MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION
Federal state autonomous educational institution
of higher education
«Far Eastern Federal University»
(FEFU)

INSTITUTE OF LIFE SCIENCES AND BIOMEDICINE (SCHOOL)

AGREED

Head of OP

Kalenik T.K.
(signature) (full name)
«28» September 2021 г.

APPROVE

Head of VSP

Kalenik T.K.
(signature) (full name)
«28» September 2021 г.

WORKING PROGRAM OF THE DISCIPLINE

Biotechnological Process Control Systems
Direction of training 19.04.01 «Biotechnology»
(«Agri-Food Biotechnology»)
Form of training full-time

course 1 semester 1
lectures 18 hours.
practical classes 18 h.
laboratory work 00 hours.
including using
total classroom hours 36 hours.
independent work 27 h.
including preparation for the exam 45 hours (if the exam is provided).
control works (quantity) are not provided
term paper / term project are not provided
credit not included
exam 1 semester

The program of the state final certification was compiled in accordance with the requirements of the Federal State Educational Standard in the field of study 19.04.01 Biotechnology, approved by order of the Ministry of Science and Higher Education of the Russian Federation dated August 10, 2021 No. 737.

The program at the meeting of the Academic Council of the Institute of Life Sciences and Biomedicine (School) December 21, 2021
Director of the Department of Food Science and Technology Kalenik T.K.
Compiled by: Kalenik T.K.

Reverse side of the title page of the RPMU

I. The work program was revised at the meeting of the department:
Protocol dated «_____» _____ 20___ № _____
Director _____ _____
(signature) (full name)

II. The work program was revised at the meeting of the department:
Protocol dated «_____» _____ 20___ № _____
Director _____ _____
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III. The work program was revised at the meeting of the department:
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ABSTRACT

Bachelor's/Specialist's/Master'sdegreein 19.04.01 Biotechnology

Studyprofile/ Specialization/ Master'sProgram "Title" Agri-food biotechnology

Course title: Biotechnological Process Control Systems

Variable part of Block, 3 credits

Instructor: Dobrynina E.V.

At the beginning of the course a student should be able to:

the ability to search, store, process and analyze information from various sources and databases, to represent it in the required format using the information, computer and network technologies;

- the ability to use modern methods and technologies (including information) in their professional activities.

Learning outcomes:

SPC-9 - willingness to use the basic principles of organization of metrological support of production;

SPC-10 - ability to develop a quality management system for biotechnological products in accordance with the requirements of Russian and international quality standards;

SPC-16 - the ability to carry out the effective operation of control, automation and automated production control, chemical-technical, biochemical and microbiological control

SPC-17 - readiness for pilot testing of technology and scaling of processes;

SPC-19 - the ability to analyze the indicators of the technological process for compliance with the original scientific developments.

Course description: The educational program of the course is aimed at the formation of knowledge about biotechnological process control systems to solve typical professional problems of biotechnology.

Main course literature:

1. 1. Microbiological control of biotechnological production: a textbook for universities / N. B. Gradova, E. S. Babusenko, V. I. Panfilov [and others]. Moscow: DeLi Plus, 2016. - 139 p. http://lib.dvfu.ru:8080/lib/item?id=chamo:838315&theme=FEFU

2. Microbiological synthesis / A. M. Bezborodov, G. I. Kvesitadze; [resp. ed. A. G. Lobanok]. St. Petersburg: Prospect of Science, 2011. - 143 p. http://lib.dvfu.ru:8080/lib/item?id=chamo:785480&theme=FEFU

3. Biotechnology: a textbook for agricultural universities / V. A. Chkhenkeli. St. Petersburg: Prospect of Science, 2014. - 335 p. http://lib.dvfu.ru:8080/lib/item?id=chamo:785504&theme=FEFU

4. Lubentsova E.V. Synthesis of automatic control systems for biotechnological processes using approximating and neuro-fuzzy control methods [Electronic resource]: monograph / Lubentsova EV, Volodin AA - Electron. textual data. — Stavropol: North Caucasus Federal University, 2014.— 160 c .— Access mode: http://www.iprbookshop.ru/63132.html

5. Belyaev P.S. Process Control Systems [Electronic resource]: a manual for students of the 3rd and 4th year of study in the areas of training 151000, 222900, 240100, 240700, 241000, 261700 / Belyaev PS, Bukin AA - Electron. textual data. — Tambov: Tambov State Technical University, EBS DIA, 2014.— 156 p. http://www.iprbookshop.ru/64575.html

Form of final knowledge control: exam.

1. Purpose and objectives of mastering the discipline:

The purpose of the discipline is to teach the student to apply knowledge about biotechnological process control systems to solve typical professional problems of biotechnology.

The **objectives** of the discipline: the formation of the necessary knowledge base for analysis, identification and solution of issues related to the specifics of conducting biotechnological processes and working with biotechnology objects.

The discipline "Biotechnological Process Control Systems" is logically and meaningfully connected with such courses as "Modern trends in the development of biotechnology", "Methodology of scientific research in biotechnology", "Administration and management of agriculture and the agro-industrial complex".

The discipline is aimed at the formation of professional competencies.

Educational complex includes:

- the work program of the discipline;
- educational and methodological support of students' independent work (Appendix 1);
- appraisal fund (appendix 2).

As a result of studying this discipline, the following professional competencies are formed in students.

Code and wording of competency	**Competency Stages**	
SPC-9 willingness to use the basic principles of organization of metrological support of production	Knows	basic principles of organizing metrological support for the production of agricultural raw materials and food products
	Can	use the basic principles of organizing metrological support for the production of agricultural raw materials and food products
	Owns	skills in using the basic principles of organizing metrological support for the production of agricultural raw materials and food products
SPC- 10 ability to develop a quality management system for	Knows	principles of developing a quality management system for biotechnological products in accordance with the requirements of Russian and international quality standards

biotechnological products in accordance with the requirements of Russian and international quality standards	Can	develop a quality management system for biotechnological products in accordance with the requirements of Russian and international quality standards
	Owns	principles of developing a quality management system for biotechnological products in accordance with the requirements of Russian and international quality standards
SPC- 16 the ability to carry out the effective operation of control, automation and automated production control, chemical-technical, biochemical and microbiological control	Knows	operation of control, automation and automated production control, chemical
	Can	to carry out the effective operation of means of control, automation and automated production control, chemical
	Owns	knowledge of the operation of control equipment, automation and automated production control, chemical
SPC- 17 readiness for pilot testing of technology and scaling of processes	Knows	rules for conducting pilot testing of technology and scaling processes
	Can	conduct pilot testing of technology and process scaling
	Owns	knowledge in conducting pilot testing of technology and scaling processes
SPC- 19 the ability to analyze the indicators of the technological process for compliance with the original scientific developments	Knows	indicators of the technological process for compliance with the original scientific developments
	Can	analyze the indicators of the technological process for compliance with the original scientific developments
	Owns	the ability to analyze the indicators of the technological process for compliance with the original scientific developments

2. The complexity of the discipline and types of training sessions in the discipline

The total labor intensity of the discipline is 3 credit units (108 academic hours).

The types of training sessions and work of the student in the discipline can be:

Designation	Types of training sessions and work of the student
Lec	Lectures
Lab	Labs
Pe	Practical exercises
Oc	Online course
SR	Independent work of the student during the period of theoretical training
Control	Independent work of the student and contact work of the student with the teacher during the period of intermediate certification

Discipline structure:

The form of education is full-time.

№	Section name disciplines	Semester	The number of hours by type of training sessions and work of the student						Forms of intermediate certification, current monitoring of progress
			Lec	Lab	Pe	Oc	SR	Control	
1	Section 1. Computer modeling of biotechnological processes and systems	1	9	0	9	0	27	45	Seminar, exam
2	Section 2. Examples of computer modeling of the simplest typical biotechnological processes and systems	1	9	0	9	0			Seminar, exam
	Total:		18		18		27	45	

3.STRUCTURE AND CONTENT OF THE THEORETICAL PART OF THE COURSE (18 H)

Section 1. Computer modeling of biotechnological processes and systems

Computer modeling is now increasingly becoming an integral part of not only the technical field, but also of all types of human activity. However, this term does not yet have a generally accepted formal definition, and its boundaries are not yet clearly defined in a semantic sense. Such a situation is characteristic of any scientific field at the intersection of its formation and rapid development. From a fairly general point of view, computer modeling can be considered as one of the most powerful methods and tools for cognition, analysis, and synthesis available to specialists responsible for the development and operation of complex technical devices and technological objects (for example, processes, apparatuses, and biotechnology systems).

