Subject 1. Safety and security in the laboratory. Biogenic *s*-,p-,d-elements in medicine and dentistry

1. Importance:

Knowledge of electronic structure and properties of biogenic *s*- and *p*-elements explains their biological role in organism.

Association of the amount of biogenic elements in the human body and their contents in the environment helps understand causes and mechanisms of endemic diseases, their associations with features of biogeochemical provinces (areas with natural deficiencies or excess of certain chemical elements in the lithosphere). It emphasises problems of pollution of the biosphere with toxic chemical compounds of technogenic origin.

Competences

Ability of abstract thinking, analysis and synthesis, ability to learn.

Ability to apply knowledge in practical situations.

Ability to choose strategy of communication; ability to work in a team; skills of interpersonal interaction.

Ability to excercise self-control and maintain healthy lifestyle, ability to adapt and act in new situations.

Motivation and persistence in following goals.

Skills in using information and communication technologies.

Ability to assess and ensure quality of performed work.

Strive to preserve the environment.

Ability to assess results of laboratory and practical experiments.

Ability to solve standard problems and to solve practical problems in the course of training.

2. Concrete aims:

Explain associations of biological roles of biogenic *s*-, *p*-elements and their properties in the organism.

Analyze associations between chemical properties of compounds of *s*-, *p*-elements and their contents in organism.

Write electronic formulas of atoms and ions in ground and excited states.

Write molecular and structural formulas of compounds.

Determine oxidation level of an atom in a compound.

Perform qualitative chemical reactions for micro- and macroelements in solutions.

Follow safety regulationss and be able to provifr first aid in case of accidents in the chemical laboratory.

Use chemical glassware and know its applications. Work with measuring chemical glassware.

3. Basic knowledge, skills necessary for studying the subject (interdisciplinary integration)

Previous subjects	Obtained skills
1. Chemistry and Biology (school course)	- understand electronic structure, degree of oxidation, valence, electronegativity. - know the Periodic Law and Periodic System. - be able to write electronic formulas of atoms and ions. - be able to write equations of chemical reactions.
2. Biological and Bioorganic Chemistry	- understand the concept of "organogenic elements". - know concentrations and amount of organogenic elements in the human body.
3. Medical Biology	- understand chemical composition of cells, macro- and microelements.
4. Medical and Biological Physics	- understand molecular organization of active transport with the example of Na-K pump. -
5. Foreign language for professional purposes	- have a thorough knowledge of English language. - be able to communicate in English language both orally and in writing.
6. Safety, basics of bioethics and biosafety	- seek to preserve the environment

4. Tasks for independent work during preparation for the class and in class.

4.1. The list of key terms, parameters, characteristics, which the student is to learn while preparing for classes:

Term	Definition
1. Biogenic elements	Chemical elements necessary for building and functioning of cells and organisms
2. *s*-elements	Elements, which atoms have the *s*-orbitals filled last.
3. Endemic diseases	The diseases caused by abnormal levels of certain elements in soil and water of certain geographical areas.

4.2. Theoretical questions to the lesson:

1. Biogenic elements:
   a) organogens;
   b) macroelements;
   c) microelements.
2. Electron structure of biogenic *s*-, *p*-elements.
3. Typical chemical properties of *s*-, *p*-elements and their compounds (reactions without change of oxidation state).
4. Biological role of biogenic elements.
5. Relationship of location of *s*-, *p*-elements in the Periodic table and their content in the organism.
6. Endemic diseases and their relationship with properties of biochemical provinces (regions with natural deficit or excess of certain chemical elements in the lithosphere).
7. Application of compounds of *s*-, *p*-elements in dental practice.
8. Metals of life.
9.. Electron structure and electronegativity of biogenic *d*-elements.
10. Typical chemical properties of *d*-elements and their compounds:
   a) reactions with a change of the oxidation states;
   b) formation of complexes.
11. The biological role of biogenic *d*-elements. Applications of biogenic *d*-elements in medicine.
12. Applications of compounds of *d*-elements in dental practice.

4.3. Practical work (task) done by students in class

1**. Acquaintance with safety regulations and first aid rules in case of accidents in chemical laboratory.**

When performing laboratory work students have to follow regulations and rules of accident prevention. After acquaintance with safety regulations, each student signs the register of safety instructing.

