PROGRAM OF ENTRANCE EXAMS

OF THE GROUP "CHEMICHAL SCIENCES"

FOR THOSE WHO APPLY FOR THE PHD

During the exam you will be asked questions on the final graduation thesis as well as questions corresponding to the subject of the future research.

Questions on the final graduation thesis (master's and specialist's)

1. General provisions.

2. Novelty.

3. Relevance of the research activity an applicant.

Bioorganic chemistry.

1. Chemistry as the basis of biology. Water as a medium for biochemical reactions. Electrolytic dissociation, buffer components, polyelectrolytes.
2. Bioorganic chemistry as a science that studies the structure and mechanisms of functioning of biologically active molecules. History of the development of the chemistry of natural compounds and bioorganic chemistry. Practical use of natural compounds of biological origin by man and progress in the development of organic chemistry. The place of bioorganic chemistry among the natural sciences and its role in solving problems in various areas of the national economy.
3. Amino acids. Peptides. Squirrels. Classification, structure, functions. Role in biological systems. Levels of spatial organization of proteins. Protein research methods.
4. Chemical synthesis of peptides. Methods for the protection of functional groups. Creation of a peptide bond: methods of mixed anhydrides, activated esters, carbodiimide and carboxyanhydride condensation methods. The concept of block and stepwise synthesis of peptides. Racemization problem. Solid phase peptide synthesis.
5. Chemical modification of proteins. Problems solved with the help of chemical modification. Basic reactions of functional groups of proteins. bifunctional reagents. Introduction of fluorescent, spin and photoaffinity labels. Post-translational modification of proteins.
6. Spatial structure of proteins. Electronic structure and configuration of the peptide bond. Angles φ, ψ, ω. Ramachandran cards. Types of interactions that determine the spatial structure of polypeptides. Relation of the spatial structure of a protein to the sequence of amino acid residues.
7. Secondary structure of peptides and proteins. α-helix, β-structure, β-bend, other types of regular structures of the polypeptide chain. Circular dichroism and optical rotation dispersion as methods for determining the secondary structure. Super secondary structure of proteins. The concept of domains.
8. Tertiary structure of proteins. X-ray diffraction analysis as a method for studying the spatial structure of proteins. Nuclear magnetic resonance as a method for studying the conformation of peptides and proteins in solutions. Denaturation and renaturation.

9. Quaternary structure of proteins. Examples of subunit structures. Methods for studying the quaternary structure.
10. The biological role of proteins. Enzymes. Classification. Introduction to biocatalysis. Principles of enzymatic kinetics. Factors affecting the rate of enzymatic reactions. The concept of the active center. Enzyme-substrate complex. Protein hormones. The mechanism of action of peptide-protein hormones. Structure and properties of the adenylate cyclase system. insulin, growth hormones.
11. Nucleotides. Nucleic acids. Nucleic acid research methods.
12. Primary structure of polynucleotide chains. 3'--5' phosphodiester bond. Chemical disparity of 3'- and 5'-terminal groups.
13. Double-stranded nucleic acids. Base pairs, polarity and complementarity of chains. Secondary structure of DNA. Various forms of double-stranded molecules, their conformational characteristics and mutual transitions. Denaturation and Renaturation of Double Helix Structures.
14. Single-stranded nucleic acids. The idea of the secondary and tertiary structure of tRNA and macromolecular RNA. Chemical and enzymatic methods for studying the secondary structure of ribonucleic acids.
15. Chemical synthesis of nucleic acids. Phosphodi- and triester methods in solution and on polymers. Methods based on the use of compounds of trivalent phosphorus (amidophosphite, H-phosphonate). Protective groups and condensing reagents. Methods for the removal of protective groups. Purification of the final product. Synthesis of polynucleotides using enzymes.
16. Application of genetic engineering to study the structure of genes and genome regions. Cloning as an integral part of the determination of DNA sequences.
17. Monosaccharides. Structure and stereochemistry. Cyclic forms. Stereochemistry of the anomeric center. Conformations of open and cyclic forms. Chemical properties of monosaccharides.
18. Oligo- and polysaccharides. Synthesis and chemical properties of glycosides. Methods for determining the structure of oligosaccharides (NMR spectroscopy; mass spectrometry; chemical, enzymatic and combined approaches). General principles for establishing the structure of polysaccharides. Carbohydrate containing biopolymers. Glycoproteins: structure and main functions. Methods for establishing the structure, types of carbohydrate N- and O-chains, the concept of “glycosylation site”.
19. Polysaccharides of animal, plant and bacterial cells; bacterial lipopolysaccharides.
20. Biological membranes. Composition, structure, functions.
21. Membrane transport, passive and active. Artificial membranes: monolayer, flat bilayer; liposomes (vesicles).
22. Immunocompetent cells: origin, types, role in immunity. Antigens and antigenic determinants.
23. Antigen-recognizing receptors of lymphocytes: structure specificity.
24. Interferons.
25. Alkaloids. A group of opium alkaloids. The concept of opiate receptors and their endogenous ligands. Tropane alkaloids: groups of cocaine and atropine. Painkillers and sleeping pills. Drugs and hallucinogens. Psychotropic drugs of the phenothiazine group. Tranquilizers of the benzodiazepine series and natural ligands of their receptors are β-

