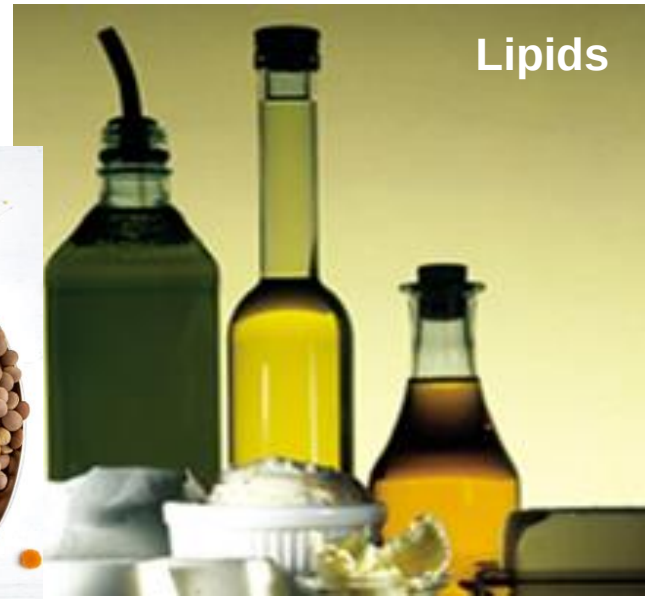
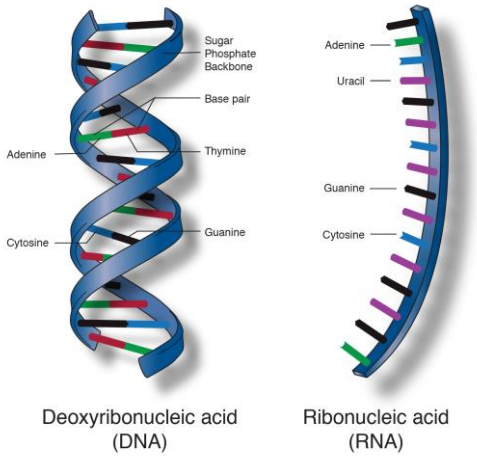
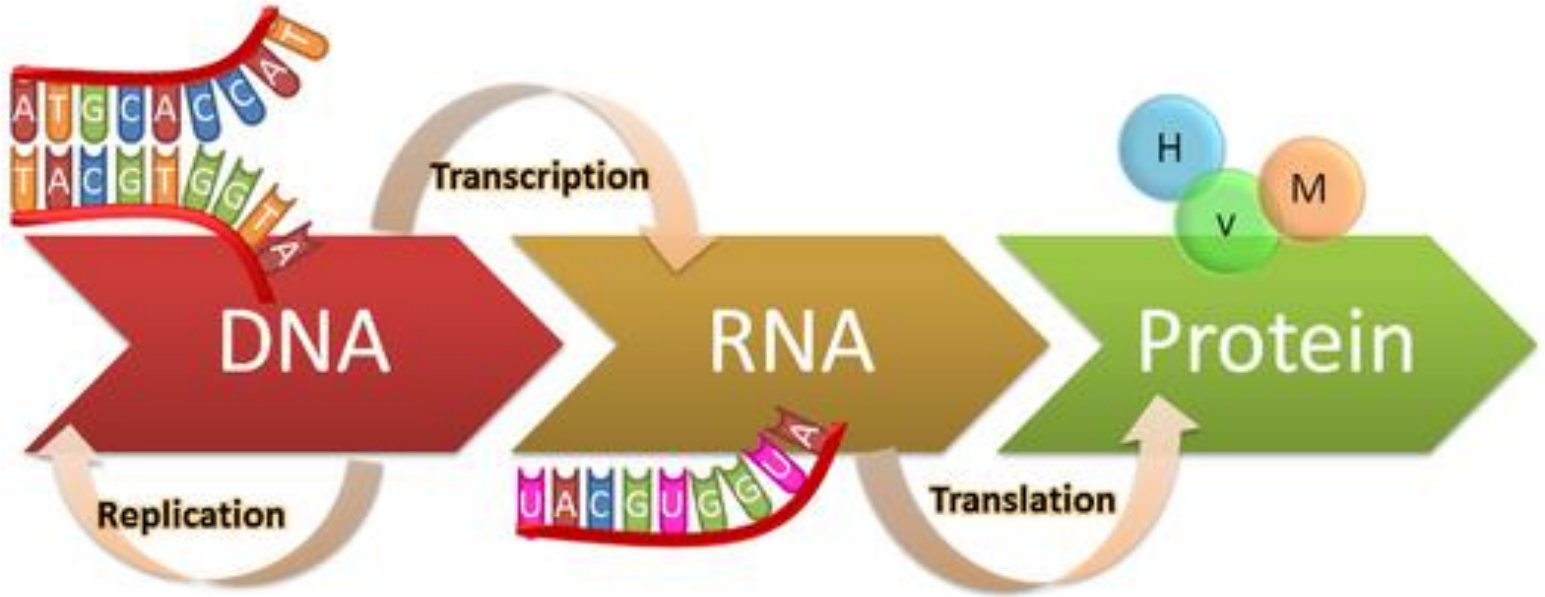
BIOMOLECULES





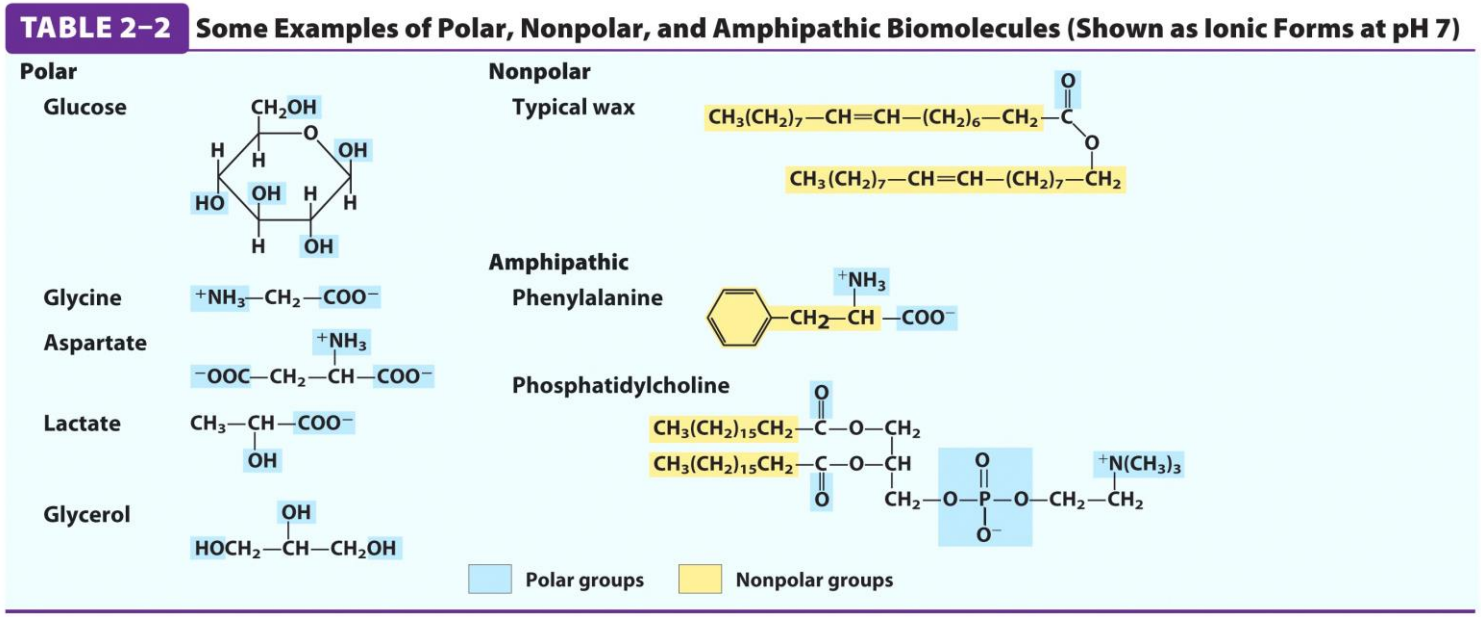
Nucleic acids

CENTRAL DOGMA OF LIFE



WATER

- Polar biomolecules → dissolve easily in water → Hydrophilic.
- Nonpolar biomolecules → do not dissolve appreciably in water → Hydrophobic
- Amphipathic biomolecules have significant amounts of both hydrophilic & hydrophobic structure.



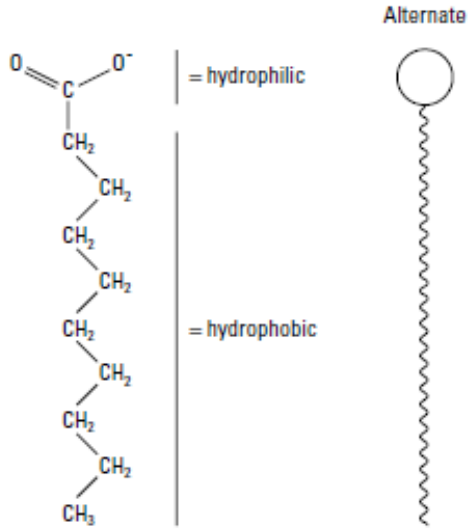


Figure 2-2: Structure of a typical amphipathic (both water-loving and water-hating) molecule.

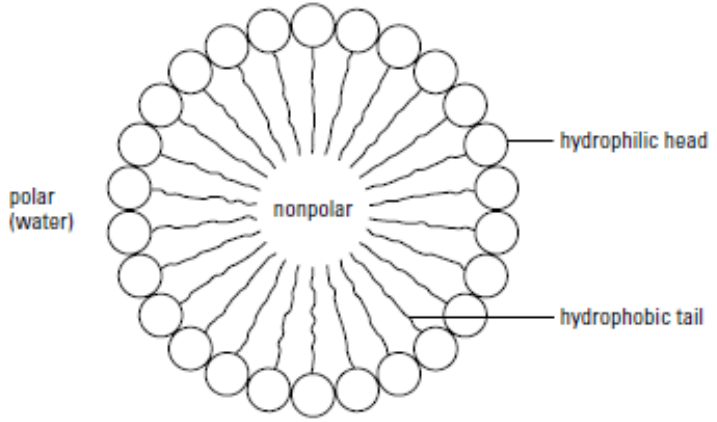
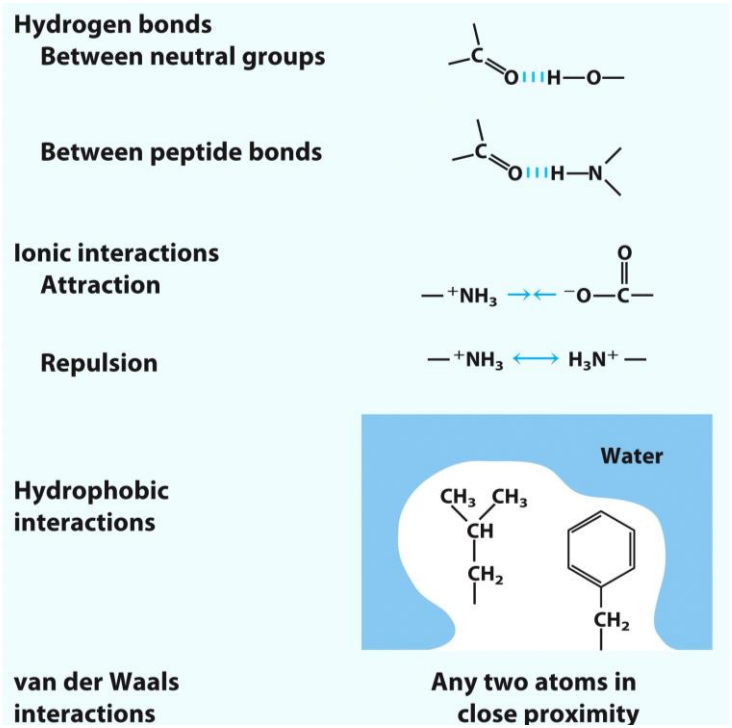


Figure 2-3: Structure of a micelle, composed of amphipathic molecules, with their hydrophilic "heads" pointing "out."

