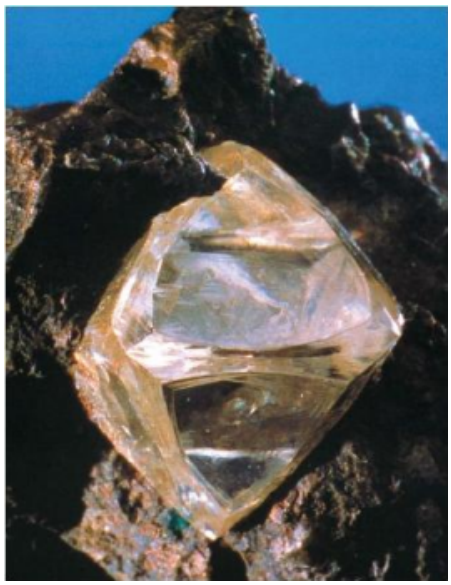
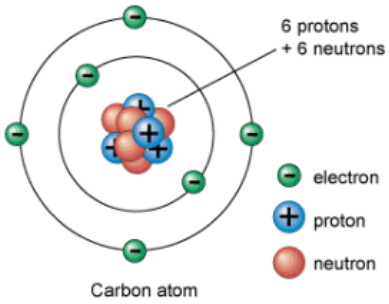
Carbon Compounds
Ch 2.3



2.3 Carbon Compounds

A. The Chemistry of Carbon

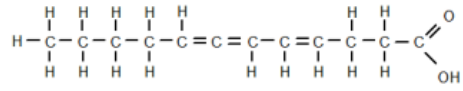
Organic- any substance that contains carbon except CO_2 and CO.

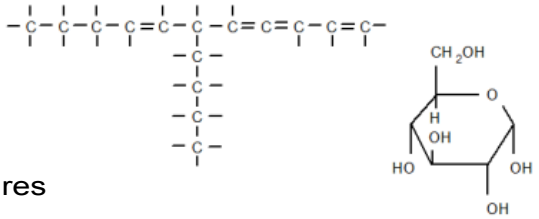


Carbon is very important to living things

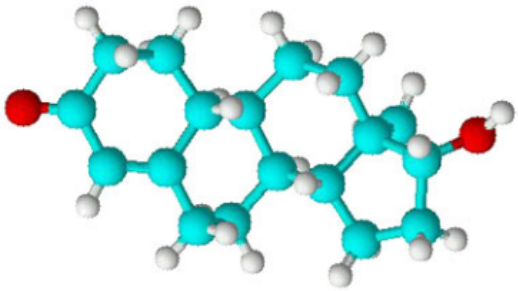
1. Carbon has 4 Valence electrons
   - Makes it very versatile
   - Will easily bond with
   - H, O, N, P, S..all important for living things

2. Carbon has the ability to form bonds with itself
   a. makes long chains



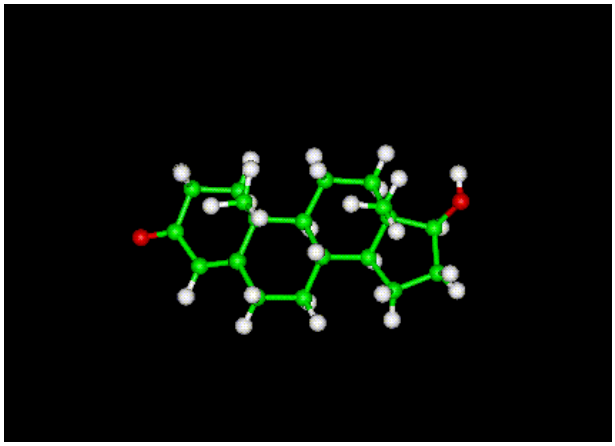


   b. complex structures



Steroids

Testosterone



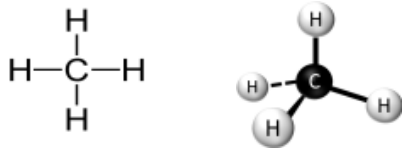
FORM DICTATES FUNCTION
FORM = Shape or Its structure
Function = Job it Performs

B. Hydrocarbons and Functional Groups

1. Hydrocarbons: Made of Hydrogen and Carbon Only
   Represent our Fossil Fuels

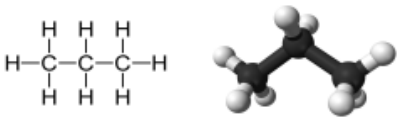
   a. Alk**anes**: Hydrocarbon chains containing only single bonds

Methane



Ethane

Propane

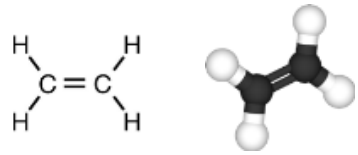


Butane

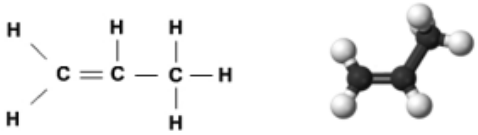
Octane

   b. Alk**enes**: Hydrocarbon chains containing at least one DOUBLE bond

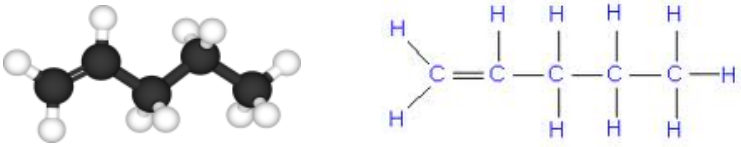
Ethene



Propene

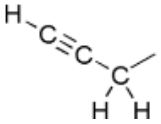


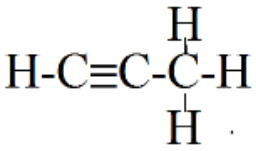
Pentene



c. Alk**ynes**: Hydrocarbon chains containing at least one TRIPLE bond

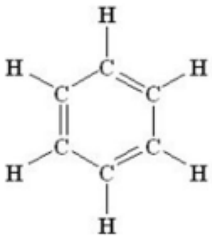
Prop**yne**



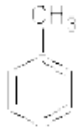


d. Aromatic: Hydrocarbon chains in a ring structure

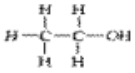
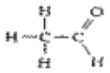
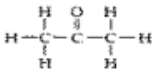
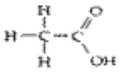
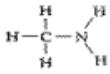
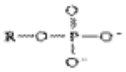
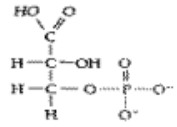
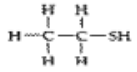
Benz**ene**



Tolu**ene**



2. Functional Groups: atoms and ions added to our hydrocarbons to alter their function

Functional Groups	Class of Molecules	Formula	Example
Hydroxyl —OH	Alcohols	R—OH	 Ethanol
Carbonyl —CHO	Aldehydes		 Acetaldehyde
CO	Ketones		 Acetone
Carboxyl —COOH	Carboxylic Acids		 Acetic Acid
Amino —NH2	Amines		 Methylamine
Phosphate —OPO3-2	Organic Phosphates		 3-Phosphoglyceric acid
Sulfhydryl —SH	Thiols	R-SH	 Mercaptoethanol

Important for our Understanding

C. Macromolecules of Life

Macromolecules

Macro=Large

Large Molecules made up of smaller pieces

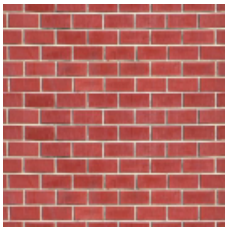
Also known as Polymers

A *Polymer* is made up of many *Monomers*-small units that combine to form larger ones

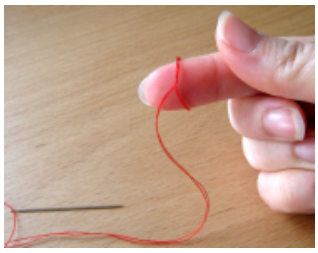
Monomer

acr

Many Monomers



Polymer (Macromolecule)

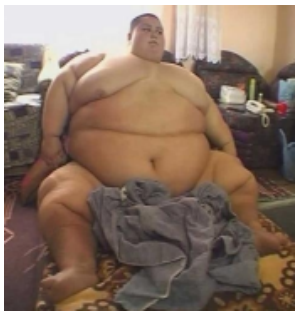


Monomer

Many Monomers

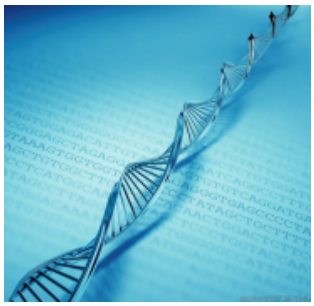
Polymer

Sugar



Fat

Protein



Nucleic Acids (DNA)

Are all Polymers made up of smaller Monomers!

