MINISTRY OF HEALTH OF UKRAINE
Zaporizhzhia State Medical University
Analytical Chemistry Department

MEDICAL CHEMISTRY

Module 1

PHYSICAL CHEMISTRY OF SURFACE PHENOMENA LYOPHOBIC AND LYOPHILIC DISPERSE SYSTEMS

(Abstract)

Topic module 4

Manual

for teachers and students
of the 1-st course of the Medical Faculty
speciality "General Medicine"

Zaporizhzhia
2013

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Module 1. Medical chemistry. Topic module 4. Physical chemistry of surface phenomena lyophobic and lyophilic disperse systems (abstract) : manual for teachers and students of the 1-st course of the Medical Faculty speciality "General Medicine" / comp. S. A. Vasyuk [et al.]. – Zaporizhzhia : [ZSMU], 2013. – 79 p.

The Manual is considered and approved at the meeting of The Central Methodical Council of Zaporizhzhia State MedicalUniversity
(record № 3 of 22.02.2013)

REFACE

Medicalchemistryisstudied according to the approved standard of academic curriculum of 2005 yearfor students of the Universities of the III-IV levels of accreditationof Ukraine for specialty 7.110101 "General medicine" field of study 1101 "Medicine" is established in accordance with the educational and skill characteristics (ESC) and education and professional programs (EPP) training approved by order of the Ministry of Education of Ukraine from 16.04.03 № 239.

Organization of studying process is proceed according to the requirements of European Credit Transfer System (ECTS).

Study of Medical Chemistry is carried out during 1 semester of 1st year of training according to theacademic curriculum.

The curriculum consists of a discipline module, including 4 blocks of topic modules:

1. Chemistry of biogenic elements. Complex formation in biological fluids.
2. Acid – base equilibriums in biological fluids.
3. Thermodynamic and kinetic processes regularities and electrokinetic phenomena in biological systems.
4. Physics and chemistry of surface effects. Lyophobic and lyophilic disperse systems.

TOPIC MODULE 4

PHYSICAL CHEMISTRY OF SURFACE PHENOMENA LYOPHOBIC AND LYOPHILIC DISPERSE SYSTEMS

Tutorial № 15

1. THEME: Sorption of biologically active substances at the inteface

2. PURPOSE: To get knowledge of the sorption processes and regularities occurring in the interfacial layer

3. OBJECTIVIES:

3.1. To form a conception of sorption processes in human life.

3.2. To form a conception of the structure of biological membranes.

3.3. To learn to use surfactants in medical practice.

3.4. To learn the regularities of adsorption.

3.5. To learn how to build an adsorption isotherms.

4. PLAN AND ORGANIZATIONAL STRUCTURE OF THE TUTORIAL:

4.1. Organizational part…………………………………………..5 min

4.2. Goal-setting and motivation of the theme studying (opening address of the teacher)…………………………… …………...5 min

4.3. Determination of initial knowledge level…………………..15 min

4.4. Correction of the initial knowledge level…………………….25 min

4.5. Organization of independent work of students (target teacher guidance, rules of accident prevention)……… ………………….5 min

4.6. Laboratory work……………………………….………...45 min

4.7. Final control: checking of the laboratory work results and protocols……………………………………………….......10 min

4.8. Concluding remarks of the teacher, instructional lines for the next lesson…………………………………………………......3 min

5. REFERENCE FOR SELF-STUDY:

5.1. Questions for self-study

1. Surface tension of liquids and solutions. Isotherm of surface tension.
2. The surface active and surface inactive substances. Surface activity. Duclos-Traube rule.
3. Adsorption at the liquid - liquid and gas-liquid interface. Gibbs equation.
4. The orientation of the surfactants molecules in the surface layer.
5.Conception of the biological membranes structure.
6. Adsorption at solid - gas interface.
7. Langmuir equation.
8. Adsorption at the solid – solution interface. Physical and chemical adsorption.
9. Adsorption regularities of dissolved substances, vapors and gases. Freundlich equation.
10. Physical and chemical bases of adsorption therapy (hemosorbtion, plasmosorption, lyphosorbtion, enterosorption, application therapy). Immunosorbents.

5.2. Solve the tasks:

Task 1. Using the Duclos-Traube rule calculate how many times the surface activity of amyl alcohol $CH_3(CH_2)_3CH_2OH$is higher than surface activity of ethanol CH_3CH_2OH.

Answer: 32,77 times.

Task 2. Calculate the adsorption of caproic acid ($C_5H_{11}COOH$) aqueous solution at 15°C if its concentration is 0,25 mol/m^3, the surface tension of the solution is $35 \cdot 10^{-3}$ N/m and the surface tension of water is 73.4 · 10-3 N/m.

Answer: $4{,}01 \cdot 10^{-6}$ mol/m^2.

Task 3. Find the area per a molecule in the saturated adsorption layer of aniline on the surface of its aqueous solution if the limiting adsorption is $6{,}0 \cdot 10^{-6}$ mol/m^2.

Answer: $2{,}77 \cdot 10^{-19}$ m^2

5.3. Examples of the solved tasks:

Task 1. Using the Duclos-Traube rule calculate how many times the surface activity of palmitic acid ($C_{15}H_{31}COOH$) is lower than surface activity of eicosanoicacid($C_{19}H_{39}COOH$).

Solution. According to the Duclos-Traube rule the surface activity is increased by an average of 3,2 times with each addition of a methylene group to the homolog:

$$\frac{g_{C_{19}H_{39}COOH}}{g_{C_{15}H_{31}COOH}} = 3{,}2^4 = 104{,}86$$

Answer: 104,86 times

Task 2. Calculate the adsorption of a solution containing 0,05 g/l of pelargonic acid $C_8H_{17}COOH$ (M ($C_8H_{17}COOH$)= 158 g/mol) at 10 °C. The surface tension of water and of the test solution is $74{,}2 \cdot 10^{-3}$ N/m and $57 \cdot 10^{-3}$ N/m respectively.

Solution. The adsorption value at the liquid–gas interface is calculated using the Gibbs equation:

$$\Gamma = -\frac{C_M}{R \cdot T} \cdot \frac{\Delta\sigma}{\Delta C}$$

It is necessary to find molar concentration of pelargonic acid solution beforehand:

$$C_M = \frac{m}{M} = \frac{0{,}05}{158} = 0{,}0003\,\text{mol/l}$$

Converting the concentration in mol/m^3 we have: 0,0003 · 10^3 = 0,3 mol/m^3.

$$\Gamma = -\frac{0{,}3}{8{,}31 \cdot 283} \cdot \frac{(57 \cdot 10^{-3} - 74{,}2 \cdot 10^{-3})}{(0{,}3 - 0)} = 7{,}3 \cdot 10^{-6}\,\text{mol/m}^2 .$$

Answer: 7,3·10^{-6} mol/m^2 .

Task 3. Limitingadsorption ofisoamyl alcoholis 7·6,10mol/m^2, its molar weight is88 g/mol, the density is 0,81·10^{6}g/m^3.Calculate the length ofthe molecule andthe area per a moleculeat the interface.

Solution. Area occupied by a molecule is calculated using the formula:

$$S_0 = \frac{1}{\Gamma_\infty \cdot N_A} = \frac{1}{7{,}0 \cdot 10^{-6} \cdot 6{,}02 \cdot 10^{23}} = 2{,}37 \cdot 10^{-19}\ \text{m}^2$$

The length of the molecule is:

$$l = \frac{\Gamma_\infty \cdot M}{\rho} = \frac{7{,}0 \cdot 10^{-6} \cdot 88}{0{,}81 \cdot 10^6} = 7{,}6 \cdot 10^{-10}\ \text{m}$$

Answer: 2,37·10^{-19} m^2, 7,6·10^{-10} m.

5.4. Study tests (p. 66).

Literature:

1.Medical Chemistry : textbook / V. A. Kalibabchuk [and ol.] ; ed. by V. A. Kalibabchuk. - K. : Medicine, 2010. - 224 p.

2. Levitin Ye.Ya. General and Inorganic Chemistry : textbook for students of higher schools / Ye. Ya. Levitin, I. A. Vedernikova. - Kharkiv : Golden Pages, 2009. - 360 p.

3. Inorganic Chemistry : textbook / ed.: D. F. Shriver, P. W. Atkins. - 3th ed. - [s. l.] : Oxford University Press, 2004. - 763 p.

4. Petrucci R.H., Harwood W.S., Herring F.G. General Chemistry. Principles and Modern Applications. – 8th ed. – Prentice Hall, 2002. – 1160 p.

6. LABORATORY WORK

6.1. Acetic acid adsorption on active carbon

You need to take 4 numbered flasks. Measure 10,00 ml 0,05 N, 0,10 N, 0,15 N and 0,20 N of acetic acid solution into the flasks. Add 0,5 g of active carbon into each of 4 flasks and leave for over 20 minutes (stirring regularly).

At this time you need to titrate 5,00 ml of acetic acid of each concentration with 0,1 N NaOH solution (phenolphthalein indicator).

In 20 minutes filter each solution from active carbon with the help of paper filter into separate flasks. Take 5,00 ml of solution from each filtrate, carry it over into the titration flasks and titrate with the help of 0,1 N NaOH solution (phenolphthalein indicator).

Put down the results of the experiments into the table:

№ flask	C_0 (CH_3COOH)	V_0(NaOH), ml	V_1(NaOH), ml	$\Delta V=V_0-V_1$, ml	Γ
1	0,05				
2	0,10				
3	0,15				
4	0,20				

Calculate the value of adsorption Γ according to the formula:

$$\Gamma = \frac{C_{(NaOH)} \cdot \Delta V \cdot V_{1(CH_3COOH)}}{V_{2(CH_3COOH)} \cdot m_{ads.} \cdot 1000}, \text{ where}$$

$V_{0\ (NaOH)}$ -volume of NaOH solutionthat is consumed inthe titrationof acetic acid, ml;

$V_{0\ (NaOH)}$ -volume of NaOH solutionthat is consumed inthe filtratetitration, ml;

V_1 (CH_3COOH) - volume of CH_3COOH solutiontreated with adsorbent,ml;

V_2(CH_3COOH) - volume of CH_3COOHsolutiontakenfor the titration, ml;

m_{ads}. - the massof the adsorbent, g.

