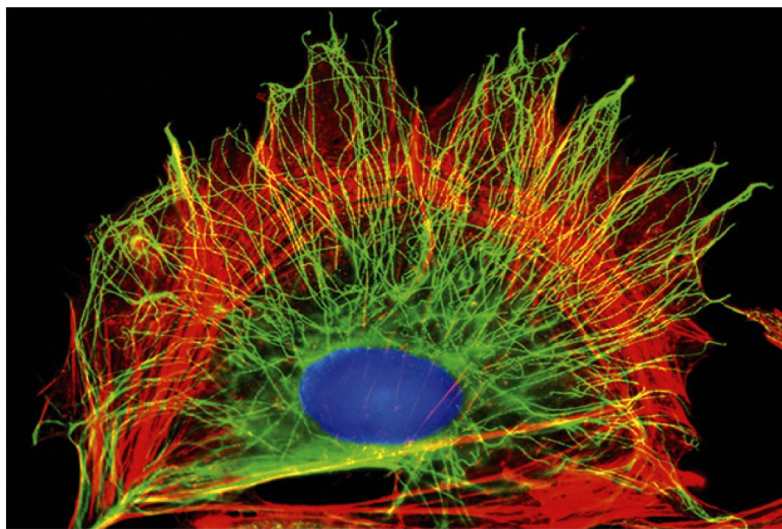


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***Molecular Biology of the Cell***  
Fifth Edition

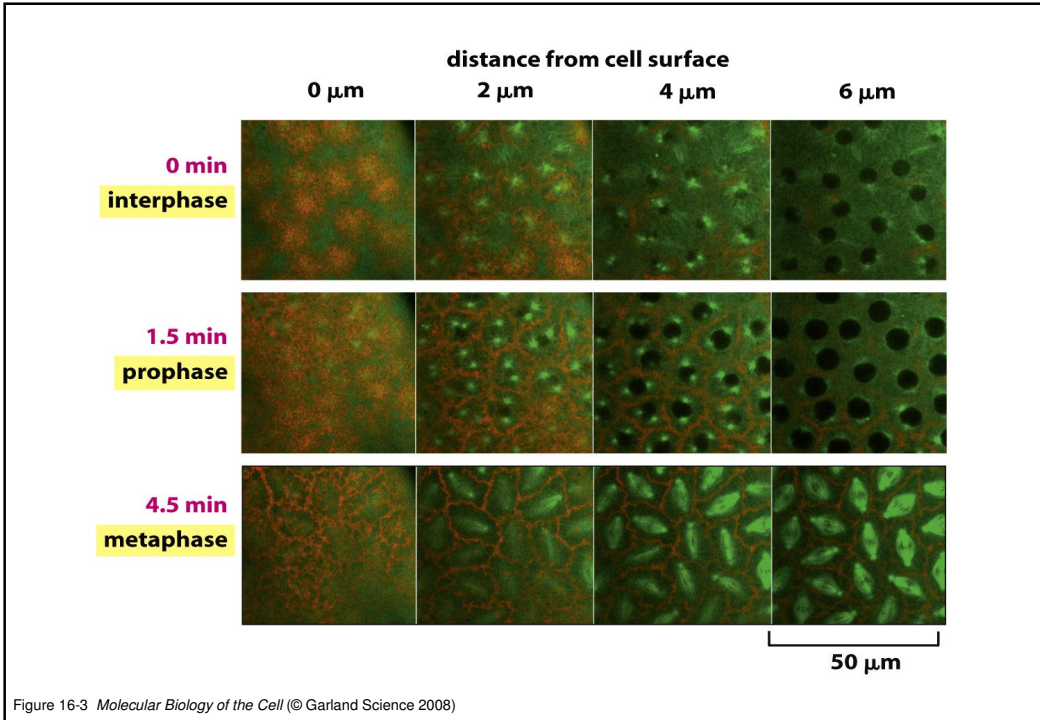
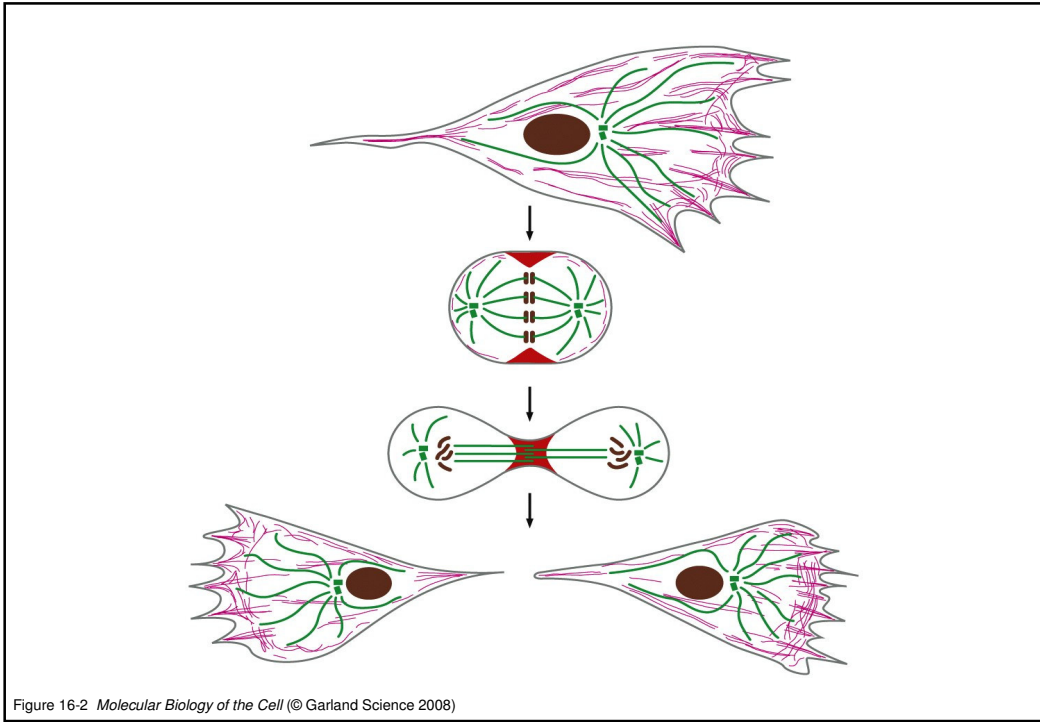
**Chapter 16**  
The Cytoskeleton

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Figure 16-1 *Molecular Biology of the Cell* (© Garland Science 2008)



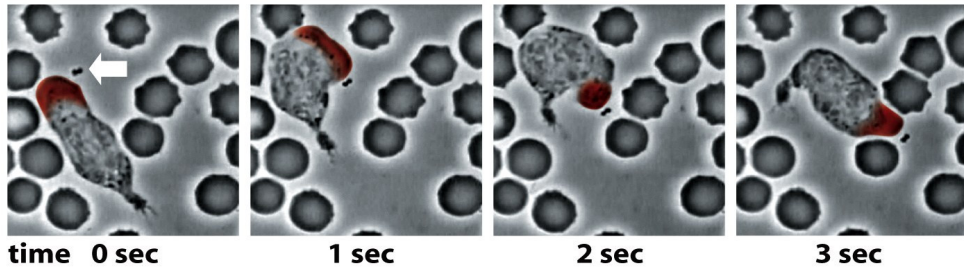


Figure 16-4 *Molecular Biology of the Cell* (© Garland Science 2008)

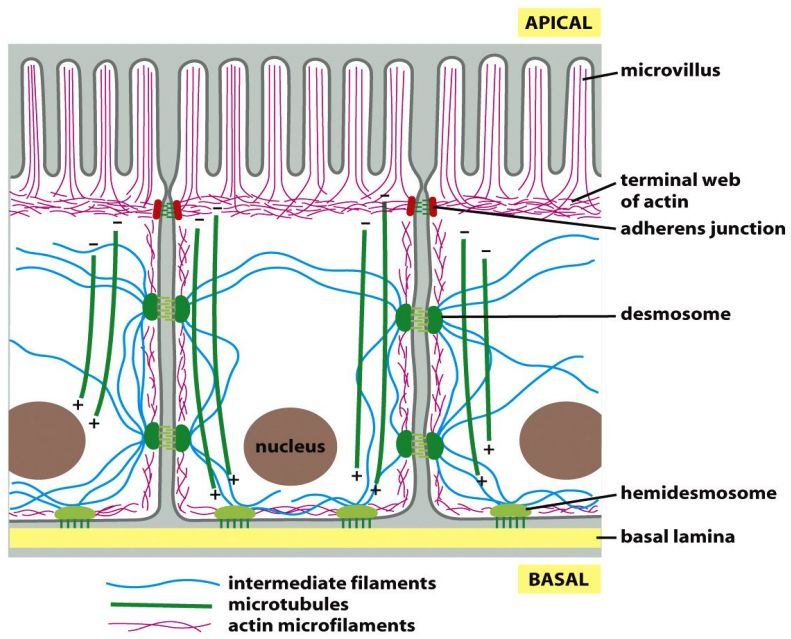


Figure 16-5 *Molecular Biology of the Cell* (© Garland Science 2008)

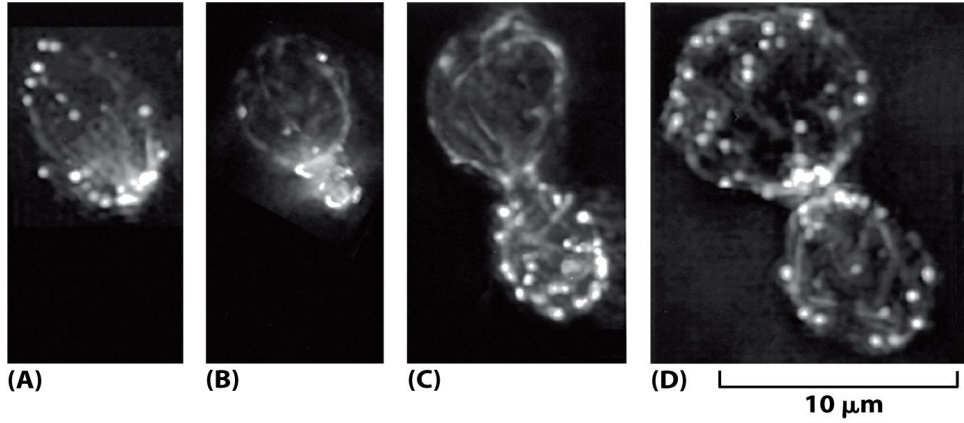


Figure 16-6 *Molecular Biology of the Cell* (© Garland Science 2008)

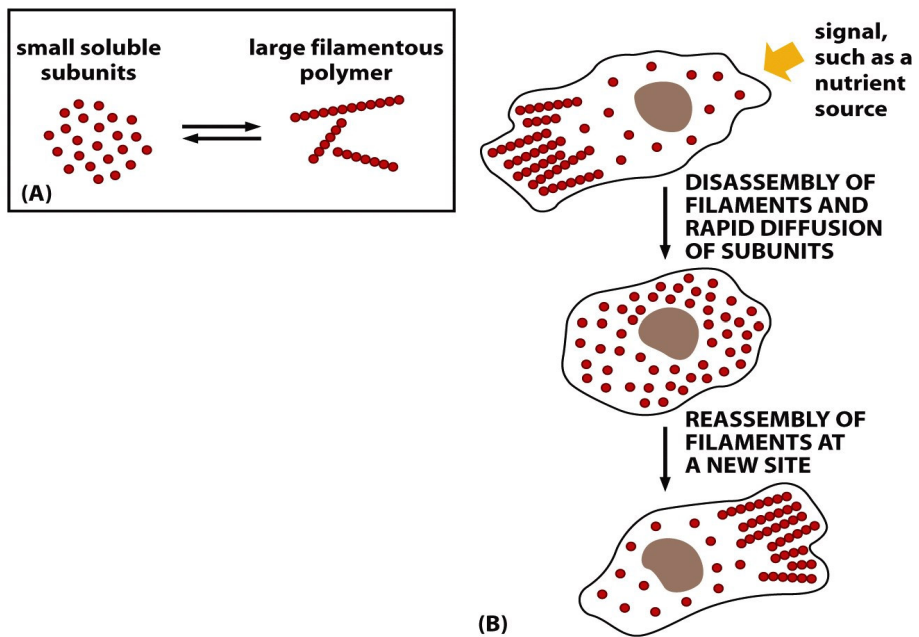
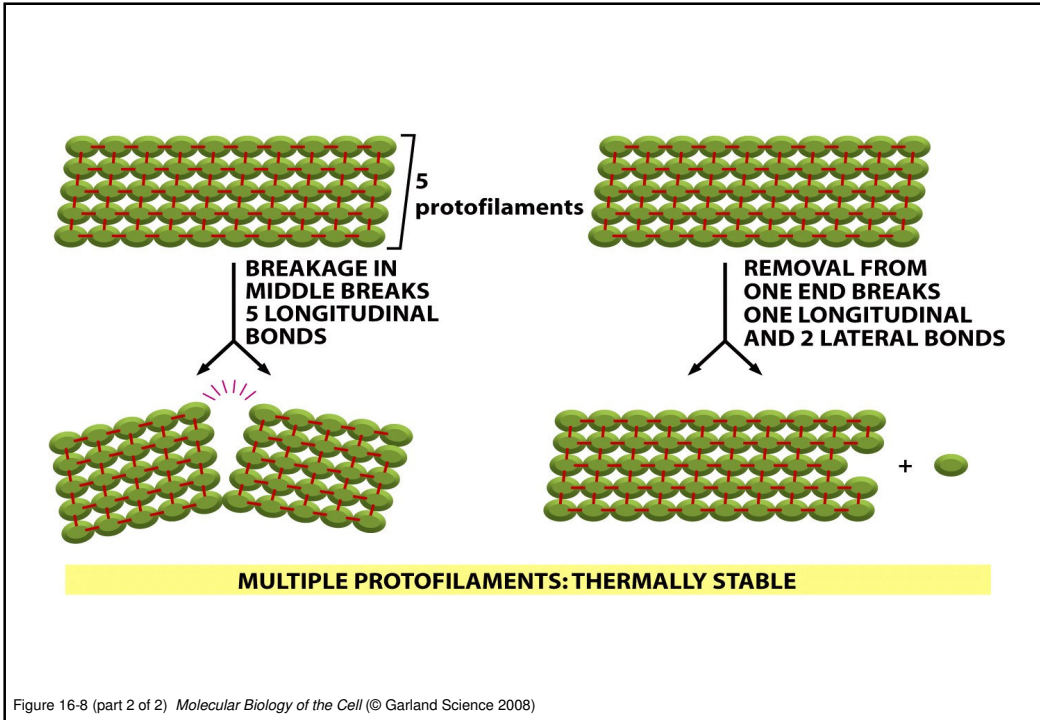
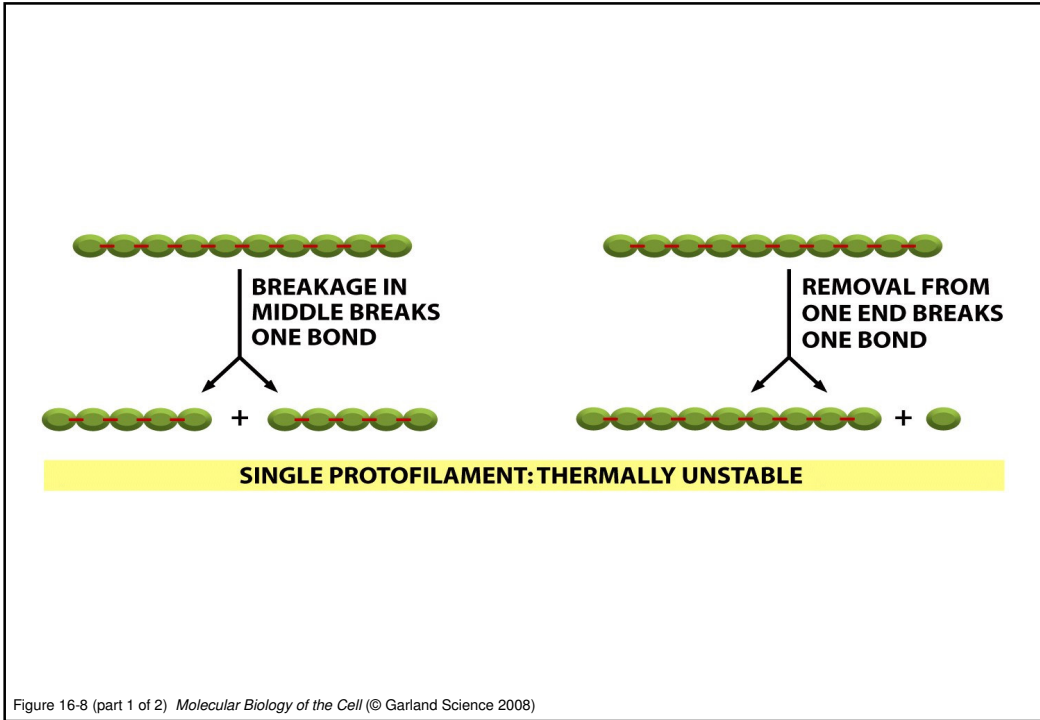
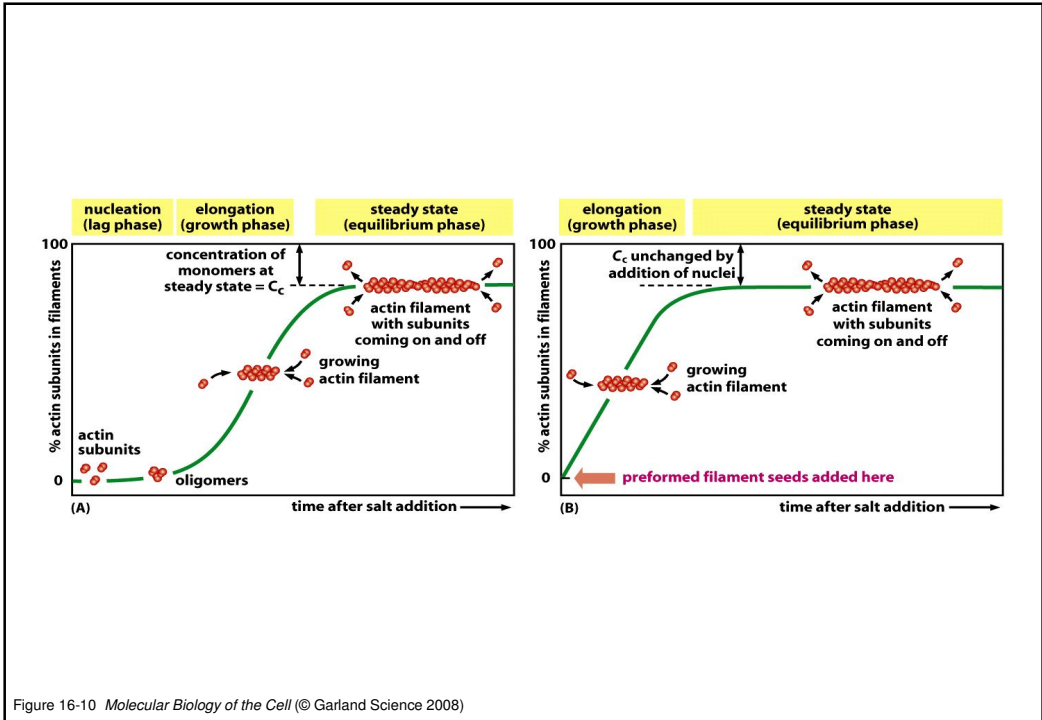
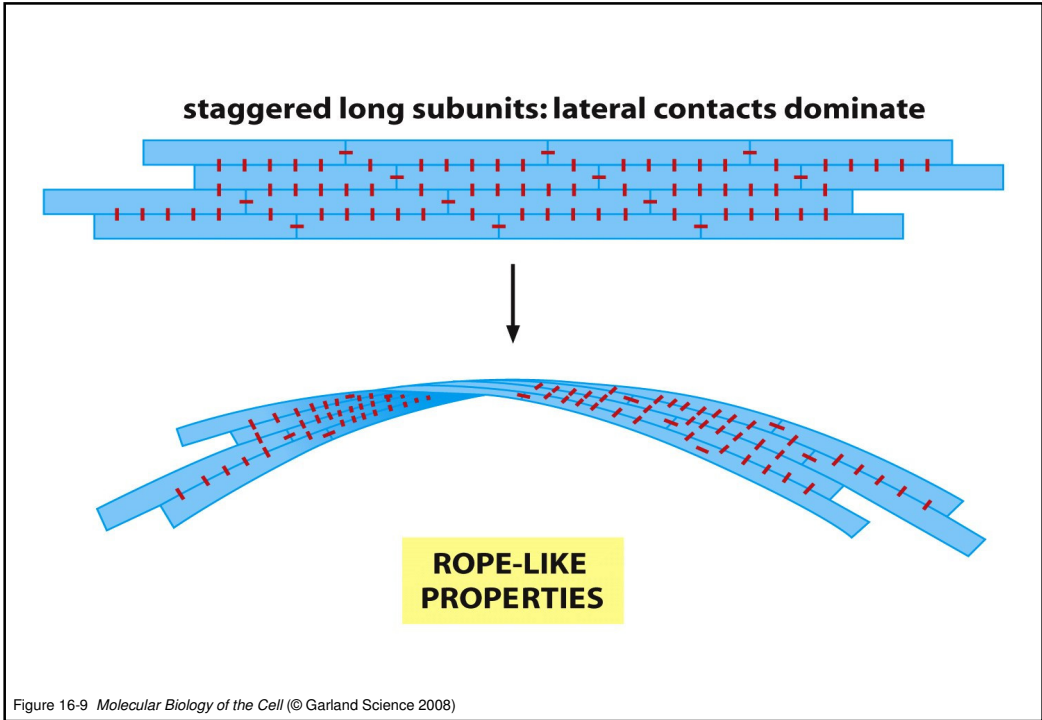
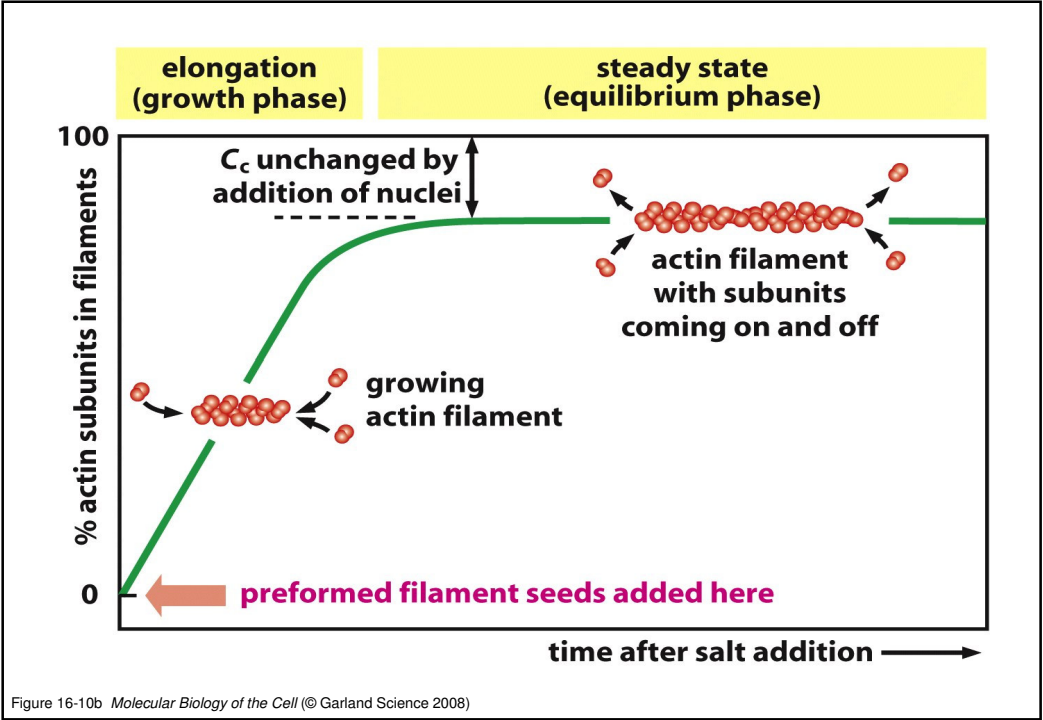
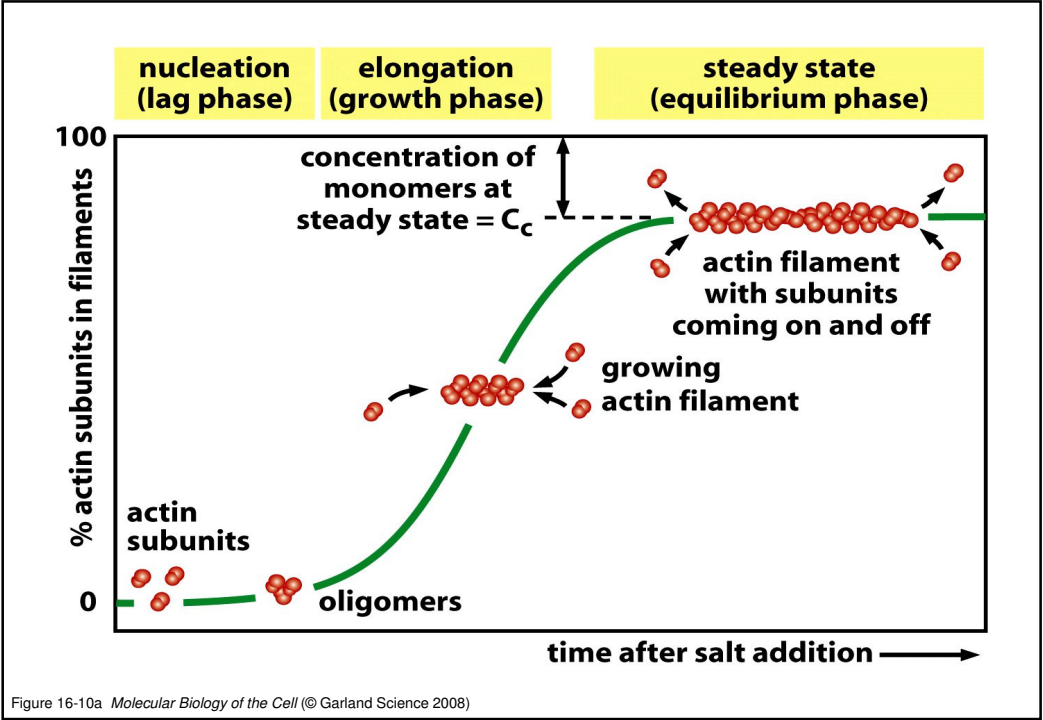
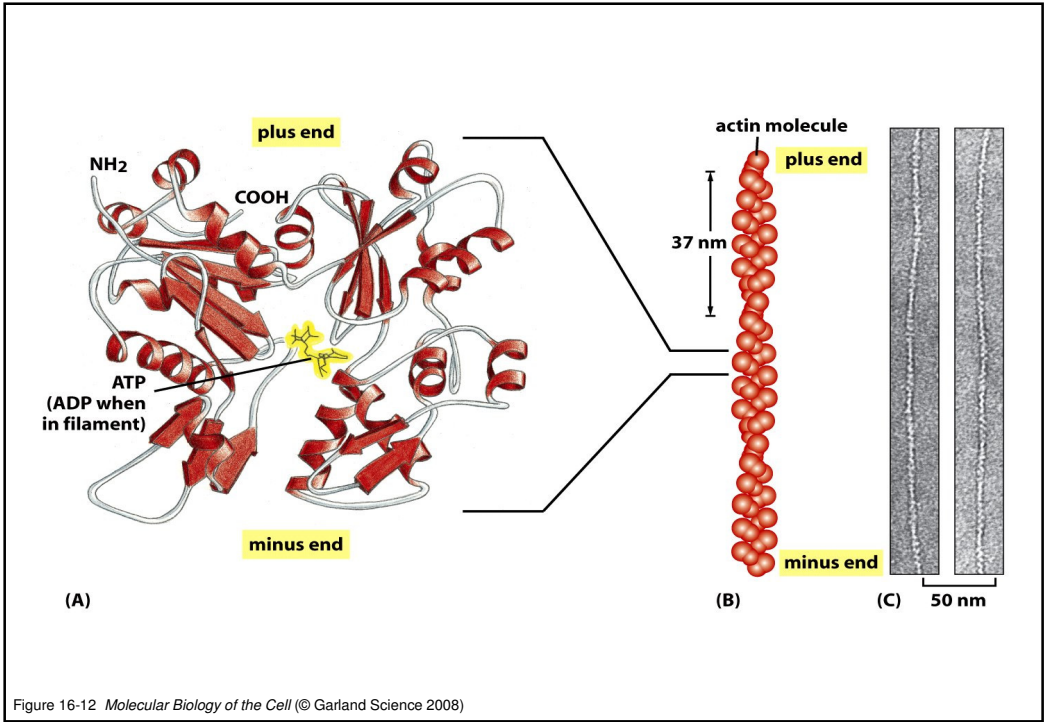
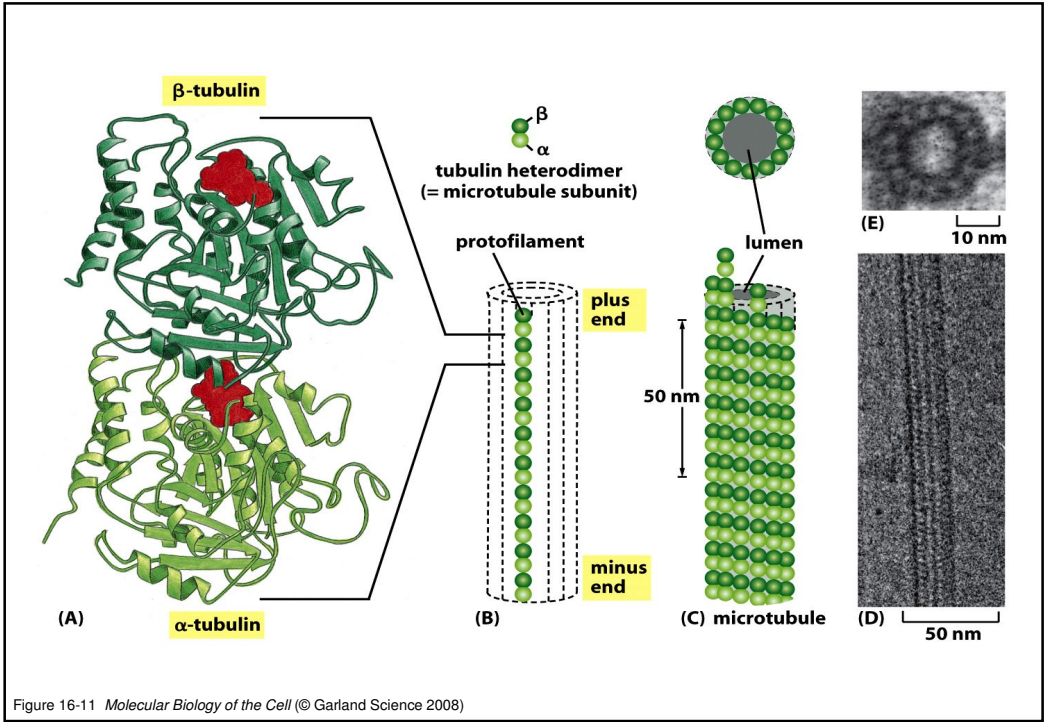