Safety rules in educational laboratories of medical chemistry:

1. Students are only allowed to work in the laboratory if they wear white coats and white hats.
2. Each student has to keep their workplace clean and in order. There should not be bulky personal belongings (bags, packages, etc.) on the desk.
3. Experiments should only be performed after the student had attentively studied the instruction and listened to the teacher's explanations. The work should be performed accurately, deliberately and without haste.
4. It is strictly forbidden to perform experiments that are not stipulated in the instruction to the lesson.
5. It is strictly forbidden to touch substances with bare hands and to taste them. When determining substances by smell the test tube should be kept at arm's length and the movement of the hand should direct the air from the test tube opening to the nose. At mixing of reactants it is recommended not to bend over the glassware opening to prevent splashing of the mixture on the person and clothes.

6. Experiments must only be performed in pure glassware, using such amount and concentration of substances, in such sequence and at such conditions as it is specified in the instruction.

7. All vials with reagents and solutions must be capped immediately after using them, and caps must not be confused.

8. All experiments with concentrated acids and alkalis should be performed only under the hood.

9. To dilute a concentrated acid, especially sulfuric acid, carefully pour acid into water and not vice versa.

10. Do not bend over a heated liquid as it could throw out of the test tube. The opening of the test tube must be directed away from the person who performs the experiment and from people next to him.

11. It is strictly forbidden to turn on and off electrical appliances without a teacher, and light the alcohol burner without need.

12. After each lesson the student should wash the the used glassware and clean his/her desk. The person on duty must maintain the order in the entire lab.

Principal rules of first aid:

1. If injured with sharp glass, quench bleeding with a 3% hydrogen peroxide solution, apply a solution of iodine around the wound and place a bandage.

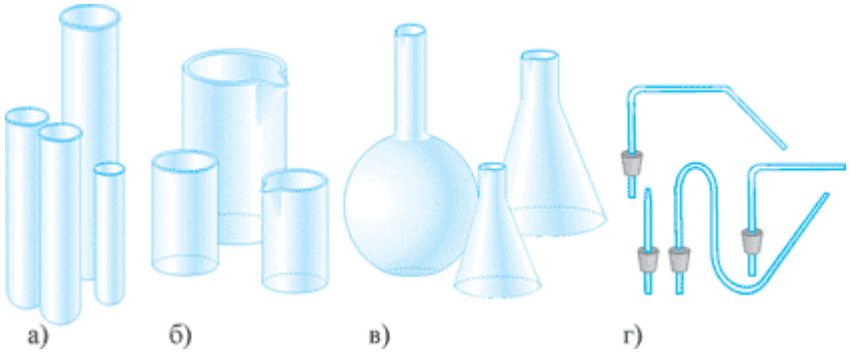
2. In case of chemical burns to hands or face, wash away the aggressive substance with a large amount of water, and then apply 2% solution of boric acid (if burned with an alkali), or 2% sodium hydrocarbonate solution (if burned with an acid), and then again wash with water.

3. In case of thermal burns, apply a freshly prepared solution of potassium permanganate then apply a burn cream.

4. At chemical burns to eyes wash the eyes with a large amount of water, and then see a doctor.

2. Acquaintance with chemical glassware and its uses. Work with measuring chemical glassware.

Chemical laboratory glassware can be classified by different properties. By designation chemical glassware can be divided into general purpose glassware (test tubes, glasses, flasks, retorts, funnels, crystallizers etc.) and special purpose glassware.



General purpose glassware:

a) test tubes
b) beakers
c) flasks
d) exhaust tubes

Test tubes. Test tubes are the principal glassware for performing practical and laboratory works. They are used to perform experiments with liquids, solids and gases.

