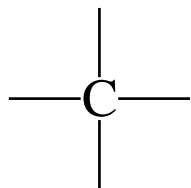


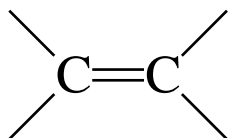
Organic and Biochemistry

Chapters 19 and 20

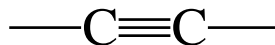
Carbon always has 4 bonds



single bonds



double bond

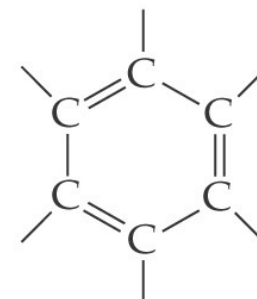
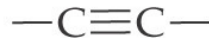
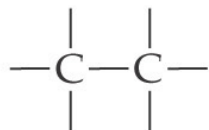
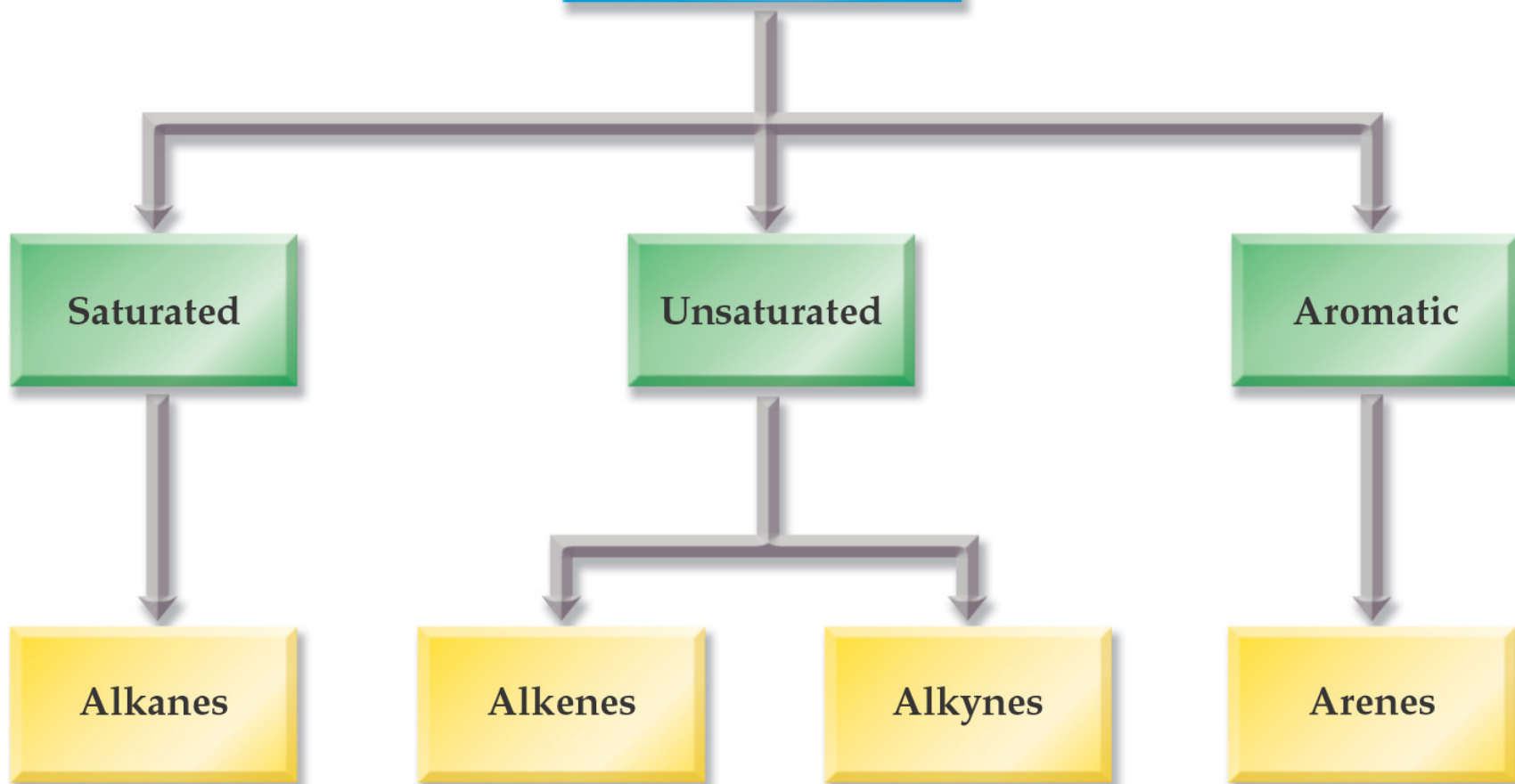


triple bond



never quadruple bonds

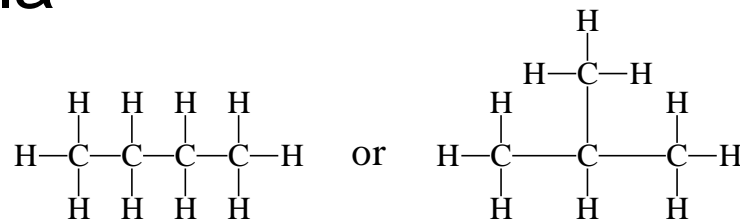
HYDROCARBONS



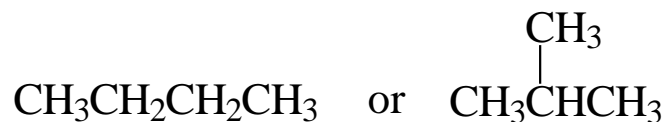
n	Name	Molecular formula C_nH_{2n+2}	Structural formula	Condensed structural formula
1	methane	CH_4	<pre> H H - C - H H </pre>	CH_4
2	ethane	C_2H_6	<pre> H H H - C - C - H H H </pre>	CH_3CH_3
3	propane	C_3H_8	<pre> H H H H - C - C - C - H H H H </pre>	$CH_3CH_2CH_3$
4	n-butane	C_4H_{10}	<pre> H H H H H - C - C - C - C - H H H H H </pre>	$CH_3CH_2CH_2CH_3$
5	n-pentane	C_5H_{12}	<pre> H H H H H H - C - C - C - C - C - H H H H H H </pre>	$CH_3CH_2CH_2CH_2CH_3$
6	n-hexane	C_6H_{14}	<pre> H H H H H H H - C - C - C - C - C - C - H H H H H H H </pre>	$CH_3CH_2CH_2CH_2CH_2CH_3$
7	n-heptane	C_7H_{16}	<pre> H H H H H H H H - C - C - C - C - C - C - C - H H H H H H H H </pre>	$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$
8	n-octane	C_8H_{18}	<pre> H H H H H H H H H - C - C - C - C - C - C - C - C - H H H H H H H H H </pre>	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$
9	n-nonane	C_9H_{20}	<pre> H H H H H H H H H H - C - C - C - C - C - C - C - C - C - H H H H H H H H H H </pre>	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$
10	n-decane	$C_{10}H_{22}$	<pre> H H H H H H H H H H H - C - C - C - C - C - C - C - C - C - C - H H H H H H H H H H H </pre>	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$

Representing Organic Compounds

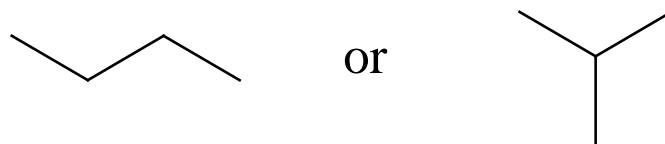
- Molecular Formula -- C_4H_{10}
- Complete structural formula –



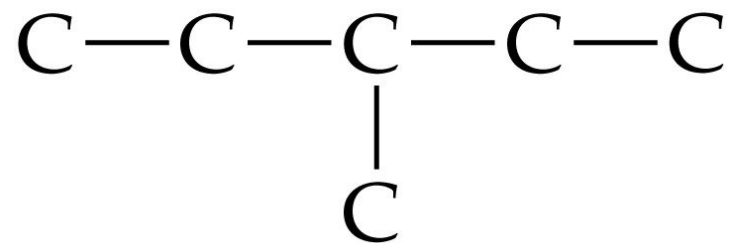
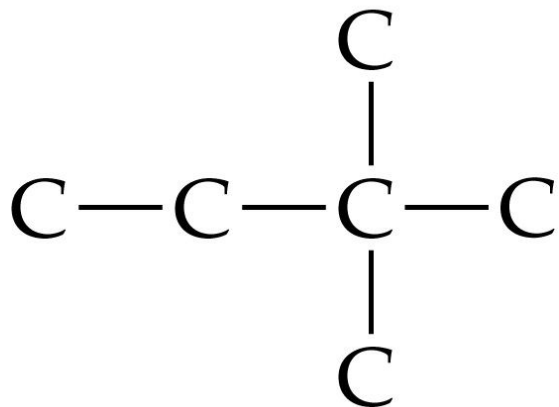
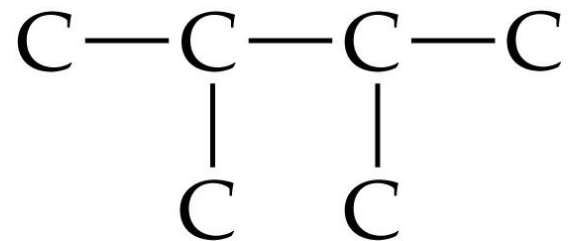
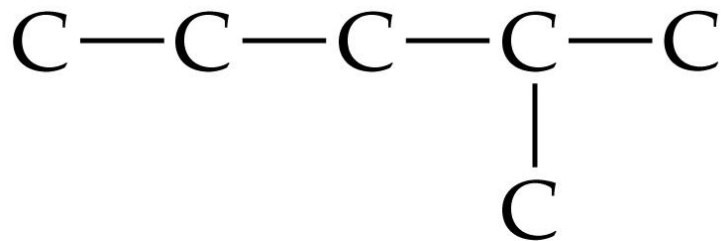
- Condensed structural formula –



