S.O. Krasniuk, S.M. Goncharenko

ESP: «PHARMACY»

Educational textbook

THE MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

KYIV NATIONAL UNIVERSITY
OF TECNOLOGIES AND DESIGN

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Recommended by the Academic Council
of Kyiv National University of Technology and Design
for the students of chemical and pharmaceutical technologies faculty,
course of study «English for specific purposes»

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The textbook ESP: "Pharmacy" is needed for the students – future specialists in the field of pharmacy. This textbook provides an important opportunity for students to learn the core concepts of pharmaceutical technologies. At the same time, the textbook includes materials for the following areas of study as chemistry, biotechnology, genetics, biology.

CONTENTS

Part 1. Fundamentals of Pharmacy

Unit 1

Topic: PHARMACEUTICAL EDUCATION

TEXT A
Pharmacy

I. Read and translate the text using the dictionary:

herbalism	травництво
dispensing	дозування
pharmacognosy	фармакогнозія
biologically active additives	біологічно активні добавки
ointment	мазь
injection solution	розчин для ін'єкцій
bioavailability	біодоступність
side effect	побічний ефект
drug counterfeiting	підробка ліків

II. Having read the text decide whether the following sentences are true (T) or false (F). Correct the false ones:

1) Pharmacy began to form in recent times.

2) The history of pharmacy is the history of the search for medicines, their manufacture, standardization and rational use.

3) The secondary goals of pharmacy are to provide society with effective, safe and high-quality medicines that contribute to the preservation and restoration of the health of the population.

4) Pharmacognosy studies the mechanisms of action of drugs on the body, their pharmacodynamics and pharmacokinetics, interactions with other substances, side effects and toxicity.

5) Technology of dosage forms is engaged in the development of optimal forms of delivery of medicinal substances to the body.

6) Pharmacy is a fundamental science with applied significance that provides one of the main needs of humanity - preserving medicines.

Pharmacy has a thousand-year history, which is closely related to the development of medicine, chemistry and natural sciences. As a separate branch of knowledge, it began to form in ancient times, when people tried to use natural

substances to treat diseases. The history of pharmacy is the history of the search for medicines, their manufacture, standardization and rational use. In the process of evolution, pharmacy has transformed from the art of herbalism into a modern interdisciplinary science based on scientific data, technology and innovation.

Pharmacy is a branch of medical science and practice that studies the processes of creation, research, production, storage, quality control, dispensing and use of medicines. As an interdisciplinary science, pharmacy combines knowledge from chemistry, biology, medicine, toxicology, pharmacology, drug technology and management. Its main goal is to provide society with effective, safe and high-quality medicines that contribute to the preservation and restoration of the health of the population.

Pharmacy performs extremely important functions:

Medical and social: ensuring access to medicines, promoting the treatment and prevention of diseases;

Scientific: developing new medicines, studying their effects on the body;

Industrial: manufacturing drugs at pharmaceutical enterprises in accordance with international standards;

Control: ensuring the quality, effectiveness and safety of medicines;

Economic: regulating the circulation of medicines, the pharmaceutical market and the cost of medicines;

Educational: training qualified pharmacists for pharmacies, hospitals, laboratories and industry.

Pharmacy includes a number of interrelated scientific and applied areas:

Pharmaceutical chemistry. This branch studies the chemical structure of medicinal substances, methods of their synthesis, identification, analysis and standardization. Its task is to create new compounds with therapeutic activity and improve existing ones.

Pharmacognosy. Pharmacognosy studies medicines of natural origin (plant, animal, mineral) - their morphology, anatomy, chemical composition, biological activity and methods of preparation. In modern pharmacy, this area is important for the creation of herbal medicines and biologically active additives.

Technology of dosage forms. This discipline is engaged in the development of optimal forms of delivery of medicinal substances to the body (tablets, capsules, ointments, suppositories, injection solutions, etc.), and also studies their stability, bioavailability and production methods.

Pharmacology. Pharmacology studies the mechanisms of action of drugs on the body, their pharmacodynamics and pharmacokinetics, interactions with other substances, side effects and toxicity.

Clinical pharmacy. Clinical pharmacy is a modern direction that studies the rational prescription and use of drugs in medical practice. It is aimed at individualizing pharmacotherapy, increasing its effectiveness and safety.

Organization and economics of pharmacy. This direction analyzes the functioning of the pharmaceutical market, the logistics of drugs, pharmaceutical legislation, pricing, management and marketing in the field of drug circulation.

Modern pharmacy faces a number of challenges: - increasing antibiotic resistance; - the emergence of new infections (COVID-19, new viruses); - the need to create personalized medicines; - the need to develop innovative medicines, including biologics, gene and nanomedical devices; - drug counterfeiting and insufficient control over circulation; - accessibility of medicines for socially vulnerable groups.

Pharmacy is a fundamental science with applied significance that provides one of the main needs of humanity - preserving health. Thanks to the rapid development of sciences, pharmacy is reaching a new level, becoming an integral part of innovative medicine. Its role in the future will only grow, and the training of competent specialists will become a key condition for ensuring the health of the nation.

III. Fill in the gaps with the given words:

biotechnology , law, chemistry, information technologies, medicine

Pharmacy, as an interdisciplinary science, is closely related to other sciences:

With _____ (1) - through pharmacotherapy and interaction with doctors.

With _____ (2) - in the creation of new active substances.

With _____ (3) - in the creation of biopharmaceuticals (insulin, vaccines, monoclonal antibodies).

With _____ (4) - when implementing electronic prescriptions, pharmacy automation, pharmacovigilance.

With _____ (5) - when regulating the circulation of medicines, licensing and certification of production.

IV. Match the words with their definitions:

1) Pharmacogenetics	a) electronic prescriptions, mobile applications, artificial intelligence;
2) Digital pharmacy	b) harmonization of drug standards at the international level.
3) Biotechnological drugs	c) selection of drugs taking into account the genetic characteristics of the patient;
4) Globalization	d) monoclonal antibodies, new generation vaccines

V.Read and translate this information. D o you agree with these opinions? Justify your answer. Expand the answer if you can.

In the future development of pharmacy, we should expect:

- Expanding the use of gene therapy, nanotechnologies, artificial intelligence in the creation of medicines.

- The emergence of personalized medicines based on the patient's genetic analysis.

- Deepening cooperation between pharmacists and doctors within the framework of multidisciplinary medicine.

- Development of pharmaceutical ethics and increasing patients' trust in pharmacists as medical professionals.

VI. Put the following expressions into two columns:

1) knowledge of chemistry, biology, anatomy, pharmacology;
2) pharmacy (retail);
3) knowledge of pharmaceutical legislation, ethics and logistics.
4) skills in preparing and quality control of medicines;
5) public administration in the field of healthcare.
6) scientific research;
7) quality control and laboratory diagnostics;
8) the ability to advise patients on the use of medicines;
9) pharmaceutical production;

A modern pharmacist is not just a seller of medicines in a pharmacy.

A *He/This is a highly qualified specialist who must have:*	**B** *Pharmacists work in such areas as:*

VII. Translate the following sentences into English:

1. Історія фармації є невід'ємною частиною історії людства.

2. Від магічних ритуалів і травників давнини до молекулярної фармакології та біотехнології, фармація пройшла складний, але величний шлях.

3.Сьогодні це одна з ключових наук, що забезпечують здоров'я та якість життя людини.

4. З урахуванням сучасних викликів (пандемії, старіння населення, зростання хронічних захворювань), роль фармації в майбутньому лише зростатиме.

5.Фармація забезпечує суспільство безпечними та ефективними лікарськими засобами, сприяє покращенню якості життя населення та зниженню рівня захворюваності.

6.Як динамічна та високотехнологічна галузь, фармація постійно розвивається, інтегруючи досягнення інших наук та впроваджуючи інновації.

7. Її подальший розвиток є ключовим фактором у боротьбі з глобальними загрозами здоров'ю людини.

VIII. Speak on the topic using these phrases:

The history of pharmacy, mankind, molecular pharmacology, biotechnology, pharmacy, human health, quality of life, modern challenges, pandemics, population aging, growth of chronic diseases, the role of pharmacy in the future.

Text B
Pharmaceutical education in Ukraine

I. Read and translate the text using the dictionary:

integral part	невід'ємна частина
legislative framework	законодавча база
internship	стажування
mentoring	наставництво
insufficient level	недостатній рівень
outdated equipment	застаріле обладнання
safe circulation of medicines	безпечний обіг ліків

Pharmaceutical Education

Pharmaceutical education is an integral part of training personnel for the healthcare system. Pharmaceutical education is a system of training specialists in the field of pharmacy, which includes: theoretical training (general and special disciplines); practical training (work in laboratories, pharmacies, at enterprises); scientific and research activities (participation in research, writing course and diploma theses); ethical and legal education (professional responsibility, legislative framework).

The main goal is to form a competent, responsible, morally and ethical specialist, capable of making independent decisions in professional activities.

Structure of pharmaceutical education

1. Basic level (pre-university)

Medical colleges and pharmaceutical schools.

Training of junior specialists or pharmacists with the qualification of "pharmacist" (for example, for pharmacy establishments).

2. Higher pharmaceutical education

Training in the specialty "Pharmacy, industrial pharmacy" at universities or medical academies. Main educational levels:

Bachelor (4 years) - basic training in the field of pharmacy.

Master (1–1.5 years after bachelor's or 5–5.5 years of integrated education) - full higher education, which gives the right to professional activity.

Internship - practical training for independent work.

Postgraduate / doctoral studies - scientific and pedagogical career, training of scientists.

Main disciplines of pharmaceutical education: biological sciences (anatomy, physiology, microbiology, biochemistry*); c*hemical disciplines (inorganic, organic, analytical, pharmaceutical chemistry); pecialized subjects (pharmacognosy, drug

technology, pharmacology, clinical pharmacy, toxicology, pharmaceutical care, pharmacy organization and economics); social sciences (pharmaceutical law, bioethics, medical psychology).

Current trends in pharmaceutical education:

- Integration with the European educational space: implementation of Bologna process standards, credit-modular system.
- Digitalization of education: electronic platforms, virtual laboratories, distance learning.
- Internationalization: academic mobility of students, international exchange programs.
- Interdisciplinarity: combination of pharmacy with biotechnology, IT, management.
- Continuous professional development: postgraduate education, trainings, seminars, certification.

Pharmaceutical education is impossible without close connection with practice: clinical facilities, pharmacies, laboratories, pharmaceutical production; mentoring by experienced pharmacists forms the professional identity of the student; the introduction of simulation training contributes to the development of clinical thinking.

Pharmaceutical education is the foundation for training qualified specialists who are able to ensure the rational use of medicines, contribute to the preservation of public health and the development of the pharmaceutical industry. The successful functioning of the healthcare system is impossible without competent and responsible pharmacists. Therefore, constant modernization of educational programs, integration of science and practice, development of professional ethics and critical thinking are strategic tasks of modern pharmaceutical education.

II. Having read the text decide whether the following sentences are true (T) or false (F). Correct the false ones:

1) Pharmaceutical education is a system of training specialists in the field of pharmacy.
2) The secondary goals are to form a competent, responsible, morally and ethical specialist, capable of making independent decisions in professional activities.
3) Pharmaceutical education is possible without close connection with practice.
4) The successful functioning of the healthcare system is impossible without competent and responsible pharmacists.
5) Professional ethics and critical thinking are strategic tasks of modern pharmaceutical education.
6) Social sciences in pharmaceutical education are: pharmaceutical law, bioethics, medical psychology.

III. Match the words with their definitions:

1) anatomy	**a)** the study of microorganisms (also known as microbes), which are living organisms too small to be

	seen with the naked eye
2) physiology	**b)** encompasses the scientific and technical methods used in the development, formulation, production, and quality control of drugs
3) biochemistry	**c)** the study of ethical issues that arise in the life sciences, healthcare, and related fields
4) microbiology	**d)** the study of how living organisms, including humans, function
5) drug technology	**e)** the study of medicinal drugs derived from natural sources, including plants, animals, and minerals
6) pharmacognosy	**f)** the study of the structure of living organisms, including their cells, tissues, organs, and organ systems
7) bioethics	**g)** the study of chemical processes within and relating to living organisms

IV.Read and translate this information. Do you agree with this opinion? Justify your answer. Expand the answer if you can.

Problems and prospects of Pharmaceutical education are:

Problems:

Insufficient level of practical training;

Outdated equipment in some educational institutions;

Insufficient connection with the pharmaceutical industry;

Low level of motivation of young people for scientific activity.

Prospects:

Creation of simulation training centers;

Involvement of industrial partners;

Increasing the role of clinical pharmacy in education;

Expanding international cooperation.

V. Make up the sentences with these words and phrases:

the formation of professional knowledge, practical skills, ethical principle, future pharmacists, rapid development of medical science, the pharmaceutical industry, digital technologies, pharmaceutical education, professional improvement, a guarantee, circulation of medicines.

VI. Make up a plan of the text and a summary to cover the topic.

Text C
Basics of pharmaceutical terminology

I. Read and translate the text:

Pharmaceutical terminology is a set of specialized words, terms and concepts used in pharmacy, medicine, biology, chemistry and related sciences to accurately

describe medicinal products, their properties, forms, methods of administration, manufacture and use. The basis of pharmaceutical terminology is words originating from:

- Latin - the main international language of pharmacists and doctors;

Latin is used in pharmaceutical practice for the following reasons: an international standard since antiquity; brevity and accuracy; universality in recipes and annotations; neutrality in countries with different languages.

- Greek - numerous terms from anatomy, botany, pharmacology;
- Ukrainian and English - adapted modern scientific and production concepts;
- chemical and biological nomenclature - systematic names of substances, classes of compounds, etc.

Pharmaceutical terms are divided by areas of use:

1) Drug terms

- Name of active ingredient: *Ibuprofenum, Paracetamolum, Acidum acetylsalicylicum.*
- Trade name (brand): *Nurofen, Panadol, Aspirin*.
- International Nonproprietary Name (INN): official standardized name of the substance according to WHO.

2) Dosage form terms. Denote the physical form in which the drug is manufactured:

- *Tabuletta* — tablet
- *Capsula* — capsule
- *Suppositorium* — suppository (candle)
- *Solutio* — solution
- *Unguentum* — ointment
- *Pulvis* — powder
- *Injectio* — injection

3) Pharmacological terminology. Indicates the mechanism of action or group of drugs:

- *Analgesics* - painkillers
- *Antibiotics* - antimicrobials
- *Antiseptics* - disinfectants
- *Diuretics* - diuretics
- *Antihypertensives* - lower blood pressure
- *Antagonists, agonists, inhibitors, modulators* - by mechanism of action

4) Terms of methods of administration. Denote the routes of administration of drugs into the body:

- *Per os* — through the mouth
- *Intravenosa* (i.v.) — intravenously
- *Intramuscularis* (i.m.) — intramuscularly
- *Subcutanea* (s.c.) — subcutaneously
- *Rectalis* — rectally
- *Topica* — topically
- *Inhalatio* — inhalation

5) Terms of preparation and dosage:

- *Misce (M.)* — mix
- *Da (D.)* — give
- *Signa (S.)* — mark (instructions for the patient)
- *Repetatur* — repeat
- *Ad usum externum* — for external use
- *Ad usum internum* — for internal use
- *Quantum satis* — in sufficient quantity

Terminology in pharmacopoeia and regulatory documents. The State Pharmacopoeia of Ukraine (SPU) is the main standard regulating the terms, quality requirements and methods of analysis of medicinal substances. The pharmacopoeia uses specialized language that defines:

- purity of the substance;
- impurity content;
- permissible deviation limits;
- methods of analysis (e.g. *HPLC, UV spectrophotometry, titration*, etc.).

Drug classification systems. International systems are used to organize terms:

1) ATC classification (Anatomical Therapeutic Chemical) - assigns a code to each drug based on:

- anatomical group (A - digestion, B - blood, C - heart);
- therapeutic action;
- chemical structure.

Example: C09AA05 - *Enalapril*, a drug for the treatment of hypertension.

2) INN (International Nonproprietary Name) - a standardized name of a substance, independent of the brand. In Ukraine, it is maintained by the State Register of Medicinal Products.

II. Come up with 5 questions on the gist of the text and ask your group-mates to answer them.

III. Read and translate this information. Do you agree with this opinion? Justify your answer. Expand the answer if you can.

Professional pharmaceutical vocabulary, current trends:

- introduction of English-language terms in international trade and scientific publications: *Bioequivalence, Clinical trials, GMP, Pharmacovigilance*.
- development of pharmacoinformatics - digital terms: *E-prescription, eHealth, drug interaction checker.*
- increasing importance of interoperability of terms in international standards, especially within the EU.

IV. Match the appropriate from two columns:

The practical significance of pharmaceutical terminology:

1) for a pharmacist	**a)** - a guarantee of the correct manufacture

	of the drug;
2) for a pharmaceutical Technologist	**b) -** unification of documents, certifications, instructions.
3) for a scientist	**c)** - a guarantee of accuracy in the formulation and consultation;
4) for regulatory authorities	**d) -** the possibility of publishing research results at the international level;

V. Make up the sentences with the words and phrases:

pharmaceutical terminology, functioning of the entire healthcare system, to ensure accuracy in the formulation, pharmacotherapy, drug manufacturing, pharmacological supervision, modern trends, specialists, a deep knowledge of terminology, Latin, a sign of professionalism, an element of patient safety, prevention of errors in the manufacture and use of medicines, correct conduct of pharmacotherapy, international scientific and commercial cooperation.

VI. Watch and listen to Marie Curie's life story and present information on the following:

1. What kind of challenging barriers did she face when getting education?
2. Were there any obstacles in her career development? What kind of?
3. How did she acquire her teaching position?
4. What did she become Nobel Laureate in Chemistry for?
5. What is her benefit to humanity?

Unit 2

Topic: BASIC CONCEPTS OF CHEMISTRY. ITS ELEMENTS

TEXT A
Chemistry

I. Read and translate the text using the dictionary:

Matter	матерія
manifestations	прояви
driver	рушійна сила
sustainable development	сталий розвиток
composition of substances	склад речовин
catalysis	каталіз
hydrogen	водень
oxygen	кисень
nitrogen	азот
reaction rates	швидкості реакцій
dispersed systems	дисперсні системи
equilibrium	рівновага
cellular respiration	клітинне дихання

II. Having read the text decide whether the following sentences are true (T) or false (F). Correct the false ones:

1) Chemistry is one of the fundamental natural sciences that studies the composition, structure, properties and transformations of matter
2) In the 20th century, chemistry has acquired a new strategic importance.
3) Without knowledge of chemistry, it is impossible to understand modern trends - from the development of new drugs to the creation of "green" energy sources
4) The second goal of chemistry is to know, model and control chemical processes for use in science, production and everyday life.
5) In General chemistry basic concepts are: atom, molecule, valence, electronic structure, chemical bond.
6) Physical chemistry combines chemistry with biology and physics.

Chemistry is one of the oldest and at the same time the most modern natural sciences. Chemistry is one of the fundamental natural sciences that studies the composition, structure, properties and transformations of matter. It studies matter in

all its manifestations - from atoms and molecules to complex organic systems. Chemistry is not only a fundamental science, but also a practical tool that is actively used in industry, medicine, pharmacy, ecology, the agricultural sector and everyday life. It is a bridge between physics and biology, a basic tool for medicine, pharmacy, ecology, materials science and many other areas of human activity.

In the 21st century, chemistry has acquired a new strategic importance. In the 21st century, chemistry not only remains the basis of modern science, but also becomes a powerful driver of technological progress. It is the basis of innovations that ensure sustainable development: the creation of new materials, safe energy technologies, new generation medicines, environmentally friendly production. Without knowledge of chemistry, it is impossible to understand modern trends - from the development of new drugs to the creation of "green" energy sources. Its achievements determine the future of humanity.

Chemistry studies: - the composition of substances (what elements are included in their composition); - the structure of substances (how exactly atoms are arranged in a molecule or crystal); - properties of substances (physical, chemical, optical, etc.); - regularities of chemical reactions (speed, direction, energy, catalysis); - conditions for the transformation of substances (pressure, temperature, environment).

The objects of Chemistry`s study are: - atoms, molecules, ions; - simple and complex substances; - mixtures, solutions, polymers, colloids.

The main goal of chemistry is to know, model and control chemical processes for use in science, production and everyday life.

Chemistry is an extremely broad field of knowledge, which includes a number of specialized areas:

General chemistry. Basic concepts: atom, molecule, valence, electronic structure, chemical bond. Basic laws: conservation of mass, constancy of composition, Mendeleev's periodic law.

Inorganic chemistry. Studies inorganic substances: metals, oxides, salts, acids, bases. Studies their structure, properties, methods of preparation, chemical reactions.

Organic chemistry. Studies compounds of Carbon, in particular with Hydrogen, Oxygen, Nitrogen and others. Studies the structure, reactions, properties of organic substances, including drugs, polymers, biomolecules.

Physical chemistry. Combines chemistry with physics: studies energy changes (thermochemistry), reaction rates (kinetics), equilibrium, electrochemical processes.

Analytical chemistry. Methods of substance analysis: qualitative (element detection), quantitative (content in %), instrumental (spectroscopy, chromatography).

Biochemistry. Studies chemical processes in living organisms: metabolism, enzymes, DNA, hormones, vitamins, cellular respiration.

Colloidal and polymer chemistry. Study of dispersed systems (gels, emulsions), as well as the synthesis and properties of polymers: plastics, synthetic fibers, composites.

Chemistry as an experimental science uses a variety of research methods:

- Experimental: laboratory experiments, reactions, synthesis of new substances; modeling of processes under various conditions;

- Instrumental: spectroscopy (ultraviolet, infrared, nuclear magnetic); mass spectrometry, chromatography, electrophoresis; microscopy at the atomic level.

- Theoretical: quantum chemistry, thermodynamics, computer modeling of molecules and reactions.

Chemistry is not just the science of substances. It is the language of nature through which a person learns the laws of matter and controls them.

III. Fill in the gaps with the given words:

everyday life, Industry, environmental protection, medicine, agriculture

The role of chemistry in human life

In _____ (1): synthesis of drugs, bioavailability, pharmacodynamics, development of vaccines, contrast agents, antibiotics; research on the biochemistry of diseases, creation of biosensors, test systems.

In _____ (2): production of fertilizers, paints, polymers, fuel, rare earth metals, explosives, cement; metallurgy, food chemistry, household chemicals.

In _____ (3): effective and safe use of pesticides, growth regulators, fertilizers; soil chemistry; product analysis.

In _____ (4): cosmetics, detergents, packaging, preservatives, lighting materials, filters.

In _____ (5): chemical monitoring, pollution analysis; water and air purification, waste processing, bioremediation.

IV. Put the following expressions into appropriate columns:

1) the creation of materials at the atomic level;
2) - enzymatic processes, GMOs, fermentation;
3) - hydrogen fuel, fuel cells, batteries;
4) - superconductors, biocompatible polymers, membranes.

The importance of chemistry in science and technology

Chemistry plays a key role in the development of interdisciplinary areas:

Biotechnology	***nanotechnology***	***new materials***	***energy of the future***

V. Match the words with their definitions:

1) Green chemistry	a) Creation of materials at the level of atoms and molecules (nanoparticles, nanotubes, biocompatible drug carriers).
2) Nanochemistry	b) Hydrogen fuel, fuel cells, CO_2 conversion, new types of batteries.
3) Pharmaceutical chemistry	c) Molecular modeling, substance database, virtual drug screening.
4) Energy chemistry	d) Development of safe and renewable

	processes.Reduction of waste, use of catalysts, environmentally friendly solvents.
5) Information chemistry	e) Aimed at the targeted synthesis of biologically active substances.

VI. Read and translate this information. Do you agree with this opinion? Justify your answer. Expand the answer if you can.

It is important to highlight the Environmental and ethical responsibility of chemistry.

1) Chemistry bears great social responsibility:

- Green chemistry - development of environmentally friendly processes;
- Ethical principles - safe use of substances, rejection of toxic and carcinogenic compounds;
- Reduction of the impact of production - control of harmful emissions, disposal of chemical waste.

2) In the coming decades, chemistry will play a leading role in:

- Ensuring food security;
- Developing new medicines and treatments;
- Switching to environmentally friendly energy sources.

