

CHIMICA ORGANICA

Informazioni sul corso

- Docente: Prof. Paolo Tecilla
 - Edificio C11, terzo piano, stanza 328
 - E-mail: ptecilla@units.it Tel.: 040 558 3919
- Il corso di chimica organica é la BASE per la comprensione di tutti i corsi avanzati di chimica organica e farmaceutica
- 64 ore di lezione (8 CFU) integrate con ore di esercizi per approfondire la materia.
- L'esame si compone di una **prova scritta e di una prova orale**. Lo scritto può comprendere sia domande di teoria a risposta aperta che esercizi su sintesi, trasformazione di gruppi funzionali, stereochimica, etc.. Il superamento dello scritto dà accesso alla prova orale che sarà rivolta ad accertare una adeguata conoscenza degli argomenti trattati nel corso. **Dopo aver superato la prova scritta l'esame orale dovrà essere sostenuto entro la sessione straordinaria (gennaio/febbraio) dell'anno accademico in corso.** In caso contrario la prova scritta dovrà essere sostenuta nuovamente. **Durante il corso sono proposti agli studenti che seguono il corso due test scritti (intermedio/finale) che valgono come prova scritta.**
- Ogni anno ci sono sei sessioni d'esame: due sessioni nel periodo Gennaio-Febbraio; tre sessioni nel periodo Giugno-Luglio, una sessione a Settembre. Sessioni straordinarie possibili dopo Pasqua o su richiesta (da valutare).

Libri di testo

John McMurry
Chimica Organica
PICCIN-NUOVA LIBRARIA

Brown; Iverson, Anslyn, Foote
Chimica Organica
EdiSES

Jonathan Clayden, Nick Greeves e Stuart Warren
Chimica Organica
Piccin

D'Auria M.V.; Taglialatela Scafati O.; Zampella A.
Guida ragionata allo svolgimento di esercizi di chimica organica
Loghia

G. Brogginì, C. Loro, G. Palmisano
Chimica Organica - 800 esercizi con soluzione
Zanichelli

Janice Gorzynski Smith
Organic Chemistry
McGraw-Hill

Vollhardt K. Peter; Schore Neil E.
Chimica organica
Zanichelli

Solomons T.W. Graham;
Fryhle Craig B.
Chimica organica
Zanichelli

Seyhan N. Ege
Chimica Organica: Struttura e reattività
Idelson-Gnocchi

Materiale didattico, esercizi,
compiti corretti, etc. disponibili
su Moodle

ORGANIC CHEMISTRY = Chemistry of Carbon Compounds

Before 1828:

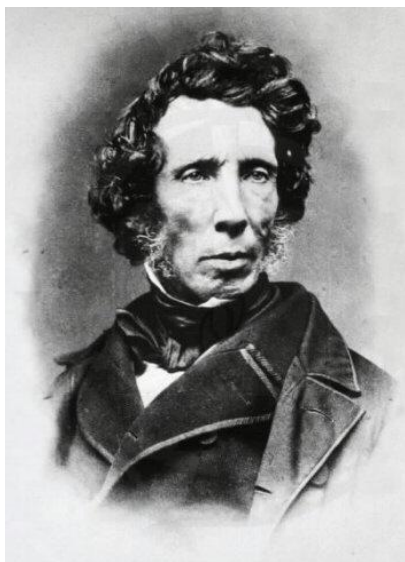
Non-Living Entities: Inorganic

Living World: Organic

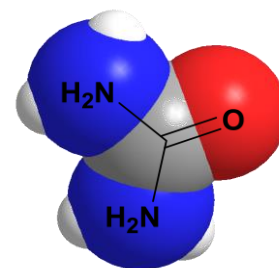
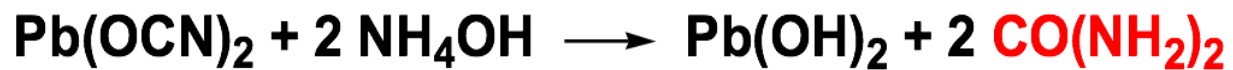


