Advanced Cell Biology. Lecture 38

Alexey Shipunov

Minot State University

May 6th, 2011

Outline

Questions and answers

Cytoskeleton

Outline

Questions and answers

Cytoskeleton

Previous final question: the answer

How do researchers use constantly active Ras protein?

Previous final question: the answer

How do researchers use constantly active Ras protein?

- For determining sequence of proteins in a signal pathway, or, more generally
- For cancer research

Cytoskeleton

- Filament-like: intermediary filaments and actin filaments
- Microtubules
- All are polymers of proteins

Intermediate filaments

- Keratin in epithelial cells
- Vimentin in connective-tissue cells
- Neurofilaments
- Nuclear lamins
- Strengthening cell

Strengthening of cell layer

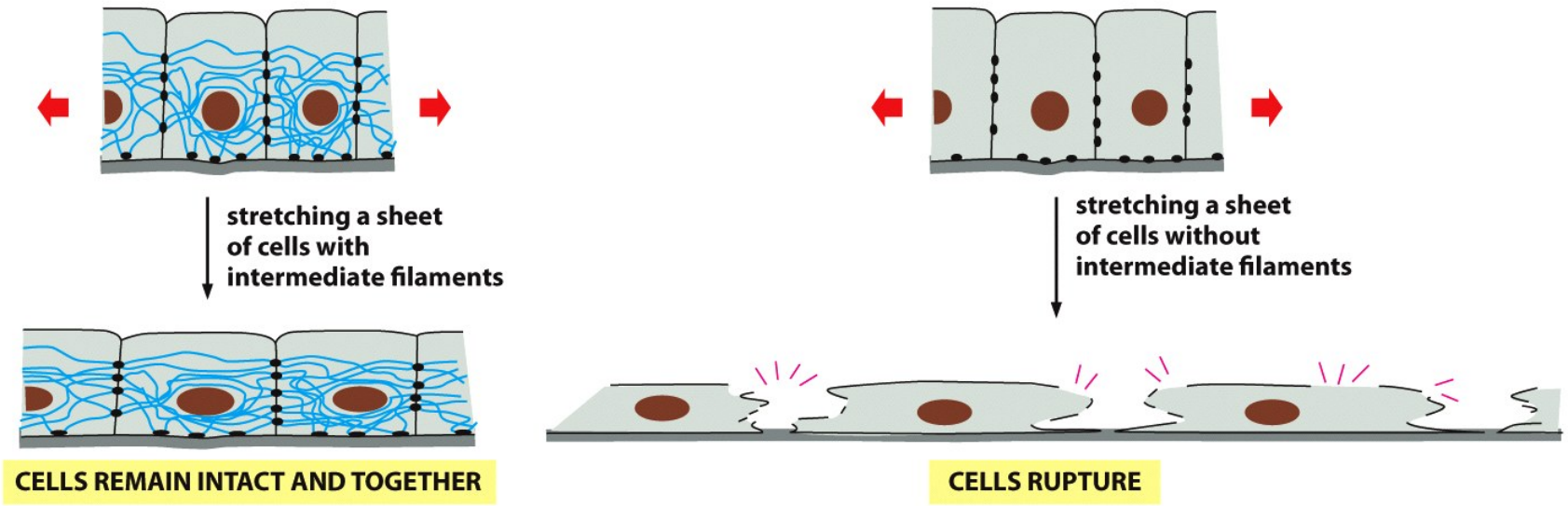


Figure 17-4 Essential Cell Biology 3/e (© Garland Science 2010)

Microtubules

- Grow from centrosome
- Form flagella or cilia
- Form mitotic spindle
- Organize interior of cell
- Drive intracellular transport