VII. Translate into English:

1) Хімія – це наука, яка лежить в основі багатьох сучасних технологій та відкриттів.
2) Хімія – це не просто наука про речовини. Це мова природи, за допомогою якої людина пізнає закони матерії та керує ними.
3) Знання хімії потрібні кожному – від школяра до інженера, від лікаря до агронома.
4) Її практична цінність безмежна, а потенціал невичерпний.
5) Її значення важко переоцінити, адже вона забезпечує: розвиток медицини; продовольчу безпеку; охорону навколишнього середовища; створення нових матеріалів та джерел енергії.
6) Оволодіння хімією відкриває доступ до розуміння складних процесів навколишнього світу та надає інструменти для його вдосконалення.
7) Майбутнє людства тісно пов'язане з досягненнями хімічної науки. Це ключ до сталого розвитку, інновацій, здоров'я та безпеки.
8) У найближчі десятиліття хімія відіграватиме провідну роль у: - створенні інтелектуальних матеріалів, що реагують на зовнішні умови; промисловій переробці, тобто переробці відходів на нові ресурси.

VIII. Speak on the topic using these phrases:

social responsibility, green chemistry, rejection of toxic and carcinogenic compounds; developing new medicines and treatments, modern technologies and discoveries, understanding the complex processes of the world.

TEXT B
BASIC CONCEPTS OF CHEMISTRY

I. Read and translate the text using the dictionary:

substance	речовина
particle	частинка
retain properties	зберігати властивості
an electron shell	електронна оболонка
compound substances	складні речовини
chemical bonding	хімічний зв'язок
chemical equation	хімічне рівняння
molar mass	молярна маса
mole	моль
combustion	горіння
oxidation	окиснення
reduction	відновлення
decomposition	розкладання
substitution	заміщення
homogeneous mixtures	однорідні суміші
heterogeneous mixtures	гетерогенні суміші

Chemistry is a natural science that studies the composition, structure, properties of substances and chemical transformations. The basic concepts of chemistry form the basis necessary for understanding chemical phenomena, laws and interactions. Mastering these concepts is the foundation for further study of both general and applied chemistry, in particular analytical, organic, inorganic, biochemistry, etc.

Substance and matter. Substance is what all physical objects consist of. It has mass, volume and consists of atoms and molecules. In chemistry, matter is the main object of study. Examples of substances: water (H_2O), table salt (NaCl), oxygen (O_2), gold (Au). Matter is everything that has mass and occupies space. It exists in the form of substances and physical fields.

Atom and molecule. An atom is the smallest chemically indivisible particle of an element that retains its properties. It consists of a nucleus (protons and neutrons) and an electron shell. Proton (p^+): charge +1

Neutron (n^0): charge 0

Electron (e^-): charge -1

Example: a Hydrogen atom (H) has 1 proton and 1 electron.

A molecule is the smallest particle of a substance that retains its chemical properties and consists of two or more chemically bonded atoms.

Example: a water molecule (H_2O) consists of 2 Hydrogen atoms and 1 Oxygen atom.

Chemical element and periodic table. A chemical element is a group of atoms with the same nuclear charge (number of protons). There are more than 100 elements in

the periodic table. For example, carbon (C), iron (Fe), oxygen (O), sodium (Na). The periodic table of elements was created by D. I. Mendeleev. It classifies elements according to their properties, atomic mass, and electronic structure.

Simple substances and Compound substances. Simple substances are formed by atoms of one chemical element. Examples: O_2, H_2, Fe, S_8

Compound substances are formed by atoms of two or more different elements.

Examples: H_2O, CO_2, NaCl, H_2SO_4

Chemical bonding. A chemical bond is an interaction between atoms that unites them into molecules or crystals. Types of chemical bonds:

- Covalent bond - a shared pair of electrons (H_2, Cl_2).
- Ionic bond - the transfer of an electron from one atom to another (NaCl).
- Metallic bond - between positive metal ions and a "cloud" of electrons.
- Hydrogen bond - a weak bond between molecules (water, DNA).

Chemical formula and chemical equation. A chemical formula indicates the qualitative and quantitative composition of a molecule or substance.

Examples: H_2O — 2 atoms of Hydrogen, 1 — of Oxygen

CO_2 — 1 atom of Carbon, 2 — of Oxygen

NaCl — 1 atom of Sodium, 1 — of Chlorine

A chemical equation shows the course of a chemical reaction using the formulas of substances. Example: $2H_2 + O_2 \rightarrow 2H_2O$ (the reaction of hydrogen combustion with the formation of water)

Quantitative concepts of chemistry. Atomic mass: the relative mass of an atom compared to 1/12 of the mass of a Carbon-12 atom. For example: H = 1, O = 16,

Na = 23

Molar mass: the mass of one mole of a substance (g/mol), numerically equal to the relative molecular mass.

Mole: the amount of a substance containing 6.022×10^{23} particles (atoms, molecules). This number is called Avogadro's number.

1 mol H_2O = 18 g = 6.022×10^{23} molecules

Mixtures and substances. Pure substances: consist of one type of particle (atoms or molecules).For example: H_2O, O_2, NaCl

Mixtures consist of two or more substances that do not react with each other.

Mixtures are: Homogeneous: solutions (salt in water);

Heterogeneous: mixtures of sand and iron, suspensions.

Chemistry is the language of nature, which opens the way to new technologies, medicines, materials and solutions for humanity. Without knowledge of the basic concepts, further mastery of more complex topics and practical aspects of this science is impossible.

II. Come up with 5 questions on the gist of the text and ask your group-mates to answer them.

III. Match the appropriate from two columns:

1) *A chemical reaction is a process in which one substance is converted into another with the formation of new chemical compounds.*

Examples:

a) Combustion	1) $Fe + O_2 \rightarrow Fe_2O_3$
b) Neutralization	2) $(AB \rightarrow A + B)$
c) Oxidation/reduction	3) $C + O_2 \rightarrow CO_2$
d) Combination	4) $(A + BC \rightarrow AC + B)$
e) Decomposition	5) $(AB + CD \rightarrow AD + CB)$
f) Exchange	6) $(A + B \rightarrow AB)$
g) Substitution	7) $NaOH + HCl \rightarrow NaCl + H_2O$

2) *LAWS OF CHEMISTRY*

a) Law of conservation of mass	1) the properties of elements change periodically with increasing atomic masses (now atomic numbers).
b) Law of constancy of composition	2) the mass of substances before the reaction is equal to the mass of products after it.
c) Mendeleev's periodic law	3) each pure substance has a constant mass composition regardless of the method of preparation.

IV. Make up the sentences with the words and phrases:

The basic concepts of chemistry, understanding the nature of substances, chemical processes, atom, molecule, element, chemical formula, reaction, mole, to analyze, to explain, predict chemical phenomena, chemistry, new technologies, medicines, materials and solutions.

V. Read these quotes, translate them and explain which ones you liked and why.

1) “A physicist is just an atom's way of looking at itself” – Bohr
2) "There is a beauty in discovery. There is mathematics in music, a kinship of science and poetry in the description of nature, and exquisite form in a molecule." Seaborg
3)"The elements whisper secrets to those who listen." — Unknown
4) "Change is the only constant, just ask a chemist." — Unknown
5) "In chemistry, as in life, balance is key." — Unknown
6) "Feeling negative? Just add a proton." — Unknown
7) "Atoms: Tiny, but mighty." — Unknown
8) "Life is a chemical reaction." — Unknown
9) "Science is a gift." — Unknown
10) "Everything is chemicals." — Unknown
11) "Chemistry is life." — Unknown

VI. Make up a plan of the text and a summary to cover the topic.

Text C
Elements of chemistry

I. Read and translate the text:

Chemical elements are the basis of the entire material world. They are the primary components of matter, from which all objects are built: from stars and planets to living organisms and artificially created materials. It is the elements that are the "alphabet" of nature - all substances, and therefore all forms of life and inorganic matter, are "made up" of their combinations. There are more than 90 natural elements in the world, and dozens more have been discovered or synthesized artificially. Each of them has unique physical and chemical properties, is determined by the number of protons in the nucleus and occupies a certain place in the periodic table.Understanding the nature of chemical elements is one of the key achievements of mankind, which gave impetus to the development of medicine, industry, energy, astronautics and nanotechnology. Without this knowledge, the functioning of the modern world is impossible.

Chemical element. A chemical element is a type of atom with the same number of protons in the nucleus, or, in other words, with the same atomic number. All atoms of the same element have the same chemical properties, regardless of where they are located - in a star, rock, or living organism.

Examples: All Hydrogen (H) atoms have 1 proton
All Oxygen (O) atoms have 8 protons
All Uranium (U) atoms have 92 protons

Structure of the atom. Each atom of an element consists of: a nucleus containing protons (+) and neutrons (0); an electron shell where electrons orbit (-).

Atomic number (Z) = number of protons = number of electrons (in a neutral atom).

Mass number (A) = protons + neutrons.

Isotopes are atoms of the same element with different numbers of neutrons (for example, ^{16}O, ^{17}O, ^{18}O).

PERIODIC TABLE OF CHEMICAL ELEMENTS

History of creation. In 1869, the Russian scientist Dmytro Ivanovych Mendelejev discovered the periodic law, according to which the properties of elements depend on their atomic mass (now - atomic number).

The periodic table is an organized set of chemical elements:

Periods (horizontal rows) - reflect the increase in electron shells.

Groups (vertical columns) — have similar chemical properties and number of electrons in the outer shell.

CLASSIFICATION OF CHEMICAL ELEMENTS

By physical properties:

Metals (iron, sodium, aluminum): luster, ductility, electrical conductivity.

Nonmetals (oxygen, phosphorus, sulfur): poor conductors, brittle.

Metalloids (silicon, boron, arsenic): have properties of both metals and nonmetals.
By place in the table:
Main groups (1–2, 13–18): predicted properties.
Transition metals (groups 3–12): variable valence, complex formation.
Lanthanides and actinides: rare earth and radioactive elements.
By role in biosystems:
Macroelements (C, H, O, N, Ca, K, Mg)
Microelements (Fe, Zn, Cu, Se, I)
Toxic elements (Pb, Hg, Cd - in excessive concentration)

PROPERTIES OF ELEMENTS

Physical properties:
State of aggregation: solid (Fe), liquid (Hg), gaseous (O_2)
Color, luster, density, melting and boiling points
Chemical properties: Valency
Redox activity
Reactions with water, acids, alkalis, non-metals

GROUPS OF ELEMENTS AND THEIR CHARACTERISTICS

Group 1: Alkali metals (Na, K, Li). Very reactive; Stored in kerosene; React with water to form alkali and hydrogen.
Group 17: Halogens (F, Cl, Br, I). Most active nonmetals; Form salts with metals.
Group 18: Inert gases (He, Ne, Ar, Kr, Xe). Do not form compounds (with rare exceptions).Used in lighting, cooling.
Transition elements (Fe, Cu, Zn, Ag, Au): Metals with different oxidation states; Form colored salts and compounds.

MODERN TRENDS IN THE STUDY OF ELEMENTS

Synthesis of new elements: elements with numbers over 100 have been obtained in particle accelerators (for example, Oganesson — No. 118)
Bioelements and pharmacology: metal-based compounds are being studied for the treatment of diseases (for example, platinum drugs against cancer)
Ecological studies: the toxicity of heavy metals (Pb, Cd, Hg) and methods for their removal are studied

Thus, the study of chemical elements not only forms the basis of scientific literacy, but also provides a powerful tool for transforming the world for the better.

II. Come up with 5 questions on the gist of the text and ask your group-mates to answer them.

III. Match the appropriate from two columns:

Importance of chemical elements in nature and in biosystems:

1) Oxygen (O)	a- the basis of sand, clay, minerals
2) Silicon (Si)	b- DNA, energy molecules (ATP)
3) Iron (Fe)	c- thyroid hormones

4) Carbon (C)	d- skeleton, muscles, nervous system
5) Calcium (Ca)	e- the Earth's core, minerals, hemoglobin
6) Phosphorus (P)	f -the most common element in the earth's crust
7) Iodine (I)	g- the basis of organic life

IV. Read and translate this information. Do you agree with this opinion? Justify your answer. Expand the answer if you can.

1) Chemical elements are not just abstract symbols in the periodic table. They are the fundamental components of all existence, the basis of all matter, and the key to understanding the world at the microscopic level.

2) Knowledge of the elements allows us to:

- develop new materials,
- synthesize drugs and vaccines,
- create energy-efficient systems,
- predict the behavior of substances in reactions.

3) The periodic table has become the universal language of chemistry, combining scientific theories with practical discoveries. Its flexibility and versatility allow us to integrate chemistry with biology, medicine, ecology, physics, and engineering.

V. Make up the sentences with the words and phrases:

Chemical elements, the primary components of matter, substances, inorganic matter, combinations, natural elements, unique physical and chemical properties, protons, nucleus, the periodic table, key achievements of mankind, living organism.

VI. Watch and listen to the presentation "Chemicals in your body". Speak about:

- elements that make our existence possible;
- what 65% of our body is composed of;
- what 18% and 3% of our body is composed of;
- what exposure to lead (Pb)can cause;
- what elements are responsible for metabolism and toxic elements we should avoid.

Unit 3

Topic: INORGANIC CHEMISTRY. SOLUTIONS. CHEMICAL COMPOUNDS

TEXT A

Inorganic chemistry

I. Read and translate the text using the dictionary:

carbon compounds	вуглецеві сполуки
complex crystalline structure	складна кристалічна структура
soil	ґрунт
acid	кислота
alkalis	луги
fertilizers	добрива
semiconductor	напівпровідник
materials science	матеріалознавство
photocatalyst	фотокаталізатор
base	основний компонент
hydroxide ion	гідроксид-іон
soluble	розчинний
insoluble	нерозчинний

II. Having read the text decide whether the following sentences are true (T) or false (F). Correct the false ones.

1) Inorganic chemistry studies all other elements and their compounds - from the simplest ions to complex crystalline structures, from noble gases to heavy metals.

2) Inorganic chemistry, as a fundamental field of physical science, has deep historical roots dating back to ancient times.

3) The history of inorganic chemistry is an example of how practical problems, philosophical ideas, observations, and experiments have come together to form a single powerful scientific discipline.

4) Today, inorganic chemistry is the foundation of science.

5) The modern world can be imagined without inorganic substances.

6) The history of this science is the history of the formation of scientific schools on which modern chemistry and technology of the 21st century are based.

Chemistry is a science that studies the composition, structure, properties and transformations of substances. One of its fundamental and most important branches is inorganic chemistry. Unlike organic chemistry, which focuses on carbon compounds, inorganic chemistry studies all other elements and their compounds - from the simplest ions to complex crystalline structures, from noble gases to heavy metals.

Inorganic chemistry, as a fundamental field of natural science, has deep historical roots dating back to ancient times. Its development is directly related to the evolution of human thinking, practical needs, crafts, medicine and philosophy. From the primitive use of fire and minerals in prehistoric times to the most complex theories of atomic structure and quantum chemistry — the path of inorganic chemistry has been long and continuous. The history of this science is the history of the discovery of elements, the systematization of substances, the development of ideas about the structure of matter and the formation of scientific schools on which modern chemistry and technology of the 21st century are based.

The main stages in the history of inorganic chemistry: 1) pre-scientific stage (ancient world and antiquity); 2) alchemical stage (3rd – 16th centuries)*;* 3) the beginning of scientific chemistry (17th–18th centuries); 4) 19th century — systematization and elements*;* 5) 20th century — quantum chemistry and coordination compounds*;* 6) Inorganic Chemistry in the 21st Century.

The history of inorganic chemistry is an example of how practical problems, philosophical ideas, observations, and experiments have come together to form a single powerful scientific discipline.

At every stage — from ancient metallurgy and alchemy to quantum chemistry and nanotechnology — humanity has expanded the horizons of understanding matter, discovering the laws of nature, creating new substances and transforming reality. Today, inorganic chemistry is not only the foundation of science, but also the key to the future in energy, medicine, ecology and information technology. Understanding its historical path allows us to better understand where and how it will develop further.

The modern world cannot be imagined without inorganic substances: they are part of minerals, soils, metals, building materials, acids, alkalis, fertilizers, semiconductors and even medicines. Inorganic chemistry is also the foundation for such applied sciences as geochemistry, materials science, electrochemistry, metallurgy, nanotechnology and environmental chemistry.

Its importance has especially increased in the context of technological progress: the creation of superconductors, photocatalysts, batteries, solar panels and new functional materials requires a deep understanding of the behavior of inorganic compounds.

MAIN CLASSES OF INORGANIC COMPOUNDS

Simple substances - consist of atoms of one chemical element:

- Metals (Fe, Cu, Al)

- Non-metals (S, P, O_2, H_2)
- Allotropic forms (diamond and graphite - forms of carbon)

Complex substances (chemical compounds)

1.) Oxides — binary compounds with oxygen:
- acidic (SO_2, CO_2)
- basic (Na_2O, FeO)
- amphoteric (ZnO, Al_2O_3)
- neutral (NO, CO)

2.) Acids — substances containing mobile hydrogen ions (H^+):
- oxygen-free (HCl, H_2S)
- oxygen-containing (H_2SO_4, HNO_3)

3.) Bases — compounds of metals with hydroxide ion OH^-:
- soluble (NaOH, KOH)
- insoluble ($Fe(OH)_3$, $Cu(OH)_2$)

4.) Salts — compounds consisting of metal cations and acid anions:
- medium (NaCl, KNO_3)
- acidic ($NaHSO_4$)
- basic (Cu(OH)Cl)

STRUCTURE OF INORGANIC SUBSTANCES

Types of chemical bonds: Ionic (NaCl, CaF_2)
Covalent polar / non-polar (H_2O, O_2)
Metallic (in pure metals)
Coordination (complex compounds: $[Cu(NH_3)_4]^{2+}$)

Types of crystal lattices: Ionic (NaCl)
Atomic (diamond, SiO_2)
Molecular (ice, I_2)
Metallic (Fe, Cu)

Inorganic chemistry is not just the science of acids, salts, and metals. It is a fundamental field that underlies many modern and future technological advances.

From understanding the structure of the atom to developing new materials, from industrial synthesis to environmental protection, inorganic chemistry remains the cornerstone of scientific and engineering progress. It forms the knowledge base without which the development of medicine, ecology, energy, information technology, and education is impossible. Therefore, its study and development are a prerequisite for the formation of a sustainable, innovative, and safe future for humanity.

III. Order the following according to the text:

The main stages in the history of inorganic chemistry:

A__ systematization and elements
B__ the beginning of scientific chemistry
C__ quantum chemistry and coordination compounds

D__ pre-scientific stage
E__ Inorganic Chemistry
F__ alchemical stage

IV. Fill in the gaps with the given words:

Energy, ecology, industry, nanotechnology, medicine

SIGNIFICANCE OF INORGANIC CHEMISTRY

In _____ (1): production of acids, fertilizers, glass, cement, metals; water and wastewater treatment.
In _____ (2): fuel, batteries, solar cells, thermonuclear fusion.
In _____ (3): contrast agents, antiseptics, iron and magnesium preparations.
In _____ (4): Monitoring of pollutants, purification of emissions.
In _____ (5): Synthesis of oxide nanoparticles, catalysts, sensors.

V. Match the wordexpressions with their definitions:

1) Inorganic chemistry	a) the study of the structure, properties, composition, and reactions of carbon-containing compounds
2) Chemical properties	b) the study of matter, its properties, and how it changes. It explores the composition, structure, and behavior of substances, as well as the interactions between them
3) Organic chemistry	c) the branch of chemistry that studies the properties and behavior of all chemical compounds that are not classified as organic (carbon-based)
4) Scientific chemistry	d) characteristics of a substance that can only be observed during or after a chemical reaction, where the substance's chemical identity is altered

VI. Title the columns (1, 2, 3) using the names (a, b, c) below.

a- Classification of reactions
b- Mendeleev's Periodic Law
c- Oxidation state and valence

1	2	3
The chemical properties of elements and their compounds change regularly depending on the atomic number. The periodicity reflects the electron structure of atoms.	Characteristic of the ability of an atom to give up or accept electrons in a compound.	Combination reactions (A + B → AB) Decomposition reactions (AB → A + B) Substitution reactions (A + BC → AC + B) Exchange reactions (AB + CD → AD + CB) Redox reactions

VII. Read and translate this information. Do you agree with these opinions? Justify your answer. Expand the answer if you can.

1*) Contemporary trends and research in inorganic chemistry:*

- Synthesis of new superconductors and ceramics.
- Study of functional materials based on inorganic compounds.
- Complex compounds for medicine and photonics.
- Development of environmentally friendly technologies based on inorganic catalysts.

*2) **Understanding the historical path of inorganic chemistry allows you to***:

- Better understand the logic of scientific progress;
- See mistakes and how to overcome them;
- Understand how modern concepts and classifications were formed;
- Understand the role of chemistry in the history of civilization.

VIII. Translate into English:

1) Неорганічна хімія займається синтезом та поведінкою неорганічних та металоорганічних сполук.

2) Ця галузь охоплює хімічні сполуки, що не мають вуглецевої основи, що є предметом органічної хімії.

3) Різниця між цими двома дисциплінами далеко не абсолютна, оскільки існує багато спільних рис у піддисципліні металоорганічної хімії.

4) Вона має застосування в усіх аспектах хімічної промисловості, включаючи каталіз, матеріалознавство, пігменти, поверхнево-активні речовини, покриття, ліки, паливо та сільське господарство.

5) Багато неорганічних сполук зустрічаються в природі як мінерали.

6) Ґрунт може містити сульфід заліза у вигляді піриту або сульфат кальцію у вигляді гіпсу.

7) Неорганічні сполуки також виконують багато функцій як біомолекули: як електроліти (хлорид натрію), у накопиченні енергії (АТФ) або в будівництві (поліфосфатний каркас у ДНК).

8) Неорганічні сполуки демонструють ряд зв'язуючих властивостей.

9) Деякі з них є іонними сполуками, що складаються з дуже простих катіонів та аніонів, з'єднаних іонним зв'язком.

10) Прикладами солей (які є іонними сполуками) є хлорид магнію $MgCl_2$, який складається з катіонів магнію Mg^{2+} та аніонів хлориду Cl^-; або гідроксид натрію NaOH, який складається з катіонів натрію Na^+ та гідроксид-аніонів OH^-.

11) Деякі неорганічні сполуки є висококовалентними, такі як діоксид сірки та пентакарбоніл заліза.

12) Багато неорганічних сполук мають полярний ковалентний зв'язок, який є формою проміжного зв'язку між ковалентним та іонним зв'язком.

Text B
Solutions

I. Read and translate the text using the dictionary:

solutions	розчини
medium	середовище
precipitation	осади
acid-base neutralization	кислотно-лужна нейтралізація
complexation	комплексоутворення
redox reactions	окисно-відновні реакції
comprehending	розуміння
solubility principles	принципи розчинності
solvent	розчинник
solute	розчинена речовина
redox reaction	окисно-відновна реакція

Inorganic chemistry deals with the study of elements and their compounds, excluding most carbon-containing compounds. Solutions are a central concept in inorganic chemistry, as they form the medium in which many inorganic reactions occur—such as precipitation, acid-base neutralization, complexation, and redox reactions. Understanding solutions is essential for comprehending the behavior of ions, solubility principles, and the reactions that drive industrial processes, analytical techniques, and environmental chemistry.

Definition of a Solution. A solution is a homogeneous mixture of two or more substances: Solvent: the substance present in the largest amount, often water in inorganic chemistry.

Solute: the substance that is dissolved in the solvent.

Example: In a solution of sodium chloride (NaCl) in water:

Water is the solvent.

NaCl is the solute.

NaCl dissociates into Na^+ and Cl^- ions in the solution.

Types of Inorganic Solutions.

Aqueous Solutions: Water acts as the solvent. Most common in laboratories and natural systems. Supports ionic dissociation, acid-base behavior, and electrochemical processes.

Non-Aqueous Solutions: Solvents like ammonia, sulfur dioxide, or acetic acid are used. Useful when water interferes with the desired reaction or the solute is water-insoluble.

Characteristics of Ionic Solutions. When ionic compounds dissolve in water, they dissociate into their constituent ions. This is called electrolytic dissociation.

Example: $NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$. Such solutions can conduct electricity due to the movement of ions and are called electrolytes.

Strong electrolytes: completely dissociate (e.g., HCl, NaOH, KNO_3).
Weak electrolytes: partially dissociate (e.g., NH_3, H_2CO_3).
Nonelectrolytes: do not dissociate (e.g., glucose).

Concentration of Solutions. Solutions in inorganic chemistry are often described using different units of concentration:

Unit	*Definition*
Molarity (M)	moles of solute per liter of solution
Molality (m)	moles of solute per kilogram of solvent
Normality (N)	equivalents of solute per liter of solution
Percent (%)	grams or volume per 100 mL (mass or volume %)

Concentration affects the **rate of reactions**, **solubility**, and **conductivity** of the solution.

Solubility and its Rules. Solubility is the maximum amount of solute that can dissolve in a solvent at a given temperature. Factors affecting solubility: temperature; nature of solute and solvent (polarity); common ion effect.