Vital Spark

1828: The End of Vitalism



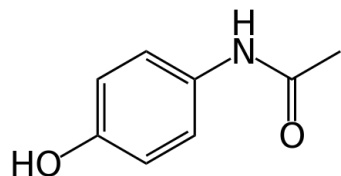
Friedrich Woehler
1800-1882



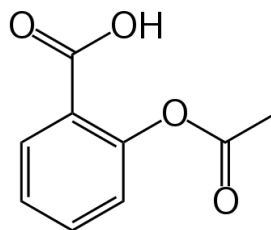
Organic Compounds are Ubiquitous

- There are approximately 60.000.000 organic molecules.
 - *Carbohydrates, lipids, proteins and nucleic acids* are produced by living organisms.
 - We make extensive use of natural products derived, from plants (*cotton, paper, wood*), from animals (*leather, silk, wool*), from fossil oil (*benzin, oils*).
 - By modifying natural compounds (mainly oil) we also manufacture a wide variety of synthetic products, such as *drugs, plastics, paints, dyes, artificial fibres, fertilizers, aromas, cosmetics, detergents, perfumes, sweeteners*, etc.

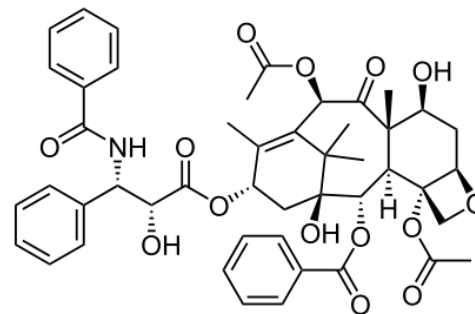
Many drugs are Organic Compounds



Paracetamol

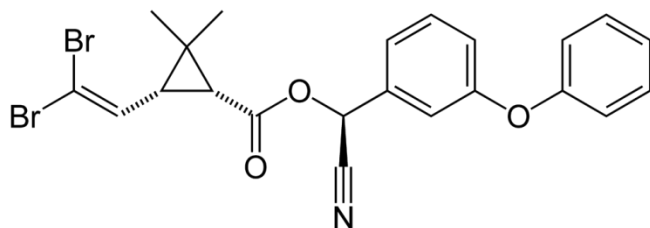


Aspirin

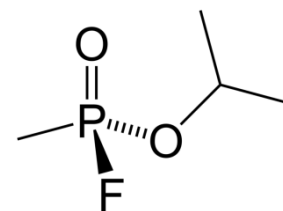


Taxol (chemotherapeutic)

Many toxic compounds are Organic Compounds

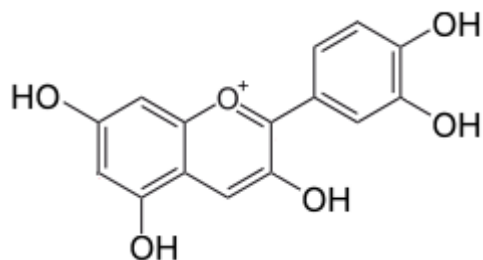


Synthetic Pyrethrin
(insecticide)



Sarin
(nerve agent)

Many colorants are organic compounds



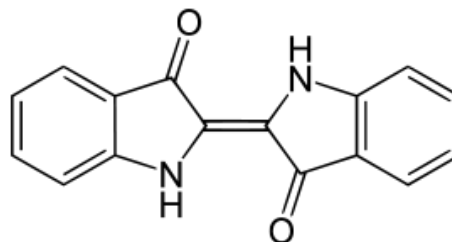
Antocianine
(change color with pH)



Rose
(acidic pH)



Cornflower
(fiordaliso, basic pH)

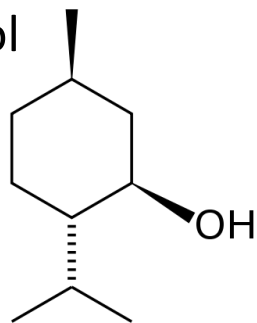


Indigo
(from *Indigofera tinctoria*)