Topic 1. System analysis of biotechnological objects

The researcher has the opportunity to experiment with the model of the object, even in cases where it is almost impossible or inexpedient to do this on a real object. The basis of the modern cybernetic approach to solving the problems of analysis and synthesis of biotechnological objects is system analysis. The essence of system analysis is determined by its strategy, which is based on general principles applicable to the solution of any system problem.

These include:

1) a clear statement of the goal of the study, the statement of the problem to achieve a given goal and the definition of a criterion for the effectiveness of solving the problem;

2) development of a detailed research strategy with an indication of the main stages and directions in solving the problem: sequentially-parallel promotion throughout the whole complex of interconnected stages and possible directions; the organization of successive approximations and repeated research cycles at individual stages; the principle of the descending hierarchy of analysis and the ascending hierarchy of synthesis in solving composite particular problems. In this case, the formalization of the system is carried out using a mathematical model that displays the relationship between the output variables of the system, its internal parameters and input variables, including control and disturbing influences. The methodology of mathematical modeling provides for the thorough development of models. The development of applied biotechnologies, flexible automated production systems and devices, and other rapidly developing high-tech industries has led to further complication of the developed and operated technical devices, biotechnological processes, devices and systems. Their experimental development began to require more and more time and material resources, and in some cases, its implementation in full turned into a problem that does not have an acceptable solution. Under these conditions, the value of the calculation and theoretical analysis of the characteristics of such devices, technologies and systems has significantly increased. This was facilitated by a breakthrough in the improvement

of computer technology and numerical methods, which led to the emergence of modern computers with a phenomenal amount of memory and the speed of arithmetic operations. As a result, the material basis for the formation and rapid development of computer modeling (mathematical modeling and computational experiment) arose, not only as a theoretical and theoretical support at the stage of testing technical devices, technological processes, apparatuses and systems of biotechnology, but also in their design, selection and optimization their operational modes, reliability analysis and prediction of failures and emergencies, as well as assessing the possibility of boosting characteristics and modernization of technical devices, technological processes, devices and systems of biotechnology. Computer modeling of biotechnological systems is based on the methodology, technology and algorithmization of the development of computer models taking into account indicators of information uncertainty; organization of a computer experiment with a model and multimedia presentation of the results; the development of the provisions of intelligent modeling, including questions of diagnosing the state and predicting the evolution of systems and computer analysis of cause and effect relationships at micro and macro levels; tracking the dynamics of the functioning of the main elements of biotechnological systems, allowing to make optimal decisions in the operational management mode.

Actually, computer modeling is the process of constructing a model of a real object (system) and setting up computational experiments on this model with the goal of either understanding (investigating) the behavior of this system or evaluating the effectiveness of various strategies (algorithms) for its functioning using computational logic algorithms implemented on computers . Thus, the process of computer modeling includes the construction of the model and its application to solve the problem: analysis, research, optimization or synthesis (design) of biotechnological processes, devices and systems.

No less important is the fact that modern interface tools make it possible to conduct a dialogue with computers - to analyze alternatives, test hypotheses, and

experiment with mathematical models. The practical implementation of the capabilities of computer modeling significantly increases the efficiency of engineering developments, especially when creating fundamentally new technological machines and devices without prototypes, materials and technologies, which reduces the time and cost of using advanced achievements in physics, chemistry, mechanics and others in engineering and technology fundamental sciences. The noted capabilities of computer modeling are far from exhausted; they seem quite promising and therefore deserve a detailed consideration.

Topic 2. General information about mathematical models and computer modeling

Studying complex technological processes, apparatuses, and physicochemical phenomena, we cannot take into account all factors: some are significant, and some can be neglected. At the same time, a system of assumptions is put forward, which is carefully justified and allows one to identify and take into account the most characteristic features of the object under study in the mathematical description. As a result, a mathematical model of the studied technological object is formed. In the process of computer modeling, the researcher deals with three objects: a system (real, projected, imagined), a mathematical model, and a computer program that implements an algorithm for solving the model equations. The traditional scheme of computer modeling as a single process of building and researching a model that has the appropriate software support can be represented as a set of stages. Based on the fact that computer modeling is used for research, optimization and design of real technological objects (systems), the following stages of this process can be distinguished:

1) the definition of the object - the establishment of boundaries, restrictions and measures of the effectiveness of the operation of the object;

2) formalization of an object (building a model) - the transition from a real object to a certain logical scheme (abstraction);

3) the definition of the object - the establishment of boundaries, restrictions and measures of the effectiveness of the operation of the object.

4) formalization of an object (building a model) - the transition from a real object to a certain logical scheme (abstraction);

5) data preparation - selection of data necessary for building a model, and their presentation in the appropriate form;

6) the development of a modeling algorithm and a computer program;

7) adequacy assessment - increasing to an acceptable level the degree of confidence with which one can judge regarding the correctness of conclusions about a real object obtained on the basis of an appeal to the model;

8) strategic planning - planning a computational experiment, which should provide the necessary information;

9) tactical planning - determining the method of conducting each series of tests provided for by the experimental plan;

10) experimentation - the process of imitation in order to obtain the desired data and sensitivity analysis;

11) interpretation - the construction of conclusions from data obtained by simulation;

12) implementation - the practical use of the model and modeling results;

13) documentation - recording the progress of the computer simulation process and its results, as well as documenting this process. The listed stages of computer simulation are determined under the assumption that the formulated problem can be solved in the best way by this method.

The totality of concepts and relations expressed using a system of mathematical symbols and notation and reflecting the most significant (characteristic) properties of the studied object is called the mathematical model of this object.

In a fairly general case, the technical or technological object (TO) under study can be quantitatively characterized by the vectors x (R), a (R), y (R), and Rk, input, internal, output, and indefinite (disturbing) variables (parameters), respectively.

It follows from the foregoing that when studying a real or conceivable TO, mathematical methods are applied to its MM. Moreover, this application will be effective if the properties of the MM satisfy certain requirements. Consider the main of these properties. The completeness of MM allows us to adequately reflect precisely those characteristics and features of TO that interest us from the point of view of the set goal of computer simulation. For example, a model can adequately describe the processes occurring in an object, but not reflect its overall, mass, or cost indicators. A causal relationship between our parameters will be set using a variety of functional relationships. The elements of the sets AY X ,, can be numbers or functions, and the elements of Φ can be functions or operators, respectively. All sets are finite, but the number of elements in them is quite large. The set Φ reflecting the dependences of the vector of output variables Y of a technological object on its input variables X, internal parameters A, and disturbing influences will be called a mathematical model. Very often, the set Φ consists of a system of equations, therefore, the definition of a mathematical model of an object can also be formulated as follows: a mathematical model is a system of equations connecting the output parameters Y of an object with input parameters X, internal parameters A in the presence of disturbing parameters. The completeness of the model is determined by the assumptions we made when compiling the system of equations of the mathematical model. Assumptions are phenomena that we neglect when constructing MM. The accuracy of the MM makes it possible to ensure an acceptable match between the real and found values of the output TO variables found using the MM.

Adequacy of MM is the ability of MM to display the output variables of TO with a relative error of no more than some given value?.

Cost-effectiveness of MM is estimated by the cost of computing resources (machine time and memory) necessary for conducting a computational experiment with MM on a computer.

MM robustness characterizes its stability with respect to the errors of the initial data, the ability to level these errors and prevent their excessive influence on the result of a computational experiment.

MM productivity is associated with the ability to have sufficiently reliable source data.

Structural MMs are divided into topological and geometric, which make up two levels of the hierarchy of MMs of this type. The former reflect the composition of the TO and the relationship between its elements. It is advisable to apply topological MM at the initial stage of the study of a complex structure of TO, consisting of a large number of elements, primarily to understand and clarify their relationship. Such MMs are in the form of graphs, tables, matrices, lists, etc .; its construction is usually preceded by the development of the structural scheme of maintenance. Geometric MM in addition to the information presented in the topological MM, contain information about the shape and size of TO and its elements, about their relative position. Geometric models are used in the design of maintenance, the development of technical documentation and technological processes for the manufacture of its elements (for example, on machines with numerical control).

We now state specific criteria that a “good” model must satisfy. Such a model should be:

1) simple and understandable to the user;

2) focused;

3) reliable in the sense of a guarantee against absurd answers;

4) convenient to manage and handle;

5) complete from the point of view of the possibilities of solving the tasks;

6) adaptive, i.e. allowing you to easily switch to other modifications or update data;

7) allowing gradual changes in the sense that, being initially simple, it can become more complex and accurate in interaction with the user.

