МИНОБРНАУКИ РОССИИ

Федеральное государственное автономное образовательное учреждение высшего образования "Пермский государственный национальный исследовательский университет"

Кафедра микробиологии и иммунологии

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Рабочая программа дисциплины

MICROBIOLOGY AND VIROLOGY

Код УМК 93050

Утверждено
Протокол №9
от «17» мая 2021 г.

Пермь, 2021

1. Наименование дисциплины

Microbiology and Virology

2. Место дисциплины в структуре образовательной программы

Дисциплина входит в обязательную часть Блока « С.1 » образовательной программы по направлениям подготовки (специальностям):

Специальность: **33.05.01** Фармация

направленность Программа широкого профиля (для иностранных граждан)

3. Планируемые результаты обучения по дисциплине

В результате освоения дисциплины **Microbiology and Virology** у обучающегося должны быть сформированы следующие компетенции:

33.05.01 Фармация (направленность : Программа широкого профиля (для иностранных граждан))

ОПК.1 Владеет базовыми знаниями о современной научной картине мира на основе положений, законов и методов математических и естественных наук

Индикаторы

ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук

ОПК.7 Способен представлять результаты своей работы в устной и письменной форме в соответствии с нормами и правилами, принятыми в профессиональном сообществе

Индикаторы

ОПК.7.1 Представляет результаты работы в виде письменного отчета с учетом требований библиографической культуры

4. Объем и содержание дисциплины

Направления подготовки	33.05.01 Фармация (направленность: Программа широкого профиля (для иностранных граждан))
форма обучения	очная
№№ триместров, выделенных для изучения дисциплины	4
Объем дисциплины (з.е.)	3
Объем дисциплины (ак.час.)	108
Контактная работа с преподавателем (ак.час.), в том числе:	42
Проведение лекционных занятий	28
Проведение лабораторных работ, занятий по иностранному языку	14
Самостоятельная работа (ак.час.)	66
Формы текущего контроля	Входное тестирование (1) Итоговое контрольное мероприятие (1) Письменное контрольное мероприятие (2)
Формы промежуточной аттестации	Экзамен (4 триместр)

5. Аннотированное описание содержания разделов и тем дисциплины

Historical developments of Microbiology and its connections with other biology disciplines

Scope of Microbiology

Definition of Microbiology and its foundational concepts. The leading role of Microbiology in solving the main problems of biology: the origin of life; the nature of biological processes such as fermentation, decay, decomposition; the causes of infectious diseases. Spontaneous generation versus biotic generation of life. Contributions of Microbiology to medicine, environmental science, agriculture and food production, pharmaceutical industry and biotechnology.

Contributions of great microbiologists

Overview of history of Microbiology. The discovery of microorganisms by Antony van Leeuwenhoek (1632-1723) and further progress in microscopic techniques – the descriptive period of Microbiology. The role of Louis Pasteur (1822-1895) in developing medical, technical and agricultural Microbiology. The "Golden age" of Microbiology – contributions of R. Koch (1843-1910), M.W. Beijerinck (1851-1931), I.I. Mechnikov (1845-1916). The method of pure cultures of Robert Koch and Koch's postulates. Introduction of elective cultures and discovery of autotrophy by Sergey Vinogradsky (1856-1953). Discovery of viruses by Dmitry Ivanovsky (1864-1920) and Martinus Beijerinck (1851-1931). The work of Russian microbiologysts: L.S. Zankovskey (1822-1887), I.I. Mechnikov, D.I. Ivanovsky (1864-1920), V.L. Omelyanskiy (1867-1928), V.S. Butkevich (1872-1942), F. Gamaleya (1859-1949), G.A. Nadson (1897-1939), B.L. Isachenko (1871-1948), V.N. Shaposhnikov (1884-1968), N.D. Jerusalemskey (1901-1967), N.A. Krasil'nikov (1896-1973), etc.

Problems of prokaryote taxonomy. Characteristics of the main systematic groups

Diversity of prokaryotic and eukaryotic microorganisms

Microbial diversity under the Convention on Biological Diversity and Agenda 21. Roles of microbial culture collections in the conservation and sustainable use of microbial resources. Diversity of prokaryotic microorganisms: Bacteria and Archaea. Brief description of eukaryotic Algae & Fungi and protozoa.

Problems of prokaryote taxonomy. Classification, nomenclature and identification. Species concept in microbiology

Classification, nomenclature and identification of microorganisms. Whittaker's five kingdom classification of living system. Problems of prokaryote taxonomy. International Code of Nomenclature of Bacteria. Species concept in microbiology. Bergey's Manual of Systematic Bacteriology. Phenotypic classification systems based on morphological, cultural, physiological and biochemical properties. Numerical analysis: general principles, possibilities and limitations in the classification and identification of bacteria.

