

The list of questions for the admission test for the program 19.04.01 Food Biotechnology

Part 1. Fundamental Biology

The variety of life. The structure and common traits of living systems. Principal division of living organisms. Species and their criteria. Population.

Part 2. Fundamental Microbiology

Structural components of cells and viruses. Bacterial, actinomycetic and fungal cell walls. Cell wall chemical composition, structure and functionality. L-forms and mycoplasmas.

The morphology and systematic of microorganisms. Prokaryotes. Single-cell bacteria, their size and morphology. Multi-cell bacterial forms. The basics of bacterial systematic. Natural and artificial identification patterns. Criteria of bacterial identification. Up-to-date systematic of bacteria. Principal division of bacteria and the criteria of such division. Bacterial nomenclature.

Elemental genetics of microorganisms

The concepts of heritability and variability. The genotype and the phenotype. The cell as the basic element of character and reproduction. Passing and reproduction of genetic information. Genetic reproduction of cells. Genetic information and specific protein synthesis (replication, transcription, translation, regulation). Variability of microorganisms (heritable and non-heritable). The effect of the environment on character formation by the genotype. The role of variability in adaptation.

Fundamental principles of microbial metabolism regulation

Metabolite classification. Microbial culture growth control and genetic expression. The basics of metabolic regulation. Kinetics of enzyme catalyzed reactions.

Enzyme-substrate complexes and the schematics of enzyme action. The structure of enzymes, active and allosteric centres. Kinetics of microbial growth and metabolite formation. Growth and metabolite formation models.

Kinetics of balanced growth. Monod equation for cell growth kinetics. The effect of endogenous and sustaining metabolism on growth kinetics.

Batch and continuous cultivation. Cultivation control and optimization

Batch cultivation in the advancement of microbiological synthesis. Continuous cultivation of microorganisms. Full replacement and full mixture processes, the merits and the flaws of both, applications in technology. Substrate utilization in the cell as the basis of biosynthesis regulation.

Part 3. The fundamentals of biotechnology

Synthesis of primary and secondary metabolites. Microbial synthesis of amino acids and microbial synthesis regulation. Formation pathways of various amino acid groups in biosynthesis.

Fermentation for lactic and propionic acid production. Oxidation processes in acetic, citric, gluconic, itaconic acid production (the producing microorganisms and composition of the media, the activators and the inhibitors). Joint chemical and enzymatic synthesis of *L*-malic acid.

Synthesis of alcohols and ketones. Ethanol fermentation. Ethanol producing microorganisms and composition of the media, production pathways. Co-production and dedicated production of bakers' yeast. Acetone-butylic fermentation. Acetone and butanol biosynthesis (the producing microorganisms

and composition of the media, minor components and by-products).

Production and modification of antibiotics.

Part 4. General biotechnology

Techniques of biologically active compound production, industrial microorganisms.

The scope of biotechnology: yeasts, bacteria, *Actinomycetales*, mycelial fungi, animal and plant cell cultures, hybridomes. High capacity industrial strain production techniques. The principal techniques of selection: stage selection, application of auxotrophic mutation, recombination (hybridization, conjugation, protoplast fusion).

Genetic engineering of industrial strains: vectors, restrictases, cloned DNA, recipient choice, cloning and detection methods for hybrid molecules. Practical applications of the method.

Biotechnological applications of immobilized cells and enzymes. Biotechnology production methods using immobilized enzymes. Physical and chemical immobilization techniques.

Cultivation of animal and plant cells

Driving vectors of animal and plant cells cultivation industry. The common traits of animal and plant cell cultures. Restrictions in cultivator design.

Cultivation of animal cells. Necessary components in the medium. Natural and artificial media. Oxygen supply. The stages and parameters of cultivation; the principles of cultivator design.

Cultivation of plant cells. Components in the medium, sterilization conditions. Means of plant cell adaptation for *in vitro* viability. Varieties in cultivator design. In-depth cultivation of plant cells. Methods of shikonine production.

Fermentation product recovery. Industrial strains. Raw materials. The stages of production from various raw materials; the devices and machinery.

Part 5. Technical design of biotechnology production facilities

Technical design of devices for processing and purifying products of microbiological synthesis.

Machinery and devices used for *ad-hoc* treatment of biosynthetic products (reduction, oxidation, etherification, introduction and removal of protector prosthetics, hydrolysis et cetera). Machinery and devices used for recovery of biosynthetic products (filtration and ion exchange sorption devices, extractors, centrifuges, ultracentrifuges, separators et cetera). Improving device productivity by re-fitting and infrastructure re-modeling.

Part 6. Fundamental immunochemistry

Human immune system.