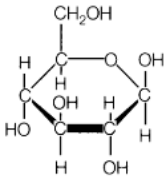
Carbohydrates

1. Carbohydrates (Sugars and Starches)

a. Contain Carbon, Hydrogen and Oxygen only

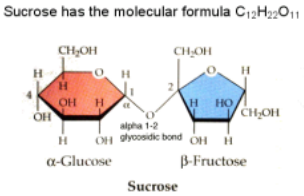
b. These elements always occur in a 1:2:1 Ratio (C:H:O)

This is important for identifying them



Glucose

$C_6H_{12}O_6$



Sucrose

$C_{12}H_{24}O_{11}$

Sucralose

c. Structure Can be Simple or Complex

1. Simple Sugars

a. Monosaccharides- Single Sugar

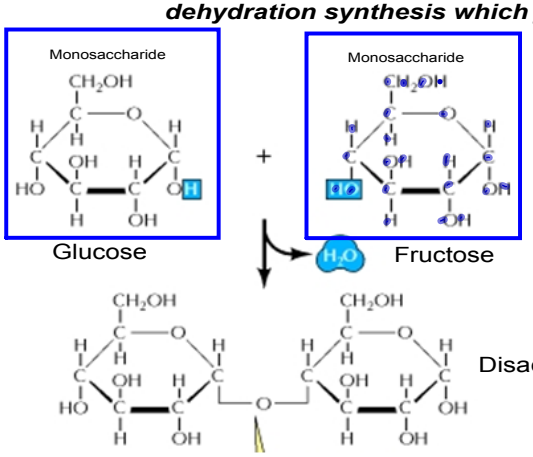
Glucose and Fructose

b. Disaccharides- Double Sugar

Made from joining two monosachharides together

Dehydration Synthesis-building by removing water

Glycosidic Linkage- specific type of dehydration synthesis which joins carbs



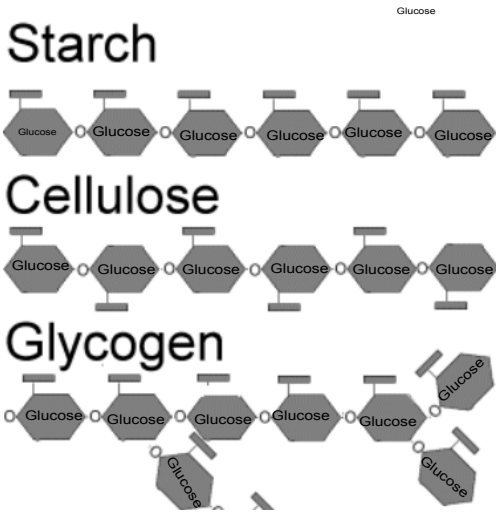
c. Polysaccharide- 3 or more single sugars joined together

2. Complex Carbohydrates

a. Starch- Thousands of monosaccharides joined together

Cellulose/Fiber from plants

Glycogen from animals

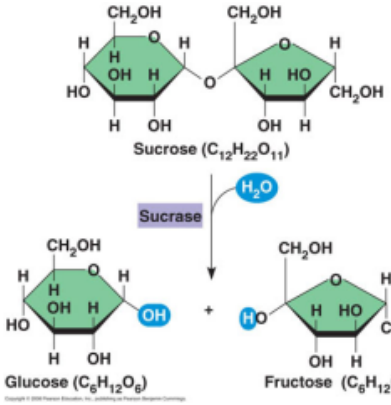


D. Function:

1. Most Carbs are readily available sources of energy

   Energy is stored in the bonds between Carbon Atoms
   It is released by the breaking of bonds between monosaccharide through a process called
   HYDROLYSIS-breaking apart by adding water

   Once broken down into monosaccharides they are dismantled by Respiration



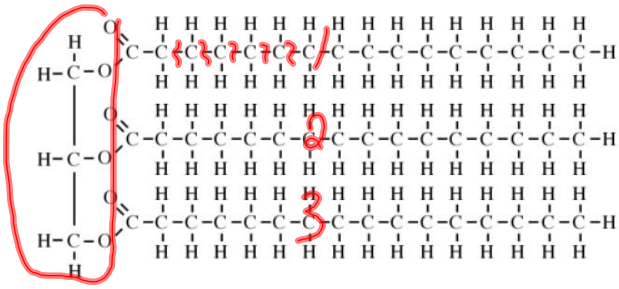
HYDROLYSIS

2. Some Starches are Structural Components

   Chitin is made of Cellulose and is found in cell walls of plants and the exoskeleton of insects

LIPIDS

2. **Lipids (**Fats, Oils, and Waxes)
   a. Contains Carbon, Hydrogen, and Oxygen (Same as Carbs)
   b. Ratio is different from Carbs ($C_{a\ lot}H_{a\ lot}O_{not\ so\ much}$)



FAT aka Triglyceride

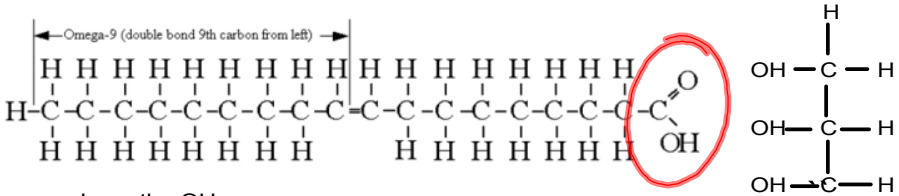
OH-

OH-

c. Structure:

Monomers are Glycerol and Fatty Acids

Lipids are made when a glycerol molecule bonds with fatty acids

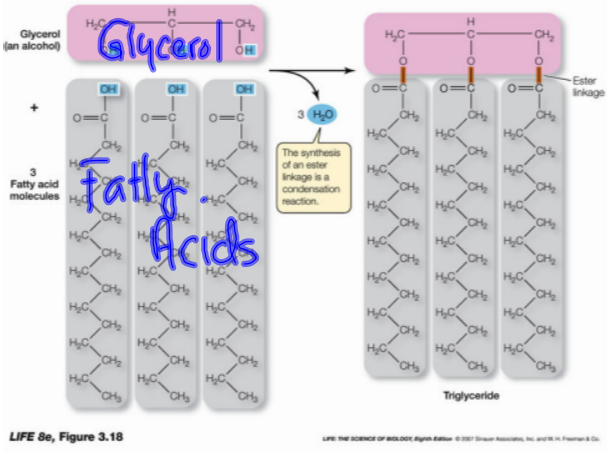


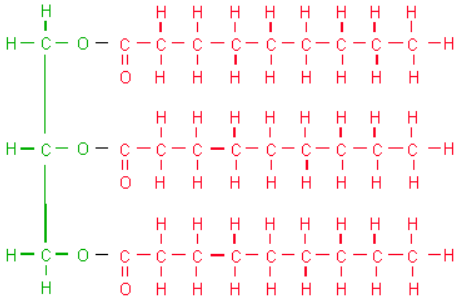
Lose the OH- from Fatty Acids and the H from the glycerol

