1. The Cytoskeleton

Cells have the ability to create a shape characteristic of their cell type, dynamically change that shape, move around in their environments, and move organelles and other structures within them.

The cytoskeleton is the system of filaments and associated proteins that give cells these properties.

The 3 major types of cytoskeletal filaments are:

a) Actin (micro)filaments
b) Microtubules
c) Intermediate filaments

Why filaments? Elongated polymers are required for movement in one direction. (trains needs tracks)

All of these filaments are built from subunits. Why subunits? Why not build cell structures out of very long, single molecules?
Filaments with both end to end and side to side bonds are more stable.

Stronger filaments can be formed from elongated fibrous subunits with more lateral contacts. E.g. intermed. fils (but at the expense of easy disassembly and reassembly)

2. Actin and microfilaments

A globular monomer with a bound ATP
**Actin Polymerization in vitro**

(Treadmilling: a steady state with net growth at one end and loss at the other)

Tubulin exists in solution as a dimer with GTP on both monomers in the polymerizable state.

The 2 ends of MTs and MFs are different and cause polarity of growth. + & - or fast and slow ends

E.g. flagellar axoneme or plus tubulin

Myosin-head labeled MF plus actin

(Spears, not arrows.) + end binds to membranes & Z line of muscle
4. Intermediate filaments are strong, rope-like filaments

Found inside nuclear envelope as nuclear lamins in all eukaryotic cells, but only as cytoskeletal filaments in animal cells. (lamins are presumably their ancestors)

<table>
<thead>
<tr>
<th>Type</th>
<th>Protein</th>
<th>Location</th>
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<tbody>
<tr>
<td>Nuclear</td>
<td>lamins A, B, C</td>
<td>Nuclear lamina</td>
</tr>
<tr>
<td>Epithelial</td>
<td>keratins (I &amp; II)</td>
<td>Epithelial cells, hair, nails</td>
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<tr>
<td>Vimentin-like</td>
<td>vimentin desmin</td>
<td>cells of mesenchymal origin muscle glial fibrillary acidic protein glial cells of CNS; Schwann cells</td>
</tr>
<tr>
<td>Neuronal</td>
<td>neurofilament proteins (L, M, H)</td>
<td>neurons</td>
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</tbody>
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Keratin filaments (Figs 18 & 19)

Neurofilaments and glial filaments (Fig. 20)

Steady-state behaviors of MTs and MFs:
Treadmilling and dynamic instability