

Документ подписан простой электронной подписью

Информация о владельце:

ФИО: Кубанов Сергей Исмаилович

Должность: и.о. декана медико-биологического факультета

Дата подписания: 20.10.2026 10:11:25

Уникальный программный ключ:

bbc0243907972fc80f279c67afb4501106151a7d

MINISTRY OF SCIENCE AND HIGHER EDUCATION

RUSSIAN FEDERATION

Federal State Autonomous Educational Institution of Higher Education

NORTH-CAUCASUS FEDERAL UNIVERSITY

APPROVED

Assoc. Prof. Kubanov S.I.

PhD in Medical Sciences

Dean

Faculty of Medicine and Biology

ASSESSMENT TOOLS FUND FOR THE DISCIPLINE

Additive Technologies in Biology and Medicine

Name of the discipline (module)

- Specialty: 31.05.01 General Medicine
- Mode of training: Full-time
- Year of commencement of studies: 2026
- Delivered in Semester 4, 5

Introduction

1. Intended for carrying out current control of academic performance progress and intermediate attestation in the discipline of Information Technology in Biology and Medicine for students of the specialty (majoring in) 31.05.01 General Medicine.
2. The ATF is an appendix to the program of the discipline (module) Additive Technologies in Biology and Medicine
3. Developer(s): Babenko Mikhail Grigorievich, head of the department of Computational Mathematics and Cybernetics
4. Expert examination of the ATF has been completed.

Expert group:

Chairperson: S.I. Kubanov, Associate Professor of the Department of Surgery, Orthopedics and Traumatology

Committee members:

G.S. Ivchenko, Acting Head of the Department of Propaedeutics of Internal Diseases

S.M. Kotelevets, Professor of the Department of Propaedeutics of Internal Diseases

5. Employer organization representative: Vilensky I.L., Chief Physician of Independent CDL, LLC

Expert conclusion – the ATF allows evaluating the level of competency levels and is recommended to be employed in the educational process.

6. The validity period for the ATF shall be determined by the period of implementation of the educational program.

1. Description of Evaluation Criteria at Various Stages of Their Formation, Description of Evaluation Scales

Levels of formation of competence(s), indicator(s)	Descriptors			
	Minimum level not achieved (Unsatisfactory) 2 points	Minimum level (Satisfactory) 3 points	Intermediate level (Good) 4 points	High level (Excellent) 5 points
Competency OPK-10				
Learning outcomes for the discipline (module): Able to analyze the structural organization of tissue constructs created using additive technologies in comparison with native tissues; assesses the biocompatibility of materials and the viability of cell cultures used in 3D bioprinting. <i>Indicator: OPK-10.1., OPK-10.2.</i>	The student does not know the histological structure of tissues and organs, does not understand the principles of tissue engineering. Is unable to distinguish native tissue from a tissue-engineered construct. Is not familiar with biocompatibility criteria. Cannot assess cell viability by morphological features. Makes gross errors when describing cell cultures and scaffolds.	The student knows the general principles of the structure of major tissue types. Is able to give a basic characterization of a tissue-engineered construct but has difficulty comparing it with native tissue. Understands the basic requirements for biocompatibility but cannot justify them. Has fragmented knowledge of methods for assessing cell viability.	The student confidently analyzes the structural organization of tissues and organs in normal conditions. Is able to compare the characteristics of native tissues and tissue-engineered constructs. Knows the criteria for biocompatibility and can apply them in assessing materials for 3D printing. Can interpret the results of histological analysis of scaffolds. Understands the principles of cell cultivation and assessment of their viability.	The student has an excellent command of knowledge of histology and morphofunctional features of all tissue types. Independently performs a comparative analysis of native tissues and bioengineered constructs, identifying their structural correspondences and differences. Demonstrates a deep understanding of cell differentiation processes and tissue morphogenesis. Arguably justifies the choice of materials and cell lines for specific bioprinting tasks. Is able to predict the integration of an implant with recipient tissues based on biocompatibility analysis.

