



Cihan University Sulaimaniya
College of Health Sciences
Department of Anesthesia



General Chemistry

For First Stage
First Semester

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Organic Chemistry, Synthetic Chemistry, Carbon nanomaterials

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Chapter 2: Classes of Organic Compounds

- ❑ The purpose of this chapter is to review the kinds and structures of the common **classes of organic compounds**, and briefly to explore their **chemical and physical properties and their nomenclature**.

- A patient is brought to the preoperative area for a planned total shoulder replacement.
 - As part of the anesthetic, the certified registered nurse anesthetist (CRNA) decides to perform an interscalene block for postoperative pain control.
 - When reviewing the patient history, the CRNA discovers that the patient reports an allergy to procaine.
 - When interviewed, the patient reports that with the use of procaine, she experienced respiratory arrest, denoting a true allergy versus a drug reaction.
- Can the CRNA still perform an interscalene block? What local anesthetics should be avoided?
- Local anesthetics exist in two classes: **esters and amides**.
1. **An ester anesthetic** (benzocaine, procaine, and tetracaine) are more likely to lead to allergic reaction and toxicity.
 2. **One of the amide anesthetics** (bupivacaine, etidocaine, lidocaine, mepivacaine, ropivacaine, prilocaine) is recommended for use in a patient with a history of allergy to an ester local anesthetic.
- In this case, the CRNA performs an interscalene block with 25 mL of 0.25% bupivacaine and the patient experiences 18 hours of postoperative pain control.

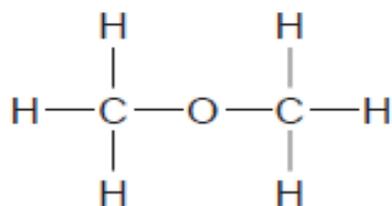
2.1 Introduction

- ❑ Organic compounds are based on carbon.
- ❑ Carbon merits its own branch of chemistry because it is nearly unique in its ability to form bonds to other carbon atoms, including straight-chained, branched-chained, and cyclic structures.
- ❑ Carbon also forms stable covalent bonds with many other elements, including hydrogen, oxygen, nitrogen, phosphorus, and sulfur. Because of this versatility in bonding, carbon-based compounds exhibit isomerism.

2.1 Introduction

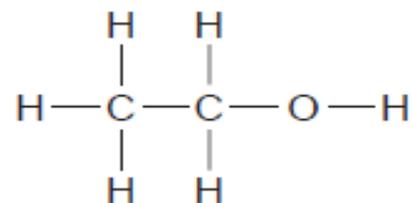
Molecular formula, Structural formula and Constitutional isomers

- **Molecular formula:** show the number of each type of atom in a molecule like C_2H_6O
- **Structural formula:** show how the atoms in a molecule are bonded to each other
- **Constitutional isomers** share the same molecular formula but have different connectivity of atoms and different physical properties.



Dimethyl ether
Boiling point = -23°C

Colorless gas used as an aerosol spray propellant



Ethanol
Boiling point = 78.4°C

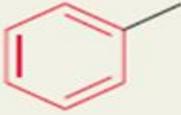
Clear liquid, commonly referred to as “alcohol,” found in alcoholic beverages.

2.2 Identifying Functional Groups: definition and structural features

- ❑ A **functional group** is defined as an **atom** or a **group of atoms/bonds** that effectively determines the **chemical properties** of an organic compound.
- ❑ The chemistry of every organic compound is determined by the functional groups present in the compound. For example, compounds with **carbon-carbon double** bonds are classified as **alkenes**, while compounds possessing an **OH** group are classified as **alcohols**.
- ❑ Organic compounds are commonly **classified** and **named** based on the type of **functional group** present.



Examples of common functional groups

Functional group	Classification	Example
$\text{R}-\ddot{\text{X}}:$ <p>(X=Cl, Br, or I)</p>	Alkyl halide	 n-Propyl chloride
$\begin{array}{c} \text{R} & & \text{R} \\ & \diagdown & / \\ & \text{C}=\text{C} \\ & / & \diagdown \\ \text{R} & & \text{R} \end{array}$	Alkene	 1-Butene
$\text{R}-\text{C}\equiv\text{C}-\text{R}$	Alkyne	 1-Butyne
	Aromatic (or arene)	 Methylbenzene

* The "R" refers to the remainder of the compound, usually carbon and hydrogen atoms.

Examples of common functional groups

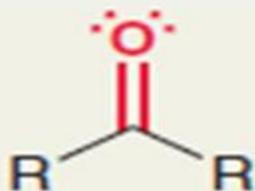
Functional group	Classification	Example
$R-\ddot{O}H$	Alcohol	 1-Butanol
$R-\ddot{O}-R$	Ether	 Diethyl ether
$R-\ddot{S}H$	Thiol	 1-Butanethiol
$R-\ddot{S}-R$	Sulfide	 Diethyl sulfide

Examples of common functional groups

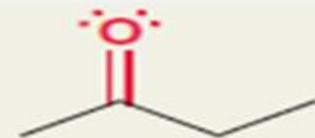
Functional group

Classification

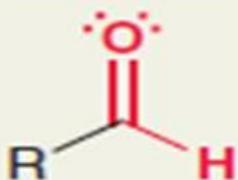
Example



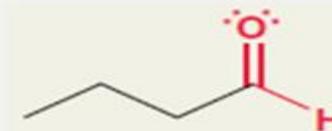
Ketone



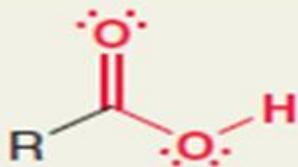
2-Butanone



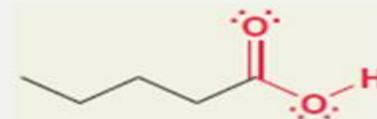
Aldehyde



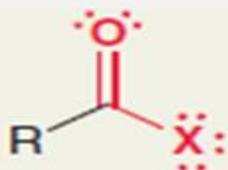
Butanal



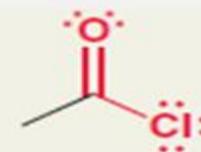
Carboxylic acid



Pentanoic acid

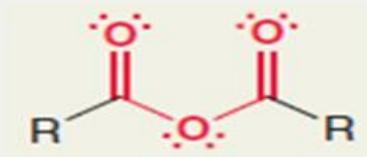
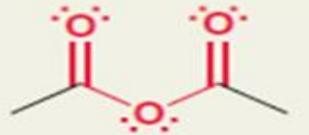
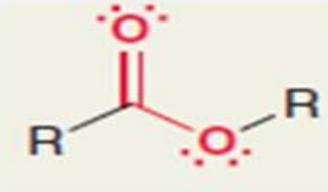
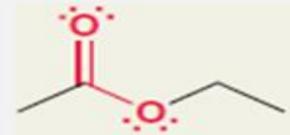
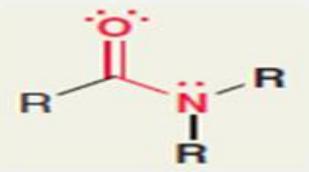
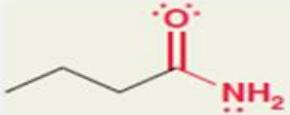
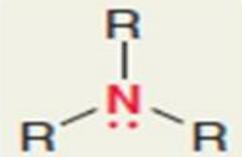
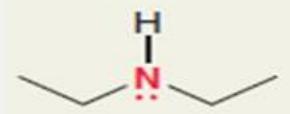


Acyl halide



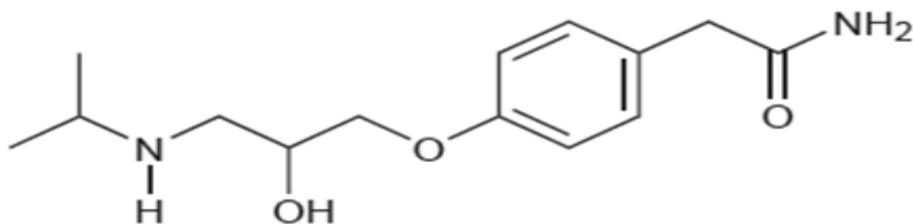
Acetyl chloride

Examples of common functional groups

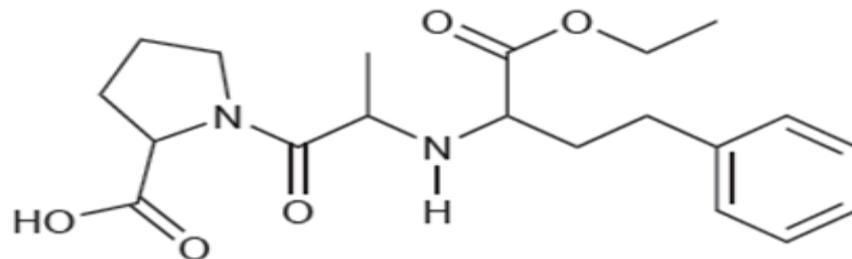
Functional group	Classification	Example
	Anhydride	 Acetic anhydride
	Ester	 Ethyl acetate
	Amide	 Butanamide
	Amine	 Diethylamine

2.2 Identifying Functional Groups: definition and structural features

E.g Atenolol and enalapril are drugs used in the treatment of heart disease. Both of these drugs lower blood pressure (albeit in different ways) and reduce the risk of heart attack. Using Table 2.1, identify and label all functional groups in these two compounds:

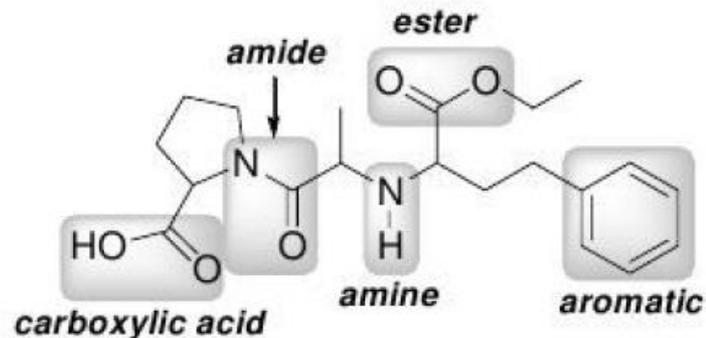
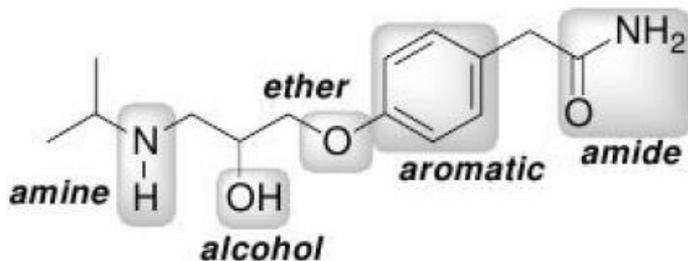


Atenolol



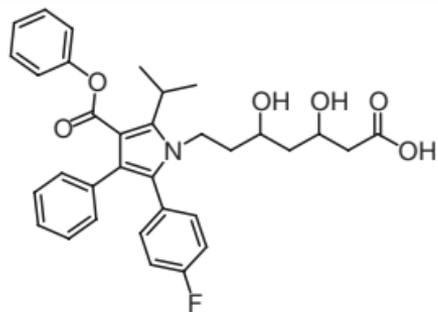
Enalapril

Solutions

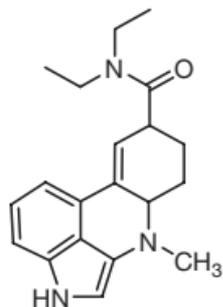


REVIEW QUESTION FOR ORGANIC COMPOUNDS

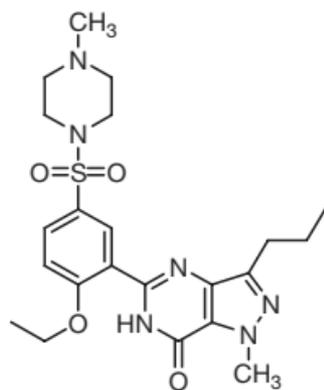
Identify all of the functional groups in these medications and drugs. All of the drug names are registered trademarks of their respective manufacturers (except lysergic acid diethylamide [LSD], of course).



