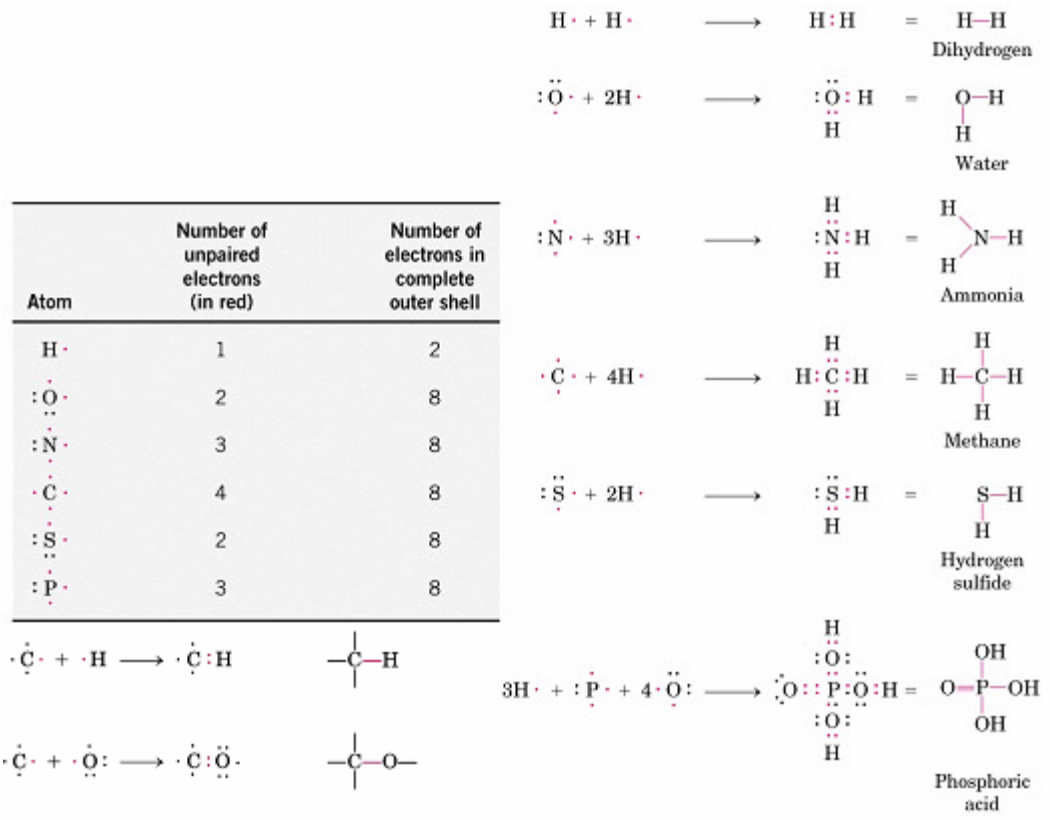
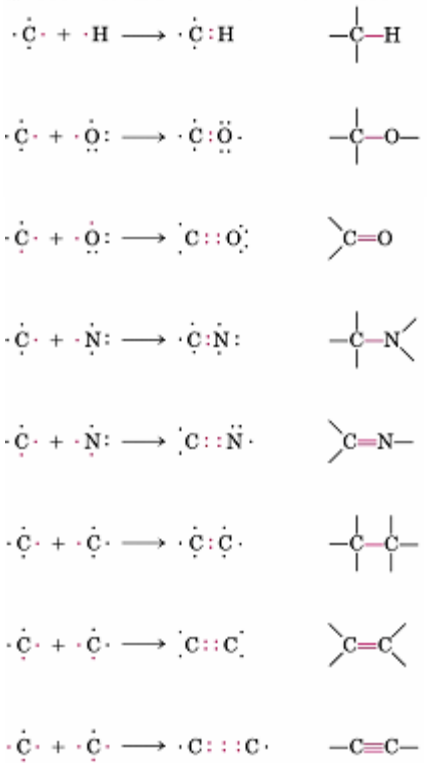
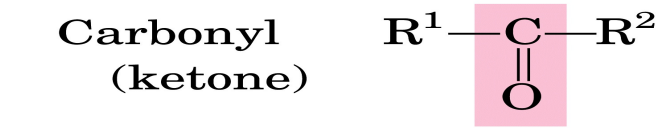
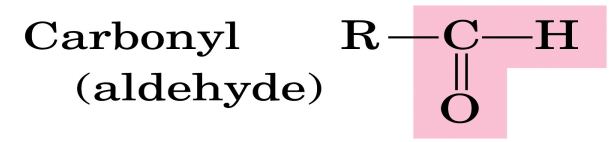
Biomolecules

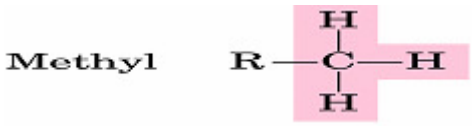
Atom	Number of unpaired electrons (in red)	Number of electrons in complete outer shell
H·	1	2
:Ö·	2	8
:N·	3	8
·C·	4	8
:S·	2	8
:P·	3	8