Advances in polyphasic taxonomy and molecular phylogeny

Advances in polyphasic taxonomy and molecular phylogeny. Chemotaxonomy, including chemical composition and diagnostic components of the bacterial cell wall: peptidoglycan structure and lipid composition (fatty acids, phospholipids, menaquinones etc.). Genotypic characteristics: G+C composition of DNA, genome size, DNA-DNA and DNA-rRNA homology. Homology of 16S rRNA gene sequences in the phylogeny of bacteria. Analysis of complete bacterial genome sequences and genome signatures in bacterial classification and identification.

Organization and structure of microorganisms. Morphological differentiation and levels of prokaryotic cell organization.

Bacterial morphology

Bacterial cell morphology and classification: definition, shapes & arrangements. Three basic shapes: coccus, rod or bacillus, and spiral. Coccus shape 5 arrangements: diplococcus, streptococcus, tetrad, sarcina and

staphylococcus. Bacillus shape three arrangements: single bacillus, streptobacillus and coccobacillus. Spiral shape three arrangements: vibrio, spirillum and spirochete. Unusual forms: sheathed, stalked, filamentous, square, star-shaped, spindle-shaped, lobed, trichome-forming and pleomorphic bacteria. Bacterial cell sizes and ultrasmall bacteria.

Laboratory practice: Obtaining pure cultures of bacteria – Streak plate. Examination of the morphology of bacterial colonies. Light microscopy: principles, parts & function, operation. Preparation of smears and simple staining / Gram staining. Bacterial cell microscopic observation & morphometry.

Structure and function of prokaryotic cell and its components

The structure of typical prokaryotic cell: nuclear zone (nucleoid), in which a single chromosomal, circular, double-stranded DNA molecule is located, plasmids, ribosomes, inclusions, plasma membrane, cell wall, capsules, regularly structured S-layers. Cell wall of Gram-positive and Gram-negative bacteria. Differences in prokaryotic and eukaryotic cell organization. Chemical components of a bacterial cell. Flagella, pilus, fimbriae. Bacterial motility and gliding. Resting forms of prokaryotes. Spores and spore forming, endospores & exospores; roles of sporulation.

Membrane structure and transport

Models of membrane structure. Membrane lipids, proteins and carbohydrates. Water and ion transport. Solute transport by simple diffusion, facilitated diffusion and active transport.

Microbial growth and reproduction

Microbial nutrition and growth, estimation of microbial numbers. An overview of cell cycle. Components of cell cycle control system, intracellular and extra-cellular control of cell division. The kinetics of microbial growth: generation time and growth curve. Factors affecting microbial growth. Growth in multicellular microorganisms, reproduction patterns. Direct measurement of microbial growth: serial dilution and pour and spread plate, membrane filtration and microscopic count. Indirect methods: spectrophotometry (turbidity) and dry weight.

Physical organization of bacterial genomes, mechanism of gene regulation

Structure and function of genetic material in bacteria. Elements and scales of genome organization. Interplay between the nucleoid and genome organization and expression. Bacterial chromosome structure and architectures. Gene regulation: operon theory. Operon’s regulatory region includes both the promoter and the operator. Repressible and inducible operons. The trp operon: a repressible operon. The lac operon: an inducible operon.

Cultivation and storage of microorganisms

Microbial culture methods, growth media

Isolation and cultivation of microorganisms. Enriched, selective and diagnostic media. Most common growth media for microorganisms: nutrient broths and agar plates. Growth media: chemically defined and undefined (complex). Types of media according to sources of energy, carbon, electron donors and acceptors. Batch and periodic (continuous) cultures, chemostat (turbidostats and auxostats). Synchronous cultures as a method of studying the life cycle of microorganisms. Cultivation of immobilized microbial cells. Aerobic vs. anaerobic cultivation. Microorganism growth control. Methods for assessing the viability of cells and microbial populations. Strategies for culture of 'unculturable' bacteria.

Laboratory practice: Determination of bacterial growth with hydrocarbons – Testing the ability of bacteria to assimilate hydrocarbons in Petri dishes with mineral agar and hydrocarbons.

Preservation and storage. Role of culture collections in microbial diversity conservation

Preservation and maintenance methods for bacteria, fungi and yeasts. Sub-culturing, cryopreservation, freeze-drying, spray drying. Cryoprotective additives (lyoprotectants) and the use of stressful bioprocessing conditions. Novel emerging preservation technologies: microencapsulation and gel immobilization, electrospinning and electrospraying. Methods for assessing the success of preservation methods. History and types of microbial culture collections, services & databases. The role of biological resource centers (BRC) in providing a basic infrastructure for microbial research and biotechnology. International Depositary Authority (IDA) for the deposition of patent cultures. Biobanking genetic resources and DNA barcoding. Networks of Culture Collections: WFCC and ECCO. Regional Specialised Collection of Alkanotrophic Microorganisms (WDCM # 768) as an example of bioresource centre.

