TUTORIAL GUIDE

BIOORGANIC CHEMISTRY

WORKBOOK TO PRACTICE

Edited
by professor N.A. Tyukavkina

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CONTENTS

Part 1

The Basics of the Structure and Reactivity of Organic Compounds

Topic 1. Classification and Nomenclature of Organic Compounds

The student should be able

1. To determine by the structure of the carbon skeleton the affiliation of organic compounds to the respective classification groups.
2. To establish by structural formula the presence of a functional group in a molecule and to attribute the organic compound to a particular class.
3. To compose the name of an organic compound by IUPAC nomenclature (substitutive and radicofunctional) and, conversely, by a name to draw up a structural formula.
4. To represent possible structural isomers of a particular organic compound.

The student should know

1. Criteria for classifying organic compounds.
2. Basic classes of organic compounds. Functional groups.
3. The basic rules of the systematic IUPAC nomenclature. Terms: parent structure, substituents, functional groups.

The content of the topic

Classification signs of organic compounds: the structure of a carbon skeleton and the nature of a functional group. Functional group. Structural formula, constitutional (structural) isomers.

General formulas of biologically important classes of organic compounds: alcohols, phenols, thiols, amines, ethers, sulfides, aldehydes, ketones, carboxylic acids. Hydrocarbon residues.

The basic rules for naming organic compounds by IUPAC nomenclature; substitutive and radicofunctional nomenclature. The parent structure, substituents, functional groups.

INFORMATION SOURCES

Textbook: Chapter 1, pp. 24–25; Chapter 2, pp. 27–39.

Glossary (check your competence)

Constitutional (structural) isomers	Parent structure
Structural formulas	Functional group
Substitutive nomenclature	Substituent
Radicofunctional nomenclature	Hydrocarbon group

CLASSROOM WORK

1. Write down the following definitions:

Functional group — _____

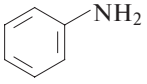
Parent structure — _____

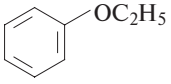
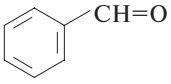
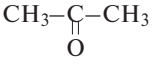
Hydrocarbon group — _____

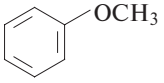
2. Which functional group in each of the cited compounds determines its belonging to the organic compound class?

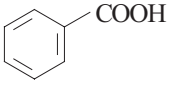
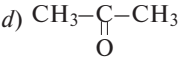
Example.

Structural formula:	*Functional group:*	*Class:*
CH_3CH_2**OH**	OH - hydroxy group	alcohols

2.1. *a*) CH_3COOH acetic acid; *b*) $H_2C{=}O$ formaldehyde; *c*)  aniline; *d*) C_2H_5SH ethanethiol

2.2. *a*)  phenetole; *b*) $CH_3CH_2CH_2COOH$ butyric acid; *c*)  benzaldehyde; *d*)  acetone

2.3. *a*) $CH_3CH_2CH_2CH_2COOH$ valeric acid; *b*) CH_3NHCH_3 dimethylamine; *c*) $C_2H_5SC_2H_5$ diethyl sulfide; *d*)  anisole

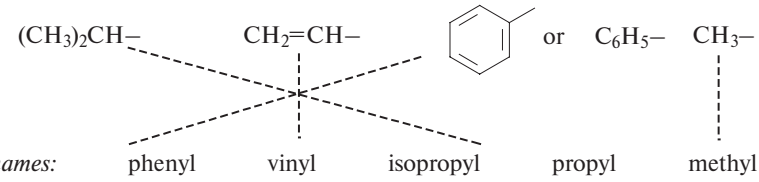
2.4. *a*)  benzoic acid; *b*) $CH_3CH_2NH_2$ ethylamine; *c*) CH_3OH methanol; *d*)  butanone

	Functional group:	*Class:*
a)	_____	_____
b)	_____	_____
c)	_____	_____
d)	_____	_____

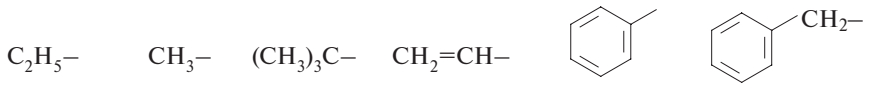
3. Connect the structural formulas of hydrocarbon groups and their names with a line.

