

**MINISTRY OF HEALTH OF UKRAINE**  
**ODESSA NATIONAL MEDICAL UNIVERSITY**

**Faculty of Pharmacy**

**Department of Pharmaceutical Chemistry and Drug Technology**

**APPROVED by**

Vice-rector for scientific and pedagogical work

\_\_\_\_\_ Eduard BURYACHKIVSKY

\_\_\_\_\_, 202\_

**METHODOLOGICAL DEVELOPMENT**  
**TO THE INDEPENDENT WORK OF HIGHER EDUCATION ACQUIRES**  
**FROM EDUCATIONAL DISCIPLINE**

Faculty, course \_\_\_\_\_ Pharmaceutical, II year \_\_\_\_\_

Academic discipline \_\_\_\_\_ Organic chemistry \_\_\_\_\_

*(name of academic discipline)*

**Approved:**

The meeting of the department Pharmaceutical chemistry

Odesa National Medical University

Minutes № \_ dated \_\_\_\_\_

Head of Department (\_\_\_\_\_) Volodymyr GELMBOLDT  
(*signature*) (Name, last name)

**Developers:**

prof. Gelmboldt V.O., docent Lozhichevskaya, T. V., as. Ulizko I.V. as. Shishkin I.O.

## *Independent work No. 1*

**Topic:** The subject of organic chemistry. Classification and nomenclature of organic compounds. Types of chemical bonds and mutual influence of atoms.

**Goal:** get acquainted with different types of nomenclature of organic compounds.

**Basic concepts:** Classification. Functional groups. Classes. Nomenclature systems.

### Plan

#### **1. Theoretical questions for the lesson:**

1. The subject of organic chemistry, its importance and connection with pharmacy.
2. Ways of formation of organic chemistry. Development of theoretical ideas about the structure of organic compounds.
3. Basic methods of imaging organic molecules.
4. Classification of organic compounds according to the structure of the carbon chain and the nature of the functional group.
5. Basic functional groups and corresponding classes of organic compounds.
6. Nomenclature systems: trivial, rational and international (IUPAK).
7. The basic principles of building the names of organic compounds according to the IUPAK nomenclature (substituent and radical-functional nomenclature).

#### **Questions for self-control:**

1. Development of theoretical ideas about the structure of organic compounds.
2. Chemical bond. Types of chemical bonds.
3. Valence states of the carbon atom.
4. Covalent  $\sigma$ - and  $\pi$ -bonds.
5. Electronic effects in organic compounds.

#### **Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

#### **2. Practical works (tasks) that will be performed during the lesson: 1.**

Name the main methods of imaging organic molecules. Using the appropriate formulas, indicate: a) qualitative and quantitative composition; b) the chemical

structure of the following organic substances: propane, cyclopropane, pentene-1, chlorobenzene, diethyl ether.

2. List the main advantages of structural formulas over molecular (gross) formulas.

3. Write all possible structural formulas and give the names of organic substances:  $C_4H_8$ ,  $C_2H_2$ ,  $C_5H_{12}$ ,  $C_6H_6$ ,  $C_3H_7Cl$ .

### 3. Test tasks for self-control: are added

### 4. Individual tasks for students on the subject of the lesson.

1. What substances are called organic?
2. What is their atomic composition?
3. How do organic compounds differ from inorganic compounds?
4. What is the relationship between organic chemistry and other chemical disciplines?

### 5. List of recommended literature.

#### Main:

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
2. General workshop on organic chemistry / V.P. Chernykh, I.S. Hrytsenko, M.O. Lozinskyi, Z.I. Kovalenko; Under the editorship V.P. Black people – Kh.: NfaU Publishing House; Golden Pages, 2003. – 592 p.
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#### Additional:

1. Zimenkovskiy B.S., Muzychenko V.A., Nizhenkovskaya I.V. Biological and bioorganic chemistry. Volume I: - Kyiv: Medicine, 2014: 398p.
2. Stoker, HS (2001). Organic and biological chemistry. Houghton Mifflin. 556

### **Information resources:**

1. [www.ncbi.nlm.nih.gov/PubMed](http://www.ncbi.nlm.nih.gov/PubMed) – free access to the scientific database in the field of biomedical sciences.
2. <https://pubchem.ncbi.nlm.nih.gov/> free access to the scientific database in the field of biomedical sciences.
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4. [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

### *Independent work No. 2*

**Topic:** Isomerism of organic compounds. Acidic and basic properties of organics.

**Goal:** get acquainted with isomerism of organic compounds, acidic and basic properties of organic compounds.

**Basic concepts:** Structural isomerism. Stereoisomers. Optical isomerism. Chirality. Asymmetric carbon atom. Geometric isomerism. Cis-trans isomerism.

#### Plan

#### **1. Theoretical questions for the lesson:**

1. Spatial structure of molecules (configuration, conformation). Ways of depicting the spatial structure of molecules.
2. Structural isomerism (carbon chain isomerism, positional isomerism, functional group isomerism).
3. Stereoisomerism (conformational, configurational).
  - Configurational isomerism (optical, geometric).
  - Conformational (rotational) isomerism.

#### **Questions for self-control:**

1. What are the types of isomerism of organic compounds.
2. Suggest the possibility of formation of different types of isomers.
3. Name the types of reaction mechanisms.

#### **Approximate tasks for processing the theoretical material:**

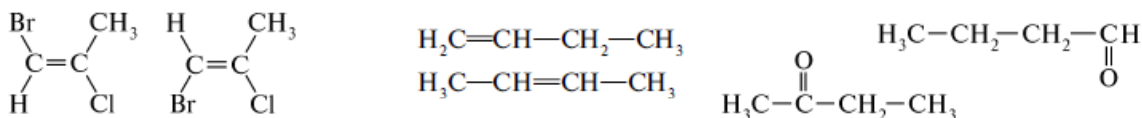
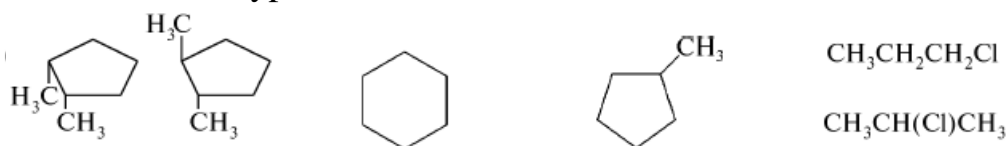
- compile a dictionary of basic concepts on the topic.

#### **2. Practical works (tasks) that will be performed during the lesson:**

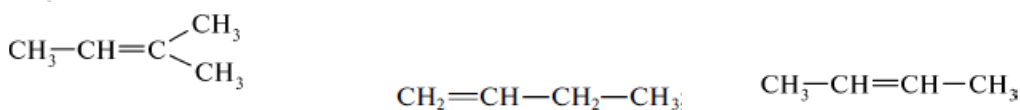
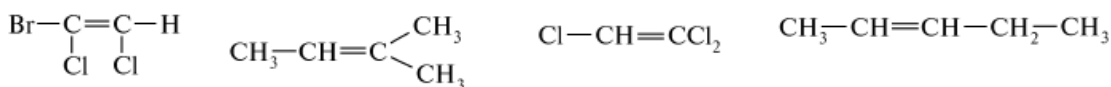
1. Among the proposed formulas, identify the isomers:  $\text{CH}_3\text{—CaC—CH}_2\text{—CH}_2\text{—CH}_3$ ,  $\text{C}_6\text{H}_{12}$ ,  $\text{C}_6\text{H}_6$ ,  $\text{C}_5\text{H}_{11}\text{C(O)H}$ ,  $\text{C}_3\text{H}_7\text{(C=O)C}_2\text{H}_5$ ,  $\text{CH}_3\text{—CH=CH—C}_3\text{H}_7$ ,

$C_2H_5OC_3H_7$ ,  $C_5H_{11}COOH$ ,  $C_5H_{11}NH_2$ ,  $C_6H_{10}$ ,  $CH_3-(CH_2)_4-CH_3$ ,  $CH_3-CH=CH-CH=CH-CH_3$ ,  $C_6H_{14}$ ,  $C_5H_{11}OH$ .

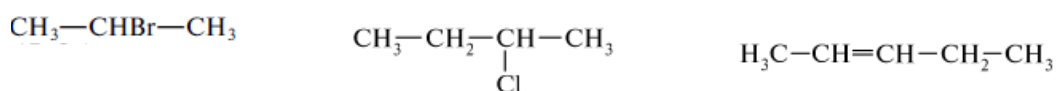
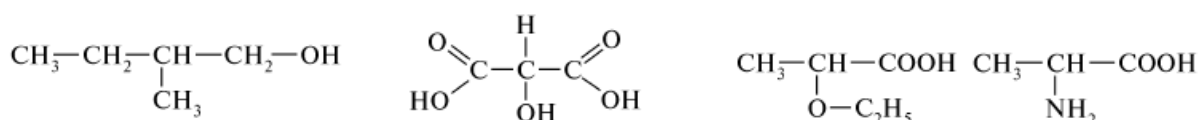
2. Determine the type of isomerism:



1. What compounds are characterized by geometric isomerism? Define cis and trans isomers.



2. What compounds are characterized by optical isomerism? Define chiral centers.



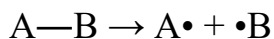
**3. Test tasks for self-control:** are added

**4. Individual tasks for students on the subject of the lesson.**

1. When specifying the mechanisms of chemical reactions, carbocations may appear as intermediate products. Are these intermediate active particles yak?:

2. Different types of particles can act as attacking reagents when determining the mechanisms of chemical reactions. Which of the statements corresponds to the concept of nucleophilic reagents?

3. The stage of formation of active particles is represented by the equation:



determine the nature of the disconnection:

4. Choose the definitions corresponding to the concept of "acid" from the point of view of Lewis theory.

### 5. List of recommended literature.

#### Main:

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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#### Additional:

- 1 Zimenkovsky B.S., Muzychenko V.A., Nizhenkovskaya I.V. Biological and bioorganic chemistry. Volume I: - Kyiv: Medicine, 2014: 398p.
- 2 Stoker, HS (2001). Organic and biological chemistry. Houghton Mifflin. 556

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- 4 www.bioorganica.org.ua is a scientific publication presenting works on bioorganic and medical chemistry.

### *Independent work No. 3*

**Topic**"Classification of organic reactions and reagents. Methods of determining the structure of organic compounds".

**Goal:**familiarize yourself with the classification of organic reactions and reagents.

**Basic concepts:** carbocations, carbanions, free radicals, electrophiles, nucleophiles.

#### Plan

#### **1. Theoretical questions for the lesson:**

1. Physical research methods. Determination of boiling point, melting point, density, etc.
2. The essence of the refractometry method and its use in pharmacy.
3. Chemical research methods. Qualitative reactions of the main functional groups.
4. Biological fluids and their physical and chemical studies.
5. Instrumental methods of studying the structure of organic compounds (infrared IR spectroscopy), types of oscillations, covalent, deformation, characteristic frequencies.
6. Electronic spectroscopy (UV and visible region), types of electronic transitions and their energy; the main parameters of absorption bands, band shift (bathochromic, hypochromic) and their cause.
7. Nuclear magnetic resonance spectroscopy (NMR), proton magnetic resonance (PMR), chemical shift, spin-spin splitting.