Figure 16-7 *Molecular Biology of the Cell* (© Garland Science 2008)

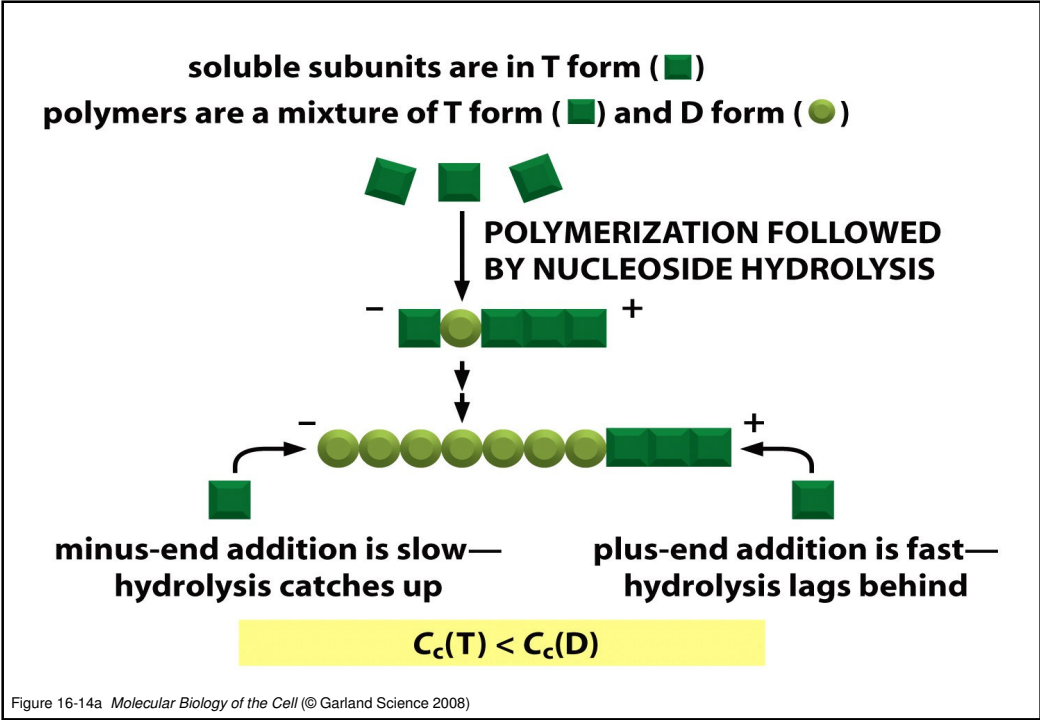
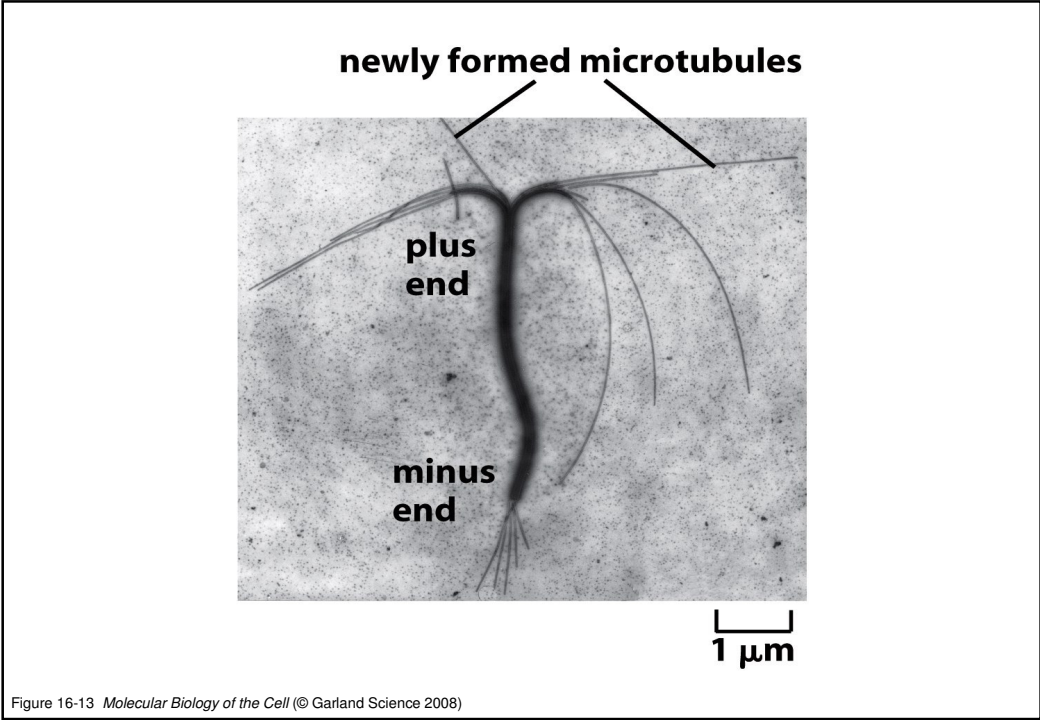


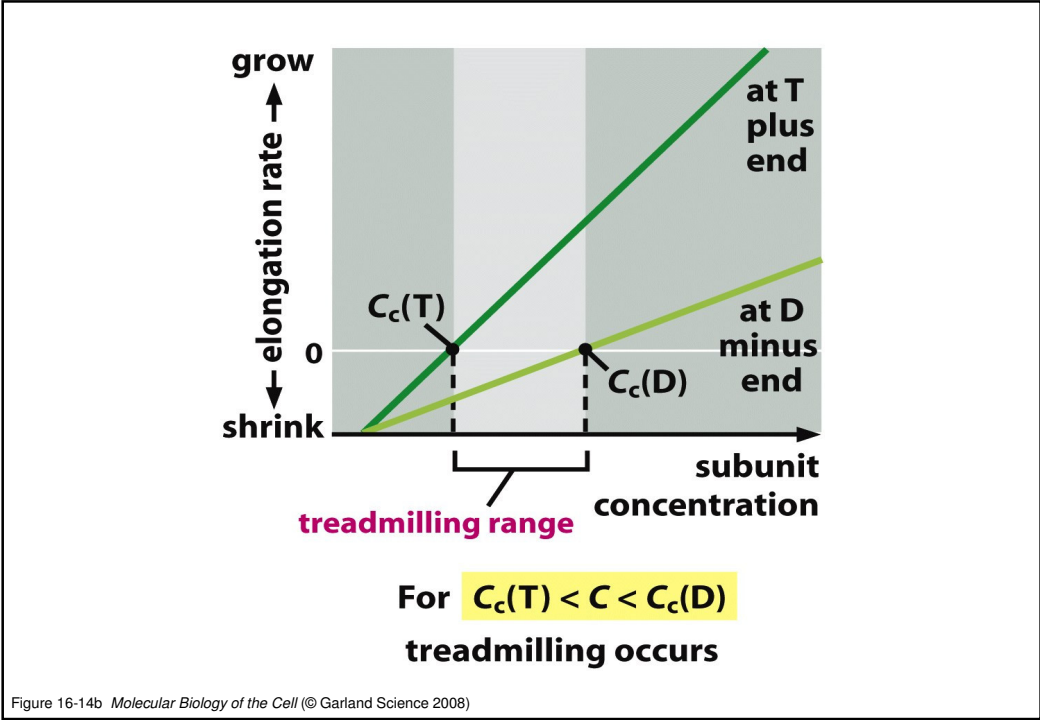


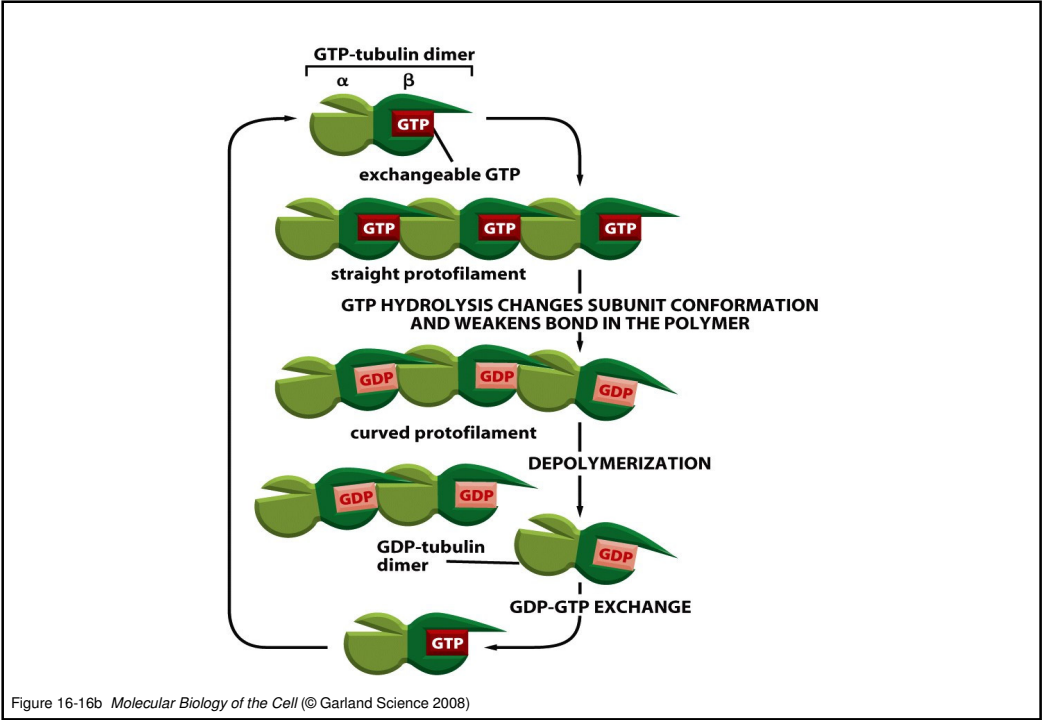
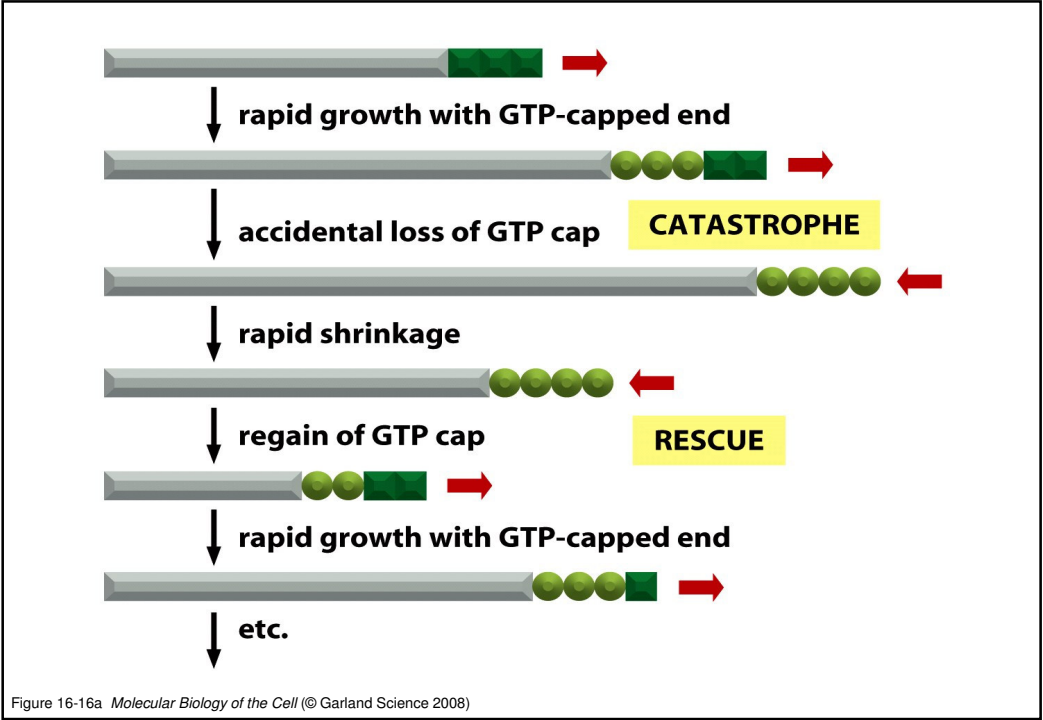


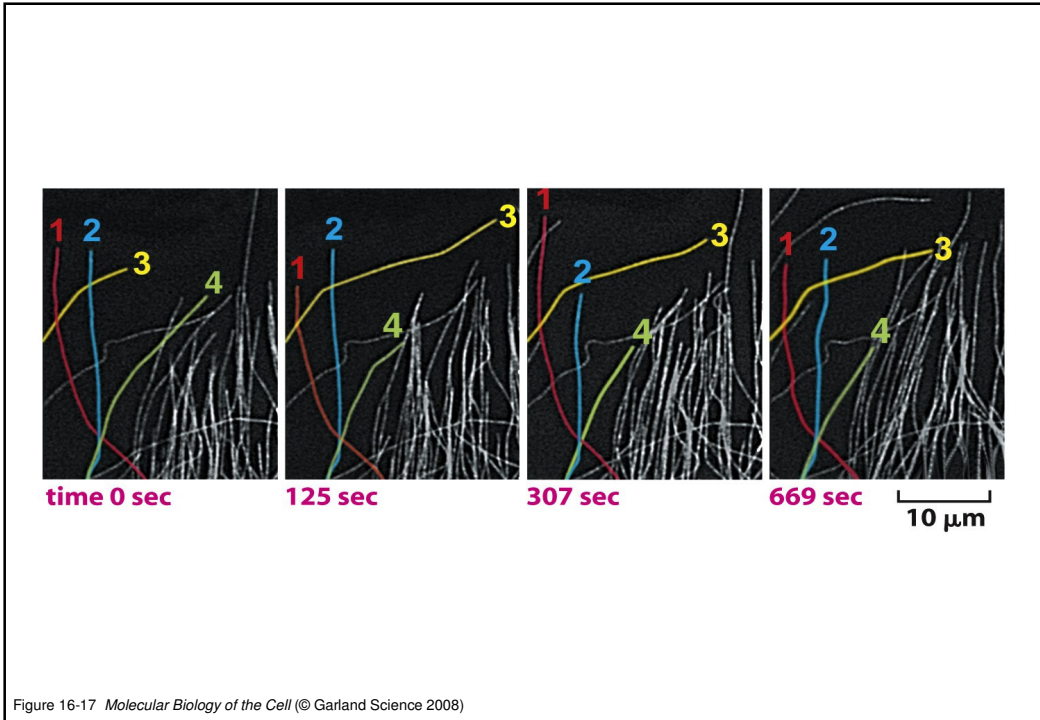
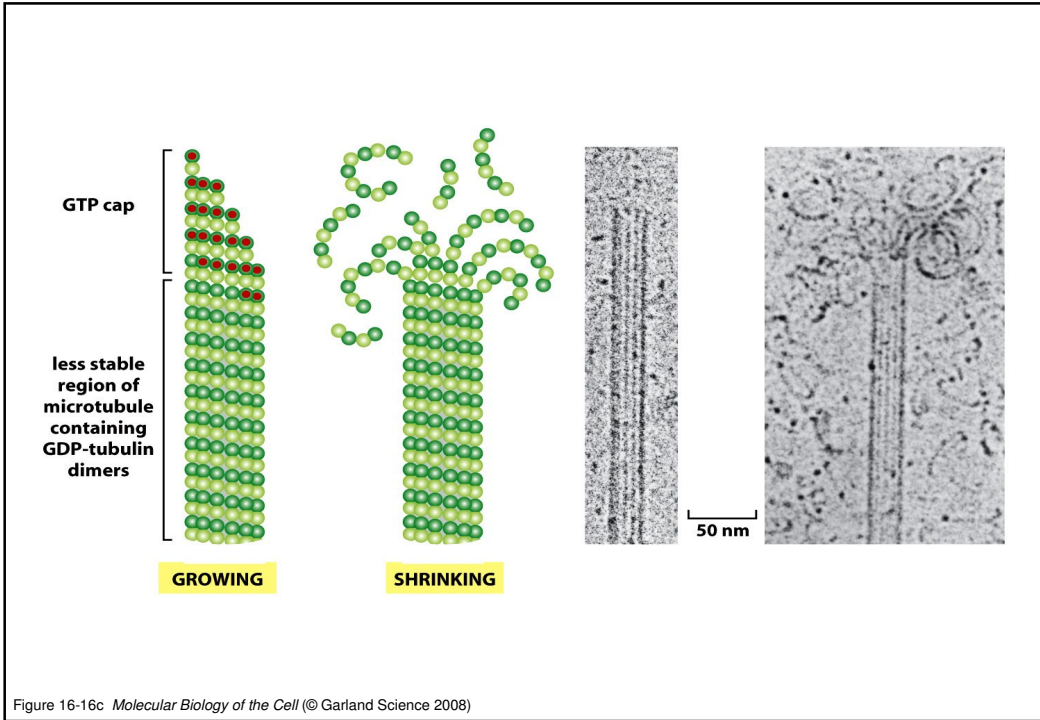


