



Biological and Bioorganic Chemistry

Some useful material

Kharkov V. N. Karazin National University
Institute for Chemistry

Department of Physical Organic Chemistry

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Teaching



Biological and Bioorganic Chemistry (Faculty of Medicine)

Lecturer: Dr. Denis Svechikarev

A semester-long introduction to organic, bioorganic and biological chemistry for first-year foreign students of the Faculty of Medicine is fully taught in English. The course comprises a small series of lectures, 10 seminars and 5 practice sessions and gives 2 credits according to ECTS.

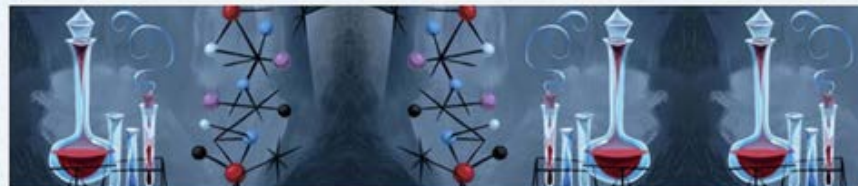
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- [Calendar working plan \[PDF\]](#)
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CHEMLABA

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will be announced ...

What shall we do?



Feb 19

Introduction to organic and biological chemistry. Classes and nomenclature of organic compounds. Saturated and unsaturated hydrocarbons. S_R and Ad_E reactions.

Mar 4

Aromatic hydrocarbons. Orientation in the aromatic ring. Halogen derivatives of hydrocarbons. S_N reactions. Alcohols, ethers. Polyhydric alcohols.

Mar 18

Carbonyl compounds – aldehydes and ketones. Carbohydrates.

Apr 1

Carboxylic acids and their derivatives: amides, nitriles, anhydrides. Esters, fats.

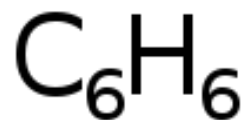
Apr 15

Amines, aminoacids, peptides. Heterocyclic compounds and their biological activity.

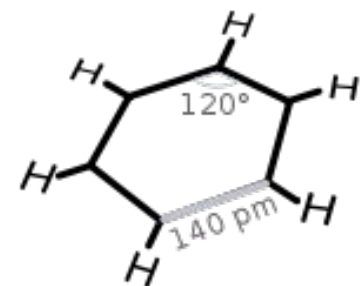
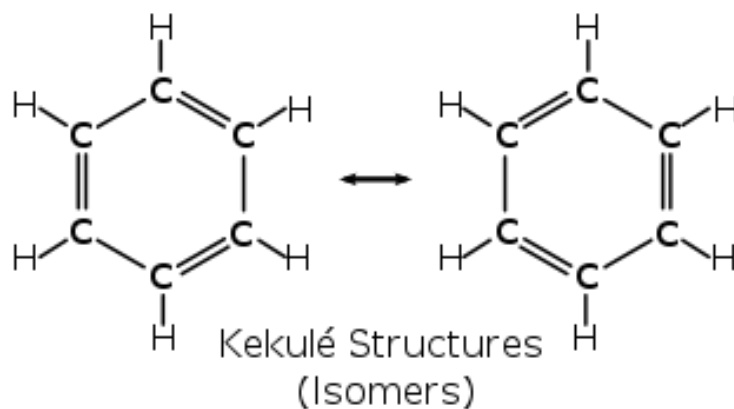


**Aromatic
hydrocarbons**

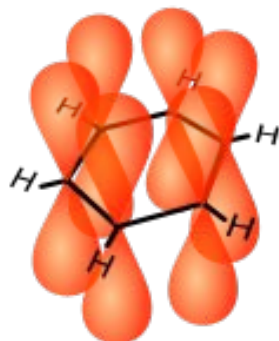
Structure of the benzene ring



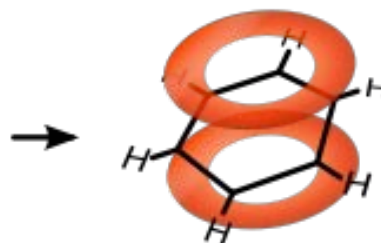
Benzene
Molecular formula



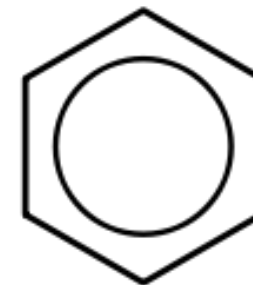
Sigma Bonds
 sp^2 Hybridized orbitals



6 p_z orbitals

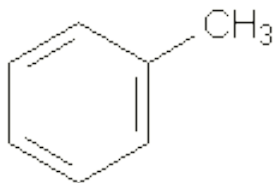


delocalized pi
system

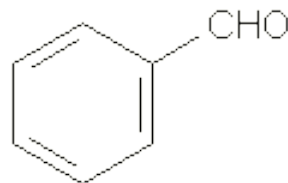


Benzene ring
Simplified depiction

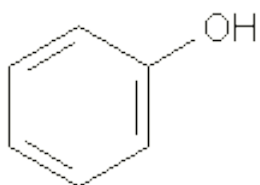
Names of main benzene derivatives



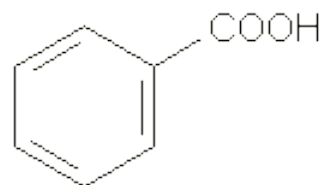
toluene



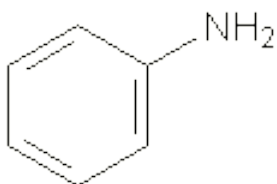
benzaldehyde



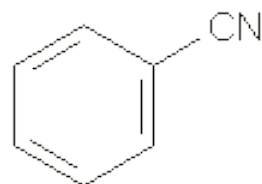
phenol



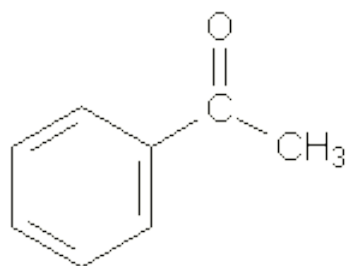
benzoic acid



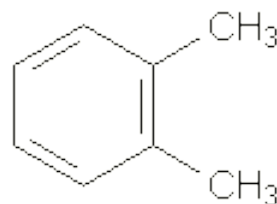
aniline



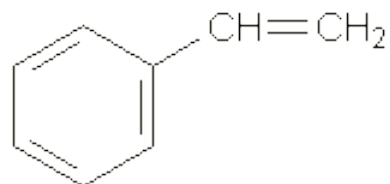
benzonitrile



acetophenone

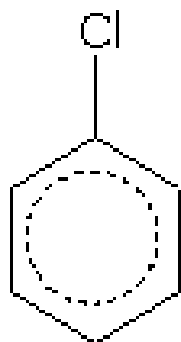


***ortho*-xylene**

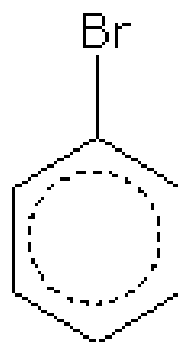


styrene

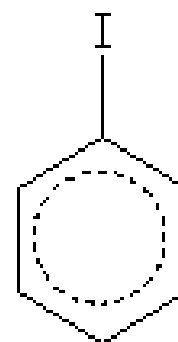
Naming benzene derivatives



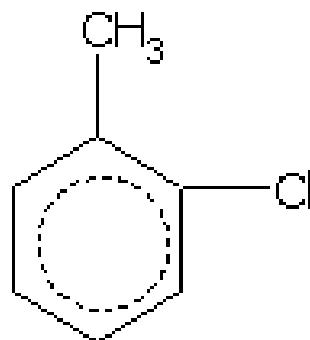
Chlorobenzene



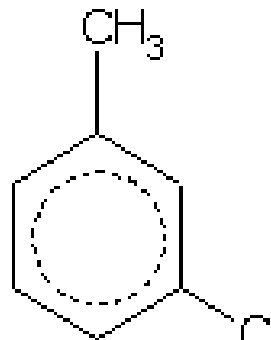
Bromobenzene



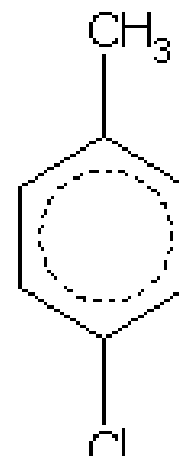
Iodobenzene



2-Chlorotoluene
(o-Chlorotoluene)