Example.

Formulas of hydrocarbon groups:

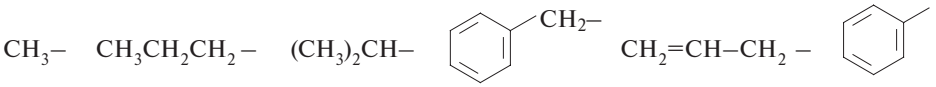


3.1. *Formulas of hydrocarbon groups:*



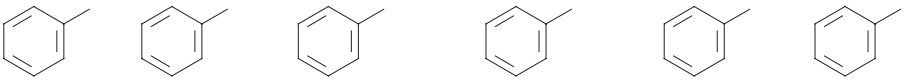
The group names: methyl ethyl vinyl *tert*-butyl benzyl butyl phenyl

3.2. *Formulas of hydrocarbon groups:*



The group names: propyl methyl isopropyl isobutyl allyl phenyl benzyl

4. Add functional or hydrocarbon groups to structural formulas according to the names of benzene derivatives:



phenol toluene benzaldehyde chlorobenzene benzoic acid aniline

5. Fill in the spaces using Table 2.2 (Textbook, p. 31).

Functional group		
Formula*	**Prefix name**	**Suffix name**
–OH	hydroxy-	
		-thiol
	amino-	
–**C**OOH	—	
–COOH	carboxy-	
–**C**H=O	—	
	oxo-	-one

* Accented carbon atom is included in the parent structure.

6. Give the IUPAC substitutive names for the following compounds, using Tables 2.1 and 2.2 (Textbook, pp. 26 and 31).

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Example. $CH_3^{3}-CH^{2}(OH)-COOH^{1}$ (the common name is lactic acid)

Senior functional group: the carboxy group, reflected by a combination of -**oic acid**.

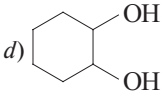
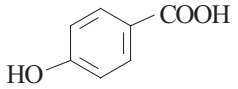
Parent structure and numbering in it: the parent structure is **propane**, numbering is carried out so that the carbon atom of the carboxy group gets the lowest number.

Substituent: the hydroxy group, reflected by the prefix **hydroxy** with indicating its position (the atom C-2).

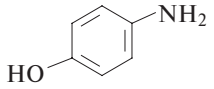
Substitutive name: 2-hydroxypropanoic acid.

.....

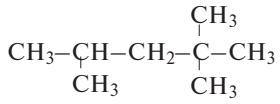
6.1. *a*) $CH_2=CH-CH=CH_2$ *b*) $CH_3-C(=O)-C_2H_5$ *c*) $CH_3-CH(NH_2)-COOH$

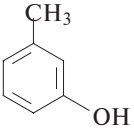
d)  *e*) 

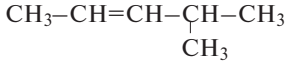
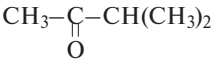
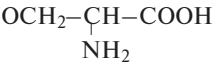
6.2. *a*) $CH_2=C(CH_3)-CH=CH_2$ *b*) $CH_3-C(=O)-H$ *c*) $HOOC-CH_2-CH(NH_2)-COOH$

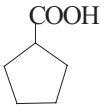
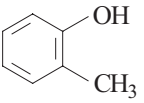
d) C_2H_5SH *e*) 

6.3.

a)  *b*) $HOCH_2CH_2COOH$ *c*) $CH_3CH_2CH_2SH$

d) $HOCH_2CH_2OH$ *e*) 