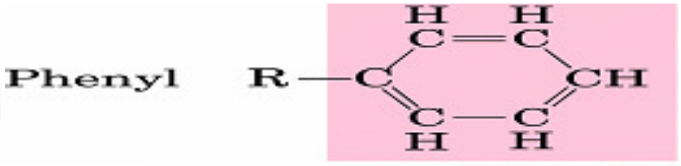


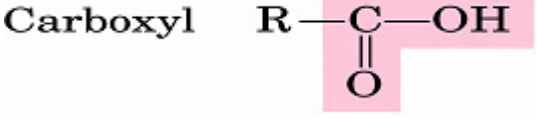


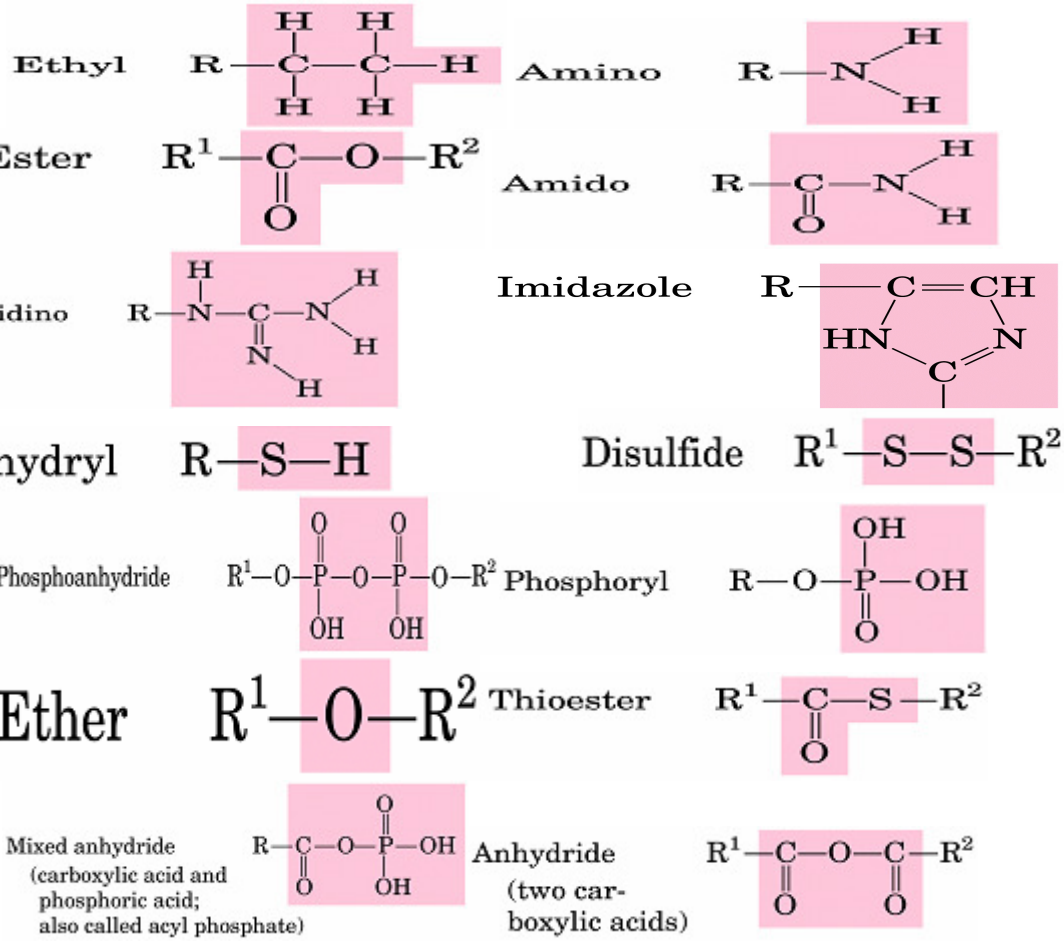


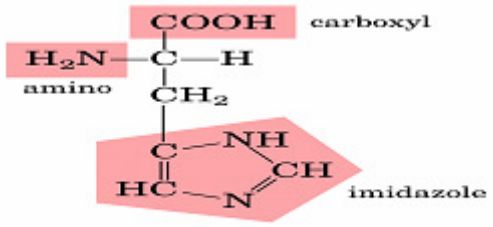




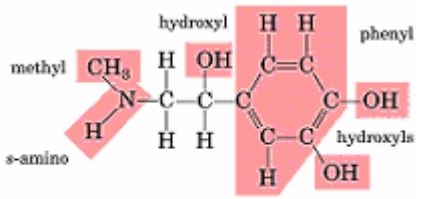




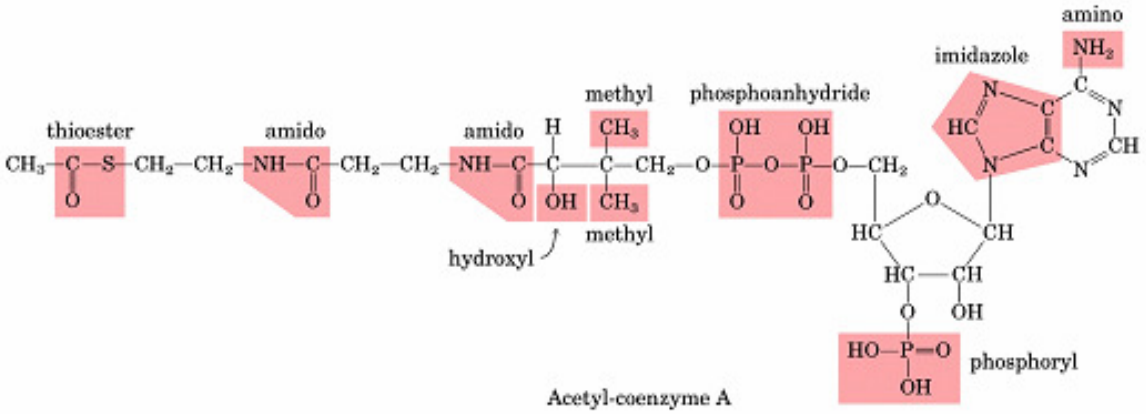