Solubility Rules (Aqueous Solutions):

Compound Type	**Solubility in Water**
Group 1 metals, NH_4^+ salts	Always soluble
Nitrates (NO_3^-), acetates	Soluble
Halides (Cl^-, Br^-, I^-)	Soluble (except Ag^+, Pb^{2+})
Sulfates (SO_4^{2-})	Soluble (except Ba^{2+}, Pb^{2+})
Carbonates, phosphates	Insoluble (except Group 1)
Hydroxides	Mostly insoluble

Reactions in Inorganic Solutions. Many inorganic reactions occur in solution and are categorized by type:

Precipitation Reaction -Occurs when two soluble salts form an insoluble product.
Example: $BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s)\downarrow + 2NaCl(aq)$
Acid-Base Neutralization - Involves H^+ and OH^- forming water.
Example:$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$
Redox Reaction - Electrons are transferred between species.
Example: $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$
Complexation - Formation of complex ions by ligands binding to metal centers.
Example: $Cu^{2+}(aq) + 4NH_3(aq) \rightarrow [Cu(NH_3)_4]^{2+}(aq)$

Solutions in inorganic chemistry are essential to understanding how substances dissolve, interact, and react in liquid media. They provide the foundation for countless processes in both natural and industrial systems.

From acid-base titrations to nanotechnology and environmental remediation, the chemistry of solutions is a critical area of research, application, and innovation. Mastery of this topic equips chemists with tools to analyze, synthesize, and transform materials that shape the world.

II. Having read the text decide whether the following sentences are true (T) or false (F). Correct the false ones.

1) Solutions are a central concept in inorganic chemistry, as they form the medium in which many inorganic reactions.

2) A solution is a homogeneous mixture one substance.

3) Water acts as the solvent.

4) Solute: the substance that is not dissolved in the solvent.

5) Solubility is the maximum amount of solute that can dissolve in a solvent at a given temperature.

III. Match the appropriate from two columns.

Applications of Inorganic Solutions:

1) Analytical Chemistry	A- Water treatment, heavy metal removal
2) Environmental Science	B - Intravenous solutions, mineral supplement
3) Medicine	C - Demonstration of ionic reactions and conductivity
4) Industry	D- Titrations, detection of ions
5) Education	E - Electroplating, battery electrolytes, catalysis

IV. Fill in the gaps with the given words.

diluting, syrup, concentrated, concentration, ammonia water, concentrating, seltzer, saline, brine

Some solutions are so common to us that we give them a unique name. A solution of water and sugar is called _____ (1). A solution of sodium chloride (common table salt) in water is called _____ (2). A sterilized specific concentration (0.15 molar) of sodium chloride in water is called _____ (3). A solution of carbon dioxide in water is called _____ (4), and a solution of ammonia gas in water is called _____ (5).

A solution is said to be _____ (6) if there is less of the solute. The process of adding more solvent to a solution or removing some of the solute is called_____ (7). A solution is said to be _____ (8) if it has more solute. The process of adding more solute or removing some of the solvent is called _____ (9). The _____ (10) of a solution is some measurement of how much solute there is in the solution.

V. Read and translate this information. Do you agree with this opinion? Justify your answer. Expand the answer if you can.

The current trends in solution research are:

- Green solvents: ionic liquids and supercritical fluids as eco-friendly alternatives.
- Molecular sensors: using solution chemistry to detect metal ions.
- Nanomaterials: synthesis of nanoparticles in solution for electronics and medicine.
- Artificial photosynthesis: using inorganic catalysts in solution to mimic plants.

VI. Read and translate the text. Make dialogues using the lexis from the text.

The material to be dissolved is the solute and the substance which does the dissolving is the solvent. The rate at which a substance may be dissolved can be controlled in several ways. The surface area, the agitation, and the temperature all are found to have an effect on the rate of solution.

The ease with which a substance may be dissolved is known to be its solubility. The solubility of solid, liquid, or gaseous solutes is determined by a number of factors, such as the nature of the solvent, the nature of the solute, the temperature and the pressure. In a solution the solute cannot be separated from the solvent by filtration.

The concentration of solute in solution may vary from dilute (a small amount of solute relative to the solvent) to concentrated (a large amount of solute relative to the solvent). The most common of the solvents is known to be water. Among the organic compounds such materials as alcohol and benzene are commonly used solvents. Most organic compounds can be dissolved only in organic solvents.

Text C
Chemical compounds

I. Read and translate the text:

Inorganic chemistry focuses on the study of inorganic compounds—substances that are not primarily composed of carbon-hydrogen (C–H) bonds, which are typical of organic compounds. Inorganic compounds include salts, oxides, acids, bases, and a wide variety of minerals and metals, playing essential roles in geology, industry, biology, and materials science. Understanding inorganic compounds is fundamental for identifying how elements behave, interact, and form stable or reactive structures that are found naturally or synthesized in laboratories.

Definition of Inorganic Compounds. Inorganic compounds are chemical substances composed of two or more elements, typically excluding those based on long chains of carbon atoms (i.e., organic molecules). However, some carbon-containing compounds are considered inorganic:

- Carbonates (CO_3^{2-})
- Bicarbonates (HCO_3^-)
- Cyanides (CN^-)

- Carbon dioxide (CO_2) and carbon monoxide (CO)

Classification of Inorganic Compounds. Inorganic compounds are commonly categorized into four main types:

Oxides: Compounds formed between oxygen and another element.

Acidic oxides: react with water to form acids (e.g., $SO_3 \rightarrow H_2SO_4$)

Basic oxides: react with water to form bases (e.g., $Na_2O \rightarrow NaOH$)

Amphoteric oxides: react as both acids and bases (e.g., Al_2O_3)

Neutral oxides: no acidic or basic properties (e.g., CO, NO)

Acids: Compounds that release H^+ ions in solution.

Binary acids: contain hydrogen and a nonmetal (e.g., HCl, HBr)

Oxyacids: contain hydrogen, oxygen, and another element (e.g., H_2SO_4, HNO_3)

Bases: Compounds that release OH^- ions in solution (or accept H^+).

Strong bases: fully dissociate in water (e.g., NaOH, KOH)

Weak bases: partially dissociate (e.g., NH_4OH)

Salts: Formed from the reaction of an acid and a base (neutralization).

Normal salts: all replaceable H^+ ions substituted (e.g., NaCl, K_2SO_4)

Acid salts: not all H^+ replaced (e.g., $NaHSO_4$)

Basic salts: contain hydroxide groups (e.g., Mg(OH)Cl)

Naming Inorganic Compounds (IUPAC Nomenclature)

Binary Compounds (Two Elements)

Metal + non-metal: name metal first, then non-metal ending in "-ide"

$NaCl \rightarrow$ sodium chloride

$FeO \rightarrow$ iron(II) oxide

Non-metals: use prefixes (mono-, di-, tri-, etc.)

$CO_2 \rightarrow$ carbon dioxide

$N_2O_5 \rightarrow$ dinitrogen pentoxide

Ternary Compounds (Three Elements)

Often oxoacids and salts (e.g., H_2SO_4, $NaNO_3$)

Transition Metal Compounds

Roman numerals indicate oxidation state:

$CuCl \rightarrow$ copper(I) chloride

$CuCl_2 \rightarrow$ copper(II) chloride

Structure and Bonding

1. Types of Chemical Bonds in Inorganic Compounds:

Ionic: transfer of electrons (NaCl, MgO)

Covalent: shared electrons (CO_2, NH_3)

Metallic: delocalized electrons in a metal lattice (Fe, Cu)

Coordination/complex bonds: central metal ion with ligands (e.g., $[Fe(CN)_6]^{3-}$)

2. Crystal Structures

Ionic crystals: NaCl, CaF_2

Covalent crystals: SiO_2 (quartz), diamond

Metallic crystals: pure metals

Molecular crystals: dry ice (CO_2), sulfur

3. Special Class: Coordination Compounds:

- Central transition metal ion bonded to ligands.
- Exhibit geometrical and optical isomerism.
- Important in biological systems (e.g., hemoglobin) and catalysis.

Example: $[Cu(NH_3)_4]^{2+}$ — tetraamminecopper(II)

Inorganic compounds are the backbone of many natural processes and human technologies. From the air we breathe (O_2, CO_2) to the building materials around us ($CaCO_3$, SiO_2), inorganic chemistry reveals the structure and behavior of matter at every scale.

With their diverse structures, bonding types, and wide applications, inorganic compounds offer endless opportunities for innovation in materials science, energy, healthcare, and sustainability. Mastering their principles enables us to shape and improve the world in scientifically meaningful ways.

II. Come up with 5 questions on the gist of the text and ask your group-mates to answer them.

III. Title the columns (1, 2, 3) using the names (a, b, c) below.

a- In Medicine
b- In Environment
c- In Industry

Roles and Applications of Inorganic Compounds

1	2	3
Acids and bases in cleaning, synthesis, and pH control. Salts in fertilizers (e.g., ammonium nitrate), explosives, and dyes. Oxides used in ceramics, catalysts, glass, and pigments.	Salts used in electrolyte therapy (NaCl, KCl). Metal complexes in cancer therapy (cisplatin). Minerals as dietary supplements (Fe^{2+}, Mg^{2+}, Ca^{2+}).	Neutralization of acids and bases in water treatment. Precipitation reactions to remove heavy metals.

IV. Read and translate fun facts about compounds. Which one did you like most and why?

Fun Facts About Compounds

1. Compounds are everywhere around us!
Compounds are substances made up of two or more different elements. They can be found in the air we breathe, the food we eat, and even in our own bodies!

2. Water is a compound we can't live without.
Water is a compound made up of two hydrogen atoms and one oxygen atom. It is essential for all living things and covers about 71% of the Earth's surface.

3. Some compounds can change colors.
Compounds called indicators can change color when they come into contact with acids or bases. This property is often used in chemistry experiments to test the pH of a substance.

4. Compounds can have different states of matter.
Compounds can exist as solids, liquids, or gases, depending on the temperature and pressure. For example, water can be a solid (ice), a liquid (water), or a gas (water vapor).

5. Some compounds have unique smells.
Compounds like vanilla, cinnamon, and peppermint have distinct smells that we often associate with certain foods or products. These smells are caused by the specific compounds present in them.

6. Compounds can be found in nature or made by humans.
Some compounds occur naturally, like salt (sodium chloride), while others are created by humans through chemical reactions. Examples of human-made compounds include plastics, medicines, and cleaning products.

7. Compounds can have different properties than their individual elements.
When elements combine to form compounds, they often have different properties than the elements themselves. For example, sodium is a highly reactive metal, but when combined with chlorine, it forms sodium chloride, which is table salt.

8. Compounds can be used to create fireworks.
Fireworks contain compounds that produce different colors when ignited. For example, copper compounds create a blue color, while strontium compounds create a red color.

9. Some compounds are used to make everyday items.
Compounds like plastic, rubber, and glass are used to make everyday items such as toys, shoes, and windows. These compounds have unique properties that make them suitable for specific purposes.

10. Compounds can be separated through chemical reactions.
Through chemical reactions, compounds can be broken down into their individual elements or other compounds. This process is often used in industries to extract useful substances or recycle materials.

11. Compounds can have different melting and boiling points.
Each compound has a specific temperature at which it melts and boils. For example, the compound methane (CH_4) melts at -182.5°C and boils at -161.5°C.

12. Compounds play a crucial role in the food we eat.
Many compounds found in food, such as carbohydrates, proteins, and fats, provide us with the energy and nutrients our bodies need to function properly. Without compounds, our bodies wouldn't be able to survive![1]

V. Translate into English:

The Five Laws of Chemical Combination:
П'ять законів хімічного з'єднання:

1) Закон збереження маси – стверджує, що речовина не може бути створена або знищена в результаті хімічної реакції або фізичної зміни.
2) Закон визначених пропорцій – стверджує, що дана хімічна сполука завжди містить свої складові елементи у фіксованому співвідношенні (за масою), незалежно від джерела або способу отримання.
3) Закон кратних пропорцій – стверджує, що коли два елементи з'єднуються, утворюючи різні сполуки, співвідношення мас одного елемента, що з'єднуються, з фіксованою масою іншого елемента, є простими цілими числами.
4) Закон газоподібних об'ємів Гея Люссака – стверджує, що коли гази реагують, вони роблять це у простих цілочисельних співвідношеннях за об'ємом, за умови, що температура та тиск залишаються постійними.
5) Закон хімічного з'єднання Авагадро – стверджує, що рівні об'єми всіх газів за однакової температури та тиску містять однакову кількість молекул.
6) **Чи є зубна паста сполукою?**

7) Відповідь полягає в тому, що існує багато різних сполук, з яких складається зубна паста.

8) Сучасна зубна паста – це справжнє диво сучасної науки, яке може видаляти плями та запобігати карієсу.

9) Офіційна назва зубної пасти – dentrifice (засіб для дентифікації зубів), що означає будь-яку речовину, призначену для видалення залишків із зубів з метою запобігання карієсу.

VI. Watch and listen to the presentation made by Martin Hanczyc on his research.

1. Explain the aim of his investigation.
2. Describe one of the experiments.

Unit 4

Topic: ORGANIC CHEMISTRY. ANALYTICAL METHODS OF ANALYSIS

TEXT A
Organic chemistry

I. Read and translate the text using the dictionary:

carbon-containing compounds	вуглецевмісні сполуки
carbon–hydrogen (C–H) bonds	вуглець-водневі (C–H) зв'язки
oxygen	кисень
nitrogen	азот
sulfur	сірка
urea	сечовина
inorganic ammonium cyanate	неорганічний ціанат амонію
hydrocarbons	вуглеводні
alkanes	алкани
single bonds	одинарні зв'язки
acid	кислота
esters	естери
amides	аміди
halides	галогеніди
insights	розуміння
indispensable	незамінний
sustainability	сталий розвиток

II. Having read the text decide whether the following statements are true (T) or false (F). Correct the false ones:

1) Organic chemistry centers on compounds with carbon–hydrogen bonds, though it also includes compounds containing other elements such as oxygen, nitrogen, sulfur, phosphorus, and halogens.

2) Organic chemistry is often called the “chemistry of biology” because it is the foundation for understanding biological processes.

3) Organic chemistry is the scientific discipline that studies the structure, properties, reactions, and synthesis of inorganic compounds.

4) The term “organic” was originally associated with compounds from living organisms.
5) In 19th–20th centuries saw the rapid development of synthetic organic chemistry, discovery of structure theories (Kekulé), and creation of organic reagents.
6) To understand and manipulate organic compounds, chemists do not use advanced tools.

Organic chemistry is a fundamental branch of chemistry focused on the structure, properties, composition, reactions, and synthesis of carbon-containing compounds. Unlike inorganic chemistry, which deals mostly with minerals and metals, organic chemistry centers on compounds with carbon–hydrogen (C–H) bonds, though it also includes compounds containing other elements such as oxygen, nitrogen, sulfur, phosphorus, and halogens.

Organic chemistry is often called the “chemistry of life” because it is the foundation for understanding biological processes, pharmaceuticals, fuels, plastics, and modern materials. It lies at the heart of numerous scientific fields, from biochemistry to materials science, medicine, and environmental science. Organic chemistry is the scientific discipline that studies the structure, properties, reactions, and synthesis of organic compounds — substances that contain carbon atoms bonded to hydrogen and often other elements.

The term “organic” was originally associated with compounds from living organisms. However, since the 19th century, it has expanded to include all carbon-based compounds, whether natural or synthetic.

BRIEF HISTORY OF ORGANIC CHEMISTRY

Period	Key Developments
Ancient Times	Use of natural organic substances like dyes, oils, and resins.
1770s–1800s	Chemistry began distinguishing between organic and inorganic substances.
1828	*Friedrich Wöhler* synthesized urea from inorganic ammonium cyanate — disproving the idea that organic compounds could only come from living beings.
19th–20th centuries	Rapid development of synthetic organic chemistry, discovery of structure theories (Kekulé), and creation of organic reagents.
Modern era	Development of spectroscopy, computational chemistry, pharmaceutical chemistry, green chemistry, and advanced synthesis techniques.

ORGANIC COMPOUNDS can be broadly divided into:

1. Hydrocarbons (only carbon and hydrogen):
   - Alkanes (single bonds): CH_4, C_2H_6
   - Alkenes (double bonds): C_2H_4
   - Alkynes (triple bonds): C_2H_2

- Aromatic compounds (benzene ring): C_6H_6

2. Functionalized Compounds:
   - Alcohols: –OH group (e.g., ethanol)
   - Aldehydes and Ketones: –CHO, >C=O
   - Carboxylic Acids: –COOH
   - Esters and Amides: derived from acids
   - Halides: contain halogen atoms
   - Amines: $–NH_2$ group

EXPERIMENTAL AND ANALYTICAL TECHNIQUES OF ORGANIC CHEMISTRY

To understand and manipulate organic compounds, chemists use advanced tools such as: - Chromatography (TLC, GC, HPLC); - Mass spectrometry (MS); - Nuclear magnetic resonance (NMR) spectroscopy; - Infrared (IR) spectroscopy; - Ultraviolet-visible (UV-Vis) spectroscopy; - X-ray crystallography. These techniques help determine molecular structure, composition, and purity.

Organic chemistry is a dynamic and ever-evolving science that plays a central role in modern life. It offers insights into the molecular basis of life, enables the design of pharmaceuticals, and supports the development of advanced materials and technologies. With its diverse reactions, functional complexity, and synthetic flexibility, organic chemistry is indispensable for innovations in medicine, energy, agriculture, and sustainability.

III. Fill in the gaps with the given words:

chemistry, industrial, origins, raw, living organisms, carbon, matter, artificial, organic

Organic chemistry now embraces not only substances produced by _____ (1) but also an immense range of synthetic chemicals. These include many of _____ (2) importance. Nearly all plastics and synthetic fibers in everyday use are _____ (3) chemicals. So also are such diverse materials as dry-cleaning fluids, _____ (4) sweeteners, pesticides, and many pharmaceuticals.

Many of today's industrially important organic _____ (5) are produced from fossil fuels – mainly oil and natural gas. These are the remains of once-living _____ (6). In that respect, much of industrial organic chemistry retains its truly organic _____ (7). Such is the sophistication of modern _____ (8) that if supplies of these _____ (9) materials become exhausted, then the same products can still be produced from other _____ (10) sources, such as carbon monoxide gas.

IV. Match the appropriate from two columns:

Importance of organic chemistry

Field	***Examples of Applications***
1) Medicine	**A -** Fuels (gasoline, diesel), lubricants
2) Agriculture	**B -** Fragrances, skincare, hair products
3) Petrochemicals	**C -** Nylon, polyester, PVC, Teflon

4) Food Industry	**D -** DNA synthesis, bioengineering tools
5) Cosmetics	**E -** Drug design, antibiotics, vaccines, anesthetics
6) Biotechnology	**F -** Flavors, preservatives, sweeteners
7) Polymers and Plastics	**G -** Fertilizers, pesticides, herbicides

V. Fill in the columns (1-7) with the given phrases and expressions (A-G).

MAJOR BRANCHES OF ORGANIC CHEMISTRY:

Structural Organic Chemistry	Stereo chemistry	Physical Organic Chemistry	Synthetic Organic Chemistry	Bio organic Chemistry	Organo metallic Chemistry	Green Chemistry
1	**2**	**3**	**4**	**5**	**6**	**7**

A - interface between organic chemistry and biology
B - explores reaction mechanisms and kinetics
C - studies the 3D arrangement of atoms.
D - design of environmentally friendly chemical processes
E - focuses on the structure and bonding
F - compounds containing metal–carbon bonds
G - development of new synthetic methods

VI. Read and translate this information. Do you agree with these opinions? Justify your answer. Expand the answer if you can.

- Ultimately, we reach the very complex or ganic chemicals produced by the synthetic chemist.
- A synthetic chemist combines chemical elements and compounds to duplicate naturally occurring substances. He also produces compounds that do not occur naturally, including many drugs and pesticides.
- Many of these compounds have provided extraordinarily complex challenges to the synthetic chemist.
- Yet many of the compounds found naturally in plants and animals are produced with greater efficiency in nature than in the laboratory. It is thus more economical to extract them from a natural source, rather than to make them in the laboratory [2].

VII. Translate into English

A. *СУЧАСНІ ДОСЯГНЕННЯ ОРГАНІЧНОЇ ХІМІЇ:*

1. Асиметричний синтез для отримання енантіомерно чистих ліків.
2. Клік-хімія: швидкі та ефективні реакції для біологічного мічення.
3. Фотоокислювально-відновний каталіз: використання світла для проходження складних реакцій.

4. Органічні напівпровідники: для гнучкої електроніки та сонячних елементів.
5. Синтез природних продуктів: імітація сполук, отриманих у природі.
6. Обчислювальна хімія: прогнозування реакцій та проектування молекул.

В. *ОСНОВНІ ОСОБЛИВОСТІ ОРГАНІЧНИХ СПОЛУК*

1. Вуглецевий каркас: атоми вуглецю утворюють стабільні ковалентні зв'язки між собою та іншими елементами, створюючи ланцюги, кільця та складні 3D-структури.
2. Ковалентний зв'язок: органічні сполуки зазвичай містять ковалентні, а не іонні зв'язки.
3. Функціональні групи: групи атомів (наприклад, –OH, –COOH, $–NH_2$) визначають хімічну реакційну здатність сполуки.
4. Ізомерія: молекули з однаковою молекулярною формулою можуть мати різні структури (ізомери), такі як:
5. Структурні ізомери:- Геометричні (цис-транс) ізомери;- Оптичні ізомери (енантіомери).
6. Моделі реакційної здатності. Органічні сполуки часто зазнають певних типів реакцій: - Приєднання; - Елімінування; - Заміщення; - Перегрупування; - Окиснення/ відновлення.

VIII. Speak on the topic using these phrases:

organic chemistry, biology, reaction, atoms, environmentally friendly, chemical processes, structure, properties, composition, bonds, pharmaceuticals, fuels, plastics, modern materials, living organisms.

Text B
Analytical methods of analysis

I. Read and translate the text using the dictionary:

organic compounds	органічні сполуки
crucial	вирішальний
to quantify	для кількісного визначення
qualitative analysis	якісний аналіз
quantitative analysis	кількісний аналіз
wet chemistry	волога хімія
preliminary identification	попередня ідентифікація
precision	точність
conjugated π systems	спряжені π-системи
elucidation	з'ясування
nucleus	ядро
volatile organic compounds	леткі органічні сполуки
enhanced analysis	покращений аналіз

high-resolution separation	розділення з високою роздільною здатністю

In organic chemistry, understanding the identity, structure, purity, and concentration of organic compounds is crucial. This is achieved through analytical chemistry, which provides methods to detect, quantify, and characterize organic molecules. Analytical techniques are divided into two major categories:

- Qualitative analysis – *What is present?* (identification)
- Quantitative analysis – *How much is present?* (measurement)

Modern organic chemistry relies on a combination of classical (wet chemistry) and instrumental methods to fully analyze a compound.

Classical (Wet) Methods of Organic Analysis

1. Elemental Analysis (CHNS Analysis).

Determines the percentage of carbon (C), hydrogen (H), nitrogen (N), sulfur (S), and sometimes oxygen (O) in an organic compound. Based on combustion of a sample in oxygen. The mass of combustion products (CO_2, H_2O, NO_x) is used to calculate elemental composition. Use: Confirms molecular formula.

2. Functional Group Tests

Qualitative chemical reactions used to identify specific functional groups.

Functional Group	Reagent/Test	Observation
Alkene / Alkyne	Bromine water	Discoloration
Alcohol	Lucas test, chromic acid	Cloudiness, color change
Aldehyde	Tollens' reagent	Silver mirror
Ketone	2,4-DNP test	Yellow/orange precipitate
Carboxylic acid	$NaHCO_3$	Effervescence (CO_2)
Amine	Hinsberg test	Precipitate with sulfonyl chloride

Use: Quick preliminary identification of organic classes.

Instrumental Methods of Organic Analysis

Modern organic analysis relies heavily on instrumental techniques, which provide high sensitivity, precision, and structural information.

1. Spectroscopic Methods

1) UV-Visible Spectroscopy (UV-Vis):

- Measures absorption of ultraviolet or visible light by organic compounds.
- Useful for compounds with conjugated π systems (e.g., aromatics, alkenes).

2) Infrared Spectroscopy (IR).

Measures vibrations of bonds when exposed to infrared light. Each functional group absorbs at specific wavenumbers (cm^{-1}).