Microtubules

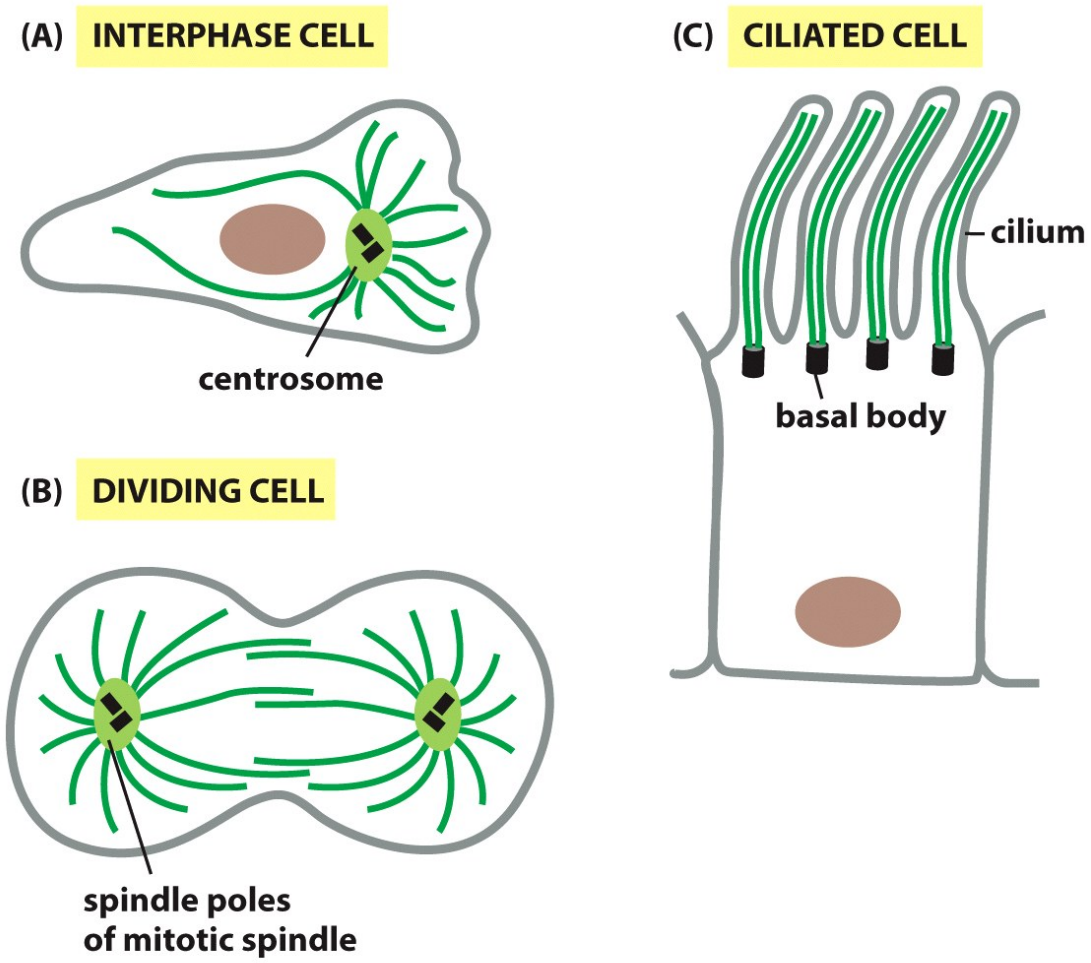


Figure 17-8 Essential Cell Biology 3/e (© Garland Science 2010)

Growth and shrinking of microtubules

- Microtubule is made of 13 tubulin microfilaments, each contain pairs of β-tubulin (– end) and α-tubulin (+ end)
- Tubulin dimers bind GTP and form a growing GTP cap of microtubule; if GTP cap is lost, microtubules start to shrink
- Capturing the plus end will stabilize microtubule