Topic 3. Methodology of computer modeling

At the first stage, an informal transition from the considered TO to its design scheme is carried out. At the same time, depending on the direction of the computational experiment and its ultimate goal, those properties, operating conditions, and features of the TO are emphasized that, together with the parameters characterizing them, should be reflected in the design scheme, and, conversely, arguments are made that allow not to take into account those qualities of TO whose influence is assumed to be insignificant in the present case. When developing new maintenance programs, the successful implementation of the first stage largely depends on the professional level of the engineer, his creative potential and intuition. The completeness and correctness of taking into account the properties of TO in the calculation scheme, which are essential from the point of view of the research goal, are the main prerequisite for obtaining reliable mathematical modeling results in the future.

At the same stage, a qualitative and evaluative quantitative analysis of the constructed MM is carried out. In this case, contradictions can be identified, the elimination of which will require clarification or revision of the design scheme of maintenance. Quantitative estimates may give reason to simplify the model by excluding from consideration some parameters, ratios, or their individual components, despite the fact that the influence of the factors described by them is taken into account in the calculation scheme (substantive or conceptual model). In most cases, assuming additional assumptions relative to the design scheme, it is useful to construct such a simplified version of the MM that would make it

possible to obtain or attract a known exact solution. This solution can then be used for comparison when testing the results in subsequent steps. The second stage involves the development of a method for calculating a formulated mathematical problem, or, as they say, a computational or modeling algorithm. In fact, it is a combination of algebraic formulas by which calculations are carried out, and logical conditions that allow you to establish the desired sequence of application of these formulas. Computational algorithms should not distort the basic properties of the model and, therefore, the initial technological object, be economical and adaptable to the particularities of the tasks being solved. According to the method of composing equations (functional dependencies F, f), they can be divided into formal (empirical, regression) and informal (analytical) When constructing empirical (regression) MMs, the structure of functional dependencies F, f is set on the basis of some formal considerations that are not related to the type of technological object, its design features, or mechanisms of the processes. The task of F, f in formal MMs is made taking into account the convenience of the subsequent use of equations or the simplicity of determining the vector a from experimental data. Under the convenience of using MM is understood the possibility of obtaining an analytical solution, y (x, a) or economical finding an approximate solution on computers and used computers.

Topic 4. Mathematical and kinetic models of biotechnological processes

The implementation of the individual stages of computer modeling requires certain knowledge, skills and practical training in the field of technological objects subjected to mathematical modeling. The main concept in the field of biotechnological processes and systems is the concept of biotechnology. Biotechnology is the targeted production of valuable products for the national economy and various fields of human activity, in the process of which the biochemical activity of microorganisms, isolated cells or their components is used.

The main types of biochemical activity of micro-objects used in biotechnology, as a rule, are the following:

The growth of cell mass of bioreagents, which are the product. This class of processes includes obtaining baker's yeast in the food industry, fodder yeast in agriculture, vaccines in medicine.

The formation (biosynthesis) during the growth and development of cells of valuable biochemical products - some of which are released into the environment (extracellular products), some accumulate in the biomass (intracellular products). In these cases, production exists for the sake of obtaining such products, rather than the biomass itself, which is often ballast.

Biotransformation is a process, as a result of which, under the influence of the biological activity of microorganisms or enzymes, the chemical composition of the initial chemical substance changes. An example of a biotransformation process is the conversion of glucose to fructose by the action of the enzyme glucoisomerase or glycerol into dioxiacetone by the action of gluconobacteria.

The consumption by microorganisms from liquid media of various substances that are pollutants. During these processes, the biomass of microorganisms is an intermediate agent. Such processes are used in biochemical wastewater treatment.

Microorganism leaching, i.e. the translation into the dissolved state of certain substances in solids. An example of these processes is the microbiological leaching of metals from ores in the mining and metallurgical industries.

The use of biochemical activity of microorganisms for the formation of gases and due to this creation, for example, of porous materials. These processes are widely used in the food industry for the preparation of bread, beer or champagne. In the mathematical description of these processes, the main task is to assess the response of microreagents to various disturbing environmental factors. At the same time, microreagents are very complex objects, the mathematical description of which from traditional concepts used to describe technological objects is difficult and is possible only on the basis of an extensive system of assumptions. In view of this, the synergetic approach developed by G. Nichols and I. Prigogine for

nonequilibrium systems in chemistry and biology has been particularly popular in recent decades. Another common method for describing biotechnological micro-reagents is the use of geometric models called cellular automata. Cellular automata were first considered by von Neumann and Ulam in 1948 and later popularized by D. Conway in 1970 in the form of the “Life” game. A feature of cellular automata is that they represent a mathematical idealization of biological systems in which space and time are discrete, and the physical parameters of the medium take a finite set of discrete values. These mathematical models are widely used to describe complex biological processes and systems, examples of which can be: processes of mutation of microorganism strains, complex biochemical processes (for example, glycolysis), ecosystem evolution processes, and many others.

The kinetics of biotechnological processes studies the patterns of changes in the growth rate of microorganisms and the biosynthesis of metabolic products depending on the current concentrations of substrates, biomass, metabolic products, temperature and pH of the environment. Consider the kinetic laws of biotechnological processes in more detail. The most common equations describing the kinetics depending on the concentration of only one substrate, which is called limiting; other substrates are considered to be in excess and not affecting the growth rate.

Section 2. Examples of computer modeling of the simplest typical biotechnological processes and systems.

Topic 1. Mathematical modeling of the processes of periodic cultivation of microorganisms.

Microbiological synthesis (biosynthesis) is a process that proceeds with the participation of microorganisms and is accompanied by the formation of biomass. The target product of biosynthesis is either the biomass itself, or various substances produced by microorganisms in the process of their life. The main stages of the biosynthesis process - the growth of microorganisms and the accumulation of biomass - occurs in fermenters that work most often periodically.

A nutrient medium and a seed dose of microorganisms are loaded into them. The resulting culture fluid is intensively mixed. However, despite mixing, the culture fluid is not uniform. Firstly, the cells of microorganisms can combine to form agglomerates; secondly, the nutrient medium itself is heterogeneous: it may contain dispersed drops of poorly soluble hydrocarbons and gas bubbles. In addition, cell sizes may be different. When modeling the periodic process of biosynthesis with heterogeneous biomass, it is assumed that the limiting substrate is in a nutrient medium in a dissolved form, and the biomass loaded into the apparatus is a collection of individual agglomerates of different masses.

Topic 2. Mathematical modeling of the processes of continuous cultivation of microorganisms

There are two types of continuous processes for the cultivation of microorganisms: processes of complete displacement, or tubular, and processes of complete mixing, or chemostatic. Consider the tubular cultivation process. During this process, the nutrient medium and inoculum continuously enter the apparatus, in which there is no back mixing. The device is made in the form of a long pipe of large diameter.

Block diagram of the mathematical model of the fermenter.

In flows of gases or liquids, the transfer of matter is carried out both due to the direct contact of the molecules and their interaction (molecular transfer, determined by the laws of microkinetics), and due to the transfer of matter by liquid particles - conglomerates of molecules - moving from one point of a given medium to another (vortex transfer determined by the laws of macrokinetics). Mostly the influence of one mechanism or another is determined by the hydrodynamic situation of the process. The transfer mechanism within each phase is directly related to the hydrodynamics of a single-phase flow, while the transfer mechanism through the interface is associated with the hydrodynamics of a two-phase flow. Therefore, in the case of macro-transfer of matter, the vortex motion of a liquid becomes important, since vortices are carriers of energy and matter in a

stream. In the process of fluid movement, a change in some physical quantities occurs, by which one can evaluate the process of motion itself. A change in the physical quantity in the general case can occur both at a given point with time (local change), and during the transition from one point in space to another (convective change).

Topic 3. Mathematical modeling of biotransformation and biocatalysis processes

Biocatalysis and biotransformation are processes of chemical conversion of one or more substances that occur under the action of enzyme catalysts used in purified form or as part of microorganism cells or isolated animal or plant cells. At the same time, biotransformation is a relatively shallow chemical transformation of an already largely formed chemical compound under the influence of enzymes. In biocatalysis, it is possible to synthesize a new substance from reagents of different structure or decomposition of a complex substance under the influence of enzymes.