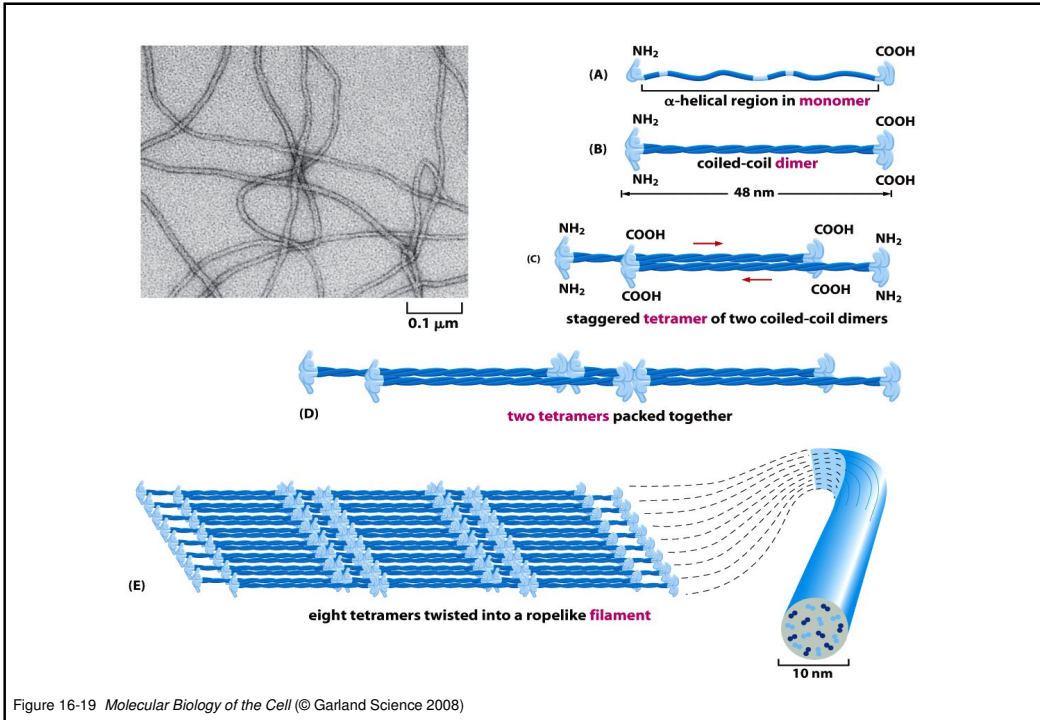
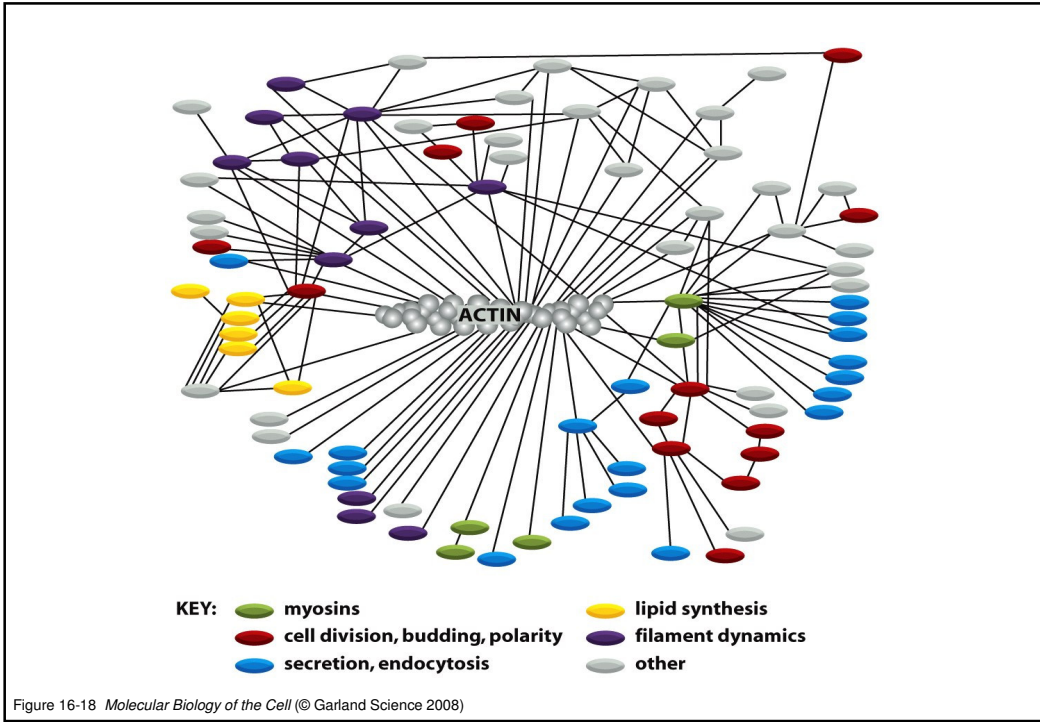












**Table 16–1 Major Types of Intermediate Filament Proteins in Vertebrate Cells**

TYPES OF IF	COMPONENT POLYPEPTIDES	LOCATION
Nuclear	lamins A, B, and C	nuclear lamina (inner lining of nuclear envelope)
Vimentin-like	vimentin	many cells of mesenchymal origin
	desmin	muscle
	glial fibrillary acidic protein	glial cells (astrocytes and some Schwann cells)
Epithelial	peripherin	some neurons
	type I keratins (acidic) type II keratins (basic)	epithelial cells and their derivatives (e.g., hair and nails)
Axonal	neurofilament proteins (NF-L, NF-M, and NF-H)	

Table 16-1 *Molecular Biology of the Cell* (© Garland Science 2008)

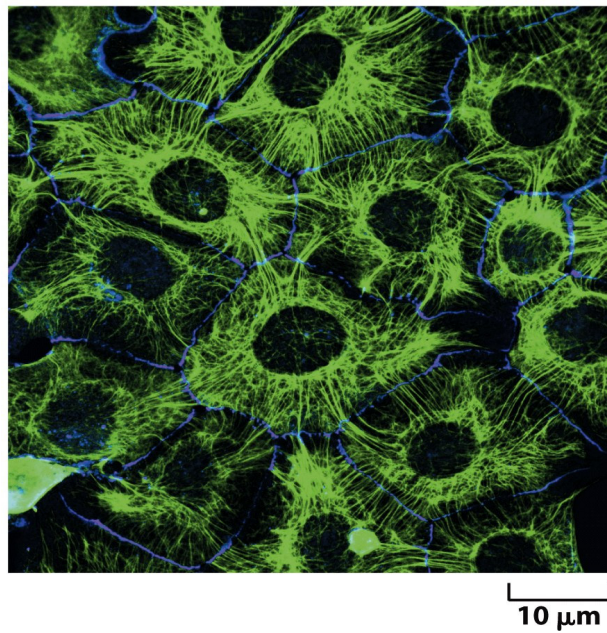
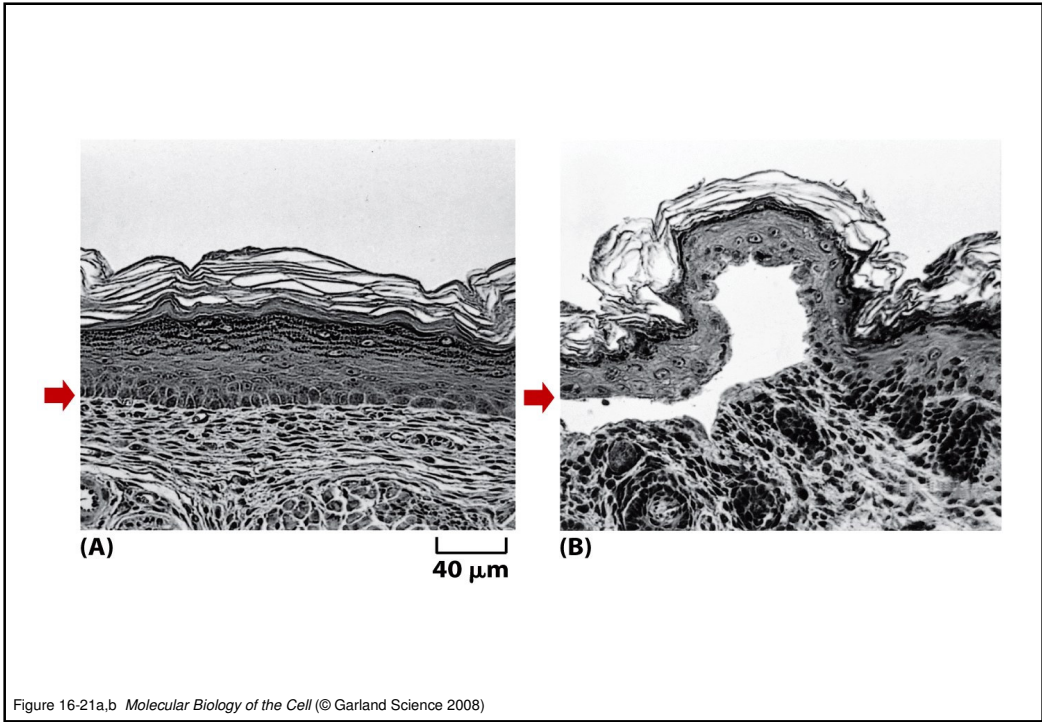
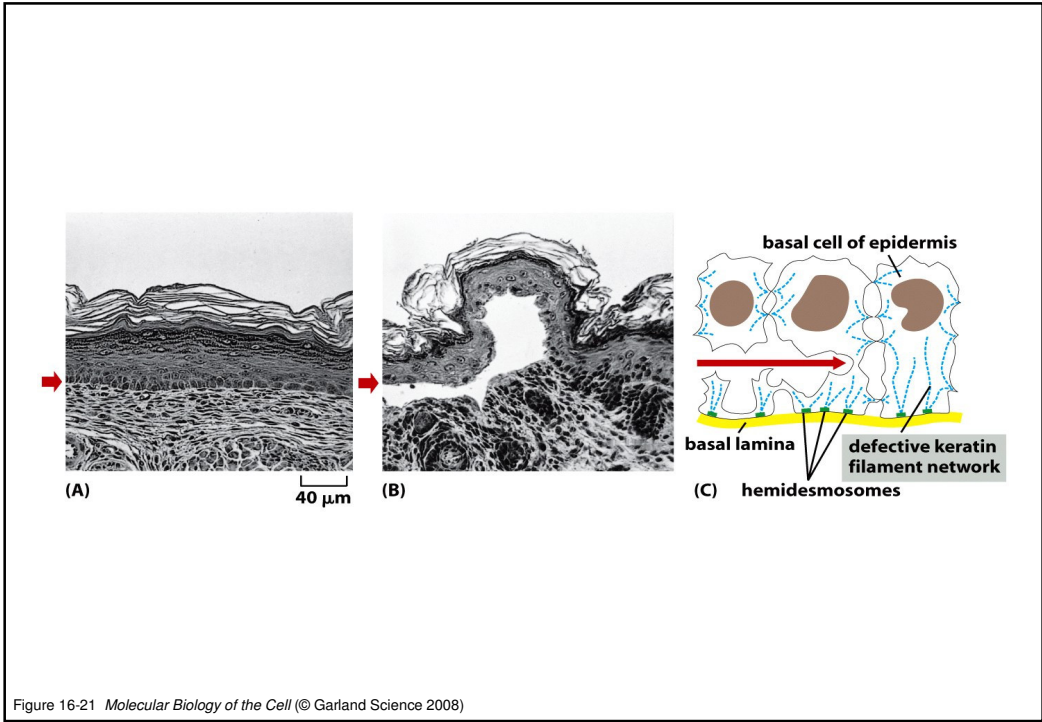
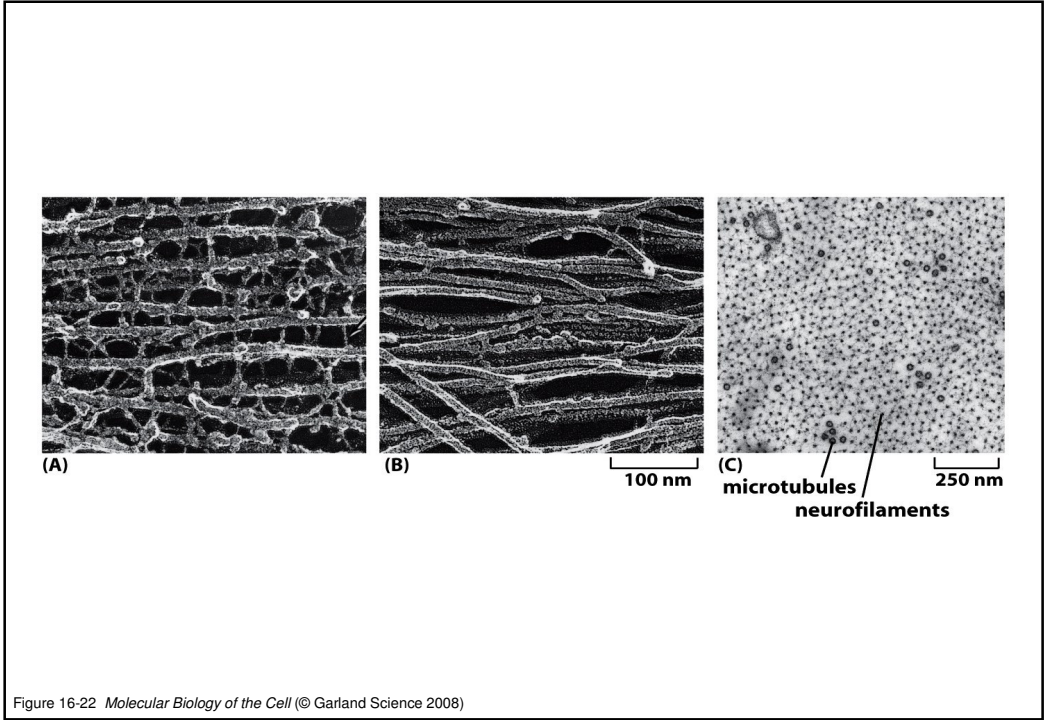
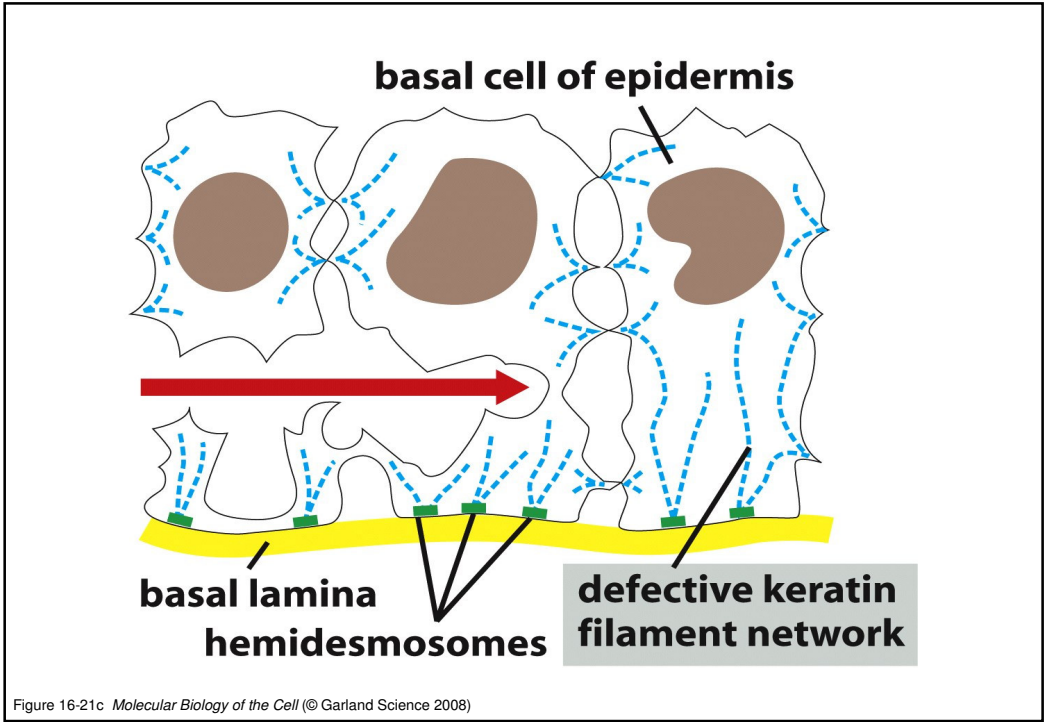


Figure 16-20 *Molecular Biology of the Cell* (© Garland Science 2008)







**Table 16–2 Drugs That Affect Actin Filaments and Microtubules**

ACTIN-SPECIFIC DRUGS	
Phalloidin	binds and stabilizes filaments
Cytochalasin	caps filament plus ends
Swinholide	severs filaments
Latrunculin	binds subunits and prevents their polymerization
MICROTUBULE-SPECIFIC DRUGS	
Taxol	binds and stabilizes microtubules
Colchicine, colcemid	binds subunits and prevents their polymerization
Vinblastine, vincristine	binds subunits and prevents their polymerization
Nocodazole	binds subunits and prevents their polymerization

Table 16-2 *Molecular Biology of the Cell* (© Garland Science 2008)