Growing and shrinking of microtubules

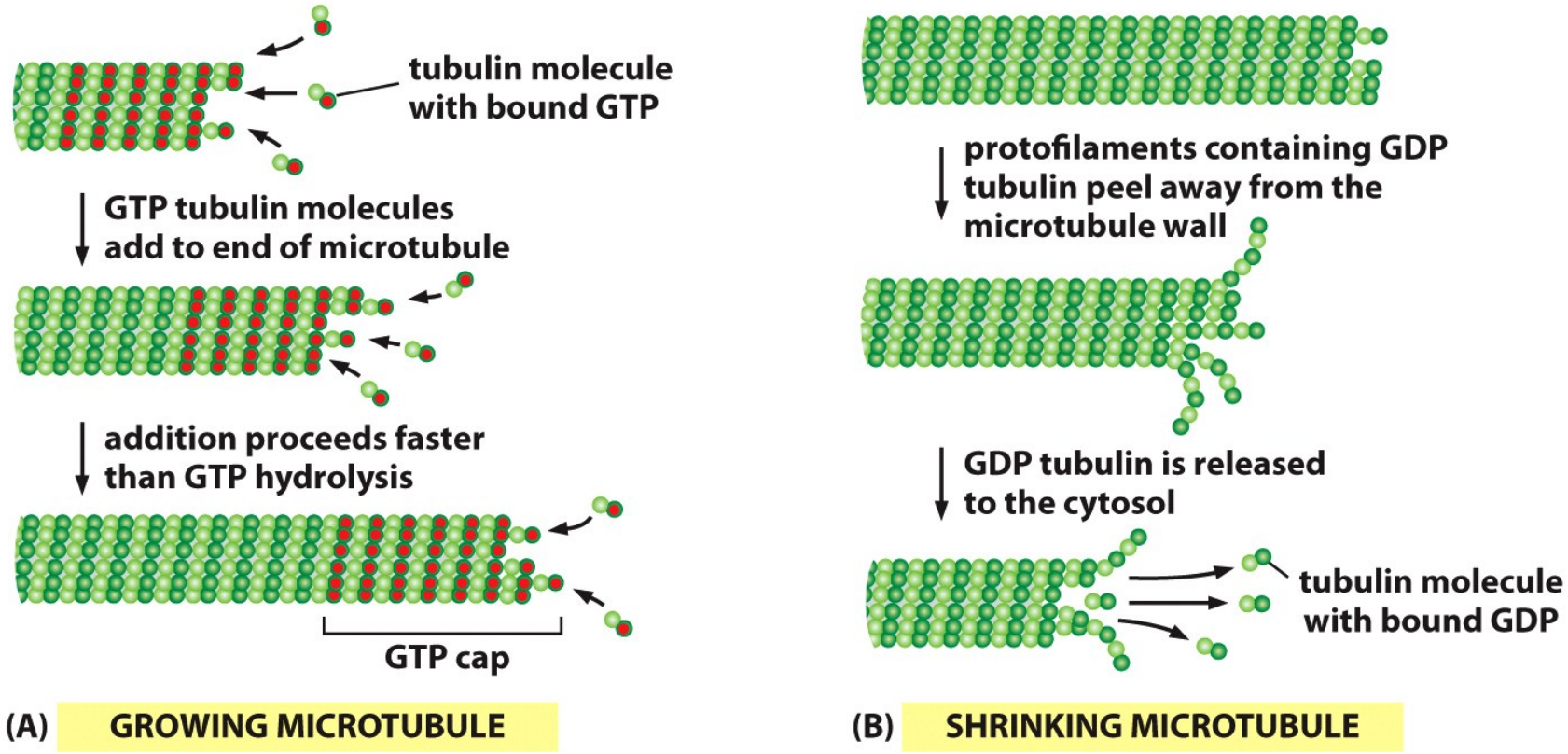


Figure 17-12 Essential Cell Biology 3/e (© Garland Science 2010)

Microtubule-specific drugs

	Action
Microtubule-specific drugs	
Taxol	binds and stabilizes microtubules
Colchicine, colcemid	binds subunits and prevents polymerization
Vinblastine, vincristine	binds subunits and prevents polymerization

Centrosomes

- γ-tubulin rings: starting places of microtubule growth
- Two perpendicular centrioles (they are similar to basal bodies of flagella)
- Cetrosome has a fisherman-like behavior: microtubules are constantly growing out of it, then degrading, but some are stabilizing

Motor proteins

- Kinesins and dyneins are dimers that hydrolyze ATP and move
- They can move molecules and even whole organelles

Kinesin and dynein

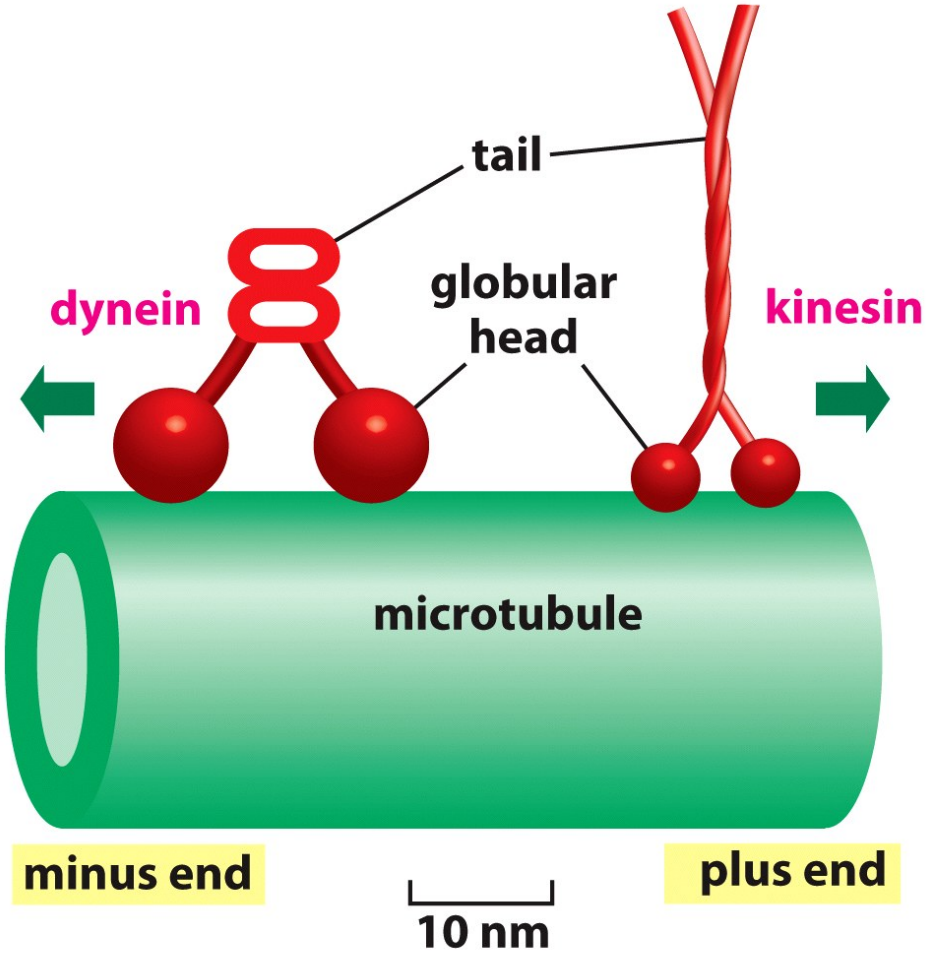


Figure 17-16a Essential Cell Biology 3/e (© Garland Science 2010)

Kinesin movie

Organelle movement movie

Flagella/cilia

- Hairlike structures growing from cytoplasmic basal bodies
- Contain $9 \times 2 + 2$ microtubules connected by dynein arms
- They are natural oars