- Line formula -



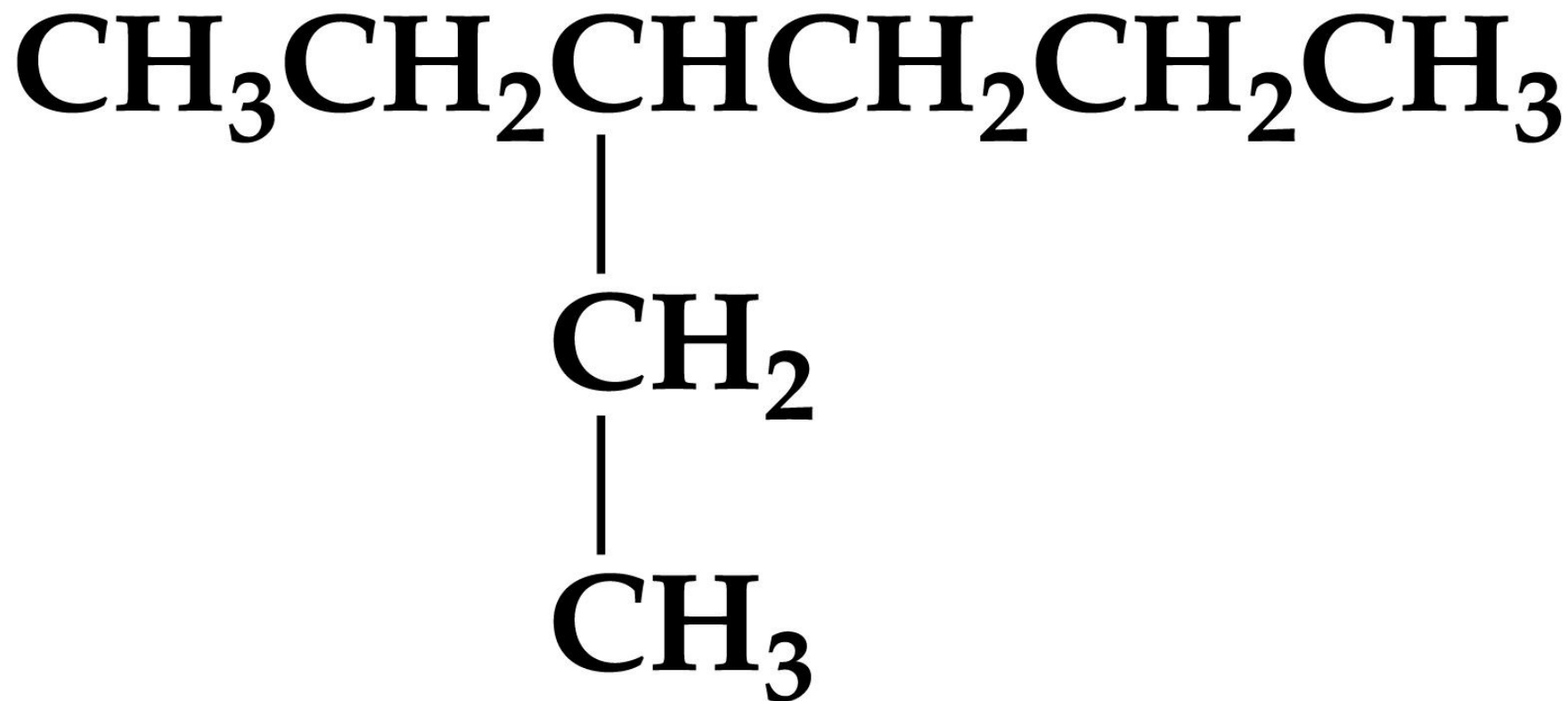
Isomers - Compounds that have the same molecular formula but different structural formulas.



Nomenclature – alkanes

- Find the longest chain of carbon atoms --- this is the base name of the alkane.
- Alkyl groups branch off of the main chain
- Main chain is numbered to show where alkyl groups are attached.