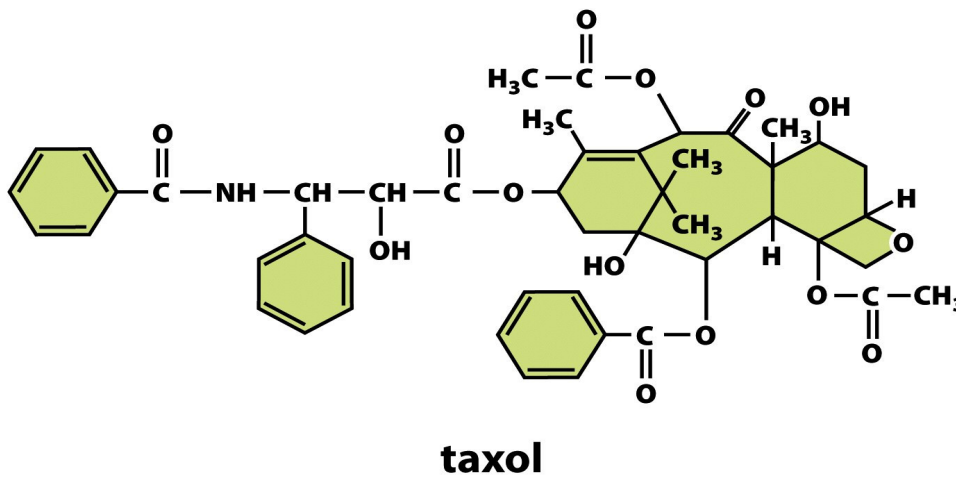
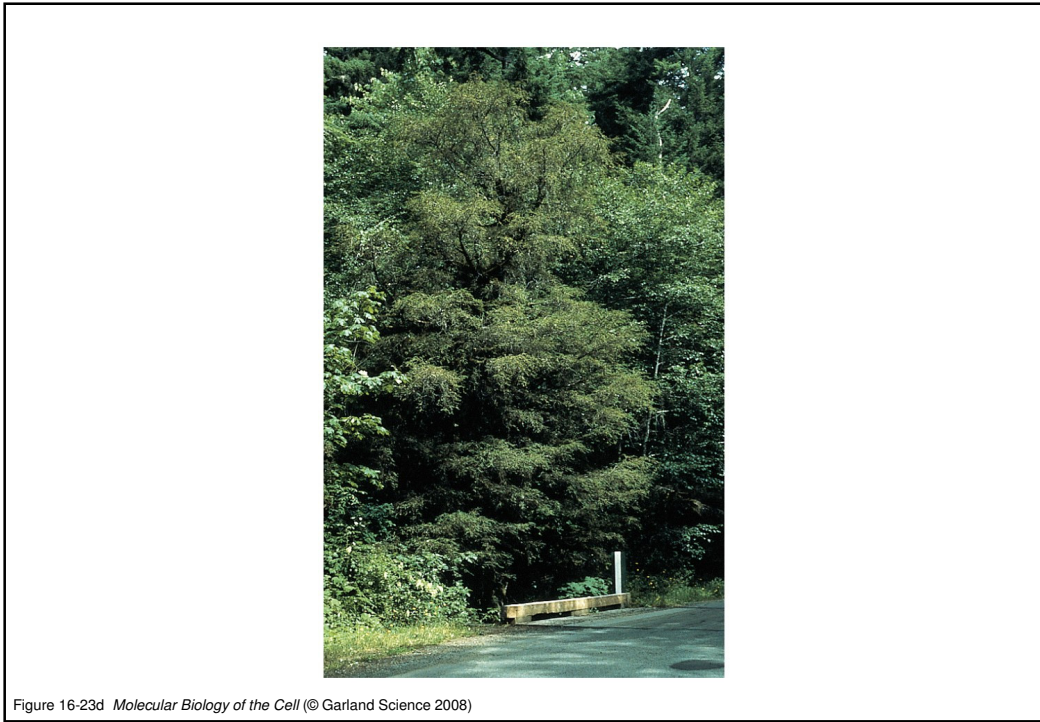
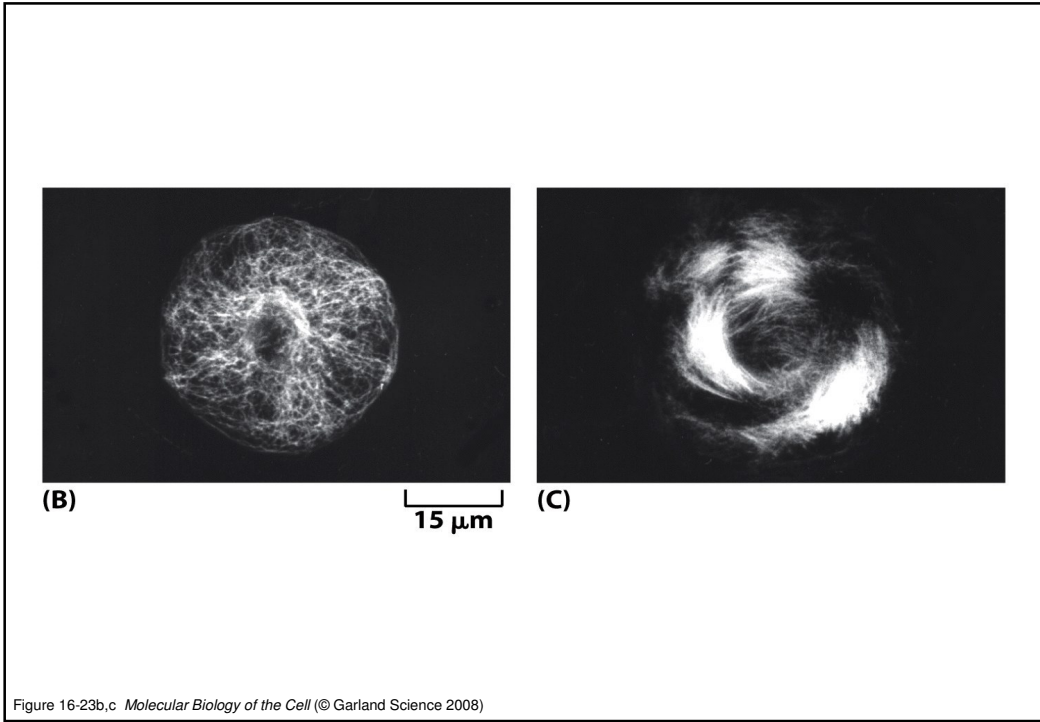
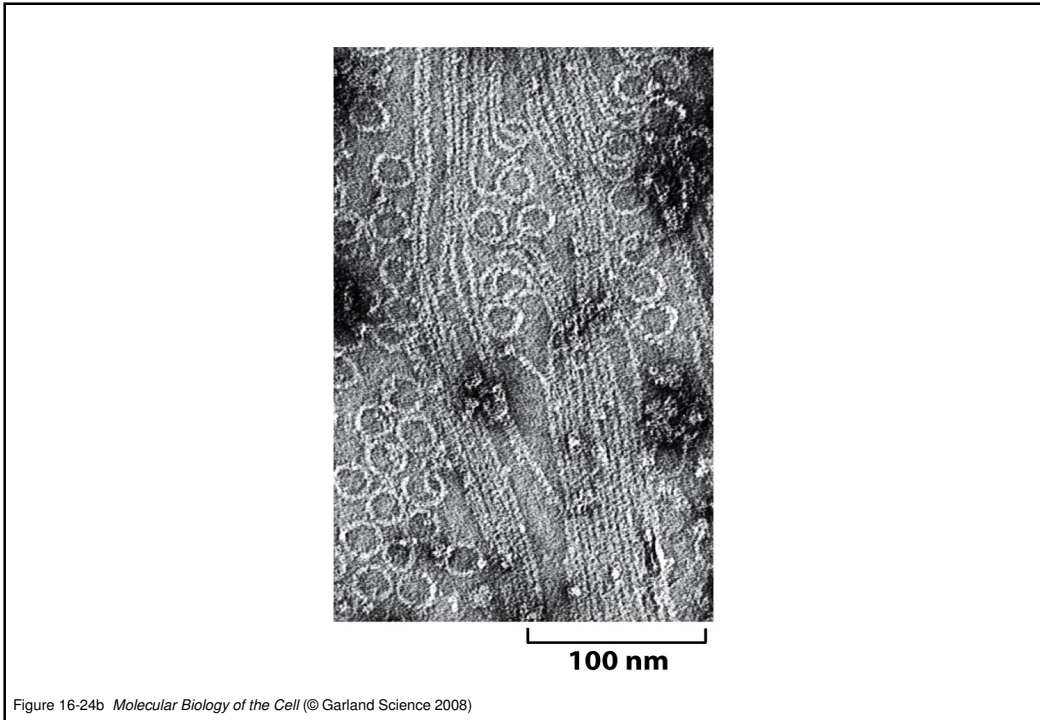
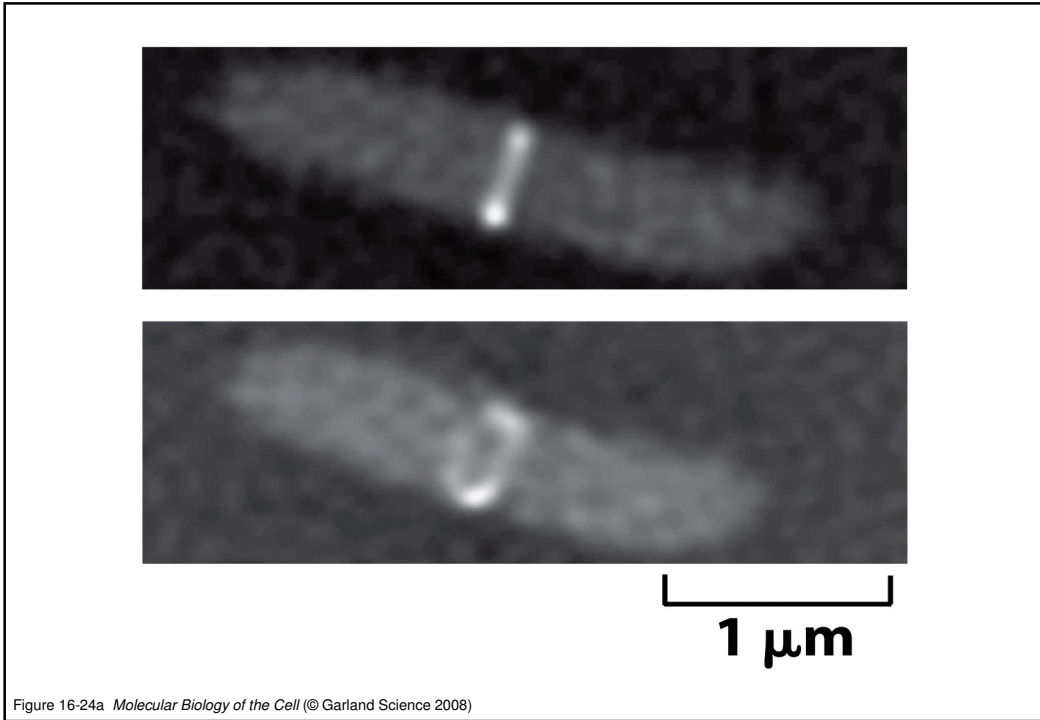
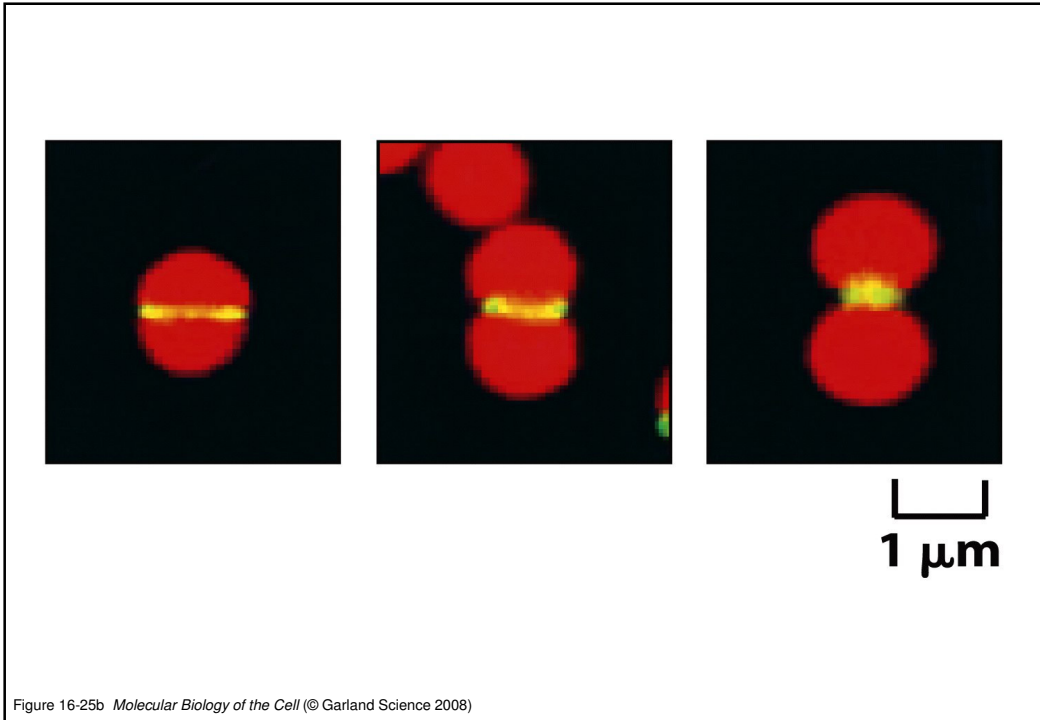
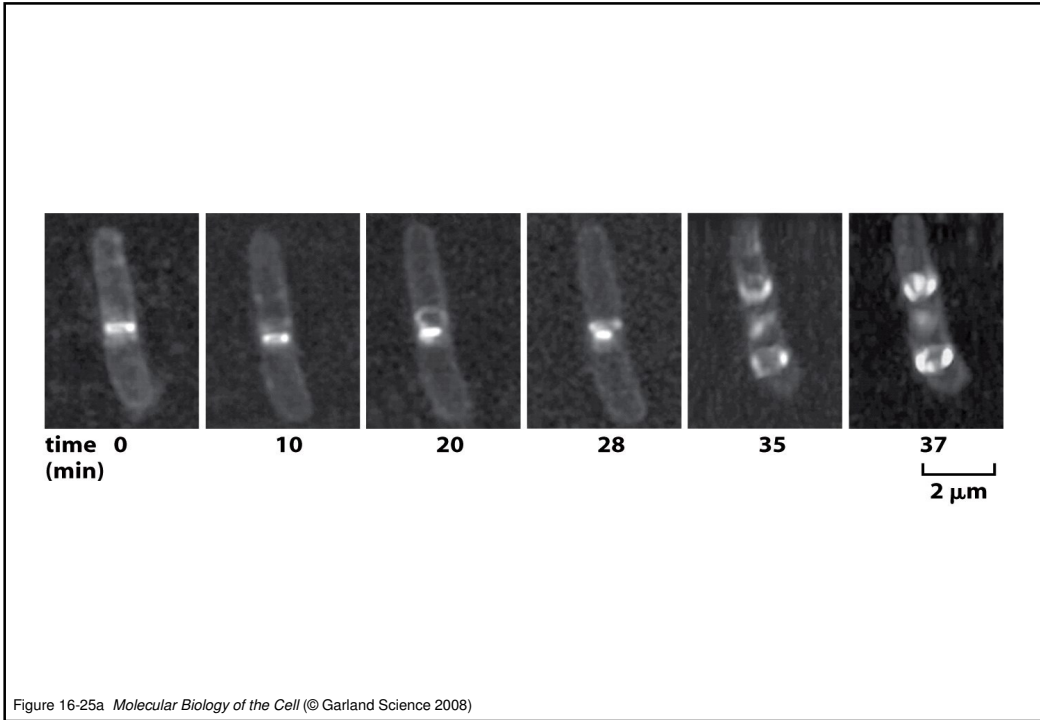


Figure 16-23a *Molecular Biology of the Cell* (© Garland Science 2008)







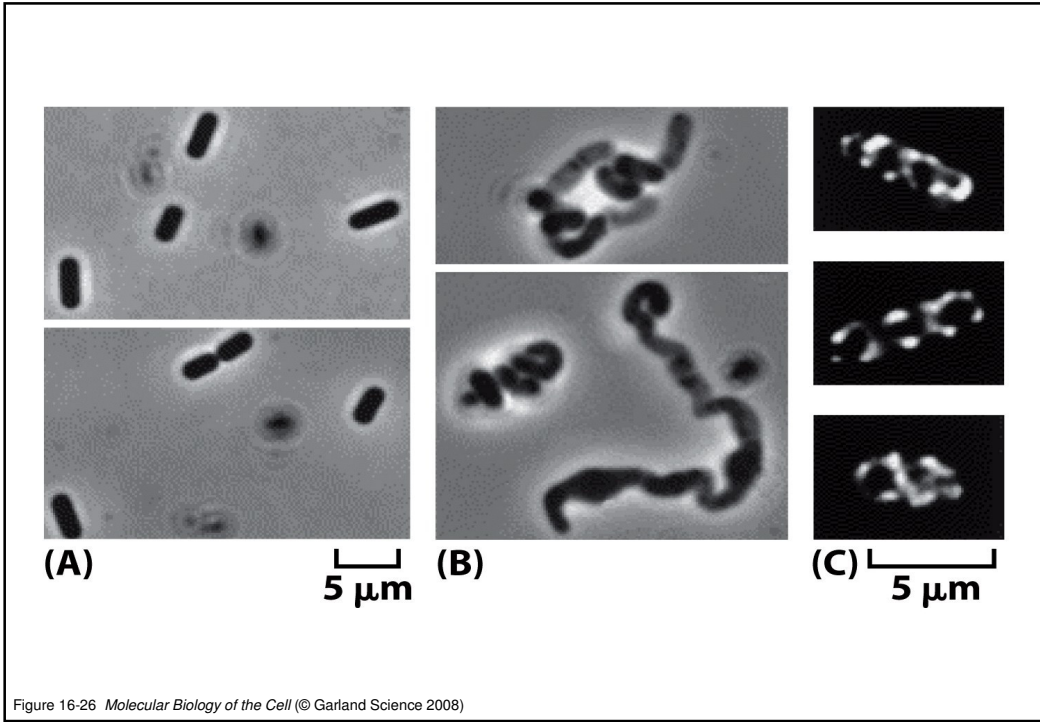


Figure 16-26 *Molecular Biology of the Cell* (© Garland Science 2008)

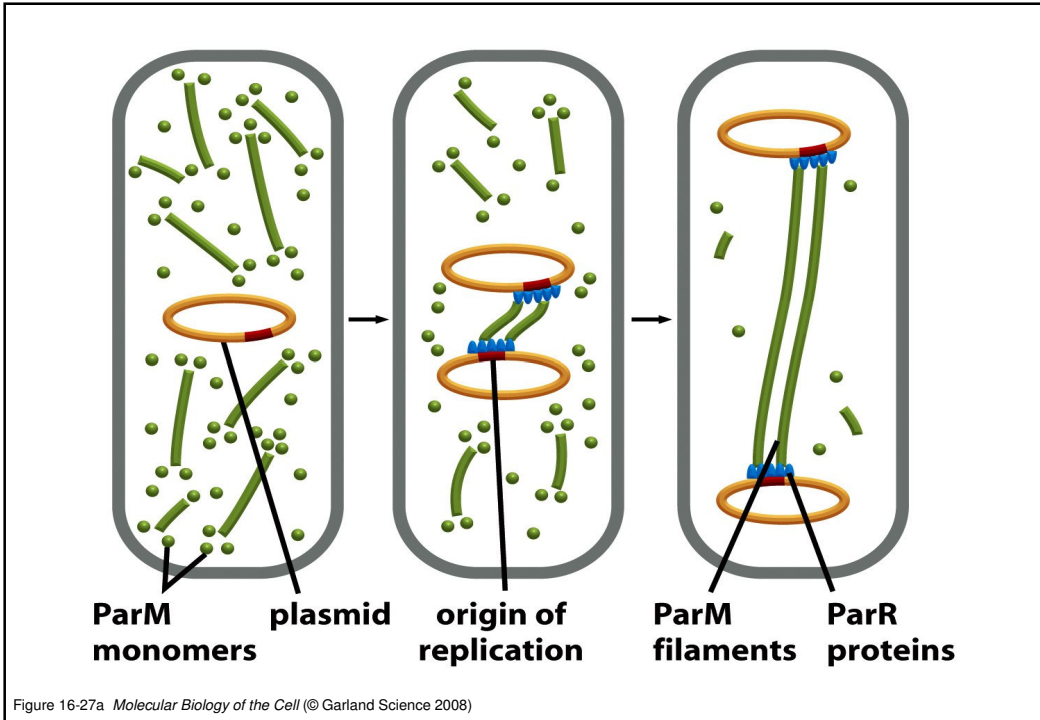


Figure 16-27a *Molecular Biology of the Cell* (© Garland Science 2008)

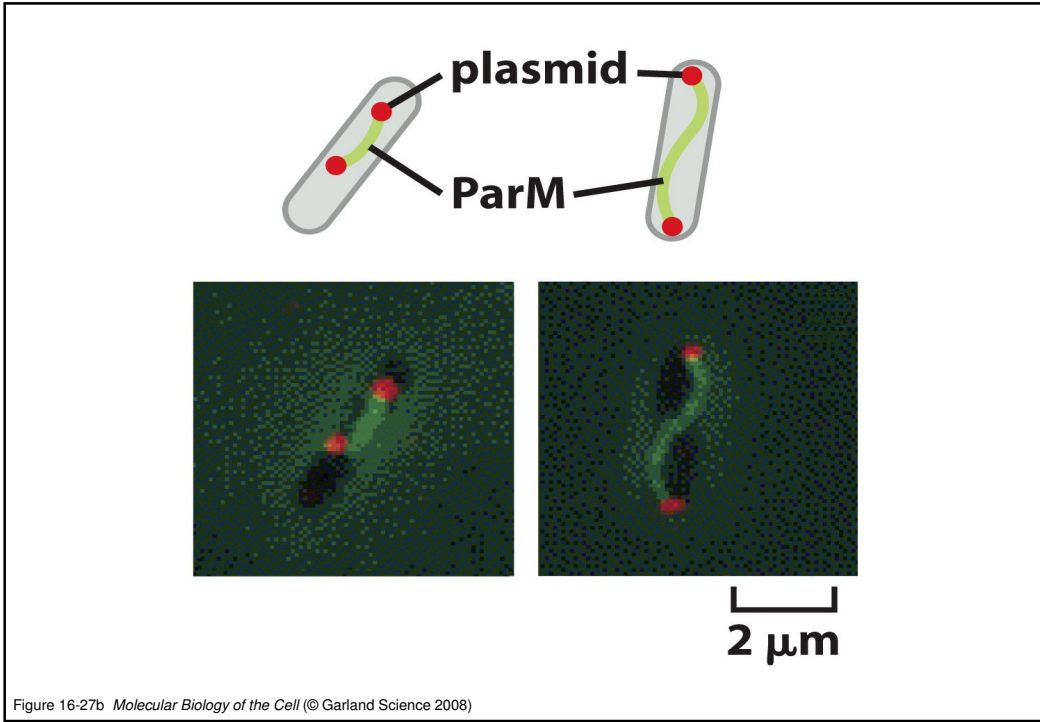


Figure 16-27b *Molecular Biology of the Cell* (© Garland Science 2008)

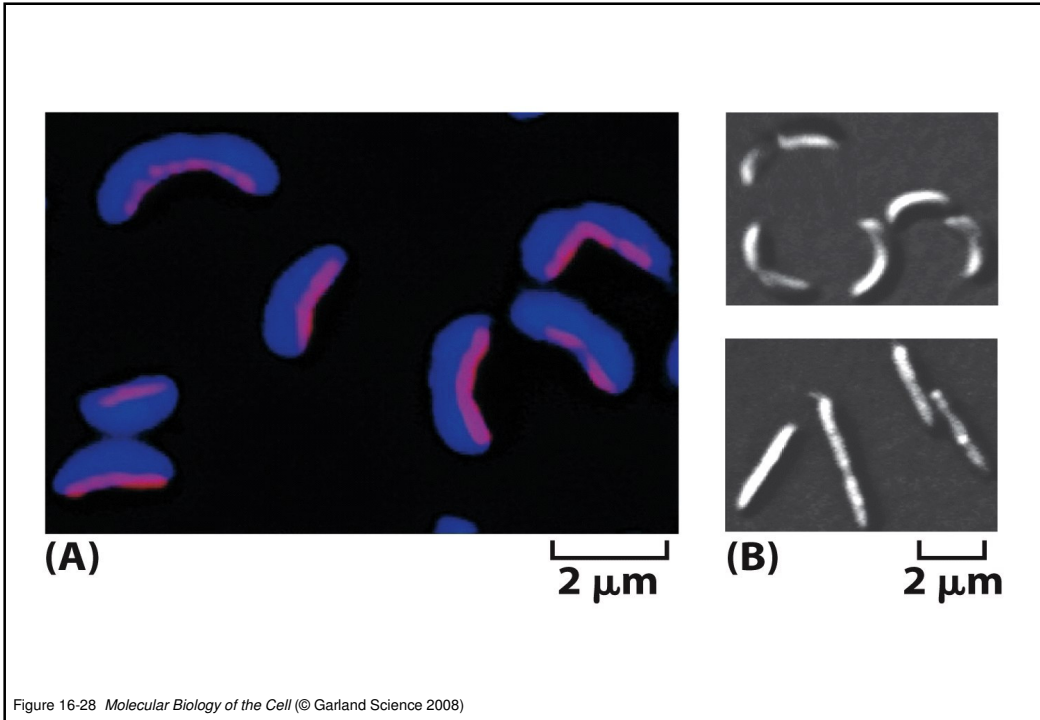
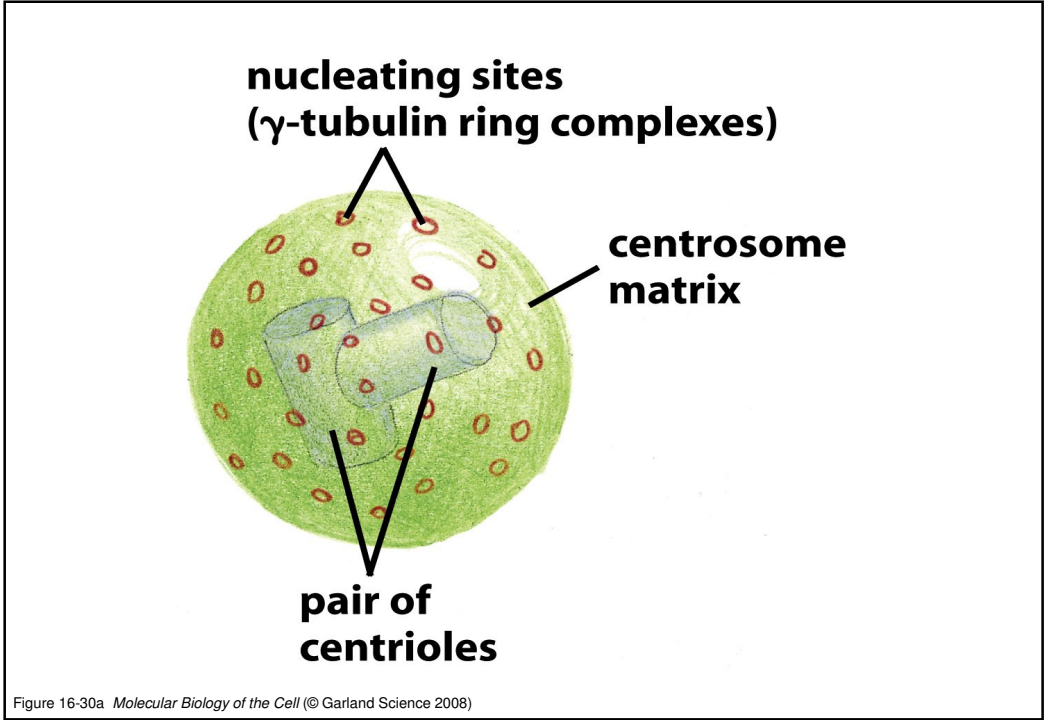
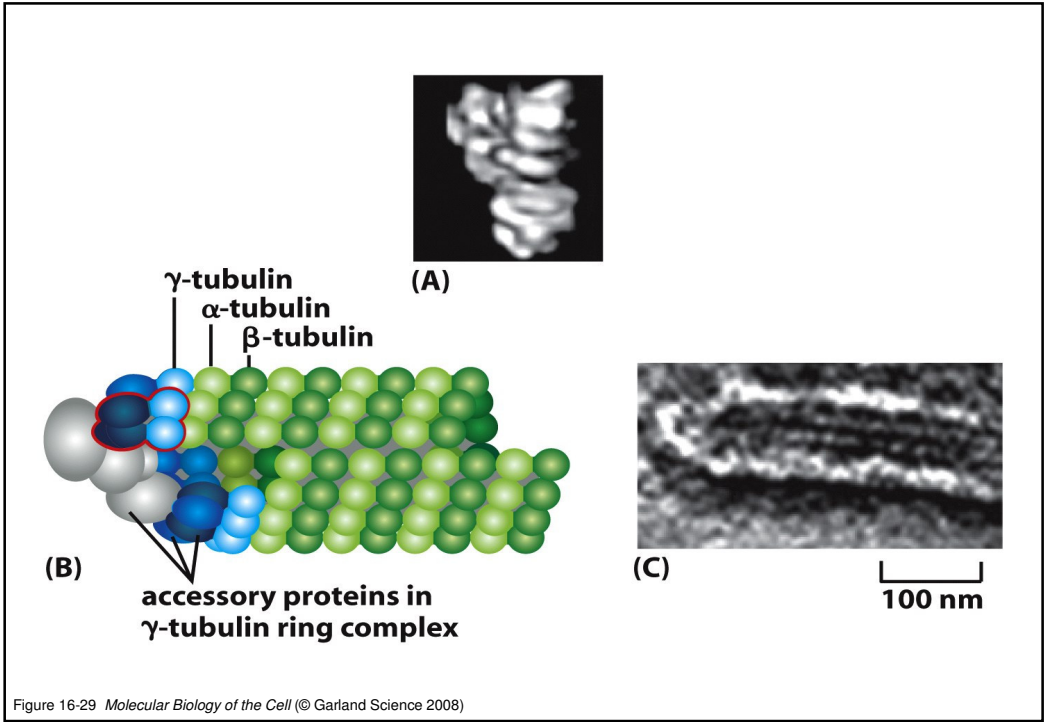
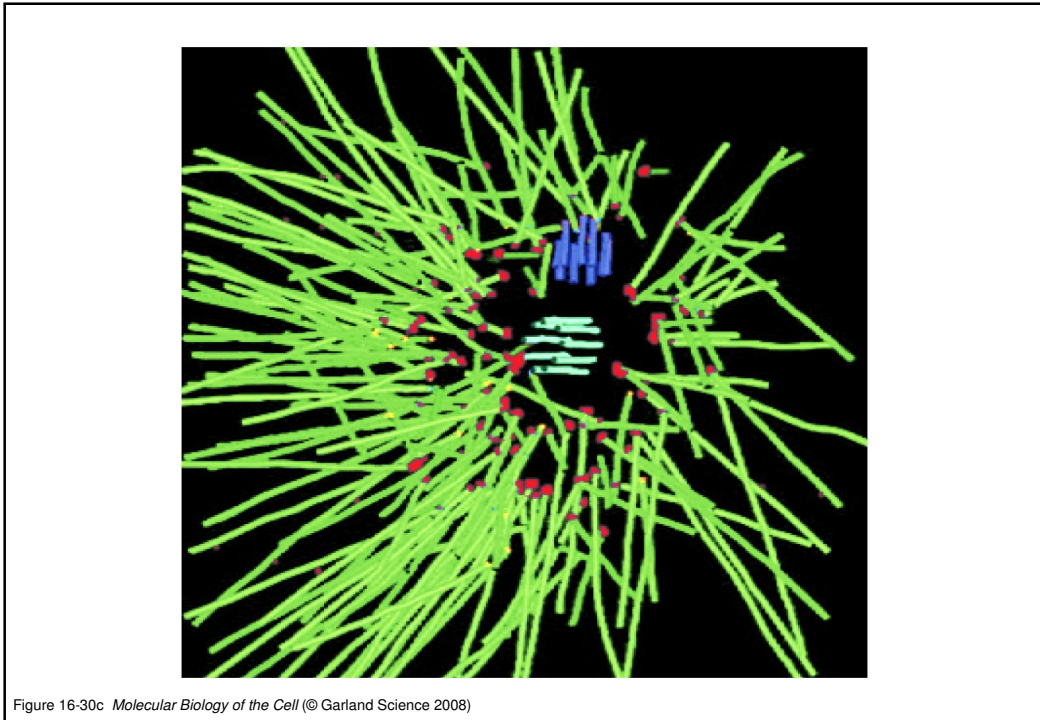
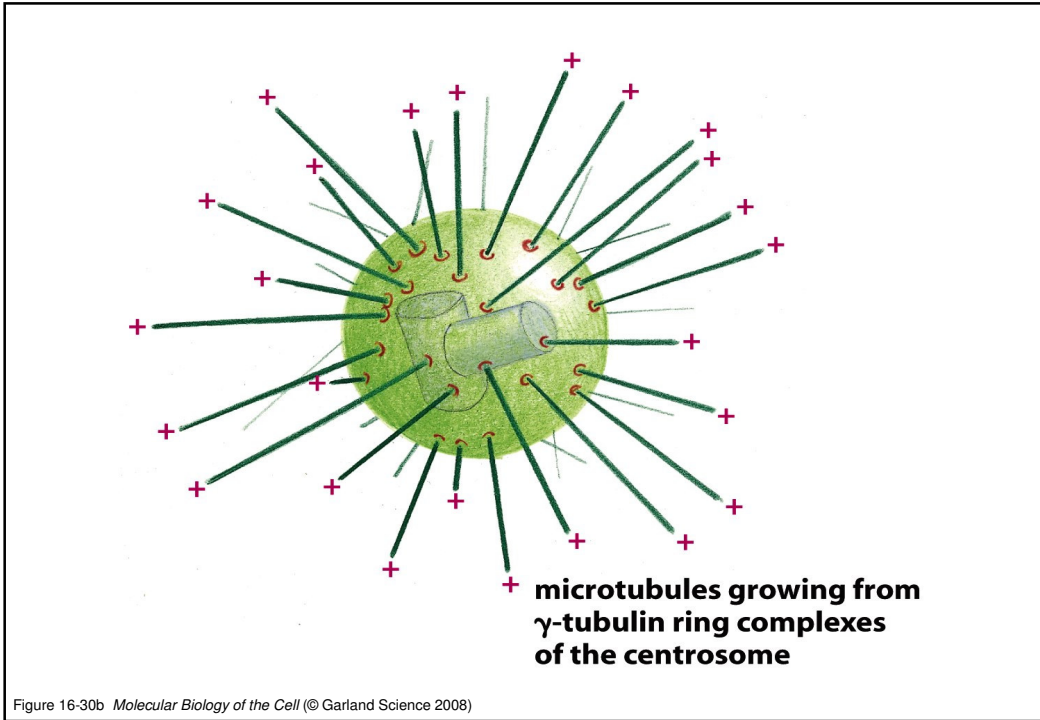
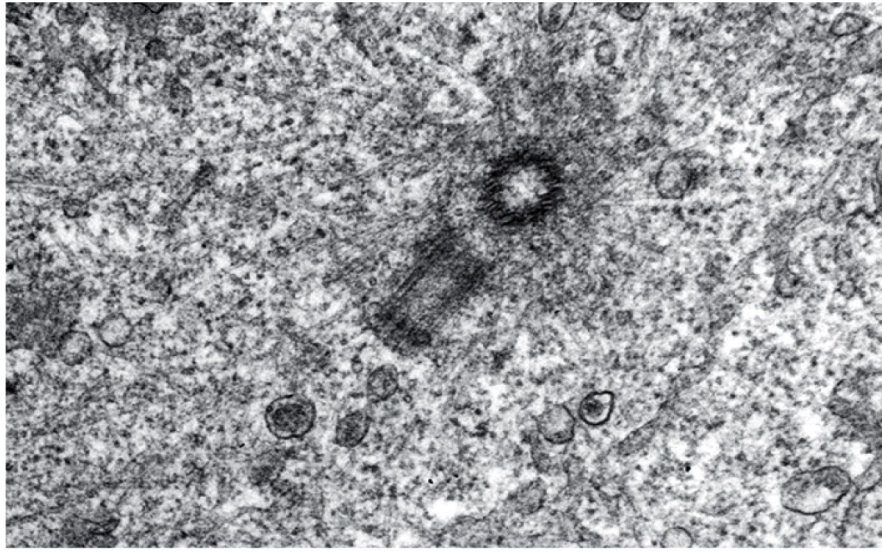