#### **Questions for self-control:**

1. Instrumental methods of studying the structure of organic compounds.
2. Infrared spectroscopy (vibrational spectroscopy):
3. Spectroscopy in the ultraviolet and visible ranges
4. Nuclear magnetic resonance spectroscopy (NMR):
5. Mass spectrometry:
6. Diffraction methods (electronography, radiography, neutronography)

#### **Approximate tasks for processing the theoretical material:**



- compile a dictionary of basic concepts on the topic.

## **2. Practical works (tasks) that will be performed during the lesson:**

1. Name the methods of determining the structure of organic compounds.
2. List the physical research methods.
3. Solubility of organic substances. Organic solvents.
4. Structure of refractometer (polarimeter).
5. Determination of the specific rotation of optically active substances.
6. Optically active substances of the D and L series.
7. Qualitative reactions to aldehydes.
8. Qualitative reactions to phenols and unsaturated compounds

## **3. Test tasks for self-control:** are added

## **4. Individual tasks for students on the subject of the lesson.**

1. Determination of the specific rotation of optically active substances.
2. Optically active substances of the D and L series.
3. Qualitative reactions to aldehydes.
4. Qualitative reactions to phenols and unsaturated compounds.

## **5. List of recommended literature.**

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1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

*Independent work No. 4*

**Topic**"Alkanes".

**Goal:**get acquainted with the chemical properties of alkanes.

**Basic concepts:**Homologous series. Nomenclature. Isomerism. Mining methods. Natural sources of hydrocarbons. Physical properties. Chemical properties.

Plan

**1. Theoretical questions for the lesson:**

1. Structure, nomenclature, isomerism of alkanes, homologous series and homologous difference.
2. Conformation of alkanes.
3. Methods of extracting alkanes.
4. Radical substitution reactions (Sr) in a number of alkanes. Mechanisms of halogenation, nitration, sulfochlorination.
5. Oxidation of alkanes.
6. Cracking and reforming of alkanes.

**Questions for self-control:**

1. Where is methane found in nature and what is it called?

2. In what ratio does methane and oxygen form an explosive mixture?
3. What does the saying mean - "Methane is the Adam of the organic world."
4. Environmental problems related to natural sources of hydrocarbons and their use.
5. Isomerization of alkanes.

**Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

**2. Practical works (tasks) that will be performed during the lesson:**

1. What kind of flame do alkanes burn? Their practical use.
2. Write reaction equations with the help of which the following transformations can be carried out: a)  $\text{Al}_4\text{C}_3 \rightarrow \text{butane}$ ; b) ethane  $\rightarrow$  2,3 - dimethylbutane.
3. With which of the following compounds does butane react: a) conc.  $\text{H}_2\text{SO}_4$ , (20  $^\circ\text{C}$ ); b)  $\text{HNO}_3$  solution (140  $^\circ\text{C}$ ); c)  $\text{Br}_2$  in the dark and in the light.
4. Alkane identification methods.

**3. Test tasks for self-control:** are added

**4. Individual tasks for students on the subject of the lesson.**

1. Give examples of radical substitution reactions (SR).
2. Write the halogenation mechanism, nitration, sulfochlorination.
3. State the regioselectivity of radical substitution.

**5. List of recommended literature.**

**Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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***Independent work No. 5***

**Topic**Cycloalkanes.

**Goal:**get acquainted with the chemical properties of cycloalkanes.

**Basic concepts:**had cycles, large cycles, conformation.

Plan

**1. Theoretical questions for the lesson:**

1. Structure, nomenclature, isomerism of cycloalkanes, homologous series and homologous difference.
2. Conformation of cycloalkanes.
3. Methods of producing cycloalkanes.
4. Mechanisms of halogenation, nitration, sulfochlorination.

**Questions for self-control:**

1. Nomenclature and isomerism in a series of cycloalkanes.
2. Voltage cycles. Bayer and Pitzer stress theories.

3. Conformations of cyclopentane and cyclohexane. The concept of axial and equatorial connections.
4. Peculiarities of reactivity of small cycles.

**Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

**2. Practical works (tasks) that will be performed during the lesson:**

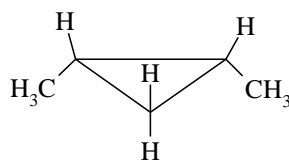
1. Choose the correct chemical name for this chemical compound:



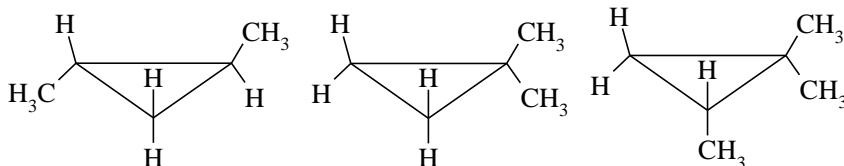
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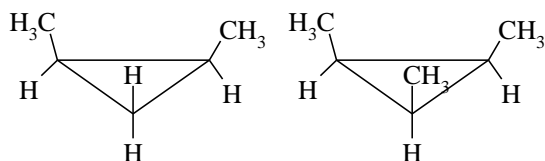
2. The proposed cycloalkane formula of the following structure.



Choose its geometric isomer among the proposed cycloalkanes:



ABC



DE

3. Cyclopentane can be obtained from calcium adipate. What is the name of this method of obtaining cycloalkanes.
4. Which conformation for cyclohexane will be the most energetically stable?
5. What type of covalent carbon-carbon bond exists in the cyclopropane molecule?
6. With which reagents will cyclobutane react without opening the cycle.

**3. Test tasks for self-control:** are added

#### **4. Individual tasks for students on the subject of the lesson.**

1. Isomerism of cycloalkanes. Different shapes of molecules.
2. Find the formula of a hydrocarbon whose hydrogen density is 28.
3. Give the name and write the formulas of its isomers.
4. Polycyclic systems: prismane, cubane, adamantane.
5. Methods of identification of cycloalkanes.

#### **5. List of recommended literature.**

##### **Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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##### **Additional:**

- 1 Zimenkovsky B.S., Muzychenko V.A., Nizhenkovskaya I.V. Biological and bioorganic chemistry. Volume I: - Kyiv: Medicine, 2014: 398p.
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### *Independent work No. 6*

**Topic**"Allyl halogenation of alkenes. Oxidation of alkenes (hydroxylation, epoxidation, ozonation). Diene synthesis (Diels-Alder reaction). Polymerization of 1,3-dienes (butadiene, isoprene).»

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:**Alkenes. Alkadienes. Markovnikov's rule. Diene synthesis.

#### Plan

#### **1. Theoretical questions for the lesson:**

1. Oxidation reactions.
2. Polymerization reactions, its mechanism
3. Polymeric materials, their properties and applications.
4. Methods of identification of alkenes.
5. What are the properties of ethene?
6. Qualitative reaction to ethene hydrocarbons.

#### **Questions for self-control:**

1. Structure and nomenclature of alkenes.
2. Structural and cis-trans isomerism.
- 3 Methods of extraction of alkenes.
4. Reactions of electrophilic addition (AB).
5. Markovnikov's rule and its electronic interpretation.

#### **Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

#### **2. Practical works (tasks) that will be performed during the lesson:**

1. Types of isomerism of alkenes. Cis- and trans-isomers, E and Z systems.
2. Polymerization reactions. Monomer. Polymer. Monomer link.
3. Polyethylene, its production and properties.

4. Teflon, its properties and use in surgery.
5. Application of polymeric materials in pharmacy.

### **3. Test tasks for self-control:**are added

#### **4. Individual tasks for students on the subject of the lesson.**

1. Application of ethene in industry and agriculture.
2. What happens to the  $\text{KMnO}_4$  solution when ethene is passed through it?
3. How does the degree of oxidation of manganese change in this case?

#### **5. List of recommended literature.**

##### **Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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9. State Pharmacopoeia of Ukraine. - 1st edition. - Kh.: RIREG, 2001. - 556 p.

##### **Additional:**

- 1 Zimenkovsky B.S., Muzychenko V.A., Nizhenkovskaya I.V. Biological and bioorganic chemistry. Volume I: - Kyiv: Medicine, 2014: 398p.
- 2 Stoker, HS (2001). Organic and biological chemistry. Houghton Mifflin. 556

##### **Information resources:**

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### *Independent work No. 7*

**Topic**"Alkynes. Reactions of electrophilic addition, substitution, dimerization (vinyl acetylene) and cyclotrimerization (benzene) of acetylene. Identification of unsaturated hydrocarbons.»

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:**Reactions of substitution, dimerization, trimerization.

#### Plan

#### **1. Theoretical questions for the lesson:**

1. The structure of the triple bond, the type of hybridization.
2. Physical properties of acetylene.
3. Complete and incomplete oxidation of acetylene.
4. Acetylene identification reaction.
5. What effect does acetylene have on the body?
6. Industrial methods of obtaining acetylene, its use.

#### **Questions for self-control:**

1. Structure and nomenclature of alkynes.
2. Methods of producing alkynes.
3. Reactions of electrophilic addition (AB).

#### **Approximate tasks for processing the theoretical material:**

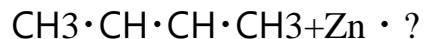
- compile a dictionary of basic concepts on the topic.

#### **2. Practical works (tasks) that will be performed during the lesson:**

1. Indicate which name corresponds to the radical whose structural formula is:

CH<sub>2</sub> CH

2. Specify the product of the reaction of 2,3-dibromobutane with zinc:



Br Br

3. Select the polymerization product of the proposed alkene:



4. Write a reaction scheme for the production of 2-butyne from propyne through organomagnesium compounds.

### 3. Test tasks for self-control: are added

#### 4. Individual tasks for students on the subject of the lesson.

1. Write a reaction scheme for the production of 2-butyne from propyne through organomagnesium compounds.
2. What effect does acetylene have on the body?
3. Industrial methods of obtaining acetylene, its use.

#### 5. List of recommended literature.

##### Main:

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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*Independent work No. 8*

**Topic**"Characteristics of an aromatic bond. Types of  $\rho$ - $\pi$  and  $\pi$ - $\pi$  conjugation. Aromaticity of arenas."

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:**Mononuclear arenas. Hückel's rule. Aromatic properties.

Plan

**1. Theoretical questions for the lesson:**

1. Classification of cyclic compounds. Arenas.
2. Aromaticity of compounds. Hückel's rule.
3. The structure of the benzene molecule, its properties.
4. Homologs of benzene, their properties.
5. Mechanisms of halogenation, sulfonation, nitration reactions.
6. Addition and oxidation reactions.