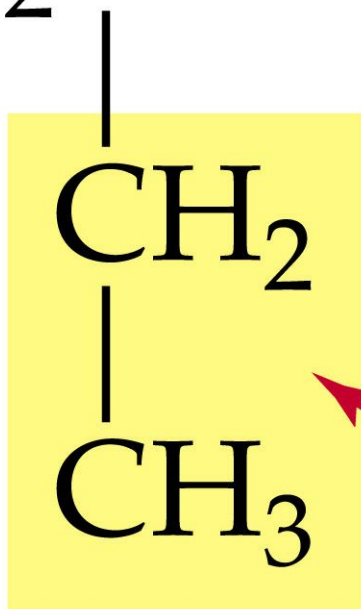
Name this compound



Longest chain highlighted



2 carbon group attached to main chain



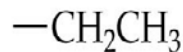
Ethyl

Condensed structural formula

Name



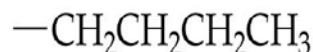
methyl



ethyl

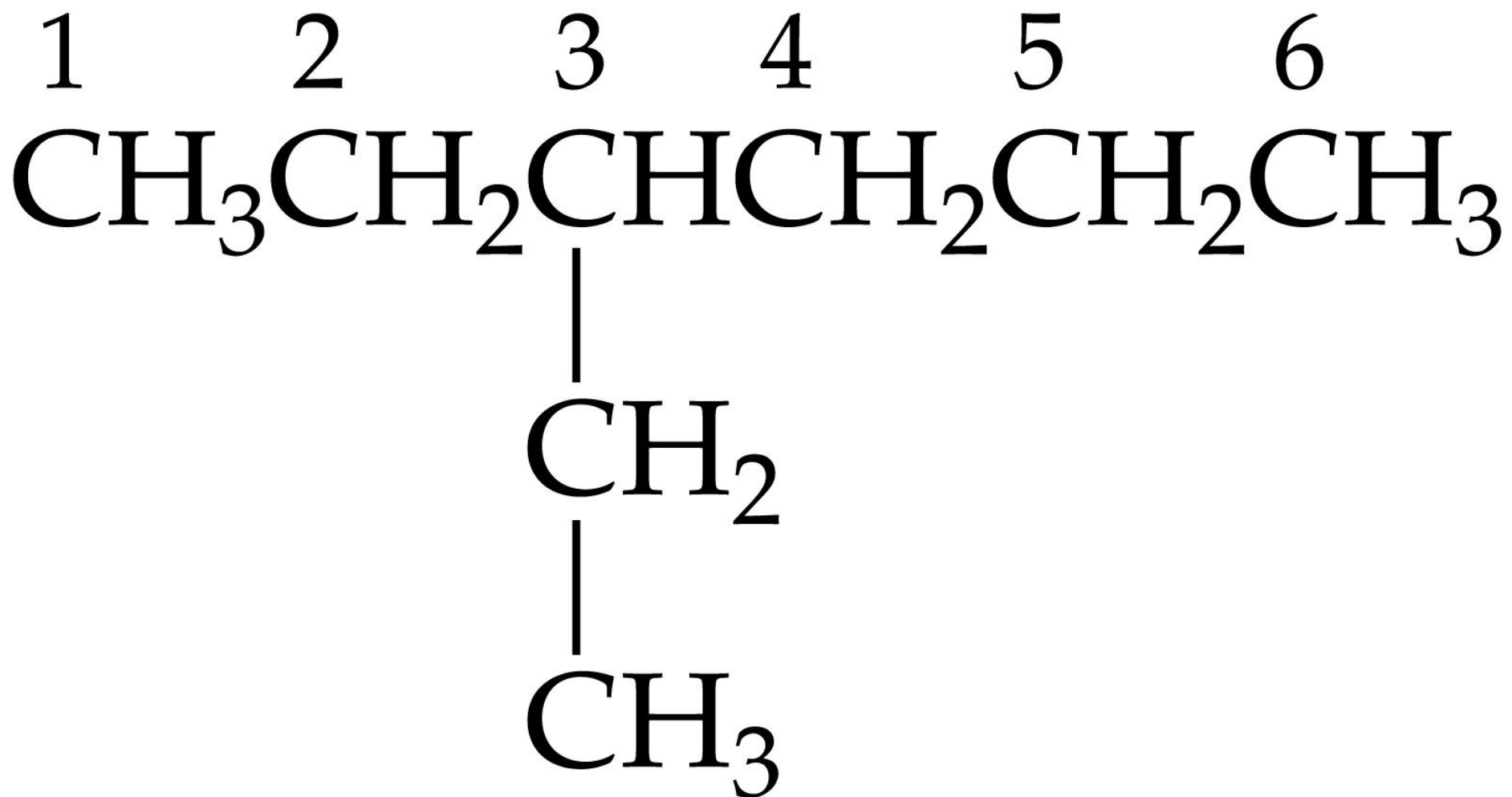


propyl



butyl

3-ethyl hexane

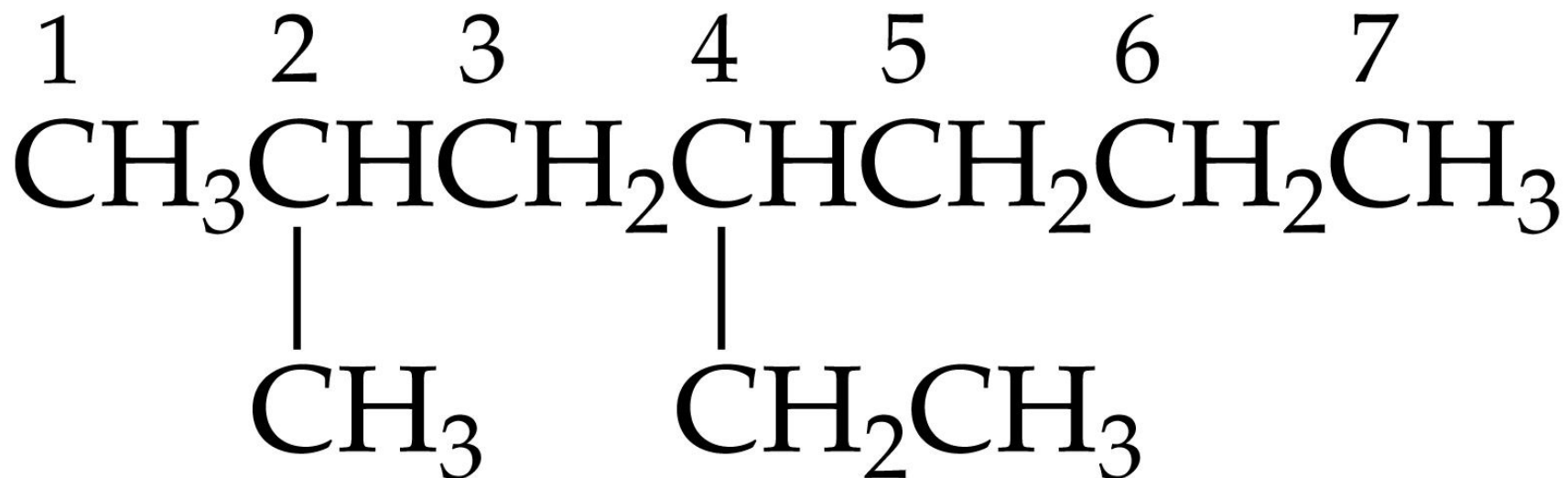




Methyl

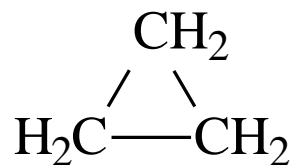
Ethyl

4-ethyl-2-methyl heptane

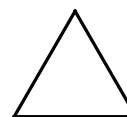


Cycloalkanes

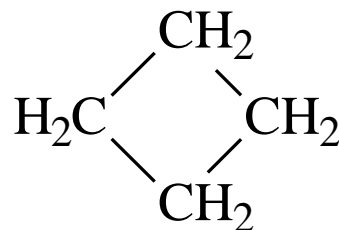
cyclopropane



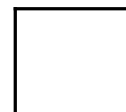
or



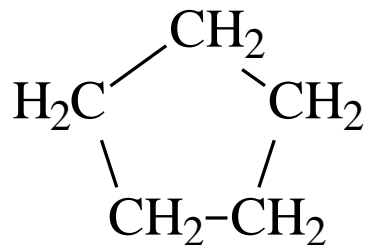
cyclobutane



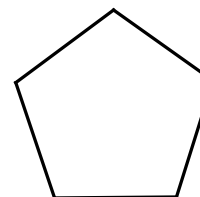
or



cyclopentane



or

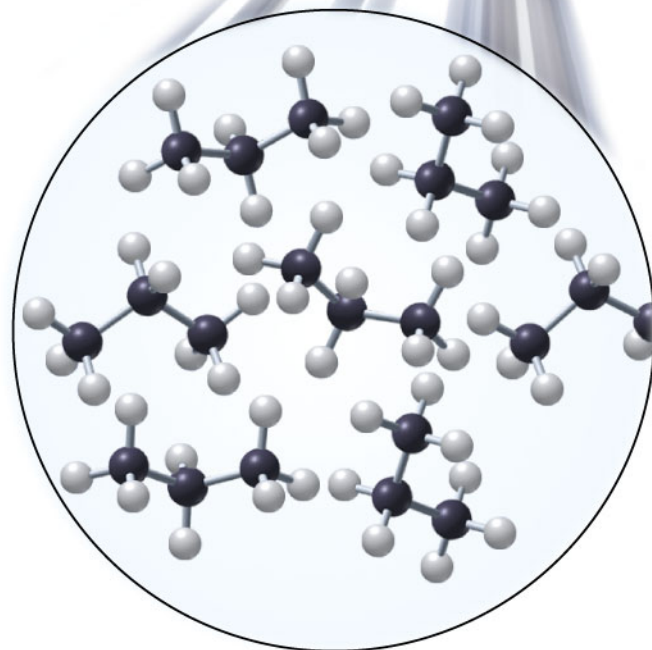


Physiological Properties of Alkanes

- Methane (CH_4) is physiologically inert.
- Cyclopropane (C_3H_6) is a safe, effective, and fast acting anesthetic.
- Pyrethrins are cyclopropane derivatives found in the pyrethrum daisy which have insecticidal activity. Pyrethrins are frequently used in flea sprays.
- Liquid alkanes (gasoline) dissolve and wash away oils.
- Solid alkanes are applied to the skin as emollients (skin softeners).

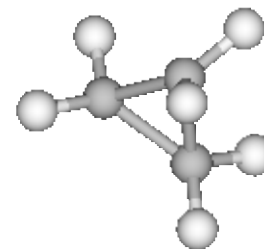
Properties of Alkanes

- Methane (CH_4), propane (C_3H_8), and butane (C_4H_{10}) are all used as fuels.
- Cyclopropane (C_3H_6) is a safe, effective, and fast acting anesthetic.
- Pyrethrins are cyclopropane derivatives found in the pyrethrum daisy which have insecticidal activity. Pyrethrins are frequently used in flea sprays.



Properties of Alkanes

- Cyclopropane (C_3H_6) is a safe, effective, and fast acting anesthetic.
- Pyrethrins are cyclopropane derivatives found in the pyrethrum daisy which have insecticidal activity. Pyrethrins are frequently used in flea sprays.



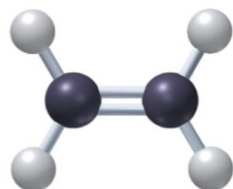
Properties of Alkanes

- Liquid alkanes (gasoline) dissolve and wash away oils.
- Solid alkanes make up the waxy coating on fruits and vegetables. They are also applied to the skin as emollients (skin softeners).



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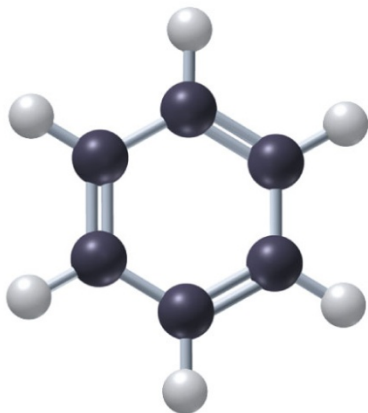
Unsaturated Hydrocarbons



Alkene



Alkyne



Aromatic

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Ethene used to ripen fruit.

Alkenes – double bonds

n	Name	Molecular formula C_nH_{2n}	Structural formula	Condensed structural formula
2	ethene	C_2H_4	$\begin{array}{c} \text{H} & & \text{H} \\ & \diagdown & / \\ & \text{C}=\text{C} & \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array}$	$\text{CH}_2=\text{CH}_2$
3	propene	C_3H_6	$\begin{array}{c} \text{H} & & \text{H} & \text{H} \\ & \diagdown & / & \\ & \text{C}=\text{C} & -\text{C} & -\text{H} \\ & / & & \\ \text{H} & & & \text{H} \end{array}$	$\text{CH}_2=\text{CHCH}_3$
4	1-butene*	C_4H_8	$\begin{array}{c} \text{H} & & \text{H} & \text{H} & \text{H} \\ & \diagdown & / & & \\ & \text{C}=\text{C} & -\text{C} & -\text{C} & -\text{H} \\ & / & & & \\ \text{H} & & & \text{H} & \text{H} \end{array}$	$\text{CH}_2=\text{CHCH}_2\text{CH}_3$
5	1-pentene*	C_5H_{10}	$\begin{array}{c} \text{H} & & \text{H} & \text{H} & \text{H} & \text{H} \\ & \diagdown & / & & & \\ & \text{C}=\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{H} \\ & / & & & & \\ \text{H} & & & \text{H} & \text{H} & \text{H} \end{array}$	$\text{CH}_2=\text{CHCH}_2\text{CH}_2\text{CH}_3$
6	1-hexene*	C_6H_{12}	$\begin{array}{c} \text{H} & & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & \diagdown & / & & & & \\ & \text{C}=\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{H} \\ & / & & & & & \\ \text{H} & & & \text{H} & \text{H} & \text{H} & \text{H} \end{array}$	$\text{CH}_2=\text{CHCH}_2\text{CH}_2\text{CH}_2\text{CH}_3$

* These alkenes have one or more isomers depending on the position of the double bond. The isomers here have the double bond in the #1 position, meaning the first carbon-carbon bond of the chain.

Alkynes – triple bonds

n	Name	Molecular formula C_nH_{2n-2}	Structural formula	Condensed structural formula
2	ethyne	C_2H_2	$H-C\equiv C-H$	CHCH
3	propyne	C_3H_4	$ \begin{array}{c} H \\ \\ H-C\equiv C-C-H \\ \\ H \end{array} $	$CH\equiv CCH_3$
4	1-butyne*	C_4H_6	$ \begin{array}{c} H \quad H \\ \quad \\ H-C\equiv C-C-C-H \\ \quad \\ H \quad H \end{array} $	$CH\equiv CCH_2CH_3$
5	1-pentyne*	C_5H_8	$ \begin{array}{c} H \quad H \quad H \\ \quad \quad \\ H-C\equiv C-C-C-C-H \\ \quad \quad \\ H \quad H \quad H \end{array} $	$CH\equiv CCH_2CH_2CH_3$
6	1-hexyne*	C_6H_{10}	$ \begin{array}{c} H \quad H \quad H \quad H \\ \quad \quad \quad \\ H-C\equiv C-C-C-C-C-H \\ \quad \quad \quad \\ H \quad H \quad H \quad H \end{array} $	$CH\equiv CCH_2CH_2CH_2CH_3$

* These alkynes have one or more isomers depending on the position of the triple bond. The isomers shown here have the triple bond in the #1 position, meaning the first carbon-carbon bond in the chain.

Functional Groups in Organic Compounds

- Hydrocarbons
- Alcohols and Ethers
- Aldehydes and Ketones
- Carboxylic acids and Esters
- Amines and Amides
- Amino Acids

Alcohols and Ethers

- Alcohol

- General formula R-OH

Methanol CH_3OH

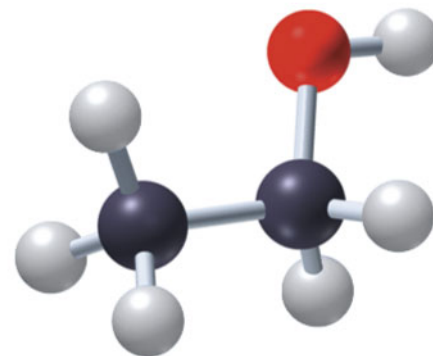
Ethanol $\text{CH}_3\text{CH}_2\text{OH}$

- Ether

- General formula R-O-R

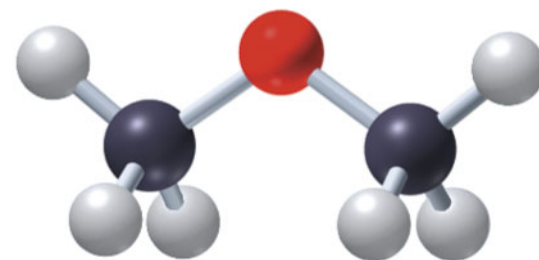
Dimethyl ether CH_3OCH_3

Diethyl ether $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$



Alcohol

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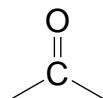
Ether

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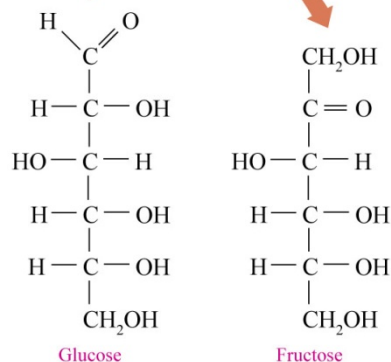
Aldehydes and Ketones



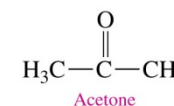
- Contain a carbonyl group



- Aldehydes
 - Carbonyl attached to at least 1 hydrogen



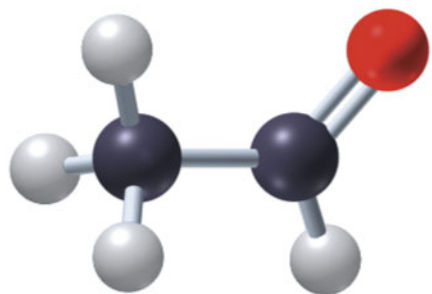
- Ketones
 - No hydrogen attached to carbonyl.