Plot a graph of dependence of Γ from f($C_{0\ (CH3COOH)}$). Draw conclusions.

6.2. Activated carbon adsorption of colored substances from mixture

Put 5 ml of blend of fuchsine-fluorescein aqueous solution into the test tube, add 0,2 g of active carbon and shake for 3 minutes. Filter it into another tube.

Describe an external effect and draw conclusions.

6.3. Dependence of adsorption on the adsorbent nature

Put 5 ml of $Pb(NO_3)_2$ into each of 3 tubes. Add 0,2 g of Al_2O_3 into the first tube, 0,2 g of active carbon into the second one, the third one leave for comparison. Shake the tubes for 2 minutes. Filter contents of the first two tubes. Instill 5 drops of KI solution into each 3 tubes.Put down the external effect of the experiments into the table.

№ of test tube	Adsorbent	External effect
1	Al_2O_3	
2	carbon	
3	–	

Draw conclusions.

7. TRAINING AND TESTING MEANS

– table funds on the theme of the tutorial;
– card for determination of initial level of knowledge and skills;
–questions for review;
– tests.

Tutorial № 16

1. THEME: Ion exchange. Chromatography.

2. PUROSE: To learn the theoretical basis of adsorption and ion exchange, the possibility of their use in medical practice

3. OBJECTIVIES:

3.1. To learn the basics of ion exchange and to understand the application of this phenomenon in the medical practice.

3.2. To acquire practical skills of chromatographic separation of substances.

4. PLAN AND ORGANIZATIONAL STRUCTURE OF THE TUTORIAL:

4.1. Organizational part…………………………………………..5 min
4.2. Goal-setting and motivation of the theme studying (opening address of the teacher)…………………………… …………...5 min
4.3. Determination of initial knowledge level…………………..15 min
4.4. Correction of the initial knowledge level……….………....25 min
4.5. Organization of independent work of students (target teacher guidance, rules of accident prevention)……… ………………….5 min
4.6. Laboratory work…………………………….………...45 min
4.7. Final control: checking of the laboratory work results and protocols…………………………………………………......10 min
4.8. Concluding remarks of the teacher, instructional lines for the next lesson…………………………………………………......3 min

5. REFERENCE FOR SELF-STUDY:

5.1. Questions for self-study

1. Chromatography. The essence of the method.

2. Classification of chromatographic methods according to the mechanism of separation, phases aggregate state and the experimental technique.

3. Adsorption chromatography. Thin-layer chromatography.

4.Partition chromatography. Paper chromatography. Gaschromatography.

5. Sedimentary chromatography.

6. Ion-exchange chromatography.

7. Molecular sieve (gel permeation) chromatography. Affinity (biospecific) chromatography.

8. Chromatography application in biology and medicine. The role of ion exchange process in plant and animal life. Selective adsorption of substances in the human body.

5.2. Solve the tasks:

Task 1. For standard solutions of substances A and B the following R_f values were obtained – 0,56 and 0,34 respectively. In thin layer chromatography analysis of unknown solutionthe distances from the starting line to the centers of two spots were 5,7 cm and 4,3 cm. The solvent passed the distance of 12,6 cm. Determine if the substances A and B were present in the sample.

5.3. Examples of the solved tasks:

Task 1. When identifyingof amino acids inthe proteinhydrolyzateconcentratethe solventfrontmoved55mm. After spraying thechromatogramwith a solutionof ninhydrinthree bluespots were obtained at the distance from thestarting lineof 20, 25 and45 mm.Amino acid solutions were chromatographed under identicalconditionsand the followingvaluesof R_f were calculated:asparticacid–

0,24,glutamicacid–0,36,lysine–0,46,Val–0,64; alanine–0,82; tyrosine–0,90.Whichamino acids was containedin theprotein hydrolyzateconcentrate?

Solution. Calculate R_f of the mixture components using the formula:

$$R_f = \frac{x}{L}, \text{ where}$$

x – the distance from the starting line to the center of the spot;

L – the distance passed by the solvent during the same time.

$$R_{f_1} = \frac{20}{55} = 0{,}36;\ R_{f_2} = \frac{25}{55} = 0{,}46;\ R_{f_3} = \frac{45}{55} = 0{,}81.$$

5.4. Study tests (p. 75).

Literature:

1. Medical Chemistry : textbook / V. A. Kalibabchuk [and ol.] ; ed. by V. A. Kalibabchuk. - K. : Medicine, 2010. - p.37-49
2. Levitin Ye.Ya. General and Inorganic Chemistry : textbook for students of higher schools / Ye. Ya. Levitin, I. A. Vedernikova. - Kharkiv : Golden Pages, 2009. - 360 p.
3. Inorganic Chemistry : textbook / ed.: D. F. Shriver, P. W. Atkins. - 3th ed. - [s. l.] : Oxford University Press, 2004. - 763 p.

6. LABORATORY WORK

6.1. Separation of cations using the method of paper precipitation chromatography

Apply aqueous solution which consists of mixture of Ag^+-, Bi^{3+}-, Hg_2^{2+}-cations at the center of potassium iodine paper with the help of capillary.

A green yellow spot will be formed at the center of the paper, which corresponds to Hg_2^{2+}-cation):

$$Hg_2^{2+} + 2I^- \leftrightarrow Hg_2I_2\downarrow;$$

yellow zone corresponds to Ag^+-cation:

$$Ag^+ + I^- \leftrightarrow AgI\downarrow,$$

black zone corresponds to Bi^{3+}-cation:

$$Bi^{3+} + 3I^- \leftrightarrow BiI_3\downarrow.$$

6.2.Analysis of amino acids mixture by thin-layer chromatography method

Apply 1 drop of test solution (mixture of 0,004 M glycine and methionine solutions) on the spotting line at a distance of 2-3 sm from the plate edge, and 1 drop of glycine solution and 1 drop of methionine solution as reference solutions at 1,5-2 sm stepouts. Air dry the spots and put vertically the plate into the chromatographic chamber, vaporous with solvents: propanol-1 – acetone – water (5:2:2).

While the movement of liquid phase on the plate you will observe the division of substance mixture, and the separated components will form separate zones (spots) on the plate. When the front of solvent raises 6 sm high from the spotting line. you should take the plate out of the chamber and air-dry it and develop the spots with 0,25% of propanol-1 solution of ninhydrin. After drying of the plate you should identify the spots, i.e. define which compound corresponds to each of the spots of the separated mixture. Calculate their R_f values:

$$R_f = \frac{x}{L}$$

and compare them to R_f values of standard solutions.

7. TRAINING AND CONTROL MEANS

- – table funds on the theme of the tutorial;
- – card for determination of initial level of knowledge and skills;
- –questions for review;
- – tests.

Tutorial № 17

1. THEME: Preparation, purification and propertiesof colloidal solutions

2. PUROSE: To forman idea ofthe structure and propertiesof biologicallyimportantcolloids

3. OBJECTIVIES:

3.1. To study the methods of preparation, purification and properties of colloidal solutions.

3.2. To use physical and chemical characteristics of colloidal solutions to evaluate properties of biological objects and drugs.

3.3. To learn how to write micelles.

4. PLAN AND ORGANIZATIONAL STRUCTURE OF THE TUTORIAL:

4.1. Organizational part……………………………………………………5 min

4.2. Goal-setting and motivation of the theme studying (opening address of the teacher)…………………………… ………..5 min

4.3. Determination of initial knowledge level……………………………..15 min

4.4. Correction of the initial knowledge level……………………………….25 min

4.5. Organization of independent work of students (target teacher guidance, rules of accident prevention)……… ………………………………………………5 min

4.6. Laboratory work………………………………….……......................45 min

4.7. Final control: checking of the laboratory work results and protocols……………………………………………………..........................10 min

4.8. Concluding remarks of the teacher, instructional lines for the next lesson……………………………………………………..........................3 min

5. REFERENCE FOR SELF-STUDY:

5.1. Questions for self-study

1. Human body as a complex of disperse systems.
2. Classification of disperse systems according to the dispersion degree.
3. Colloidal state. Lyophilic and lyophobic colloids.
4. The structure of colloidal particles.
5. Double electric layer. Electrokinetic potential of colloidal particles.
6. Methods of preparation and purification of colloidal solutions.
7. Dialysis, electrodialysis, ultrafiltration, compensatory dialysis, vividialysis. Hemodialysis and kidney machine.
8. Molecular-kinetic properties of colloidal systems. Brownian movement, diffusion, osmotic pressure.
9. Optical properties of colloidal systems.
10. Electrokinetic phenomena. Electrophoresis. Helmholtz-Smoluchowski equation. The use of electrophoresis in the research and clinical laboratories. Electropherograms.

5.2. Solve the tasks:

Task 1. Sol of copper hexacyanoferrate (II) is obtained by the action of $CuSO_4$ excess on $K_4[Fe(CN)_6]$. Write the micelle formula.

Task 2. Berlin blue sol is prepared by mixing of equal volumes of 0,008 N. $FeCl_3$ solution and 0,01 N. solution of $K_4[Fe(CN)_6]$. Write the micelleformula and indicate the granule charge.

Task 3. Write a micelle of sol obtained in the reaction of $BaCl_2$ with Na_2SO_4. Which of the electrolytes is taken in excess if the particles move to the anode in electrophoresis?

5.3. Examples of the solved tasks:

Task 1. 15 ml of 0,025 N. KCl solution and 85 ml of 0,005 N. $AgNO_3$ solution were mixed to obtain silver chloride sol. Write the micelle formula and indicate the sign of the granule charge.

Solution.We can find KCl millimoles number:

$15 \cdot 0,025 = 0,375$ mmol.