Topic 4. Mathematical modeling of membrane processes in biotechnology

Membrane methods are used in biotechnology to isolate, purify and concentrate products. All of them are outwardly similar to filtration (since the process scheme includes a semi-permeable septum), but they are designed to separate particles of different sizes and differ somewhat in the driving force of the process and the hardware design. So, for example, microfiltration is used to separate microorganisms and suspended particles. In the process of isolation and purification of the product, membrane methods of a different type are often used: dialysis, ultrafiltration and reverse osmosis, which make it possible to separate not only the solid phase, but also molecules simply dissolved in liquids, and not necessarily very large ones. Ultrafiltration is usually carried out at particle sizes or molecules from 10 nm to 10 microns, reverse osmosis and dialysis - at sizes from 0.5 nm to 0.5 microns.

Mathematical modeling of biotechnological processes in medicine

Currently, biotechnology is actively used in medicine to obtain vaccines, antibiotics, vitamins, immunomodulators, insulin, immunosuppressants, blood substitutes, monoclonal antibodies. The above examples, of course, do not exhaust all the prospects of biotechnology in medicine, but they demonstrate the paramount importance of biotechnology for this type of human activity. The event is to connect metal electrodes to the affected area of the organ.

The manual discusses the main aspects of mathematical modeling of biotechnological processes and systems. A strict classification of mathematical models is given, their structure, properties and basic definitions that clearly define the goals and objectives of computer modeling and its role in the study of complex biotechnological systems. Clear ideas about the main stages of computer modeling are given. Based on the classification of biotechnological processes, their main features and differences from chemical-technological processes are formulated. Particular attention is paid to the fundamental models of the growth of microorganisms, the accumulation of metabolic products and the change in substrate concentration during biotechnological processes. The influence of various environmental factors on the kinetics of these processes is estimated. Typical problems arising in the synthesis and analysis of various nonlinear biotechnological processes and systems are considered and illustrated.

4. STRUCTURE AND CONTENT OF THE PRACTICAL PART OF THE COURSEPractical classes (18h.)

Lesson 1. Current state and development trends of biotechnology and standardization methods. Standardization as the basis of product safety.

Lesson 2. Innovative technologies in biotechnological production, specialized equipment for biotechnological production.

Lesson 3. Integrated process control systems.

Lesson 4. Technical and economic analysis of biotechnological production systems, etc.

Lesson 5. Mathematical modeling of biotechnological processes and systems. Classification of mathematical models their structure

Lesson 6. Properties and basic definitions, the study of complex biotechnological systems.

Lesson 7. The main stages of computer modeling.

Lesson 8. Classification of biotechnological processes, the main features and differences from chemical-technological processes.

Lesson 9. Fundamental models of the growth of microorganisms, the accumulation of metabolic products and changes in substrate concentration during biotechnological processes.

1. Assessment of the influence of various environmental factors on the kinetics of biotechnological processes.

2. Typical tasks arising in the synthesis and analysis of various nonlinear biotechnological processes and systems.

5. TRAINING AND METHODOLOGICAL SUPPORT OF STUDENTS'S INDEPENDENT WORK

Educational and methodological support for the independent work of students in the discipline "Biotechnological Process Control Systems" is presented in Appendix 1 and includes:

- a schedule of independent work on the discipline, including approximate norms of time to complete each task;
- characteristics of tasks for independent work of students and guidelines for their implementation;
- requirements for the presentation and presentation of the results of independent work;

criteria for evaluating the performance of independent work.

6 CONTROL OF ACHIEVING COURSE OBJECTIVES

№	Supervised sections / topics of discipline	Codes and stages of formation of competencies		Evaluation Tools	
				current control	intermediate certification
1	Section 1. Computer modeling of biotechnological processes and systems	SPC-9 SPC-10 SPC-16 SPC-17 SPC-19	Knows how to manage the quality, safety and traceability of the production of biotechnological products	UO-1 - interview, UO-2 – colloquium	Exam
			Able to apply methods of quality management, safety and traceability of the production of biotechnological products		
			Knows how to manage the quality, safety and traceability of the production of biotechnological products		
2	Section 2. Examples of computer modeling of the simplest typical biotechnological processes and systems	SPC-9 SPC-10 SPC-16 SPC-17 SPC-19	Knows how to develop proposals for optimizing biotechnological processes and managing the release of biotechnological products	UO-1 - interview, UO-2 - colloquium, PR-4 – essay	Exam
			Able to apply methods for developing proposals for optimizing biotechnological processes and managing the release of biotechnological products		
			Owns how to		

			develop proposals for optimizing biotechnological processes and managing the release of biotechnological products		

Typical control tasks, methodological materials that determine the procedures for assessing knowledge, skills and (or) experience, as well as criteria and indicators necessary for assessing knowledge, skills, and characterizing the stages of formation of competencies in the process of mastering an educational program are presented in the Appendix 2.

7 LIST OF TRAINING LITERATURE AND INFORMATION AND METHODOLOGICAL SUPPORT OF DISCIPLINE

Main literature

(print and electronic publications)

1. Microbiological control of biotechnological production: a textbook for universities / N. B. Gradova, E. S. Babusenko, V. I. Panfilov [and others]. Moscow: DeLi Plus, 2016. - 139 p. http://lib.dvfu.ru:8080/lib/item?id=chamo:838315&theme=FEFU

2. Microbiological synthesis / A. M. Bezborodov, G. I. Kvesitadze; [resp. ed. A. G. Lobanok]. St. Petersburg: Prospect of Science, 2011. - 143 p. http://lib.dvfu.ru:8080/lib/item?id=chamo:785480&theme=FEFU

3. Biotechnology: a textbook for agricultural universities / V. A. Chkhenkeli. St. Petersburg: Prospect of Science, 2014 .-- 335 p. http://lib.dvfu.ru:8080/lib/item?id=chamo:785504&theme=FEFU

4. Lubentsova E.V. Synthesis of automatic control systems for biotechnological processes using approximating and neuro-fuzzy control methods [Electronic resource]: monograph / Lubentsova EV, Volodin AA - Electron. textual data. — Stavropol: North Caucasus Federal University, 2014.— 160 c .— Access mode: http://www.iprbookshop.ru/63132.html

5. Belyaev P.S. Process Control Systems [Electronic resource]: a manual for students of the 3rd and 4th year of study in the areas of training 151000, 222900, 240100, 240700, 241000, 261700 / Belyaev PS, Bukin AA - Electron. textual data. — Tambov: Tambov State Technical University, EBS DIA, 2014.— 156 p. http://www.iprbookshop.ru/64575.html

Additional literature

(print and electronic publications)

1. Reshetnyak EP Chemical-technological process control systems [Electronic resource]: lecture notes for students of the Biotechnology specialty / Reshetnyak EP - Electron. textual data. - Saratov: Saratov State Agrarian University named after N.I. Vavilova, Higher education, 2009.— 213 p. http://www.iprbookshop.ru/8143.html

Regulatory Materials

1. RF. The laws. On amendments to the Federal Law «Technical Regulations for Milk and Dairy Products»: Federal Law of July 22, 2010 No. 163-ФЗ // New Laws and Normative Acts. - 2010. - No. 31. - S. 31-80.

2. RF. The laws. Technical Regulations for Milk and Dairy Products: Federal Law of June 12, 2008 No. 88

3. RF. The laws. Technical regulation of the Customs Union «On food safety» TR CU 021/2011

4. GOST 25011-81 «Meat and meat products. Methods for determining protein».

5. Federal Law of the Russian Federation of June 12, 2008 N 88-ФЗ 2Technical Regulations for Milk and Dairy Products2

6. GOST 31981-2013 Yoghurts. General specifications

7. GOST R 53104-2008 Catering services. The method of organoleptic assessment of the quality of catering products.

8. GOST 3624-92 Milk and dairy products. Titrometric methods for determining acidity

9. GOST 23327-98 Milk and dairy products. The method of measuring the mass fraction of total nitrogen according to Kjeldahl and determining the mass fraction of protein

10. GOST 3628-78 Dairy products. Sugar Determination Methods

11. GOST 10444.11-89 Food Products. Method for the determination of lactic acid microorganisms

12. GOST 9225-84 Milk and dairy products. Microbiological analysis methods

13. GOST R 52738-2007 Milk and milk processing products. Terms and Definitions

The list of resources of the information and telecommunication network "Internet"

1. http://elibrary.ru Scientific Electronic Library eLIBRARY.RU
2. The electronic library system "Doe" http://e.lanbook.com/
3. The electronic library system "IPRBOOK" http://www.iprbookshop.ru
4. Scopushttp database: http://www.scopus.com/home.url
5. Web of Science Database http://apps.webofknowledge.com/
6. Database of full-texting academic journals in China http://oversea.cnki.net/
7. The electronic library of dissertations of the Russian State Library http://diss.rsl.ru/
8. EBSCO Electronic Databases http://search.ebscohost.com/

8 METHODOLOGICAL INSTRUCTIONS FOR THE DEVELOPMENT OF THE DISCIPLINE

Guidelines for organizing an independent study of the discipline.