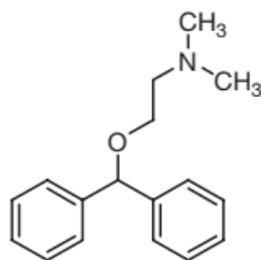
• Lipitor



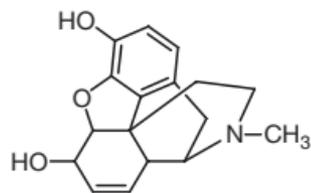
• LSD



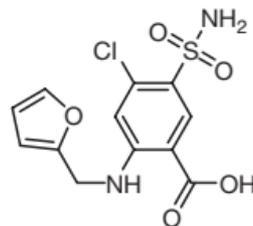
• Viagra



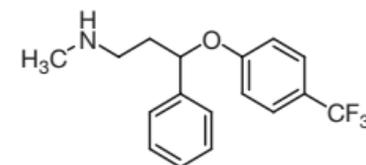
• Benadryl



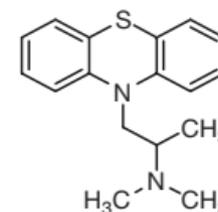
• Morphine



• Lasix



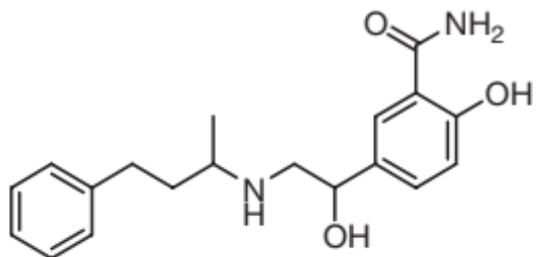
• Prozac



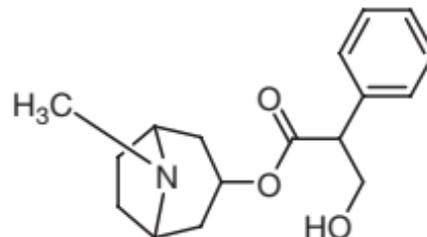
• Phenergan

REVIEW QUESTION FOR ORGANIC COMPOUNDS

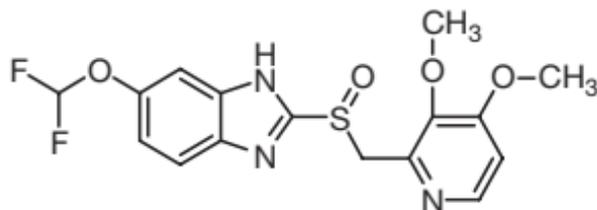
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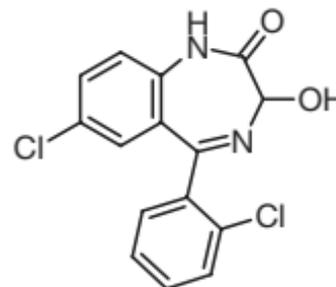
- Labetalol



- Atropine



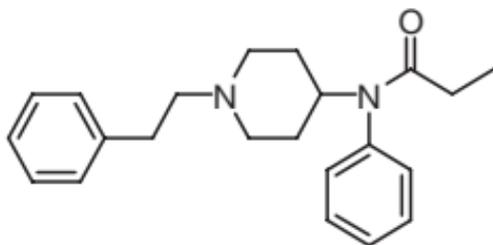
- Prontonix



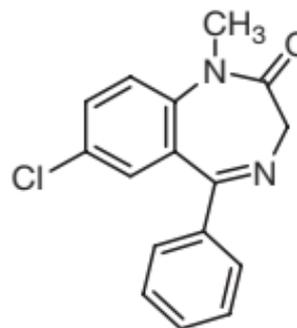
- Ativan

REVIEW QUESTION FOR ORGANIC COMPOUNDS

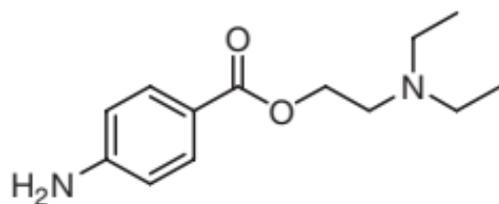
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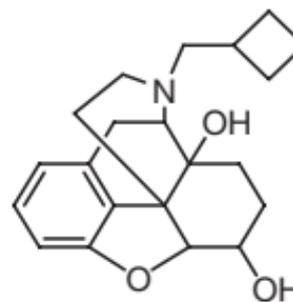
- Fentanyl



- Valium



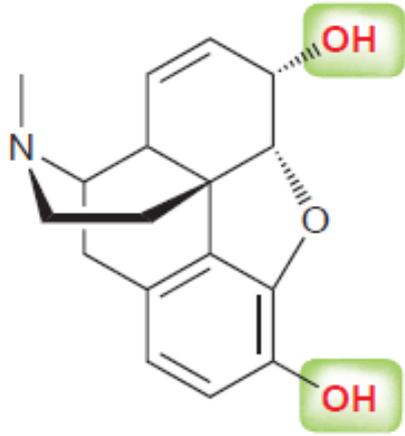
- Procaine



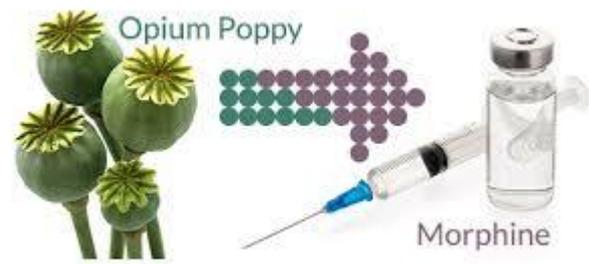
- Nubain

MEDICALLY SPEAKING)))

Identifying the Pharmacophore

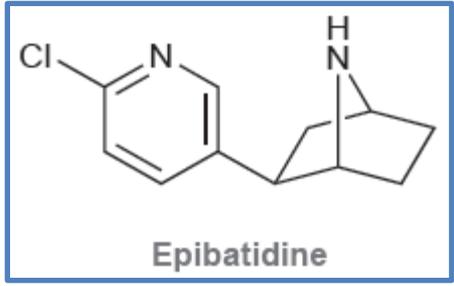
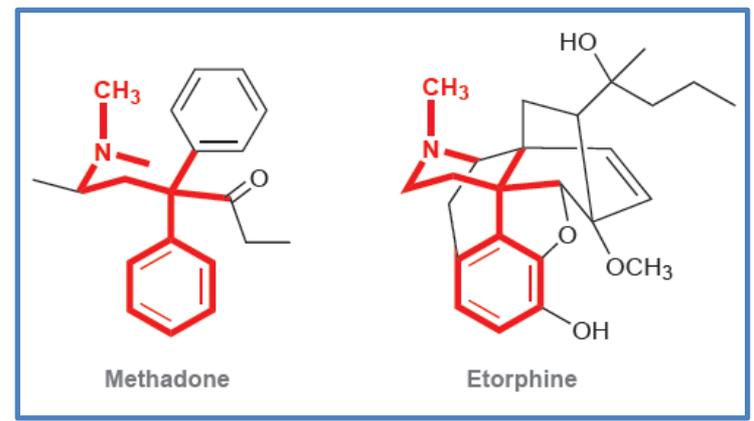
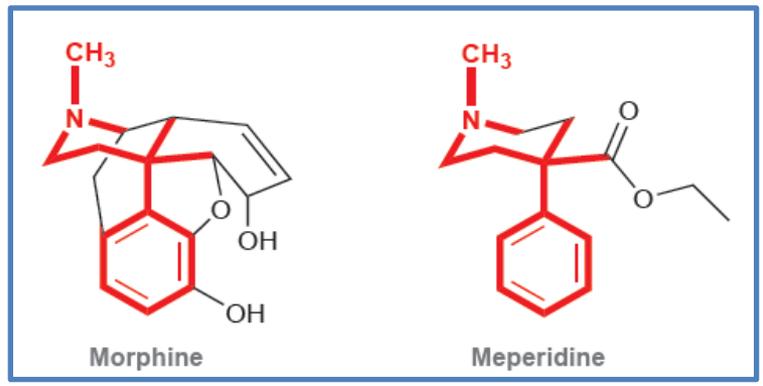
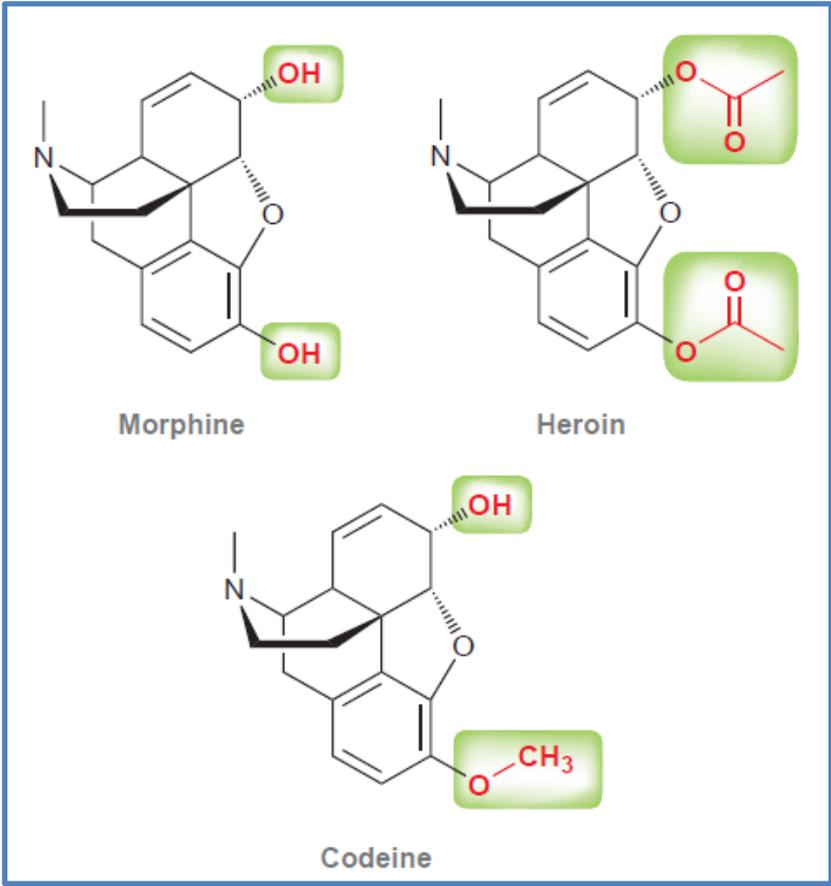


Morphine



MEDICALLY SPEAKING)))