carboline alkaloids. Tubocurarine and synthetic muscle relaxants. Cinchona alkaloids and purine alkaloids.

26. Antibiotics. Penicillins, cephalosporins and related antibiotics. The concept of the mechanism of biosynthesis of the bacterial cell wall and the mechanism of action of penicillins. Tetracyclines - structure and mechanism of antimicrobial action. Antibiotics as tools for studying protein biosynthesis: the main stages of this biosynthesis and related antibiotics. Understanding the biosynthesis of nucleic acids and the antibiotics that affect it. Nucleoside antibiotics and synthetic nucleoside derivatives are inhibitors of the herpes virus and HIV. Antibiotics - tools for studying ion transport across membranes (polyene macrolides, gramicidins, cyclodepsipeptides).
27. Steroids. Biosynthesis and functional role. Structure and biological significance of the main representatives of steroid hormones. Features of the reception of steroid hormones.
28. Toxins. Mycotoxins. Blue-green algae toxins. Amphibian and fish toxins. Use of toxins in bioorganic chemistry and neurophysiology
29. Phytohormones and other plant regulators. Pesticides. insecticides and herbicides. Superecotoxicants of the dioxin series.
30. The main methodological techniques used in the process of isolating biomolecules. Ways of destruction of tissues and cells, salting out, dialysis, ultrafiltration, lyophilization. Properties of biomolecules that determine the methods for their separation. sedimentation methods. Basic concepts of the theory of centrifugation. The choice of method and method of centrifugation to solve a specific experimental problem. Extraction as a method of isolation. Distribution coefficient. Extraction with organic solvents and detergents.
31. Mass spectrometry. Ways of ionization of organic molecules. Application area of mass spectrometry.
32. Spectral methods and corresponding areas of electromagnetic radiation.

Recommended literature

1. Ю.А.Овчинников. Биоорганическая химия. М., Просвещение, 1987.
2. Д.Г.Кнорре, Т.С.Годовикова, С.Д.Мызина, О.С.Фёдорова. Биоорганическая химия. Новосибирск, РИЦ НГУ, 2011.
3. Тюкавкина Н.А., Бауков Ю.И. Биоорганическая химия. М., Дрофа, 2010 г.
4. В.Албертс, Д.Брей, Дж.Льюис, М.Рэфф, К.Роберте, Дж.Уотсон. Молекулярная биология клетки. Т. 1-3. М., Мир, 1994.
3. Р.Марри, Д.Греннер, П.Мейес, В.Родуэлл. Биохимия человека. Т. 1-2. М., Мир, 1993.
4. А.Уайт, Ф.Хендлер, Э.Смит, Р.Хилл, И.Леман. Основы биохимии. Т. 1-3. М., Мир, 1981.
5. А.Ленинжер. Основы биохимии. Т. 1-3. М., Мир, 1985.
6. Д.Нельсон, М.Кокс. Основы биохимии Ленинджера. Т.1-3. М., Бином, 2011.
7. Д.Мецлер. Биохимия. Т. 1-3. М., Мир, 1980.
8. Л.Страйер. Биохимия. Т. 1-3. М., Мир, 1985.
9. J.M.Berg, J.L.Tymoczko, L.Stryer. Biochemistry. The 5th edition, W.H. Freeman & Company, 2002.