Functional Group	Absorption Range (approx.)
–OH (alcohol)	3200–3600 cm^{-1} (broad)

Functional Group	Absorption Range (approx.)
–C=O (carbonyl)	~1700 cm^{-1}
–NH (amine)	3300–3500 cm^{-1} (sharper)
–C–H (alkane)	2800–3000 cm^{-1}

3) Nuclear Magnetic Resonance (NMR) Spectroscopy.
Most powerful tool for structure elucidation. Based on the magnetic properties of certain nuclei (^{1}H, ^{13}C, etc.).
Types: - ^{1}H-NMR (Proton NMR): tells how many hydrogen atoms and their environment.
- ^{13}C-NMR (Carbon-13 NMR): shows types of carbon atoms.
Key Parameters: - Chemical shift (δ) – environment of nucleus; Multiplicity – neighboring hydrogen atoms (splitting); Integration – relative number of atoms
4) Mass Spectrometry (MS).
Measures mass-to-charge ratio (m/z) of ionized fragments. Gives molecular weight, isotopic patterns, and structural information.
Types: - Electron impact (EI); - Electrospray ionization (ESI); - MALDI-TOF (for biomolecules).

2. Chromatographic Methods
Used for separation, identification, and quantification of components in mixtures.
1)Thin-Layer Chromatography (TLC)
Fast and simple method for **qualitative analysis**.
A drop of mixture is spotted on a silica-coated plate and developed in a solvent.
2) Gas Chromatography (GC)
Used for **volatile organic compounds**.
Separates based on boiling points and polarity.
Often coupled with **mass spectrometry (GC-MS)** for identification.
3)High-Performance Liquid Chromatography (HPLC)
Used for **non-volatile and polar organic compounds**.
Offers high-resolution separation and quantification.

3. Advanced Hybrid Techniques
Modern instruments combine multiple techniques for enhanced analysis:

Instrument	Combination	Use
GC-MS	Gas chromatography + mass spectrometry	Identifies volatile components
LC-MS	Liquid chromatography + mass spectrometry	Used for biomolecules and drugs
NMR-MS	NMR + mass spectrometry	Deep structure confirmation

4. Quantitative Organic Analysis
Used to determine the concentration of a substance in a solution:

- Titration (acid-base, redox, complexometric);
- Spectrophotometry (UV-Vis absorbance);
- Gravimetric methods (mass-based);
- Chromatographic quantification (HPLC or GC with standard calibration).

Analytical methods in organic chemistry are essential for: Identifying compounds; Determining structures; Ensuring purity; Monitoring reactions; Understanding mechanisms. From traditional tests to advanced spectroscopic and chromatographic techniques, these tools provide the foundation for both academic research and industrial applications in organic chemistry. Mastery of these methods enables chemists to explore, understand, and innovate at the molecular level.

II. Having read the text decide whether the following statements are true (T) or false (F). Correct the false ones.

1) In organic chemistry, understanding the identity, structure, purity, and concentration of organic compounds is not crucial.
2) Analytical techniques are divided into three major categories.
3) The mass of combustion products (CO_2, H_2O, NO_x) is used to calculate elemental composition.
4) Chromatographic methods are used for separation, identification, and quantification of components in mixtures.
5) Analytical methods in organic chemistry are essential for: identifying compounds; determining structures; ensuring purity; monitoring reactions and understanding mechanisms.

III. Match the appropriate from two columns.
Applications Analytical methods of analysis in Research and Industry:

Sector	Example Uses
1)Pharmaceuticals	a- Detecting flavors, preservatives, toxins
2)Food Chemistry	b- Monitoring organic pollutants (e.g., pesticides, hydrocarbons
3)Environmental Chemistry	c- Monitoring organic pollutants (e.g., pesticides, hydrocarbons
4)Petrochemicals	d- Structural analysis of biomolecules (proteins, DNA analogs)
5)Biotechnology	e- Drug identification, purity, and stability testing

IV. Fill in the gaps with the given words.

hypothesis, assumption, conclusions, establish, theory, check, common, phenomenon

The artificial reproduction of a _____ (1) is called an experiment. Experiments are mostly intended to _____ (2) the truth of ideas or assumptions which arise in studying a phenomenon. Assumptions put forth to explain a

phenomenon, to _____ (3) its connection with other phenomena studied earlier, to unite several phenomena under a _____ (4) idea, are called hypotheses. If the conclusions which follow logically from the _____ (5) made are confirmed by experiment, if the hypothesis explains not only the phenomenon in question, but permits general _____ (6) and prediction of new phenomena as well, the hypothesis becomes a _____(7). If, on the other hand, experiment fails to confirm it, the _____ (8) must be discarded.

V. Read and translate this information. Do you agree with these opinions? Justify your answer. Expand the answer if you can.

- Theory makes it possible to carry on investigations without groping in the dark, according to a prearranged plan, from a definite standpoint and on the basis of established laws.
- Especially important theoretical generalizations in chemistry, which have made for progress in this branch of science, are: the theory of atoms and molecules, the theory of chemical structure, the Periodic Law and the periodic system of chemical elements.

VI. Make up the sentences with these words and phrases:

phenomenon, to confine – обмежувати(ся), to strive(strove, striven), to delve, to ascertain, to occur, artificially, assumption, discarded, to facilitate, to enable, nalytical methods, organic chemistry, identifying compounds, to explore, to understand, to innovate at the molecular level.

VII. Make up a plan of the text and a summary to cover the topic.

Text C
Chemistry of carbon

I. Read and translate the text.

Carbon is one of the **most** versatile and essential elements in the periodic table. It is the primary building block of life, capable of forming an extraordinary variety of compounds due to its unique bonding properties. The chemistry of carbon, also known as organic chemistry, investigates how carbon atoms bond with themselves and other elements to form the complex molecules that drive biological, chemical, and industrial processes.

Basic Atomic Properties of Carbon

Property	Value
Atomic Number	6
Atomic Mass	~12.01 u
Electron Configuration	$1s^2\ 2s^2\ 2p^2$

Property	Value
Valency	4 (forms four covalent bonds)
Allotropes	Diamond, Graphite, Fullerenes, Graphene, Amorphous Carbon

Carbon belongs to **Group 14** (IVA) in the periodic table and is **tetravalent**, meaning it can form four covalent bonds—this makes it **extremely versatile** in chemical bonding.

Allotropes of Carbon. Carbon exists in several **elemental forms**, each with distinct physical and chemical properties:

1. Diamond
   - Each carbon atom is tetrahedrally bonded to four others.
   - Forms a 3D rigid lattice**.**
   - Hardest known natural substance, excellent insulator.
2. Graphite
   - Each carbon atom is sp^2 hybridized and bonded to three others in layers of hexagonal lattices.
   - Conducts electricity, soft and slippery.
   - Used in lubricants and electrodes.
3. Fullerenes (C_{60}, etc.)
   - Molecules composed of **spherical cages** of carbon atoms.
   - Exhibit **unique reactivity and symmetry**.
   - Important in nanotechnology and medicine.
4. Graphene
   - A single layer of graphite, **one-atom thick**.
   - Extremely strong, **excellent conductor**, used in advanced electronics.
5. Amorphous Carbon
   - Includes soot, charcoal, lampblack.
   - Disordered structures; used in inks, pigments.

Bonding Properties of Carbon. Carbon's **tetravalency** allows it to form:

- Single bonds (σ bonds): C–C
- Double bonds (σ + π): C=C
- Triple bonds (σ + 2π): C≡C

Carbon can catenate—form long chains, branched molecules, and rings. This property is unparalleled among elements and is the foundation of molecular diversity in organic chemistry.

Hybridization in Carbon

Hybridization	Geometry	Bond Angles	Example
sp^3	Tetrahedral	109.5°	Methane (CH_4)
sp^2	Trigonal planar	120°	Ethene (C_2H_4)
Sp	Linear	180°	Ethyne (C_2H_2)

Hybridization explains the **geometry** of molecules and the distribution of electrons around carbon atoms.

Types of Carbon Compounds. Carbon forms a wide range of compounds**,** classified as:

Hydrocarbons.**Compounds of only carbon and hydrogen.**

- **Alkanes** (saturated): C–C single bonds (e.g., CH_4, C_2H_6)
- **Alkenes** (unsaturated): C=C double bonds (e.g., C_2H_4)
- **Alkynes**: C≡C triple bonds (e.g., C_2H_2)
- **Aromatic hydrocarbons**: Benzene rings (e.g., C_6H_6)

Functionalized Compounds **Contain functional groups like:**

–OH (Alcohols)
–COOH (Carboxylic acids)
–NH_2 (Amines)
–CHO (Aldehydes)
–C=O (Ketones)
–Cl, –Br, –I (Halides)

These groups define the **chemical reactivity** and **physical properties** of the molecules.

Isomerism in Carbon Compounds. Carbon compounds often exhibit **isomerism**, where compounds have the same molecular formula but different structures:

Type of Isomerism	Description
Structural Isomerism	Different connectivity (e.g., butanol vs. methylpropanol)
Geometrical (cis-trans)	Different spatial arrangement around a double bond
Optical Isomerism	Non-superimposable mirror images (chiral centers)

The chemistry of carbon is both vast and foundational. Due to its tetravalency, catenation ability, and formation of multiple bond types, carbon can create diverse, stable, and functional molecules. From the simplest hydrocarbon to the most complex biomolecule, carbon is at the heart of all living systems, technological materials, and chemical industries. Its study continues to fuel advancements in medicine, energy, materials science, and sustainability.

II. Come up with 5 questions on the gist of the text and ask your group-mates to answer them.

III. Read and translate this information. Do you agree with these opinions? Justify your answer. Expand the answer if you can.

1) Environmental Role of Carbon:

- Carbon Cycle: Movement of carbon between atmosphere, biosphere, and geosphere;
- Carbon Dioxide (CO_2): Greenhouse gas; role in climate change;
- Methane (CH_4): Potent greenhouse gas;
- Carbon Sequestration: Storage of atmospheric CO_2 to mitigate global warming.

2) Carbon is essential in biomolecules:

- Carbohydrates: energy source (C, H, O)
- Proteins: made of amino acids (contain C, H, O, N)
- Lipids: fats and oils (long carbon chains)
- Nucleic acids: DNA/RNA backbones are carbon-based sugars.

The carbon atom's ability to form stable chains, rings, and 3D shapes enables the complex molecular architecture required for life.

3) Understanding carbon chemistry not only deepens our grasp of life but also empowers us to design solutions for the world's most pressing challenges.

IV. **Fill in the gaps with the given words:**

carbon, attach, electron, empty, atom, compounds , elements, share, organic, bonds, oxygen, halogens

Carbon's combining power. In its outer shell, a carbon _____ (1) has four electrons. The shell is exactly half-filled. A single _____ (2) atom can thus form four two-electron bonds. This means that a carbon atom is able to _____ (3) itself to up to four other atoms. By sharing one _____ (4) from each of four other atoms, the carbon atom "fills up" the four _____ (5) spots in its outer shell. The carbon atom can also _____ (6) four electrons from only one other atom or any number of atoms up to four.

Not only is a carbon atom able to form _____ (7) with other carbon atoms, it can also bond readily with hydrogen atoms and with atoms of the _____ (8) to its right in the periodic table: nitrogen and_____ (9). A very large number of _____ (10) substances are made up of the elements carbon, hydrogen, oxygen, and/or nitrogen. Other elements often found in organic _____ (11) include sulfur, phosphorus, and the halogens. The _____ (12) include fluorine, chlorine, bromine, and iodine. Chlorine is particularly active with carbon.

V. Translate into English:

1.За останні кілька десятиліть хімікам у лабораторії вдалося поєднати атоми вуглецю з атомами більшості інших елементів.

2. Відкрилася цілком нова галузь хімії – металоорганічна хімія.

3. Ця галузь вивчає поведінку речовин, що містять вуглець-метал зв'язки.

4.Багато з них знайшли важливе застосування в промисловості як каталізатори, речовини, які викликають хімічні зміни, не змінюючись самі.

5. Ще одним важливим аспектом хімії на основі вуглецю є здатність атомів вуглецю з'єднуватися між собою більш ніж одним зв'язком.

6.Два атоми вуглецю можуть бути з'єднані двома або навіть трьома парами електронів, утворюючи подвійні або потрійні вуглець-вуглецеві зв'язки.

7. Атоми вуглецю, з'єднані кратними (multiple) зв'язками, є дуже реакційними.

8.Це означає, що вони легко вступають у хімічну активність з іншими атомами.

9.І навпаки, чим більша кількість одинарних зв'язків, що об'єднують атоми вуглецю, тим менша їх реакційна здатність.

10.У простих сполуках, таких як етен (етилен), підвищена реакційна здатність широко використовується у створенні широкого спектру промислово важливих хімічних речовин.

11.У складніших органічних речовинах такі подвійні або потрійні зв'язки можуть впливати на колір речовини.

12.Наприклад, частина зорового процесу у людини залежить від подвійного зв'язку у сполуці родопсину(rhodopsin), яка знаходиться в сітківці (the retina) в задній частині ока.

VI.Watch and listen to Jakob Magolan's lecture and give the answers to the questions.

1. What's the aim of Jakob Magolan's lecture?
2. What effect does epinephrine have on the body?
3. What's the second name for epinephrine?
4. How do we extract epinephrine? Is there any difference between synthetic and natural molecule of epinephrine?
5. What's the value of carbon in organic chemistry?

Part 2. Pharmacology

Unit 5

Topic: PHARMACOLOGY. MECHANISMS OF DRUG ACTION. DRUG INTERACTIONS

TEXT A
Pharmacology

I. Read and translate the text using the dictionary:

substances	речовини
regimen	режим
observational medicine	обсерваційна медицина
high-precision control	високоточний контроль
clinical trials	клінічні випробування
marketing surveillance	маркетинговий нагляд
excretion	виведення
is eliminated via	виводиться через
kidneys	нирки
bile	жовч
liver	печінка
adverse effects	побічні ефекти
side effects	побічні ефекти
enzymes	ферменти
ion channels	іонні канали
forefront	на передньому плані

II. After reading the text decide if the following statements are true (T) or false (F). Correct the false ones:

1) Ancient pharmacology dates back to Egyptian, Indian, Greek, and Chinese civilizations.

2) Modern pharmacology plays the second role in the development of new drugs, the prevention of diseases, the spread of pathologies, and the improvement of the quality of people's life.

3) Drug development is lengthy (10–15 years) and expensive, requiring regulatory approval (FDA, EMA, etc.).
4) Pharmacodynamics (PD) is what the body does to the drug.
5) Toxicology is **-** an application of pharmacological principles in humans.
6) Neuropharmacology is the study of drugs that influence mood, perception, and behavior**.**

Pharmacology is a fundamental science that lies at the intersection of medicine, chemistry, biology, and physiology. Its study is the study of the action of drugs on living organisms, as well as on the human body with these substances.

History and Evolution. Ancient pharmacology dates back to Egyptian, Indian, Greek, and Chinese civilizations (herbal remedies, minerals, and animal products). Hippocrates and Galen laid early foundations with observational medicine.

- In the 19th century, pharmacology became a scientific discipline with the isolation of active substances like morphine, quinine, and digitalis.
- The 20th century saw the development of: Synthetic drugs; Antibiotics; Anesthetics; Chemotherapy; Rational drug design
- Modern pharmacology integrates genomics, bioinformatics, biotechnology, and AI for personalized medicine

Modern pharmacology plays a key role in the development of new drugs, the prevention of diseases, the spread of pathologies, and the improvement of the quality of life of millions of people around the world.

Drug Development and Clinical Trials.

Stages: Discovery**:** screening of potential molecules
Preclinical Testing: in vitro and animal studies
Clinical Trials: Phase I – Safety (healthy volunteers),
Phase II – Efficacy (patients), Phase III – Large-scale testing.
Phase IV – Post-marketing surveillance.

Drug development is lengthy (10–15 years) and expensive, requiring regulatory approval (FDA, EMA, etc.).

Pharmacology is the scientific study of drugs, including their regimen, composition, pharmacokinetics, pharmacodynamics, therapeutic use, and toxicology. It lies at the intersection of medicine, chemistry, biology, and physiology and plays a key role in the observed interaction of drugs with biological sequences. Core Areas of Study: Drug composition and properties; Mechanism of action; Biological effects; Therapeutic and toxicological uses; Drug metabolism and excretion; Interactions with other substances.

This field is at odds with everything from how drugs are discovered and synthesized, to their effects on the body, how they are metabolized and formed from the body, and how they can be used.

Major Branches of Pharmacology.

Pharmacokinetics (PK). What the body does to the drug Focuses on ADME**:**

- Absorption – how a drug enters the bloodstream
- Distribution – how it spreads through tissues

- Metabolism – how it is chemically modified (usually in the liver)
- Excretion – how it is eliminated (via kidneys, bile, etc.)

Pharmacodynamics (PD). What the drug does to the body

Studies the mechanism of action, including:

- Drug-receptor interactions
- Dose-response relationships
- Therapeutic effects and side effects

Clinical Pharmacology:

- Application of pharmacological principles in humans.
- Covers drug safety, efficacy, dosage, drug interactions, and clinical trials.

Toxicology:

- Study of the adverse effects of chemicals or drugs.
- Includes poisoning, overdose, and carcinogenicity.

Neuropharmacology: Focuses on drugs affecting the central and peripheral nervous systems**.**

Psychopharmacology: Study of drugs that influence mood, perception, and behavior**.**

Pharmacogenetics and Pharmacogenomics:

- Study of how genetic variation affects individual responses to drugs.
- Central to personalized medicine.

Molecular Pharmacology: Explores drug actions at the molecular level: genes, proteins, enzymes, ion channels.

With the rapid development of biomedicine, molecular genetics, biotechnology and information technology, pharmacology is moving from the traditional study of the effects of substances to high-precision control of the body's molecular mechanisms. This makes it a responsible part of clinical practice, scientific research and the pharmaceutical industry.

From the discovery of new drugs to the treatment of patients, pharmacology ensures that therapeutics are targeted, effective and minimally toxic. As new diseases and treatments emerge, pharmacology remains at the forefront of medical innovation, safety and personalized healthcare.

Pharmaceutical science continues to evolve and will play a critical role in future medical innovation, digital health and biotechnology.

III.Fill in the gaps with the given words:

circulation, effects, advances, complex, sciences, molecular, pharmacology, modern

Pharmacology is the cornerstone of _____ (1) medicine. As a science, it covers all stages of drug _____ (2) : from the discovery and synthesis of a molecule to its clinical use and safety assessment.

Pharmacology is a _____ (3) and dynamic science of critical importance to modern medicine. It unites biological, chemical and clinical_____ (4), explaining the mechanisms of action of drugs and how to use them safely and effectively.

Modern _____ (5) is not limited to the simple study of drugs - it is becoming an integral platform connecting _____(6) biology, genomics,

bioengineering and informatics. Thanks to the _____ (7) in pharmacology, it has become possible to treat previously incurable diseases, prolong life, minimize side _____ (8) and create personalized approaches to therapy.

IV. Match the words with their definitions:

1) Pharmacokinetics	a) a medical specialty focused on the safe, effective, and appropriate use of medicines in humans.
2) Pharmacodynamics	b) the study of how a person's genes affect their body's response to medications.
3) Clinical Pharmacology	c) the study of how drugs affect the nervous system, including the brain and spinal cord
4) Toxicology	d) the study of how the body interacts with administered substances for the entire duration of exposure
5) Neuropharmacology	e) a subfield of pharmacology that focuses on the mechanistic understanding of drug action at the molecular level
6) Pharmacogenetics	f) the scientific study of the harmful effects of chemical, physical, and biological agents on living organisms and the environment
7) Molecular Pharmacology	g) the study of the biochemical and physiologic effects of drugs

V. Title the columns (1-5) using the names (a-e) below.

a- **Targeted therapy**
b- **Gene and RNA therapy**
c- **Nanomedicine**
d- **AI in Drug Discovery**
e- **Personalized Medicine**

Modern Trends in Pharmacology:

1	2	3	4	5
Drug delivery systems using nanoparticles.	Pharmacogenomics to tailor drugs to genetic profiles.	Monoclonal antibodies (e.g., trastuzumab); Tyrosine kinase inhibitors.	Predicting drug-receptor interactions; Accelerating clinical trial analysis.	- mRNA vaccines; - siRNA drugs.

VI. Thranslate into English:

8 цікавих фактів про фармацію

1. Coca-Cola винайшов фармацевт на ім'я Джон Пембертон. Він носив глечик з новим продуктом по вулиці до аптеки Джейкоба, де його

пробували, визнавали «чудовим» і виставляли на продаж за 5 центів за склянку як газовану воду.
2. Інший фармацевт, Чарльз Алдертон, винайшов Dr. Pepper. Pepsi також був винайдений фармацевтом, як і імбирний ель Vernor's Ginger Ale фармацевтом з Детройта Джеймсом Вернором.
2. Перший ліцензований фармацевт відкрив магазин у Французькому кварталі. Луї Дюфіло-молодший з Нового Орлеана став першим ліцензованим фармацевтом Америки на початку 1800-х років. До того часу, щоб стати фармацевтом, ліцензія не була потрібна.
3. Світовий фармацевтичний ринок оцінюється в 300 мільярдів доларів.
4. Бенджамін Франклін був фармацевтом, а Агата Крісті була фармацевтичним техніком.
5. Ліпітор (Lipitor) — найпопулярніший препарат усіх часів. Він був представлений у 1997 році, а термін дії його патенту закінчився у 2011 році, принісши близько 125 мільярдів доларів.
6. Інсулін є одним із найпоширеніших препаратів, що викликають побічні ефекти.
7. Гідрокодон/ацетамінофен (Hydrocodone/acetaminophen) є найчастіше призначеним препаратом у Сполучених Штатах. Лізиноприл (Lisinopril) посідає друге місце станом на 2014 рік.
8. Найдорожчим препаратом є Glybera, оптова вартість якого становить 1,21 мільйона доларів на рік. Це генна терапія, яка допомагає відновити активність ферменту ліпопротеїнліпази у людей із сімейним дефіцитом ліпопротеїнліпази. Лише 1 мільйон пацієнтів мають цей надзвичайно рідкісний стан.

VII. Put the following expressions into appropriate columns:

Toxicology in Pharmacology	*a- Acute and chronic toxicity* **……**
Pharmacovigilance. Ongoing monitoring of **drug safety** post-approval:	*b-- Reports adverse drug reactions (ADRs)* **……**

c- Teratogenicity
d- Mutagenicity
e- LD_{50} and NOAEL (no observed adverse effect level)
f- May lead to:
- Label updates
- Black-box warnings
- Drug withdrawal

g- Ensures safe long-term use
h- Carcinogenicity

VIII. Speak on the topic using these phrases:

Substances, regimen, observational medicine, high-precision control, clinical trials, marketing surveillance, excretion, be eliminated via, adverse effects side effects, drug therapy experts, primary health professionals, to produce positive health-outcomes, to interact with living organisms, specialized branches, pure and applied sciences, quality control process, pharmaceutical production, drug discovery, a scientific discipline.

Text B
Mechanisms of drug action

I.Read and translate the text using the dictionary:

composed	складається з
interacting cells	взаємодіючі клітини
signaling molecules	сигнальні молекули
feedback loops	петлі зворотного зв'язку
to disrupt	порушувати
alter functions	змінюють функції
mitigate symptoms	пом'якшувати симптоми
tissue	ткана
systemic levels	системні рівні
enzyme inhibition	інгібування ферментів
competitive	конкурентний
irreversible	незворотний
dose-response relationship	залежність доза-реакція
prodrugs	проліки

The human body is a highly complex biological system composed of trillions of interacting cells, signaling molecules, and feedback loops. When disease disrupts these systems, pharmacological intervention becomes necessary. But how exactly do drugs restore health, alter functions, or mitigate symptoms?

The science behind this lies in the mechanism of drug action**,** which refers to how drugs produce their effects at the molecular, cellular, tissue, and systemic levels**.** Understanding drug mechanisms is essential for: designing effective therapeutics; predicting side effects and interactions; **o**ptimizing dosing regimens; personalizing treatments based on genetic profiles.

Drugs act not by creating new biological functions, but by modifying existing physiological and biochemical pathways**.** This is achieved primarily through interactions with specific targets, such as receptors, enzymes, ion channels, and transporters. The mechanisms can be broadly categorized into receptor-mediated actions and non-receptor actions**,** with further complexity introduced by signal transduction pathways**,** feedback inhibition, and genomic responses**.**

This in-depth explanation will cover the types of drug targets, molecular interactions, signal pathways, and the clinical implications of these mechanisms.

Principles of Drug Action. Drugs exert their effects by binding to specific biological molecules**.** This interaction is often highly selective and dose-dependent**.** Binding can either stimulate (agonism) **or** inhibit (antagonism) a physiological response.

Primary Drug Targets.

Drugs typically act on one or more of the following four primary types of targets:

Target Type	Example Drugs	Function
Receptors	Beta-blockers, opioids	Signal transduction
Enzymes	ACE inhibitors, aspirin	Catalysis
Ion channels	Local anesthetics	Regulate ion flow
Transporters	SSRIs, diuretics	Move molecules across membranes

Drug-Receptor Interactions.