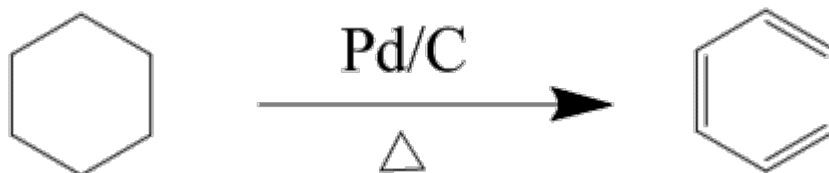
3-Chlorotoluene
(m-Chlorotoluene)



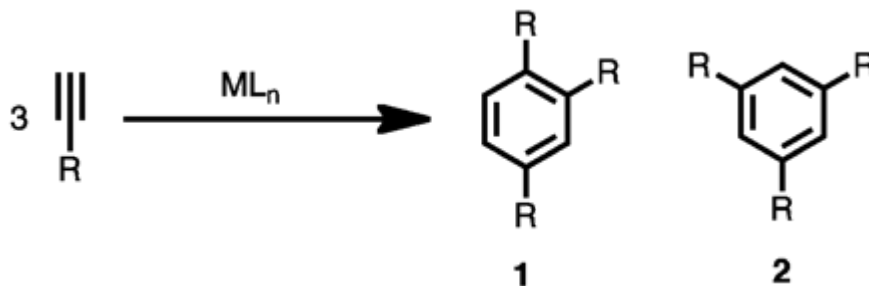
4-Chlorotoluene
(p-Chlorotoluene)

