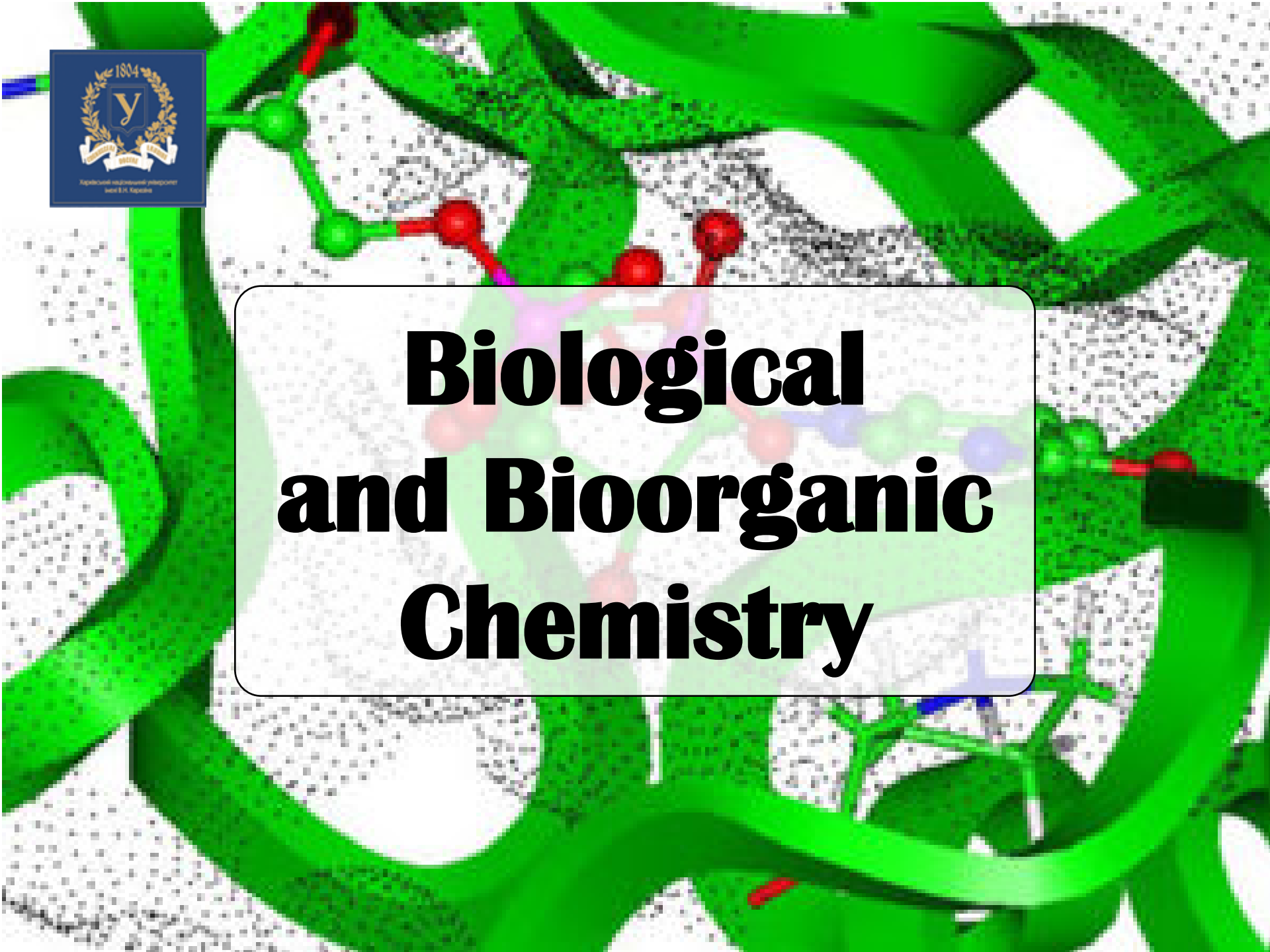
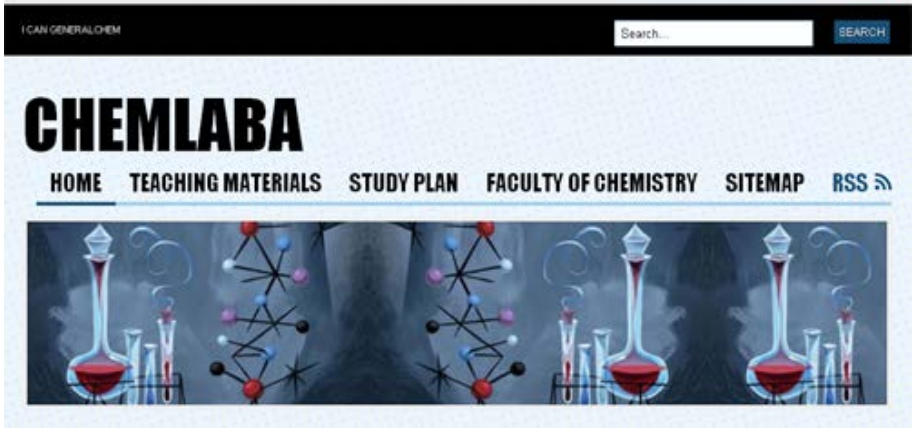
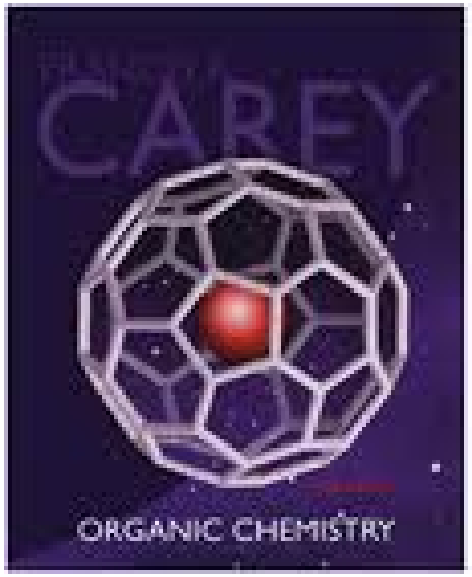

Biological
and Bioorganic
Chemistry

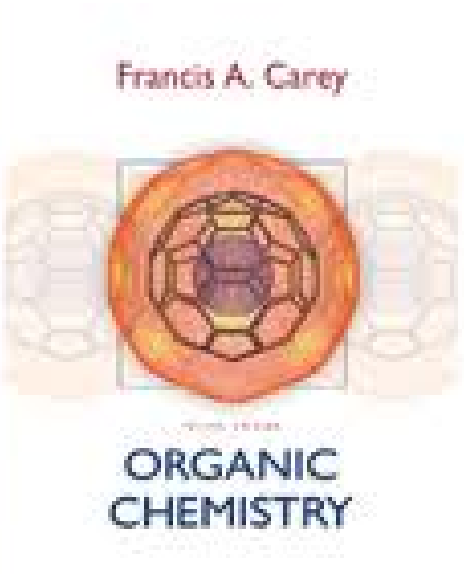
Some useful web-materials

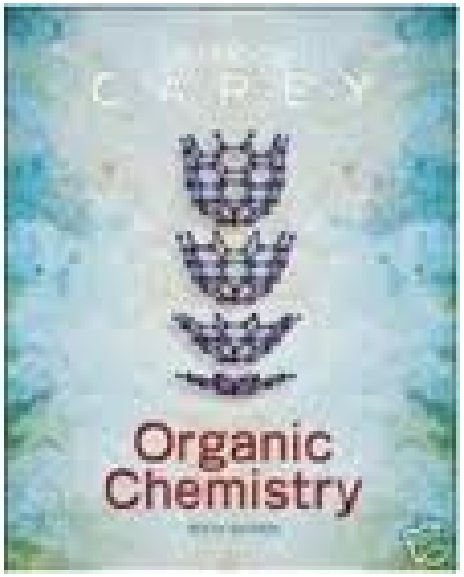


will be announced ...

Some useful web-materials

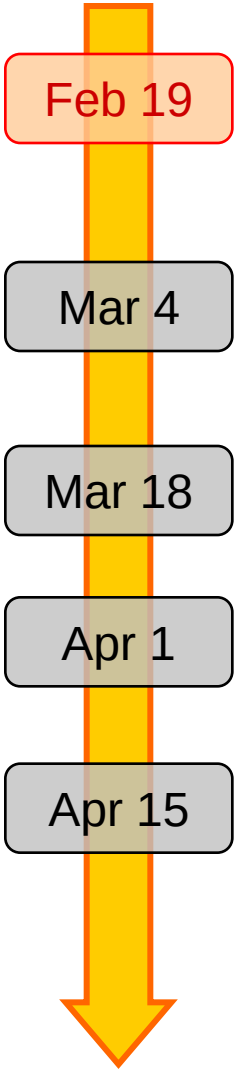






F. A. Carey. Organic Chemistry, 5th Edition, The MgGraw-Hill, 2004. P. 211.
(http://www.chem.ucalgary.ca/courses/350/Carey5th/Carey.html)

What shall we do?



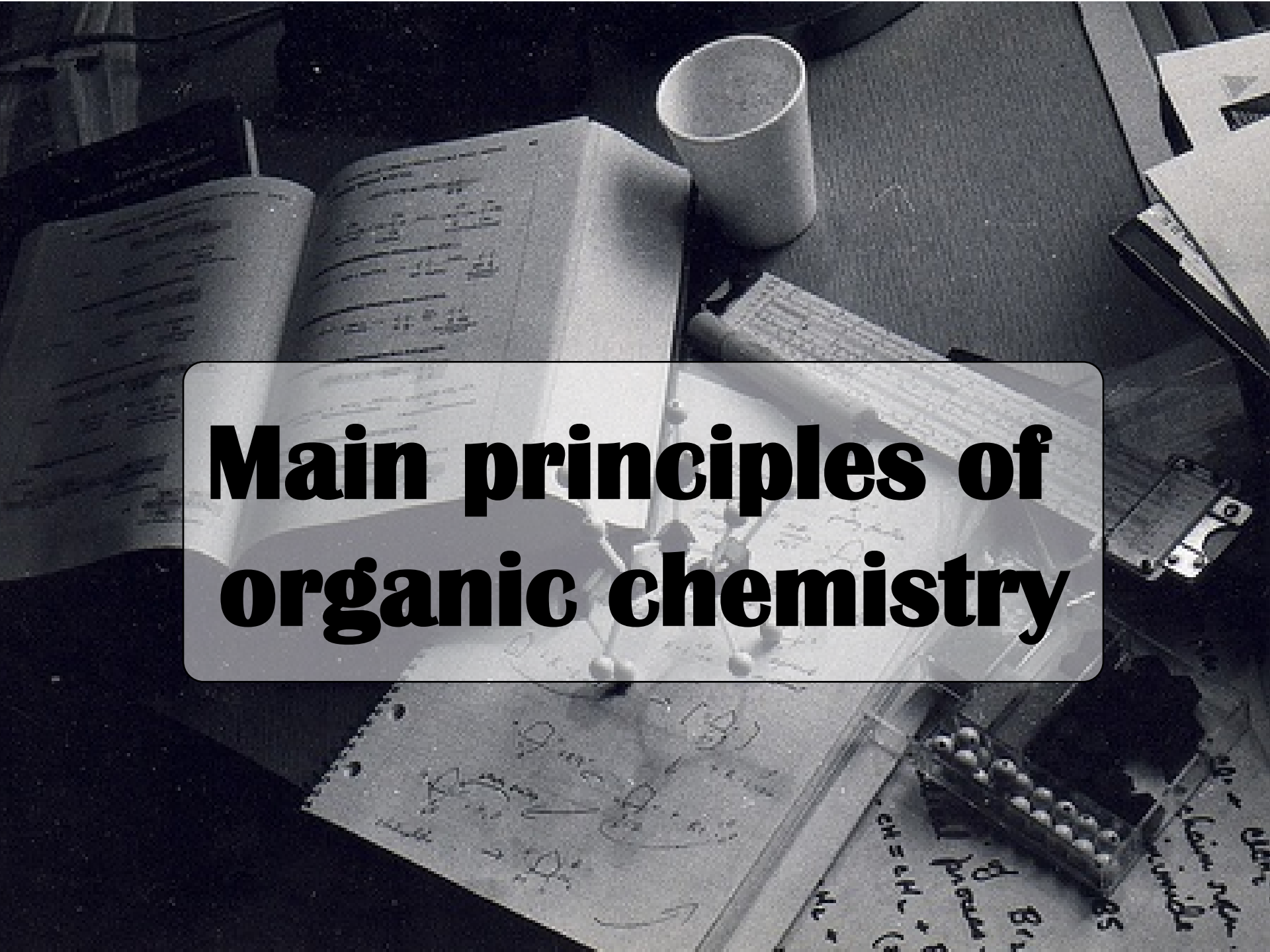
Feb 19 — Introduction to organic and biological chemistry. Classes and nomenclature of organic compounds. Saturated and unsaturated hydrocarbons. S_R and Ad_E reactions.

