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Protein-Nanoparticle Interactions

The Bio-Nano Interface

 Springer

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Morteza Mahmoudi: I dedicate this book to the following lovely people: Haniyeh Aghaverdi, Fatemeh Ardeshir, Shokrollah Mahmoudi, Sedighe Soleimani, Ali Aghaverdi, Hossein Ardeshir, Mahin Khosravi, Mahmood Mahmoudi, and Moazameh Asadi-Khoyi.

Preface

Nanoscience has been a subject of study for at least a century, although fields, such as colloid science and cellular biology, were not known by this name. Nanotechnology started in the early 1980s due to the advances made in integrated circuits and has gained drastic growth and development over the last decade. Due to the high potential for commercial product developments, today, nanoscience and nanotechnology are tremendous topics of interest for both academic communities and industrial sectors. A distinguishing feature of nanotechnology and nanoscience is the design of new physicochemical properties of nanostructured materials that cannot be attained by using bulk materials. Designed properties of nanomaterials have great potential to enhance many conventional and well-recognized matters in our modern life. The rapid launch of new products incorporating nanotechnology is showing a clear trend across a wide spectrum of fields from manufacturing and bio (nano)materials to electronics and information technology applications. One of the promising subfields of bionanoscience is “nanomedicine,” which is recognized as a highly interdisciplinary field to provide precise theranostic (i.e., simultaneous diagnosis and treatment) agents for fast, high-yield, easy, and low-cost treatment of catastrophic syndromes with minimal side effects and lower patient compliance. Although nanomedicine field has been extensively developing by scientific community, these will have the longest time to successful market. The major shortcoming for commercialization of bionanomaterials is the “protein corona” effect and poor understanding of protein–nanomaterials interactions, to date. Protein corona is recognized as the protein (and other biomolecules) layers which are formed at the surface of nanomaterials, upon their entrance to the biological medium. Therefore, what a biological entity (e.g., cells, tissues, and organs) actually “sees” when interacting with nanomaterials is completely different from the original pristine surface of the nanomaterials. This new biological identity of the nanomaterials is achieved by creation of a new interface between the nanomaterials and the biological medium, the so-called bio-nano interface.

In this book, a wide scope of current and future developments of protein corona is covered by combining contributions from faculty members in materials science, chemical engineering, chemistry, biomedical engineering, and biology. Great emphasis is given to the interdisciplinary nature of the protein corona and bionanointerfaces.

After deep description of the biological significance of nanointeractions in Chap. 1, the authors dedicate Chap. 2 to protein corona; in this case, the importance of the physicochemical characteristics of nanomaterials (e.g., size, shape, charge, coatings, surface modifications with targeting ligands, crystallinity, electronic states, surface wrapping in the biological medium, hydrophobicity, and wettability) on the nature of the formed corona is discussed in details. In Chap. 3, full applications, opportunities, and challenges of protein corona, to date, are provided; in addition, a broad overview of both *in vitro* and *in vivo* data on the role of protein–nanomaterials interactions in determining nanomaterials' fate and behavior is provided. Chapter 4 presents comprehensive description of the currently available evaluation techniques for assessing the protein corona.

Readers will obtain a deep understanding of the effect of the nanomaterials' physicochemical properties and other factors (such as slight incubating temperature changes) on the final structure, composition, and function of nanomaterials–protein complexes present in biological fluids and on their possible impact on the nanomaterials' fate and behavior either *in vitro* or *in vivo*. Also, a broad overview on the major shortcomings of the protein corona effect would be achieved. In addition, the reader will realize the further steps required to fully understand the role of protein–nanomaterials interactions in determining nanomaterials' fate and behavior together with the strategies to control/predict biological fate of nanomaterials.

Finally, I would like to thank the production team of Springer for their continuous and dedicated support during the preparation of this book.

Tehran, Iran
Spring 2013

Morteza Mahmoudi

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