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Cell morphologies depend on substrate rigidity.

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Extracellular matrices and intracellular cytoskeletons are composed mainly of open meshworks formed by semi-flexible polymers linked by accessory proteins in networks with specific geometries. The viscoelastic properties of such networks often differ strongly from those of flexible polymer gels and are characterized by relatively large elastic moduli for low volume fractions, increased rigidity at increasing strains, and in some cases, negative normal stresses when deformed in simple shear. Cell structure and function depend on the stiffness of the surfaces on which cells adhere as well as on the type of adhesion complex by which the cell binds its extracellular ligand. Most cell types, including fibroblasts and endothelial cells, switch from round to spread morphology as stiffness is increased between 1000 and 10,000 Pa. In contrast, other cells types such as neutrophils do not require rigid substrates in order to spread, and neurons extend processes better on soft (50 Pa) materials than on stiffer gels. Differences in rigidity sensing and response can be exploited to design soft matrices optimized for growth and differentiation of specific cell types.