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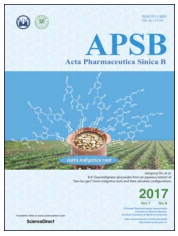

REVIEW

Biomacromolecules as carriers in drug delivery and tissue engineering

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Abstract Natural biomacromolecules have attracted increased attention as carriers in biomedicine in recent years because of their inherent biochemical and biophysical properties including renewability, nontoxicity, biocompatibility, biodegradability, long blood circulation time and targeting ability. Recent advances in our understanding of the biological functions of natural-origin biomacromolecules and the progress in the study of biological drug carriers indicate that such carriers may have advantages over synthetic material-based carriers in terms of half-life, stability, safety and ease of manufacture. In this review, we give a brief introduction to the biochemical properties of the widely used biomacromolecule-based carriers such as albumin, lipoproteins and polysaccharides. Then examples from the clinic and in

Abbreviations: ABD, albumin binding domain; ACM, aclacinomycin; ACS, absorbable collagen sponge; ADH, adipic dihydrazide; ART, artemisinin; ASF, *Antheraea mylitta* silk fibroin; ATRA, all-trans retinoic acid; ATS, artesunate; BCEC, brain capillary endothelial cells; BMP-2, bone morphogenetic protein-2; BSA, bovine serum albumin; BSF, *Bombyx mori* silk fibroin; CC-HAM, core-crosslinked polymeric micelle based hyaluronic acid; CD, cyclodextrin; CD/BP, cyclodextrin–bisphosphonate complexes; CD-*g*-CS, chitosan grafted with β-cyclodextrin; CD-NPs, amphiphilic MMA–tBA β-CD star copolymers that are capable of forming nanoparticles; CIA, collagen-induced arthritis; CM, collagen matrices; CMD-ChNP, carboxylmethyl dextran chitosan nanoparticle; DHA, dihydroartesunate; DOXO-EMCH, (6-maleimidocaproyl)hydrazone derivative of doxorubicin; DOX–TRF, doxorubincin–transferrin conjugate; DTX-HPLGA, HA coated PLGA nanoparticulate docetaxel; ECM, extracellular matrix; EMT, epithelial mesenchymal transition; EPR, enhanced permeability and retention; FcRn, neonatal Fc receptor; GAG, glycosaminoglycan; GC-DOX, glycol–chitosan–doxorubicin conjugate; Gd, gadolinium; GDNF, glial-derived neurotrophic factor; GO, grapheme oxide; GSH, glutathione; HA, hyaluronic acid; HA-CA, catechol-modified hyaluronic acid; HCF, heparin-conjugated fibrin; HDL, high density lipoprotein; HEK, human embryonic kidney; HSA, human serum albumin; IDL, intermediate density lipoprotein; INF, interferon; LDL, low density lipoprotein; LDLR, low density lipoprotein receptor; LDV, leucine–aspartic acid–valine; LMWH, low molecular weight heparin; MSA, mouse serum albumin; MTX–HSA, methotrexate–albumin conjugate; NIR, near-infrared; NSCLC, non-small cell lung cancer; OP-Gel-NS, oxidized pectin-gelatin-nanosliver; pDNA, plasmid DNA; PEC, polyelectrolyte; PTX, paclitaxel; RES, reticuloendothelial system; RGD, Arg–Gly–Asp peptide; rHDL, recombinant HDL; rhEGF-2/HA, recombinant human fibroblast growth factor type 2 in a hyaluronic acid carrier; SF, silk fibroin; SF-CSNP, silk fibroin modified chitosan nanoparticle; SFNP, silk fibroin nanoparticle; SPARC, secreted protein acidic and rich in cysteine; Tf, transferrin; TfR, transferrin receptor; TRAIL, tumor-necrosis factor-related apoptosis-inducing ligand; VEGF, vascular endothelial growth factor; VLDL, very low density lipoprotein

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recent laboratory development are summarized. Finally the current challenges and future prospects of present biological carriers are discussed.

1. Introduction

The development of carrier systems for effective delivery of therapeutic compounds or imaging agents is crucial in the battle against various diseases. The ideal carriers should be safe, efficient and have optimal bioavailability. In addition, stability, nontoxicity and non-immunogenicity, and targeting ability to a specific site are very important.

