BIOLOGICAL FRAMEWORKS FOR ENGINEERS

Session #16 [Cell Cytoskeleton]

General Objectives:

- ✓ Discuss the importance of cytoskeletal filaments
- ✓ Discuss mechanisms of regulating cell shape

Central Framework:

- ✓ Cell shape is central to the life of an organism and is accomplished via different mechanisms.

Interactive Activity:

- ✓ Videos of cell movement and cytoskeletal dynamics

Session Outline:

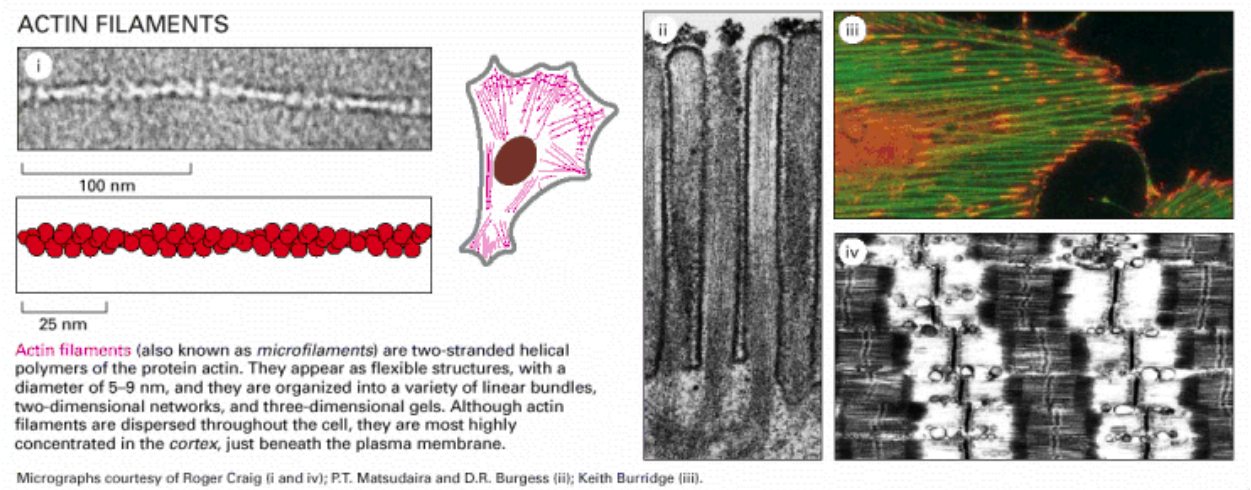
A. Cytoskeleton

Dynamics

Polymerization

Treadmilling

B. Actin

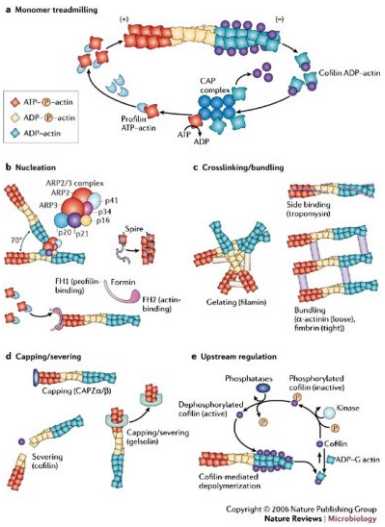


Actin filaments (also known as *microfilaments*) are two-stranded helical polymers of the protein actin. They appear as flexible structures, with a diameter of 5–9 nm, and they are organized into a variety of linear bundles, two-dimensional networks, and three-dimensional gels. Although actin filaments are dispersed throughout the cell, they are most highly concentrated in the *cortex*, just beneath the plasma membrane.