**Questions for self-control:**

1. Laboratory method of obtaining benzene? Conditions and type of reaction.
2. Arrange these compounds in order of increasing reactivity in electrophilic substitution reactions:  $C_6H_5OH$ ,  $C_6H_5Cl$ ,  $C_6H_5H_2$ ,  $C_6H_5COOH$ .
3. Landmarks of the 1st kind. Examples.
4. Landmarks of the II-type. Examples.

**Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

## 2. Practical works (tasks) that will be performed during the lesson:

1. What is sulfonated easier: toluene or xylene?
2. Write the equation for the sulfonation reaction of toluene.
3. Which reactions are more typical for arenes - addition or substitution?
4. Does it discolor benzene bromine water and  $\text{KMnO}_4$  solution?

## 3. Test tasks for self-control: are added

## 4. Individual tasks for students on the subject of the lesson.

1. Why is toluene chemically more active than benzene?
2. Using reaction equations, explain the chemical properties of ethylbenzene.
3. What kind of flame does benzene burn? Why?

## 5. List of recommended literature.

### Main:

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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***Independent work No. 9***

**Topic**"Multicore arenas. Naphthalene. Anthracene. Phenanthrene."

**Goal:** get acquainted with the chemical properties of substances.

**Basic concepts:** Naphthalene. Anthracene. Phenanthrene.

**Plan****1. Theoretical questions for the lesson:**

1. Classification, nomenclature and isomerism of polynuclear compounds.
2. Polynuclear compounds with condensed nuclei, their numbering, aromaticity.
3. Naphthalene, its properties, production, application.
4. Naphthalene derivatives. Naphthols. Their application.
5. Other polynuclear compounds: anthracene, phenanthrene, structure of their molecules.
6. Oxidation and substitution reactions, their mechanism.

**Questions for self-control:**

1. Carcinogenicity of polynuclear compounds.
2. Polynuclear compounds with non-condensed nuclei. Diphenyl, its properties.
3. Triphenylmethane is the basis for obtaining dyes.
4. Polynuclear compounds of non-benzoic structure.

**Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

## **2. Practical works (tasks) that will be performed during the lesson:**

1. What is naphthalene soluble in, how can it be cleaned from foreign impurities?
2. How many mono- and disubstituted isomers are there in naphthalene?
3. How is naphthalene similar and different from benzene in terms of its structure and properties?
4. Alizarin and triphenylmethane dyes, their use.

## **3. Test tasks for self-control:are added**

## **4. Individual tasks for students on the subject of the lesson.**

1. Phenolphthalein as an indicator and medicine (purgen).
2. Write schemes for extracting active particles of the triphenylmethane series and explain the reason for their stability?
3. How do electron-donating and electron-accepting substituents affect the stability of active particles of the triphenylmethane series?
4. Why does ferrocene enter the acylation reaction more easily than benzene?
5. Write schemes of reactions of azulene with  $\text{Br}_2(\text{AlBr}_3)$ ;  $\text{HNO}_3(\text{conc})$ ;  $\text{CH}_3\text{COCl}(\text{AlCl}_3)$ ?

## **5. List of recommended literature.**

### **Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

*Independent work No. 10*

**Topic**"Prediction of the reactivity of halogens - alkanes depending on the type of halogen atom. Mechanism of SN1, SN2 reactions, their stereochemical orientation. Elimination reactions. Mechanisms E1, E2"

**Goal:** get acquainted with the chemical properties of substances.

**Basic concepts:** Haloalkanes. Haloalkenes. Zaitsev's rule. Elimination reactions.

Plan

**1. Theoretical questions for the lesson:**

1. Elimination reactions of halogen derivatives.
  2. Halogen derivatives of saturated and unsaturated hydrocarbons.
  3. Halogen derivatives of aromatic hydrocarbons with halogen in the core and in the side chain.
  4. Halogen derivatives as drugs, methods of their identification.
  5. Alkyl, vinyl halogen derivatives, their properties.

**Questions for self-control:**

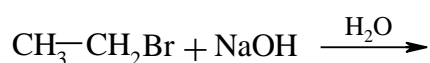
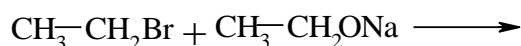
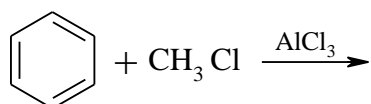
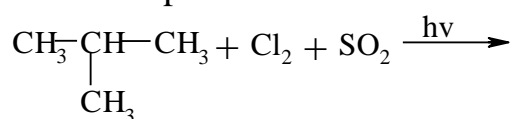
1. Reactions of nucleophilic substitution (SN).
2. Deactivating effect of halogen in SE reactions.
3. Orienting effect of halogen in SE reactions.
4. Methylation.

**Approximate tasks for processing the theoretical material:**

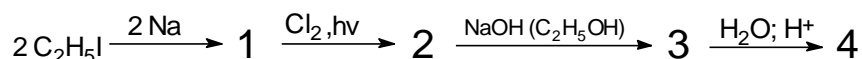
- compile a dictionary of basic concepts on the topic.

**2. Practical works (tasks) that will be performed during the lesson:**

1. Complete the chemical reaction equation:



2. Perform the conversion. Name all compounds in the transformation chain.



**3. Test tasks for self-control:** are added

**4. Individual tasks for students on the subject of the lesson.**

1. Methods of identification of halogen derivatives.
2. Genetic relationship between hydrocarbons and their halogen derivatives and other classes of organic compounds.

**5. List of recommended literature.**

**Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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***Independent work No. 11***

**Topic**"Prediction of the reactivity of halogens - arenes. The mechanism of SE and SN reactions."

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:**Halogenarenes. Arylalkyl halides

Plan

**1. Theoretical questions for the lesson:**

1. General characteristics of halogen derivatives, their classification.
2. Isomerism and nomenclature of halogen derivatives.
3. Physical and chemical properties.

4. Methods of obtaining.

**Questions for self-control:**

1. Reactions of nucleophilic substitution (SN).
2. Deactivating effect of halogen in SE reactions.
3. Orienting effect of halogen in SE reactions.
4. Methylation.

**Approximate tasks for processing the theoretical material:**

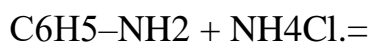
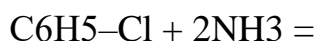
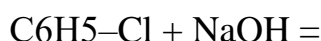
- compile a dictionary of basic concepts on the topic.

**2. Practical works (tasks) that will be performed during the lesson:**

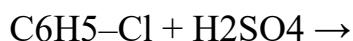
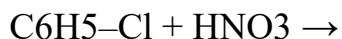
1. Names of the above compounds according to the substitute nomenclature of IURAS:

- a) 7-amino-9-methyl-1-chlorophenanthrene
- b) 2,4,6-trinitrotoluene
- c) 2,3,3,5-tetramethyl-4-ethylhexane
- d) methyl cyclopropane
- f) acetophenone.

2. Complete the chemical reactions:



3. Specify the type of reaction and products



**3. Test tasks for self-control:** are added

**4. Individual tasks for students on the subject of the lesson.**

1. Halogen derivatives of aromatic hydrocarbons with halogen in the core and in the side chain.

2. Halogen derivatives as drugs, methods of their identification.

## 5. List of recommended literature.

### Main:

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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## *Independent work No. 12*

**Topic**"Classification. Nomenclature. Electronic structure of the nitro group. Acinitro-tautomerism, interaction with alkalis. Reactions of nitro compounds with

nitric acid, aldehydes and ketones. Reduction of nitroarenes. Reactions of electrophilic substitution in a series of nitroarenes. The influence of the nitro group on the reactivity of the hydrocarbon radical."

**Goal:** get acquainted with the chemical properties of substances.

**Basic concepts:** Nitro compounds. Nitroalkanes. Nitroarenes.

#### Plan

### 1. Theoretical questions for the lesson:

1. General characteristics of nitro compounds.
2. Isomerism and nomenclature of nitro compounds.
3. Physical and chemical properties.
4. Methods of obtaining.
5. Nitro compounds as drugs, methods of their identification.

### Questions for self-control:

1. Zinin's reaction, its meaning.
  2. Primary, secondary and tertiary nitro compounds.
  3. Nitrobenzene as a solvent.
4. Synthesis of streptocide. Its application.

### Approximate tasks for processing the theoretical material:

- compile a dictionary of basic concepts on the topic.

### 2. Practical works (tasks) that will be performed during the lesson:

1. Structure, isomerism, nomenclature of nitro compounds of the aliphatic series.
2. Mono and poly nitro compounds, their preparation and properties.
3. Nitro compounds of the aromatic series, their properties.
4. Properties of nitroso compounds, their isomerism, nomenclature, properties and preparation.
5. Individual representatives of nitrogenous compounds as drugs (acetanilide, phenatidine, streptocid, etazol, paracetamol, chloramphenicol) and their use as drugs.
6. Methods of identification of nitro compounds

### 3. Test tasks for self-control: are added

#### **4. Individual tasks for students on the subject of the lesson.**

1. Give examples of the influence of the nitro group on the reactivity of the hydrocarbon radical.

2. Draw up schemes: - nitro-acynitroautomerism and the formation of salts.

#### **5. List of recommended literature.**

##### **Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.

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9. State Pharmacopoeia of Ukraine. - 1st edition. - Kh.: RIREG, 2001. - 556 p.

##### **Additional:**

1 Zimenkovsky B.S., Muzychenko V.A., Nizhenkovskaya I.V. Biological and bioorganic chemistry. Volume I: - Kyiv: Medicine, 2014: 398p.

2 Stoker, HS (2001). Organic and biological chemistry. Houghton Mifflin. 556

##### **Information resources:**

1 [www.ncbi.nlm.nih.gov/PubMed](http://www.ncbi.nlm.nih.gov/PubMed) – free access to the scientific database in the field of biomedical sciences.

2 <https://pubchem.ncbi.nlm.nih.gov/> free access to the scientific database in the field of biomedical sciences.

3 [www.bpci.kiev.ua](http://www.bpci.kiev.ua) is the official website of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.

4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

### ***Independent work No. 13***

**Topic**"Aliphatic amines. Interaction of primary, secondary, tertiary aliphatic and aromatic amines with nitrous acid. Oxidation of amines.»

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:**Amen. Schiff's Basics. Isonitrile reaction.

#### Plan

#### **1. Theoretical questions for the lesson:**

1. General characteristics.
2. Isomerism and nomenclature of nitro compounds.
3. Physical and chemical properties.
4. Methods of obtaining.
5. Methods of their identification.

#### **Questions for self-control:**

1. Aliphatic amines, their chemical properties, and production.
2. Chemical and physical-chemical methods of identification of amines.
3. Individual representatives of nitrogenous compounds as drugs (acetanilide, phenatidine, streptocid, etazol, paracetamol, levomyctin) and their use as drugs.