Figure 16-28 *Molecular Biology of the Cell* (© Garland Science 2008)









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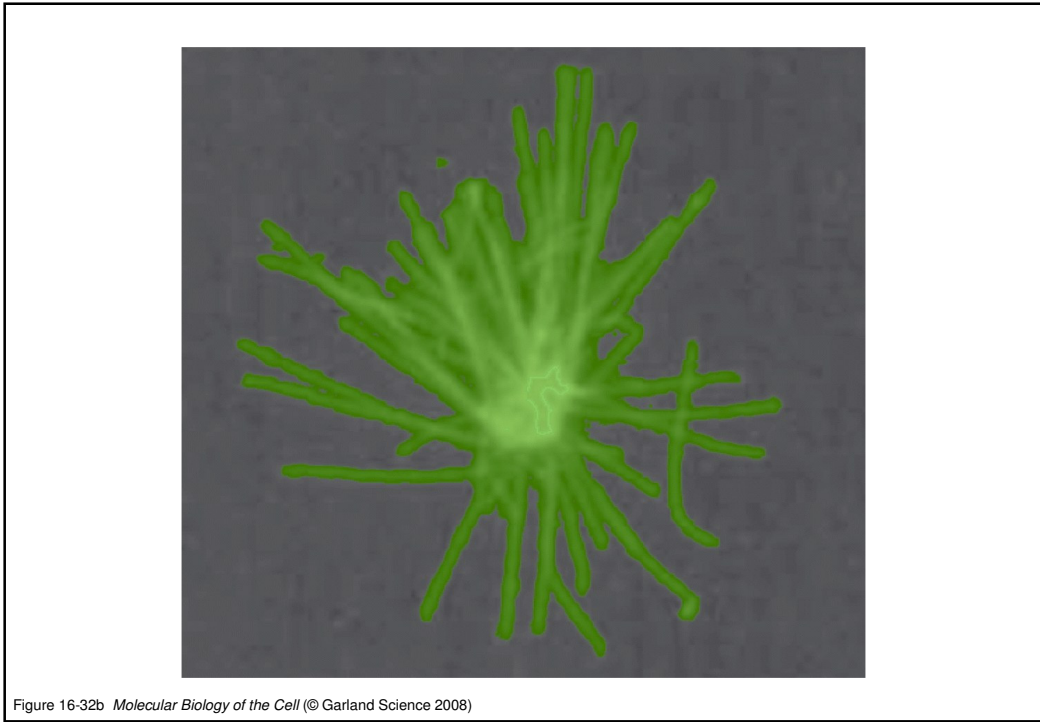
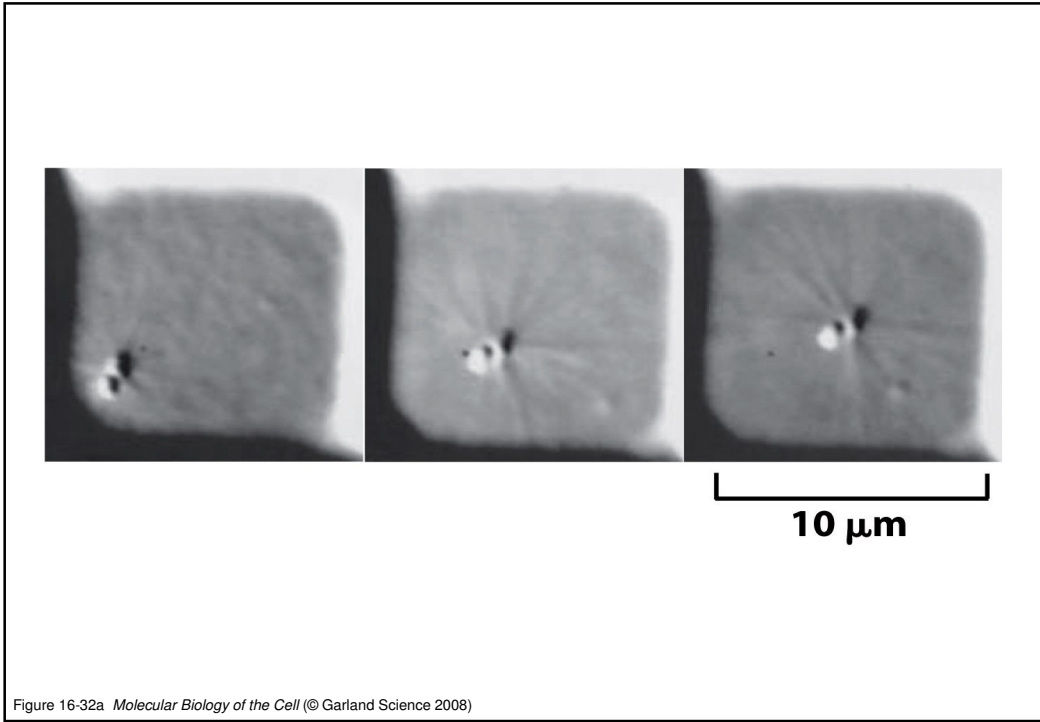
Figure 16-31a *Molecular Biology of the Cell* (© Garland Science 2008)

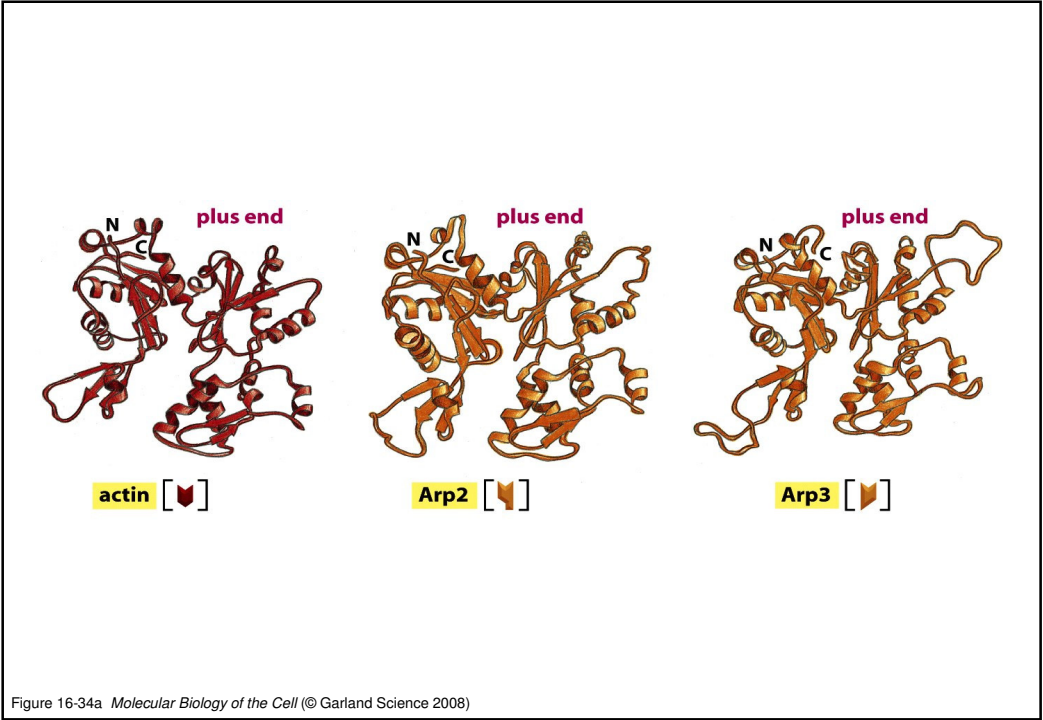
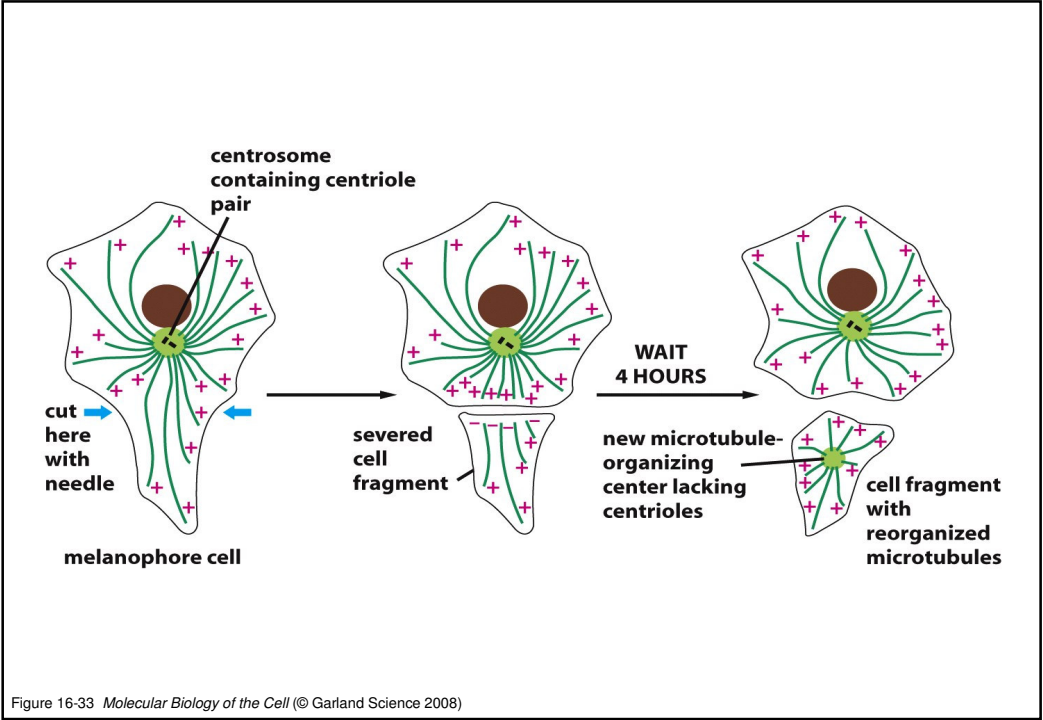
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matrix**

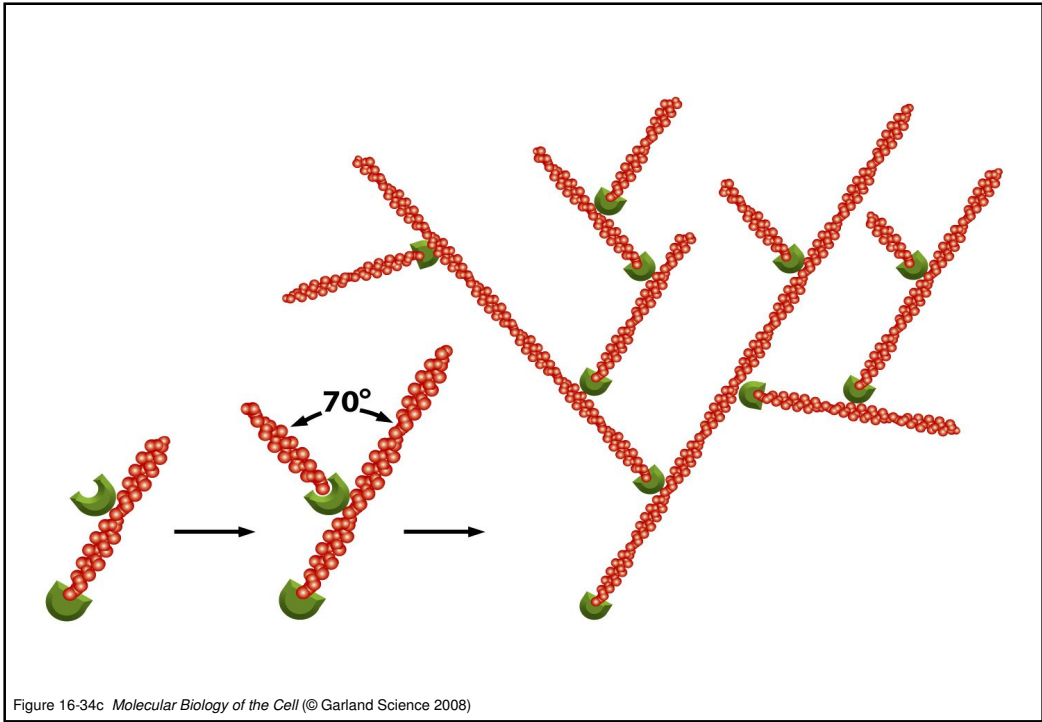
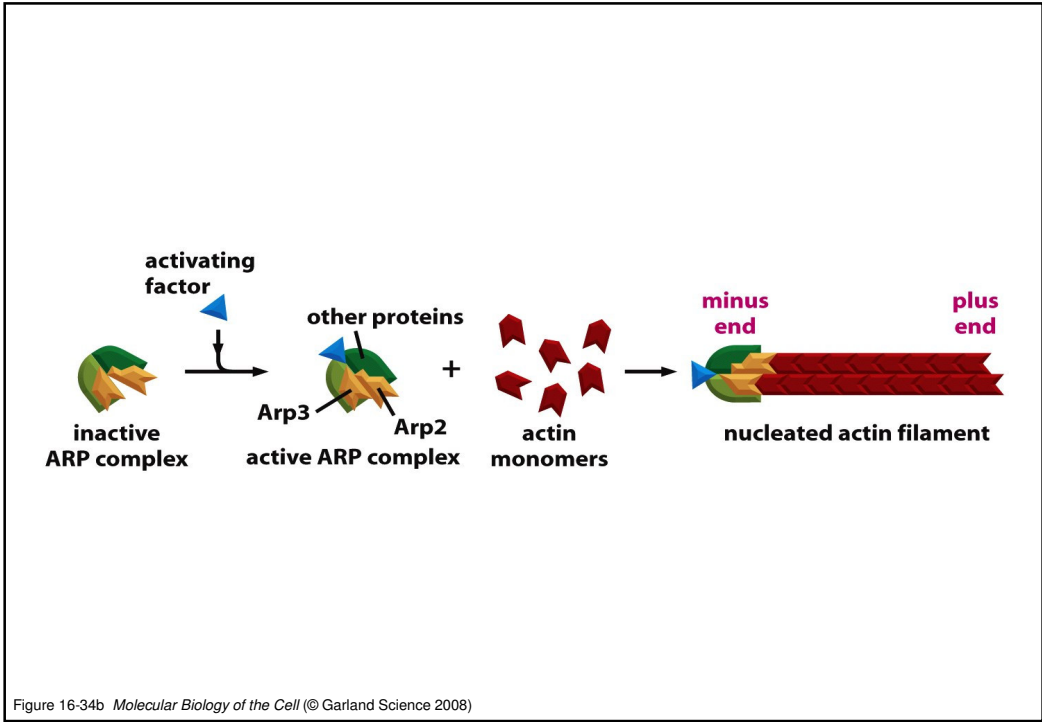
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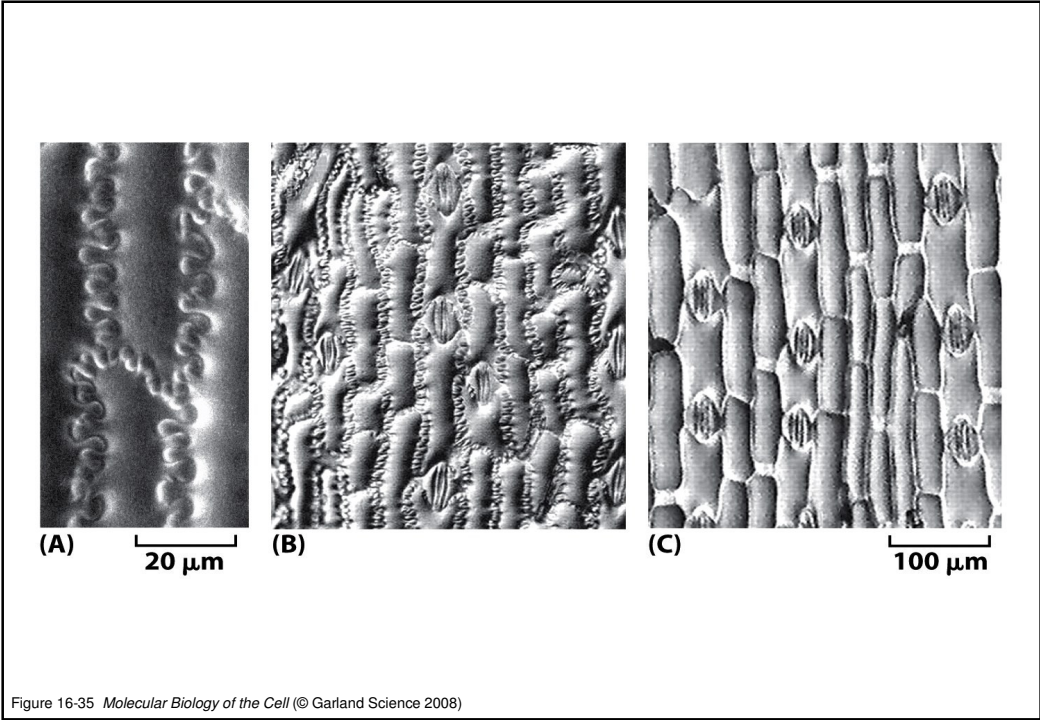
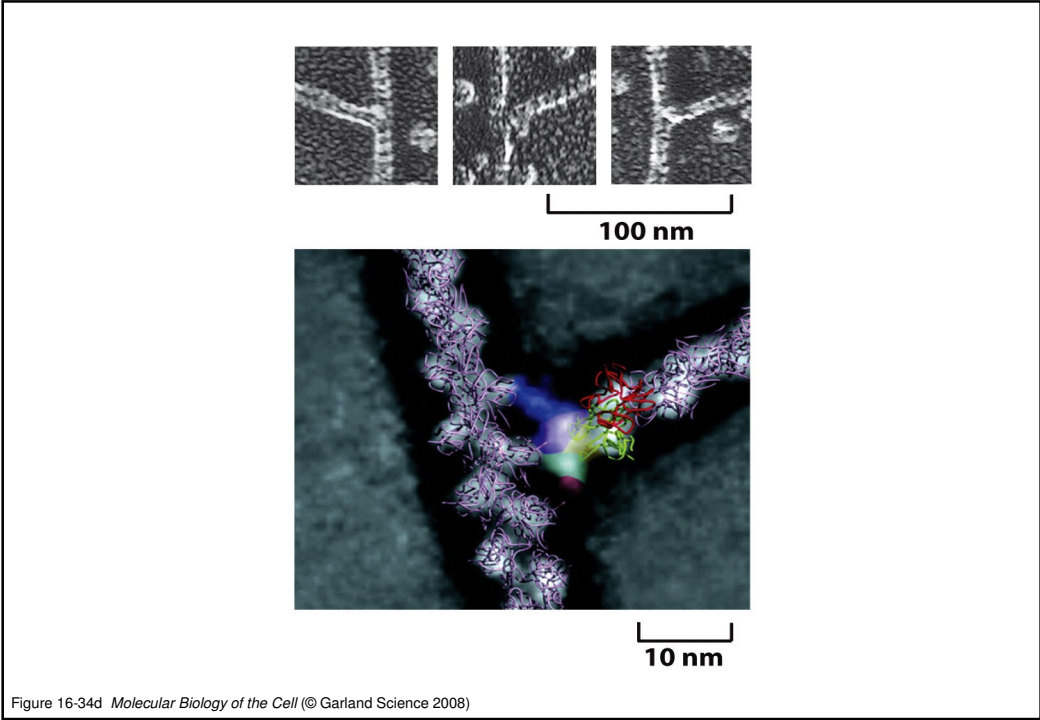
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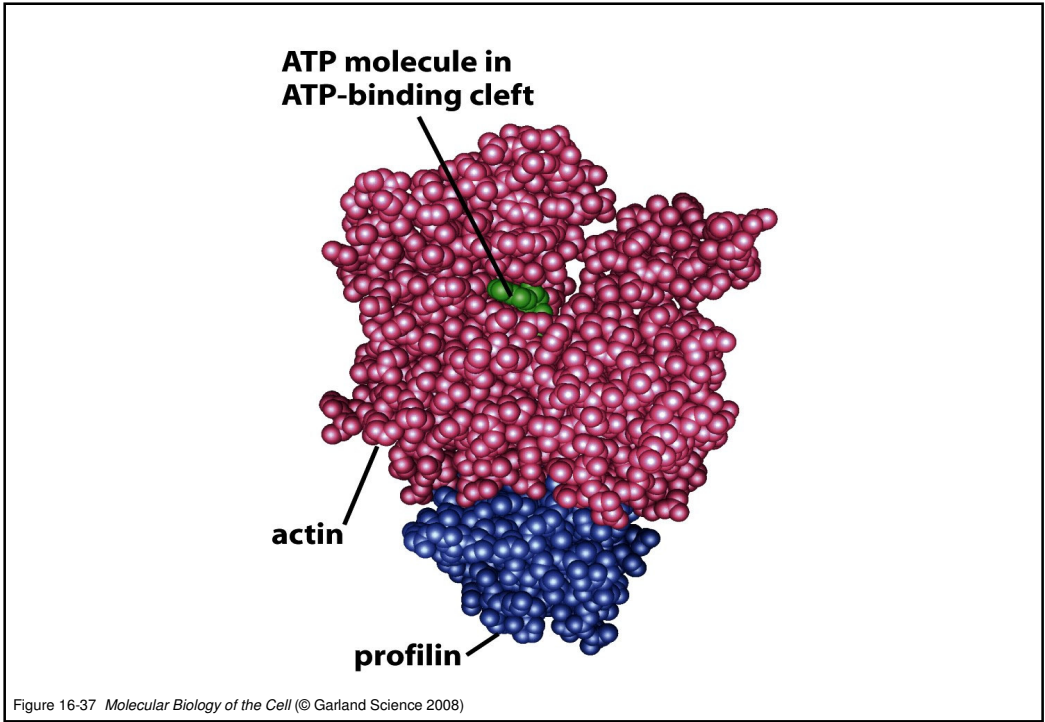
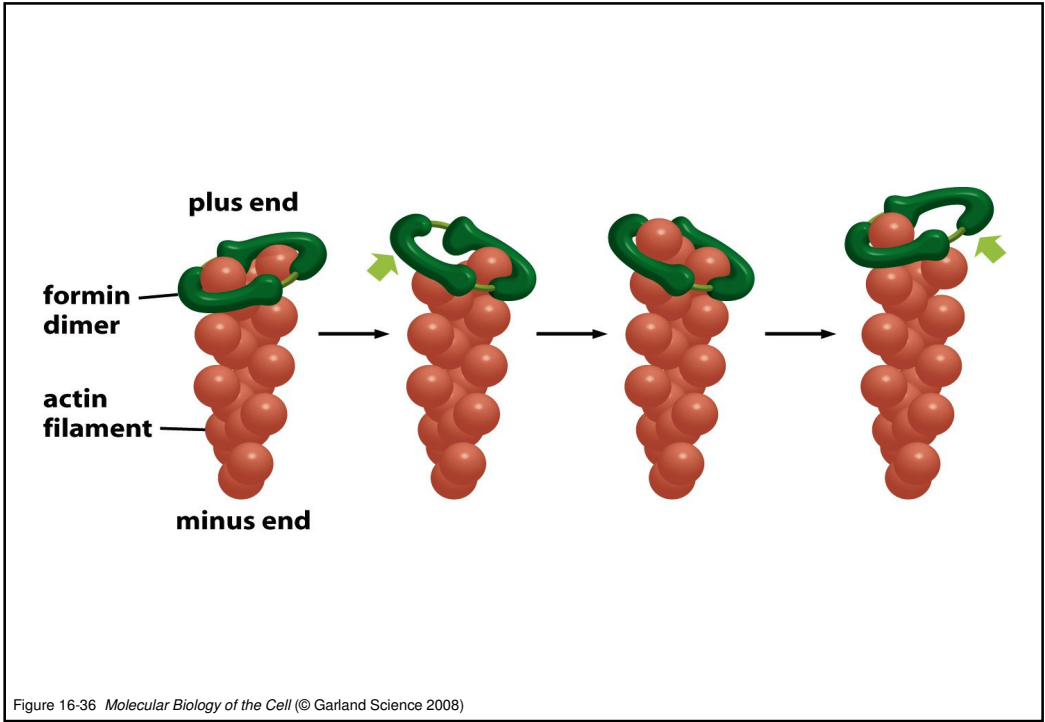
Figure 16-31b *Molecular Biology of the Cell* (© Garland Science 2008)