Synthesis of aromatic compounds

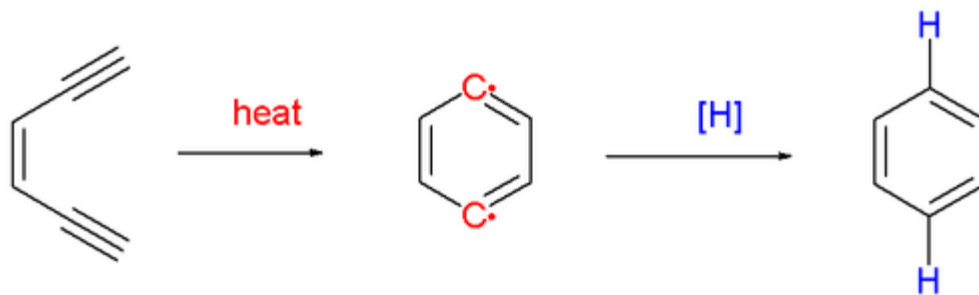
aromatization



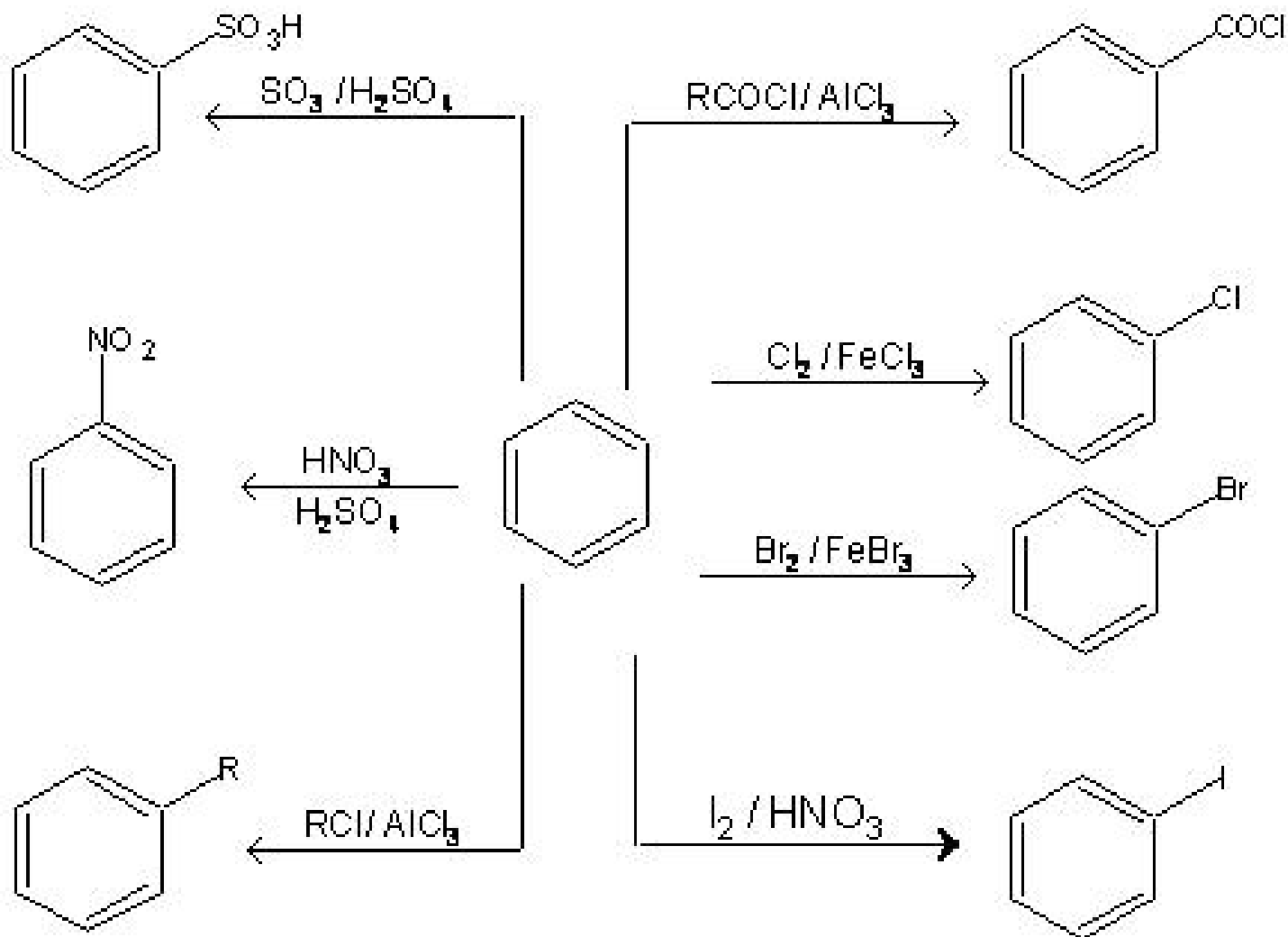
alkynes cycloaddition



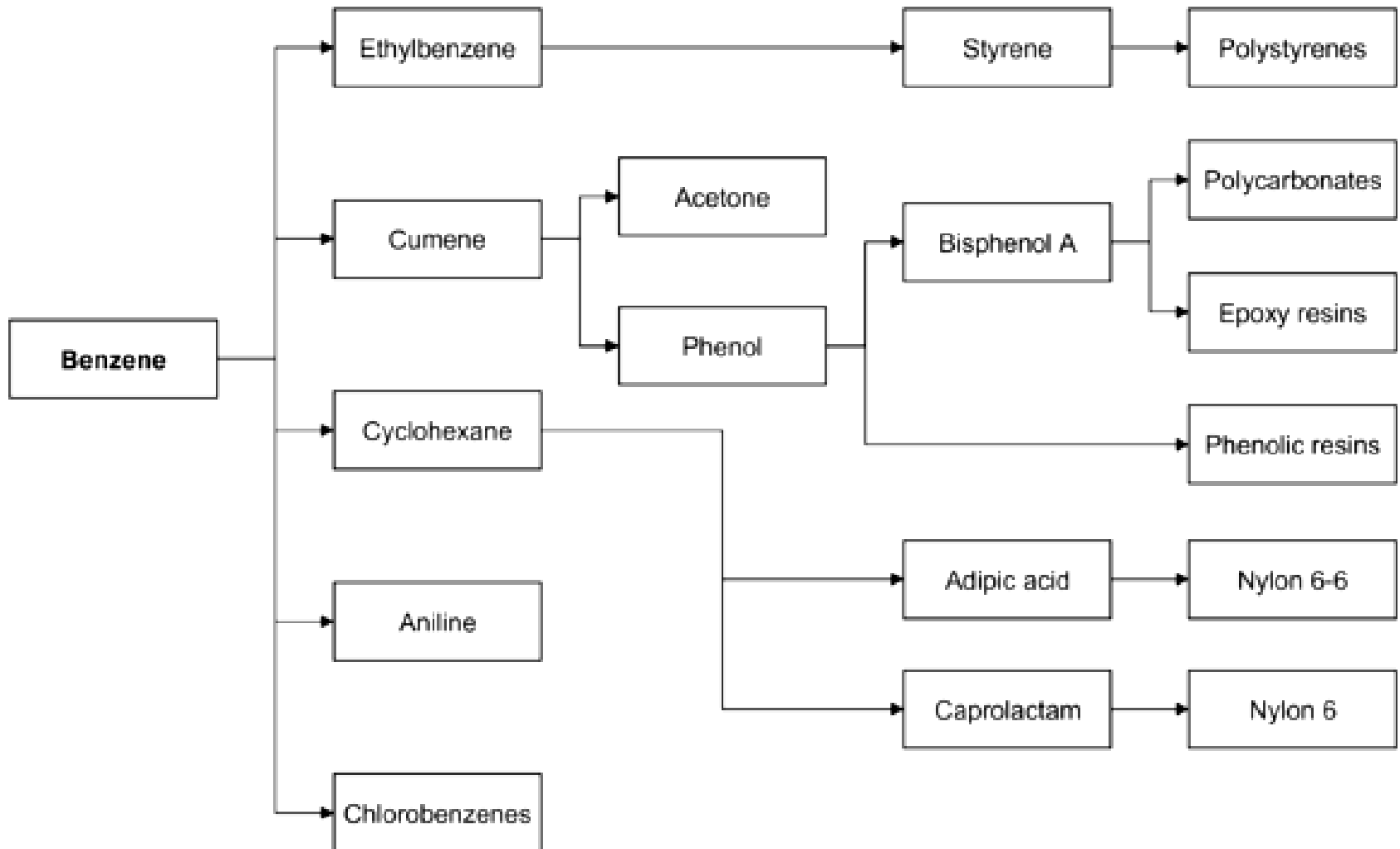
Bergman reaction




Reactions of benzene – S_E reactions



Industry of benzene derivatives

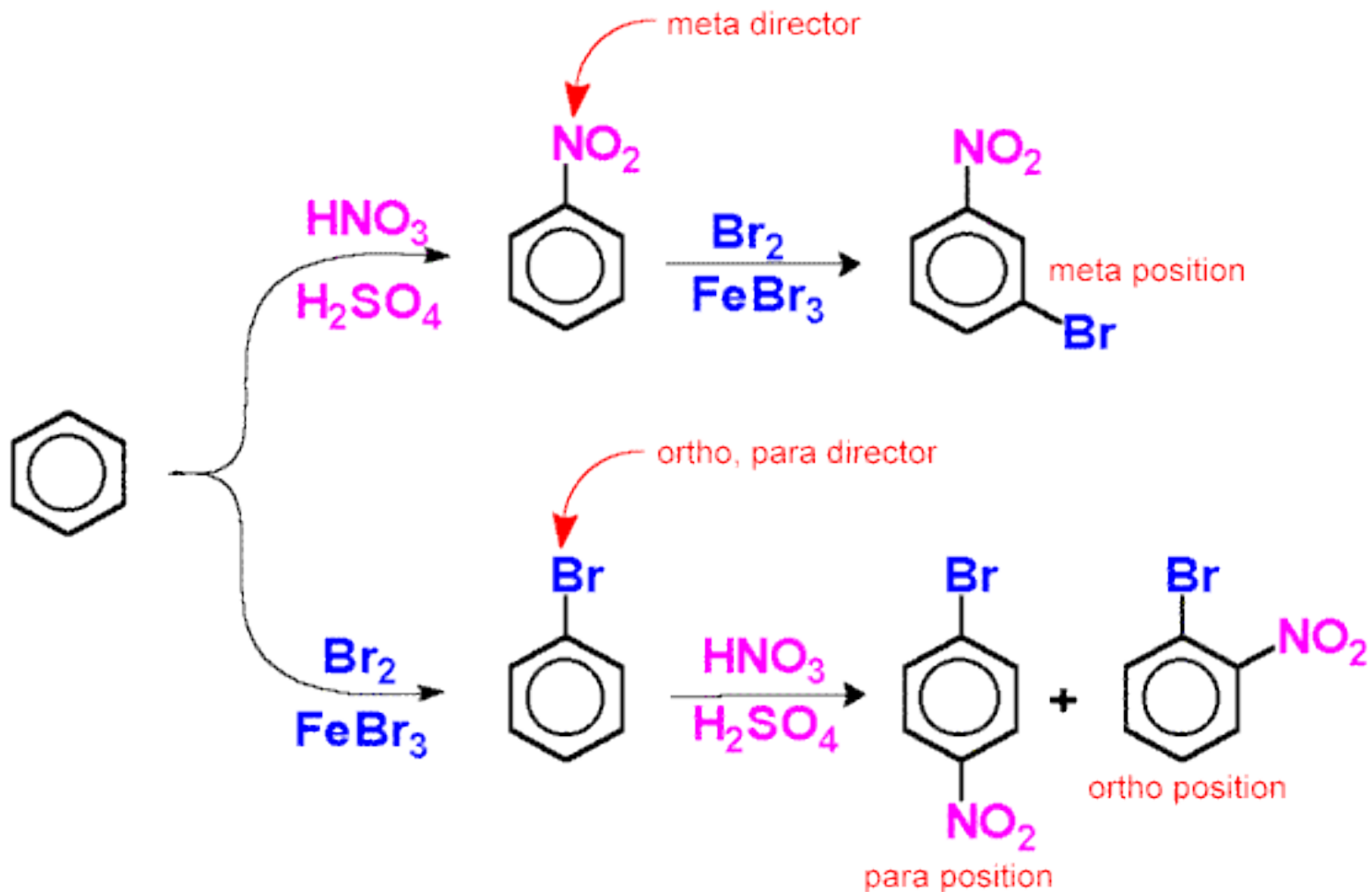


Orientation in the benzene ring



<u>Substituent</u>	<u>Reactivity</u>	<u>Orientation</u>	<u>Inductive Effect</u>	<u>Resonance Effect</u>
-NH ₂	Activating	<i>ortho, para</i>	weak; electron-withdrawing	strong, electron-donating
-OH	Activating	<i>ortho, para</i>	weak; electron-withdrawing	strong, electron-donating
-OR	Activating	<i>ortho, para</i>	weak; electron-withdrawing	strong, electron-donating
-NHCOR	Activating	<i>ortho, para</i>	weak; electron-withdrawing	strong, electron-donating
-R	Activating	<i>ortho, para</i>	weak; electron-donating	none
-Ar	Activating	<i>ortho, para</i>	weak; electron-donating	electron-donating
-H	-----	-----	-----	-----
-X	Deactivating	<i>ortho, para</i>	strong; electron-withdrawing	weak; electron-donating
-CHO	Deactivating	<i>meta</i>	strong; electron-withdrawing	strong; electron-withdrawing
-COOR	Deactivating	<i>meta</i>	strong; electron-withdrawing	strong; electron-withdrawing
-COOH	Deactivating	<i>meta</i>	strong; electron-withdrawing	strong; electron-withdrawing
-COR	Deactivating	<i>meta</i>	strong; electron-withdrawing	strong; electron-withdrawing
-SO ₃ H	Deactivating	<i>meta</i>	strong; electron-withdrawing	strong; electron-withdrawing
-C≡N	Deactivating	<i>meta</i>	strong; electron-withdrawing	strong; electron-withdrawing
-NO ₂	Deactivating	<i>meta</i>	strong; electron-withdrawing	strong; electron-withdrawing
-NR ₃ ¹⁺	Deactivating	<i>meta</i>	strong; electron-withdrawing	none

Orientation in the benzene ring



RED4 24H_LF

RD4 24H_LF

RTI MEDICAL
9705100
R105 INF
ACROSS FRID
15 May 2007
#1 20120

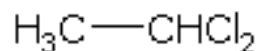
Halogen derivatives

C04 24H_LF

C0N4 24H_LF

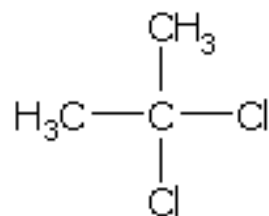


Naming halogen derivatives



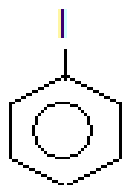
Ethylidene dichloride

IUPAC : 1,1-Dichloroethane

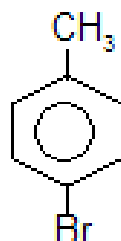


Iso-propylidene dichloride

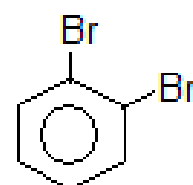
IUPAC : 2, 2-Dichloropropane



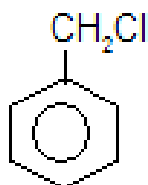
Iodobenzene



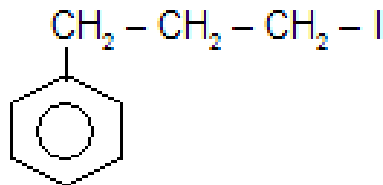
4-Bromotoluene
(*p*-Bromotoluene)



