Chapter 21: Phenomena

Phenomena: Below are the names and pictures of several organic compounds. Can you determine the naming conventions of these compounds?

a) $H_2CCH_2CH_2CH_3$ / $H_3CCH_2CH_2$ — heptane

b) CH_3 — methylcyclopentane

c) H_3CCH_3 — ethane

d) $H_3CCH_2CH_2CH_3$ — butane

e) cyclopentane

f) CH_3 / $H_3CCHCHCH_2CH_3$ / CH_3 — 2,3-dimethylpentane

g) cyclobutane

h) CH_3 / $H_3CCHCH_2CH_3$ — methylbutane

i) H_3C — methylcyclopropane

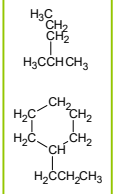
j) CH_3 / H_3CCHCH_3 — methylpropane

k) $H_3CCH_2CH_2CH_2CH_3$ — pentane

l) $H_3CCH_2CH_2CH_2CH_2CH_3$ — hexane

m) CH_3 / CH_2 / $H_3CCH_2CH{-}CH_2CH_2CH_3$ — 3-ethylhexane

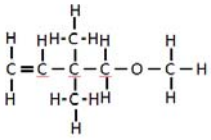
What are the names of the following structures and why?



Simple Organic Molecules

Structural Representations

Lewis Structure



Line Notation

- Chemical Formula

$CH_2CHC(CH_3)_2CH_2OCH_3$

Note: When other groups of hydrocarbons are coming off of a longer chain of carbons they are put in parentheses in the chemical formula.

Big Idea: The large number of hydrocarbons arise from the ability of carbon atoms to form long chains and rings with one another. The properties of hydrocarbons are dominated by the functional groups present. Functional groups properties are independent of their bonding environment.

Chapter 21: Organic and Biochemical Molecules

- Simple Organic Molecules
- Isomers
- Functional Groups
- Organic Reactions
- Polymers
- Biochemistry

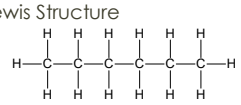
Simple Organic Molecules

Short Chemical Formula	Long Chemical Formula	Name	Space Filling Model	Short Hand
CH_4	CH_4	Methane		
C_2H_6	CH_3CH_3	Ethane		
C_3H_8	$CH_3CH_2CH_3$	Propane		
C_4H_{10}	$CH_3CH_2CH_2CH_3$	Butane		
C_5H_{12}	$CH_3CH_2CH_2CH_2CH_3$	Pentane		

Simple Organic Molecules

Structural Representations

Lewis Structure



Chemical Formula

$CH_3CH_2CH_2CH_2CH_2CH_3$

Line notation

Simple Organic Molecules

Short Chemical Formula	Long Chemical Formula	Name	Space Filling Model	Short Hand
C_6H_{14}	$CH_3CH_2CH_2CH_2CH_2CH_3$	Hexane		
C_7H_{16}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$	Heptane		
C_8H_{18}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	Octane		
C_9H_{20}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	Nonane		
$C_{10}H_{22}$	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	Decane		

Simple Organic Molecules

- Rules for Naming Branching Alkanes (C_nH_{2n+2})

1. The longest continuous chain of carbon atoms determines the root name for the hydrocarbon. Note the longest chain might not be in a straight line.
   - Example:

2. The longest chain will be named by taking the core name and adding -ane.
   - Example:

root name: hexane

# of Carbons	Core Name	# of Carbons	CoreName
1	meth-	6	hex-
2	eth-	7	hept-
3	prop-	8	oct-
4	but-	9	nan-
5	pent-	10	dec-

Simple Organic Molecules

- Rules for Naming Branching Alkanes (C_nH_{2n+2})

3. When alkane groups appears as a substituent (bonded to a larger alkane), they are named by taking the core name and adding –yl.
   - Example: CH_3CH_2- ethyl

4. When halogens are present as substituents they are named using the following:

Halogen	Name
F	fluoro
Cl	chloro
Br	bromo
I	iodo

Simple Organic Molecules

- Rules for Naming Branching Alkanes (C_nH_{2n+2})

5. When multiple of the same substituents are present the appropriate prefix is added to the name of the substituent.
   - Example: trimethyl

# of the same substituents	Name
2	di-
3	tri-
4	tetra-

Simple Organic Molecules

- Rules for Naming Branching Alkanes (C_nH_{2n+2})

6. Number the carbons in the chain so that the lowest number is given to the substituent.
   - Example:

Correct  Incorrect 

7. If both directions give the same lowest number for the 1st substituent then use the numbering which gives the lowest number for the 2nd substituent.
   - Example:

Correct  2,2,4

Incorrect  2,4,4

Simple Organic Molecules

- Rules for Naming Branching Alkanes (C_nH_{2n+2})