Miscellaneous drug carriers including liposomes, synthetic polymeric micelles, hydrogels, magnetic nanoparticles, microspheres and microcapsules have been developed in recent years for the diagnosis and treatment of disease[1–8]. However, it is very difficult to identify an ideal drug carrier system. The shortcomings of the above carrier systems are obvious: liposomes have poor stability, high cost, low drug loading content and undesired release of hydrophobic drugs[1,9]. The toxicity and nondegradable property of some nano-materials also limit their applications as drug carriers[10].

Natural-origin biomacromolecules perform a diverse set of functions in their native setting. For example, polysaccharides function in membranes, intracellular communication and as storage sites, whereas proteins function as structural materials, transport

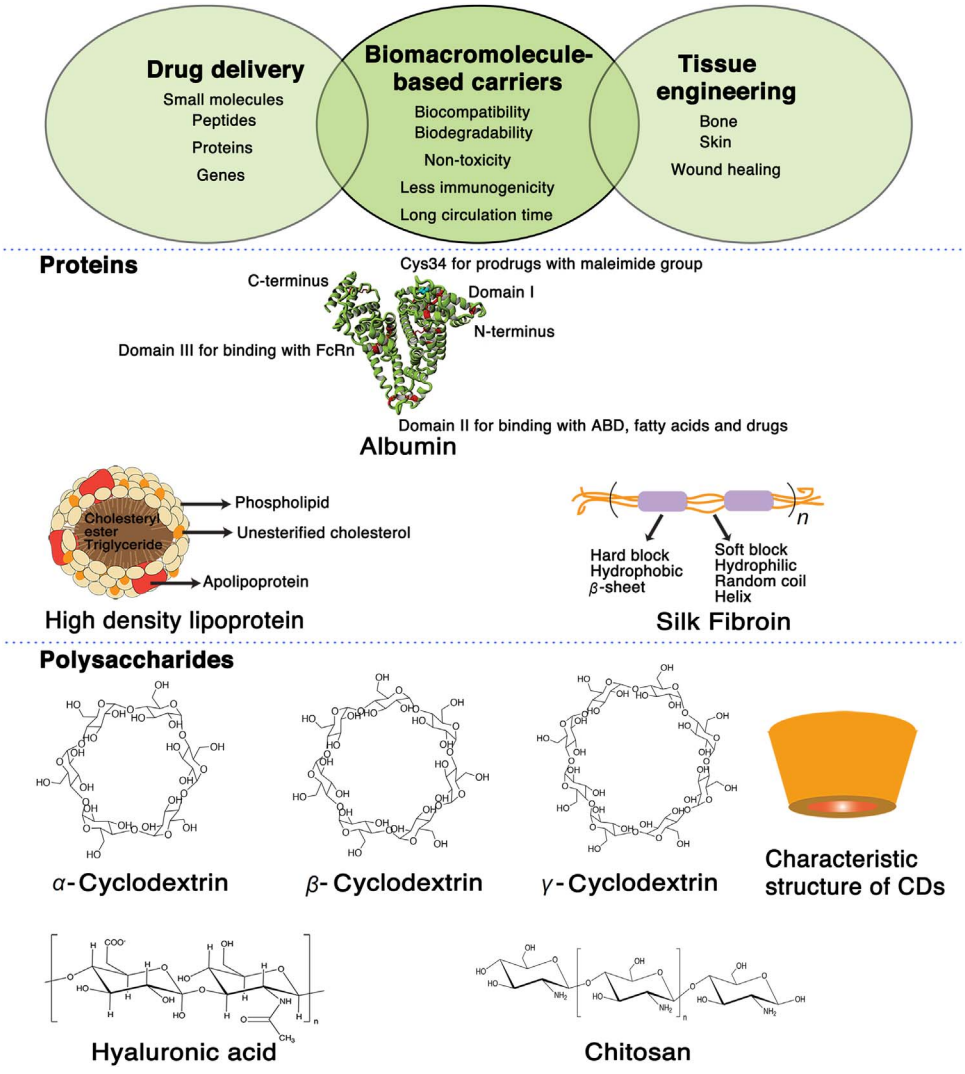

Figure 1 The properties and applications of biomacromolecule-based carriers and structures of representative proteins and polysaccharides.

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