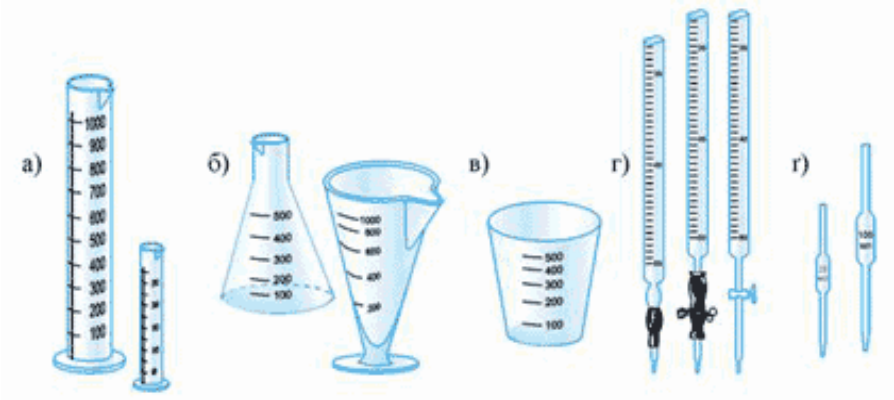
Flasks. There are the following types of flasks:

1) flat-bottom flask with a narrow neck,
2) flat-bottom flask with a wide neck;
3) round-bottom flask with a narrow long neck, it is used to heat low-boiling liquids in a water or oil bath at distillation.

Beakers. Beakers are used for dissolving, mixing and heating of liquids.

Funnels. Laboratory glass funnels have various forms and the sizes depending on their use. The common conical funnel is used for filtering of solutions and for transfer of liquids into vessels with narrow necks.

Pipettes, burettes, flasks, cylinders, beakers, glasses belong to ***measuring glassware***. They are used to measure volume of liquids, prepare solutions of different concentration.



Measuring glassware:

a) measuring cylinders;
b) measuring flasks;
c) measuring glasses;
d) burettes;
e) droppers.

3. Qualitative reactions for ions of *s*-elements in solutions.

a) qualitative reaction for Ca^{2+}. Reaction with ammonium oxalate $(NH_4)_2C_2O_4$.

Add 1 mL of a calcium salt (chloride or nitrate) solution and 1 mL ammonium oxalate solution to a test tube. White crystals of calcium oxalate precipitate:

$$CaCl_2 + (NH_4)_2C_2O_4 = 2NH_4Cl + CaC_2O_4\downarrow;$$

$$Ca^{2+} + C_2O_4^{2-} = CaC_2O_4\downarrow.$$

The reaction is used to determine calcium in the urine and blood.

Check, how the obtained precipitate reacts with a strong mineral acid and acetic acid. Write molecular and short ionic equations of the reaction of the precipitate dissolving in a strong mineral acid. Make a conclusion about conditions of opening the calcium cation by ammonium oxalate.

b) qualitative reaction for the barium cation. Reaction with sodium sulfate or sulfuric acid.

Add 1 mL of a barium salt solution and 1 mL of sodium sulfate or sulfuric acid to a test tube. A white crystalline precipitate is obtained.

$BaCl_2 + Na_2SO_4 = BaSO_4\downarrow + 2NaCl$

$Ba^{2+} + SO_4^{2-} = BaSO_4\downarrow$

Check, how the obtained precipitate reacts with a strong mineral acid.

Make a conclusion about conditions of opening the barium cation.

e) writing a report of the laboratory work:

Write reaction equations and conclusions to each experiment in the laboratory notebook.

Contents of the subject (abstract):

1. Biogenic elements: a) organogenic elements; b) macroelements; c) microelements.

Biogenic elements are chemical elements that take part in biological processes of live organisms.

The most important of them are chemical elements that make 97.5% of the mass of the organism. These are **organogenic elements** (carbon, hydrogen, oxygen, nitrogen, phosphorus, sulfur).

By their amount in the organism, biogenic elements are classified as following:

- macroelements (10^{-2}% and more): C, N, O, N, P, S, Na, Ca, K, Cl;
- microelements (10^{-3} – 10^{-12}%): Mg, Cu, Zn, Mn, Co, Fe, I, Al, Mo;

2. Electronic structure of biogenic *s*-, *p*-elements.

***s*-Elements** are those where the *s*-sublevel is last filled with electrons.

Electronic structure of biogenic *s*-elements:

+1 H $1s^1$

+11 Na $1s^2 2s^2 2p^6 3s^1$

+12 Mg $1s^2 2s^2 2p^6 3s^2$

+19 K $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

+25 Ca $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

***p*-Elements** are those where the *p*-sublevel is last filled with electrons.

Electronic structure of biogenic *p*-elements:

