

Program: Biology and Biotechnology

This document outlines the scope of themes, which may be included in the Olympiad tests. The themes are grouped by areas and are followed by the list of recommended references in the Russian and English languages.

Olympiad winner's skill set by Subject

Analytical skills: analysis of literature data and study of biological samples

Genetics, cell, and general biology

You must be familiar with the structure of the eukaryotic and prokaryotic cells, the features of the cells of plants, animals, and fungi; the features of the karyotype and genotype of a human cell; the specifics of heredity and variation, conjugation and crossing over, mitosis and meiosis; the fundamentals of ecology and evolution.

You must be able to solve genetic problems (first and second Mendel's law, monohybrid, and dihybrid crossing, linked inheritance, non-allelic interaction of genes); to distinguish between cell organelles, to distinguish mitotic cell division from meiotic; determine the ecological interactions of organisms.

You must have the skills in using a light microscope, working with cell and tissue preparations, and determining structures from photographs, drawings, and diagrams.

Physiology and Immunology

You must be familiar with the principles of human immune system organization, the basics of the work of internal body organs, and the structures and mechanisms of hormone and neurotransmitter synthesis.

You must be able to compare physiological parameters in health and disease, determine the molecular mechanisms of pathological processes, and identify the nervous and humoral mechanisms of life regulation.

You must have skills in employing the methods of flow cytometry, obtaining monoclonal antibodies, and analyzing the physiological parameters of the human body using medical instruments.

Project-oriented competence: laboratory work

Biotechnology

You must be familiar with the molecular foundations of biotechnology, modern methods of biotechnology, and their scope; know how to choose producers of biologically active substances, and determine the optimal strategy for developing and purifying biologically active substances.

You must be able to use the methods of polymerase chain reaction, restriction analysis, gel electrophoresis, prokaryotic and eukaryotic cell cultivation, cell culture transformation and transfection, and recombinant protein isolation.

Research competence: participation in R&D work, writing reports, and articles

Microbiology and virology

You must be familiar with the principles of classification and taxonomy of bacteria and viruses, the basic organization of virus and bacterial genomes, the basics of using bacteria and viruses in biotechnology, and the life cycles of viruses.

You must have skills in working with viral vectors, as well as employing methods for cultivating prokaryotic cells and isolating plasmid DNA.

Biochemistry and Molecular Biology

You must be familiar with the structure of the main classes of biological molecules (proteins, lipids, sugars, nucleic acids), the kinetics of enzymatic reactions, the principles of enzyme operation, the mechanisms of intracellular cascades, the central dogma of molecular biology, and the mechanisms of replication, transcription, and translation.

You must be able to design gene constructs and solve plastic and energy metabolism problems.

You must have skills in employing the methods of nucleic acid isolation, chromatography, genetic engineering, bioinformatics analysis, polymerase chain reaction, reverse transcription, and gel electrophoresis.

Content

Section 1. Biotechnology

1. Recombinant DNA technologies. Vectors. Reverse transcription
2. Restriction enzymes. Polymerase chain reaction
3. Cloned gene expression. Cloning. Transgenic organisms
4. Biomass production. Recombinant protein isolation
5. Biosecurity

Section 2. Genetics, cell, and general biology

1. Cell division. Mitosis. Meiosis. Gametogenesis
2. Chromosomal theory of heredity. Organization of chromatin
3. Cell membrane structure. Eukaryotic cell organelles. Cell cycle
4. Diversity of living organisms: plants, animals, fungi. Systematics
5. Levels of living system organization. Biological evolution. Ecology

Section 3. Microbiology and virology

1. Viruses. Classification
2. Bacteria and archaea
3. Symbiotic theory of eukaryotic cell origin
4. Light and electron microscopy
5. Bacteria and viruses causing human diseases

Section 4. Physiology and immunology

1. Metabolism
2. Neuro-humoral regulation
3. The immune system. Humoral and cellular immunity
4. Vaccines: History and prospects
5. Allergies. Autoimmune processes

Section 5. Biochemistry and molecular biology

1. Proteins, lipids, nucleic acids. Functions of proteins. Enzymes. Enzymatic kinetics.
2. Cell metabolism, cellular respiration, photosynthesis
3. DNA replication and repair. DNA sequencing
4. Transcription. Regulation of transcription in pro- and eukaryotes