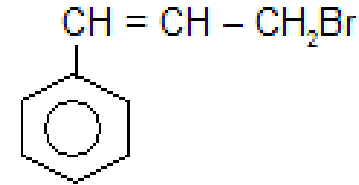
1,2-Dibromobenzene
(*o*-Dibromobenzene)



Benzyl chloride

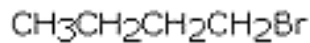
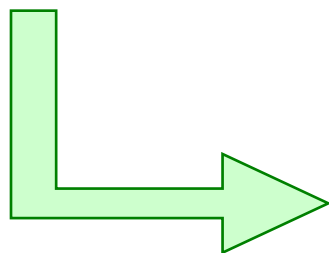
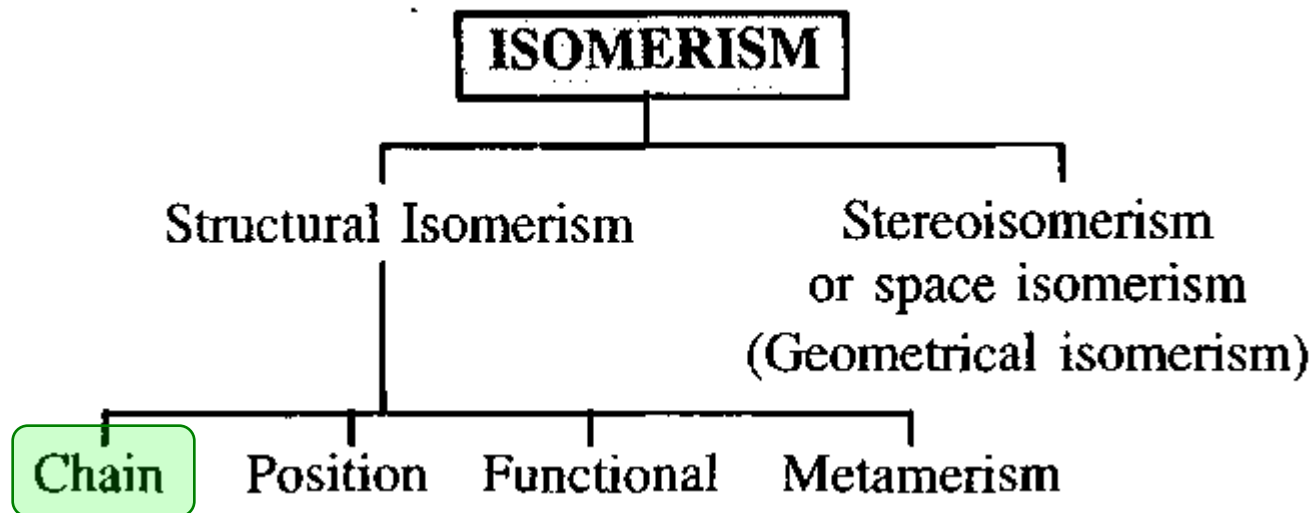


1-Iodo-3-phenylpropane

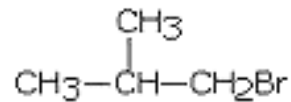


3-Bromo-1-phenylpropene

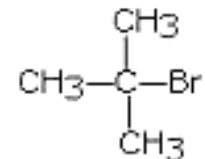
Isomerism of the halogen derivatives



1-Bromobutane

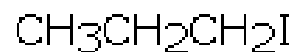
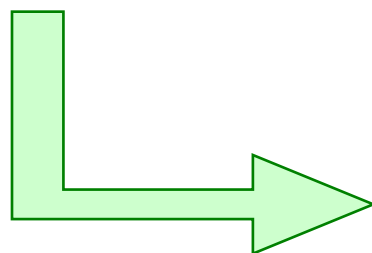
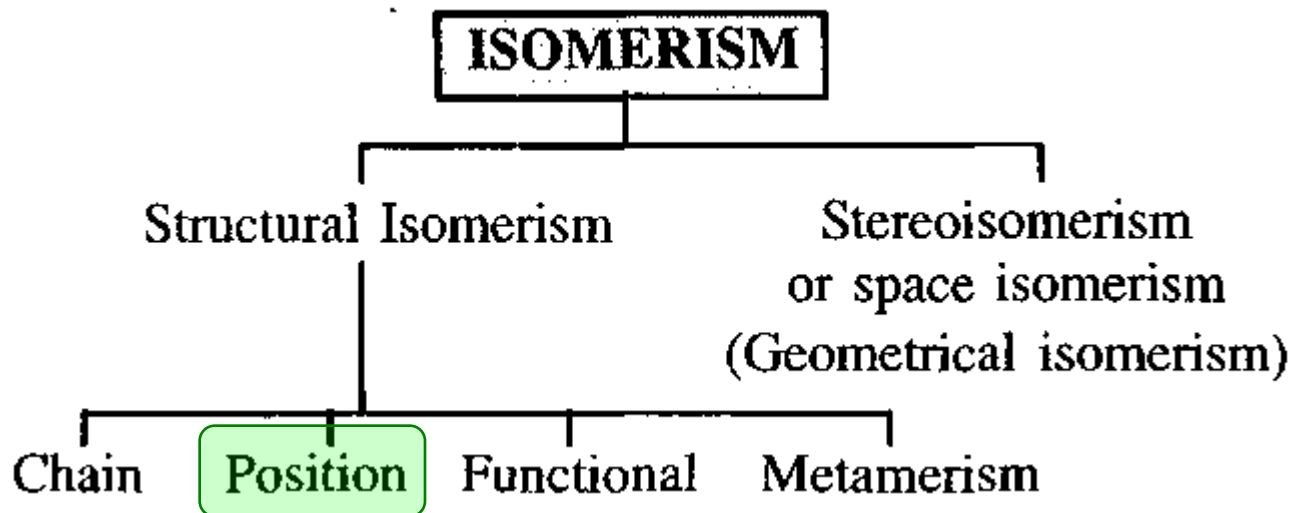


