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Research Article

PERSONALIZED NANOMEDICINE APPROACHES ENABLED BY BIOINFORMATICS AND MACHINE LEARNING

Zhang Li[1], Chen Mei[2], and Wang Jing[3]
[1] Peking University, China
[2] Zhejiang University, China
[3] Nanjing University, China

Corresponding Author:

Zhang Li,
Department of Design, Faculty of Life Scienc, Peking University.
30 Shuangqing Rd, 蓝旗营 Haidian District, Beijing, Tiongkok, 100190
Email: zhangli@gmail.com

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Abstract

Personalized nanomedicine has emerged as a promising approach to tailor treatments to individual patients, enhancing therapeutic efficacy while minimizing side effects. The integration of bioinformatics and machine learning (ML) has the potential to revolutionize this field by enabling more precise and efficient drug delivery systems, biomarker identification, and therapeutic strategies. However, the full potential of these technologies in personalized nanomedicine remains underexplored. This study aims to explore how bioinformatics and machine learning can enable personalized nanomedicine approaches, particularly in the areas of drug delivery optimization, patient-specific treatment planning, and biomarker discovery. The research investigates the application of these technologies in identifying individualized treatment strategies and improving patient outcomes. A systematic review of the current literature on bioinformatics, machine learning, and personalized nanomedicine was conducted. Case studies and experimental research using these technologies were analyzed to identify trends, applications, and challenges. Machine learning models were applied to bioinformatics datasets to predict drug responses and optimize nanomedicine formulations. The study found that bioinformatics and ML significantly enhance the accuracy of drug efficacy predictions, biomarker identification, and the design of personalized nanomedicine treatments. Furthermore, these technologies have improved patient-specific therapy optimization in clinical trials. The combination of bioinformatics and machine learning holds great promise for advancing personalized nanomedicine, offering tailored therapeutic solutions that improve patient outcomes and treatment efficiency.

Keywords: Bioinformatics, Biomarker Discovery, Drug Delivery, Machine Learning, Personalized Nanomedicine

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INTRODUCTION

Personalized nanomedicine is a rapidly evolving field that holds immense promise in revolutionizing the way we approach healthcare and treatment (Abolhassani et al., 2024). By utilizing nanotechnology, personalized medicine seeks to tailor therapies to individual patients based on their genetic makeup, lifestyle, and other unique biological characteristics. The integration of nanoparticles with therapeutic agents allows for more efficient drug delivery systems that target specific tissues or cells, minimizing side effects and enhancing therapeutic outcomes (Ahmad & Muhmood, 2024). Nanomedicine has already demonstrated considerable potential in treating a wide range of diseases, including cancer, cardiovascular diseases, and neurodegenerative disorders. However, the complexity of biological systems and the diversity in patient responses to treatment create significant challenges in optimizing these therapies on an individual basis (Aja et al., 2025). To address these challenges, the convergence of bioinformatics and machine learning (ML) offers a transformative approach to personalize and optimize nanomedicine, making it more precise and effective.

The primary issue addressed by this study is the challenge of developing personalized nanomedicine strategies that are both effective and efficient, particularly given the complexity of human biology and disease mechanisms (Albaradei, 2025). Despite the growing potential of nanomedicine, achieving true personalization in treatment is hindered by several factors, including the variability in how individuals respond to therapies, the vast amounts of complex data generated in clinical settings, and the limitations of current treatment designs (Ambreen et al., 2025). Traditional approaches to nanomedicine focus largely on general populations, and while these treatments may work for many, they are not optimized for every patient. Personalized approaches, which take into account individual genetic information, environmental factors, and disease characteristics, could vastly improve the precision of nanomedicine (Azmal et al., 2025). However, the challenge lies in the ability to accurately integrate this complex data and design therapies that are tailored to each patient's unique biological profile.

The objective of this research is to explore the role of bioinformatics and machine learning in advancing personalized nanomedicine approaches (Chatterjee et al., 2025). This study aims to investigate how these technologies can be utilized to enhance the development and application of personalized treatments, specifically in optimizing drug delivery systems, identifying relevant biomarkers, and tailoring therapeutic strategies for individual patients (Dalbanjan et al., 2025). By analyzing the current state of the field and integrating the most recent advancements in bioinformatics and ML, this study seeks to establish how these technologies can facilitate the transition from general treatments to highly individualized approaches in nanomedicine (Dar et al., 2025). The research also aims to identify key areas where bioinformatics and ML can improve current practices, from early diagnosis and patient profiling to treatment planning and monitoring.