5. Translation. Genetic code. The regulation of protein synthesis on ribosomes in prokaryotes and eukaryotes

Recommended literature

Section 1. Biotechnology

Sources	Topic
Alberts B., Johnson A., Lewis J., Morgan D., Raff M., Roberts K., Walter P. Molecular Biology of the Cell Sixth Edition. W. W. Norton & Company, 2014. – 1464 p. https://www.amazon.com/Molecular-Biology-Sixth-Bruce-Alberts/dp/0815345240 – restricted access	Recombinant DNA technologies. Vectors. Reverse transcription. Cloned gene expression. Restriction enzymes. Polymerase chain reaction. Biosecurity
Campbell N. A., Urry L. A., Cain M. L., Wasserman S. A., Orr R. A., Minorsky P. V., Reece J. B. Biology: A Global Approach – 12th Edition. 1510 p. https://www.amazon.com/Biology-Global-Approach-12th-Latest/dp/B09Y93QQMJ – restricted access	Recombinant DNA technologies. Vectors. Reverse transcription. Restriction enzymes. Polymerase chain reaction. Cloned gene expression. Cloning. Transgenic organisms. Biomass production. Recombinant protein isolation. Biosecurity
El-Mansi, E. M. T., Bryce C. F. A., Arnold L. Demain, Allman A.R. Fermentation Microbiology and Biotechnology. 3rd Edition, CRC Press - 2012, 555 p. https://www.agrifs.ir/sites/default/files/27.Fermentation%20Microbiology%20and%20Biotechnology%20-2011.pdf – free access	Biomass production. Recombinant protein isolation
Глик Б., Пастернак Дж. Молекулярная биотехнология. Принципы и применение. М.: Мир, 2002. https://vk.com/wall-120203091_10779 – free access	Biomass production. Recombinant protein isolation. Biosecurity
Мамонтов С. Г., Захаров В. Б., Козлова Т. А.; ред. Мамонтов С. Г. Биология: учебник для студентов вузов – М.: Академия ИЦ, 2008 – 568 с. https://vk.com/doc502213246_474939969 – free access	Recombinant DNA technologies. Vectors. Cloning. Transgenic organisms. Biosecurity

Section 2. Genetics, Cell and General Biology

Sources	Topic
Alberts B., Johnson A., Lewis J., Morgan D., Raff M., Roberts K., Walter P. Molecular Biology of the Cell Sixth Edition. W. W. Norton & Company, 2014. - 1464 p. https://www.amazon.com/Molecular-	Cell membrane structure. Eukaryotic cell organelles. Cell cycle. Oncological diseases

Sources	Topic
Biology-Sixth-Bruce-Alberts/dp/0815345240 – restricted access	
Bowman W. D., Hacker S. D., Cain M. L. Ecology - 4th Edition. Oxford University Press – 2017, 744 p. https://www.amazon.com/Ecology-Michael-Bowman-William-Hardcover/dp/B00NYIWBW0 – restricted access	Biological evolution. Ecology
Campbell N. A., Urry L. A., Cain M. L., Wasserman S. A., Orr R. A., Minorsky P. V., Reece J. B.. Biology: A Global Approach – 12th Edition. 1510 p. https://www.amazon.com/Biology-Global-Approach-12th-Latest/dp/B09Y93QQMJ – restricted access	Cell membrane structure. Eukaryotic cell organelles. Cell cycle. Diversity of living organisms: plants, animals, fungi. Systematics. Levels of living system organization . Biological evolution. Ecology
Futuyma D. J., Kirkpatrick M. Evolution 4th Edition. Oxford University Press – 2017, 594 p. https://www.amazon.com/Evolution-Third-Douglas-Futuyma-2013-03-04/dp/B01N3MELOM – restricted access	Biological evolution. Ecology
Krebs J. E., Goldstein E. S., Kilpatrick S. T. Lewin's GENES XII 12th Edition. Jones & Bartlett Learning, 2017 - 838 p. https://www.amazon.com/Lewins-GENES-XII-Jocelyn-Krebs/dp/1284104494 – restricted access	Cell division. Mitosis. Meiosis. Gametogenesis. Chromosomal theory of heredity. Chromatin organization
Гиляров А. М. Экология биосферы. — М.: Издательство Московского университета, 2018. — 158 с. https://www.ozon.ru/product/ekologiya-biosfery-uchebnoe-posobie-dlya-studentov-biologicheskikh-spetsialnostey-gilyarov-a-m-267551813/ – restricted access	Biological evolution. Ecology
Жимулев, И. Ф. Общая и молекулярная генетика: учебное пособие. Изд. 4-е, стереотип. 3-му. – Новосибирск: Сибирское университетское издательство, 2007. – 480 с. https://vk.com/wall-120203091_4930 – free access	Chromosomal theory of heredity. Chromatin organization

