

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION

**Federal State Autonomous Educational Institution of Higher Education  
«National Research Lobachevsky State University of Nizhny Novgorod»**

Институт клинической медицины

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УТВЕРЖДЕНО

решением Ученого совета ННГУ

протокол № 10 от 02.12.2024 г.

**Working programme of the discipline**

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Higher education level

Specialist degree

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Area of study / speciality

31.05.03 - Dentistry

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Focus /specialization of the study programme

Dentistry

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Mode of study

full-time

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Nizhny Novgorod

Year of commencement of studies 2025

## 1. Место дисциплины в структуре ОПОП

Дисциплина Б1.О.50 Основы биомеханики челюстно-лицевого аппарата относится к обязательной части образовательной программы.

## 2. Планируемые результаты обучения по дисциплине, соотнесенные с планируемыми результатами освоения образовательной программы (компетенциями и индикаторами достижения компетенций)

Формируемые компетенции (код, содержание компетенции)	Планируемые результаты обучения по дисциплине (модулю), в соответствии с индикатором достижения компетенции		Наименование оценочного средства	
	Индикатор достижения компетенции (код, содержание индикатора)	Результаты обучения по дисциплине	Для текущего контроля успеваемости	Для промежуточной аттестации
ОПК-5: Способен проводить обследование пациента с целью установления диагноза при решении профессиональных задач	ОПК-5.1: Знать методы обследования пациента с целью установления диагноза при решении профессиональных задач ОПК-5.2: Уметь проводить обследование пациента с целью установления диагноза при решении профессиональных задач ОПК-5.3: Владеть навыком обследования пациента с целью установления диагноза при решении профессиональных задач	ОПК-5.1: Знает методы обследования пациента с целью установления диагноза при решении профессиональных задач  ОПК-5.2: Умеет проводить обследование пациента с целью установления диагноза при решении профессиональных задач  ОПК-5.3: Владеет навыком обследования пациента с целью установления диагноза при решении профессиональных задач	Задачи Тест	Зачёт с оценкой: Контрольные вопросы
ПК-3: Способностью к проведению обследования пациента с целью установления диагноза стоматологического заболевания	ПК-3.1: Знать принципы разработки и реализации индивидуальных реабилитационных программ для пациентов со стоматологическими заболеваниями ПК-3.2: Уметь разрабатывать и реализовывать индивидуальные реабилитационные программы для пациентов со стоматологическими	ПК-3.1: Знает принципы разработки и реализации индивидуальных реабилитационных программ для пациентов со стоматологическими заболеваниями  ПК-3.2: Умеет разрабатывать и реализовывать индивидуальные реабилитационные программы для пациентов со	Задачи Тест	Зачёт с оценкой: Контрольные вопросы

	заболеваниями ПК-3.3: Владеть опытом разработки и реализации индивидуальных реабилитационных программ для пациентов со стоматологическими заболеваниями	стоматологическими заболеваниями  ПК-3.3: Владеет опытом разработки и реализации индивидуальных реабилитационных программ для пациентов со стоматологическими заболеваниями		
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### 3. Структура и содержание дисциплины

#### 3.1 Трудоемкость дисциплины

	<b>очная</b>
<b>Общая трудоемкость, з.е.</b>	<b>2</b>
<b>Часов по учебному плану</b>	<b>72</b>
в том числе	
<b>аудиторные занятия (контактная работа):</b>	
- занятия лекционного типа	<b>16</b>
- занятия семинарского типа (практические занятия / лабораторные работы)	<b>48</b>
- КСР	<b>1</b>
<b>самостоятельная работа</b>	<b>7</b>
<b>Промежуточная аттестация</b>	<b>0</b> <b>Зачёт с оценкой</b>

#### 3.2. Содержание дисциплины

(структурированное по темам (разделам) с указанием отведенного на них количества академических часов и виды учебных занятий)

Наименование разделов и тем дисциплины	Всего (часы)	в том числе			
		Контактная работа (работа во взаимодействии с преподавателем), часы из них			Самостоятельная работа обучающегося, часы
		Занятия лекционного типа	Занятия семинарского типа (практические занятия/лабораторные работы), часы	Всего	
	0 Ф 0	0 Ф 0	0 Ф 0	0 Ф 0	0 Ф 0
Introduction to the course of biomechanics of the musculoskeletal system and CHLA	21	5	15	20	1
Biomechanical foundations of orthodontic treatment of anomalies and defects	22	5	15	20	2

of the human body					
Biomechanics of TMJ and orthopedic treatment	28	6	18	24	4
Аттестация	0				
КСР	1			1	
Итого	72	16	48	65	7

### Contents of sections and topics of the discipline

1. The section "Introduction to the course of biomechanics of the musculoskeletal system and CHLA" includes:  
An introduction to the course of biomechanics of the ESR.