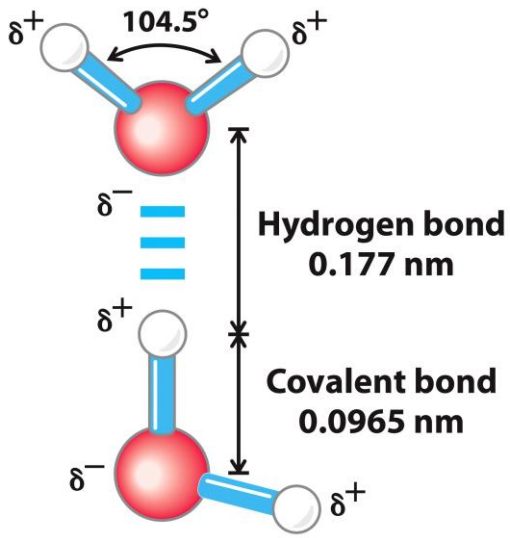
Universal solvent- ionic/ sugar/ alcohol

BONDS

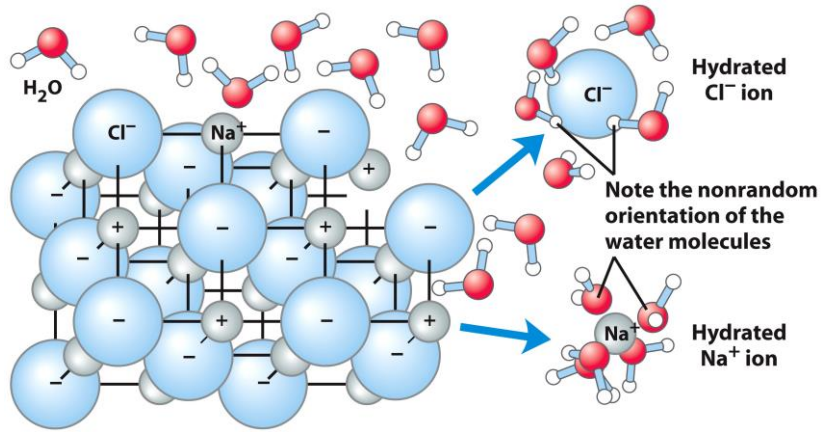
Non-covalent Bonds



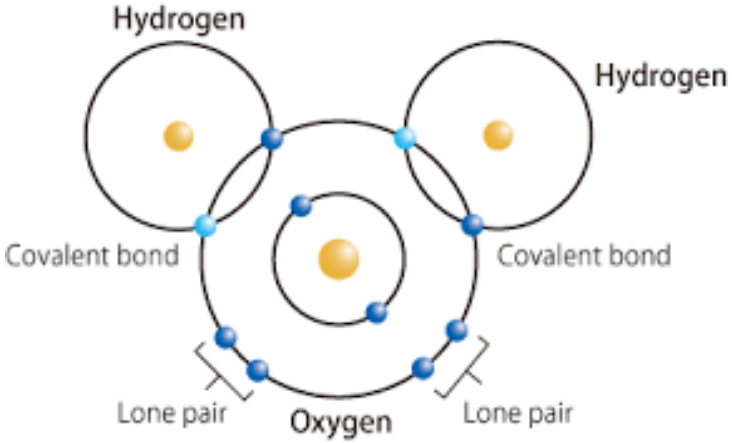
Non-covalent interactions are weak electrical bonds (1-5 kcal/mol) & typically ~100-fold weaker than covalent bonds.



Ionic interactions → between cations and anions.

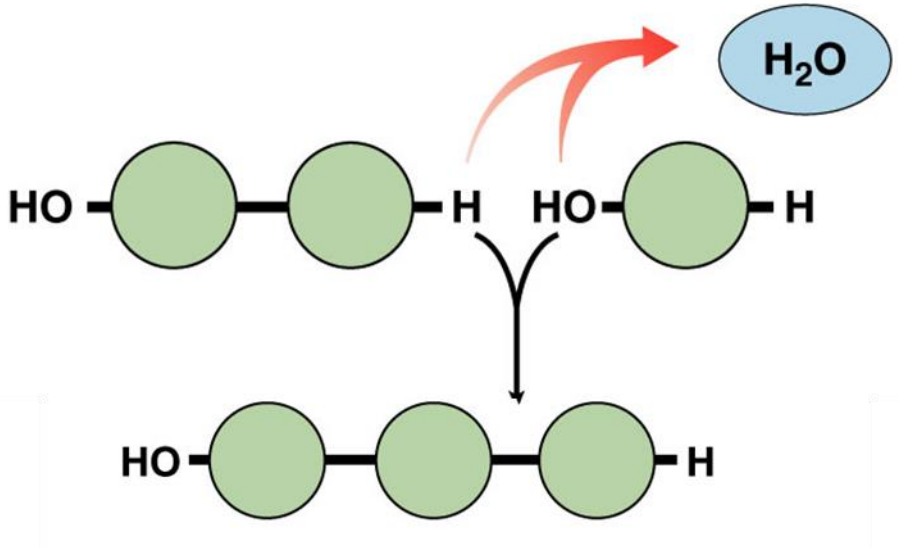


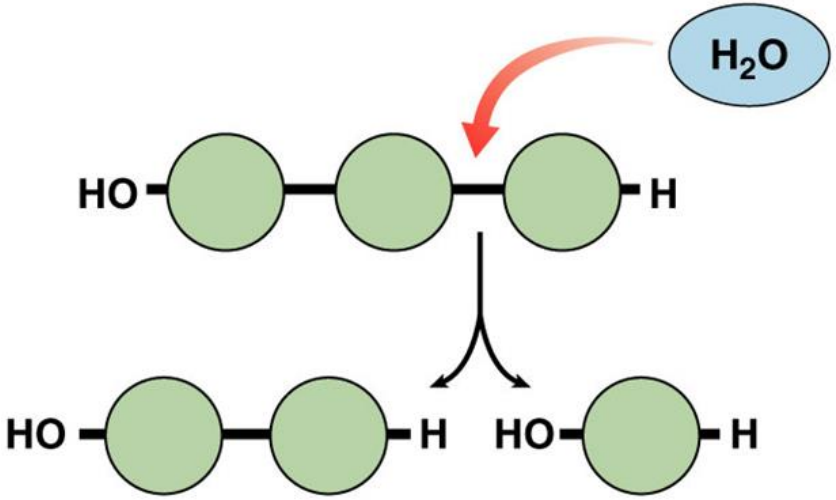
Covalent Bonds



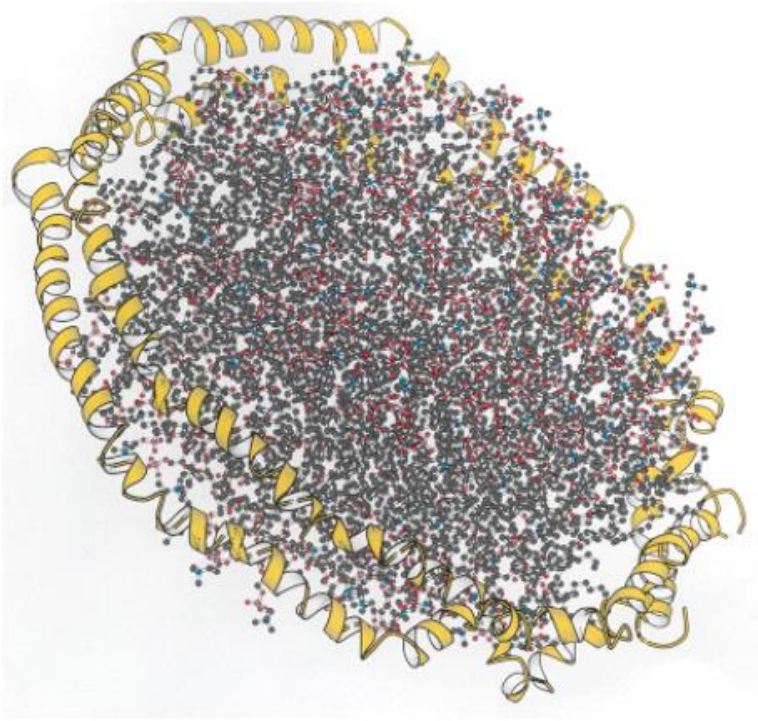
POLYMERS

- Long molecules built by linking together small, similar subunits (monomers)
- Formed by condensation polymerization (dehydration synthesis) → removal of water molecule
- Energy in the form of ATP is required
- Hydrolysis of polymers to monomers → Breaks covalent bond by adding -H/-OH





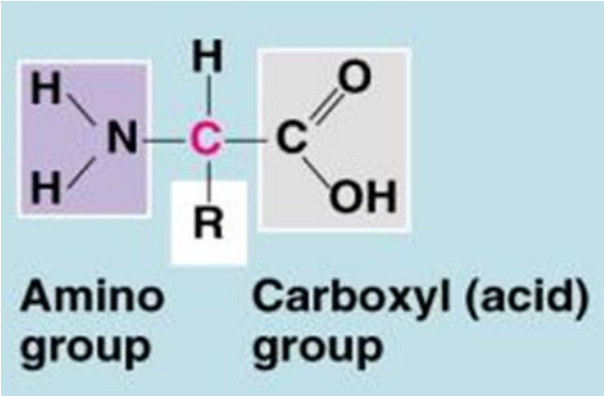
PROTEINS

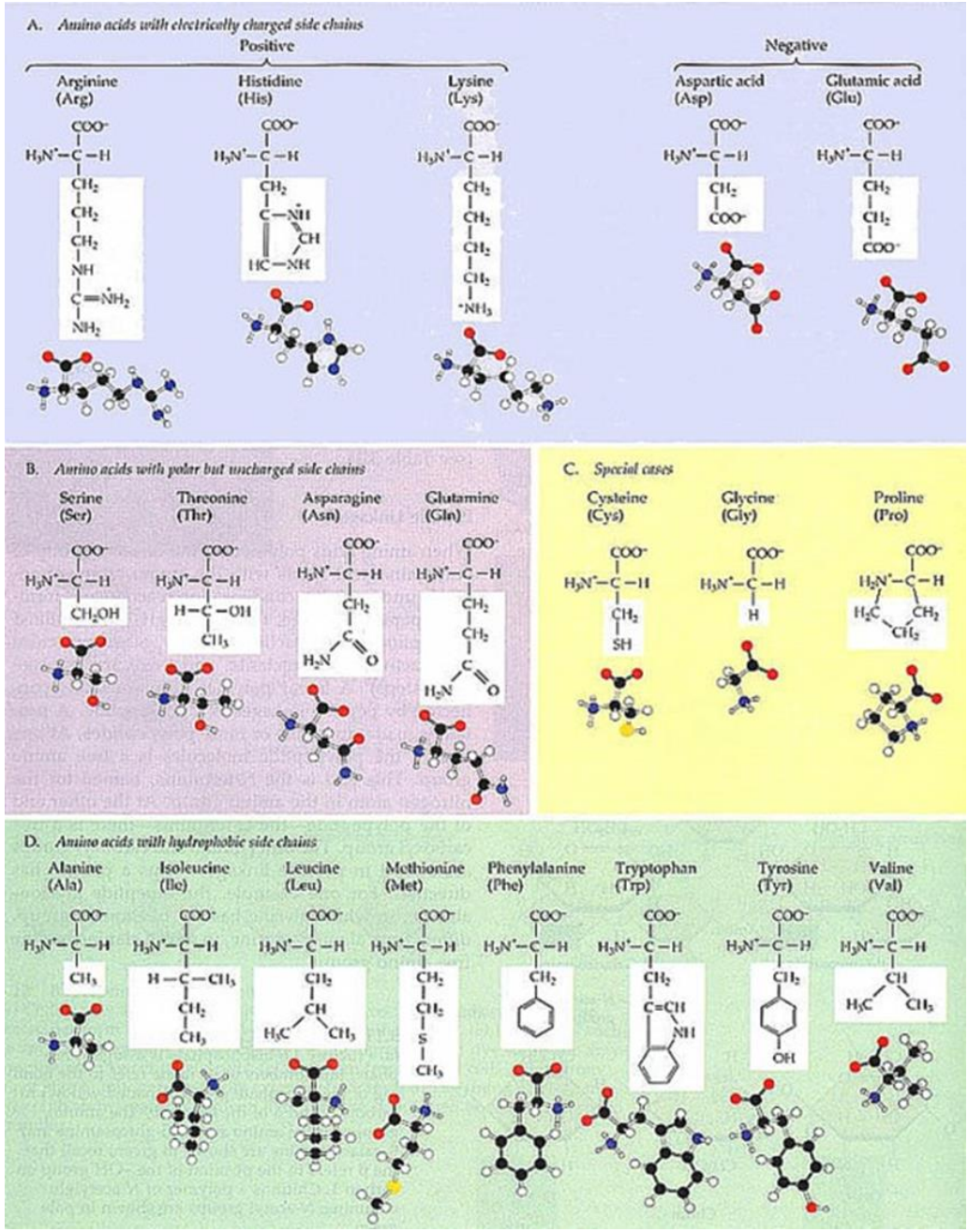


Part of a lipoprotein particle. A model of the structure of apolipoprotein A-I (yellow), shown surrounding sheets of lipids. The apolipoprotein is the major protein component of high-density lipoprotein particles in the blood. These particles are effective lipid transporters because the protein component provides an interface between the hydrophobic lipid chains and the aqueous environment of the bloodstream. [Based on coordinates provided by Stephen Harvey.]