Abstracting of educational and scientific literature.

The review of educational and scientific literature involves an in-depth study of individual scientific works, which should ensure the development of the necessary skills for working on a book. All this will contribute to expanding the

scientific horizons, increasing their theoretical training, the formation of scientific competence.

For abstracting, textbooks, individual monographic studies and articles on issues provided for in the curriculum are offered. When selecting literature on the selected issue, it is necessary to cover the most important areas of development of this science at the present stage. Particular attention should be paid to those literary sources that (directly or indirectly) can assist a specialist in his practical activities. However, this section also includes works and individual studies on issues that go beyond the studied discipline. This literature is recommended to be used if you want to expand your knowledge in any branch of science.

Along with the literature on general issues for undergraduates, literature is supposed to be taken into account independently of the profile of their professional activity. Not all of the proposed literature is equivalent in content and volume, so a different approach to its study is possible. In one case, this may be a general review of several literary sources of various authors devoted to the consideration of the same issue, in the other case, a detailed study and review of one of the recommended works or even its individual sections, depending on the degree of complexity of the issue (issue). In order to decide what to do in each case, you should consult with the teacher.

The choice of a specific work for abstracting should be preceded by a detailed familiarization with the list of all literature given in the curriculum of the discipline. It is recommended that you first familiarize yourself with the selected work by looking at the subheadings, selected texts, diagrams, tables, general conclusions. Then it is necessary to carefully and thoughtfully (delving into the ideas and methods of the author) read it, making notes along the way on a separate sheet of paper about the main points and key issues. After reading, you should consider the content of the article or a separate chapter, paragraph (if it is a monograph) and write it down briefly. Literally, only strict definitions, formulations of laws should be written out. It is sometimes useful to include one or two examples in a record to illustrate. In the event that there are strange places, it is

recommended to read the subsequent statement, as it can help to understand the previous material, and then return again to understanding the previous statement.

The result of work on literary sources is an essay.

In preparing the essay, it is necessary to highlight the most important theoretical points and justify them independently, paying attention not only to the result, but also to the methodology used in studying the problem. Reading non-fiction should be critical. Therefore, we must strive not only to master the main content, but also the method of proof, to reveal the features of various points of view on the same issue, to evaluate the practical and theoretical significance of the results of the abstracted work. A very desirable element of the essay is the expression by the listener of his own attitude to the ideas and conclusions of the author, supported by certain arguments (personal experience, statements of other researchers, etc.).

Abstracts of monographs, journal articles of a research nature must certainly contain a definition of the problem and the specific objectives of the study, a description of the methods used by the author, as well as the conclusions reached by him as a result of the study.

9.MATERIAL AND TECHNICAL SUPPORT OF DISCIPLINE

Training lab Vladivostok, Russian Island, 10 Ajax, Building 25.1, aud. M311, area 96.6 m2	Monoblock Lenovo C360G-i34164G500UDK; Screen with electric 236 * 147 cm Trim Screen Line; DLP projector, 3000 ANSI Lm, WXGA 1280x800, 2000: 1 EW330U Mitsubishi; Subsystem of specialized hardware mounts CORSA-2007 Tuarex; Video Switching Subsystem: DVI DXP 44 DVI Pro Extron matrix switcher; Extender DVI over twisted pair DVI 201 Tx / Rx; Subsystem of audio switching and sound reinforcement; ceiling mount speaker SI 3CT LP Extron; Sennheiser EW 122 G3 UHF Microphone Lavalier Radio System with a wireless microphone and receiver; DMP 44 LC Extron digital audio processor; Extron IPL T S4 Network Management Controller; Wireless LANs for students are provided with a system based on 802.11a / b / g / n 2x2 MIMO (2SS) access points

Reading rooms of the FEFU Scientific Library with open access to the fund Vladivostok, Russian island, 10 Ajax, building A - level 10	All-in-One HP All-in-One 400 All-in-One Monoblock 19.5 (1600x900), Core i3-4150T, 4GB DDR3-1600 (1x4GB), 1TB HDD 7200 SATA, DVD +/- RW, GigEth, Wi-Fi, BT, usb kbd / mse, Win7Pro (64-bit) + Win8.1Pro (64-bit), 1-1-1 Wty Internet access speed of 500 Mbps. Workplaces for people with disabilities are equipped with braille displays and printers; equipped with: portable devices for reading flat-printed texts, scanning and reading machines with a video enlarger with the ability to control color spectra; magnifying electronic magnifiers and ultrasonic markers
Computer class Vladivostok, Russian Island, 10 Ajax, Building 25.1, aud. M621, area 44.5 m2	Monoblock Lenovo C360G-i34164G500UDK 19.5 "Intel Core i3-4160T 4GB DDR3-1600 SODIMM (1x4GB) 500GB Windows Seven Enterprise - 17 pcs; Wired LAN - Cisco 800 series; Wireless LAN for students with a system based on 802.11a / b access points / g / n 2x2 MIMO (2SS)

10. VALUATION FUNDS

Code and wording of competency	Competency Stages	
SPC-9 willingness to use the basic principles of organization of metrological support of production	Knows	basic principles of organizing metrological support for the production of agricultural raw materials and food products
	Can	use the basic principles of organizing metrological support for the production of agricultural raw materials and food products
	Owns	skills in using the basic principles of organizing metrological support for the production of agricultural raw materials and food products
SPC- 10 ability to develop a quality management system for biotechnological products in accordance with the requirements of Russian and international quality standards	Knows	principles of developing a quality management system for biotechnological products in accordance with the requirements of Russian and international quality standards
	Can	develop a quality management system for biotechnological products in accordance with the requirements of Russian and international quality standards
	Owns	principles of developing a quality management system for biotechnological products in accordance with the requirements of Russian and international quality standards
SPC- 16 the ability to carry out the	Knows	operation of control, automation and automated production control, chemical

effective operation of control, automation and automated production control, chemical-technical, biochemical and microbiological control	Can	to carry out the effective operation of means of control, automation and automated production control, chemical
	Owns	knowledge of the operation of control equipment, automation and automated production control, chemical
SPC- 17 readiness for pilot testing of technology and scaling of processes	Knows	rules for conducting pilot testing of technology and scaling processes
	Can	conduct pilot testing of technology and process scaling
	Owns	knowledge in conducting pilot testing of technology and scaling processes
SPC- 19 the ability to analyze the indicators of the technological process for compliance with the original scientific developments	Knows	indicators of the technological process for compliance with the original scientific developments
	Can	analyze the indicators of the technological process for compliance with the original scientific developments
	Owns	the ability to analyze the indicators of the technological process for compliance with the original scientific developments

I. Evaluation tools for intermediate certification

Interim certification includes the student's answer to the questions for the classification and passing the final test.

Student Examination Criteria

Points required to evaluate the final test	Credit score	Requirements for completed competencies in the student's oral response
85-100	Excellent	Excellent rating is given to a student who has strong knowledge of the raw material base for the production of functional foods. Able to successfully conduct research to identify sources for the production of functional foods. He knows the methods of processing current production information, performing analysis of the obtained data for use in product quality management
75-85	Good	Good rating is given to a student who knows a significant part of the program material, does not make significant mistakes, but hesitantly performs practical work
61- 75	Satisfactory	The grade "satisfactory" is given to a student who knows a significant part of the program material, but makes significant mistakes, uncertainly with great difficulties performs practical work
60-0	«Unsatisfactory»	The grade "unsatisfactory" given to a student who does not know a significant part of the program material, makes significant mistakes, unsurely performs practical

		work with great difficulties and cannot continue training without additional classes in the relevant discipline.

I. Evaluation tools for intermediate certification

Interim certification includes the student's answer to the questions for the classification and passing the final test.

Student Examination Criteria

Points required to evaluate the final test	Credit score	Requirements for completed competencies in the student's oral response
100-61	«Credited»	The student gets "credit" if he has knowledge on the physiological basis of the organization of balanced rational nutrition of various population groups. Able to successfully conduct research on the digestibility and digestibility of food substances by a person, as well as to calculate the energy value of food, human consumption of useful substances. He owns methods for determining the biological and energy value of food, digestibility and digestibility of food substances, taking into account the characteristics of the human body.
60-0	«Not credited»	The student does not get a "Credit" if he does not know a significant part of the program material, makes significant mistakes, unsurely performs practical work with great difficulties and cannot continue training without additional classes in the relevant discipline.