Fatty Acid

Glycerol

Joined together by Dehydration Synthesis known as **ESTER LINKAGE**



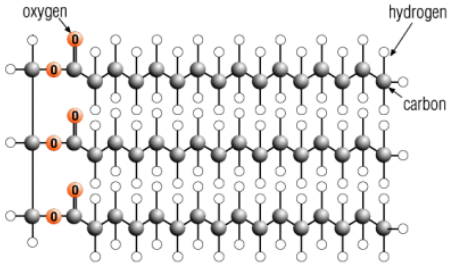


1. Fats/Oils (Triglycerides):

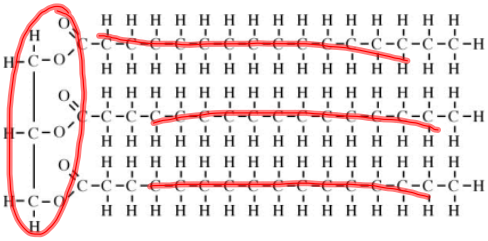
1 Glycerol Molecule and 3 Fatty Acid Chains

Fat is solid at Room Temperature

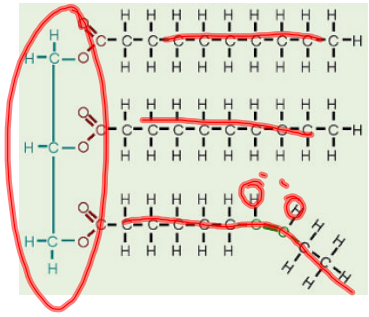
Oil is a liquid at Room Temp



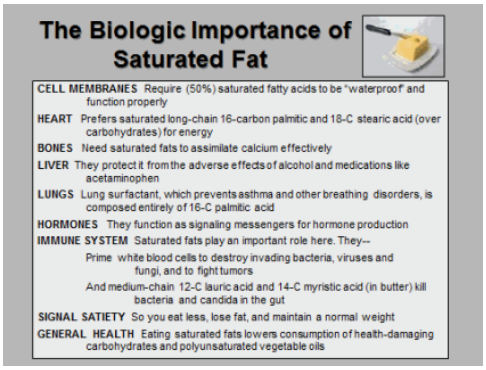
Fats can be ***Saturated*** or ***Unsaturated***

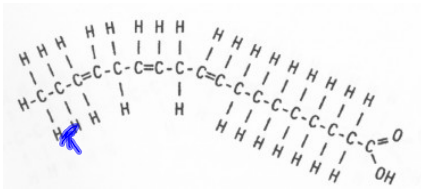


Saturated



Unsaturated (MONO)

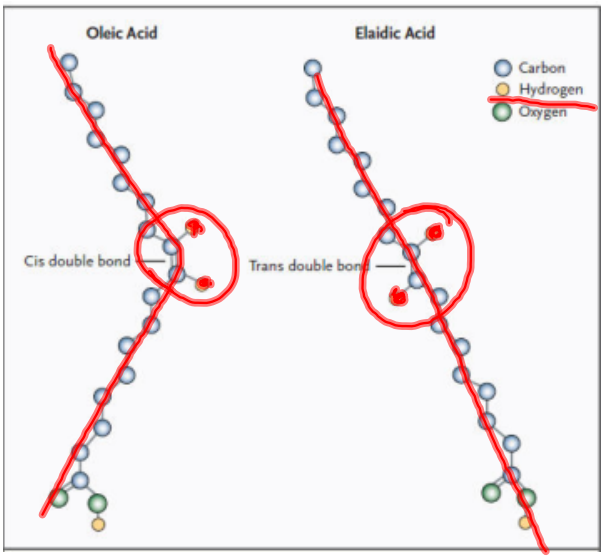


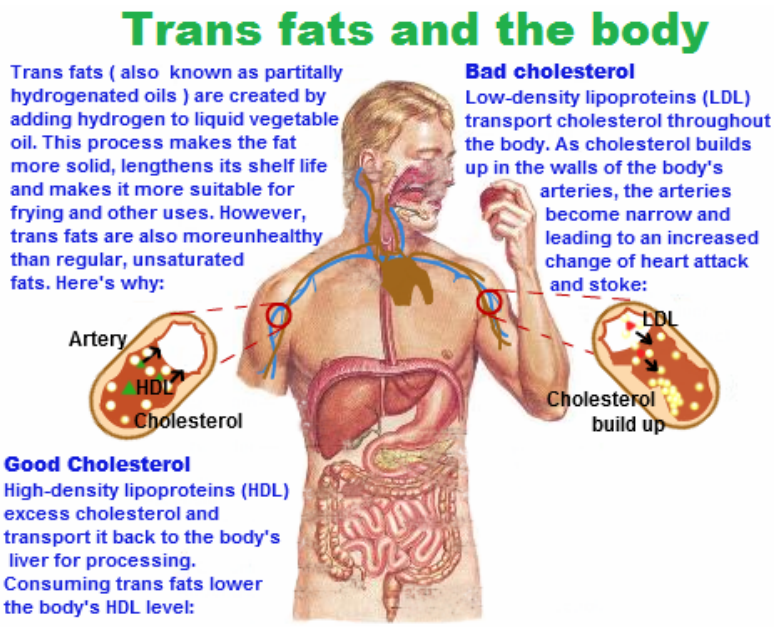


Unsaturated (POLY)

