GLIMPSES INTO THE EXCITING WORLD OF BIOMATERIALS THROUGH DRUG DELIVERY SYSTEMS

Dhirendra S. Katti

Department of Biological Sciences and Bioengineering,

Indian Institute of Technology Kanpur, Kanpur – 208016, INDIA

ABSTRACT

'Biomaterial science' addresses the properties and application of materials (both synthetic and natural) that are used in contact with biological systems. The field encompasses aspects of *medicine, biology, chemistry, and material science* and sits on the foundation of *engineering principles*. Advances in these areas in last few decades have led to evolution of biomaterials from simple inert prosthetic devices to those that have bio-instructive capabilities. A successful example of newer generation biomaterials is the orthopedic metallic implant that is plasma-sprayed with hydroxyapatite to bond to bone at a faster rate and with higher strength. While a lot of emphasis has been given to material design for implants, another important domain of biomaterials has 'delivery of drugs' as its major aim. 'Drug delivery' involves the design and development of intelligent cargo carrier systems that can deliver their cargo (drugs/pharmaceutical agents/bioactive molecules) to specific parts (organs/tissues) in the human body on demand with control on the rate of delivery. This area derives its motivation from the strong need for improved therapeutics in human health care. There have been several challenges in engineering successful drug delivery systems, these include (i) Controlled drug delivery – modulation of duration and kinetics of drug released into the body; (ii) Targeted delivery –

delivery of biologically active form of drug to specific site or cell population; (iii) Crossing tissue barrier such as lungs, intestine, blood-brain-barrier etc.; and (iv) Crossing cellular barriers like endosomal escape for cytoplasmic/nuclear delivery of molecules/ proteins/ DNA. A wide variety of cargo carrier systems/vehicles have been developed for overcoming these challenges including dendrimers, polymer drug conjugates, micelles, liposomes, polymeric particles and polymeric capsules. Further, surface modifications have been made to these basic vehicles to facilitate the process of overcoming the aforementioned challenges. These modifications include but are not limited to surface immobilization of monoclonal antibodies, engineered peptides, poly(ethylene glycol), and mucoadhesive molecules. Specific examples which address each of the aforementioned challenges will be discussed to enable a deeper understanding of the intricacies involved. An example of controlled release of drug at desired site is the use of polymeric particles which are degraded only in presence of microbiota intrinsic to colon of human alimentary canal, thus opening avenues for controlled drug release in the colon. Another recent development is of nanoparticles surface modified with small molecules which enable targeting of nanoparticles specifically to endothelial cells that line blood vessels over any other cell type. The third case will be that of design of nanoparticles for improved penetration across tissue barriers for drug delivery into posterior part of the eye. Finally, an example of polymer conjugate will be discussed. In this case a combination of targeting moiety, endosomal escape peptide and therapeutic molecule has been used for targeted delivery and for crossing tissue and cell barriers. The talk will end with current achievements and challenges in the field and directions that are opening up in the near future.