SCI-CONF.COM.UA

SCIENTIFIC RESEARCH: MODERN CHALLENGES AND FUTURE PROSPECTS

PROCEEDINGS OF VI INTERNATIONAL SCIENTIFIC AND PRACTICAL CONFERENCE JANUARY 20-22, 2025

MUNICH 2025

SCIENTIFIC RESEARCH: MODERN CHALLENGES AND FUTURE PROSPECTS

Proceedings of VI International Scientific and Practical Conference

Munich, Germany

20-22 January 2025

Munich, Germany

2025

UDC 001.1

The 6th International scientific and practical conference "Scientific research: modern challenges and future prospects" (January 20-22, 2025) MDPC Publishing, Munich, Germany. 2025. 608 p.

ISBN 978-3-954753-06-2

The recommended citation for this publication is:
Ivanov I. Analysis of the phaunistic composition of Ukraine // Scientific research: modern challenges and future prospects. Proceedings of the 6th International scientific and practical conference. MDPC Publishing. Munich, Germany. 2025. Pp. 21-27. URL: https://sci-conf.com.ua/vi-mizhnarodna-naukovo-praktichna-konferentsiya-scientific-research-modern-challenges-and-future-prospects-20-22-01-2025-myunhen-nimechchina-arhiv/.

Editor
Komarytskyy M.L.
Ph.D. in Economics, Associate Professor

Collection of scientific articles published is the scientific and practical publication, which contains scientific articles of students, graduate students, Candidates and Doctors of Sciences, research workers and practitioners from Europe, Ukraine and from neighbouring countries and beyond. The articles contain the study, reflecting the processes and changes in the structure of modern science. The collection of scientific articles is for students, postgraduate students, doctoral candidates, teachers, researchers, practitioners and people interested in the trends of modern science development.

e-mail: munich@sci-conf.com.ua

homepage: *https://sci-conf.com.ua*

DNA: DISCOVERY OF STRUCTURE, FUNCTION AND ITS ROLE IN THE PRESERVATION OF GENETIC INFORMATION

Slipchuk Valentyna
Doctor of Sciences in Pedagogy, Professor,
Professor of the Department of Medical Biochemistry
and Molecular Biology
Cherednyk Oleksandra
Student of medical faculty № 1,
specialty 222 “Medicine”,
Bogomolets National Medical University,
Kyiv, Ukraine

Introductions. The discovery of the DNA double helix by James Watson and Francis Crick was a real breakthrough that changed the way humanity understood heredity and life in general. The structure of DNA not only revealed the mechanisms of genetic information transmission, but also made it possible to understand how nature works at the deepest level [1].

DNA research is of great practical importance. Today, for example, thanks to technologies such as CRISPR-Cas9, we can change the genetic code, opening up new opportunities for treating diseases and creating organisms with specified properties. Genetics is becoming the basis for many industries, helping to solve the most pressing problems of humanity [2, 6].

DNA research is constantly moving medical science forward, opening up new opportunities.

Aim: to study the stages of discovery of the DNA double helix structure, functions and its role in the preservation of genetic information**.**

Materials and methods. This study uses two theoretical methods: descriptive and historical. The descriptive method allows us to outline the main characteristics of DNA. The historical method is used to trace the stages of DNA structure discovery and to explore the origins of their implementation in medicine. In addition, this method allows us to determine how CRISPR-Cas9 has transformed approaches to genetic research, which has influenced the transformation of the possibility of

therapeutic use in medicine to correct hereditary diseases. The integration of both methods provides a holistic approach to analyzing sources on the selected topic.

Results and discussion. The discovery of the DNA structure in 1953 was one of the greatest achievements of the twentieth century. James Watson and Francis Crick introduced the double helix model, which explained how genetic information is stored and transmitted. Their breakthrough was made possible by scientific knowledge, mathematical calculations, and especially by the X-ray diffraction data obtained by Rosalind Franklin, although her contribution remained in the shadows for a long time. Her “Photograph 51” played a key role in the discovery of the DNA structure, which became the basis for building the model. Today, the scientific community honors her achievements, recognizing their critical importance. This model showed that DNA consists of two chains connected by hydrogen bonds between nitrogenous bases (adenine, thymine, guanine, and cytosine), which form a stable structure [7, 8].

Creating the double helix model was an extremely creative process. Watson and Crick used cardboard models to visualize the molecule. The advice of American scientist Jerry Donoghue helped them to correctly determine the spatial arrangement of the atoms. This allowed them to discover that the nitrogenous bases are perfectly complementary. This approach not only confirmed the Chargeff rule but also became the basis for explaining DNA replication [4].

Knowledge about the structure of DNA gave rise to innovations. Jennifer Doudna and her colleagues built on these discoveries to develop CRISPR-Cas9 technology, a tool that uses complementarity mechanisms to edit the genome. The system, based on the adaptive immunity of bacteria, allows for precise genetic changes through the use of RNA instructions. What is particularly interesting is that CRISPR-Cas9 can be reprogrammed for any DNA site, which greatly simplifies research in medicine and biotechnology. The possibilities of therapeutic use for the correction of hereditary diseases are also being explored [3, 4].

CRISPR-Cas9 has not only transformed approaches to genetic research, but has also sparked ethical debates. According to Doudna, this technology raises important

questions for society: whether it is appropriate to use it for human enhancement and how to avoid potential social inequality due to genetic modifications [4].