Unsaturated Fats can be ***CIS*** or ***TRANS*** fats

The bend makes it easier to digest and less likely to congest arteries

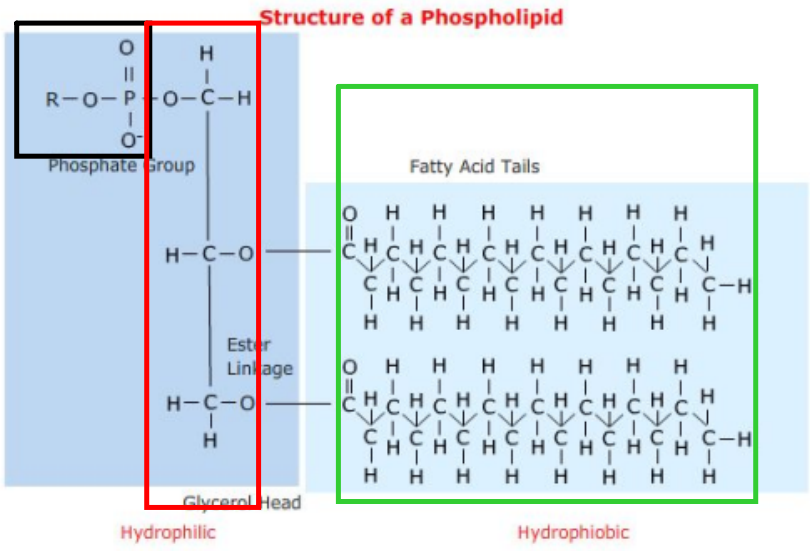




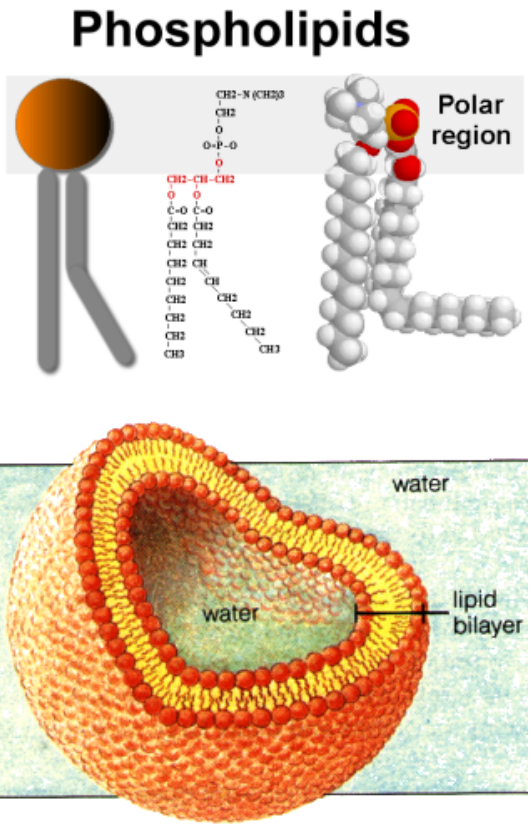
2. Functional Lipids

1 Glycerol Molecule attached to two Fatty Acids and something else that alters its function

EX: Phoshpholipid



Create a membrane that protects a cell from the outside environment

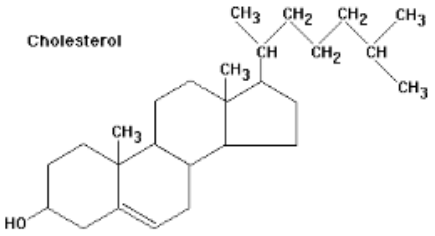


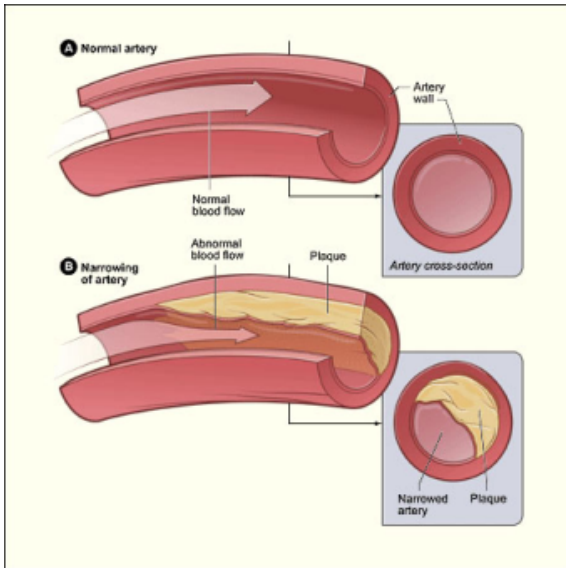
3. Waxes and Cholesterol (Steroids)
    a. Waxes: One fatty acid chain linked to an alcohol

Type	Structural Formula	Source	Uses
Beeswax	$CH_3(CH_2)_{14}-\overset{\overset{O}{\|}}{C}-O-(CH_2)_{29}CH_3$	Honeycomb	Candles, shoe polish, wax paper
Carnauba wax	$CH_3(CH_2)_{24}-\overset{\overset{O}{\|}}{C}-O-(CH_2)_{29}CH_3$	Brazilian palm tree	Waxes for furniture, cars, floors, shoes
Jojoba wax	$CH_3(CH_2)_{18}-\overset{\overset{O}{\|}}{C}-O-(CH_2)_{19}CH_3$	Jojoba	Candles, soaps, cosmetics

b. Steroids: a carbon skeleton with a 4 ring structure

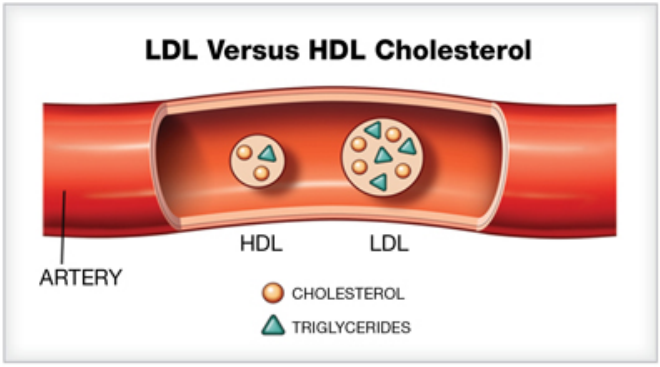
Cholesterol: Lipoproteins



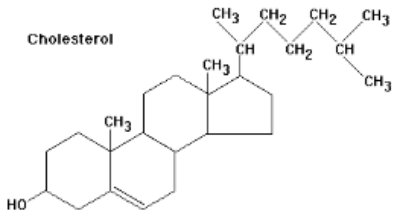


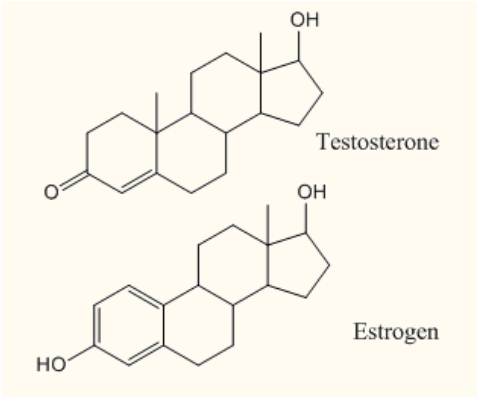
HDL: High Density Lipoprotein
aka: Good Cholesterol: increases the transport of saturated fats for digestion: prevents clogging of arteries

LDL: Low Density Lipoprotein
aka: Bad Cholesterol: Decreases the transport of triglycerides causing them to accumulate as plaque in arterial walls



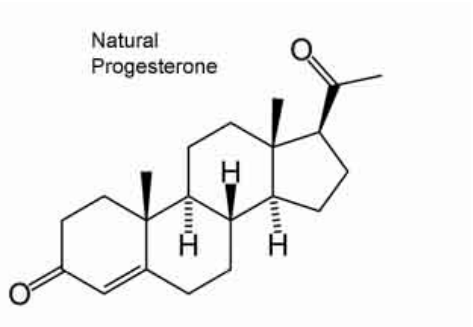
Steroids: have the same shape as cholesterol but generally serve as hormones in the body



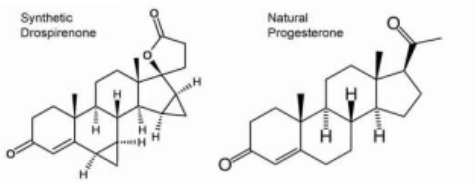


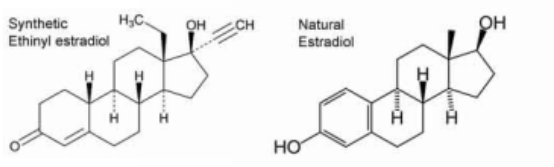
Androgen: aka. male hormone responsible for development of male primary and secondary sexual characteristics and tissue building

