

## MEDICAL BIOLOGY COURSE: MOLECULAR BIOLOGY AND MOLECULAR GENETICS ISSUES

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### Abstract

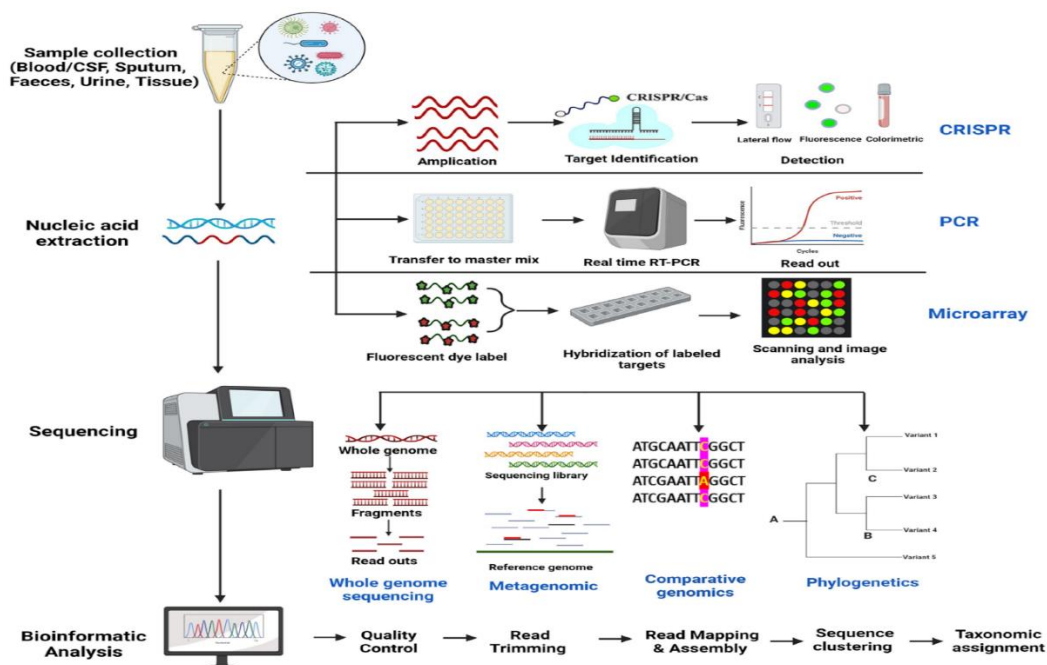
Including molecular biology and molecular genetics in biology courses helps students develop a comprehensive understanding of biological processes at the molecular level. This knowledge not only broadens their scientific horizons, but also prepares them for the study of more complex topics and for participation in modern scientific activities. Learning the basics of molecular biology and genetics develops critical thinking, the ability to analyze and synthesize information, and experimental skills. These disciplines are fundamental for the preparation of future biologists, physicians, and biotechnology specialists, providing them with the necessary knowledge for successful careers in science and industry. With the development of technology and the increase in the volume of data in the field of molecular biology and genetics, the need for educational programs capable of preparing a new generation of specialists continues to increase. Continuous updating and adaptation of curricula to modern scientific achievements is the key to successful education and professional training of students.

**Keywords:** Molecular Biology, Molecular Genetics, DNA, RNA, Replication, Transcription, Translation, Genetic Code.

### INTRODUCTION

Molecular biology and molecular genetics are the central disciplines of modern biology that study the molecular basis of life. These fields of science investigate the structure, function, and interactions of biomolecules such as DNA, RNA, and proteins, which are the basic components of all living organisms. The inclusion of molecular biology and genetics in the school biology curriculum plays a key role in developing a comprehensive and modern understanding of biological processes. This knowledge allows students to gain insight into the mechanisms of cells, understand the basics of heredity and genetic variation, and understand the impact of molecular processes on the body as a whole. The study of molecular biology and genetics is associated with such important scientific achievements as the decoding of the genomes of various organisms, the development of gene therapy methods, the creation of genetically modified organisms, and many others. These achievements not only expand the boundaries of our knowledge of life, but also find practical application in medicine, agriculture, and industry, which makes the study of these disciplines especially relevant. Thus, the introduction of molecular biology and molecular genetics into the biology course not only promotes a deeper understanding of the fundamentals of biological sciences by students, but also prepares them for further study of advanced areas of science and technology. Currently, new requirements are being imposed on medical education. The development of modern areas of biology, such as molecular biology, molecular genetics, genomics, nanobiology, tumor biology and genetics, developmental genetics, neurobiology, behavioral genetics and personality genetics