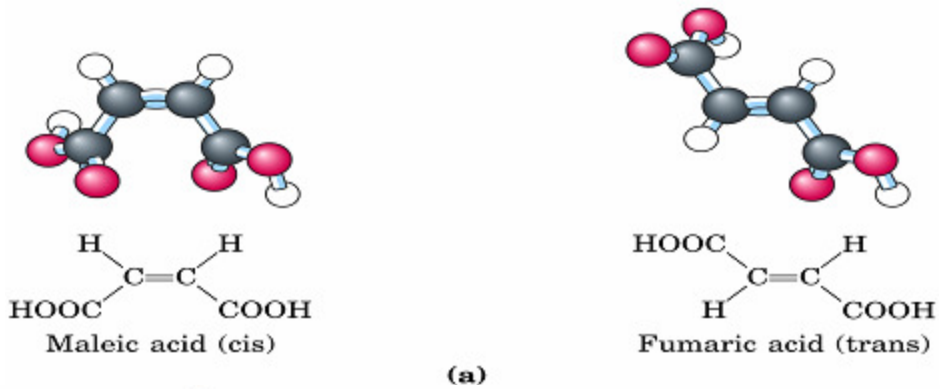
Histidine



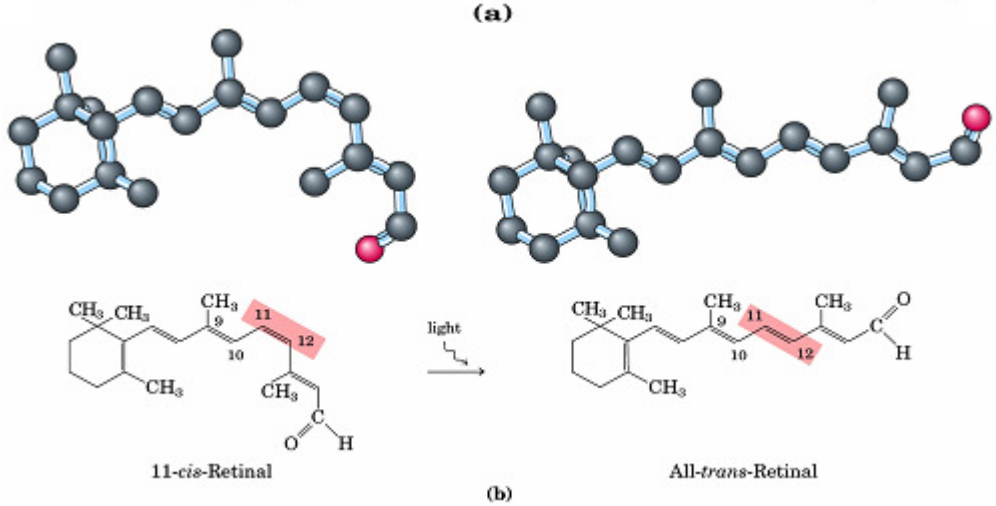
Epinephrine



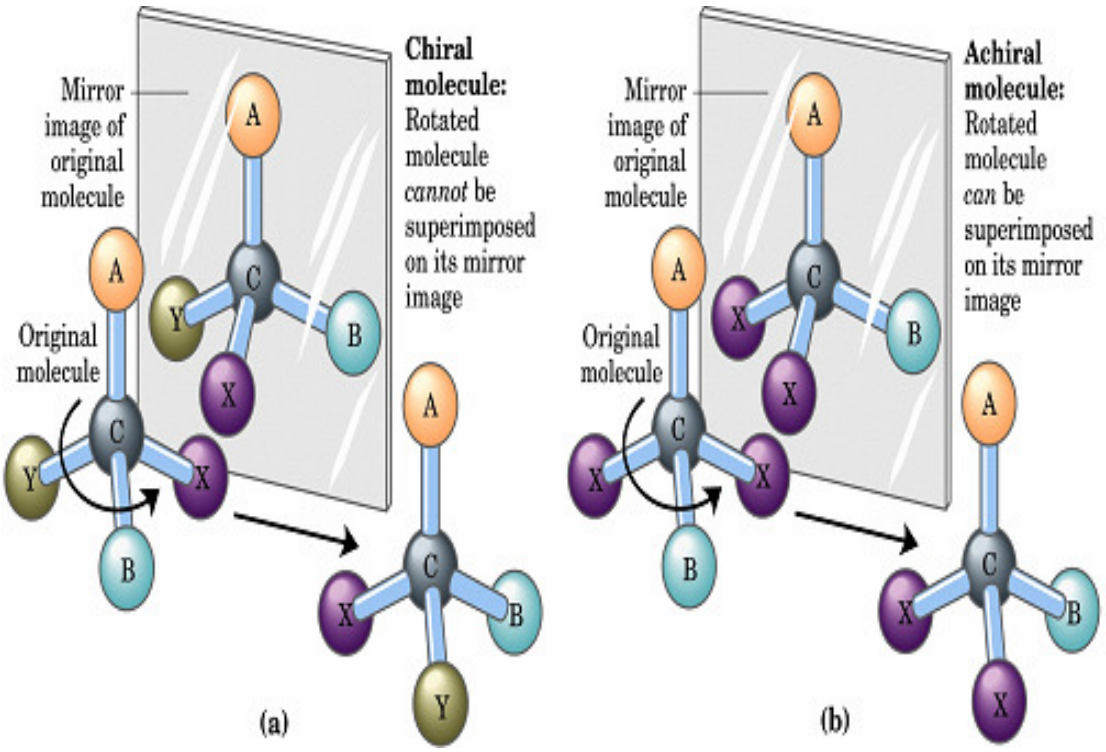
Acetyl-coenzyme A

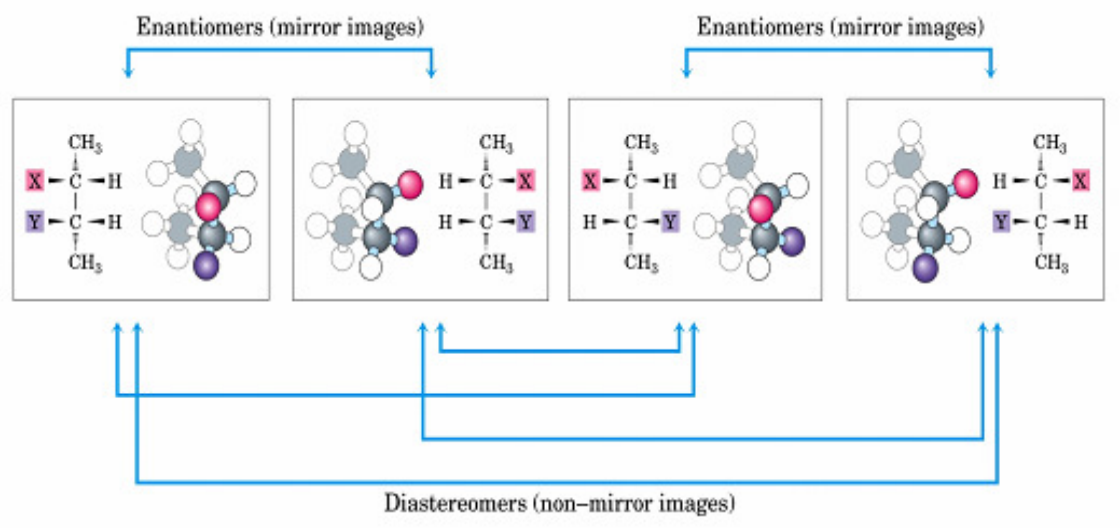

Maleic acid (cis)
Fumaric acid (trans)