The evaluation of the competency formation level in the discipline is carried out on the basis of the Regulations on conducting current control of academic progress and intermediate attestation of students in higher education educational programs – Bachelor’s programs, Specialist’s programs, Master’s programs – at the Federal State Autonomous Educational

ASSESSMENT TOOLS FOR CHECKING THE LEVEL OF COMPETENCY DEVELOPMENT

Task Number	Correct Answer	Content of the Question	Competency
1	B) Creating three-dimensional objects by adding material layer by layer	What is the definition of additive manufacturing (3D printing)? A) A method of removing material from a solid block B) Creating three-dimensional objects by adding material layer by layer C) Casting objects in a mold D) Forging metal parts under high pressure	OPK-10
2	B) FDM (Fused Deposition Modeling)	Which of the following 3D printing technologies is most commonly used for creating anatomical models from thermoplastics? A) SLA (Stereolithography) B) FDM (Fused Deposition Modeling) C) SLS (Selective Laser Sintering) D) DLP (Digital Light Processing)	OPK-10
3	B) Hydrogels and bioinks containing living cells	What are "bioinks" in the context of 3D bioprinting? A) Standard printer inks for office printers B) Hydrogels and bioinks containing living cells C) Mineral pigments for ceramic printing	OPK-10

		D) Metal powders for laser sintering	
4	B) Mimics (Materialise)	Which software is most commonly used for medical image segmentation and conversion to 3D models for printing? A) Adobe Photoshop B) Mimics (Materialise) C) Microsoft Word D) AutoCAD Architecture	OPK-10
5	B) A lattice structure with interconnected pores that mimics the extracellular matrix	What is a "scaffold" in tissue engineering and bioprinting? A) A solid metal implant B) A lattice structure with interconnected pores that mimics the extracellular matrix C) A thin film coating for implants D) A surgical instrument for bone cutting	OPK-10
6	B) To ensure minimal tissue damage and better cosmetic outcomes	Why are patient-specific surgical guides created using 3D printing increasingly used in maxillofacial surgery? A) To reduce the cost of surgery B) To ensure minimal tissue damage and better cosmetic outcomes C) To speed up the operation regardless of accuracy D) To replace the need for experienced surgeons	OPK-10
7	A, B, D	Which of the following are major biomedical	OPK-10

		applications of additive manufacturing? (Select all that apply) A) Production of personalized implants (hip, knee, cranial) B) Bioprinting of tissues and organs (skin, bone, cartilage) C) Printing of paper documents for medical records D) Creation of anatomical models for surgical planning	
8	A, B, C	Which of the following are key components of a 3D bioprinter? (Select all that apply) A) Printhead/extruder for bioink deposition B) Computer-controlled XYZ positioning system C) Temperature-controlled environment and UV/light curing system D) High-pressure water jet for cutting materials	OPK-10
9	A, B, D	What are the main advantages of using 3D printing in surgery and orthopedics? (Select all that apply) A) Personalization of implants to patient-specific anatomy B) Reduction of surgery time due to pre-planning and surgical guides C) Elimination of all post-operative complications	OPK-10

		D) Ability to create complex porous structures for bone ingrowth	
10	A, B, D	Which of the following materials are commonly used as bioinks in extrusion-based bioprinting? (Select all that apply) A) Alginate hydrogels B) Gelatin methacryloyl (GelMA) C) PLA (Polylactic acid) filament D) Collagen hydrogels	OPK-10
11	A, B, C	What are the steps of the 3D printing workflow for medical applications? (Select all that apply) A) Acquiring medical imaging data (CT, MRI) in DICOM format B) Segmentation and 3D model reconstruction using software (Mimics, 3D Slicer) C) Slicing and generating G-code for the 3D printer D) Direct printing without any digital processing	OPK-10
12	A, B, C, E	Which of the following are known limitations or challenges of current 3D bioprinting technologies? (Select all that apply) A) Low resolution of printed structures compared to native	OPK-10