The subject, tasks and content of the biomechanics of emergency situations. Phylogeny and ontogenesis of PHS: phylogenetic development of PHS from cartilaginous fish to humans;

intrauterine and extrauterine ontogenesis of PHS; Haeckel's law on the relationship between phylogeny and intrauterine ontogenesis. Biomechanics of the maxillofacial apparatus as part of the musculoskeletal system of the body. Osteopathic concept of the structure and functioning of the musculoskeletal system and ESR. Teeth and periodontal disease. Chewing load and chewing efficiency.

The tooth is like a lever of the first kind. The structure of the tooth. Periodontal tissues. Elastic properties of tooth and periodontal tissues. The structure and functions of the periodontium.

The structural model of the periodontium. Periodontium as an elastic, viscoelastic and poroelastic medium.

Stresses in the tissues of the tooth and periodontal during various chewing and orthodontic loads acting on the tooth. Geometry of dental arches according to Bonville. Sagittal and transversal occlusal curves. Hodon's theory of articulatory equilibrium. Secondary deformation of the dentition. Distribution of chewing load along the dentition in central occlusion.

A static method for measuring the chewing efficiency of N.I. Agapov. A dynamic method for measuring chewing efficiency by S.E. Gelman.

2. The section "Biomechanical fundamentals of orthodontic treatment of anomalies and defects of the CHLA" includes:

Biomechanics of orthodontic treatment of ESRD. Defects and pathologies of the ESR that can be eliminated during orthodontic treatment. Classification of orthodontic loads and movements. The center of rotation and the center of resistance of the tooth. Bone tissue reconstruction as the basis of orthodontic treatment. Mathematical models of orthodontic tooth movement.

3. The section "Biomechanics of TMJ and orthopedic treatment" includes:

Natural coordinate axes and coordinate planes. The muscles involved in the act of chewing. Topography of the masticatory muscles and their attachment points. The direction and maximum amount of effort developed by the chewing muscles. The structure of the temporomandibular joint (TMJ). The lower jaw is like a lever of the third kind. Biomechanics of orthopedic treatment of ESCH. Defects and pathologies of the ESR that can be eliminated during orthopedic treatment. Types and designs of fixed and removable prostheses. Supporting properties of the mucous membrane of the prosthetic bed. Determination of stresses in prostheses and tissues of the prosthetic bed under the action of various chewing loads.

Optimization of denture designs. Biomechanics of dental implants. Biomechanical analysis of orthopedic treatment of congenital cleft of the hard palate.

### 4. Учебно-методическое обеспечение самостоятельной работы обучающихся

Самостоятельная работа обучающихся включает в себя подготовку к контрольным вопросам и заданиям для текущего контроля и промежуточной аттестации по итогам освоения дисциплины приведенным в п. 5.

Анатомия, физиология и биомеханика зубочелюстной системы / Колесников Л.Л., Арутюнов С.Д., Лебеденко И.Ю., Будылина С.М., Дегтяр В.П., Антоник М.М., Костюшин М.М., Аникин Ю.М. - Москва : ГЭОТАР-Медиа, 2015.<https://e-lib.unn.ru/MegaPro/UserEntry?Action=FindDocs&ids=644209&idb=0>

## **5. Assessment tools for ongoing monitoring of learning progress and interim certification in the discipline (module)**

### **5.1 Model assignments required for assessment of learning outcomes during the ongoing monitoring of learning progress with the criteria for their assessment:**

#### **5.1.1 Model assignments (assessment tool - Tasks) to assess the development of the competency ОПК-5:**

##### **Task 3**

In patient A., during an objective examination of the oral cavity, the following pattern was noted: uniform sharp atrophy of the alveolar process of the lower jaw, the movable mucous membrane is attached almost at the level of the crest of the alveolar process.