$9 \times 2 + 2$ structure of flagella

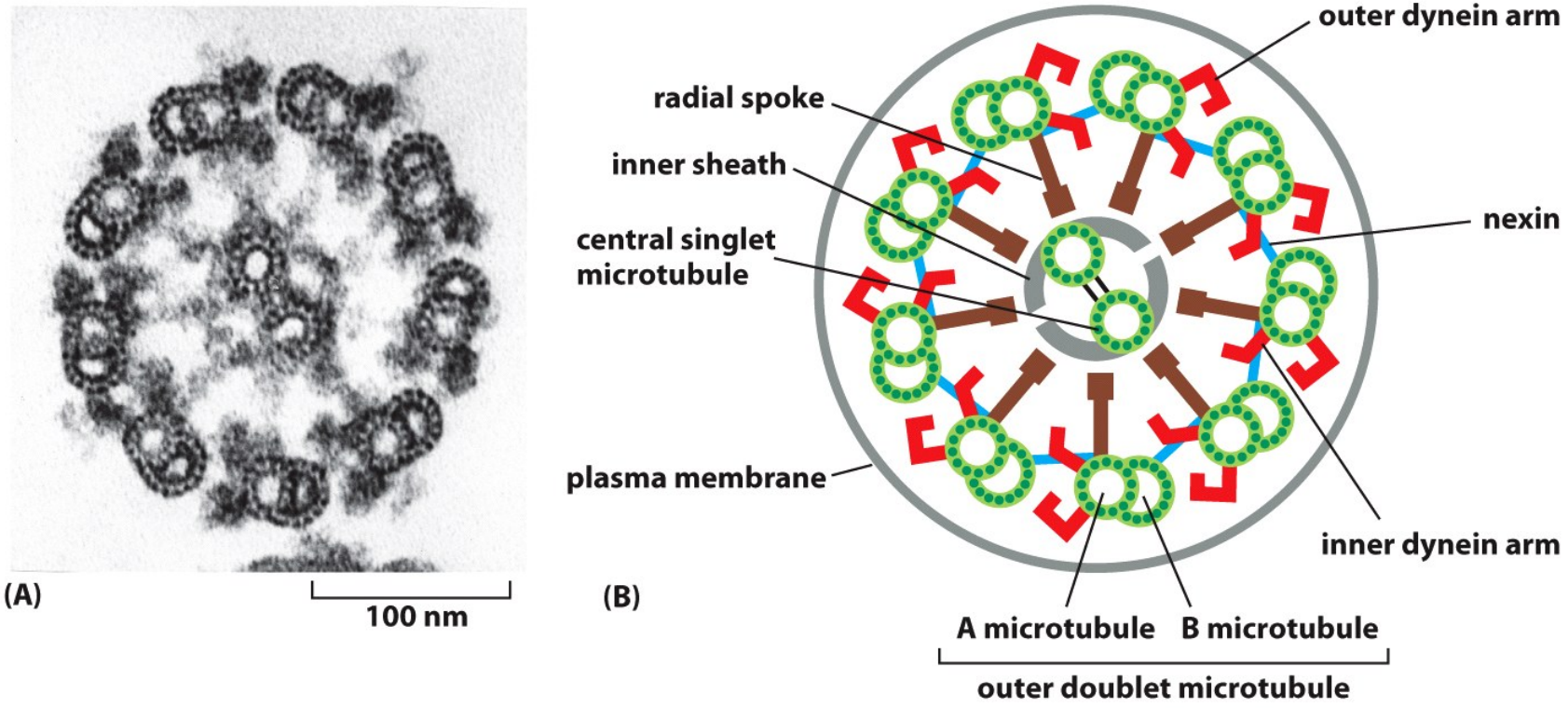
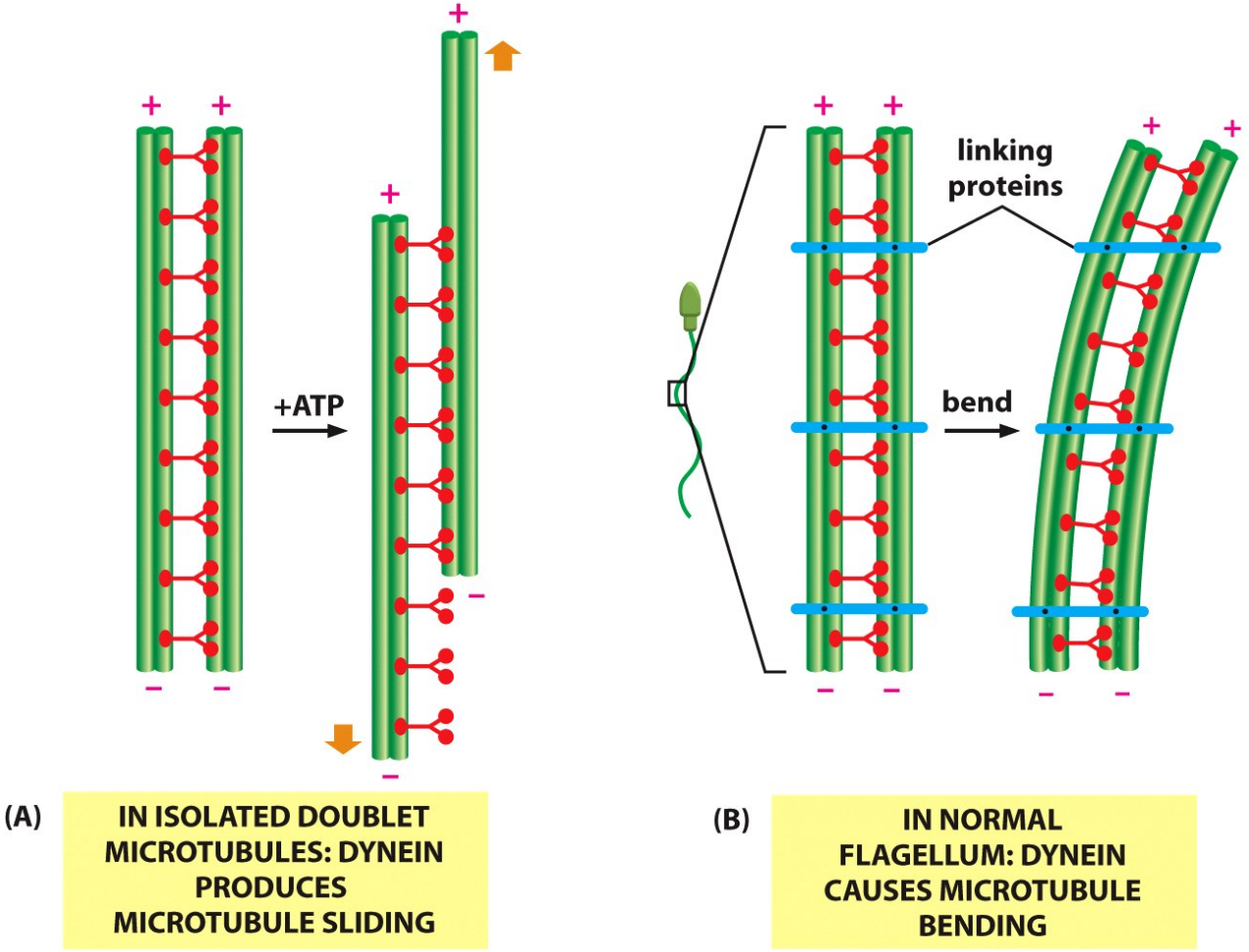