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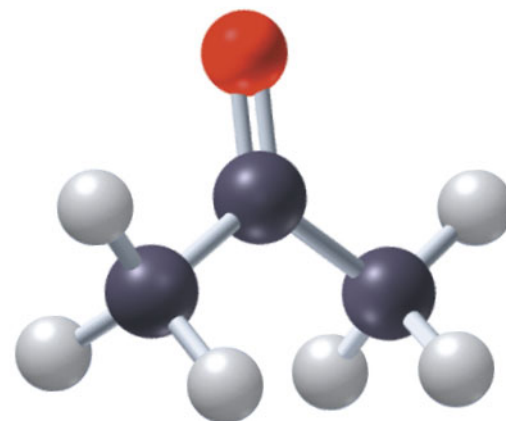
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Aldehydes and Ketones



Aldehyde

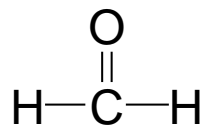
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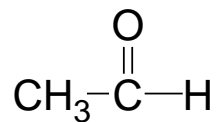
Ketone

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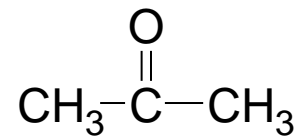
Methanal



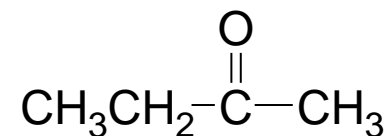
Ethanal



Propanone



Butanone

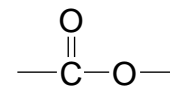


Carboxylic Acids and Esters

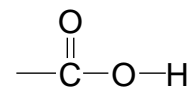


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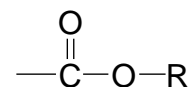
- Contain a carboxyl group



- Carboxylic acid
 - Oxygen attached to H

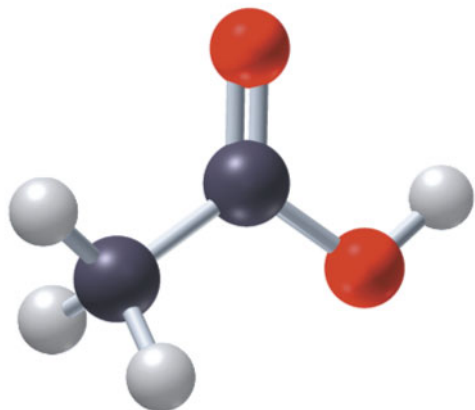


- Esters
 - Carbon (R) group attached to H



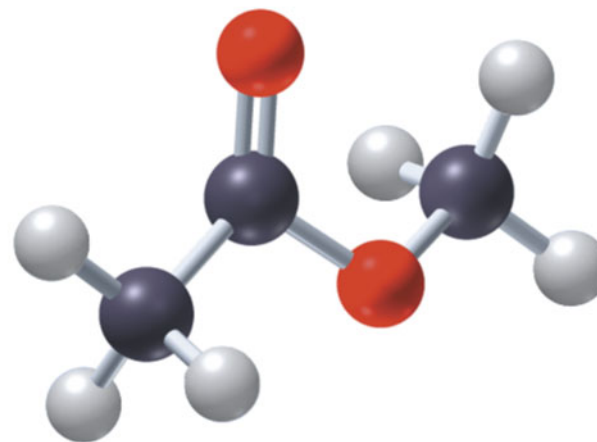
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Carboxylic Acids and Esters



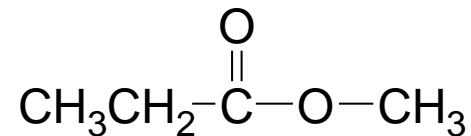
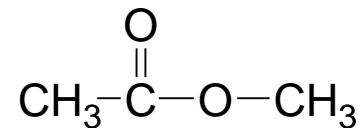
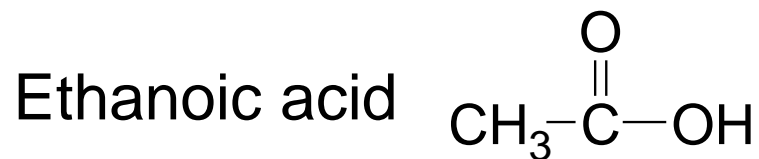
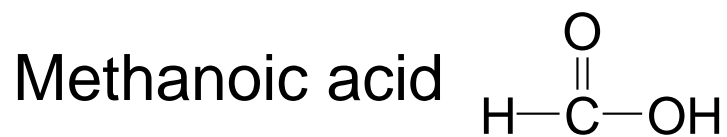
Carboxylic acid

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Ester

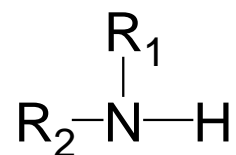
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Amines and Amides

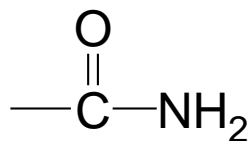
- Contain nitrogen

- Amines



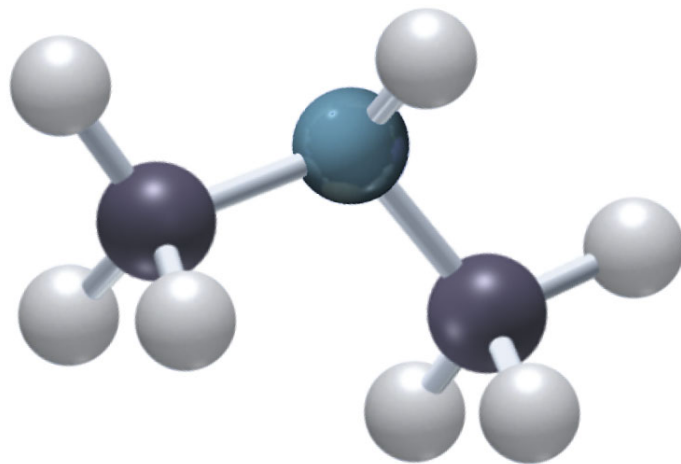
- Amides

- Carbonyl attached to a nitrogen



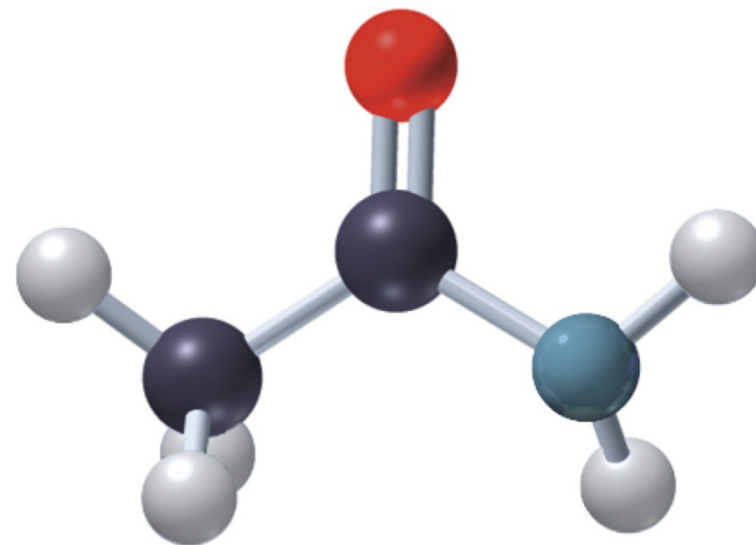
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Amines and Amides



Amine

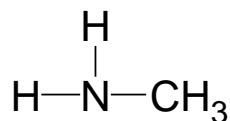
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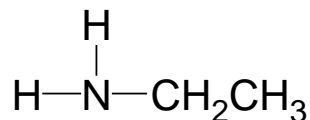
Amide

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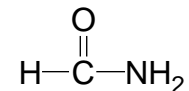
Methyl amine