#### **Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

#### **2. Practical works (tasks) that will be performed during the lesson:**

1. Acid-base properties;
2. Nucleophilic nature of the amino group;
3. Alkylation, acylation and N-halogenation;
4. Isonitrile sample;
5. Formation of azomethine;
6. Relation of amines to the action of oxidizing agents.

#### **3. Test tasks for self-control:**are added

#### **4. Individual tasks for students on the subject of the lesson.**

1. Interaction of primary, secondary, tertiary aliphatic and aromatic amines with nitric acid.

2. Make a scheme for the formation of Schiff bases.
3. Alkylation, acylation reactions.

## 5. List of recommended literature.

### Main:

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
2. General workshop on organic chemistry / V.P. Chernykh, I.S. Hrytsenko, M.O. Lozinskyi, Z.I. Kovalenko; Under the editorship V.P. Black people – Kh.: NfaU Publishing House; Golden Pages, 2003. – 592 p.
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### Additional:

- 1 Zimenkovsky B.S., Muzychenko V.A., Nizhenkovskaya I.V. Biological and bioorganic chemistry. Volume I: - Kyiv: Medicine, 2014: 398p.
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- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

## ***Independent work No. 14***

**Topic**"The influence of the amino group in aromatic amines on the passage of electrophilic substitution (SE) reactions: halogenation, sulfonation, nitration, nitrosation. Sulfanilic acid. Synthesis of streptocide. Sulfanilamide drugs."

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:**Methylamine, dimethylamine, trimethylamine, aniline, toluidines, phenamine.

### Plan

#### **1. Theoretical questions for the lesson:**

1. General characteristics.
2. Isomerism and nomenclature of nitro compounds.
3. Physical and chemical properties.
4. Methods of obtaining.
5. Methods of their identification.

#### **Questions for self-control:**

1. Aniline, its properties, extraction.
2. Zinin's reaction.
3. Chemical and physical-chemical methods of identification of amines.
4. Individual representatives of nitrogenous compounds as drugs (acetanilide, phenatidine, streptocid, etazol, paracetamol, chloramphenicol) and their use as drugs.

#### **Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

#### **2. Practical works (tasks) that will be performed during the lesson:**

1. Zinin's reaction, its meaning.
2. Identification of primary, secondary and tertiary amines.
3. Synthesis of streptocide. Its application.
4. Sulfanilic acid and its derivatives as medicines.
5. Specify the features of the reactivity of diamines.
6. Arrange in descending order the main properties of amines: methylamine, diethylamine, aniline, p-nitroaniline.



7. To propose a method of obtaining p-nitroaniline from benzene.

**3. Test tasks for self-control:** are added

**4. Individual tasks for students on the subject of the lesson.**

1. Synthesis of streptocide.
2. Sulfonamide drugs,
3. Methods of extraction and chemical properties of diamines.
4. Identification of amines.

**5. List of recommended literature.**

**Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.

- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

### *Independent work No. 15*

**Topic**"Diazo-, azo compounds.Physical foundations of color theory. Concept of chromophores and auxochromes. Azo dyes (methyl orange, methyl red), indicator properties.»

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:**Azo coupling reaction. Azo dyes.

#### Plan

##### **1. Theoretical questions for the lesson:**

1. Structure and nomenclature of diazo and azo compounds.
2. Methods of extracting diazonium salts.
3. Reactions of diazo compounds with the release of nitrogen.
4. Reactions without nitrogen release.
5. Azo coupling reactions. Azo dyes.

##### **Questions for self-control:**

1. Physical foundations of color theory: chromophores and auxochromes.
2. Chemical classification of dyes. Color change depending on the pH of the medium.
3. Azo dyes are indicators. Methyl orange.
4. Methyl red.

##### **Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

##### **2. Practical works (tasks) that will be performed during the lesson:**

1. What is the difference between azo and diazo compounds?
2. What properties do diazonium salts exhibit?
3. Why are diazonium salts not isolated in crystalline form?
4. What dyes do you know?

5. The advantage of azo dyes over dyes of other classes?
6. How do auxochromes affect color?
7. What is the role of chromophores, what is their structure?

**3. Test tasks for self-control:** are added

**4. Individual tasks for students on the subject of the lesson.**

1. Azo dyes as indicators and their use in volumetric analysis.
2. Write the structural formulas of compounds: 4-nitrobenzenediazonium nitrate, sodium methylbenzenediazotate, phenyldiazonium chloride.
3. With what compounds do diazonium salts form azo dyes?

**5. List of recommended literature.**

**Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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- 1 Zimenkovsky B.S., Muzychenko V.A., Nizhenkovskaya I.V. Biological and bioorganic chemistry. Volume I: - Kyiv: Medicine, 2014: 398p.
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  - 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

### ***Independent work No. 16***

**Topic**"Alcohol. Peculiarities of the chemical behavior of polyatomic alcohols. Unsaturated alcohols. Prototropic tautomerism of enols. Eltekov's rule. All alcohols. Chemical properties of amino alcohols as bifunctional compounds. Biologically active alkanolamines (colamine, choline)."

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:**Eltekov's rule. Glycerin. Ethylene glycol.

#### Plan

##### **1. Theoretical questions for the lesson:**

1. Structure, isomerism, nomenclature of monoatomic alcohols.
2. Homologous series of monoatomic alcohols, formation of associates.
3. Chemical properties of alcohols, intermolecular and intramolecular dehydration.

##### **Questions for self-control:**

1. Compare the acid-base properties of mono- and polyhydric alcohols.
2. How to distinguish glycerol from ethylene glycol using qualitative reactions?
3. Unsaturated alcohols and their properties. Eltekov's rule.

##### **Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

##### **2. Practical works (tasks) that will be performed during the lesson:**

1. How does a hydrogen bond affect the physical properties of alcohols?
2. Why does the volume decrease when ethanol is dissolved in water?

3. What is the effect of ethanol on the human body?
4. How to check the purity of medical ether?
5. Qualitative reaction to polyatomic alcohols.

**3. Test tasks for self-control:** are added

**4. Individual tasks for students on the subject of the lesson.**

1. Formation of haloalkanes, esters.
2. Intermolecular and intramolecular dehydration.
3. Oxidation of alcohols.

**5. List of recommended literature.**

**Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
2. General workshop on organic chemistry / V.P. Chernykh, I.S. Hrytsenko, M.O. Lozinskyi, Z.I. Kovalenko; Under the editorship V.P. Black people – Kh.: NfaU Publishing House; Golden Pages, 2003. – 592 p.
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### ***Independent work #17***

**Topic**"Phenols. Reactions of electrophilic substitution: halogenation, sulfonation, nitration, nitrosation. Alkylation. Acylation, azo compound. Carboxylation, hydroxymethylation. Polyatomic phenols. Pyrocatechin. Resorpine. Hydroquinone. Phloroglucin. Pyrogallol. o-, m-, p-aminophenols. Paracetamol. Phenacetin. Norepinephrine.»

**Goal:** get acquainted with the chemical properties of substances.

**Basic concepts:** Alkylation. Carboxylation. Hydroxymethylation.

#### Plan

#### **1. Theoretical questions for the lesson:**

1. Classification, nomenclature and isomerism of phenols;
2. Methods of extracting phenols;
3. Physical and chemical properties of mono- and polyatomic phenols;
4. Extraction methods and chemical properties of aminophenols.
5. Phenol identification reactions.
6. Significance of phenol derivatives in pharmaceutical chemistry.

#### **Questions for self-control:**

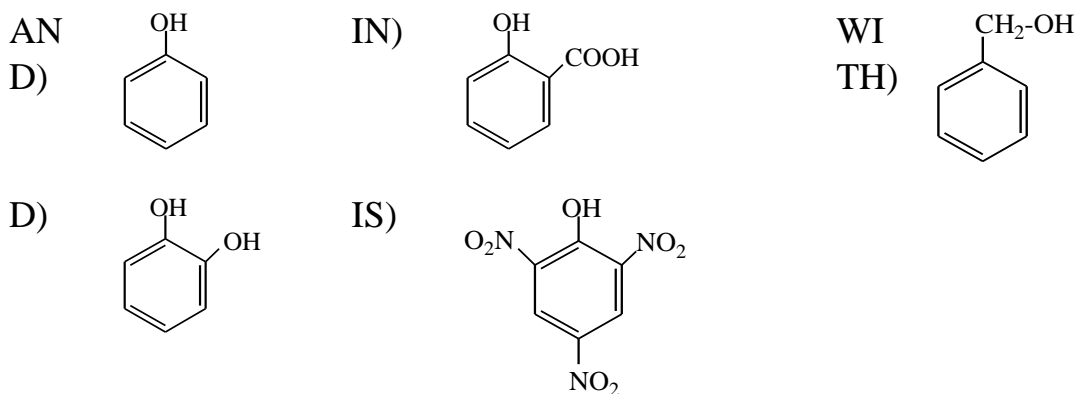
1. Solubility of phenol in water.
2. Proof of acidic properties of phenol.
3. The decomposition of sodium phenoxide under the influence of acid.
4. Protein precipitation with phenol.
5. Color reactions of phenols with iron chloride.

#### **Approximate tasks for processing the theoretical material:**

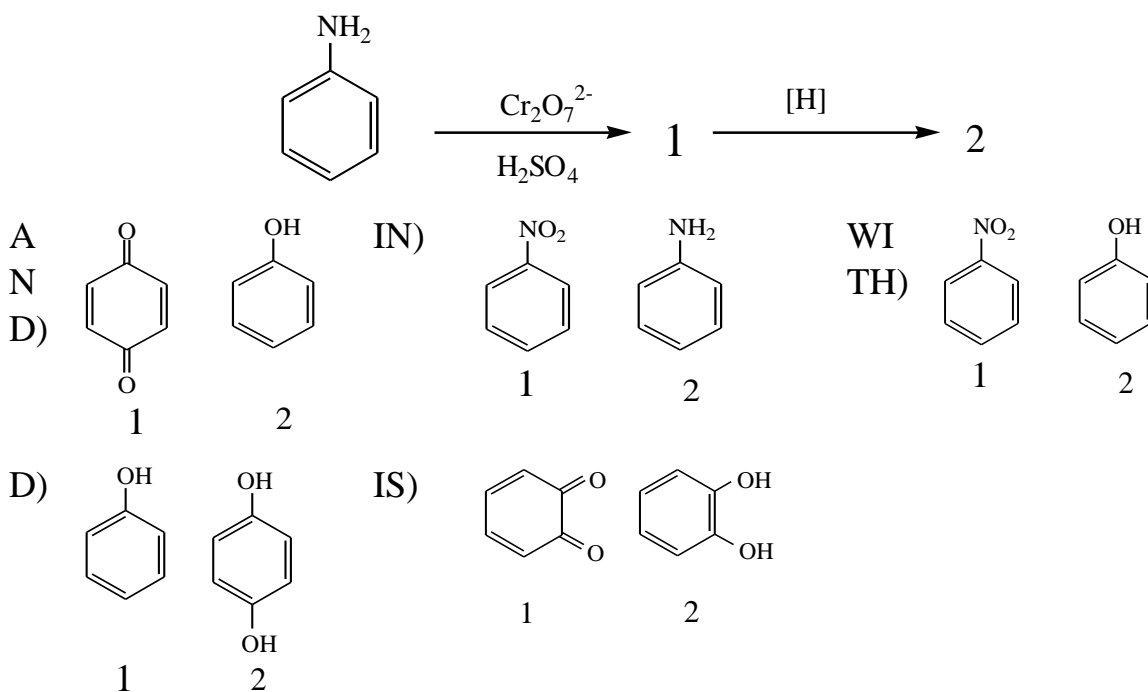
- compile a dictionary of basic concepts on the topic.