Mar 4 — Aromatic hydrocarbons. Orientation in the aromatic ring. Halogen derivatives of hydrocarbons. S_N reacions. 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.


Main principles of
organic chemistry

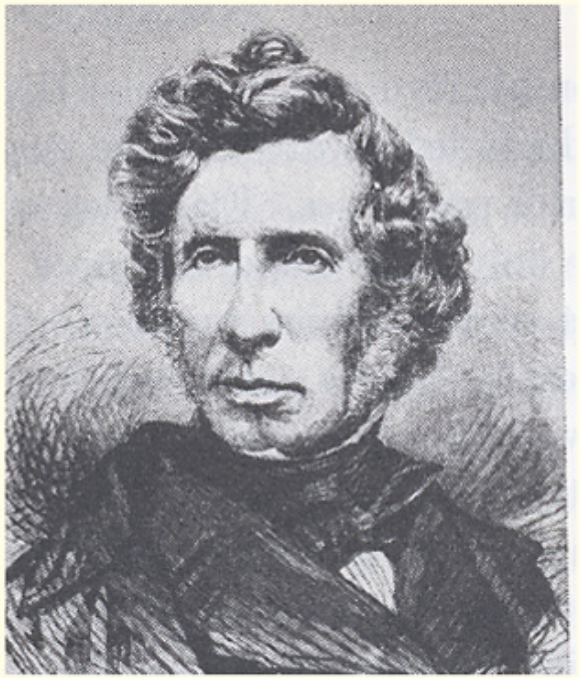
Organic *vs.* Inorgaic

Comparison of Inorganic vs. Organic compounds:

Inorganic	Organic
Ionic Bonding, hence:	Covalent/van der waals
High melting point	Low melting point
High boiling point	Low boiling point
Non-volatile	Volatile
Soluble in water	Insoluble in water
Insoluble in organic solvents	Soluble in organic solvents
Electrical conductors in aqueous solutions when melted	Electrical insulators in solutions when melted
Have fast reactions	Have slow reactions
Ex. salts	Ex. wax
water	butter
oxides	alcohols
carbonates	gasoline
	sugar

Power of life and vitalism

Friedrich Woller
1800-1882



Made the first organic compound from non-living substances. Shot down the *Vital Force* idea of organic substances.

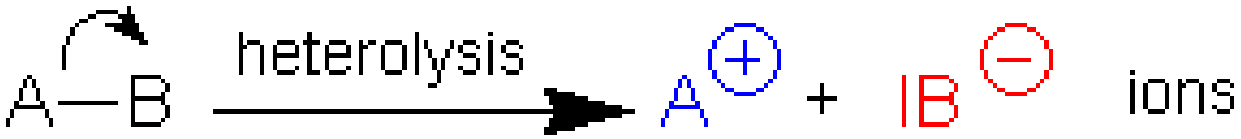
$AgNCO + NH_4\mathbf{Cl} \rightarrow$
$(NH_2)_2CO + AgCl$

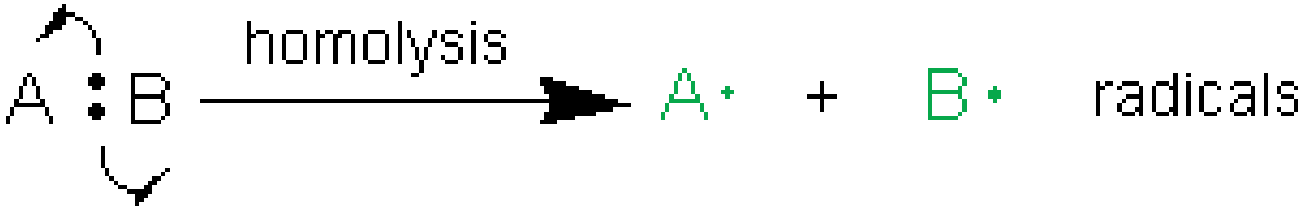
Theory of chemical structure

Alexander Butlerov

Eminent Russian chemist, one of the founders of the theory of chemical structure. First scientist to introduce double bonds in structural formulae.