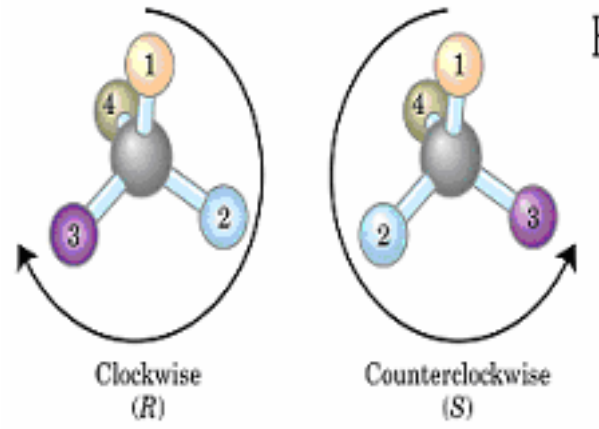
(a)

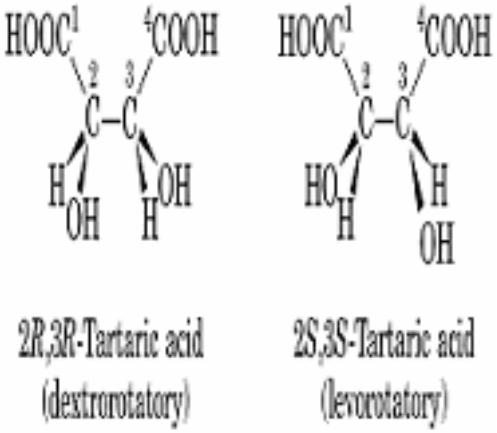

light
11-cis-Retinal
All-trans-Retinal

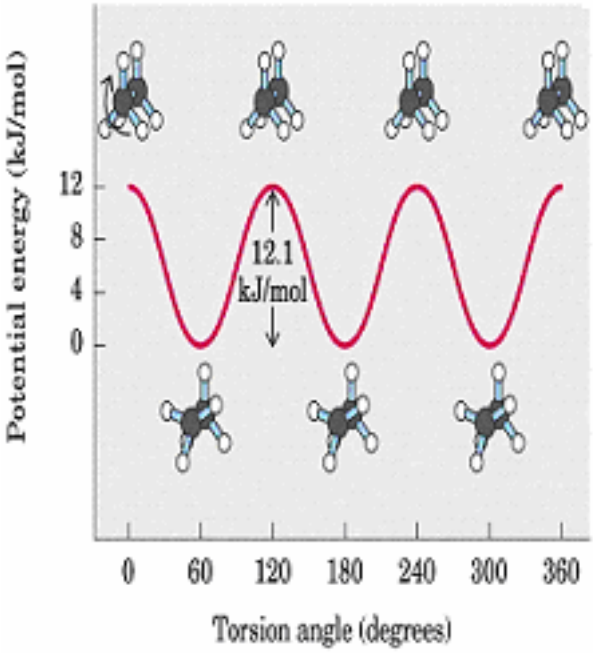
(b)

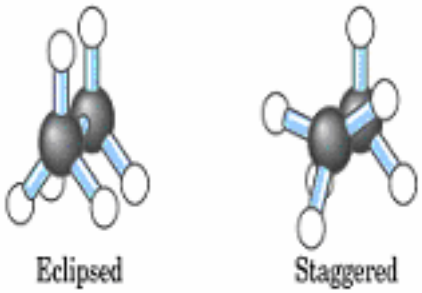

Mirror image of original molecule
Original molecule
Chiral molecule: Rotated molecule cannot be superimposed on its mirror image
(a)
Mirror image of original molecule
Original molecule
Achiral molecule: Rotated molecule can be superimposed on its mirror image
(b)

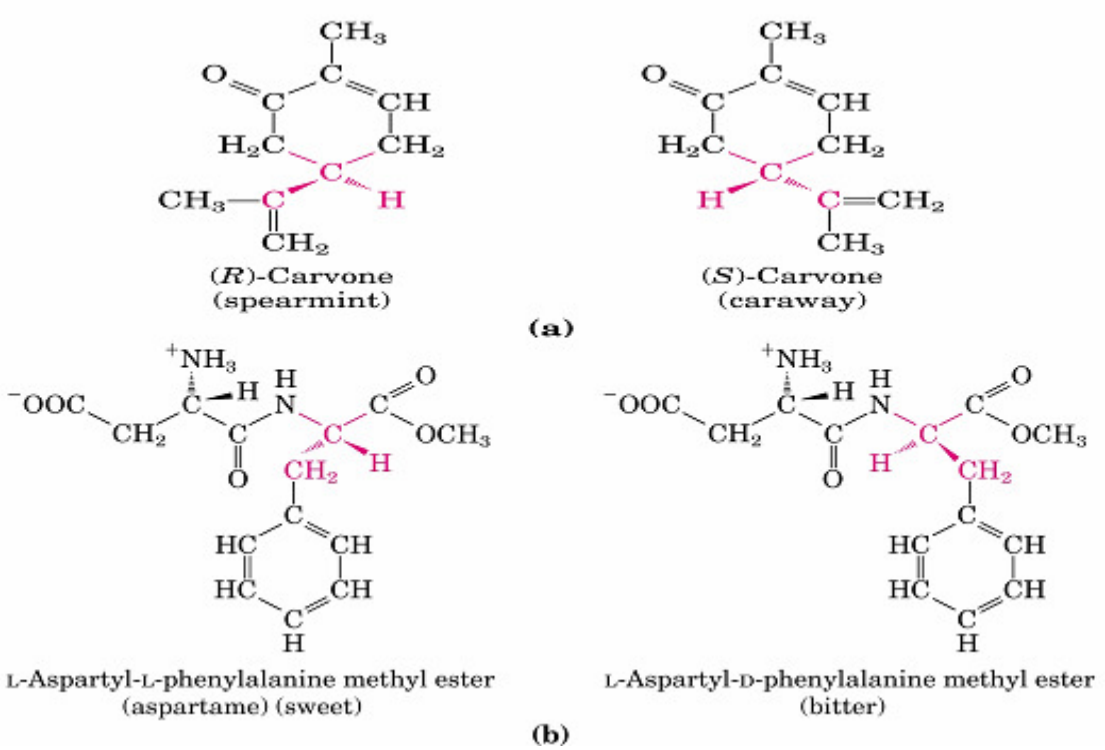

Enantiomers (mirror images)
Enantiomers (mirror images)
Diastereomers (non–mirror images)


