Organic Chemistry

- introduction 1 -

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Composition of Matter

- **inorganic mater**
  - oxygen (O) 50%
  - silicon (Si) 25%
  - aluminium (Al) 7%
  - iron (Fe) 5%
  - calcium (Ca) 3%

    90%
  - sodium (Na)
  - potassium (K)
  - magnesium (Mg)
  - hydrogen (H)
  - titanium (Ti) 0,6%

- **organic mater**

  „compounds of carbon"

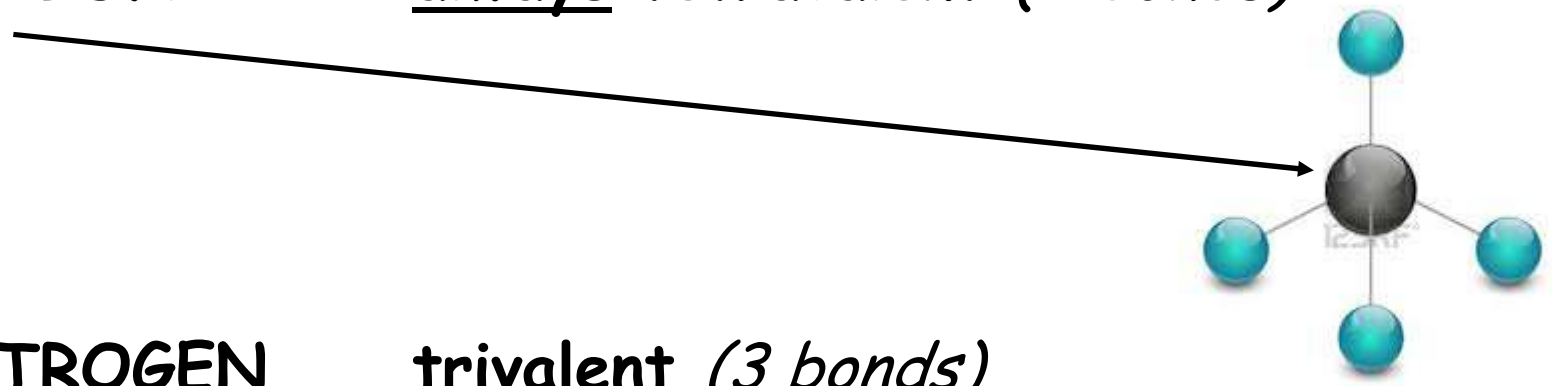
  C, O, H, N

  - carbon (C)
  - oxygen (O)
  - hydrogen (H)
  - nitrogen (N)
  - phosphorus (P)
  - sulfur (S)

Valence of elements in organic compounds

(= number of bonds forming in organic compounds)

- **CARBON** **always tetravalent** *(4 bonds)*



- **NITROGEN** **trivalent** *(3 bonds)*
- **OXYGEN** **bivalent** *(2 bonds)*
- **SULPHUR** **bivalent** *(2 bonds)*
- **HYDROGEN** **monovalent** *(1 bond)*
- **HALOGENS** **monovalent** *(1 bond)*

Inorganic compounds

- **oxides**
- **peroxides**
- **hydroxides**
- **acids**

1 C

CO, CO_2, HCN, H_2CO_3

Organic compounds

- **hydrocarbons**
- **hydrocarbon derivatives**

nomenclature example:

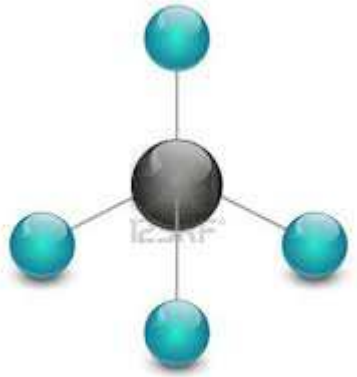
propane + derivatives

1C

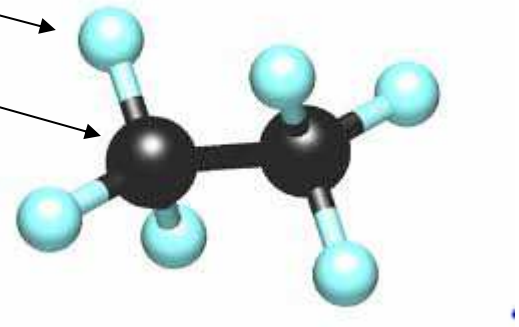
CH_4, CH_3OH, $HCHO$, $HCOOH$

organic derivatives of H_2CO_3 and H_3PO_4

Organic compounds



- „compounds of carbon“
- **hydrocarbon skeleton**: **C, H**
  (linear / branched / cyclic)
  - *saturated*: CH_3-$(CH_2)_n$-CH_3
  - *unsaturated*: -CH=CH- or -C≡C-