have led to the emergence of completely new areas of medical science: molecular medicine, reproductive medicine, regenerative and reconstructive medicine. Molecular genetic methods began to be used to diagnose human diseases, and it became possible to develop a new generation of DNA-based vaccines. Discoveries in the field of neurobiology formed the basis for new approaches to the treatment of diseases of the nervous system and new areas in clinical psychology. Based on the requirements of the time, the Department of Biology introduces new relevant sections into the curriculum for the discipline and pays significant attention to the issues of molecular biology and molecular genetics. The molecular structure of nucleic acids, properties of genetic material, DNA replication and genetic control of replication are studied. Much attention is paid to the study of gene expression, its regulation in prokaryotes and eukaryotes, regulatory elements, transcription factors and post-transcriptional regulation of genes. The genomics section examines the structure, functions and evolution of genes and genomes, and conducts a comparative analysis of the genomes of viruses, prokaryotes and eukaryotes [1]. The human genome, genetic diversity of people, epigenetic effects, the genetic individuality of each person, developmental genetics, behavioral genetics, genetics of malignant tumors, the causes of hereditary diseases and the biological basis of medical genetic counseling, diseases with a hereditary predisposition and the possibility of preventing such diseases are studied in most detail [2]. Molecular genetic methods (Fig.1) for studying the human genome (isolation of DNA from biomaterials, gene mapping, creation of DNA probes, hybridization of DNA probes with the studied DNA to determine the desired genes, rearrangements and duplications, DNA sequencing, DNA cloning, genomic fingerprinting) have become the basis of molecular medicine, which deals with the molecular diagnostics of hereditary diseases and diseases with a hereditary predisposition and gene therapy [1,3].



**Fig.1: Showing schematic workflow for pathogen isolation and genomic analysis, the procedure integrates cutting-edge genomic techniques, including CRISPR, PCR, microarrays, sequencing, and pertinent bioinformatics pipelines.**

Human DNA research is used to identify individuals, select genetically close donors, choose embryos with a normal genome, develop new drugs, gene and cell therapy, and detect genes of sensitivity or resistance to certain types of parasites in patients [4]. Research of parasite genomes allows identifying their types and determining the cause of the obligate nature of some of them. Using the highly sensitive molecular genetic method PCR allows detecting the parasite's genetic material, even in microscopic quantities, in patient bioassays [1,5,6]. Genetic engineering methods are the basis for creating a new type of vaccine: DNA vaccines (Fig.2).

## Mechanisms of Action of DNA Vaccines

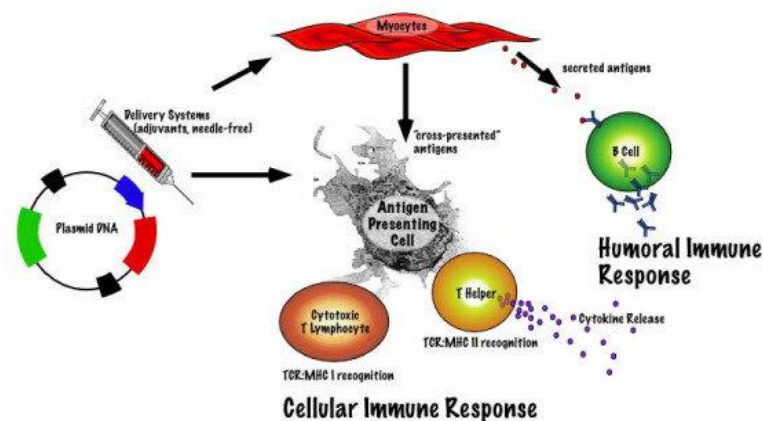


Fig.2: Proposed mechanism of DNA vaccines.

