Biomimetic Materials
Mechanotransduction Controlling Cellular Activity

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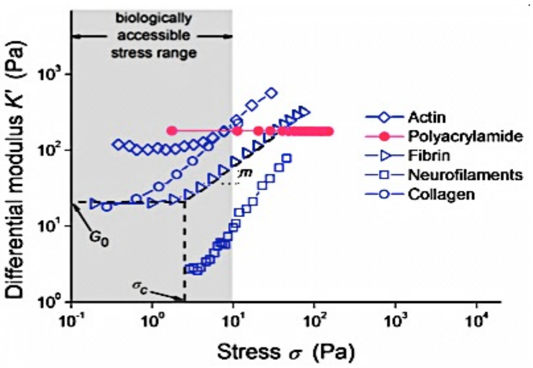
Fibrous networks of biopolymers are found in both the intracellular and extracellular matrix. From the microscopic scale of a single cell to the macroscopic scale of fibrous tissues, biopolymers with different stiffness control cellular processes such as cell differentiation, proliferation, transportation and communication.[1] In recent years, a large number of different hydrogels has been developed, often with the goal to create an artificial extracellular matrix for biomedical applications. However, the mechanical environment inside and outside the cell is not determined by a single component.[1] Multiple biopolymers with different structural and mechanical properties which physically interact with each other, make the mechanical environment of a cell *in vivo* much more complicated than the environment of a cell in a single-component artificial matrix.



$$G_0 = 6\rho k_B T \frac{l_{p,B}^2}{l_c^3}$$

$$\sigma_c = \rho k_B T \frac{l_{p,B}}{l_c^2}$$

The mechanics of natural biopolymer gels however, are very different from most synthetic hydrogels because they show strain stiffening behaviour.[2-3] Reconstituted networks of cytoskeletal polymers such as actin or intermediate filaments or extracellular biopolymers such as collagen or fibrin show a large increase in stiffness upon an applied stress or deformation.[3] The stiffening response prevents these networks from breaking under external stresses and also enables communication between cells growing in these materials. Recently a new biomimetic polymer hydrogel was developed with unique cytomimetic properties, based upon oligo(ethylene glycol) grafted polyisocyanopeptides. These extremely stiff helical polymers form gels upon ***warming*** at concentrations as low as 0.005 %-wt polymer, with materials properties almost identical to these of intermediate filaments and extracellular matrices.[3] The unique ability of these materials and their application in cell growth and drug therapeutics revealed the importance of polymer stiffness and material non-linear mechanics.[4] How to control these nonlinear mechanical properties and how the stiffening response is affected by the composite nature of natural biopolymer networks such as the cytoskeleton or the extracellular matrix will be presented.[5]

References

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