Metabolic diversity of microorganisms

Energy metabolism

Overview of cell metabolism: anabolism and catabolism. Energy generating principles and patterns. Adenosine triphosphate (ATP), phosphorylation and dephosphorylation. Oxidation-reduction or redox reactions, NAD+ and NADP+. Enzymes and catalytic activity & enzyme–substrate interaction. Major classes of enzymes and their specificity. Cofactors and coenzymes. Environmental factors affecting enzyme activity.

Oxygen and nutrient requirements, nutrition types

Oxygen requirements: aerobes, obligate and facultative anaerobes, microaerophiles. Primary nutritional groups: classification of organisms based on their metabolism (energy source, electron donor, carbon source). Autotrophs (photosynthetic and chemoautotrophic bacteria) and heterotrophs (saprophyte and parasite). Most prokaryotes are chemoheterotrophs. Catabolic pathways in heterotrophs. Alternative energy generating patterns: chemolithotrophic metabolism.

Main metabolic pathways (glycolysis, anaerobic respiration and fermentation)

Aerobic and anaerobic respiration. Embden–Meyerhof pathway, glycolysis. Entner–Doudoroff pathway. Pentose phosphate pathway (hexose monophosphate shunt). Tricarboxylic acid (TCA) cycle (Krebs cycle) and role of acetyl-Coenzyme A. Anaplerotic reactions: glyoxylate cycle (glyoxylate shunt or bypass). Fermentation pathways: alcoholic fermentation & lactic acid fermentation and mixed acid fermentation. Metabolism of lipids and proteins.

Respiratory chain and oxidative phosphorylation. Photosynthesis

Oxidative phosphorylation and the electron transport chain. Chemiosmotic theory of Peter Mitchell: an active transport of protons across the membrane creates a gradient of charge and concentration (proton motive force), mechanism of ATPase. Bacterial photosynthesis: oxygenic (cyanobacteria) and anoxygenic (purple and green photosynthetic bacteria), main differences. Bacteriochlorophylls & accessory pigments (carotenoids and phycobilins). Bacteriorhodopsin of halophilic members of the Archaea. Photosystem I and photosystem II, non-cyclic and cyclic photophosphorylation. Calvin cycle: carbon enters the cycle as carbon dioxide and leaves as glyceraldehyde-3-phosphate, from which hexoses are formed. Biosynthesis of carbohydrates, lipids and amino acids. Regulation of metabolism & feedback inhibition.

Major and minor biogenic elements, growth factors

Macro or major mineral nutrients: O, H, C, N, P and S. Minor (micro) nutrients or trace elements and their cellular functions. Growth factors (essential metabolites): amino acids, purines & pyrimidines, and vitamins.

Detection and identification of microorganisms

Ex situ methods

Ex situ methods of detection and identification of microorganisms: agar medium plating, pure culture obtaining, establishment of microbial collections, microscopy (optical, electronic, confocal, AFM, etc.), functional diagnostics (physiology and biochemistry), immunochemistry, respirometry, PCR with genus- & species-specific primers, mathematical modeling, etc.

Laboratory practice: Identification of bacteria using the species-specific polymerase chain reaction (PCR) - Testing PCR with given primers and identifying Rhodococus sp. strains based on PCR results.

In situ methods

In situ methods of detection and identification of microorganisms: denaturing gradient gel electrophoresis (DGGE), real-time PCR, pyrosequencing, T-RFLP, FISH, Microarray, immunoblotting, microscopy, ecological modeling, etc. Isolation & identification steps: enriched culture (using complete media, e.g. Nutrient Agar, or hyrocarbon media, e.g. diesel agar), isolation of pure culture (single colony), macromorphology (culture properties), micromorphology (cell properties), physiology/biochemistry, chemotaxonomy (cell wall structure) and molecular (16S rRNA sequencing).

Genetics of bacterial diversity

Genetic variability of bacteria. Mutations

DNA replication in procaryotes and action of specialized enzymes: helicases, DNA topoisomerases, DNA polymerase I and III, DNA primase, DNA ligase. Replication fork. Mechanism of DNA replication – rolling circle model & Theta structure - bidirectional replication. Transcription in procaryotes: role of the promoter and a terminator sequence. The molecular basis of mutations, spontaneous and induced mutagenesis, mutagenic agents. Carcinogenicity testing: the Ames test with auxotrophic Salmonella.

Gene recombinations in bacteria (transformation, transduction, conjugation)

Molecular mechanisms and natural strategies of genetic variation in microorganisms. Horizontal genetic transfer in microorganisms: transformation, transduction, conjugation. Discovery of bacterial transformation: transformation experiment of Fred Griffith. Gene transfer in conjugation: F (fertility) conjugative plasmids. Conjugation with an Hfr cell results in transfer of chromosomal genes. Bacteriophage-mediated transduction: generalized & specialized. Transposable elements and insertion sequences (IS), a relatively short piece of chromosomal or plasmid DNA which contains a gene for the enzyme transposase. Bacterial restriction/modification systems limit horizontal gene transfer.