Identifying the Pharmacophore



Lead compound
Lead modification

Heroin exhibits stronger activity than morphine

Codeine shows less activity than morphine

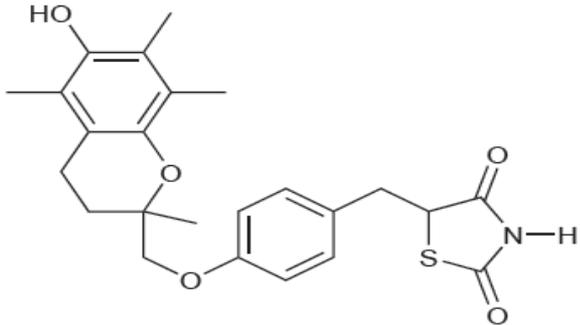
Epibatidine was found to be an analgesic that is 200 times more potent than morphine

MEDICALLY SPEAKING)))

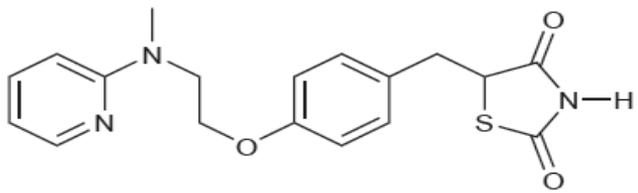
Identifying the Pharmacophore

CONCEPTUAL CHECKPOINT

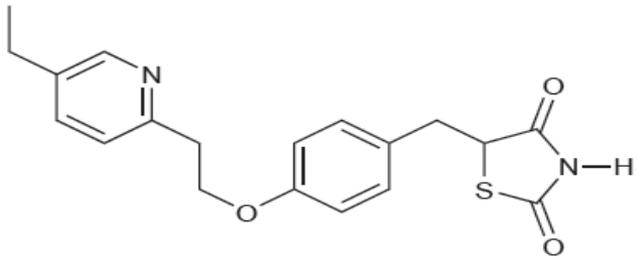
2.20 Troglitazone, rosiglitazone, and pioglitazone, all anti-diabetic drugs introduced to the market in the late 1990s, are believed to act on the same receptor:



Troglitazone

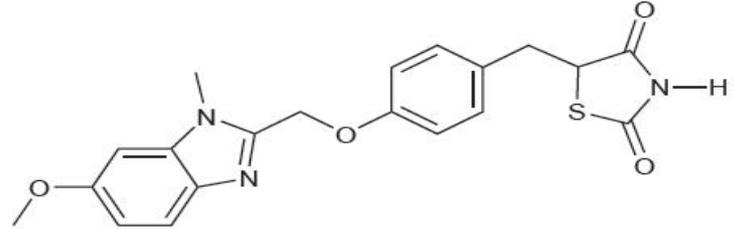
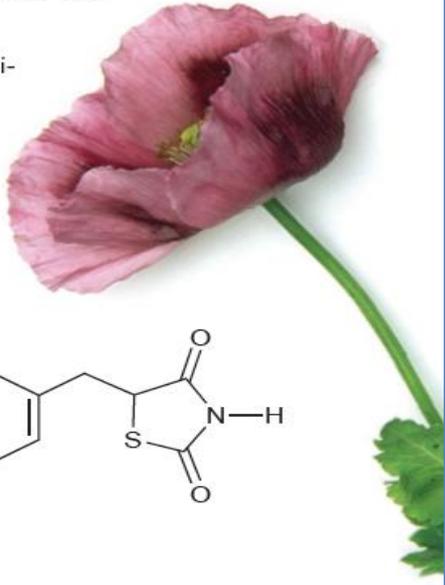


Rosiglitazone



Pioglitazone

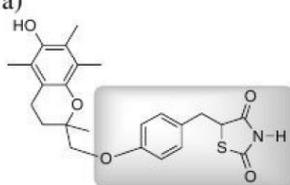
- (a) Based on these structures, try to identify the likely pharmacophore that is responsible for the antidiabetic activity of these drugs.
- (b) Consider the structure of rivoglitazone (below). This compound is currently being studied for potential antidiabetic activity. Based on your analysis of the likely pharmacophore, do you believe that rivoglitazone will exhibit antidiabetic properties?



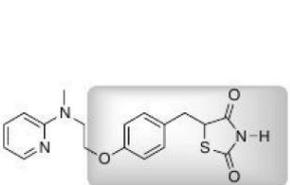
Rivoglitazone

SOLUTION

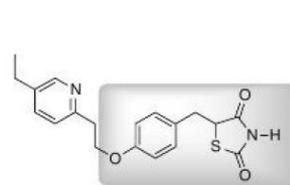
a)

Cc1c(O)c(C)c2c1OCC2COc3ccc(cc3)CC4C(=O)NC(=O)S4

Troglitazone

CN(C)CCOc1ccc(cc1)CC2C(=O)NC(=O)S2c3ccc(cc3)

Rosiglitazone

CCc1ccc(cc1)N=C2C=CC=C2COc3ccc(cc3)CC4C(=O)NC(=O)S4

Pioglitazone

b) Yes, it contains the likely pharmacophore highlighted above.

2.3 Hydrocarbons

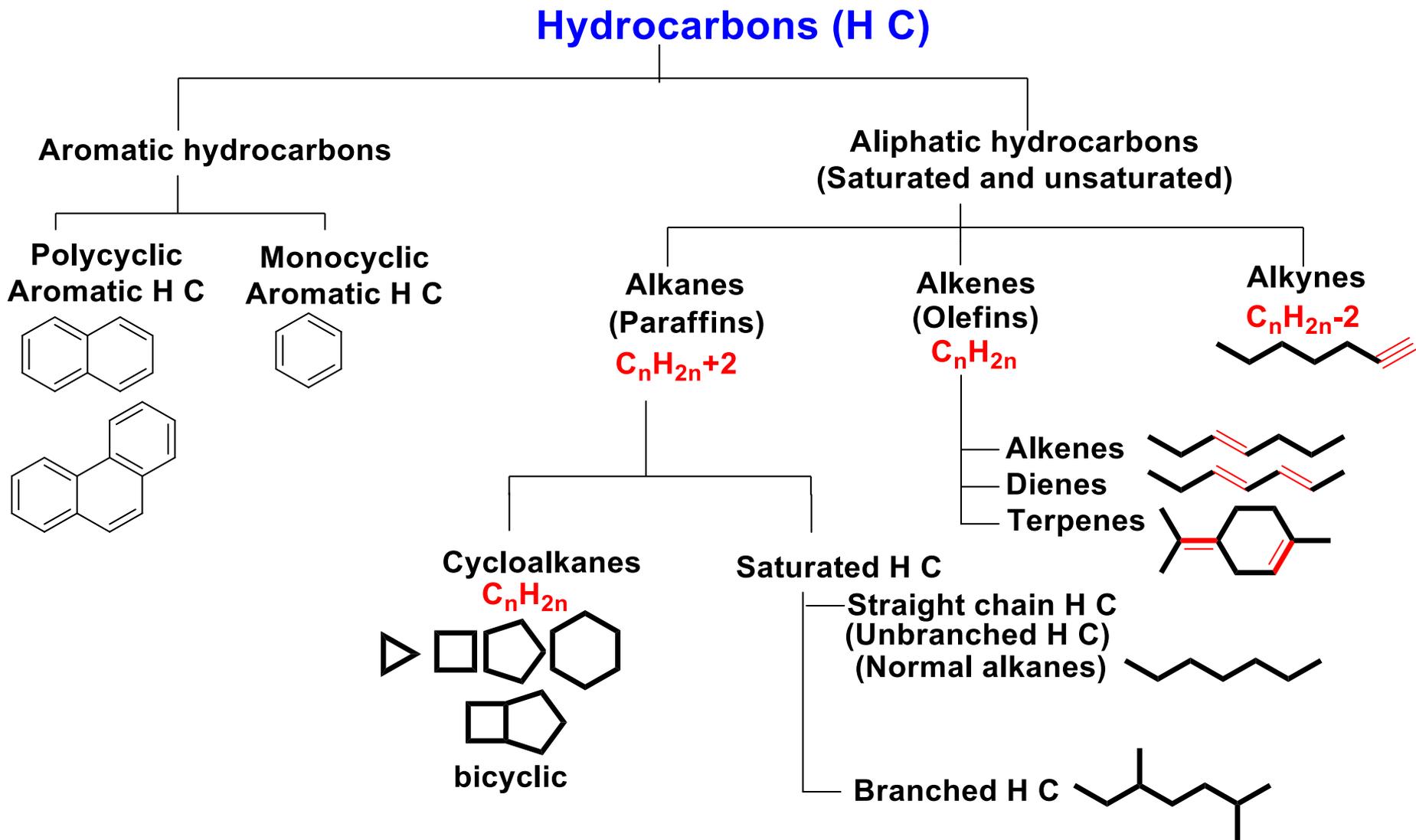
- ❑ **Organic compounds** are divided into two main classes: **hydrocarbons** and **hydrocarbon derivatives**.

- ❑ **Hydrocarbons** are organic compounds that contain only **C** and **H** atoms. The **three** main groups of hydrocarbons are:
 1. **Saturated hydrocarbons:** hydrocarbons with only **single** bonds between the carbon atoms or **lack π bonds** are called saturated hydrocarbons or **alkanes**.

 2. **Unsaturated hydrocarbons:** hydrocarbons that contain **double or triple** bonds between carbon atoms. (**Alkenes & Alkynes**)

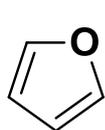
 3. **Aromatic hydrocarbons (arenes):** hydrocarbons that contain a **benzene ring** (a six-membered ring of carbon atoms with alternating single and double carbon-carbon bonds).
 - The **saturated** and **unsaturated** hydrocarbons are often referred to as the **aliphatic (open chain and cyclic) hydrocarbons**.
 - The system of rules for naming compounds is called **nomenclature**.

2.3 Hydrocarbons

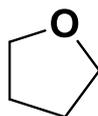


Heterocyclic compounds

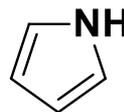
- ❑ Compounds without rings are acyclic
- ❑ Compound with rings are cyclic.
- ❑ Other atoms may be found in some rings.
- ❑ Atoms other than carbon within rings are heteroatoms, and the compounds are heterocyclic.



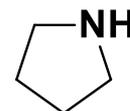
Furan



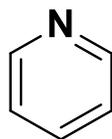
Tetrahydrofuran
(THF)



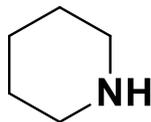
pyrrol



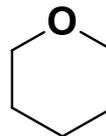
pyrrolidine



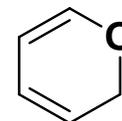
pyridine



piperidine



tetrahydro-pyran



Pyran

2.4 Alkanes, cycloalkanes and their derivatives

2.4.1 Alkanes, cycloalkanes

+ Nomenclature of Alkanes & Cycloalkanes

- In chemical nomenclature, the **IUPAC** nomenclature of organic chemistry is a **systematic method** of naming organic chemical compounds as recommended by the **International Union of Pure and Applied Chemistry (IUPAC)**.

+ Four steps are required when assigning the name of an alkane:

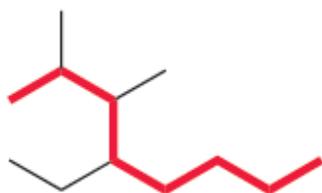
1. *Identify the parent chain:* Choose the longest chain. For two chains of equal length, the parent chain should be the chain with the greater number of substituents.
2. *Identify and name the substituents.*
3. *Number the parent chain and assign a locant to each substituent:* Give the first substituent the lower possible number. If there is a tie, choose the chain in which the second substituent has the lower number.
4. *Arrange the substituents alphabetically.* Place locants in front of each substituent. For identical substituents, use di, tri, or tetra, which are ignored in alphabetizing.