1
2
3
4
Clockwise
(R)
Counterclockwise
(S)

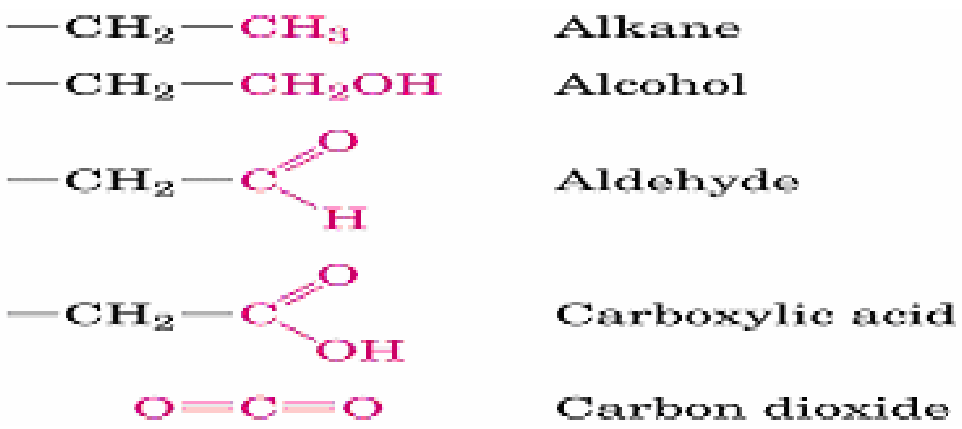

2R,3R-Tartaric acid
(dextrorotatory)
2S,3S-Tartaric acid
(levorotatory)


Potential energy (kJ/mol)
12
8
4
0
12.1
kJ/mol
0
60
120
180
240
300
360
Torsion angle (degrees)

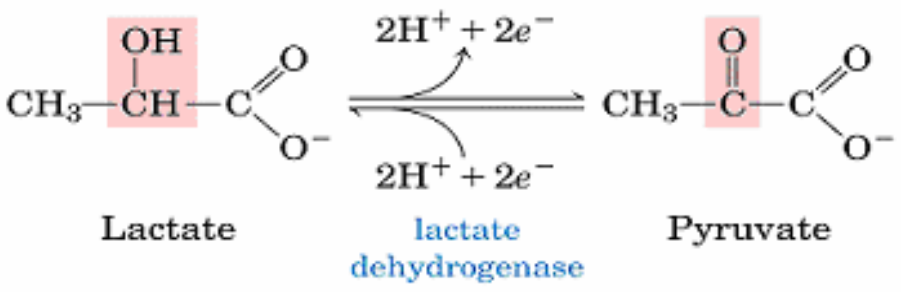

Eclipsed
Staggered



Oxidation States of carbon



1. **Redox Reactions**

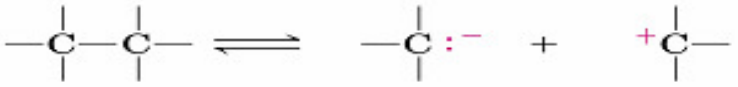


2. Substitution Reaction

Homolytic cleavage

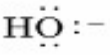
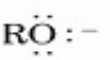
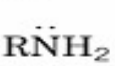
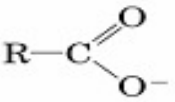
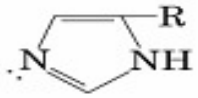
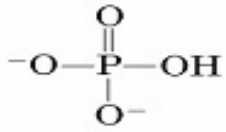
Carbon radicals

Heterolytic cleavage



Carbanion Carbocation

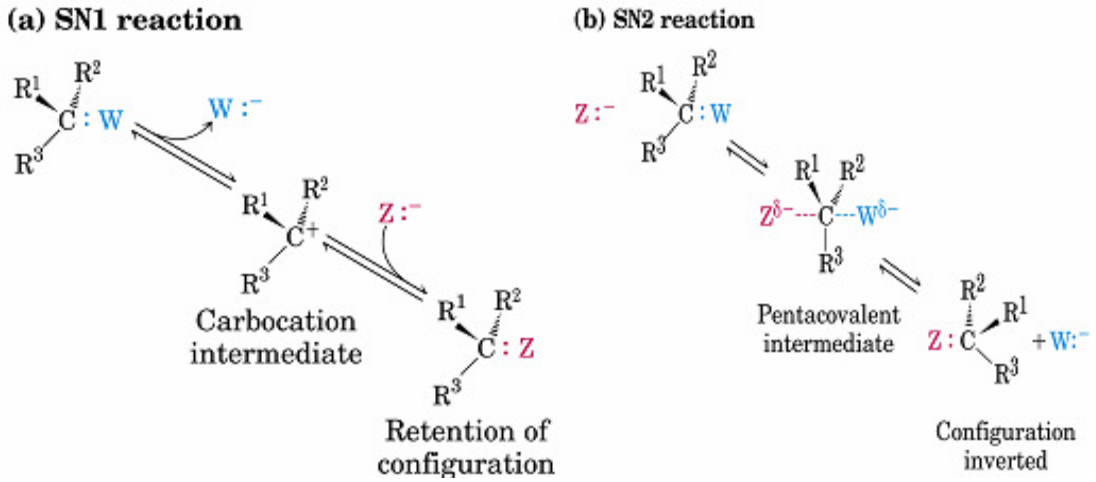
Some Functional Groups Active as Nucleophiles within Cells*

Water	
Hydroxide ion	
Hydroxyl (alcohol)	
Alkoxyl	
Sulfhydryl	
Sulfide	
Amino	
Carboxylate	
Imidazole	
Inorganic orthophosphate	

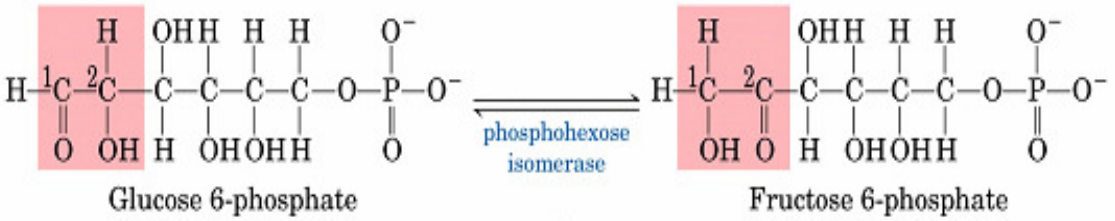
*Listed in order of decreasing strength. Weaker nucleophiles make better leaving groups.