Microbial genomics and bioinformatics

Theoretical and practical issues in microbial genomics and metagenomics. Bacterial genomes: from DNA to protein function using bioinformatics. Bioinformatics tools, DNA and protein sequences. Retrieving DNA and protein sequences from public repositories (GenBank, SILVA etc). Methods used to assemble, annotate and analyze microbial genomes. Comparative microbial genomics. Metabolic reconstruction from a complete genome sequence. Phylogenomics and the reconstruction of the Tree of Life.

Basic concepts of Virology

General characteristics and classification of viruses

Definition of viruses, their general characteristics as obligate intracellular parasites. Fundamental difference between RNA- and DNA-viruses. Classification and taxonomy of viruses according to the International Committee on Taxonomy of Viruses (ICTV): families and genera based on viral genetics, chemistry, morphology and mechanism of multiplication in host cells.

Physical and chemical structures of viral particles

Virions (viral particles) consist of a nucleic acid, DNA or RNA, but not both, surrounded by a protein capsid. There may also be a phospholipid membrane surrounding the capsid. Naked (nonenveloped) and enveloped viruses. General characteristics of viral life cycles: lytic and lysogenic. Differences between bacteriophages, plant viruses and animal viruses. Cultivating viruses.

Viroids and prions

Viroids, virusoids and their unique characteristics. Viroids consist of small, naked ssRNAs that cause diseases in plants. Virusoids are ssRNAs that require other helper viruses to establish an infection. Discovery of prions by Stanley Prusiner. Transmissible spongiform encephalopathy (TSE) in human and animals.

Role of viruses in horizontal gene transfer. Bacteriophages

Viruses as mobile genetic elements: polymorphic host sequence insertions in viral genome populations. Viruses as vectors of horizontal transfer of genetic material in eukaryotes. The horizontal transfer of genes by viruses and other means is essential for evolutionary progress. Brief history of bacteriophage discovery and research. Phage abundance and diversity. Isolation and characterization of Archaeal viruses.

Protective immunity, vaccines and antiviral treatment

Common pathogenic viruses and their clinical features. Airborne transmission: influenza. Transmission by water or food: viral gastroenteritis. Latent and slow (persistent) viral infections, viruses and cancer. Virus vaccines: attenuated (='weakened'), inactivated, subunit and DNA vaccines. Principles and methods of production and control of vaccines. Viral variability and its consequences for protective immunity, vaccines and antiviral treatment.

Microbial evolution and ecology

Microbial interactions (symbiosis, competition, parasitism)

Types of microbial interaction. Positive interaction: mutualism, proto-cooperation, commensalism. Negative interaction: Ammensalism (antagonism), parasitism, predation, competition. Competitive exclusion principle and resource partitioning.

Microbes in extreme environments

Microbial life in extreme environments: thermophiles, psychrophiles, acidophiles, alkaliphiles. Extreme microbial habitats: hydrothermal vents, cold and hot hydrocarbon seeps, deep subsurface, Arctic and Antarctic. Beneficial and harmful effects of microorganisms in the environment. Synthetic extreme environments as sources of potential biotechnologically relevant microorganisms.

Pathogenic microorganisms

Medically important microorganisms including bacteria, fungi and viruses. Pathogenic bacteria categorized by disease, source & transmission. Emerging and reemerging infectious diseases. Human microbiome and host-parasite interactions. Microbial pathogenicity and virulence factors. Role of the immune system in pathogenesis and protection. Microbiological stains for infection agents: bacteria – Gram stain (mycobacteria – acid fast stains), fungi – KOH, lactophenol blue, India ink, silver stains in tissue, parasites – trichrome stain, Wright's stain, viruses – antibody conjugated dyes. Diagnostic immunology: complement fixation, agglutination assay, neutralization/hemagglutination assay, enzyme immunoassays (EIAs, ELISAs), radioimmunoassays (RIA), fluorescent antibody techniques. Molecular diagnostics: nucleic acid probes, signal amplification methods (PCR, RT-PCR, nested PCR, multiplex PCR).

Microorganisms in biogeochemical cycling

Biogeochemical cycling entails three processes: production, consumption and decomposition. Microbial

contributions to the Earth atmosphere: microbes are responsible for cycling life essential elements (O, N, C, S, and H). Microbial regulation of global biogeochemical cycles. The oxygen cycle: oxygenic photosynthesis (microalgae and cyanobacteria) and aerobic respiration (most microorganisms). The carbon cycle: CO2 fixation by photoautotrophs and chemoautotrophs; methanogenesis by Archaea methanogens; organic compound biodegradation anaerobically (fermentation) or aerobically (respiration). The nitrogen cycle: nitrogen fixation (growth aerobic, fixation anaerobic), ammonification (aerobic or anaerobic), nitrification (aerobic) and denitrification (anaerobic). The sulfur cycle: sulfur oxidation (aerobic) by many chemolithotrophs, (anaerobic) by purple & green photoautotrophs; assimilatory sulfate reduction; desulfurylation; H2S oxidation (aerobic) by Thiobacillus, Beggiotoa (chemolithotrophs) and anaerobic by Chlorobium, Chromatium (anoxigenic photoautotrophs); dissimilatory sulfate and sulfite reduction by Desulfovibrio and related organisms; elemental sulfur reduction by Desulfuromonas, thermophilic archaea, cyanobacteria in hypersaline sediments. The phosphorus cycle: conversion of P from organic to inorganic forms and P solubilization. The cycling of metals: Fe2+, Zn2+, Cu2+, Cd2+, Mg2+.