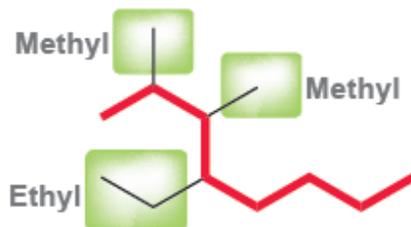
Nomenclature of Alkanes & Cycloalkanes

ASSEMBLING THE SYSTEMATIC NAME OF AN ALKANE

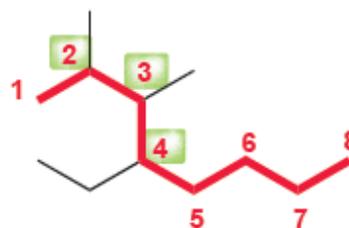
STEP 1 Identify the parent.



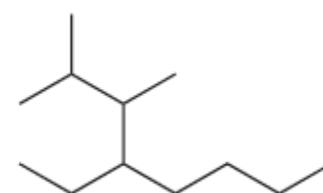
STEP 2 Identify and name substituents.



STEP 3 Number the parent chain and assign a locant to each substituent.



STEP 4 Arrange the substituents alphabetically.



4-Ethyl-2,3-dimethyloctane

Parent Names for Alkanes

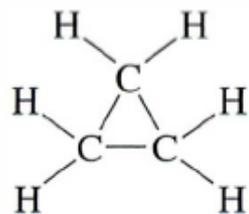
Parent + ane = Name of alkane

NUMBER OF CARBON ATOMS	PARENT	NAME OF ALKANE	NUMBER OF CARBON ATOMS	PARENT	NAME OF ALKANE
1	<i>meth</i>	methane	11	<i>undec</i>	undecane
2	<i>eth</i>	ethane	12	<i>dodec</i>	dodecane
3	<i>prop</i>	propane	13	<i>tridec</i>	tridecane
4	<i>but</i>	butane	14	<i>tetradec</i>	tetradecane
5	<i>pent</i>	pentane	15	<i>pentadec</i>	pentadecane
6	<i>hex</i>	hexane	20	<i>eicos</i>	eicosane
7	<i>hept</i>	heptane	30	<i>triacont</i>	triacontane
8	<i>oct</i>	octane	40	<i>tetracont</i>	tetracontane
9	<i>non</i>	nonane	50	<i>pentacont</i>	pentacontane
10	<i>dec</i>	decane	100	<i>hect</i>	hectane

Nomenclature of Alkanes & Cycloalkanes

Parent Names for Cycloalkanes

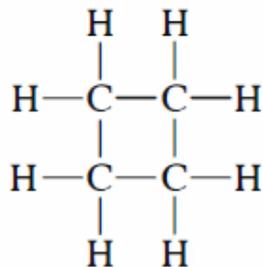
Cyclo + alkane = Name of Cycloalkane



or



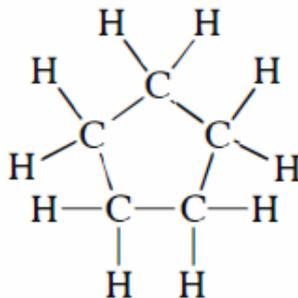
cyclopropane
 C_3H_6



or



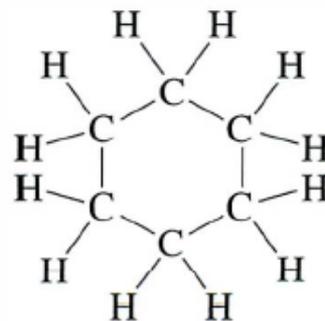
cyclobutane
 C_4H_8



or



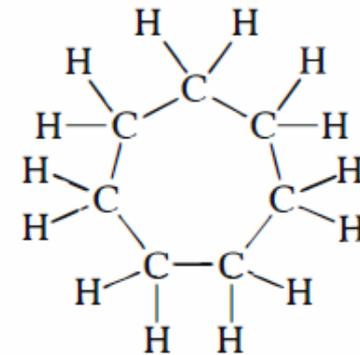
cyclopentane
 C_5H_{10}



or



cyclohexane
 C_6H_{12}



or



cycloheptane
 C_7H_{14}

Structures of some cycloalkanes.

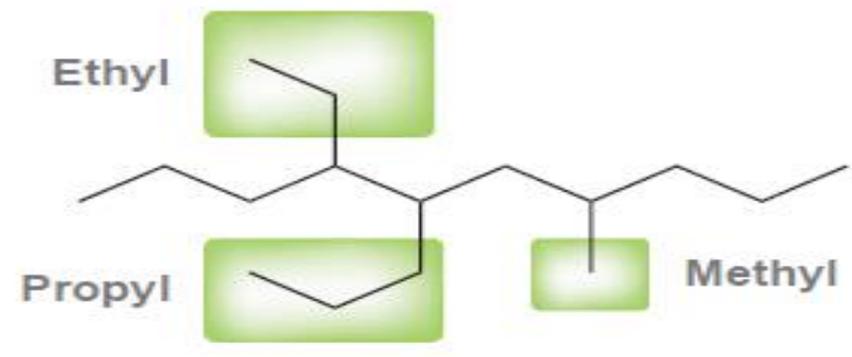
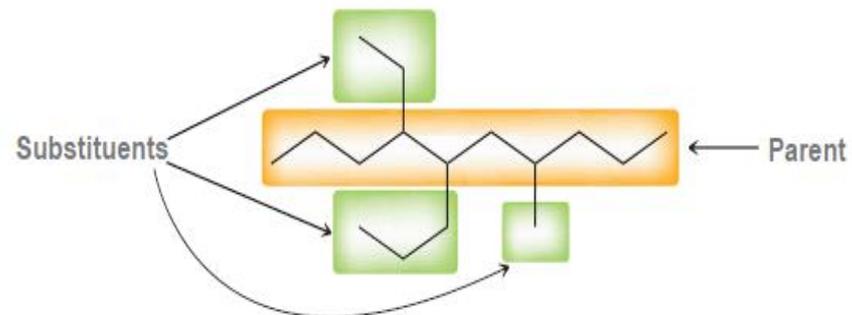
Alkanes containing a ring are called cycloalkanes

Nomenclature of Alkanes & Cycloalkanes

Identify and name the substituents:

Alkane \longrightarrow alkyl group

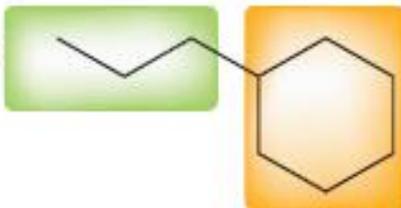
NUMBER OF CARBON ATOMS IN SUBSTITUENT	TERMINOLOGY
1	<i>Methyl</i>
2	<i>Ethyl</i>
3	<i>Propyl</i>
4	<i>Butyl</i>
5	<i>Pentyl</i>
6	<i>Hexyl</i>
7	<i>Heptyl</i>
8	<i>Octyl</i>
9	<i>Nonyl</i>
10	<i>Decyl</i>



Nomenclature of Alkanes & Cycloalkanes

Cycloalkanes substituent

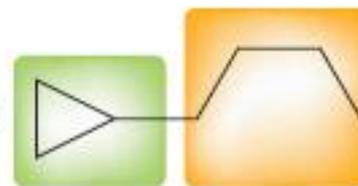
Substituent



Parent

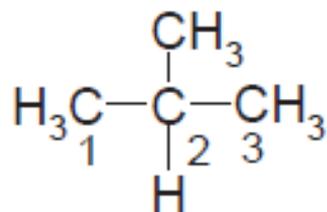
Propyl cyclohexane

Substituent

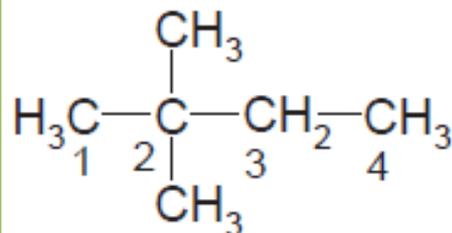


Parent

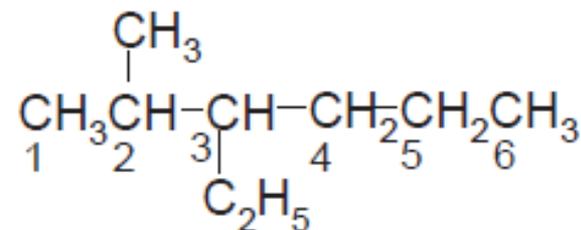
1-Cyclopropyl butane



Systematic name: 2-Methylpropane
Common name: Isobutane

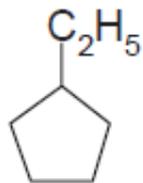


2,2-Dimethylbutane

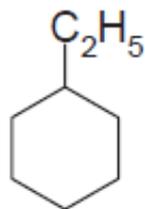


3-Ethyl-2-methylhexane

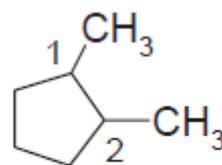
Nomenclature of Alkanes & Cycloalkanes



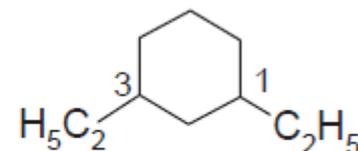
Ethylcyclopentane



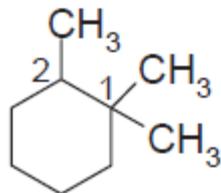
Ethyl cyclohexane



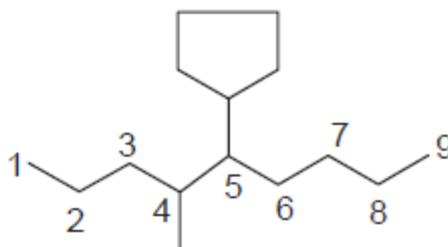
1,2-Dimethylcyclopentane
not 1,5-dimethylcyclopentane



1,3-Diethylcyclohexane
not 1,5-diethylcyclohexane



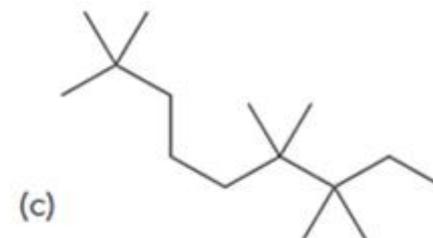
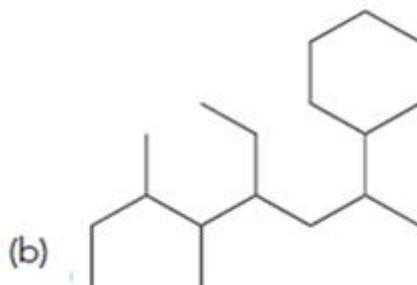
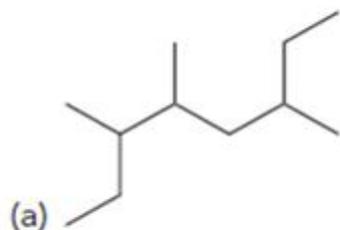
1,1,2-Trimethylcyclohexane
not 1,2,2-Trimethylcyclohexane



5-Cyclopentyl-4-methylnonane
not 5-Cyclopentyl-6-methylnonane

Nomenclature of Alkanes & Cycloalkanes

H.W. Provide a systematic name for each of the following compounds below:



a) 3,4,6-trimethyloctane

H.W. Draw a bond-line drawing for each of the following compounds:

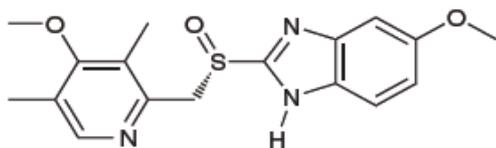
(a) 4-Ethyl-2-methylhexane

(b) 1,1,2,2-Tetramethylcyclopropane

Naming Drugs



Pharmaceuticals often have cumbersome IUPAC names and are therefore given shorter names, called *generic names*. For example, consider the following compound:



(S)-5-Methoxy-2-[(4-methoxy-3,5-dimethylpyridin-2-yl)methylsulfanyl]-1H-benzimidazole

The IUPAC name for this compound is quite a mouthful, so a generic name, *esomeprazole*, has been assigned and accepted by the international community. For marketing purposes, drug companies will also select a catchy name, called a *trade name*. The trade name of esomeprazole is Nexium. This compound is a proton-pump inhibitor used in the treatment of reflux disease (heartburn).

