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Health Modeling — An Innovative Educational Program for the General Medicine Specialty

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Aim: to present the principles and distinctive features of the innovative educational program "Health Modeling" for the General Medicine specialty, aimed at refocusing medical training toward proactive health preservation and disease prevention.
Key points. The "Health Modeling" profile was introduced in 2023 at Sechenov University in response to the need to shift the focus of physicians' work from treating existing diseases to effectively preventing the development of pathologies. This approach aligns with the global healthcare strategy of maintaining population health and increasing the duration of healthy life. The program seeks to equip students with a comprehensive set of competencies for preserving patient and public health using the latest advances in medical science and technology. Distinctive features of the curriculum include interdisciplinary modules structured by organ systems and a spiral progression of content, early immersion of students into clinical practice from the first year, and the translation of cutting-edge scientific knowledge into education through hands-on laboratory practicums. In the senior years, the learning trajectory is individualized, and students acquire healthcare management skills through internships in federal and regional healthcare institutions. Sechenov University is the first in Russia to implement such an integrated, organ system-based curriculum within the General Medicine specialty.
Conclusion. The "Health Modeling" educational program represents a significant step forward in modernizing medical education with an emphasis on preventive care. This model prepares a new generation of physicians oriented toward health preservation at both individual and population levels and should be of interest to medical educators and administrators seeking to update training programs in line with contemporary global health challenges.
Keywords: health modeling, interdisciplinary module, problem-based learning, organ-system principle, general medicine, innovative educational program
Conflict of interest: the authors declare no conflict of interest.

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Моделирование здоровья — инновационная образовательная программа лечебного дела

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Цель: представить принципы построения и отличительные особенности инновационной образовательной программы по специальности «Лечебное дело» (профиль «Моделирование здоровья»), направленной на переориентацию подготовки врачей на проактивное сохранение здоровья и профилактику заболеваний.
Основные положения. Профиль «Моделирование здоровья» был внедрен в 2023 г. в Сеченовском Университете в ответ на необходимость сместить фокус работы врача с лечения уже имеющихся заболеваний на эффективное предотвращение развития патологических состояний у человека. Этот подход соответствует глобальной стратегии здравоохранения, направленной на поддержание здоровья населения и увеличение продолжительности жизни, свободной от хронических заболеваний. Программа призвана обеспечить студентов полным комплексом необходимых компетенций для сохранения здоровья пациентов и общества с использованием новейших достижений медицинской науки и технологий. Отличительными особенностями данной образовательной модели являются междисциплинарные модули, структурированные по органно-системному принципу с применением спирального подхода и принципов проблемно-ориентированного обучения, раннее погружение студентов в клиническую практику с первого курса, а также трансляция передовых научных знаний в учебный процесс через лабораторные практикумы. На старших курсах траектория

обучения индивидуализируется и обучающиеся приобретают управленческие компетенции в сфере здравоохранения, проходя практику в федеральных и региональных медицинских организациях. Сеченовский университет стал первым вузом в России, реализовавшим подобную интегрированную программу на основе междисциплинарных модулей.
Заключение. Образовательная программа «Моделирование здоровья» является значительным шагом вперед в модернизации медицинского образования с упором на профилактическую медицину. Данная модель позволяет подготовить новое поколение врачей, ориентированных на сохранение здоровья как отдельных пациентов, так и общества в целом, и представляет интерес для преподавателей и администрации медицинских вузов, стремящихся совершенствовать образовательные программы в соответствии с современными вызовами мирового здравоохранения.
Ключевые слова: моделирование здоровья, междисциплинарный модуль, проблемно-ориентированное обучение, органно-системный принцип, лечебное дело, инновационная образовательная программа
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Introduction

For many years, medicine focused on treating diseases, relieving symptoms, and combating existing illnesses [1]. However, in recent years a significant transformation has occurred in the paradigm of global healthcare, implying the need for maximally effective preservation of human health by preventing the development of pathological conditions. Unfortunately, in Russia patients encounter age-associated diseases such as cardiovascular pathology, diabetes mellitus, and oncological diseases at an average age of 63, much earlier than in other countries [2, 3]. This trend requires urgent measures aimed at the development of preventive personalized medicine and improvement of the healthcare system as a whole. In this regard, state programs are being actively implemented in the Russian Federation, whose strategic goals are disease prevention, promotion of healthy lifestyles, support of active longevity, and protection of public health in general[1] [4–7].