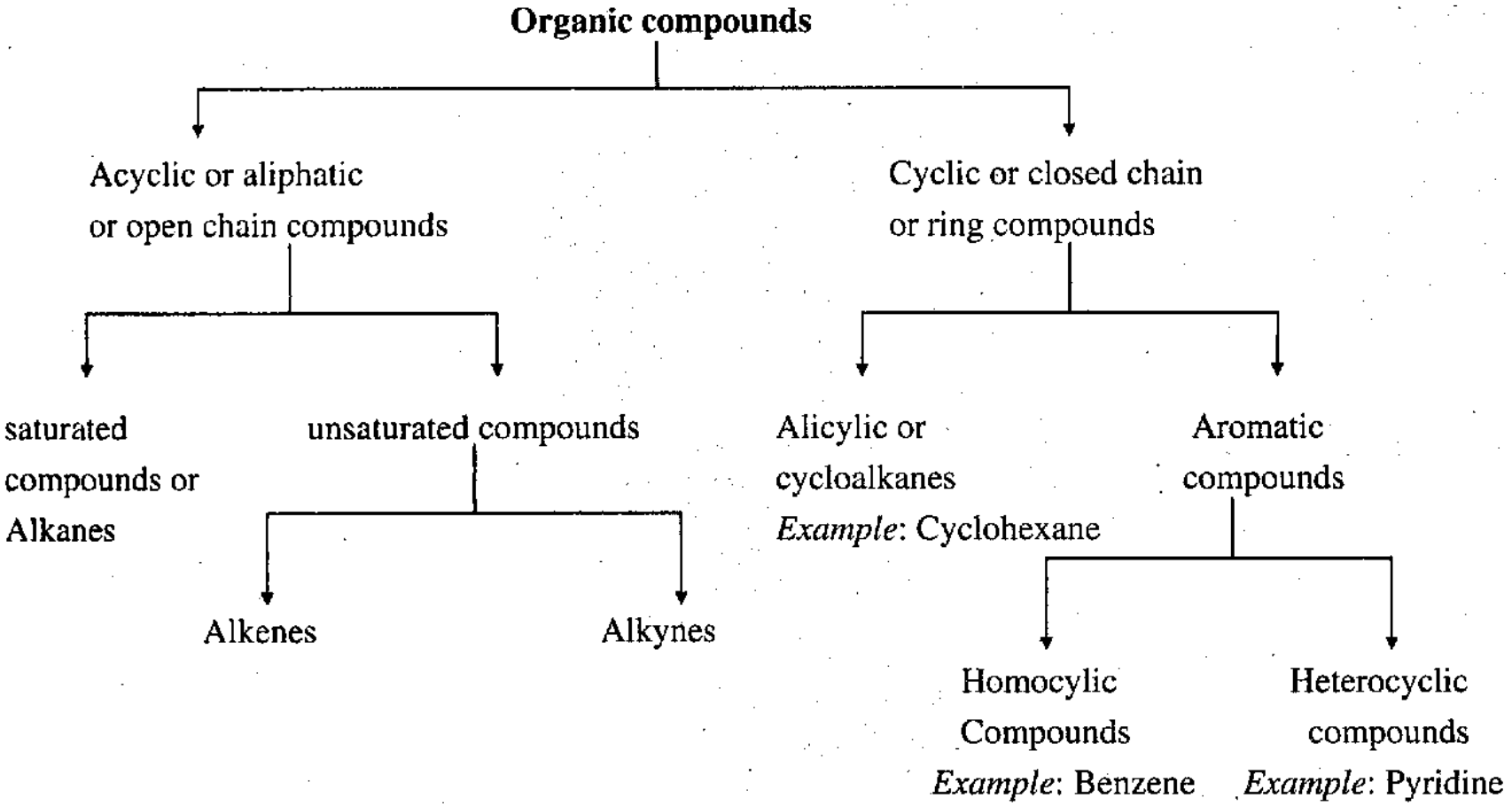
Intermediate particles



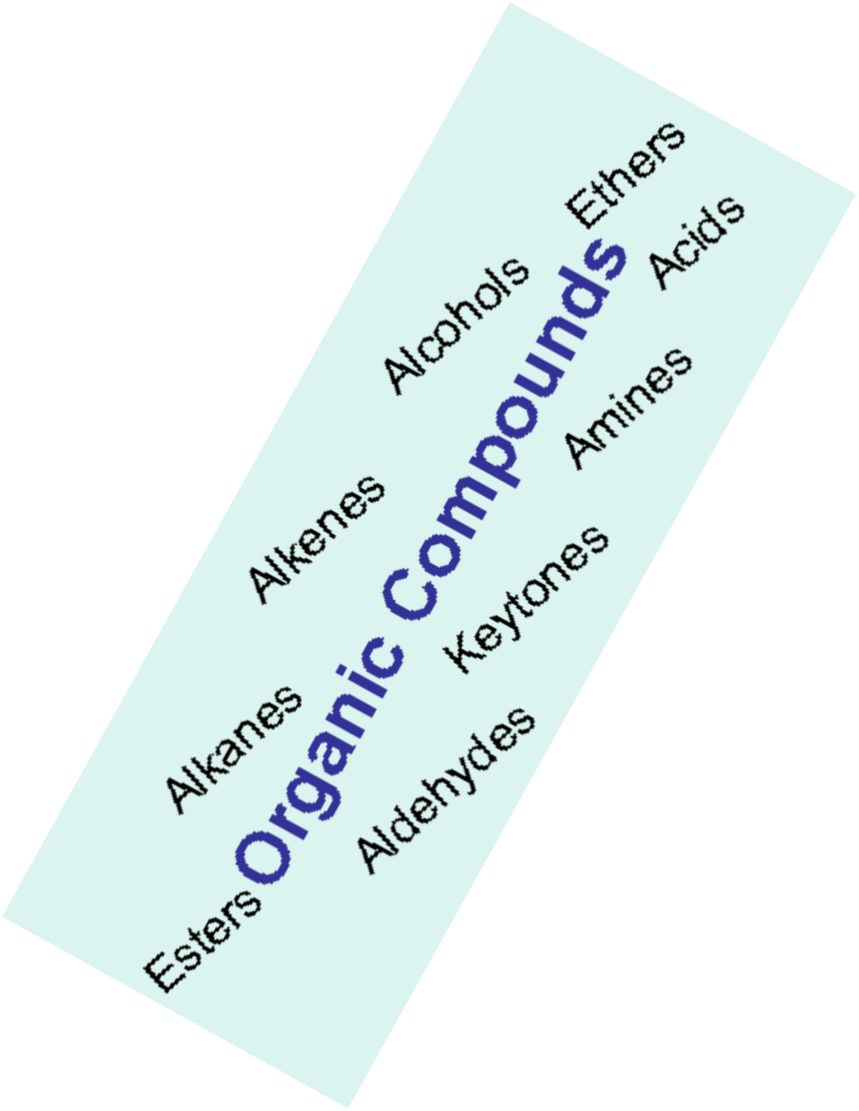


Classification of organic compounds

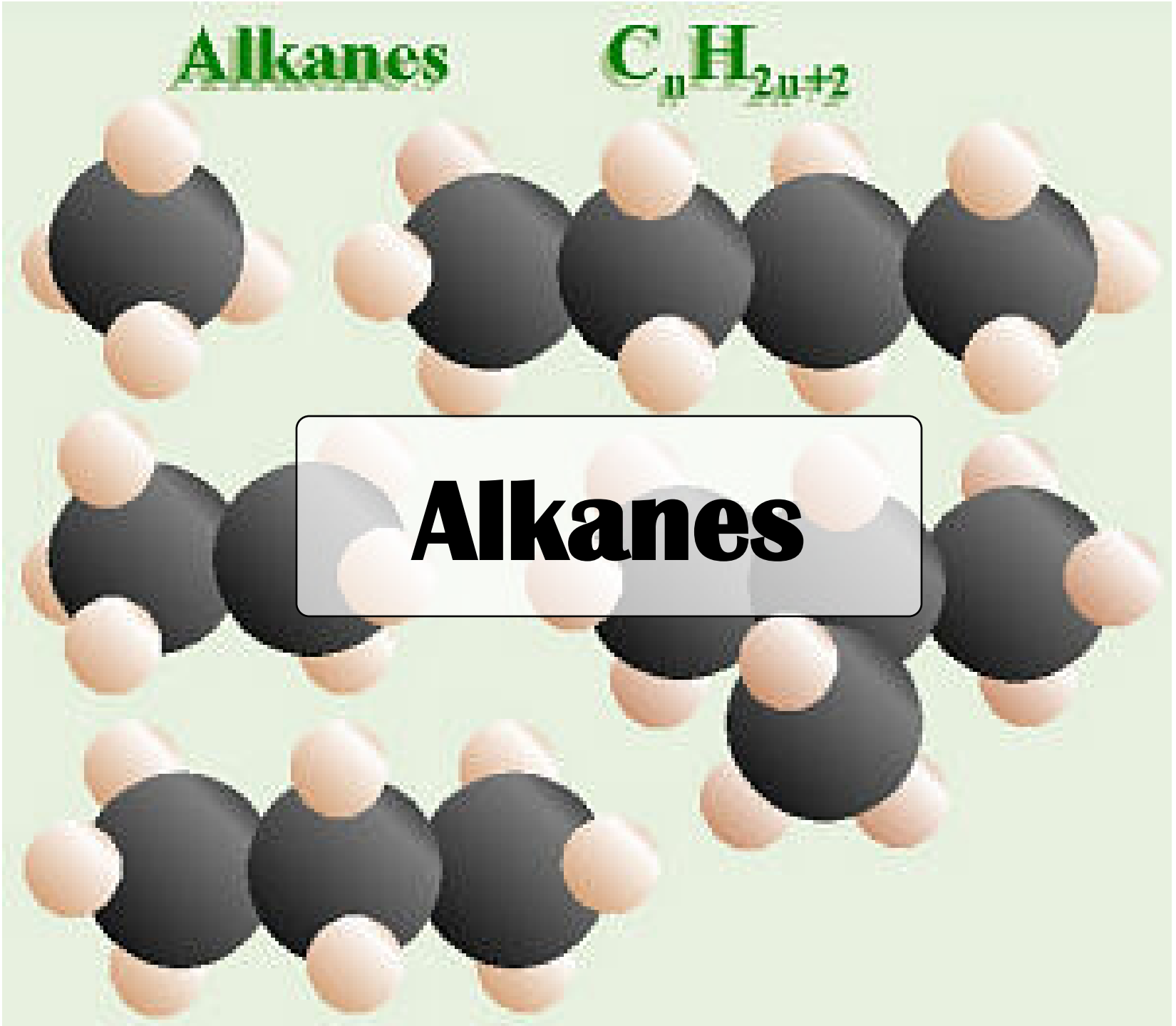
Schematic representation for the classification of organic compounds



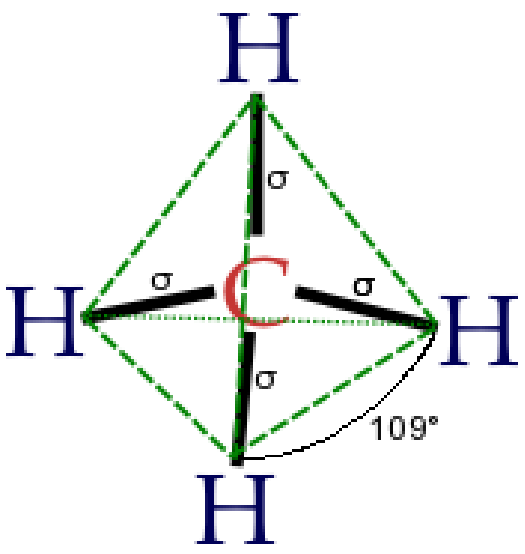
Classification of organic compounds

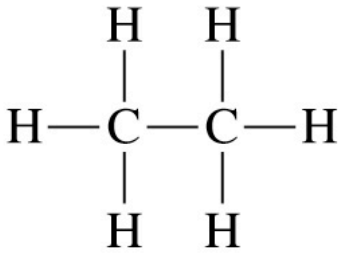


- Halogen derivatives
- Oxygen-containing:
  - Alcohols & ethers
  - Aldehydes & ketones
  - Carboxylic acids & esters
- Nitrogen-containing:
  - Amines
  - Nitriles
- Mixed:
  - Aminoacids
  - Peptides
  - Nitro compounds
- ...

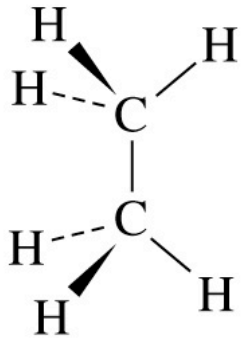

Alkanes
C_nH_{2n+2}
Alkanes

Structure and formulae

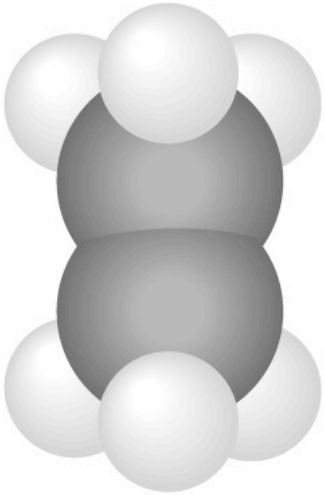




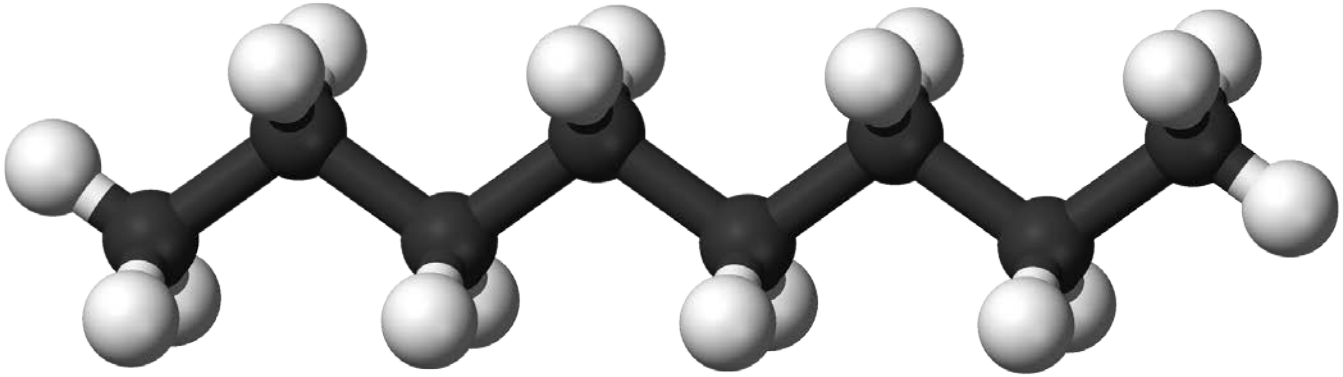
(a)



(b)



(c)

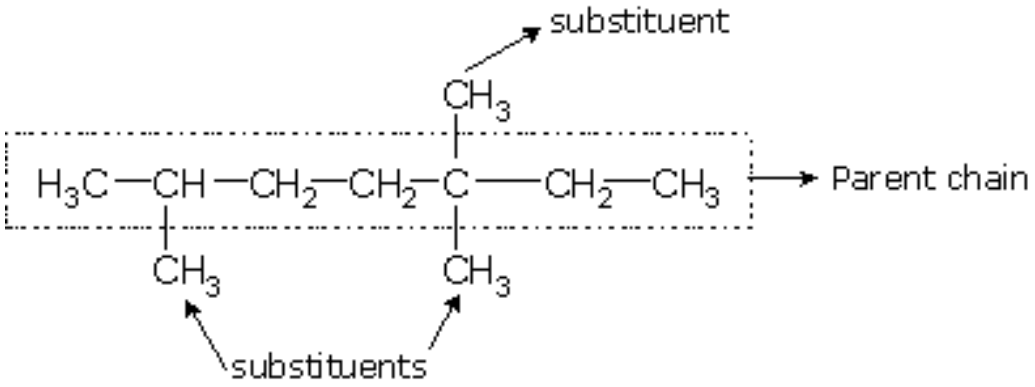


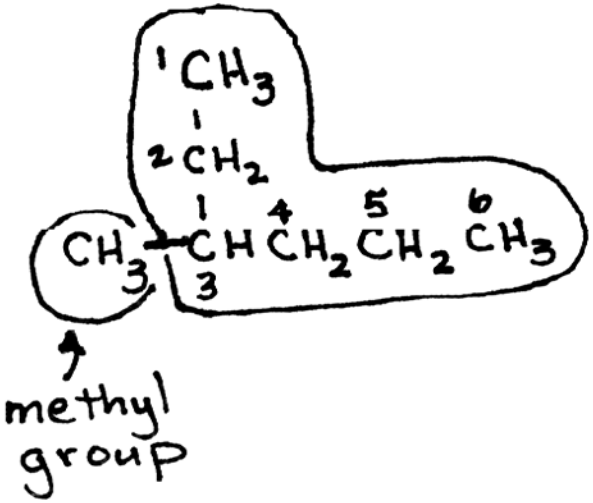
Naming alkanes

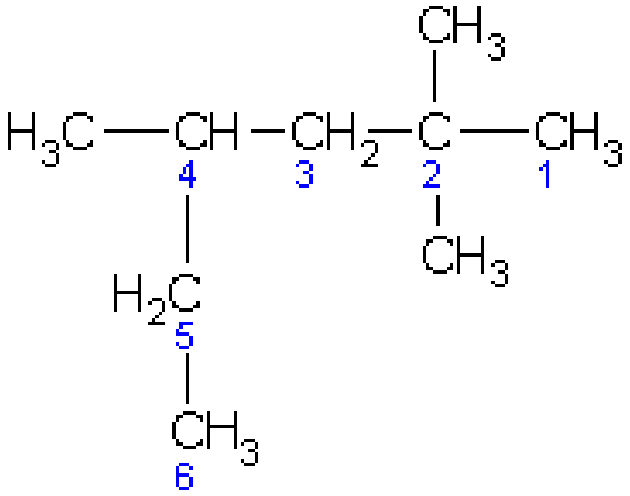
Number of 'C' atoms	Word root	IUPAC name	Structure	Molecular formula
1	Meth	Methane	CH_4	CH_4
2	Eth	Ethane	$CH_3—CH_3$	C_2H_6
3	Prop	Propane	$CH_3—CH_2—CH_3$	C_3H_8
4	But	Butane	$CH_3—(CH_2)_2—CH_3$	C_4H_{10}
5	Pent	Pentane	$CH_3—(CH_2)_3—CH_3$	C_5H_{12}
6	Hex	Hexane	$CH_3—(CH_2)_4—CH_3$	C_6H_{14}
7	Hept	Heptane	$CH_3—(CH_2)_5—CH_3$	C_7H_{16}
8	Oct	Octane	$CH_3—(CH_2)_6—CH_3$	C_8H_{18}
9	Non	Nonane	$CH_3—(CH_2)_7—CH_3$	C_9H_{20}
10	Dec	Decane	$CH_3—(CH_2)_8—CH_3$	$C_{10}H_{22}$

