

# Tackling Drug Resistance: Nanoparticle-Based Co-Delivery of Biotherapeutics and Chemotherapeutics

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## DESCRIPTION

The growing challenge of drug resistance in cancer and infectious diseases has prompted the scientific community to explore innovative strategies to overcome therapeutic limitations. One promising approach is the co-delivery of biotherapeutics and chemotherapeutics with nanoparticles. This method exploits the unique properties of nanoparticles to improve drug efficacy, reduce side effects, and mitigate the emergence of resistance, providing a novel solution to some of the most pressing medical challenges. Drug resistance, particularly in cancer and bacterial infections, is a major obstacle to successful treatment. In cancer, resistance mechanisms include overexpression of efflux pumps, altered drug targets, and enhanced DNA (Deoxyribonucleic Acid) repair pathways, which reduce the efficacy of traditional chemotherapies [1,2]. Similarly, multidrug-resistant bacteria present significant challenges in clinical settings because they evade the effects of antibiotics through various mechanisms such as bacterial target modification or drug degradation.

The inability of conventional therapies to address the root causes of resistance necessitates the development of alternative strategies. Among them, the use of nanoparticles for drug delivery is attracting considerable attention due to their potential to address the limitations of conventional therapy. Nanoparticles (NPs) are materials with a diameter between 1 nm and 100 nm [3]. Their small size, large surface area, and ability to be engineered for specific functions make them ideal candidates for drug delivery systems. Nanoparticles can encapsulate hydrophobic and hydrophilic drugs, protecting them from degradation, controlling their release, and facilitating their targeted delivery to specific tissues or cells. Nanoparticles can be functionalized with various ligands, such as antibodies, peptides, or aptamers, to improve their specificity for tumour cells or bacteria, thereby minimizing off-target effects. In addition, the surface properties of nanoparticles can be modified to improve their interaction with the cell membrane, thus ensuring effective drug uptake and release [4,5].

Co-administration of biotherapeutics and chemotherapeutics offers several advantages in overcoming drug resistance. Chemotherapeutic agents can be used to target rapidly dividing cells, while biotherapeutics can be used to block specific pathways that drive resistance, such as overexpression of drug efflux pumps or activation of signalling pathways. For example, nanoparticles loaded with a combination of paclitaxel and an anti-PD-1 antibody have shown enhanced anti-tumour effects in preclinical models by simultaneously inducing direct cytotoxicity and stimulating the immune response [6,7]. Nanoparticle-based systems also offer the advantage of controlled release, which is essential for maintaining optimal concentrations of both drugs at the target site for long periods. This controlled release minimizes systemic side effects and ensures that both agents reach the desired site where they can act synergistically.

One of the most exciting applications of nanoparticles in drug delivery is the co-delivery of biotherapies (e.g., monoclonal antibodies, RNA-based therapies) and chemotherapies (e.g., cytotoxic drugs). This strategy aims to achieve a synergistic effect, where the combination of drugs improves therapeutic outcomes by overcoming resistance mechanisms. Nanoparticles can deliver chemotherapeutic agents directly to tumour cells, bypassing the efflux pumps that are often responsible for resistance. In addition, co-administration of biotherapies, such as monoclonal antibodies that target specific cancer receptors, can block the growth and spread of cancer cells, thereby potentiating the effect of chemotherapy [8,9]. Tumour resistance is often linked to the surrounding microenvironment of cancer cells, which can hinder drug penetration and efficacy. Nanoparticles can be engineered to respond to specific tumour-related stimuli, such as low pH or overexpressed enzymes, thereby enhancing drug delivery to the tumour region.