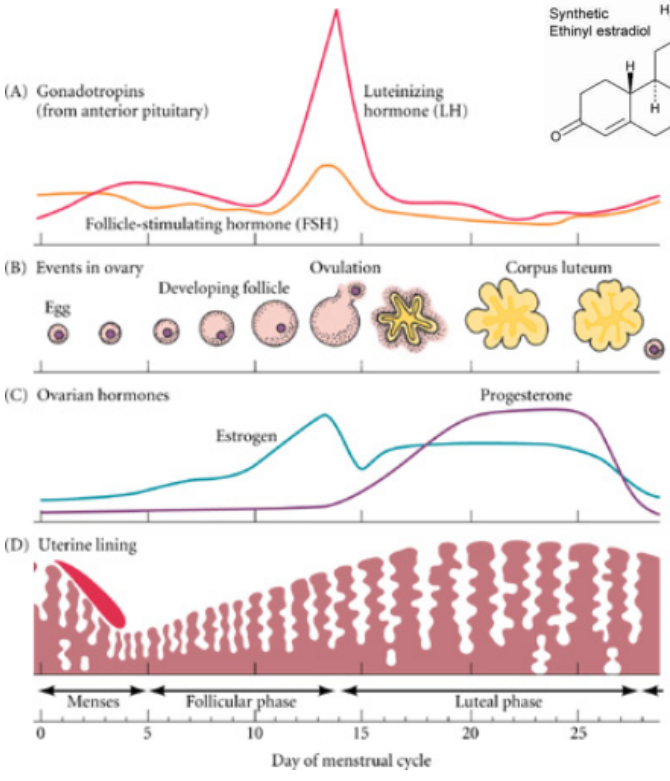
Female Sex hormones: Responsible for the development of primary and secondary sexual characteristics and regulation of menstruation



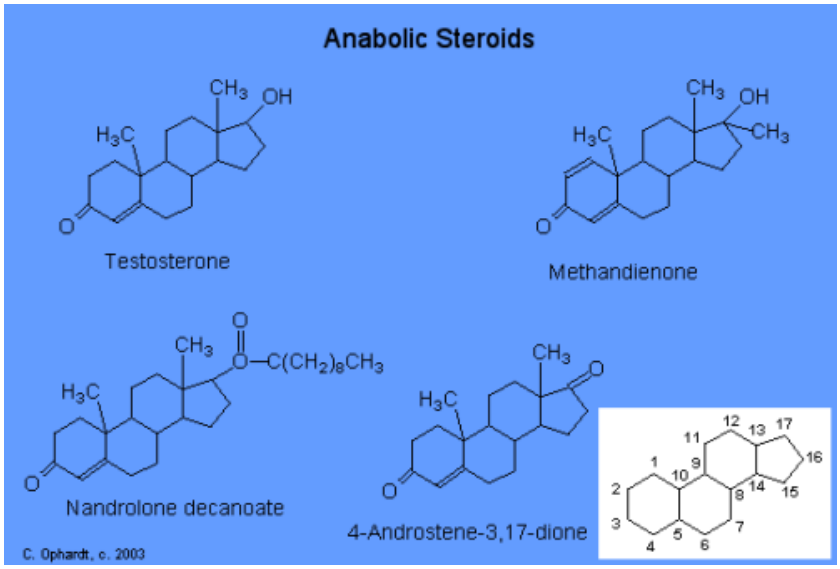
Modern birth control pills (YAZ) introduce synthetic progesterone to trick the body into thinking it is pregnant. Progesterone prevents further ovulation during pregnancy







Anabolic Steriods: Synthetic versions of male hormones that promote accelerated tissue growth



d. Functions
    1. Act as Energy Storage
    2. Serve as a membrane to protect the cell from the outside environment
    3. Serve as chemical messengers (hormones) in the body

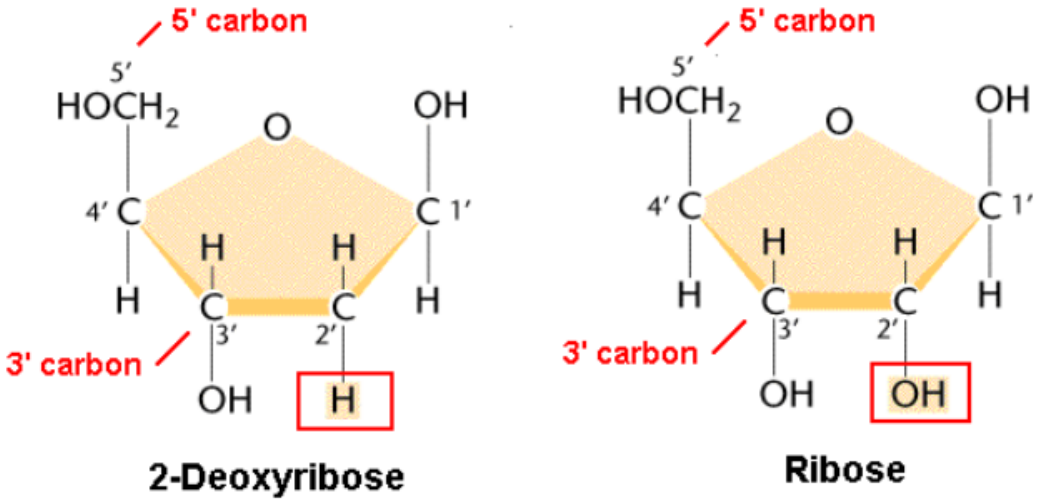
Nucleic Acids

3. Nucleic Acids
    a. Very large Macromolecules
    b. Contain Carbon, Hydrogen, Oxygen, and Nitrogen and Phosphorous

    c. Function:
        Information Carrying Molecules: DNA and RNA
        Carry instructions for Building Proteins

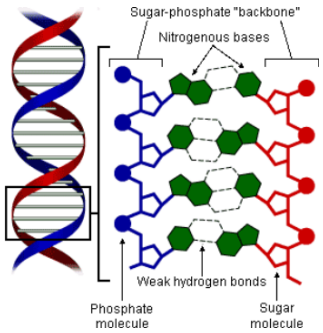
    d. Structure:
        Monomers are called nucleotides
        They contain one of each of the following

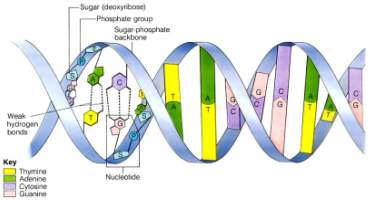
        a. 5 Carbon Sugar (Deoxyribose or Ribose)
        b. Phosphate Group
        c. Nitrogenous Base
            a. Adenine
            b. Guanine
            c. Cytosine
            d. Thymine/Uracil (Different in DNA and RNA)

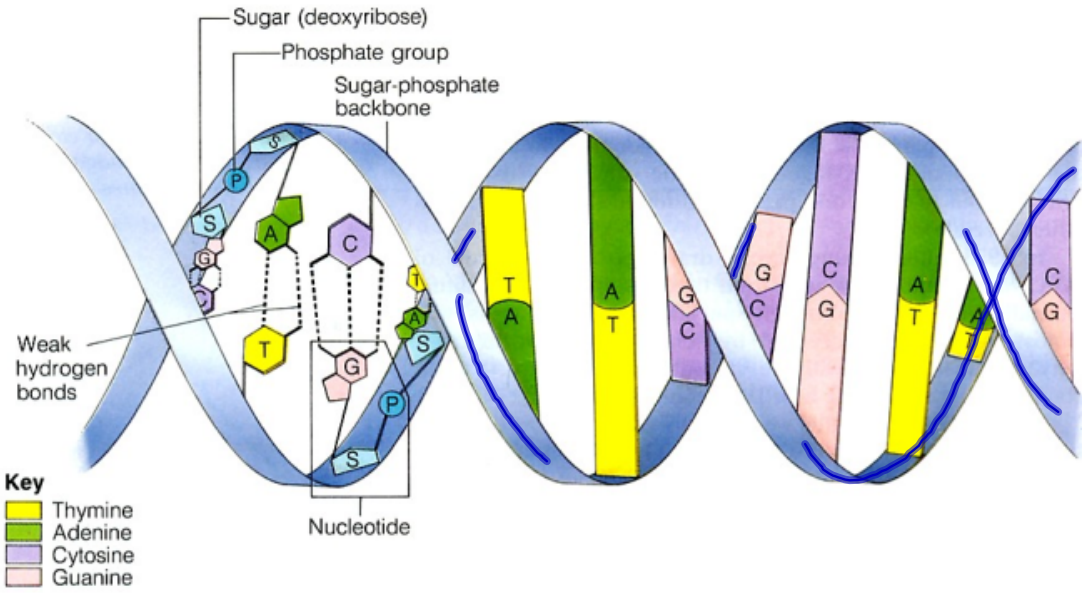


(Klug & Cummings 1997)

