УДК 61:620.3

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ПРИМЕНЕНИЕ НАНОТЕХНОЛОГИЙ В СОВРЕМЕННОЙ МЕДИЦИНЕ

Аннотация. *Нанотехнологии являются одним из наиболее перспективных междисциплинарных направлений современной медицины благодаря возможности управлять материалами и биологическими структурами на наноуровне. В статье рассмотрены основные направления применения нанотехнологий в современной медицине, включая системы доставки лекарственных средств, онкологию, диагностику, медицинскую визуализацию, регенеративную медицину и противомикробную терапию. Обзор основан на анализе современной научной литературы и авторитетных нормативных источников. К потенциальным преимуществам относятся контролируемое*

высвобождение лекарственных веществ, повышение биодоступности, более высокая эффективность адресного воздействия и снижение системных побочных эффектов. Вместе с тем сохраняются существенные проблемы: токсичность наноматериалов, долгосрочная биосовместимость, воспроизводимость, масштабирование производства, нормативное регулирование и экономическая доступность.

Ключевые слова: *нанотехнологии, наномедицина, наночастицы, доставка лекарственных средств, онкология, диагностика, таргетная терапия.*

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APPLICATION OF NANOTECHNOLOGY IN MODERN MEDICINE

Abstract. *Nanotechnology has become one of the most promising interdisciplinary areas of modern medicine due to its ability to manipulate materials and biological structures at the nanoscale. This article reviews the major applications of nanotechnology in contemporary medicine, including drug delivery, oncology, diagnostic systems, medical imaging, regenerative medicine and antimicrobial applications. The review is based on an analysis of recent scientific literature and authoritative regulatory sources. The potential advantages include controlled drug release, improved bioavailability, increased targeting efficiency and reduction of systemic adverse effects. At the same time, important challenges remain, including toxicity, long-term biocompatibility, reproducibility, scalability, regulatory requirements and economic accessibility.*

Keywords: *nanotechnology, nanomedicine, nanoparticles, drug delivery, cancer therapy, medical diagnostics, targeted therapy.*

Introduction

The rapid development of science and technology has significantly changed the possibilities of modern medicine. One of the most important technological advances of recent decades is nanotechnology. Nanotechnology deals with the design, production and application of materials and structures at the nanoscale. At this scale, materials can demonstrate physicochemical, optical, electrical, magnetic and biological properties that differ from their conventional forms.

Medicine represents one of the most important areas for the practical application of nanotechnology. The development of nanomedicine has provided opportunities for creating innovative drug delivery systems, highly sensitive diagnostic platforms, advanced imaging agents and new therapeutic approaches.

Nanotechnology is particularly important because many conventional medical technologies have limitations. For example, traditional drug administration may result in insufficient drug concentration at the target site, systemic toxicity, rapid elimination or undesirable adverse effects.

Nanotechnology-based delivery systems can potentially address some of these limitations by improving drug solubility, stability, bioavailability and distribution.

Materials and Methods

This article is based on a scientific literature review and analytical approach. Scientific publications concerning nanomedicine, nanoparticles, targeted drug delivery, cancer therapy, medical diagnostics, imaging and regenerative medicine were analyzed. Recent scientific publications from international biomedical databases and authoritative regulatory sources were considered. Particular attention was given to publications from 2024–2025 describing recent advances in nanomedicine and its clinical translation.

The analysis included the following major areas:

- nanotechnology-based drug delivery;
- cancer diagnosis and treatment;
- medical imaging;
- biosensors and early diagnosis;
- regenerative medicine and tissue engineering;
- antimicrobial applications;
- safety and regulatory challenges.

Results and Discussion

One of the most developed applications of nanotechnology in medicine is targeted drug delivery. Traditional drug administration distributes pharmaceutical substances throughout the body. As a result, the therapeutic concentration of a drug may not be sufficiently high at the site of disease, while healthy tissues may simultaneously be exposed to the drug.

Nanocarriers provide an alternative strategy. Drugs can be incorporated into or attached to nanoscale delivery systems and transported through biological environments.

Conclusion

Nanotechnology has become an important component of modern biomedical science. Its ability to manipulate materials at the nanoscale provides new opportunities for drug delivery, diagnosis, medical imaging, oncology, regenerative medicine and antimicrobial applications. Nanoparticle-based drug delivery systems can improve the physicochemical properties of therapeutic agents and provide controlled or targeted delivery. In oncology, nanotechnology offers opportunities for combining diagnosis and treatment and for developing more precise therapeutic strategies. At the same time, nanomedicine faces significant challenges related to toxicity, biocompatibility, standardization, manufacturing, cost and regulatory approval. Therefore, the successful implementation of nanotechnologies in clinical practice requires comprehensive evaluation of their safety and effectiveness.

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