#### **2. Practical works (tasks) that will be performed during the lesson:**

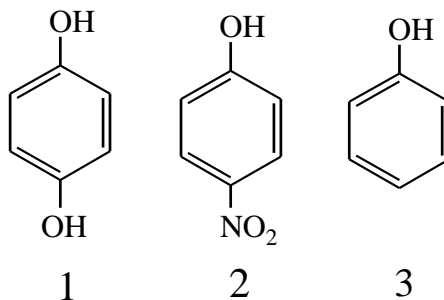
1. Which of the following structures is not phenol?



2. What intermediate and final products are formed during the oxidation of aniline with its subsequent reduction?



3. Substituents in the aromatic nucleus have a significant effect on the acidity of phenols. Arrange the following compounds in order of decreasing acidic properties:



3. Test tasks for self-control: are added

#### 4. Individual tasks for students on the subject of the lesson.

1. O-H bond reactions (formation of phenolates, simple and complex esters).
2. Reactions of electrophilic substitution (SE): halogenation, nitration, nitrosation, sulfonation, alkylation, acylation,

#### 5. List of recommended literature.

##### Main:

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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##### Additional:

- 1 Zimenkovsky B.S., Muzychenko V.A., Nizhenkovskaya I.V. Biological and bioorganic chemistry. Volume I: - Kyiv: Medicine, 2014: 398p.
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- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on



bioorganic and medical chemistry.

### *Independent work No. 18*

**Topic**"Ethers. Formation of oxonium salts. Acidolysis. Diethyl ether. Dioxane. Anisole. Phenetol. Thiols, mercaptans. Oxidation (disulfides, sulfonic acids). Physical and chemical properties of thioesters. Sulfoxides. sulfones Dimexide. Yperite."

**Goal:** get acquainted with the chemical properties of substances.

**Basic concepts:** Thio-alcohols (thiols, mercaptans). Thioethers (sulfides). Dimexide.

#### Plan

#### **1. Theoretical questions for the lesson:**

1. Structure, isomerism, nomenclature.
2. Homologous series.
3. Chemical properties.
4. Medical drugs analogues.

#### **Questions for self-control:**

1. Chemical properties of amino alcohols.
2. Chemical properties of ethers.
3. identification of alcohols, amino alcohols, ethers.
4. Individual representatives, application.

#### **Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

#### **2. Practical works (tasks) that will be performed during the lesson:**

1. Safety techniques when working with ether.
2. Why ethers have a lower boiling point compared to the corresponding alcohols.
3. Write the reaction equation of diethyl ether with HCl; HI; O<sub>2</sub>; H<sub>2</sub>SO<sub>4</sub>(conc).

### **3. Test tasks for self-control:**are added

#### **4. Individual tasks for students on the subject of the lesson.**

1. Identification of ethers.
2. Diethyl ether. Dioxane.
3. Thio-alcohols (thiols, mercaptans). Nomenclature. Mining methods.

#### **5. List of recommended literature.**

##### **Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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- 3 [www.bpci.kiev.ua](http://www.bpci.kiev.ua) is the official website of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.

- 4 www.bioorganica.org.ua is a scientific publication presenting works on bioorganic and medical chemistry.

### *Independent work No. 19*

**Topic**"Hydration of aldehydes. Formation of nagavacetals and acetals. The role of acid hydrolysis in the formation of hemiacetals and acetals. Reactions that take place with the participation of the CH acid center of the  $\alpha$ -carbon atom. Structure of the enolate ion. Keto-enol tautomerism. Halogenation. Iodoform test. Condensation reactions. Synthesis of diamond green. Specific reactions of aldehydes of aliphatic and aromatic series. Concept of dialdehydes and diketones. Quinones. Chemical properties of quinones as  $\alpha,\beta$ -unsaturated ketones."

**Goal:** get acquainted with the chemical properties of substances.

**Basic concepts:** Keto-enol tautomerism. Iodoform test. Quinones.

#### Plan

##### **1. Theoretical questions for the lesson:**

1. Electronic structure of the carbonyl group and the influence of various factors on it.
2. Reaction prices in molecules of aldehydes and ketones of the aliphatic series.
3. Structure and classification of carbonyl compounds.
4. Isomerism and nomenclature of aldehydes and ketones of the aliphatic series.
5. Chemical properties of aldehydes and ketones of the aliphatic series

##### **Questions for self-control:**

1. Reactions of electrophilic and nucleophilic addition and substitution.
2. Specific reactions of aldehydes of the aliphatic series.
3. Identification reactions of aldehydes and ketones of the aliphatic series.
4.  $\alpha$ -,  $\beta$ -unsaturated cyclic diketones, their properties and preparation.
5. Characteristics of individual representatives of aldehydes and ketones of the aliphatic series and their derivatives - medical preparations.

##### **Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

## **2. Practical works (tasks) that will be performed during the lesson:**

1. What is the difference in the chemical properties of aldehydes and ketones of the aliphatic series?
2. Write the formulas of pentanal and pentanone isomers. Give names.
3. Why are ketones not subjected to the oxidation reaction?
4. How is formalin stored? Why?
5. Who first received and established the formula of urotropin?
6. Write the formula of urotropin, give its chemical name.
7. Where did the name "aldehyde" come from? What two words does it consist of?

## **3. Test tasks for self-control:are added**

## **4. Individual tasks for students on the subject of the lesson.**

1. Write a scheme for obtaining caprolactan from phenol.
2. The substance  $C_7H_8O$  does not give color with  $FeCl_3$  solution, does not dissolve in alkalis, and upon oxidation gives benzoic acid. What is the formula of this substance?
3. How can aliphatic aldehydes and ketones be obtained?
4. Reactions of "silver mirror" and "copper mirror"?, examples.

## **5. List of recommended literature.**

### **Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
2. General workshop on organic chemistry / V.P. Chernykh, I.S. Hrytsenko, M.O. Lozinskyi, Z.I. Kovalenko; Under the editorship V.P. Black people – Kh.: NfaU Publishing House; Golden Pages, 2003. – 592 p.
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5. Grandberg I.O., Nam N.L. Organic chemistry. Textbook for universities. - K.: Drofa, 2009. - 375 p. 6. State Pharmacopoeia of Ukraine. - 1st ed., Addendum 3. -

Kh.: State enterprise "Ukrainian Scientific Pharmacopoeia Center for the Quality of Medicinal Products", 2009. - 280 p.

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8. State Pharmacopoeia of Ukraine. – 1st ed., Addendum 1. – Kh.: RIREG, 2004. – 494 p.

9. State Pharmacopoeia of Ukraine. - 1st edition. - Kh.: RIREG, 2001. - 556 p.

**Additional:**

- 1 Zimenkovsky B.S., Muzychenko V.A., Nizhenkovskaya I.V. Biological and bioorganic chemistry. Volume I: - Kyiv: Medicine, 2014: 398p.
- 2 Stoker, HS (2001). Organic and biological chemistry. Houghton Mifflin. 556

**Information resources:**

- 1 [www.ncbi.nlm.nih.gov/PubMed](http://www.ncbi.nlm.nih.gov/PubMed) – free access to the scientific database in the field of biomedical sciences.
- 2 <https://pubchem.ncbi.nlm.nih.gov/> free access to the scientific database in the field of biomedical sciences.
- 3 [www.bpci.kiev.ua](http://www.bpci.kiev.ua) is the official website of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.
- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

*Independent work No. 20*

**Topic**"Unsaturated carboxylic acids. Addition of hydrogen halides against Markovnikov's rule in a series of  $\alpha,\beta$ -unsaturated acids. Aromatic carboxylic acids. Orienting action of the carboxyl group in SE reactions.»

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:**CH-acidity. Reaction centers. Malonov Ether.

Plan

**1. Theoretical questions for the lesson:**

1. Classification of acids. Saturated and unsaturated, monobasic and polybasic, aromatic acids.

2. Influence of the nature of the substituents in the radical on the reactivity of acids.

3. Effect of the carboxyl group on the hydrocarbon radical. CH-acidity of the  $\alpha$ -carbon atom.
4. Addition to  $\alpha$ - and  $\beta$ -unsaturated acids.
5. Benzoic acid, its derivatives and their applications.

**Questions for self-control:**

1. How can formic acid be oxidized?
2. What monobasic carboxylic acids give the "silver mirror" reaction?
3. Qualitative reactions to monobasic carboxylic acids.
4. List the use of acetic acid.
5. Is the name "formic alcohol" correct, what is its composition and where is it used?
6. What is stearin, where is it used?
7. What is the role of carboxylic acids in the Krebs cycle?

**Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

**2. Practical works (tasks) that will be performed during the lesson:**

1. What reaction can be used to distinguish unsaturated from saturated acids?
2. List the medical preparations on this topic.
3. How to experimentally distinguish formic acid from acetic acid?
4. Salts of monocarboxylic acids, their solubility.
5. Write the formulas of known higher fatty acids. Specify their names and applications.

**3. Test tasks for self-control:are added**

**4. Individual tasks for students on the subject of the lesson.**

1. Chemical properties of acids: formation of salts, ethers, anhydrides, halogen derivatives, halogen anhydrides, amides, nitriles.
2. Chemical and physical methods of identification of carboxylic acids.

3. Individual representatives, their characteristics and medical and biological significance.

## 5. List of recommended literature.

### Main:

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
2. General workshop on organic chemistry / V.P. Chernykh, I.S. Hrytsenko, M.O. Lozynskiy, Z.I. Kovalenko; Under the editorship V.P. Black people – Kh.: NfaU Publishing House; Golden Pages, 2003. – 592 p.
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- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

## *Independent work No. 21*

**Topic**"Dicarboxylic acids. CH-acidity of malonic ether, structure of its carb anion. Syntheses of carboxylic acids based on malonic ether.»

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:**CH-acidity. Reaction centers. Malonov Ether.

#### Plan

##### **1. Theoretical questions for the lesson:**

1. General characteristics of dicarboxylic acids.
2. Homologous series of saturated dicarboxylic acids.
3. Saturated dicarboxylic acids, their structure, isomerism and nomenclature.
4. Oxalic acid, its salts.
5. Unsaturated dicarboxylic acids. Cis and trans isomers. Maleic and fumaric acids.