We can find $AgNO_3$ millimoles number:

$85 \cdot 0,005 = 0,425$ mmol

The solution containes an excess of silver nitrate.

$$AgNO_3 + KCl \leftrightarrow AgCl\downarrow + KNO_3$$

Micelle: $\{[(mAgCl)nAg^+](n - x)NO_3^-\}^+ \, x\, NO_3^-$

The granule charge is positive.

Task 2. Fresh iron hydroxide (III) precipitate was treated with a small amount of HCl that was not sufficient to dissolve the precipitate. Thus a sol was formed and its particles moved to the cathodein the electric field. What method was used? Write the micelle formula.

Solution. Sol of iron hydroxide (III) was obtained by chemical peptization. Peptization is the transition of precipitates formed during coagulation into colloidal solution.

Fresh precipitate of $Fe(OH)_3$ was washed and treated with a small amount of HCl. In this reaction FeOCl (peptizer) was formed:

$$Fe(OH)_3 + HCl \leftrightarrow FeOCl + 2H_2O$$
$$FeOCl \leftrightarrow FeO^+ + Cl^-$$

Thepeptizerwasadsorbed on the sediment. The particles of sediment acquiredthe double electric layer stabilizing the system and repulsive force between the particles began to prevail over the attractive force.

$$\{[(mFe(OH)_3)\ nFeO^+]\ (n - x)\ Cl^-\}^{x+}\ xCl^-$$

The resultant colloidal particles were distributed throughout the liquid volume under the influence of thermal motion forming a colloidal solution

5.4. Study tests (p. 79).

Literature:

1. Medical Chemistry : textbook / V. A. Kalibabchuk [and ol.] ; ed. by V. A. Kalibabchuk. - K. : Medicine, 2010. - p.49-54
2. Levitin Ye.Ya. General and Inorganic Chemistry : textbook for students of higher schools / Ye. Ya. Levitin, I. A. Vedernikova. - Kharkiv : Golden Pages, 2009. - 360 p.
3. Inorganic Chemistry : textbook / ed.: D. F. Shriver, P. W. Atkins. - 3th ed. - [s. l.] : Oxford University Press, 2004. - 763 p.

6. LABORATORY WORK

6.1. Preparation of colloidal solutions by chemical association

6.1.1. Preparation of colloidal solution of ferric(III) hydroxide by reaction of hydrolysis

Put 5 ml of 0,025 M $FeCl_3$ solution into the test tube. Heat the solution to boiling. Brown-red colloid solution will be formed. FeO^+ – potential-determining ions, Cl^- counter-ions. Write down the formula of a micelle.

6.1.2.Preparation of ferric hexacyanoferrate(III) colloidal solutions with different charges by double-exchange reaction

Take three tubes. Put 9 ml of 0,1 N $FeCl_3$ solution and 1 ml of 0,1 N $K_4[Fe(CN)_6]$ solution into the first tube. Put 5 ml of 0,1 N $FeCl_3$ solution and 5 ml of 0,1 N $K_4[Fe(CN)_6]$ solution into the second one. Put 1 ml of 0,1 N $FeCl_3$ solution and 9 ml of 0,1 N $K_4[Fe(CN)_6]$ solution into the third one.

Note and put down the color of colloidal solution, potential-determining ions and the granule charge sign.

№ of tubes	0,1 N$FeCl_3$ solution, ml	0,1 N $K_4[Fe(CN)_6]$ solution, ml	Color of colloid solution	Granule charge
1	9	1		
2	5	5		
3	1	9		

6.1.3. Preparation of colloidal solution of manganese(IV) dioxide by redox reaction

Put 1 ml of 0,015 M$KMnO_4$ solution and 5 ml of d-water into the test tube, mix everything. Add 0,5 ml of 0,05 M $Na_2S_2O_3$ solution. After you mix the contents of the tube a brown colloidal solution will be formed. Describe an external effect.

6.1.4.Preparation of colloidal solution of sulphur by decomposition reaction

Put 5 ml of 0,05 M $Na_2S_2O_3$ solution into the tube and add 1 ml of 0,35 M H_3PO_4 solution. Describe an external effect.

6.1.5. Preparation of colloidal solution of Berlin blue by peptization

Put into 2 tubes 0,2 ml of colloid solution of Berlin blue which was prepared during the experiment 1.2 (the second tube).

Add 2-3 ml of 0,1 N $FeCl_3$ solution into the first tube, 2-3 ml of 0,1 N $K_4[Fe(CN)_6]$ solution into the second tube. Colloid solutions will be formed: in the first tube – a blue one, in the second tube – a green one.

Make conclusions as for the granules charge signs.

№ of tubes	0,1 N$FeCl_3$ solution, ml	0,1 N $K_4[Fe(CN)_6]$ solution, ml	Color of colloid solution	Granule charge
1	2-3	–		
2	–	2-3		

6.2.Preparation of colloidal solution by physical condensation. Preparation of cholesterine colloid solution by the method of solvent substitution

Put 10 ml of water into the test tube; instill several drops of alcohol solution of cholesterine. An opalescent sol is formed.

7. TRAINING AND TESTING MEANS

– table funds on the theme of the tutorial;

– card for determination of initial level of knowledge and skills;

–questions for review;

– tests.

Tutorial № 18

1. THEME: Coagulation of colloidal solutions

2. PURPOSE: Tolearn to predict the effects of various factors on the stability of biologically important colloidal systems

3. OBJECTIVIES:

3.1. To form an idea of the types of disperse systems stability.

3.2 To study the factors affecting the stability and coagulation of disperse systems.

3.3 To learn the methods of preparation and properties of aerosols, coarsely dispersed systems, emulsions.

3.4 To get the skills of coagulation threshold determination.

4. PLAN AND ORGANIZATIONAL STRUCTURE OF THE TUTORIAL:

4.1. Organizational part……………………………………………..5 min

4.2. Goal-setting and motivation of the theme studying (opening address of the teacher)…………………………… …………...5 min

4.3. Determination of initial knowledge level…………………..15 min

4.4. Correction of the initial knowledge level…………………….25 min

4.5. Organization of independent work of students (target teacher guidance, rules of accident prevention)……… ………………….5 min

4.6. Laboratory work……………………………………………...45 min

4.7. Final control: checking of the laboratory work results and protocols…………………………………………………...10 min

4.8. Concluding remarks of the teacher, instructional lines for the next lesson……………………………………………………......3 min

5. REFERENCE FOR SELF-STUDY:

5.1. Questions for self-study

1. Kinetic (sedimentation) and the aggregation stability of disperse systems. Stability factors.
2. Coagulation. The mechanism of coagulating electrolytes action.
3. Coagulation threshold. The Schulze-Hardy rule.
4. Mutual coagulation.
5. Coagulation in drinking water purification and wastewater purification.
6. Colloidal protection.
7. Dispersed systems with gas disperse medium. Classification of aerosols, their preparation methods and properties. The use of aerosols in clinical and hygienics practices. The toxic effect of some aerosols.
8. Powders.
9. Coarsely dispersed systems with liquid dispersion medium. Suspensions, methods of their preparation and properties.
10. Pastes, their medical use.
11. Emulsions, methods of their preparation and properties. Types of emulsions. Emulsifiers. Application of emulsions in clinical practice. The biological role of emulsification.
12. Semi-colloidal soaps, detergents. Micelle formation in solutions of semi-colloids.

5.2. Solve the tasks:

Task 1. Which of the ions have a coagulating effect on the negative sol of "Berlin Blue" $Fe_4[Fe(CN)_6]_3$: Al^{3+}, Cl^-, NO_3^-, Mg^{2+}, SO_4^{2-}, K^+. Arrange the ions in order to enhance their coagulating action.

Task 2. It wasneeded9,5ml of 1N NaCl solution, 42 ml of0,01N K_2SO_4 solution,22 ml of0,001 NK_3PO_4 solutionto coagulate50 ml of AgIsol. Determine thecoagulation thresholdof eachelectrolyteand sign the chargeof the sol particles.

Task 3. Coagulation thresholds of AgI sol for KCl and K_2SO_4 are 11,0 and 0m2 mmol/l respectively. How many times is the coagulating power of potassium sulfate greater than of potassium chloride?

5.3. Examples of the solved tasks:

Task 1.100 ml ofFe(OH)$_3$solwerepouredinto threeflasks. 10,5ml of 1 NKClsolution, 62,5ml of0,01 NNa_2SO_4 solution and 37,0ml of0,001 N Na_3PO_4.solution were needed tocause coagulationof the sol. Calculate thecoagulation thresholdof eachelectrolyteand determine thesign of the chargeof the sol particles.

Solution.

Determine the coagulation threshold for KCl:

$$C_c = \frac{C_{(el.)} \cdot V_{(el.)} \cdot 1000}{V_{(sol)} + V_{(el.)}} = \frac{1 \cdot 10{,}5 \cdot 1000}{100 + 10{,}5} = 95\,\text{mmol/l}$$

Determine the coagulation threshold for Na_2SO_4:

$$C_к = \frac{C_{(el.)} \cdot V_{(el.)} \cdot 1000}{V_{(sol} + V_{(el.)}} = \frac{0{,}01 \cdot 62{,}5 \cdot 1000}{100 + 62{,}5} = 3{,}8\,\text{mmol/l}$$

Determine the coagulation threshold for Na_3PO_4:

$$C_к = \frac{C_{(el.)} \cdot V_{(el.)} \cdot 1000}{V_{(sol} + V_{(el.)}} = \frac{0{,}001 \cdot 37 \cdot 1000}{100 + 37} = 0{,}27\ \text{mmol/l}$$

The electrolytes KCl, Na_2SO_4, Na_3RO_4 contain cations of the same charge and anions a different charge. The higher the charge of the ion, the lower the coagulation threshold. PO_4^{3-} ions have the lowest coagulation threshold (but the highest coagulating power). Consequently the particles of $Fe(OH)_3$ sol are positively charged.