6.4. *a*)  *b*)  *c*) 

d)  *e*) 

a) Senior functional group: _____

Parent structure and numbering in it: .....
Substituent(s): _____
Full name: _____

b) Senior functional group: _____

Parent structure and numbering in it: .....
Substituent(s): _____
Full name: _____

c) Senior functional group: _____

Parent structure and numbering in it: .....
Substituent(s): _____
Full name: _____

d) Senior functional group: _____

Parent structure and numbering in it: .....
Substituent(s): _____
Full name: _____

7. Draw structural formulas of compounds by name, using Tables 2.1 and 2.2 (Textbook, pp. 26 and 31).

Example. 2-Amino-3-hydroxybutanoic acid.

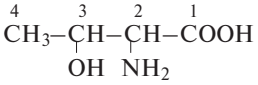
Parent structure: butane (4 carbon atoms).

Suffix: the combination **-oic acid** reflects the presence of a carboxy group whose carbon atom is included in the parent structure.

Numbering is carried out so that the carboxy group gets the lowest number.

Prefixes: **amino** and **hydroxy** show the presence of the NH_2 and OH groups respectively.

Structural formula and numbering:



7.1. *a*) 2,6-Diaminohexanoic acid; *b*) propan-2-ol; *c*) *o*-aminophenol.

7.2. *a*) Pentan-2-one; *b*) ethane-1,2-diol; *c*) *p*-aminobenzoic acid.

7.3. *a*) Hexa-1,3,5-triene; *b*) butane-1-thiol; *c*) *m*-hydroxybenzaldehyde.

7.4. *a*) 2-Oxopentanedioic acid; *b*) propenal; *c*) cyclohexanone.

a) Parent structure: _____

Suffix: _____

Numbering: .....

Prefix(es): _____

Structural formula:

.....

b) Parent structure: _____

Suffix: _____

Numbering: .....

Prefix(es): _____

Structural formula:

.....

c) Parent structure: _____

Suffix: _____

Numbering: .....

Prefix(es): _____

Structural formula:

.....

8. Write structural formulas of compounds named by radicofunctional nomenclature.

Example. Dimethyl sulfide.

Hydrocarbon group(s): two CH_3 (multiplying prefix **di-**).

Class of the compound and its general formula: sulfides R–S–R.

Structural formula: $CH_3–S–CH_3$.

It should be added here that the name of amines is written in one word, the names of other classes — separately.

8.1. *a*) Diphenyl ether; *b*) ethyl methyl ketone; *c*) cyclohexylamine.

8.2. *a*) *tert*-Butyl alcohol; *b*) methyl phenyl ketone; *c*) diisopropyl ether.

8.3. *a*) Benzyl chloride; *b*) allyl alcohol; *c*) triethylamine.

8.4. *a*) Methyl bromide; *b*) divinyl sulfide; *c*) isobutyl alcohol.

a) Hydrocarbon group(s): _____

Class of the compound, general formula: _____

Structural formula:

b) Hydrocarbon group(s): _____

Class of the compound, general formula: _____

Structural formula:

c) Hydrocarbon group(s): _____

Class of the compound, general formula: _____

Structural formula:

THE CURRENT CONTROL (approximate version)

1. Write a skeletal formula for a compound containing the cyclohexane ring and hydroxy group and determine which class it belongs to.
2. Name alanine, $CH_3CH(NH_2)COOH$, by substitutive nomenclature. Which functional groups are part of the molecule?
3. Write the structural formula for trichloroethanal.

INDEPENDENT HOMEWORK

Tasks on topic 2.

Textbook: Chapters 1 and 3.

Variant 1:	1.3,	3.1,	3.7,	3.13.
Variant 2:	1.5,	3.2,	3.8,	3.14.
Variant 3:	1.7,	3.3,	3.9,	3.15.
Variant 4:	1.8,	3.4,	3.10,	3.13.
Variant 5:	1.11,	3.5,	3.11,	3.14.
Variant 6:	1.14,	3.6,	3.12,	3.15.