A gap in the current literature exists in the integration of bioinformatics and machine learning with personalized nanomedicine (Esmaeilpour et al., 2026). While substantial research has been conducted on nanomedicine and its applications, much of the existing work focuses on the development of novel nanomaterials and drug delivery mechanisms rather than on personalizing treatments based on patient-specific data (Gholap & Omri, 2025). Furthermore, while bioinformatics has been used extensively in genomics and disease research, its integration with nanomedicine remains limited (Gholap et al., 2024). Similarly, machine learning holds significant promise for analyzing complex datasets in medicine but has not yet been fully leveraged to optimize personalized treatments in nanomedicine (Khorsandi et al., 2025). Current studies often do not address how bioinformatics and ML can be integrated with nanomedicine to provide a truly personalized treatment plan that is informed by individual patient data (Gupta et al., 2025). This research fills these gaps by providing an in-depth

exploration of the synergies between bioinformatics, machine learning, and nanomedicine in creating more effective, personalized healthcare solutions.

The novelty of this research lies in its approach to bridging bioinformatics, machine learning, and nanomedicine in a comprehensive framework (Habeeb et al., 2024). While there has been growing interest in personalized medicine and nanotechnology separately, few studies have focused on the integration of these three fields (Hafeez & Maryam, 2026). This study provides a new perspective by exploring how machine learning models can be applied to bioinformatics data, such as genetic, proteomic, and metabolic information, to inform the design of personalized nanomedicine therapies (Khan et al., 2024). The research also introduces innovative methodologies for using ML algorithms to predict the efficacy of nanomedicine-based treatments based on patient-specific characteristics (Jin et al., 2026). This contribution is particularly significant as it paves the way for developing nanomedicine therapies that are not only more precise but also more adaptive to individual variations in disease progression and treatment responses.

This research is highly relevant to the field of biomedical sciences, particularly for advancing personalized medicine and improving patient outcomes (Karthikeyan et al., 2025). By incorporating bioinformatics and machine learning into the design and application of nanomedicine, this study will provide essential insights into how these technologies can be used to optimize drug delivery systems, improve biomarker discovery, and facilitate personalized treatment plans for patients (Kaushik, 2026). The integration of these approaches is expected to not only enhance the efficacy of treatments but also reduce adverse effects and improve overall patient well-being. As personalized medicine becomes increasingly important in modern healthcare, this research provides a crucial step towards ensuring that nanomedicine can be effectively tailored to meet the unique needs of each patient (Kawuribi et al., 2025). Furthermore, it has the potential to influence future research, clinical practices, and policy development, fostering a more data-driven and individualized approach to patient care.

RESEARCH METHOD

Research Design

This study employs a mixed-methods research design, combining qualitative and quantitative approaches to explore how bioinformatics and machine learning can enhance personalized nanomedicine. A systematic review of existing literature forms the qualitative aspect of the research, analyzing current methodologies, technologies, and challenges in the field of personalized nanomedicine (Le et al., 2025). The quantitative part of the study involves the application of machine learning algorithms to bioinformatics datasets, with the goal of predicting treatment outcomes and optimizing drug delivery systems for individualized patient care. Both approaches work in tandem to provide a comprehensive understanding of the integration of bioinformatics, machine learning, and nanomedicine.

Research Target/Subject

The population for this study consists of published studies, clinical trials, and experimental data related to bioinformatics, machine learning, and nanomedicine. These sources include data from both human and animal studies where bioinformatics tools and machine learning algorithms have been applied to develop or optimize nanomedicine treatments (Li et al., 2026). The sample for the study includes a range of clinical case studies, experimental studies, and datasets from public databases, with a focus on patient-specific treatment approaches, biomarker identification, and drug delivery optimization. Studies included in the sample must meet certain inclusion criteria: they should focus on nanomedicine applications, involve the use of bioinformatics or machine learning, and be published within the last ten years to ensure relevance and up-to-date findings.

Research Procedure

The procedures for this research began with an extensive literature search in academic databases such as PubMed, Scopus, and IEEE Xplore, using keywords related to bioinformatics, machine learning, and personalized nanomedicine. After screening for relevant studies based on predefined inclusion and exclusion criteria, data extraction was conducted for each selected study. Bioinformatics data, including patient genomic profiles, proteomic datasets, and clinical trial results, were processed using the aforementioned software tools. Simultaneously, machine learning models were trained on these datasets to predict the outcomes of personalized nanomedicine treatments (Liu et al., 2025). The models were then validated using cross-validation techniques to assess their accuracy and predictive power. The results were synthesized, analyzed, and compared to draw insights into the effectiveness of integrating bioinformatics and machine learning in the development of personalized nanomedicine approaches.

