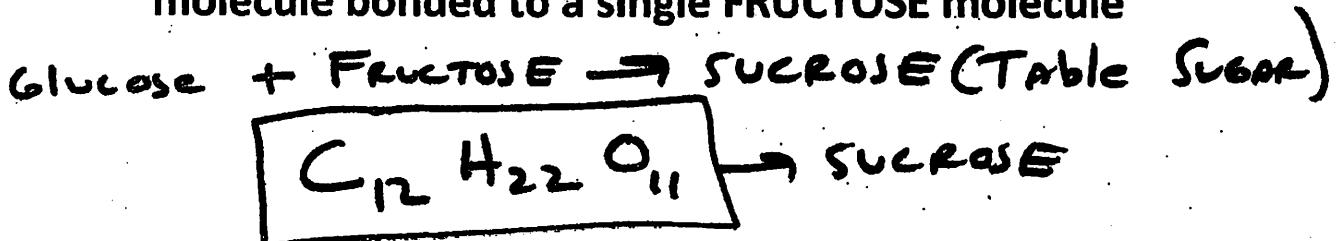
MONOSACCHARIDES:

- Composed of 5 or 6 carbon rings
- - a) GLUCOSE: $C_6H_{12}O_6$
 - This is the form our cells use for ENERGY
 - b) FRUCTOSE: $C_6H_{12}O_6$
 - Bonded differently and tastes sweeter

ISOMERS- molecules that have the same formula (number and type of atoms) but are DIFFERENT because they are arranged differently; Glucose and Fructose are isomers

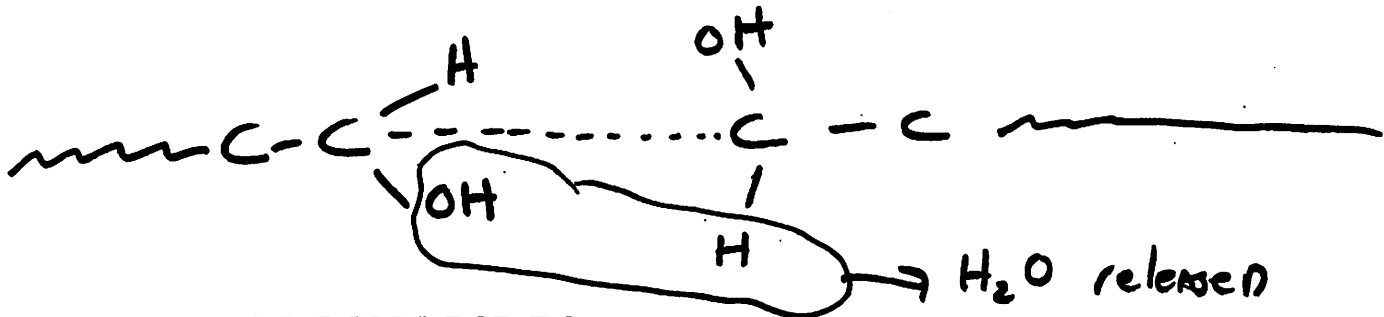
DISACCHARIDES:

- A good example is SUCROSE which is a single GLUCOSE molecule bonded to a single FRUCTOSE molecule



WHY is the formula of sucrose 2 Hydrogen and 1 oxygen LESS than you would expect?

**** Because..... It is a CONDENSATION REACTION(a synthetic reaction) in which one molecule of WATER comes out of the reaction(2 H's and one O!)



POLYSACCHARIDES:

- 1) STARCH: many glucoses hooked together; SOLUBLE
- 2) CELLULOSE: same as starch but arranged differently; used in PLANT CELL WALLS; NON-SOLUBLE
- 3) GLYCOGEN: many glucoses arranged differently; found in ANIMALS; SOLUBLE

FUNCTIONS OF CARBOHYDRATES

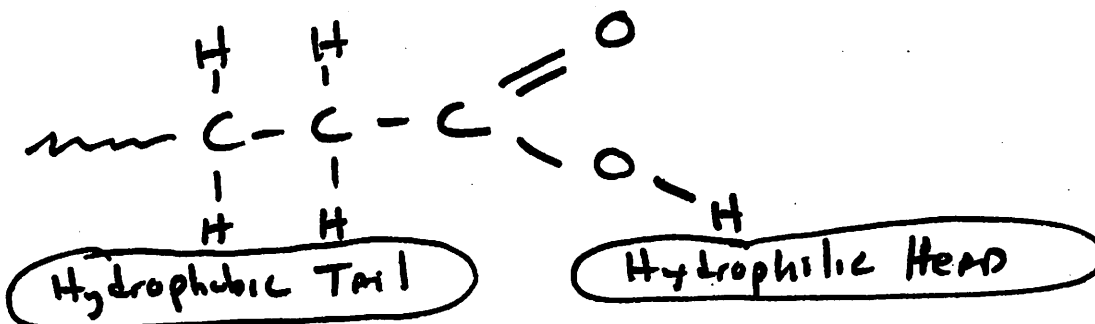
- 1) ENERGY STORAGE—save excess sugars
 - a) STARCH: in plants LONG-TERM STORAGE
 - b) GLYCOGEN: in animals LONG-TERM STORAGE
 - c) SIMPLE SUGARS(glucose) SHORT- TERM STORAGE