1-Bromo-2-methylpropane

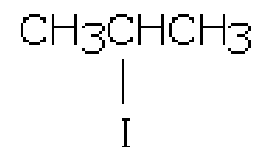


2-Bromo-2-methylpropane

Isomerism of the halogen derivatives

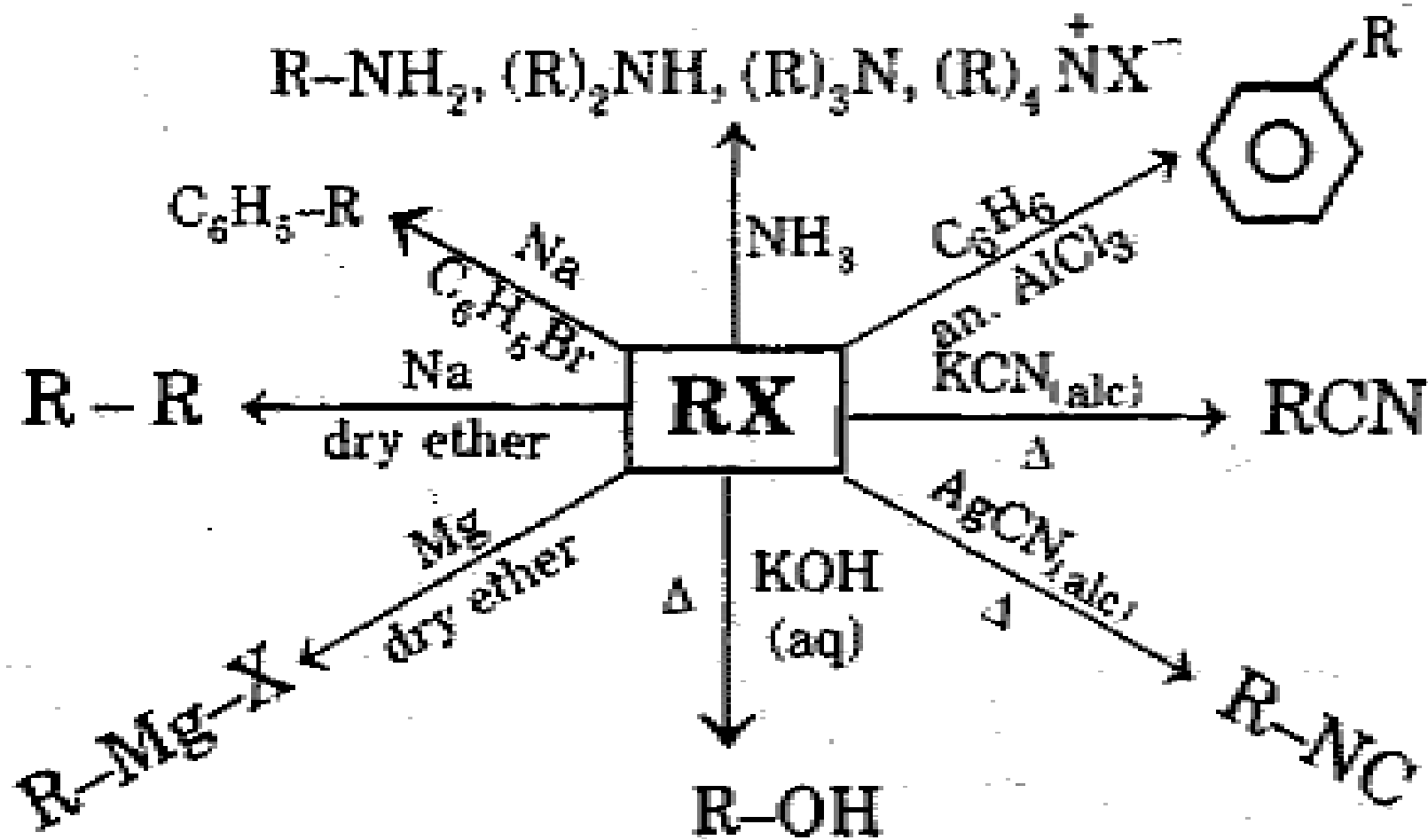


1-Iodopropane

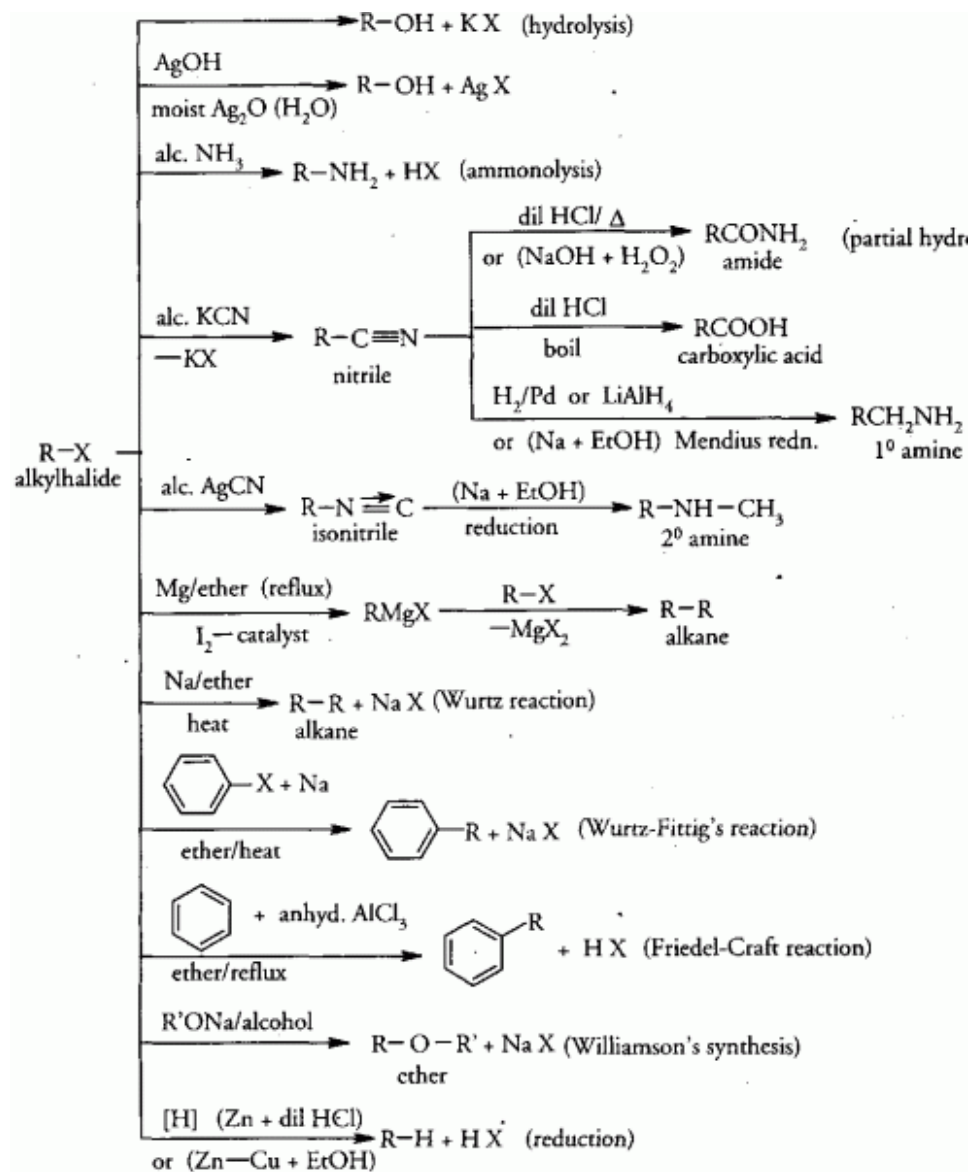


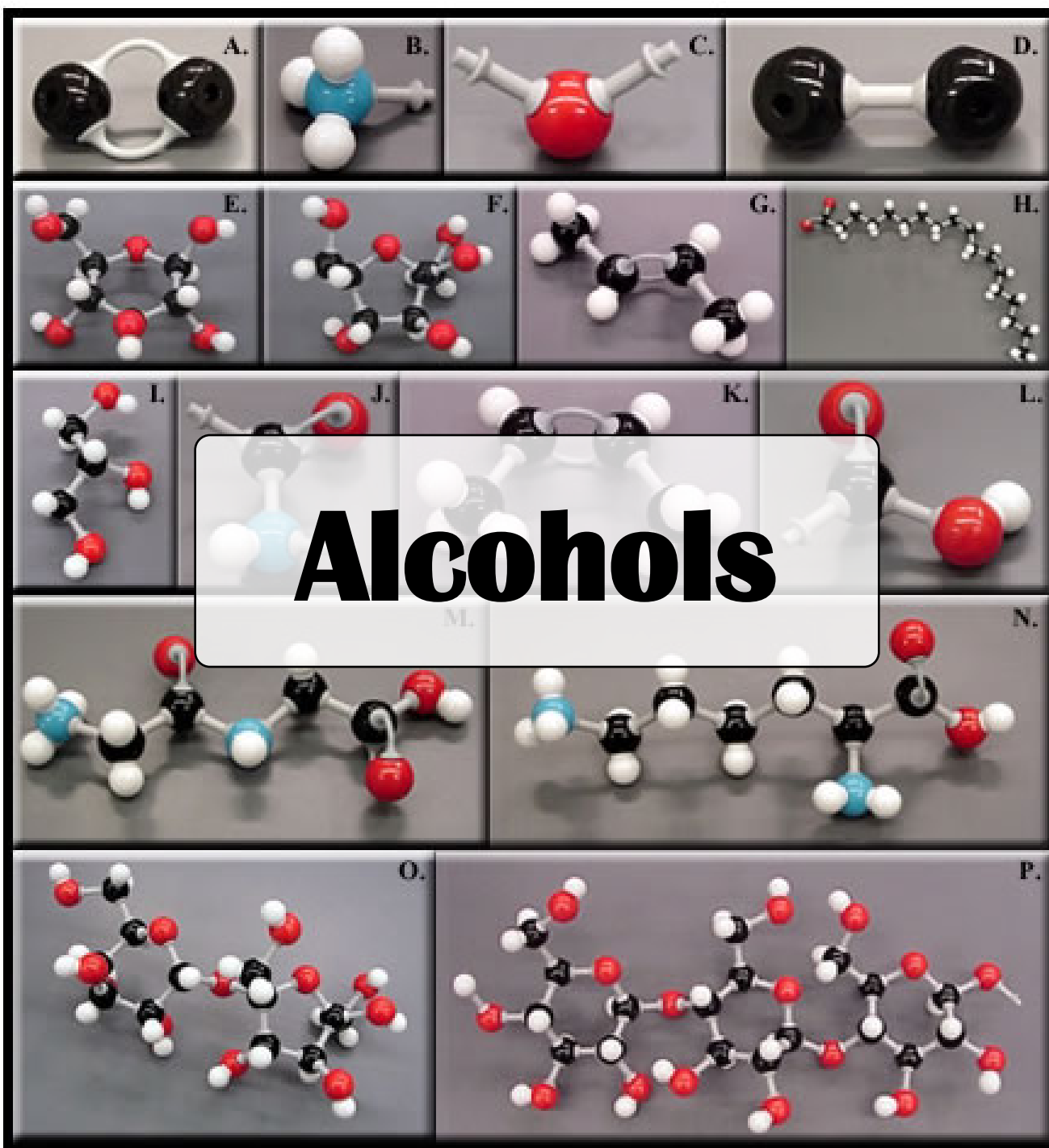
2-Iodopropane

Reactions of halogen derivatives

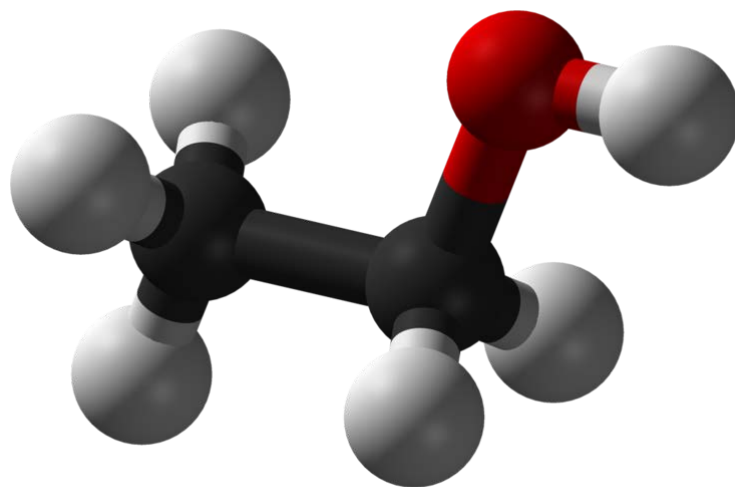
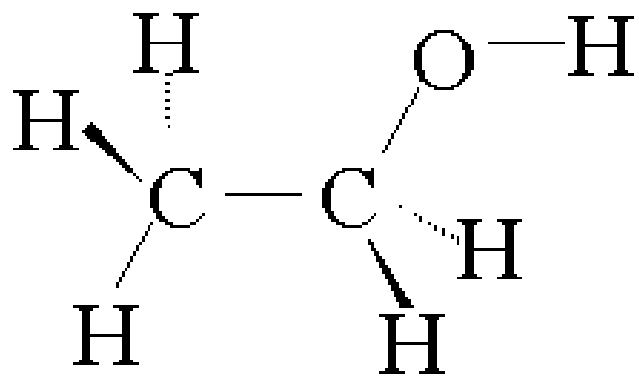
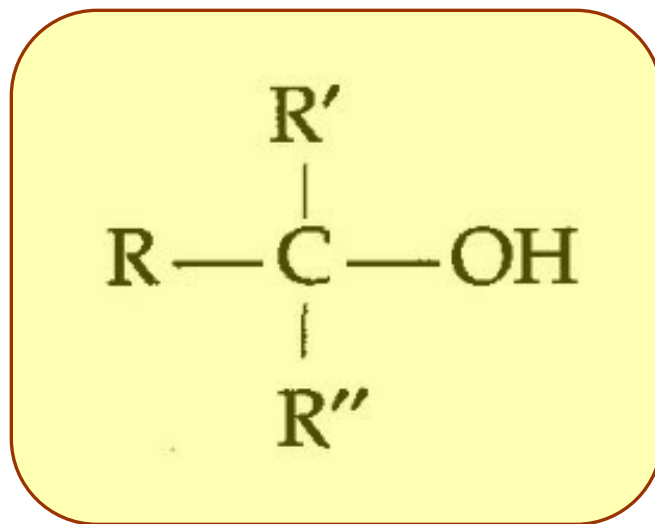


Reactions of halogen derivatives



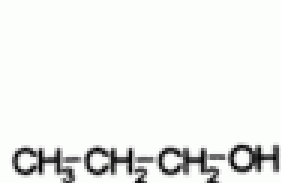


Structure of alcohols



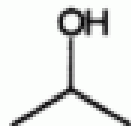