		tissues B) Limited availability of suitable bioinks that support cell viability and function C) Difficulty in vascularization of thick printed constructs D) Complete absence of regulatory issues for bioprinted products E) High cost and slow printing speed for large-scale production	
13	FDM (or Fused Deposition Modeling)	The 3D printing technology that uses a thermoplastic filament which is melted and extruded through a nozzle to build a part layer by layer is called _____.	OPK-10
14	SLA (or Stereolithography)	The 3D printing technology that uses a UV laser to cure liquid photopolymer resin layer by layer is called _____.	OPK-10
15	bioink(s)	A printable material that contains living cells and is used in bioprinting to construct tissue structures is called _____.	OPK-10
16	DICOM	The standard medical image format used for CT and MRI scans, which serves as the input for 3D model creation, is _____.	OPK-10
17	scaffold(s)	A porous, biodegradable structure used in tissue engineering to support cell attachment, growth,	OPK-10

		and tissue formation is called a _____.	
18	stereolithography (or SLA)	The 3D printing technology that uses a laser to cure photopolymer resin layer by layer is called _____.	OPK-10
19	1 → 2 → 3 → 4 → 5 → 6	Arrange the steps of the 3D printing workflow for creating a patient-specific implant from medical imaging data in the correct order: 1) Acquire CT/MRI scan in DICOM format 2) Segment the region of interest (bone, defect area) using Mimics or 3D Slicer 3) Reconstruct a 3D model of the anatomy 4) Design the implant or surgical guide using CAD software 5) Slice the 3D model using slicer software (Cura, PrusaSlicer) 6) Print the model or implant using an appropriate 3D printer	OPK-10
20	1 → 2 → 3 → 4 → 5	Arrange the steps of the bioprinting process in the correct order: 1) Prepare the bioink containing cells and biomaterial 2) Load the bioink into the printhead/extruder 3) Set printing parameters (temperature, pressure, speed) 4) Print the construct layer by layer	OPK-10

		5) Crosslink or cure the printed construct and culture in a bioreactor	
21	1 → 2 → 3 → 4	Arrange the steps for designing a patient-specific surgical guide in the correct order: 1) Import the 3D anatomical model from CT/MRI data 2) Design the guide in CAD software based on the patient's anatomy and surgical plan 3) Export the design as an STL file 4) Slice and print the guide using a 3D printer	OPK-10
22	1 → 2 → 3 → 4 → 5	Arrange the steps of pre-operative planning using 3D printing in the correct order: 1) Acquire medical images (CT/MRI) 2) Create a 3D model of the patient's anatomy 3) Print an anatomical model and/or surgical guides 4) Perform virtual surgery and simulation 5) Use the printed models/guides during the actual surgery	OPK-10
23	1 → 2 → 3 → 4	Arrange the steps for preparing a 3D model for printing (slicing) in the correct order: 1) Load the STL file into slicing software (Cura, PrusaSlicer) 2) Set printing parameters (layer	OPK-10

		height, infill, supports, temperature) 3) Generate G-code 4) Transfer G-code to the 3D printer	
24	1 → 2 → 3 → 4 → 5	Arrange the steps for printing a scaffold for bone tissue engineering in the correct order: 1) Select an appropriate biomaterial (e.g., PLA, PCL, or ceramic) or bioink 2) Design the scaffold geometry in CAD software (porosity, pore size) 3) Print the scaffold using the selected technology (FDM, SLA, or bioprinting) 4) Sterilize the printed scaffold 5) Seed the scaffold with osteogenic cells and culture in a bioreactor	OPK-10
25	A-2, B-3, C-1, D-4	Match the 3D printing technology with its description: Left: A) FDM (Fused Deposition Modeling) B) SLA (Stereolithography) C) SLS (Selective Laser Sintering) D) Bioprinting Right: 1) Laser fuses powder particles layer by layer 2) Thermoplastic filament is melted and extruded 3) UV laser cures	OPK-10