##### **Questions for self-control:**

1. How are dicarboxylic acids different from monocarboxylic acids?
2. Salts of which acids form "stones" in the body?
3. How to prepare a 2N solution of oxalic acid in a volume of 0.5 dm<sup>3</sup>? Make calculations.
4. What are soluble oxalates?
5. Which vegetables and fruits contain the most oxalic acid.
6. Phthalic anhydride. Phenolphthalein, its use as an indicator in volumetric analysis.
7. Phenolphthalein, its pharmacological action and application.

##### **Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

##### **2. Practical works (tasks) that will be performed during the lesson:**

1. Special chemical properties of dicarboxylic acids.
2. Derivatives of dicarboxylic acids, their use in organic synthesis.
3. Dicarboxylic acids and their derivatives as medicinal products.
4. How does the strength of dicarboxylic acids change as their molecular weight increases.



### **3. Test tasks for self-control:**are added

#### **4. Individual tasks for students on the subject of the lesson.**

1. Dicarboxylic acids in nature, their biological role.
2. Special chemical properties of oxalic acid.

#### **5. List of recommended literature.**

##### **Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

## *Independent work No. 22*

**Topic**"Complex ethers. Mechanism of acid and alkaline hydrolysis of esters. Transesterification. Ammonolysis of esters. Essential natural higher fatty acids. Properties of fats (hydrolysis, hydrogenation, oxidation). Analytical characteristics of fats (iodine number, saponification number). Soaps and their properties. Synthetic soap substitutes.»

**Goal:** get acquainted with the chemical properties of substances.

**Basic concepts:** Esterification reaction. Saponification of fats. Analytical characteristics.

### Plan

#### **1. Theoretical questions for the lesson:**

1. Complex esters - esters. Esterification reaction, its mechanism.
2. Lipids, their classification and biological significance.
3. Simple lipids. waxes
4. Fats, their composition and properties. Fat oxidation products.
5. Saponification of fats and their hydrolysis. Soap, synthetic detergents (SMZ).
6. Fat hydrogenation. Artificial fats.
7. Analytical characteristics (saponification number, iodine number).

#### **Questions for self-control:**

Write the formation reactions:

- 1) glycerol trinitrate;
- 2) isopropyl ester of butyric acid, indicating the mechanism by which the reaction takes place;
- 3) formation of biuret.

#### **Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

#### **2. Practical works (tasks) that will be performed during the lesson:**

1. How do soaps differ from synthetic detergents?
2. What is iodine number, what does it determine?
3. Saponification number, its essence and method of determination.
4. Tweens, their use in pharmacy.
5. Fruit essences, their composition and production.

### 3. Test tasks for self-control:are added

#### 4. Individual tasks for students on the subject of the lesson.

1. The advantage of synthetic detergents over soaps.
2. Medical soap; lead patch, their use.
3. Qualitative reactions to different oils.

#### 5. List of recommended literature.

##### Main:

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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- 3 [www.bpci.kiev.ua](http://www.bpci.kiev.ua) is the official website of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of

Ukraine.

- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

### ***Independent work No. 23***

**Topic**"Conversion of halocarboxylic acids into hydroxy and amino acids. Specific reactions of  $\alpha,\beta,\gamma$ -hydroxy acids. Lactic, hydroxycinnamic, tartaric, malic, citric acids. Pharmaceutical use of lactic and citric acids and their salts. Salicylic acid. Medicines (methyl-, phenylsalicylates, acetylsalicylic acid, sodium salicylate, salicylamide, oxaphenamide). p-Aminosalicylic acid. Gallic acid. Ideas about tanning compounds."

**Goal:** get acquainted with the chemical properties of substances.

**Basic concepts:** Kolbe-Schmidt reaction. Lactides. Lactones.

#### Plan

##### **1. Theoretical questions for the lesson:**

1. Isomerism, nomenclature and preparation of hydroxy- and phenolic acids.
2. Chemical properties of hydroxy and phenolic acids, their relation to heating.
3. Properties of salicylic acid. Its derivatives as medical preparations.
4. Tautomerism and double reactivity of acetoacetic ether

##### **Questions for self-control:**

1. Methods of identification of heterofunctional carboxylic acids.
2. Heterofunctional carboxylic acids and their derivatives as drugs.
3. Qualitative reaction to salicylic acid.

##### **Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

##### **2. Practical works (tasks) that will be performed during the lesson:**

1. What are phenolic acids, what properties do they exhibit?
2. Qualitative reaction to salicylic acid.
3. How to prepare a 2N lactic acid solution? Make calculations.

4. Derivatives of salicylic acid as medicine.
5. How to check the benign quality of aspirin?
6. What are citrates? Where is sodium citrate used?

### **3. Test tasks for self-control:are added**

#### **4. Individual tasks for students on the subject of the lesson.**

1. What is the pharmacological action of acetylsalicylic acid?
2. What products are formed during the hydrolysis of acetylsalicylic acid?
3. Use of citric acid in the food industry.

#### **5. List of recommended literature.**

##### **Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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- 2 <https://pubchem.ncbi.nlm.nih.gov/> free access to the scientific database in the field of biomedical sciences.
- 3 [www.bpci.kiev.ua](http://www.bpci.kiev.ua) is the official website of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.
- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

### *Independent work No. 24*

**Topic** "Syntheses of carboxylic acids and ketones based on acetoacetic ether. Aldehyde and keto acids. Medicinal preparations, derivatives of p-aminobenzoic acid: anesthesin, novocaine, novocaineamide. Peptides. Electronic and spatial structure of a peptide bond. Biuret test. Methods of determining the amino acid sequence of peptides."

**Goal:** get acquainted with the chemical properties of substances.

**Basic concepts:** Biuret and cysteine reactions. Aldo acids. Keto acids.

#### Plan

**1. Theoretical questions for the lesson:**

1. Oxoacids. Nomenclature. Mining methods.
2. Specific properties of oxoacids due to the mutual influence of functional groups.
3. Synthesis, tautomerism and double reactivity of acetoacetic ether.
4. Syntheses of carboxylic acids and ketones based on acetoacetic ether.
5. Amino acids. Nomenclature, extraction methods.
6. Chemical properties. Amphoteric nature of amino acids.

**Questions for self-control:**

1. Tautomerism and double reactivity of acetoacetic ether.
2. Methods of identification of heterofunctional carboxylic acids.
3. Aldo acids, their properties.
4. Keto acids and their properties.
5. Heterofunctional carboxylic acids and their derivatives as drugs

### **Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

### **2. Practical works (tasks) that will be performed during the lesson:**

1. Write the formulas of monoaminocarboxylic, monodiaminocarboxylic and diaminodicarboxylic acids. Give a name.
2. Why does glycine not work on litmus?
3. What amino acids are used in medicine?
4. Which amino acids show acidic and which basic properties?
5. What amino acids are used in the food industry?

### **3. Test tasks for self-control:are added**

### **4. Individual tasks for students on the subject of the lesson.**

1. The essence of the protein coagulation reaction.
2. How to distinguish natural fabric from synthetic?
3. Protein precipitation reactions.
4. Xanthoprotein, biuret and cysteine reactions to proteins.

### **5. List of recommended literature.**

#### **Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

***Independent work No. 25***

**Topic**"Functional derivatives of sulfonic acids (ethers, amides, chlorides). Derivatives of carbonic acid. Properties of urea (urea): hydrolysis, formation of salts, interaction with nitrous acid and hypobromites. Guanidine, basic properties. Guanidine fragment in biologically active compounds (arginine, streptidine)."

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:**Urea. Phosgene. Carbamic acid.

Plan

**1. Theoretical questions for the lesson:**

1. Sulfonic acids. Nomenclature. Mining methods. Physical properties. The structure of the sulfo group. Chemical properties.
2. Acidity of sulfonic acids. The formation of salts.
3. Functional derivatives of sulfonic acids (ethers, amides, anhydrides).
4. Carbonic acid and its functional derivatives.



5. Carbonic acid chlorides (chlorformic acid, phosgene), ethers (urethanes), amides (carbamic acid, urea).
6. Guanidine, main properties. Guanidine fragment in biologically active compounds (arginine, streptidine).

**Questions for self-control:**

1. Carbonic acid salts, their names.
2. Carbonic acid chlorides.
3. Carbonic acid amides.
4. Urea is a product of nitrogen metabolism.

**Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

**2. Practical works (tasks) that will be performed during the lesson:**

1. Carbonic acid salts, their names.
2. Carbonic acid chlorides.
3. Carbonic acid amides.
4. Calculate the pH of a 0.01N solution of carbonic acid.
5. What are ureides and urethanes, their pharmacological action.

**3. Test tasks for self-control:are added**

**4. Individual tasks for students on the subject of the lesson.**

1. Use of urea in industry in agriculture.
2. Calculate the pH of a 0.01N solution of carbonic acid.
3. What are ureides and urethanes, their pharmacological action.

**5. List of recommended literature.**

**Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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**Information resources:**

- 1 [www.ncbi.nlm.nih.gov/PubMed](http://www.ncbi.nlm.nih.gov/PubMed) – free access to the scientific database in the field of biomedical sciences.
- 2 <https://pubchem.ncbi.nlm.nih.gov/> free access to the scientific database in the field of biomedical sciences.
- 3 [www.bpci.kiev.ua](http://www.bpci.kiev.ua) is the official website of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.
- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

***Independent work No. 26***

**Topic** "Three- and four-membered heterocycles with one heteroatom. Aromaticity of heterocyclic compounds. Acid-base properties.»

**Goal:** get acquainted with the chemical properties of substances.

**Basic concepts:** Oxirane, aziridine, oxetane, azetidine.

Plan

**1. Theoretical questions for the lesson:**

1. Aromaticity of heterocycles. Addition and substitution reactions.
2. Acid-base properties of heterocycles.
3. Comparative properties of 3- and 4-membered heterocycles.

4. Derivatives of these cycles as medicine.

**Questions for self-control:**

1. Structure and biological significance of heterocyclic compounds.
2. Classification of heterocyclic compounds.
3. Nomenclature of heterocyclic compounds, their isomerism.

**Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

**2. Practical works (tasks) that will be performed during the lesson:**

1. 3-membered heterocycles with one heteroatom.
2. 4-membered heterocycles with one heteroatom.
3. Oxygen heterocycles, their properties.
4. Nitrogen heterocycles. Their structure and properties.