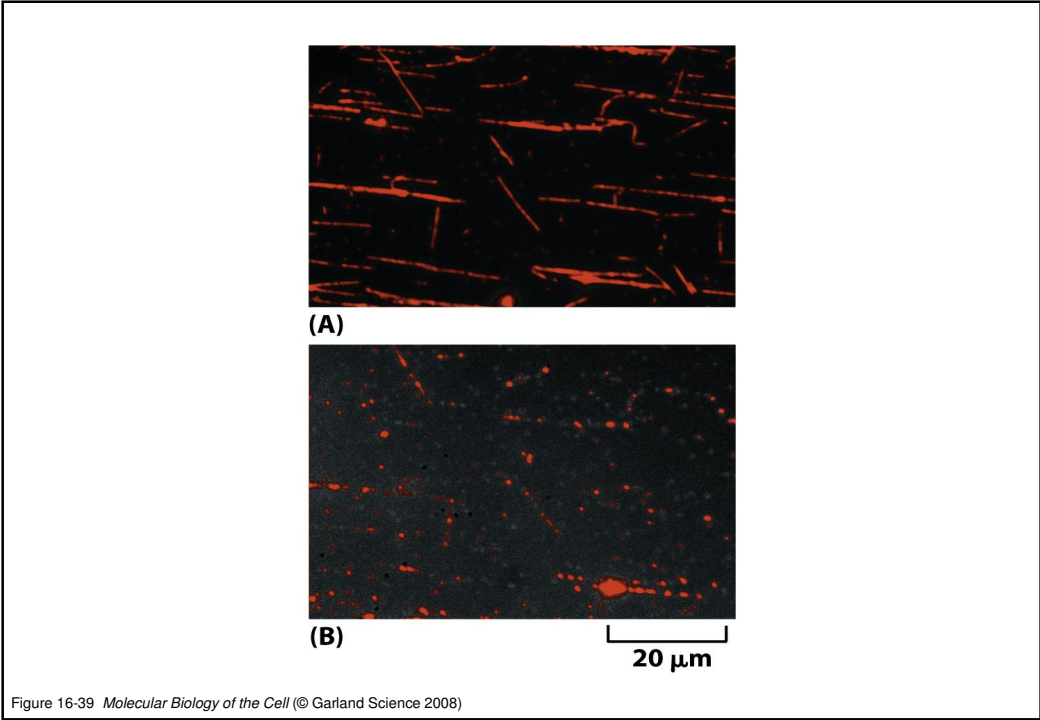
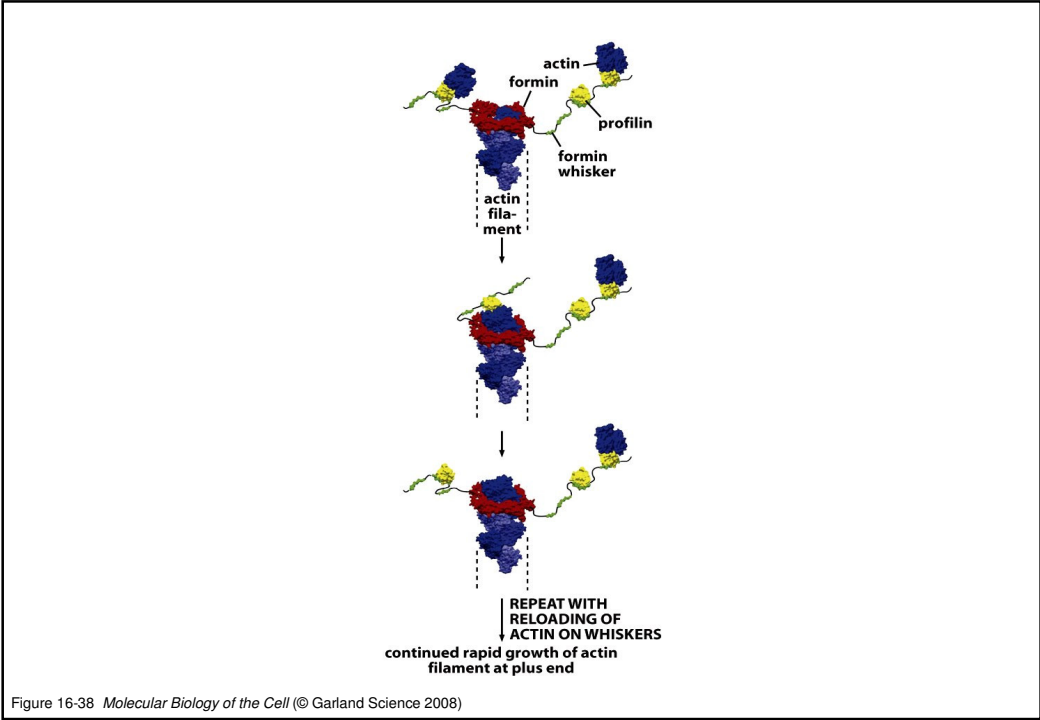


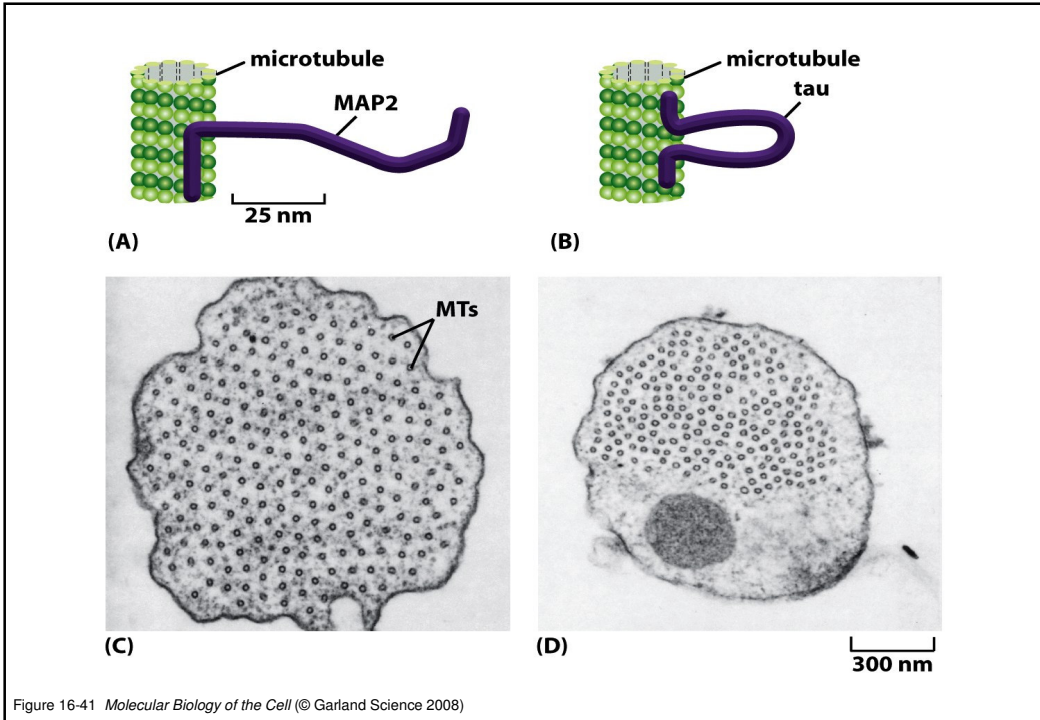
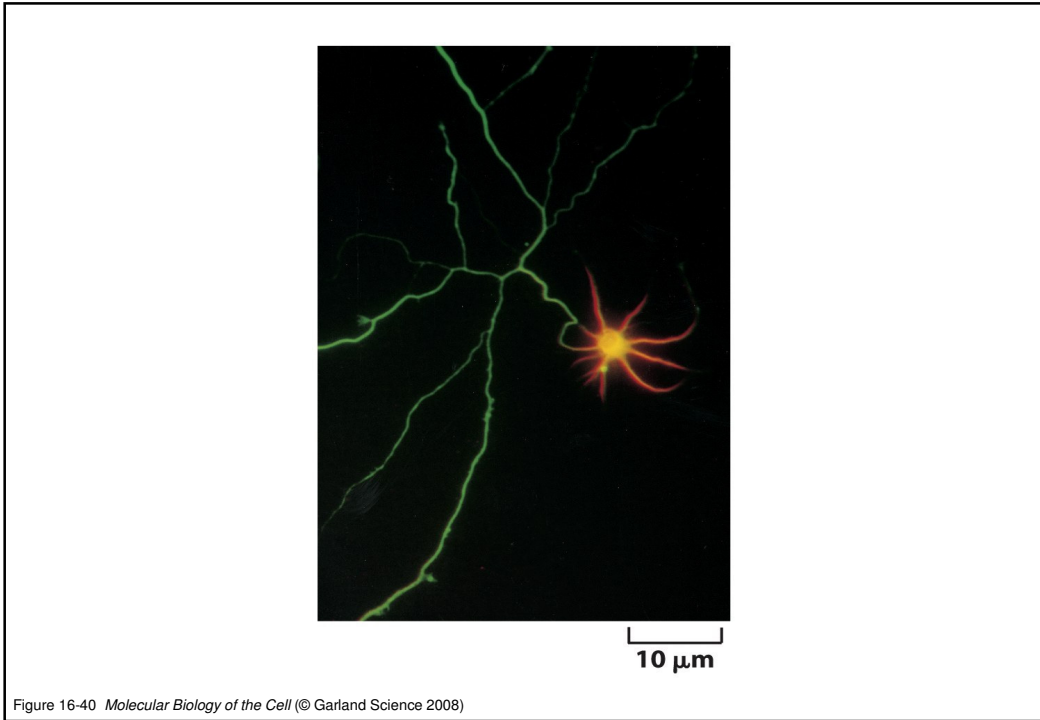




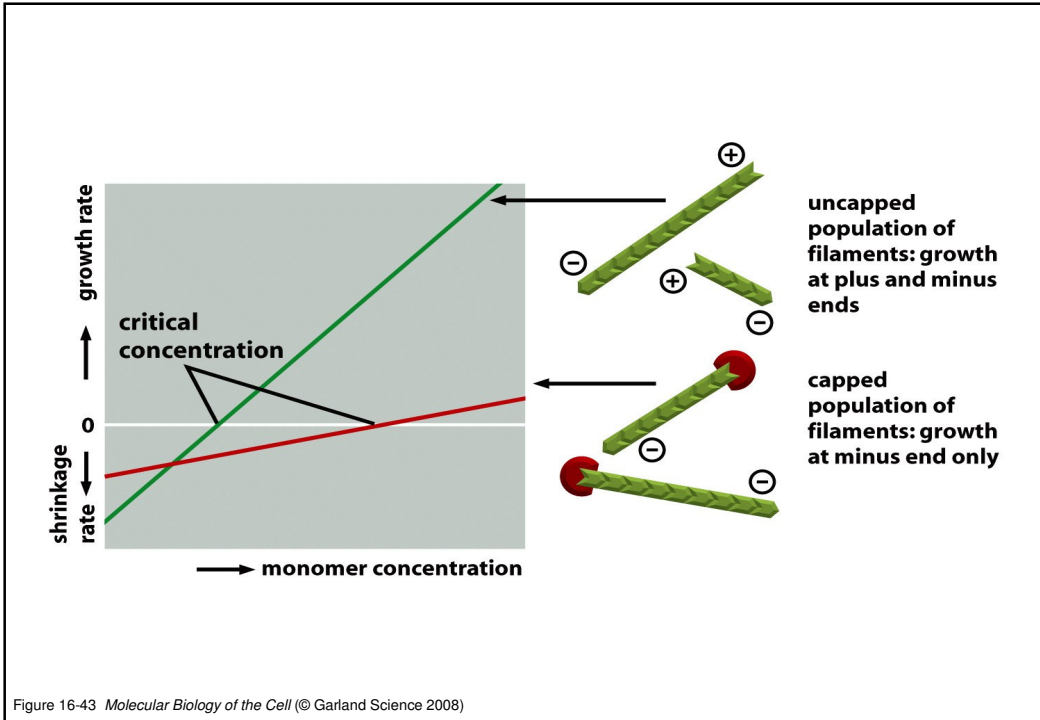
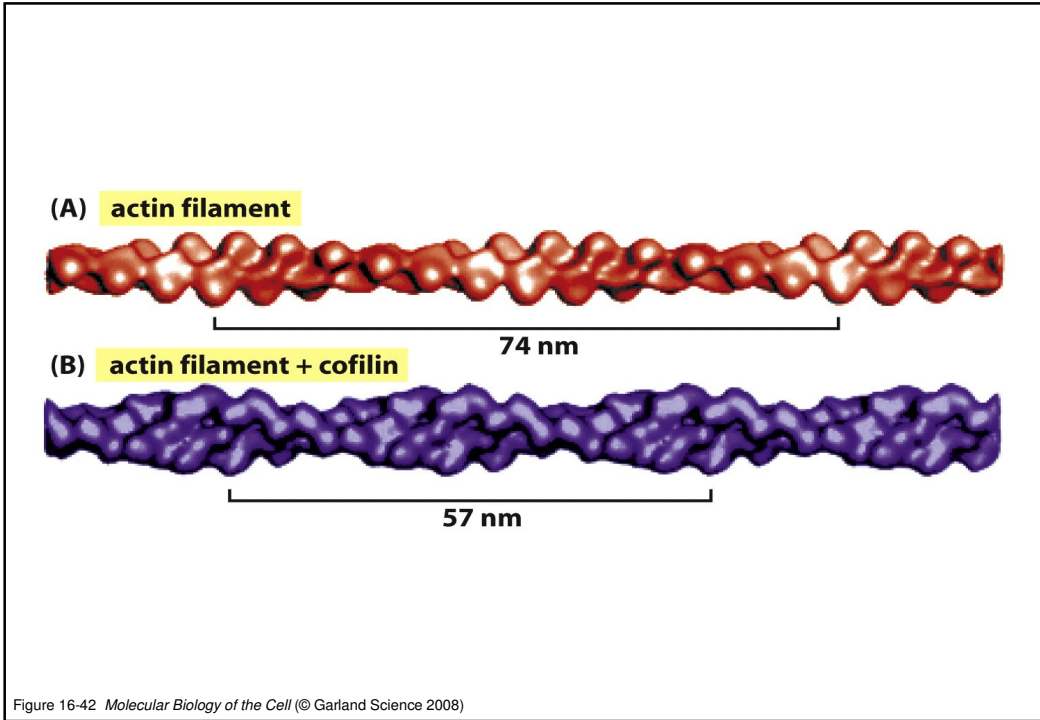


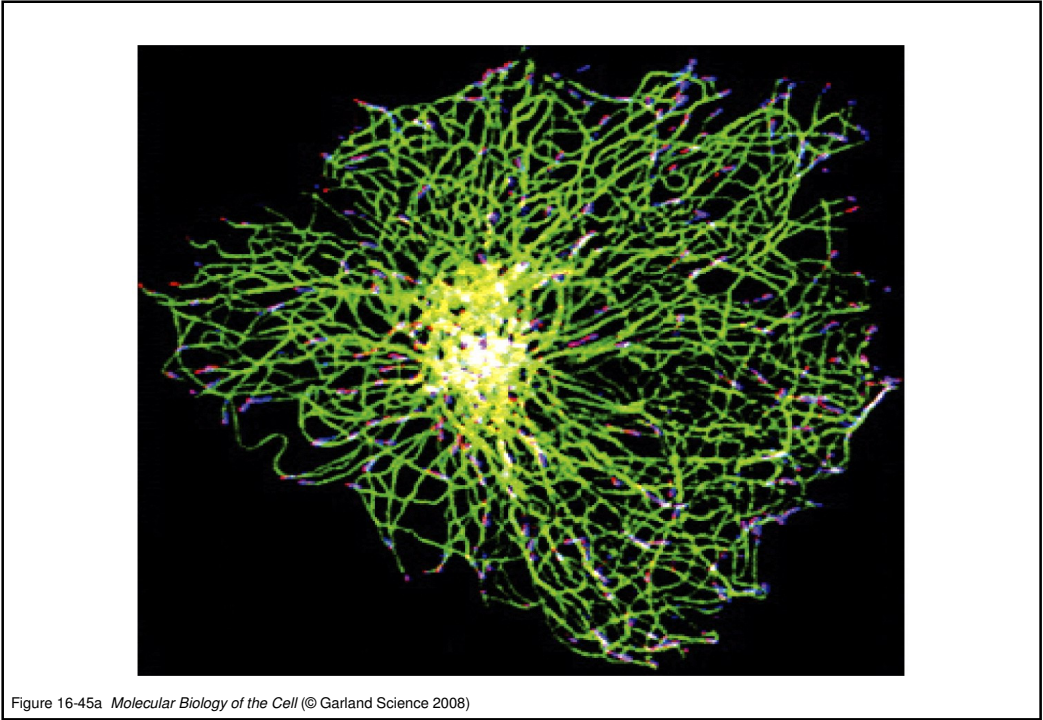
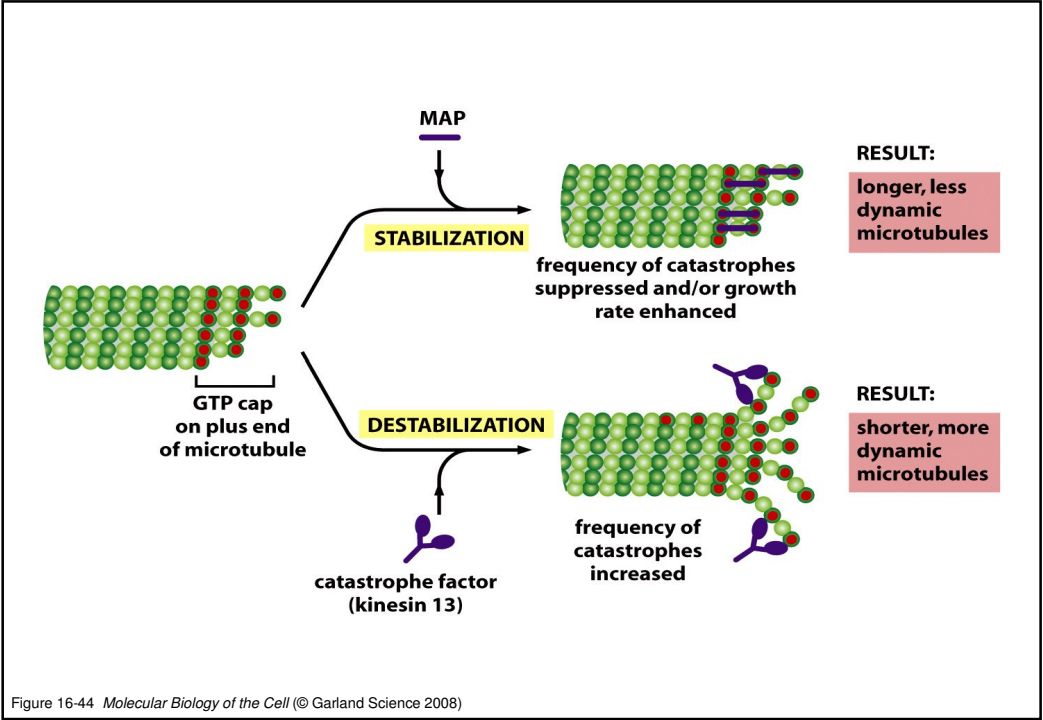