8. If two numbering schemes have the same lowest numbering scheme, give the lowest number to the substituent that appears first in the name.
   - Example:

Correct  Incorrect 

9. In front of each substituent, list the carbon number in which the substituent is bonds to in the alkane. If there are multiple of one type of substituent, multiple numbers will need to be used. Separate multiple numbers with comas. Separate the number from the name with a hyphen.
   - Example: 2,2,4-trimethyl

Simple Organic Molecules

- Rules for Naming Branching Alkanes (C_nH_{2n+2})

10. Substituents are listed in alphabetic order with respect to their root name (methyl, ethyl etc.). If multiple substituents are present, they are separated from each other with a hyphen. The substituent that is closest to the root name is combined with the root name.
    - Example: 4-ethyl-2,3-dimethyloctane

Simple Organic Molecules

CH_3CHCH_3	R	isopropyl
$-CH_2-C(H)(CH_3)-CH_3$	R	*isobutyl*
$CH_3CHCH_2CH_3$	R	sec-butyl
$C(CH_3)_3$	R	*tert*-butyl

Simple Organic Molecules

Student Question

Which of the following has the lowest boiling point?

a) Butane
b) Ethane
c) Propane
d) Methane

Simple Organic Molecules

- Rules for Naming Alkene and Alkynes

1. If a double bond is present, the root hydrocarbon is the longest chain that contains the double bond. The root hydrocarbon will be named by adding –ene to the core.
   - Example: pentene

2. If a triple bond is present, the root hydrocarbon is the longest chain that contains the triple bond. The root hydrocarbon will be named by adding –yne to the core.
   - Example: butyne

Simple Organic Molecules

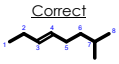
- Rules for Naming Alkene and Alkynes

3. If multiple double and triple bonds are present the following notation is placed in front of the –ene or –yne suffix which identifies the number of bonds in addition an "a" is added to the root name.
   - Example: heptadiene

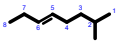
# of bonds	Name
2	di-
3	tri-
4	tetra-

4. The root chain will be numbered so that multiple bonds get the lowest possible number. This takes precedence over giving branching hydrocarbons or halogens.
   - Example:

Correct



Incorrect

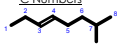


Simple Organic Molecules

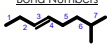
- Rules for Naming Alkene and Alkynes

5. Bonds are numbered in the same order as the carbons.
   - Example:

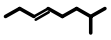
C Numbers



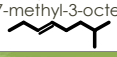
Bond Numbers



6. The bond number is placed in front of the root name. If there are multiple double or triple bonds, multiple numbers will need to be used. Separate multiple numbers with comas. Separate the number from the name with a hyphen.
   - Example: root name: 3-octene



7. Use the rules for naming alkanes to name the rest of the substituents.
   - Example: 7-methyl-3-octene



Simple Organic Molecules

- Rules for Naming Cyclic Hydrocarbons

1. Use a ring for the root name if the ring has more carbons than any of the other chains.
2. The root name is formed by adding the prefix cyclo- to the core name (indicating the number of carbons).
3. If only single bonds exist in the ring, the suffix –ane is added to the core name.
4. If double bonds exist in the ring, the suffix –ene is added to the core name. If multiple double bonds exist, include di-, -tri-, etc.
5. Number the cyclic hydrocarbon so that double bonds get preference over halogen or hydrocarbon chains

- Examples:

Simple Organic Molecules

- Rules for Naming Cyclic Hydrocarbons

6. Include the number indicating the substituents placement in front of the name of the substituent. If there is only one double bond then the number 1 does not need to be included prior to the core name because the position of the double bond is implied. If there is only 1 substituent and no double bonds, the number does not need to be included because it is implied.
   - Examples:


3-methylcylopentene


2-methyl-1,3-cylopentadiene

bromocylopropane

7. Use rules for naming alkanes to complete the name of the structure.
   - Example:


1-ethyl-2-methylcylobutane

Simple Organic Molecules

- Rules for Naming Aromatics

1. The same rules are used for naming benzene complexes as other cyclohydrocarbons except instead of using 1,3,5-cyclohexatriene for the root name, benzene is used.
   - Example: ethylbenzene

2. The same rules are used for naming toluene complexes as other cyclohydrocarbons except instead of using 1-methyl-1,3,5-cyclohexatriene for the root name, toluene is used. For toluene the methyl group is always counted as the number 1 carbon.

Note: The numbering of the carbons can be different for the same compound depending if you are using toluene or benzene as the root name.

Simple Organic Molecules

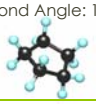
- Shapes of Cyclic Hydrocarbons

Carbon atoms in cycloalkanes are sp^3 hybridized therefore the ideal C-C bond angle is 109.5˚.