1. Specify the type of toothless upper jaw according to the Shredder.
2. Name the methods for evaluating the supporting properties of the mucous membrane of the prosthetic bed.

##### **Task 5**

Patient I., 58 years old, complained about the poor fixation of a complete removable prosthesis on the upper jaw. Objectively: the atrophy of the alveolar process of the upper jaw is moderate, its slope in the area of the maxillary tubercles on the right and left is pronounced, with a canopy. When examining the oral cavity with the applied base of the prosthesis, blind pits are visible. The boundaries of the base reach the most prominent sections of the slope.

1. Indicate how the patient's complaints can be explained during prosthetics.
2. Name the methods for determining stresses in prostheses and tissues of the prosthetic bed under the action of various chewing loads.

#### **5.1.2 Model assignments (assessment tool - Tasks) to assess the development of the competency ПК-3:**

##### **Task 1**

In patient B., during an examination of the oral cavity, it was noted: a high alveolar process, evenly covered with a dense mucous membrane, well-defined tubercles of the upper jaw. Deep sky. The torus is not pronounced.

1. Specify the type of toothless upper jaw according to the Shredder.

2. Name the methods for evaluating the supporting properties of the mucous membrane of the prosthetic bed.

## Task 2

During the examination of the oral cavity in patient M., the complete absence of the alveolar process of the upper jaw, significant atrophy of the tubercles of the upper jaw, flat palate and low-lying valvular zones were noted.

1. Specify the type of toothless upper jaw according to the Shredder.

2. Name the methods for evaluating the supporting properties of the mucous membrane of the prosthetic bed.

### Assessment criteria (assessment tool — Tasks)

Grade	Assessment criteria
outstanding	A high level of training, impeccable command of theoretical material, the student demonstrates a creative approach to solving non-standard situations. The student gave a complete and detailed answer to all the theoretical questions of the ticket, confirming the theoretical material with practical examples. The student actively worked in practical classes. 100% completion of control exam tasks.
excellent	High level of training with minor mistakes. The student gave a complete and detailed answer to all the theoretical questions of the ticket, confirms the theoretical material with practical examples. The student actively worked in practical classes. Completion of control exam tasks by 90% and above.
very good	Good preparation. The student gives an answer to all the theoretical questions of the ticket, but there are inaccuracies in the definitions of concepts, processes, etc. The student actively worked in practical classes. Completion of control exam tasks from 80 to 90%.
good	In general, good preparation with noticeable mistakes or shortcomings. The student gives a complete answer to all theoretical questions of the ticket, but there are inaccuracies in the definitions of concepts, processes, etc. Mistakes are made when answering additional and clarifying questions from the examiner. The student worked in practical classes. Completion of control exam tasks from 70 to 80%.
satisfactory	Minimum sufficient level of training. The student shows a minimum level of theoretical knowledge, makes significant mistakes, but when answering leading questions, he can orient himself correctly and give the correct answer in general terms. The student attended practical classes. Completion of control exam tasks from 50 to 70%.
unsatisfactory	The preparation is insufficient and requires additional study of the material. The student gives erroneous answers, both to the theoretical questions of the ticket, and to the leading and additional questions of the examiner. The student missed most of the practical classes. Completion of control exam tasks up to 50%.
poor	The preparation is absolutely insufficient. The student does not answer the questions posed. The student was absent from most lectures and practical classes. The completion of control

Grade	Assessment criteria
	exam tasks is less than 20%.

### **5.1.3 Model assignments (assessment tool - Test) to assess the development of the competency OIK-5:**

Occlusion is a type of closure of the dentition in the position of occlusion:

- 1) central
- 2) Side left
- 3) front
- 4) distal
- 5) Side right

The anatomical neck of the tooth corresponds to:

- 1) the transition of enamel into root cement
- 2) the border of the supra- and subgingival parts of the tooth
- 3) the equator of the tooth
- 4) the tooth groove

Tabs are used for:

- 1) restoration of a completely destroyed tooth crown
- 2) splinting teeth
- 3) filling in the defect of the dentition
- 4) bridge supports +
- 5) prevention of functional overload of teeth.