The Sequence of Nitrogenous Bases makes up the genetic code= instructions for building proteins


Sugar-phosphate "backbone"
Nitrogenous bases
Weak hydrogen bonds
Phosphate molecule
Sugar molecule


Sugar (deoxyribose)
Phosphate group
Sugar-phosphate backbone
Weak hydrogen bonds
Nucleotide
Key
Thymine
Adenine
Cytosine
Guanine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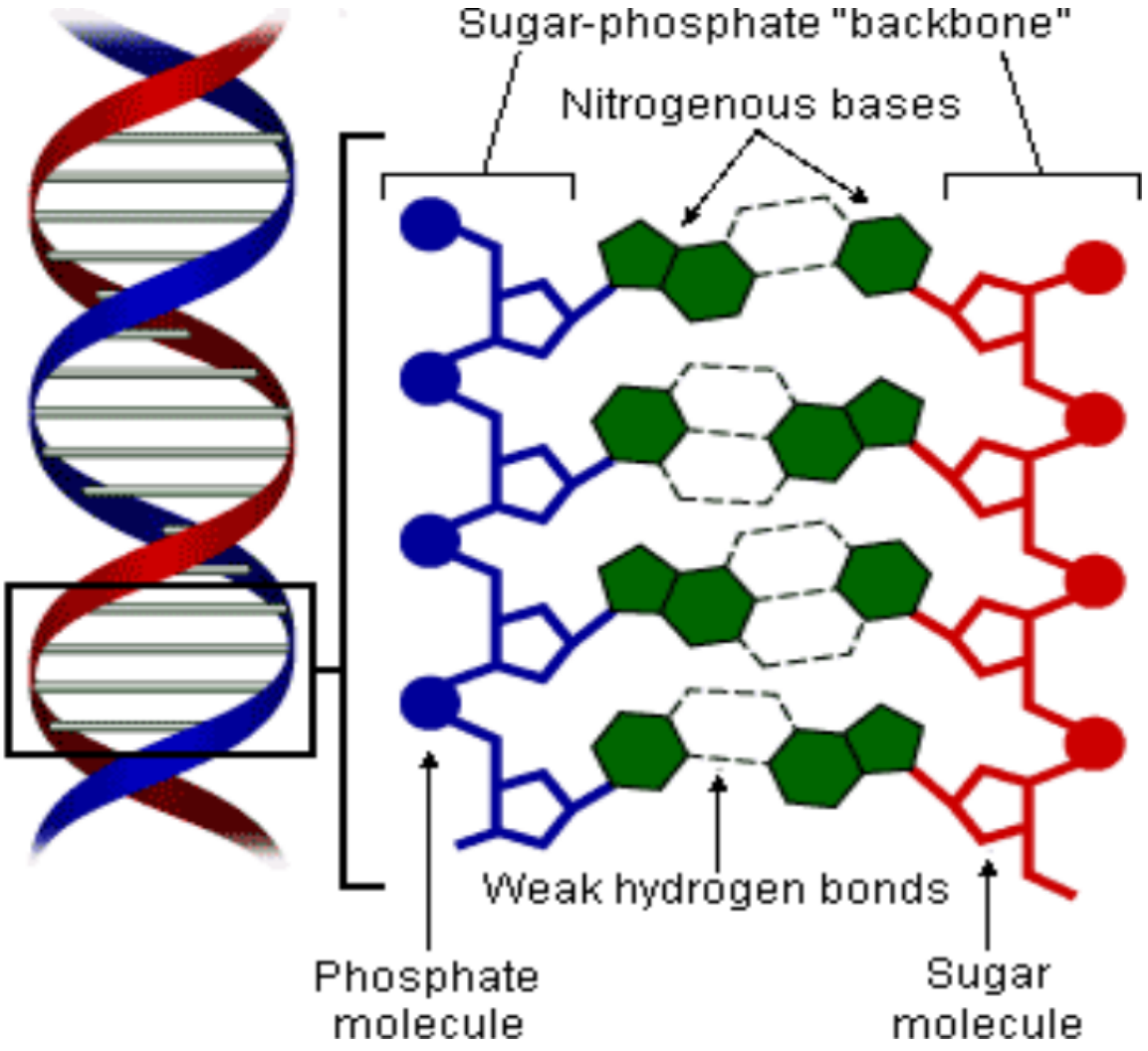
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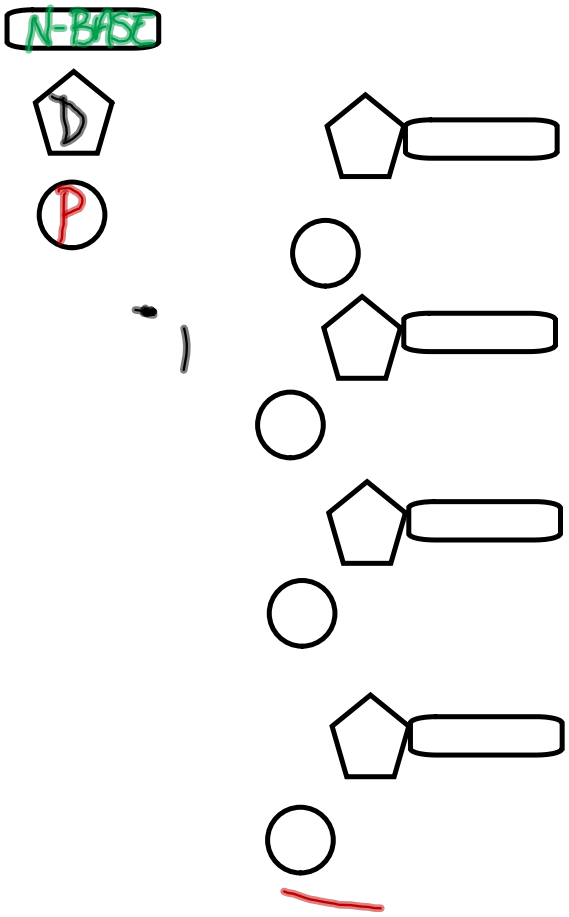
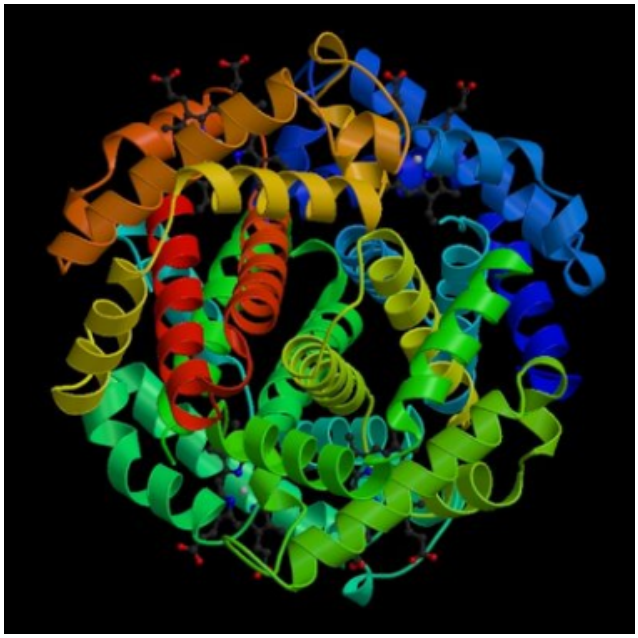