These changes in healthcare principles pose an important task for medical education — to provide the labor market with a new generation of specialists capable of effectively maintaining health at both the individual patient level and the population level. This requires a comprehensive understanding of all processes occurring in the human body at various levels, the ability to synthesize and analyze multi-format data on patients' health status, and the application of modern achievements of medical science and technology.

Sechenov University has traditionally held a leading position in implementing innovative solutions in medical education in Russia. The University's development program envisions the creation of a model of a world-class research medical university with no analogues in Russia. Successful realization of this task requires a transition to a new paradigm of medical education, based on strengthening interdisciplinary connections and fostering research thinking in students [8].

All of the above formed the basis for creating the innovative educational program for the General Medicine specialty with the "Health Modeling" profile, which was launched as a pilot project at Sechenov University.

It should be noted that within this educational program, for the first time in Russia, an integrated organ-system principle of teaching has been implemented. This approach to education focuses on the interconnection of fundamental and clinical disciplines in the study of various body systems in interdisciplinary modules and has a number of advantages compared to traditional medical education based on sequential study of separate subjects [9–12].

Below, we describe the main principles of building the innovative educational program for the General Medicine specialty in the "Health Modeling" profile.

[1] According to the Decree of the President of the Russian Federation No. 474 dated July 21, 2020, "On the national development goals of the Russian Federation for the period up to 2030", the following objectives were established: increasing life expectancy to 78 years, raising healthy life expectancy to 67 years, creating conditions to increase the proportion of citizens leading a healthy lifestyle, forming a system for motivating citizens towards a healthy lifestyle, and developing a program for systematic support of the quality of life for the elderly population.

Design of the educational program

Interdisciplinary modules

Unlike the traditional model of teaching in preclinical departments that is usually used in medical education in our country, the "Health Modeling" track is structured on an integrated modular principle. Each module is interdisciplinary, and therefore a number of the university's educational and laboratory units are involved in it. Training students using an organ-system approach entails dividing the curriculum into modules, each dedicated to a separate organ system. During the first three years of study in the "Health Modeling" track, ten organ systems are covered through modules: the hematopoietic system, the immune system, the musculoskeletal system and skin (integumentary system), the cardiovascular system, the respiratory system, the digestive system, the nervous system and sense organs, the urinary system, the endocrine system, and the reproductive system.

For successful mastery of the material on organ systems, the first semester of the first year includes two interdisciplinary modules "Fundamentals of a Systematic Approach" and "Fundamentals of Fundamental Medicine", which are necessary for students to acquire basic knowledge in a number of fundamental disciplines while mastering universal and general professional competencies. The curriculum of these first two introductory modules includes the basics of Latin, normal physiology, histology, pathological anatomy, pathophysiology, microbiology, biochemistry, pharmacology, and medical genetics.

To ensure understanding of the body's functioning as a single whole, after completing the modules on individual organ systems a final interdisciplinary module called "Integration of Systems" is provided. This module allows students to broaden their understanding of the interconnection of various body systems by studying the multi-organ and multi-system nature of damage in different diseases, as well as to deepen their insight into the problem of comorbid conditions and the influence of various exogenous and socio-psychological risk factors on the human body within the framework of the biopsychosocial model of human pathology development [13].

Within each interdisciplinary organ-system module, students study the anatomy, histology, physiology, pathophysiology, pathology, medical