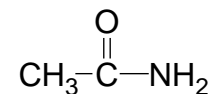
Ethyl amine



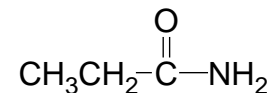
Methanamide



Ethanamide



Propanamide



Amino Acids

TABLE 8.6 Some Typical Amino Acids in Proteins

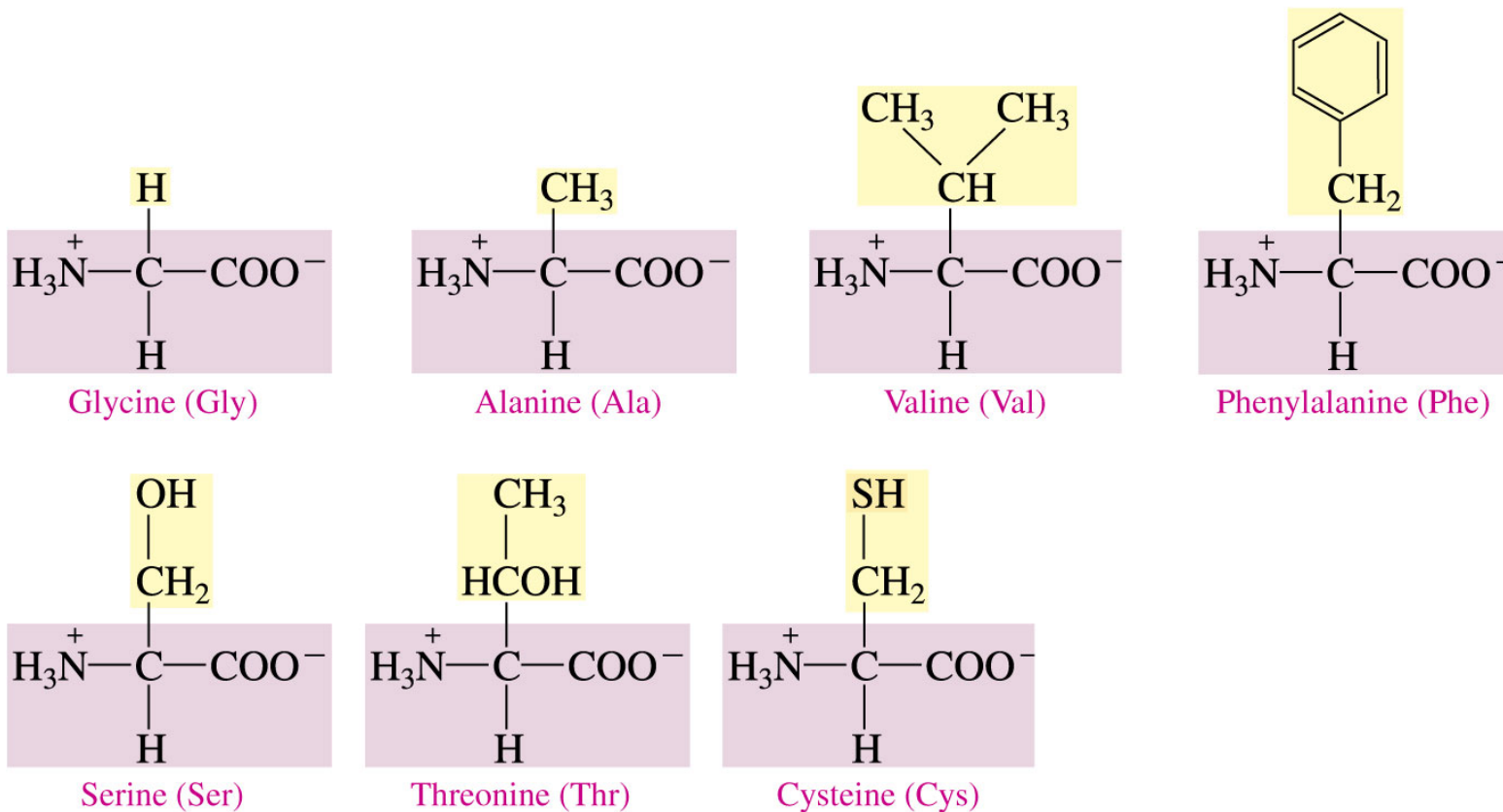
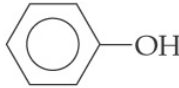


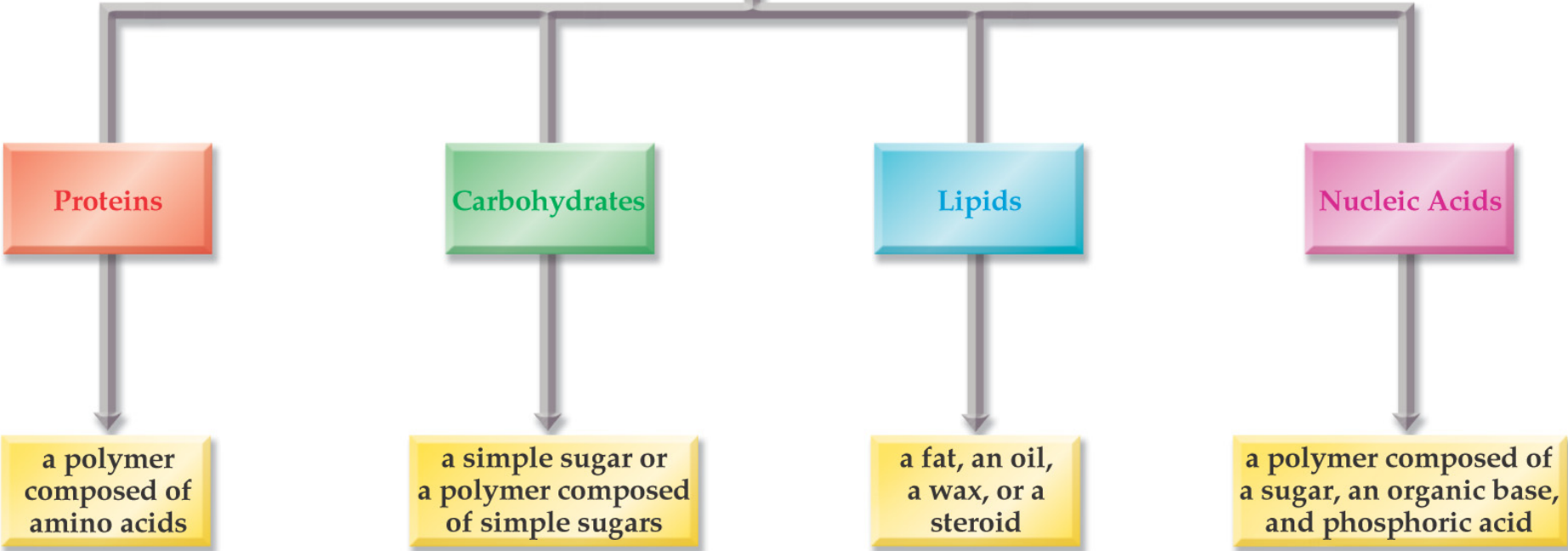
TABLE 8.7 Classification of Organic Compounds

Class	Functional Group	Example
Alkene	$\begin{array}{c} \diagup \quad \diagdown \\ \text{C}=\text{C} \\ \diagdown \quad \diagup \end{array}$	$\text{H}_2\text{C}=\text{CH}_2$
Alkyne	$-\text{C}\equiv\text{C}-$	$\text{HC}\equiv\text{CH}$
Alcohol	$-\text{OH}$	$\text{CH}_3-\text{CH}_2-\text{OH}$
Ether	$-\text{O}-$	$\text{CH}_3-\text{O}-\text{CH}_3$
Aldehyde	$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{H} \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{CH}_3-\text{C}-\text{H} \end{array}$
Ketone	$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}- \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{CH}_3-\text{C}-\text{CH}_3 \end{array}$
Carboxylic acid	$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{O}-\text{H} \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{CH}_3-\text{C}-\text{O}-\text{H} \end{array}$
Ester	$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{O}- \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{CH}_3-\text{C}-\text{O}-\text{CH}_3 \end{array}$
Amine	$\begin{array}{c} \\ -\text{N}- \end{array}$	CH_3-NH_2
Amide	$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{N}- \\ \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{CH}_3-\text{C}-\text{NH}_2 \end{array}$

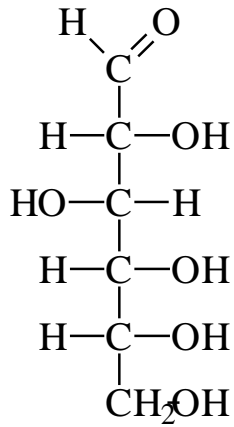
Table 19.14 Summary of Hydrocarbon Derivatives

Family Name	General Formula	Functional Group	Example
Organic halide	$R-X$	$-X$	CH_3-CH_2-Cl "ethyl chloride"
Alcohol	$R-OH$	$-OH$	CH_3-CH_2-OH "ethyl alcohol"
Phenol	$Ar-OH$	$-OH$	 phenol
Ether	$R-O-R'$	$-O-$	CH_3-O-CH_3 "dimethyl ether"
Amine	$R-NH_2$	$-NH_2$	$CH_3-CH_2-NH_2$ "ethyl amine"
Aldehyde	$R-\overset{\overset{O}{\parallel}}{C}-H$	$-\overset{\overset{O}{\parallel}}{C}-H$	$CH_3-\overset{\overset{O}{\parallel}}{C}-H$ "acetaldehyde"
Ketone	$R-\overset{\overset{O}{\parallel}}{C}-R'$	$-\overset{\overset{O}{\parallel}}{C}-$	$CH_3-\overset{\overset{O}{\parallel}}{C}-CH_3$ "acetone"
Carboxylic acid	$R-\overset{\overset{O}{\parallel}}{C}-OH$	$-\overset{\overset{O}{\parallel}}{C}-OH$	$CH_3-\overset{\overset{O}{\parallel}}{C}-OH$ "acetic acid"
Ester	$R-\overset{\overset{O}{\parallel}}{C}-O-R'$	$-\overset{\overset{O}{\parallel}}{C}-O-$	$CH_3-\overset{\overset{O}{\parallel}}{C}-O-CH_3$ "methyl acetate"
Amide	$R-\overset{\overset{O}{\parallel}}{C}-NH_2$	$-\overset{\overset{O}{\parallel}}{C}-NH_2$	$CH_3-\overset{\overset{O}{\parallel}}{C}-NH_2$ "acetamide"

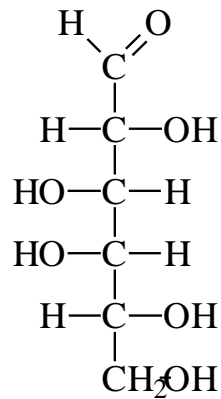
**BIOLOGICAL
COMPOUNDS**



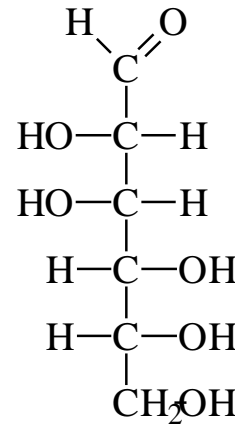
Monosaccharides - Simple carbohydrates that cannot be broken down by hydrolysis