Receptors are macromolecules (usually proteins) that recognize specific ligands and initiate a cellular response.

1. Types of Receptors:

1. **G protein-coupled receptors (GPCRs)** – e.g., adrenergic receptors
2. **Ion channel-linked receptors** – e.g., nicotinic acetylcholine receptor
3. **Enzyme-linked receptors** – e.g., insulin receptor
4. **Nuclear receptors** – e.g., steroid hormone receptors

2. Ligand Types:

- **Agonists**: Activate the receptor to produce a response
- **Partial agonists**: Activate but produce a submaximal response
- **Antagonists**: Bind but do not activate (block agonist action)
- **Inverse agonists**: Inhibit basal activity of receptor

Example:

- Epinephrine (agonist) binds to β-adrenergic receptor → activates cAMP pathway → increased heart rate;

- Propranolol (antagonist) blocks the same receptor → reduced heart rate

Signal Transduction Pathways: Drugs can initiate or inhibit intracellular signaling cascades**:**

Enzyme Inhibition. Many drugs work by inhibiting enzymes**,** either reversibly or irreversibly. Types of Inhibition:

- **Competitive**: Drug competes with substrate (e.g., statins)
- **Non-competitive**: Drug binds elsewhere and changes enzyme shape
- **Irreversible**: Drug forms covalent bond with active site (e.g., aspirin)

Example: Aspirin irreversibly inhibits cyclooxygenase (COX) → ↓ prostaglandins → ↓ inflammation.

Ion Channel Modulation

Drugs can **open or block** ion channels in membranes:

Drug	Target Channel	Effect
Lidocaine	Na^+ channel (neurons)	Blocks nerve conduction
Calcium channel blockers	L-type Ca^{2+} channels	Relax smooth muscle

Transporter Inhibition.

Some drugs block membrane transport proteins**,** affecting substance movement:

Example: Fluoxetine (Prozac) inhibits serotonin reuptake transporter (SERT) → ↑ serotonin in synapse → antidepressant effect

Genomic Mechanisms

Some drugs act at the **nuclear level**, altering **gene expression**:

Type	Example
Steroid hormones	Cortisol, estrogen
Retinoids	Tretinoin
Thyroid hormones	Levothyroxine

Mechanism:

1. Drug crosses membrane
2. Binds **nuclear receptor**
3. Alters **transcription of target genes**
4. Delayed but sustained cellular effects

Indirect Drug Actions: **Prodrugs -** Inactive compounds metabolized into active forms (e.g., codeine → morphine); **Placebo effect -** psychological mechanism where belief produces biological response; **Synergistic/antagonistic interactions** -one drug may enhance or reduce another's effect.

Dose-Response Relationship:

Graded response: Continuous effect with increasing dose
Quantal response: All-or-none effect in a population
ED_{50}: Dose producing 50% of maximum effect
Therapeutic Index (TI) = LD_{50} / ED_{50} → indicator of safety

Understanding mechanisms of drug action allows: do rational drug design; reduction of adverse effects**;** to predict drug interactions; personalized therapy and targeted treatments (e.g., monoclonal antibodies). Mechanisms of drug action reflect a vast diversity of molecular interactions and physiological outcomes**.** Drugs act through receptors, enzymes, ion channels, and transporters, and can exert effects

rapidly (e.g., ion channel blockers) or slowly (e.g., gene regulators). Understanding these allows for the rational development of therapies, optimized dosing, minimization of toxicity, and the advancement of precision medicine. For example, the knowledge of receptor subtypes led to the development of selective beta-blockers, minimizing respiratory side effects. Similarly, insights into enzyme inhibition mechanisms guide cancer chemotherapy and antimicrobial design.

In essence, the study of drug mechanisms is the bridge between molecule and medicine — turning chemical potential into therapeutic power**.**

II. Having read the text decide whether the following statements are true (T) or false (F). Correct the false ones.

1) When disease disrupts these systems, pharmacological intervention becomes necessary.

2) Drugs act not by creating new biological functions

3) Drugs exert their effects by binding to specific biological molecules**.**

4) All drugs block membrane transport proteins**,** affecting substance movement

5) Prodrug is a psychological mechanism where belief produces biological response.

6) Many drugs work by inhibiting enzymes**,** either reversibly or irreversibly.

III.Match the words with their definitions:

1) drug	**a)** a part of the DNA in a cell that controls the physical development, behaviour, etc
2) nanomedicine	**b)** Prodrug is a compound with little or no pharmacological activity that metabolizes inside the body and converts into a pharmacologically active drug compound.
3) gene	**c)** specialized proteins embedded in cell membranes that act as pores, allowing ions to pass through and across the membrane
4) prodrug	**d)** is defined as the application of nanobiotechnology in clinical medicine,
5) placebo effect	**e)** refers to the process where molecules (inhibitors) reduce the activity of enzymes, either by directly blocking the enzyme's active site or by altering its shape, thus preventing it from binding to its substrate or catalyzing a reaction
6) enzyme inhibition	**f)** is a chemical substance that triggers a change in a cellular process
7) ion channels	**g)** a phenomenon where a person experiences a positive change in their condition after receiving a treatment that has no active therapeutic effect.

IV.Read and translate this information. Do you agree with these opinions? Justify your answer. Expand the answer if you can.

1. Mechanisms of drug action represent the core of pharmacological science, linking chemical structure with biological function
2. Drugs act through receptors, enzymes, ion channels, and transporters. Understanding these mechanisms is not only academically essential, but also clinically vital**.**

3. In the modern era of biotechnology and genomics, the depth of our understanding of drug mechanisms continues to grow. This knowledge forms the foundation for next-generation therapeutics, including biologics, mRNA vaccines, nanomedicines**,** and AI-guided drug discovery.

V. Make up the sentences with these words and phrases:

mechanism of drug action; drugs effects at the molecular, cellular, tissue, and systemic levels**;** drug mechanisms; **d**esigning effective therapeutics; **p**redicting side effects and interactions; **o**ptimizing dosing regimens; **p**ersonalizing treatments based on genetic profiles; receptor-mediated actions**;** signal transduction pathways**;** feedback inhibition**;** genomic responses**.**

VI. Make up a plan of the text and a summary to cover the topic.

Text C
Drug interactions

I. Read and translate the text.

In modern medicine, it is common for patients—especially those with chronic illnesses—to be prescribed multiple medications simultaneously. This practice, known as polypharmacy, increases the risk of drug interactions—situations in which the effect of one drug is altered by the presence of another**.** These interactions can lead to treatment failure**,** adverse drug reactions (ADRs)**,** toxicity, or even life-threatening conditions**.**

Drug interactions are not limited to prescription drugs—they may also involve over-the-counter (OTC) medications**,** herbal supplements**,** nutrients**,** and lifestyle factors like alcohol, smoking, and food. Clinicians, pharmacists, and patients must therefore possess a clear understanding of how drugs can interact to ensure safe and effective pharmacotherapy**.** Understanding drug interactions requires knowledge of pharmacokinetics (what the body does to the drug), pharmacodynamics (what the drug does to the body), and biochemical mechanisms involved in absorption, metabolism, distribution, and excretion.

A drug interaction occurs when the pharmacological or clinical response to the administration of a drug is altered by the presence of another drug, food, chemical substance, or condition**.**

Classification of Drug Interactions

By Mechanism: - Pharmacokinetic interactions
- Pharmacodynamic interactions
- Pharmaceutical (physical/chemical) interactions

By Outcome: - Synergistic (potentiation) *– Enhanced effect*
- Antagonistic **– Diminished effect**
- Additive **– Sum of effects**
- No interaction **– Neutral coexistence**

By Clinical Relevance: - Major *– Potentially life-threatening*
- Moderate **– May require therapy adjustment**
- Minor **– Clinically insignificant**

Pharmacokinetic interactions affect one or more of the ADME processes**:**

1. Absorption: Drug A affects the absorption of Drug B from the GI tract**.** Examples: Antacids reduce absorption of tetracyclines by forming chelates**;** Omeprazole reduces stomach acidity, affecting ketoconazole absorption**.**

2. Distribution: Competition for plasma protein binding sites. Examples: Warfarin displaced by NSAIDs, increasing free active form → bleeding risk.

3. Metabolism: Enzyme induction or inhibition, mainly involving cytochrome P450 enzymes (CYPs):

Type	Effect	Example
Inhibition	↓ metabolism → ↑ drug level	**Erythromycin** inhibits CYP3A4 → ↑ levels of statins
Induction	↑ metabolism → ↓ drug level	**Rifampin** induces CYP3A4 → ↓ levels of oral contraceptives

4. Excretion: Altered renal or biliary excretion. Examples: Probenecid blocks renal secretion of penicillin, prolonging its effect; NSAIDs decrease renal clearance of methotrexate → toxicity.

Pharmacodynamic Drug Interactions. Pharmacodynamic interactions occur when two drugs act on the same or related targets, enhancing or diminishing each other's effects:

1. **Synergism / Potentiation.** Example**:** Alcohol + benzodiazepines → increased CNS depression; Sulfamethoxazole + trimethoprim → synergistic antibacterial effect.

2. **Antagonism.** Example**:** Beta-agonists (e.g., salbutamol) **+** beta-blockers (e.g., propranolol) → reduced bronchodilation; Naloxone antagonizes opioids like **morphine.**

3. **Additive Effects.** Example**:** Antihypertensives (ACE inhibitors + diuretics) → increased blood pressure lowering.

Pharmaceutical (In Vitro) Interactions occur before administration, such as during mixing of drugs in IV lines. Examples: Phenytoin precipitates in dextrose solution; Incompatibility between heparin and certain antibiotics. These are **avoidable** with proper formulation and preparation practices.

Interactions with Food and Supplements:

- **Grapefruit juice** inhibits **CYP3A4**, increasing levels of drugs like **simvastatin**
- **Vitamin K-rich foods** antagonize **warfarin**
- **Calcium-containing dairy** interferes with absorption of **fluoroquinolones**
- **St. John's Wort** induces **CYP3A4**, reducing effectiveness of antidepressants, contraceptives.

*Understanding the mechanisms—whether pharmacokinetic or pharmacodynamic provides the foundation for **personalized medicine**, where drug choices and doses are tailored to an individual's genetics, comorbidities, and concurrent treatments.*

From life-saving synergistic combinations in chemotherapy to dangerous antagonistic effects in cardiovascular drugs, drug interactions can enhance therapy or endanger life—depending on how well they are managed.

Therefore, the comprehensive assessment of drug interactions should be integral to every prescribing decision**.** This includes staying current with medical literature, utilizing interaction checkers, and maintaining open communication among healthcare providers and with patients.

In summary, managing drug interactions is not just a clinical task—it's a cornerstone of patient safety, therapeutic efficacy, and responsible pharmacological practice.

II. Come up with 5 questions on the gist of the text and ask your group-mates to answer them.

III.Read and translate this information. Do you agree with these opinions? Justify your answer. Expand the answer if you can.

1) Drug interactions represent one of the most common and preventable causes of medication-related morbidity and mortality.
2) With the increasing complexity of pharmacotherapy, particularly in aging populations and patients with comorbidities, awareness and vigilance regarding drug interactions are essential.
3) Understanding the mechanisms—whether pharmacokinetic or pharmacodynamic—allows healthcare professionals to anticipate and mitigate potentially harmful interactions**.**

IV.Find explanation to the strategy matching (1-5) to (a-e).

Prevention and Management Strategies

Strategy	*Explanation*

1) Medication reconciliation	…..
2) Use of drug interaction databases	……
3) Start low, go slow	…….
4) Monitor therapeutic drug levels	**……**
5)Patient education	**……**

a- Especially for narrow TI drugs
b- Especially in elderly or high-risk patients
c- Lexicomp, Micromedex, Medscape
d- Avoid OTC meds, herbal products without consulting a doctor
e- Review of all current drugs

V. Make up sentences with these words and phrases:
Polypharmacy, over-the-counter (OTC) medications**,** herbal supplements**,** nutrients, biochemical mechanism, absorption, metabolism, distribution**,** excretion**,** clinical examples, prevention strategies, drug interactions.

VI.Watch and listen to Katherine Eban speaking about generic drugs and answer the questions.

1. What is FDA?
2. Why did she start her investigation?
3. What did she start the investigation with?
4. What did she proceed with?
5. What did she find out?

Unit 6

Topic: MEDICINES. PHARMACEUTICAL PRODUCTION EQUIPMENT

TEXT A
Forms of medicines

I. Read and translate the text using the dictionary

dosage form	лікарська форма
drug's efficacy	ефективність препарату
patient compliance	дотримання пацієнтом режиму прийому ліків
shelf-life	термін придатності
to facilitate	для сприяння
precision in dosing	точність дозування
duration of release	тривалість вивільнення
route of administration	шлях введення
clinical application	клінічне застосування
therapeutic outcomes	терапевтичні результати
inactive excipients	неактивні допоміжні речовини
therapy delivery	доставка терапії
dosing frequency	частота дозування
OTC remedy	безрецептурний засіб

II. Having read the text decide whether the following statements are true (T) or false (F). Correct the false ones:

1) Medicinal forms are developed to facilitate the delivery of active pharmaceutical ingredients.
2) The form in which a medication is delivered to a patient—commonly known as its dosage form or pharmaceutical form.
3) Choosing the appropriate form is essential for optimizing therapeutic outcomes and minimizing side effects.
4) A dosage form is an oral form in which a drug is produced and administered.
5) Tablets may be coated (film, sugar, enteric) or uncoated.
6) Pharmaceutics is a branch of pharmaceutical science that bridges drug discovery and clinical application.

The form in which a medication is delivered to a patient—commonly known as its dosage form or pharmaceutical form—is just as critical as the drug itself. A drug's efficacy, safety, absorption, patient compliance, and even shelf-life are highly influenced by how it is formulated and administered**.**

Medicinal forms are developed not only to facilitate the delivery of active pharmaceutical ingredients (APIs) to their site of action but also to ensure stability, patient acceptability, precision in dosing, and control over the rate and duration of release. They can vary greatly depending on age, condition, route of administration, and the pharmacokinetics of the active substance.

The science behind creating these various forms is known as pharmaceutics—a branch of pharmaceutical science that bridges drug discovery and clinical application. Choosing the appropriate form is essential for optimizing therapeutic outcomes and minimizing side effects**.**

Definition of Dosage Form. A dosage form is the physical form in which a drug is produced and administered to a patient. It includes both the active drug and inactive excipients that aid in delivery, absorption, taste, stability, and preservation.

Solid Dosage Forms:

1. **Tablets** may be coated (film, sugar, enteric) or uncoated.

Advantages:- Accurate dosing; - Easy to handle and store; - Mass production-friendly. *Disadvantages***:** - Swallowing difficulty in children/elderly; - Slower onset than liquids or injections.*Types of Tablets***:** - Conventional tablets; - Chewable tablets**;** - Effervescent tablets**;** - Sublingual and buccal tablets**;** - Controlled-release tablets (ER, SR, CR).

2. Capsules - Gelatin shells filled with powder or liquid drug. May be: - Hard gelatin capsules **(**for powders), - Soft gelatin capsules (for oils or liquids).

Advantages:- Mask unpleasant taste;- Rapid disintegration in GI tract.

3. **Powders and Granules** - Used for oral or reconstitutable forms (e.g., antibiotics)

4. Liquid Dosage Forms:

1. Solutions - Drug completely dissolved in solvent (e.g., syrups, elixirs)
2. Suspensions - Insoluble particles suspended in liquid medium
3. Emulsions - Mixtures of oil and water (two immiscible liquids)

Advantages: - Easier swallowing; - Faster onset than solids; - Flexible dosing.

Disadvantages:- Less stability; - Potential microbial contamination.

5. **Parenteral Dosage Forms** - Administered via injection, bypassing GI tract:

Type	*Route*	*Example*
Intravenous (IV)	Vein	Antibiotics, fluids, anesthesia
Intramuscular (IM)	Muscle	Vaccines, hormones
Subcutaneous (SC)	Under skin	Insulin, heparin

Advantages: - Immediate effect (especially IV),- Useful in unconscious patients.

Disadvantages: - Requires sterile techniques, - Pain, risk of infection.

6. **Topical Dosage Forms** - Applied directly to skin, eyes, or mucous membranes:

Form	*Base Type*	*Application*
Cream	Oil-in-water	Moisturizing, absorption
Ointment	Water-in-oil	Occlusive, protective
Gel	Aqueous polymer	Non-greasy, cooling
Patch	Polymer matrix	Sustained transdermal delivery (e.g., nicotine, fentanyl)

7. Inhalation Dosage Forms - Used primarily for respiratory disorders:

Type	*Example Drugs*
Metered-dose inhaler (MDI)	Salbutamol, corticosteroids
Dry powder inhaler (DPI)	Tiotropium, formoterol
Nebulizers	Ipratropium, salbutamol

Advantages: - Direct lung action; - Rapid onset.

8. Sublingual and Buccal Dosage Forms: Placed under tongue or inside cheek. ***Example:*** Nitroglycerin, loratadine. *Advantages:* Rapid absorption through mucosa → avoids first-pass metabolism

9. **Advanced and Novel Drug Delivery Systems:**

1. Controlled-release systems (e.g., Osmotic Pump Tablets);
2. Transdermal systems;
3. Liposomes and Nanoparticles;
4. Implants and biodegradable depots;
5. mRNA delivery systems (e.g., lipid nanoparticles);
6. Oral thin films (rapid disintegration, pediatric uses).

10. Packaging and Stability Considerations:

Dosage forms must protect drugs from moisture, light, air, microbes. Blister packs, glass ampules, sachets, vials are designed based on form sensitivity.

Dosage forms are far more than a matter of packaging or patient preference—they represent the strategic design of therapy delivery. By altering the route, composition, and release profile of a drug, pharmaceutical scientists can dramatically influence how quickly, where, and how effectively a medication acts in the body**.**

The evolution from basic solid pills to sophisticated targeted delivery systems such as liposomes, patches, and nanoparticles has revolutionized the ability to treat diseases that were once considered intractable. Today, dosage forms are not only functional but also engineered to enhance compliance, reduce dosing frequency, and minimize side effects.

In clinical practice, the choice of form is influenced by:

- Patient factors (age, consciousness, swallowing ability)

- Drug properties (solubility, stability, absorption site)
- Therapeutic goals (local vs systemic, immediate vs sustained effect)

Moreover, in global health contexts, forms like oral rehydration solutions**,** implants, and heat-stable powders have made critical medications accessible in remote and resource-limited settings.

III.Fill in the gaps with the given words:

registered, available, distinction, pharmacist, prescribed, called, regulated

Dispensing of medication is often _____ (1) by governments into three categories — *over-the-counter* (OTC) medications, which are _____ (2) in pharmacies and supermarkets without special restrictions. *Behind-the-counter* (BTC), which are dispensed by a _____ (3) without needing a doctor's prescription. Aand *Prescription only medicines* (POM), which must be _____(4) by a licensed medical professional, usually a physician.

In the UK, BTC medicines are _____ (5) pharmacy medicines. Which can only be sold in _____ (6) pharmacies, by or under the supervision of a pharmacist. However, the precise _____ (7) between OTC and prescription drugs depends on the legal jurisdiction.

IV. Match the words with their definitions:

1) dosage forms	a) a microscopic particle with at least one dimension measuring between 1 and 100 nanometers (nm).
2) an active drug	b) a dry substance composed of very fine, loose particles.
3) inactive excipients	c) are small agglomerates of pharmaceutical powders, prepared by special processing methods.
4) drug delivery	d) is a homogeneous mixture where one or more substances (solutes) are dissolved in a liquid (solvent).
5) nanoparticle	e) are pharmaceutical drug products presented in a specific form for use.
6) a tablet	f) a mixture of two or more liquids that typically don't mix (immiscible), where one liquid is dispersed as tiny droplets within the other.
7) a capsule	g) a type of pharmaceutical product used for daily skin care, as well as medicated and non-medicated applications.
8) a powder	h) the component of a medication that directly produces the intended therapeutic effect on the body.
9) granules	i) a semi-solid preparation typically used for topical application to the skin.
10) a liquid solution	j) is a semi-solid that can have properties ranging from soft and weak to hard and tough.

11) a suspension	k) a small, sealed container, often made of gelatin, that encloses medication or other substances.
12) an emulsion	l) substances in medications that are not the active ingredient intended to treat a disease or condition.
13) Creams	m) various methods and technologies designed to transport pharmaceutical compounds .
14) an ointment	n) a tiny piece of black silk or court plaster worn on the face or neck especially by women.
15) a gel	o) is a temporary removal or interruption of something, often as a form of punishment or restriction.
16) a patch	p**)** is a pharmaceutical oral dosage form (oral solid dosage, or OSD) or solid unit dosage form.

V.Read and translate this information. Do you agree with these opinions? Justify your answer. Expand the answer if you can.

1. As medical science continues to advance, the importance of intelligent, adaptable, and patient-centered formulation strategies will only grow.

2. A thorough understanding of medicinal forms is therefore essential for pharmacists, physicians, formulators, and everyone involved in the drug delivery chain**.**

VI. Match examples (a-h) with the routes (1-8).

Classification by Route of Administration:

Route	***Examples***
1) Oral	…..
2) Parenteral	…..
3)Topical	…..
4) Inhalational	…..
5) Rectal/Vaginal	…..
6) Ophthalmic	…..
7) Nasal	…..
8) Sublingual/Buccal	…..

a - Suppositories, pessaries
b - Tablets, capsules, syrups
c - Creams, ointments, patches
d - Sprays, drops
e - Aerosols, dry powder inhalers (DPIs)
f - Injections (IV, IM, SC)
g - Eye drops, gels
h - Lozenges, sublingual tablets

VII. Translate into English:

Взаємодія препарату з рецептором:

1). Препарати здійснюють ефект, зв'язуючись з клітинними мішенями, такими як:
- Рецептори (GPCR, іонні канали, ядерні рецептори)
- Ферменти
- Транспортні білки
- ДНК/РНК
2). Ключові поняття:
- Агоністи: активують рецептори
- Антагоністи: блокують рецептори
- Часткові агоністи: спричиняють слабшу активацію
- Зворотні агоністи: спричиняють протилежний ефект агоністам

VIII. Speak on the topic using these phrases:

Dosage forms, therapy delivery, pharmaceutical scientists, acts in the body, pills, to treat diseases, side effects, clinical practice, a tablet, a capsule, a suspension, a liquid solution, a patient, a pharmaceutical form, patient compliance, precision in dosing, control, release.

Text B
Classification and main characteristics of medicines

I.Read and translate the text using the dictionary

alleviating diseases	полегшення захворювань
common analgesics	поширені анальгетики
appropriate usage	відповідне використання
molecular backbone	молекулярна основа
dispensing	видача ліків
alphanumeric codes	алфавітно-цифрові коди
bioavailability	біодоступність
bioequivalence	біоеквівалентність

Medicines are at the core of modern healthcare, serving as tools for treating, preventing, diagnosing, or alleviating diseases and medical conditions. However, the diversity of medicines—ranging from common analgesics to complex biologics—demands a structured approach to understanding their types, properties, and appropriate usage**.** To facilitate rational prescribing, manufacturing, regulatory control, and research, medicines are classified into various categories based on different criteria**,** such as chemical structure, mechanism of action, therapeutic use, legal status, and route of administration**.** Beyond classification, it is essential to understand the main characteristics that define a medicine's identity, quality, safety, and effectiveness. These include its active ingredient**,** formulation**,** pharmacodynamics**,** pharmacokinetics**,** dosage**,** and stability**.**

A medicine is any substance or combination of substances that is used or intended to be used for treating or preventing disease**,** diagnosing medical conditions, or modifying physiological functions in humans or animals.

I.Classification of Medicines

1. By Therapeutic Use (Pharmacological Classification).

This is the most common system used in clinical practice and formularies. It groups drugs based on what condition or system they target.

Category	*Examples*	*Function*
Analgesics	Paracetamol, ibuprofen	Relieve pain
Antibiotics	Amoxicillin, azithromycin	Kill/inhibit bacteria
Antihypertensives	Amlodipine, enalapril	Lower blood pressure
Antidepressants	Fluoxetine, sertraline	Treat depression
Antidiabetics	Metformin, insulin	Control blood sugar
Antivirals	Acyclovir, oseltamivir	Treat viral infections
Anticoagulants	Warfarin, rivaroxaban	Prevent blood clotting

2. **By Chemical Structure.** This groups drugs based on their molecular backbone or chemical family, often used in drug development and pharmacology.