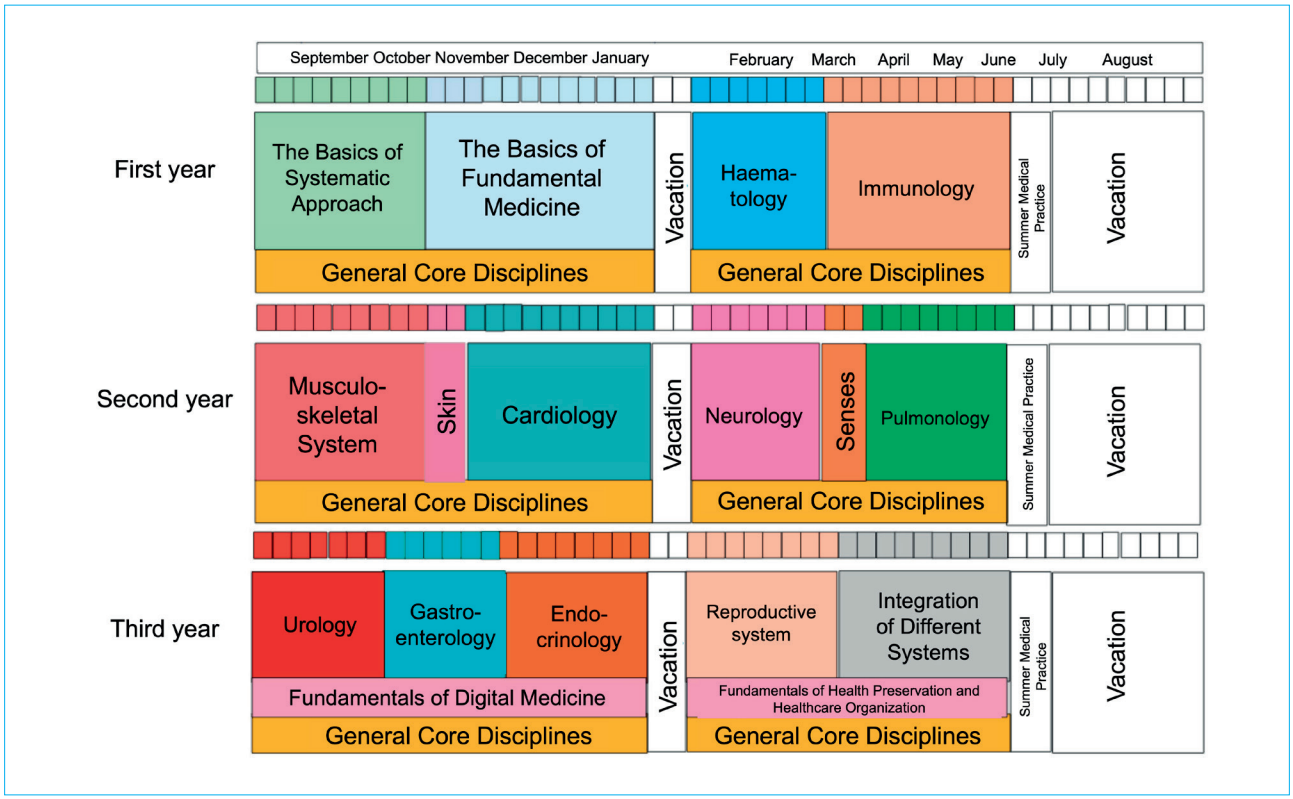

Figure 1. Scheme of the curriculum for semesters 1–6 of the innovative educational program General Medicine in the Health Modeling profile

Рисунок 1. Схема учебного плана 1–6-го семестров обучения инновационной образовательной программы лечебное дело по профилю «Моделирование здоровья»