The shape of the dental arch of the upper jaw

- 1) trapezoid
- 2) half-ellipse
- 3) oval

4) parabola

The shape of the dental arch of the lower jaw

1) trapezoid

2) half-ellipse

3) oval

4) parabola

The sagittal occlusal curve on the upper jaw starts from:

1) incisors

2) the first premolar

3) fangs

4) the second premolar

#### **5.1.4 Model assignments (assessment tool - Test) to assess the development of the competency IIK-3:**

The sagittal occlusal curve on the mandible starts from:

1) incisors

2) the first premolar

3) fangs

4) the second premolar

In a state of relative physiological rest, the dentition

1) closed

2) separated by 0.5-1.0 mm

3) separated by 2.0-4.0 mm

4) separated by 4.0-6.0 mm

The sagittal occlusal curve was first described:



- 1) Spee (1890)
- 2) Bonneville (1895) 3) Ghisi (1912)
- 4) Astakhov (1938)

The sagittal occlusal curve on the upper jaw is convex:

- 1) up
- 2) down
- 3) inside
- 4) outside

The sagittal occlusal curve on the lower jaw is convex:

- 1) up
- 2) down
- 3) inside
- 4) outside

#### Assessment criteria (assessment tool — Test)

Grade	Assessment criteria
pass	more than 70% of the correct answers
fail	less than 70% of the correct answers

#### 5.2. Description of scales for assessing learning outcomes in the discipline during interim certification

##### Шкала оценивания сформированности компетенций

Уровень сформированности компетенций (индикатор достижения)	плохо	неудовлетворительно	удовлетворительно	хорошо	очень хорошо	отлично	превосходно
	не зачтено		зачтено				

ения компет							
<u>Знания</u>	Отсутствие знаний теоретического материала. Невозможность оценить полноту знаний вследствие отказа обучающегося от ответа	Уровень знаний ниже минимальных требований. Имели место грубые ошибки	Минимально допустимый уровень знаний. Допущено много негрубых ошибок	Уровень знаний в объеме, соответствующем программе подготовки. Допущено несколько негрубых ошибок	Уровень знаний в объеме, соответствующем программе подготовки. Допущено несколько несущественных ошибок	Уровень знаний в объеме, соответствующем программе подготовки. Ошибок нет.	Уровень знаний в объеме, превышающем программу подготовки.
<u>Умения</u>	Отсутствие минимальных умений. Невозможность оценить наличие умений вследствие отказа обучающегося от ответа	При решении стандартных задач не продемонстрированы основные умения. Имели место грубые ошибки	Продemonстрированы основные умения. Решены типовые задачи с негрубыми ошибками. Выполнены все задания, но не в полном объеме	Продemonстрированы все основные умения. Решены все основные задачи с негрубыми ошибками. Выполнены все задания в полном объеме, но некоторые с недочетами	Продemonстрированы все основные умения. Решены все основные задачи. Выполнены все задания в полном объеме, но некоторые с недочетами	Продemonстрированы все основные умения. Решены все основные задачи с отдельными несущественными недочетами, выполнены все задания в полном объеме	Продemonстрированы все основные умения. Решены все основные задачи. Выполнены все задания, в полном объеме без недочетов
<u>Навыки</u>	Отсутствие базовых навыков. Невозможность оценить наличие навыков вследствие отказа обучающегося от ответа	При решении стандартных задач не продемонстрированы базовые навыки. Имели место грубые ошибки	Имеется минимальный набор навыков для решения стандартных задач с некоторыми недочетами	Продemonстрированы базовые навыки при решении стандартных задач с некоторыми недочетами	Продemonстрированы базовые навыки при решении стандартных задач без ошибок и недочетов	Продemonстрированы навыки при решении нестандартных задач без ошибок и недочетов	Продemonстрирован творческий подход к решению нестандартных задач