		liquid photopolymer resin 4) Deposits bioink containing living cells	
26	A-1, B-3, C-2, D-4	Match the medical application with the correct 3D printing technology typically used: Left: A) Anatomical bone models for surgical planning B) Custom cranial implants C) Dental crowns and bridges D) Soft tissue bioprinted constructs Right: 1) FDM or SLS (large models) 2) SLA (high precision) 3) SLS or powder-bed fusion (metal implants) 4) Bioprinting	OPK-10
27	A-3, B-1, C-4, D-2	Match the biomaterial with its typical use in additive medicine: Left: A) PLA (Polylactic acid) B) PCL (Polycaprolactone) C) Titanium alloy (Ti-6Al-4V) D) Alginate hydrogel Right: 1) Slow-degrading scaffolds for long-term tissue regeneration 2) Bioink for cell encapsulation and 3D bioprinting 3) Biodegradable	OPK-10

		scaffolds and implants (bone fixation) 4) Metal implants (hip, knee, cranial)	
28	A-2, B-4, C-1, D-3	Match the software tool with its primary function in 3D printing for medicine: Left: A) Mimics (Materialise) B) Slicer (Cura, PrusaSlicer) C) CAD software (SolidWorks, Blender) D) 3D Slicer (open source) Right: 1) 3D modelling and design of medical devices 2) Segmentation and reconstruction from medical images (DICOM) 3) Free segmentation, visualization, and analysis 4) Preparing 3D models for printing (G-code generation)	OPK-10
29	A-3, B-2, C-4, D-1	Match the 3D printing technique with its primary material: Left: A) Fused Deposition Modeling (FDM) B) Stereolithography (SLA) C) Selective Laser Sintering (SLS) D) Bioprinting Right: 1) Bioinks (hydrogels with cells) 2) Photopolymer	OPK-10

		resins 3) Thermoplastic filaments (PLA, ABS, PCL) 4) Powder materials (nylon, metals)	
30	A-2, B-4, C-3, D-1	Match the type of 3D printed medical product with its description: Left: A) Anatomical models B) Surgical guides C) Custom implants D) Bioprinted scaffolds Right: 1) Porous 3D structures for cell growth and tissue regeneration 2) Physical replicas of patient anatomy for surgical planning and training 3) Patient-specific devices made of metal or polymer for replacing damaged tissues 4) Custom instruments for precise bone cuts and implant positioning during surgery	OPK-10

2. Description of the Evaluation Scale

Within the framework of the rating system, students' academic progress in each discipline is evaluated during current control and intermediate attestation. The rating system for assessing students' knowledge is based on the use of a combination of control activities to check the covered material (checkpoints), optimally located throughout the entire time interval of studying the discipline. The principles of the rating system for assessing students' knowledge are based on the requirements described in the Regulations on the organization of the educational process based on the rating system for assessing students' knowledge at NCFU.

3. Criteria for Evaluating Competencies

The grade **Excellent** shall be awarded to a student if the theoretical content of the course has been mastered completely, without gaps; the material is presented exhaustively, consistently, clearly, and logically; the student freely copes with tasks, questions, and other types of knowledge application; uses additional material in the answer; all tasks provided for by the

program are completed, and the quality of their execution is evaluated by a number of points close to the maximum; analyzes the obtained results; demonstrates independence when performing tasks.

The grade **Good** is to be awarded to a student if the theoretical content of the course is mastered completely, the necessary practical competencies are mainly formed, all educational tasks provided for by the training program are completed, and the quality of their execution is sufficiently high. The student firmly knows the material, presents it competently and strictly on the merits of the matter, without allowing significant inaccuracies in answering the question.

The grade **Satisfactory** is awarded to a student in case the theoretical content of the course has been mastered in part only, but the gaps are not of a significant nature, most of the tasks provided for by the program are completed, but contain errors, the student allows inaccuracies and insufficiently correct wording when answering the question, and violations of logical sequence are observed in the presentation of the program material.

The grade **Unsatisfactory** is awarded to a student if they do not know a significant part of the program material, allow significant errors, perform practical works with great difficulty and uncertainty, the necessary practical competencies are not formed, most of the educational tasks provided for by the training program are not completed, and the quality of their execution is evaluated by a number of points close to the minimum.