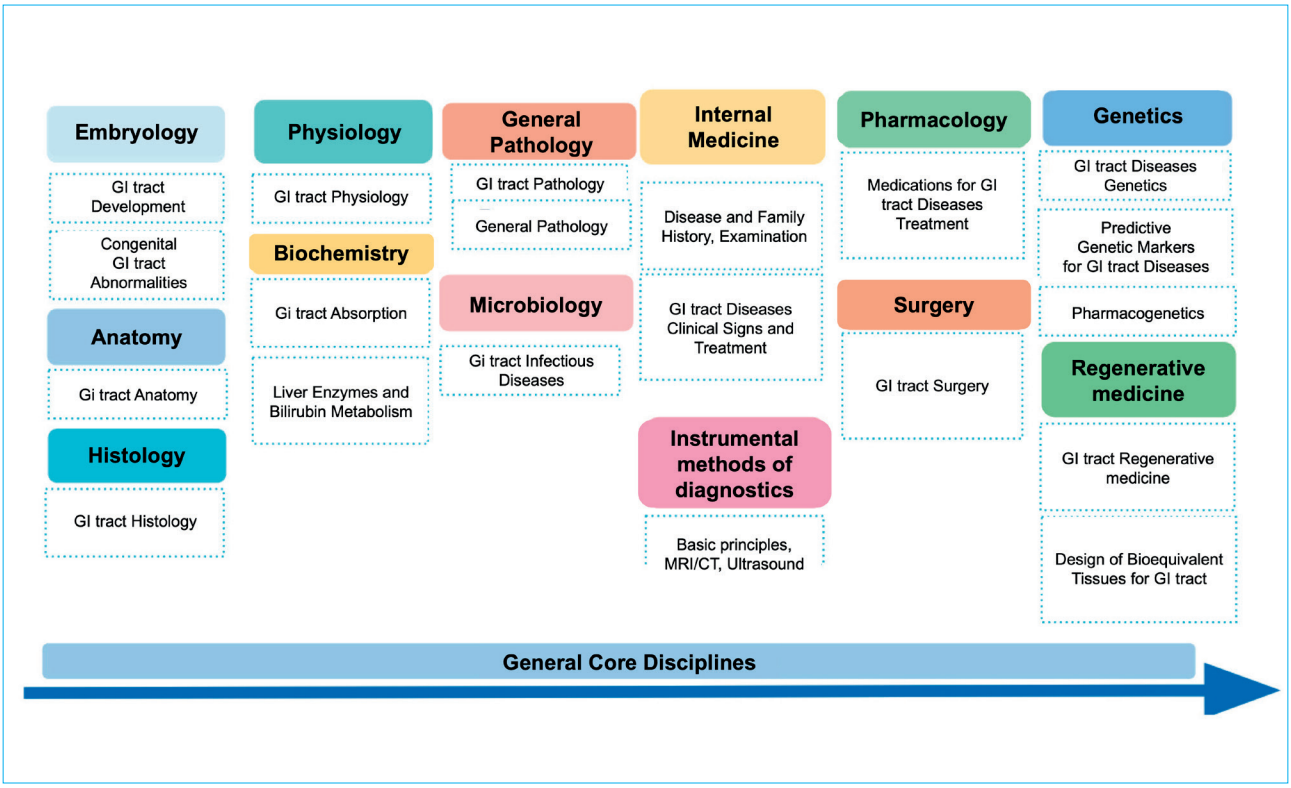

Figure 2. Example of an interdisciplinary module on the digestive system

Рисунок 2. Пример междисциплинарного модуля по пищеварительной системе

genetics, biochemistry, basics of diagnostics, and principles of treatment of the most common diseases of the given organ system. Figure 2 presents an example of the structure of an interdisciplinary module on the digestive system, which involves more than ten different subdivisions of the university.

The structure of each module provides for "horizontal" and "vertical" integration of knowledge when studying an organ system, which develops systemic and interdisciplinary thinking in students (Fig. 3). Vertical integration implies a sequential progression of the learning process from biomedical sciences to clinical sciences, while horizontal integration involves studying the organ system from normal state to pathology [14]. This approach ensures that organ systems are studied at different levels — from molecular-genetic, through embryological, to cellular, organ, and system-level understanding of material in normal and pathological states. Vertical integration strengthens the link between preclinical and clinical knowledge [14]. Training in preclinical departments becomes more focused on clinical practice, and training in clinical departments becomes more structured and relies on the fundamental clinically oriented disciplines of the module [14]. As a result, learning through interdisciplinary modules contributes to greater student engagement in the educational process.

Spiral principle of curriculum organization

The spiral principle of curriculum organization, which within the framework of vertical integration entails a gradual complication and deepening of knowledge from year to year, has deep roots in the history of medical education. This principle was consciously applied for the first time in the 19th century, when medical schools began moving from narrowly specialized training to a more comprehensive approach [15]. The spiral principle allows students to be introduced more effectively to the world of medicine, gradually revealing to them the complexity and multifaceted nature of medical science. In the modern system of medical education, the spiral principle is foundational, allowing students to consolidate and deepen their knowledge with each year of study, forming a holistic understanding of medical science and practice [16].