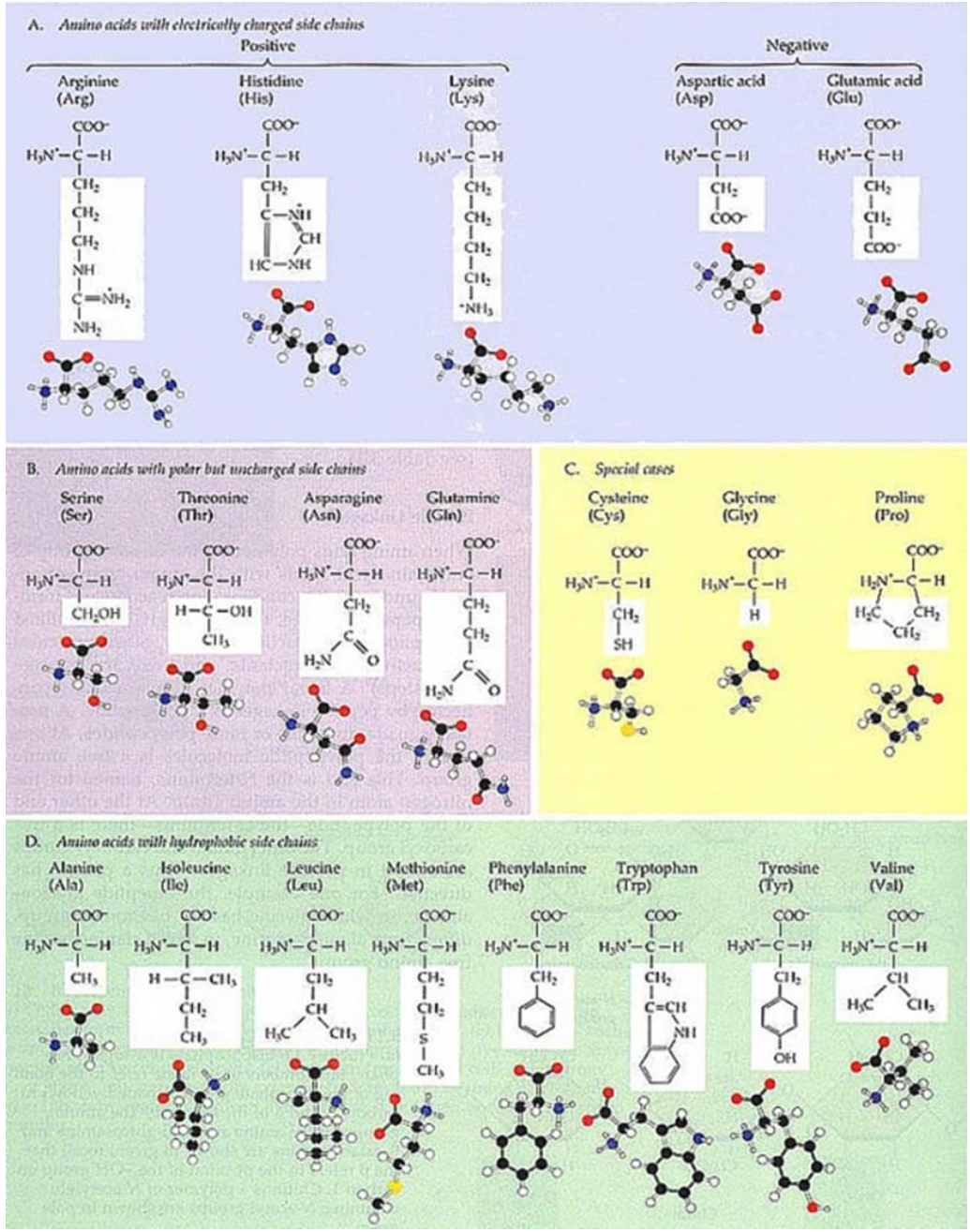
PROTEINS

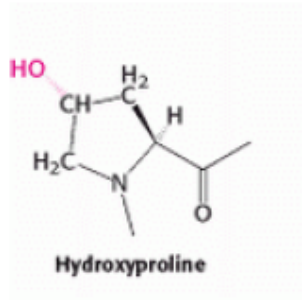
- Macromolecules formed from amino acids
- 20 naturally occurring AA's
- R= side group → determines the chemical properties

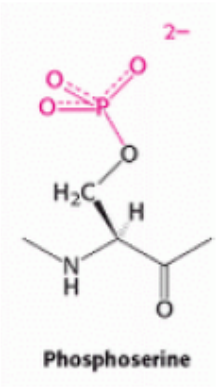




PROTEINS

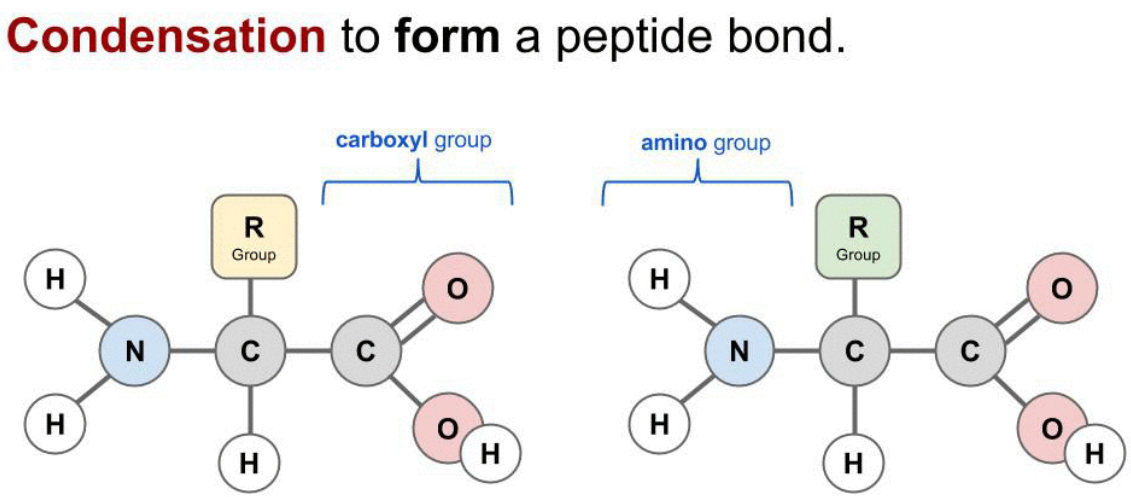

A. Amino acids with electrically charged side chains
Positive
Negative
Arginine (Arg)
Histidine (His)
Lysine (Lys)
Aspartic acid (Asp)
Glutamic acid (Glu)
B. Amino acids with polar but uncharged side chains
Serine (Ser)
Threonine (Thr)
Asparagine (Asn)
Glutamine (Gln)
C. Special cases
Cysteine (Cys)
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)


HO
Hydroxyproline


2−
Phosphoserine

PEPTIDE BONDS

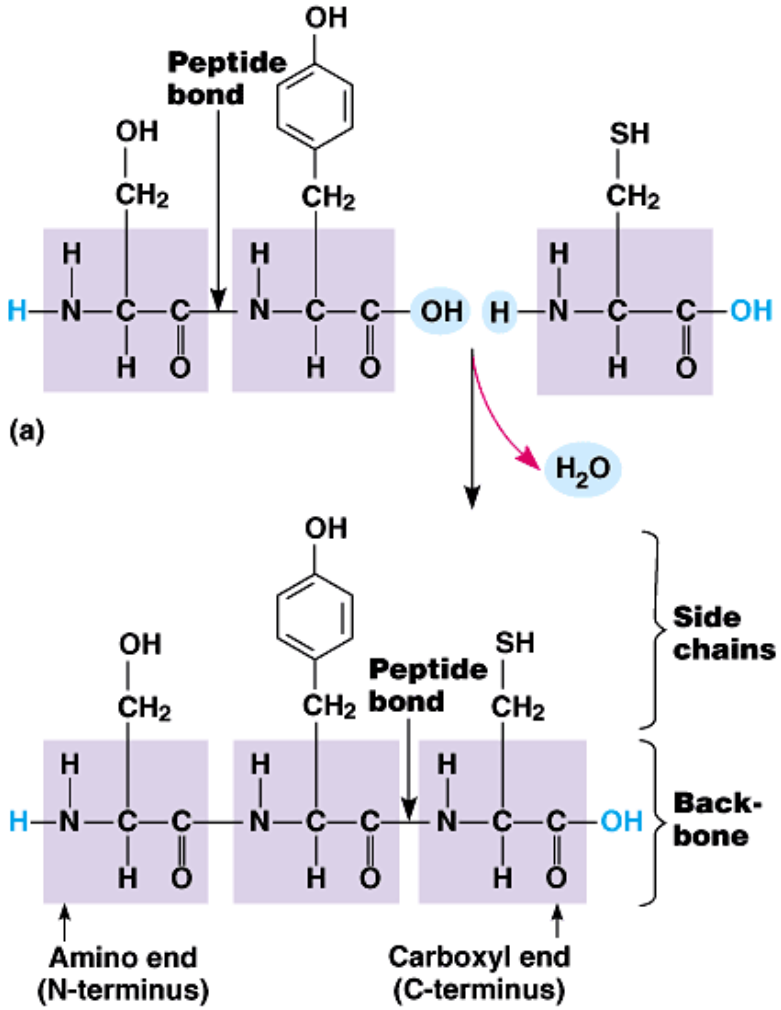
- Peptide Bond is formed by condensation of two AA's to form a peptide bond



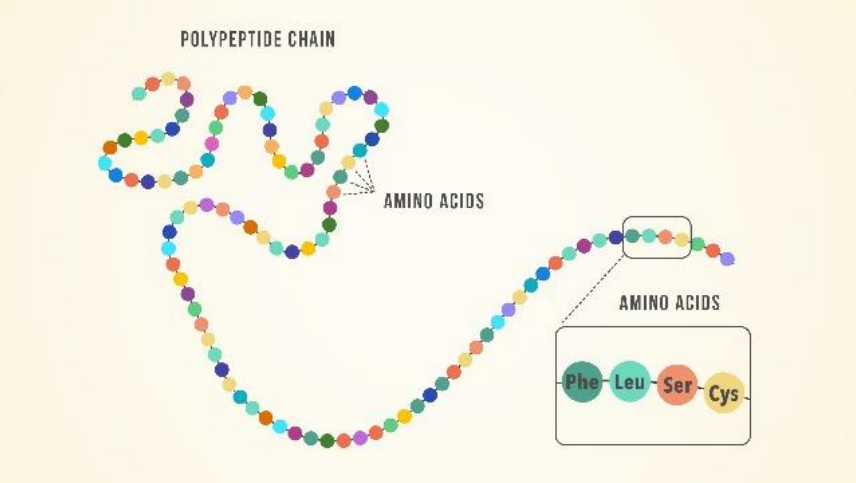
amino acid + amino acid → dipeptide + water