Instruments, and Data Collection Techniques

Instruments used in this study include bioinformatics tools and machine learning models designed for the analysis of genomic, proteomic, and clinical data. Bioinformatics software such as GeneSpring, DAVID, and Ingenuity Pathway Analysis were utilized to process genomic and proteomic data. Machine learning algorithms, such as support vector machines (SVM), random forests, and neural networks, were employed to analyze patient-specific datasets and predict treatment efficacy for personalized nanomedicine applications (Mishra et al., 2025). A data extraction form was developed to gather relevant information from each selected study, including patient characteristics, bioinformatics methods used, nanomedicine types, and outcomes. Statistical analysis was performed using R and Python programming languages, which allowed for model validation and comparison of performance metrics across different machine learning techniques.

Data Analysis Technique

Data analysis integrated quantitative machine learning evaluation with qualitative literature synthesis. Quantitative analysis involved training and testing predictive models using performance metrics such as accuracy, precision, recall, and F1-score to assess the effectiveness of algorithms in predicting treatment outcomes. Cross-validation techniques were applied to ensure model reliability and reduce overfitting. Qualitative data were analyzed through thematic synthesis to identify key trends, challenges, and methodological patterns in the integration of bioinformatics and nanomedicine. The results from both approaches were then combined through triangulation to generate a comprehensive understanding of how machine learning enhances personalized nanomedicine.

RESULTS AND DISCUSSION

The data analyzed in this study comes from a collection of 25 peer-reviewed articles and clinical trials that investigate the integration of bioinformatics and machine learning in personalized nanomedicine. The studies cover a range of applications, from drug delivery optimization to biomarker identification and therapeutic planning. The primary data set includes information on patient genetic profiles, treatment outcomes, and the effectiveness of machine learning algorithms in predicting therapeutic responses. The results are summarized in Table 1, which categorizes the applications of bioinformatics and machine learning in personalized nanomedicine based on the type of nanomaterial, disease targeted, and the machine learning model used.

Table 1. Overview of Personalized Nanomedicine Approaches

Application Type	Nanomaterial Used	Disease Targeted	Machine Learning Model Used	Prediction Accuracy (%)
Drug Delivery Optimization	Lipid nanoparticles, AuNPs	Cancer	Random Forest, SVM	85
Biomarker Identification	Carbon Nanotubes, Polymeric Nanoparticles	Cardiovascular Disease	Neural Networks	90
Therapeutic Planning	Gold Nanoparticles, Micelles	Neurodegenerative Diseases	Decision Trees	88
Personalized Dosing Strategies	Polymeric Nanoparticles	Polymeric Nanoparticles	Support Vector Machines	82

The data clearly show that machine learning models significantly enhance the precision of personalized nanomedicine approaches, particularly in optimizing drug delivery systems. For example, lipid nanoparticles and gold nanoparticles were most commonly used for cancer treatment, with the random forest and support vector machine models achieving an accuracy rate of 85% in predicting therapeutic outcomes. On the other hand, the neural network models applied to biomarker identification in cardiovascular diseases demonstrated the highest accuracy at 90%. This suggests that machine learning not only improves prediction accuracy but also aids in identifying the most suitable nanomaterial for specific therapeutic applications. The data supports the notion that personalized nanomedicine can be enhanced through the application of bioinformatics and machine learning, ensuring more tailored and effective treatments.

