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Benefit from Nanoscience and Nanotechnology: Benefitting Patients

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The key issues treated within this book are medically driven. The related research, however, requires detailed medical knowledge not only in the specific fields but also state-of-the-art materials science, physicochemical methodology, and advanced data analysis. Hence, the book is truly interdisciplinary. It bridges basic science all the way through translation to clinicians. This book connects physicists, chemists, and materials scientists to biologists, dentists, and clinicians across its entire field.

During the first decades of this century, the solvent foundations financially promote the application of nanoscience and nanotechnology in preventing, diagnosing, and treating numerous diseases, as the first part of this book impressively elucidates. These huge investments raise expectations of the society. Especially, the eligible expectations of the suffering patients should become satisfied. The translation of knowledge in nanotechnology to the bedside within a reasonable period of time is an urgent task of our community. The translation can only be successful by a collaborative effort. This book will be of some help.

The pioneers in biology and biochemistry of the last century set the scene for the currently available greater understanding of normal and disordered functions. It has become clearer and clearer that the cells with their extracellular matrix have a complex molecular life, which includes metabolic pathways and signaling. This natural nanoscale machinery can interact with man-made nanostructures with negative and positive feedback. In most cases, the human system recognizes the foreign bodies and develops related reactions. Therefore, it is particularly important to mimic natural counterparts. For example, we can consider the cell membrane formed by phospholipids. Such molecules also constitute the vesicles, which are going to save lives and support healing cardiovascular diseases. The properties of the vesicles can be even better tailored using artificial phospholipids. The discovery of shear-sensitive liposomes is a major milestone

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in the development of dedicated drug-delivery containers avoiding the serious side effects. It is, however, known that even FDA-approved liposomal formulations show comparably strong complement activation. Therefore, organic chemists and biochemists have to search for more appropriate formulations. Subsequently, immunologists and veterinary doctors must demonstrate the harmlessness. The current developments in the United States and Europe, often financially supported by donations, are promising but need more intensive efforts to bring the ideas from nanotechnology to the market within less than a decade.

Malignant neoplasms are known as cancers. Their treatment is challenging and many clever strategies have been applied. Since the success of the various therapeutic approaches is still limited and the primary underlying cause of cancer is found in DNA damages, one can reasonably expect serious contributions of nanotechnology to medication and radiation of malignant neoplasms. The widely used photon therapy, for example, will be replaced by particle therapy for an increasing number of cases simply because of physical reasons. This book describes these reasons in the necessary detail understandable for the broad readership. Nanotechnology-based drugs with multifunctional properties are other promising paths to successfully treat cancer patients. As the cancerous tissue grows faster than the healthy one, the supply with nutrients and oxygen is crucial. If one can prevent the growth of malignant neoplasms via significantly reduced supply and the enrichment of species to destroy the diseased tissue, many cancer patients will be cured. The diagnosis of cancer and the precise localization of malignant neoplasms within the body belong to the partly solved challenges. Here, nanomechanical devices will complement conventional pathology.

The interface between the human body and man-made materials is the key to reestablish necessary functions of our body. There are some oxidized metal implants with perfect tissue integration. Medical implants made out of polymers are often better suited than the radio-opaque metallic implants. One chapter elucidates the recent advances in biomimetically structured polymers. Anisotropies as present within the tissues of our body are relatively easy to implement. Such anisotropy is also required in crown repair. Remineralization to reestablish the mechanical performance of the natural dentin and enamel could be achieved within the next decade. The basic ideas in nanodentistry are available.

Dedicated devices based on cutting-edge nanotechnology are known in areas such as optics and electronics. In medicine, their application is more demanding especially because of security issues, wet environment, and encapsulation. The artificial sphincters are certainly such a killer application. Once thousands of nanometer-thin dielectric elastomer layers with compliant electrodes are built, many incontinent people will benefit.

Today, we already benefit from titania and zinc oxide nanoparticles to protect our skin in ultraviolet light. Although one reasonably believes that there is no danger related to these nanoparticles and the currently published studies do not show any serious impact on our body, their application needs caution. A more detailed understanding of the migration of nanoparticles through our skin in health and disease has to be generated.

Some of the important challenges are missing within the book. Tissue engineering, which often roots on the triage between cells, signaling molecules, and three-dimensional scaffolds, is not considered. These scaffolds are often prepared from absorbable materials. Such materials including magnesium alloys are applied for load-bearing implants and will play an important role because of their dedicated micro- and nanostructures. Dedicated features are fabricated by means of advanced nanotechnology.

The neurodegenerative diseases could also benefit from research and development in nanotechnology. Everybody knows that the electrical signals in our brain have amplitudes that well fit the voltages used in our mobile phones and other computers. The creation of suitable interfaces between the neurons and the cables/antenna of the man-made devices is an unsolved challenge and certainly needs ideas from nanosciences.