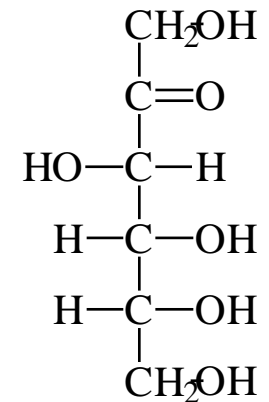
D-(-)-glucose



D-(+)-galactose

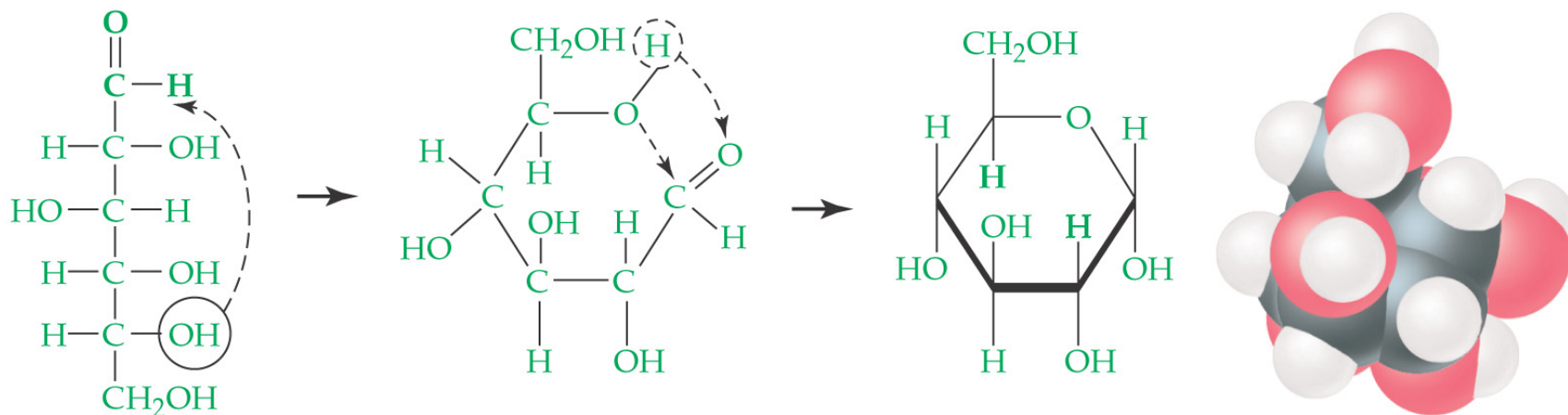


D-(+)-mannose

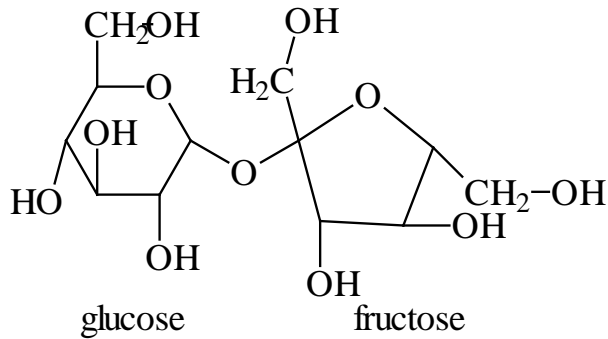


D-(-)-fructose

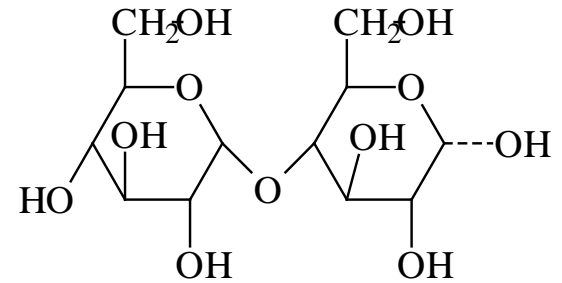
Sugars form a ring in solution



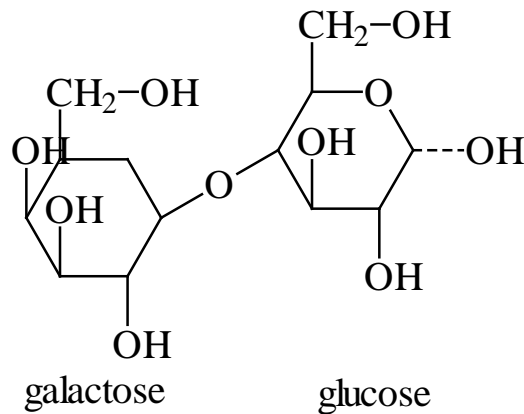
Disaccharides - sugars consisting of 2 monosaccharides



Sucrose

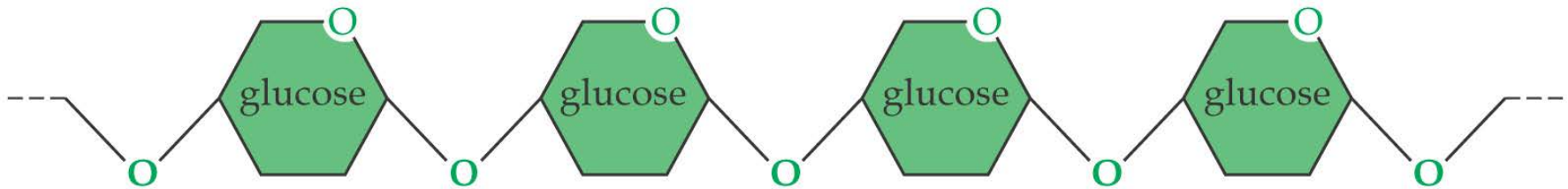


Maltose

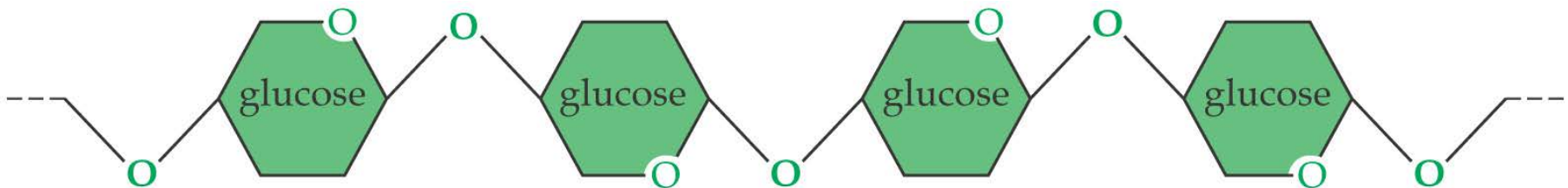


Lactose

Polysaccharides

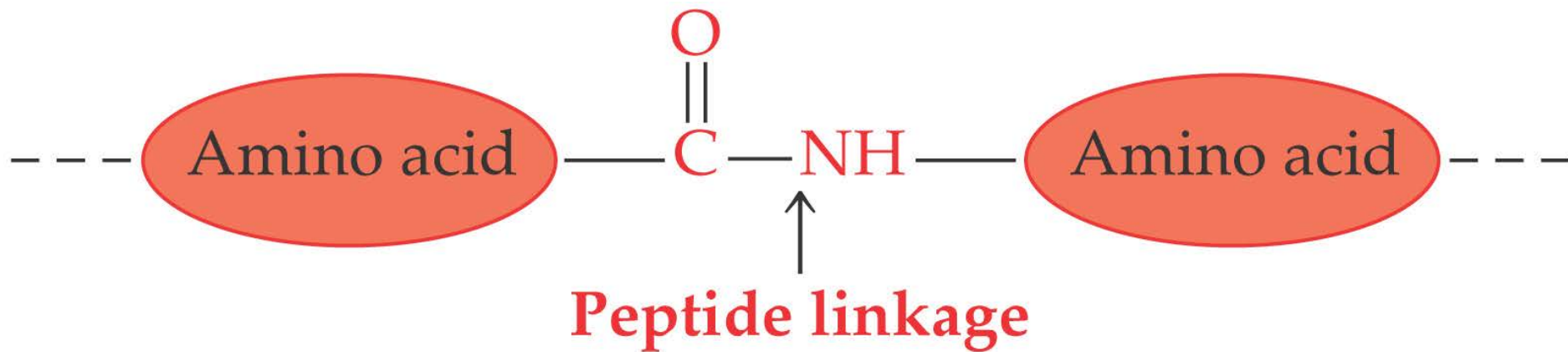


starch



cellulose

Proteins – composed of amino acid chains

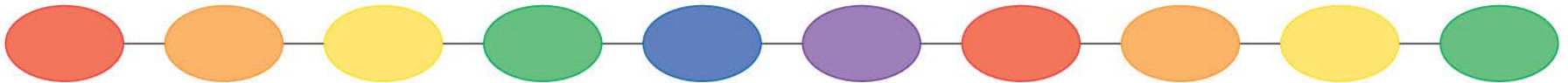


Major Classes of Protein

- Fibrous Proteins
 - Long rod-shaped or string-like molecules that can intertwine with each other and form strong fibers.
- Globular Proteins
 - Folded to be spherical

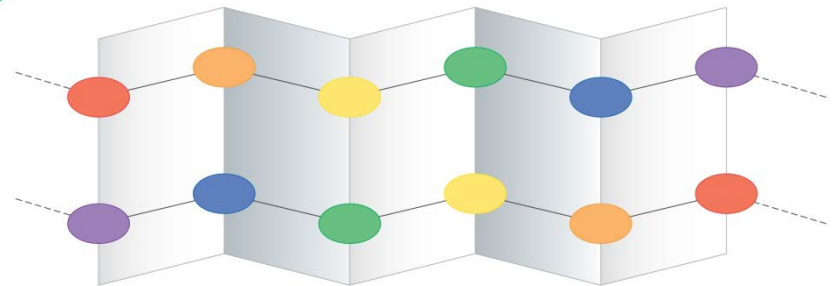
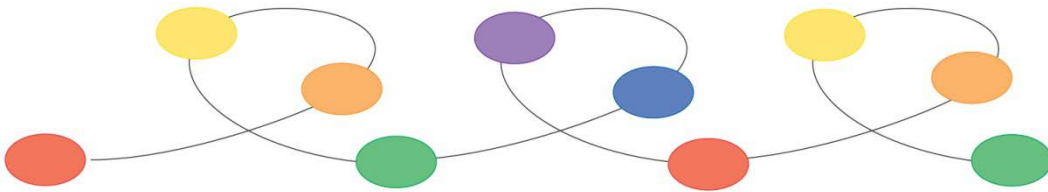
Primary structure

- refers to the number and sequence of amino acids in a peptide chain
- the unique sequences of each of the proteins determine their shapes and properties



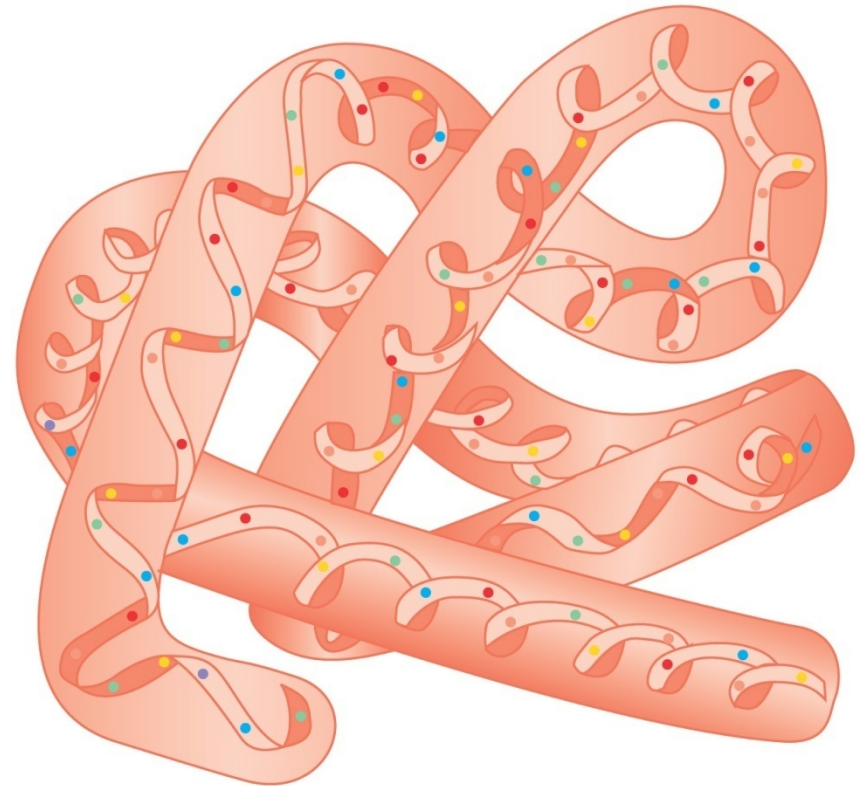
Secondary structure

- Refers to the ordered arrangement of the polypeptide backbone.
- Alpha helix
- Beta sheet



Tertiary structure

- Refers to the unique 3-D shape that results from the unique folding of the secondary structure.