PEPTIDE BONDS

- Peptide Bond is formed by condensation of two AA's to form a peptide bond



POLYPEPTIDE- PRIMARY STRUCTURE



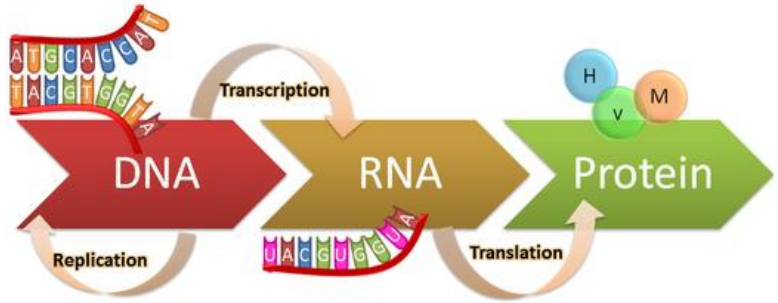
Primary Structure- Polypeptide

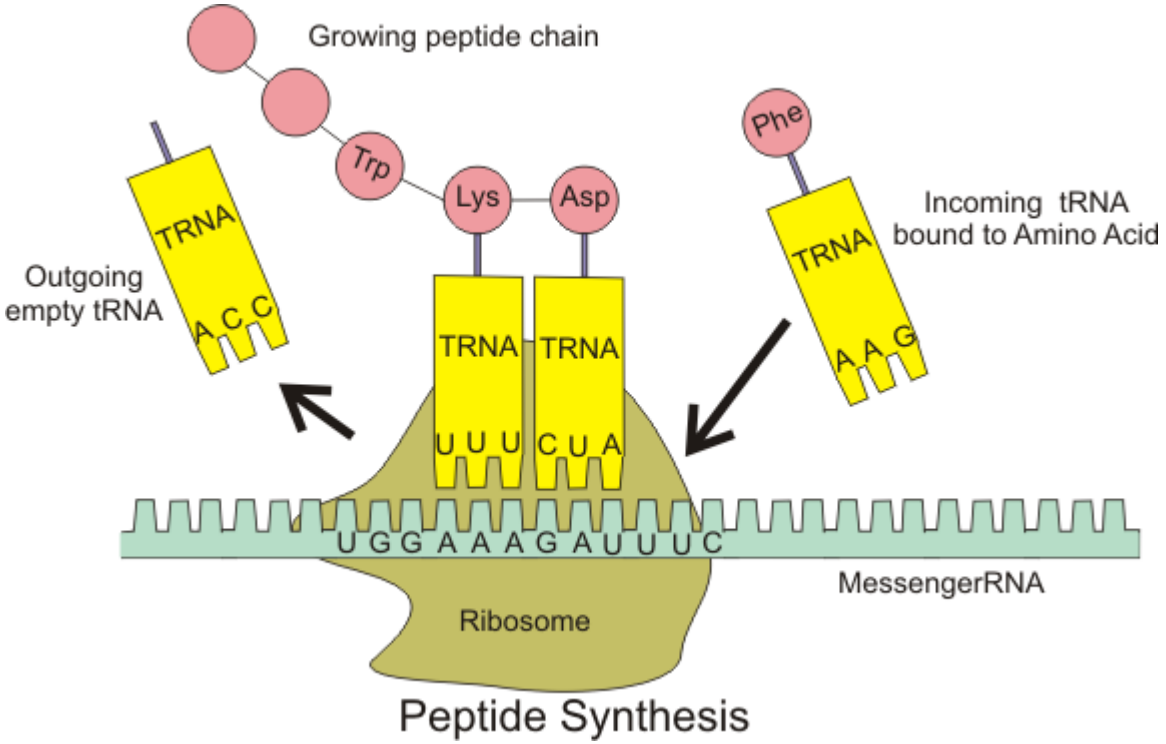
- The first AA – N-terminal
- Last AA- C-terminal
- N→C (Start → End)
- Usually ~50 AA → Polypeptide

- Average Molecular Weight (MW) of 1AA = 128 Dalton (Da)
- Peptide bond formation eliminates H20 (MW= 18Da)
- So each AA addition = 128-18 → 110 Da

What will be the MW of a protein formed of 50 amino acids?

POLYPEPTIDE



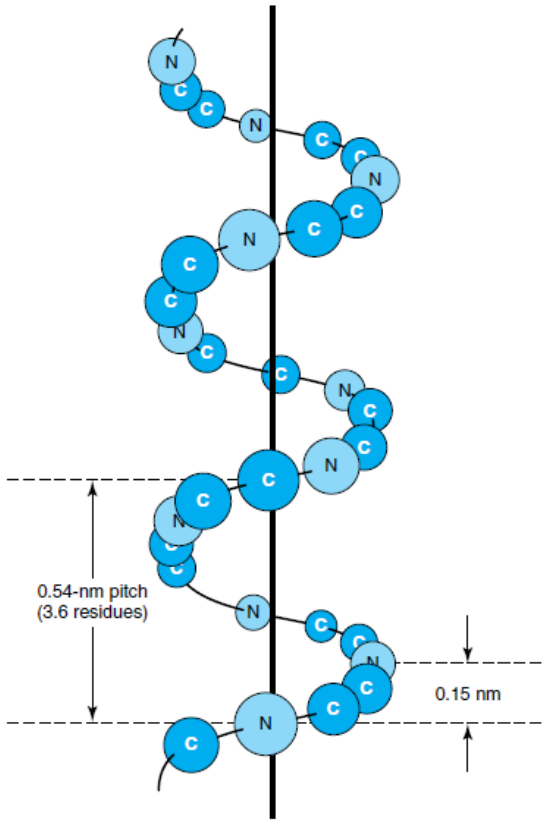


- AA sequence dictated by DNA
- Who makes polypeptides in cells?

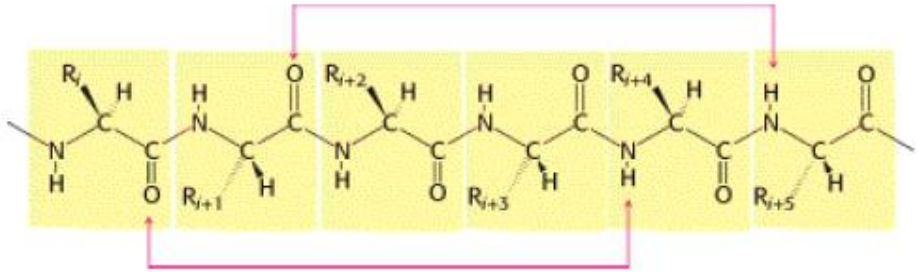
- Ribosome, a cell organelle

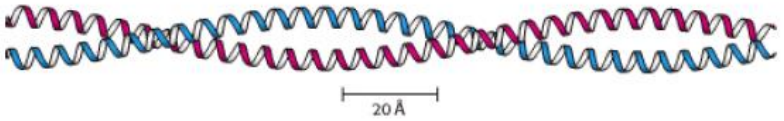
POLYPEPTIDE- SECONDARY STRUCTURE

α-Helix



n+4



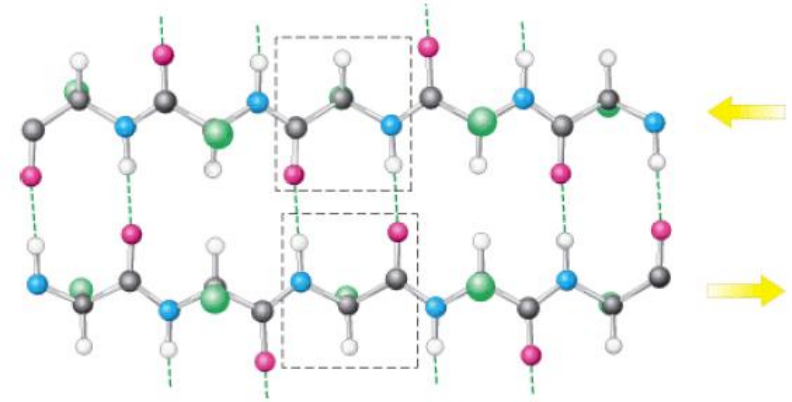


Keratin (hair/ claws)

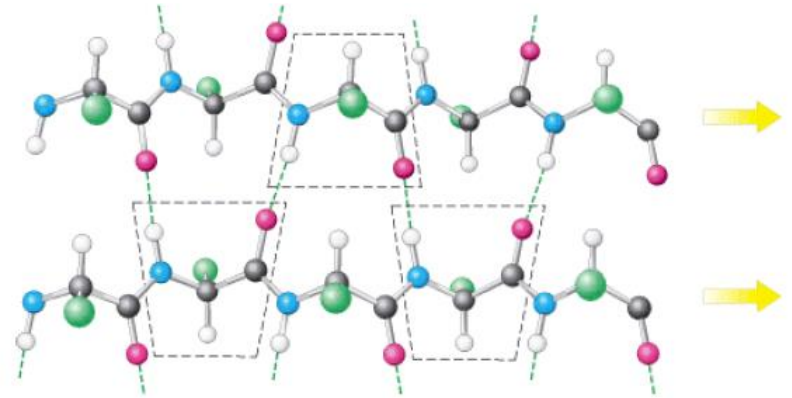
POLYPEPTIDE- SECONDARY STRUCTURE

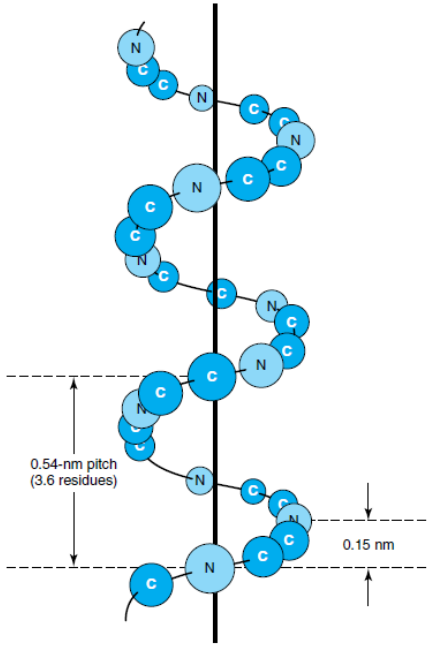
β-sheet

Anti-Parallel



Parallel





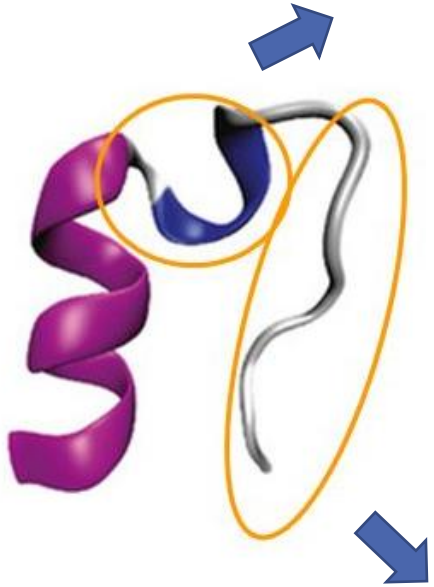
Length/ AA-
α-helix: 0.15nm
β-sheet: 0.35nm

What would be the lengths of A-helix and linear secondary structures formed by a 10AA chain?

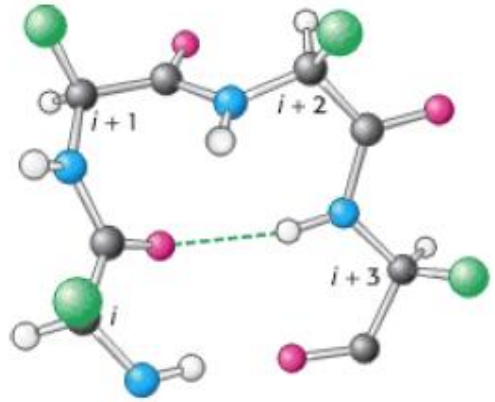
POLYPEPTIDE- SECONDARY STRUCTURES

Alpha helix

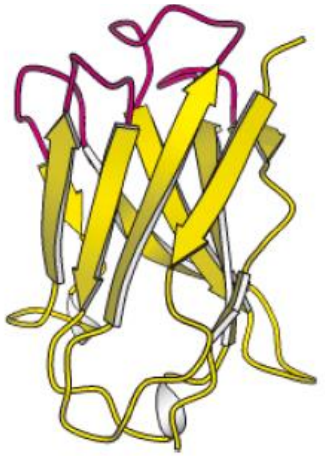
Beta strand (sheet)