Chemical Class	*Examples*
β-lactams	Penicillin, cephalosporins
Benzodiazepines	Diazepam, lorazepam
Macrolides	Erythromycin, clarithromycin
Steroids	Prednisolone, dexamethasone
Sulfonamides	Sulfamethoxazole, sulfasalazine

3. **By Mechanism of Action.**

This classification focuses on how the medicine works at the molecular level.

Mechanism	*Example*	*Effect*
Beta-blockers	Propranolol	Block β-adrenergic receptors
ACE inhibitors	Enalapril	Inhibit angiotensin-converting enzyme
Proton pump inhibitors	Omeprazole	Block gastric acid secretion
SSRIs	Fluoxetine	Inhibit serotonin reuptake

4. By Legal Status.

This classification affects dispensing and regulation**.**

Category	*Characteristics*
Prescription-only (Rx)	Requires a licensed prescriber

Category	*Characteristics*
Over-the-counter (OTC)	Available without prescription
Controlled substances	Subject to special regulation due to abuse potential (e.g., opioids, benzodiazepines)
Investigational drugs	Used only in clinical trials

5. **By Origin:**

Type	*Source*
Natural	Digoxin (from foxglove), morphine
Semi-synthetic	Amoxicillin (modified penicillin)
Synthetic	Paracetamol, aspirin
Biotechnological	Insulin (recombinant), monoclonal antibodies

6. **By Route of Administration:**

Route	*Dosage Forms*	*Example Drugs*
Oral	Tablets, syrups	Ibuprofen, metformin
Parenteral (injectable)	IV, IM, SC	Heparin, vaccines
Topical	Creams, ointments	Hydrocortisone
Inhalational	Aerosols, inhalers	Salbutamol
Sublingual	Sublingual tablets	Nitroglycerin
Rectal/Vaginal	Suppositories, pessaries	Glycerin, clotrimazole

7. **By ATC System (Anatomical Therapeutic Chemical Classification).**

A WHO-endorsed system that uses alphanumeric codes to classify drugs into **5 levels**: Anatomical group; Therapeutic subgroup; Pharmacological subgroup; Chemical subgroup; Specific substance.

Example: A10BA02 → Metformin

A = Alimentary tract and metabolism; 10 = Antidiabetics

II.Main Characteristics of Medicines

Each medicine is defined not only by its class but also by several core characteristics that influence its therapeutic use.

1. Active Pharmaceutical Ingredient (API):

- The biologically active substance responsible for the effect
- Can be synthetic, semi-synthetic, or natural

2. **Formulation (Dosage Form):**

- The physical form in which the medicine is produced
- Includes excipients that aid in delivery, taste, stability, etc.

3. **Pharmacokinetics.**

Describes what the body does to the drug (ADME):

Phase	*Description*
Absorption	How the drug enters the bloodstream
Distribution	How it spreads through tissues
Metabolism	How it's broken down (e.g., liver)
Excretion	How it's removed (e.g., kidneys)

4. **Pharmacodynamics.** Describes what the drug does to the body**:** interaction with receptors, enzymes, ion channels; dose-response relationship**;** therapeutic window (balance of efficacy vs toxicity).

5. **Potency and Efficacy:**

- *Potency*: Amount of drug needed to produce effect;
- *Efficacy*: Maximal effect a drug can produce.

6. **Safety Profile and Toxicity:**

- Therapeutic index (TI)**:** Margin between effective and toxic dose
- Side effects, contraindications, risk factors

7. **Stability and Shelf Life:** influenced by temperature, humidity, light, pH; requires proper packaging and storage**.**

8. **Bioavailability and Bioequivalence:**

- Bioavailability**:** Fraction of administered dose that reaches systemic circulation;
- Bioequivalence: Similar bioavailability between branded and generic products.

Furthermore, the main characteristics of medicines—from their pharmacodynamics and pharmacokinetics to their formulation and safety profile—are critical to ensuring that the right drug is given to the right patient at the right dose and time**.**

In the era of precision medicine, digital therapeutics, and biologics, the importance of understanding both classification and characteristics has never been greater. They underpin everything from drug discovery and development to clinical decision-making, public health planning, and patient education**.**

As pharmaceutical science evolves, so too will the complexity of medicines—but the fundamental need to classify, understand, and evaluate them remains unchanged. This knowledge empowers healthcare providers, pharmacists, researchers, and regulators to ensure safe, effective, and accessible treatment for all.

II. Having read the text decide whether the following statements are true (T) or false (F). Correct the false ones:

1) Medicines are classified into various categories based on different criteria.
2) It is not essential to understand the main characteristics that define a medicine's identity, quality, safety, and effectiveness.
3) A medicine is any substance or combination of substances that is used or intended only to be used for treating or preventing disease**.**
4) Pharmacodynamics describes what the drug does to the body.
5) Therapeutic index (TI) is a margin between effective and toxic dose
6) Bioavailability is an amount of drug needed to produce effect.

III. Determine what is a myth and what is a fact in each statement.

7 Myths about medication and the facts behind them

1) **A __**If you're really hurting, you can ignore the label and take more pills.
   B __ The truth is, if you take more than the dosage on the label it can hurt you.
2) **A __** Once you feel better, you don't have to keeo taking medication.
   B __ Your doctor prescribed that medicine because you need it. You want to make sure to take all of the medication your doctor prescribed to you.
3) **A __** The word "natural" doesn't always mean "safe". It also doesn't mean you can skip talking to your doctor about them.
   B __ Natiral supplements are always a safe choice.
4) **A __** Antibiotics are only helpful in illnesses caused by bacteria, such as Step throat. Most illnesses, like colds and sore throats, are caused by viruses that don't respond at all to antibiotics.
   B __ Antibiotics are the answer for every illness.
5) **A __** You don't need to tell your doctor which vitamins you take.
   B__ When prescribing a new medication or suggesting an OTC remedy (Over-the-counter remedy) your doctor does need to know about your die, lifestyle and all the OTC and prescription medications, vitamins and supplements you are taking.
6) **A __** IIt' best to keep medication handy in the bathroom or kitchen.
   B __ Unless you're told otherwise, you should always store medications in a dry area, away from heat and direct light – which generally means putting them away and out of sight.
7) **A __** You must pay attention to how pills should be taken and always take them exactly according to the label and prescription.
   B__ It doesn't matter how you swallow a pill as long as it gets where it needs to go. [3]

IV.Read and translate this information. Do you agree with these opinions? Justify your answer. Expand the answer if you can.

1) Medicines are not just chemical compounds**,** but complex therapeutic agents with biological, chemical, clinical, and societal dimensions.

2) Classifying them allows healthcare systems to organize pharmacological knowledge**,** regulate distribution, and ensure rational use**.**

3) Whether by therapeutic action, chemical structure, mechanism, legal category, or route of administration, each classification system serves a unique and essential function.

V. Make up the sentences with these words and phrases:

main characteristics of medicines; right drug is given to the right patient; precision medicine; digital therapeutics; drug discovery; clinical decision-making; public

health planning; healthcare providers; pharmacists; researchers; accessible treatment.

VI. Make up a plan of the text and a summary to cover the topic.

Text C
Pharmaceutical production equipment

I.Read and translate the text:

Pharmaceutical production is a highly specialized, technically rigorous, and strictly regulated process aimed at transforming active pharmaceutical ingredients (APIs) into safe, effective, and stable dosage forms (e.g., tablets, injections, creams, etc.). At the heart of this manufacturing process lies an extensive range of pharmaceutical production equipment, each designed for specific tasks that ensure the precision, quality, consistency, and cleanliness required in medicinal product development and mass production.

In a highly regulated environment—governed by Good Manufacturing Practices (GMP) and monitored by regulatory authorities like the FDA (USA)**,** EMA (Europe)**,** and WHO (globally)**—**the reliability and functionality of equipment is essential. Pharmaceutical machinery is engineered to operate within cleanroom standards, minimize cross-contamination, and facilitate scale-up from lab to commercial manufacturing. Each stage of production—from raw material handling to final packaging—relies on dedicated machinery that is validated, calibrated, and compliant with stringent operational protocols.

With the emergence of advanced manufacturing technologies such as Process Analytical Technology (PAT)**,** Continuous Manufacturing**,** AI-based process optimization**,** and single-use systems**,** pharmaceutical equipment is becoming more modular, automated, and intelligent**.** Understanding the types, functions, advantages, and challenges associated with each type of equipment is critical for professionals across formulation, production, QA/QC, and regulatory domains.

Material Handling and Pre-Processing Equipment.

These systems are used **for** raw material receipt, handling, preparation, and blending prior to actual formulation.

Key Equipment:

- Raw material dispensing systems (automated or manual weighing in controlled environments (dispensing booths));
- Bin and drum lifters/tippers (**H**ygienic transfer of bulk powders and excipients);
- Vibro-sifters / Sieves (**R**emove agglomerates, foreign particles);
- Multicolumn blenders (V-blender, double cone) **(**Achieve homogenous powder mixing).

Granulation Equipment

Granulation improves powder flow, compressibility, and homogeneity. It may be wet or dry**,** depending on drug stability.

1. Wet Granulation Machines:

- High-Shear Granulators: Impeller and chopper mix powder with granulating liquid
- Fluid Bed Granulators: Combine mixing, granulation, and drying in one unit

2. Dry Granulation Machines

- Roller Compactors: Compact powder between two rollers → granulated flakes.

Compression and Encapsulation Equipment

These machines create solid oral dosage forms, the most common drug format globally.

1. Tablet Press (Compression Machines):

- Single-punch and rotary tablet presses
- Precision-controlled punches and dies compress powder into tablets
- Features: force sensors, automatic weight adjustments, feeders

2. Capsule Filling Machines:

- Hard or soft gelatin capsules filled with powder, granules, or liquids
- Semi-automatic or fully automatic lines

Coating Equipment

Tablet coatings serve various purposes: taste masking, protection from moisture/light, modified release, and branding.

Equipment Types:

- Traditional coating pans: Manually operated or semi-automatic
- Perforated pan coaters: High-efficiency, automated airflow systems
- Fluidized bed coaters: Precise coating of pellets or granules

Sterile and Aseptic Processing Equipment

Used for injectables, ophthalmics, and other sterile preparations. Must meet ISO cleanroom classifications**.**

Equipment:

- Autoclaves (Steam Sterilizers**)**: Moist heat sterilization of instruments/media
- Dry Heat Ovens: Sterilize glassware, depyrogenate ampules
- Sterile Filtration Units: For terminal filtration of heat-sensitive solutions
- Isolators/RABS (Restricted Access Barrier Systems)**:** For aseptic filling

Utility and Environmental Equipment

Supports cleanroom operation, energy systems, and contamination control.

Examples:

- HVAC (Heating, Ventilation, Air Condition**ing)**: HEPA filtration, pressure differentials
- Water Purification Systems**:** WFI (Water for Injection), purified water
- Clean Steam Generators
- Air Showers, Pass Boxes
- Compressed Air/Nitrogen Systems
- Effluent Treatment Units

Pharmaceutical production equipment plays an indispensable role in ensuring that medicines are produced safely, efficiently, and in strict compliance with global regulatory standards. From the initial weighing of raw ingredients to final packaging and labeling, each piece of equipment contributes to maintaining the integrity, efficacy, and safety of medicinal products.

The choice and configuration of equipment is not merely technical—it is central to the compliance culture of the pharmaceutical industry. Proper equipment selection, qualification (IQ, OQ, PQ)**,** maintenance**,** calibration**,** and documentation are critical to regulatory approval and market readiness.

II. Come up with 5 questions on the gist of the text and ask your group-mates to answer them.

III.Read and translate this information. Do you agree with these opinions? Justify your answer. Expand the answer if you can.

1) As the industry moves toward continuous manufacturing**,** automation**,** AI-driven control systems**,** and single-use technologies, the role of equipment is evolving from isolated machines to integrated systems that enable real-time monitoring, faster scale-up, and lower contamination risks.
2) Professionals involved in pharmaceutical operations—engineers, pharmacists, regulators, and quality managers—must possess a deep understanding of equipment functionalities, limitations, and regulatory expectations to build and maintain a robust manufacturing infrastructure.
3) Pharmaceutical production equipment is not just machinery—it is the foundation of modern medicine manufacturing, a convergence of science, engineering, and compliance, delivering on the promise of safe and effective healthcare for populations worldwide.

IV.Match the equipment (1, 2, 3) with its functions (A, B, C).

Filling and Sealing Equipment	***Packaging and Labeling Equipment***	***Inspection and Quality Control Equipment***
1	**2**	**3**

A _____

Ensures **precise dosing** and **integrity** of pharmaceutical products into their final containers.

1. Machines for liquid:

- For syrups, solutions, suspensions
- Use peristaltic or piston pumps for precision

2. Sealing and Stoppering Machines: Ampoule/vial cappers, blister sealers, strip-pack machines

3. Powder Filling Machines:

- For vials, bottles, sachets
- Use vacuum, auger, or gravimetric filling

B _____

Ensures **uniformity, integrity, and safety** before release.

Examples:

- Checkweighers**:** Verify weight uniformity
- Metal Detectors: Eliminate foreign particles
- Visual Inspection Machines: Detect breakage, discoloration
- Hardness and Friability Testers
- Dissolution Testers
- HPLC, GC, UV-Vis: For chemical analysis

C_____

Ensures **product protection, identification, traceability, and patient usability**.

Key Machines:

- Bottle Filling and Capping Machines: For liquids and tablets
- Cartoning Machines: Insert leaflets, label boxes
- Blister Packaging Machines: Tablets/capsules in unit-dose formats
- Labeling and Serialization Units**:** For barcodes, QR codes, compliance with Track & Trace.

V. Make up sentences with these words and phrases:

a highly specialized; technically rigorous; astrictly regulated; active pharmaceutical ingredients (APIs); pharmaceutical production equipment; pharmaceutical machinery; cleanroom standards**;** commercial manufacturing**;** raw material; final packaging; operational protocols; AI-based process optimization; single-use systems**;** intelligent**; a** systematic exploration**;** working principles**;** technical features**;** GMP implications**.**

VI.Watch and listen to Daniel Kraft speaking about perspectives of pharmacy and make a summary on the following:

- Personalized pills
- 3D printed at home

Unit 7

Topic: PHARMACOGNOSY. THE PLANT

TEXT A
Pharmacognosy

I. Read and translate the text using the dictionary:

pharmacognosy	фармакогнозія
crude drugs	неочищені ліки
ethnomedicine	етномедицина
natural substances	природні речовини
complementary medicine	додаткова медицина
lead compounds	сполуки свинцю
morphine	морфін
quinine	хінін
paclitaxel (Taxol)	паклітаксел (Таксол)
phytochemical constituents	фітохімічні складові
natural precursors	природні попередники
lead molecules	молекули свинцю
synergistic combinations	синергетичні комбінації
domain	домен/галузь/ділянка
indigenous uses	використання корінними народами
bioprospecting	біорозвідка
plant tissue culture	культура рослинних тканин
biodiversity conservation	збереження біорізноманіття

II. Having read the text decide whether the following statements are true (T) or false (F). Correct the false ones.

1) In today's context, pharmacognosy is a multidisciplinary science that incorporates aspects of different sciences.

2) Natural products do not inspire lead compounds for drug development.

3) Pharmacognosy integrates traditional knowledge systems such as: Ayurveda**;** Traditional Chinese Medicine (TCM)**;** folk medicine.

4) Pharmacognosy is about the past of medicine.

5) By integrating botanical expertise, chemical profiling**,** clinical research, and technological innovation, pharmacognosy plays a foundational role.

6) Derived from the Greek words *"pharmakon"* (drug) and *"gnosis"* (knowledge), pharmacognosy literally means “history of drugs.”

Pharmacognosy is one of the oldest disciplines in pharmaceutical sciences, dating back to the origins of medicine itself. Derived from the Greek words *"pharmakon"* (drug) and *"gnosis"* (knowledge), pharmacognosy literally means “knowledge of drugs.” Traditionally, it focused on the identification and study of crude drugs of natural origin, particularly those obtained from plants, but also from microorganisms**,** animals**,** and minerals**.**

In today’s context, pharmacognosy is a multidisciplinary science that incorporates aspects of botany, chemistry, biochemistry, molecular biology, pharmacology, and ethnomedicine to explore and understand natural substances with potential therapeutic value.

With the resurgence of interest in herbal medicine**,** natural product-based drug discovery, and complementary and alternative medicine (CAM)**,** pharmacognosy has re-emerged as a vital field in pharmaceutical sciences. Natural products continue to inspire lead compounds for drug development—examples include morphine**,** quinine**,** artemisinin**,** paclitaxel (Taxol)**,** and lovastatin**.**

Definition and Scope of Pharmacognosy.

Pharmacognosy is the scientific study of medicinal substances derived from natural sources, including their: Botanical identity; Morphology and histology; Chemical constituents; Pharmacological properties**;** Therapeutic uses**;** Toxicology**;** Quality control.

Sources of Crude Drugs

Plant Origin:

- Leaves: *Digitalis purpurea* (digoxin)
- Bark: *Cinchona* (quinine)
- Roots: *Rauwolfia* (reserpine)
- Flowers: *Matricaria* (chamomile)
- Seeds: *Strychnos nux-vomica* (strychnine)
- Gums/resins: *Acacia*, *Myrrh*

Animal Origin:

- Hormones: *Insulin*, *heparin*
- Enzymes: *Pepsin*, *trypsin*
- Oils: *Cod liver oil*

Mineral Origin: Elements and salts: *Iron, calcium carbonate, kaolin*

Marine Origin: Sponges, algae, and marine invertebrates (source of cytotoxins and anti-cancer agents)

Classification of Crude Drugs:

- Based on Morphology: Organized: Leaf, flower, bark, seed*;*Unorganized: Gums, latex, resins.

- Based on Chemical Constituents: Alkaloids (e.g., morphine, atropine)*;* Glycosides (e.g., digoxin)*;* Tannins (e.g., catechin)*;* Volatile oils (e.g., menthol, eugenol)*;* Resins (e.g., benzoin).

- ***Based on Therapeutic Use:*** Laxatives (e.g., senna)*;* Cardiac drugs (e.g., digitalis)*;* Antimalarials (e.g., quinine).
- ***Based on Taxonomy*:** Classification by botanical family (e.g., Solanaceae, Lamiaceae)

Phytochemical constituents

1.Alkaloids: - Nitrogen-containing organic compounds
- Often pharmacologically active (e.g., codeine, nicotine)

2.Glycosides: Sugar + non-sugar component (aglycone)
Example: *Cardiac glycosides* in Digitalis

3.Tannins: - Polyphenols with astringent properties
- Used in diarrhea, wound healing

4.Volatile (Essential) Oils: Aromatic compounds from leaves/seeds/flowers
Example: *Clove oil* (eugenol), *Peppermint oil* (menthol)

5.Saponins, Resins, Flavonoids, Terpenoids: Contribute to anti-inflammatory, anticancer, antioxidant properties

Many modern drugs are derived from natural precursors: artemisinin (from *Artemisia annua*) → antimalarial; paclitaxel (from *Taxus brevifolia*) → anticancer; morphine, aspirin, quinine, vincristine. Used as: lead molecules; templates for semisynthetic modifications; sources of synergistic combinations.

Pharmacognosy integrates traditional knowledge systems such as: Ayurveda; Traditional Chinese Medicine (TCM); Folk medicine. This domain, often called ethnopharmacognosy, evaluates indigenous uses scientifically, preserving knowledge and aiding bioprospecting.

Modern applications and advances in pharmacognosy: Nutraceuticals and Dietary Supplements; Cosmeceuticals (cosmetics with medicinal properties); Biotechnology in Plant Tissue Culture (Micropropagation, genetic engineering, secondary metabolite enhancement); Nanotechnology-based delivery of herbal compounds; Sustainable harvesting and biodiversity conservation.

Pharmacognosy is evolving from simple plant identification to cutting-edge analytical chemistry, molecular biology, and bioinformatics-based discovery. Moreover, pharmacognosy emphasizes the sustainable use of natural resources, ethical bioprospecting, and respect for indigenous knowledge systems.

By integrating botanical expertise, chemical profiling, clinical research, and technological innovation, pharmacognosy plays a foundational role in: herbal medicine standardization; evidence-based phytotherapy; pharmaceutical innovation; public health and global medicine accessibility.

Pharmacognosy is not only about the past of medicine but is actively shaping its future. For pharmacists, researchers, clinicians, and policymakers alike, it offers a vital link between nature and health, tradition and science, sustainability and innovation.

III.Fill in the gaps with the given words:

treatment, preparing, core, drugs, regaining, semisynthetic, phytochemists, plants, chemistry, pushed, importance, apothecaries

Crude _____ (1) of natural origin that is obtained from plants, animals and mineral sources and their active chemical constituents are the _____ (2) subject matter of pharmacognosy. These are also used for the _____ (3) of various diseases besides being used in cosmetic, textile and food industries. During the first half of the nineteenth century _____ (4) stocked the crude drugs for the preparation of herbal tea mixtures, all kinds of tinctures, extracts and juices which in turn were employed in _____ (5) medicinal drops, syrups, infusions, ointments and liniments.
The second half of the nineteenth century brought with it a number of important discoveries in the newly developing fields of _____ (6) and witnessed the rapid progress of this science. Medicinal _____ (7) became one of its major objects of interest and in time, _____ (8) succeeded in isolating the pure active constituents. These active constituents replaced the crude drugs, with the development of _____ (9) and synthetic medicine, they became predominant and gradually _____ (10) the herbal drugs, which had formerly been used, into the background. It was a belief that the medicinal plants are of no _____ (11) and can be replaced by man-made synthetic drugs, which in today's scenario is no longer tenable. The drug plants, which were rapidly falling into disuse a century ago, are _____ (12) their rightful place in medicine.[4]

IV. Match the words with their definitions:

1) pharmacognosy	a) plants that contain substances used for therapeutic purposes or as precursors for drug synthesis.
2) medicinal plants	b) natural substances, either from plants, animals, fungi, bacteria, or minerals, that have not been chemically processed or purified and are used for medicinal purposes.
3) ethnomedicine	c) (two or more agents) can overcome toxicity and other side effects associated with high doses of single drugs, by either countering biological compensation, sparing doses on each compound, or accessing context-specific multi-target mechanisms[8–10].
4) crude drugs	d) the variety of life on Earth, encompassing all living organisms, their genes, and the ecosystems they inhabit.
5) natural precursors	e) the study of medicinal drugs derived from natural sources, primarily plants, but also including animals, microbes, and minerals.
6) synergistic combinations	f) substances, often derived from biological sources, that serve as starting materials for producing various compounds, materials, or even entire structures.
7) biodiversity	g) the study and comparison of traditional medical practices, focusing on how different cultures understand and address health, illness, and healing.

V.Read and translate this information. Do you agree with these opinions? Justify your answer. Expand the answer if you can.

1) Pharmacognosy is one of the most ancient pharmaceutical disciplines and remains strikingly relevant in the 21st century**.**

2) As drug resistance rises and synthetic drug pipelines face stagnation, natural product research is being re-embraced for its chemical diversity and biological activity.

3) Pharmacognosy bridges traditional medicine and modern pharmacology, offering a scientifically validated pathway to new drug leads and holistic therapies.

VI.Translate into English:

Історія фармакогнозії

1) Люди століттями виробляли ліки з рослин та інших організмів, тому фармакогнозія зазвичай вважається найстарішим видом фармацевтики.

2) Існують 5000-річні свідчення виробництва ліків на шумерській глині з Нагпура, і було знайдено близько 12 стародавніх лікарських рецептів з рослинними інгредієнтами, такими як мак та мандрагора, середземноморська рослина родини пасльонових.

3) Виробництво ліків з рослин також згадується в багатьох стародавніх текстах.

4) Протягом століть була виявлена інформація про те, як люди виготовляли ліки з часнику, гірчиці, капусти, петрушки та м'яти.

5) Жодна країна чи нація не домінувала у виробництві ліків з використанням рослин та організмів; ця практика здійснювалася в усьому світі.

6) Інгредієнти відрізнялися залежно від того, що було легкодоступно людям у їхньому середовищі.

7) Видобуток алкалоїдів з маку та інших рослин сприяв виникненню сучасної медицини у 19 столітті.

8) З того часу інші активні інгредієнти були видобуті з інших рослин для виробництва ліків, які ми маємо зараз.

VII. Speak on the topic using these phrases:

Pharmacognosy; medicine; crude drugs; obtained from plants; microorganisms**,** animals**,** and minerals**;** aspects of botany, chemistry, biochemistry, molecular biology; therapeutic value; herbal medicine**;** natural product-based drug discovery; drug development; biological sources; to serve as starting materials for producing various compounds; materials; drug synthesis.