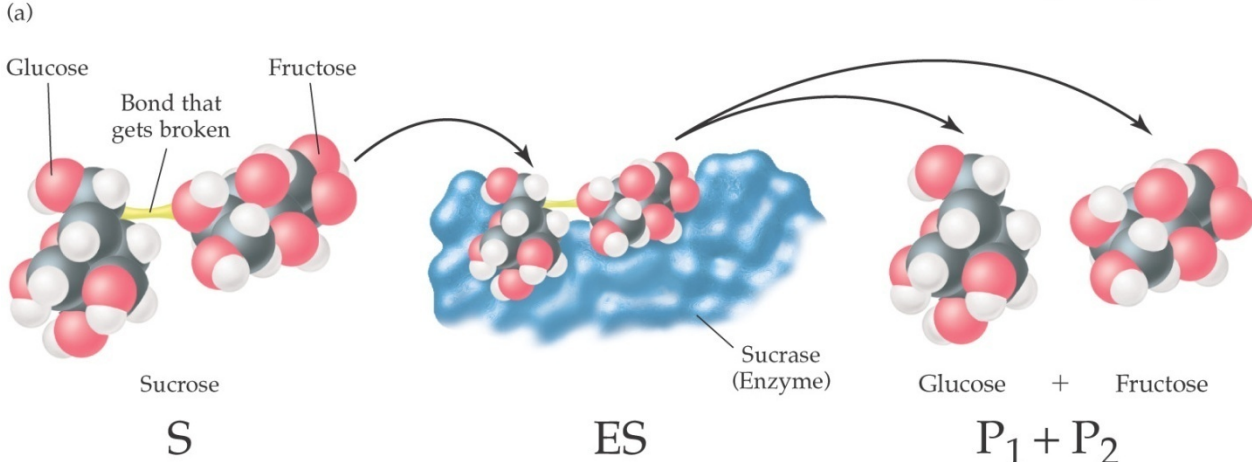
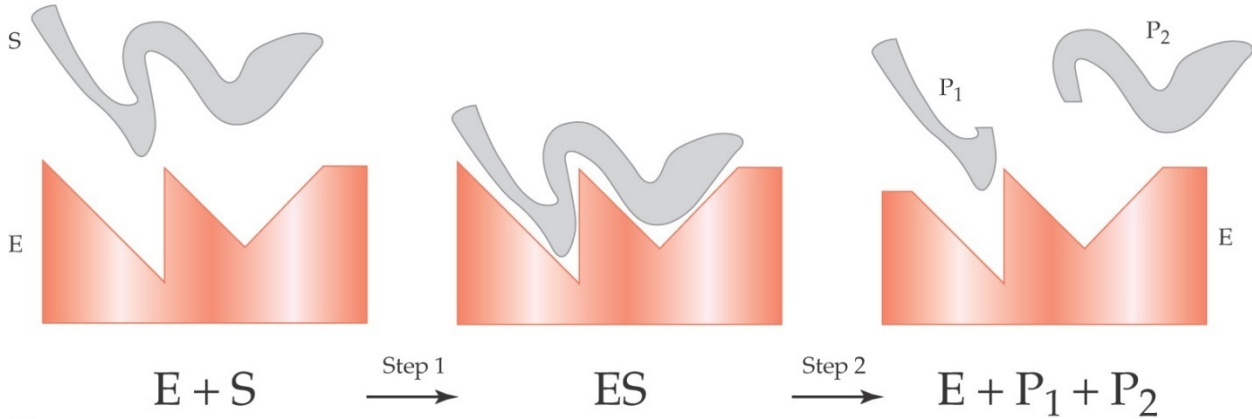


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Protein Function

- Catalytic
- Structural
- Storage
- Protective
- Regulatory
- Nerve impulse transmission
- Motion
- Transport

Enzymes



(b)

Denaturation of proteins

- Denaturation is any process that results in the loss of a proteins native configuration and thus its activity.
- Denaturing agents
 - Heat and UV light
 - Organic solvents
 - Strong acids and bases
 - Detergents
 - Heavy Metals

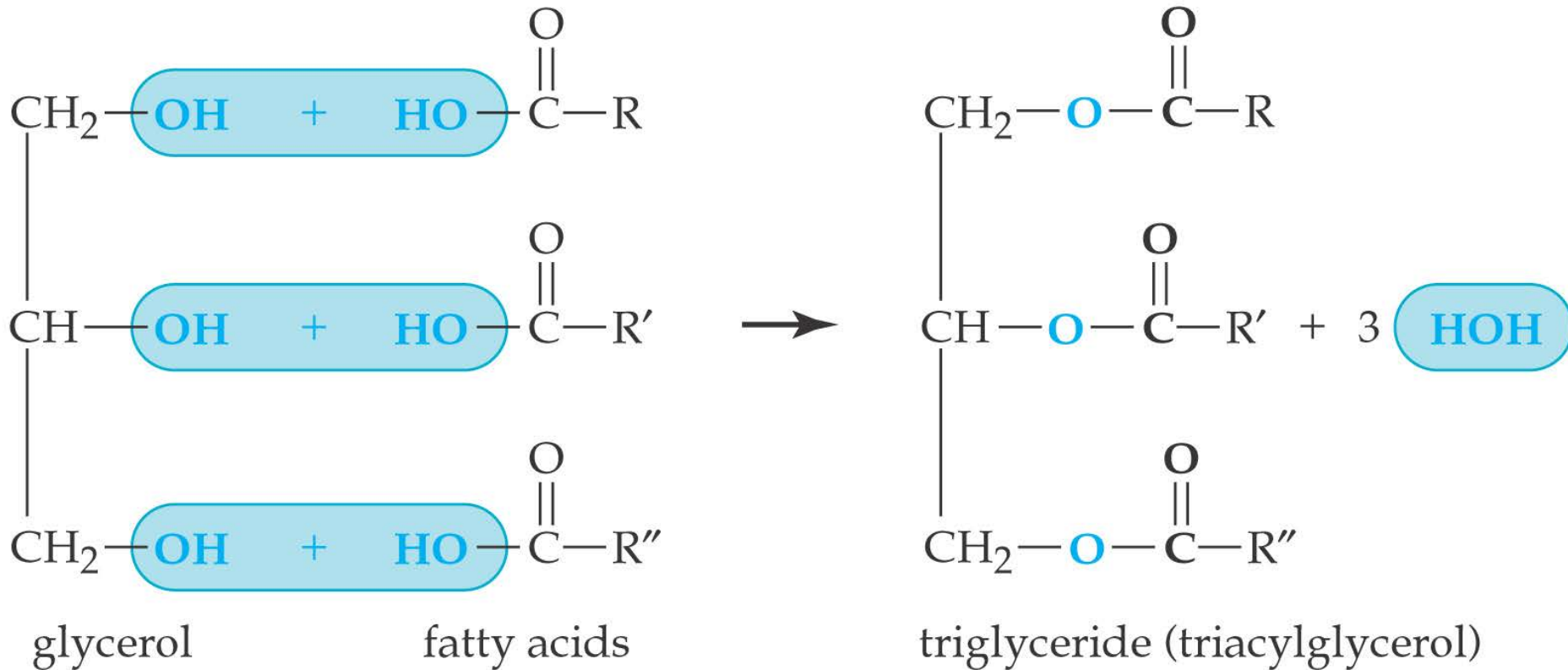
Lipids

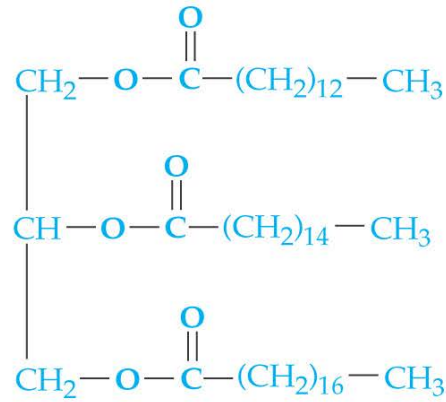
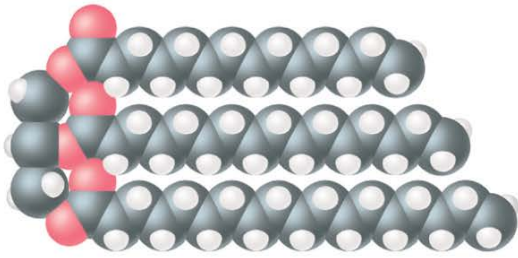
- Lipids are biological molecules that are insoluble in water and soluble in organic solvents.
 - Saponifiable lipids -- hydrolyzed to form carboxylic acid salts and alcohols.
 - tryglycerides
 - Nonsaponifiable lipids -- not hydrolyzed
 - Cholesterol and steroids

Lipid Function

- Energy Storage
 - 2 X the calories of carbohydrates per gram
- Important components of brain and nerve tissue
- They store and provide fat soluble vitamins
 - (Vitamins A, D, E, and K)
- They serve as protective padding and insulation for vital organs.
- They are a major constituent of cell membranes.

