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A REVIEW PAPER ON COATING NANOPARTICLES FOR DRUG DELIVERY

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ABSTRACT:

Targeted delivery makes it possible to absorb drug molecules preferentially at the sites of action and thus holds great promise to enhance the therapeutic index. Nanoparticle-based delivery systems, among different drug-targeting methods, give some specific strengths and have achieved exciting preclinical and clinical outcomes. This is a summary of the recent development of the cell membrane-coated nanoparticle method, a new class of biomimetic nanoparticles that incorporates both cell membrane functionality and the engineering versatility of synthetic nano materials for efficient drug delivery and innovative therapeutics. This review focuses in particular on novel cell membrane-coated nanoparticles designs, as well as their underlying principles that promote drug targeting purposes. Three particular areas are highlighted, including: I coating of the cell membrane to prolong nanoparticle circulation, (ii) coating of the cell membrane to achieve cell-specific targeting, and (iii) coating of the cell membrane for targeting the immune system. Overall, nanoparticles coated with cell membrane have emerged as a new class of targeted nano therapeutics with high potential for enhancing drug delivery and therapeutic efficacy for the treatment of different diseases.

KEYWORDS: *Cell, Drug, Molecules, Nanoparticles, Nano science, Medicines.*

INTRODUCTION

The vast majority of drug molecules used in the clinic are non-targeted, especially those for systemic applications. The drugs fail to spread uniformly across the body following administration and require a significant dose to achieve sufficient local concentration [1]. As a consequence, their use, along with other harmful side effects, is widely associated with non-specific toxicity. Efficient therapeutics remain missing for different diseases because the disease sites may be inaccessible to drugs through concentration-dependent diffusion. Targeted delivery that enables drug molecules

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to accumulate preferentially at the sites of action for the treatment of these diseases has great potential to increase the therapeutic index [2].

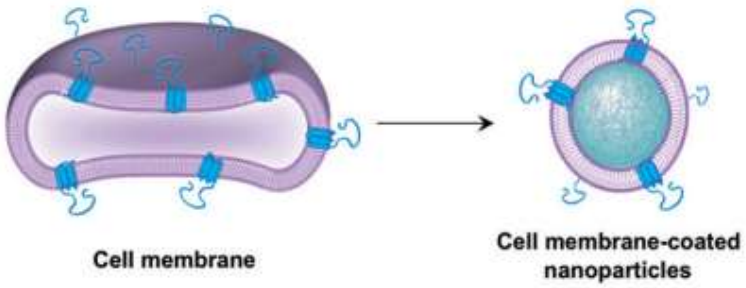

Figure 1: Illustrates the schematic representation of nanoparticle surface [3]

Dr. Robert Langer has made an unprecedented contribution to the field as a pioneer and revolutionary in targeted drug delivery, and has altered the landscape of using nanotechnology, especially nanoparticles, to allow targeted drug delivery [4].

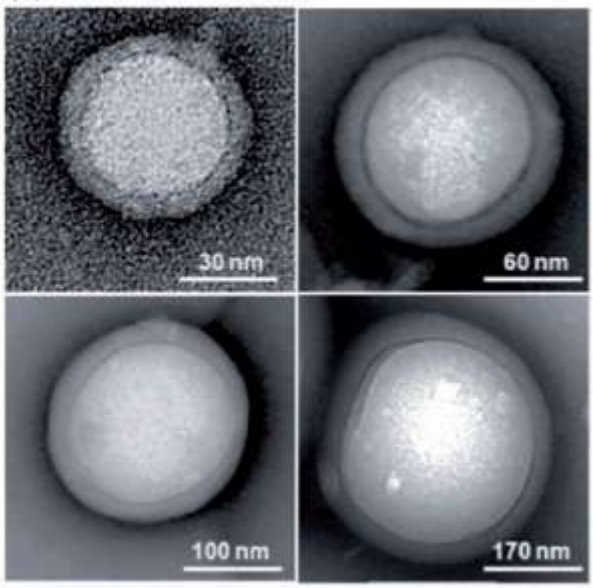

Figure 2: Illustrates the representative transmission electron microscopy (TEM) pictures [5]

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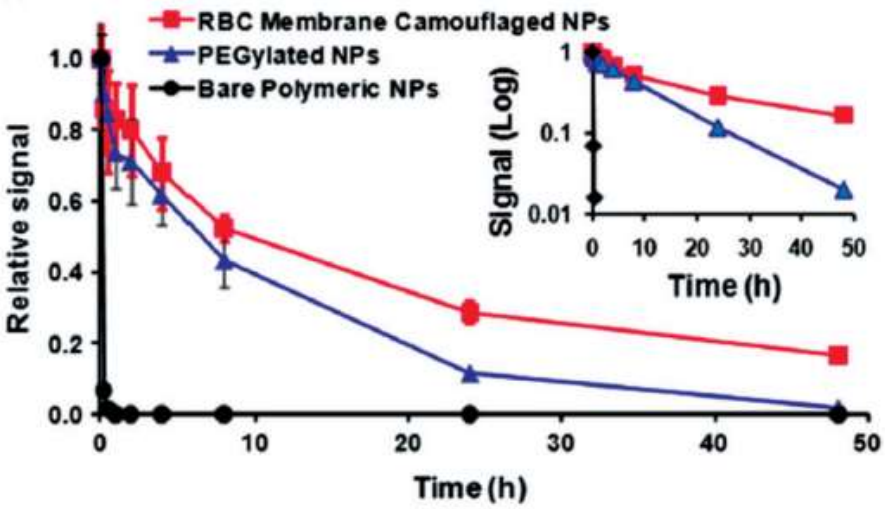