Anything else – turn/loop

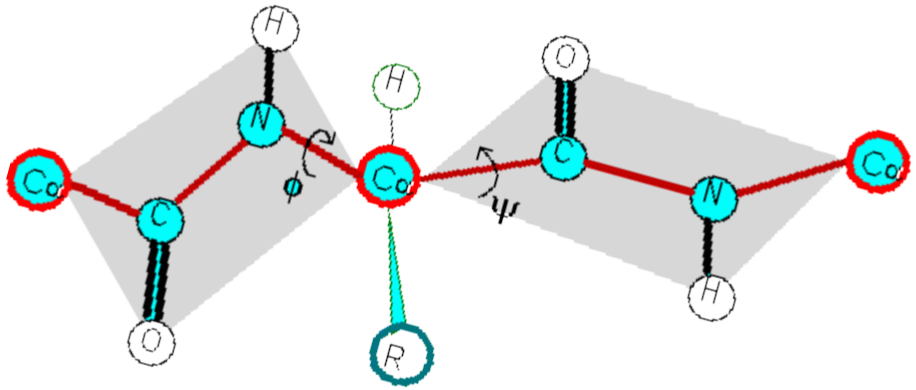


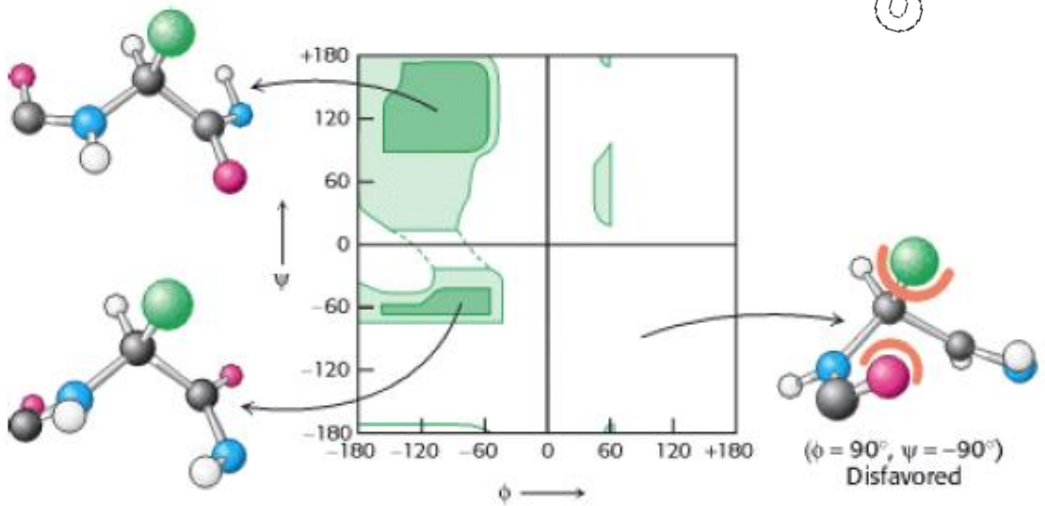
Turn

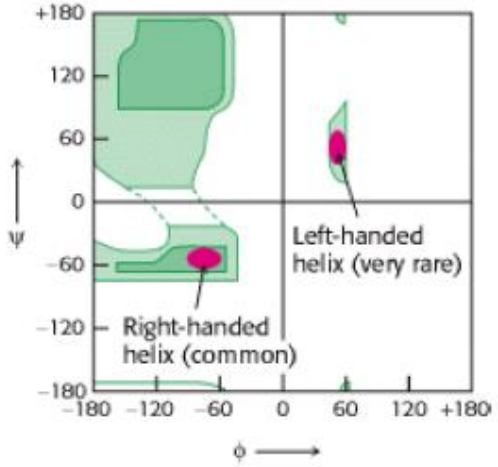


Loop

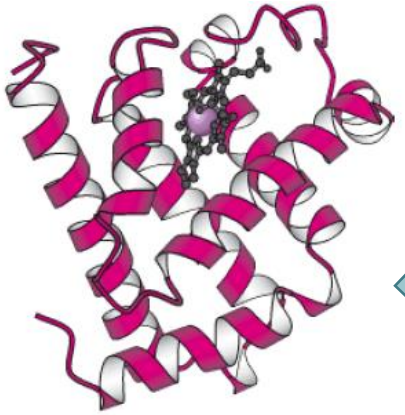
RAMACHANDRAN PLOT







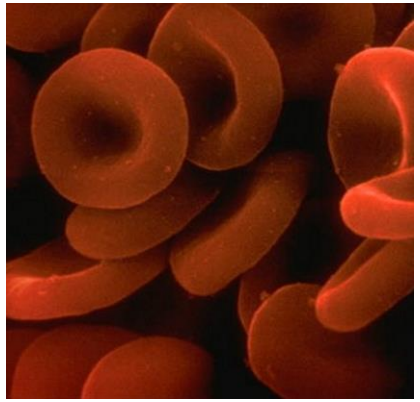
STRUCTURE LEVELS

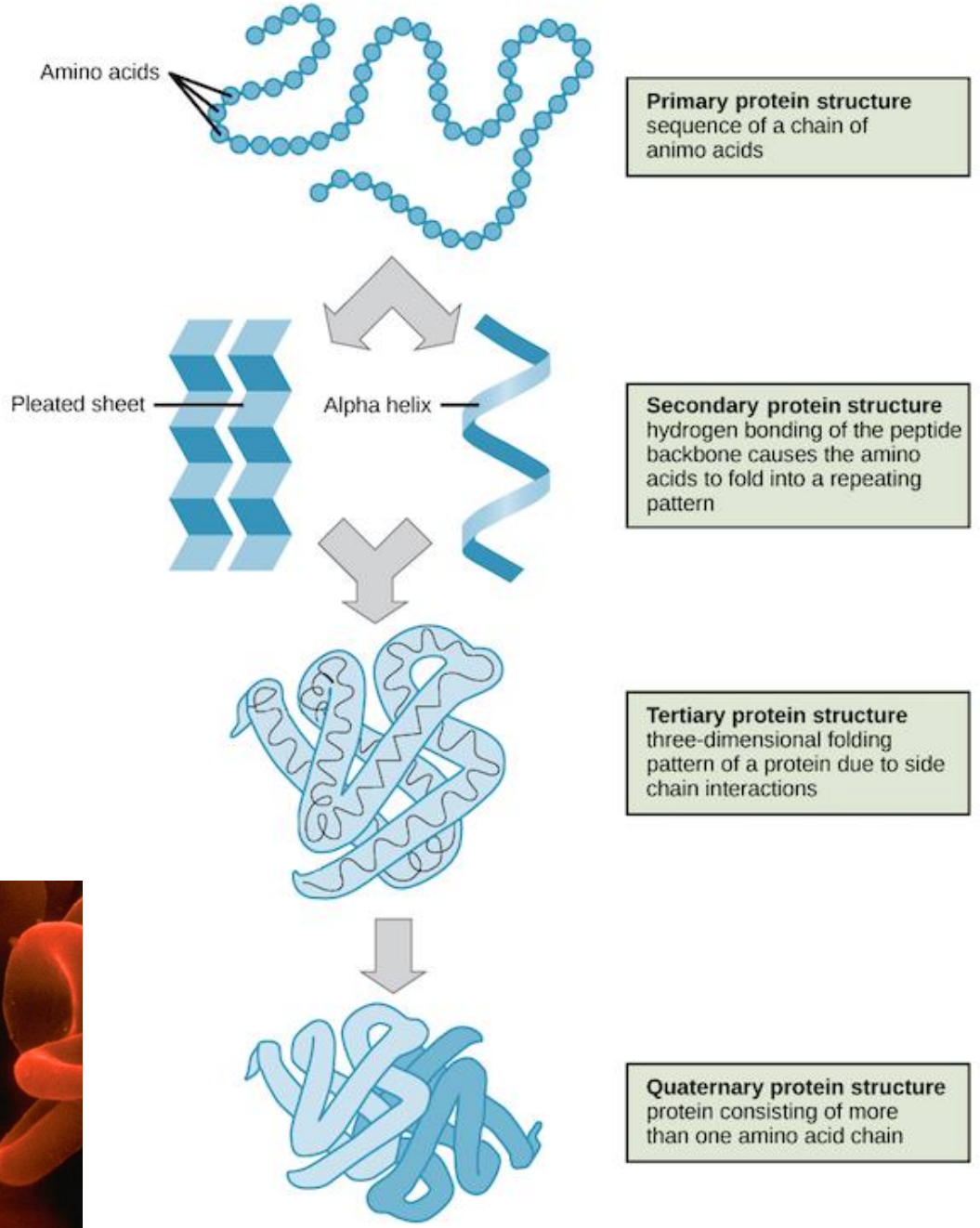


Tertiary Structure

Black- Heme
Purple- Iron

Quaternary Structure





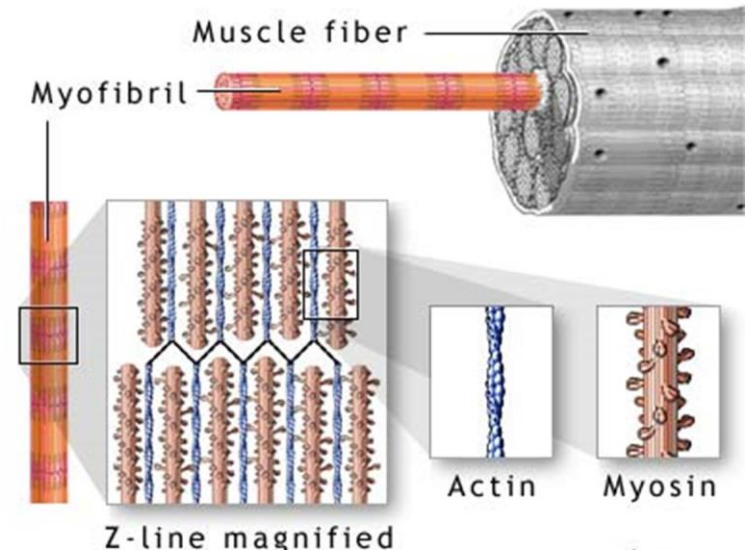
Primary protein structure
sequence of a chain of animo acids

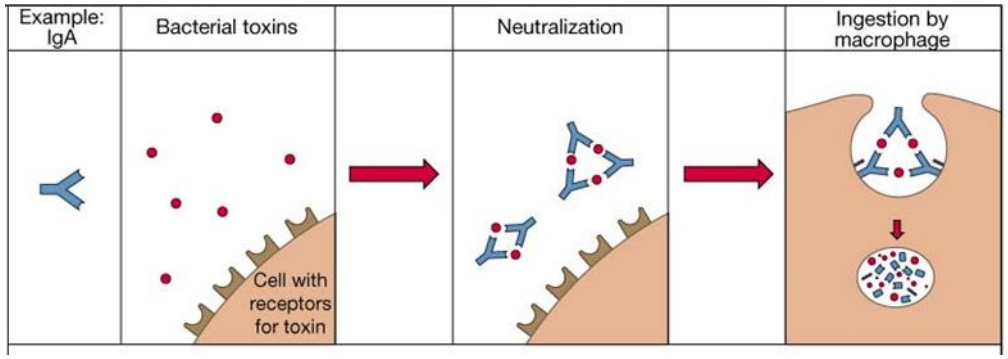
Secondary protein structure
hydrogen bonding of the peptide backbone causes the amino acids to fold into a repeating pattern

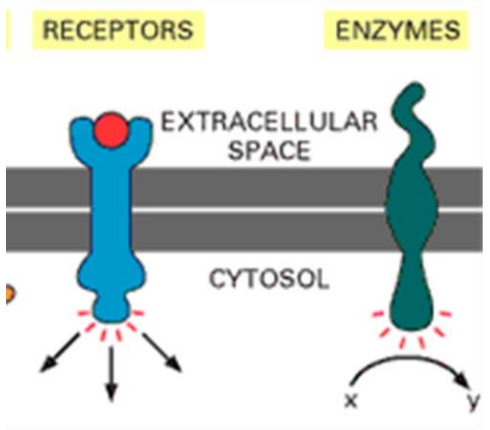
Tertiary protein structure
three-dimensional folding pattern of a protein due to side chain interactions

Quaternary protein structure
protein consisting of more than one amino acid chain