Task 2. Coagulation thresholds of KI and $K_2Cr_2O_7$ for $Fe(OH)_3$ sol are 10,0 and 0,195 mmol/l respectively. How many times is the coagulating power of potassium dichromate higher than of potassium iodide?

Solution. Coagulating power (V_c) is the inverse value to the coagulation threshold:

$$V_c = \frac{1}{C_c}$$

$$V_{c\,(KI)} = \frac{1}{10} = 0{,}1$$

$$V_{c\,(K_2Cr_2O_7)} = \frac{1}{0{,}195} = 5{,}1$$

$$V_{c\,(KI)} : V_{к\,(K_2Cr_2O_7)} = 0{,}1 : 5{,}1 = 1 : 51$$

Answer: The coagulating power of potassium dichromate is 51 times higher than the coagulating power of potassium iodide.

5.4. Study tests (p. 84).

Literature:

1. Medical Chemistry : textbook / V. A. Kalibabchuk [and ol.] ; ed. by V. A. Kalibabchuk. - K. : Medicine, 2010. - p.92-107

2. Levitin Ye.Ya. General and Inorganic Chemistry : textbook for students of higher schools / Ye. Ya. Levitin, I. A. Vedernikova. - Kharkiv : Golden Pages, 2009. - 360 p.

3. Inorganic Chemistry : textbook / ed.: D. F. Shriver, P. W. Atkins. - 3th ed. - [s. l.] : Oxford University Press, 2004. - 763 p.

6. LABORATORY WORK

6.1. Coagulation threshold evaluation of ferric(III) hydroxide colloid solution

Put 2,5 ml of $Fe(OH)_3$ colloid solution into 3 series of tubes (4 tubes in each series). Add d-water and electrolytes solutions (KCl, K_2SO_4, $K_3[Fe(CN)_6]$) (shaking) according to the data of the table into each series of tubes. You get 3 series of solutions where concentration of colloid solution is the same and concentration of electrolytes solutions in each next tube is twice as high as in the previous tube.

In half an hour note in what tubes coagulation (clouding) took place. Mark these tubes in the table with «+».

Thus you will mark the minimum concentration of electrolytes, which caused coagulation.

Put down the results of the experiments into the table:

№ tubes	Colloid solution $Fe(OH)_3$, ml	D-water, ml	Electrolyte, ml	External effect
1 series			2 MKCl solution	
		The coagulating ion:		

1	2,5	2,25	0,25	
2	2,5	2,0	0,5	
3	2,5	1,5	1,0	
4	2,5	0,5	2,0	
$C_{к}(KCl)$ =				
2 series 0,05 M K_2SO_4 solution The coagulating ion:				
1	2,5	2,25	0,25	
2	2,5	2,0	0,5	
3	2,5	1,5	1,0	
4	2,5	0,5	2,0	
$C_{к}(K_2SO_4)$ =				
3 series 0,005 M $K_3[Fe(CN)_6]$ solution The coagulating ion:				
1	2,5	2,25	0,25	
2	2,5	2,0	0,5	
3	2,5	1,5	1,0	
4	2,5	0,5	2,0	
$C_{к}(K_3[Fe(CN)_6])$ =				

1. Calculate of the coagulation threshold:

$$Cc = \frac{C_{(el.)} \cdot V_{(el.)} \cdot 1000}{V_{(sol.)} + V_{(el.)}} =$$

2. Note the coagulating ions.

3. Check the Schultze-Hardy rule:

$C_c(KCl) : C_c(K_2SO_4) : C_c(K_3[Fe(CN)_6]) =$

6.2. Coagulation of negatively charged «Berlin blue» colloid solution

Prepare 3 series of test-tubes (3 tubes in each series). Getnegatively charged «Berlin blue» colloid solution by adding 9 ml of 0,1 N $K_4[Fe(CN)_6]$ solution to 1 ml of 0,1 N $FeCl_3$ solution.

Pour 1 ml of made colloid solution into all tubes of each series; add d-water and electrolytes solutions according to the data of the table into each tube.

Evaluate coagulation (clouding) in the tubes in 35 minutes. Mark the tubes with clouding with «+».

Put down the results of the experiments into the table:

№ of tubes	$Fe_4[Fe(CN)_6]_3$ colloid solution, ml	D-water, ml	Electrolyte, ml	External effect
1 series 1 MKCl solution The coagulatng ion:				
1	1,0	1,8	0,2	
2	1,0	1,5	1,5	
3	1,0	-	2,0	
$C_c(KCl) =$				
2 series 0,02 $MBaCl_2$ solution The coagulating ion:				
1	1,0	1,0	1,0	
2	1,0	0,5	1,5	

3	1,0	-	2,0	
$C_c(BaCl_2)$ =				
3 series 0,002 M$AlCl_3$solution The coagulating ion:				
1	1,0	1,5	0,5	
2	1,0	0,5	1,5	
3	1,0	-	2,0	
$C_c(AlCl_3)$ =				

1. Calculate of the coagulation threshold by formula:

$$C_c = \frac{C_{(\text{ээл.}} \cdot V_{(\text{ээл.}}}{V_{(\text{ззоля}} + V_{(\text{ээл.}}}$$

2. Check Schultze-Hardy rule:

$C_c(KCl) : C_c(BaCl_2) : C_c(AlCl_3)$ =

3. Determine the dependence of electrolytes coagulating action on the charge of coagulating ion.

7. TRAINING AND TESTING MEANS

– table funds on the theme of the tutorial;

– card for determination of initial level of knowledge and skills;

–questions for review;

– tests.

Tutorial № 19

1. THEME: The roperties of biopolymers solutions. Isoelectric point of a protein.

2. PURPOSE: Tolearn to estimate the properties of polymer materials based on the chemical nature and the characteristics of the molecules

3. OBJECTIVIES:

3.1. To form an idea of the types of disperse systems stability.

3.2 To study the factors affecting the stability and coagulation of disperse systems.

3.3 To learn the methods of preparation and properties of aerosols, coarsely dispersed systems, emulsions.

3.4 To get the skills of coagulation threshold determination.

4. PLAN AND ORGANIZATIONAL STRUCTURE OF THE TUTORIAL:

4.1. Organizational part………………………………………..5 min

4.2. Goal-setting and motivation of the theme studying (opening address of the teacher)…………………………… ………....5 min

4.3. Determination of initial knowledge level…………………..15 min

4.4. Correction of the initial knowledge level……….………….25 min

4.5. Organization of independent work of students (target teacher guidance, rules of accident prevention)……… ………………….5 min

4.6. Laboratory work………………………………….………...45 min

4.7. Final control: checking of the laboratory work results and protocols……………………………………………………......10 min

4.8. Concluding remarks of the teacher, instructional lines for the next lesson………………………………………………………......3 min

5. REFERENCE FOR SELF-STUDY:

5.1. Questions for self-study

1. HMC solutions, their role in the body. Classification of HMC.
2. The structural organization of the protein molecule (globular and fibrillar). Isoelectric state of the protein. The isoelectric point of the protein and methods of its determination. Electrophoresis.
3. Properties of HMC solutions and their comparative analysis with colloidal solutions and true solutions.
4. Swelling and dissolution of HMC. Effect of pH, temperature and electrolytes to swelling. The role of swelling in the body's physiology.
5. Stability of HMC solutions. Methods of proteins precipitation.
6. The osmotic pressure of biopolymers solutions. Oncotic pressure. Donnan membrane equilibrium.
7. The viscosity of biopolymers solutions: an abnormally high viscosity, specific viscosity, reduced and intrinsic viscosity.
8. Jellies, their formation and properties. Thixotropy. Syneresis. The biological significance.

5.2. Solve the tasks:

Task 1. The solutioncontainesa mixture ofproteins:globulin(pI=7), albumin(pI = 4,9)and collagen(pI = 4,0).At whatpHis it possibleto separate theproteins by electrophoresis?

Task 2. Whichelectrodewill protein particles move toin electrophoresiswhen itspI =4 and thepHis 5?

Task 3.200g ofthe rubberswellingabsorbed964ml of chloroform(density1,9 g/ml).Calculatethe rubber swelling degreeandthe components mass fractionsin the obtainedjelly.

Answer:α = 915,8%; ω_{rubber} = 9.84% = 90.16%
$\omega_{chloroformium}$= 90.16%.

5.3. Examples of the solved tasks:

Task 1. Which electrode will γ-lactoglobulin move to in electrophoresis in a buffer solution with pH = 7,2 if at pH=5,2 the protein remains at start?

Solution. The pH at which the protein is electrically neutral and remains at the start of electrophoresis is called the isoelectric point (pI). When the pH> pIthe protein is negatively charged and at pH <pI it is positively charged. Since the pH (7,2) is greater than pI (5,2) the protein is negatively charged and moves toward the anode having a positive charge in electrophoresis.

Task 2.2 g of a polymer were placed in a flask with benzine. After 20 minutes the polymer was removed from flasks and weighed, the weight was 2,5 g. Calculate the swelling degree of the polymer (in %).

Solution. The swelling degree of the polymer α is calculated by the formula:

$$\alpha = \frac{m - m_0}{m_0} \cdot 100\%, \text{ where}$$

m_0 - mass of the polymer to swell;
m - mass of the polymer after swelling.

$$\alpha = \frac{m - m_0}{m_0} \cdot 100\% = \frac{2{,}5 - 2}{2} \cdot 100 = 25\%.$$

Answer: The swelling degree of the polymer in benzene is 25%.

5.4. Study tests (p. 88).

Literature:

1. Medical Chemistry : textbook / V. A. Kalibabchuk [and ol.] ; ed. by V. A. Kalibabchuk. - K. : Medicine, 2010. - p.92-107
2. Levitin Ye.Ya. General and Inorganic Chemistry : textbook for students of higher schools / Ye. Ya. Levitin, I. A. Vedernikova. - Kharkiv : Golden Pages, 2009. - 360 p.
3. Inorganic Chemistry : textbook / ed.: D. F. Shriver, P. W. Atkins. - 3th ed. - [s. l.] : Oxford University Press, 2004. - 763 p.