VIII. Make a dialogue using the vocabulary from exercises III-VII.

Text B
The plant, its structure and functions

I. Read and translate the text using the dictionary:

therapeutic agents	терапевтичні засоби

millennia	тисячоліття
nutrition	живлення
phytochemicals	фітохімічні речовини
accurate identification	точна ідентифікація
localizing active constituents	локалізація активних інгредієнтів
adulteration detection	виявлення фальсифікацій
reservoirs	резервуари

In the discipline of pharmacognosy, the plant is not merely a passive source of natural substances—it is the foundation and subject of the science. Plants have served as the primary reservoir of therapeutic agents for millennia, with countless civilizations utilizing them for healing, nutrition, and rituals. Even in modern pharmacology, many drugs are either derived from or inspired by phytochemicals, the secondary metabolites produced by plants. Understanding the structure and function of plant organs is central to pharmacognosy for several reasons:

It enables the accurate identification and authentication of medicinal plants.

It helps in localizing active constituents (e.g., alkaloids in bark, glycosides in leaves). It informs the harvesting, processing, and standardization of crude drugs. It supports microscopic and macroscopic analyses, critical in quality control.

Plants are complex multicellular organisms with highly specialized organs adapted for photosynthesis**,** nutrient transport, reproduction, and secondary metabolite biosynthesis. Their anatomy, both external (morphological) and internal (anatomical/histological)**,** provides pharmacognosists with valuable information regarding drug yield, potency, and adulteration detection.

Classification of Plant Organs

Plants have vegetative organs and reproductive organs, each with distinct anatomical features and pharmacognostic significance:

Organ Type	***Examples***	***Function***
Vegetative Organs	Roots, stems, leaves	Growth, support, nutrient flow
Reproductive Organs	Flowers, fruits, seeds	Reproduction and dispersal

Microscopic Plant Features in Pharmacognosy.

Microscopic analysis is crucial for standardization, identification, and adulteration detection**.**

Feature	*Importance*
Stomata	Type, frequency, shape aid in plant ID
Trichomes	Types (unicellular, multicellular, glandular) identify species
Calcium oxalate crystals	Present in specific tissues, diagnostic markers
Vascular bundle	Differentiates monocots/dicots

Feature	*Importance*
pattern	
Secretory cells and ducts	Store oils, resins, latex

Phytochemical Localization in Plant Parts

Different plant organs serve as reservoirs for distinct secondary metabolites:

Compound Type	*Primary Location*	*Example Plant*
Alkaloids	Roots, seeds, bark	*Rauwolfia*, *Nux vomica*
Glycosides	Leaves, stems	*Digitalis, Senna*
Volatile Oils	Leaves, flowers, fruits	*Mentha, Lavender*
Tannins	Bark, leaves	*Quercus, Acacia*
Resins	Stems, bark	*Myrrh, Ginger*

Developmental and Functional Specializations

1. Secretory Tissues:
- Oil glands, resin ducts, latex tubes;
- Store medicinal compounds (e.g., *Citrus oil*, *Opium latex*).

2. Storage Tissues: Parenchyma stores starch, inulin, oils (e.g., *Onion, Garlic, Aconite*).

3. Mechanical Tissues: Sclerenchyma and collenchyma provide rigidity, used in plant identification

Understanding the structure and function of plants is a cornerstone of pharmacognosy. The plant, in all its complexity, is both a pharmacy and a chemical factory, producing a vast array of bioactive compounds that serve as direct therapies or models for synthetic drug development. Each part of the plant—from the root absorbing nutrients to the flower facilitating reproduction—plays a specific biological role, and often serves as a repository for therapeutic agents**.** The integration of microscopy**,** phytochemistry**,** plant anatomy, and biotechnology into pharmacognosy equips scientists to harness nature's pharmacy with precision and sustainability**.** To master pharmacognosy is to understand the plant as a living system—one that not only sustains ecosystems but also holds cures, comfort, and discoveries within its roots, leaves, flowers, and seeds.

II. Having read the text decide whether the following statements are true (T) or false (F). Correct the false ones.

1) Plants have served as the primary reservoir of therapeutic agents for millennia.
2) Many drugs are either derived from or inspired by phytochemicals, the secondary metabolites produced by plants.
3) Plants are simple multicellular organisms with highly specialized organs.

4) Anatomy of plants, external and internal**,** provides pharmacognosists with valuable information.
5) Each part of the plant—from the root absorbing nutrients to the flower facilitating reproduction—plays a specific biological role.
6) The role of plants in pharmacognosy will not continue to expand.

III.Match the words with their definitions:

1) phytochemicals	**a)** the process by which living organisms take in and utilize food for growth, maintenance, and overall health
2) nutrition	**b)** the specific chemical compounds within a substance, like a plant or a product, that are primarily responsible for its biological or other effects.
3) accurate identification	**c)** the process by which plants, algae, and some bacteria convert light energy, usually from the sun, into chemical energy in the form of glucose (a sugar), while also producing oxygen as a byproduct
4) active constituents	**d)** the set of metabolic pathways through which living organisms produce metabolites,
5) photosynthesis	**e)** are multicellular eukaryotes that belong to the kingdom Plantae and are characterized by their ability to produce food from water, minerals, and carbon dioxide using sunlight and pigments like chlorophyll.
6) metabolite biosynthesis	**f)** naturally occurring chemical compounds found in plants that are not considered essential nutrients, but are believed to offer health benefits
7) plants	**g)** the process of correctly recognizing and naming something or someone

IV.Read and translate this information. Do you agree with these opinions? Justify your answer. Expand the answer if you can.

1) The scientific evaluation of these structures enables pharmacognosists to:
- Accurately identify medicinal species
- Authenticate raw materials
- Detect adulteration
- Optimize harvesting for maximum yield
- Ensure safety, efficacy, and consistency

2) In the modern pharmaceutical landscape, where the demand for natural products**,** herbal medicines**,** and bioprospecting is surging, this knowledge remains more relevant than ever.

3) As global interest grows in plant-based medicine, the role of plants in pharmacognosy will continue to expand—bridging traditional wisdom with modern science.

V. Read, translate and find the most interesting fact for you. Explain why.

From the "click&grow" blog news

March 08, 2022

10 Mind-Blowing Facts About Plants

1. Plants Talk To Each Other

For a long time, people believed that plants were simple organisms that used basic forms of intelligence to adapt to their environment. Modern times, however, have taught us that plants are more complex than we could ever have imagined.

For instance, science tells us that plants 'talk' to each other. They do this via their roots in a very unique way, by secreting chemicals into the soil. These chemicals, called 'root exudates' tell every other living thing in the root zone how the plant is doing.

2. Plants Recognize Their Siblings (And Give Them Preferential Treatment)

Biologists have found that plants exhibit competitiveness amongst strangers of the same species but they are more accommodating towards their siblings.

A study led by researchers at McMaster University looked at the annual plant Cakile edentula. They found that root allocation increased when groups of strangers shared a pot - but not when groups of siblings shared a pot. In other words, plants compete with strangers by allocating more of their roots below ground. This helps them as they fight for access to water and soil nutrients.

3. Plants React To Sound

Recent research has found that plant roots actually respond to environmental sound. They examined the pea plant *Pisum sativum* and discovered its roots were able to locate a water source by sensing the vibrations generated by water flowing below ground.

4. Plants Sense Gravity

Plants know a lot more than we give them credit for. They can sense gravity and respond positively to it. Scientists call this response 'gravitropism.' It's similar to how we humans can sense the pull of gravity and know which way is up. Plant cells in their roots and stems have the ability to detect the pull of gravity on their bodies, thanks to some specialized cells called statocytes. These cells contain starch grains that collect at the bottom due to the force of gravity, acting as a sort of "internal compass." When a plant is tilted, these starch grains shift from side to side, which stimulates hormones that tell the plant which way is up. Plants will then grow toward gravity by elongating the cells on one side and shortening those on another.

5. Plants Use Tricks To Lure Pollinators

Plants are just as capable of deception as animals. In fact, some plants use lures to trick potential pollinators into visiting flowers that don't actually produce any nectar for reward. They still receive pollen with the help of the insect as it visits each flower searching for nectar.

6. Plants Release Distress Signals When Under Stress

The smell of freshly cut grass is actually a plant distress call. Many plants release scents or volatile chemicals when they are stressed, attracting insects and other

animals that can help them escape from a dangerous situation. For instance, when caterpillars feed on a plant, it releases chemicals to attract parasitic wasps that lay eggs inside the caterpillars and kill them.

7. Plants Know What Time It Is

You might know that our bodies have a clock called a circadian rhythm, which regulates our sleeping and waking cycles. But did you know that plants also have such a clock? This means that they can prepare themselves for various times of the day. Plants use sugar signals to establish this circadian phase when it's light and dark. Circadian rhythms determine the time when plants grow, when they open their flowers, and when they release scents. These rhythms help plants use their energy carefully so they don't starve during the night.

8. Plants Know Their Season, But They Don't Use A Calendar

For plants that live in climates with drastic temperature changes, it's important to tell when the seasons are altering.

One way plants can tell the seasons is through day length. The leaves of some plants are sensitive to how much light they are getting, and they use this information to produce seeds or flowers at the appropriate time of year….

Other plants react directly to temperature changes. Plants in colder regions only grow when temperatures rise above freezing during the day and drop below freezing at night.

9. Strawberry Is the Only Fruit That Bears Its Seeds on the Outside

There are over 600 varieties of strawberries, each one containing around 200 seeds. The reason why a strawberry's seeds are on the outside is because of the plant's structure, which has a central receptacle surrounded by tiny, dry fruits. Not many people know that strawberry is a member of the rose family and not actually a berry (despite having 'berry' in its name!) Technically, it's a 'multiple fruit', as it consists of tiny individual fruits embedded in its fleshy receptacle.

10. Trees Are the Longest-Living Organisms on Earth

Many trees live hundreds, even thousands of years, sending down new roots and sprouting new branches as their bodies grow. It's believed that the Great Basin Bristlecone Pine is the oldest living tree species. Situated in the White Mountains of California, it has an estimated age of around 5,000 years. [5]

VI. Make a list of the most effective medical plants you know. Speak about their uses, effects and some other interesting facts.

Text C
Enzymes

I.Read and translate the text.

Enzymes are biological macromolecules—primarily proteins—that act as catalysts to accelerate chemical reactions in living systems without being consumed in the process. Their role is central to all forms of life, as they mediate nearly every biochemical transformation, from digestion and respiration to DNA

replication and energy production. In the pharmaceutical sciences, enzymes hold exceptional importance due to their specificity**,** efficacy, and biocompatibility**.** Their applications span a wide spectrum, including:

- **Therapeutic agents** (e.g., thrombolytics, digestive aids)
- **Diagnostic tools** (e.g., glucose testing, liver enzyme assays)
- **Industrial biotechnology** (e.g., drug synthesis, bio-catalysis)
- **Drug delivery systems** (e.g., enzyme-sensitive nanocarriers)

Moreover, advances in protein engineering**,** recombinant DNA technology**,** and enzyme immobilization have significantly expanded the pharmaceutical potential of enzymes—enabling better drug targeting**,** controlled release, and personalized medicine**.**

Enzymes are biological catalysts that lower the activation energy of chemical reactions, thereby increasing the rate of the reaction without being permanently altered. Key Properties of enzymes:

- **High specificity** for substrates
- **Efficient catalysis** (reaction rates increased by 10^6–10^{12} times)
- **Activity under mild conditions** (neutral pH, body temperature)
- **Regulation and inhibition** by physiological or chemical factors

Structure of Enzymes:

- **Apoenzyme**: The protein portion
- **Cofactor**: Non-protein component (e.g., metal ions like Zn^{2+}, Mg^{2+})
- **Coenzyme**: Organic molecule cofactor (e.g., NAD^+, FAD)
- **Holoenzyme**: Complete, active enzyme with apoenzyme + cofactor/coenzyme
- **Active site**: Specific region where substrate binds

Structure-function relationship is key in drug design targeting enzymes (e.g., enzyme inhibitors in cancer therapy or antibiotics).

Mechanism of Enzyme Action: 1) Substrate Binding: Lock-and-key model, Induced fit model; 2) Catalysis: Enzyme stabilizes the transition state, Lowers activation energy; 3) Product Formation and Release: Enzyme remains unchanged, Reaction is reversible or irreversible.

Enzymes are classified into six major classes by the International Union of Biochemistry and Molecular Biology **(IUBMB)**:

Class	*Type of Reaction*	*Example (EC number)*
EC 1	Oxidoreductases	Lactate dehydrogenase
EC 2	Transferases	Alanine transaminase
EC 3	Hydrolases	Amylase, Protease
EC 4	Lyases	Decarboxylases
EC 5	Isomerases	Glucose-6-phosphate isomerase
EC 6	Ligases	DNA ligase

Pharmaceutical Applications of Enzymes

1. Therapeutic Enzymes

Enzymes are directly used as **drugs** to treat various diseases:

Enzyme	Use	Brand Example
Streptokinase, **Urokinase**	Dissolve blood clots (thrombolytics)	Streptase, Abbokinase
Pancreatin	Digestive aid for pancreatic insufficiency	Creon
Asparaginase	Cancer treatment (acute lymphoblastic leukemia)	Elspar
Hyaluronidase	Enhances drug absorption (tissue permeability)	Hylenex
DNase (Dornase alfa)	Reduces mucus viscosity in cystic fibrosis	Pulmozyme
Lactase	Treats lactose intolerance	Lactaid
Glucocerebrosidase	Treats Gaucher's disease	Cerezyme

Therapeutic enzymes must be: Highly pure; Free of immunogenic contaminants; Produced by recombinant technology.

2. Diagnostic Applications

Enzymes are used in **biochemical assays** for diagnosis:

-Glucose oxidase: Blood glucose monitoring
-Alanine transaminase (ALT), Aspartate transaminase (AST): Liver function tests
-Creatine kinase (CK-MB): Cardiac biomarker
-Alkaline phosphatase: Bone and liver diseases
-Peroxidase and HRP: Immunoassays (ELISA)

*Enzymes offer **high specificity**, allowing accurate and fast detection of disease markers.*

3. Enzymes in Drug Formulation and Delivery

- Enzyme-sensitive carriers (e.g., hydrogels that degrade in tumor microenvironments)
- Prodrugs activated by enzymes at target sites
- Enzymatic degradation systems for controlled drug release

*Example: **Glutathione-sensitive liposomes** for cancer drugs.*

4. Enzymes in Pharmaceutical Manufacturing

- Catalyze reactions in drug synthesis (biocatalysis)
- Used in chiral resolution, esterification, amidation
- Enzymes like lipases, nitrilases, and oxidoreductases are widely employed
- Advantages:
- Green chemistry (less toxic solvents)
- High regio- and stereoselectivity
- Cost-effective and scalable

5. ***Enzymes in Biotechnology and Biosimilars:***

- Production of biosimilars and biologics
- Use in fermentation and recombinant protein expression
- Gene editing **tools** like **CRISPR-Cas9** rely on enzymes

Enzymes are no longer confined to their role as biochemical catalysts; in the pharmaceutical industry, they have emerged as therapeutic agents, diagnostic tools, formulation aids, and manufacturing assets. Their ability to facilitate specific and complex chemical transformations under physiological conditions has revolutionized the treatment of diseases ranging from metabolic disorders and digestive insufficiencies to cardiovascular conditions and cancers**.**

Despite challenges like instability**,** immunogenicity, and cost, research and biotechnology continue to overcome these barriers—broadening the scope and effectiveness of enzyme applications in pharmacy.

Enzymes represent a vital bridge between biology and pharmaceutical science, offering limitless potential to transform medicine, healthcare, and industry. Their role in innovative therapeutics**,** diagnostic technology**,** and sustainable drug production will only deepen as scientists will continue to explore and engineer these remarkable biological catalysts.

II. Come up with 5 questions on the gist of the text and ask your group-mates to answer them.

III.Read and translate this information. Do you agree with these opinions? Justify your answer. Expand the answer if you can.

1) ***Enzyme Engineering and Innovations:***

- **Recombinant DNA technology**: Produces therapeutic enzymes in **E. coli, yeast, CHO cells**
- **PEGylation**: Enhances enzyme stability and reduces immunogenicity
- **Immobilization**: Fixing enzymes on solid supports for reuse
- **Directed evolution**: Improves enzyme properties for pharmaceutical use

2) ***Challenges in Enzyme Use:***

- **Stability**: Sensitive to temperature, pH, degradation
- **Immunogenicity**: Risk of allergic reactions
- **Cost**: High purification and formulation cost
- **Storage**: Requires cold chain logistics

3) As biologic drugs and precision medicine grow in prominence, ***enzymes are central to advancing personalized therapies***, particularly those that target enzyme deficiencies or exploit enzymatic differences between healthy and diseased tissues.

4) ***The therapeutic enzyme market is expanding rapidly***, driven by innovations in recombinant technology**,** enzyme engineering, and delivery systems**.**

5) Enzymes support **greener, cleaner, and more efficient** pharmaceutical manufacturing, contributing to sustainable development goals in the life sciences.

6) Their use in **biosensors** and **point-of-care diagnostics** continues to make healthcare more **accessible and responsive**.

IV.Match the words with their definitions:

1) an enzyme	**a)** is a non-protein chemical compound or metallic ion that is required for an enzyme's role as a catalyst
2) biocompatibility	**b)** also known as heart and circulatory conditions, encompass a range of diseases affecting the heart and blood vessels.
3) recombinant DNA technology	**c)** is a protein that acts as a biological catalyst by accelerating chemical reactions.
4) metabolic disorders	**d)** also known as drugs or medications, are substances used to treat, prevent, or alleviate the symptoms of a disease or condition.
5) a cofactor	**e)** are a group of conditions where the body's chemical processes for converting food into energy are disrupted.
6)cardiovascular conditions	**f)** a process where scientists combine DNA from different sources to create a new DNA sequence with desirable characteristics
7) therapeutic agents	**g)** the ability of a material to perform its intended function in a living system without causing any harmful or undesirable effects to the body

IV. Match the enzymes (1, 2, 3) with functions and applications (A, B, C)

Enzymes in Biotechnology and Biosimilars: ***1***	***Enzymes in Drug Formulation and Delivery*** ***2***	***Enzymes in Pharmaceutical Manufacturing*** ***3***
……..	**……..**	**……..**

A _____

- Enzyme-sensitive carriers (e.g., hydrogels that degrade in tumor microenvironments)
- Prodrugs activated by enzymes at target sites
- Enzymatic degradation systems for controlled drug release

Example: Glutathione-sensitive liposomes for cancer drugs.

B _____

- Catalyze reactions in drug synthesis (biocatalysis)
- Used in chiral resolution, esterification, amidation
- Enzymes like lipases, nitrilases, and oxidoreductases are widely employed

- Advantages:
- Green chemistry (less toxic solvents)
- High regio- and stereoselectivity
- Cost-effective and scalable
-

C_____

- Production of biosimilars and biologics
- Use in fermentation and recombinant protein expression
- Gene editing tools like CRISPR-Cas9 rely on enzymes

VI. Watch and listen to Miguel A. Modestino speaking about the chemical industry. What did he say about:

- current effect of chemical industry on the environment
- chemical industry share in a country's economy
- solutions and perspectives

Unit 8

Topic: PHARMACEUTICAL CHEMISTRY. PHARMACOPOEIA OF UKRAINE

Text A
Pharmaceutical chemistry

I. Read and translate the text using the dictionary.

cornerstone	наріжний камінь
interface	інтерфейс
precision pharmacotherapy	прецизійна фармакотерапія
pivotal	ключовий
structural elucidation	структурне пояснення
facilitating	сприяння
yield	вихідність
computational docking	обчислювальне стикання
solubility	розчинність
to evolve	еволюціонувати

II. Having read the text decide whether the following statements are true (T) or false (F). Correct the false ones.

1) Pharmaceutical chemistry represents the interface between chemistry and biology.

2) The primary focus of pharmaceutical chemistry is the understanding of their structure-activity relationships (SAR)**,** metabolism**,** toxicity**,** and physicochemical properties.

3) The field plays the second role throughout the drug development pipeline.

4) Pharmaceutical chemistry is defined as the study of drugs and drug development.

5) Pharmaceutical chemistry is not merely a discipline—it is the scientific heart of drug development

6) The role of pharmaceutical chemistry stay without expanding.

Pharmaceutical chemistry is a cornerstone of the pharmaceutical sciences. It represents the interface between chemistry and pharmacy, dedicated to the discovery,

design, synthesis, analysis, and development of biologically active chemical compounds used as drugs. It integrates concepts from organic chemistry, inorganic chemistry, biochemistry, medicinal chemistry, analytical chemistry, and pharmacology, making it one of the most interdisciplinary fields in pharmacy.

The primary focus of pharmaceutical chemistry is not only the creation of therapeutic compounds but also the understanding of their structure-activity relationships (SAR)**,** metabolism**,** toxicity**,** and physicochemical properties. As modern medicine moves toward precision pharmacotherapy, pharmaceutical chemistry is pivotal in designing targeted, safe, and effective medications**.**

The field plays a critical role throughout the drug development pipeline: from lead compound discovery through chemical optimization, to formulation development and quality control**.** Its evolution has been propelled by advances in computational chemistry**,** synthetic methodologies**,** analytical instrumentation, and biotechnology**.**

Pharmaceutical chemistry is defined as the study of drugs and drug development, with a focus on the chemical aspects of pharmaceutical agents. It involves:

- Molecular design and synthesis of new drug candidates
- Characterization and structural elucidation of bioactive compounds
- Analytical evaluation for purity, potency, and safety
- Understanding pharmacokinetics and drug metabolism

It acts as a bridge between chemistry and pharmacology, facilitating the transformation of chemical compounds into therapeutic drugs**.**

Branches of Pharmaceutical Chemistry

1. ***Medicinal Chemistry:***

- Focuses on drug design and structure-activity relationships (SAR)
- Applies knowledge of receptor binding**,** pharmacodynamics**,** lipophilicity**,** metabolism**.** - Key processes: Lead compound identification; Molecular modification; Bioisosteric replacement; Prodrug design.

Example: Modifying penicillin to create ampicillin and amoxicillin with improved activity.

2. ***Synthetic Pharmaceutical Chemistry:***

- Involves chemical synthesis of drug molecules
- Use of organic synthesis, green chemistry, and stereochemistry
- Focuses on optimizing: Yield; Stereoselectivity; Reaction safety

*Example**:*** Synthesis of aspirin from salicylic acid.

3. ***Analytical Pharmaceutical Chemistry:***

- Concerned with qualitative and quantitative analysis of drugs
- Techniques include: -Titrimetry (acid-base, redox); -Spectroscopy (UV, IR, NMR, MS); -Chromatography (TLC, HPLC, GC). Used in: Drug purity testing; Content uniformity; Stability analysis.

Example: HPLC assay of paracetamol in tablets.

*4. **Biopharmaceutical Chemistry:***
- Examines the interaction of drugs with biological systems
- Covers pharmacokinetics (ADME) and pharmacodynamics
Key concepts: -Bioavailability; -Plasma protein binding; -Enzyme-drug interactions; Includes studies of biologics and biosimilars.
*5. **Inorganic Pharmaceutical Chemistry:***
- Deals with metal-based drugs**,** electrolytes**,** radiopharmaceuticals
- Important for: -Antacids (e.g., $Mg(OH)_2$); -Hematinics (e.g., $FeSO_4$); -Contrast agents (e.g., barium sulfate); -Radiotracers (e.g., Technetium-99m).

Core Concepts and Principles

*1. **Structure-Activity Relationship (SAR):***
- Studies how structural modifications affect drug activity
- Helps optimize efficacy**,** selectivity**,** toxicity

*2. **Lipinski's Rule of Five - p**redicts **drug-likeness**:*
- Molecular weight < 500
- ≤ 5 hydrogen bond donors
- ≤ 10 hydrogen bond acceptors
- LogP < 5

*3. **Isosterism and Bioisosterism:***
- Substitution of atoms/groups to retain or enhance biological activity
- Improves pharmacokinetics and reduces side effects

Drug Development Process (Chemical Perspective)

Drug Discovery:
- Identification of biological targets;
- Use of natural products**,** high-throughput screening**,** computational docking.

Lead Optimization: Enhancing potency, selectivity, solubility, metabolic stability.
Preformulation Studies - Assessing chemical properties:
- pKa, solubility, partition coefficient
- Polymorphism and crystallinity

Formulation and Stability:
- Designing dosage forms (tablets, injectables, suspensions)
- Stability testing for: Hydrolysis; - Oxidation;- Photodegradation.

Instrumentation and Laboratory Techniques:

Technique	*Use*
UV-Vis Spectroscopy	Quantification, purity check
IR Spectroscopy	Functional group identification
NMR Spectroscopy	Structural elucidation
Mass Spectrometry (MS)	Molecular weight, fragmentation
HPLC/GC	Drug separation and quantification

Technique	*Use*
TLC	Qualitative analysis, identity check

These tools are essential for quality control, regulatory compliance, and research.