Microbial biotechnology

Products from microorganisms (bioactive metabolites, enzymes, antibiotics)
Distribution of bioactive compounds derived from microbiological sources. Pharmaceutically active secondary metabolites of marine actinobacteria. The historical approach to microbial product screening and possible improvements: high-throughput and high-quality screening, genome mining and Naicons technology. Search for new antibiotics and chemical modifications of natural antibiotic structures. Microorganisms as source of antimicrobial proteins (bacteriocins as biopreservatives), cancer chemotherapeutic agents, enzyme inhibitors and immunomodulators. Microbial enzymes and their applications in industries and medicine.

Bacterial degradation of xenobiotics and bioremediation
Application of microorganisms for the biodegradation of xenobiotics: pesticides, fuels, solvents, alkanes, polycyclic hydrocarbons (PAHs), antibiotics, synthetic azo dyes, dioxins and polychlorinated biphenyls, polyaromatic, chlorinated and nitroaromatic compounds. Biodegradation pathways: aerobic vs. anaerobic, co-metabolic pathway. Parameters influencing bioavailability and the rate of biodegradation. Pathways of hydrocarbon degradation (aliphatic, aromatic, polycyclic compounds), convergence of microbial catabolism. Catabolic gene location and organization. Evolution of catabolic pathways and bacterial adaptation to xenobiotic compounds. Bioremediation strategies: natural attenuation, biostimulation and bioaugmentation.

Antimicrobial resistance (AMR) and its prevention strategy
Antimicrobial resistance (AMR or AR): definition and examples. Multidrug resistant (MDR) or “superbugs”; Methicillin-Resistant Staphylococcus aureus (MRSA). Modes of action and mechanisms of antibiotic resistance: enzymatic modifications of drug (e.g. β-lactamases, glycosylation, phosphorylation and ADP ribosylation) or target (target overproduction or mimicry, enzymatic bypass), prevention of drug penetration (cell wall and outer membrane) or accumulation (efflux pump). The WHO Global Strategy for Containment of Antimicrobial Resistance and national action plans. UN General Assembly high-level meeting (2016) on antimicrobial resistance; alliance to support UN resolution against antimicrobial resistance formed. Strategies for more focused applications of antibiotics. Antimicrobial stewardship and associated key roles of microbiology laboratories. Cutting-edge approaches for detection of resistance and antibiotic discovery, chemical optimization, and usage that minimizes the development of resistance.

Laboratory practice: Antibiotic sensitivity disk diffusion test – Performing the Kirby-Bauer antibiotic disk diffusion test and evaluating the effects of antibiotics on different bacterial cultures.

Concept of sterilization and sterility testing

Physical methods of controlling microbial growth: heating (moist and dry heat, boiling, autoclaving and pasteurization), refrigeration & ultra-low freezing, high-pressure treatment and desiccation (lyophilization), ionizing irradiation (X-rays, gamma rays, and high-energy electron beams) and nonionizing radiation (UV light), and filtration (HEPA and membrane filters). Chemical agents employed in control and management of microbial growth – disinfectants: variants and critical evaluation. Concept of sterilization and sterility testing: critical factors, guidelines and necessary details. Sterility tests for pharmaceutical products: membrane filtration and direct inoculation of culture media. Biological risks and biological safety cabinets (BSCs) classes I-IV.

Introduction to GLP, GMP and GPP

Introduction to the requirements and basic concepts of quality control for microbiological testing laboratories operating under good laboratory practice (GLP) guidelines. The OECD Principles of Good Laboratory Practice (GLP). Non-clinical laboratory studies – in vitro or in vivo experiments to determine the safety of products: food and color additives, human and animal drugs, medical devices for human use, biological products and electronic products. Basic elements of GLP: personnel and facility, documents, test and control articles. General GLP requirements: objectionable microorganisms, waste disposal and housekeeping, sample and material flows. Introduction to current good manufacturing practices (cGMPs): maintaining product quality, cleaning and sanitation, proper documentation, essential packaging and production controls, personal hygiene requirements. Introduction to good pharmacy practice (GPP): evolution of GPP in hospital setting, preparation of sterile medication and hazardous drug handling. Joint FIP/WHO Guidelines on Good Pharmacy Practice: Standards for Quality of Pharmacy Services.