REAL LIFE

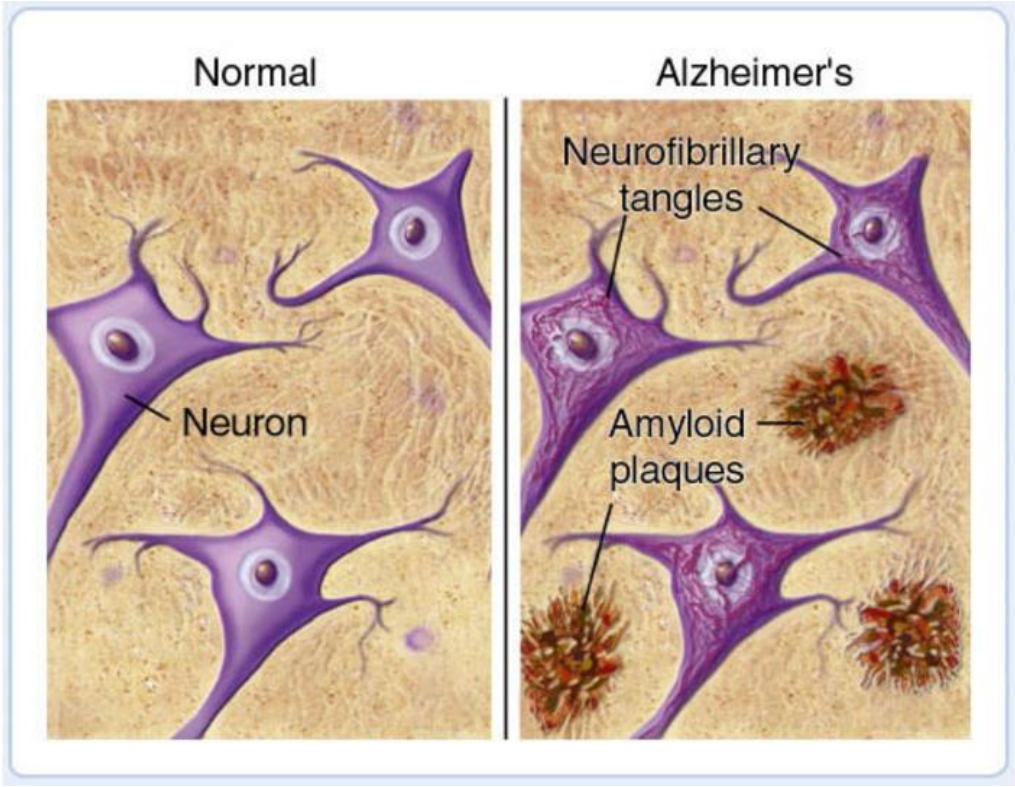

Muscle fiber
Myofibril
Actin
Myosin
Z-line magnified


Example: IgA
Bacterial toxins
Neutralization
Ingestion by macrophage
Cell with receptors for toxin

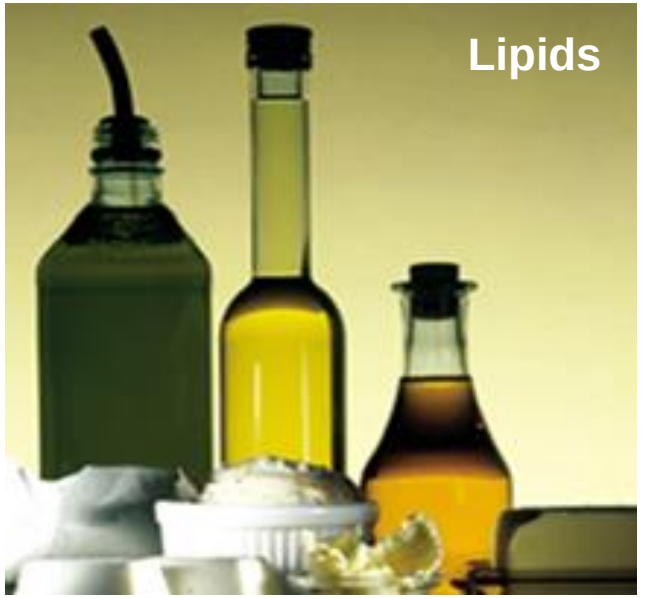

RECEPTORS
ENZYMES
EXTRACELLULAR SPACE
CYTOSOL
x
y

REAL LIFE

In Alzheimer's disease patients, levels of β-amyloid become elevated, and this protein undergoes a conformational transformation from a soluble a-helix–rich state to a state rich in β–sheet and prone to self-aggregation.

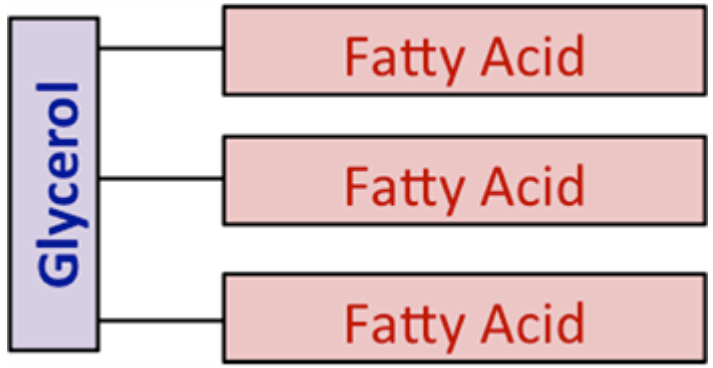


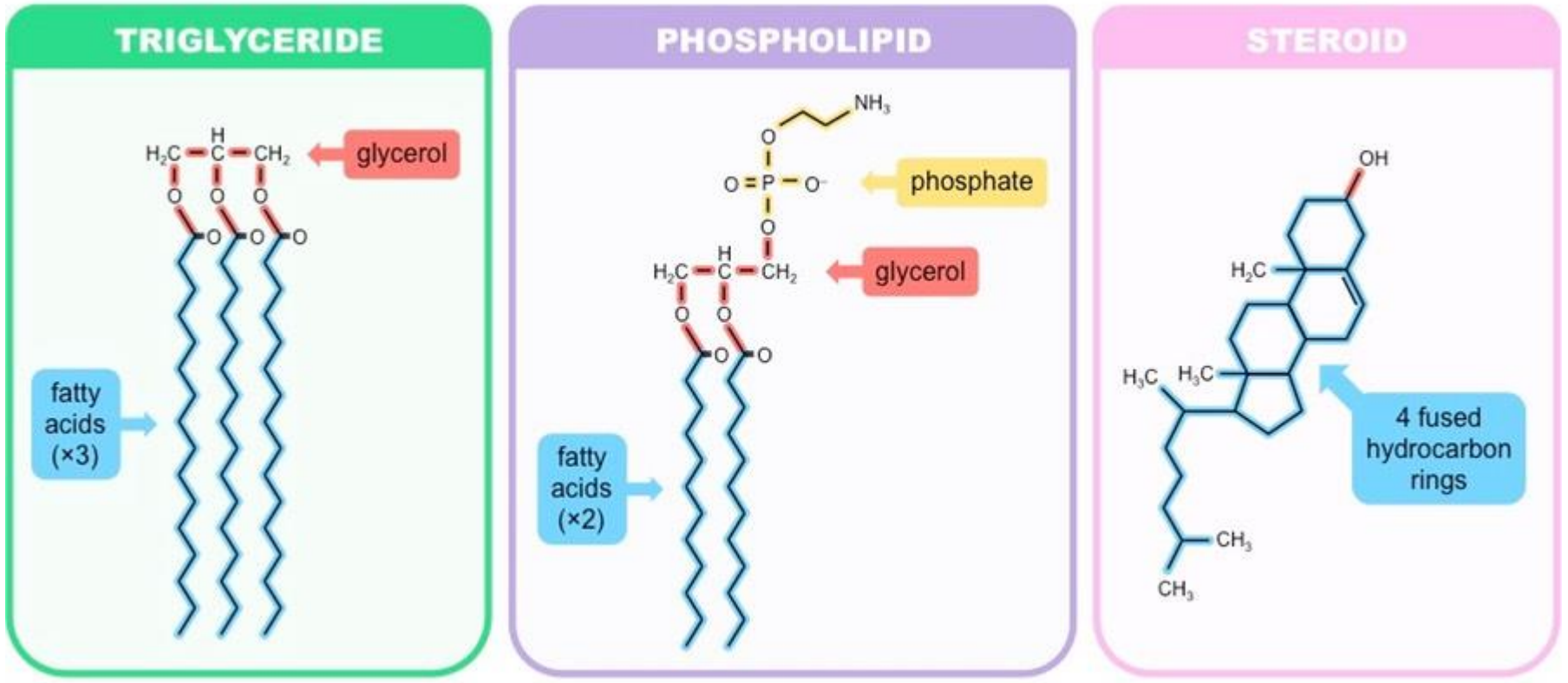
LIPIDS



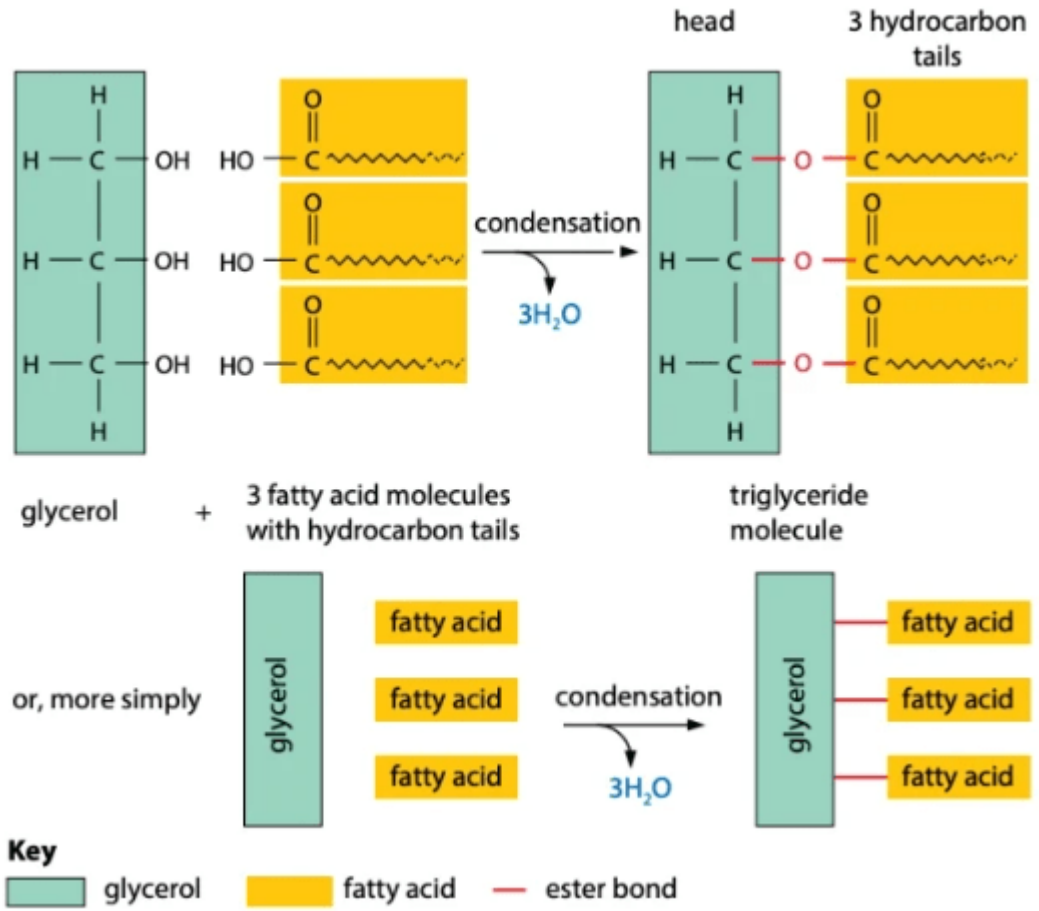
- Metabolic fuel- storage & transport
- Structural components of membranes
- Outer coating in animals
- Pigments – carotene (carrots)
- Cofactors- Vitamin K
- Hormones- Vitamin D derivatives
- Thromboxanes- blood clotting
- Prostaglandins- short range messengers

LIPIDS


Glycerol
Fatty Acid
Fatty Acid
Fatty Acid

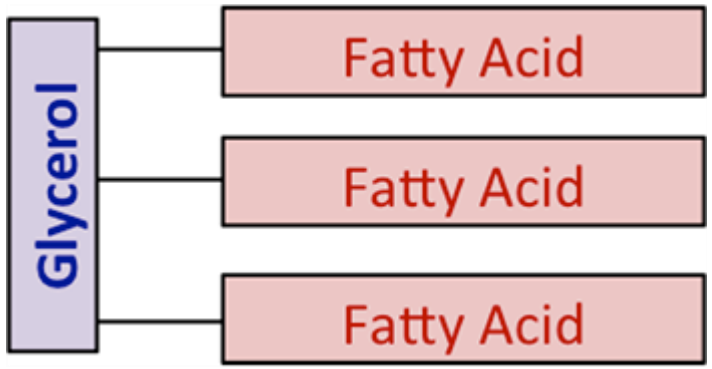

TRIGLYCERIDE
glycerol
fatty acids (×3)
PHOSPHOLIPID
phosphate
glycerol
fatty acids (×2)
STEROID
4 fused hydrocarbon rings