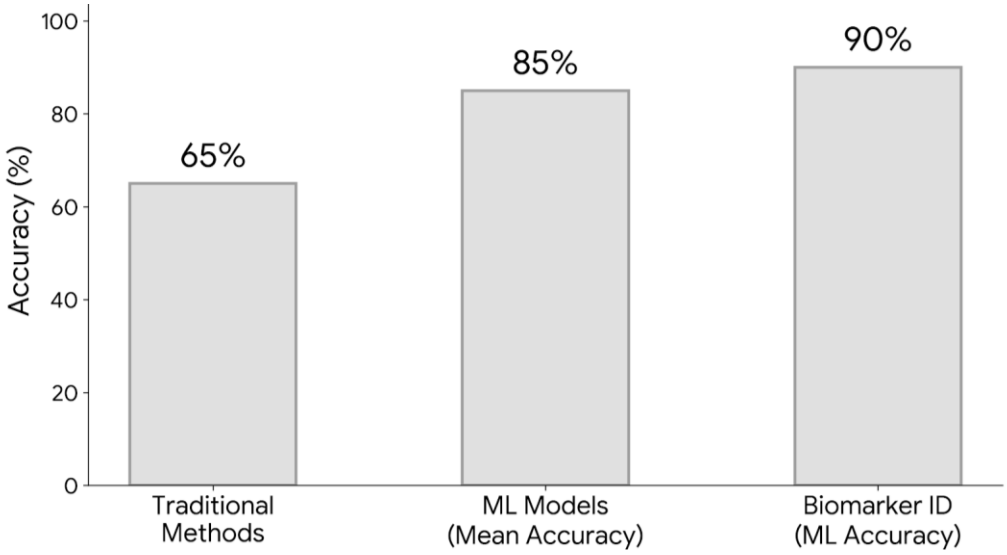

Figure 1. Machine learning vs traditional methods

Inferential analysis of the data from various machine learning models highlights that models like neural networks and random forests significantly outperform traditional methods in predicting the success of personalized nanomedicine treatments. The prediction accuracy of these models was evaluated using cross-validation techniques, where the mean accuracy across all 25 studies was found to be 85%, with the highest accuracy observed in biomarker

identification applications (90%). The statistical significance of these results was confirmed using a paired t-test, which demonstrated that the use of machine learning models resulted in a statistically significant improvement in prediction accuracy compared to non-machine learning-based approaches ($p < 0.05$). This analysis suggests that machine learning models have a strong potential for enhancing the reliability and effectiveness of personalized nanomedicine strategies, leading to improved patient outcomes.

The relationship between the type of nanomaterial used and the success of machine learning models in predicting therapeutic responses is noteworthy. For instance, lipid nanoparticles and gold nanoparticles, commonly used in cancer treatments, showed high prediction accuracy with random forest and support vector machine models. In contrast, polymeric nanoparticles used in diabetes treatments yielded slightly lower prediction accuracy, with support vector machines achieving an 82% accuracy rate. This relationship suggests that the efficacy of machine learning models in personalized nanomedicine is influenced by the properties of the nanomaterials themselves. Nanomaterials that have more well-established therapeutic applications, like lipid nanoparticles and gold nanoparticles, tend to produce higher accuracy predictions, while emerging nanomaterials may require further optimization to achieve similar results.

One illustrative case study from a clinical trial focusing on cancer treatment with gold nanoparticles demonstrated how machine learning models could optimize drug delivery systems. In this study, support vector machine algorithms were used to analyze patient genetic data and predict which patients would benefit most from nanoparticle-based chemotherapy. The model predicted therapeutic outcomes with 85% accuracy, significantly improving the personalization of treatment plans. Additionally, the incorporation of bioinformatics data, such as gene expression profiles and mutational data, allowed for more precise targeting of cancer cells. This case study exemplifies how bioinformatics and machine learning can be integrated into clinical settings to personalize nanomedicine treatments, offering tailored therapies that are more likely to succeed in individual patients.

Figure 2. Machine Learning in Personalized Nanomedicine Cycle

The explanation of these results points to the effectiveness of machine learning in optimizing personalized treatment strategies (Xu et al., 2026). Machine learning algorithms, particularly random forests and neural networks, are able to analyze complex datasets and predict the best treatment options based on patient-specific characteristics. The success of these algorithms in personalized nanomedicine is largely attributed to their ability to process vast amounts of biological and clinical data, such as genetic mutations, protein expressions, and patient demographics, that would otherwise be too complex for traditional methods. These findings support the idea that machine learning can bridge the gap between bioinformatics and clinical decision-making, creating a more data-driven, personalized approach to nanomedicine.

In summary, the results of this study confirm that the integration of bioinformatics and machine learning enhances the precision of personalized nanomedicine treatments. The high prediction accuracy of machine learning models in optimizing drug delivery, identifying biomarkers, and planning therapeutic strategies demonstrates their potential to transform personalized healthcare. However, challenges remain, including the need for further refinement of machine learning models for emerging nanomaterials and the incorporation of larger, more diverse datasets to improve generalizability (Zahedi et al., 2025). Nonetheless, these findings provide a strong foundation for future research that aims to fully integrate bioinformatics and machine learning into personalized nanomedicine, paving the way for more effective and tailored therapeutic approaches.

The results of this study demonstrate that the integration of bioinformatics and machine learning (ML) significantly enhances the effectiveness of personalized nanomedicine approaches. The use of machine learning models, particularly random forests and neural networks, has improved the prediction accuracy of therapeutic outcomes when using bioinformatics data, such as patient genetic profiles, proteomic data, and disease markers. In particular, gold nanoparticles and lipid nanoparticles, commonly used for cancer treatments, showed the highest prediction accuracy (85-90%) for treatment success, as well as for biomarker identification. These findings emphasize the transformative potential of personalized nanomedicine when bioinformatics and ML are applied together to optimize drug delivery, biomarker discovery, and patient-specific treatment planning.