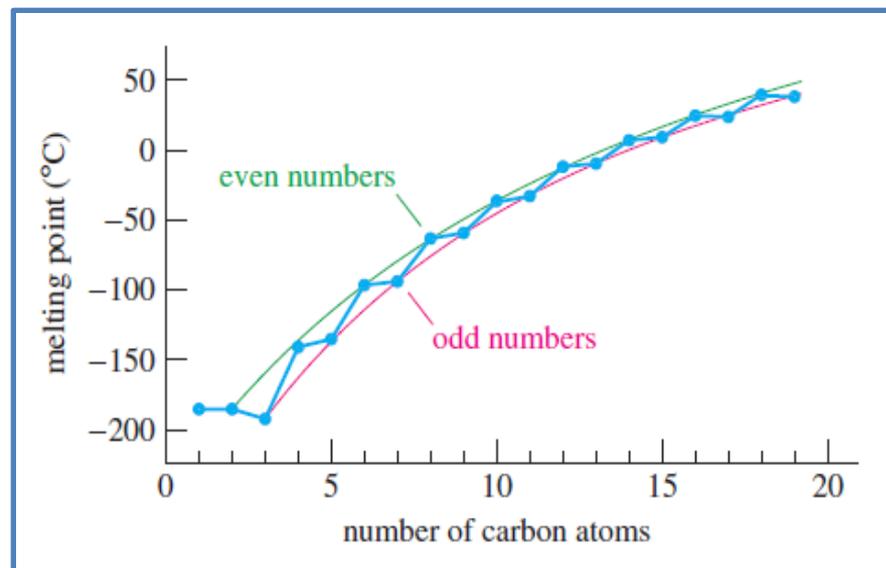
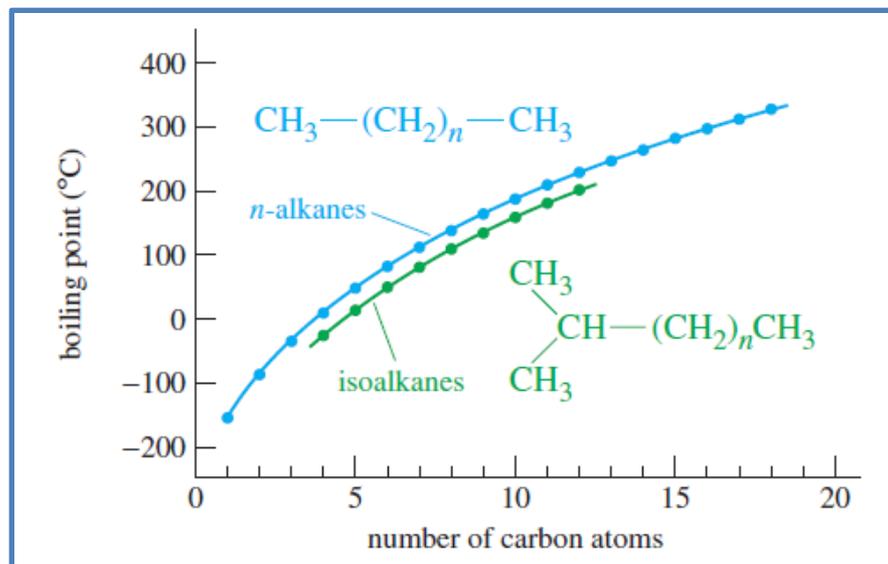
In summary, pharmaceuticals have three important names: (1) trade names, (2) generic names, and (3) systematic IUPAC names. Table 4.3 lists several common drugs whose trade names are likely to sound familiar.

TABLE 4.3 NAMES OF COMMON PHARMACEUTICALS

TRADE NAME	GENERIC NAME	STRUCTURE AND IUPAC NAME	USES
Aspirin	Acetylsalicylic acid	<p>2-Acetoxybenzoic acid</p>	Analgesic, antipyretic (reduces fever), anti-inflammatory
Advil or Motrin	Ibuprofen	<p>2-[4-(2-Methylpropyl)phenyl]propanoic acid</p>	Analgesic, antipyretic, anti-inflammatory

Physical Properties of Alkanes

- Solubilities of Alkanes:** Alkanes are **nonpolar**, so they dissolve in nonpolar or weakly polar organic solvents. Alkanes are said to be **hydrophobic (“water hating”)** because **they do not dissolve in water**. Alkanes are good lubricants and preservatives for metals because they keep water from reaching the metal surface and causing corrosion.
- Densities of Alkanes:** Alkanes have densities around **0.7 g/mL**, compared with a density of 1.0 g/mL for water. Because alkanes are less dense than water and insoluble in water, a mixture of an alkane (such as gasoline or oil) and water quickly separates into two phases, with the alkane on top.
- Boiling and melting points**



The boiling points of alkanes increase steadily with increasing molecular weights, as shown in the below table. Alkanes from methane to butane are gases at room temperature.

Name	Number of carbons	Molecular formula	Condensed structure	bp (°C)	mp (°C)
Methane	1	CH ₄	CH ₄	-164	-182.5
Ethane	2	C ₂ H ₆	CH ₃ CH ₃	-88.6	-183.3
Propane	3	C ₃ H ₈	CH ₃ CH ₂ CH ₃	-42.1	-189.7
Butane	4	C ₄ H ₁₀	CH ₃ (CH ₂) ₂ CH ₃	-0.60	-138.4
Pentane	5	C ₅ H ₁₂	CH ₃ (CH ₂) ₃ CH ₃	36.1	-129.7
Hexane	6	C ₆ H ₁₄	CH ₃ (CH ₂) ₄ CH ₃	68.9	-93.5
Heptane	7	C ₇ H ₁₆	CH ₃ (CH ₂) ₅ CH ₃	98.4	-90.6
Octane	8	C ₈ H ₁₈	CH ₃ (CH ₂) ₆ CH ₃	125.7	-56.8
Nonane	9	C ₉ H ₂₀	CH ₃ (CH ₂) ₇ CH ₃	150.8	-51.0
Decane	10	C ₁₀ H ₂₂	CH ₃ (CH ₂) ₈ CH ₃	174.1	-29.7
Undecane	11	C ₁₁ H ₂₄	CH ₃ (CH ₂) ₉ CH ₃	196	-26
Dodecane	12	C ₁₂ H ₂₆	CH ₃ (CH ₂) ₁₀ CH ₃	216	-10

Cycloalkenes are nonpolar molecules like alkanes. As a result, they tend to have low melting and boiling points compared with other functional groups.



Sources of alkanes and cycloalkanes

- The main source of alkanes **is petroleum**” Petroleum is a complex mixture of hundreds of hydrocarbons, most of which are alkanes (ranging in size and constitution). It also contains small amounts of oxygen-, nitrogen-, and sulfur-containing compounds.
- These compounds are separated into **fractions via distillation (separation based on differences in boiling points)**. The process of separating crude oil (petroleum) into commercially available products is called **refining**.
- Cycloalkanes of ring sizes ranging from three to 30 are found in nature. **Compounds containing five-membered rings (cyclopentane) and sixmembered rings (cyclohexane) are especially common.**

✚ Conformation of alkanes & Cycloalkanes

DID YOU EVER WONDER...

why scientists have not yet developed a cure for AIDS?



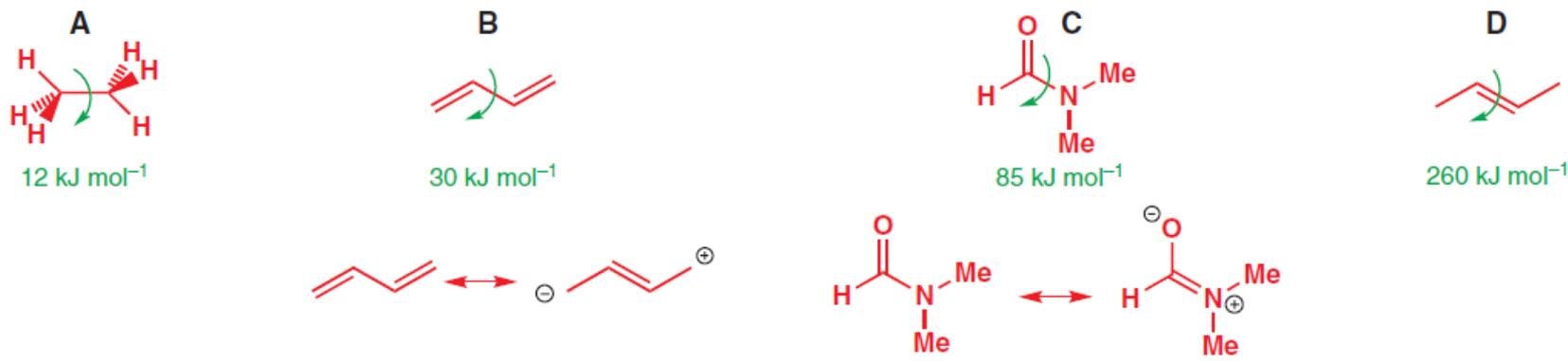
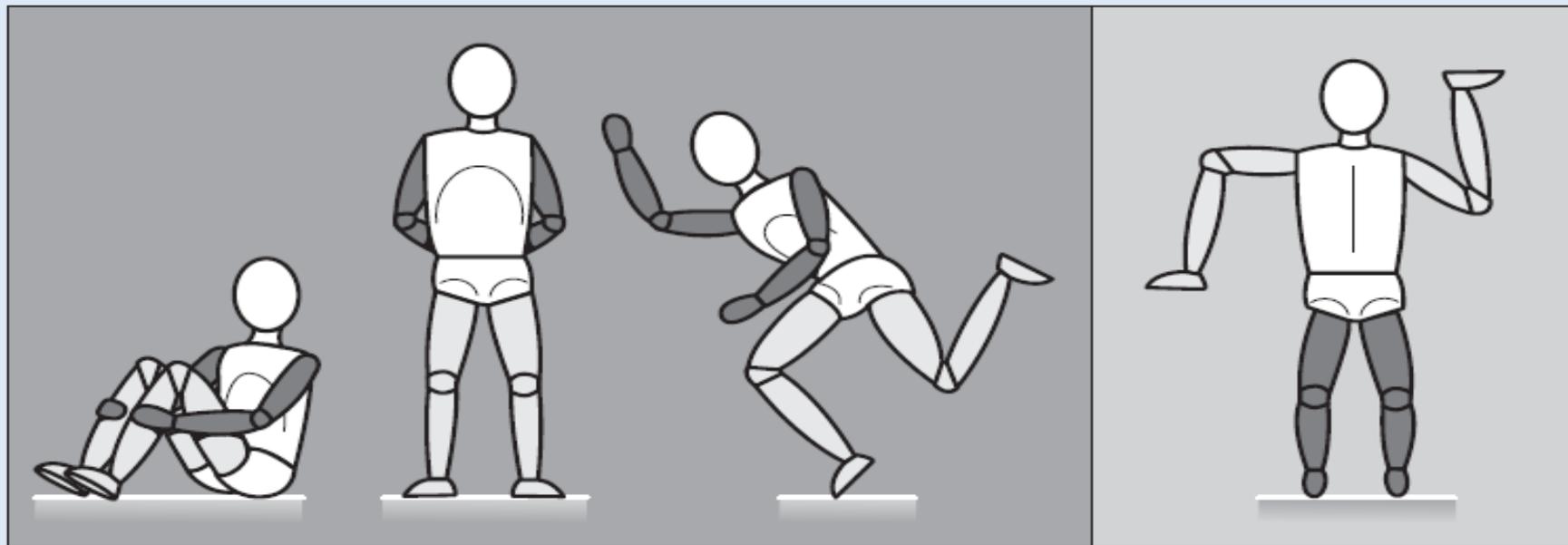
A flexible molecule is one that can adopt many different **shapes**, or **conformations**. The study of the three-dimensional shapes of molecules is called conformational analysis.