$$C_nH_{2n+2}$$

Naming branched-chain alkanes

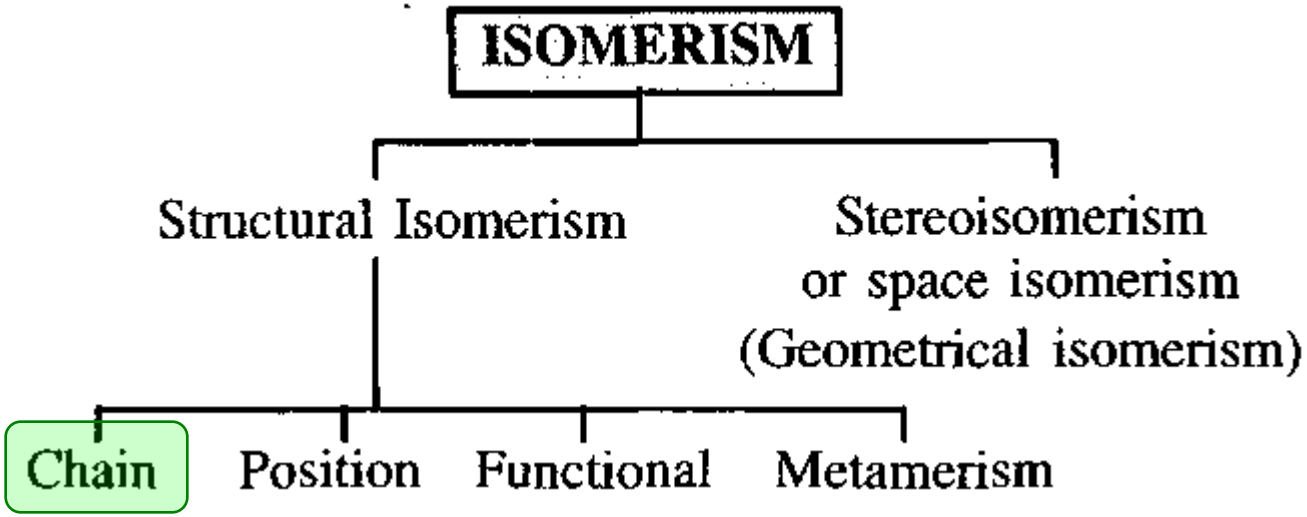


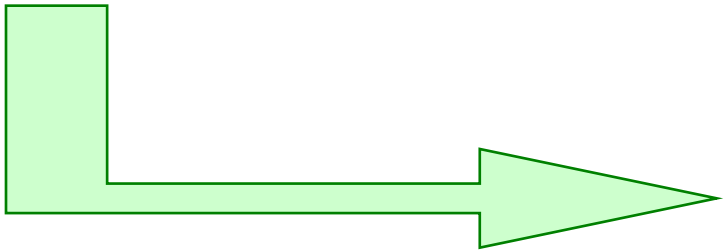


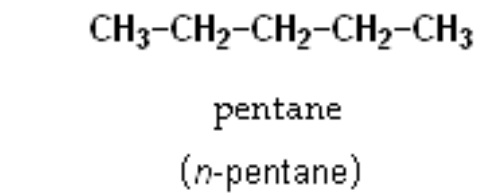


2,2,4-trimethylhexane

Isomerism of alkanes

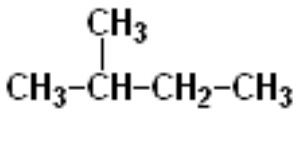






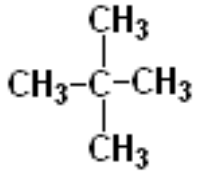
pentane

(*n*-pentane)



methylbutane

(isopentane)



dimethylpropane

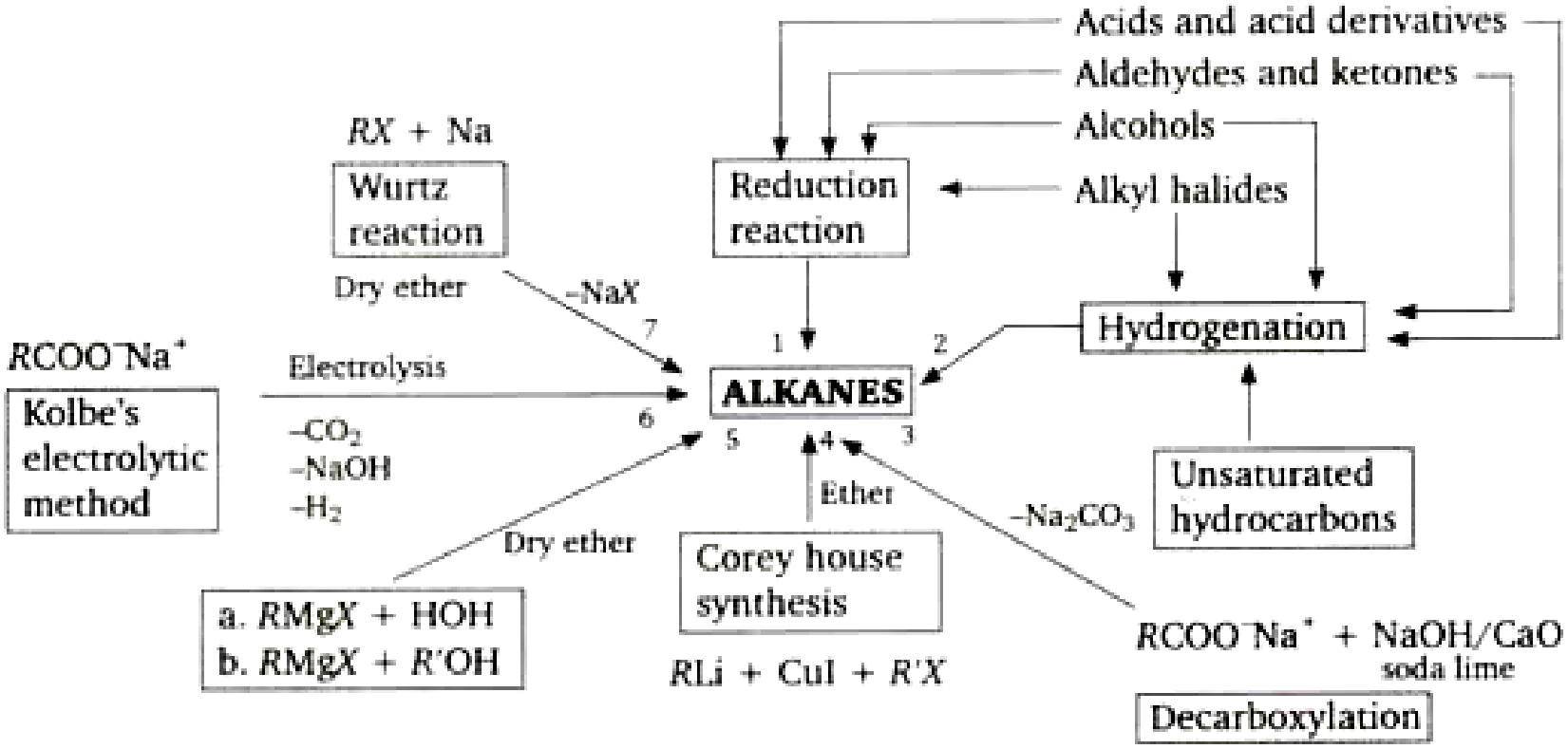
(neopentane)

Alkanes

Physical Properties:

Name	Formula	MP (°C)	BP (°C)	Density (g/mL)
Methane	CH_4	-182	-164	--
Ethane	C_2H_6	-183	-89	--
Propane	C_3H_8	-190	-42	--
Butane	C_4H_{10}	-138	-1	--
Pentane	C_5H_{12}	-130	36	0.63
Hexane	C_6H_{14}	-95	69	0.66
Heptane	C_7H_{16}	-91	98	0.68
Octane	C_8H_{18}	-57	125	0.70
Nonane	C_9H_{20}	-51	151	0.72
Decane	$C_{10}H_{22}$	-30	174	0.73