N-BASE
D
P

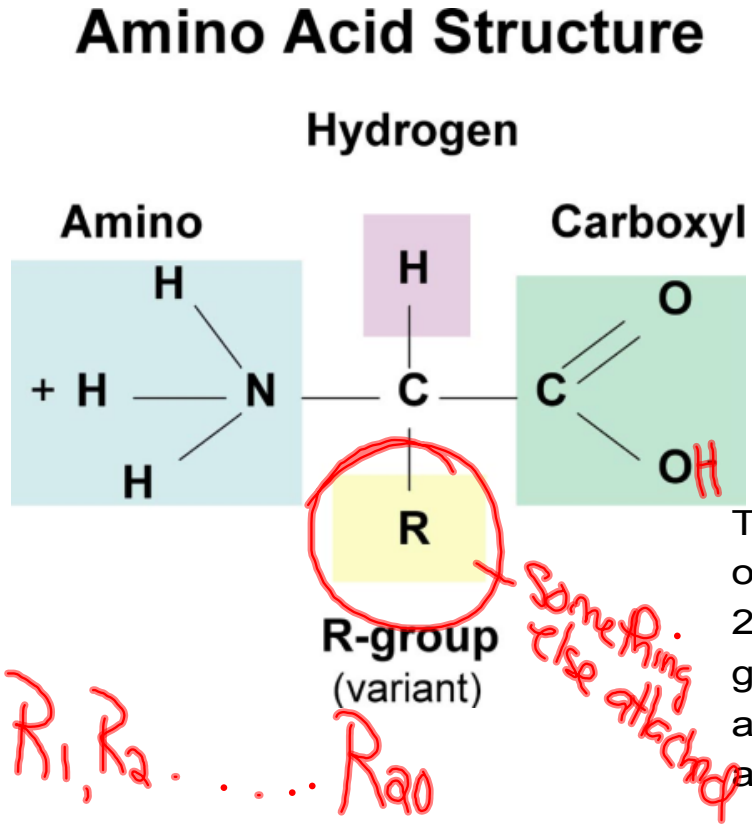
Proteins


EXAMPLES OF FOODS HIGH IN PROTEIN:
Beef, chicken, salmon, eggs, lentils,
black beans, and nuts



4. Proteins
    a. Made up of Carbon, Hydrogen, Oxygen, and Nitrogen
    b. Structure

Monomers are Amino Acids



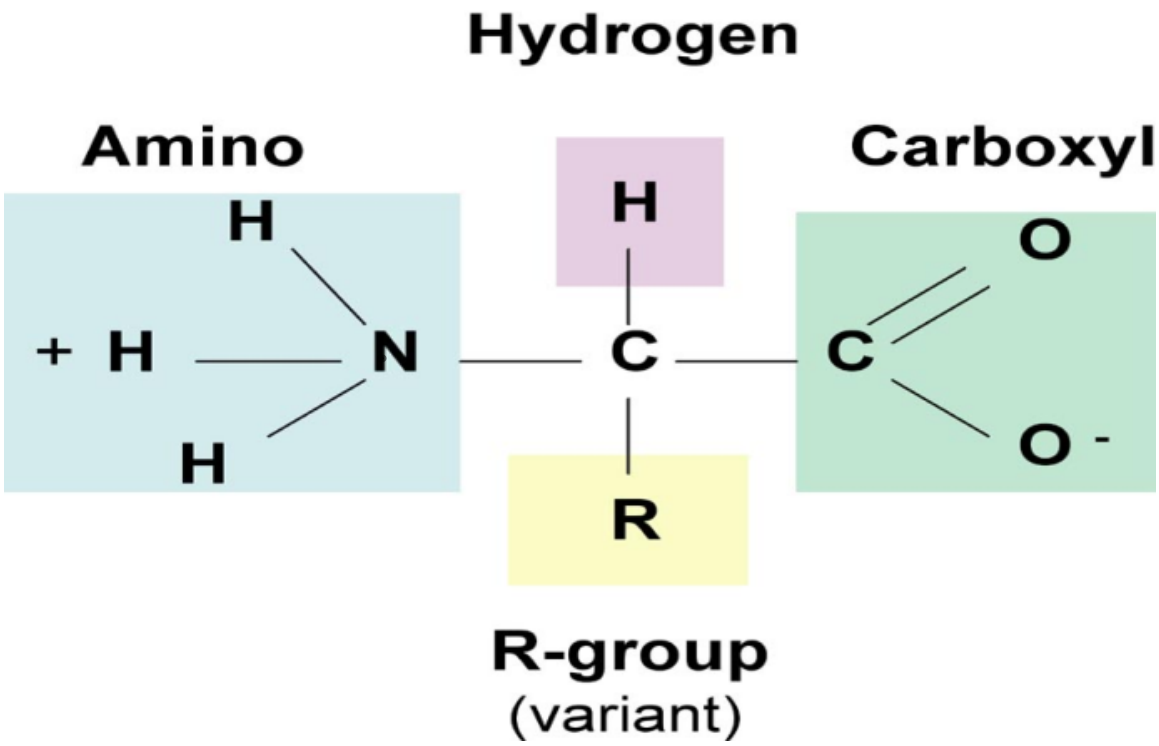
All Amino Acids have the same ***Amino group*** $(NH_3)^+$
Amino means Nitrogen

