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Surface-Modified Nanoparticles for Improved Drug Targeting and Reduced Toxicity

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Short Communication

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DESCRIPTION

Surface modification of nanoparticles is an essential strategy for enhancing drug delivery systems. By altering the surface properties of nanoparticles, researchers can improve drug targeting to specific cells and reduce systemic toxicity.

Importance of surface modification

Targeted delivery: Surface modifications can facilitate the attachment of ligands, antibodies, or peptides that target specific cell types, enhancing drug delivery to diseased tissues [1].

Reduced toxicity: Surface modifications can decrease interactions between nanoparticles and healthy cells, minimizing off-target effects and toxicity.

Improved pharmacokinetics: Modifying the surface of nanoparticles can alter their circulation time in the bloodstream, improving therapeutic efficacy.
design enables controlled release of drugs over extended periods.

Methods of surface modification

Pegylation: Attaching Poly Ethylene Glycol (PEG) to nanoparticles increases their circulation time and reduces recognition by the immune system [2-6].

Ligand attachment: Conjugating specific ligands (e.g., antibodies) to the surface of nanoparticles allows for targeted delivery to specific cells, such as cancer cells.

Charge modification: Altering the surface charge of nanoparticles can influence their interactions with cells, enhancing cellular uptake.

Applications of surface-modified nanoparticles

Cancer therapy: Surface-modified nanoparticles can deliver chemotherapeutic agents specifically to tumor cells, reducing toxicity to healthy tissues.

Gene therapy: Surface modifications can enhance the delivery of nucleic acids (e.g., siRNA, DNA) to target cells, improving the effectiveness of gene therapies.

Antibiotic delivery: Surface-modified nanoparticles can enhance the delivery of antibiotics to infected tissues, improving treatment outcomes.

Challenges in surface modification

Characterization and quality control: Ensuring consistent and reproducible surface modifications can be challenging.

Regulatory hurdles: The approval process for surface-modified nanoparticles requires thorough evaluation of safety and efficacy [7].

Stability and storage: Surface modifications can impact the stability of nanoparticles, affecting their shelf-life and therapeutic efficacy.

Ongoing research focuses on optimizing surface modifications, exploring new targeting strategies and understanding the mechanisms of drug release from modified nanoparticles [8-11]. Advances in this field hold great promise for enhancing drug delivery systems.

Furthermore, the integration of stimuli-responsive elements into surface-modified nanoparticles can significantly enhance drug delivery efficacy. These nanoparticles can be designed to release their therapeutic payloads in response to specific environmental activates, such as pH changes, temperature fluctuations, or the presence of specific enzymes. This targeted approach ensures that drugs are released precisely where and when needed, minimizing systemic exposure and associated toxicity [12].

Recent advancements in nanotechnology have also enabled the development of multifunctional nanoparticles that combine therapeutic and imaging capabilities. These dual-functioning nanoparticles can provide real-time imaging of drug delivery, allowing for better monitoring of treatment efficacy and enabling clinicians to make informed decisions during therapy [13-15]. By incorporating imaging agents, healthcare providers can visualize the distribution and accumulation of drugs within the target tissues.

Additionally, personalized medicine stands to benefit from the customization of surface-modified nanoparticles. By tailoring nanoparticle properties to the individual patient's disease profile, treatments can be more effectively matched to patient needs, improving therapeutic outcomes. Collaborative efforts among chemists, biologists and clinicians will be essential to overcome current challenges and translate these innovative drug delivery systems into clinical practice. As research in surface-modified nanoparticles progresses, they hold the potential to revolutionize various therapeutic areas, including oncology, infectious diseases and regenerative medicine.

REFERENCES

1. Shi J, et al. Cancer nanomedicine: Progress, challenges and opportunities. Nat Rev Cancer. 2016;17:2-3.
2. Cabral H, et al. Supramolecularnanodevices: From design validation to theranosticnanomedicine. Acc Chem Res. 2011;44:999-1008.
3. Thanou M, et al. Polymer-protein and polymer-drug conjugates in cancer therapy. Curr Opin Investig Drugs. 2003;4:701-709.
4. Shi JJ, et al. Self-assembled targeted nanoparticles evolution of technologies and bench to bedside translation. Acc Chem Res. 2011;44:1123-1134.
5. Park DH, et al. Biodegradable inorganic nanovector: Passive versus active tumor targeting in siRNA transportation. Angew Chem Int Ed. 2016;55:4582–4586.
6. Jin YZ, et al. Core-shell nanocarriers with high paclitaxel loading for passive and active targeting. Sci Rep UK. 2016;6:1-6.

7. Guo Y, et al. Transferrin-conjugated doxorubicin-loaded lipid-coated nanoparticles for the targeting and therapy of lung cancer. Oncol Lett. 2015;9:1065–1072.
8. Liu GD, et al. PEG-PLGA Nanoparticle modified by Transferrin Loading Doxorubicin: *In vitro* and *in vivo* Studies for glioma. Adv Mater Res. 2013;750–752.
9. Hrkach J, et al. Preclinical development and clinical translation of a PSMA-targeted docetaxel nanoparticle with a differentiated pharmacological profile. Sci Transl Med. 2012;4:128-139.
10. Peter AJ, et al. Targeting the cancer epigenome for therapy. Nat Rev Geneti. 2016;17:630-636.
11. Shin WK, et al. Cross-linked composite gel polymer electrolyte using mesoporous methacrylate-functionalized SiO2 nanoparticles for lithium-ion polymer batteries. Sci rep. 2016;6:263-268.
12. Daglioglu C, et al. Environmentally responsive dual-targeting nanoparticles: improving drug accumulation in cancer cells as a way of preventing anticancer drug efflux. J Pharm Sci. 2018;107:934-941.
13. Torchilin VP. Multifunctional nanocarriers. Adv Drug Deliv Rev. 2006;58:1532-1555.
14. Xia Y, et al. pH sensitive liposomes delivering tariquidar and doxorubicin to overcome multidrug resistance of resistant ovarian cancer cells. Colloids Surf B Biointerfaces. 2018;170:514-520.
15. Chittasupho C, et al. CXCR4 targeted dendrimer for anti-cancer drug delivery and breast cancer cell migration inhibition. Eur J Pharm Biopharm. 2017;119:310-321.