2) STRUCTURAL:

- a) CELLULOSE—forms the main portion of the body of PLANTS; NON-SOLUBLE; rigid
- b) CHITIN—forms the OUTER SKELETON of Arthropods and INSECTS and the cell walls of FUNGI

LIPIDS

- NON-POLAR MOLECULES THAT DO NOT DISSOLVE IN WATER
- Composed of C's and H's (and some O's)
- The most basic form is called a FATTY ACID (the building blocks of lipids)



a) Saturated Fatty Acids

- Found in animals
- All single bonds between carbons; more hydrogens than unsaturated fatty acids

b) Unsaturated Fatty Acids

- Found in plants
- One or more double bonds between carbons
- Fewer hydrogens than saturated fatty acids

FATS AND OILS (TRIGLYCERIDES)

- Composed of 3 FATTY ACIDS and a GLYCEROL
 - a) FAT- solid at room temperature
(generally found in ANIMALS)
 - b) OIL- liquid at room temperature
(generally found in PLANTS)

FUNCTION OF LIPIDS

***** VERY LONG TERM ENERGY STORAGE**

PHOSPHO-LIPIDS:

- Are the main component of CELL MEMBRANES
- The structure of phospho-lipids looks like triglycerides except with a PHOSPHATE GROUP instead of one or two fatty acids
- The phosphate portion is SOLUBLE

STEROIDS:

- Large molecules composed of 4 rings
- They are NON-POLAR
- Examples are hormones such as ESTROGEN and TESTOSTERONE
- CHOLESTEROL is a steroid; it is needed for proper functioning of the nerves and is embedded in the cell membranes of animals

- The LIVER makes 85% of cholesterol in humans; DIET provides the other 15%
- Cholesterol is also needed to produce vitamin D

WAXES:

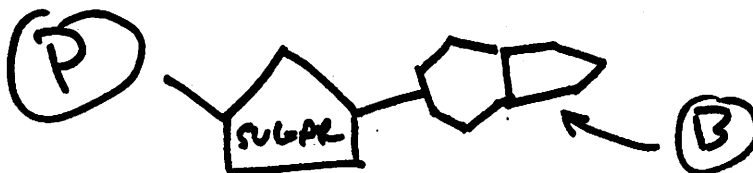
- Form WATER-PROOF BARRIERS
- Examples include coatings on leaves; bird feathers, etc

NUCLEIC ACIDS

- Composed of C's, H's, O's, N's, and P's
- The monomers are NUCLEOTIDES
- DNA is a nucleic acid; contains genetic information
- RNA is also a nucleic acid
- ATP is a nucleic acid; an energy carrying molecule

NUCLEOTIDES:

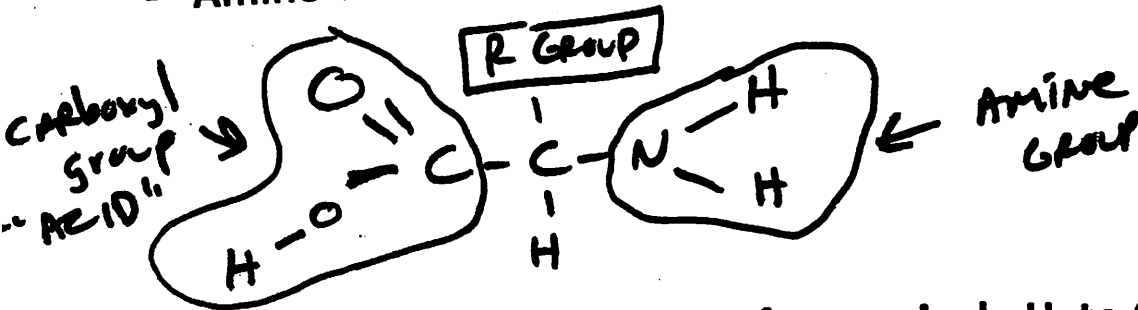
3 PARTS: a 5 carbon SUGAR(either ribose or deoxyribose)
 a PHOSPHATE GROUP(phosphorus and oxygens)
 a NITROGENOUS BASE(1 or 2 rings carbon/nitrogen)