Sources	Topic
Мамонтов С. Г., Захаров В. Б., Козлова Т. А.; ред. Мамонтов С. Г. Биология: учебник для студентов вузов – М.: Академия ИЦ, 2008 – 568 с. https://vk.com/doc502213246_474939969 – free access	Diversity of living organisms: plants, animals, fungi. Systematics. Levels of living system organization. Biological evolution. Ecology
Северцов А. Теория эволюции: учеб. для студентов вузов. – Владос, 2005. https://vk.com/doc70981420_458632157 – free access	Biological evolution. Ecology
Ченцов Ю. С., Введение в клеточную биологию. Учебник. Изд. Альянс, 2015. - 496 с. https://vk.com/wall-120203091_511 – free access	Cell division. Mitosis. Meiosis. Gametogenesis. Cell membrane structure. Eukaryotic cell organelles. Cell cycle

Section 3. Microbiology and Virology

Sources	Topic
Campbell N. A., Urry L. A., Cain M. L., Wasserman S. A., Orr R. A., Minorsky P. V., Reece J. B.. Biology: A Global Approach – 12th Edition. 1510 p. https://www.amazon.com/Biology-Global-Approach-12th-Latest/dp/B09Y93QQMJ – restricted access	Viruses. Classification. Bacteria and Archaea. Symbiotic theory of eukaryotic cell origin. Light and electron microscopy. Bacteria and viruses causing diseases in humans
Hewlett M. J., Camerini D., Bloom D. C. Basic Virology, Fourth Edition. Wiley-Blackwell, 2021. - 576 p.. https://www.amazon.com/Basic-Virology-Fourth-Edition/dp/1119314054 – restricted access	Viruses. Classification. Bacteria and viruses causing diseases in humans
Madigan M. T., Martinko J. M., Bender K. S., Buckley D. H., Stahl D. A., Brock T. Brock Biology of Microorganisms 14th Edition. Pearson, 2014. - 1032 p. https://www.amazon.com/Brock-Biology-Microorganisms-Michael-Madigan/dp/0134261925 – restricted access	Bacteria and archaea. Symbiotic theory of eukaryotic cell origin. Light and electron microscopy
Гусев М. В., Минеева Л. А. Микробиология. Москва, 2003. - 461 с.	Bacteria and archaea. Bacteria and viruses causing diseases in humans

https://vk.com/doc145912791_532760429 – free access	
Мамонтов С. Г., Захаров В. Б., Козлова Т. А.; ред. Мамонтов С. Г. Биология: учебник для студентов вузов – М.: Академия ИЦ, 2008 – 568 с. https://vk.com/doc502213246_474939969 – free access	Viruses. Classification. Bacteria and archaea. Symbiotic theory of eukaryotic cell origin. Light and electron microscopy. Bacteria and viruses causing diseases in humans
Пиневиц А. В., Сироткин А. К., Гаврилова О. В., Потехин А. А. Вирусология: учебник. СПб.: Изд-во С.-Петербур. ун-та, 2012. — 432 с. https://www.ozon.ru/product/virusologiya-potehin-a-a-gavrilova-o-v-184342407/ – restricted access	Viruses. Classification. Symbiotic theory of eukaryotic cell origin. Light and electron microscopy