In the educational program of the "Health Modeling" track, the spiral principle is realized, among other ways, by revisiting clinical disciplines tied to the pathology of a specific organ system in later years of training. For example, in

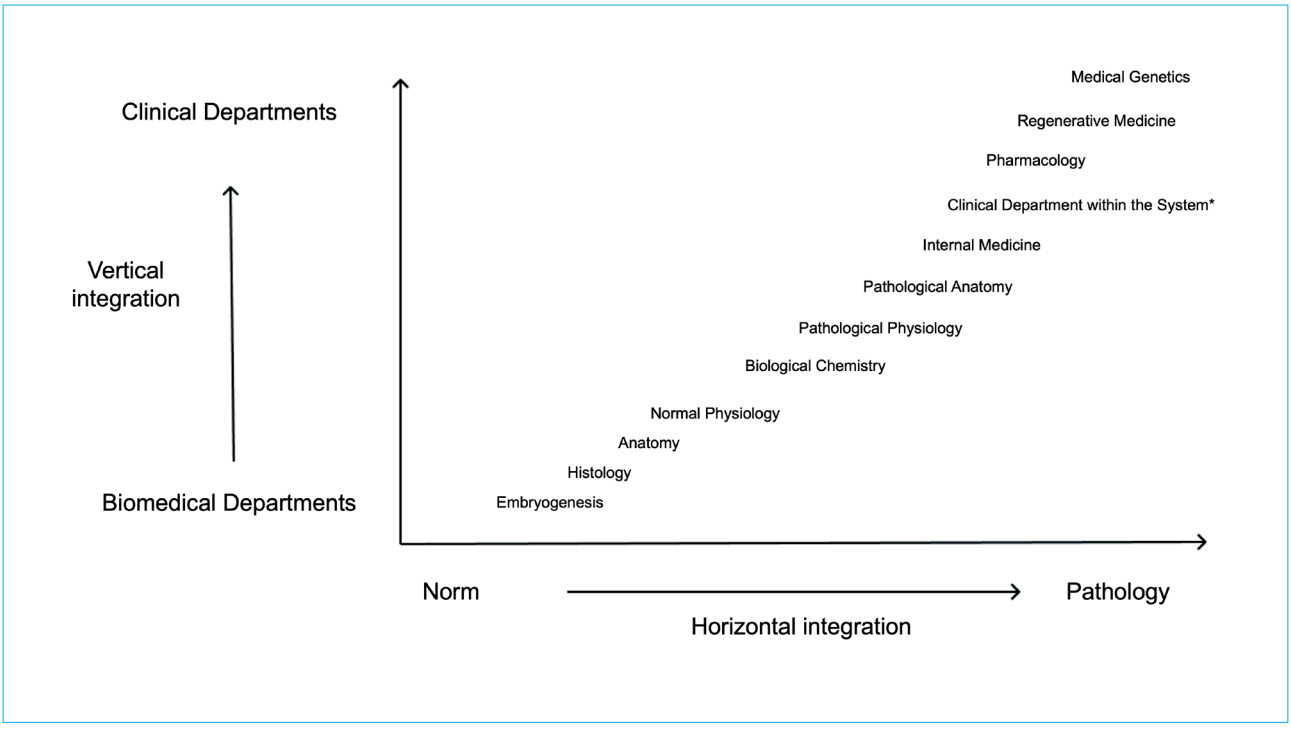

Figure 3. Vertical and horizontal integration within the organ system; * — each system corresponds to a clinical department: for example, when studying the module "Digestive system", the Department of Propaedeutics of Internal Diseases, Gastroenterology and Hepatology is integrated into the program

Рисунок 3. Вертикальная и горизонтальная интеграция в рамках системы органов; * — каждой системе соответствует клиническая кафедра: например, при изучении модуля «Пищеварительная система» в программу интегрируется кафедра пропедевтики внутренних болезней, гастроэнтерологии и гепатологии

the "Digestive System" module, which is studied by students in the early years, students learn how the gastrointestinal tract functions in normal and pathological states at various levels of its organization and operation, and also gain an initial understanding of the most common pathologies affecting the digestive system that are encountered in medical practice, becoming familiar with principles of treatment and prevention of these diseases. In the more advanced years of training, students return to the pathology of the digestive system, studying various diseases of this organ system at a deeper level within elective courses in the field of gastroenterology. Moreover, at this stage students have the option to choose an individual educational trajectory, where they can study this problem either from a therapeutic perspective ("Therapeutic Gastroenterology") or from the perspective of surgical care for this category of patients ("Surgery of Gastrointestinal Diseases"). This individualization of the educational trajectory in the senior years is based on a competency-based approach and demonstrates an increase in the competitiveness of graduates of Sechenov University's educational programs [17].