6. LABORATORY WORK

6.1. Determination of isoelectric point of gelatin by the degree of coagulation

Put 2 ml of acetated buffer solution with pHaccording to the data of the table into 4 test tubes. Put 2 ml of 0,5 % gelatin solution into each tube, mix and fold 3 ml of ethanol in. Evaluate clouding degree in the tubes in 5 minutes and determine the isoelectric point.

№ tubes	pH of system	Volume of 0,5% gelatin solution, ml	Volume of ethanol, ml	Clouding degree

1	3,8	2	3	
2	4,4	2	3	
3	4,7	2	3	
4	5,1	2	3	

6.2. Effect of pH value on swelling

Put 0,5 sm of dry gelatin into 3 tubes and add 5 ml of solutions pointed in the table into each tube.

Make conclusions in 15 – 20 minutes.

Put down them into the table.

№ of tubes	Dry gelatin	Solution, ml	Conclusions
1	0,5 sm	5 ml of 0,1 N HCl solution	
2	0,5 sm	5 ml of acetated buffer solution with pH=4,7	
3	0,5 sm	5 ml of 0,1 N NaOH solution	

6.3. Effect of electrolytes on swelling

Put 0,5 sm of dry gelatin into 2 tubes and add 5 ml of solutions pointed in the table into each tube.

Make conclusions in 15 – 20 minutes.

№ of tubes	Dry gelatin	Solution, ml	Conclusions
1	0,5 sm	5 ml of 1 N K_2SO_4 solution	
2	0,5 sm	5 ml of 1 N KCl solution	

7. TRAINING AND TESTING MEANS

– table funds on the theme of the tutorial;

– card for determination of initial level of knowledge and skills;

–questions for review;

– tests.

Tutorial № 20

1. THEME:Final control of learning module 1 "Medical Chemistry"

2. PURPOSE:To assess the knowledge and skills of students in the subject "Medical Chemistry".

3. OBJECTIVES

3.1. Test control and personal interview with each student on Medical chemistry

4. PLAN AND ORGANIZATIONALSTRUCTURE OF THE TUTORIAL:

4.1. Organizational part …………………………….....................5 min
4.2. Test control…………………………………………….....50 min
4.3. Personal interview with each student..…............................45 min
4.4. Checking of laboratory work protocols……………………10 min
4.5. Concluding remarks of the teacher.......................................3 min

5. REFERENCE FOR SELF -STUDY:

5.1. Revise the theoretical material and the numerical problems on the topics № № 1-19.

5.2. Study tests of the 1 – 4 topic modules.

Literature:

1.Medical Chemistry : textbook / V. A. Kalibabchuk [and ol.] ; ed. by V. A. Kalibabchuk. - K. : Medicine, 2010. - 224 p.

2. Levitin Ye.Ya. General and Inorganic Chemistry : textbook for students of higher schools / Ye. Ya. Levitin, I. A. Vedernikova. - Kharkiv : Golden Pages, 2009. - 360 p.

3. Quantitative Chemistry Analysis : textbook / D. C. Harris. – 7th ed.: W.H Freeman and Company, 2007. – 808 p.

4. Inorganic Chemistry : textbook / ed.: D. F. Shriver, P. W. Atkins. - 3th ed. - [s. l.] : Oxford University Press, 2004. - 763 p.

2. Applied Colloid and Surface Chemistry Textbook / R. Pashley, M. Karaman. – 2nd ed.. :John Wiley and Sons, 2004. – 190 p.

5. Petrucci R.H., Harwood W.S., Herring F.G. General Chemistry. Principles and Modern Applications. – 8th ed. – Prentice Hall, 2002. – 1160 p.

6. Basic Concepts of Analytical Chemistry: textbook / S.M. Khopkar. – 2nd ed.. : New Age International., 1998. – 500 p.

6. TRAINING AND TESTING MEANS

– table funds on the theme of the tutorial;
– cards for determination of initial level of knowledge and skills;
–questions for review;
– tests.

TEST QUESTIONS

Tests for tutorial № 15

1. The surface energy can be reduced:
   A. Reducing the interface and increasing the surface tension.
   B. Increasing the interface and reducing the surface tension.
   C. Reducing the interface and reducing the surface tension. *

2. The dependence of theadsorptionequilibriumonthe concentration orpartial pressureat a constant temperatureis called:
   A.Adsorption isochore.
   B.Adsorption adiabats
   C.Adsorptionisobars.
   D.Adsorption isotherm. *

3. Theadsorption isothermis described with equation of:
   A. VanderWaals forces.
   B.Langmuir. *
   C.Arrhenius.
   D.Smoluchowski.

4. Which definitioncharacterizes surface-activesubstances?
   A. Substanceswhichadsorptionat the interfaceleads toa significant increase insurface tension.
   B. Substanceswhichadsorptionat the interfaceleads to a significantreduction inthe surface tension.*
   C. Substanceswhich concentrate in thesolution volume that leads to a significantreduction inthe surface tension.

D.Substances that are adsorbed onthe interface anddo not affect thevalue of the surfacetension.

5. What is amphiphilicstructureof surfactants?

A. The presence of hydrophilicgroups and hydrophobicfragments (long-chain radicals) inthe structure.*

B.The presenceof ionogenic groupsin the structure.

C. The presenceoflong-chainradicals (hydrophobic "tails") in the structure.

D.The presence of cations andanions in the structure.

6. What is cationic surfactants definition?

A. Surfactant molecules dissociate in aqueous solution forming cations with long hydrophobic chain. *

B. Surfactant molecules dissociate in aqueous solution forming anions associated with the long hydrophobic chains and cations.

C. Surfactant molecules contain two or more cations associated with long hydrophobic chains.

D. Surfactant molecules dissociate forming ammonia and hydroxyl groups.

7. What is the surface activity?

A. The ability of a substance to reduce the surface tension of the solvent at the interface.

B. The ability of a substance to change (decrease or increase) the surface tension of the solvent at the interface. *

C. The ability of the solute to decrease density of the solution.

D. The ability of a substance to change the optical properties of the solution comparing to the solvent.

8. A measure of the surface activity is:

A The derivative of the surface tension on the surfactant concentration taken with the minus sign. *

B. The ratio of the surface tension to the solute concentration

C. The value of the surface tension referred to the low concentration of surfactant.

D. the ratio of the solution density to the concentration of dissolved surfactant.

9. Howare the phospholipid molecules oriented in biological membranes?

A. They form a bilayer with the orientation of the polar heads to the aqueous phase and of long-chain tails – into the bilayer. *

B. They form monomolecular layers with the orientation of long tails to the aqueous phase within the cell.

C. They form micelles with the orientation of the polar heads into the supramolecular structure.

D. They form a bilayer with the orientation of long tails to the aqueous phase and of the polar heads - into the bilayer.

10. How are surfactants applied in medicine?

A. As deodorants.

B. As antiseptics. *

C. As softening agents.

D. As insecticides.

11. Which of the surfactants are involved in the formation of biological membranes?

A. n-dodecylbenzene.

B. Benzalkonium hydrochloride

C. Phosphatidylcholine. *
D. Twin.

12. How does surface activity change according to Duclos-Traube Rule with increasing of the hydrocarbon chain by one methylene group (-CH2-)?
A. 10^3 times increases.
B. 3 times increases. *
C. 9 times decreases.
D. 9 times increases.

13. What is adsorbent?
A. A substance which is adsorbed on a solid surface.
B. The solid surface on which the adsorption occurs. *
C. The substance forming the insoluble complex with the compound dissolved in the solution.
D. The substance which dissolves absorber.

14. What is the optimal solvent for better adsorption of non-polar solute?
A. The solvent with low polarity.
B. A mixture of the solvents with low and high polarity.
C. The solvent with high polarity. *
D. Water.

15. What cations have the highest adsorption on the surface of the negatively charged adsorbent?
A. K^+.
B. Fe^{3+}.*
C. Cu^{2+}.
D. Cu^+.

16. What cations have the highest adsorption on the surface of the positively charged adsorbent?

A. PO_4^{3-}.*

B. SO_4^{2-}.

C. S^{2-}.

D. I^-.

17. Specify the correct formulation of the rules of polarities alignment:

A. The higher the adsorbate solubility in the solvent, the worse it is adsorbed. The less the solubility, the better it is adsorbed. *

B. The higher the adsorbate solubility in the solvent, the better it is adsorbed. The less the solubility, the worse it is adsorbed

18. Adsorption is the process of:

A. Substances adhesion to the solid surface.

B. Substances accumulation at the interface. *

C. Substances absorption by the phase volume.

19. The substanceconcentration change at the interface compared to the volume of contacting phases is called:

A. Adsorption. *

B. Desorption.

C. Absorption.

D. Condensation.

20. What objects have free energy excess:

A. The molecules adsorbed.

B. The molecules at the interface. *

C. The molecules in the phase volume.

21. Surface molecules at the interface have an energy:
A. That is equal to the energy of the molecules deep.
B. They have an excess of free energy. *
C. They have a minimum free energy.
D. Their energy is equal to zero.

22. The driving force of adsorption is:
A Enthalpy decreasing.
B. The free surface Gibbs energy decreasing. *
C. Entropy increasing.
D. The free surface increasing.

23. Processes occur spontaneouslyat the interface, because the surface energy of the system, ∆G:
A. Increases.
B. Decreases. *
C. Does not change.

24. The adsorption isotherm is the functional dependence of adsorption
A. On temperature.
B. On the concentration of the adsorbate. *
C. On the time of adsorption.

25. Adsorbent is :
A. A substance adsorbed from the phase at the interface.
B. A substances which surface adsorbs other substances from gaseous or liquid phase. *
C. A substance that increases the surface tension.
D. A substance that reduces surface tension.

26. Which type of adsorption is the adsorption of oxygen on the aluminum plate:
    A. Physical.
    B. Chemical. *
    C. Molecular.
    D. Ion.