Figure 17-26 Essential Cell Biology 3/e (© Garland Science 2010)

Flagella bending


+ +
+ +
+ +

Actin filaments

- Fast-growing and unstable, they need to contact with multiple protein types (e.g., capping proteins stabilize actin ends)
- Actin filaments are polar, but thinner and shorter than microtubules, ATP-binding
- Allow cell to change its form

Growing and shrinking of actin filaments

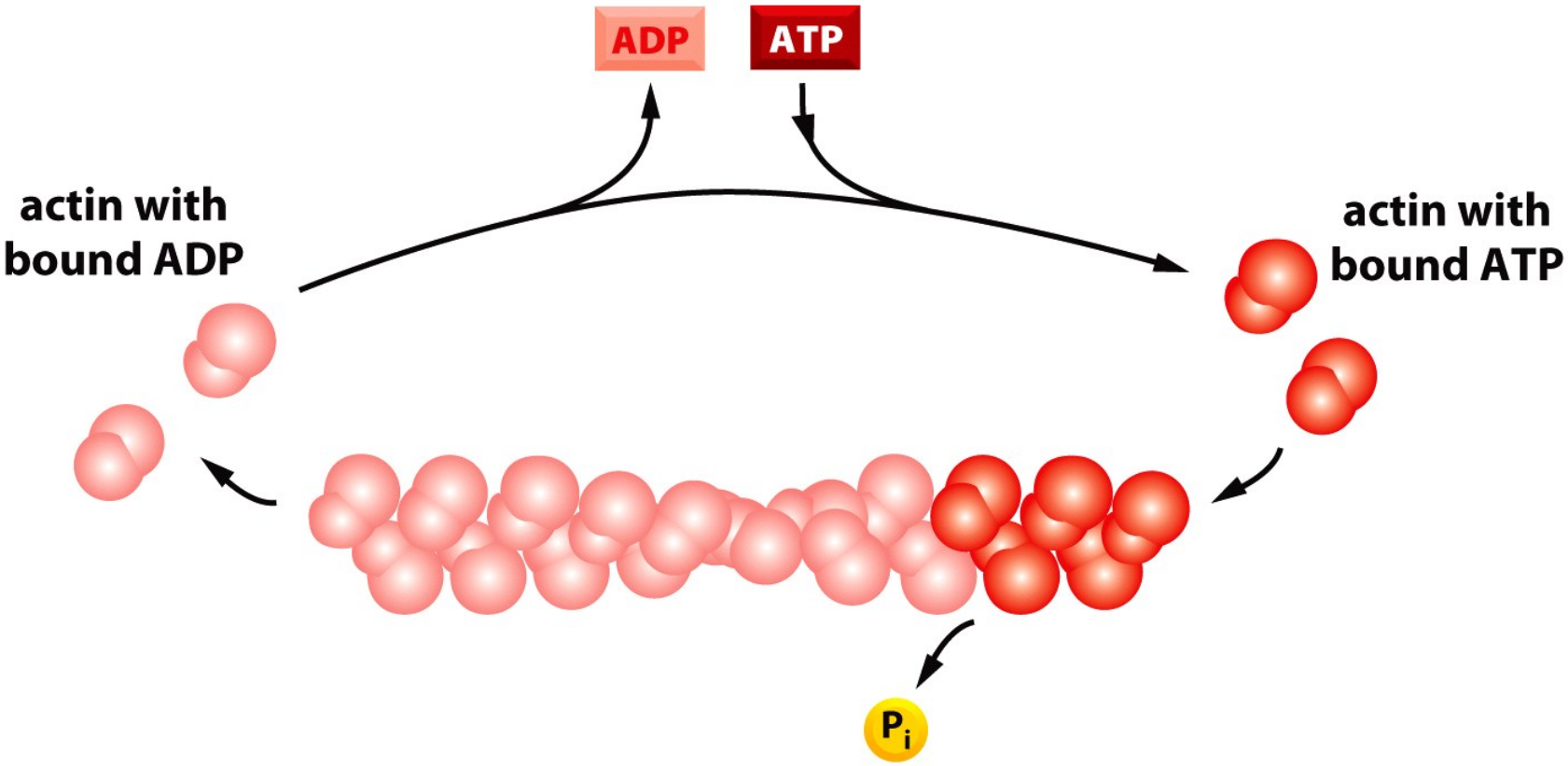
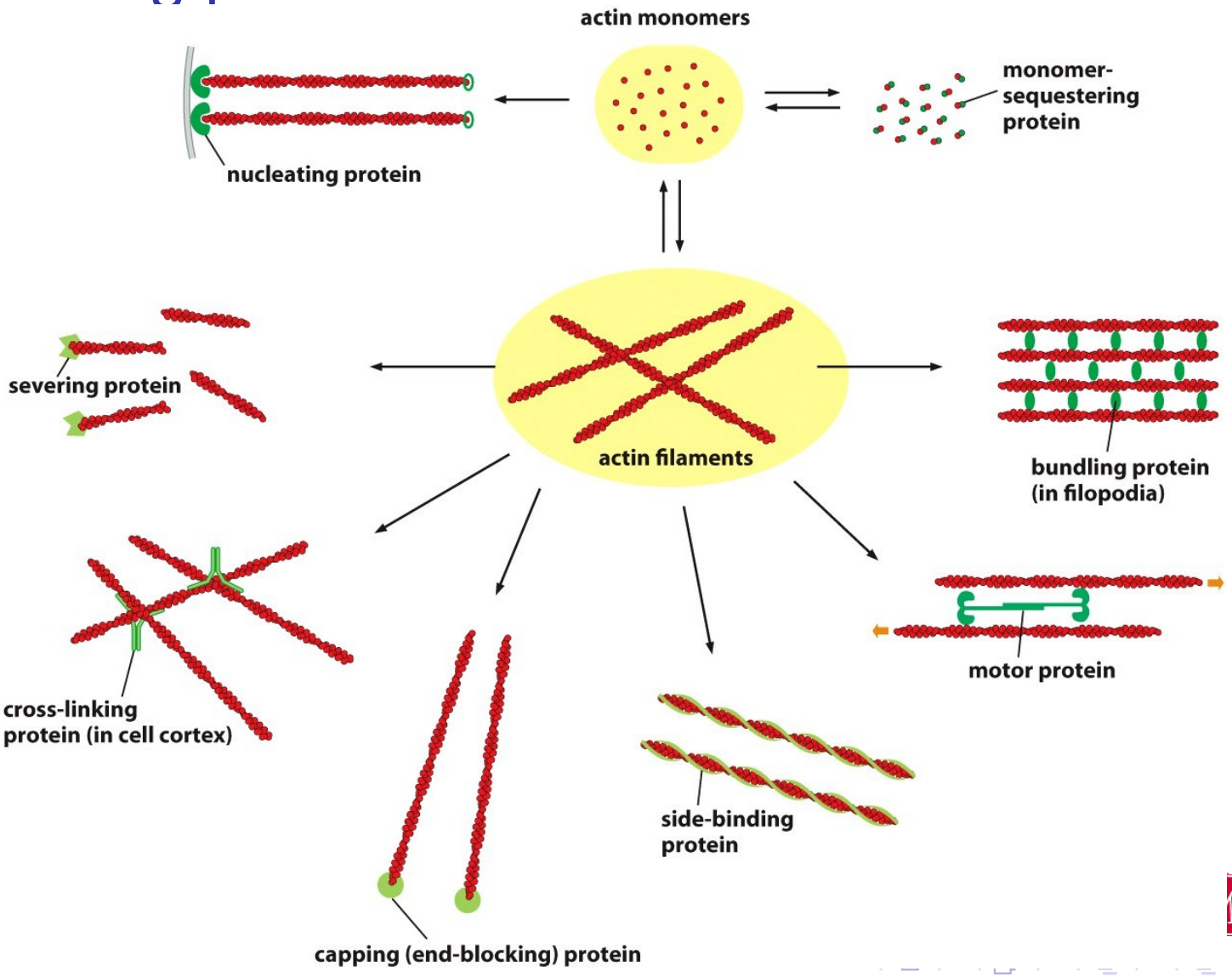


Figure 17-30 Essential Cell Biology 3/e (© Garland Science 2010)

Actin binding proteins



Cell crawling

- Web of growing actin filament will push the leading edge of pseudopodium forward
- ARPs are starting poins of new filaments, formins promote filament growing