A double helix consists of two antiparallel polynucleotide chains, each of which is made up of nucleotides [5].

Nucleotides consist of three main components: deoxyribose, a phosphate group, and a nitrogenous base (adenine, guanine, cytosine, thymine).

Nitrogenous bases are connected by hydrogen bonds according to the principle of complementarity - adenine with thymine (two hydrogen bonds), guanine with cytosine (three hydrogen bonds). This principle ensures structural stability and replication accuracy [5].

DNA performs several basic functions:

1. *Preservation of genetic information.* The sequence of nucleotides in DNA acts as a code containing instructions for all biological processes. This information is written in genes and is extremely stable due to the double helix structure and precise mutation protection mechanisms, in particular through the CRISPR system, which allows bacteria to protect themselves from viruses and modify their own genome in response to threats.

2. *Transmission of hereditary information.* DNA replication allows you to copy genetic information, ensuring its accurate transfer from one cell to another during division, as well as from parents to offspring. Thanks to the mechanisms of nitrogen base complementarity, this transfer occurs with high accuracy. CRISPR-Cas9, described by Jennifer Dowdna and Emmanuelle Charpentier, is an example of a technology that allows targeted DNA editing, creating opportunities for correcting genetic defects.

3. *Coding of proteins.* Through transcription and translation, DNA converts the genetic code into mRNA, which further controls the synthesis of proteins. This process ensures the functioning of cells and organisms. Tools such as CRISPR already allow not only to study these mechanisms but also to modify them to create new therapies and biotechnologies.

DNA provides long-term information storage due to its chemical stability and

repair mechanisms that correct damage or errors. The principle of complementarity allows the DNA molecule to be precisely copied, which reduces the risk of mutations and ensures the stability of hereditary information [5].

Modern technologies, such as CRISPR-Cas9, are a vivid example of the practical application of knowledge about the structure and function of DNA. CRISPR uses the principle of complementarity to precisely edit genetic material. This technology has opened up new opportunities in the treatment of genetic diseases [9].

Thanks to genome sequencing, it is possible to study the genetic nature of organisms, identifying rare mutations that cause diseases.

CRISPR-Cas9 technology allows not only to edit genes, but also to introduce "genetic scissors" that can treat genetic diseases, such as sickle cell anemia [4].

In medicine, DNA is the basis of personalized therapy: by analyzing DNA, it is possible to predict the risks of cancer or heart disease and choose the optimal treatment.

Conclusions. The study of DNA, its structure and functions is the foundation of modern medical science, providing insight into the mechanisms of heredity, genome stability and evolution. The study of DNA has led to innovations such as CRISPR-Cas9, which allows for precise genome editing, opening up opportunities for disease treatment and personalized medicine. The application of this knowledge is transforming medicine, although ethical challenges are being raised about its use. The study of DNA remains a key factor for the development of medical science and the improvement of human life.

REFERENCES

1. Watson, J., Crick, F. Molecular Structure of Nucleic Acids: A Structure for Deoxyribose Nucleic Acid. *Nature* 171, 737–738 (1953). https://doi.org/10.1038/171737a0

2. Martin Jinek *et al.*. A Programmable Dual-RNA–Guided DNA Endonuclease in Adaptive Bacterial Immunity. *Science* 337, 816-821 (2012). https://doi.org/10.1126/science.1225829

3. Sabin Russell. Cracking the Code: Jennifer Doudna and Her Amazing

Molecular Scissors. *California*. December 8, 2014. https://alumni.berkeley.edu/california-magazine/winter-2014-gender-assumptions/cracking-code-jennifer-doudna-and-her-amazing#

4. Robert Sanders. UC Berkeley's Jennifer Doudna wins 2020 Nobel Prize in Chemistry. *Berkeley News*. 7 жовтня 2020. https://web.archive.org/web/20201007145404/https://news.berkeley.edu/2020/10/07/jennifer-doudna-wins-2020-nobel-prize-in-chemistry/

5. Lodish, H., Berk, A., Matsudaira, P. *et al*. Molecular Cell Biology, Fifth Edition. (August 1, 2003). Publisher: W. H. Freeman. 973 pages. https://www.mustafaaltinisik.org.uk/s-molecularcellbiology.pdf

6. Jennifer A. Doudna, Emmanuelle Charpentier. The new frontier of genome engineering with CRISPR-Cas9. *Science*, 346, 1258096 (2014). DOI:10.1126/science.1258096

7. Pray, L. (2008). Discovery of DNA structure and function: Watson and Crick. *Nature Education*,1(1):100. https://www.nature.com/scitable/topicpage/discovery-of-dna-structure-and-function-watson-397/

8. Photo 51. From Wikipedia, the free encyclopedia. https://uk.wikipedia.org/wiki/%D0%A4%D0%BE%D1%82%D0%BE%D0%B3%D1%80%D0%B0%D1%84%D1%96%D1%8F_51

9. Walter Isaacson. The Code Breaker: Jennifer Doudna, Gene Editing, and the Future of the Human. *Book*. March 9, 2021. https://www.amazon.com/Code-Breaker-Jennifer-Doudna-Editing/dp/1982115858?asin=1982115858&revisionId=&format=4&depth=1