+6 C $1s^2 2s^2 2p^2$

+7 N $1s^2 2s^2 2p^3$

+8 O $1s^2 2s^2 2p^4$

+16 S $1s^2 2s^2 2p^6 3s^2 3p^4$

+15 P $1s^2 2s^2 2p^6 3s^2 3p^3$
+17 Cl $1s^2 2s^2 2p^6 3s^2 3p^5$

3. Typical chemical properties of *s*-, *p*-elements and their compounds (reactions without change of the oxidation level).

s-Elements of the IA group have 1 *s*-electron on the outer energy level. Their atoms easily give off the *s*-electron, showing reducing properties.

s-Elements of the IIA group have 2 *s*-electrons on the outer energy level. Their atoms easily give off the *s*-electrons and become bivalent cations.

Compounds of *s*-elements react without change of the oxidation level.

In *p*-elements of the IIIA – VIIIA groups the *p*-sublevel of the outer energy level is being filled with electrons. Atoms of the elements have from three to eight valence electrons on the outer level.

Each of these groups begins with typical nonmetals and ends with metals. Oxidizing properties decrease, while reducing properties increase.

In the periods nonmetallic properties of elements increase from left to right.

4. Biological role of biogenic *s*-elements:

Hydrogen (H) is a constituent of organic substances (carbohydrates, lipids, proteins) and inorganic substances (waters, acids, salts).

Protons H+ participate in redox processes, maintain acid-base equilibrium, and catalyze hydrolysis of molecules of nutrients.

Sodium (Na) and potassium (K)

Na^+ is the main extracellular ion, and K^+ is the main intracellular ion.

Ions of sodium and potassium maintain constant osmotic pressure in cells and fluids of the organism, as a part of buffer systems they support acid-base equilibrium, they are necessary for activity of the sodium - potassium pump, that ensures transmission of nervous impulses and contraction of the cardiac muscle.

Magnesium (Mg)

It is found in skeletal bones and tooth enamel in the form of insoluble phosphates. Ions of magnesium are constituents of biocomplexes with nucleic acids. It activates synthesis and hydrolysis of ATP.

Magnesium is a constitutent of enzymes carboxypeptidase, ATPase, choline esterase. Ions of magnesium activate enzymes phosphatase and kinase.

Calcium (Ca)

Calcium ions take part in transmission of nervous impulses, muscle contraction, regulation of heart function, blood coagulation, effect acid-base equilibrium of biological fluids, and have antiinflammatory and desensibilizing effect. Calcium is the the main component of bone tissue and teeth.

Biological role of biogenic *p*-elements:

Al is an inhibitor of enzymes of aldolase, alkaline phosphatase, and the enzymes that participate in blood formation. It promotes development and regeneration of epithelial, connective and bone tissues.

Carbon (C) is a component of bioorganic compounds: biopolymers (proteins, nucleic acids, carbohydrates), lipids, bioregulators (enzymes, hormones, vitamins).

Carbon (IV) oxide CO_2 is the end product of biological oxidation of different biosubstrates: glucose, lipids and, to a lesser extent, proteins in cells.

Nitrogen (N) is a component of organic substances: proteins, vitamins, hormones, nucleic acids.

Nitrogen (II) oxide regulates cardiovascular activity; it maintains tone of walls of blood vessels.

Phosphorus (P)

Phosphate residues are components of nucleic acids that store, transfer and realize genetic information.

ATP is formed in oxidative phosphorylation of carbohydrates and lipids, and it is a source and an accumulator of energy in the organism.

Phosphorus is a component of macroergic compounds: creatine phosphate in the muscle, phosphoproteins, phospholipids of cellular membranes and nucleotide coenzymes.

Phosphorus is found in bones and teeth as phosphate residues in hydroxyapatite, fluorapatite, chlorapatite and carboxyapatite.

Oxygen (O) is a component of inorganic compounds and organic biomolecules: proteins, fats, carbohydrates, nucleic acids, enzymes, vitamins.