27. Surface-active substances (surfactants):
    A. Accumulate in the depth of a liquid and reduce the surface tension
    B. Accumulate on the surface of a liquid and reduce the surface tension. *
    C. Do not change the surface tension.

28. Surfactants molecules are:
    A Hydrophilic.
    B. Hydrophobic.
    C. Amphiphilic. *
    D. Electrophilic.

29. Which of the following substances are surface active?
    A. Na_2CO_3.
    B. $CH_3(CH_2)_{12}CH_3$.
    C. $CH_3(CH_2)_{12}COOH$.*
    D. $C_6H_{12}O_6$.

30. If the solvent is water the surfactant molecules at the interface are oriented to the water:
    A With non-polar tail.
    B. With polar head. *
    C. In parallel the interface.
    D. They are not adsorbed remaining in the liquid depth.

31. If the detergent (surfactant) is dissolved in water, the water surface and its drops become:
    A Non-polar. *
    B. Polar.
    C. Diphilic (amphiphilic).
    D. Hydrophilic.

32. If activated carbon is immersed in a soap solution, what will its surface be due to the surfactant adsorption?
    A Non-polar.
    B. Hydrophilic. *
    C. Diphilic.

33. If the detergent (surfactant) is dissolved in water, the water surface tension :
    A Does not change.
    B. Increases.
    C. Decreases. *
    D. It firstly increases and then it decreases.

34. Inorganic ionic substances are:
    A. Surface active.
    B. Surface non-active.
    C. Surface inactive. *

35. Saturated hydrocarbons (e.g., hexane) are the following substances:
    A. Surface active.
    B. Surface non-active. *
    C. Surface inactive.

36. What is the measuring unit of the surface tension:

A. mol/m^2.

B. N/m. *

C. mol/g.

D. J · m / mole.

E. mol/m^3.

37. What is the measuring unit of the adsorption on a moving interface:

A. mol/m^2. *

B. N/m.

C. mol/g.

D. J · m / mole.

E. mol/m^3.

38. What is the measuring unit of the adsorption on a stationary interface:

A. mol/m^2. *

B. N/m.

C. mol/g.*

D. J · m / mole.

E. mol/m^3.

39. The substances which molecules are amphiphilic are:

A. Surface active. *

B. Surface non-active.

C. Surface inactive.

40. Molecular adsorption of non-electrolyte from a solution is the higher:

A. The better the solvent wets the surface of the adsorbent.

B. The worse the solvent wets the surface of the adsorbent. *

C. It depends only on the polar properties of the non-electrolyte.

41.What kind of adsorbent activated carbon is?

A. Non-polar. *

B. Polar.

C. Hydrophilic.

42. The surface of the activated carbon is better wetted with:

A. Water.

B. Hexane. *

C. Heptane.

43. The polar surface of the aluminum oxide is better wetted with:

A. Alcohol. *

B. Hexane.

C. Benzene.

44. What substance is used to remove phenol from water?

A. Aluminum oxide.

B. Activated carbon. *

C. Aluminosilicates.

D. Silica gel.

E. Clay.

45. What adsorbent is used for vegetable oil clarification from coloring compounds?

A. Aluminum oxide. *

B. Activated carbon.

C. Carbon-black.

46. Benzene is better absorbed:

A. At the polar adsorbents.

B. At non-polar adsorbents. *

C. At cation exchangers.

D. At anion exchangers.

E. At any adsorbents.

47. What adsorbent should be selected for the absorption of acetic acid from an aqueous solution:

A. Silica gel.

B. Activated carbon. *

C. Cation exchanger .

D. Anion exchanger.

E. Aluminum oxide.

48. Which anions are adsorbed on the bone surface first?

A. Cl^-.

B. NO_3^-.

C. NO_2^-.

D.PO_4^{3-}.*

E. I^-.

49. For what is hemosorption used?

A. To remove excess water from the cells.

B. For purification of the blood of toxins. *

C. For drugs introduction.

D. For desorption of gases.

50. What process is accompanied by the adsorption from a mixture of gases?

A. Melting ice.

B. Air conditioning. *

C. Clarification of colored solutions.

D. Mineralization of water

51. What is the most effective adsorbent for dehumidification?

A. Activated carbon.

B. Solt.

C. Silica gel. *

D. Graphite black.

52. What is the measuring unit of the surface tension:

A. mol/m^2.

B. J/m^2. *

C. mol/g.

D. J · m / mole.

E. mol/m^3.

53. When surface wetting its surface tension:

A. Increases. *

B. Decreases.

C. Does not change.

54. Which ions may be adsorbed on the surface of lead sulphide (PbS) obtained in the reaction $Pb(NO_3)_2 + Na_2S \rightarrow PbS\downarrow + 2NaNO_3$?

A. Pb^{2+}.*

B. NO_3^-.

C. NO_2^-.

D.Na^+.

55. Which ions may be adsorbed on the surface of lead sulphide (PbS) obtained in the reaction $Pb(NO_3)_2 + Na_2S \rightarrow PbS\downarrow + 2NaNO_3$?

A. Na^+.

B. NO_3^-.

C. NO_2^-.

D.S^{2-}.*

56. With increasing temperature, adsorption:

A. Does not change.

B. Increases.

C. Decreases. *

D. First increases, then remains unchanged.

57. Which ions may be adsorbed on the surface of the sediment obtained in the reaction $H_2SO_4 + BaCl_2$ (excess) → $BaSO_4 + 2HCl$?

A. Ba^{2+}.*

B. NO_3^-.

C. SO_4^{2-}.

D. K^+.

Tests for tutorial № 16

1. Chromatography is a method of:

A. analysis based on the sorption process.

B. analysis based on the desorption process.

C. separation, purification and analysis of substances based on the different distribution between the two phases. *

D. analysis of substances which are close by adsorption abilities.

2. The methods ofhromatographic analysis are divided according to:
   A. The mechanism of substances separation.
   B. The aggregation state of phases.
   C. The experimental technique.
   D. All answeres are correct. *

3. Chromatographic methods of analysis are distinguished by the mechanism of components separation. What mechanism is of adsorption chromatography separation?
   A. The difference in the substances adsorption affinity to the adsorbent. *
   B. The process of substances redistribution between the two phases.
   C. The process of reversible ion exchange between adsorbent and substances.
   D. The difference in solubility of poorly soluble compounds formed.
   E. Separation due to the corresponding redox potentials of the substances.

4. What is the difference between the distribution of adsorption chromatography:
   A. In partition chromatography lower temperatures are use.
   B. There is no difference.
   C. Partition chromatography makes it possible to separate mixtures of substances more accurately.
   D. In partition chromatography a liquid absorbs substances and in adsorption - the surface of a solid sorbent absorbs substances. *
   E. Adsorption chromatography makes it possible to separate mixtures of substances more accurately.

5. What is the basis for mixtures separating by sedimentary chromatography:
   A. Forming of precipitates of mixture components with precipitation reagent.
   B. Different solubility of the resulting compounds. *
   C. Different solubility products of the compounds formed.

D. Difference in solubility of the substance distributed in two immiscible liquid phases.

E. The difference between the particle sizes of components to be separated and a pore size of stationary phase.

6. The chromatographic method based on the specific macromolecules separation from a solution is called:

A. Partition chromatography.

B. Affinity chromatography. *

C. Ion-exchange chromatography.

D. Sieve chromatography.

7. The location of a component zone is set using Rf, because Rf is defined as:

A. The distance passed by the substance from the starting line.

B. The ratio of the distance passed by the substance to 10 cm

C. The distances passed by the substance duringa certain period of time.

D. The ratio of the distance passed by a solvent to the distance passed by a substance.

E. The ratio of the distance passed by a substance to the distance passed by a solvent. *

8. What is the stationary phase for thin layer chromatography?

A. An ion-exchanger.

B. Polyethylene glycol.

C. Aluminum oxide. *

D. Nitrogen.

E. Water.

9. In thin layer chromatography the below listed compounds can be used as adsorbents except for:

A Cellulose.

B. Activated carbon.

C. Aluminum oxide.

D. Silica gel.

E. Ion exchange resins. *

10. For what purpose is two-dimensional paper chromatography used:

A. For separation of substances, one of which is carried by one mobile solvent and another is carried by the other mobile solvent.

B. For separation of substances, some of which have similar Rf in one solvent and different Rf in the other solvent. *

C. To separate two substances with the same Rf values in both solvents.

D. To increase the sensitivity of the chromatographic method.

E. For colored areas in the chromatogram.

11. What factors determine the speed of movement and the value of Rf:

A. The method of spots development.

B. The analyte concentration.

C. The solvent vapor pressure.

D. The nature of a substance and the structure of a solvent. *

E. The size of a chromatography plate.

12. What characteristic is used for the characterization of separated components in thin-layer chromatography?

A. Distribution coefficient.

B. Separation factor.

C. Concentration factor.

D. Retention factor. *

13. Which ions are exchanged by cation exchangers?

A. Ca^{2+}иMg^{2+}.*

B. $B_4O_7^{2-}$ и Ba^{2+}.
C. SCN^- и Al^{3+}.
D. K^+ и SO_4^{2-}.
E. CO_3^{2-} иSO_4^{2-}.

14. What substances are used as stationary phase in molecular sieve chromatography?
A. Activated carbon.
B. Organic solvents.
C. Porous materials. *
D. Ion exchange resins.
E. Polyamide resins.

15. What substances are used as stationary phase in ion exchange chromatography?
A. Activated carbon.
B. Organic solvents.
C. Porous materials.
D. Polyamide resins.
E. Ion exchange resin. *

16. What substance is used as stationary phase in thin layer chromatography?
A. Silica gel. *
B. Organic solvent.
C. Porous material.
D. Ion exchange resin.

