Global Science Research Journals

Global Journal of Animal Breeding and Genetics

Extended Abstract Open Access

Harnessing Biomaterials in Nanomedicine

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Abstract:

Biomaterials are substances that are engineered to form them suitable for interaction with a biological system. Biomaterial constructs and self-assemblies have been explored for drug and protein carriers, cell engineering and tissue scaffolds, or to manage the interactions between artificial devices and the body, just to make some examples of the more recent developments. Biomaterials involves not only synthetic materials (polymers, ceramics and composites), but also biological materials such as proteins, cells and tissues. The range of applications for biomaterials is rapidly increasing, with different physical, mechanical and medical properties required for various applications.

The protein-based fibres for biomedical applications stems from the very fact that a lot of proteolytic enzymes are capable of degrading commonly used natural polymers which are already present within the body. In the case of protein-based biomaterials, degradation of those materials results in the assembly of amino acids that pose no risk and may be reabsorbed by the body. One of research interest is in fabricating protein nanofibers for medical purposes. We have developed protein nanofibers using electrospinning method for wounds induced in mice. These interesting studies in biomaterials will be presented during the presentation. Vaccination has produced one of the greatest impacts on human health in history (1). No other breakthrough has virtually eradicated fatal diseases like polio or smallpox with just a few doses.Therefore, many diseases makes impact on public health create complex challenges for existing vaccine and immunotherapy strategies. For example, HIV evades clearance by mutation and concealment within the mucosa, tumors actively suppress tumor-destructive immune cells, and lots of treatments for autoimmune disorder lack specificity. To address challenges like these, new vaccines and immunotherapies will got to generate potent responses against specific molecules—termed antigens—while also tuning the characteristics of those responses to combat a target disease. Lymph nodes (LNs) and therefore the spleen are a number of the key structures that coordinate the sort and specificity of those responses.

In last sidereal years, the impact of nanoparticles (NPs), microparticles (MPs), and other biomaterial vaccine and immunotherapy carriers on LNs has been an intriguing area of focus. These studies reveal the potential of biomaterials to program the local LN microenvironment to regulate systemic immune reaction. A broad potential of biomaterials for vaccination and immunotherapy has recently been reviewed (2–4). This paper generallyfd focuses specifically more on the interactions of biomaterials with LNs and other immune tissues during the generation of stimulatory or regulatory immune responses. The discussion begins with background describing how adaptive immune responses are generated, with a stress on the active role that LN tissues and resident cells play in these processes. Recent examples are then discussed to demonstrate that how biomaterials enhance the generation of immunity, for instance , against a far off pathogen, or of tolerance, like to combat autoimmune disorder . The review concludes by identifying unanswered questions and highlighting some of the ways in which answers to these questions could inform new approaches to exploit the interactions between biomaterials and LNs for vaccination, immunotherapy, and tissue engineering.

The innate immune system is composed of first-response defines mechanisms including (i) skin that creates a physical barrier against pathogens, (ii) immune cells that home to and engulf pathogens or other in organic structures, and (iii) receptors that detect broad classes of molecular patterns absent in mammals but present in viruses and bacteria. In contrast, adaptive immunity involves the generation of immune responses specific for a molecule, termed an antigen. Generation and control of those antigen-specific responses require complex interactions between immune cells, antigens, and soluble factors in secondary lymphoid organs. These tissues include the spleen, LNs, and Peyer's patches. The spleen samples circulating antigens present in blood, while specialized nodules termed Peyer's patches sample antigens in mucosal tissues like the tiny intestine.

LNs form throughout the body, concentrating on antigens from a network of lymphatic vessels that continually sample tissue for antigens or other immune signals (7,8). Soluble antigens with molecular weights of ~70 kDa or with particle size between 20 and 50 nm passively drain along the lymphatics, while larger antigens or pathogens are phagocytosed and carried to those LNs by specialized antigen-presenting cells (APCs) like dendritic cells. APCs continually survey tissue and blood for inflammatory signals and antigens, which upon detection, stimulate phagocytosis and a change within the expression of homing receptors that permits antigen-experienced APCs to travel to nearby "draining" LNs. In LNs,the processed antigens represented by APCs to activate resident T and B lymphocytes. Lymphocytes and molecules which are secreted by these cells exit LNs and search the periphery to immobilize or destroy the pathogens against which they're armed in LNs. Thus, LNs are key structures that vaccines and immunotherapies must reach to get antigen-specific responses which will combat pathogens and diseased tissue located in other regions of the body. Nanoparticles and microparticles, and other biomaterials are the advantages in vaccination because these materials provide opportunities to modulate specific characteristics of immune responses. The idea of "tuning" immune responses has recently been wont to combat infectious diseases and cancer, and to induce tolerance during organ transplants or autoimmune disorder. Lymph nodes and other secondary lymphoid organs like the spleen play crucial roles in determining if and the way these responses develop following vaccination or immunotherapy. Thus, by manipulating the local microenvironments within these immunological command centres, the character of systemic immune reaction is often controlled. Strategies that draws on mechanical properties, surface chemistry, stability, were targeting to change the interactions of cells, signals, and vaccine components in lymph nodes. There are still unanswered questions circulating how best to style biomaterial-based vaccines to market specific structures or functions in lymph nodes, features like controlled release and targeting will help pave the way for next generation of vaccines and immunotherapies that generate immune responses tuned for specific applications. LNs are bean-shaped like structures surrounded by a collagen-rich fibrous capsule. Antigens—in soluble form or phagocytosed within APCs enter LNs via afferent lymphatic that drains lymph fluid flowing from upstream lymphatic vessels. This fluid travels around the periphery.

Biography:

Dr. Srinivasan completed her MSc and PhD from University of Bradford, UK. She briefly worked at Max Plank, Germany, followed by her postdoctoral research at Thomas Jefferson University, Philadelphia. USA. Currently, Dr. Srinivasan, heads PG program in Nanoscience and Technology at Department of Nanoscience and Technology, Faculty of Life Sciences, JSS Academy of Higher Education and Research, Mysore. India. Her area of research involves development of aerosol formulations for pulmonary delivery, development of nanoformulation of biologics especially antibody, harnessing biomaterials in nanomedicine, endocytosis of nanomedicine.