- Cyclopropane Bond Angle: ~60˚

- Cyclobutane Bond Angle: ~90˚

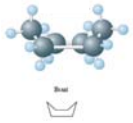
- Cyclopentane Bond Angle: 108˚



- Cyclohexane

Flat Bond Angle: 120˚

Bent Bond Angle: ~109.5˚



Simple Organic Molecules

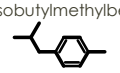
- Rules for Naming Aromatics

3. If two substituents are present on benzene or one on toluene the ortho/meta/para naming can be used. Place the following in front of the name when using ortho/meta/para naming.

Configuration	Start of Name
ortho	o-
meta	m-
para	p-

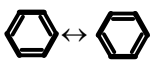
- Example: 1-bromo-2-ethylbenzene
  o-bromoethylbenzene

- Example: 4-isobutyltoluene
  p-isobutyltoluene
  1-isobutyl-4-methylbenzene
  p-isobutylmethylbenzene



Simple Organic Molecules

- **Aromatics:** A compound that includes a benzene ring as part of its structure


benzene


toluene

Note: Instead of showing the resonance structures for benzene, the symbol  is used to represent benzene.

Otho/Meta/Para

Ortho

Meta

Para

Note: The ortho/meta/para notation can be used for any ring structure but it is commonly used with aromatics.

Isomers

Student Question

What is the maximum number of structural isomers of C_5H_{12}?

a) 2
b) 3
c) 4
d) 5
e) None of the Above

Isomers

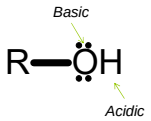
Student Question

What is the maximum number of structural and geometric isomers of C_4H_8?

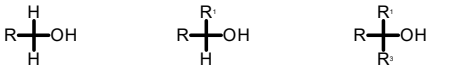
a) 3
b) 4
c) 5
d) 6
e) None of the Above

Functional Groups

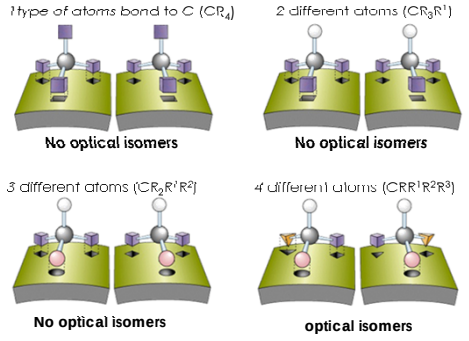
- Alcohols
  - H-Bonding occurs for alcohols
  - Increases boiling point and melting point from the alkanes
  - More soluble in water
  - Amphoteric, but better acid than a base



Note: When the alcohol is functioning as an acid, the hydrogen bonded to the oxygen dissociates. When the alcohol is functioning as a base, a hydrogen bonds to the lone pair of electrons on the oxygen



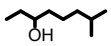
Isomers



Functional Groups

- Rules for Naming Alcohols:-OH R–OH

1. The root name is formed by taking the alkane name corresponding to the number of carbons that the alcohol is bonded to, and replacing the e with -ol
   - Example:

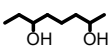


Root Name: octanol

2. If multiple alcohols are present the e is kept on the alkane name and the following is inserted between the alkane name and -ol:

# of -OH	Name
2	di-
3	tri-
4	tetra-

- Example:



octanediol

Note: When prefix is put on the e in the alkane name goes back on.

Functional Groups

TABLE 21.4
The Common Functional Groups

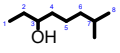
Class	Functional Group	General Formula*	Example
Halohydrocarbons	—X (F, Cl, Br, I)	R—X	CH_3I Iodomethane (methyl iodide)
Alcohols	—OH	R—OH	CH_3OH Methanol (methyl alcohol)
Ethers	—O—	R—O—R'	CH_3OCH_3 Dimethyl ether
Aldehydes	—C(=O)—H	R—C(=O)—H	CH_2O Methanal (formaldehyde)
Ketones	—C(=O)—	R—C(=O)—R'	CH_3COCH_3 Propanone (dimethyl ketone or acetone)
Carboxylic acids	—C(=O)—OH	R—C(=O)—OH	CH_3COOH Ethanoic acid (acetic acid)
Esters	—C(=O)—O—	R—C(=O)—O—R'	$CH_3COOCH_2CH_3$ Ethyl acetate
Amines	$-NH_2$	$R-NH_2$	CH_3NH_2 Aminomethane (methylamine)

*R and R' represent hydrocarbon fragments.