Oxygen is necessary for tissue respiration (consecutive enzymatic reactions of oxidation of carbohydrates, lipids, proteins with formation of water) that is conjugated with oxidative phosphorylation and ATP formation.

Sulfur (S) is a component of amino acids (cysteine, methionine), proteins and some vitamins (B1) and hormones (insulin).

Sulphuric acid that is formed in the organism participates in detoxification of toxic compounds: phenol, cresol, indole, that are produced in metabolism of amino acids in the intestine.

Chlorine (Cl) participates in inhibition of action biopotentials and in water and electrolyte exchange. As a part of NaCl, it regulates osmotic pressure. It promotes deposition of glycogen in the liver, activates enzyme amylase and is a component of gastric juice in the form of hydrochloric acid.

Iodine (I) is a component of hormones of the thyroid gland (thyroxine and triiodothyronine) that stimulate energy metabolism of cells, effect growth and

differentiation of tissues, increase excitability of nervous system, positively influence brain development.

Deficiency of iodine causes endemic goiter and hypothyroidism, excess of iodine causes hyperthyroidism.

Fluorine (F) is a component of fluorapatite. It participates in formation of bones, increases resistance of teeth to caries, stimulates blood formation and immunity.

Deficiency of fluorine causes caries, and excess of fluorine causes dental fluorosis.

5. Association of location of *s*-, *p*-elements in the Periodic System and their amount in the organism.

A. P. Vinogradov discovered the general law of distribution of chemical elements: the quantitative amount of chemical elements in the organism is inversely proportional to their numbers in the Periodic System.

6. Endemic diseases, their association with properties of biogeochemical provinces (areas with natural dedeficiency or excess of certain chemical elements in the lithosphere).

The human body maintains balance of optimum concentrations of biogenic elements. If the balance is disturbed it causes various diseases.

Diseases that are caused by abnormal concentrations of elements in the soil and water of certain geographical areas are called endemic.

A. P. Vinogradov introduced the concept of biogeochemical provinces – geographical areas where concentrations of chemical elements in the soil differs from average.

In Ukraine, there are biogeochemical provinces with deficiency or excess of some elements. For instance, the Carpathians and the Crimea have a decreased content of iodine in soil and drinking water, in Poltava region there is an increased content of fluorine in drinking water (1.5 times higher than normal).

7. Applications of compounds of *s*-, *p*-elements in dental practice.

A 10% water solution of sodium hydroxide is a component of silamin that is used in orthopedic practice to model dentures of cobalt-chromium alloy.

Magnesium oxide is a component of Cristosil-2 that is used to cast dentures of cobalt-chromium alloy.

Calcium sulfate is used to make a mold of the oral cavity.

Sodium borate and aluminum hydroxide are components of pastes used as powdered glue for dentures.

8. Chemical properties of *p*-elements and their compounds:

a) qualitative reaction for Al^{3+}. Reaction with a solution of alkali.

Add 1 mL of an aluminium salt solution to a test tube. Add by drops an alkali solution until a white amorphous precipitate is obtained.

$AlCl_3 + 3NaOH = Al(OH)_3\downarrow + 3NaCl$;

$Al^{3+} + 3OH^- = Al(OH)_3\downarrow$.

Check, how strong mineral acids and alkalis react with the precipitate. Write molecular and short ionic equations of the reactions of the precipitate dissolving in a mineral acid and in excessive amount of alkali.

b) qualitative reaction for the sulfate ion. Reaction with barium chloride solution.

Add 1 mL sodium or potassium sulfate solution to a test tube. Add a solution of barium chloride until small white crystals of barium sulfate precipitate.

$Na_2SO_4 + BaCl_2 = BaSO_4\downarrow + 2\ NaCl$

$Ba^{2+} + SO_4^{2-} = BaSO_4\downarrow$

Check, how sulfuric or nitric acid reacts with the precipitate. Make a conclusion about conditions of opening of the sulfate ion.

9. Chemical properties of *d*-elements and their compounds:

a) a reaction with a change of the oxidation state:

Qualitative reaction for permanganate ion. Reaction with hydrogen peroxide in an acidic medium

Add 1 mL of potassium permanganate solution, 2-3 drops of sulfuric acid solution and 5 drops of 10% hydrogen peroxide solution to a test tube. The potassium permanganate solution becomes colorless.