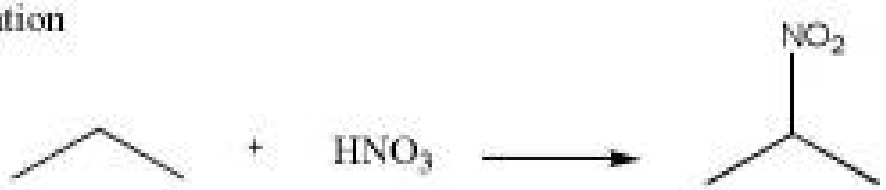
How to obtain alkanes



Chemical properties of alkanes

Halogenation

Nitration



Sulphonation

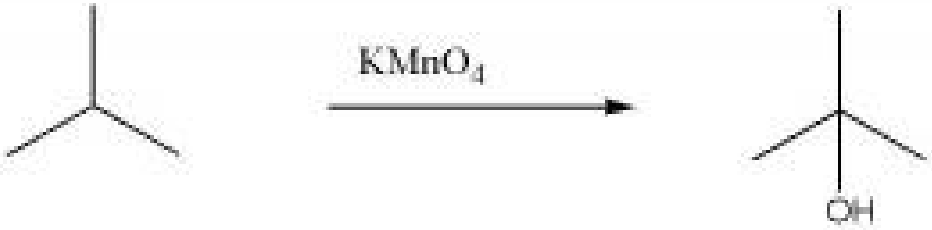
Alkylation

Chemical properties of alkanes

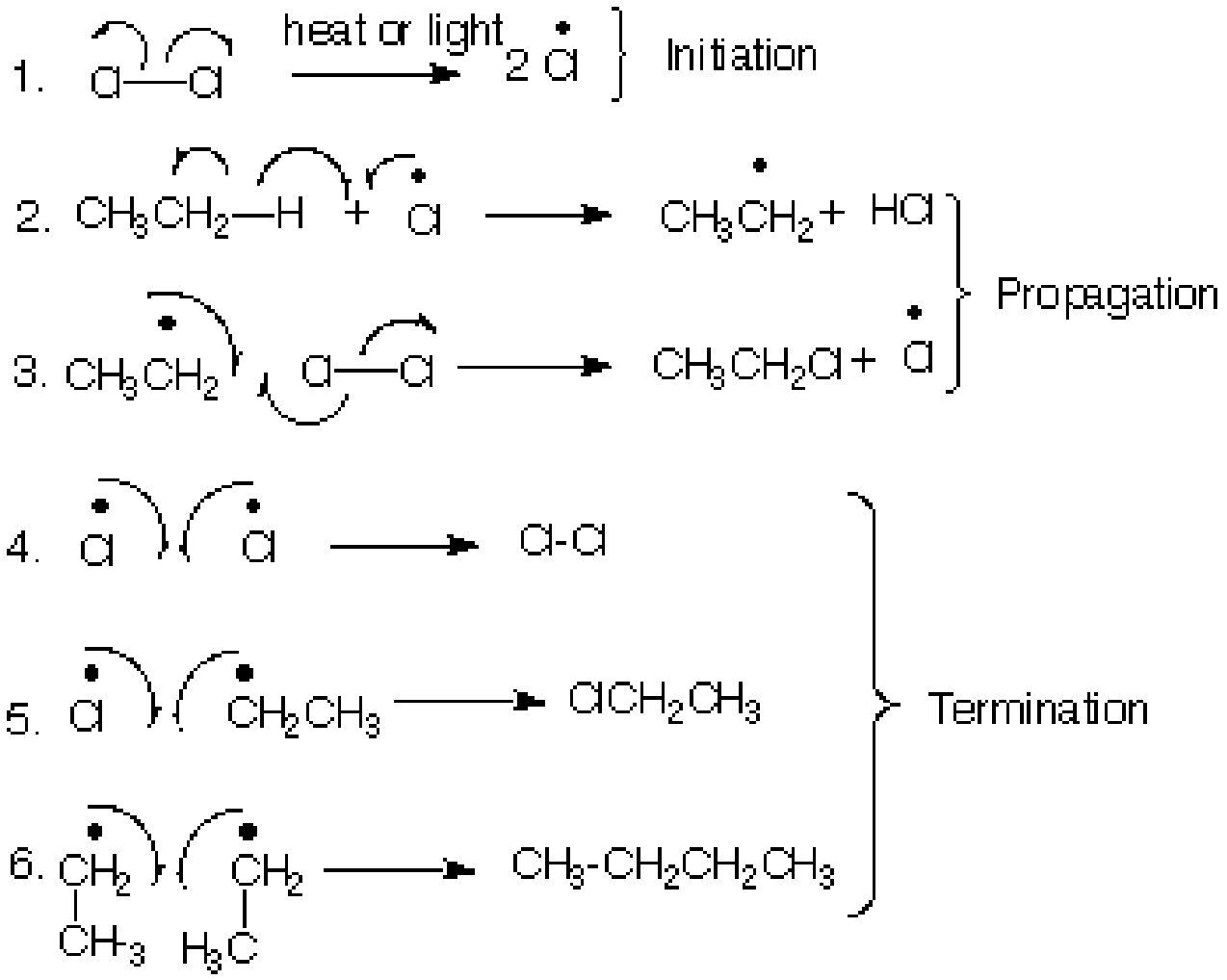
Isomerisation

Aromatisation

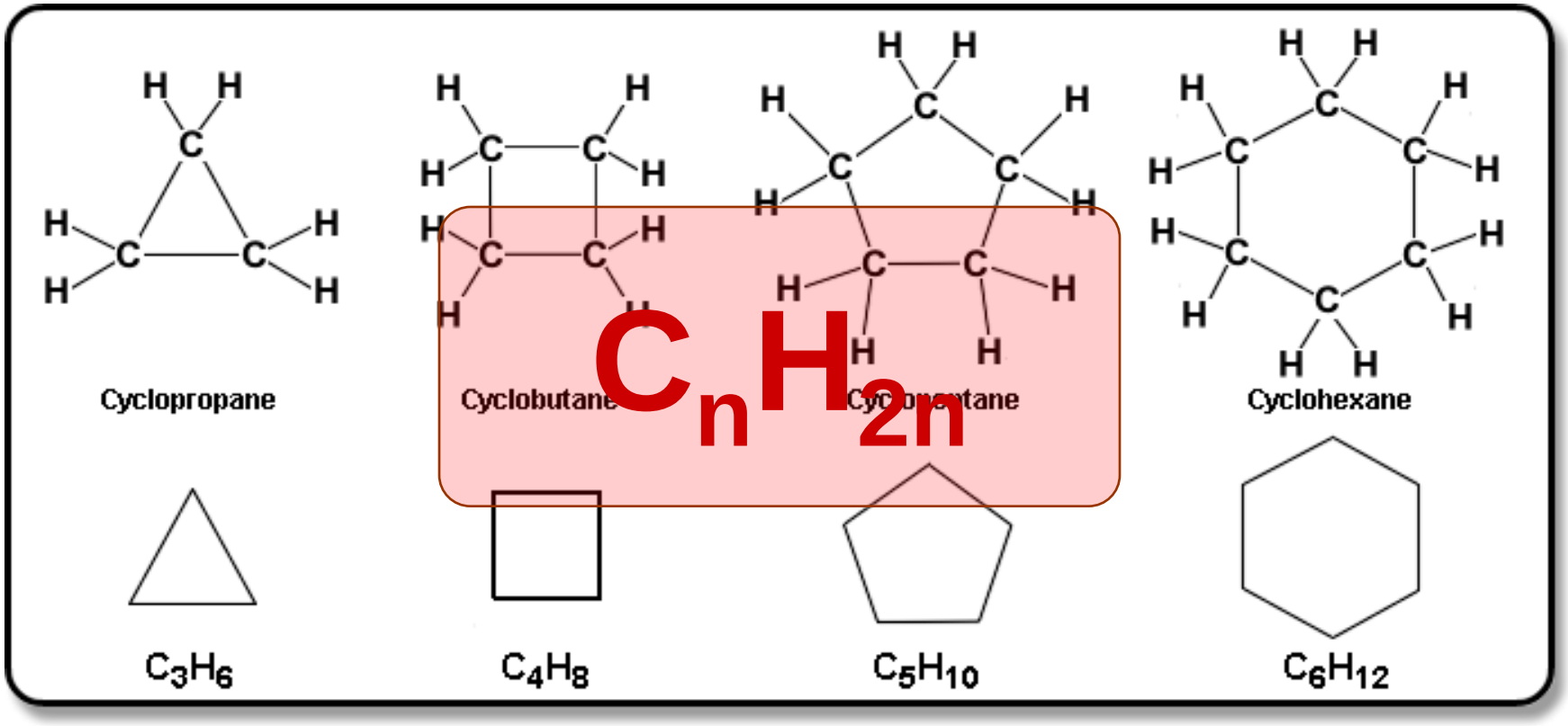
Oxidation



Radical substitution - S_R

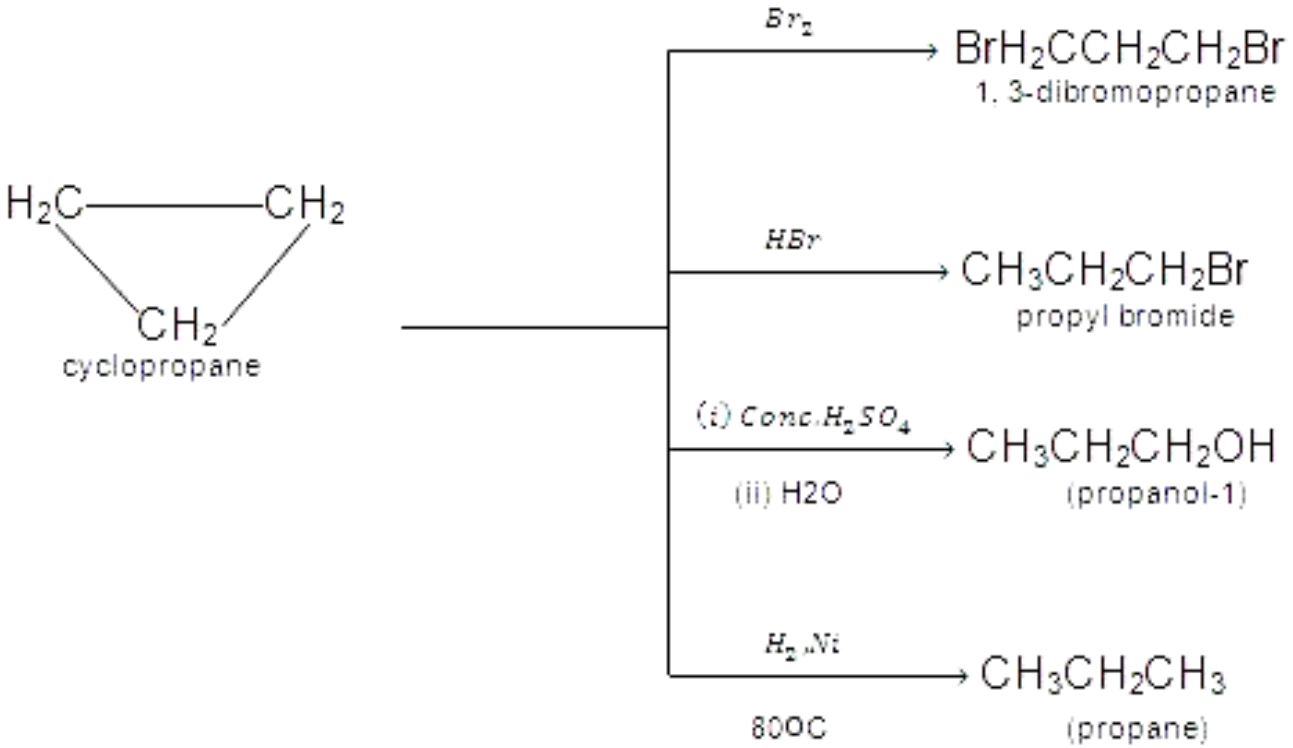


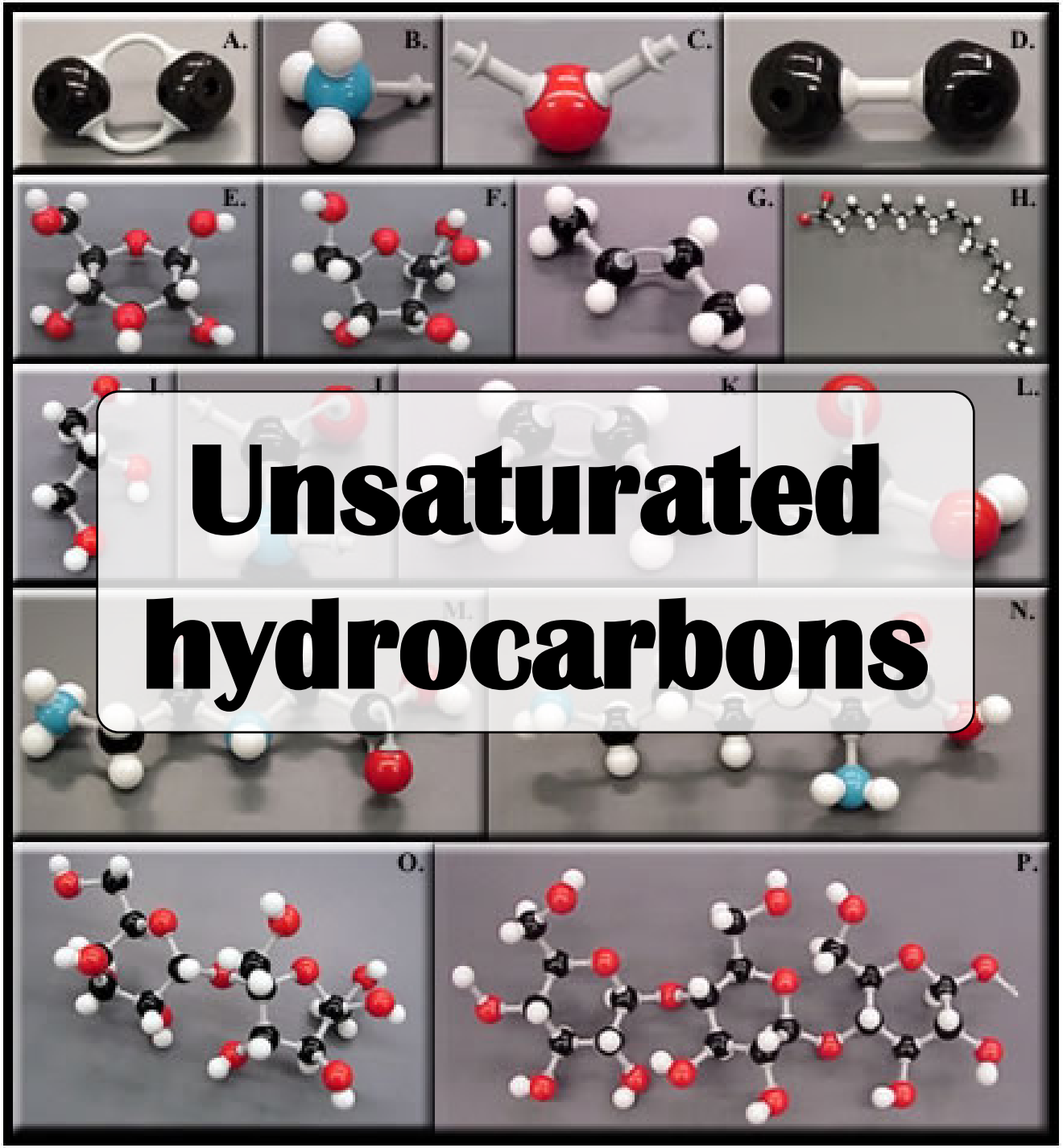
Cycloalkanes



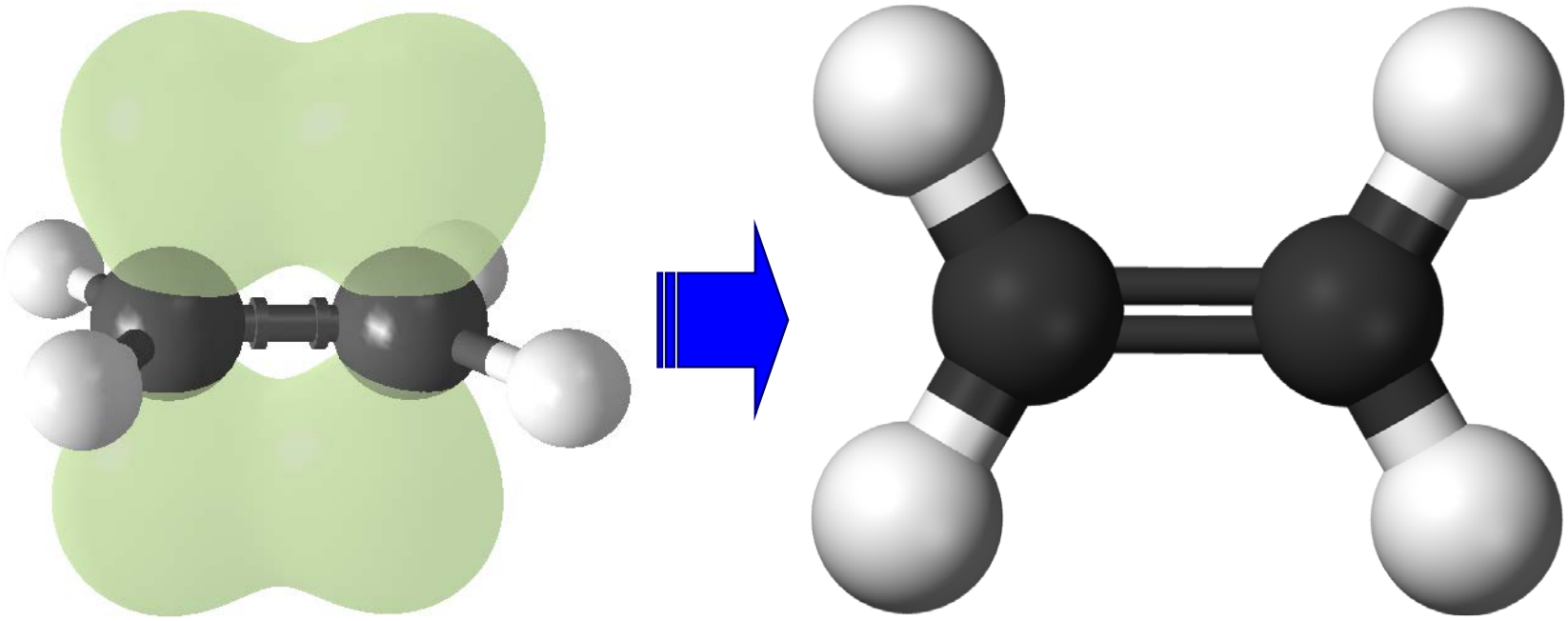