Functional Groups

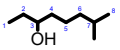
- Rules for Naming Alcohols:-OH R–OH

3. If the only functional group that is present is the alcohol, the root carbons are numbered such that the alcohol is bonded to the lowest numbered carbon. The number of the carbon that the alcohol is bonded to, is placed in front of the root name.
   - Example:



Root Name: 3-octanol

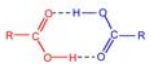
4. Follow the remaining rules for naming alkanes and cycloalkanes.
   - Example:

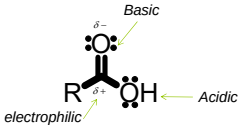


7-methyl-3-octanol

Functional Groups

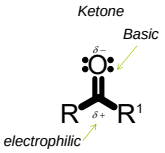
- Carboxylic Acids
  - H-Bonding occurs for carboxylic acids
  - Increases boiling point and melting point from the alcohols
  - Water soluble
  - Amphoteric

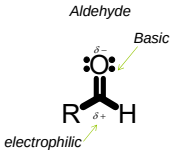




Functional Groups

- Aldehydes and Ketones
  - Cannot participate in hydrogen bonding by themselves.
  - Short ketones and aldehydes are water soluble.
  - Aldehydes are easier oxidized than ketones



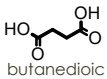


Functional Groups

- Rules for Naming Carboxylic Acid: -COOH

1. The root name is formed by taking the alkane name corresponding to the number of carbons that the carboxylic acid is bonded to and replacing the e with –oic acid.
   - Example:

   Root Name: pentanoic acid
2. If two carboxyl groups are present, add the suffix -dioic acid to the alkane name.
   - Example:



   butanedioic acid

Note: When prefix is put on the e in the alkane name goes back on.

Functional Groups

- Rules for Naming Aldehydes: -CHO

1. The root name is formed by taking the alkane name corresponding to the number of carbons that the aldehyde is bonded to, and replacing the e with –al.
   - Example:

   Root Name: butanal
2. If two aldehydes are present add the suffix -dial to the alkane name.
   - Example:

   butanedial

Note: When prefix is put on the e in the alkane name goes back on.

Functional Groups

- Rules for Naming Carboxylic Acid: -COOH

3. If the only functional group that is present is the carboxylic acid, the root carbons are numbered such that the carboxylic acid is bonded to carbon number 1. Since the carboxylic acid always must be bonded to carbon number 1, no number needs to be included in front of the root name.
   - Example:

   Root Name: pentanoic acid
4. Follow the remaining rules for naming alkanes and cycloalkanes
   - Example: 3-methylpentanoic acid

Functional Groups

- Rules for Naming Aldehydes: -CHO

3. If the only functional group that is present is the aldehyde, the root carbons are numbered such that the aldehyde is bonded to carbon number 1. Since the aldehyde always must be bonded to carbon number 1, no number needs to be included in front of the root name.
   - Example:

   Root Name: butanal
4. Follow the remaining rules for naming alkanes and cycloalkanes.
   - Example: 3-bromobutanal

Functional Groups

- Rules for Naming Ketone: -C=O-

1. The root name is formed by taking the alkane name corresponding to the number of carbons that the ketone is bonded to, and replacing the e with –one.
   - Example:

   Root Name: hexanone

2. If multiple ketones are present the e is kept on the alkane name and the following is inserted between the alkane name and –one:

# of =O	Name
2	di-
3	tri-
4	tetra-

   - Example:

   Root Name: hexanedione

Note: When prefix is put on the e in the alkane name goes back on.

Functional Groups

- Rules for Naming Ketone: -C=O-

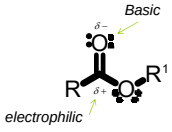
3. If the only functional group that is present is the ketone the root carbons are numbered such that the ketone is bonded to the lowest number carbon. The number of the carbons that the ketone is bonded to is placed in front of the root name.
   - Example:

   Root Name: 2-hexanone

4. Follow the remaining rules for naming alkanes and cycloalkanes.
   - Example: 4-ethyl-3-methyl-2-hexanone

Functional Groups

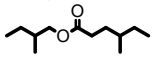
- Esters
  - Fairly high boiling points
  - Cannot participate in hydrogen bonding by themselves
  - Slightly water soluble (the larger the molecules, the less water soluble)



Functional Groups

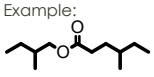
- Rules for Naming Esters: -COO-

1. Count the number of carbons in R¹(). Take the corresponding core name and add –yl.
   - Example:



   butyl

2. Count the number of carbons in R and add 1 (). Take the corresponding alkane name for R+1 and replace the e with -oate.
   - Example:

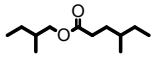


   hexanoate

Functional Groups

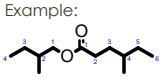
- Rules for Naming Esters: -COO-

3. The root name of the ester is formed by placing the name in step 1 in front of the name in step 2.
   - Example:



   Root Name: butyl hexanoate

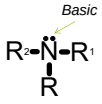
4. The substituents that are bonded to R¹() are placed in front of the R¹ name and the substituents that are bonded to R are placed in front of the R name. This causes the root name to be broken up.
   - Example:



   2-methylbutyl-4-methylhexanoate

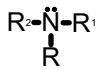
Functional Groups

- Amines
  - Allows H-Bonding to occur (primary and secondary only).
  - Every amino acid contains at least 1 amine (and a carboxylic acid).