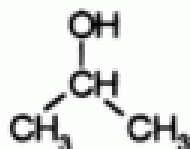
Naming alcohols

Origin: from arabic الكحل (*al-kuhl*)



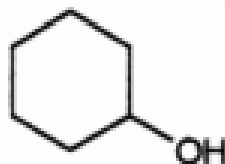
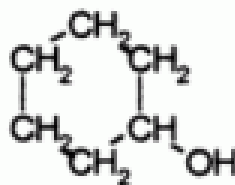
n-propyl alcohol
or propan-1-ol
or 1-propanol

A primary alcohol

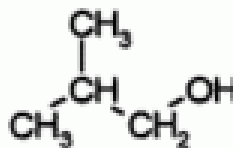


isopropyl alcohol
or propan-2-ol
or 2-propanol

A secondary alcohol

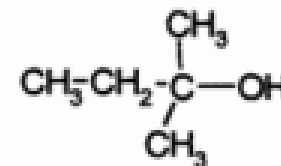


cyclohexanol, a
secondary alcohol



isobutyl alcohol
or 2-methylpropan-1-ol
or 2-methyl-1-propanol

A primary alcohol



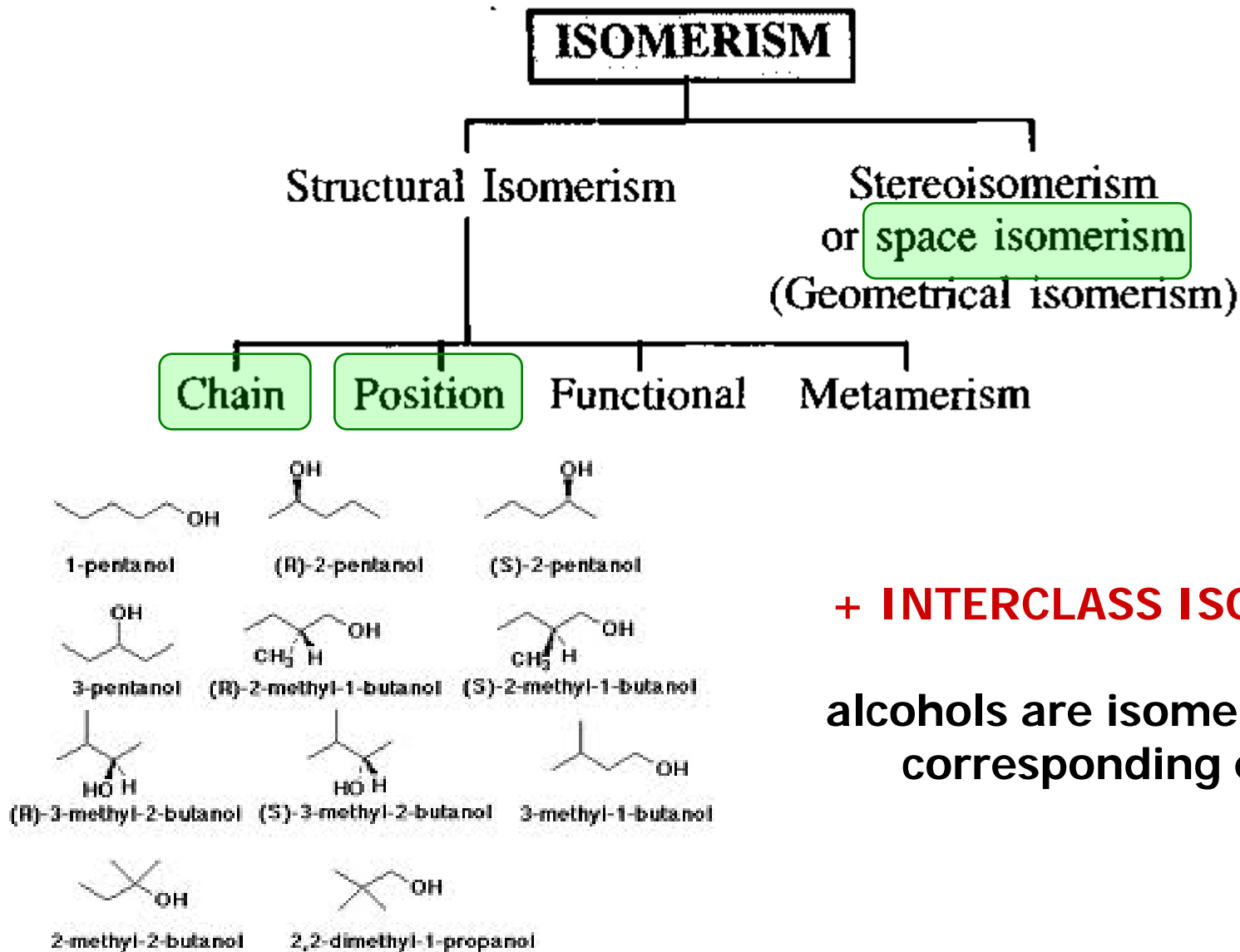
tert-amyl alcohol
or 2-methylbutan-2-ol
or 2-methyl-2-butanol