Triglycerides



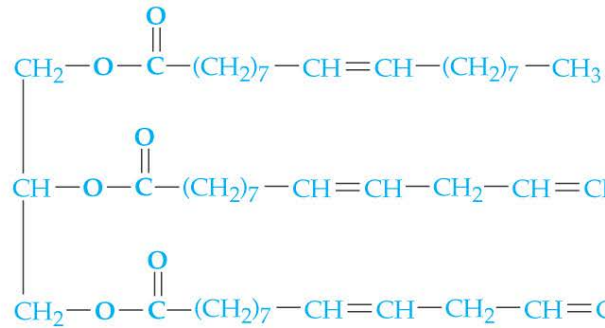
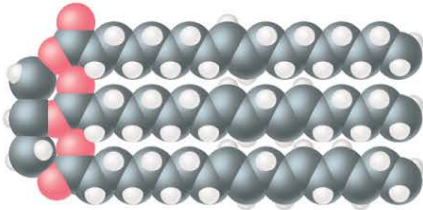


myristic acid ester

palmitic acid ester

stearic acid ester

Saturated fat



oleic acid ester

linoleic acid ester

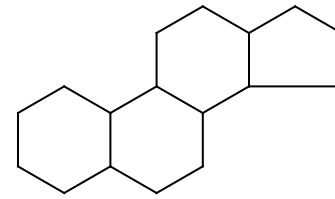
linolenic acid ester

Unsaturated fat

Steroids

- Cholesterol

- most prevalent steroid
- membrane component
- combines with fatty acids and abnormal muscle tissue in atherosclerosis
- Cholesterol is precursor to other steroids including bile salts, sex hormones, vitamin D, and adrenocortical hormones.



Nucleic acids

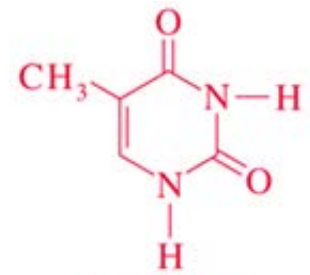
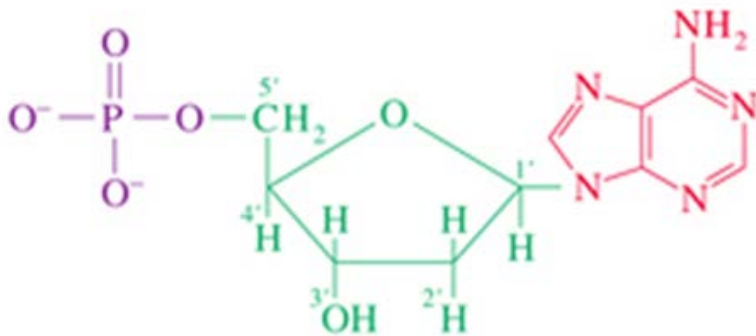
- Contain genetic information

Nucleotide

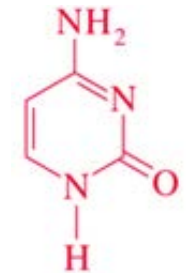
- A **nucleotide** in DNA consists of one of the 4 bases linked to a deoxyribose sugar which is linked to a phosphate:



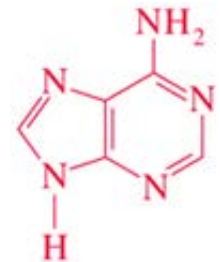
- Adenine deoxyribonucleotide:



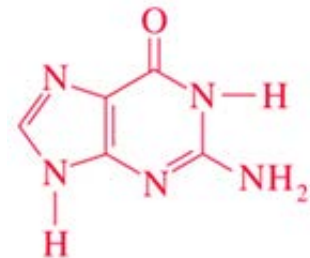
thymine (T)



cytosine (C)



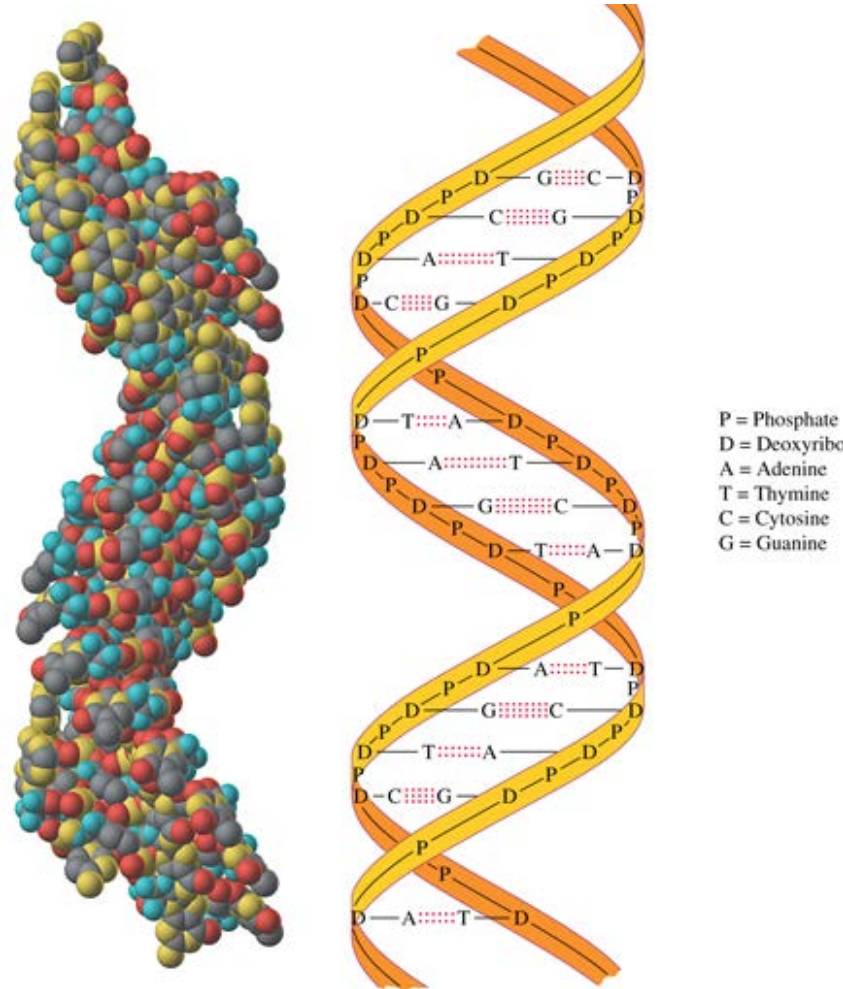
adenine (A)



guanine (G)

DNA

- **DNA** is a polymeric substance made up of thousands of units called **nucleotides**.
- The structure of DNA consists of two polymeric strands of nucleotides in the form of a double helix.
- The sequence of **base pairs** in the DNA is the genetic code for the individual.



RNA

- **RNA** is a single stranded polymer of nucleotides that contains ribose rather than deoxyribose and the base uracil rather than thymine.
- The main function of RNA is to direct the synthesis of proteins in the ribosomes of the cell.
- **Transcription** is the process by which DNA directs the synthesis of three types of RNA: messenger RNA, transfer RNA and ribosomal RNA

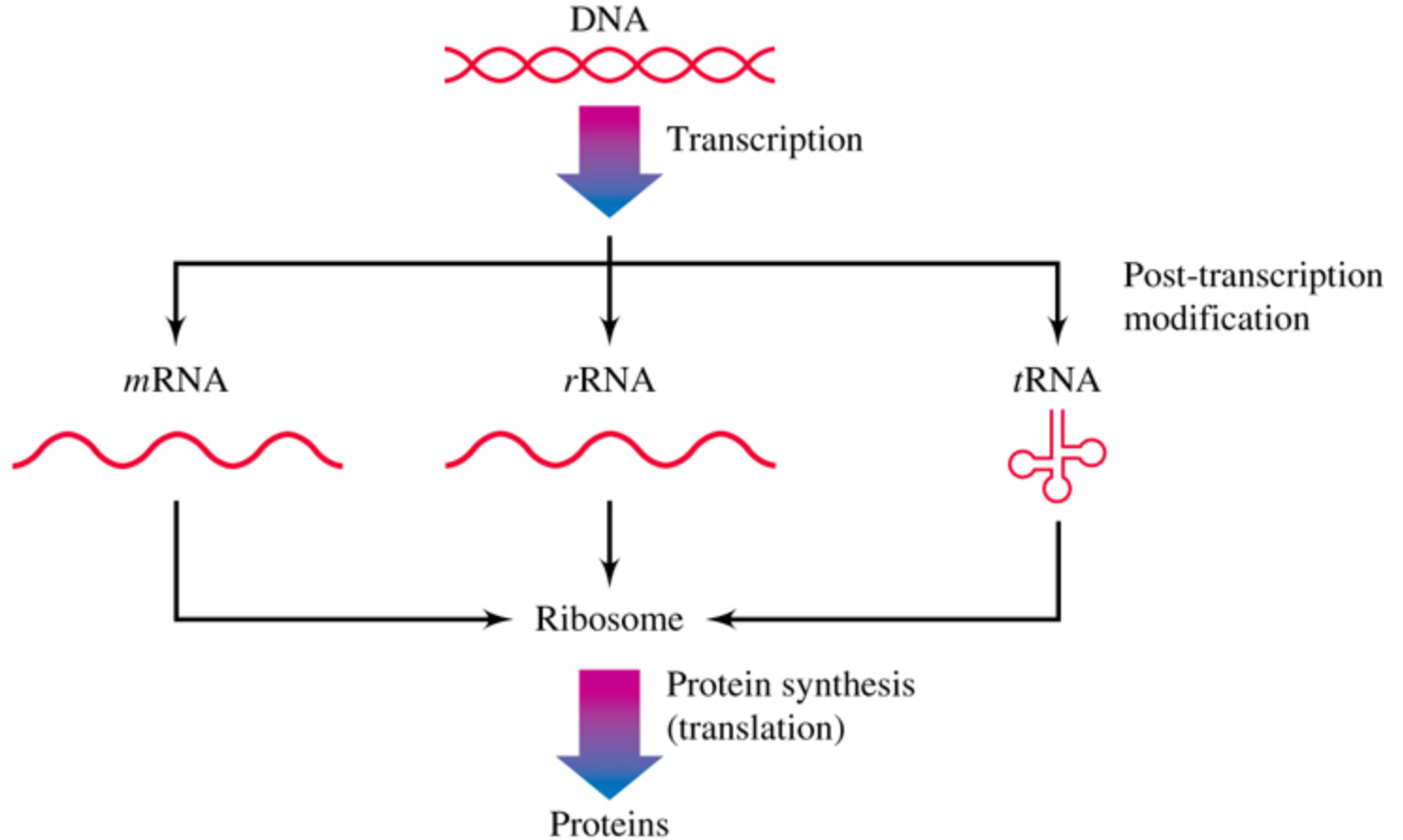


Figure 20.9
The process of cellular genetic information.