Primary Amine


Secondary Amine


Teriary Amine

Functional Groups

- Rules for Naming Amines:

1. Find the longest carbon chain. Take the corresponding alkane name and drop the e and add amine.

- Example:

Root Name: pentanamine

2. Number the carbons in the longest chain so that the nitrogen is attached to the lowest number carbon possible. Place the nitrogen attach number in front of the root name.

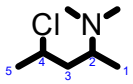
- Example:

Root Name: 2-pentanamine

Functional Groups

- Rules for Naming Amines:

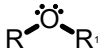
1. Follow the remaining rules for naming alkanes. If the substituent comes of the nitrogen put a *N* instead of a number in front of the substituents name.



- Example:
4-chloro-*N*,*N*-dimethyl-2-pentanamine

Functional Groups

- Ethers
  - Slightly polar.
  - Not very soluble in water.
  - Relatively unreactive.
  - Most common ether reaction is cleavage of the carbon oxygen bond by a strong acid.



Functional Groups

- Rules for Naming Ethers: ROR_1

1. Count the number of carbons in the shorter R chain. Take the corresponding core name and add –oxy.

- Example:

Root Name: ethoxy

2. Number the carbons in the longer chain in order to give the shorter chain the lowest number attachment point. Place the attachment number in front of the root name.

- Example:

Root Name: 1-ethoxy

3. Name the longer chain using the rules for naming alkanes.

- Example:
1-ethoxy-2,3-dimethypentane

Functional Groups

Student Question

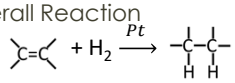
The boiling point of methanol is much higher than that of ethane. This is primarily due to:

a) the significant difference in the molar masses of methanol and ethane.
b) the hydrogen bonding in methanol and the lack of hydrogen bonding in ethane.
c) the significant difference in the molecular sizes of methanol and ethane.
d) the carbon–oxygen bond in the methanol.

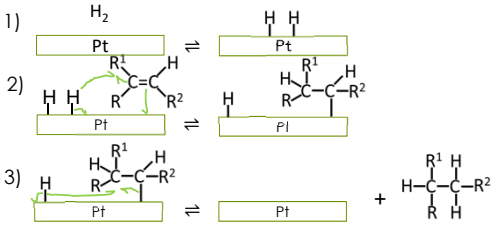
Organic Reactions

Hydrogenation Reactions

- Overall Reaction

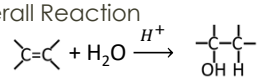


- Mechanism



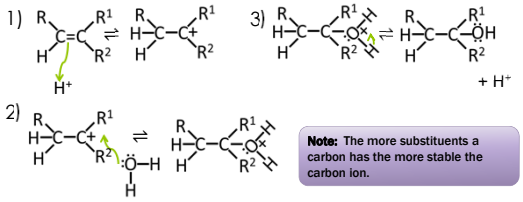
Organic Reactions

- Overall Reaction



Note: The OH will add to more substituted side.

- Mechanism



Note: The more substituents a carbon has the more stable the carbon ion.

Organic Reactions

Substitution Reactions

- Overall Reaction

$$CH_4 + Cl_2 \xrightarrow{h\nu} CH_3Cl + HCl$$
$$CH_3Cl + Cl_2 \xrightarrow{h\nu} CH_2Cl_2 + HCl$$
$$CH_2Cl_2 + Cl_2 \xrightarrow{h\nu} CHCl_3 + HCl$$
$$CHCl_3 + Cl_2 \xrightarrow{h\nu} CCl_4 + HCl$$

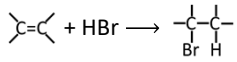
- Mechanism

$$Cl_2 \xrightarrow{h\nu} Cl\cdot$$
$$CH_4 + Cl\cdot \longrightarrow \cdot CH_3 + HCl$$
$$\cdot CH_3 + Cl\cdot \longrightarrow CH_3Cl$$

Note: A dot represents a single e⁻. Structures will single e⁻ are called radicals.

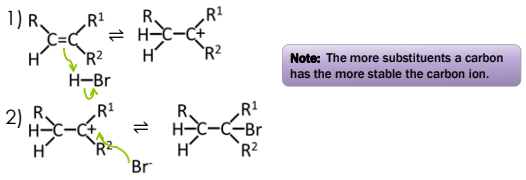
Organic Reactions

- Overall Reaction



Note: The Br will add to the more substituted side.

- Mechanism

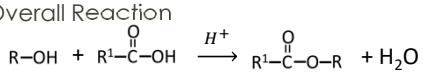


Note: The more substituents a carbon has the more stable the carbon ion.