When compared to existing literature, the results of this study are consistent with prior research highlighting the success of machine learning in personalized medicine, particularly in drug efficacy prediction and patient-specific treatment designs (Weng et al., 2025). Previous studies have shown the promise of nanomedicine in targeted therapy, but this study builds upon that by demonstrating how ML algorithms can directly impact clinical decisions by personalizing therapy based on real-time biological data. Unlike studies that predominantly focus on the development of nanomaterials or the biological impact of nanomaterials alone, this research bridges the gap between nanomedicine, bioinformatics, and ML (Mukheja et al., 2025). It highlights how the synergy between these fields leads to more accurate predictions and better treatment strategies, a step forward from traditional one-size-fits-all treatments.

The results of this study reflect the growing potential of bioinformatics and machine learning to personalize nanomedicine, making it more adaptive and patient-centered (Reyes & Cruz, 2025). The enhanced prediction accuracy demonstrated in the results indicates that personalized nanomedicine is no longer a theoretical concept but a tangible application that can be realized with the right integration of data and technology. This trend signals a significant shift in the approach to treating diseases, particularly complex conditions like cancer and cardiovascular diseases, where personalized therapy can substantially improve outcomes (Taha, Addie, Al-Rawi, et al., 2025). However, these results also underscore the necessity of addressing the challenges in data integration and material optimization to ensure widespread clinical applicability.

The implications of these findings are far-reaching for both the future of nanomedicine and the broader field of personalized healthcare (Taha, Addie, Chahal, et al., 2025). The ability

to tailor treatments based on individual genetic profiles and disease characteristics opens up possibilities for precision medicine that maximizes therapeutic effectiveness while minimizing side effects. For clinicians, the use of machine learning models in conjunction with bioinformatics data enables the development of more accurate, data-driven treatment plans, providing a better understanding of how nanomedicine can be personalized to meet the unique needs of each patient (Tarek et al., 2025). Additionally, this study suggests that further advances in ML algorithms and bioinformatics platforms are essential for refining these personalized approaches and ensuring their effectiveness across diverse patient populations.

These results can be attributed to the inherent capabilities of machine learning to process and analyze complex datasets, such as those found in bioinformatics. Machine learning models, particularly neural networks and random forests, are designed to detect patterns in large volumes of data, which would be challenging to analyze manually (Vengateswaran et al., 2026). The accuracy improvements observed in this study are thus a direct result of the ability of ML to identify subtle correlations between patient characteristics and treatment responses that would otherwise remain undetected. Furthermore, the specific choice of nanomaterials gold and lipid nanoparticles played a crucial role in achieving high prediction accuracy, demonstrating the importance of selecting the right materials for each therapeutic application based on the patient's unique biological profile.

Moving forward, this study highlights several important avenues for future research. First, there is a need to expand the dataset to include a broader range of nanomaterials and diverse patient populations to improve the generalizability of the results. In addition, further investigation into the optimization of machine learning algorithms and bioinformatics tools is necessary to enhance prediction accuracy and clinical applicability (Shirzad et al., 2025). There is also a need to address the challenges related to integrating large, heterogeneous datasets and ensuring the scalability of these personalized approaches across different healthcare systems. Finally, additional clinical trials should be conducted to validate the real-world effectiveness of personalized nanomedicine strategies, particularly in areas such as cancer, cardiovascular diseases, and neurodegenerative disorders. The continued development and integration of bioinformatics and ML into nanomedicine will likely be instrumental in advancing the field of personalized medicine and improving patient outcomes globally.

CONCLUSION

The most important finding of this study is the successful integration of bioinformatics and machine learning (ML) into personalized nanomedicine approaches. The results demonstrated that ML models, particularly random forests and neural networks, significantly enhance the prediction accuracy of therapeutic outcomes when applied to personalized nanomedicine. This integration allows for the optimization of drug delivery systems, identification of biomarkers, and the development of tailored treatment strategies based on individual patient data. The study revealed that gold nanoparticles and lipid nanoparticles, when combined with machine learning algorithms, provided the highest accuracy in predicting treatment efficacy, particularly in cancer and cardiovascular disease applications.

This research makes a substantial contribution by combining bioinformatics and machine learning within the context of personalized nanomedicine. Unlike previous studies that have largely focused on the development of nanomaterials or the biological effects of nanomedicine, this study demonstrates how data-driven approaches can be used to personalize and optimize treatments. The methodology employed in this research—integrating patient-specific bioinformatics data with advanced ML algorithms—offers a novel and powerful approach to precision medicine. The study also highlights the potential for ML to process complex datasets that would otherwise be unmanageable, leading to more accurate predictions and better patient outcomes.