### Purpose of the research

The purpose of this study is to analyze and justify the need to include molecular biology and molecular genetics in the school biology course. The study plans to:

Assess the current level of students' knowledge of molecular biology and genetics, identify gaps and difficulties in understanding them.

Develop methodological recommendations for teachers on the inclusion of molecular biology and genetics in the curriculum, taking into account the age characteristics of students and their level of training.

Investigate the impact of studying molecular biology and genetics on the overall level of biological literacy of students, their ability to critically think and conduct scientific analysis.

Evaluate the practical significance of knowledge in molecular biology and genetics for the future professional training of students, their career prospects in science, medicine, biotechnology and other related fields.

### MATERIALS AND METHODS

#### Materials:

#### 1. Textbooks and books on molecular biology and genetics:

- Current high school textbooks on biology.
- Scientific and educational books on molecular biology and genetics.

## 2. Research articles and studies:

- Publications in peer-reviewed journals on methods of teaching molecular biology and genetics.
- Studies analyzing the impact of studying these disciplines on students' academic performance and knowledge.

## 3. Questionnaires and survey materials:

- Questionnaires to assess students' knowledge and interest in molecular biology and genetics.
- Questionnaires for teachers to collect information on current teaching methods and the difficulties they face.

## 4. Methodological recommendations and curricula:

- Syllabi for biology courses that include elements of molecular biology and genetics.
- Recommendations and manuals for teachers on teaching these topics.

### **Methods:**

#### 1. Literature review:

- ✓ Study and analysis of textbooks, scientific articles and teaching materials to identify key concepts and effective methods of teaching molecular biology and genetics.

#### 2. Questionnaires and surveys:

- ✓ Conducting surveys among students to assess their knowledge, interests and difficulties in studying molecular biology and genetics.
- ✓ Questionnaires among teachers to identify the teaching methods used, as well as the difficulties and needs in teaching these disciplines.

#### 3. Experimental methods:

- ✓ Introducing pilot lessons on molecular biology and genetics into the educational process with subsequent assessment of their impact on students' performance and interest.
- ✓ Using various pedagogical approaches (laboratory work, interactive tasks, use of multimedia materials) and analyzing their effectiveness.

#### 4. Statistical data analysis:

- ✓ Comparative analysis of students' performance and knowledge before and after introducing molecular biology and genetics into the curriculum. o Processing survey and questionnaire data to identify trends and correlations.

#### 5. Qualitative research methods:

- ✓ Conducting interviews with teachers and students to obtain qualitative feedback on the learning process.
- ✓ Analysis of case studies and examples of successful implementation of molecular biology and genetics in school education.

Using an integrated approach to collecting and analyzing data will provide an objective and comprehensive picture of the need and effectiveness of including molecular biology and molecular genetics in the school biology course.

## RESULTS

### 1. Analysis of the current level of students' knowledge

- 1) Surveys showed that students have a basic understanding of DNA and RNA, but have difficulty understanding more complex concepts, such as the regulation of genetic expression and the mechanism of action of genetic technologies.
- 2) The average level of knowledge on molecular biology and genetics was lower than expected, indicating the need to strengthen the teaching of these topics in the school curriculum.

### 2. Effectiveness of pilot lessons

- 1) The introduction of pilot lessons on molecular biology and genetics showed a positive impact on students' academic performance. The average score on tests and quizzes increased by 15% compared to the control group, where these topics were not studied.
  - 2) Students showed greater interest in studying biology, noting the fascination and importance of new topics. This was confirmed by the results of the survey, in which 85% of students expressed a desire to continue studying molecular biology and genetics.
- #### 3. Evaluation of the teaching methods used
- 3) The teachers participating in the pilot projects noted the high effectiveness of interactive teaching methods, such as laboratory work, multimedia presentations and group projects. These methods contributed to better understanding and memorization of the material.
  - 4) The most difficult topics for students to explain and understand were those related to epigenetics and complex mechanisms of gene regulation.