Chemical properties of cycloalkanes

Small cycles show some particular properties:




A.
B.
C.
D.
E.
F.
G.
H.
L.
N.
O.
P.
Unsaturated
hydrocarbons

Structure of alkenes: σ- and π-bonds

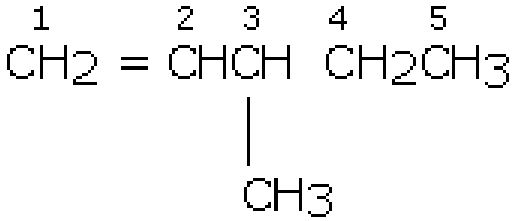


Naming alkenes

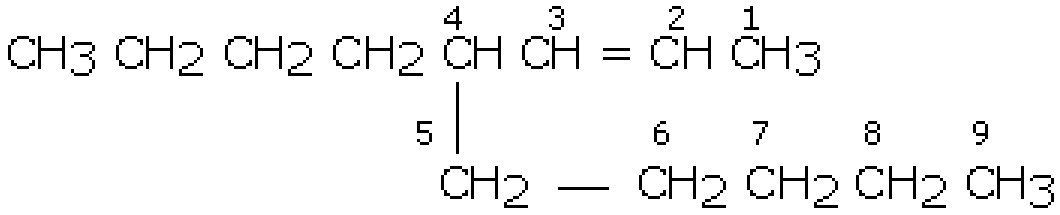
Formula	Common name	IUPAC name
C_nH_{2n}	Alkylene or olefin	Alkene
1. C_2H_4	Ethylene	Ethene
2. C_3H_6	Propylene	Propene
3. C_4H_8	Butylene	Butene
4. C_5H_{10}	-	Pentene
5. $C_{10}H_{20}$	-	Decene

