IOP Concise Physics

Advances in Nanomaterials for Drug Delivery

Polymeric, nanocarbon and bio-inspired

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Chapter 1

Introduction

Living organisms such as the human body are colonized (or sometimes invaded) by a large variety of micro-organisms such as bacteria, archaea and viruses. Needless to say, these micro-organisms have adapted their life-cycle to allow them to survive in many organs and tissues within the human body. Bacterial cells colonize the human intestine, the mouth and even the skin. A considerable fraction of these bacterial species is composed of beneficial bacteria, which control some of the critical metabolic functions in the gut, and modulate the immune function in many mucosal surfaces. Moreover, these bacteria have a vital role in modulating our immune system to help with the intrinsic defense of the host [1, 2].

Over many years it has been proved that some of these bacteria can play a role as oncolytic agents in the treatment of cancer. In this case, pathogenic bacteria can be applied as anti-cancer agents, although this procedure in some cases is very specific to individual patients. For example, cancer regression has occasionally been observed as a result of *Clostridium perfringens* infection. Some novel techniques use therapeutic bacteria delivered to the target tissue by physiologic injection [3, 4].

Nanomedicine is a developing field which includes different disciplines, such as material science, chemistry, engineering and medicine devoted to the design, synthesis and construction of high-tech nanostructures. The ability of these structures to have their chemical and physical properties tuned by structural modification has allowed their use in drug delivery systems, gene therapy delivery and various types of theranostic approaches. Colloidal noble metal nanoparticles (NPs) and other nanostructures have many therapeutic and diagnostic applications. The concept of drug targeting as a magic bullet has led to much research in chemical modification to design and optimize binding to targeted receptors [5].

The tunability of these high-tech nanostructures, such as surface modification and control of the molecular weight, has attracted much attention to the potential of

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doi:10.1088/2053-2571/aadd7cch1

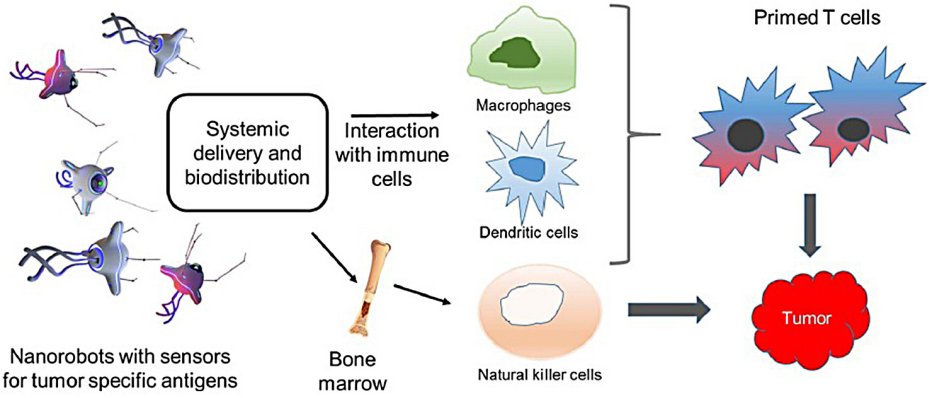

Figure 1.1. Schematic illustration of the mechanism of bio-inspired nanorobots to trigger priming of T cells against destruction of tumor cells. Reprinted from [7], with permission from Elsevier.

nanotechnology in drug delivery systems to achieve critical goals such as time-controlled and target-specific delivery [6].

Immune-targeted nanotherapeutics (nanorobots) have been introduced as a novel strategy to produce gene or drug delivery systems. Nanorobots may contain polymeric, hyper-branched, nature-based and pathogen-based nanomaterials that can, for example, be conjugated with an antibody to target specific cells. In addition, these systems can be functionalized with ultra-sensitive moieties to interact with biological cells to trigger a tailored response. Bio-inspired delivery systems take advantage of structures found in nature to construct nanosystems with advantages over synthetic polymeric-type materials (figure 1.1) [7].

It is vital to understand the precise relationship between the drug and the carrier, and its ability to target specific tissues and pathogens, in order to make an efficient drug delivery system.

In this book, we cover advances based on different drug delivery systems: polymeric and hyper-branched nanomaterials, carbon-based nanomaterials, nature-inspired nanomaterials and pathogen-based carriers.

References

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