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SYSTEMS BIOLOGY APPROACH IN COMPUTATIONAL BIOMECHANICS

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Most organs of the human body, including the eyeball, esophagus, stomach, gallbladder, uterus, ureter, and bladder, can be viewed as thin shells. They are made out of biological tissues are heterogeneous, incompressible composites with inherently nonlinear behavior and high deformabilty. The above properties define the high degree of variability of shapes that the organ can take on in the process of loading. Biomechanical investigations into different aspects of structure and function of organs have mostly utilized reductionist approaches to analyze mechanics of processes, leaving unstudied the operative integration of component processes involving electrical, chemical and mechanical coupling. Integrative systems biology based models that incorporate various data and serve as the basis for multilevel analysis of interrelated biological phenomena are lacking. Such models will have enormous impact on unraveling hidden mechanisms of diseases and assist in the design of their treatment.

With the latest advancement in computacional biomechanics, it has become possible to develop achúrate, biologically plausible models of multiple organs. Thus, with a model of the gastrointestinal tract it has been possible to reproduce a variety of electromechanical wave phenomena including the gradual reflex, pendular movements, segmentation and peristalsis in the stomach and intestines [1]. A theoretical framework for the analysis of integrated physiological phenomena in the pregnant uterus [2] has allowed us to reveal intricate processes of synchronicity in electromechanical activity of the uterus during different stages of labor and delivery. A biomechanical model of the human urinary bladder has help us unravel the dinamics of urination and study the pathogenesis of detrusor overactivity [3].

The modern systems biology approach in computational biomechanics offers insight into the physics of complex wave phenomenon by providing new explanations for experimental data and re-interpreting old observations using novel conceptual views on hierarchical electromechanical and electrochemical conjugation in biological media. With this strategy it will become posible to eliminate many of the mistakes and misinterpretations of physiological and clinical findings that have been dominating the biomedical field for several decades.

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