C_nH_{2n}

Naming branched-chain alkenes

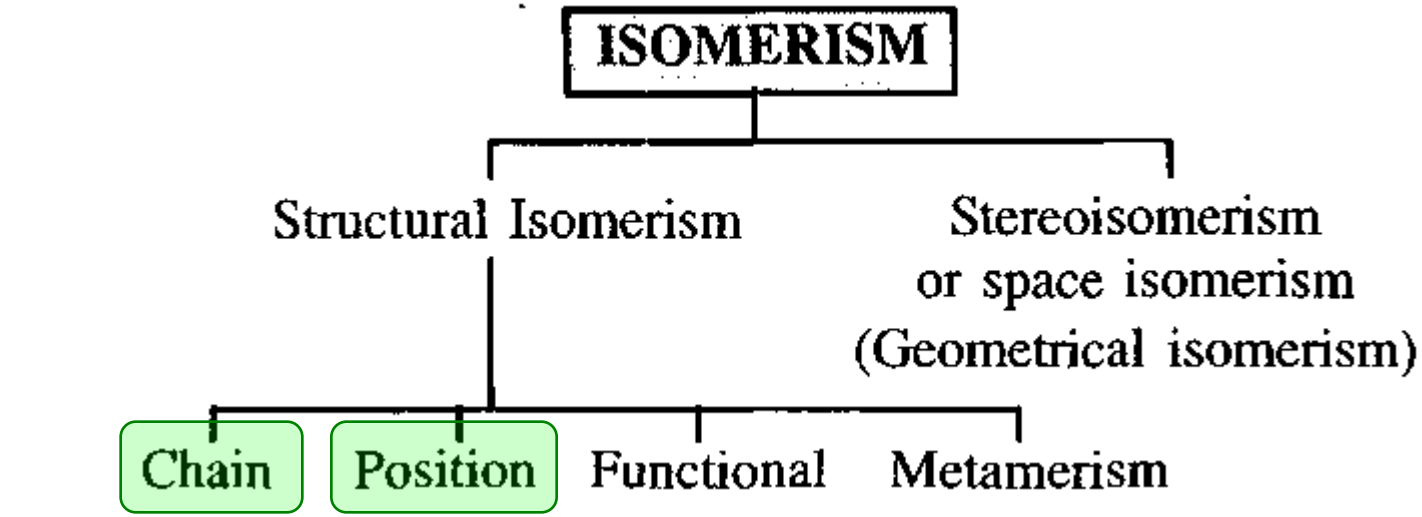


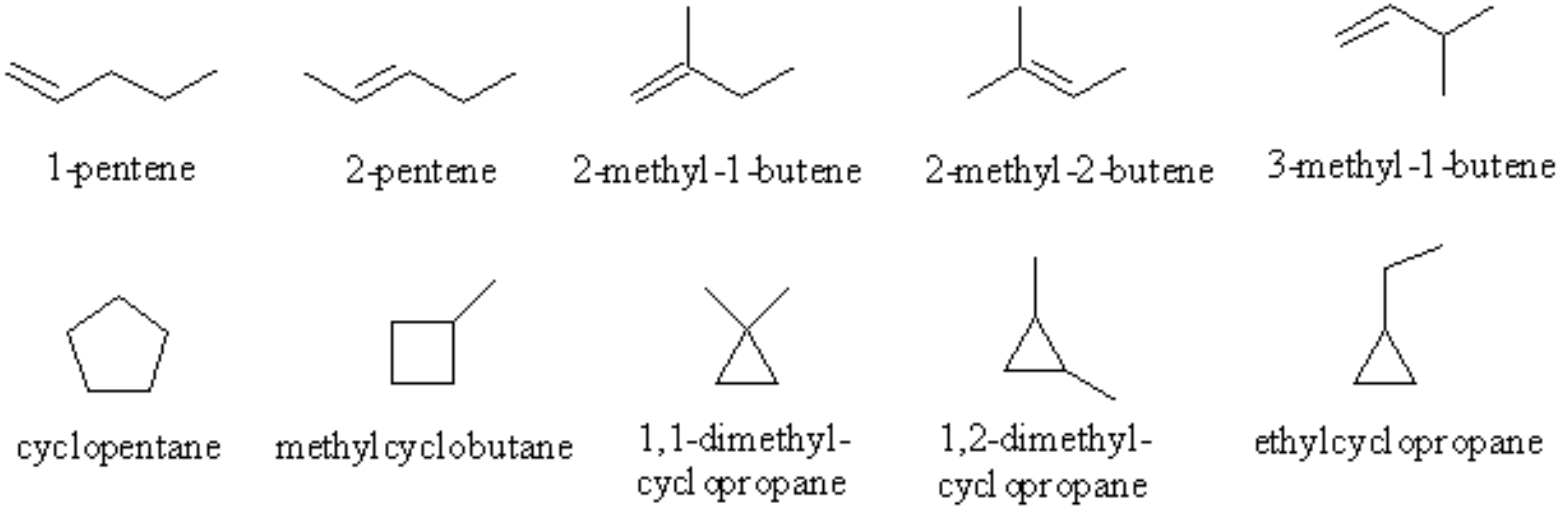
3-methyl-1-pentene



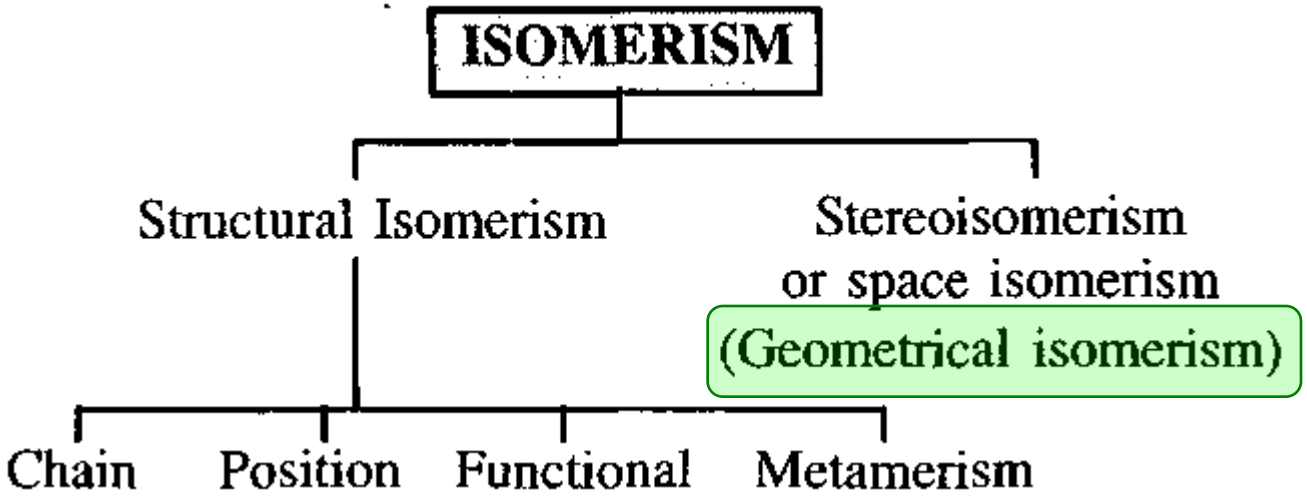
4-butyl-2-nonene

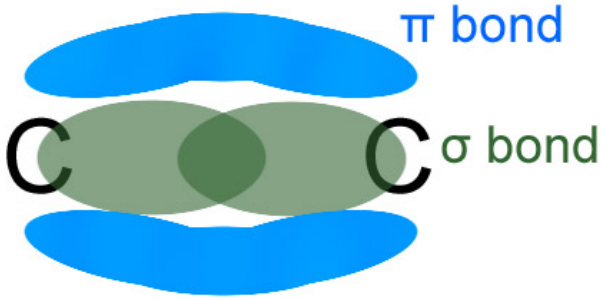
Isomerism of alkenes

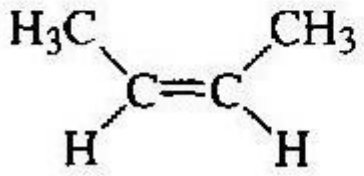




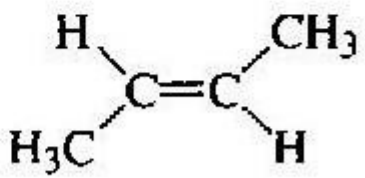
Isomerism of alkenes





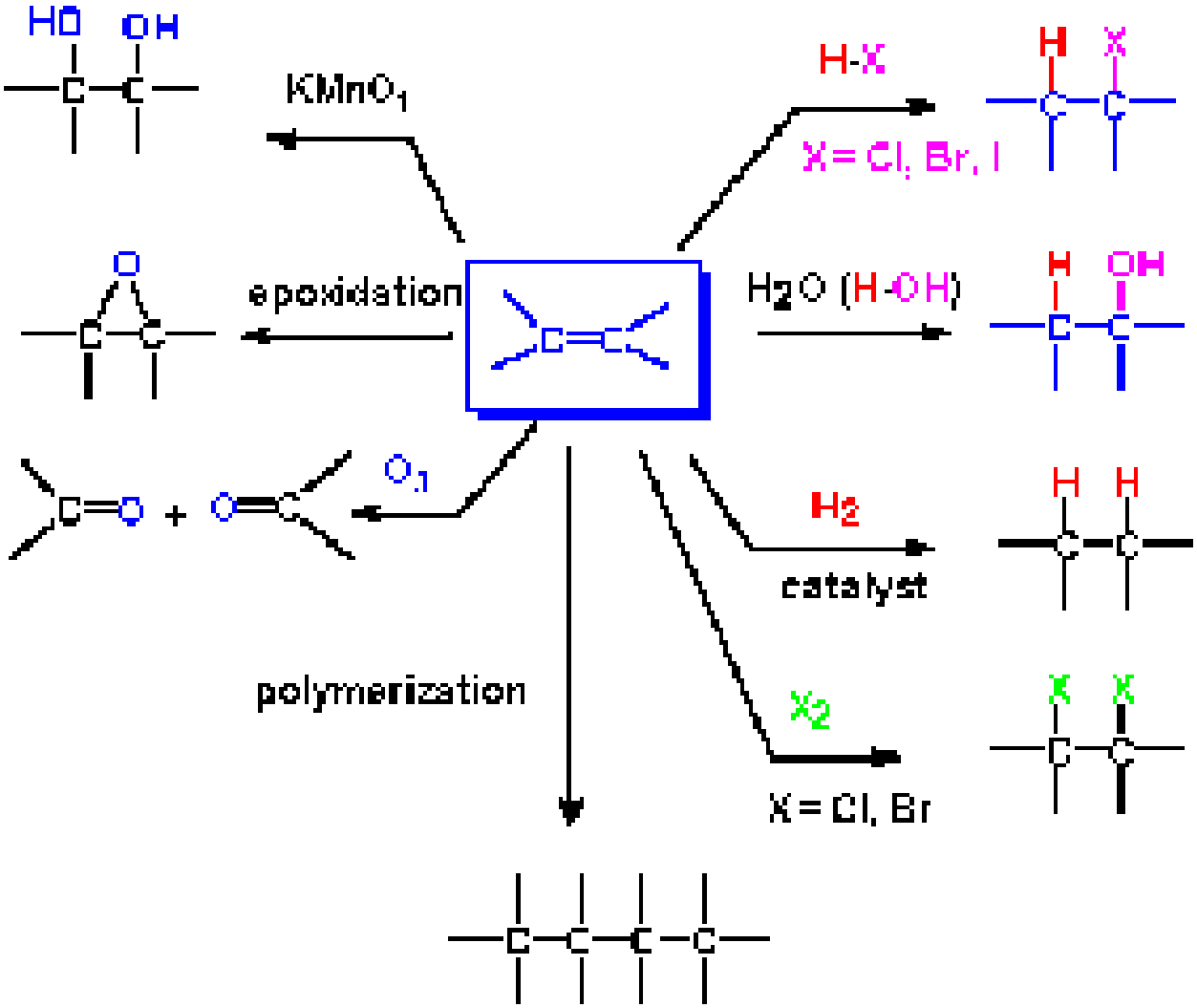


CH_3's on same side;
called *cis-*

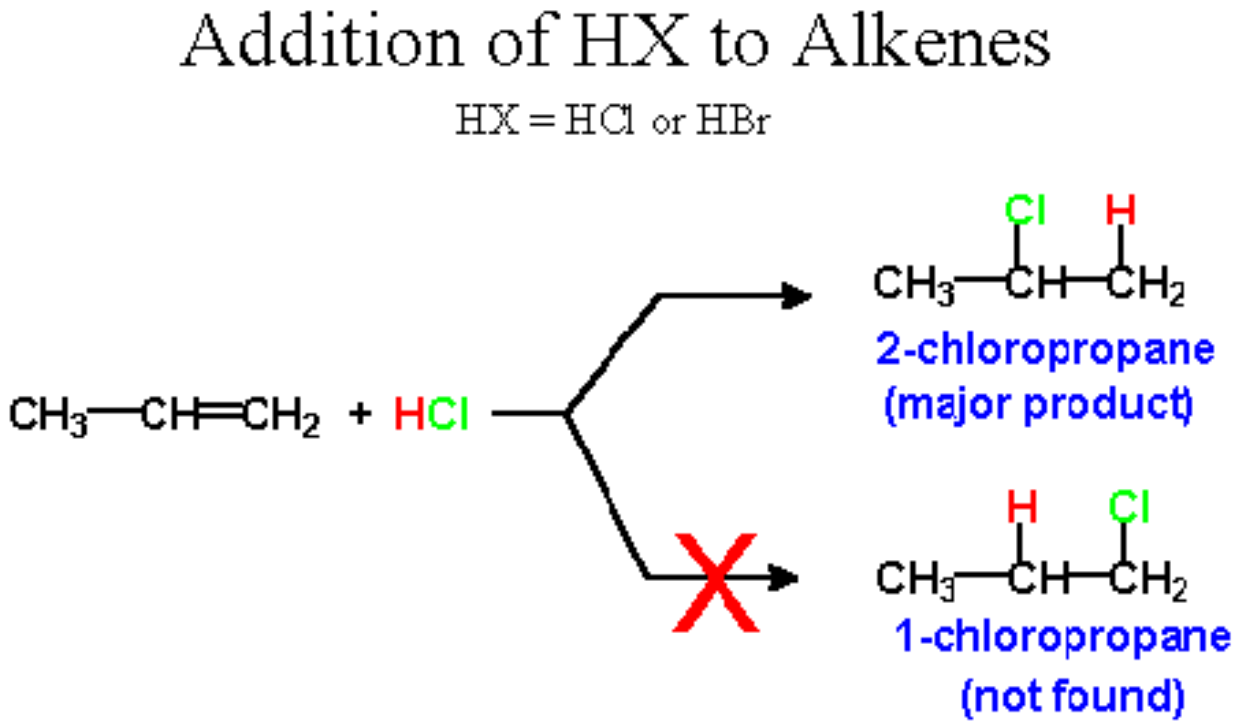


CH_3's on opposite sides;
called *trans-*

Reactions of Alkenes

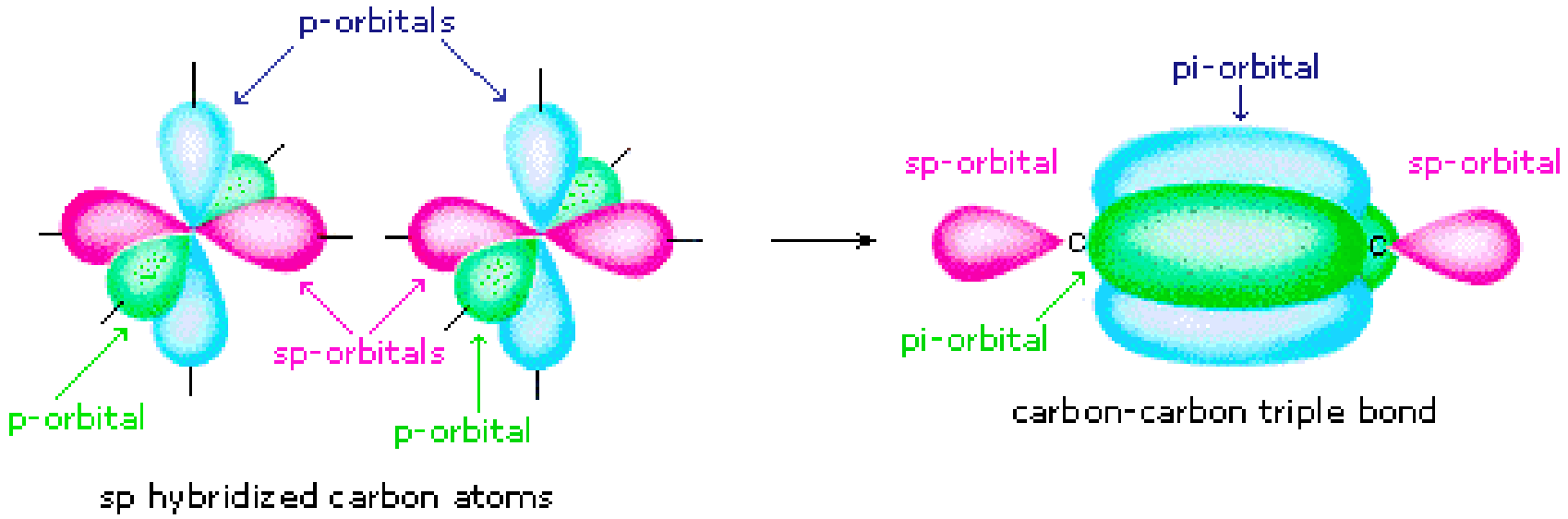


Addition to the double bond – Ad_E reactions



Markovnikov rule

Structure of alkynes: σ- and π-bonds

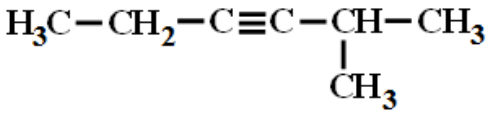


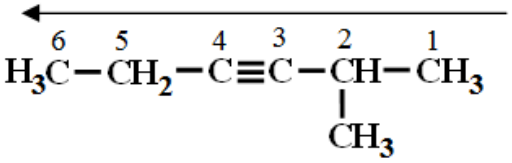
Naming and properties of alkynes

Name	Formula	M.p. °C	B.p. °C
Acetylene	$HC{\equiv}CH$	−82	−75
Propyne	$HC{\equiv}CCH_3$	−101.5	−23
1-Butyne	$HC{\equiv}CCH_2CH_3$	−122	9
1-Pentyne	$HC{\equiv}C(CH_2)_2CH_3$	−98	40
1-Hexyne	$HC{\equiv}C(CH_2)_3CH_3$	−124	72
1-Heptyne	$HC{\equiv}C(CH_2)_4CH_3$	−80	100
1-Octyne	$HC{\equiv}C(CH_2)_5CH_3$	−70	126
1-Nonyne	$HC{\equiv}C(CH_2)_6CH_3$	−65	151
1-Decyne	$HC{\equiv}C(CH_2)_7CH_3$	−36	182
2-Butyne	$CH_3C{\equiv}CCH_3$	−24	27
2-Pentyne	$CH_3C{\equiv}CCH_2CH_3$	−101	55
2-Hexyne	$CH_3C{\equiv}C(CH_2)_2CH_3$	−92	84