Combining biotherapies with chemotherapy can also boost the immune system. For example, immune checkpoint inhibitors, when administered together with chemotherapy drugs, can enhance the immune system's ability to recognize and destroy cancer cells. Similarly, RNA-based therapies, such as siRNA (small interfering RNA), can be used to silence genes associated

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with resistance in bacteria or cancer cells, thereby increasing the sensitivity of target cells to the treatment. In the context of bacterial infections, co-administration of antibiotics with biotherapies such as Antimicrobial Peptides (AMPs) or CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats)-based therapies offers a multifaceted approach to combat multidrug-resistant pathogens. Nanoparticles can protect sensitive biotherapies from degradation by the body's enzymes, allowing them to specifically target resistant bacteria. Although the co-delivery of biotherapeutics and chemotherapeutics using nanoparticles shows great promise, several challenges remain [10,11]. The complexity of creating nanoparticles capable of efficiently delivering multiple drugs while ensuring their stability, safety, and controlled release poses a significant obstacle. In addition, issues of potential toxicity, long-term biodistribution, and the risk of immune system activation require special attention.

## CONCLUSION

However, continued advances in nanotechnology, materials science, and drug formulation are likely to overcome these challenges. Continued refinement of nanoparticle design, combined with thorough preclinical and clinical studies, will be essential to fully exploit the potential of this approach. Nanoparticle-based co-delivery systems represent a recent strategy to combat drug resistance, offering a multifaceted approach to improve the efficacy of biotherapeutics and chemotherapy. By improving drug targeting, minimizing side effects, and overcoming resistance mechanisms, this innovative approach holds great promise for improving treatment outcomes for cancer and infectious diseases. Thanks to new research and technological advances, nanoparticle therapies could revolutionize the treatment of drug-resistant diseases, offering patients more effective and personalized treatment options.

## REFERENCES

1. Bostami RD, Abuwatfa WH, Hussein GA. Recent advances in nanoparticle-based co-delivery systems for cancer therapy. *Nanomaterials*. 2022;12(15):2672.
2. Wei X, Song M, Li W, Huang J, Yang G, Wang Y. Multifunctional nanoplateforms co-delivering combinatorial dual-drug for eliminating cancer multidrug resistance. *Theranostics*. 2021;11(13):6334.
3. Teixeira PV, Fernandes E, Soares TB, Adegas F, Lopes CM, Lucio M. Natural compounds: co-delivery strategies with chemotherapeutic agents or nucleic acids using lipid-based Nanocarriers. *Pharmaceutics*. 2023;15(4):1317.
4. Liang Y, Liu ZY, Wang PY, Li YJ, Wang RR, Xie SY. Nanoplateform-based natural products co-delivery system to surmount cancer multidrug-resistant. *J Controlled Release*. 2021;336:396-409.
5. Yoo H, Kim Y, Kim J, Cho H, Kim K. Overcoming Cancer Drug Resistance with Nanoparticle Strategies for Key Protein Inhibition. *Molecules*. 2024;29(17):3994.
6. Ashique S, Garg A, Hussain A, Farid A, Kumar P, Taghizadeh-Hesary F. Nanodelivery systems: An efficient and target-specific approach for drug-resistant cancers. *Cancer Med*. 2023;12(18):18797-825.
7. Bukhari SN. Emerging nanotherapeutic approaches to overcome drug resistance in cancers with update on clinical trials. *Pharmaceutics*. 2022;14(4):866.
8. Khot VM, Salunkhe AB, Priel S, Bauer J, Thorat ND, Townley H. Nanomedicine-driven molecular targeting, drug delivery, and therapeutic approaches to cancer chemoresistance. *Drug Discov Today*. 2021;26(3):724-39.
9. Wang C, Li Q, Xiao J, Liu Y. Nanomedicine-based combination therapies for overcoming temozolomide resistance in glioblastomas. *Cancer Bio Med*. 2023;20(5):325.
10. SV S, Augustine D, Hosmani J, Pagnoni F, Reda R, Testarelli L, et al. Nanoparticle-based biomolecules in cancer diagnosis, therapy, drug delivery and prognosis. *Front dent med*. 2024;5:1482166.
11. Jogdeo CM, Panja S, Kanvinde S, Kapoor E, Siddhanta K, Oupický D. Advances in lipid-based codelivery systems for cancer and inflammatory diseases. *Adv healthc mater*. 2023;12(7):2202400.