Section 4. Physiology and immunology

Sources	Topic
Campbell N. A., Urry L. A., Cain M. L., Wasserman S. A., Orr R. A., Minorsky P. V., Reece J. B.. Biology: A Global Approach – 12th Edition. 1510 p. https://www.amazon.com/Biology-Global-Approach-12th-Latest/dp/B09Y93QQMJ – restricted access	Metabolism. Neuro-humoral regulation. The immune system. Humoral and cellular immunity. Vaccines: History and prospects. Allergies. Autoimmune processes
Marieb E., Hoehn K. Human Anatomy & Physiology. 11th Edition. Pearson, 2018 - 1264 p. https://www.amazon.com/Human-Anatomy-Physiology-Elaine-Marieb/dp/0134580990 – restricted access	Metabolism. Neuro-humoral regulation
Murphy K. M., Weaver C. Janeway's Immunobiology. Ninth Edition. W. W. Norton & Company, 2016 - 924 p. https://www.amazon.com/Janeways-Immunobiology-Ninth-Kenneth-Murphy/dp/0815345054 – restricted access	The immune system. Humoral and cellular immunity. Vaccines: History and prospects. Allergies. Autoimmune processes
Барышников С. Д. Лекции по анатомии и физиологии человека с основами патологии. Изд. 2-е. М.: ГОУ ВУНМЦ, 2002. – 416 с. https://vk.com/doc19546201_621838796 – free access	Metabolism. Neuro-humoral regulation. The immune system. Humoral and cellular immunity. Vaccines: History and prospects. Allergies. Autoimmune processes

Sources	Topic
Мамонтов С. Г., Захаров В. Б., Козлова Т. А.; ред. Мамонтов С. Г. Биология: учебник для студентов вузов – М.: Академия ИЦ, 2008 – 568 с. https://vk.com/doc502213246_474939969 – free access	Metabolism. Neuro-humoral regulation. The immune system. Humoral and cellular immunity. Vaccines: History and prospects. Allergies. Autoimmune processes
Покровский, В. М. Физиология человека: учебник / Под ред. В. М. Покровского, Г. Ф. Коротько - 3-е изд. - Москва : Медицина, 2011. - 664 с. - https://vk.com/doc-67003026_636340327 – free access	Metabolism. Neuro-humoral regulation. The immune system. Humoral and cellular immunity. Vaccines: History and prospects. Allergies. Autoimmune processes

Section 5. Biochemistry and molecular biology

Sources	Topic
Alberts B., Johnson A., Lewis J., Morgan D., Raff M., Roberts K., Walter P. Molecular Biology of the Cell Sixth Edition. W. W. Norton & Company, 2014. - 1464 p. https://www.amazon.com/Molecular-Biology-Sixth-Bruce-Alberts/dp/0815345240 – restricted access	DNA replication and repair. DNA sequencing. Transcription. Regulation of transcription in pro- and eukaryotes. Translation. The genetic code. The regulation of protein synthesis on ribosomes in prokaryotes and eukaryotes
Campbell N. A., Urry L. A., Cain M. L., Wasserman S. A., Orr R. A., Minorsky P. V., Reece J. B.. Biology: A Global Approach – 12th Edition. 1510 p. https://www.amazon.com/Biology-Global-Approach-12th-Latest/dp/B09Y93QQMJ – restricted access	Proteins, lipids, nucleic acids. Functions of proteins. Enzymes. Enzymatic kinetics. Cell metabolism, cellular respiration, photosynthesis. DNA replication and repair. DNA sequencing. Transcription. Transcription regulation in pro- and eukaryotes. Translation. The genetic code. The regulation of protein synthesis on ribosomes in prokaryotes and eukaryotes
Nelson D. L. Lehninger Principles of Biochemistry 8th Edition. W.H. Freeman, 2021 - 1248 p. https://www.amazon.com/Lehninger-Principles-Biochemistry-David-Nelson/dp/1319228003 – restricted access	Proteins, lipids, nucleic acids. The functions of proteins. Enzymes. Enzymatic kinetics. Cell metabolism, cellular respiration, photosynthesis
Альбертс Б., Джонсон А., Льюис Д., Рэфф М., Робертс К., Уолтер П. Молекулярная биология клетки. В 3 томах. Регулярная и хаотическая динамика, Институт компьютерных исследований.	Proteins, lipids, nucleic acids. Functions of proteins. Enzymes. Enzymatic kinetics. Cell metabolism, cellular respiration, photosynthesis. DNA sequencing