17. What substance is not used as stationary phase in thin layer chromatography?

A. Silica gel.
B. Activated carbon.
C. Butanol. *
D. Talc.
E. Cellulose.

18. The method of ion exchange chromatography is based on ion exchange between:
A. A stationary solid phase and a gas.
B. A stationary solid phase and a mobile liquid phase. *
C. A stationary liquid phase and a mobile liquid phase.
D. A stationary liquid phase and a gas.

19. Cation exchangers are called ion-exchangers which exchange their mobile ions to:
A. Anions of a sample solution.
B. Cations of a sample solution. *
C. Cations and anions of a sample solution.

20. Anion exchangers are called ion-exchangers which exchange their mobile ions to:
A. Anions of a sample solution. *
B. Cations of a sample solution.
C. Cations and anions of a sample solution.

21. Which ions are not exchanged by cation exchangers?
A. Al^{3+}.
B. Na^{+}.
C. SCN^{-}.*
D. K^{+}.

22. In ion-exchange chromatography the ion exchange is:

A. on the thin layer of a sorbent applied to a glass plate.

B. on the chromatographic paper.

C. in capillary tubes.

D. in the chromatographic columns. *

E. in a thin layer of a sorbent applied to an aluminum plate.

23. Ion exchangers are called high-molecular adsorbents that:

A. Change their cations to anions of a sample solution.

B. Change their anions to cations of a test solution

C. Form a sparingly soluble compound with one of the ions of a sample solution.

D. Equivalently exchange their ions to ions of the sample solution. *

24. Which ions are not exchanged by anion exchangers?

A. $B_4O_7^{2-}$.

B. Ba^{2+}.*

C. SCN^-.

D. CO_3^{2-}.

E. SO_4^{2-}.

Tests for tutorial № 17

1. What ion is potential-determining in the colloidal particles formed in the interaction of excess silver nitrate solution excess with sodium chloride:

A. Ag^+.*

B. Cl^-.

C. Na^+.

D. NO_3^-.

2. The ion which is adsorbed on the surface of the nucleus and determines the charge of the colloidal particles is called:

A. Coagulating ion.

B. Potential-determining ion. *

C. Dispersion ion.

D. Surface ion.

3. When mixing equal volumes of 0,001 M solution of $AgNO_3$ and 0,002 M solution of KI the micelles aggregate is:

A. AgI.*

B. KI.

C. $AgNO_3$.

D. KNO_3.

4. Which of the substances below is a disperse system ?

A. Mineral water.

B. Salt solution.

C. A solution of sugar.

D. Milk. *

5. The method of separation based on the molecules and ions penetration through the membrane that is impermeable to colloidal particles is called:

A. Electrophoresis.

B. Dialysis. *

C. Transfer.

D. Coacervation.

6. A disperse system consists of:
  A. A disperse phase and a disperse medium. *
  B. Two solvents.
  D. A solvents and a disperse medium.

7. Dispersion is:
  A. The value that is inverse proportional to particles diameter. *
  B. The value that is inverse proportional to particles volume.
  C. The value that is inverse proportional to particles radius.
  D. The value that is directly proportional to the particles size.

8. Choose the property according to which disperse systems are classified:
  A. Solubility.
  B. Dispersion degree. *
  C. Viscosity.
  D. Optical properties.

9. Colloidal particles obtained by the introduction of saturated solution of $BaCl_2$ into diluted H_2SO_4 solution have:
  A. The charge that is not compensated by the layer of counter-ions.
  B. Zero charge.
  C. Positive charge. *
  D. Negative charge.

10. Colloidal particles obtained by the introduction of saturated solution of H_2S into diluted solution of $AsCl_3$ have:
  A. The charge that is not compensated by the layer of counter-ions.
  B. Zero charge.
  C. Positive charge.
  D. Negative charge. *

12. Which ion forms the diffusion layer of micelles of hydrophobic sol obtained by the reactionKCl + $AgNO_{3\,(excess)} \leftrightarrow AgCl\downarrow + KNO_3$:

A. Ag^+.

B. K^+.

C. NO_3^-.*

D. Cl^-.

13. Which ion forms the countrions layer of micelles of hydrophobic sol obtained by the reaction $BaCl_2 + Na_2SO_{4(excess)} \leftrightarrow BaSO_4\downarrow + 2NaCl$:

A. Ba^{2+}.

B. SO_4^{2-}.

C. Na^+.*

D. Cl^-.

14. The method of substances mixture separating under the influence of electric current is called:

A. Elektrodializ.

B. Electrophoresis. *

C. Electroosmosis.

D. Electrolysis.

15. Granule is the part of a micelle which consists of:

A Diffusion layer and aggregate.

B. Nucleus and adsorption layer of counter-ions. *

C. Aggregate and potential-determining ions.

16. The core is the part of the micelle which consists of:

A. Granule and potential-determining ions.

B. Potential-determining ions and counter-ions.

C. Aggregate and potential-determining ions. *

17. Lyophobic colloidal systems include systems that without stabilizer are :

A Thermodynamically stable, transmit the light, have a high osmotic pressure.

B. Thermodynamically unstable, scatter light, have a low osmotic pressure. *

C. Thermodynamically stable, scatter light, have a high osmotic pressure.

18. According to the dispersion degree disperse systems are classified into:

A. Suspensions and emulsions.

B. Hydrophilic and hydrophobic.

C. Coarsely dispersed, fine-grained and molecular dispersed *

19. In colloidal solutions disperse particles (micelles) are visible:

A. With the naked eye.

B. In microscope.

C. In ultramicroscope. *

20. Colloidal solutions can be distinguished from true solutions using:

A. A microscope - colloidal particles are visible.

B. Filtration - colloidal particles are on the filter.

C. Scattering of a narrow beam of light in a colloidal solution. *

21. For lyophobic colloids formation of is required:

A. A catalyst.

B An inhibitor.

C. A stabilizer. *

D. A condenser.

22. An electrolyte excess in colloidal solutions preparation by exchange reaction forms:
   A. Nucleus.
   B. Diffuse layer.
   C. Adsorption layer.
   D. Double electric layer. *
   E. Micelle.

23. What ions can be adsorbed on the surface of the micelle nucleus according to the Paneth-Fajans rule if the micelle is obtained by the reaction $LiNO_3 + NaF \leftrightarrow LiF\downarrow + NaNO_3$?
   A. Li^+.*
   B. NO_3^-.
   C. Na^+.

24. What ions can be adsorbed on the surface of the micelle nucleus according to the Paneth-Fajans rule if the micelle is obtained by the reaction $LiNO_3 + NaF \leftrightarrow LiF\downarrow + NaNO_3$?
   A. Na^+.
   B. NO_3^-.
   C. F^-.*

25. What are the potential-determining ions in the micelles of $Ni(OH)_2$ colloidal solution obtained by the exchange reaction:$NiC1_2 + 2NaOH_{(excess).} \leftrightarrow Ni(OH)_2\downarrow + 2HCl$?
   A. Ni^{2+}.
   B. Cl^-.
   C. Na^+.
   D. OH^-.*
   E. H^+.

26. What are the potential-determining ions in the micelles obtained by the exchange reaction:$Pb(NO_3)_2 + H_2SO_{4(excess)} \leftrightarrow PbSO_4\downarrow + 2HNO_3$?

A.Pb^{2+}.

B. NO_3^-.

C. H^+.

D. SO_4^{2-}.*

27. What charge of the granule has the micelle of HgS sol obtained in an excess of hydrogen sulfide?

A. Positive.

B. Neutral.

C. Negative. *

28. Colloidal solution of CuS obtained by reaction $CuCl_2 + H_2S \leftrightarrow CuS + 2HCl$ in excess of hydrogen sulfide has:

A. The granule with positive charge.

C. The granule with negative charge. *

C. The micelles with charge "+".

D. The micelles with charge "-".

E. It is lyophilic colloid solution with uncharged particles.

29. Dialysis is a method of colloidal solutions purification from:

A Low-molecular impurities. *

B. High-molecular impurities.

C. Dispersion medium.

30. Osmotic pressure of colloids compared to this of true solutions at the same mass concentration of the disperse phase is:

A. Higher because of large size of the particles.

B. Lower because of large size of the particles. *

C. Equal due to the same mass concentration.

D. Equal due to the same number of particles.

31. During electrophoresis a granule of silver chloride sol obtained in excess of KCl migrates:

A. To the cathode (-).

B. To the anode (+). *

C. Do not move because it is in isoelectric state.

32. Specify the micelle nucleus of hydrophobic sol obtained by the reaction $CaCl_{2(excess)} + Na_2CO_3 \leftrightarrow CaCO_3\downarrow + 2NaCl$:

A. $[m\ (CaCO_3)\ nCl^-]$.

B. $[m\ (Na_2CO_3)\ nCl^-]$.

C. $[m\ (CaCO_3)\ nCa^{2+}]$.*

D. $[m\ (CaCl_2)\ nCa^{2+}]$.

33. Adsorption of potential-determining ions takes place in accordance to the rule of:

A Van't Hoff.

B. Paneth-Fajans. *

C. Boyle.

34. The drug containing colloidal silver is called:

A. Silver nitrate.

B. Silver water.

C. Collargol. *

Tests for tutorial № 18

1. Which ion has the best coagulating effect on $BaSO_4$ sol prepared by the reaction $BaCl_2 + K_2SO_{4(exscess)} \leftrightarrow BaSO_4 + 2KCl$?

A. Mg^{2+}.

B. Fe^{3+}.*

C. Fe^{2+}.

D. K^+.

2. What causes coagulation of $BaSO_4$ sol prepared by the reaction $BaCl_2 + K_2SO_{4(изб.)} \leftrightarrow BaSO_4 + 2KCl$?

A Neutral molecule.

B. Cations and anions simultaneously.

C. Electrolyte anions.

D. Electrolyte cations. *

3. Smoke and mist belong to disperse systems such as:

A. Sol.

B. Aerosol. *

C. Suspension.

D. Emulsion.

4. Coagulation of colloids can occur under the action of:

A Surfactant.