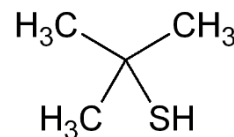


Many odorous substances (nice or nasty) are organic compounds

Menthol



peppermint

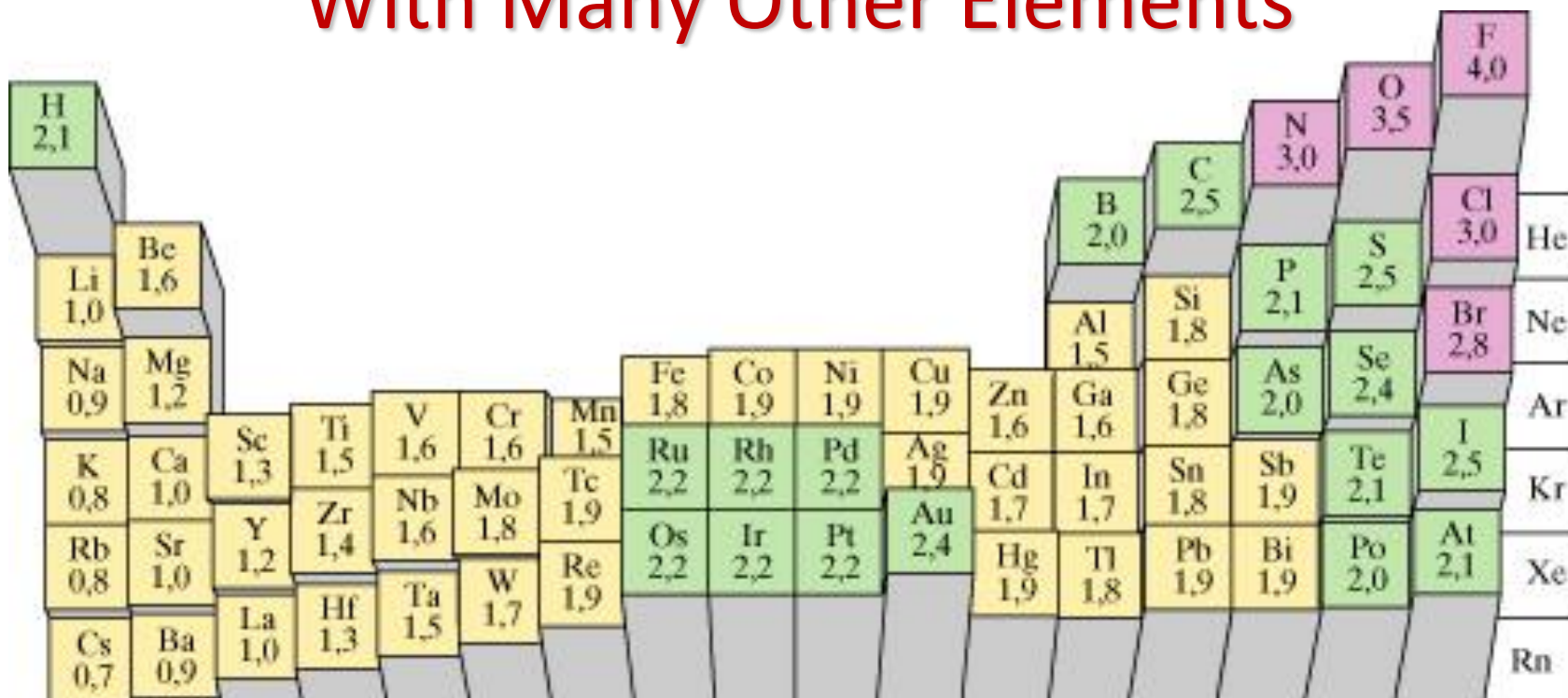


Tert-Butylmercaptan
(added to methane)