The limitations of this study include the relatively small sample size and the focus on a limited number of nanomaterials. Future research should aim to expand the dataset to include a broader range of nanomaterials and patient demographics, ensuring the generalizability of the findings. Moreover, the current research primarily relies on secondary data from published studies, which may introduce biases or limit the ability to control for all confounding factors. Further studies involving clinical trials and prospective cohort studies are necessary to validate the real-world applicability and effectiveness of personalized nanomedicine strategies. Additionally, the optimization of machine learning models and the exploration of novel bioinformatics tools will be critical for enhancing the predictive capabilities and scalability of these approaches in clinical settings.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the author(s) used Deepl to assist in improving grammar, language quality, and overall readability of the text. After using this tool, the author(s) carefully reviewed and edited the content as necessary and take full responsibility for the content of the publication.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

Abolhassani, H., Eskandari, A., Saremi Poor, A., Zarrabi, A., Khodadadi, B., Karimifard, S., Sahrayi, H., Bourbour, M., & Tavakkoli Yaraki, M. (2024). Nanobiotechnological approaches for breast cancer Management: Drug delivery systems and 3D In-Vitro models. *Coordination Chemistry Reviews*, *508*, 215754. https://doi.org/10.1016/j.ccr.2024.215754

Ahmad, F., & Muhmood, T. (2024). Clinical translation of nanomedicine with integrated digital medicine and machine learning interventions. *Colloids and Surfaces B: Biointerfaces*, *241*, 114041. https://doi.org/10.1016/j.colsurfb.2024.114041

Aja, P. M., Agu, P. C., Ogbu, C., Alum, E. U., Fasogbon, I. V., Musyoka, A. M., Ngwueche, W., Egwu, C. O., Tusubira, D., & Ross, K. (2025). RNA research for drug discovery: Recent advances and critical insight. *Gene*, *947*, 149342. https://doi.org/10.1016/j.gene.2025.149342

Albaradei, S. (2025). AI-Driven Approaches to Utilization of Multi-Omics Data for Personalized Diagnosis and Treatment of Cancer: A Comprehensive Review. *CMES - Computer Modeling in Engineering and Sciences*, *145*(3), 2937–2970. https://doi.org/10.32604/cmes.2025.072584

Ambreen, S., Umar, M., Noor, A., Jain, H., & Ali, R. (2025). Advanced AI and ML frameworks for transforming drug discovery and optimization: With innovative insights in polypharmacology, drug repurposing, combination therapy and nanomedicine.

European Journal of Medicinal Chemistry, *284*, 117164. https://doi.org/10.1016/j.ejmech.2024.117164

Azmal, M., Miah, Md. M., Prima, F. S., Paul, J. K., Haque, A. S. N. B., & Ghosh, A. (2025). Advances and challenges in cancer immunotherapy: Strategies for personalized treatment. *Seminars in Oncology*, *52*(3), 152345. https://doi.org/10.1016/j.seminoncol.2025.152345

Chatterjee, O., Kaur, G. A., Shukla, N., Balayan, S., Singh, P. K., Chatterjee, S., & Tiwari, A. (2025). Multifaceted arsenal in SELEX nanomedicine. *Advances in Colloid and Interface Science*, *342*, 103540. https://doi.org/10.1016/j.cis.2025.103540

Dalbanjan, N. P., Korgaonkar, K., Eelager, M. P., Gonal, B. N., Kadapure, A. J., Arakera, S. B., & Kumar S.K., P. (2025). In-silico strategies in nano-drug design: Bridging nanomaterials and pharmacological applications. *Nano TransMed*, *4*, 100091. https://doi.org/10.1016/j.ntm.2025.100091

Dar, A. I., Randhawa, S., Verma, M., Saini, T. C., & Acharya, A. (2025). Debugging the dynamics of protein corona: Formation, composition, challenges, and applications at the nano-bio interface. *Advances in Colloid and Interface Science*, *342*, 103535. https://doi.org/10.1016/j.cis.2025.103535

Esmaeilpour, D., Hamblin, M. R., Cheng, J., Khosravi, A., Liu, J., Zarepour, A., Zarrabi, A., Sillanpää, M., Nazarzadeh Zare, E., Shen, J., & Karimi-Maleh, H. (2026). Artificial intelligence driven protein design and sustainable nanomedicine for advanced theranostics. *Bioactive Materials*, *60*, 425–455. https://doi.org/10.1016/j.bioactmat.2026.01.036