Compose the reaction equation with the following scheme:

$$KMn^{7+}O_4 + H_2SO_4 + H_2O_2 \rightarrow Mn^{2+}SO_4 + O_2 + K_2SO_4 + H_2O.$$

b) a reaction of complexing:

Qualitative reaction for Cu^{2+}

Add 1 mL of a cupric salt solution to 1 mL of potassium ferrocyanate (II). A brownish precipitate $Cu_2[Fe(CN)_6]_2$ is obtained.

$$CuSO_4 + K_4[Fe(CN)_6] = Cu_2[Fe(CN)_6]\downarrow + 2K_2SO_4;$$

$$2Cu^{2+} + [Fe(CN)_6]^{4-} = Cu_2[Fe(CN)_6]\downarrow.$$

Check, how strong mineral acids and alkalis react with the precipitate. Make a conclusion about conditions of opening the cuprous cation as copper hexacyanoferrate.

10. Writing a report of the laboratory work:

Write reaction equations and conclusions to each experiment in the laboratory notebook.

Contents of the subject (abstract):

Eight *d*-elements (Fe, Cu, Zn, Mn, Co, Ni, Cr, Mo) are well studied in terms of their content, topography and biological role. These elements are constituents of a great number of about 300 enzymes, other proteins and some vitamins. The elements mostly exist as coordination compounds in the organism.

Electronic structure of biogenic *d*-elements.

+24 Cr $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$

+25 Mn $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$
+26 Fe $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$
+27 Co $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^2$
+28 Ni $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2$
+29 Cu $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$
+30 Zn $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$
+42 Mo $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^5 4f^0 5s^1$

Biological role of biogenic *d*-elements.

Essential d-elements Zn, Cu, Fe, Mn, Co, Mo are called **metals of life**.

Iron (Fe) is an essential microelement (10^{-5}%). Recommended daily amount is 15-20 mg. It is found in erythrocytes and in respiratory enzymes cytochromes. Iron is a constituent of hemoglobin, cytochromes, catalase, peroxidase, xantine oxidase, aldehyde oxidase and iron transport and storage proteins ferritin, transferrin, hemosiderin. Iron participates in redox reactions in the organism, immune reactions. Deficiency of iron causes anemias.

Copper (Cu) is an essential microelement (10^{-4}%). Copper is found in cells of all organs, but mostly concentrates in the liver and brain. Recommended daily amount is 2-3 mg. It is found in more than 30 proteins (ceruloplasmin, albocupreins, neurocupreins) and enzymes (some oxidases, alsolase, lipase, superoxide dismutase etc.).

1. Enhances action of insulin and pituitary hormones.
2. Has positive impact on the growth and development of the organism.
3. Influences synthesis of hemoglobin and tformation of red blood cells.
4. Has hypoglycemic effect.
5. Impacts water and mineral metabolism.
6. Activates enzymes.

Zinc (Zn) is an essential microelement (10^{-3}%). Recommended daily amount is 10-15 mg. Topography in the body: retina of the eye, prostate, semen, breast, liver, muscles. It is a constituent of the more than 40 enzymes (hydrolases, carboxy peptidase, carbonic anhydrase, alcohol dehydrogenase). It activates enzyme peroxidase, amino peptydase, enolase, arginase; it inhibits phosphoglucomutase, alkaline phosphatase, ribonuclease.

1. It impacts ie reproductive function.
2. It participates in metabolism of nucleoproteins and has a positive effect on growth and reproduction.
3. It binds to insulin.
4. It impacts metabolism of calcium and phosphorus.

Manganese (Mn) is a constituent of amino peptidase, choline esterase, pyruvate carboxylase, arginase.

1. It enhances synthesis of thyroid hormones.
2. It accelerates formation of antibodies.
3. It has a lipotropic effect.
4. It prevents atherosclerosis.