B. Light.

C. Strong electrolytes. *

D. Solvent molecules.

5. Air that contains dust particles belongs to:

A. Sols.

B. Aerosols. *

C. foams.

D. Emulsions.

6. The disperse phase of emulsions is:

A. Liquid. *

B. Solid.

C. Gaseous.

7. The disperse medium of emulsions is:

A. Liquid. *

B. Solid.

C. Gaseous.

8. The greatest coagulation effect on sol with negatively charged colloidal particles is provided by:

A. $FeSO_4$.

B. K_3PO_4.

C. KCl.

D. $AlCl_3$.*

9. Precipitation of colloidal particles under the influence of gravity is called:

A Sedimentation. *

B. Coagulation.

C. Aggregation.

D. Condensation.

E. Opalescence.

10. When increasing the charge of coagulant coagulation threshold:

A. Remains unchanged.

B Decreases. *

C. Increases.

11. Coagulation is:

A A surface adhesion of the substance to the adsorbent.

B. Fusion of the emulsion droplets into larger and delamination of a liquid.

C. Adhesion of colloidal particles and recovering of the solid phase. *

D. Extruding of the liquid phase from the polymer grid (dehydration).

12. According to the rule of Schulze-Hardy coagulation of colloidal solutions is caused by:

A. Any electrolytes ion.

B. Ions charged oppositely to pellet. *

C. Ions charged equally to the granule.

D. Only ions with a high charge.

13. Which ion of the electrolyte NaCl will cause coagulation of silver iodide sol stabilized with $AgNO_3$?

A. Na^+.

B. Cl^-.*

C. Na^+ и Cl^-.

14. Which ion of calcium chloride $CaCl_2$ will cause coagulation of lead sulfate sol stabilized with sulfuric acid?

A. $CaCl_2$ does not cause coagulation of the sol.

B. Ca^{2+}.*

C. Cl^-.

15. Which of the electrolytes has the lowest coagulation threshold for silver chloride sol stabilized with KCl?

A. NaCl.

B. $CaCl_2$.

C. $AlCl_3$.*

D. Na_2SO_4.

16. Which electrolyte causes the greatest coagulation effect on the lead sulfide (PbS) sol stabilized with hydrogen sulfide?

A. NaCl.

B. $CaCl_2$.

C. $AlCl_3$.*

D. Na_2SO_4.

E. Na_3PO_4.

17. What type of disperse systems do emulsions belong to:

A. S/L.

B. S/S.

C. G/L.

D. L/L. *

E. G/S.

18. In emulsion W/O stabilized by a surfactant, surfactant molecules oriented to the particles of the disperse phase with:

A. Tail.

B. Head. *

C. The tails are parallel particle.

19. Determining the nature of the emulsion it was revealed that it wets the hydrophobic surface. Which type is the emulsion?

A. W/O. *

B. O/W.

C. O/O.
D. W/W.

20. Which ion has the largest coagulating effect on colloidal solution with a negatively charged granule?
A. Na^+.
B. SO_4^{2-}.
C. PO_4^{3-}.
D. Ca^{2+}.*

21. Which ion has the largest coagulating effect on colloidal solution with a positively charged granule?
A. Na^+.
B. SO_4^{2-}.
C. PO_4^{3-}.*
D. Ca^{2+}.

22. Which ion has the largest coagulating effect on colloidal solution with a negatively charged granule?
A. Ba^{2+}.*
B. K^+.
C. NO_3^-.
D. Cl^-.

23. When increasing the coagulating ion charge its coagulating power:
A. Remains unchanged.
B. Decreases.
C. Increases. *

24. The colloidal dissolution process in micellar systems of the compounds that are not soluble in the solvent is called:
    A. Solubilization. *
    B. Coalescence.
    C. Flocculation.
    D. Coagulation.

25. The process when liquid droplets of a disperse phase stick together is called:
    A. Solubilization.
    B. Coalescence. *
    C. Flocculation.
    D. Coagulation.

Tests for tutorial № 19

1. What is the effect of "salting out" of proteins solutions?
    A. Adsorption of salt by structures of HMC.
    B. Removing of the hydration shell of a protein particles. *
    C. Increasing of the viscosity of the solution.
    D. Turning HMC solution to jelly.

2. What is colloidal protection of HMC solutions?
    A. Giving of additional charge to sol particles.
    B. Neutralization of sol granules.
    C. Adsorption of HMS particles on sol particles. *
    D. Appearance of a stronger hydration shell of sol particles.
    E. Increasing of a sol mass by HMC.

3. The least HMC swelling occurs in solutions with:
   A. pH of pI. *
   B. pH greater than pI.
   C. pH less than pI.

4. Macromolecular compounds are called:
   A. Solutions which are thermodynamically unstable.
   B. Solutions which have large interface with a solvent.
   C. Solid substances which do not swell.
   D. Solutions which do not possess high viscosity.
   E. Compounds with molecular weight of from a few thousand to several million. *

5. HMC are obtained in the reaction of:
   A. Hydrolysis.
   B. Substitution.
   C. Polycondensation. *
   D. Exchange.
   E. Oxidation-reduction.

6. HMC are obtained in the reaction of:
   A. Hydrolysis.
   B. Polymerization. *
   C. Substitution.
   D. Exchange.
   E. Oxidation-reduction.

7. A mixture of proteins may be divided into separate fractions by:
   A. Heating.
   B. Electrophoresis.

C. Dissolving in water.
D. Salting out. *

8. Coacervation is the process of:
A. HMC sedimentation.
B. Decreasing of HMC solubility by solvent replacement.
C. Separation of HMC solution into two liquid phases with different polymer concentrations. *
D. Preparation of HMC solution from dry sediment.

9. Which compounds are HMS?
A. Protein, polysaccharides, polyethylene, cellulose. *
B. Sucrose, cellulose, ethylene, benzene.
C. Phenol, glycogen, ethanol, cryolite.
D. Glucose, starch, ethylene, glycerol.
E. Collagen, methanol, starch, keratin.

10. Which reaction produces proteins in living organisms?
A. Polycondensation of monosaccharides.
B. Polymerization of amino acids.
C. Polycondensation of α-amino acids. *
D. Polycondensation of β-amino acids.
E Polymerization of α-amino acids.

11. The molecular weight of the polymers is determined by methods of:
A. Polarography.
B. Potentiometry.
C. Refractometry.
D. Conductometry.
E. Viscometry. *

12. Thixotropy is the phenomenon of:
   A. Reversible gelation of the sol. *
   B. Progressive compression of a polymer net with liquid phase separation.
   C. Irreversible transition of jelly into HMC solution.
   D. HMC separation by introduction of electrolyte solution.

13. Which substances are natural proteins?
   A. Polyester, nylon, polyelectrolytes, polyethylene.
   B. Glycogen, hemoglobin, gelatin, agar. *
   C. Protein, polyethylene, butadiene rubber.
   D. Nylon, gelatin, polyvinyl chloride.
   E. Nucleic acids, glycogen, gelatin, nylon.

14. Which molecules do not correspond to the polymers classification according to the macromolecule form?
   A. Globular.
   B. Linear. *
   C. Fibrillar.

15. Which molecules do not correspond to the polymers classification according to the polymer chain structure?
   A. Mesh.
   B. Linear.
   C. Globular. *
   D. Branching.
   E. Stair.

16. Typical physical states of HMC are:
   A. Crystal, liquid or gaseous.

B. Solid, liquid or gaseous.

C. Crystal, vitreous, liquid. *

D. Gaseous, high-elastic, vitreous.

17. The structures of living organisms include such HMC:

A. Glucose, proteins, nucleic acids.

B. Siloxanes, agar-agar, nylon.

C. Polyester, gelatin, nylon, paraformaldehyde.

D. Nucleic acids, polysaccharides, globulins. *

18. What is the charge of a protein molecule in isoelectric state?

A. Positive.

B. Negative.

C. Zero. *

19. How to reach the isoelectric protein state?

A. Increase the concentration of protein.

B. Denature the protein.

C. Apply salts in different concentrations.

D. Remove the charge of the macromolecule. *

20. HMC solutions in contrast to colloidal solutions are:

A. Hydrophobic.

B. Lyophobic.

C. Lyophilic. *

21. At the isoelectric point of the protein its stability is:

A. The lowest. *

B. The highest.

C. Average.

22. HMC swelling is the increase of the polymer volume by:
   - A. Temperature increase.
   - B. Selective uptake of a low-molecular solvent. *
   - C. Pressure increase.

23. In what process does a violation of the protein macrostructure occure?
   - A. Coacervation.
   - B. Salting out.
   - C. Denaturation. *
   - D. Renaturation.

24. What is the basis of the salting-out process?
   - A. Integration of hydration shells of several particles.
   - B. Violation of the protein structure.
   - C. Removing of the protein molecule charge.
   - D. Removing of the hydration shell of a protein molecule. *

25. What underlies the process of coacervation:
   - A. The integration of hydration shells of several particles without combining the particles themselves. *
   - B. Violation of the protein structure.
   - C. Removing of the protein molecule charge.
   - D. Removing of the hydration shell of a protein molecule.

26. What process that takes place with HMC is the basis of life on Earth?
   - A. Swelling.
   - B. Denaturation.
   - C. Coacervation. *

D. Jellification.

E. Salting out.

27. Jellification is the process of:

A.Association of hydration shells of several particles.

B. Transition of a polymer solution into the form of jelly. *

C. Transition of a polymer solution into a colloidal system.

28. HMC solutions are the systems which are:

A. Thermodynamically stable, allow light to have a high osmotic pressure.

B. Thermodynamically unstable and scatter light, have low osmotic pressure.

C. Thermodynamically stable, scatter light, have low osmotic pressure. *

29. At what pH jellification process will be more efficient?

A. pH = Ip. *

B. pH <Ip.

C. pH >Ip.

30. Which method is used for determination of polymers molar mass?

A. Conductometry.

B. Potentiometry.

C. Polarography.

D. Viscometry.

E. Coulometry. *

CONTENT