A tertiary alcohol

Classification of alcohols:

- primary
- secondary
- tertiary

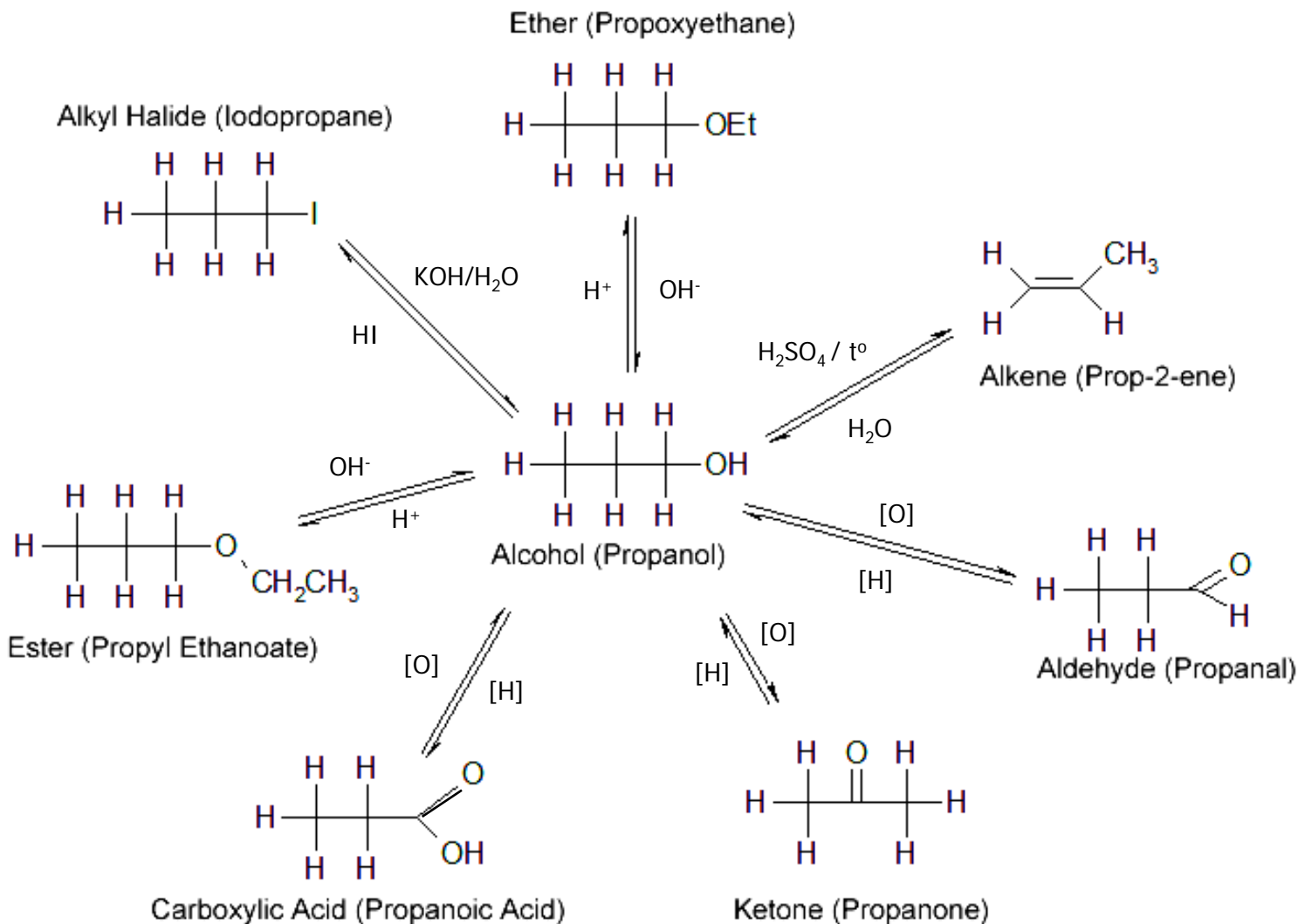
Isomerism of alkenes



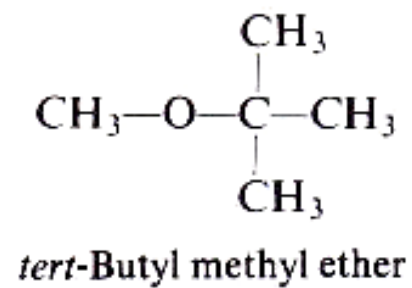
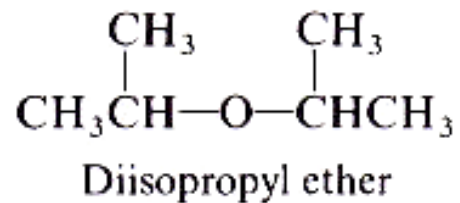
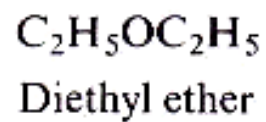
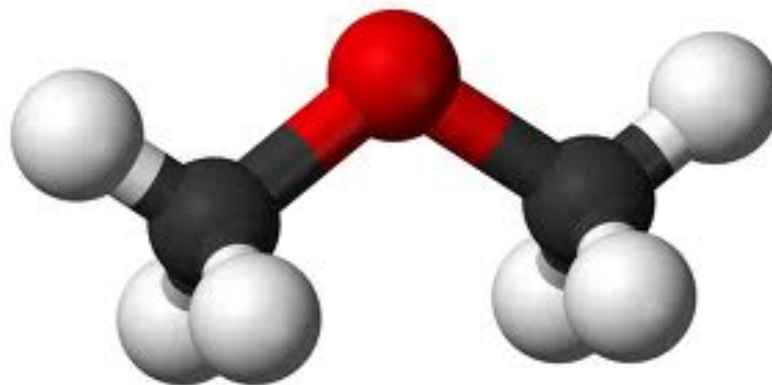
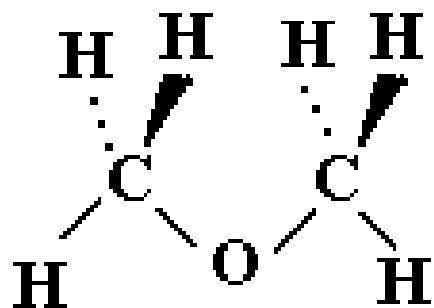
+ INTERCLASS ISOMERISM

alcohols are isomeric to the corresponding ethers

Synthesis and reactions of alcohols



Ethers



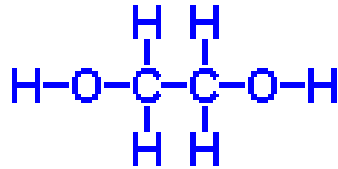
Physiological role of alcohols



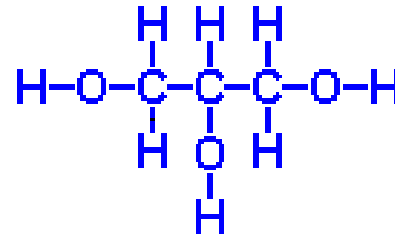
Ethanol in alcoholic beverages has been consumed by humans since prehistoric times. The consumption of large doses of ethanol causes drunkenness (intoxication). Depending upon the dose and the regularity of its consumption, ethanol can cause acute respiratory failure or death. Because ethanol impairs judgment in humans, it can be a catalyst for reckless or irresponsible behavior. The LD_{50} of ethanol for rats is 10.3 g/kg.