https://vk.com/doc28047_409848095 – free access	
Дымшиц Г. М. Основные начала молекулярной биологии: 25 иллюстрированных лекций. Новосибирск: Издательско-полиграфический центр НГУ, 2018.— 179 с. — https://e-lib.nsu.ru/reader/bookView.html?params=UmVzb3VyY2UtNjY2NA/cGFnZTAwMDA – free access	DNA replication and repair. Transcription. Transcription regulation in pro- and eukaryotes. Translation. The genetic code. The regulation of protein synthesis on ribosomes in prokaryotes and eukaryotes
Мамонтов С. Г., Захаров В. Б., Козлова Т. А.; ред. Мамонтов С. Г. Биология: учебник для студентов вузов – М.: Академия ИЦ, 2008 – 568 с. https://vk.com/doc502213246_474939969 – free access	Proteins, lipids, nucleic acids. Functions of proteins. Cell metabolism, cellular respiration, photosynthesis. DNA replication. Transcription. The genetic code

Recommended online courses

Section 1. Biotechnology

1. Chemical Biology (Coursera) <https://coursera.org/learn/chemical-biology>
2. Drug Development Product Management (Coursera) <https://coursera.org/specializations/drug-development-product-management>
3. Industrial Biotechnology (Coursera) <https://www.coursera.org/learn/industrial-biotech>
4. Methods of molecular biology (Coursera) <https://coursera.org/learn/methods-of-molecular-biology>
5. Systems Biology and Biotechnology (Coursera) <https://www.coursera.org/specializations/systems-biology>

Section 2. Genetics, cell, and general biology

1. Anatomy Specialization (Coursera) <https://www.coursera.org/specializations/anatomy>
2. Big Stuff: Evolution and Ecology (Coursera) <https://www.coursera.org/learn/the-big-stuff-evolution-and-ecology>
3. Ecology: Ecosystem Dynamics and Conservation (Coursera) <https://www.coursera.org/learn/ecology-conservation>
4. Genomics: Decoding the Universal Language of Life (Coursera) <https://coursera.org/learn/genomics-research>
5. Introduction to Genetics and Evolution (Coursera) <https://www.coursera.org/learn/genetics-evolution>
6. Science of Stem Cells (Coursera) <https://www.coursera.org/learn/stem-cells>
7. Understanding Plants - Part I: What a Plant Knows (Coursera) <https://coursera.org/learn/plantknows>
8. Understanding Plants - Part II: Fundamentals of Plant Biology (Coursera) <https://coursera.org/learn/plant-biology>

Section 3. Microbiology and virology

1. Bacteria and Chronic Infections (Coursera) <https://www.coursera.org/learn/bacterial-infections>
2. Biology Everywhere (Coursera) <https://coursera.org/specializations/biology-everywhere>
3. Epidemics - the Dynamics of Infectious Diseases (Coursera)
<https://www.coursera.org/learn/epidemics>
4. From Disease to Genes and Back (Coursera) <https://coursera.org/learn/disease-genes>

Section 4. Physiology and immunology

1. Biochemical Principles of Energy Metabolism (Coursera)
<https://coursera.org/learn/energy-metabolism>
2. Fundamentals of Immunology (Coursera)
<https://www.coursera.org/specializations/immunology>
3. Fundamentals of Immunology: T Cells and Signaling (Coursera)
<https://coursera.org/learn/immunologyfundamentalstcellssignaling>
4. Heart Physiology (Coursera) <https://coursera.org/learn/heart-physiology>
5. Introductory Human Physiology (Coursera) <https://www.coursera.org/learn/physiology>

Section 5. Biochemistry and molecular biology

1. Biochemical Principles of Energy Metabolism (Coursera)
<https://www.coursera.org/learn/energy-metabolism>
2. Chemical Biology (Coursera) <https://coursera.org/learn/chemical-biology>
3. Industrial Biotechnology (Coursera) <https://coursera.org/learn/industrial-biotech>
4. Methods of molecular biology (Coursera) <https://coursera.org/learn/methods-of-molecular-biology>
5. Methods of molecular biology (Coursera) <https://www.coursera.org/learn/methods-of-molecular-biology>