Early immersion in clinical practice

With the development of simulation equipment, the component of real interaction with patients in clinical settings is increasingly disappearing from medical education. In the "Health Modeling" program, certain elements of each interdisciplinary organ-system module take place at the university's clinical bases, which promotes the earliest possible immersion of students in clinical practice and increases students' engagement in the educational process. This experience from the very beginning of training allows students to witness the healthcare system from the inside, as well as providing a real understanding of preventive care for the population and the role of healthcare professionals in this area [6, 7, 18, 19].

Early immersion in clinical practice, beginning in the first year of study, is a crucial principle of the "Health Modeling" program. This approach allows students from the very start of training to engage with the medical environment, seeing diseases not only in theoretical models but also in the context of direct doctor-patient interaction [6, 7, 18, 19]. The content of each interdisciplinary module includes discussion of clinical cases in a

problem-based learning format, visits with patients in the clinic, and the acquisition of practical skills starting in the first year. This contributes to the development of clinical thinking, the formation of communication skills with patients and medical staff, and the early mastery of practical skills in diagnosis, treatment, and disease prevention.

Translation of cutting-edge scientific knowledge into the educational process

Each module of the track includes laboratory practicums in the innovative divisions of Sechenov University's Biomedicine Science & Technology Park, which serve as a key tool for translating cutting-edge scientific knowledge into the educational process. Students have the opportunity to participate in experiments such as skin bioprinting, decellularization of an aortic valve as part of creating valvular bioprostheses, evaluation of hemocompatibility of tissue-engineered constructs, and other promising areas of biomedical research at the Institute of Regenerative Medicine of Sechenov University. Every organ-system module includes a thematic laboratory practicum. For example, in the module "Musculoskeletal System and Skin", under the guidance of mentors, students learn how to culture human mesenchymal stem cells.

To encourage students to apply innovative health-preserving methods in their future practice, each interdisciplinary organ-system module features lectures and master classes by leading experts (opinion leaders) in the relevant clinical fields. For instance, in the "Immune System" module, the students of the "Health Modeling" track were given lectures by leading experts in molecular allergology (Professor Rudolf Valenta from the University of Vienna and by Igor Nabiev, the head of the Nanoparticle Laboratory at the University of Reims, France).

Such sessions allow students to gain hands-on experience with modern equipment and technologies, expand their knowledge of advanced approaches to the diagnosis, treatment, and prevention of diseases, and develop skills in scientific research. The approach used ensures that students acquire innovative competencies such as forecasting, prediction, prevention, health monitoring and management, and health modeling.

In-depth study of a foreign language by students of the "Health Modeling" track provides them with access to the latest scientific publications, educational materials, and medical literature, and also allows participation in international conferences, internships, and research projects. The program provides for internships at leading clinical and research centers in Russia and partner countries.

This greatly contributes to the training of highly qualified specialists who are ready to apply innovative methods and advanced technologies not only for diagnosis and treatment, but also for effective prevention of various human pathologies[2] [20, 21].

Interdisciplinary integrated examination based on solving clinical cases: A new approach to assessing students' knowledge

With the above-described curriculum structure, a logical question arises regarding the method of periodic assessment.

Although oral examinations are traditionally described in the literature as a method with certain biases in knowledge evaluation [22], some works emphasize that students devote more effort and time when preparing for oral exams than for written exams [23]. We are inclined to agree with the latter view and consider the oral part of the assessment a very important stage in monitoring students' mastery of the material [24].

Assessment for each interdisciplinary module of the program consists of two stages: a centralized test and an oral exam. The centralized test contains a set of multiple-choice questions from each department of the university involved in the module. The number of test items contributed by each department is proportional to the number of credit units of that discipline's material in the module. The oral exam requires students to answer questions in the context of solving interdisciplinary clinical cases developed specifically for this track. Each case integrates material taught by 2–3 departments of the university, whose faculty jointly compose the case scenario and corresponding questions for students. The cases represent clinical scenarios, usually supplemented by a full spectrum of laboratory and instrumental diagnostic data. A portion of the cases include images and photographs of histological slides. Thus, the problem-based learning principle is preserved even during assessment. The examination board for each module includes representatives of all university departments involved in that module. Since each case unites 2–3 departments, for the oral exam the faculty examiners are divided into groups of 2–3 people according to a pre-arranged list of exam cases. In this way, each student at the exam is presented with one case and examined by 2–3 examiners.