Students' independent work consists of preparing for practical classes, working on recommended literature, writing reports on the topic of a seminar, and preparing presentations.

The teacher offers each student individual and differentiated tasks. Some of them can be carried out in a group (for example, several students can do the preparation of a report and presentation on the same topic, sharing their responsibilities - one prepares the scientific and theoretical part, and the second analyzes the practice).

Tasks for self-fulfillment

1. On a given topic of the simulation game, an analysis of the literature on the discipline under study should be carried out. Based on the developed material, an imitation game should be prepared and presented for discussion.

2. Writing an essay on a topic proposed by the teacher or independently selected by the student and agreed with the teacher.

3. Preparation of presentations using multimedia equipment.

Methodological instructions for the implementation of the essay

The goals and objectives of the essay

The essay(from lat. Referto - report, report) is a summary of the problems of a practical or theoretical nature with the formulation of certain conclusions on the subject. A student-selected problem is studied and analyzed based on one or more sources. In contrast to the term paper, which is a comprehensive study of the problem, the essay is aimed at analyzing one or more scientific papers.

The objectives of writing an essay are:

development of students' skills in finding relevant problems of modern legislation;

• development of skills to summarize the material with highlighting only the most significant points necessary to reveal the essence of the problem;

• development of skills to analyze the material studied and formulate their own conclusions on the selected issue in writing, in a scientific, competent language.

The tasks of writing an essay are*:*

- teach the student to convey the opinions of the authors as faithfully as possible, on the basis of which the student writes his essay;
- teach the student to correctly state their position on the problem analyzed in the abstract;
- prepare the student for further participation in scientific - practical conferences, seminars and competitions;
- help the student to determine the topic of interest to him, the further disclosure of which is possible when writing a term paper or diploma;
- to clarify for themselves and state the reasons for their consent (disagreement) with the opinion of one or another author on this issue.

The basic requirements for the content of the essay, course project

The student should use only those materials (scientific articles, monographs, manuals) that are directly related to their chosen topic. Remote reasoning not related to the problem being analyzed is not allowed. The content of the essay should be specific, only one problem should be investigated (several are allowed, only if they are interconnected). The student must strictly adhere to the logic of presentation (start with the definition and analysis of concepts, go to the problem statement, analyze the ways to solve it and draw the appropriate conclusions). The essay should end with a conclusion on the topic.

The structure of the essay consists of:

1. The title page;

2. Introduction, where the student formulates the problem to be analyzed and investigated;

3. The main text, which consistently reveals the selected topic. Unlike term paper, the main text of the essay involves a division into 2-3 paragraphs without highlighting the chapters. If necessary, the text of the abstract can be supplemented by illustrations, tables, graphs, but they should not "overload" the text;

4. Conclusions, where the student formulates conclusions made on the basis of the main text.

5. The list of used literature. This list refers to those sources that the student refers to in preparing the essay, as well as others that were studied by him during the preparation of the essay.

The essay is 10-15 pages of typewritten text, but in any case should not exceed 15 pages. Interval - 1.5, font size - 14, margins: left - 3 cm, right - 1.5 cm, upper and lower - 1.5 cm. Pages must be numbered. The indent from the beginning of the line is 1.25 cm.

The order of delivery of the essay and its assessment

Essays are written by students during the semester in the terms set by the teacher in a particular discipline, reported by the student and submitted for discussion. The printed version is given to the teacher, leading the discipline.

Based on the results of the check, the student is given a certain number of points, which is included in the total number of student points scored by him during the semester. When evaluating the essay, the correspondence of the content to the chosen topic, the clarity of the work structure, the ability to work with scientific literature, the ability to pose a problem and analyze it, the ability to think logically, knowledge of professional terminology, and literacy are taken into account.

Report topics

1. Current status and development trends of biotechnology and standardization methods.

2. Standardization as the basis of product safety

3. Innovative technologies in biotechnological production, specialized equipment for biotechnological production.

4. Integrated process control systems

5. Technical and economic analysis of biotechnological production systems.

6. Mathematical modeling of biotechnological processes and systems.

7. Classification of mathematical models their structure

8. Properties and basic definitions, the study of complex biotechnological systems.

9. The main stages of computer simulation.

10. Classification of biotechnological processes, the main features and differences from chemical-technological processes.

11. Fundamental models of the growth of microorganisms.

12. Assessment of the influence of various environmental factors on the kinetics of biotechnological processes.

13. Typical tasks arising in the synthesis and analysis of various nonlinear biotechnological processes and systems

Recommended topics and list of essays

1. Accumulation of metabolic products and changes in substrate concentration during biotechnological processes.
2. Substances that increase the shelf life of products.
3. Biological objects and raw material base
4. Cultivation of microorganisms and obtaining final products
5. Cultivation of microorganisms and obtaining final products
6. Russian food production quality control system.
7. The principles of the HACCP system.
8. International Food and Agriculture Organization Standards CAC / PCP.
9. Biotechnological bread production process
10. Biotechnological method for the production of citric acid.
11. Biotechnological method of deep fermentation using Aspergillus niger mold.
12. Biotechnological method for the production of lactic acid.
13. Biotechnological method of producing paprika.
14. Biotechnological method for the synthesis of amino acids.
15. Biotechnological method for the production of feed lysine
16. Development of adaptive control algorithms for the process of cultivation of alcohol producers.
17. Fermentation control algorithms.
18. Optimization of culture media and microorganism cultivation modes using situational management algorithms.
19. The study of oxygen mass transfer in the processes of microbiological synthesis.
20. Investigation of the process of obtaining nutrient media for biotechnological production based on acid hydrolysates of plant waste.
21. Development of methods for the operative diagnosis of microbiological processes.

22. Development of an installation for measuring the benignity of plant waste hydrolysates as secondary material resources.

23. Intensification of the processes of utilization of liquid waste from chemical and food industries.

24. Intensification of grain processing in the production of ethyl alcohol using enzymes.

25. Experimental determination of the parameters of technological processes necessary for the optimal design of complex waste-free technological systems with reverse cycles of water and other components.

26. Development of test systems for assessing the biological benignness of hydrolysates and fermentolysates.

27. Development of laboratory regulations for the production of biotechnological products using dense crops and intensive modes.

28. Biotechnological methionine production method.

29. Innovative technologies in biotechnological production

30. Methods of mathematical modeling of biotechnological processes

31. Specialized equipment for biotechnological production

32. Integrated Process Control Systems

33. Techno-economic analysis methods for biotechnological production systems

34. Methods for optimizing biotechnological production

35. The main methods of biotechnological processes as objects of management.

36. Principles of automatic control of technological parameters.

37. The structure of technical means of control systems.

38. Technological processes of control objects

39. Principles of automatic control of technological parameters;

40. The structure of technical means of control systems;

41. The main types of automatic control systems

Questions for the exam

in the discipline "Biotechnological Process Control Systems":

1. Substances that increase the shelf life of products.
2. Biological objects and raw material base
3. Cultivation of microorganisms and obtaining final products
4. Cultivation of microorganisms and obtaining final products
5. Microbiological safety of the hospital.
6. The Russian system of quality control of food production, including the use of water fishing facilities.
7. Description of international quality standards for aquatic habitats.
8. The principles of the HACCP system.
9. International Food and Agriculture Organization Standards CAC / PCP.
10. Standard Methods for Determining Microbiological Indices in Food
11. Give a diagram of the biotechnological process of bread production
12. Biotechnological method for the production of citric acid.
13. Biotechnological method of deep fermentation using Aspergillus niger mold.
14. The most important product of the microbiological industry is food grade acetic acid.
15. Biotechnological method for the production of lactic acid.
16. Biotechnological method of producing paprika.
17. Biotechnological method for the synthesis of amino acids.
18. Biotechnological method for the production of feed lysine
19. Development of adaptive control algorithms for the process of cultivation of alcohol producers.
20. Contours and control algorithms of fermentation processes.
21. Optimization of culture media and microorganism cultivation modes using situational management algorithms.

22. The study of oxygen mass transfer in the processes of microbiological synthesis.

23. Investigation of the process of obtaining nutrient media for biotechnological production based on acid hydrolysates of plant waste.

24. Development of methods for the operative diagnosis of microbiological processes.

25. Development of an installation for measuring the benignity of plant waste hydrolysates as secondary material resources.