The Carbon Atom

- Atomic Number: 6 (number of protons)
- Atomic weight: 12.01 (weight average of the atomic mass of the isotopes)
- 2 Isotopes
 - ^{12}C (99,98%): 6 protons, 6 neutrons
 - ^{13}C (1,11%): 6 protons, 7 neutrons
- Electron Configuration: $1s^2$
 $2s^2 2p^2$

1. Carbon Forms Covalent Bonds With Many Other Elements



Electronegativity

2. Carbon Is Tetravalent

1

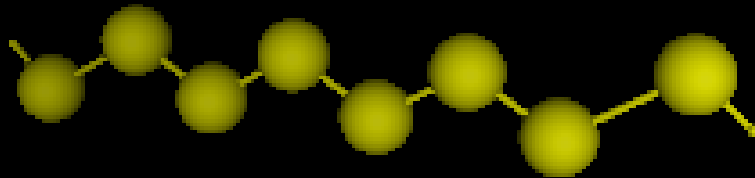
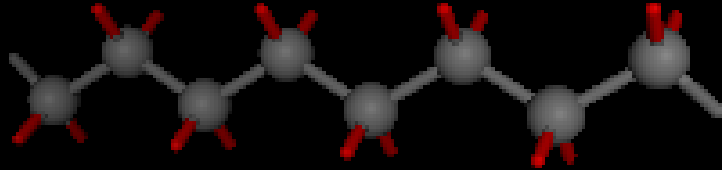
1 H Hydrogen 1.0																	2 He Helium 4.0
3 Li Lithium 6.9	4 Be Beryllium 9.0											5 B Boron 10.8	6 C Carbon 12.0	7 N Nitrogen 14.0	8 O Oxygen 16.0	9 F Fluorine 19.0	10 Ne Neon 20.2
11 Na Sodium 23.0	12 Mg Magnesium 24.3											13 Al Aluminum 27.0	14 Si Silicon 28.1	15 P Phosphorus 31.0	16 S Sulfur 32.1	17 Cl Chlorine 35.5	18 Ar Argon 40.0
19 K Potassium 39.1	20 Ca Calcium 40.2	21 Sc Scandium 45.0	22 Ti Titanium 47.9	23 V Vanadium 50.9	24 Cr Chromium 52.0	25 Mn Manganese 54.9	26 Fe Iron 55.9	27 Co Cobalt 58.9	28 Ni Nickel 58.7	29 Cu Copper 63.5	30 Zn Zinc 65.4	31 Ga Gallium 69.7	32 Ge Germanium 72.6	33 As Arsenic 74.9	34 Se Selenium 79.0	35 Br Bromine 79.9	36 Kr Krypton 83.8
37 Rb Rubidium 85.5	38 Sr Strontium 87.6	39 Y Yttrium 88.9	40 Zr Zirconium 91.2	41 Nb Niobium 92.9	42 Mo Molybdenum 95.9	43 Tc Technetium 99	44 Ru Ruthenium 101.0	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
55 Cs Caesium 132.9	56 Ba Barium 137.4	57-71	72 Hf Hafnium 178.5	73 Ta Tantalum 181.0	74 W Tungsten 183.9	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium 210.0	85 At Astatine 210.0	86 Rn Radon 222.0
87 Fr Francium 223.0	88 Ra Radium 226.0	89-103	104 Rf Rutherfordium 261	105 Db Dubnium 262	106 Sg Seaborgium 263	107 Bh Bohrium 263	108 Hs Hassium 265	109 Mt Meitnerium 266	110 Uun Ununnilium 272								

57 La Lanthanum 138.9	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 142	61 Pm Promethium 147.0	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.3	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0
89 Ac Actinium 132.9	90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium 237.0	94 Pu Plutonium 242.0	95 Am Americium 243.0	96 Cm Curium 247.0	97 Bk Berkelium 247.0	98 Cf Californium 251.0	99 Es Einsteinium 254.0	100 Fm Fermium 257.0	101 Md Mendelevium 258.0	102 No Nobelium 259.0	103 Lr Lawrencium 261.0