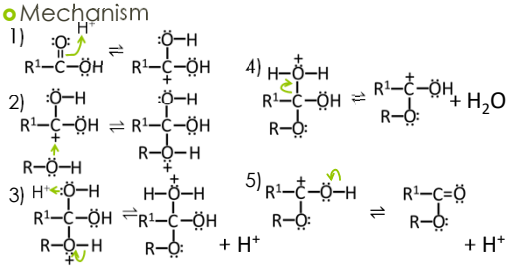
Organic Reactions

Esterification

- Overall Reaction



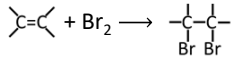
- Mechanism



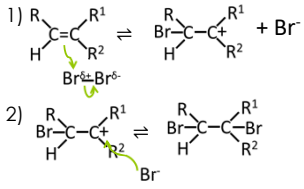
Organic Reactions

Halogenation

- Overall Reaction

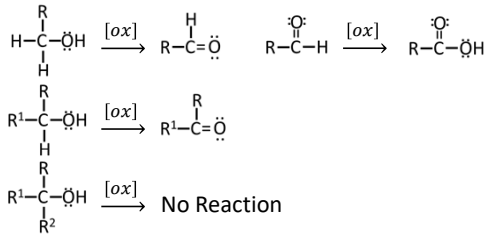


- Mechanism



Organic Reactions

- **Oxidation:** Addition of electronegative atoms to carbon or removal of hydrogen atoms from carbon.
- **Reduction:** Removal of electronegative atoms from carbon or addition of hydrogen atoms to carbon.



Organic Reactions

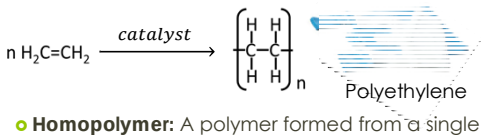
Student Question

What might be the product of the oxidation of 2-methyl-1-butanol?

a) 2-methyl-2-butanone
b) 2-methylbutanal
c) 2-methylbutanoic acid
d) Both b and c
e) Both a and c

Polymers

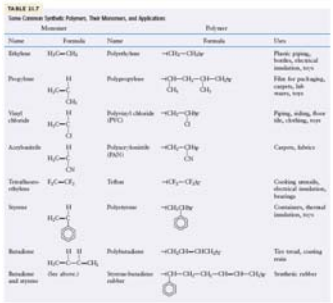
- **Polymers:** Compound in which chains or networks of small repeating units form giant molecules.
- **Addition Polymer:** A polymer formed by adding monomer units together (usually by reacting double bond).



- **Homopolymer:** A polymer formed from a single monomer.

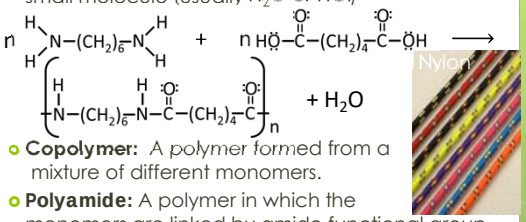
Polymers

- **Other Addition Polymers**



Polymers

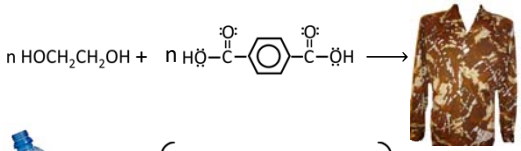
- **Condensation Polymer:** A polymer that forms when two monomers combine by eliminating a small molecule (usually H_2O or HCl)

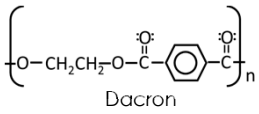


- **Copolymer:** A polymer formed from a mixture of different monomers.
- **Polyamide:** A polymer in which the monomers are linked by amide functional group (nitrogen next to double bonded oxygen) formed by condensation.

Polymers

- **Polyester:** A polymer in which the monomers are linked by ester groups formed by condensation.

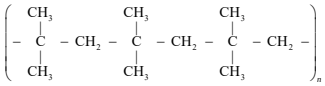




Polymers

Student Question

Consider the polymer:

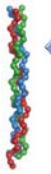


What monomer(s) is/are needed to produce the above polymer?

a) $CH_2=CH_2$ and $CH_3CH = CH_2$
b) $CH_2=C(CH_3)_2$
c) $CH_3CH=CHCH_3$
d) CO and $CH_2=CH_2$
e) None of the Above

Biochemistry

- **Protein:** A natural high-molecular-weight polymer formed by condensation reactions between amino acids.