Conformation of alkanes & Cycloalkanes

Conformation and configuration

Different conformations of a person – Some more stable than others ...

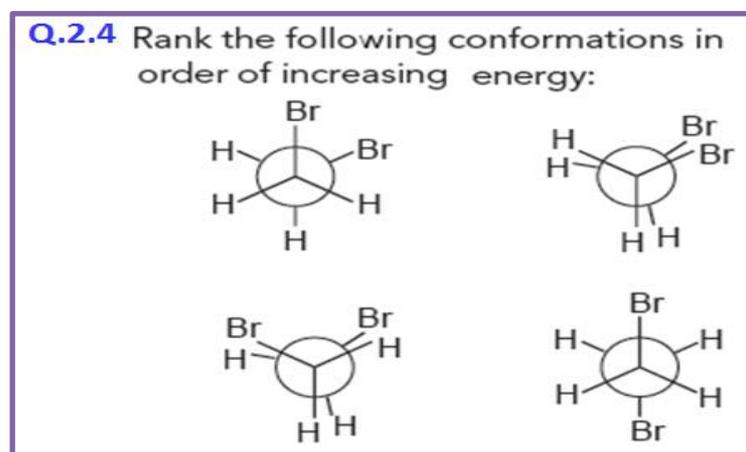
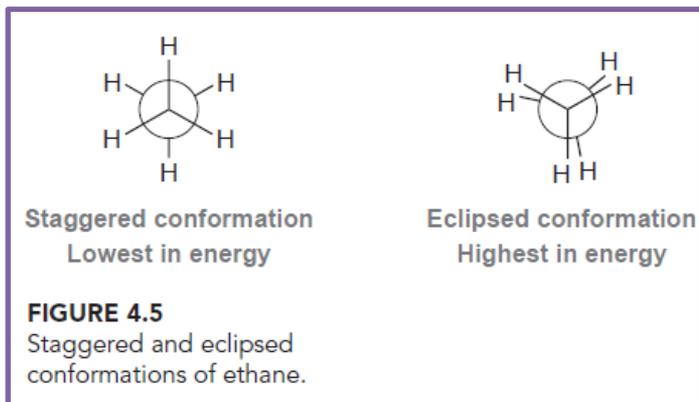
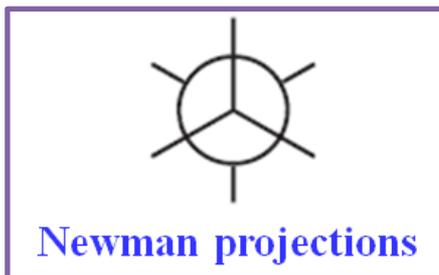
A different configuration





Conformation of alkanes & Cycloalkanes

- There are **two** very important drawing styles that show conformations and give us the power to predict what conformations are available to different types of molecules:



Conformation of alkanes & Cycloalkanes

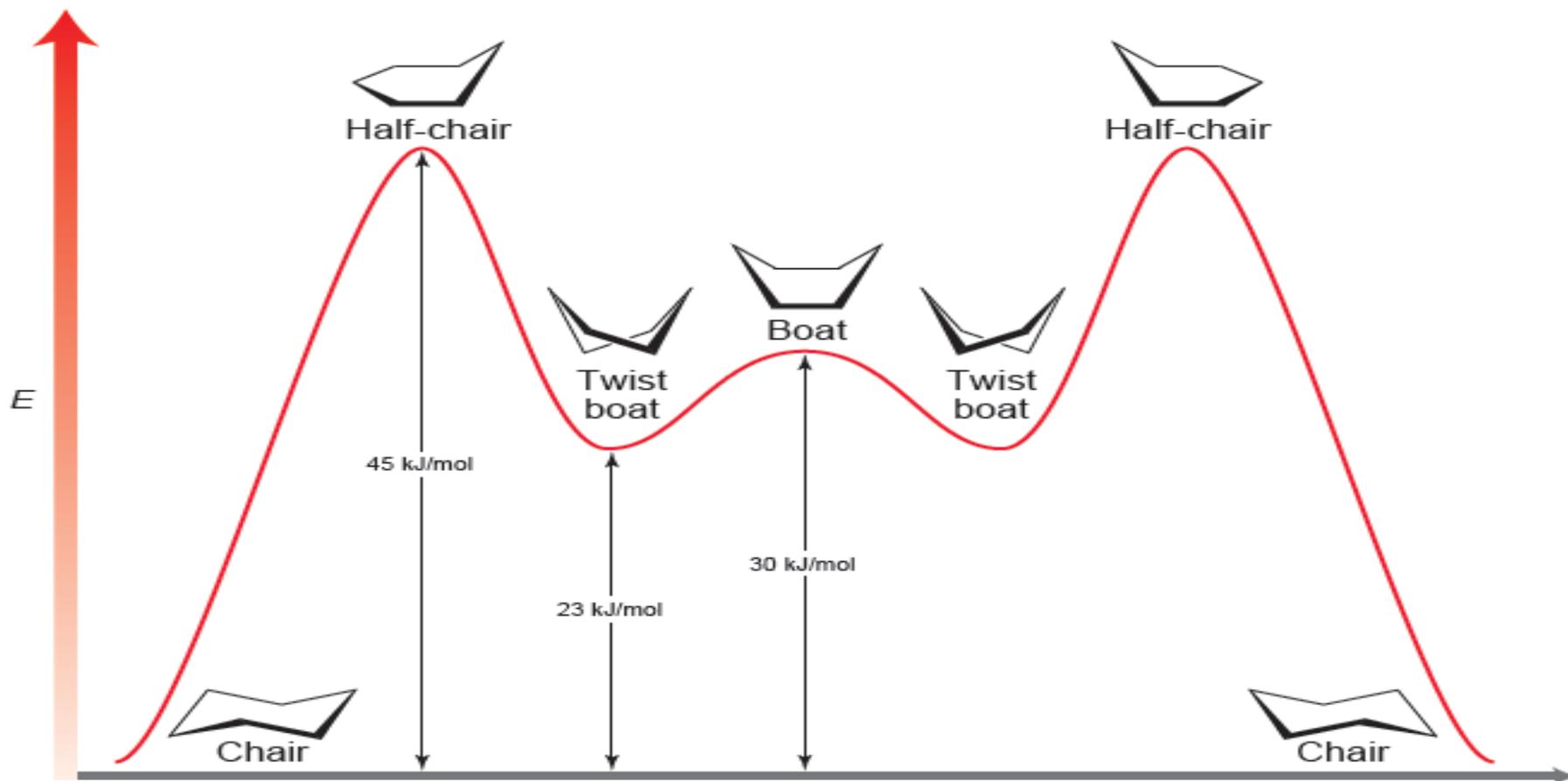
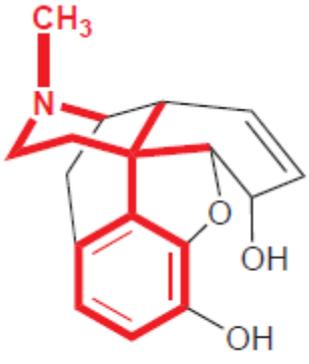
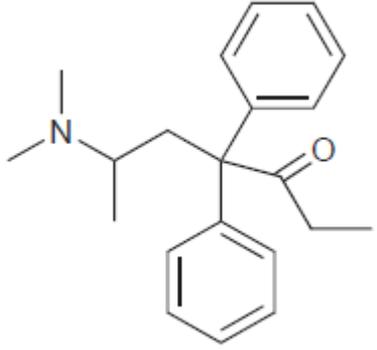


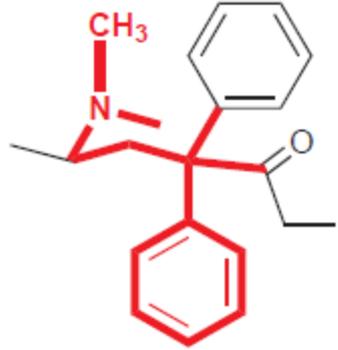
FIGURE 4.24
An energy diagram showing the conformational analysis of cyclohexane.