**3. Test tasks for self-control:are added**

**4. Individual tasks for students on the subject of the lesson.**

1. Addition reactions (AN) by cycle break point.
2. Reactions of aziridine and azetidione as secondary amines.

**5. List of recommended literature.**

**Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
2. General workshop on organic chemistry / V.P. Chernykh, I.S. Hrytsenko, M.O. Lozinskyi, Z.I. Kovalenko; Under the editorship V.P. Black people – Kh.: NfaU Publishing House; Golden Pages, 2003. – 592 p.
3. Biological and bioorganic chemistry: teaching. study guide universities/A.A. Mardashko, L.M. Myronovych, G.F. Stepanov. - K.: Caravella, 2008. - 248 p.
4. Chernykh V.P. Lectures on organic chemistry - Kh.: NFaU; Golden Pages, 2005. - 480 p.
5. Grandberg I.O., Nam N.L. Organic chemistry. Textbook for universities. - K.: Drofa, 2009. - 375 p. 6. State Pharmacopoeia of Ukraine. - 1st ed., Addendum 3. - Kh.: State enterprise "Ukrainian Scientific Pharmacopoeia Center for the Quality of Medicinal Products", 2009. - 280 p.

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9. State Pharmacopoeia of Ukraine. - 1st edition. - Kh.: RIREG, 2001. - 556 p.

**Additional:**

- 1 Zimenkovsky B.S., Muzychenko V.A., Nizhenkovskaya I.V. Biological and bioorganic chemistry. Volume I: - Kyiv: Medicine, 2014: 398p.
- 2 Stoker, HS (2001). Organic and biological chemistry. Houghton Mifflin. 556

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***Independent work No. 27***

**Topic**"Porphine as a stable tetrapyrrole aromatic system. Metalloporphins. Hem. Chlorophyll. Vitamin VI2. Indoxyl. Indigo. Indigo carmine. Tryptophan. Serotonin.  $\beta$ -Indolylacetic acid. Indomethacin.»

**Goal:** get acquainted with the chemical properties of substances.

**Basic concepts:** Chlorophyll. Vitamin VI2. Indoxyl. Indigo.

Plan

**1. Theoretical questions for the lesson:**

1. General characteristics of 5-membered heterocycles with one heteroatom, numbering and position of carbon atoms.
2. Pyrrole derivatives. Their biological significance.
3. Derivatives of furan and thiophene.
4. 5-membered heterocycles with two heteroatoms, their structure and properties.

5. Pyrazolone-5, its synthesis and properties.

**Questions for self-control:**

1. Pyrazolone-5 derivatives, their pharmacological action.
2. Antipyrine, its synthesis and application.
3. Amidopyrin, its structure, properties, application.
4. Sulfoamidopyrine, its solubility. Analgin, its pharmacological action.
5. Thiazole and imidazole derivatives as drugs.

**Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

**2. Practical works (tasks) that will be performed during the lesson:**

1. Hemoglobin and its role in the body. Respiratory poisons.
2. Chlorophylls and their role in photosynthesis.
3. Vitamin B-12, its structure and biological role.
4. Indole is a condensed heterocyclic system, its composition and properties.
5. Tryptophan, serotonin,  $\beta$ -indolylacetic acid. Indomethacin.

**3. Test tasks for self-control:are added**

**4. Individual tasks for students on the subject of the lesson.**

1. Cubic dyes, their use in volumetric analysis.
2. In what does indigo dissolve well?

**5. List of recommended literature.**

**Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
2. General workshop on organic chemistry / V.P. Chernykh, I.S. Hrytsenko, M.O. Lozinskyi, Z.I. Kovalenko; Under the editorship V.P. Black people – Kh.: NfaU Publishing House; Golden Pages, 2003. – 592 p.
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- 1 Zimenkovsky B.S., Muzychenko V.A., Nizhenkovskaya I.V. Biological and bioorganic chemistry. Volume I: - Kyiv: Medicine, 2014: 398p.
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- 3 [www.bpci.kiev.ua](http://www.bpci.kiev.ua) is the official website of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.
- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

***Independent work No. 28***

**Topic**"Azoles. Acid-base properties. Medicines. Thiazolidine is a structural fragment of penicillin antibiotics.»

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:** Azoles. Azole tautomerism. Penicillin antibiotics.

Plan

**1. Theoretical questions for the lesson:**

1. General characteristics of 5-membered heterocycles with two heteroatoms, numbering and position of carbon atoms.
2. Pyrazole derivatives. Their biological significance.
3. Derivativesimidazole.
4. Thiazole derivatives.
5. Pyrazolone-5, its synthesis and properties.

**Questions for self-control:**

1. Pyrazolone-5 derivatives, their pharmacological action.
2. Antipyrine, its synthesis and application.
3. Amidopyrin, its structure, properties, application.
4. Analgin, its pharmacological effect.

**Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

**2. Practical works (tasks) that will be performed during the lesson:**

1. 5-membered heterocycles with two heteroatoms, their structure and properties.
2. Pyrazolone-5, its synthesis and properties.
3. Pyrazolone-5 derivatives, their pharmacological action.
4. Antipyrine, its synthesis and application.
5. Amidopyrin, its structure, properties, application.

**3. Test tasks for self-control:are added**

**4. Individual tasks for students on the subject of the lesson.**

1. Sulfoamidopyrine, its solubility.
2. Thiazole and imidazole derivatives as drugs.
3. Antipyrine synthesis.

**5. List of recommended literature.**

**Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.

2. General workshop on organic chemistry / V.P. Chernykh, I.S. Hrytsenko, M.O. Lozinskyi, Z.I. Kovalenko; Under the editorship V.P. Black people – Kh.: NfaU Publishing House; Golden Pages, 2003. – 592 p.
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- 1 Zimenkovsky B.S., Muzychenko V.A., Nizhenkovskaya I.V. Biological and bioorganic chemistry. Volume I: - Kyiv: Medicine, 2014: 398p.
- 2 Stoker, HS (2001). Organic and biological chemistry. Houghton Mifflin. 556

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- 3 [www.bpci.kiev.ua](http://www.bpci.kiev.ua) is the official website of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.
- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

***Independent work No. 29***

**Topic**"Azines: pyridine, quinoline, isoquinoline. Acridine. Nomenclature, structure, aromaticity. Alkylpyridinium ion and its reduction by hydride ion as the basis of the action of the redox coenzyme NAD+."

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:**Quinoline. Acridine. Piranha



## Plan

### 1. Theoretical questions for the lesson:

1. Picolines, their oxidation.
2. Pyridine acids.
3. Nicotinic acid, its derivatives.
4. Isonicotinic acid derivatives.

### Questions for self-control:

1. Nicotinic acid, its strength and chemical properties.
2. Isonicotinic acid's strength and chemical properties.
3. Derivatives of isonicotinic acid's chemical properties.

### Approximate tasks for processing the theoretical material:

- compile a dictionary of basic concepts on the topic.

### 2. Practical works (tasks) that will be performed during the lesson:

1. How and from what can pyridine be obtained?
2. Pyridine derivatives and their use.
3. Picolines, their oxidation.

### 3. Test tasks for self-control: are added

### 4. Individual tasks for students on the subject of the lesson.

1. What are pyridine bases, what is their structure and biological role?
2. What is the difference between pyridine and benzene.
3. Compare the properties of both substances.

### 5. List of recommended literature.

#### Main:

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
2. General workshop on organic chemistry / V.P. Chernykh, I.S. Hrytsenko, M.O. Lozinskyi, Z.I. Kovalenko; Under the editorship V.P. Black people – Kh.: NfaU Publishing House; Golden Pages, 2003. – 592 p.

3. Biological and bioorganic chemistry: teaching. study guide universities/A.A. Mardashko, L.M. Myronovych, G.F. Stepanov. - K.: Caravella, 2008. - 248 p.
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5. Grandberg I.O., Nam N.L. Organic chemistry. Textbook for universities. - K.: Drofa, 2009. - 375 p.
6. State Pharmacopoeia of Ukraine. - 1st ed., Addendum 3. - Kh.: State enterprise "Ukrainian Scientific Pharmacopoeia Center for the Quality of Medicinal Products", 2009. - 280 p.
7. State Pharmacopoeia of Ukraine. - 1st ed., Addendum 2. - Kh.: State enterprise "Scientific-expert pharmacopoeial center", 2008. - 620 p.
8. State Pharmacopoeia of Ukraine. - 1st ed., Addendum 1. - Kh.: RIREG, 2004. - 494 p.
9. State Pharmacopoeia of Ukraine. - 1st edition. - Kh.: RIREG, 2001. - 556 p.

**Additional:**

- 1 Zimenkovsky B.S., Muzychenko V.A., Nizhenkovskaya I.V. Biological and bioorganic chemistry. Volume I: - Kyiv: Medicine, 2014: 398p.
- 2 Stoker, HS (2001). Organic and biological chemistry. Houghton Mifflin. 556

**Information resources:**

- 1 [www.ncbi.nlm.nih.gov/PubMed](http://www.ncbi.nlm.nih.gov/PubMed) – free access to the scientific database in the field of biomedical sciences.
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- 3 [www.bpci.kiev.ua](http://www.bpci.kiev.ua) is the official website of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.
- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

***Independent work #30***

**Topic**"8-Hydroxyquinoline. Complexing ability and application in medicine. Quinoxol. Nitroxoline (5-NOK).Heterocycles of the pyran group. Benzopyrones. Flavanoids. Tocopherol (vitamin E)."

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:** Scroup synthesis, Bischler-Napiralsky reaction.

Plan

### **1. Theoretical questions for the lesson:**

1. Structure of molecules of 6-membered heterocycles with one heteroatom.
2. Acridine as an aromatic compound, its properties and extraction.
3. Structure and properties of quinoline homologues.
4. Piranhas, their structure and properties.

### **Questions for self-control:**

1. Quinoline and its derivatives.
2. Acridine and its derivatives.
3. Pirans, pyrones, their structure and properties. coumarin, its derivatives.
4. Medico-biological significance of drugs based on these heterocycles.

### **Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

### **2. Practical works (tasks) that will be performed during the lesson:**

1. Quinoline and its derivatives.
2. Acridine and its derivatives.
3. Pyrons, their structure and properties.
4. Coumarin, its derivatives.
5. Medico-biological significance of drugs based on these heterocycles.

### **3. Test tasks for self-control:are added**

### **4. Individual tasks for students on the subject of the lesson.**

1. Preparation, tautomerism and acidic properties of barbituric acid and its derivatives.
2. Properties of pyrimidine bases (uracil, thymine, cytosine).
3. Tautomeric transformations.

### **5. List of recommended literature.**

#### **Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.

2. General workshop on organic chemistry / V.P. Chernykh, I.S. Hrytsenko, M.O. Lozinskyi, Z.I. Kovalenko; Under the editorship V.P. Black people – Kh.: NfaU Publishing House; Golden Pages, 2003. – 592 p.
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4. Chernykh V.P. Lectures on organic chemistry - Kh.: NFaU; Golden Pages, 2005. - 480 p.
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- 1 Zimenkovsky B.S., Muzychenko V.A., Nizhenkovskaya I.V. Biological and bioorganic chemistry. Volume I: - Kyiv: Medicine, 2014: 398p.
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- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

***Independent work No. 31***

**Topic**"Diazines: pyrimidine. Pyrazine, pyridazine. Features of electrophilic substitution reactions.»

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:** Diazepine, benzodiazepine. Tranquilizers. Purine Azole tautomerism

## Plan

### 1. Theoretical questions for the lesson:

1. Phenothiazine derivatives as drugs.
2. Barbiturates, their use.
3. Tautomeric transformations.
4. Phenothiazine: production methods, physical and chemical properties.
5. Properties of pyrimidine bases (uracil, thymine, cytosine).