26. Intensification of the processes of utilization of liquid waste from chemical and food industries.

27. Intensification of grain processing in the production of ethyl alcohol using enzymes.

28. Experimental determination of the parameters of technological processes necessary for the optimal design of complex waste-free technological systems with reverse cycles of water and other components.

29. Development of test systems for assessing the biological benignness of hydrolysates and fermentolysates.

30. Development of laboratory regulations for the production of biotechnological products using dense crops and intensive modes.

31. Biotechnological methionine production method.

32. Innovative technologies in biotechnological production

33. Methods of mathematical modeling of biotechnological processes

34. Specialized equipment for biotechnological production

35. The concept of integrated process control systems

36. Techno-economic analysis of biotechnological production systems

37. Methods for optimizing biotechnological production

38. The main methods of biotechnological processes as objects of management.

39. Principles of automatic control of technological parameters.

40. The structure of technical means of control systems.

41. Technological processes of control objects
42. Principles of automatic control of technological parameters;
43. The structure of technical means of control systems;
44. The main types of automatic control systems.

II. Evaluation tools for ongoing certification

Evaluation Criteria

- 100-86 points are awarded to the student, if the student expressed his opinion on the formulated problem, argued for it, accurately determining its content and components. The data of domestic and foreign literature, statistical information, and regulatory information are presented. The student knows and possesses the skill of independent research work on the topic of research; methods and techniques of analysis of theoretical and / or practical aspects of the study area. There are no factual errors related to understanding the problem; graphically, the work is framed correctly

- 85-76 - points - the work is characterized by semantic integrity, coherence and sequence of presentation; no more than 1 mistake was made in explaining the meaning or content of the problem. For argumentation, data from domestic and foreign authors are given. Demonstrated research skills. There are no actual errors related to understanding the problem. One or two errors in the design of the work

- 75-61 points - the student conducts a fairly independent analysis of the main stages and semantic components of the problem; understands the basic foundations and theoretical justification of the chosen topic. The main sources on this topic were brought. No more than 2 errors were made in the meaning or content of the problem, the design of the work

- 60-50 points - if the work is a retransmitted or completely rewritten source text without any comments, analysis. The structure and theoretical component of the topic is not disclosed. Three or more than three errors were made in the semantic content of the problem being revealed and in the design of the work.

Questions for colloquia, interviews on the discipline

"Identity and authenticity of functional foods":

1. What is the main task of the identification examination of functional products?

2. For what purpose is the examination of the authenticity of functional products?

3. What does the term “conformity” mean for a particular product?

4. List the types of conformity assessment activities

product quality.

5. What is “functional food”?

6. What document are the results of the quality examination?

7. In which document does the expert reflect the results of identification products?

8. What indicators are confirmed with mandatory certification?

9. What is the purpose of consumer identification?

10. What indicators of a functional product are suitable for identification?

11. What is falsification of a functional product?

12. What are organoleptic studies?

13. What is assortment falsification of a functional product?

14. What are the main ingredients that provide food functionality?

15. What is information falsification of a functional product?

16. What organoleptic characteristics are used to identify functional products?

17. What physico-chemical quality indicators are used to identify functional products?

18. How is the evaluation of research results to identify functional products?

19. The requirements of which regulatory document must meet product information?

20. Requirements for functional foods

21. The range of functional food products

22. The main provisions of the concept of healthy and safe nutrition of the population of Russia.

23. What is the time frame for identifying functional products?

24. Classification of functional products

VARIANTS OF THE CONTROL WORKS FOR THE INTERMEDIATE CERTIFICATION

Variant 1

1. Define the acid number of the oil.

2. Give the chemical reactions underlying the determination of nitrites in sausages.

3. Give the chemical reactions underlying the method for the determination of sugars by the iodine method.

4. What is the essence of the method and why is titratable acidity of dairy products determined.

5. Assess the freshness of sea fish, if the number of LO 48, and TMA 4

6. How to determine the completeness of pasteurization of milk?

7. Give the chemical reactions that underlie the definition of salt by the Mohr method.

8. To determine table salt by the method of Folhard, 2.2 g of product was taken. 25ml 0.1n was added to the sample. silver nitrate. After the addition of reagents and indicator, an excess of silver nitrate was titrated to 13.5 ml 0.1011N. potassium thiocyanate. 24.5 ml of potassium thiocyanate were spent on a blank experiment. Calculate the% content of sodium chloride.

9. For the study of poultry meat took 0.6530 g of fat. After the addition of reagents and an indicator for titration, 0.95 ml of 0.002 N were consumed. sodium thiosulfate. Calculate the peroxide value (in% of iodine) and evaluate the freshness of the bird.

10. Make a conclusion about the freshness of freshwater fish on the basis of the following data when determining volatile bases: the weight of the sample is 7.8 g, 25 ml of 0.0980 n are poured into the receiver flask. sulfuric acid. The titration of excess sulfuric acid went to 21.5 ml 0.1055n. caustic soda solution.

Variant 2

1. Define the peroxide value of the oil.

2. Give the chemical reactions underlying the method for determining the freshness of fish by the number of volatile bases and trimethylamine.

3. Give the chemical reactions that underlie the method for determining starch in sausages.

4. What is the essence of the method and why is the acid number of poultry fat determined.

5. Assess the freshness of milk if its titratable acidity is 20 degrees Turner.

6. How to determine the completeness of milk sterilization.

7. Give chemical reactions for the determination of table salt by the method of Folhard.

8. When determining the acidity of milk, 20 ml of the product were taken for analysis (pl. 1,030). 4.5 ml of 0.1021n were used for titration. caustic potassium. Calculate titratable acidity and conclude that milk is fresh.

9. For the study of poultry meat took 3.0550 g of fat. Calculate the acid number if the titration went to 0.9 ml 0.1068n. potassium hydroxide solution. Make a conclusion about the freshness of the bird.

10. Make a conclusion about the freshness of freshwater fish on the basis of the following data when determining volatile bases: the weight of the sample is 7.8 g, 25 ml of 0.0980 n are poured into the receiver flask. sulfuric acid. The titration of excess sulfuric acid went to 21.5 ml 0.1055n. caustic soda solution.

TESTS

1. Define nutritional supplements (PD):

1. Food-grade harmless substances added to food.

2. Natural or artificial substances specially introduced into products to give them the desired properties.

3. Substances of natural origin for introduction into products with the aim of the necessary change in their properties.

2. List the main functions of food additives:

1. Dyes, thickeners, flavorings, preservatives, antioxidants.

2. Improving the appearance, regulating the consistency, taste and smell, maintaining the quality of the product.

3. Tinting, texture formation, flavoring, increasing shelf life of products.

3. What attributes should the PD to which the index "E" be assigned?

1. Safety in technological application and purity of chemical composition.

2. Safety to the extent necessary for the technology and chemical purity.

3. Safety and cleanliness for prolonged use, technological necessity of use.

4. In what cases is the introduction of PD in food products not allowed?

1. When the dosage of PD meets safety margins.

2. If PD is used to hide defects in the product.

3. When the introduction of PD will reduce the energy value of the product.

5. What types of dyes are used in food technology?

1. Natural, organic, mineral.

2. Natural, synthetic, mineral.

3. Vegetable, artificial, inorganic.

6. What are the main types of thickeners and gelling agents:

1. PD polysaccharide nature: land and sea.

2. PD polysaccharide nature and their modifications.

3. PD polysaccharide nature and gelatin.

7. The mechanism of gel formation by polysaccharides:

1. The binding of water and the folding of the polymer chains of polysaccharides.

2. Due to the natural volumetric spiral structure or sugar-acid formation of the gel framework.

3. Due to the loss of water mobility in the microcells of the gel structure in the presence of calcium ions.

8. What is called hydrophilic-lipophilic balance?

1. The ratio of lipophilic and hydrophobic regions of the emulsifier molecule.

2. The efficiency of the emulsifier.

3. The ratio of the polar and nonpolar parts of the emulsifier molecule.

9. What are the most important enhancers of taste and smell of products:

1. Nutrients with the “glutamine” satisfaction effect. ”

2. Glutamic, guanilic, inosinic acids and their salts.

3. Ribonucleotides, glutamates and inositol of potassium.

10. What preservatives are natural and found in food?

1. Sorbic acid and its salts.

2. Urotropin.

3. Benzoic acid and its salts.

11. What is the principle of action of antioxidants?

1. The binding of metal ions of variable valency.

2. Neutralization of free and peroxide radicals.

3. The increase in the duration of the induction period.

12. What are the differences between probiotics and prebiotics?

1. Probiotics - dietary supplements of microbial origin, and prebiotics - dietary supplements of mixed composition.

2. Probiotics - representatives of the normal intestinal microflora; prebiotics are probiotic generators.

3. Probiotics - pure cultures of intestinal microorganisms, prebiotics - stimulants of probiotics.

TESTS FOR SELF-TESTING AND SELF-PREPARATION

The purpose of creating the PTM is to check the residual knowledge.