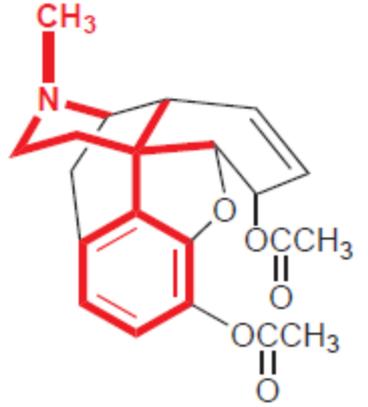
Morphine



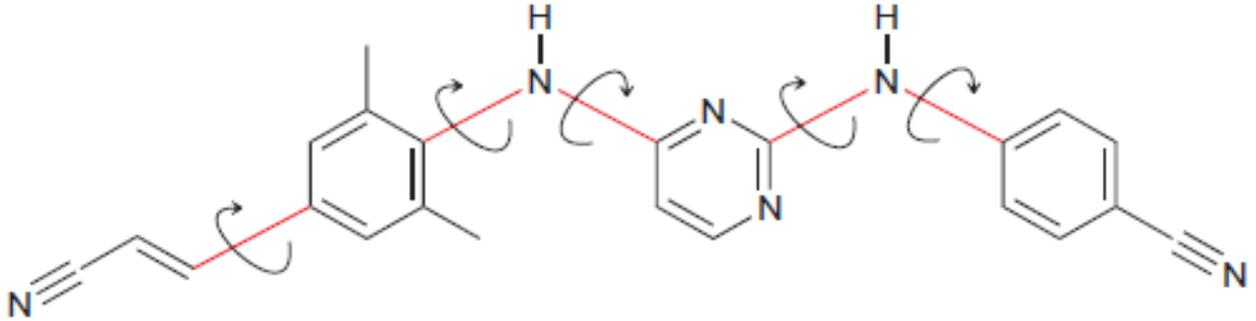
Methadone



Methadone



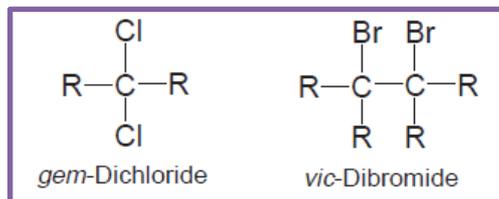
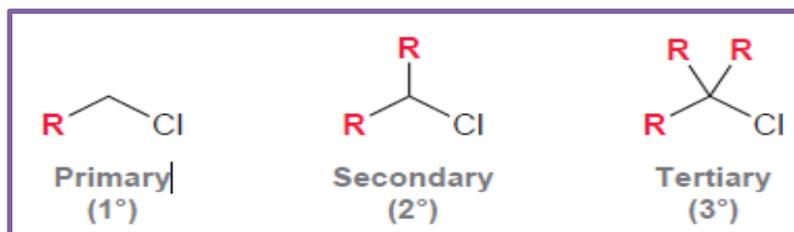
Heroin



Rilpivirine

2.5 Alkyl halides

- Alkyl halides (haloalkanes) are a class of compounds where a halogen atom or atoms are attached to a tetrahedral carbon (sp^3) atom.
- The functional group is X, where X may be F, Cl, Br or I. Two simple members of this class are methyl chloride (CH_3Cl) and ethyl chloride (CH_3CH_2Cl).
- Based on the number of alkyl groups attached to the C-X unit, alkyl halides are classed as primary (1), secondary (2) or tertiary (3).
- A geminal (gem)-dihalide has two halogen atoms on the same carbon, and a vicinal (vic)-dihalide has halogen atoms on adjacent carbon atoms.



DID YOU EVER WONDER...
what chemotherapy is?



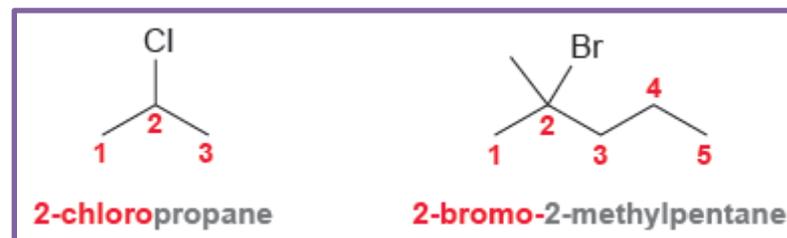
Naming Halogenated Organic Compounds

There are **two ways to name halogenated organic compounds**.

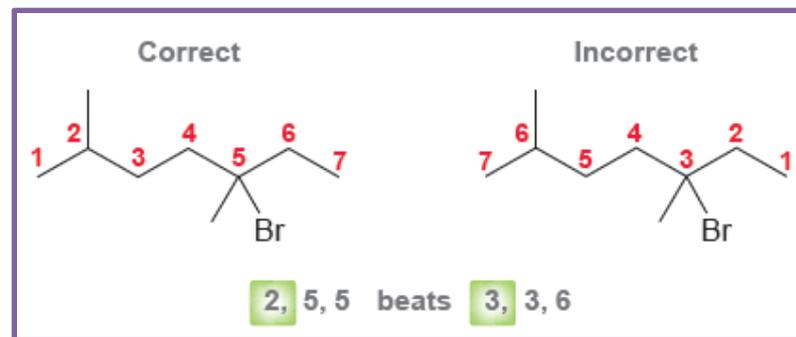
- The **systematic name** treats the compound as a **haloalkane**.
- The **common name** treats the compound as an **alkyl halide** or an **organohalide**.

Systematic name	Common name
	
Halo alkane	Alkyl halide
Chloroethane	Ethyl chloride

Halogens are simply treated as substituents and receive the following names: **fluoro-**, **chloro-**, **bromo-**, and **iodo-**. Below are two examples:

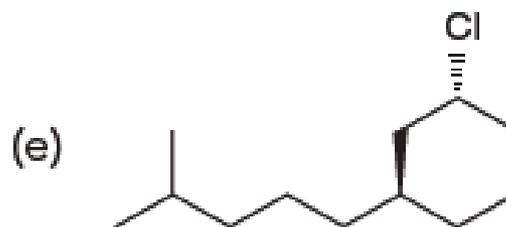
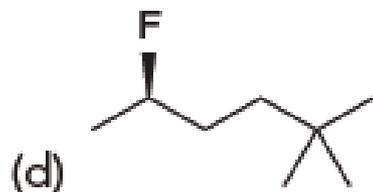
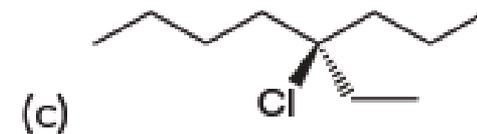
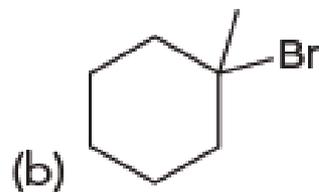
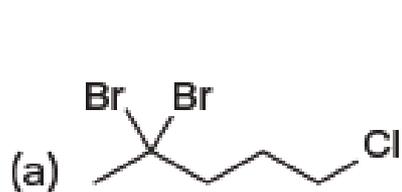


The parent is the longest chain, and it should be numbered so that the first substituent receives the lower number:



Naming Halogenated Organic Compounds

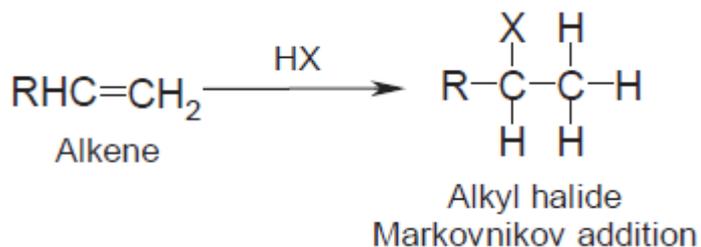
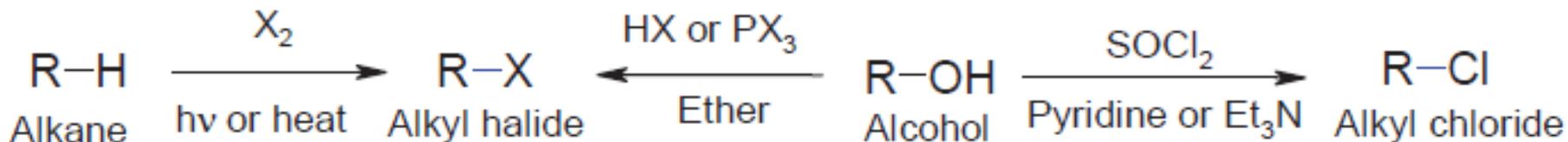
H.W. Assign a systematic name for each of the following compounds:



Physical properties of alkyl halides

- Alkyl halides have considerably higher melting and boiling points compared with analogous alkanes.
- The boiling points also increase with increasing atomic weight of the halogen atom. Thus, alkyl fluoride has the lowest boiling point and alkyl iodide has the highest boiling point.
- Alkyl halides are insoluble in water as they are unable to form hydrogen bonds, but are soluble in nonpolar solvents, e.g. ether and chloroform.

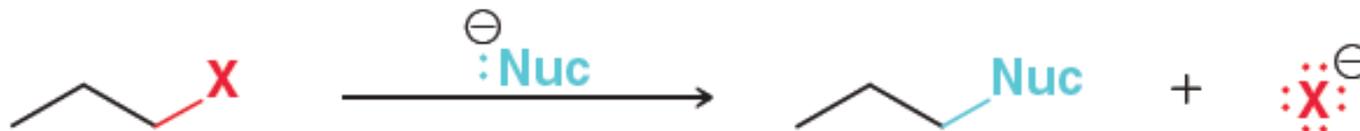
Preparation of alkyl halides



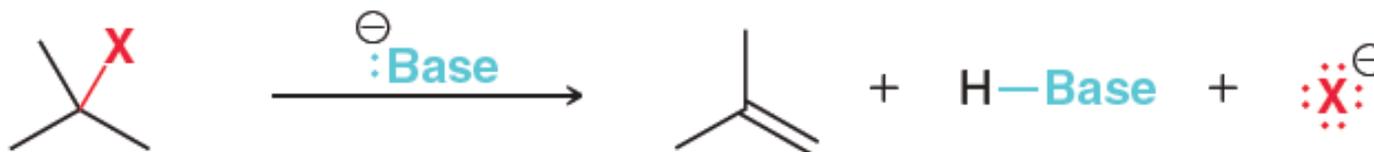
Reactions of alkyl halides

□ Alkyl halides commonly undergo two general types of reactions.

➤ Nucleophilic substitution reaction

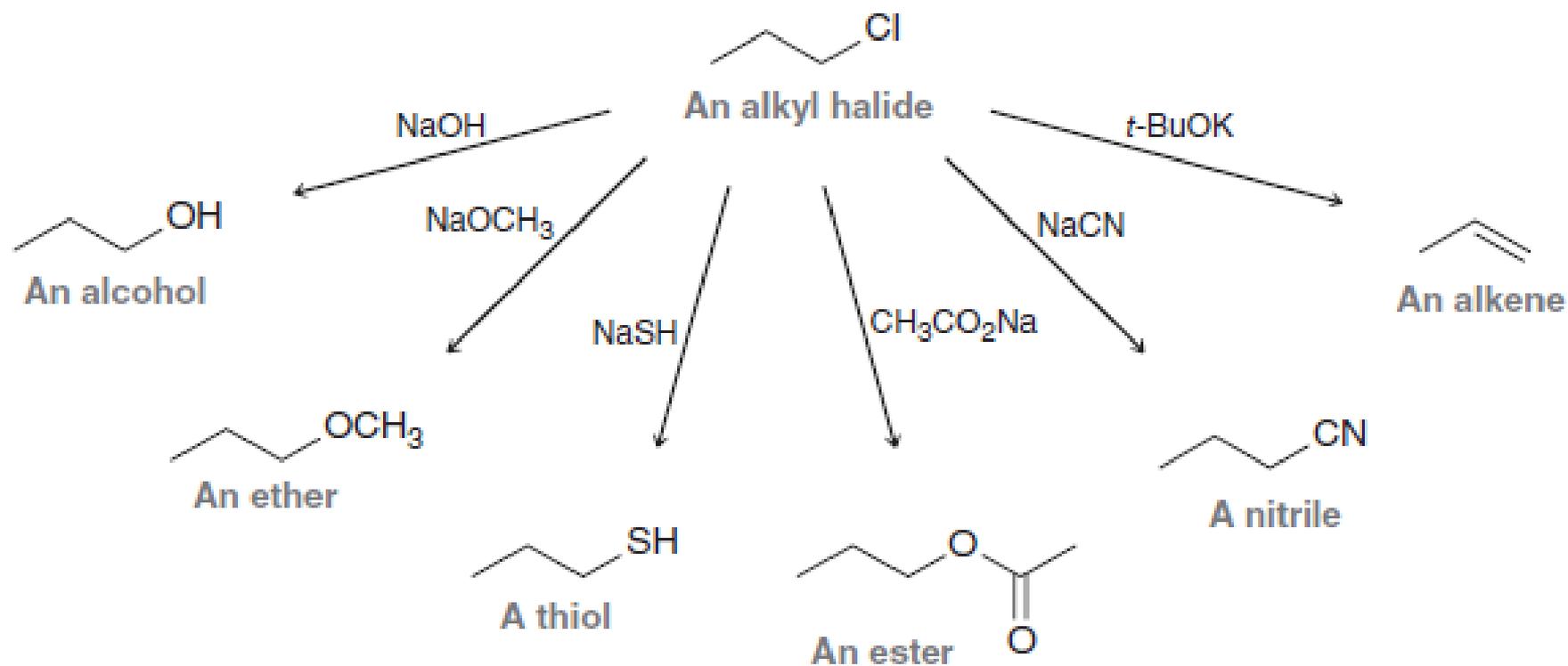


➤ Elimination reaction



Reactions of alkyl halides

Organohalides as Synthetic Precursors

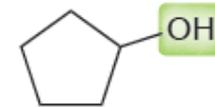


2. 6 Alcohols

- Alcohols are compounds that possess a hydroxyl group (OH) and are characterized by names ending in “ol”:



Ethanol

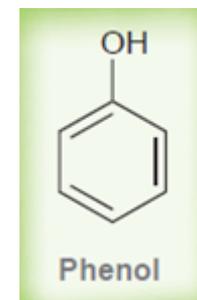


Cyclopentanol

- A vast number of naturally occurring compounds contain the hydroxyl group.
- The simplest and most common alcohols are methyl alcohol (CH_3OH) and ethyl alcohol ($\text{CH}_3\text{CH}_2\text{OH}$).
- Phenol is a special kind of alcohol. It is comprised of a hydroxyl group attached directly to a phenyl ring.