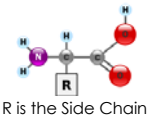


Fibrous Proteins
- Non soluble
- Provide structure integrity and strength

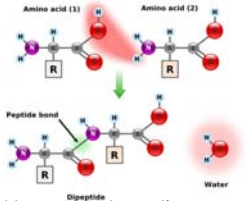
Globular Proteins
- Soluble in Water
- Transport of oxygen and nutrients and act as catalyst to reactions

Biochemistry

- **Amino Acids:** Monomers of proteins



R is the Side Chain



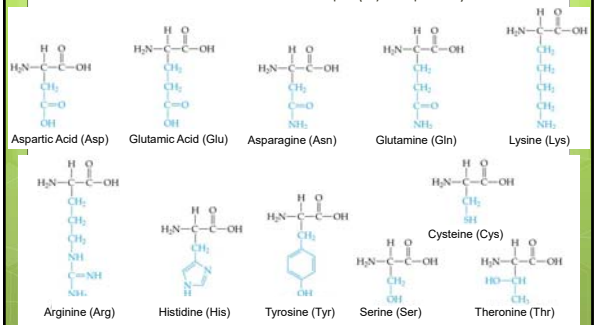
- **Peptide:** Molecule formed by a condensation reaction between amino acids.

Note: Often peptides are described in terms of the number of units. Ex. dipeptide or polypeptide.

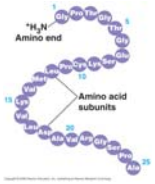
- **Peptide Bond:** The –CONH- group.

Biochemistry

- Amino Acid with Polar R Groups (hydrophilic)

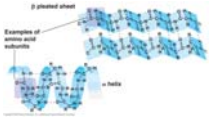


Biochemistry



Primary Structure:
- The sequence of amino acids in the polypeptide chain of a protein.

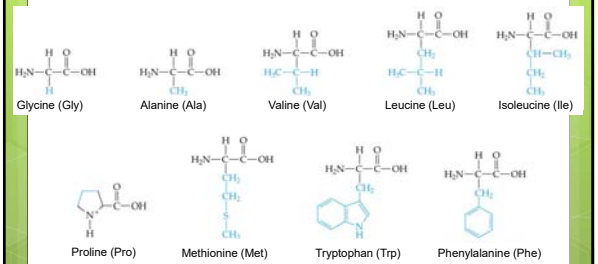
Secondary Structure:
- The manner in which a polypeptide chain is coiled. (Short range structure).



Note: Secondary structure usually a result of H-Bonding

Biochemistry

- Amino Acid with Nonpolar R Groups (hydrophobic)

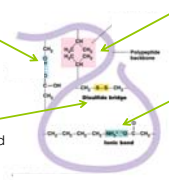


Biochemistry

- **Tertiary Structure:** The shape into which the α–helix and β–sheet sections of a polypeptide are twisted as a result of interactions between peptide groups lying in different parts of the primary structure. (Long range order)

H-Bonds: Needs each amino acid R group to contain groups that can H-Bond

Disulfide Bridge: Needs each amino acid R group to contain sulfur



London Dispersion: Needs each amino acid R to be nonpolar

Ionic: Needs the amino acid R groups to contain either COOH or NH_2

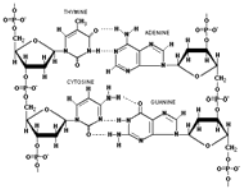
Biochemistry

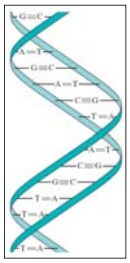
- **DNA (deoxyribonucleic acid):** A huge nucleotide polymer having a double-helical structure with complementary bases on the two strands. Its major functions are protein synthesis and the storage and transport of genetic information.
- **RNA (ribonucleic acid):** A nucleotide polymer that transmits the genetic information stored in the DNA to the ribosomes for protein synthesis.

Biochemistry

DNA structure

- Contain two strands with complementary bases
  - Thymine and Adenine
  - Cytosine and Guanine

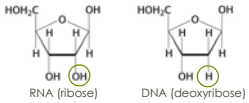




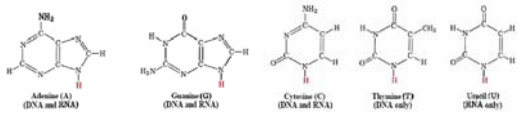
Biochemistry

Nucleotides

- Contain 5-carbon sugar

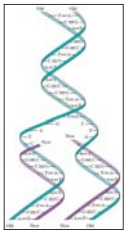


- Contain nitrogen-containing organic base



Biochemistry

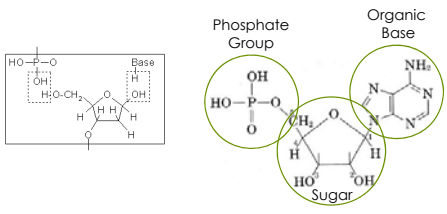
DNA is located in the cell nucleus. When cells divides, the DNA unwinds and new complimentary strands are constructed.



Biochemistry

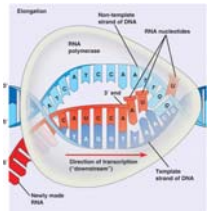
Nucleotides

- Contain a phosphoric acid molecule (H_3PO_4)



Biochemistry

RNA Transcription: Process of creating an equivalent RNA copy from a sequence of DNA.