Other alcohols are substantially more poisonous than ethanol, partly because they take much longer to be metabolized and partly because their metabolism produces substances that are even more toxic. Methanol (wood alcohol), for instance, is oxidized to formaldehyde and then to the poisonous formic acid in the liver; accumulation of formic acid can lead to blindness or death.

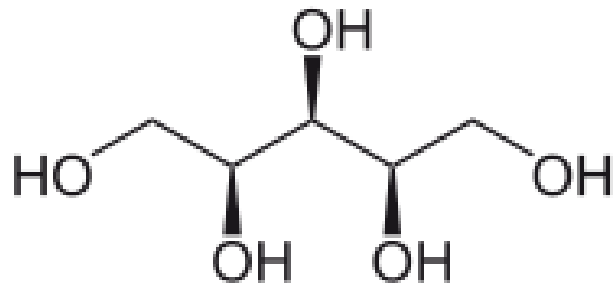
Polyhydric alcohols - names



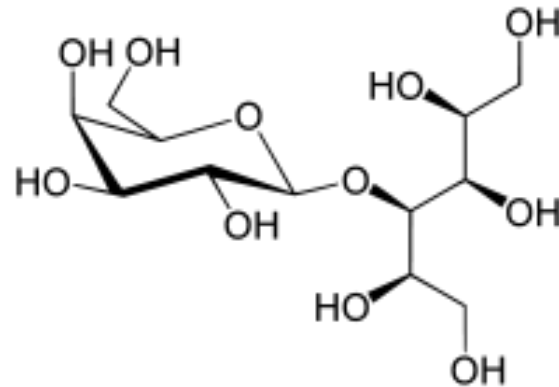
Ethan-1,2-diol
(Ethylene glycol)



Propan-1,2,3-triol
(Glycerol)



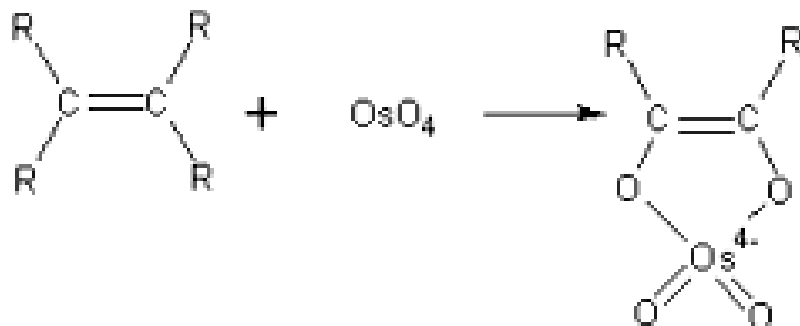
xylitol



lactitol

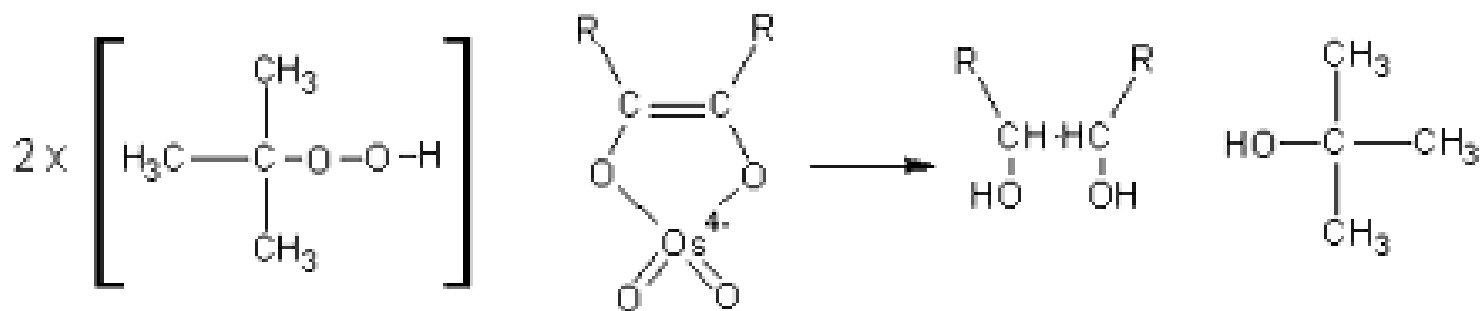
Polyhydric alcohols - synthesis

Step 1.

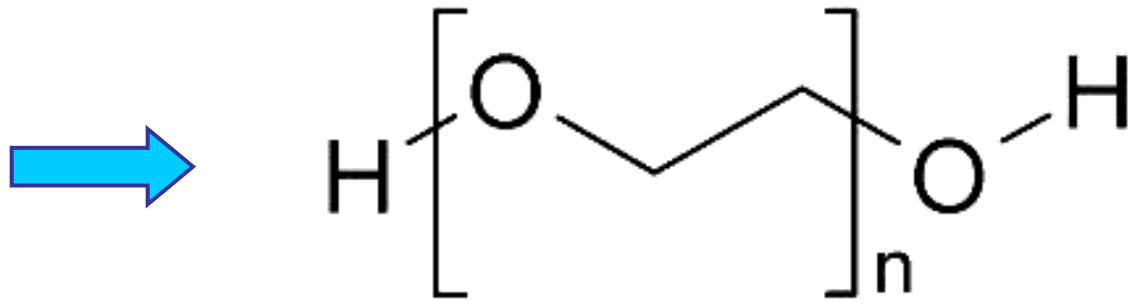
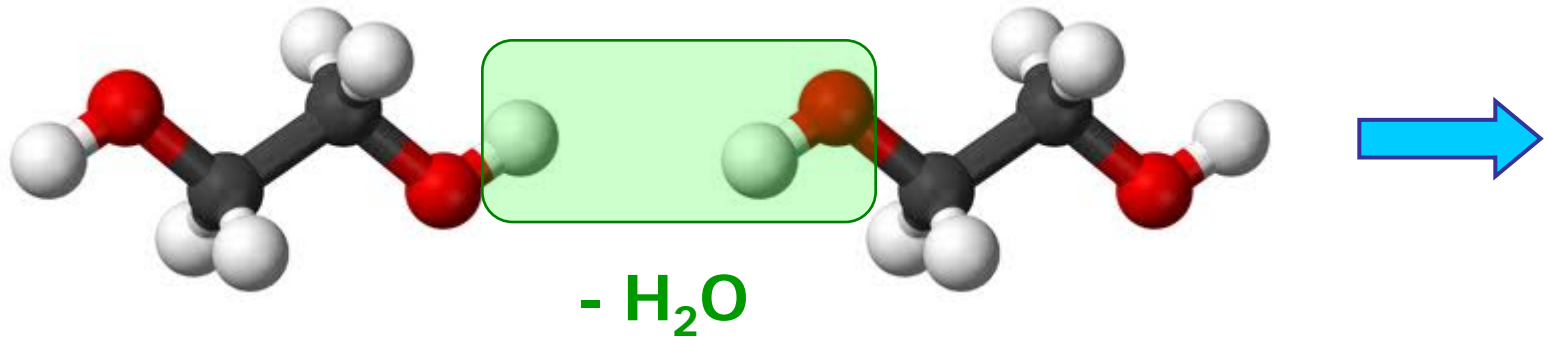


Similar procedure can be also performed using **KMnO₄**.

Step 2.



Polycondensation



polyethylene glycol

What shall we do?



Feb 19

Introduction to organic and biological chemistry. Classes and nomenclature of organic compounds. Saturated and unsaturated hydrocarbons. S_R and Ad_E reactions.

Mar 4

Aromatic hydrocarbons. Orientation in the aromatic ring. Halogen derivatives of hydrocarbons. S_N reactions. Alcohols, ethers. Polyhydric alcohols.

Mar 18

Carbonyl compounds – aldehydes and ketones. Carbohydrates.

Apr 1

Carboxylic acids and their derivatives: amides, nitriles, anhydrides. Esters, fats.

Apr 15

Amines, aminoacids, peptides. Heterocyclic compounds and their biological activity.