DID YOU EVER WONDER...

what causes the hangover associated with drinking alcohol and whether anything can be done to prevent a hangover?



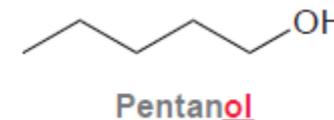
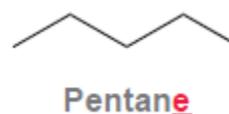
Phenol

Nomenclature of Alcohols

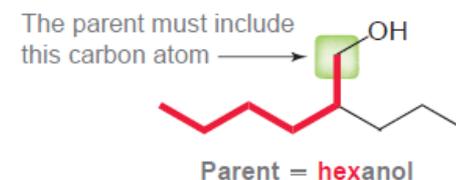
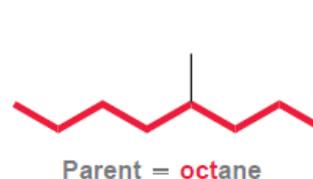


Alcohols are named much like alkanes, with the following additional rules:

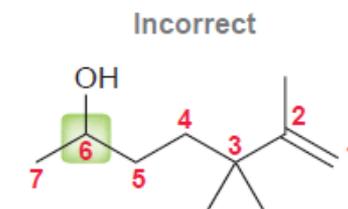
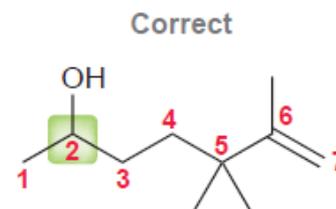
- ❑ The suffix “e” is replaced with “ol.” to indicate the presence of a hydroxyl group:



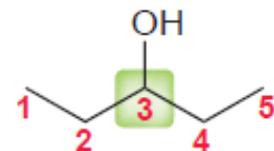
- ❑ When choosing the parent of an alcohol, identify the longest chain that includes the carbon atom connected to the hydroxyl group.



- ❑ The hydroxyl group should receive the lowest number possible, despite the presence of alkyl substituents or π bonds..

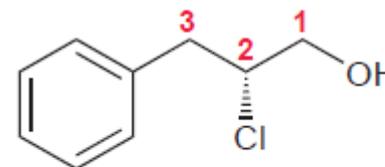


- ❑ The position of the hydroxyl group is indicated using a locant.



3-Pentanol
or
Pentan-3-ol

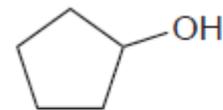
- ❑ When a chirality center is present, the configuration must be indicated at the beginning of the name; for example:



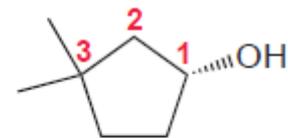
(R)-2-Chloro-3-phenyl-1-propanol

Nomenclature of Alcohols

- Cyclic alcohols are numbered starting at the position bearing the hydroxyl group, so there is no need to indicate the position of the hydroxyl group; it is understood to be at C-1.

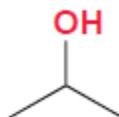


Cyclopentanol

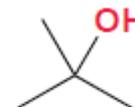


(R)-3,3-Dimethylcyclopentanol

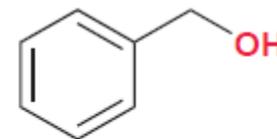
- IUPAC nomenclature recognizes the common names of many alcohols, such as the following three examples:



Isopropyl alcohol
(2-propanol)

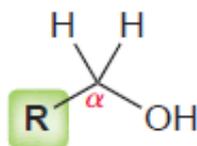


tert-Butyl alcohol
(2-methyl-2-propanol)

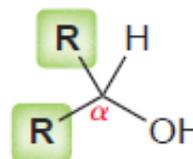


Benzyl alcohol
(phenylmethanol)

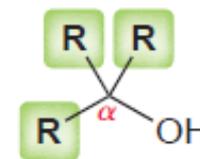
- Alcohols are also designated as primary, secondary, or tertiary, depending on the number of alkyl groups attached directly to the alpha (α) position (the carbon atom bearing the hydroxyl group).



Primary



Secondary

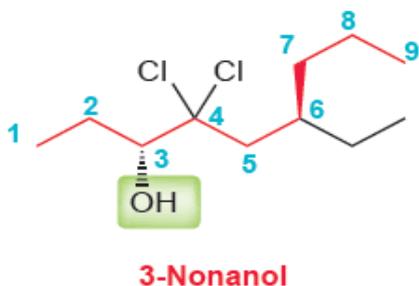


Tertiary

Nomenclature of Alcohols

NAMING AN ALCOHOL

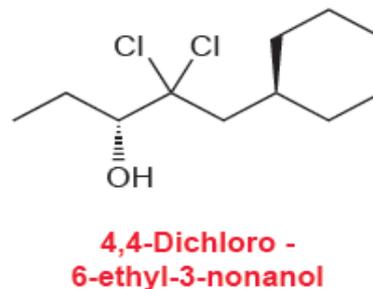
STEP 1 Choose the longest chain containing the OH group, and number the chain starting from the end closest to the OH group.



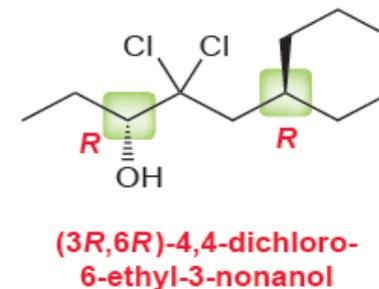
STEPS 2 AND 3 Identify the substituents and assign locants.



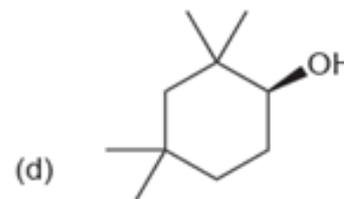
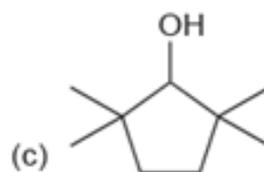
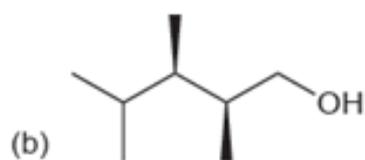
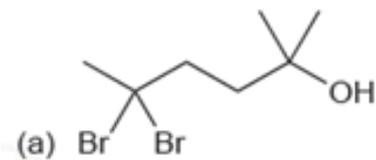
STEP 4 Assemble the substituents alphabetically.



STEP 5 Assign the configuration of any chirality center.



H.W. Provide an IUPAC name for each of the following alcohols:



13.2 Draw the structure of each of the following compounds:

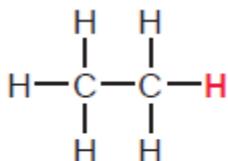
(a) (*R*)-3,3-Dibromocyclohexanol

(b) (*S*)-2,3-Dimethyl-3-pentanol

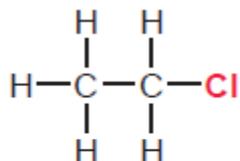
(c) (1*S*,2*S*,4*R*)-Bicyclo[2.2.1]heptan-2-ol

Physical properties of alcohols

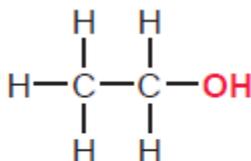
- High boiling points due to hydrogen bonding between molecules.



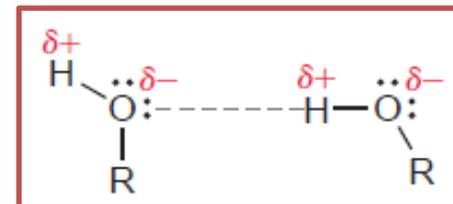
Ethane
bp = -89°C



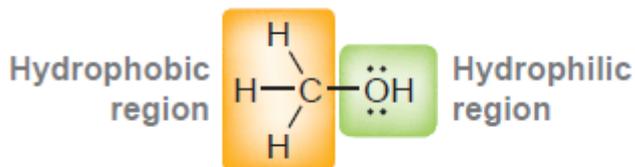
Chloroethane
bp = 12°C



Ethanol
bp = 78°C

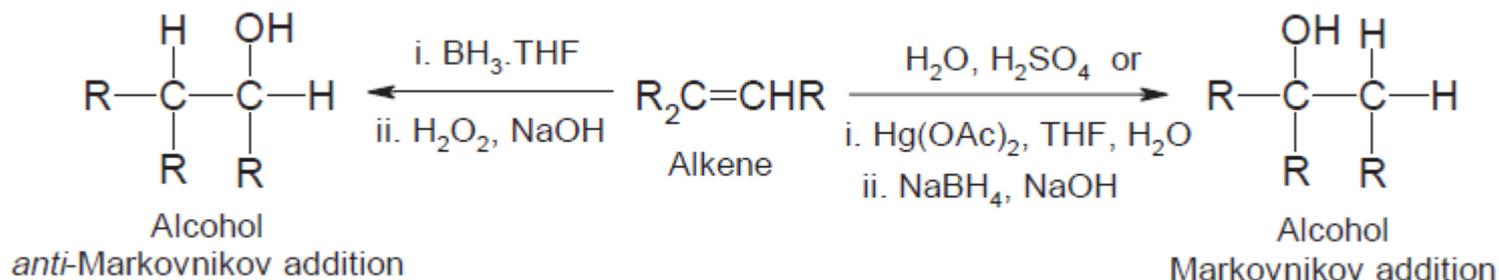


- All alcohols possess a hydrophilic region and a hydrophobic region. Small alcohols (methanol, ethanol, propanol) are miscible with water. A substance is said to be soluble in water when only a certain volume of the substance will dissolve in a specified amount of water at room temperature. Butanol is soluble in water.



Preparation of alcohols

- Alcohols can be prepared conveniently from the hydration of alkenes



Reactions of alcohols