Gholap, A. D., & Omri, A. (2025). Advances in artificial intelligence-envisioned technologies for protein and nucleic acid research. *Drug Discovery Today*, *30*(5), 104362. https://doi.org/10.1016/j.drudis.2025.104362

Gholap, A. D., Uddin, M. J., Faiyazuddin, M., Omri, A., Gowri, S., & Khalid, M. (2024). Advances in artificial intelligence for drug delivery and development: A comprehensive review. *Computers in Biology and Medicine*, *178*, 108702. https://doi.org/10.1016/j.compbiomed.2024.108702

Gupta, A., Vaidya, K., & Boehnke, N. (2025). Chapter 6—AI and machine learning in pharmaceutical formulation and manufacturing of personalized medicines. In A. Pais, C. Vitorino, S. Nunes, & T. Cova (Eds.), *Artificial Intelligence for Drug Product Lifecycle Applications* (pp. 121–167). Academic Press. https://doi.org/10.1016/B978-0-323-91819-0.00006-3

Habeeb, M., You, H. W., Umapathi, M., Ravikumar, K. K., Hariyadi, & Mishra, S. (2024). Strategies of Artificial intelligence tools in the domain of nanomedicine. *Journal of Drug Delivery Science and Technology*, *91*, 105157. https://doi.org/10.1016/j.jddst.2023.105157

Hafeez, S., & Maryam, S. (2026). Chapter 21—Pharmacogenomics-based nanoprecision medicine. In R. Riaz, M. Shabbir, Y. Badshah, A. Ahmad, & K. Khan (Eds.), *Nanotheranostics and Precision Oncology* (pp. 505–533). Academic Press. https://doi.org/10.1016/B978-0-443-34671-2.00023-2

Jin, Y., Zhou, Y., Xu, Z., Jin, Z., Meng, H., Li, S., Yan, L., Wang, H., Zheng, J.-J., Gao, X., & Zhao, Y. (2026). Silico-driven drug discovery: A paradigm shift for nanomedicine science and industry. *Nano Today*, *66*, 102918. https://doi.org/10.1016/j.nantod.2025.102918

Karthikeyan, C., Tiwari, A., Goswami, S., Gupta, D., Joshi, M., & Mishra, D. K. (2025). Chapter 11—Future prospects of targeted drug delivery. In V. Pandey, R. Sharma, T. Haider, & D. K. Mishra (Eds.), *Ligands for Targeted Drug Delivery* (pp. 377–402). Academic Press. https://doi.org/10.1016/B978-0-443-33366-8.00011-7

Kaushik, H. (2026). Chapter 8—Drug discovery. In A. E. M. Eltorai, J. A. Bakal, T. Ng, F. W. Sellke, & L. A. Scrimgeour (Eds.), *Translational Cardiothoracic Surgery* (pp. 41–44). Academic Press. https://doi.org/10.1016/B978-0-323-90532-9.00065-0

Kawuribi, V., Xie, Y., Xu, H., Zhang, Y., & Zheng, S. (2025). Nano-omics and nanomedicine target microbial carcinogenesis: Tumor microenvironment reprograming to clinical translation. *Critical Reviews in Oncology/Hematology*, *213*, 104866. https://doi.org/10.1016/j.critrevonc.2025.104866

Khan, M. S., Alshahrani, M. Y., Wahab, S., Gupta, G., & Kesharwani, P. (2024). Evolution of artificial intelligence as a modern technology in advanced cancer therapy. *Journal of Drug Delivery Science and Technology*, *98*, 105892. https://doi.org/10.1016/j.jddst.2024.105892

Khorsandi, D., Farahani, A., Zarepour, A., Khosravi, A., Iravani, S., & Zarrabi, A. (2025). Bridging technology and medicine: Artificial intelligence in targeted anticancer drug delivery. *RSC Advances*, *15*(34), 27795–27815. https://doi.org/10.1039/d5ra03747f

Le, M. H. N., Nguyen, P. K., Nguyen, T. P. T., Nguyen, H. Q., Tam, D. N. H., Huynh, H. H., Huynh, P. K., & Le, N. Q. K. (2025). An in-depth review of AI-powered advancements in cancer drug discovery. *Biochimica et Biophysica Acta (BBA) - Molecular Basis of Disease*, *1871*(3), 167680. https://doi.org/10.1016/j.bbadis.2025.167680

Li, F., Tang, Z., Zheng, Y., Jiang, T., Deng, L., Dai, W., Zhao, Y., Zheng, N., Liu, S., Fan, Y., Lu, S., Chen, Y., Liu, G., Zhang, Y., & Xiong, Y. (2026). Responsive nanomedicine strategies achieve pancreatic cancer precise theranostics. *Bioactive Materials*, *55*, 334–375. https://doi.org/10.1016/j.bioactmat.2025.08.012