6. Методические указания для обучающихся по освоению дисциплины

Освоение дисциплины требует систематического изучения всех тем в той последовательности, в какой они указаны в рабочей программе.

Основными видами учебной работы являются аудиторные занятия. Их цель - расширить базовые знания обучающихся по осваиваемой дисциплине и систему теоретических ориентиров для последующего более глубокого освоения программного материала в ходе самостоятельной работы. Обучающемуся важно помнить, что контактная работа с преподавателем эффективно помогает ему овладеть программным материалом благодаря расстановке необходимых акцентов и удержанию внимания интонационными модуляциями голоса, а также подключением аудио-визуального механизма восприятия информации.

Самостоятельная работа преследует следующие цели:

– закрепление и совершенствование теоретических знаний, полученных на лекционных занятиях;

- формирование навыков подготовки текстовой составляющей информации учебного и научного назначения для размещения в различных информационных системах;

- совершенствование навыков поиска научных публикаций и образовательных ресурсов, размещенных в сети Интернет;

- самоконтроль освоения программного материала.

Обучающемуся необходимо помнить, что результаты самостоятельной работы контролируются преподавателем во время проведения мероприятий текущего контроля и учитываются при промежуточной аттестации.

Обучающимся с ОВЗ и инвалидов предоставляется возможность выбора форм проведения мероприятий текущего контроля, альтернативных формам, предусмотренным рабочей программой дисциплины. Предусматривается возможность увеличения в пределах 1 академического часа времени, отводимого на выполнение контрольных мероприятий.

Процедура оценивания результатов обучения инвалидов и лиц с ограниченными возможностями здоровья по дисциплине предусматривает предоставление информации в формах, адаптированных к ограничениям их здоровья и восприятия информации.

При проведении текущего контроля применяются оценочные средства, обеспечивающие передачу информации, от обучающегося к преподавателю, с учетом психофизиологических особенностей здоровья обучающихся.

7. Перечень учебно-методического обеспечения для самостоятельной работы обучающихся по дисциплине

При самостоятельной работе обучающимся следует использовать:

– конспекты лекций;

– литературу из перечня основной и дополнительной учебной литературы, необходимой для освоения дисциплины (модуля);

– текст лекций на электронных носителях;

– ресурсы информационно-телекоммуникационной сети "Интернет", необходимые для освоения дисциплины;

– лицензионное и свободно распространяемое программное обеспечение из перечня информационных технологий, используемых при осуществлении образовательного процесса по дисциплине;

– методические указания для обучающихся по освоению дисциплины.

8. Перечень основной и дополнительной учебной литературы

Основная:

1. Susanne Modrow. "Molecular Virology" / Susanne Modrow, Dietrich Falke, Uwe Truyen, Hermann Schätzl // Springer, Berlin, Heidelberg. 2013. - 1016 p. ISBN 978-3-642-20718-1 https://link.springer.com/referencework/10.1007/978-3-642-20718-1

Дополнительная:

1. Eugene Rosenberg."The Prokaryotes. Human Microbiology" / Eugene Rosenberg, Edward F. DeLong, Stephen Lory, Erko Stackebrandt, Fabiano Thompson // Publisher Name: Springer, Berlin, Heidelberg. - 2013. - 554 p. ISBN 978-3-642-30144-5. https://link.springer.com/referencework/10.1007/978-3-642-30144-5

2. Eugene Rosenberg. "The Prokaryotes". / Eugene Rosenberg, Edward F. DeLong, Stephen Lory, Erko Stackebrandt, Fabiano Thompson // Publisher Name:Springer, Berlin, Heidelberg. - 2013. - 607 p. ISBN 978-3-642-30194-0. https://link.springer.com/referencework/10.1007/978-3-642-30194-0

3. Henrik Christensen. "Introduction to Bioinformatics in Microbiology" / Henrik Christensen // Springer, Cham. - 2018. - 213 p. ISBN 978-3-319-99280-8. https://link.springer.com/book/10.1007/978-3-319-99280-8

9. Перечень ресурсов сети Интернет, необходимых для освоения дисциплины

http://iegmcol.ru/ Regional Specialised Collection of Alkanotrophic Microorganisms

10. Перечень информационных технологий, используемых при осуществлении образовательного процесса по дисциплине

Образовательный процесс по дисциплине **Microbiology and Virology** предполагает использование следующего программного обеспечения и информационных справочных систем:
Presentation materials (slides on the topics of lectures and practical classes);
on-line access to the Electronic library system (ELS);
access to the PSU electronic information and educational environment.

List of required licensed and / or freely distributed software:
1) office suite of applications (word processor, a program for the preparation of electronic presentations);
2) video demonstration program (player);
3) an application that allows to view and play the media content of pdf files;
4) programs for viewing and editing digital images;
5) programs for viewing and editing DjVu files.