The source documents used in the development of the PTM - discipline program "Identification of functional foods"

The number of testing options is 3.

The number of questions in one embodiment is 12.

The choice of answer (the number of correct tests) is 1 or more than 1.

It is recommended to count only the question (test) in which all the correct answers are given.

Grade Scale:

rating “2” - less than 50% of the total number of correct answers is indicated

rating “3” - from 50% to 74%

rating “4” - from 75% to 89%

rating “5” - over 89%

TEST № 1

The test contains 12 tasks, which take 30 minutes to complete. Choose the most correct, in your opinion, answer option and mark it with any icon in the answer form.

1. Pectin substances belong to

1) proteins *2) carbohydrates*

3) fats *4) minerals*

2. The main source of carbohydrates are foods

1) dairy *2) meat*

3) vegetable *4) fish*

3. Melanoidinogenesis is a transformation in technological processes

1) carbohydrates *2) minerals*

3) fat *4) protein*

4. Food additives do not apply

1) sweeteners *2) vitamins*

3) colorants *4) flavorings*

5. When determining the protein for decomposition of the sample using

1) sulfuric acid 2) hydrochloric acid

3) nitric acid 4) hydrofluoric acid

6. The yellow pigment of apples and tomatoes is called

1) mycopene 2) xanthophyll

3) zeaxanthin 4) betanin

7. Cyclomats belong to the following group of food additives

1) sweeteners 2) flavorings

3) preservatives 4) dyes

8. The permissible daily dose of nitrates for an adult is

1) 125mg 2) 225mg

3) 325mg 4) 425mg

9. Nitrosamines are not contained in

1) smoked meats 2) cereals

3) cheeses 4) beer

10. When determining salt in foods, sample preparation is carried out

1) preliminary drying of the sample 2) preliminary ashing of the sample

3) by preparing an aqueous extract of dyes; 4) by preliminary precipitation of proteins

11. The determination of ash insoluble in 10% hydrochloric acid is not carried out in the analysis of quality

1) milk 2) flour

3) caviar 4) roasted coffee

12. When determining fats by the Soxhlet method, together with fats, an organic solvent is not extracted

1) phospholipids 2) water

3) fat-soluble vitamins 4) sterols

Answer Form

№	1	2	3	4	5	6
1)						
2)						
3)						
4)						
№	7	8	9	10	11	12
1)						
2)						
3)						
4)						

Evaluation criterion. For the correct solution to any task of the test, the student receives 2 points. The test is considered passed when a student enters a minimum of 20 points.

Criteria for evaluating independent work

Evaluation criterion	Maximum points
1. Knowledge of the basic components of food composition	5
2. The ability, depending on the type of product, to select a sampling and sample preparation sample	4
3. Knowledge of laboratory methods for the analysis of food quality	5
4. Knowledge of the classification, structure and application of food additives	5
5. Knowledge of natural toxicants and pollutants	4
Total	23 points

TEST № 2

The test contains 12 tasks, which take 30 minutes to complete. Choose the most correct, in your opinion, answer option and mark it with any icon in the answer form.

1. The moisture content of the grain that is stored must not exceed

1) 13% *2) 15%*

3) 17% *4) 19%*

2. In the study of grain in the laboratory, "kind" means mass

1) 0.5l of grain *2) 2l of grain*

3) 1l of grain *4) 3l of grain*

3. The content of metal impurities in the grain should not exceed

1) 3mg / kg *2) 7mg / kg*

3) 5mg / kg *4) 9mg / kg*

4. The humidity of pasta should not exceed

1) 9% *2) 13%*

3) 11% *4) 15%*

5. Glassy grain characterizes the structure

1) aleurone layer *2) shells*

3) endosperm *4) fetus*

6. Grain infected with barn pests has a honey smell and then a smell

1) ammonia *2) hydrogen sulfide*

3) malt *4) hay*

7. The oil content of sunflower meal obtained in forpresses is

1) 5-10% *2) 10-15%*

3) 15-18% *4) 20-25%*

8. The extraction of oil from the prepared cake of sunflower seeds is carried out using most often

1) extraction gasoline *2) benzene*

3) hexane *4) carbon tetrachloride C*

9. The first step in refining vegetable oils is

1) freezing waxes *2) alkaline neutralization*

3) hydration *4) whitening*

10. To remove wax from vegetable oil, it is cooled to a temperature

1) 5-7 ° C *2) 10-12 ° C*

3) 12-14 ° C *4) 14-16 ° C*

11. Weed and grain impurities of grain should not exceed

1) 3% *2) 4%*

3) 5% *4) 6%*

12. The moisture content of flour should not exceed

1) 10% *2) 12%*

3) 15% *4) 17%*

Answer Form

№	1	2	3	4	5	6
1)						
2)						
3)						
4)						
№	7	8	9	10	11	12
1)						
2)						
3)						
4)						

Evaluation criterion. For the correct solution to any task of the test, the student receives 2 points. The test is considered passed when a student enters a minimum of 20 points.

Criteria for evaluating independent work

Evaluation criterion	Maximum points
1. Knowledge of the structure, chemical composition and properties of grain	5
2. The ability to classify the properties and quality indicators of grain mass and grain of the main culture	4
3. Knowledge of grain processing technology and quality indicators of grain products	5
4. The ability to describe the production technology, refining and processing of vegetable oil in stages with the introduction of chemical reactions	5
5. Knowledge of the main standardized indicators of the quality of vegetable oils	3
Total	22 points

TEST №3

The test contains 12 tasks, which take 30 minutes to complete. Choose the most correct, in your opinion, answer option and mark it with any icon in the answer form.

1. Pasteurized milk is considered fresh if titratable acidity does not exceed

1) 21oT *2) 22oT*

3) 23oT *4) 24oT*

2. The volume of the combined sample of dairy products for analysis is

1) 250ml *2) 500ml*

3) 1000ml *4) 1500ml*

3. Prior to the analysis, the sample can be stored in the laboratory no more

1) 1 hours *2) 2 hours*

3) 3 hours *4) 4 hours*

4. The fat content in natural milk usually does not exceed

1) 2% *2) 4%*

3) 6% *4) 8%*

5. Casein proteins of milk precipitate at pH

1) 4.4 *2) 4.5*

3) 4.6 *4) 4.7*

6. The completeness of pasteurization of dairy products is determined by the activity of the enzyme

1) phosphatase *2) hydrolase*

3) peroxidase *4) dihydrogenase*

7. The maximum permissible concentration of nitrites in sausages is

1) 30mg / kg *2) 40mg / kg*

3) 50mg / kg *4) 60mg / kg*

8 The ratio of saturated, mono- and polyunsaturated fatty acids in pork adipose tissue is

1) 3: 3: 1 *2) 3: 4: 1*

3) 3: 5: 1 *4) 3: 6: 1*

9. The content of sodium chloride salt in cooked sausages usually does not exceed

1) 1.5% *2) 2.5%*

3) 3.5% *4) 4.5%*

10. The presence of ammonia and ammonium salts is determined by assessing the quality and freshness

1) sausages *2) meat*

3) poultry meat *4) canned meat*

11 .. The maximum permissible histamine content in fish is

1) 5mg% *2) 10mg%*

3) 15mg% *4) 20mg%*

12. The determination of nitrogen of volatile bases, including trimethylamine, is carried out when assessing the quality

1) salted fish *2) canned fish*

3) stockfish *4) frozen fish*

Answer Form

№	1	2	3	4	5	6
1)						
2)						
3)						
4)						
№	7	8	9	10	11	12
1)						
2)						
3)						
4)						

Evaluation criterion. For the correct solution to any task of the test, the student receives 2 points. The test is considered passed when a student enters a minimum of 20 points.

Criteria for evaluating independent work

Evaluation criterion	Maximum points
1. Knowledge of the chemical composition, processing technology and basic standardized indicators of milk and dairy products	5
2. Knowledge of the chemical composition, processing technology and basic standardized indicators of meat and meat products	5
3. Knowledge of the chemical composition and basic standardized indicators of poultry meat	4
4. Ability to describe the chemical composition of fish and the processes that occur during its storage	5
5. Knowledge of the technology for obtaining fish products and the main standardized quality indicators of chilled, frozen, salted fish and canned fish	5
Total	24 points