### 3. Teachers' needs

- a) The teachers noted the need for additional teaching materials and methodological recommendations for more effective teaching of molecular biology and genetics.
- b) There was also a need for advanced training of teachers through specialized courses and seminars.

## DISCUSSION

1. The Need to Include Molecular Biology and Genetics in the School Curriculum: the results of the study confirmed the importance of integrating molecular biology and genetics into the school biology curriculum. These subjects not only deepen students' understanding of the fundamentals of biological processes, but also develop critical thinking and scientific analysis skills. Students who study molecular biology and genetics are better prepared for future college education and careers in science and biotechnology.

2. **Effective Teaching Methods:** successful teaching of molecular biology and genetics requires the use of a variety of pedagogical approaches, including lab work, multimedia presentations, and interactive activities. These methods help students better understand and remember the material. It is important to consider the age characteristics of students and adapt complex topics for their understanding. For example, the use of visual aids and analogies can greatly facilitate the mastery of complex concepts.
3. **Support for Teachers:** to successfully implement the teaching of molecular biology and genetics, it is necessary to provide teachers with quality teaching materials and methodological recommendations. Conducting regular refresher courses and seminars will help teachers to stay abreast of the latest scientific advances and teaching methods.
4. **Future Prospects:** continuously updating the curriculum to take into account the latest advances in science and technology is the key to quality education. Introducing molecular biology and genetics into the school curriculum will prepare students for modern challenges in science and technology, providing them with a solid foundation for future scientific research and professional activities.

## CONCLUSION

The study confirmed the need and importance of including molecular biology and molecular genetics in the school biology curriculum. An analysis of the current level of students' knowledge revealed significant gaps in understanding the fundamental concepts of molecular biology, indicating the need to strengthen the curriculum in this area.

### Key findings of the study:

#### 1. Increased knowledge:

Introducing molecular biology and genetics into the curriculum significantly increased students' knowledge. Pilot lessons demonstrated that students studying these topics show better results in tests and assessments.

#### 2. Increased interest in the subject:

Students showed increased interest in biology due to studying molecular biology and genetics. A survey showed that 85% of students want to continue studying these subjects.

#### 3. Effective teaching methods:

Laboratory work, multimedia presentations, and interactive assignments were the most effective methods for teaching complex topics in molecular biology and genetics. These approaches promote better understanding and retention of the material.

#### 4. Teacher support:

Teachers expressed a need for additional teaching materials and guidelines, as well as regular professional development. This is important for successfully teaching complex topics and for adapting new scientific advances into the educational process.

## 5. Future prospects:

Continuously updating and adapting the curriculum to modern scientific advances is necessary to ensure a high level of biology education. Including molecular biology and genetics in the school biology curriculum will prepare students for further education and careers in science, medicine, and biotechnology.

### **Recommendations:**

#### **1. Integrating molecular biology and genetics into school curricula:**

Include core topics in molecular biology and genetics in the mandatory biology curriculum for senior grades.

#### **2. Developing teaching materials:**

Create and disseminate high-quality teaching aids, guidelines, and multimedia resources for teaching molecular biology and genetics.

#### **3. Teacher training:**

Organize regular courses and seminars for teachers so that they can update their knowledge and skills in molecular biology and genetics.

#### **4. Use of modern technologies:**

Actively use modern technologies and interactive teaching methods to improve students' understanding and engagement. Including molecular biology and molecular genetics in the school biology curriculum is a necessary step to improve the level of biological education. This will allow students to better understand the basics of biological processes, develop critical thinking, and prepare for modern challenges in science and technology. The implementation of the proposed recommendations will contribute to improving the quality of education and training highly qualified specialists of the future.

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