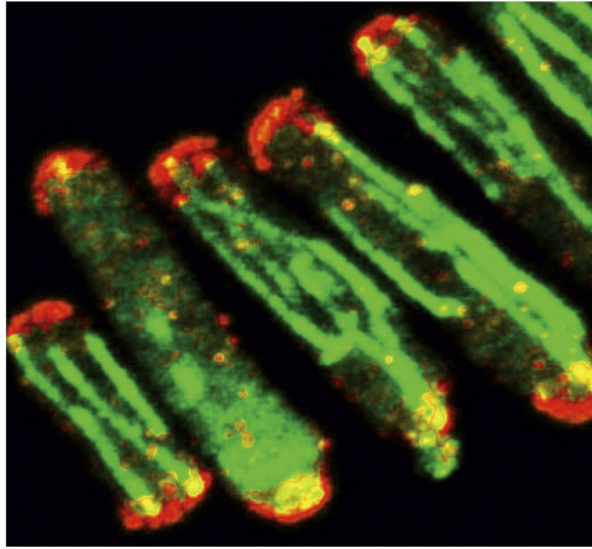






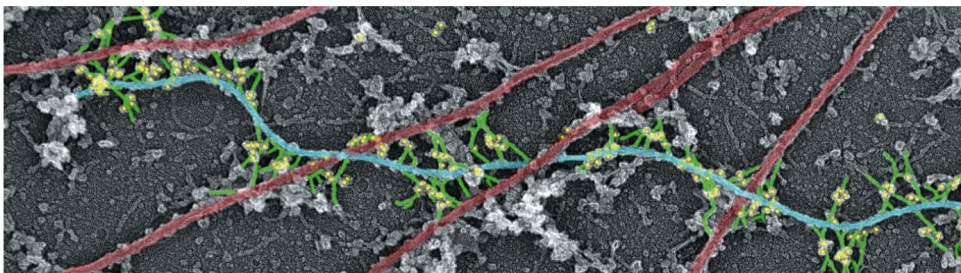






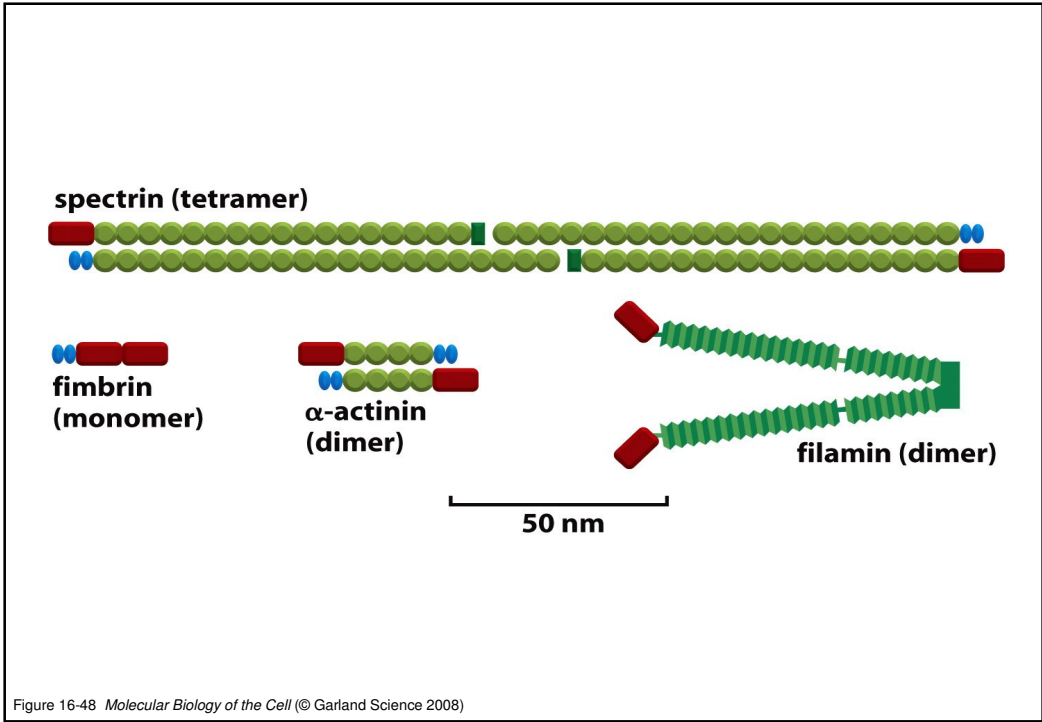
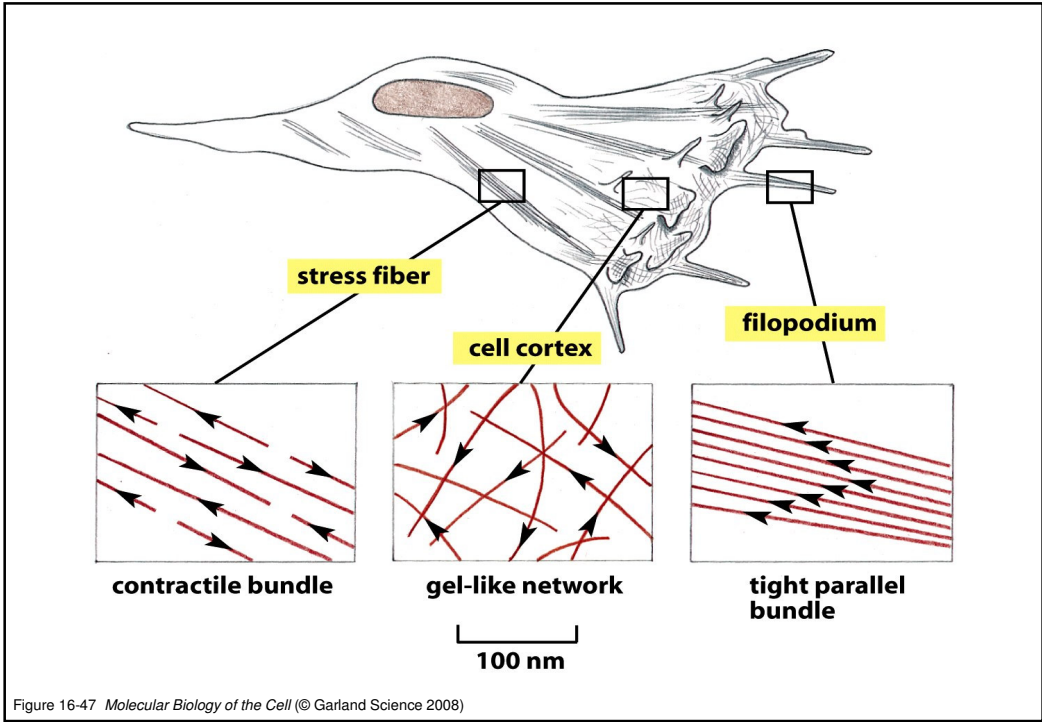
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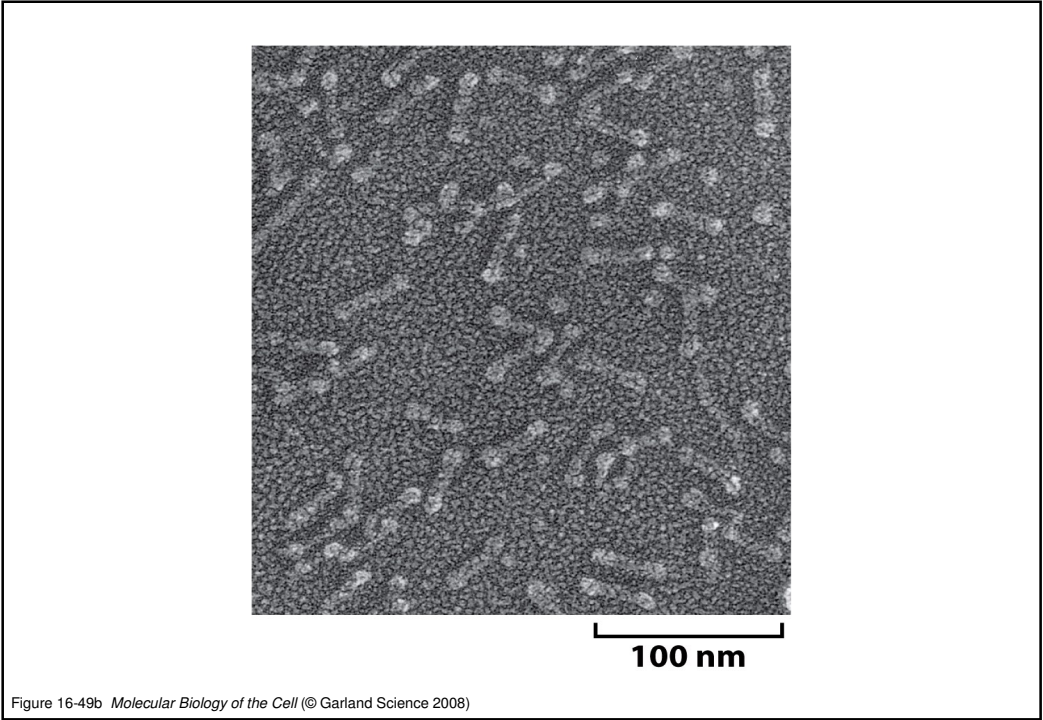
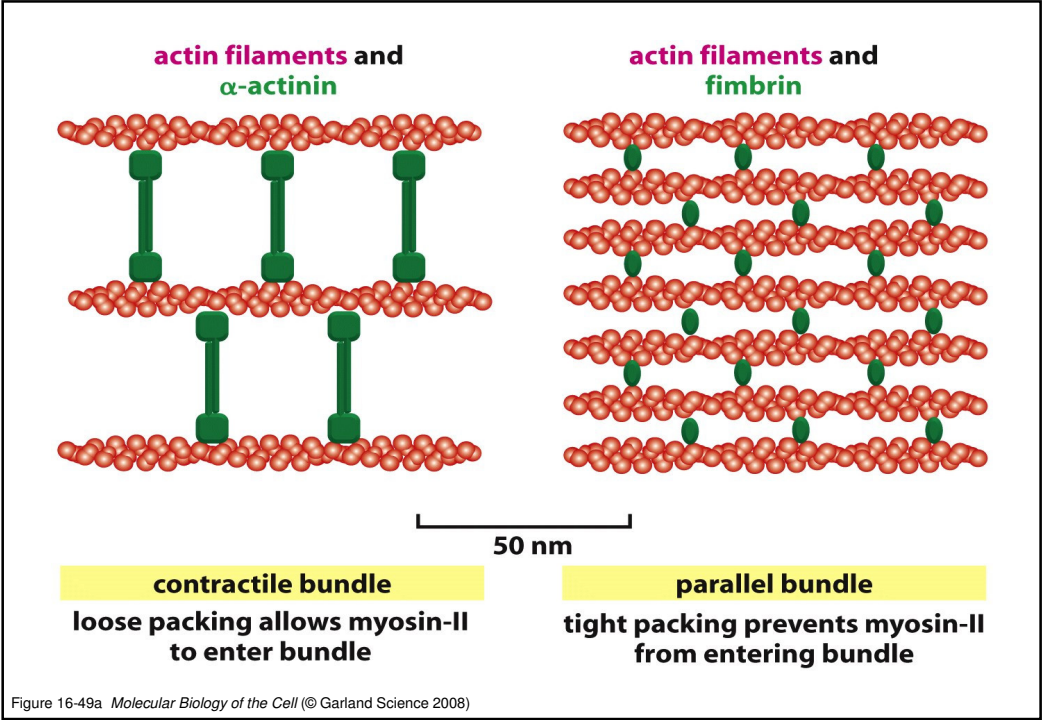
Figure 16-45b *Molecular Biology of the Cell* (© Garland Science 2008)

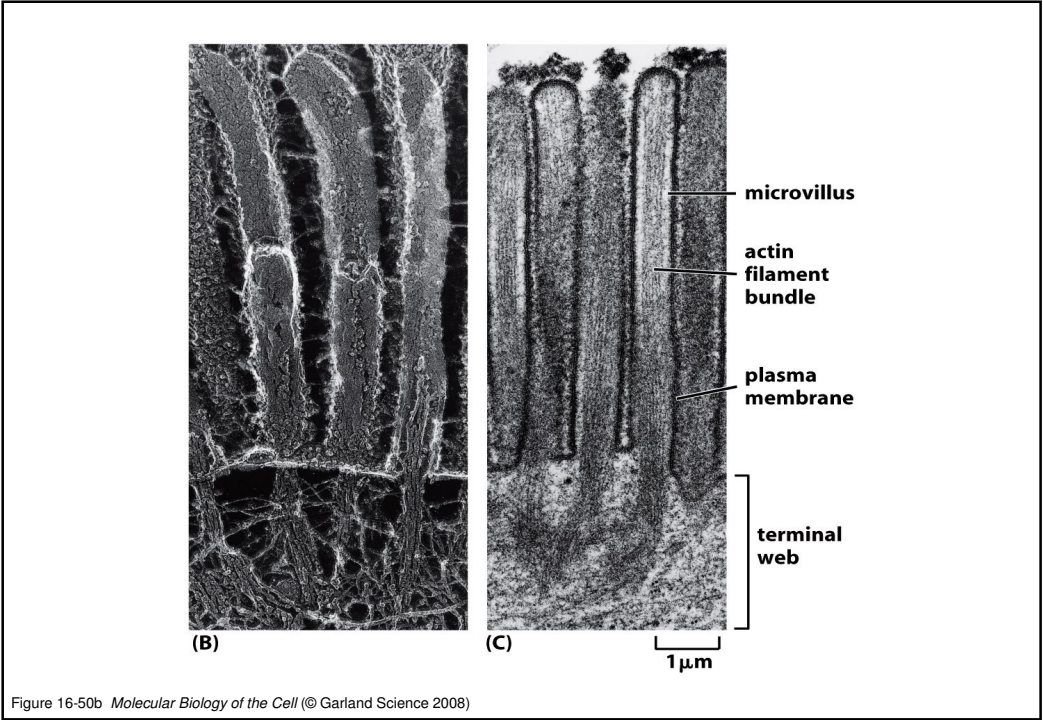
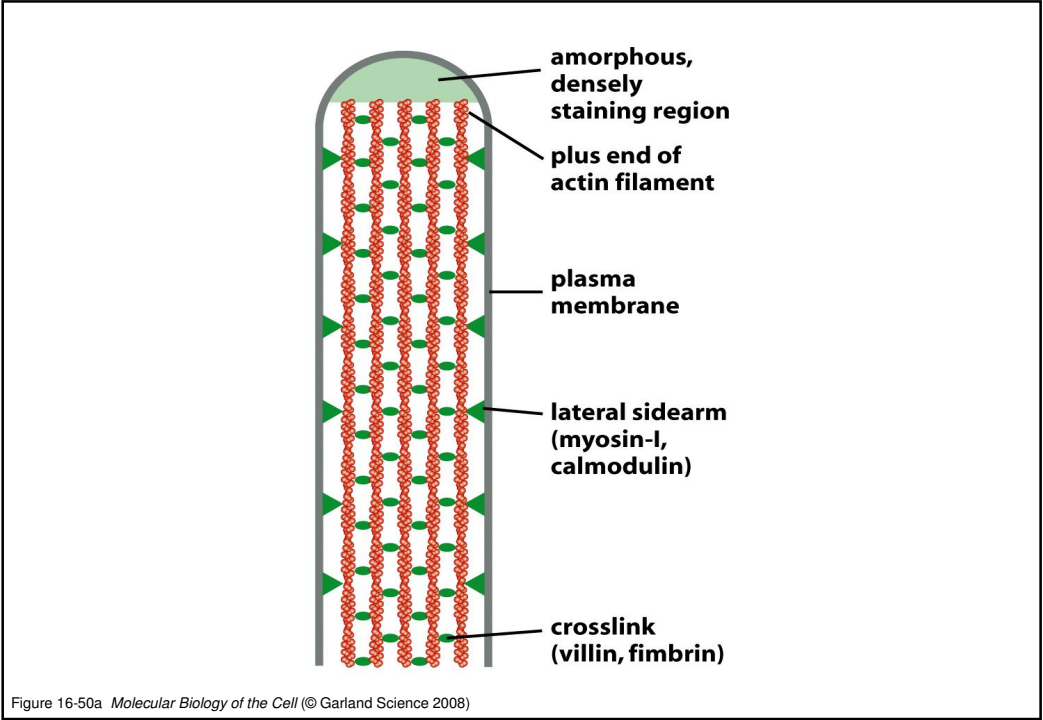


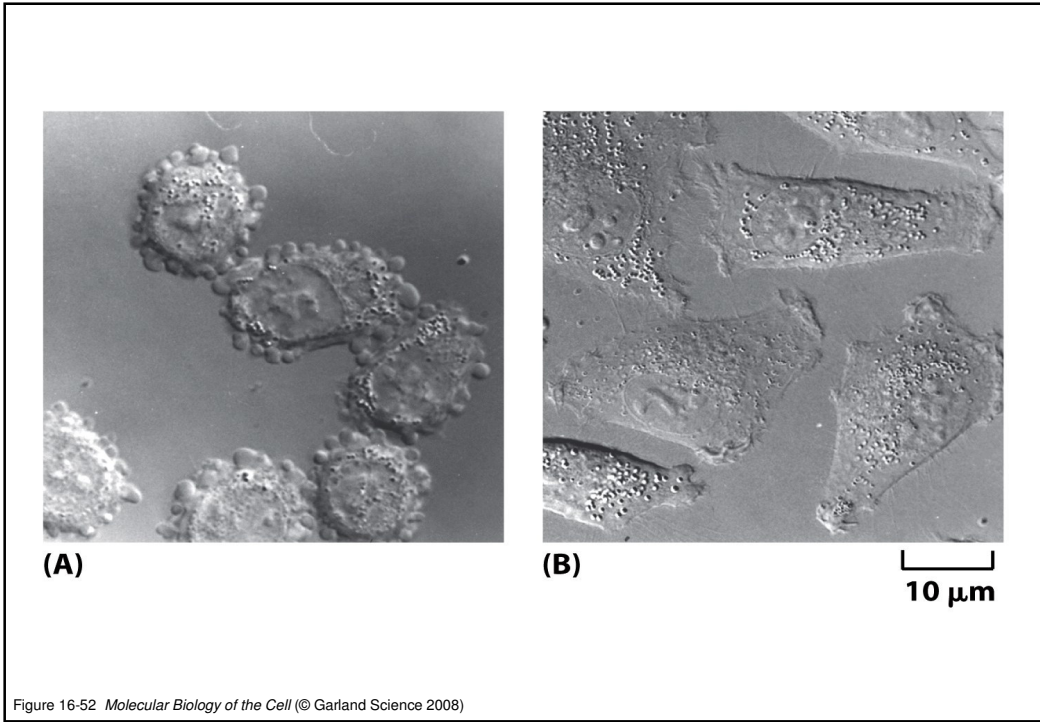
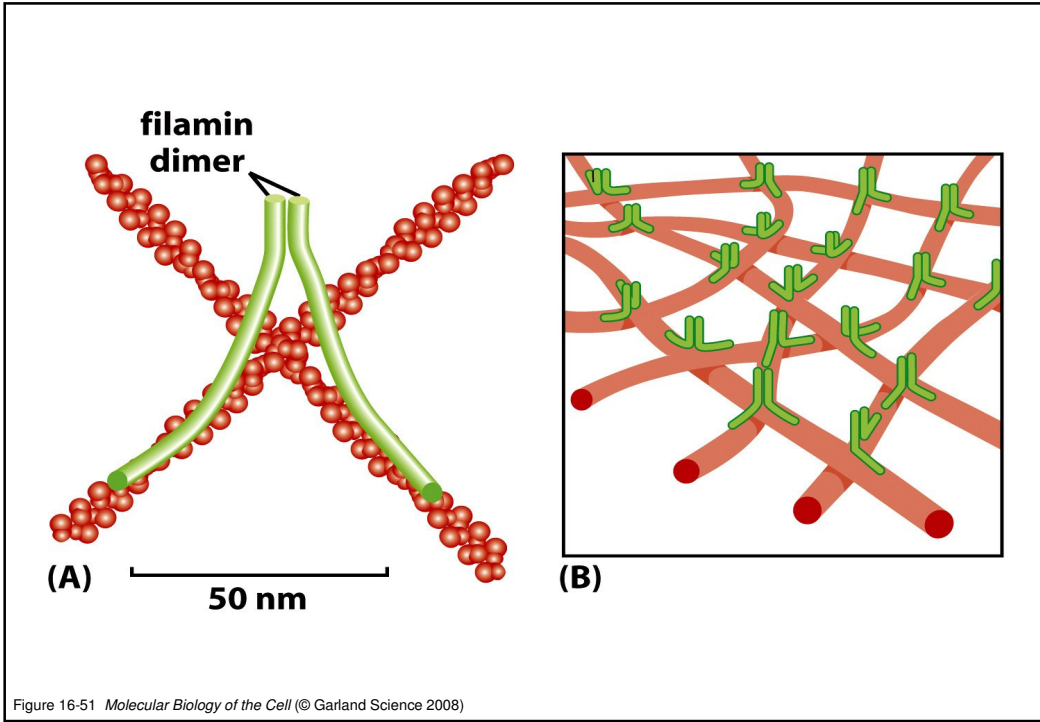
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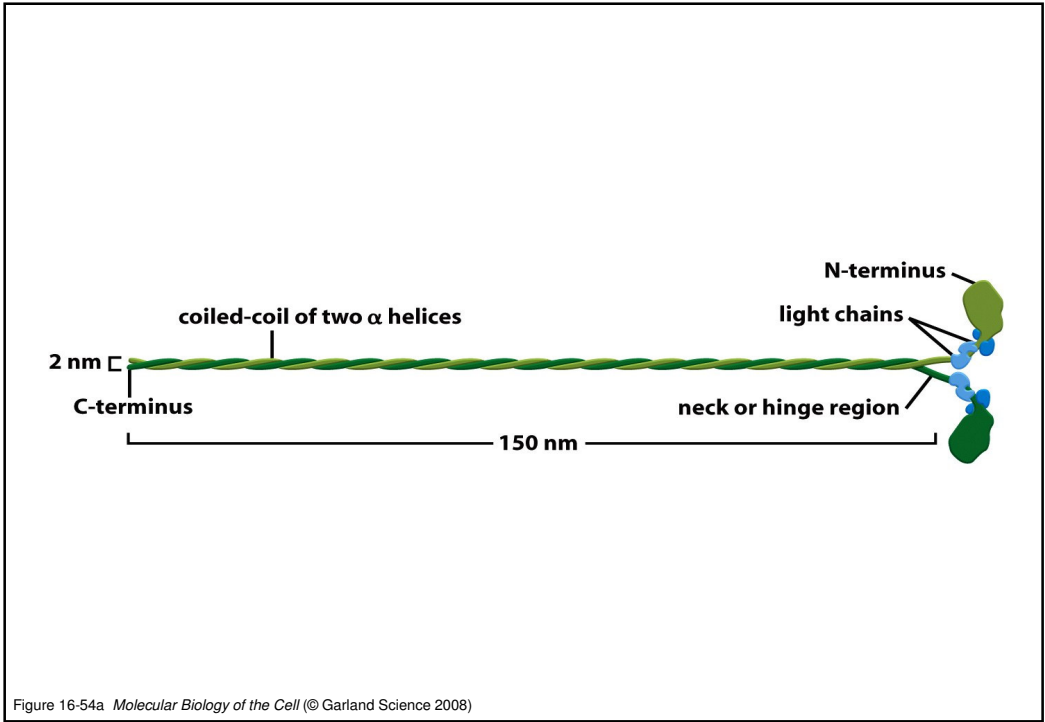
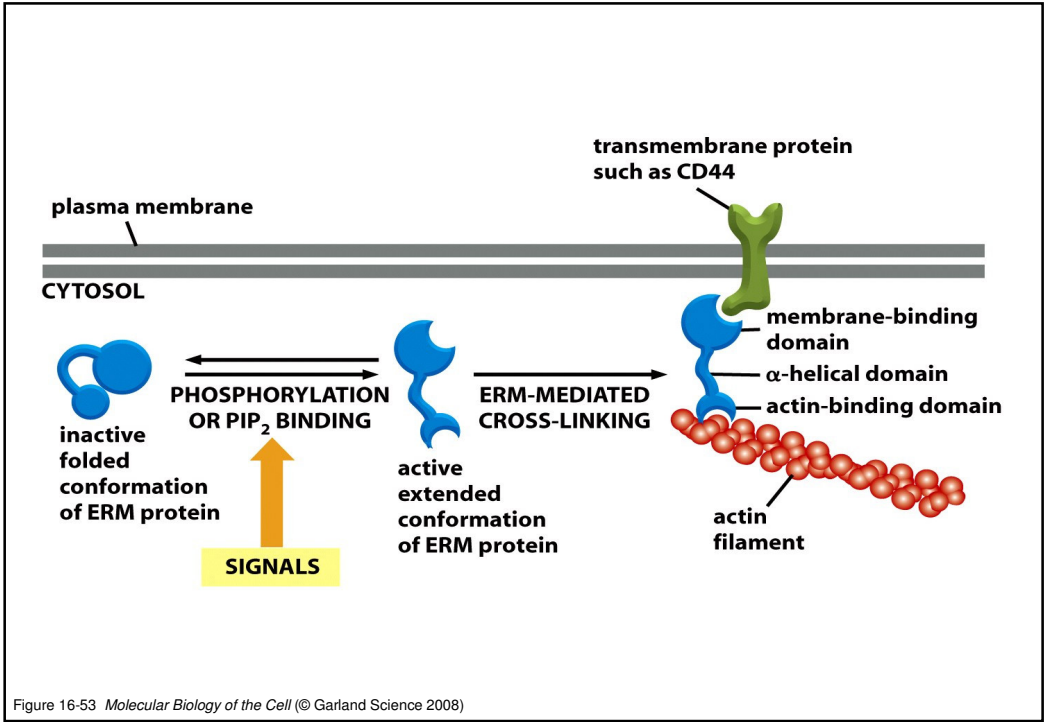
Figure 16-46 *Molecular Biology of the Cell* (© Garland Science 2008)