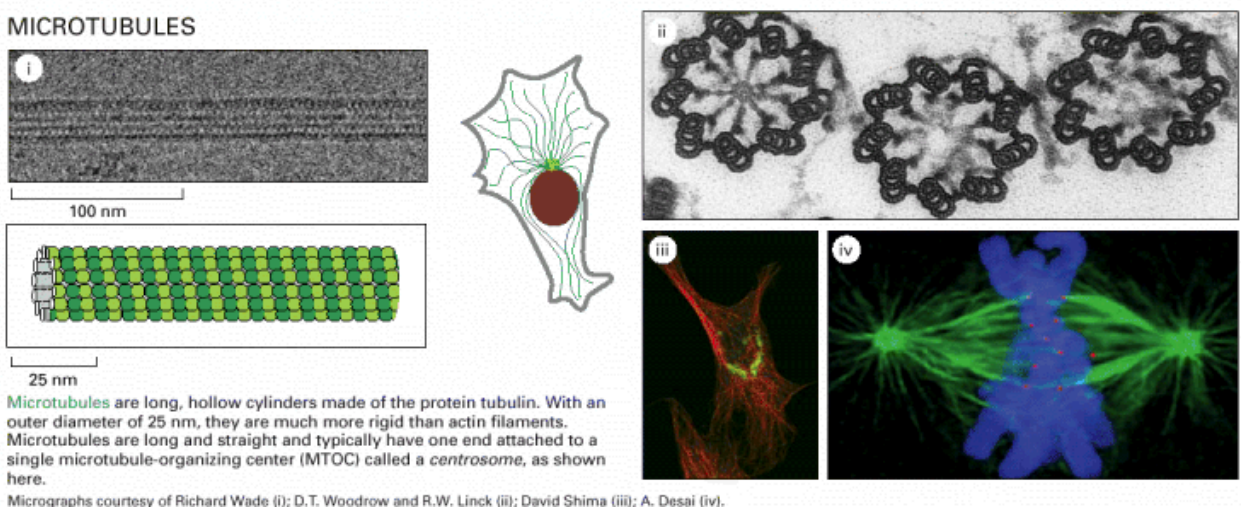
Micrographs courtesy of Roger Craig (i and iv); P.T. Matsudaira and D.R. Burgess (ii); Keith Burridge (iii).

Actin Assembly

Actin Binding Proteins



C. Microtubules

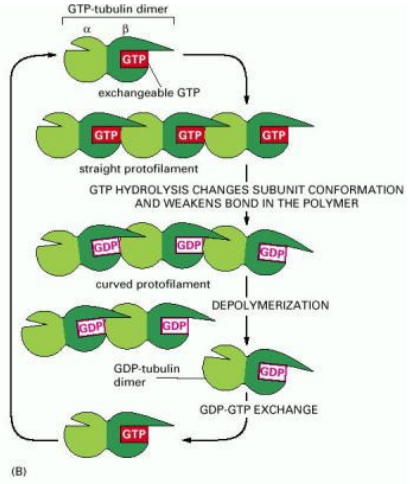


Microtubules are long, hollow cylinders made of the protein tubulin. With an outer diameter of 25 nm, they are much more rigid than actin filaments. Microtubules are long and straight and typically have one end attached to a single microtubule-organizing center (MTOC) called a *centrosome*, as shown here.

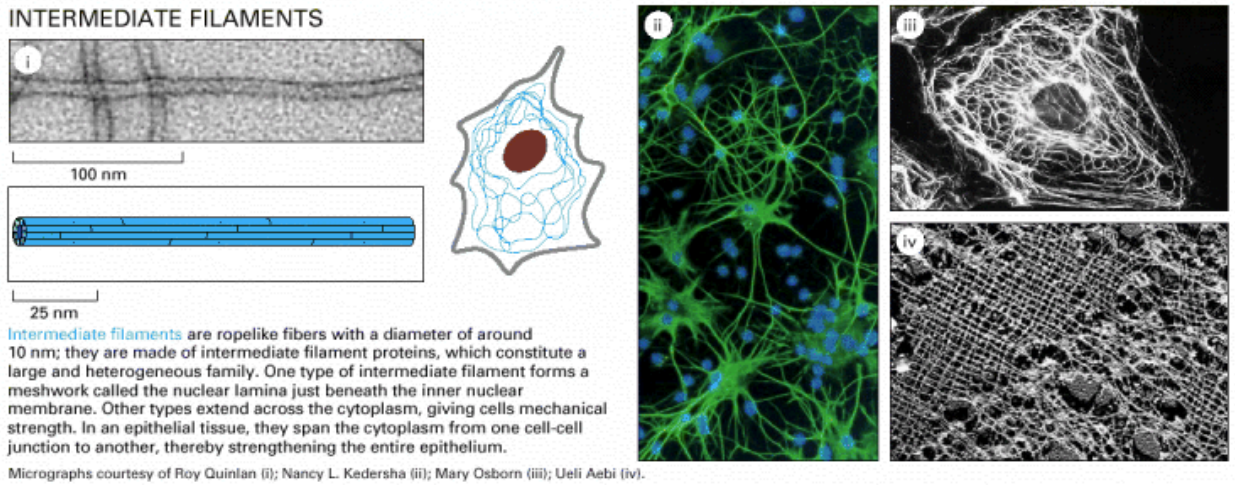
Micrographs courtesy of Richard Wade (i); D.T. Woodrow and R.W. Linck (ii); David Shima (iii); A. Desai (iv).

Microtubule Assembly

Microtubule Instability



D. Intermediate Filaments



Intermediate filaments are ropelike fibers with a diameter of around 10 nm; they are made of intermediate filament proteins, which constitute a large and heterogeneous family. One type of intermediate filament forms a meshwork called the nuclear lamina just beneath the inner nuclear membrane. Other types extend across the cytoplasm, giving cells mechanical strength. In an epithelial tissue, they span the cytoplasm from one cell-cell junction to another, thereby strengthening the entire epithelium.