### Questions for self-control:

1. Preparation, tautomerism and acidic properties of barbituric acid and its derivatives.
2. Can barbituric acid and its derivatives be considered cyclic ureides?
3. Write a scheme for obtaining phenothiazine from gasoline and other necessary reagents.

### Approximate tasks for processing the theoretical material:

- compile a dictionary of basic concepts on the topic.

### 2. Practical works (tasks) that will be performed during the lesson:

1. Carcinogenicity of heterocyclic compounds.
2. List six-membered heterocycles with two heteroatoms.
3. Carry out numbering, indicate the position of atoms in the cycles.
4. Six-membered heterocycles and their derivatives as drugs.

### 3. Test tasks for self-control: are added

### 4. Individual tasks for students on the subject of the lesson.

1. Write a scheme for obtaining phenothiazine from gasoline and other necessary reagents.
2. Write the structural formulas of the following compounds: 1,2-diazine, piperazine, uracil, 2,4,6-trihydroxypyrimidine.

### 5. List of recommended literature.

**Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
2. General workshop on organic chemistry / V.P. Chernykh, I.S. Hrytsenko, M.O. Lozinskyi, Z.I. Kovalenko; Under the editorship V.P. Black people – Kh.: NfaU Publishing House; Golden Pages, 2003. – 592 p.
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- 2 Stoker, HS (2001). Organic and biological chemistry. Houghton Mifflin. 556

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- 3 [www.bpci.kiev.ua](http://www.bpci.kiev.ua) is the official website of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.
- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

***Independent work No. 32***

**Topic** "Carbohydrates Biological significance. The concept of photosynthesis. Fermentation of monosaccharides, their use in industry. Deoxysugars. Amino sugars. D-gluconic, D-galacturonic, D-gluconic acid, calcium gluconate. Ascorbic acid (vitamin C). Neuraminic acid.»

**Goal:** get acquainted with the chemical properties of substances.

**Basic concepts:** Hexoses. Glucose. Fructose.

#### Plan

### 1. Theoretical questions for the lesson:

1. Glycosides, their structure and properties.
2. Formation of glycosides. O-, N-, S-glycosides.
3. Amino sugars.
4. Pentoses. Ribose. Deoxyribose.
5. Hexoses. Glucose. Fructose.
6. Identification of monosaccharides.
7. The main representatives of monosaccharides as medicinal products

### Questions for self-control:

1. Carbohydrates in nature, their role and classification.
2. Structure and stereoisomerism of monosugars.
3. Aldo- and ketopentoses.
4. Cyclic forms of monosaccharides, their conformation.
5. Tautomerism of monosugars, their forms.

### Approximate tasks for processing the theoretical material:

- compile a dictionary of basic concepts on the topic.

### 2. Practical works (tasks) that will be performed during the lesson:

- 1 Oxidation of monosaccharides.
2. Pentose synthesis in laboratory conditions.
3. Reaction of fermentation of monosaccharides (alcoholic, lactic, citric).
4. Which reaction can be used to distinguish glucose from fructose?
5. Qualitative reaction to fructose.
6. Glucose solutions as medicines.

### 3. Test tasks for self-control: are added

#### **4. Individual tasks for students on the subject of the lesson.**

1. Give schemes for the interaction of D-fructose with an excess of phenylhydrazine.

2. Write schemes of sequential reactions for the production of ascorbic acid from D-glucose.

#### **5. List of recommended literature.**

##### **Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.

2. General workshop on organic chemistry / V.P. Chernykh, I.S. Hrytsenko, M.O. Lozinskyi, Z.I. Kovalenko; Under the editorship V.P. Black people – Kh.: NfaU Publishing House; Golden Pages, 2003. – 592 p.

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2 Stoker, HS (2001). Organic and biological chemistry. Houghton Mifflin. 556

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3 [www.bpci.kiev.ua](http://www.bpci.kiev.ua) is the official website of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.

4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on



bioorganic and medical chemistry.

### ***Independent work No. 33***

**Topic**"Homopolysaccharides: starch. Glycogen, cellulose, dextrans (blood substitute "Polyglukin"). Colloidal wool. Collodium, cellophane. Carboxymethylcellulose, their use in medicine. DEAE-Cellulose as ionite. Pectin substances. Heteropolysaccharides.»

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:** Pectin. Colloid. Glycogen.

#### Plan

#### **1. Theoretical questions for the lesson:**

1. Disaccharides in nature, their composition and properties.
2. Restorative disaccharides. Lactose, maltose.
3. Non-reducing disaccharides. Sucrose - chemical composition and arrangement of atoms.
4. The structure of sucrose molecules, its properties and applications.
5. Production of sucrose in industry.
6. Maltose: molecular structure and chemical properties

#### **Questions for self-control:**

1. Inversion of sucrose. Invert sugar.
2. Cellobiose, its composition and biological role.
3. Lactose is milk sugar, its biological role.
4. Relationship of disaccharides to hydrolysis.
5. Detection of hydrolysis products.
6. Tautomerism of reducing disaccharides.

#### **Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

#### **2. Practical works (tasks) that will be performed during the lesson:**

1. Classification of carbohydrates by chemical structure.

2. Aldoses and ketoses, their structure and properties.
3. Natural sources of carbohydrates.
4. Carbohydrate metabolism in the body.
5. Identification of mono-, di- and polysaccharides.
6. Chondroitin sulfates, their composition and biological role.
7. Heparin, its composition and content in the body.

### **3. Test tasks for self-control:are added**

#### **4. Individual tasks for students on the subject of the lesson.**

1. Plant gums, their use in medicine.
2. List the products of starch hydrolysis, indicate their use.
3. Chemical composition of starch. Glycogen (animal starch).

#### **5. List of recommended literature.**

##### **Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
2. General workshop on organic chemistry / V.P. Chernykh, I.S. Hrytsenko, M.O. Lozinskyi, Z.I. Kovalenko; Under the editorship V.P. Black people – Kh.: NfaU Publishing House; Golden Pages, 2003. – 592 p.
3. Biological and bioorganic chemistry: teaching. study guide universities/A.A. Mardashko, L.M. Myronovych, G.F. Stepanov. - K.: Caravella, 2008. - 248 p.
4. Chernykh V.P. Lectures on organic chemistry - Kh.: NFaU; Golden Pages, 2005. - 480 p.
5. Grandberg I.O., Nam N.L. Organic chemistry. Textbook for universities. - K.: Drofa, 2009. - 375 p.
6. State Pharmacopoeia of Ukraine. - 1st ed., Addendum 3. - Kh.: State enterprise "Ukrainian Scientific Pharmacopoeia Center for the Quality of Medicinal Products", 2009. - 280 p.
7. State Pharmacopoeia of Ukraine. - 1st ed., Addendum 2. - Kh.: State enterprise "Scientific-expert pharmacopoeial center", 2008. - 620 p.
8. State Pharmacopoeia of Ukraine. – 1st ed., Addendum 1. – Kh.: RIREG, 2004. – 494 p.
9. State Pharmacopoeia of Ukraine. - 1st edition. - Kh.: RIREG, 2001. - 556 p.

##### **Additional:**

- 1 Zimenkovsky B.S., Muzychenko V.A., Nizhenkovskaya I.V. Biological and

- bioorganic chemistry. Volume I: - Kyiv: Medicine, 2014: 398p.
- 2 Stoker, HS (2001). Organic and biological chemistry. Houghton Mifflin. 556

**Information resources:**

- 1 [www.ncbi.nlm.nih.gov/PubMed](http://www.ncbi.nlm.nih.gov/PubMed) – free access to the scientific database in the field of biomedical sciences.
- 2 <https://pubchem.ncbi.nlm.nih.gov/> free access to the scientific database in the field of biomedical sciences.
- 3 [www.bpci.kiev.ua](http://www.bpci.kiev.ua) is the official website of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.
- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.

***Independent work No. 34***

**Topic**"Squirrels Lipids. Fats»

**Goal:**get acquainted with the chemical properties of substances.

**Basic concepts:**Carbohydrates Polypeptides. Lipids.

Plan

**1. Theoretical questions for the lesson:**

- 1.Nomenclature and production of proteins.
- 2.Chemical properties.
- 3.Protein identification methods.
4. Saponified lipids, their occurrence in nature and classification.
5. Liquid fats, their properties
6. Solid fats, their properties
7. Unsaturated properties of fats.
8. Extraction, properties and nomenclature of fats.

**Questions for self-control:**

1. Biological role of lipids.
2. The effect of fats on the body.
3. The history of the development of research in the field of lipids.

4. Nomenclature of lipids.
5. Biosynthesis of lipids in the body.

**Approximate tasks for processing the theoretical material:**

- compile a dictionary of basic concepts on the topic.

**2. Practical works (tasks) that will be performed during the lesson:**

1. Write the equation of the reactions of  $\alpha$ -alanine that take place with the participation of the carboxyl group.

2. What products are formed when  $\alpha$ ,  $\beta$ ,  $\gamma$  - amino acids are heated? Give the reaction schemes.

3. With which reagent does  $\alpha$ -aminopropionic acid form a blue-violet dye? Write the reaction diagram. What is her name?

4. Write the synthesis schemes of  $\alpha$ -aminobutyric acid from 1)  $\alpha$ -chloropropionic acid; 2) propanal.

5. Write the schemes of deamination and decarboxylation reactions for  $\alpha$ -alanine and  $\alpha$ -aminobutyric acid.

6. Evaluation of the quality of fats.

**3. Test tasks for self-control:** are added

**4. Individual tasks for students on the subject of the lesson.**

1. What amino acids are used in the food industry?
2. The essence of the protein coagulation reaction.
3. Protein precipitation reactions.
4. Xanthoprotein, biuret and cysteine reactions to proteins.

**5. List of recommended literature.**

**Main:**

1. Chernykh V.P., Zimenkovskiy B.S., Hrytsenko I.S. Organic chemistry: In 3 books/ Ed. V.P. Chernykh - Kharkiv.: View of the NfaU; Original, 2008. – 752 p.
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- 2 <https://pubchem.ncbi.nlm.nih.gov/> free access to the scientific database in the field of biomedical sciences.
- 3 [www.bpci.kiev.ua](http://www.bpci.kiev.ua) is the official website of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.
- 4 [www.bioorganica.org.ua](http://www.bioorganica.org.ua) is a scientific publication presenting works on bioorganic and medical chemistry.