Chapter 1
Ion Channels, Nanomechanics, and Nanomedicine

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ABSTRACT

Ion channels are naturally occurring pores found in all living organisms. These may be of different types, activated by many stimuli, but their addition or alteration may cause serious physiological issues. They allow some ions to pass through them and are resistant for some ions. So they are ion selective. For the pharmaceutical industry, ion channels are now bird’s eye view as many drugs, intended to cure a disease, target ion channels located in a specific part of our body. Quantum dots, nanoparticles, carbon nanomaterials change the channel properties in a considerable amount. A huge potential of targeting the ion channels for changing the treatment procedure completely is now opening a new side of nanomechanics, nanofluidics, biophysics and medicine. The following paragraphs will describe how experimental as well as theoretical studies can bring a lot of change in the field of medicine. The fatal disease like cancer and male infertility; these two important issues are addressed here. The dependent of such diseases on ion channels and the way of treating them are emphasized.

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INTRODUCTION

Ion channels allow the flow of ions through cell. They are integral membrane protein assemblies and activated by different stimuli. The activation procedure depends on the nature of the channel and some are activated by second messengers, some by voltage or temperature or sometimes by mechanical stress. These factors open the channel gate and changes the amount of ions entering or leaving the cell. The research on ion channel came into light by a series of work of Hodgkin and Huxley (1952a, 1952b). They measured the electrical current in the channel. They represented the membrane as an electrical circuit and measured the flow of current. There are two ways of production of current; one is the charging of the membrane capacity and other is the ionic movement through the resistors parallel to the capacitance. Sodium and potassium currents have different contribution to the total current. The movement of the isolated giant axon of Loligo got a clear reason which is the change of sodium and potassium permeability of the channel to electrical stimuli. The presence of the action potential was also established. Using only voltage clamping, the first current from individual ion channels was measured by Hladky and Haydon (1972). Gramicidin ion channel was taken by these researchers as it is made up of small peptides placed in the lipid bilayer. It is a simple channel to study the structure function relationship of the ion channels. Agre and Mckinnon (2003) were awarded the Noble prize for discovering ion channels in cell membrane. For the discovery of water channel and structure and mechanistic studies of ion channels. In the noble lecture of Mackinnon (2004) he explained the structural principles of the gating and regulation of potassium ion channel which governs the electrical signaling in the nervous system with many other physiological processes. Ion channels play pivotal functions in biological cells such as it produces action potential where ion channels are present, e.g. nerve and muscle. the regulation of hormone release from endocrine cells (Hille, 2001). Alteration of deletion of parts of ion channel induces a number of diseases, like disorder of the nervous system and cardiac system.

BACKGROUND

Considerable information about ion channels are gathered up till now that added important means of further progress in the field. The C-type inactivated K+ channels serves as water pathway (Hoomann, NJahnke, & Horner, 2013). Though it allows water transportation through it, it prevents ions. water flow is another important action observed by these channels. Homology models of the pore loop domain of voltage-gated potassium channels kv1.1-kv1.6 are generated by Liu and Lin (2004). Polyamines are marked as the gating molecules for inward-rectifier K+ channels.
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