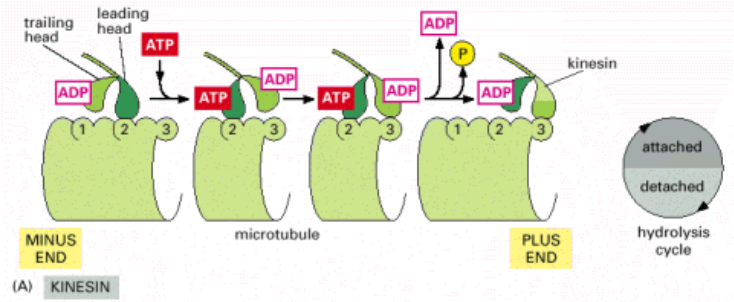
Micrographs courtesy of Roy Quinlan (i); Nancy L. Kedersha (ii); Mary Osborn (iii); Ueli Aebi (iv).

Intermediate Filament Assembly

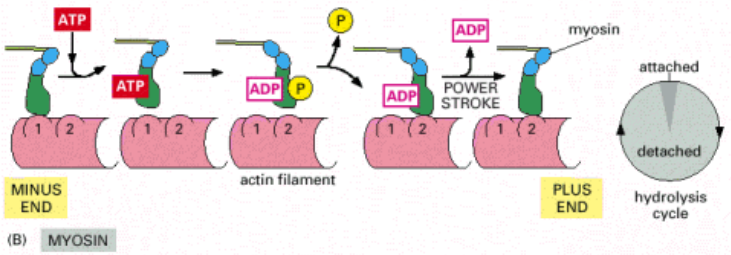
Cytoskeletal Cross-linking

E. Molecular Motors

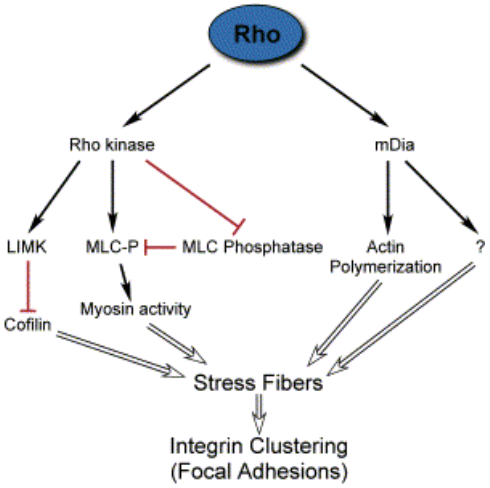
Kinesin & Dynein

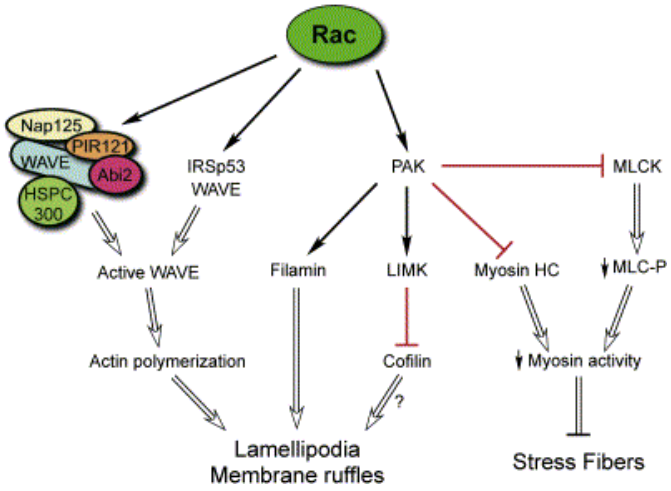


Myosin

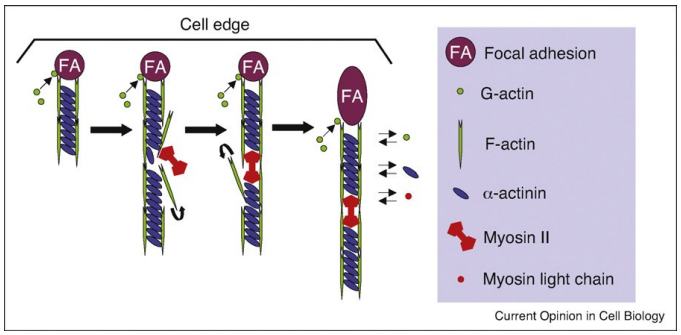


F. Rho Family GTPases





Stress Fibers



Lamellipodium & Filopodia