### Scale of assessment for interim certification

Grade		Assessment criteria
pass	<b>outstanding</b>	All the competencies (parts of competencies) to be developed within the discipline have been developed at a level no lower than "outstanding", the knowledge and skills for the relevant competencies have been demonstrated at a level higher than the one set out in the programme.
	<b>excellent</b>	All the competencies (parts of competencies) to be developed within the discipline have been developed at a level no lower than "excellent",
	<b>very good</b>	All the competencies (parts of competencies) to be developed within the discipline have been developed at a level no lower than "very good",
	<b>good</b>	All the competencies (parts of competencies) to be developed within the discipline have been developed at a level no lower than "good",

	<b>satisfactory</b>	All the competencies (parts of competencies) to be developed within the discipline have been developed at a level no lower than "satisfactory", with at least one competency developed at the "satisfactory" level.
	<b>unsatisfactory</b>	At least one competency has been developed at the "unsatisfactory" level.
<b>fail</b>	<b>poor</b>	At least one competency has been developed at the "poor" level.

### **5.3 Model control assignments or other materials required to assess learning outcomes during the interim certification with the criteria for their assessment:**

#### **5.3.1 Model assignments (assessment tool - Control questions) to assess the development of the competency ОПК-5**

1. Introduction to the course of biomechanics of emergency situations.
2. The subject, tasks and content of the biomechanics of emergency situations.
3. Phylogeny and ontogenesis of PHS: phylogenetic development of PHS from cartilaginous fish to humans; intrauterine and extrauterine ontogenesis of PHS;
4. Haeckel's law on the relationship between phylogeny and intrauterine ontogenesis.
5. Biomechanics of the maxillofacial apparatus as part of the musculoskeletal system of the body.
6. The osteopathic concept of the structure and functioning of the musculoskeletal system and PHS.
7. Teeth and periodontal disease. Chewing load and chewing efficiency.
8. The tooth as a lever of the first kind. Tooth structure.
9. Periodontal tissues. Elastic properties of tooth and periodontal tissues. The structure and functions of the periodontium.
10. The structural model of the periodontium. Periodontium as an elastic, viscoelastic and poroelastic medium.
11. Stresses in the tissues of the tooth and periodontal during various chewing and orthodontic loads acting on the tooth.
12. Geometry of dental arches according to Bonville.
13. Sagittal and transversal occlusal curves.
14. Hodon's theory of articulatory equilibrium. Secondary deformation of the dentition.
15. Distribution of the chewing load along the dental row with central occlusion.
16. Static method of measuring chewing efficiency by N.I. Agapov.

17. Dynamic method of measuring chewing efficiency by S.E.Gelman.
18. Biomechanics of orthodontic treatment of CHF.
19. Classification of orthodontic loads and movements.
20. The center of rotation and the center of resistance of the tooth.
21. Bone tissue reconstruction as the basis of orthodontic treatment.

### **5.3.2 Model assignments (assessment tool - Control questions) to assess the development of the competency ПК-3**

22. Mathematical models of orthodontic tooth movement. Natural coordinate axes and coordinate planes.
23. Determination of stresses in tooth and periodontal tissues under various chewing and orthodontic loads acting on the tooth.
24. Determination of the periodontal stiffness of the roots of teeth and calculation of the distribution of chewing load for intact dentitions.
25. Calculation of the distribution of the chewing load for dentitions with non-repaired and eliminated prosthetics defects.
26. Calculation of chewing efficiency for intact dentitions and dentitions with defects that have not been repaired and eliminated by prosthetics.
27. Mathematical modeling of orthodontic tooth movement.
28. Determination of the center of rotation and the center of resistance of the tooth.
29. Determination of stresses in the bridge prosthesis and underlying tissues and optimization of its design.
30. Determination of stresses in the lamellar prosthesis and underlying tissues and optimization of its design.
31. Determination of stresses in the clasp prosthesis and underlying tissues and optimization of its design.
32. Determination of technological and functional stresses in the metal-ceramic crown and its optimization.
33. Analysis of stresses in the tissues surrounding dental implants under the action of various chewing loads.
34. Muscles involved in the act of chewing. Topography of the masticatory muscles and their attachment points.
35. The direction and maximum amount of effort developed by the masticatory muscles.
36. The structure of the temporomandibular joint (TMJ).
37. The lower jaw as a lever of the third kind.
38. Biomechanics of orthopedic treatment of ESRD. Types and designs of fixed and removable prostheses.