RNA Complimentary Bases

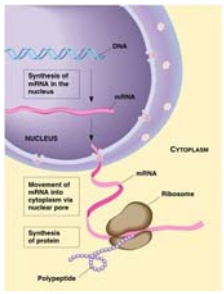
DNA Bonding Site	RNA Nucleotide
Thymine	Adenine
Adenine	Uracil
Cytosine	Guanine
Guanine	Cytosine

Biochemistry

mRNA *(messenger RNA)*: Template for protein synthesis.

tRNA *(transfer RNA)*: RNA molecules that transfer specific amino acids to a growing protein.

RNA Translation: The process in which the genetic code carried by mRNA directs the production of proteins from amino acids.



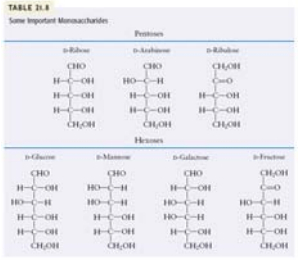
Biochemistry

Carbohydrate: an organic compound containing only carbon, hydrogen and oxygen with the general formula $C_m(H_2O)_n$.

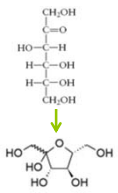
- Purpose of Carbohydrates
  - Food sources
  - Structural material (plants)
  - DNA backbone

Biochemistry

Monosaccharides *(simple sugars)*: An individual unit from which carbohydrates are considered to be composed.

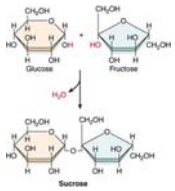


D-frutose



Note: Many monosaccharides are more stable in ring structures.

Biochemistry



Glycoside Linkage: Carbon-Oxygen-Carbon linkage that join rings together.

Disaccharide: A carbohydrate formed from to monosaccharides.

Take Away From Chapter 21

Big Idea: The large number of hydrocarbons arise from the ability of carbon atoms to form long chains and rings with one another. The properties of hydrocarbons are dominated by the functional groups present. Functional group's properties are independent of their bonding environment.

- **Simple Organic Molecules**
  - Know how to draw fisher projections (3D representations of 2D) and skeletal formula (line structures) or organic compounds.
  - Know how to name branching alkanes, alkene, and alkynes. (9,11,13,14)
  - Know how to name cyclic hydrocarbons (12,15)
  - Know fundamental properties of organic molecules (7,132)
    - Cyclic hydrocarbon rings
      - 5 and 6 member rings are commonly found.
      - 5 membered rings are flat while 6 membered rings exist in the chair or boat configuration.
  - Know how to name aromatic compounds (benzene and toluene)(16)

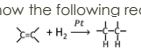
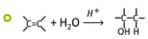
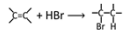
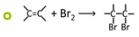
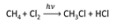
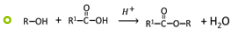
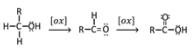
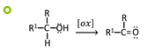
Numbers correspond to end of chapter questions

Take Away From Chapter 21

- **Isomers** (27,28,30)
  - Be able to determine the number of structural isomers for a given chemical formula. (5,8,29)
  - Be able determine if geometric isomers exist. (21,25,26)
    - Double bond or ring structure.
    - 2 different substituents on both atoms of interest.
  - Be able to determine if a compound has an optical isomer (106,112,113,114,116)
    - 4 different groups bonded to a carbon.
- **Functional Groups** (39,40)
  - Be able to recognize and name the following functional groups (37,38,43,44,45,46,49)
    - Alcohol(OH), Carboxylic acid (COOH), Aldehyde(CHO), Ketone(C=O), Esters (COO), Amines(contain N), and Ethers(COC)

Numbers correspond to end of chapter questions

Take Away From Chapter 21

- **Functional Groups**
  - Know fundamental properties of the functional groups. (40)
    - Which functional group is most soluble in water, polar, etc.
  - Be able to recognize primary, secondary and tertiary alcohols and amines.(41,42)
- **Organic Reactions** (56,61,65)
  - Know the following reactions
    - 
    - 
    - 
    - 
    - 
      this reaction can continue until all H are replaced by Cl
    - 
    - 
    - 

Numbers correspond to end of chapter questions.

Take Away From Chapter 21

- **Polymers** (69)
  - Know the difference between addition polymers and condensation polymers.
  - Be able to determine the structure of the polymer based on the monomers and the monomer based on the structure of the polymer. (72,75,76,77,84)
- **Biochemistry**
  - Know the basic properties of proteins (89,99)
    - Types of structure (primary, secondary, tertiary)(88)
    - Know how to draw the structure of peptides (95,96)
  - Know the basic properties of DNA and RNA (117,119)
  - Know the basic properties of carbohydrates (111)

Numbers correspond to end of chapter questions.