Figure 3: Illustrates the in vivo circulation time of RBC-NPs made from PLGA cores [6]

Nanoparticle-based delivery systems provide distinct benefits relative to other methods for cell- and tissue-specific delivery. On the one hand, through the leaky vasculature and the well-known enhanced permeability and retention effect, long-circulating nanoparticles will preferentially accumulate at tumour sites [7]. Researchers have been inspired by the success of this so-called "passive targeting " to engineer nanoparticles with customized physicochemical properties, including scale, surface charge, surface hydrophilicity and geometry, for improved accumulation. On the other hand, with ligands that bind to surface receptors for "active targeting" on target cells or tissues, nanoparticles can be further modified. It is commonly shown that active targeting can significantly improve the target cells' retention and cellular absorption of nanoparticles. At present, several types of ligands have been used to guide the delivery of drug nano carriers, including small molecules, peptides, antibodies and aptamers [8].

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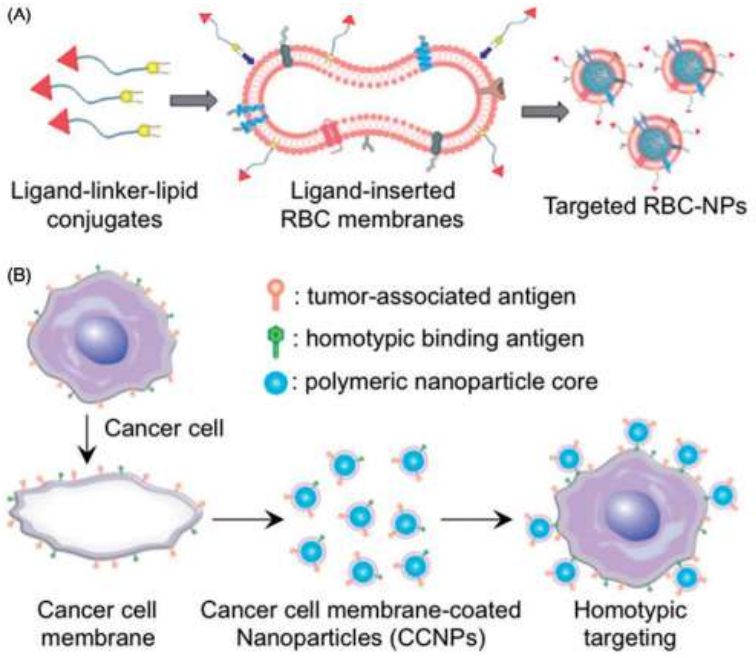

Figure 4: Depicts the schematic of the preparation of RBC-NPs with cell-specific targeting ability [9]

Cell-specific targeting is a beneficial feature in applying nanoparticles for disease treatments that promises to reduce off-target side effects. Mostly, the functionalization of nanoparticles with ligands binding to overexpressed antigens at disease sites has made this targeting effect possible, and various chemical conjugation techniques using carboxyl-, amine- or sulfhydryl-based chemistry have been used to decorate synthetic nanoparticles with targeting ligands. Targeted nanoparticles have demonstrated preferential accumulation at target sites and resulted in encouraging treatment efficacy in clinical studies [10]. The presence of biological components on the particle surfaces, however, involves a non-disruptive functionalization strategy in the case of cell membrane-coated nanoparticles, as the immune evasion capabilities of cellular membranes are predicated on providing completely functional proteins. Figure 1 illustrates the schematic representation of nanoparticle surface. Figure 2 illustrates the representative transmission electron microscopy (TEM) pictures. Figure 3 illustrates the in vivo circulation time of RBC-NPs made from PLGA cores. Figure 4 depicts the schematic of the preparation of RBC-NPs with cell-specific targeting ability.

CONCLUSION

Cell membrane-coated nanoparticles use a new top-down method to faithfully move the entire surface of the cell to synthetic nanoparticles, including all lipids and membrane-associated proteins. This latest class of biomimetic nanoparticles has shown considerable potential for

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therapy. They are capable of prolonging systemic circulation, essential for both passive and active targeting mechanisms, from a drug-targeting perspective, thus allowing synthetic biomaterials such as biocompatible polymers to be used to carry therapeutic agents. The lipid insertion approach provides these nanoparticles with suitable targeting ligands and regulated density for cell-specific targeting without requiring any chemical reactions that could potentially disrupt the protein composition on the surfaces of the nanoparticle. Alternatively, these nanoparticles achieve cell-specific targeting capacity through inherent homotypic or heterotypic adhesions when coated with membranes extracted from selected cells. Cell membrane-coated nanoparticles, meanwhile, bear an antigenic exterior that closely mimics that of the source cells, making them excellent platforms for antigen presentation. By customizing the physicochemical properties of the synthetic cores, successful immune targeting is possible.

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