3. Nucleophilic Substitution Reaction

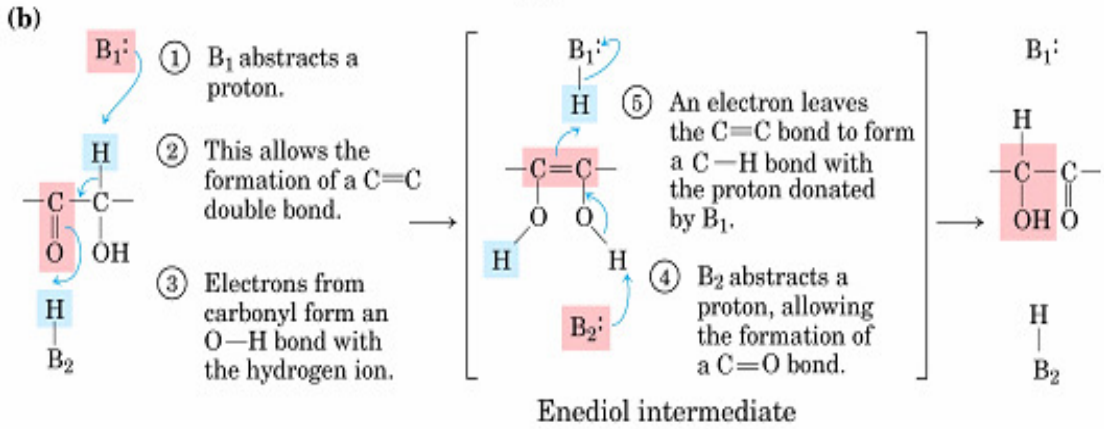
Leaving group Nucleophile



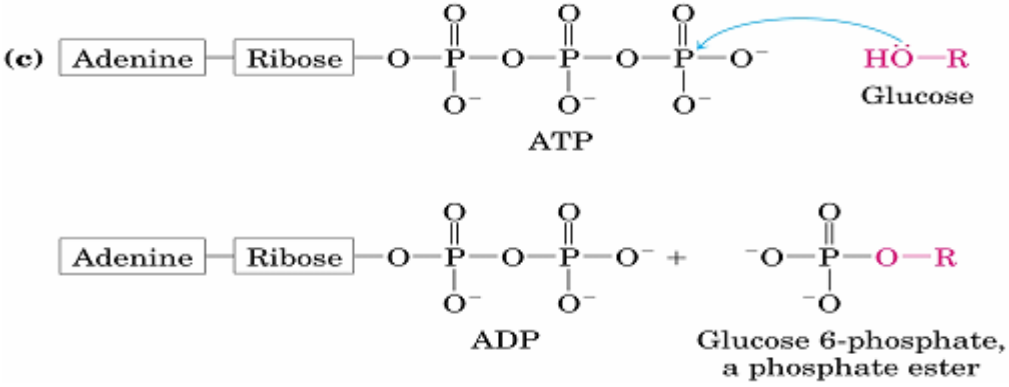
4. Internal Rearrangement



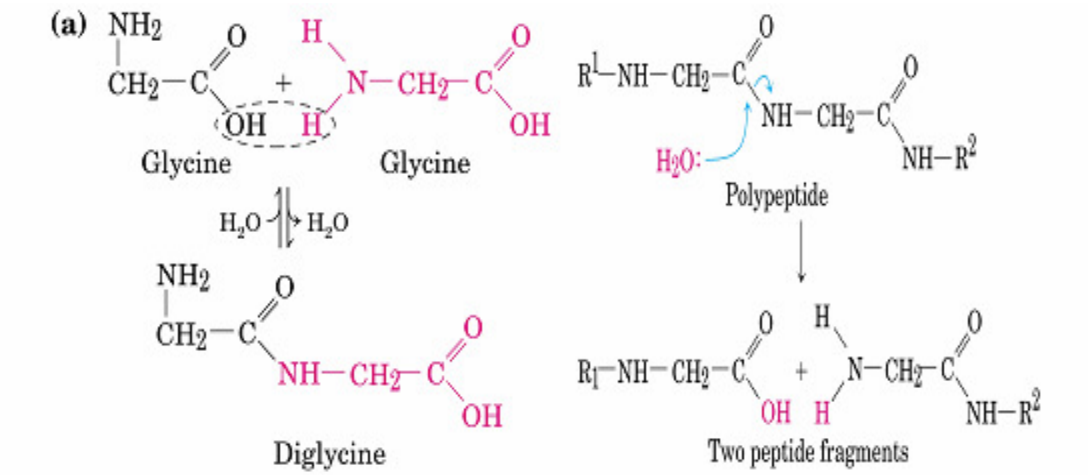
(a)