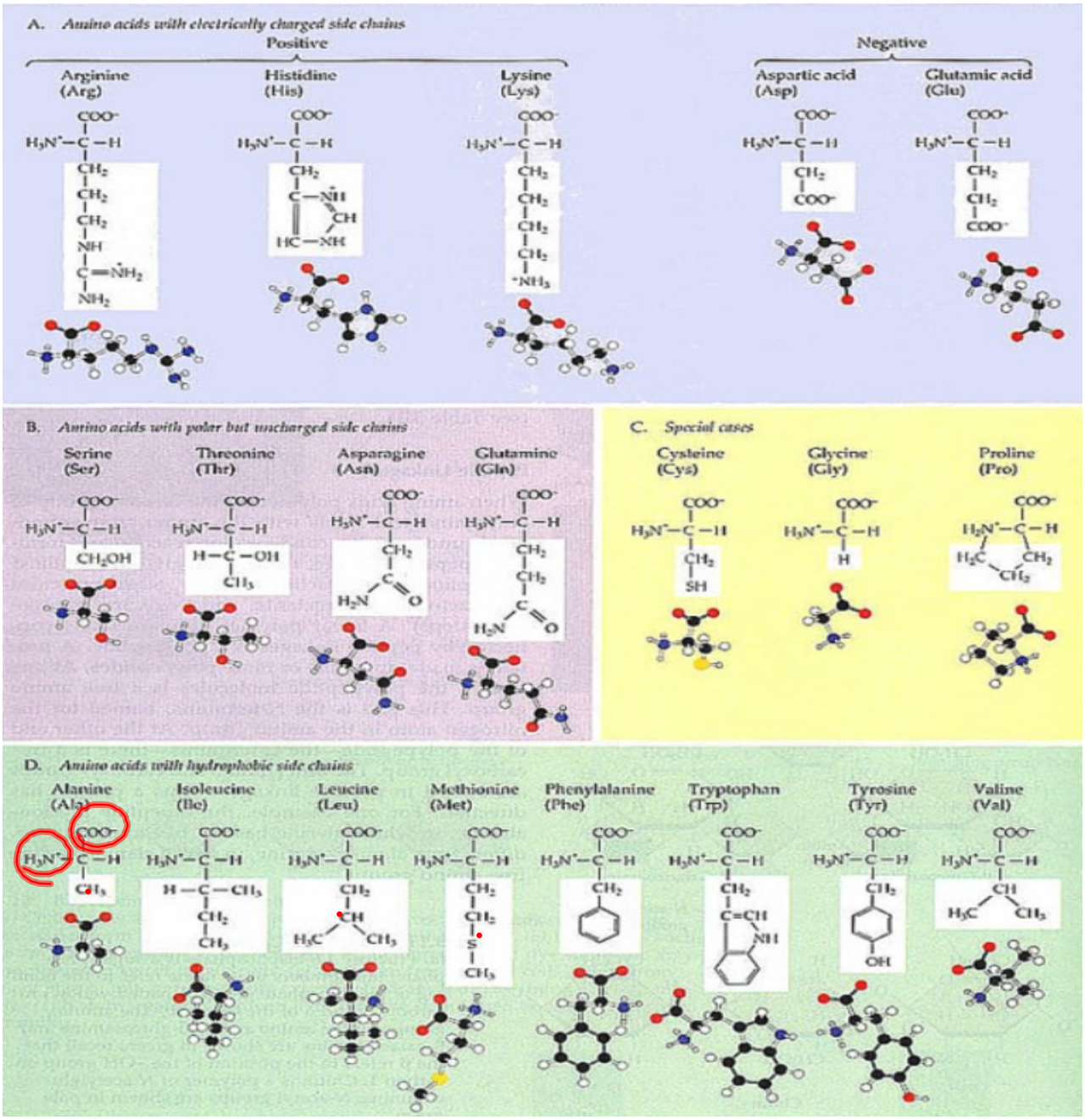
and ***Carboxyl group*** $(COO)^-$

This makes it an acid

The ***R-Group*** is for the rest of the molecule...There are 20 different R groups.....meaning there are 20 different amino acids

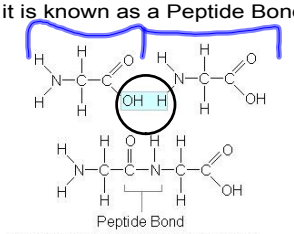
Amino Acid Structure




A. Amino acids with electrically charged side chains
Positive
Negative
Arginine (Arg)
Histidine (His)
Lysine (Lys)
Aspartic acid (Asp)
Glutamic acid (Glu)
B. Amino acids with polar but uncharged side chains
Serine (Ser)
Threonine (Thr)
Asparagine (Asn)
Glutamine (Gln)
C. Special cases
Cysteine (Cys)
Glycine (Gly)
Proline (Pro)
D. Amino acids with hydrophobic side chains
Alanine (Ala)
Isoleucine (Ile)
Leucine (Leu)
Methionine (Met)
Phenylalanine (Phe)
Tryptophan (Trp)
Tyrosine (Tyr)
Valine (Val)

When two Amino Acids are joined together water is removed...This is known as _D._____ _S._____.

In Proteins it is known as a Peptide Bond!



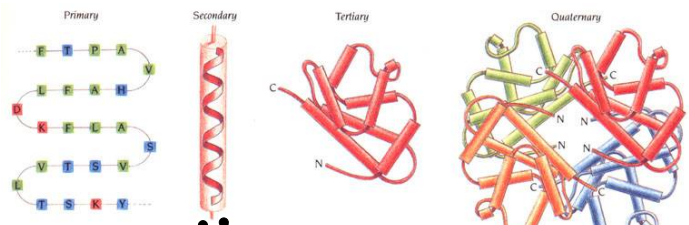
A molecule of water is removed from two glycine amino acids to form a peptide bond.

Water Out

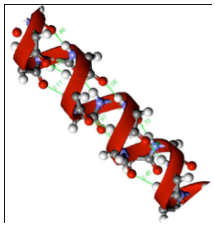
Four Levels of Structure:

1. Primary- Sequence of Amino Acids (Polypeptide)
2. Secondary- Polypeptide bends
3. Tertiary- Folds into a 3 Dimensional Polypeptide
4. Quaternary- different Polypeptides come together to make a functional protein

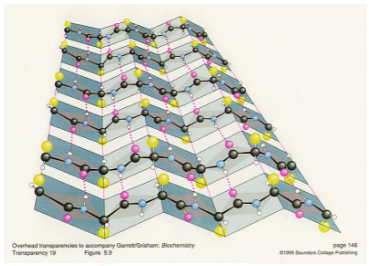
Polypeptide Protein

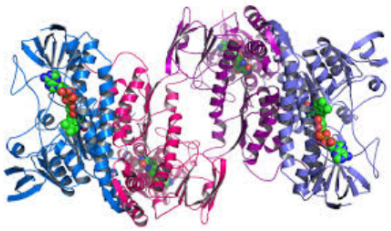


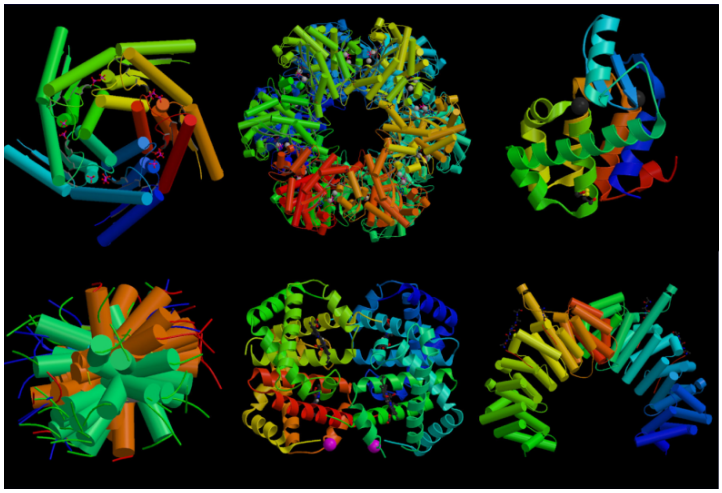
Alpha Helices



Beta Pleated Sheets

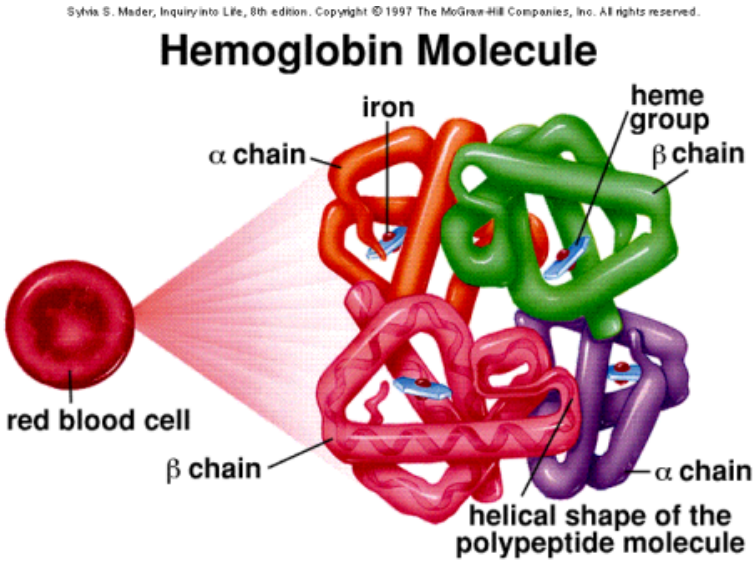






c. Functions (7)

1. **Proteins are structural components of tissue**
2. **Enzymes- carry out all of the bodies chemical reactions**
3. **Transport materials**
4. Contract to create movement
5. Act as Hormones- chemical messengers
6. Store materials
7. Antibodies for the immune system defense



Hemoglobin is a protein that carries oxygen in red blood cells