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Opinion note

Elucidation of the origin of autoimmune diseases via computational multiscale mechanobiology and extracellular matrix remodeling: theories and phenomenon of immunodominance

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ABSTRACT

Experimental practices of computational multiscale mechanobiology were applied to explicate different topographies of mechanobiology and to predict the fine minutiae of mechanosensing and mechanotransduction in a cellular system accurately. Autoimmune diseases denoted as biologically implausible. Recently, scientific and medical communities investigated autoimmune diseases and associated settings to conclude the disarrays of autoimmune as earlier as possible. Therefore, an urgent need is there to evaluate ocular immunology and the route of growth of autoimmune diseases. Scientific investigations play a significant role to detect interrelated cures and bearing research for probing treatments for autoimmune diseases, which are yet undiscovered. Extracellular matrix remodeling followed in the cellular microenvironment dynamically to manage remodelling events. Immunodominance deals with the immunodominance mechanism evolved in response to clearing any type of infection and not yet distinguished entirely.

INTRODUCTION

An urgent need is there to offer a state-of-the-art overview that explains the scientific relationship between theoretical and computational models. These interpretations were highlighted significant features of multiscale phenomena in biomechanics and mechanobiology by employing mathematical framework and computational techniques for foretelling multiscale models (Mak et al., 2015). Biomechanics defined the role of physical forces in biological systems at the molecular, cellular, and tissue scales and explain how cells produce and respond to mechanical forces. The computational techniques explore underlying mechanisms and propose theoretical and computational modeling procedures based on mechanics and mathematical biology (Wang et al., 2019). Mechanical signals are the combination of various signaling proceedings in the biological landscape and classified as force, stiffness and deformations, which complete the mechanobiological circuit, regulate protein unfolding, and cytoskeletal remodeling. Computational multiscale mechanobiology improve the current understanding of cells-nature and cellular circuit (Giorgi et al., 2016). The implementation of these findings accurately predicts details of mechanosensing and mechanotransduction, and determines the causes and origin of autoimmune diseases.

EXTRACELLULAR MATRIX REMODELING

Emerging experimental findings on computational and experimental methodologies elucidate their applicability for the study of extracellular matrix remodeling, theories, and phenomena of immunodominance (Sree and Tepole, 2020) (Fig. 1).

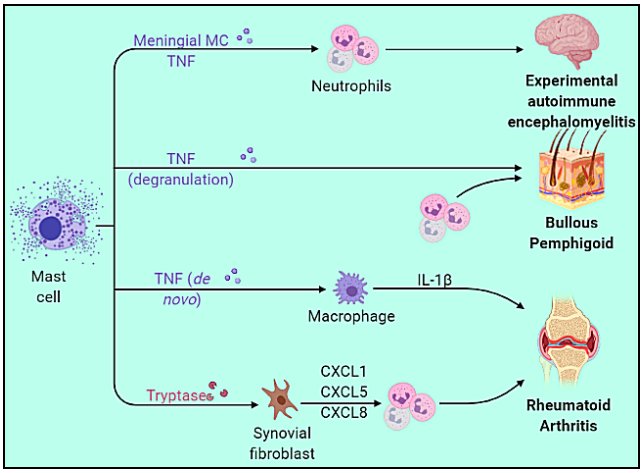

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Fig. 1. Illustration of phenomenon of immunodominance and the origin of autoimmune diseases and mast cells.

These modern approaches and tools have pointed out that they provide insight and understanding of the interplay of macromolecules at molecule and tissue-level. These features govern the impact of the biological activity and effectiveness as new computational models suggested theoretically. Evaluation of the specific interactions of

essential macromolecules in a mechanical micro-environment by the aforementioned modeling approaches enhanced the understanding of the underlying mechanism of remodeling, theories, and phenomena of immunodominance (Ursini et al., 2018). These investigations are further fruitful in designing new treatment remedies according to the need of the chemical compositions and physical needs of the extracellular environment. The prescribed computational multiscale mechanobiology models are more realistic and dissolved all the confusion continued about the cytoplasmic microtubule network (De et al., 2015).

PATHOGENESIS AND ORIGIN OF AUTOIMMUNE DISEASES

The pathogenesis and origin of autoimmune diseases are unknown despite the details available related to the underlying mechanism of extracellular matrix remodeling (Karsdal et al., 2021). Furthermore, theories and phenomenon of immuno-dominance concerned with the autoimmunity aspects and its networking connections existed in extracellular matrix elements (Cheikhi et al., 2020). Therefore, understanding the pathogenesis can explore the unsolved mysteries hindering the path of the development and can help in the underlying investigation related to the roles of different features of mechanobiology in it (Cummins et al., 2019). Unsolved mysteries (how do extracellular vesicles govern exosomes, microparticles, detect pathogen-associated molecular patterns, and involve in the pathogenesis of autoimmune diseases) are there for which researchers are searching for a scientific reply.

As, the pathogenesis of autoimmune diseases influences cell-cell communication, networking of the signaling pathways, physiopathological mechanisms of cell machinery, and several other underlying mechanisms in mechanobiology routes (inflammation, cell differentiation, immune signaling, senescence, proliferation, angiogenesis, and stress response) (Kumar et al., 2021). Moreover, the extracellular matrix contains collagen, electrolyte fluids, polysaccharides, and proteins that may have an association with the complexities of chronic disease. A serious effort can reveal several essential functions to discover the concerned routes and pathways, which are as follows: To determine the structural scaffold of cells, to establish a set of scales among cell existence and cell death, control the growth factor for better functioning of cytokines, changing the signaling patterns of cell-to-cell communication and lifestyle of cells (Nowak, 1996). The cellular activities and initiation of the antigens affect the autoimmune-prone T-cell repertoire and any change in it influences the predisposition to autoimmunity. Several features of mechanobiology maintain normal topographies of autoimmune arrangement, the origin of necroinflammation, and signaling pathways of necrotic cell death. Additionally, the research on the mechanism (initiation and progression) of diseases (autoimmune disease, infection, thrombosis, ischemic injury, fibrosis, tumour growth/progression, haemorrhage, oedema, and inflammation) and routes of transport autoimmune elicits all over the body enhance the current understanding about autoimmune diseases, and related causes i.e. cellular stress, biogenesis, and intercellular trafficking (Kim et al., 2011). Any change in the physiological or pathophysiological settings of the cells influences the production of the immunogenic intracellular molecules and finally, these happenings interrupt the immune system.

CONCLUSION

These investigations are definitely helpful in probing pharmacological solutions to treat necrosis, necro-inflammation, definite physiological and patho-physiological circumstances. In the end, to expose the complex phenomenon of immunodominance that lead the pathogenesis, serious investigations can detect it as a whole and finally help in searching for effective remedies to treat autoimmune diseases.

CONFLICTS OF INTEREST

The author declares no conflicts of interest.

DECLARATION

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