Pharmaceutical chemistry is not merely a discipline—it is the scientific heart of drug development**.** It integrates the logic and precision of chemistry with the biological complexity of human health to discover, design, and optimize medications that improve and save lives.

From the first identification of a biologically active molecule to the synthesis of a safe and effective dosage form, pharmaceutical chemistry is involved in every phase of drug discovery and production**.** Its insights shape decisions regarding a compound's solubility, stability, pharmacokinetics, toxicity, and manufacturability**.**

With the global rise of chronic diseases**,** antibiotic resistance**,** and personalized medicine**,** the role of pharmaceutical chemistry continues to expand—offering solutions through innovative synthesis**,** advanced analytics, and tailored molecular design**.** It helps bring forth new generations of drugs, whether they are small molecules**,** biologics, or hybrid therapeutics**.** The synergy between pharmaceutical chemistry and technologies such as AI**,** machine learning**,** molecular modeling, and genetic engineering is redefining how we think about medicine—making it more precise, efficient, and sustainable**.**

In conclusion, pharmaceutical chemistry is a dynamic and essential science that links molecules to medicine**,** theory to therapy, and chemistry to care. It continues to evolve and inspire innovations that define the future of healthcare and pharmacy.

III. Fill in the gaps with the given words:

substances, identification, deposition, deals, electrical energy, chemistry, properties, physics, process, atomic

There are more than 30 different branches of _____ (1). Some of them are: inorganic chemistry, organic chemistry, physical chemistry, analytical chemistry, nuclear chemistry, colloidal chemistry, and electrochemistry. Inorganic chemistry _____ (2) with substances obtained directly or indirectly from minerals, ores and similar sources. Organic chemistry deals with _____ (3) which are composed in part of carbon, and many of which are associated in some ways with living bodies, plants and animals. Physical chemistry is concerned with those parts of chemistry which are closely linked with _____ (4). Analytical chemistry is concerned with the _____ (5), separation and quantitative measurement of the composition of different substances that occur in nature. Nuclear chemistry deals with the transformations of _____ (6) nuclei and with the reactions which take place between them. Colloidal chemistry is concerned with special _____ (7) of substances in a finely dispersed condition. Electrochemistry is concerned with the relation between _____ _____ (8) and chemical change. Electrolysis is the _____ (9) whereby electrical energy causes a chemical change in the conducting medium,

which usually is a solution or a molten substance. The process is generally used as a method of _____ (10) of metals from a solution.

IV. Match the words with their definitions:

1) pharmaceutical chemistry	a) the study of the structure, properties, and reactions of carbon-containing compounds, also known as organic compounds
2) organic chemistry	b) the branch of chemistry focused on the study of the structure, properties, and reactions of inorganic compounds, which are generally those that do not contain carbon-hydrogen bonds.
3) medicinal chemistry	c) an approach to drug treatment that aims to tailor medication selection and dosage to an individual patient's unique characteristics, including their genetic makeup, lifestyle, and other health conditions.
4) analytical chemistry	d) a field that combines principles from chemistry, biology, and medicine to design, synthesize, analyze, and evaluate drugs
5) inorganic chemistry	e) the study of how drugs affect living organisms
6) pharmacology	f) the study of the three-dimensional arrangement of atoms in molecules and how this arrangement affects the molecule's properties and behavior
7) precision pharmacotherapy	g) the branch of chemistry focused on the identification and quantification of substances, essentially determining what matter is and how much of it exists
8) stereochemistry	h) a scientific discipline focused on the design, synthesis, and development of pharmaceutical drugs.

V.Read and translate this information. Do you agree with these opinions? Justify your answer. Expand the answer if you can.

1) ***Pharmaceutical chemistry must adhere to*** *Good Manufacturing Practice (GMP) and regulatory guidelines by:*

- **ICH** (International Council for Harmonisation)
- **FDA** (USA), **EMA** (Europe), **MHRA** (UK), **WHO**

2) ***Recent Advances in Pharmaceutical Chemistry****:*

- Green chemistry: Eco-friendly synthesis routes
- Computer-aided drug design (CADD**)**: Docking, QSAR, pharmacophore modeling
- Nanochemistry**:** Nanoparticle-based drug delivery
- Pharmacogenomics**:** Chemistry tailored to genetic profiles

- Artificial intelligence in synthesis planning and prediction

3) With the global rise** of chronic diseases**,** antibiotic resistance**,** and personalized medicine**, the role of pharmaceutical chemistry continues to expand.

VI.Make up the sentences with these words and phrases:

therapeutic compounds; physicochemical properties**;** precision pharmacotherapy; computational chemistry**;** synthetic methodologies**;** analytical instrumentation; molecular design; structural elucidation; hybrid therapeutics**;**

VII. Match the words with their English equivalents.

1. джерело	a) to deal with
2. розглядати	b) in part
3. частково	c) is composed of
4. складається з	d) have to do with
5. відношення	e) branch
6. особливо	f) solution
7. бути пов’язаним з	g) source
8. мати відношення до	h) particularly
9. кількісний	i) to be concerned with
10.галузь	j) quantitative
11.розчин	k) relation

VIII. Speak on the topic using the following questions as a plan.

1. What does chemistry deal with?
2. What sciences is chemistry linked with?
3. What forms of matter is chemistry concerned with?
4. What are all changes of one kind of matter into another accompanied by?
5. What are the main branches of chemistry?
6. What substances does inorganic (organic) chemistry deal with?
7. What is physical chemistry concerned with?
8. Why is the knowledge of physical chemistry particularly important?
9. What branch of chemistry is concerned with the identification, separation and composition of different substances?
10. What process is called electrolysis?

Text B
Functions of pharmaceutical chemistry

I. Read and translate the text using the dictionary.

pillar	стовп
confined	обмежений
regulatory compliance	відповідність нормативним вимогам

in vitro	(лат. in vitro) — «у склі» (з лат. вживається у значенні) «зроблено за допомогою комп'ютера або за допомогою комп'ютерної симуляції»
in silico	
lipophilicity	ліпофільність
lead optimization	оптимізація свинцю
adulterants	домішки
chromatography	хроматографія
shelf-life	термін придатності

Pharmaceutical chemistry is one of the foundational pillars of modern pharmacy. It is an interdisciplinary science that combines chemistry**,** biology**,** pharmacology, and pharmaceutical sciences to develop, analyze, and optimize medicinal agents. While chemistry focuses on understanding matter and its transformations, pharmaceutical chemistry adapts this knowledge specifically to address challenges in drug development, safety, and efficacy**.**

The primary objective of pharmaceutical chemistry is to translate chemical knowledge into therapeutic solutions. This includes designing new drug molecules, evaluating their interactions with biological systems, ensuring their stability and bioavailability, and formulating them into suitable dosage forms.

However, pharmaceutical chemistry is not confined to drug discovery alone. It extends to drug manufacturing, quality control, regulatory compliance, analytical testing, and even personalized medicine. It encompasses a range of both theoretical and practical functions that are essential for ensuring the development of safe, effective, and high-quality pharmaceuticals**.**

Design and Development of New Drug Molecules. One of the most fundamental functions of pharmaceutical chemistry is the rational design and synthesis of new chemical entities (NCEs) that have the potential to become effective drugs.

Key Concepts:

- Structure-Activity Relationship (SAR): Identifying how different chemical structures influence biological activity.
- Lead Optimization: Refining a compound to enhance efficacy, reduce toxicity, and improve pharmacokinetic properties.
- Bioisosteric Replacement**:** Substituting functional groups to maintain or improve activity.

Applications:

- Creation of synthetic analogs of natural compounds (e.g., semi-synthetic antibiotics like amoxicillin).
- Discovery of entirely new molecular frameworks for specific biological targets (e.g., kinase inhibitors in cancer therapy).

Synthesis of Pharmaceutical Compounds. Pharmaceutical chemistry provides methodologies for the safe, efficient, and cost-effective synthesis of active pharmaceutical ingredients (APIs).

Key Areas:

- Organic synthesis techniques**:** Including condensation, oxidation, reduction, cyclization.
- Stereoselective synthesis**:** Ensuring the correct 3D configuration (chirality) of drugs.
- Green chemistry approaches**:** Reducing hazardous reagents and waste.

Applications:

- Mass production of widely used drugs like paracetamol, aspirin, and ibuprofen.
- Enzymatic and chemoenzymatic synthesis of complex drugs such as statins.

Pharmacokinetic and Pharmacodynamic Optimization. Pharmaceutical chemistry helps in adjusting the physicochemical properties of drugs to enhance: Absorption**;** Distribution**;** Metabolism**;** Excretion.

Optimization Functions:

- Improving lipophilicity for membrane permeability.
- Designing prodrugs for better solubility and site-specific release.
- Preventing degradation by enzymes or pH conditions in the body.

Example: Codeine is a prodrug converted into morphine in the liver for pain relief.

Analytical Evaluation and Quality Control. A vital function of pharmaceutical chemistry is to ensure purity, identity, concentration, and stability of pharmaceutical products using advanced analytical techniques.

Core Techniques:

- Spectroscopy: UV-Vis, IR, NMR, MS for structural analysis.
- Chromatography: HPLC, GC for separation and quantification.
- Titrimetric methods**:** For determining drug strength and purity.

Applications:

- Detection of impurities, degradation products**,** or adulterants**.**
- Routine quality control in pharmaceutical manufacturing facilities.

Formulation and Preformulation Studies. Pharmaceutical chemistry provides the molecular and physicochemical foundation for designing appropriate drug formulations**.**

Key Functions:

- Assessing solubility, stability, polymorphism, and compatibility**.**
- Selecting suitable excipients and delivery systems.
- Ensuring uniformity, bioavailability, and shelf-life**.**

Example: Improving the water solubility of poorly soluble drugs through salt formation or nanoparticle formulation.

Stability Studies and Degradation Pathways. Pharmaceutical chemists investigate how drugs degrade under various conditions (light, heat, humidity, pH), which is crucial for determining shelf life and storage requirements**.**

Functions: - Conducting forced degradation studies**.**

- Understanding degradation kinetics and reaction pathways.
- Developing stabilizers and protective formulations.

Drug Metabolism and Toxicology Assessment. Pharmaceutical chemists study how drugs are metabolized**,** focusing on enzyme interactions**,** active/inactive metabolites**,** and potential toxicity**.**

Tools and Techniques: -In vitro liver microsome studies

- In silico prediction models (QSAR)
- Identifying cytochrome P450 interactions

Understanding metabolism helps avoid: Drug–drug interactions

- Toxic metabolite formation
- Accumulation and long-term risks

The diverse functions of pharmaceutical chemistry encompass every step in the pharmaceutical journey—from the molecular design of a potential drug candidate to its large-scale manufacturing, quality assurance, and patient delivery.

Its impact goes beyond laboratories and manufacturing plants—it shapes the lives of millions by ensuring that each dose of medication is precisely engineered and thoroughly tested. From curing infections to managing chronic illnesses and even fighting cancers, pharmaceutical chemistry is behind every therapeutic breakthrough.

As we enter an age of personalized medicine**,** biosimilars**,** AI-assisted drug design**,** and green pharmaceutical technologies**,** the functions of pharmaceutical chemistry are only expanding in relevance and sophistication. It not only supports innovation but also ensures scientific integrity, patient safety**,** and medicinal reliability—hallmarks of a responsible and effective healthcare system.

In conclusion, pharmaceutical chemistry is not just about molecules—it is about making medicine safer, more efficient, and more accessible. Its functional contributions are critical to public health**,** pharmaceutical progress**,** and the global healthcare ecosystem.

II. Having read the text decide whether the following statements are true (T) or false (F). Correct the false ones.

1) Pharmaceutical chemistry adapts knowledge specifically to address challenges in drug development, safety, and efficacy**.**
2) The primary objective of pharmaceutical chemistry is to translate chemical knowledge into therapeutic solutions.
3) Pharmaceutical chemistry encompasses a range of theoretical functions that are essential.
4) The least fundamental functions of pharmaceutical chemistry is rational design.
5) Pharmaceutical chemists investigate how drugs degrade under various conditions (light, heat, humidity, pH), which is crucial for determining shelf life and storage requirementsю
6) Pharmaceutical chemistry helps in adjusting the physicochemical properties.

III.Read and translate this information. Do you agree with these opinions? Justify your answer. Expand the answer if you can.

1) Modern pharmaceutical chemistry is expanding *to include peptides, proteins, monoclonal antibodies, and nucleic acid-based therapies.*

Functions:

- Chemical modification of biological drugs (e.g., PEGylation for improved half-life).
- Development of biosimilars and biobetters**.**
- Quality testing for biologic stability, purity, and activity**.**

2) ***Pharmaceutical chemistry enables the repurposing of existing drugs*** *for new therapeutic applications by modifying their chemical structure or delivery mechanism.*

Examples: - Thalidomide reintroduced for multiple myeloma.

- Chloroquine/hydroxychloroquine investigated for antiviral properties.

3) Pharmaceutical chemistry is a highly dynamic and multifaceted discipline that forms the scientific bedrock of drug development and healthcare innovation

4) Through its contributions, pharmaceutical chemistry ensures that drugs are:

- Chemically sound
- Biologically effective
- Safe and tolerable
- Stable and deliverable
- Compliant with regulations

IV. Fill in the gaps with the given words.

Recognition, inorganic, basis, colloidal, served, development, basis, progress, close, enables.

1. … chemistry deals with substances obtained directly or indirectly from minerals, ores and similar sources.
2. … chemistry is concerned with special properties of substances in a finely dispersed condition.
3. The achievements of our scientists have won a world-wide …
4. The classical works of Russian scientists … as a theoretical … for the … of the chemical industry.
5. The … links between science and industry … the chemical industry to make great… .

V.Translate into English:

1) Аналітична хімія визначає властивості хімічних речовин, а також структуру та склад сполук і сумішей.
2) Значна частина сучасної хімії побудована на результатах, отриманих в результаті аналізів.
3) Багато важливих застосувань хімії, чи то допомога у розкритті справи про вбивство, чи виявлення забруднення річки, спираються на аналітичні методи.
4) Головна мета аналізу — з'ясувати, з чого складається матеріал.

5) Таким чином, хімік може проаналізувати суміш, щоб знайти, які сполуки присутні.
6) Або він може проаналізувати чисту сполуку, щоб знайти, з яких елементів вона утворенаю
7) Аналітичні методи – це методи з'ясування чогось конкретного про елемент або сполуку.
8) Вони базуються на відмінностях у хімічних та фізичних властивостях матеріалів. Іноді ці відмінності дуже незначні.
9) Це робить аналітичну роботу складною та часто трудомісткою.
10) Важливим набором аналітичних методів є ті, що розділяють різні сполуки або елементи.
11) У XX столітті були розроблені дуже складні методи розділення.
12) Часто, як у випадку хроматографічних методів, вони мають коріння в дослідженнях XIX століття.
13) Зараз можливо відокремлювати дуже малі кількості складних молекул одну від одної.
14) Значна частина прогресу, досягнутого в останні роки в розумінні хімії біологічних процесів, залежала від розвитку таких методів.

VI. Make up a plan of the text and a summary to cover the topic.

Text C
Pharmacopoeia of Ukraine

I. Read and translate the text.

Pharmacopoeia is an official compendium of standards, specifications, and quality requirements for the preparation, testing, and distribution of medicinal substances and pharmaceutical products**.** It ensures that drugs are **s**afe, effective, and of high quality—key criteria for public health protection.

Pharmacopoeia of Ukraine (*Державна Фармакопея України*, abbreviated as ДФУ) represents the national pharmaceutical standard of Ukraine. It serves as a critical legal and scientific document that regulates the quality control, composition, manufacturing, packaging, labeling, and storage of drugs and medicinal products on the territory of Ukraine. The Ukrainian Pharmacopoeia plays an essential role in harmonizing national pharmaceutical practices with international standards, especially those of the European Pharmacopoeia (Ph. Eur.)**,** WHO**,** and ICH guidelines.

Since its inception, the Pharmacopoeia of Ukraine has not only safeguarded consumer rights and health but also strengthened the scientific infrastructure of pharmacy and pharmaceutical production in the country. It is legally binding and integrated into the national healthcare and pharmaceutical regulatory system**.**

Historical Development of the Pharmacopoeia of Ukraine

Pre-1990s: Pharmaceutical standards in Ukraine were regulated by the Pharmacopoeia of the USSR**.**

Post-independence (1991): Need for national pharmaceutical standards arose to reflect local realities and align with international practices.

2001: The first edition of the State Pharmacopoeia of Ukraine (1st ed., ДФУ) was published under the supervision of the Ukrainian Scientific Pharmacopoeial Center for Quality of Medicines**.**

2015: The second edition (ДФУ 2.0) was issued, incorporating broader harmonization with the European Pharmacopoeia and introducing modern analytical techniques**,** biotechnology standards**, and** risk-based quality management**.**

The Pharmacopoeia of Ukraine is divided into several key sections and monographs:

1. General Chapters. These cover:
   - General pharmaceutical principles
   - Requirements for purity**,** identity, and quality control
   - Methods of analysis
   - Equipment and apparatus standards
   - Validation of analytical procedures

   Examples:
   - "Determination of loss on drying"
   - "Microbial contamination limits"
   - "High-Performance Liquid Chromatography (HPLC) methods"

2. General Monographs. Standards for categories of substances, e.g.:
   - **Injectable preparations**
   - **Tablets, capsules**
   - **Sterile products**
   - **Plant-based substances**

   Each monograph contains: Description; Identification methods; Purity criteria; Assay methods; Packaging and storage instructions.

3. Specific Monographs.

   Detailed information on individual drugs, excipients, herbal products, and biologics**.**

   Each monograph provides: Structural formula; Molecular weight; Identification and assay methods; Impurity profiles; Specific tests (e.g., pH, osmolality, microbial limits).

4. Appendices and Annexes. Contain: Color standards; Reagent preparation protocols; Reference standards; Standard solutions and indicators.

The Pharmacopoeia of Ukraine is a legally binding document under the Law of Ukraine “On Medicinal Products”**.** All manufacturers, importers, pharmacists, and quality control labs must comply with its standards. It forms the legal foundation for:- Drug registration
- Market authorization

- Licensing of manufacturing facilities
- Quality audits and inspections

The Ukrainian Pharmacopoeia includes a wide range of classical and modern analytical methods**,** such as:

- Titrimetric analysis
- Gravimetry
- Spectrophotometry (UV/IR)
- Chromatography (TLC, HPLC, GC)
- Mass spectrometry
- Microbiological testing
- Biological assays
- DNA-based identification (for herbal and biological products)

It emphasizes method validation**,** analytical robustness**,** and reproducibility, which are critical for regulatory and GMP compliance.

The Ukrainian Pharmacopoeia reflects the country's long-standing use of herbal medicine and growing interest in biopharmaceuticals**.**

Monographs include: - **Medicinal plant raw materials**

- **Essential oils**
- **Standardized plant extracts**
- **Homeopathic preparations**
- **Monoclonal antibodies and biosimilars**

It incorporates modern analytical tools for DNA-barcoding**,** chromatographic fingerprinting, and toxicity testing**.**

Harmonization with International Standards:

1.Ukraine is aligning its pharmacopoeia with:

- European Pharmacopoeia (Ph. Eur.)
- United States Pharmacopeia (USP)
- British Pharmacopoeia (BP)
- International Pharmacopoeia (WHO)

2. The Ukrainian Scientific Pharmacopoeial Center participates in:

- International meetings and symposiums
- WHO and EDQM cooperation

3. Harmonization allows:

- Easier drug export
- International recognition
- Faster registration of foreign drugs in Ukraine

It guarantees that every medicine available to patients meets rigorous criteria of quality, safety, and effectiveness.

By defining and standardizing the chemical, physical, and biological attributes of medicinal products, the Pharmacopoeia plays a vital role in public health protection**.** It provides clarity and consistency to everyone involved in the drug lifecycle, from scientists and manufacturers to pharmacists and healthcare providers.

Over the years, the Ukrainian Pharmacopoeia has matured into a comprehensive, internationally oriented, and scientifically robust reference work. It is constantly updated to reflect the latest advances in analytical chemistry, pharmacology, biotechnology, and regulatory science**.** In an increasingly globalized pharmaceutical landscape, its harmonization with global pharmacopoeias ensures that Ukrainian pharmaceutical products can meet the requirements of both domestic and international markets. This promotes global competitiveness**,** pharmaceutical innovation, and public trust**.**

In conclusion, the Pharmacopoeia of Ukraine is a national achievement and a living document, continuously evolving to address modern pharmaceutical challenges. It embodies a commitment to scientific excellence**,** regulatory integrity**,** and the well-being of the Ukrainian population.

II. Come up with 5 questions on the gist of the text and ask your group-mates to answer them.

III.Read and translate this information. Do you agree with these opinions? Justify your answer. Expand the answer if you can.

1*) **Future Perspectives and Innovations:***

- Digital Pharmacopoeia access (electronic versions for regulators and companies)
- AI-supported data extraction from pharmacopoeial texts
- Enhanced inclusion of personalized medicine standards
- Ongoing adaptation to biosimilar**,** nanomedicine**,** and gene therapy standards

2) ***The Pharmacopoeia of Ukraine is more than just a regulatory document***—it is a scientific and ethical foundation for the entire Ukrainian healthcare and pharmaceutical system.

IV.Match the words with their definitions:

1) drug lifecycle	**a)** a set of core values, principles, or beliefs that guide an individual's or organization's decisions and actions
2) pharmacopoeia	**b)** encompass a broad range of guidelines, regulations, and best practices that ensure the quality, safety, and effectiveness of healthcare services
3) medicine standards	**c)** a multifaceted concept encompassing high-quality research, impactful discoveries, and the overall advancement of knowledge.
4) regulatory document	**d)** a book of standards for medicines, including their identity, strength, and purity.
5) ethical foundation	**e)** the concept that certain resources, assets, or institutions are held in trust for the benefit of the public, with a responsibility for their proper

	management and preservation
6) public trust	**f)** encompasses the stages a medication goes through from its initial discovery to its eventual generic competition.
7) scientific excellence	**g)** is a rule, guideline, or characteristic of an activity or its results, created and enforced by a regulatory body

V. Match the titles of practical applications (1-4) with functions (A-D).

Practical Applications of Pharmacopoeia

Pharmacy Education and Training: 1	**Drug Quality Control: 2**	**Drug Regulation and Licensing: 3**	**Pharmaceutical Manufacturing: 4**

A_____

Provides exact criteria for identity, purity, and potency during:

- Batch release;
- Post-market surveillance.

B _____

Guides GMP-compliant formulation, packaging, and storage.

C _____

Used by State Expert Center for drug registration decisions.

D _____

Integrated into the curriculum of pharmaceutical faculties.

VI.Translate the following words and collocations into Ukrainian.

Drug discovery, traditional remedies, serendipitous discovery, metabolic pathways, early-stage drug discovery, high-throughput screening, new active compounds, combinatorial chemistry, optimization step, synthetic modification, biological properties, lead compounds, molecular docking tools, second order equations, bulk production, suitable drug formulation, environmentally controlled conditions, shelf life, quantity, purity, purified proteins, nucleic acids, renewal of outdated chemicals, quality control, volatile, flammable, unstable, biological targets, pathology, infectivity, survival of a microbial pathogen, diseased state, computational tools, chemical synthesis, rational drug design, therapeutical applications, apparent effects, complexity, serendipity, side-effects, three-dimensional information, x-ray crystallography, structure-based drug design, necessary physical properties, effective absorption.

VII.Watch and listen to the presentation about the reasons why medications are so expensive in the US. Present the three mentioned reasons.

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Інформаційні ресурси:

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https://www.ted.com/talks/jakob_magolan_a_crash_course_in_organic_chemistry
https://www.ted.com/talks/katherine_eban_a_dose_of_reality_about_generic_drugs
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https://www.ted.com/talks/miguel_a_modestino_how_to_transform_the_chemical_industry_one_reaction_at_a_time
https://www.ted.com/talks/kiah_williams_3_reasons_why_medications_are_so_expensive_in_the_us

Навчальний посібник ESP: «Pharmacy» предназначений для здобувачів вищої освіти факультету хімічних та біофармацевтичних технологій, які вивчають дисципліну «Іноземна мова фахового спрямування». Посібник складається з двох частин, до кожного з яких належить по чотири розділи. Кожний розділ включає автентичний лексичний матеріал та систему мовних та умовно-мовленнєвих вправ для формування мовної компетенції.

Навчальне видання

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Рекомендовано Вченою радою Київського національного університету технологій та дизайну як навчальний посібник для здобувачів вищої освіти факультету хімічних та біофармацевтичних технологій з дисципліни «Іноземна мова фахового спрямування»

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