3-Hexyne	$CH_3CH_2C{\equiv}CCH_2CH_3$	−51	81
4-Octyne	$CH_3(CH_2)_2C{\equiv}C(CH_2)_2CH_3$		131
5-Decyne	$CH_3(CH_2)_3C{\equiv}C(CH_2)_3CH_3$		175

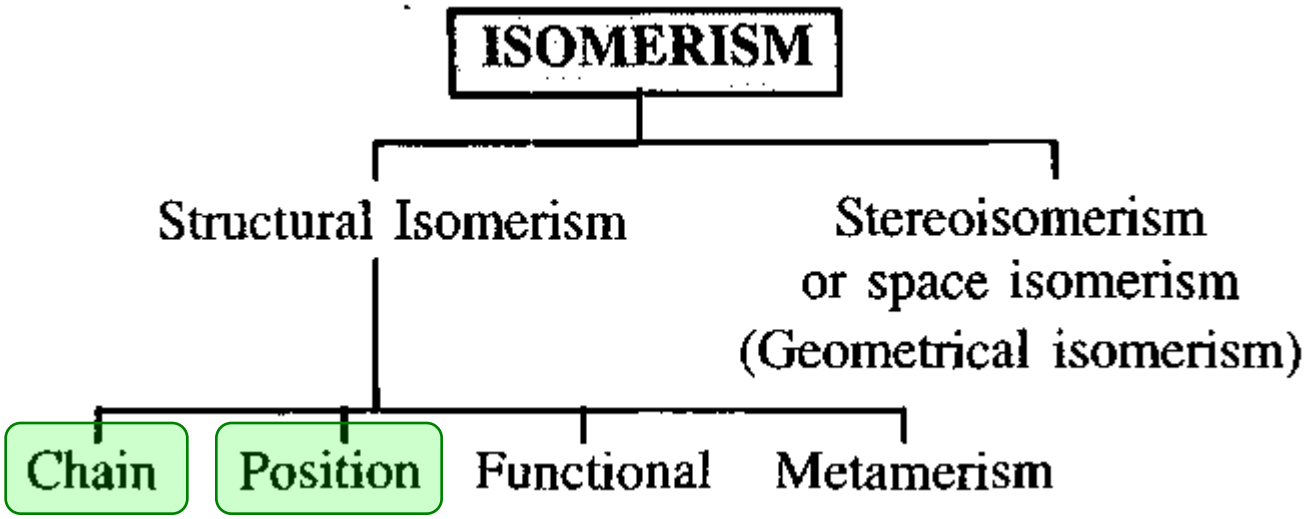
C_nH_{2n-2}

Naming branched-chain alkynes

Example 2.10. The structural formula is:  *E2.10.1*

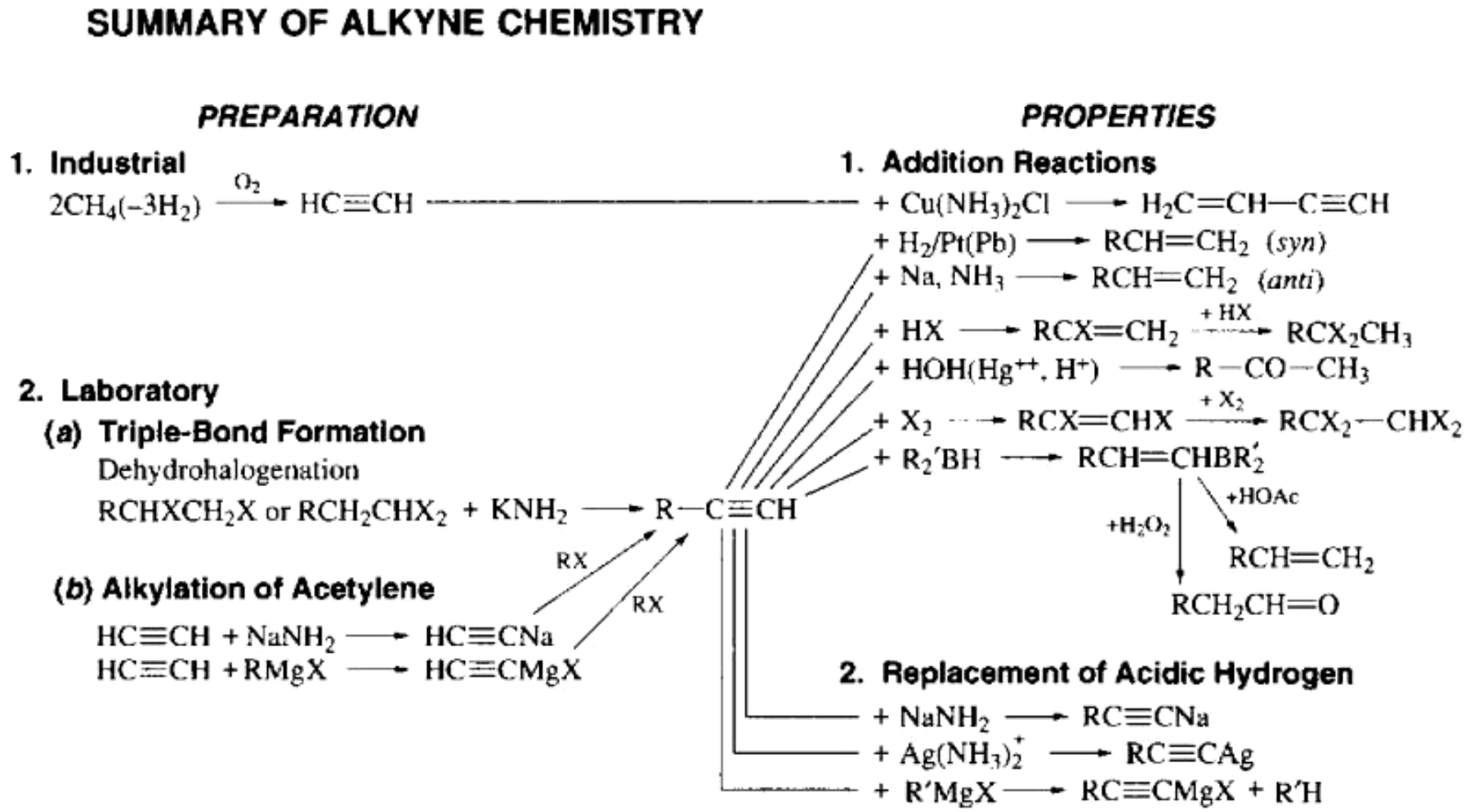
Steps 1 and 2. Choose the main chain and name it.	The longest chain contains 6 carbon atoms; its name is –**hex**–.
Step 3. Number carbon atoms in the chain.	The main chain is symmetrical. According the rules mentioned above (see *F.3*) the numbering is following: 
Step 4 and 5. Determine quantity and positions of π-bonds.	There is **two** π-bonds in **one triple** bond, which "begins" at atom **3**. The suffix will be –**yne**.
Step 6. Determine types, quantities and positions of substituents.	There is **one** substituent, it is **methyl** group. Methyl group is connected to the main chain at atom **2**. The prefix is **2–methyl**–.
Step 7. Compose the name.	prefix + chain name + suffix **2–METHYL-3-HEXYNE**

Isomerism of alkynes

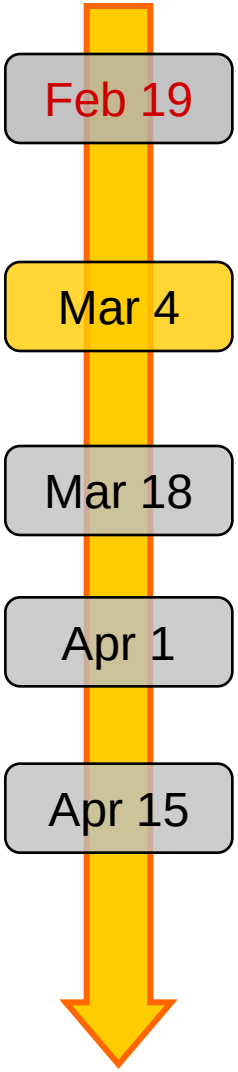


- triple bond position in alkyne molecule
- carbon skeleton branching
- interclass isomerism:
  - alkadienes
  - cycloalkenes

Synthesis and reactions of alkynes



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 reacions. 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.