The discipline does not imply the use of specialized software.

При освоении материала и выполнения заданий по дисциплине рекомендуется использование материалов, размещенных в Личных кабинетах обучающихся ЕТИС ПГНИУ (**student.psu.ru**).

При организации дистанционной работы и проведении занятий в режиме онлайн могут использоваться:

система видеоконференцсвязи на основе платформы BigBlueButton (https://bigbluebutton.org/).

система LMS Moodle (http://e-learn.psu.ru/), которая поддерживает возможность использования текстовых материалов и презентаций, аудио- и видеоконтент, а так же тесты, проверяемые задания, задания для совместной работы.

система тестирования Indigo (https://indigotech.ru/).

11. Описание материально-технической базы, необходимой для осуществления образовательного процесса по дисциплине

For conducting lectures, it is necessary to have a classroom equipped with specialized furniture, demonstration equipment (projector, screen, computer / laptop) with appropriate software, chalk (s) or marker board.
For laboratory, practical training and current control, a classroom equipped with specialized furniture, demonstration equipment (projector, screen, computer/laptop) with appropriate software, chalk (s) or marker board is required.
For intermediate control activities, group and individual consultations, a training room equipped with specialized furniture, chalk (s) or marker board is required.
For independent work, the facilities of the PSU Scientific Library are necessary that provide access to local and global networks.

Помещения научной библиотеки ПГНИУ для обеспечения самостоятельной работы обучающихся:

1. Научно-библиографический отдел, корп.1, ауд. 142. Оборудован 3 персональными компьютера с доступом к локальной и глобальной компьютерным сетям.

2. Читальный зал гуманитарной литературы, корп. 2, ауд. 418. Оборудован 7 персональными компьютерами с доступом к локальной и глобальной компьютерным сетям.

3. Читальный зал естественной литературы, корп.6, ауд. 107а. Оборудован 5 персональными

компьютерами с доступом к локальной и глобальной компьютерным сетям.

4. Отдел иностранной литературы, корп.2 ауд. 207. Оборудован 1 персональным компьютером с доступом к локальной и глобальной компьютерным сетям.

5. Библиотека юридического факультета, корп.9, ауд. 4. Оборудована 11 персональными компьютерами с доступом к локальной и глобальной компьютерным сетям.

6. Читальный зал географического факультета, корп.8, ауд. 419. Оборудован 6 персональными компьютерами с доступом к локальной и глобальной компьютерным сетям.

Все компьютеры, установленные в помещениях научной библиотеки, оснащены следующим программным обеспечением:

Операционная система ALT Linux;

Офисный пакет Libreoffice.

Справочно-правовая система «КонсультантПлюс»

Фонды оценочных средств для аттестации по дисциплине
Microbiology and Virology

Планируемые результаты обучения по дисциплине для формирования компетенции. Индикаторы и критерии их оценивания

ОПК.1

Владеет базовыми знаниями о современной научной картине мира на основе положений, законов и методов математических и естественных наук

Компетенция (индикатор)	Планируемые результаты обучения	Критерии оценивания результатов обучения
ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук	To know the achievements of Microbiology in historical periods; have a basic knowledge of the organization of prokaryotic and eukaryotic cells, microbial diversity and microorganism importance for medicine and biotechnology.	**Неудовлетворител** The student has no idea about the main metabolic pathways of microorganisms, the concepts of microbial growth, oxygen and nutrient requirements, laboratory cultivation and bioreactor principles; does not acquire laboratory skills of working with pure cultures of bacteria. **Удовлетворительн** The student has a basic knowledge of the main metabolic pathways of microorganisms but cannot explain the concepts of microbial growth, oxygen and nutrient requirements; knows only very general principles of laboratory and bioreactor cultivation, acquired minimum laboratory skills of working with pure cultures of bacteria. **Хорошо** The student has a general but not structured knowledge of the main metabolic pathways of microorganisms and can explain the concepts of microbial growth, oxygen and nutrient requirements; knows the principles of laboratory and bioreactor cultivation with some gaps of knowledge, acquired basic laboratory skills of working with pure cultures of bacteria. **Отлично** The student has a systematic knowledge of the metabolic pathways of microorganisms, can explain the concepts of microbial growth, oxygen and nutrient requirements, understands laboratory cultivation and bioreactor principles; acquired laboratory skills of working with pure cultures of bacteria.