Formation of pseudopodium

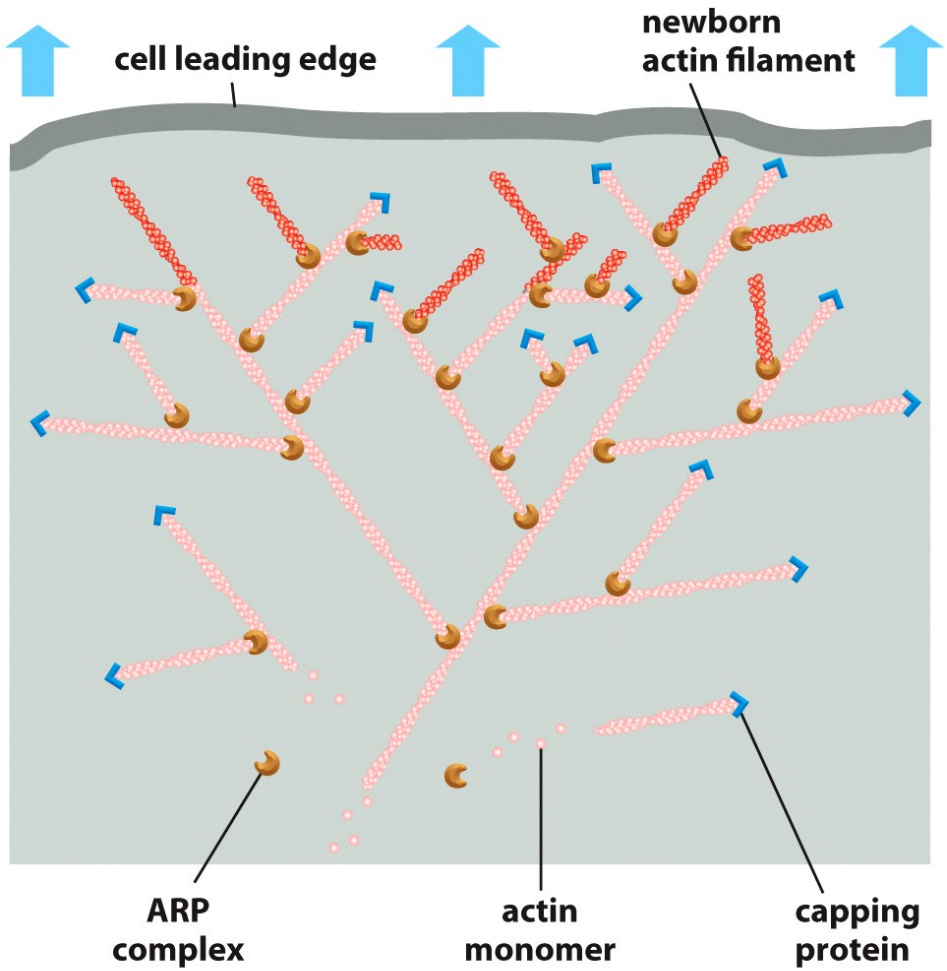


Figure 17-34b Essential Cell Biology 3/e (© Garland Science 2010)

Myosin

- Two subfamilies of ATP-binding motor proteins
- Myosin-I have one head and one tail, myosin-II (in muscle cells) are two-headed
- GTP-binding Rho proteins activate actin polymerization and subsequently the movement of cell