***NUCLEIC ACIDS ARE MACROMOLECULES MADE UP OF REPEATING CHAINS OF NUCLEOTIDES

PROTEINS

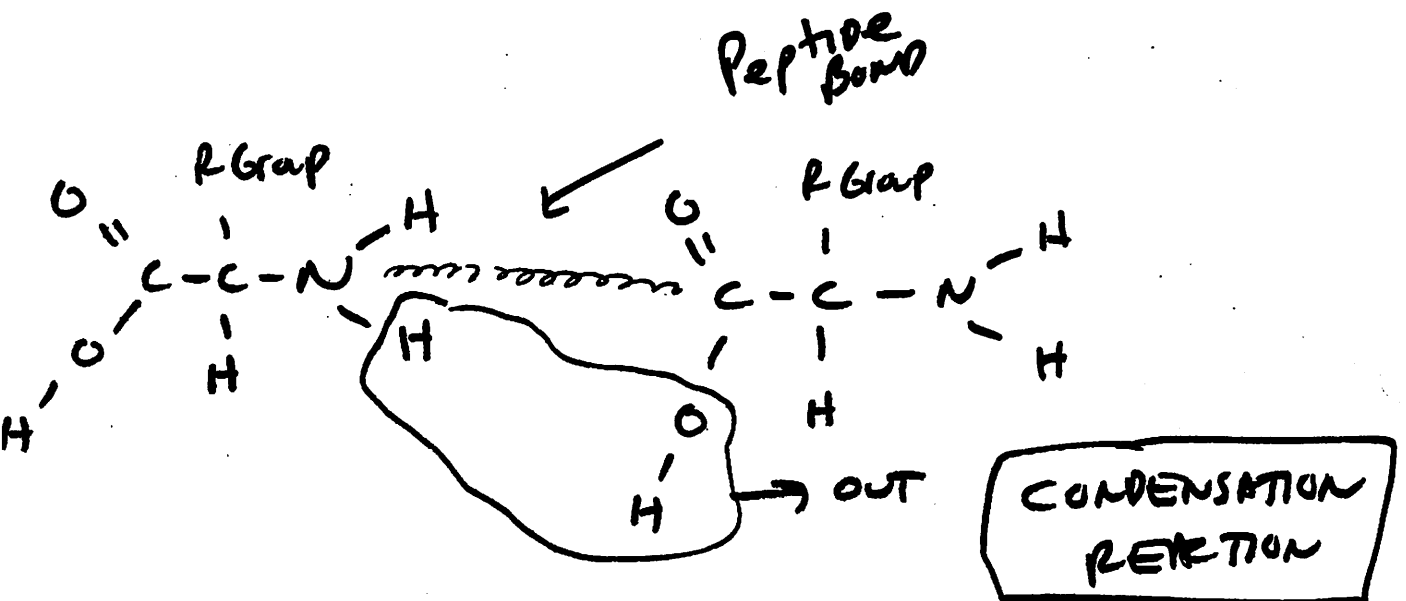
- Composed of C, H, O, N, and Sulfurs
- Monomers of proteins are AMINO ACIDS
- Amino acids are basically... C-C-N



*** the "R-group" can be anything from a single H, to CH₃, several C's, H's, O's, etc.

**** LIVING ORGANISMS USE 20 DIFFERENT AMINO ACIDS

*** amino acids form PEPTIDE BONDS TO FORM PROTEINS



- The sequence of the amino acids is what determines which protein is made

ESSENTIAL AMINO ACIDS:

- There are 8 EAA for humans
- Our bodies CANNOT make them; we must get from diet

COMPLETE PROTEIN:

- Contains all 8 EAA in correct amounts
- Animal proteins are complete proteins but plant proteins are incomplete
- This can be offset by **PROTEIN COMPLEMENTATION**(combining plant proteins in correct way to get all 8 EAA)

FUNCTIONS OF PROTEINS:

- 1) **ENZYMES**: protein molecules that act as CATALYSTS in chemical reactions; names end in – ASE(i.e.lactase)
- 2) **STRUCTURAL**:
 - a) **COLLAGEN**: makes up tendons etc in vertebrates
 - b) **KERATIN**: makes up hair, nails, horns, hoofs
- 3) **HORMONES**: insulin is the smallest protein, made up of 51 amino acids; insulin gets glucose through to the cells

4) MOVEMENT(CONTRACTILE PROTEINS)

- muscle fibers
- flagella in single-celled organisms
- cilia(hair-like projections from the cell membrane for movement or "sweeping")

5) TRANSPORT PROTEINS

- Part of the Cell Membrane
- Allow substances to pass through the membrane

6) ANTIBODIES:

- Produced by the IMMUNE SYSTEM
- They bind to foreign particles to destroy them

***** PROTEINS ARE SENSITIVE
TO TEMPERATURE AND TO pH**

ENZYMES

- ENZYMES are PROTEINS that "CATALYZE" biochemical reactions without altering the reaction equilibrium
- The activities of enzymes depend on:
 - TEMPERATURE
 - IONIC CONDITIONS
 - pH OF THE SURROUNDINGS

CATALYST: a substance that SPEEDS UP the rate of a chemical reaction

- almost all enzymes are protein catalysts made by LIVING ORGANISMS
- enzymes speed up reactions by REDUCING the ACTIVATION ENERGY required for the reaction, BUT... the enzymes ARE NOT CONSUMED BY THE REACTIONS THEY PROMOTE!!!!

ACTIVATION ENERGY: the amount of energy that is needed to get a reaction started

***** Cells use enzymes to speed up their reactions**