5. It normalizes sexual function.
6. It normalizes thyroid function.

Cobalt (Co) is an essential microelement (10–5 %). Recommended daily amount is 0.05-0.1 mg. Topography in the body: the liver, kidneys, pancreas.
1. It affects all kinds of metabolism.
2. It affects reproduction and growth.
3. It increases content of red blood cells and hemoglobin.
4. Small doses (1-5 mg) of cobalt lower blood sugar levels.
5. It positively effects absorption of calcium and phosphorus.
6. It participates in synthesis of thyroid hormones.
7. It activates the enzymes carbonic anhydrase, carboxypeptidase.
8. It is a constituent of vitamin B12 (cyanocobalamin).

Molibdenum (Mo) is an essential microelement (10^{-5}%). Recommended daily amount is 0.15-0.3 mg. Topography in the body: the liver, kidneys, endocrine glands.
1. It activates enzymes;
2. It activates synthesis of hemoglobin;
3. It effects immunity.

Enzymes that contain molybdenum are involved in metabolism of purines and nitrogen fixation, thus forming uric acid. An increased molybdenum content causes endemic gout.

Chromium (Cr) is an essential microelement (10^{-5} %). Biological effects are based on its ability to form complexes.
1. It effects formation of blood cells.
2. It is a component of the digestive enzyme trypsin.
3. It stabilizes structure of nucleic acids.
4. Chromium compounds exhibit antitumor activity.
5. It participates in metabolism of glucose.

Nickel (Ni) is a constituent of the enzyme urease.
It activates the enzymes anhydrase, carboxylase, trypsin.
It stimulates synthesis of amino acids.
It accelerates regeneration of blood plasma proteins.
It effects formation of blood cells.

Applications of compounds of *d*-elements in dental practice.

Alloys of gold, silver and copper are widely used in dental practice for prosthetics.
Silver is a of silver-palladium alloys.
Silver is a part of powder (alloy of silver, tin, copper) used for manufacture of "Silver Amalgam" (AC-2) used in metal fillings.

Copper is an integral component of the filling material "Hallodent M" and a liquid (an alloy of gallium and tin) for the manufacture of metal fillings.

Metallic chromium is a part a cobalt and chromium alloy. In addition to cobalt and chromium (major components) the alloy contains molybdenum and nickel. Chromium and nickel stainless steel is widely used in orthopedic practice.
Anhydrous zinc sulfate is used as a temporary filling material in cementc "Vynoxol", "Dentin".

Zinc oxide is a part of zinc phosphate cements used as filling materials.
Copper (I) oxide and copper (II) oxide are parts of microbicidal phosphate cements used as filling materials.
Glass ionomeric cement is a "powder - liquid" system. Glass ionomeric cements are used for dental restoration.

Materials for self control:

A. Tasks for self control:

1. Decide whether carbon is an organogenic element that builds structural components of the cell:
a) it is an organogenic element; b) it is not an organogenic element; c) it partially is an organogenic element.

2. Choose the electronic configuration of the magnesium atom:
a) $1s^2 2s^2 2p^6 3s^2$; b) $1s^2 2s^2 2p^6$; c) $1s^2 2s^2 2p^6 3s^1$; d) $1s^2 2s^2 2p^7 3s^1$.

3. Choose the characteristic oxidation level for *s*-elements of the II-A group in compounds:
a) +2; b) –2; c) +3; d) +1.

4. Decide why the valency of oxygen most often equals two:
a) because oxygen is less electronegative than fluorine;
b) because the atom of oxygen does not have a *d*-sublevel;
c) because oxygen has nonmetallic properties;
d) because its atom lacks two electrons needed to complete the outer energy level.

5. Choose what ions of *p*-elements of the V-A group participate in physiological processes of the human body:
a) NO_2^-; b) $H_2PO_4^-$; c) SbO^+; d) As^{3+}.

B. Practical tasks for self control:

1. Write an electronic formula of the element which atom contains four electrons on 3*p*-sublevel. In what period in what subgroup is it located and how is this element called?

2. Write the electronic formula of the element which number is 53.

Literature

Main:

1. Medical Chemistry: textbook / V.O. Kalibabchuk, V.I. Halynska, V.I. Hryshchenko et al.; edited by Prof. V.O. Kalibabchuk – Kyiv: “Medicine”, 2010 – 224 p. (P. 184 – 209).

Informational resources:

2. www. pdmu, edu.ua
https://med-chemistry.pdmu.edu.ua/

(Web page of Poltava State Medical University).