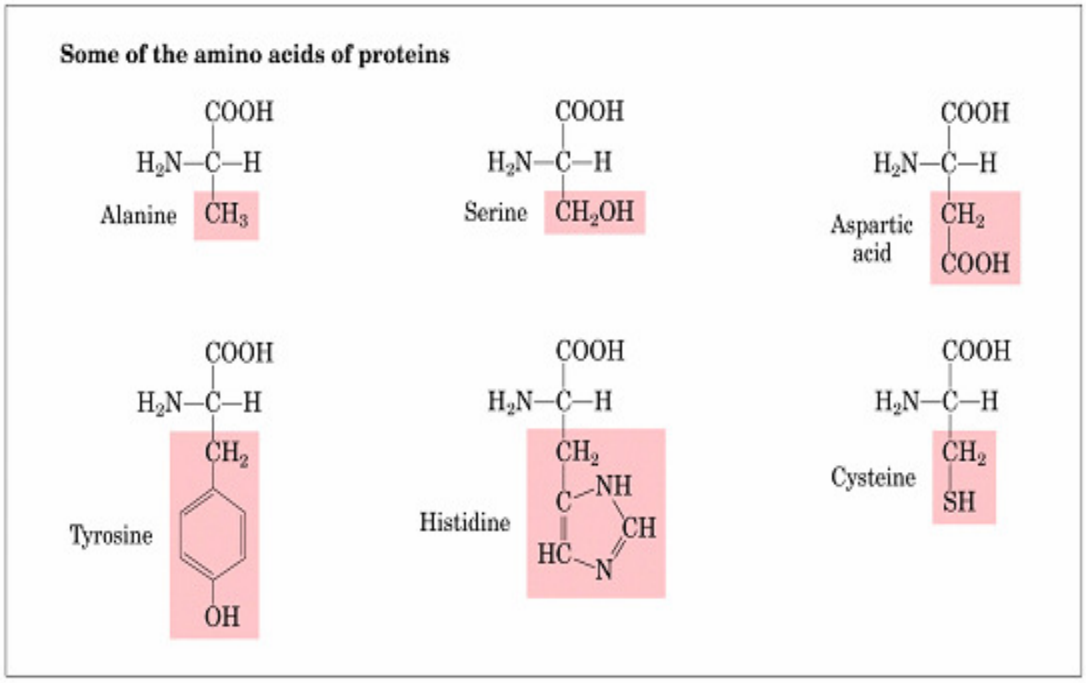


5. Group Transfer

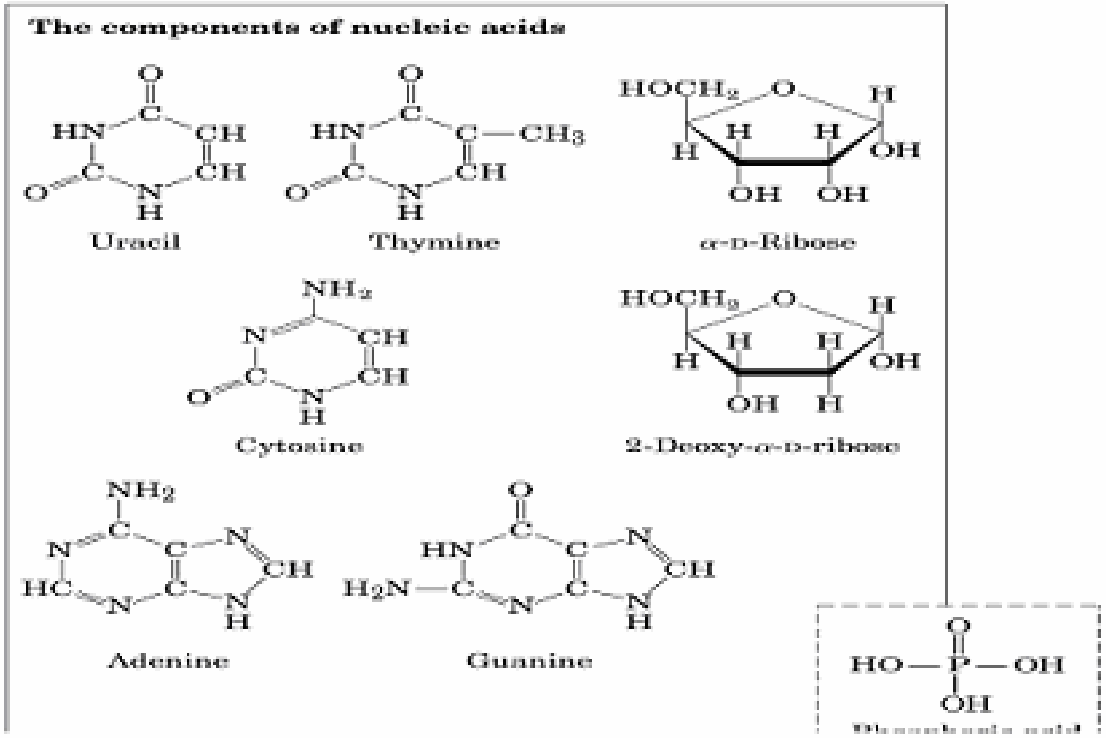


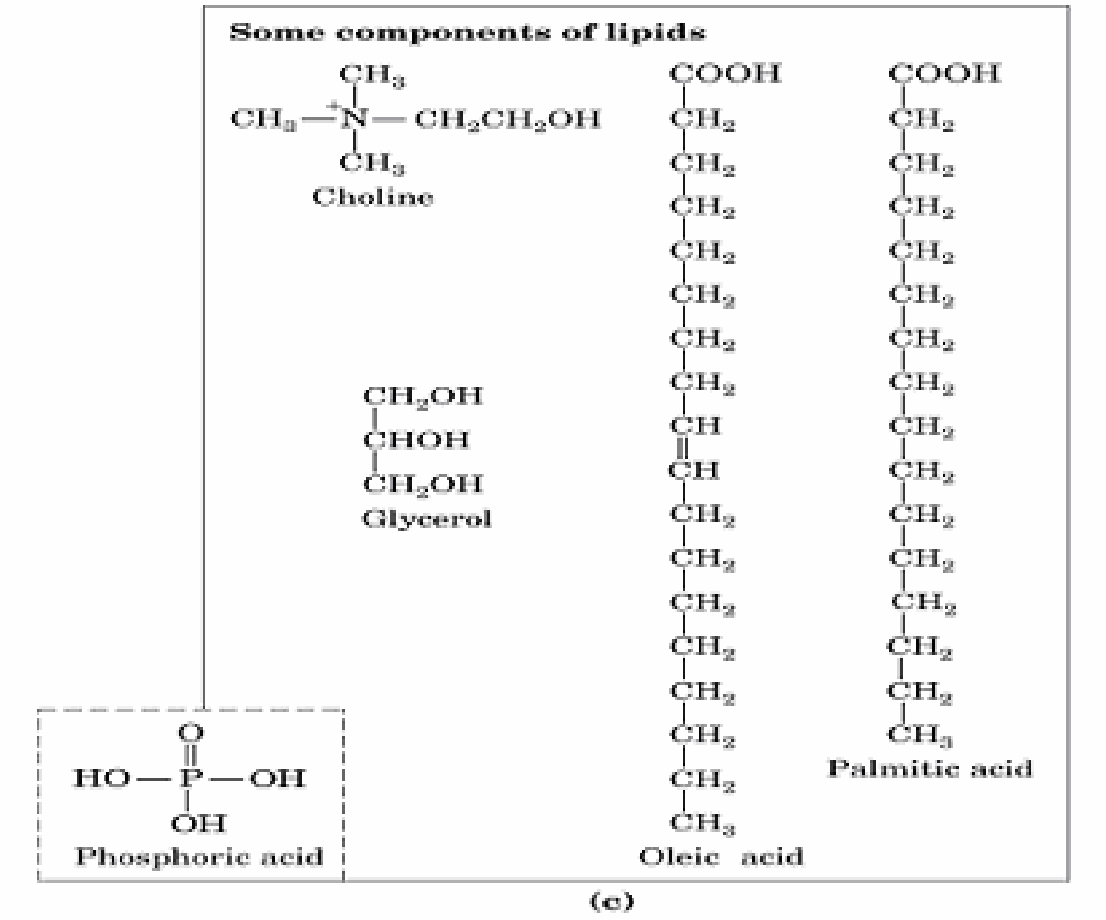
6. Condensation/Hydrolysis reactions.