Myosin-I

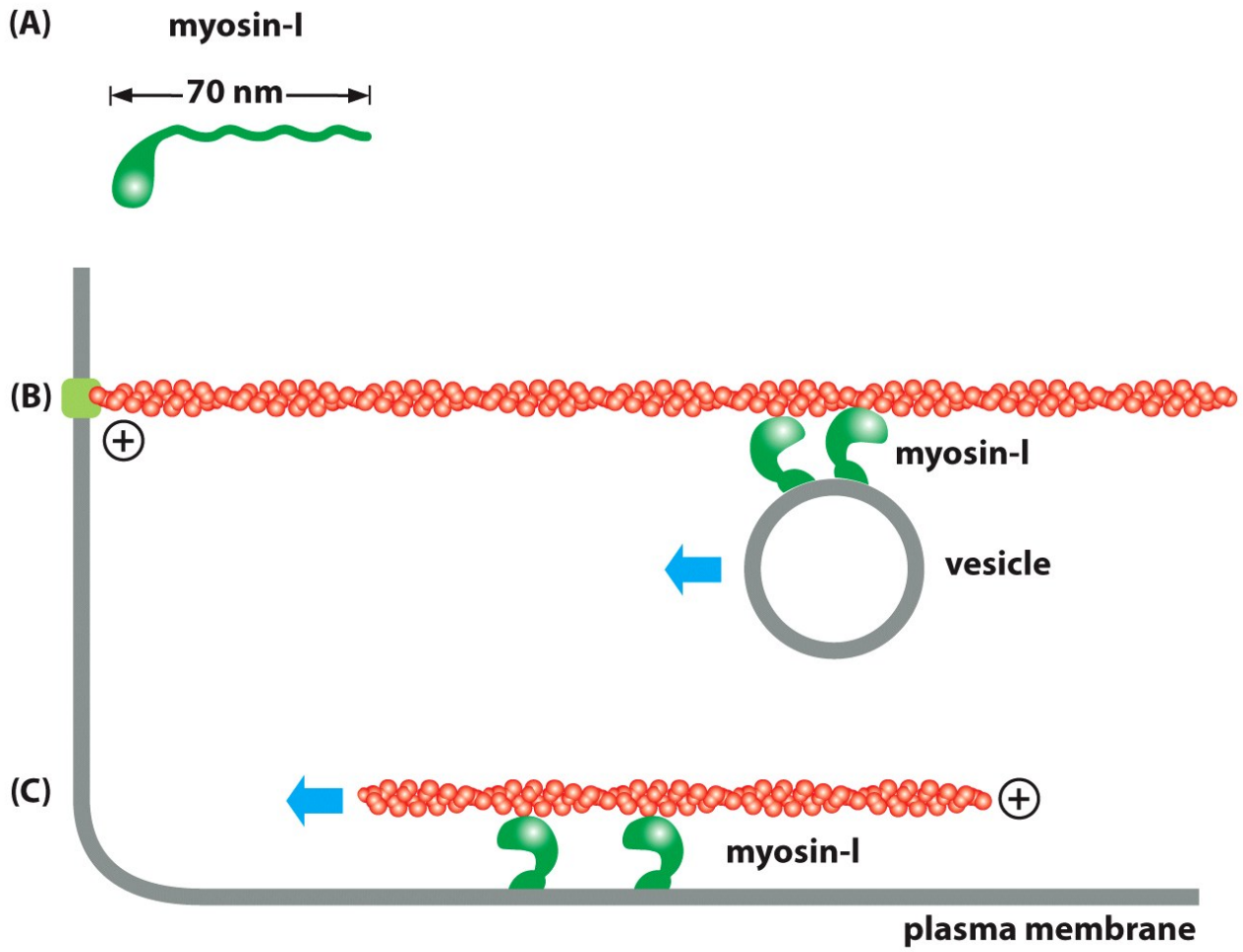


Figure 17-36 Essential Cell Biology 3/e (© Garland Science 2010)

Myosin-II

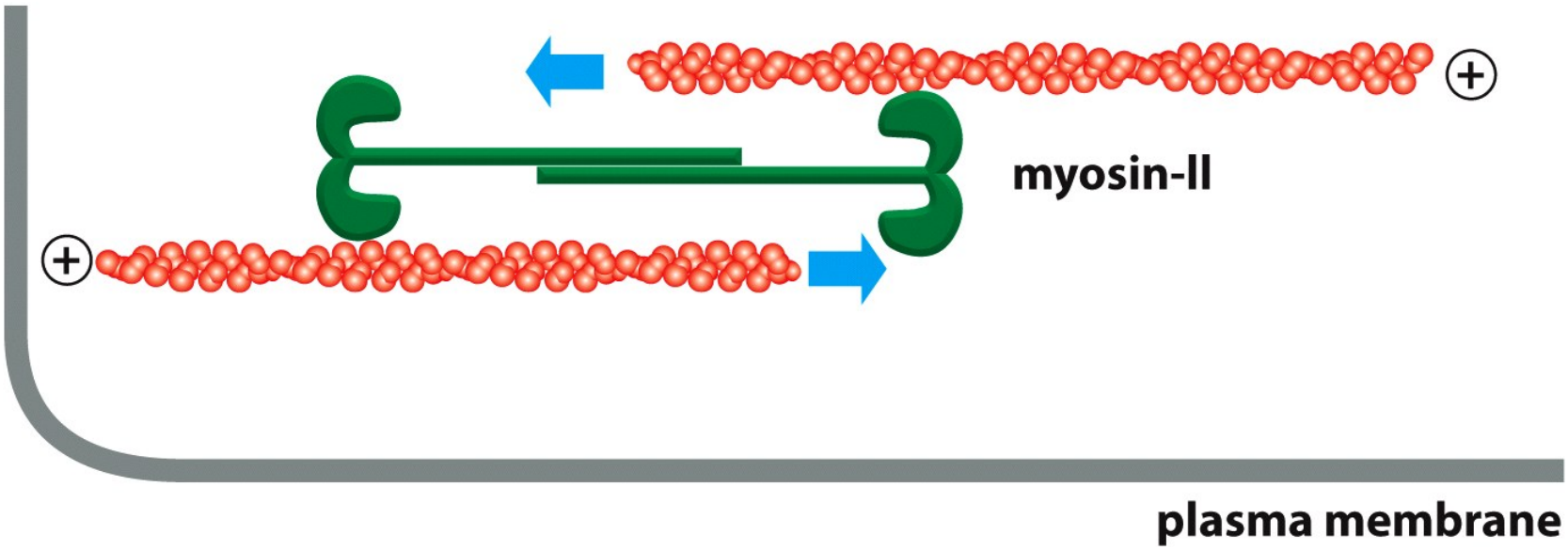


Figure 17-39 Essential Cell Biology 3/e (© Garland Science 2010)

Myosin movie

Crawling actin movie

Final question (1 point)

Final question (1 point)

What will happen with cell if microtubules will not be able to grow?

Summary

- Intermediary filaments are polymers of ropelike polymers of fibrous proteins
- Microtubules are labile hollow tubes of tubulin, kinesins and dyneins move along microtubules
- Actin filamenrts are helical polymers of actin; myosins move along actin

For Further Reading

A. Shipunov.
Advanced Cell Biology [Electronic resource].
2011—onwards.
Mode of access: http://ashipunov.info/shipunov/school/biol_250.

B. Alberts et al.
Essential Cell Biology. 3rd edition.
Garland Science, 2009.
Chapter 17: only material which relates with this lecture.

Evaluation