[2] In the context of rapid technological development, which began in the mid-20th century, educational requirements have undergone significant changes due to the growing demand for knowledge-intensive specialties. The transformation of education in the medical field is manifested by the active integration of scientific research into medical practice [21].

This approach to conducting intermediate assessments each semester in a medical university is innovative and had not been used previously at Sechenov University.

Managerial competencies in healthcare

The formation of specialists capable of solving fundamentally new tasks is possible only in an environment that fosters the development of personal and professional competencies [21]. New training programs allow students to acquire, in addition to the standard set of competencies, also research, managerial, entrepreneurial, and other skills [20]. Modern healthcare demands that medical professionals have not only deep professional knowledge, but also well-developed managerial competencies. The inclusion in the "Health Modeling" curriculum of an additional practicum "Healthcare Management" in the form of internships in departments of regional and federal healthcare authorities, as well as in large biotechnology companies (the university's industry partners), is a unique step in training a new generation of physicians. Such practice allows students to gain experience working in various healthcare management structures, become familiar with the principles of organization and management of medical care, and also evaluate the role of biotechnologies in the development of modern medicine. This contributes to the formation of managerial skills in students, such as planning, organization, coordination, analysis, and problem-solving, which will allow them to build their careers more effectively in the future and become national-level expert physicians.

Results of the student survey

When implementing any new educational program, obtaining feedback from students is an essential and important step. We conducted a survey among first- and second-year students who are studying in the "Health Modeling" program. The survey included nine questions with multiple-choice answers, and a tenth question was an open-ended item where students could enter their suggestions and comments. An anonymous survey was carried out using the Yandex Forms service, and all students gave consent to participate. Data from 21 respondents were analyzed[3]. The full text