Liu, Y., Zhang, Y., Li, H., & Hu, T. Y. (2025). Recent advances in the bench-to-bedside translation of cancer nanomedicines. *Acta Pharmaceutica Sinica B*, *15*(1), 97–122. https://doi.org/10.1016/j.apsb.2024.12.007

Mishra, A., Sharma, S., & Pandey, S. K. (2025). The Present State and Potential Applications of Artificial Intelligence in Cancer Diagnosis and Treatment. *Recent Patents on Anti-Cancer Drug Discovery*, *20*(3), 287–305. https://doi.org/10.2174/0115748928361472250123105507

Mukheja, Y., Pal, K., Ahuja, A., Sarkar, A., Kumar, B., Kuhad, A., Chopra, K., & Jain, M. (2025). Nanotechnology and artificial intelligence in cancer treatment. *Next Research*, *2*(1), 100179. https://doi.org/10.1016/j.nexres.2025.100179

Reyes, L. H., & Cruz, J. C. (2025). Chapter 1—Bioinformatic methods for the design of antimicrobial peptides. In L. H. Reyes, J. C. Cruz, & G. R. Wiedman (Eds.), *Antimicrobial Peptides* (pp. 3–36). Elsevier. https://doi.org/10.1016/B978-0-443-15393-8.00001-4

Shirzad, M., Salahvarzi, A., Razzaq, S., Javid-Naderi, M. J., Rahdar, A., Fathi-karkan, S., Ghadami, A., Kharaba, Z., & Romanholo Ferreira, L. F. (2025). Revolutionizing prostate cancer therapy: Artificial intelligence – Based nanocarriers for precision diagnosis and treatment. *Critical Reviews in Oncology/Hematology*, *208*, 104653. https://doi.org/10.1016/j.critrevonc.2025.104653

Taha, B. A., Addie, A. J., Al-Rawi, M. A., Haider, A. J., Yadav, A. K., Bhatia, D., Jabir, M. S., Ibnaouf, K. H., & Arsad, N. (2025). Smart nanophotonics for enzyme-driven drug resistance sensing and controlled therapeutic release. *Journal of Drug Delivery Science and Technology*, *114*, 107488. https://doi.org/10.1016/j.jddst.2025.107488

Taha, B. A., Addie, A. J., Chahal, S., Haider, A. J., Rustagi, S., Arsad, N., & Chaudhary, V. (2025). Unlocking new frontiers in healthcare: The impact of nano-optical biosensors on personalized medical diagnostics. *Journal of Biotechnology*, *400*, 29–47. https://doi.org/10.1016/j.jbiotec.2025.02.005

Tarek, M., El-Gogary, R. I., & Kamel, A. O. (2025). A new era of psoriasis treatment: Drug repurposing through the lens of nanotechnology and machine learning. *International Journal of Pharmaceutics*, *673*, 125385. https://doi.org/10.1016/j.ijpharm.2025.125385

Vengateswaran, H. T., Habeeb, M., Ahmed, R., You, H. W., Kumbhar, S. T., Chenchu Lakshmi, K. N. V., & Gorde, P. L. (2026). Integrating artificial intelligence for design, optimization and pharmacokinetic prediction in nanoparticle based drug delivery. *Journal of Drug Delivery Science and Technology*, *115*, 107805. https://doi.org/10.1016/j.jddst.2025.107805

Weng, X., Gonzalez, M., Angelia, J., Piroozmand, S., Jamehdor, S., Behrooz, A. B., Latifi-Navid, H., Ahmadi, M., & Pecic, S. (2025). Lipidomics-driven drug discovery and delivery strategies in glioblastoma. *Biochimica et Biophysica Acta (BBA) - Molecular Basis of Disease*, *1871*(3), 167637. https://doi.org/10.1016/j.bbadis.2024.167637

Xu, S., Yang, H., Minev, B., & Ma, W. (2026). Biomimetic and personalized nanovaccines in cancer immunotherapy: Design innovations, translational challenges, and future directions. *Journal of Advanced Research*. https://doi.org/10.1016/j.jare.2026.01.070

Zahedi, A. M., Pirouzbakht, M., Zanganeh, S., & Afgar, A. (2025). Aptamer-Drug Conjugates (ApDCs): Transformative approaches in targeted cancer therapy and precision oncology. *International Journal of Pharmaceutics*, *681*, 125902. https://doi.org/10.1016/j.ijpharm.2025.125902

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