3. Carbon Forms Very Strong Bonds

Bond	Bond Dissociation Energy (kJ/M)
C—C	360
C—H	400-550
C—O	350-400
C—N	360
N—N	250
O—O	180

4 Carbon forms chains



Energy (kJ/mol)

C-C 360

N-N 230-280

0-0 160-200

																3	4																	5
Li Lithium 6.9		Be Beryllium 9.0																		B Boron 10.8		C Carbon 12.0	N Nitrogen 14.0		O Oxygen 16.0		F Fluorine 19.0		Ne Neon 20.2					
Na Sodium 23.0		Mg Magnesium 24.3																		Al Aluminum 27.0		Si Silicon 28.1	P Phosphorus 30.9		S Sulfur 32.1	Cl Chlorine 35.5		Ar Argon 39.9						
K Potassium 39.1		Ca Calcium 40.2		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40											
Sc Scandium 44.9		Ti Titanium 47.9		V Vanadium 50.9		Cr Chromium 52.0		Mn Manganese 54.9		Fe Iron 55.8		Co Cobalt 58.9		Ni Nickel 58.7		Cu Copper 63.5		Zn Zinc 65.4		Ga Gallium 69.7		Ge Germanium 72.6		As Arsenic 74.9		Se Selenium 79.0		Br Bromine 79.9		Kr Krypton 83.8				
Rb Rubidium 85.5		Sr Strontium 87.6		Y Yttrium 88.9	Zr Zirconium 91.2	Nb Niobium 92.9		Mo Molybdenum 95.9		Tc Technetium 98.9		Ru Ruthenium 101.1		Rh Rhodium 106.4		Pd Palladium 106.3		Ag Silver 107.9		Cd Cadmium 112.4		In Indium 114.8		Sn Tin 118.7		Sb Antimony 121.8		Te Tellurium 127.6		I Iodine 126.9		Xe Xenon 131.3		
Cs Cesium 132.9		Ba Barium 137.4		La Lanthanum 138.9	Hf Hafnium 178.5	Ta Tantalum 181.0		W Tungsten 183.8		Re Rhenium 186.2		Os Osmium 190.2		Ir Iridium 192.2		Pt Platinum 195.1		Au Gold 197.0		Hg Mercury 200.6		Tl Thallium 204.4		Pb Lead 207.2		Bi Bismuth 209.0		Po Polonium 210.0		At Astatine 210.0		Rn Radon 222.0		
Fr Francium 223.0		Ra Radium 226.0		89-103		104	105	106	107	108	109	110																						
						Rf Rutherfordium 261	Db Dubnium 262	Sg Seaborgium 266	Bh Bohrium 264	Hs Hassium 265	Mt Meitnerium 266	Uu Ununium 270																						

57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Lanthanum 138.9	Cerium 140.1	Praseodymium 140.9	Neodymium 144.2	Promethium 147.9	Samarium 150.4	Europium 151.9	Gadolinium 157.3	Terbium 158.9	Dysprosium 162.5	Holmium 164.9	Erbium 167.3	Thulium 168.9	Ytterbium 173.0	Lutetium 174.9
80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
Actinium 227	Thorium 232	Protactinium 231	Uranium 238	Neptunium 237	Plutonium 244	Americium 243	Curium 247	Berkelium 247	Californium 251	Einsteinium 252	Fermium 257	Mendelevium 258	Nobelium 259	Lawrencium 261

$$2s^2 2p^2$$
$$3s^2 3p^4$$

5. Carbon Forms Multiple Bonds

Bond	Bond Dissociation Energy (kJ/M)
C—C	360
C=C	700
C≡C	950
C—O	400
C=O	750
C—N	360
C=N	700
C≡N	950

Organic Chemistry

- Structure
- Reactivity
- *Structure* and *reactivity* are correlated.