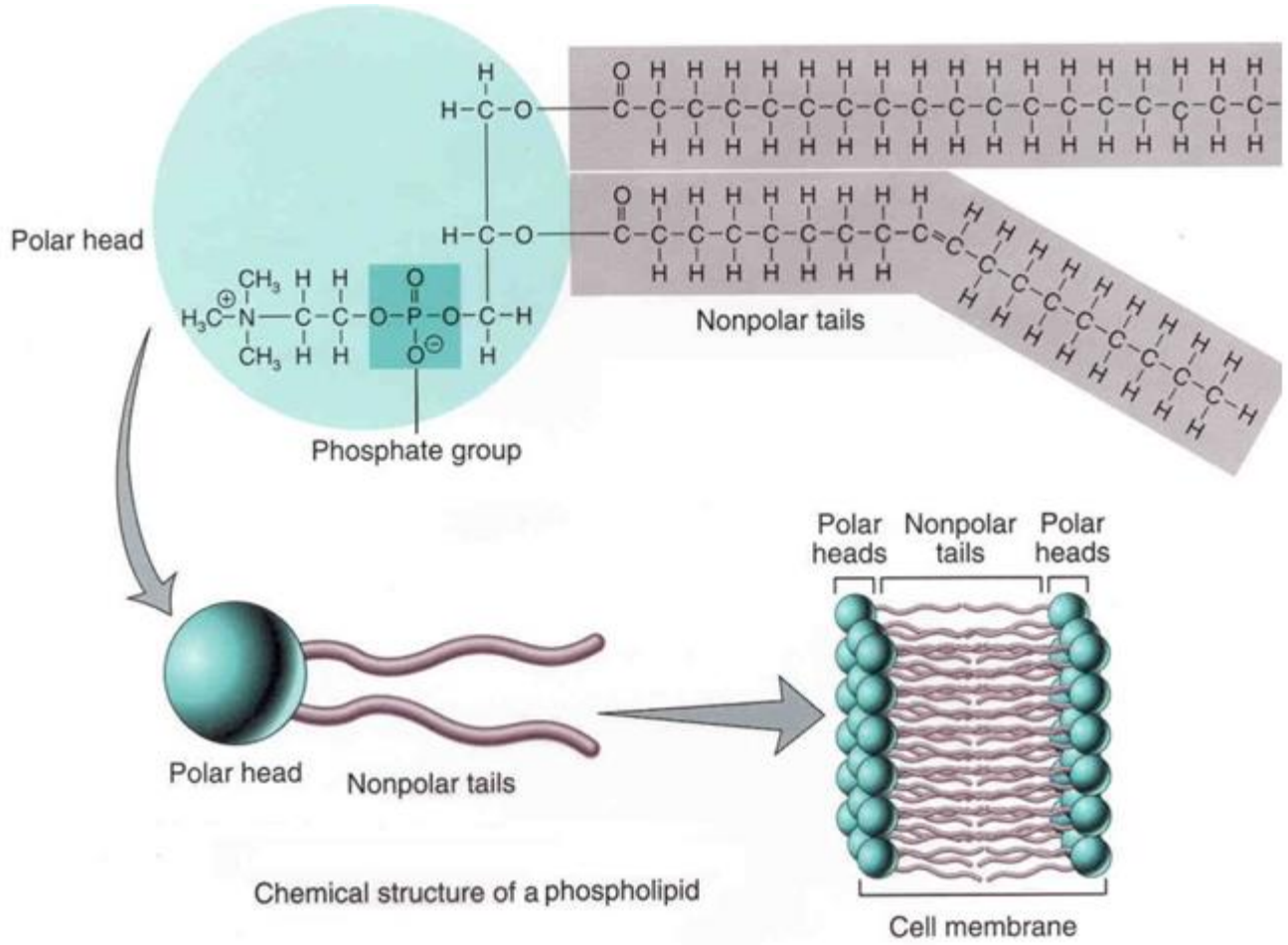
TRIGLYCERIDE FORMATION



1 Glycerol and 3 fatty acid molecules react to form a Triglyceride

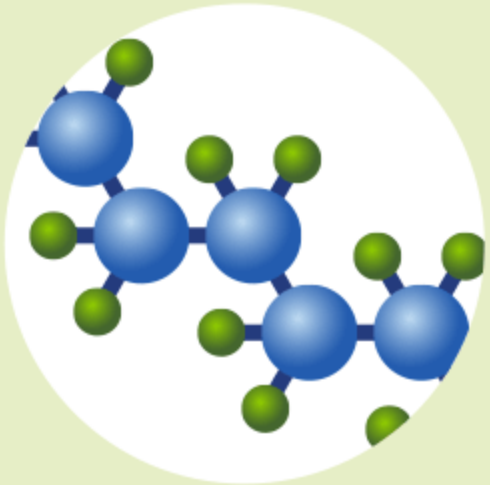
LIPIDS


Glycerol
Fatty Acid
Fatty Acid
Fatty Acid


Polar head
Phosphate group
Nonpolar tails
Polar head
Nonpolar tails
Chemical structure of a phospholipid
Polar heads
Nonpolar tails
Polar heads
Cell membrane