10. Metzler D.E. Biochemistry. The chemical reactions of living cells. The 2nd edition. V.1 – 2. Harcourt/Academic Press, London, 2001.

Дополнительная литература

1. И.В.Шугалей, А.В.Гарабаджиу, И.В.Целинский. Химия белка. Санкт-Петербург, Проспект Науки, 2011.

2. Практическая химия белка. Ред. А.Дарбре. М., Мир, 1989.

3. А.М.Степанов. Молекулярная биология. Структура и функции белков. М., Высшая школа, 1996.

4. Р.Скоупс. Методы очистки белков. М., Мир, 1985.

5. Проблема белка. Т.1. Химическое строение белка. Ред. В.М.Липкин. М., Наука, 1995.

6. Проблема белка. Т.2. Пространственное строение белка. Ред. Т.И.Соркина. М., Наука, 1996.

7. Белки и пептиды. Т.1. Ред. В.Т.Иванов, В.М.Липкин. М., Наука, 1995.

8. Х.-Д.Якубке, Х.Ешкайт. Аминокислоты. Пептиды. Белки. М., Мир, 1985.

9. Э.Шредер, К.Любке. Пептиды. Т.1-2. М., Мир, 1965.

10. Э.Гросс, И.Майенхофер. Пептиды. Основные методы образования пептидных связей. М., Мир, 1983.

11. Общая органическая химия. Т.10. Нуклеиновые кислоты, аминокислоты, пептиды, белки. Ред. Е.Хаслам. М., Химия, 1986.

12. Guide to Protein Purification. Ed. by M.P.Deutscher. Methods in Enzymology, V.182. Academic Press, 1990.

13. Techniques in Protein Chemistry VI. Ed. by J.W.Crabb. Academic Press, 1995.

14. Methods in Protein Sequence Analysis. Ed. by K.A.Walsh. Humana Press, 1987.

15. R.L.Lundblad, C.M.Noyes. Chemical Reagents for Protein Modification. V.l-2. CRC Press, 1984.

16. D.M.Bollag, S.*D*.Edelstein. Protein Methods. Wiley-Liss, 1991.

17. E.Atherton, R.C.Sheppard. Solid Phase Peptide Synthesis. A Practical Approach. JRL Press, 1989.

18. Advances in Protein Chemistry. V.47. Ed. by C.B.Anfinsen, O.T.Edsall, F.M.Rechards, D.S.Eisenberg. Academic Press, 1995.

19. Б.Льюин. Гены. М., Бином, 2011.

20. В.Зенгер. Принципы структурной организации нуклеиновых кислот. М., Мир, 1987.

21. Н.К.Кочетков и др. Органическая химия нуклеиновых кислот. М., Химия, 1970.

22. З.А.Шабарова, А.А.Богданов. Химия нуклеиновых кислот и их компонентов. М., Химия, 1978.

23. А.С.Спирин. Молекулярная биология. Структура рибосомы и биосинтез белка. М., Высшая школа, 1986.

24. Дж.Уотсон, Дж.Туз, Д.Курц. Рекомбинантные ДНК. М., Мир, 1986.

25. G.M.Blackburn, M.CJ.Gait (eds). Nucleic Acids in Chemistry and Biology. Oxford: IRL Press, 1991; 2nd edition, 1996.

26. Н.К.Кочетков и др. Химия углеводов, М., Химия, 1967.