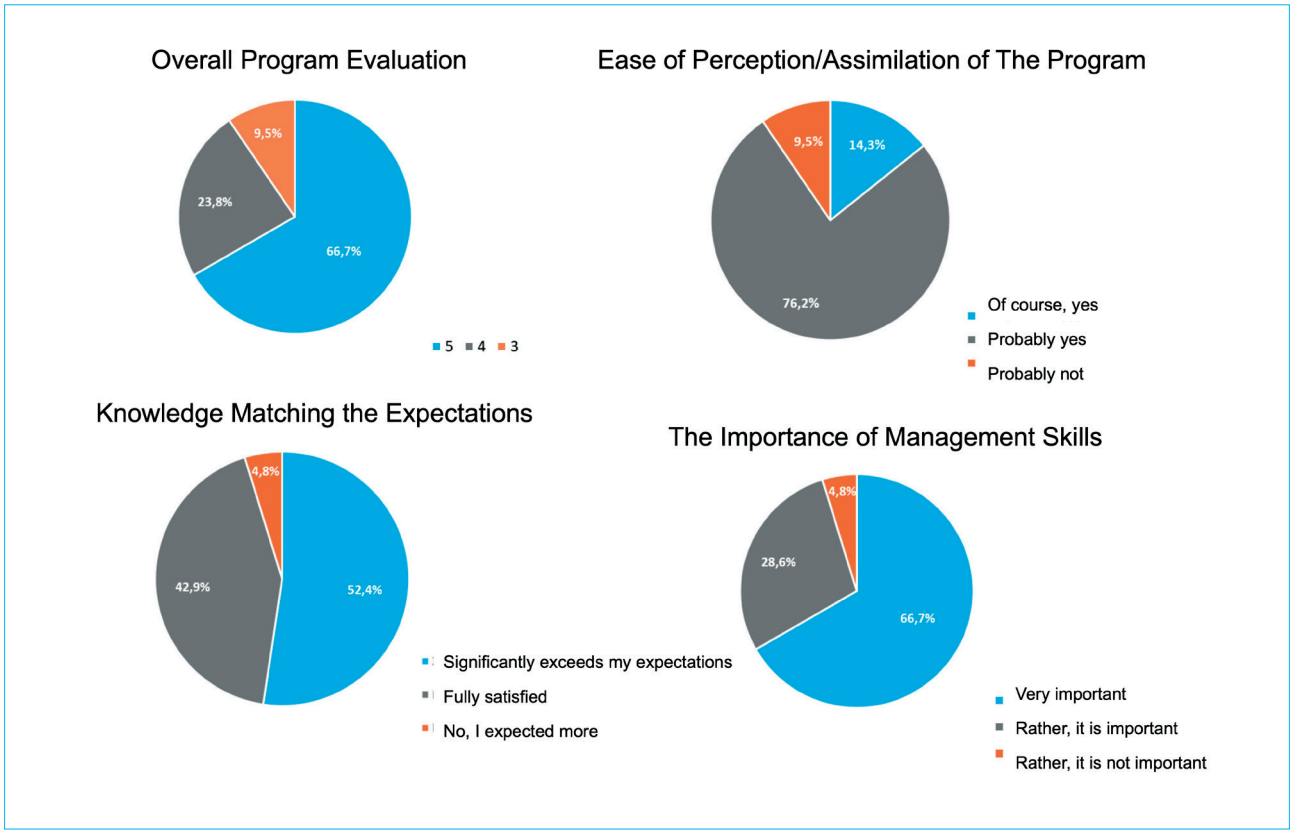

Figure 4. Summary data of the survey of students majoring in "Health Modeling"

Рисунок 4. Сводные данные анкетирования студентов профиля «Моделирование здоровья»

[3] Education under the educational program General Medicine, specializing in "Health Modeling", is conducted on a self-funded basis.

of the questions and the structure of the responses are presented in the Appendix.

According to the survey results, the majority of students reported positive impressions from training in the "Health Modeling" program, noting the high importance of acquiring managerial and digital competencies, as well as the importance of advanced study of the English language (Fig. 4).

Conclusion

The introduction of an integrative organ-system principle into Russian medical education, implemented for the first time at Sechenov University, represents a significant step forward in the training of medical personnel in Russia. This approach, which has proven itself in a number of foreign countries, differs from the traditional approach focused on the study of separate disciplines with a clear division into fundamental and clinical sciences.

The integrative approach allows the human organism to be considered as a cohesive system, taking into account the interactions of all organs and systems with each other at various levels, from the molecular-genetic to the organismal and supra-organismal. This makes it possible to train physicians capable of seeing an individual in the context of their life and overall health, considering not only physiological but also psychological, social, and environmental factors affecting their well-being.

The integrative organ-system principle is extremely promising for Russian medical education. Considering the additional innovative components introduced into the "Health Modeling" curriculum model, it allows for the training of a new generation of physicians focused on preserving the health of both individual patients and the nation as a whole, capable of preventing diseases, engaging in prevention, and promoting healthy lifestyles. This approach corresponds to modern trends in medicine aimed at preventive measures and improving the quality of life of the population.

Appendix
Survey questions and response options

1. Rate your overall impressions of training in the "Health Modeling" program on a scale from 1 to 5 (where 1 — absolutely negative impressions, and 5 — extremely positive impressions).
   (Scale of 1–5 was provided for responses.)

2. Is the content of the studied modules easy to perceive and assimilate?
   • not at all
   • rather not
   • rather yes
   • definitely yes

3. Does the volume of knowledge that you are obtaining in the "Health Modeling" program meet your expectations?
   • no, I expected more
   • fully meets my expectations
   • significantly exceeds my expectations

4. How important is the opportunity to acquire managerial competencies during the training for you?
   • not at all important
   • rather not important
   • rather important
   • very important

5. How important is early immersion in clinical practice during the training for you?
   • not at all important
   • rather not important
   • rather important
   • very important

6. How important is the presence of laboratory practicums for you?
   • not at all important
   • rather not important
   • rather important
   • very important

7. How important is acquiring digital competencies during the training (principles of working with big data, artificial intelligence, machine learning algorithms in medicine)?
   • not at all important
   • rather not important
   • rather important
   • very important

8. How important is the opportunity for in-depth study of the English language during training in the "Health Modeling" program for you?
   • not important, since I have a sufficiently good command of English
   • not important, since I do not consider strong English proficiency necessary for my future career
   • important, since I want to improve my level of medical English

9. How important is the opportunity for internships abroad as part of the training for you?
   • not at all important
   • rather not important
   • rather important
   • very important

10. Thank you for participating in the survey! If you have any suggestions or comments, please leave them in the field below. (Open-ended question for free-form feedback.)

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