39. Supporting properties of the mucous membrane of the prosthetic bed.
40. Determination of stresses in prostheses and tissues of the prosthetic bed under the action of various chewing loads.
41. Optimization of denture designs.
42. Biomechanics of dental implants.
43. Biomechanical analysis of orthopedic treatment of congenital cleft of the hard palate.

**Assessment criteria (assessment tool — Control questions)**

Grade	Assessment criteria
outstanding	A high level of training, impeccable command of theoretical material, the student demonstrates a creative approach to solving non-standard situations. The student gave a complete and detailed answer to all the theoretical questions of the ticket, confirming the theoretical material with practical examples. The student actively worked in practical classes. 100% completion of control exam tasks.
excellent	High level of training with minor mistakes. The student gave a complete and detailed answer to all the theoretical questions of the ticket, confirms the theoretical material with practical examples. The student actively worked in practical classes. Completion of control exam tasks by 90% and above.
very good	Good preparation. The student gives an answer to all the theoretical questions of the ticket, but there are inaccuracies in the definitions of concepts, processes, etc. The student actively worked in practical classes. Completion of control exam tasks from 80 to 90%.
good	In general, good preparation with noticeable mistakes or shortcomings. The student gives a complete answer to all theoretical questions of the ticket, but there are inaccuracies in the definitions of concepts, processes, etc. Mistakes are made when answering additional and clarifying questions from the examiner. The student worked in practical classes. Completion of control exam tasks from 70 to 80%.
satisfactory	Minimum sufficient level of training. The student shows a minimum level of theoretical knowledge, makes significant mistakes, but when answering leading questions, he can orient himself correctly and give the correct answer in general terms. The student attended practical classes. Completion of control exam tasks from 50 to 70%.
unsatisfactory	The preparation is insufficient and requires additional study of the material. The student gives erroneous answers, both to the theoretical questions of the ticket, and to the leading and additional questions of the examiner. The student missed most of the practical classes. Completion of control exam tasks up to 50%.
poor	The preparation is absolutely insufficient. The student does not answer the questions posed. The student was absent from most lectures and practical classes. The completion of control exam tasks is less than 20%.

## **6. Учебно-методическое и информационное обеспечение дисциплины (модуля)**

Основная литература:

1. Анатомия, физиология и биомеханика зубочелюстной системы : учебник / Арутюнов С.Д.; Колесников Л.Л.; Дегтярёв В.П.; Лебеденко И.Ю. - Москва : ГЭОТАР-Медиа, 2021. - 336 с. - ISBN 978-5-9704-6193-8., <https://e-lib.unn.ru/MegaPro/UserEntry?Action=FindDocs&ids=807769&idb=0>.

Дополнительная литература:

1. Митрофаненко В. П. Анатомия, физиология и биомеханика зубочелюстной системы : учебное пособие / Митрофаненко В. П. - 2-е изд., испр. - Санкт-Петербург : Лань, 2016. - 304 с. - Библиогр.: доступна в карточке книги, на сайте ЭБС Лань. - Книга из коллекции Лань - Медицина. - ISBN 978-5-8114-2030-8., <https://e-lib.unn.ru/MegaPro/UserEntry?Action=FindDocs&ids=704198&idb=0>.

Программное обеспечение и Интернет-ресурсы (в соответствии с содержанием дисциплины):

ЭБС «Юрайт». Режим доступа: <http://biblio-online.ru>.

ЭБС «Консультант студента». Режим доступа: <http://www.studentlibrary.ru>.

ЭБС «Лань». Режим доступа: <http://e.lanbook.com/>.

ЭБС «Znanium.com». Режим доступа: [www.znanium.com](http://www.znanium.com).

## **7. Материально-техническое обеспечение дисциплины (модуля)**

Учебные аудитории для проведения учебных занятий, предусмотренных образовательной программой, оснащены мультимедийным оборудованием (проектор, экран), техническими средствами обучения.

Помещения для самостоятельной работы обучающихся оснащены компьютерной техникой с возможностью подключения к сети "Интернет" и обеспечены доступом в электронную информационно-образовательную среду.

Программа составлена в соответствии с требованиями ФГОС ВО по направлению подготовки/специальности 31.05.03 - Dentistry.

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