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Polyelectrolyte properties of filamentous biopolymers and their consequences in biological fluids

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Polyelectrolyte filaments are common in biological cells. DNA, RNA, F-actin, microtubules, and intermediate filaments all have large net negative charge densities distributed over their surfaces. Several filamentous viruses with diameters and stiffnesses similar to those of cytoskeletal polymers also have similar negative charge densities on the order of one charge per square nm In contrast, except for highly flexible polysaccharides such as hyaluronan that form the pericellular matrix, the extracellular matrix and surrounding fluids are not normally enriched in filamentous polyelectrolytes. Extracellular protein filaments such collagen, fibrin and elastin have notably smaller charge densities and do not behave as highly charged polyelectrolytes in solution. Generic counterion-mediated effects can account for the assembly into bundles and networks of structurally unrelated biopolymers of similar charge density such as F-actin, vimentin, Pf1 virus, and hyaluronan. Such effects appear to be important for the biological and pathophysiological consequences of introducing ionic polyelectrolytes into the extracellular space in vivo.