STRUCTURE  REACTIVITY

Goals

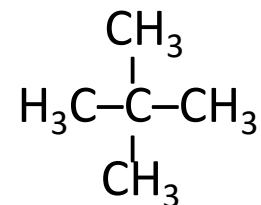
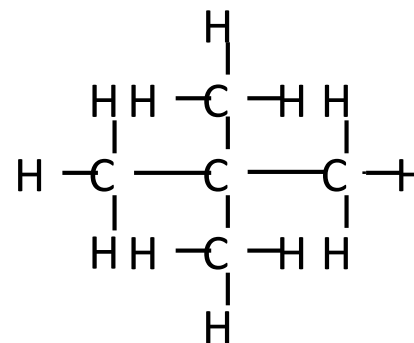
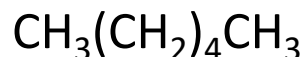
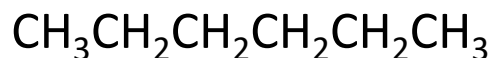
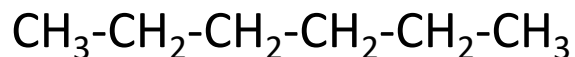
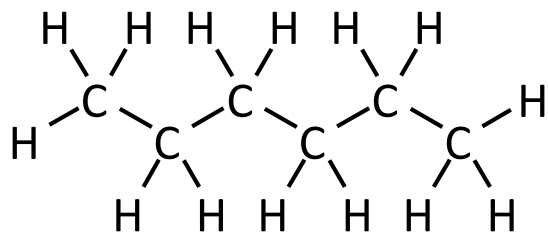
- Assign Structure and Name to Organic Compounds.
- Predict:
 - The tridimensional structure
 - The effects on reactivity (reaction rates and equilibrium constants)
- Understand the reactivity of functional groups
- Design simple synthetic pathways
- Communicate with an appropriate language

The course of Organic Chemistry is at the basis of all the other organic chemistry courses and of those of pharmaceutical chemistry!