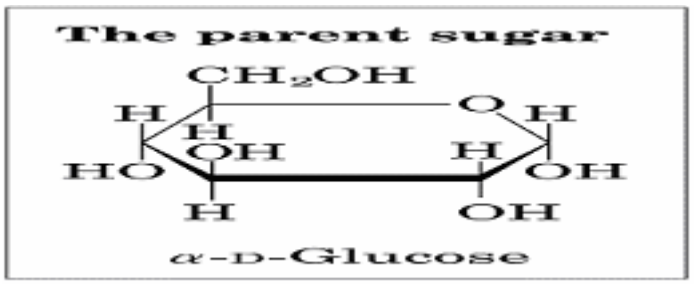


(a)


The components of nucleic acids
Uracil
Thymine
α-D-Ribose
Cytosine
2-Deoxy-α-D-ribose
Adenine
Guanine


Some components of lipids
Choline
Glycerol
Phosphoric acid
Oleic acid
Palmitic acid

(c)



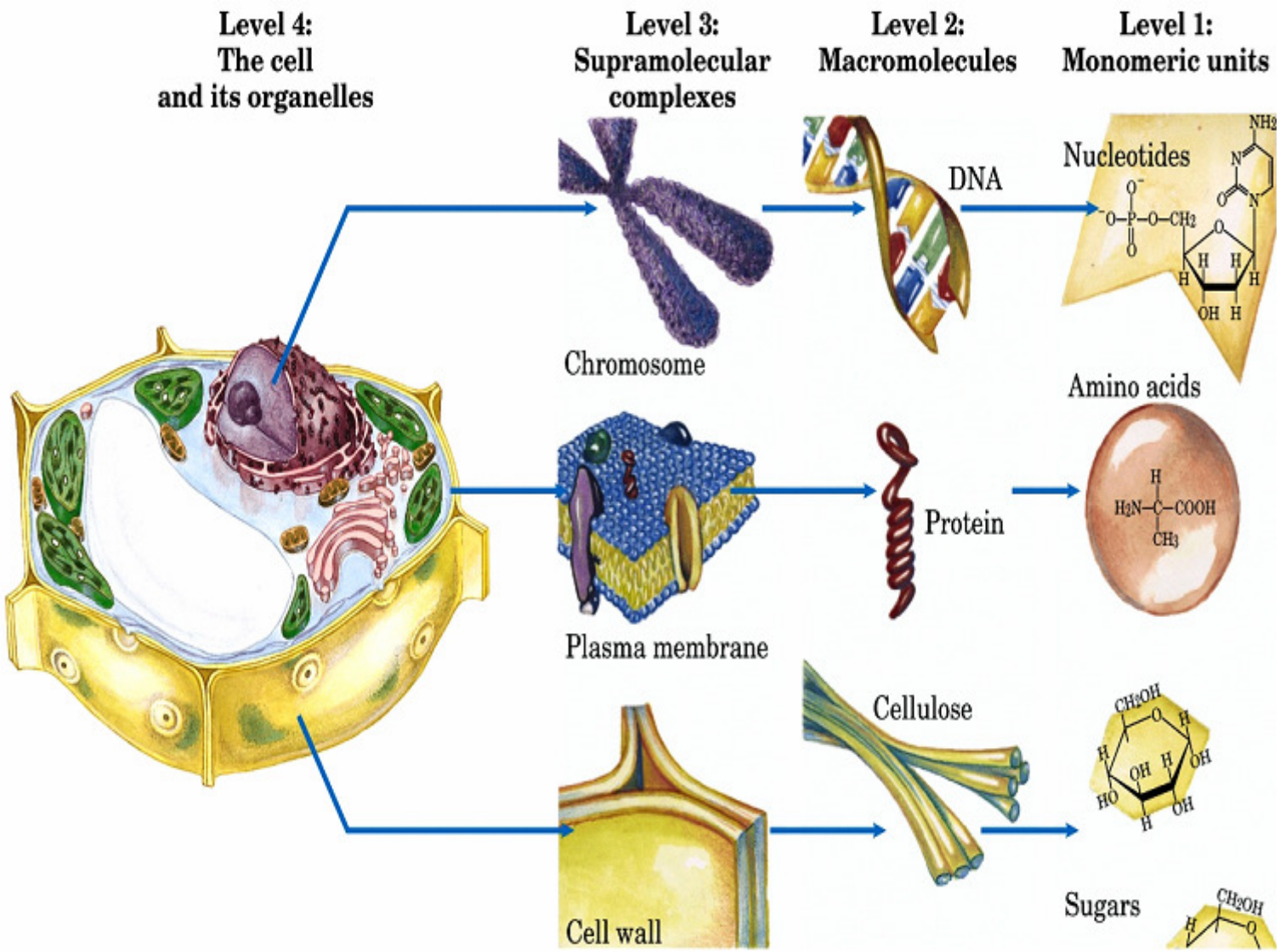
(d)

Amino acids → Proteins, Peptide hormones, Neurotransmitters, Toxic alkaloids

Adenine → Nucleic acids, ATP, Coenzymes, Neurotransmitters

Palmitic acid → Membrane lipids, Fats, Waxes

Glucose → Cellulose, Starch, Fructose, Mannose, Sucrose, Lactose


Level 4:
The cell
and its organelles
Level 3:
Supramolecular
complexes
Level 2:
Macromolecules
Level 1:
Monomeric units
Chromosome
DNA
Nucleotides
Amino acids
Plasma membrane
Protein
Cellulose
Cell wall
Sugars

How did life begin? = PREBIOTIC EVOLUTION