27. Р.Хьюз. Гликопротеины. М., Мир, 1986.

28. A. Varki. Essentials of Glycobiology. NY, Cold Springs Harbor Lab Press, 1999.

29. Р.П.Евстигнеева, Е.Н.Звонкова, Г.А.Серебренникова, В.И.Швец. Химия липидов. М., Химия, 1983.

30. Phospholipids. Eds. J.N.Hawthorne and G.B.Ansell. Amsterdam, Elsevier, 1982.

31. Введение в биомембранологию. Под ред. А.А. Болдырева. М., Изд-во МГУ, 1990.

32. M.I. Gurr, J.L.Harwood Lipid biochemistry. An Introduction. 4th-edition. Chapman&Hall, London, 1996.

33. Р.Геннис. Биомембраны. Молекулярная биология и фукции. М.,Мир, 1997.

34. Биологические мембраны. Ред. Дж.Финдлей, У.Эванс. М., Мир, 1990.

35. Cevc G., Marsh D. Phospholipid bilayers. Physical principles and models. N.Y.: Wiley, 1987.

36. Болдырев А.А., Курелла Е.Г., Павлова Т.Н., Стволинский С.Л., Федосова Н.У. Билогические мембраны. М., Изд. МГУ, 1992.

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38. А.А.Ярилин. Основы иммунологии. М., Медицина, 1999.

39. Р.М.Хаитов, Г.А.Игнатьева, И.Г.Сидорович. Иммунология. М., Медицина, 2000.

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41. А.Ройт, Дж.Бростофф, Д.Мейл. Иммунология. М., Мир, 2000.

42. М.М.Шемякин, А.С.Хохлов, М.Н.Колосов, Л.Д.Бергельсон, В.К.Антонов. Химия антибиотиков. Т. 1-2. М., Мир, 1985.

43. Д.Ланчини, Ф.Паренти. Антибиотики. М., Мир, 1985.

44. М.Д.Машковский. Лекарственные средства. Т.1-2. М., Медицина, 2002.

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46. Ф.Хухо. Нейрохимия. Основы и принципы. М., Мир, 1990.

47. К.Дёрфлинг. Гормоны растений. Системный подход. М., Мир, 1985.

48. T.C.Moore. Biochemistry and Physiology of Plant Hormones. Springer-Verlag, N.Y., 1989.

49. Л.А.Федоров. Диоксины как экологическая опасность: ретроспектива и перспективы. М., Наука, 1993.
50. Э.Дероум. Современные методы ЯМР для химических исследований. М., Мир, 1992.
51. Физико-химические методы исследования биополимеров и низкомолекулярных биорегуляторов. Ред. В.Т.Иванов. М., Наука, 1992.
52. П.Кэри. Применение спектроскопии КР и РКР в биохимии. Ред. Б.В.Локшин. М., Мир, 1985.
53. Ч.Кантор, П. Шиммел. Биофизическая химия. Т. 1-2. М., Мир, 1984.
54. Дж.Лакович. Основы флуоресцентной спектроскопии. М., Мир, 1986.
55. А.Смит. Прикладная ИК-спектроскопия. М., Мир, 1982.
56. Э.Бакс. Двумерный ядерный магнитный резонанс в жидкости. Новосибирск, Наука, 1989.
57. Р.Эрнст, Дж.Боденхаузен, А.Вокаун. ЯМР в одном и двух измерениях. М., Мир, 1990.
58. Дж.Спенс. Экспериментальная электронная микроскопия высокого разрешения. М., Мир, 1986.
59. Д.Фрайфелдер. Физическая биохимия: применение физико-химических методов в биохимии и молекулярной биологии. М., Мир, 1980.
60. Дж.Чепмен. Практическая органическая масс-спектрометрия. М., Мир, 1988.
61. Molecular Dynamics and Protein Structure. Ed. Jan Hermans, University of North Carolina, USA, 1984.