LIPIDS

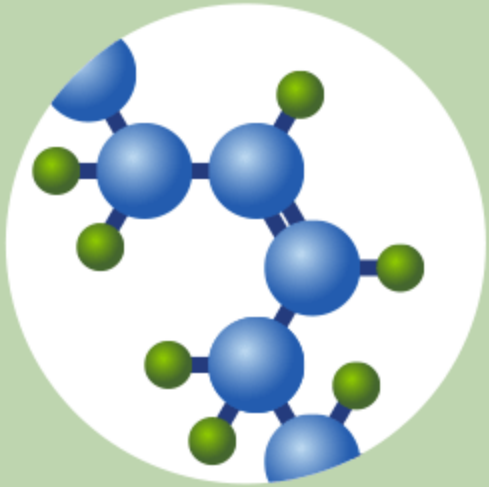
SATURATED FATS



SINGLE BONDS BETWEEN CARBONS

MAINLY SOLID AT ROOM TEMPERATURE

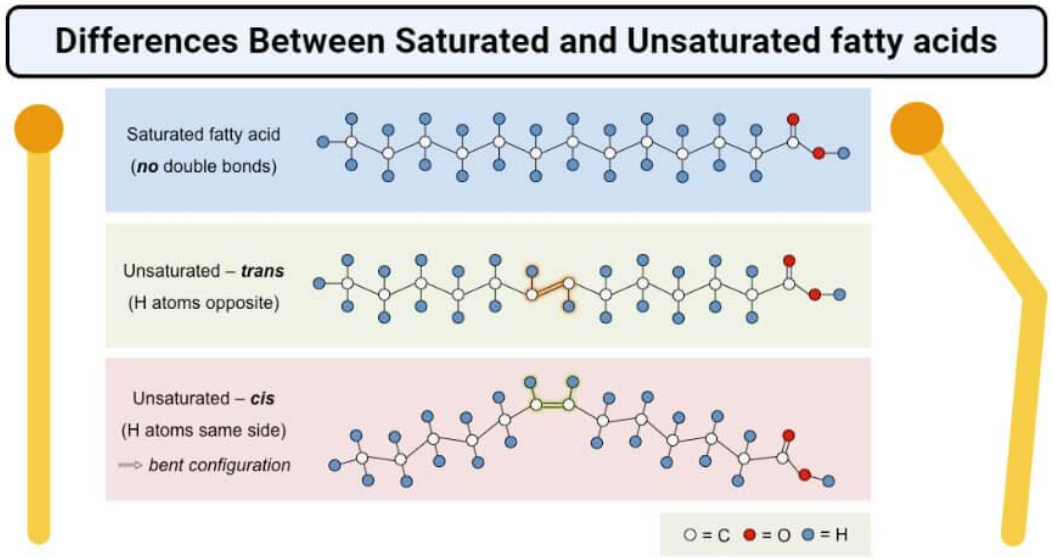
UNSATURATED FATS

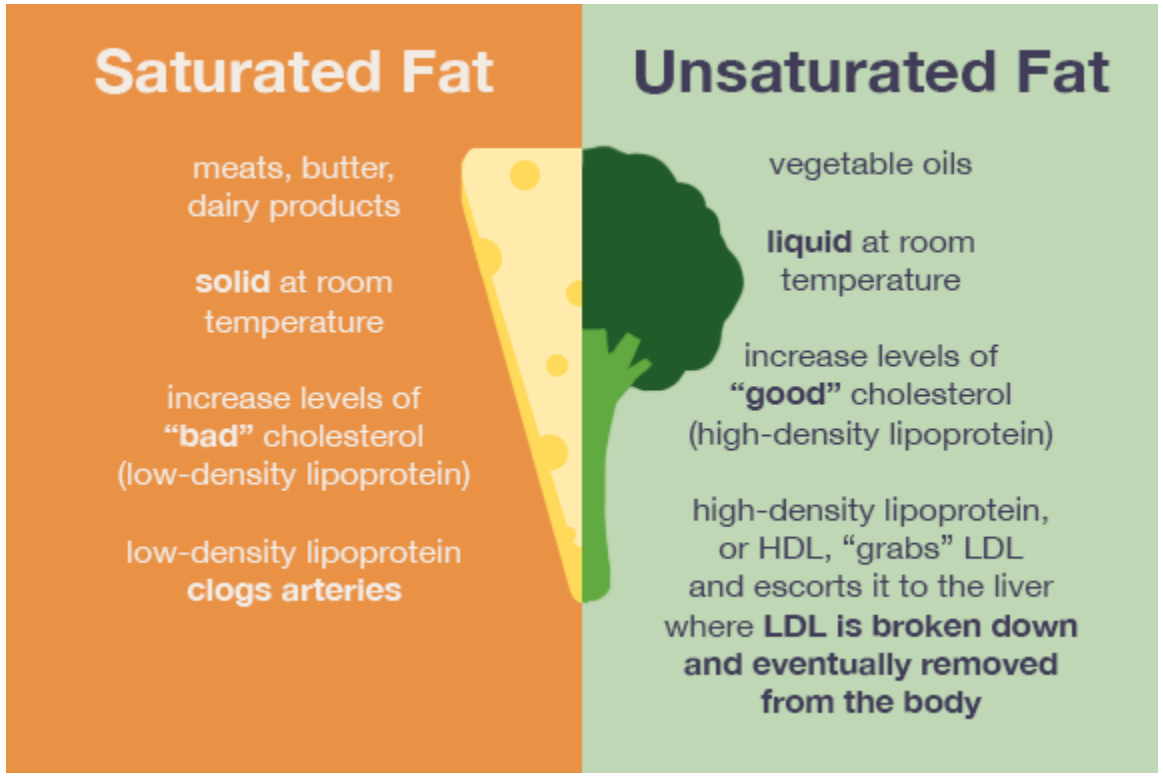


ONE OR MORE DOUBLE BONDS BETWEEN CARBONS

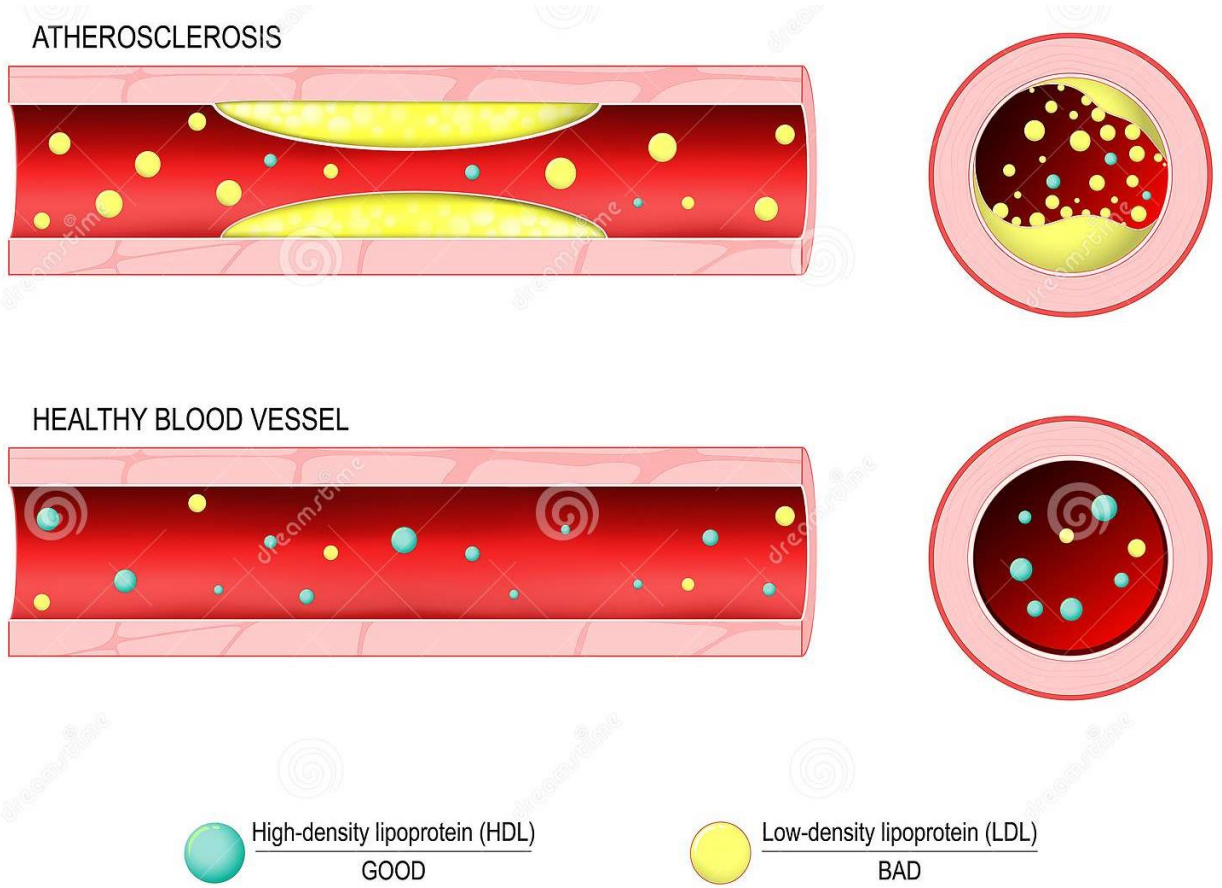
MAINLY LIQUID AT ROOM TEMPERATURE

LIPIDS

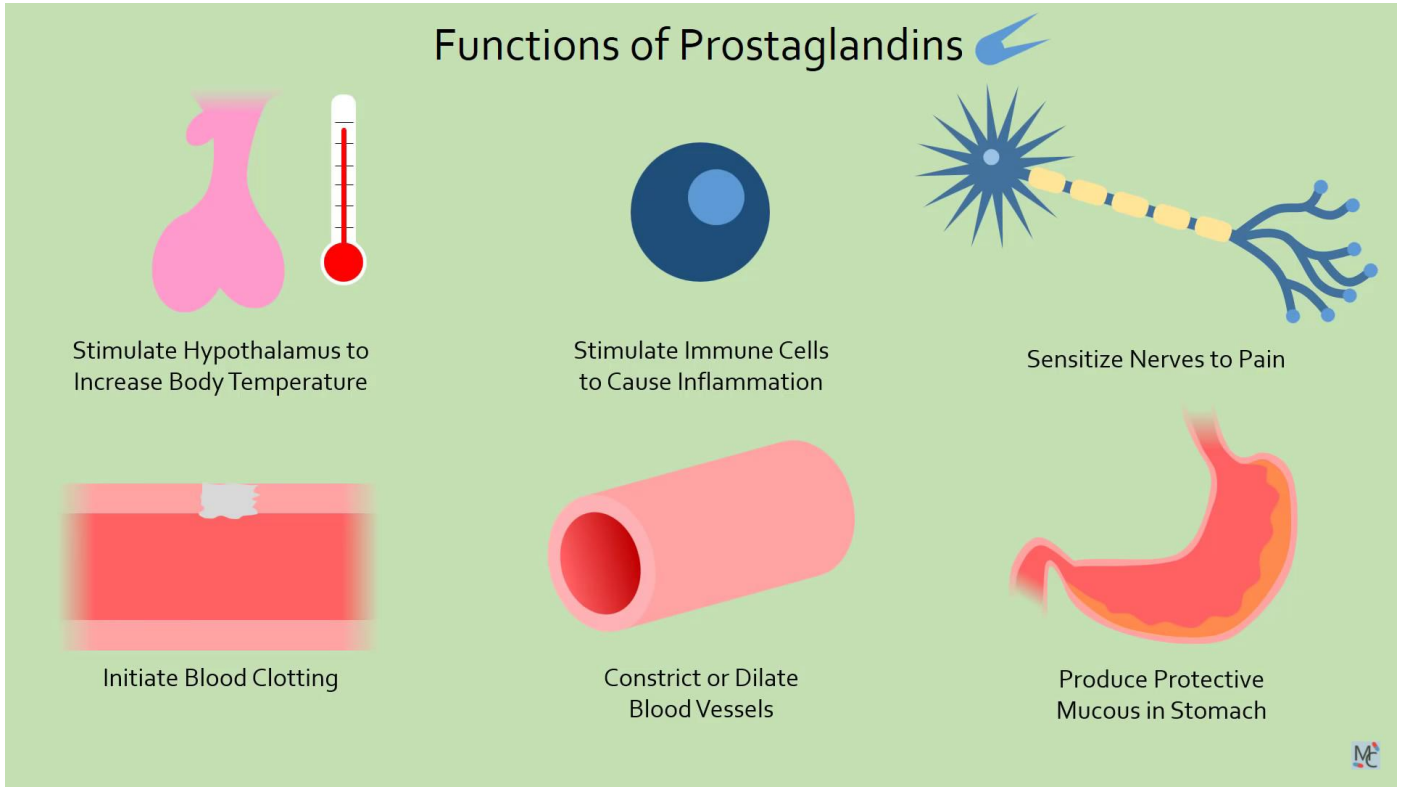

Differences Between Saturated and Unsaturated fatty acids
Saturated fatty acid
(no double bonds)
Unsaturated – trans
(H atoms opposite)
Unsaturated – cis
(H atoms same side)
bent configuration
○ = C ● = O ● = H


Saturated Fat
meats, butter, dairy products
solid at room temperature
increase levels of "bad" cholesterol (low-density lipoprotein)
low-density lipoprotein clogs arteries
Unsaturated Fat
vegetable oils
liquid at room temperature
increase levels of "good" cholesterol (high-density lipoprotein)
high-density lipoprotein, or HDL, "grabs" LDL and escorts it to the liver where LDL is broken down and eventually removed from the body

GOOD VS BAD CHOLESTEROL

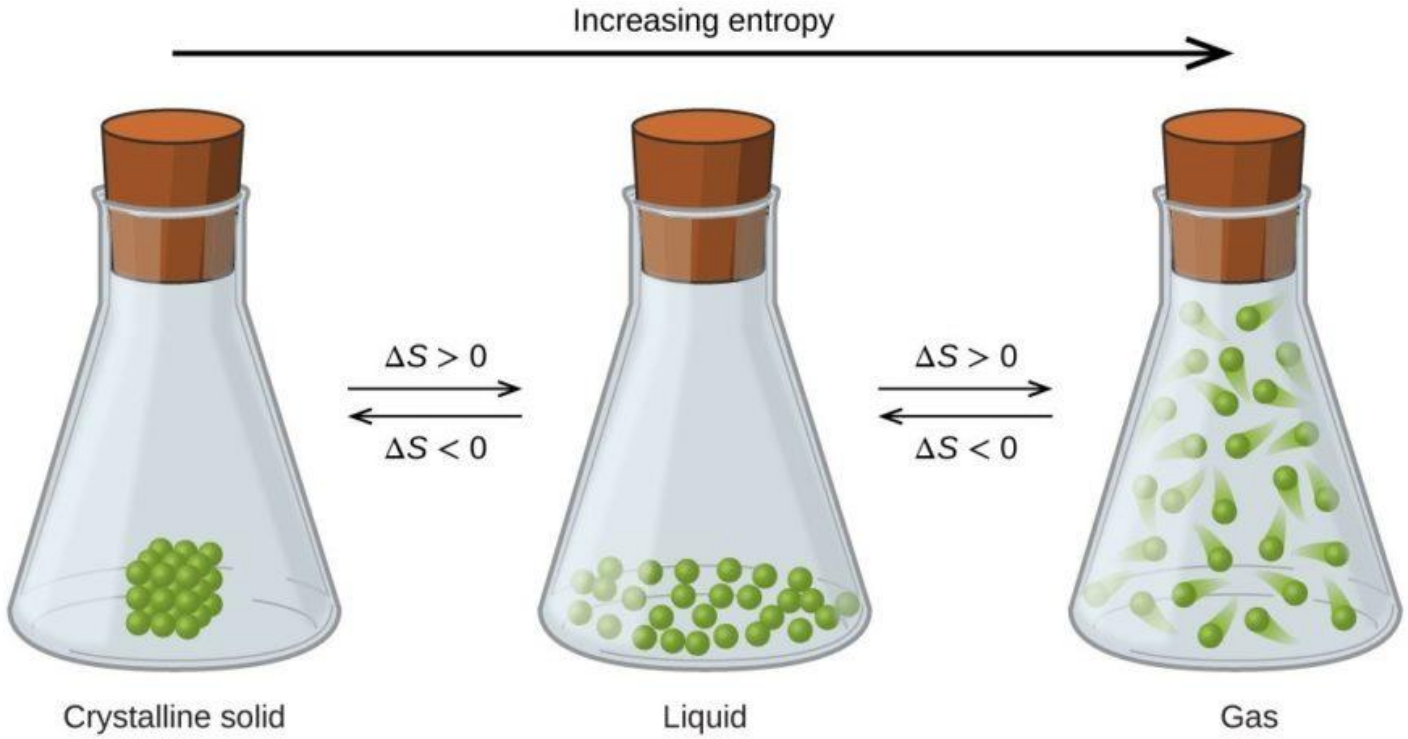


PROSTAGLANDINS



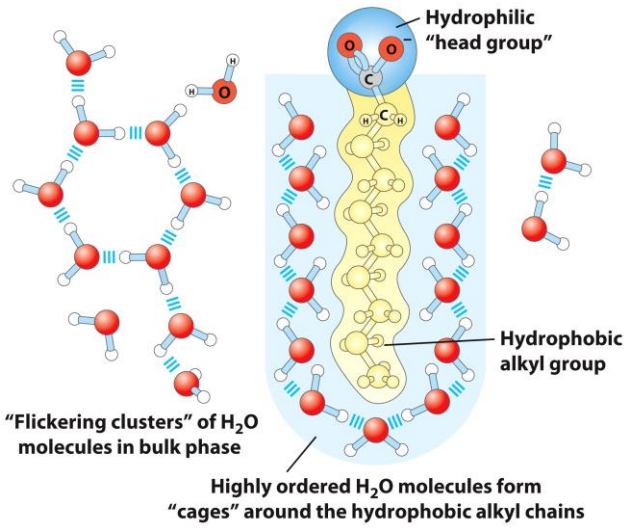
Aspirin → Pain reliever (analgesic)
→ Reduces fever (antipyretic)

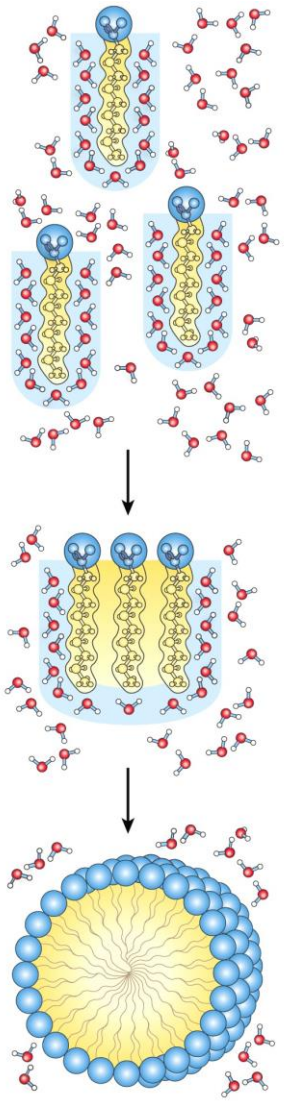
ENTROPY


Increasing entropy
ΔS > 0
ΔS < 0
ΔS > 0
ΔS < 0
Crystalline solid
Liquid
Gas

HYDROPHOBIC EFFECT

Suspension of a hydrophobic substance in water is thermodynamically unfavorable due to the decreased entropy of water molecules in the cage-like shell.





Dispersion of lipids in H_2O

Each lipid molecule forces surrounding H_2O molecules to become highly ordered.

Clusters of lipid molecules

Only lipid portions at the edge of the cluster force the ordering of water. Fewer H_2O molecules are ordered, and entropy is increased.

Micelles

All hydrophobic groups are sequestered from water; ordered shell of H_2O molecules is minimized, and entropy is further increased.

- The hydrophobic effect, and the term hydrophobic interactions, refers to the entropy-driven aggregation of nonpolar molecules in aqueous solution that occurs to minimize the ordering of water molecules with which they are in contact. This is not an attractive force, but rather a thermodynamically driven process.
- The hydrophobic effect drives the formation of membranes and contributes to the folding of proteins and the formation of double helical DNA.