Drawing molecules

Condensed Formula

- Different degrees of condensation



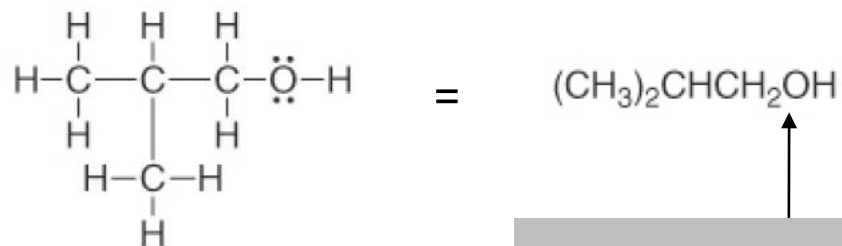
Certain bonds
are
maintained



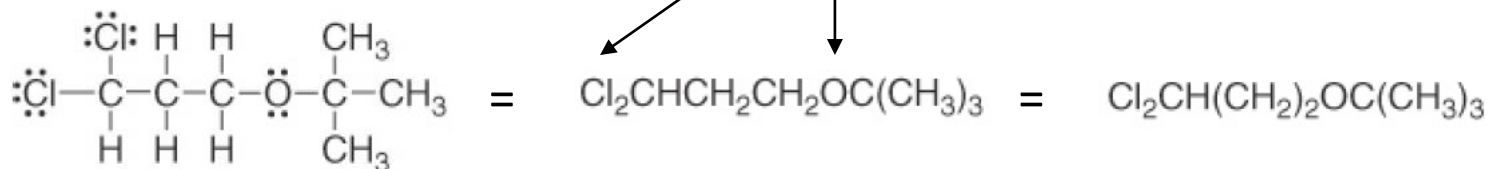
Condensed Formula



The double bond is maintained

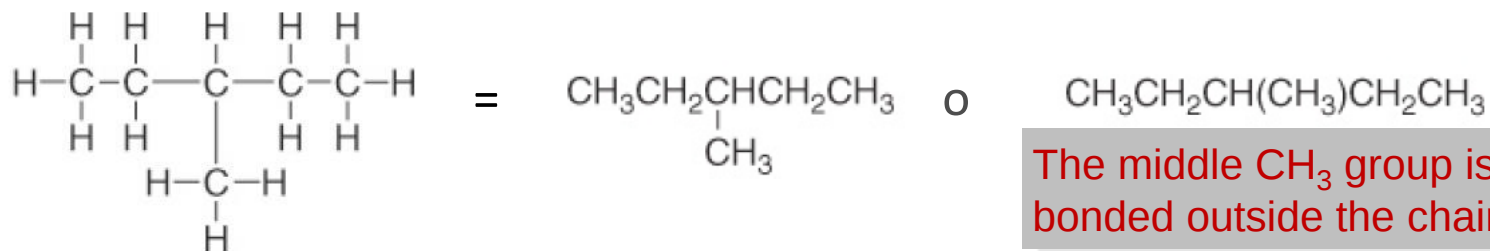


lone pairs are omitted

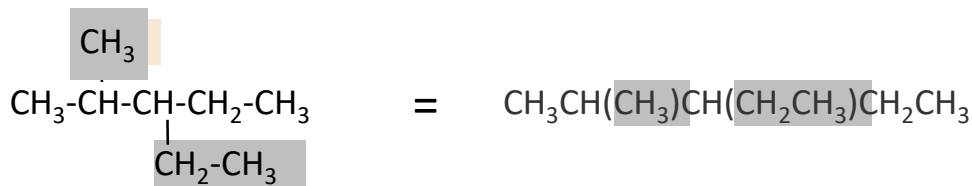


Condensed Formula

- Complex structures can be written on a single line using parentheses.



The middle CH₃ group is bonded outside the chain

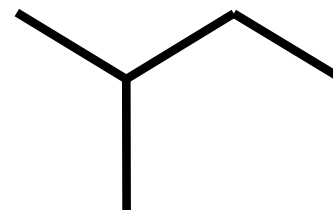


Branched alkanes

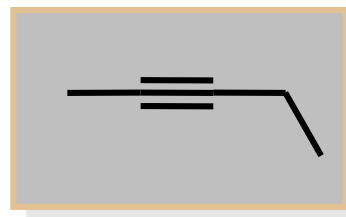
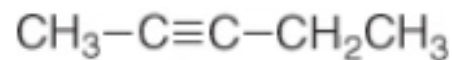
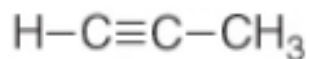
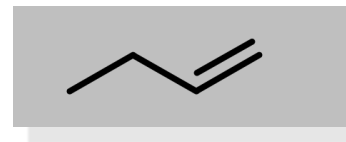
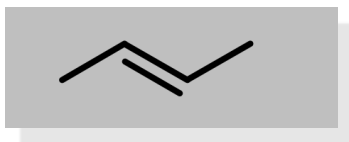
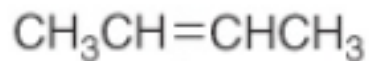
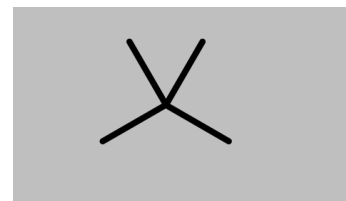
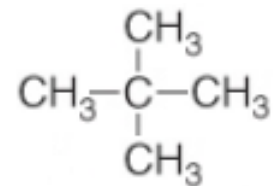
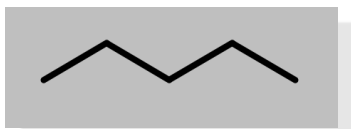
Skeletal (Linear) Formula

Minimal, non ambiguous, information

- Carbon atoms are omitted and lie on interseptions between bonds and at the end of the chain.
- Hydrogen atoms are omitted. Each carbon atom free valence is saturated with hydrogens.
- Atoms other than C and H (heteroatoms) are not omitted.



Skeletal (Linear) Formula



Examples

