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BRAIN MECHANICS ACROSS SCALES

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ABSTRACT

The brain is one of our most complex organ systems. Despite decades of intense research, many fundamental processes and diseases are still not fully understood. While a large body of literature exists regarding the role of chemical signaling in regulating brain function, only recently the important contribution of mechanical stimuli has been discovered. To fully understand brain development, homeostasis, and pathology, it is therefore key to synergize the expertise of engineers, physicists, biologists, medical researchers, and clinicians to explore mechanics as an important puzzle stone. This endeavour is challenging as brain tissue is not only ultra-soft, biphasic, and highly heterogeneous, but also continuously changes its microstructural composition and architecture as well as its mechanical properties – in close relation to evolving brain function. Living brain cells actively sense and respond to their mechanical environment, leading to sophisticated coupling effects. Therefore, it is important to consider different time (development, ageing, injury/disease) and length (cell, tissue, organ) scales to uncover how mechanical forces and mechanical properties, such as stiffness or viscosity, affect brain function. Herein, computational models based on nonlinear continuum mechanics can valuably complement experimental studies to systematically understand the mechanisms underlying mechanics-regulated biological and biomedical processes. In addition, they can allow for data transfer across species and scales, and eventually pave the way for personalized clinical predictions.

This Minisymposium will cover novel experimental and modeling approaches, including computational solid and fluid mechanics as well as data-driven modeling. It is targeted toward advancing our understanding of brain function and dysfunction, and eventually diagnosis and treatment of neurological disorders.