- **heteroatoms: O, N, S, halogens**
  - *heterocyclic compounds*
  - *hydrocarbon derivatives* (often in „functional groups“)
- **aliphatic or aromatic compounds**

Types of bonds:

1) **single (-ane)**
   → **saturated hydrocarbons** *(called „alkanes")*

2) **double (-ene) or triple (-yne)**
   → **unsaturated hydrocarbons**
   (called „alkenes" and „alkynes")

3) **conjugated bonds**
   = alteration of single and double bonds
   → **unsaturated hydrocarbons**

Prefixes used to express the number of carbons found in an organic compound

number of C	prefix-	alkane	alkene	alkyne	cycloalkane
1	meth-	methane	X	X	X
2	eth-	ethane	ethene	ethyne	X
3	prop-	propane	propene	propyne	cyclopropane
4	but-	butane	butene	butyne	cyclobutane
5	pent-	pentane	pentene	pentyne	cyclopentane
6	hex-	hexane	hexene	hexyne	cyclohexane
7	hept-	heptane	heptene	heptyne	cycloheptane
8	oct-	octane	octene	octyne	cyclooctane
9	non-	nonane	nonene	nonyne	cyclononane
10	dec-	decane	decene	decyne	cyclodecane
11	undec-	undecane	undecene	undecyne	
12	dodec-	dodecane	dodecene	dodecyne	
13	tridec-	tridecane	tridecene	tridecyne	
14	tetradec-	tetradecane	tetradecene	tetradecyne	

	1	2	3	4	5	6	7	8	9	10	11	12
multiple prefix	mono	di	tri	tetra	penta	hexa	hepta	octa	nona	deca	un deca	do deca

Naming organic compounds

1. IUPAC names = systematic names
   - exact rules (prefixes, suffixes) *e.g. ethyne*

2. common names = trivial names
   - mostly no rules *e.g. acetylene*

Formulas of organic compounds

- molecular C_4H_{10} C_2H_6O
- structural $CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_3$ $CH_3\text{-}CH_2\text{-}OH$

Chemical properties

- **hydrocarbons** are **hydrophobic** (= lipophilic) because are **nonpolar**
- **hydrocarbon derivatives**:
  polar functional group + **nonpolar** tail
- **reactivity**:
  - multiple bonds
  - functional groups
- **complete oxidation** (= burning) of a hydrocarbon skeleton → $CO_2 + H_2O$

Naming hydrocarbons

1. find the longest linear chain: it is called **„parent hydrocarbon chain"**
2. if multiple bonds are present they must be included in the parent chain
3. call the parent chain using related prefix to express number of carbons and a suffix to express the type of the hydrocarbon
4. **order substituents** (if present) **alphabetically**
5. number the parent chain from its end which gives the lovest locants to multiple bonds and to substituents (multiple bond takes precedence)

Exercise

- add names of the compounds:

1. $CH_3-CH_2-CH_2-CH_3$
2. $CH_3-CH_2-CH=CH-CH_3$
3. $CH_2=CH_2$
4. $CH_3-CH_2-CH_2-CH_2-C\equiv CH$
5. $CH_3-(CH_2)_{10}-CH_3$

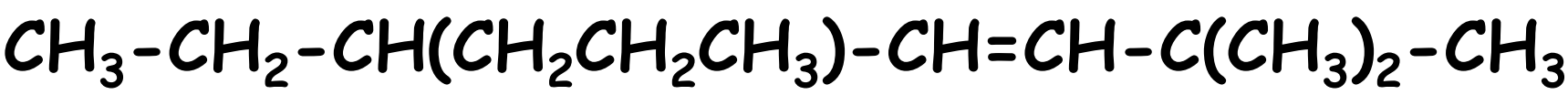
Exercise

- add names of the compounds:

1. $CH_3-CH_2-CH_2-CH_3$ butane
2. $CH_3-CH_2-CH=CH-CH_3$ pent-2-ene
3. $CH_2=CH_2$ ethene
4. $CH_3-CH_2-CH_2-CH_2-C\equiv CH$ hex-1-yne
5. $CH_3-(CH_2)_{10}-CH_3$ dodecane

Naming branched hydrocarbons

locant-**substituent**-prefix-*locant of multiple bond*-suffix



call the compound:

.....

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Naming hydrocarbons

locant-**substituent**-prefix-*locant of multiple bond*-suffix

CH_3-CH_2-$CH(CH_2CH_2CH_3)$-CH=CH-$C(CH_3)_2$-CH_3

5-**ethyl**-2,2-di**methyl**oct-3-ene

other substituents than alkyls:

F = fluoro- / **Cl** = chloro- / **Br** = bromo- / **I** = iodo-

NO_2 = nitro-