ОПК.7

Способен представлять результаты своей работы в устной и письменной форме в соответствии с нормами и правилами, принятыми в профессиональном сообществе

Компетенция (индикатор)	Планируемые результаты обучения	Критерии оценивания результатов обучения
ОПК.7.1 Представляет результаты работы в виде письменного отчета с учетом требований библиографической культуры	To know the basics of writing a scientific report, to know the requirements of bibliographic culture, to be able to make a report with taking into account the requirements of bibliographic culture.	**Неудовлетворител** The student does not know the basics of writing a scientific report, does not understand the requirements of bibliographic culture, is not able to make a report taking into account the requirements of bibliographic culture. **Удовлетворительн** The student does not know enough about the basics of writing a scientific report, does not fully understand the requirements of bibliographic culture, is not able to independently compose a report taking into account the requirements of bibliographic culture. **Хорошо** The student knows the basics of writing a scientific report with small gaps, understands the basic requirements of bibliographic culture, is able to independently compose a written report if there are minor shortcomings in it. **Отлично** The student perfectly knows the basics of writing a scientific report, fully understands the basic requirements of bibliographic culture, is able to independently compose a written report taking into account all the requirements of bibliographic culture.

Оценочные средства текущего контроля и промежуточной аттестации

Схема доставки : Базовая

Вид мероприятия промежуточной аттестации : Экзамен
Способ проведения мероприятия промежуточной аттестации : Оценка по дисциплине в рамках промежуточной аттестации определяется на основе баллов, набранных обучающимся на контрольных мероприятиях, проводимых в течение учебного периода.
Максимальное количество баллов : 100

Конвертация баллов в отметки

«отлично» - от 81 до 100
«хорошо» - от 61 до 80
«удовлетворительно» - от 50 до 60
«неудовлетворительно» / «незачтено» менее 50 балла

Компетенция (индикатор)	Мероприятие текущего контроля	Контролируемые элементы результатов обучения
Входной контроль	Problems of prokaryote taxonomy. Classification, nomenclature and identification. Species concept in microbiology **Входное тестирование**	Solution of the proposed input test on general Microbiology.
ОПК.7.1 Представляет результаты работы в виде письменного отчета с учетом требований библиографической культуры	Microbial culture methods, growth media **Письменное контрольное мероприятие**	Solution of the proposed test on the topic "Organization and structures of microorganisms. Morphological differentiation and levels of prokaryotic cell organization".
ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук **ОПК.7.1** Представляет результаты работы в виде письменного отчета с учетом требований библиографической культуры	Microbial genomics and bioinformatics **Письменное контрольное мероприятие**	Preparing a presentation on one of the suggested topics on the "Microbial metabolism and growth".

Компетенция (индикатор)	Мероприятие текущего контроля	Контролируемые элементы результатов обучения
ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук **ОПК.7.1** Представляет результаты работы в виде письменного отчета с учетом требований библиографической культуры	Introduction to GLP, GMP and GPP **Итоговое контрольное мероприятие**	Solution of the proposed test on the topic "Genetics of bacterial diversity".

Спецификация мероприятий текущего контроля

Problems of prokaryote taxonomy. Classification, nomenclature and identification. Species concept in microbiology

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы аудиторной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **0**
Проходной балл: **0**

Показатели оценивания	Баллы
Correct answers to 80-100% questions.	30
Correct answers to 70-79% questions.	25
Correct answers to 60-69% questions.	20
Correct answers to 50-59% questions.	15

Microbial culture methods, growth media

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы аудиторной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **30**
Проходной балл: **15**

Показатели оценивания	Баллы
Correct answers to 80-100% questions.	30
Correct answers to 70-79% questions.	25
Correct answers to 60-69% questions.	20
Correct answers to 50-59% questions.	15

Microbial genomics and bioinformatics

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы аудиторной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **30**

Проходной балл: **15**

Показатели оценивания	Баллы
Presentation on one of the proposed topics. The results indicate that the student consciously owns knowledge on the topic. A substantial, but containing some gaps, presentation of the studied problem is given, the scientific material is presented in general competently and consistently. The presentation and text meet the basic quality requirements, the answers to the questions are incomplete, the student knows the basic terms and concepts.	30
Presentation on one of the proposed topics. The results indicate that the student consciously owns knowledge on the topic and is able to use external sources of information. A complete and informative presentation of the problem under study is given, the scientific material is presented correctly in a logical sequence. The presentation and text meet all the quality requirements, the answers to the questions are extended, the student is fluent in terminology and concepts.	25
Presentation on one of the proposed topics. The results indicate that the student has an incomplete system of basic knowledge on the topic. An incomplete presentation of the problem under study is given, the presented material contains significant errors and elements of plagiarism. The presentation meets only basic quality requirements, answers to questions are inaccurate, the student has little knowledge of scientific terminology.	15
Presentation on one of the proposed topics. The results indicate the assimilation of only some elementary knowledge on the topic. There is no idea about the problem under study, the material is not presented or is plagiarism. The presentation does not meet the generally accepted quality requirements, the answers to the questions are unsatisfactory, the student does not know the scientific terminology.	14

Introduction to GLP, GMP and GPP

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы аудиторной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **40**
Проходной балл: **20**

Показатели оценивания	Баллы
Correct answers to 80-100% questions.	40
Correct answers to 70-79% questions.	30
Correct answers to 60-69% questions.	20
Correct answers to 50-59% questions.	19