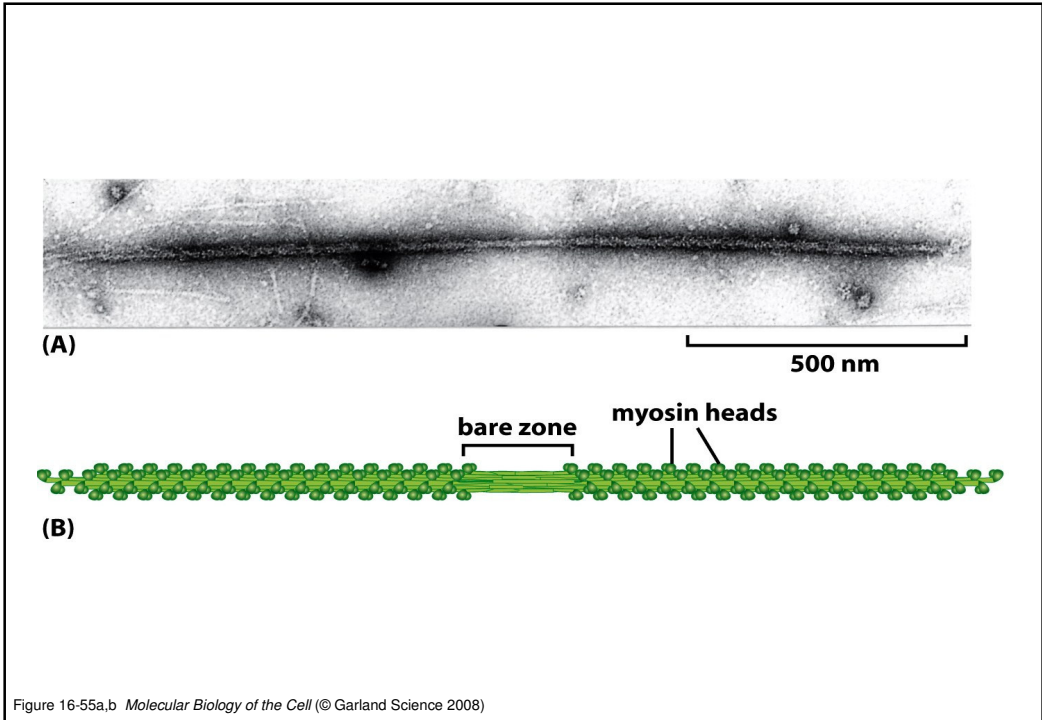
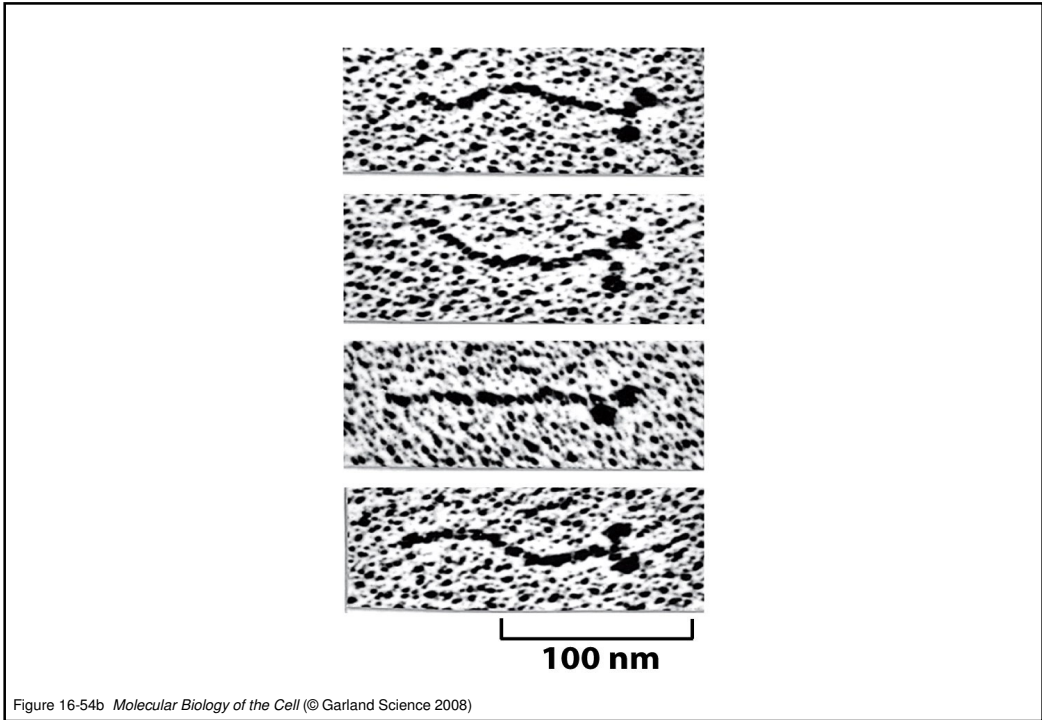


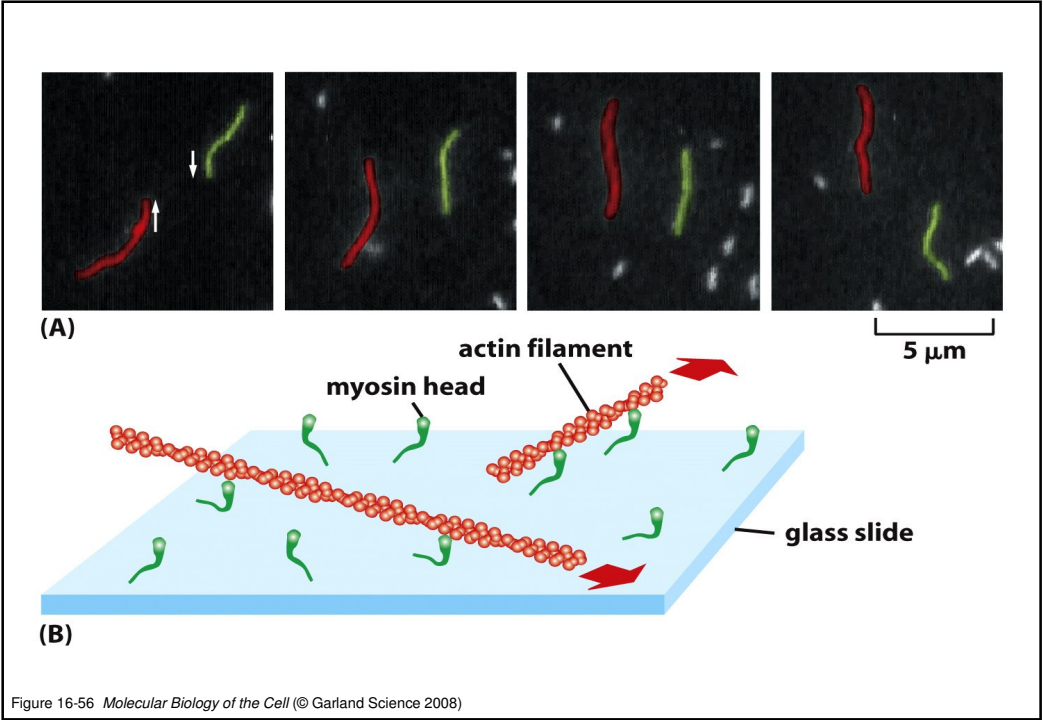
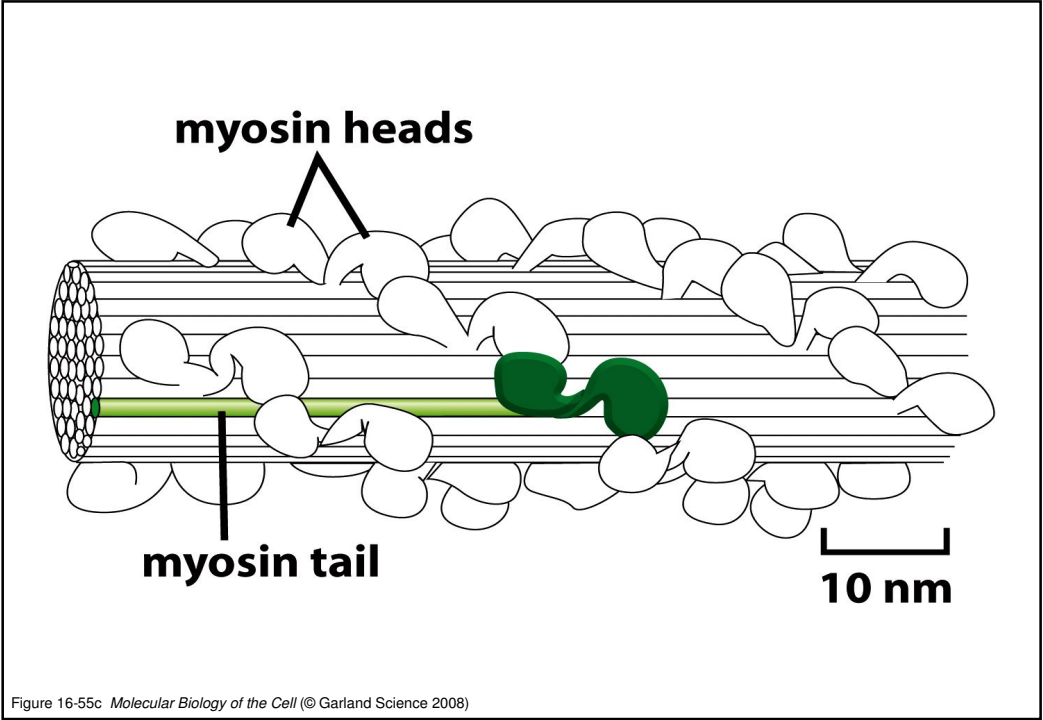


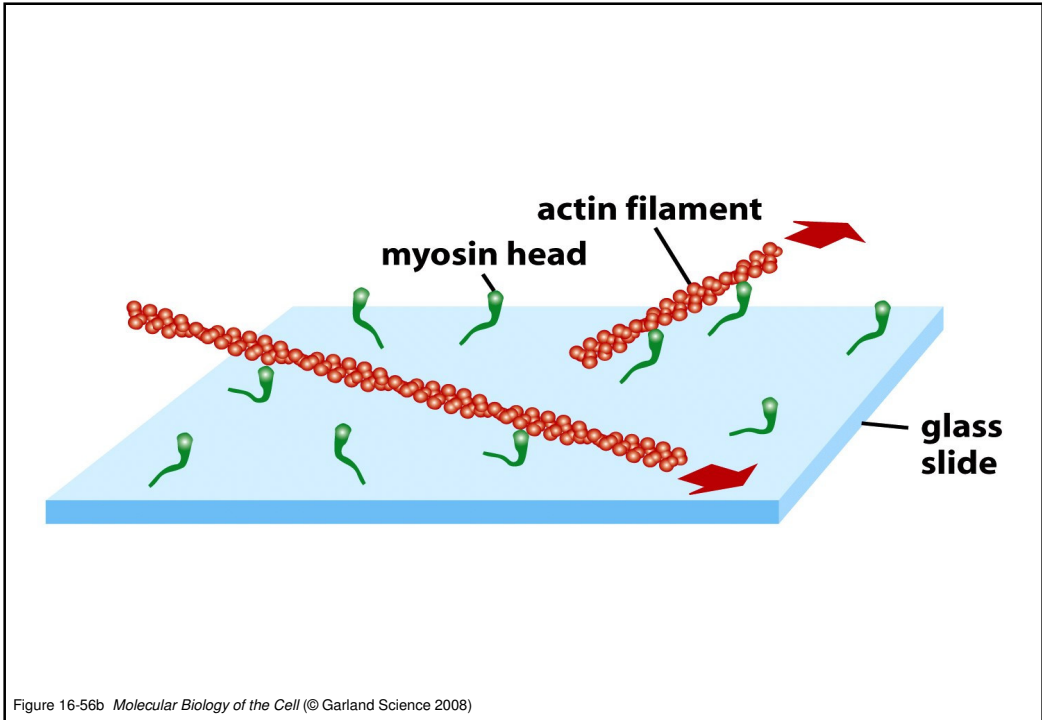
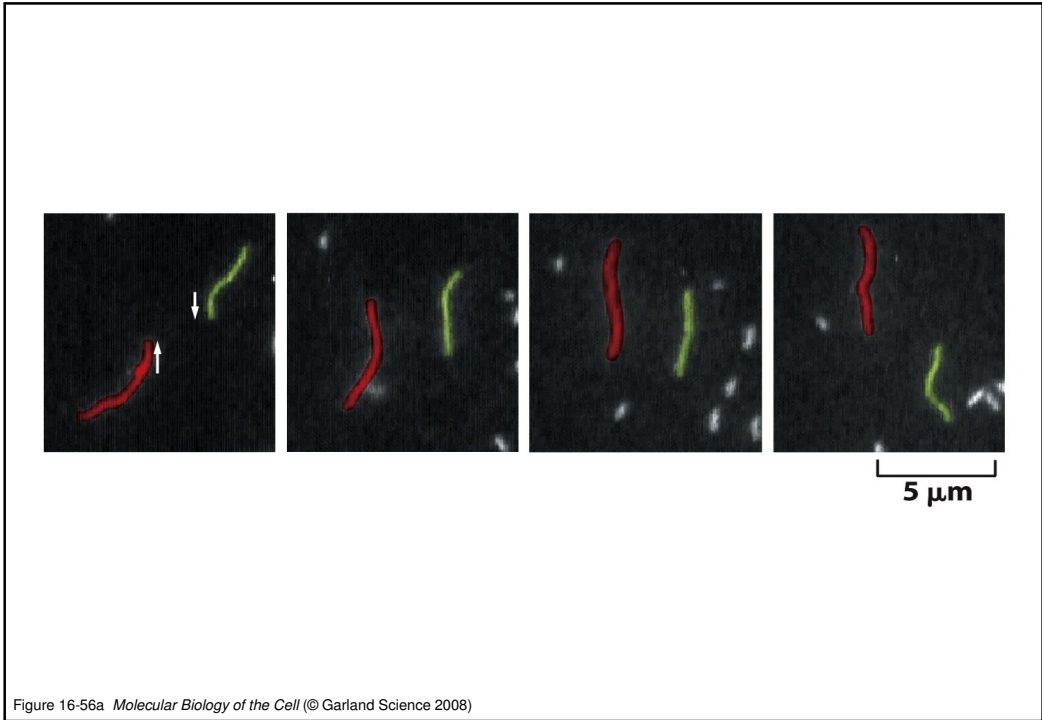


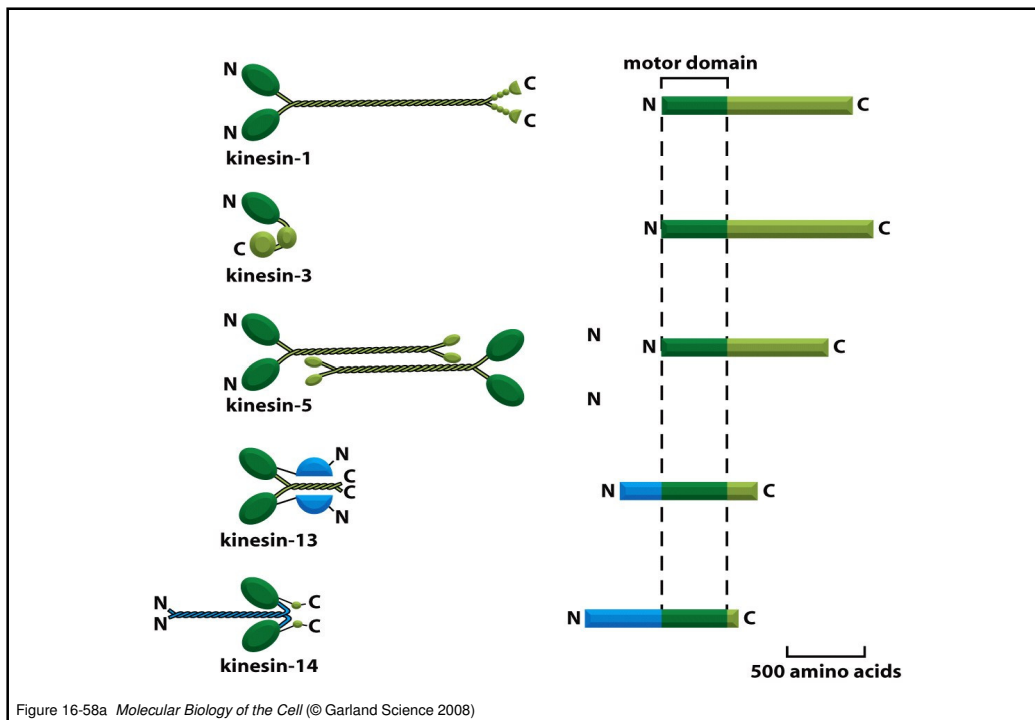
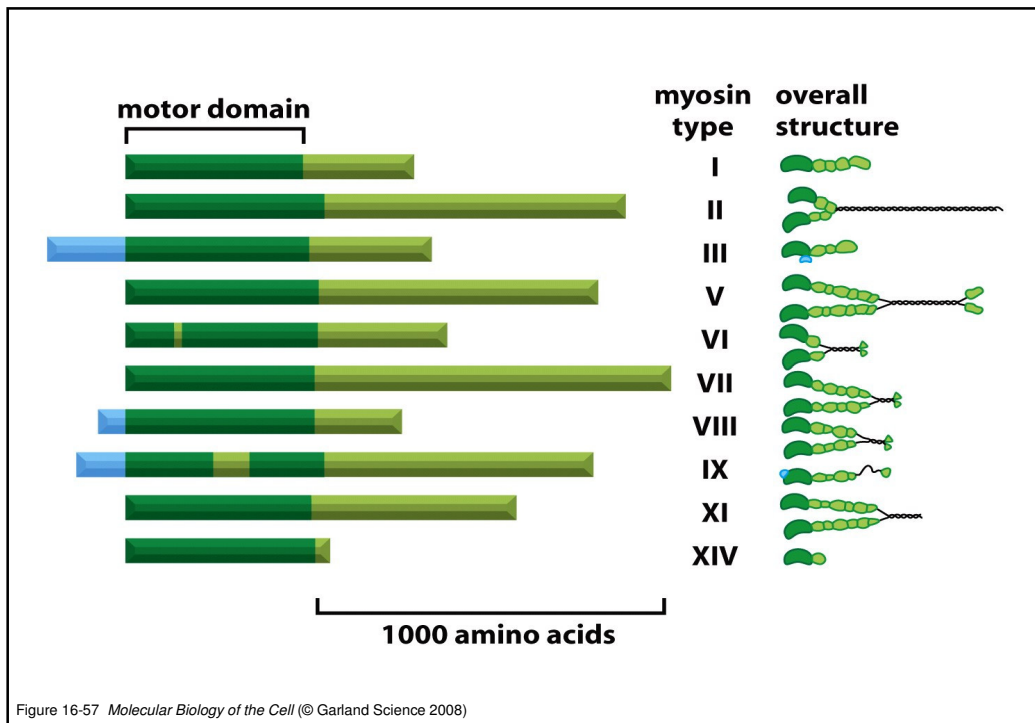


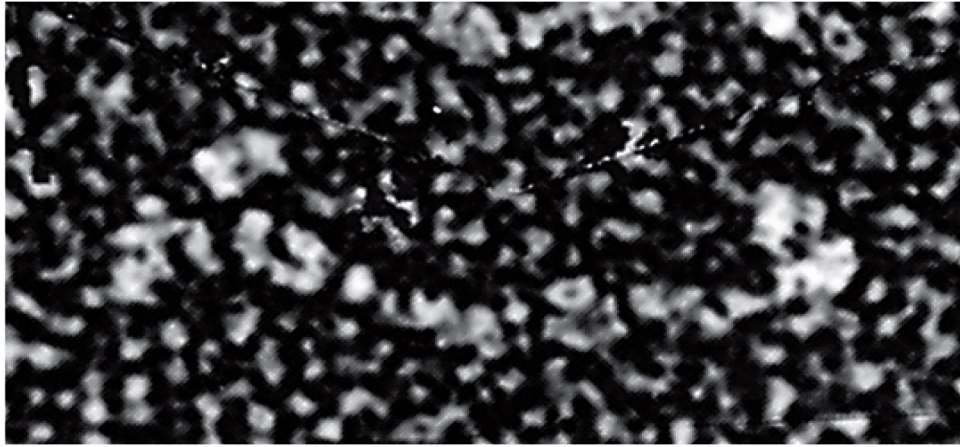










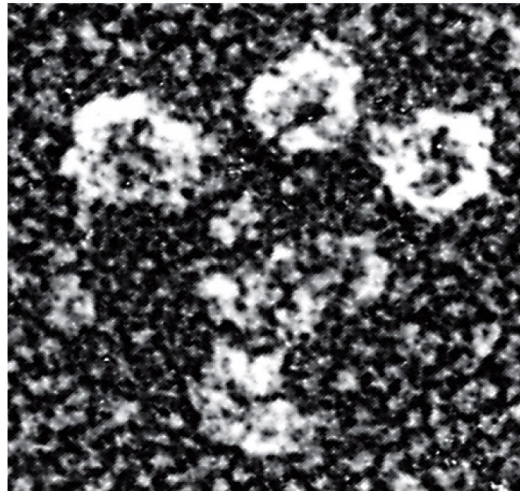
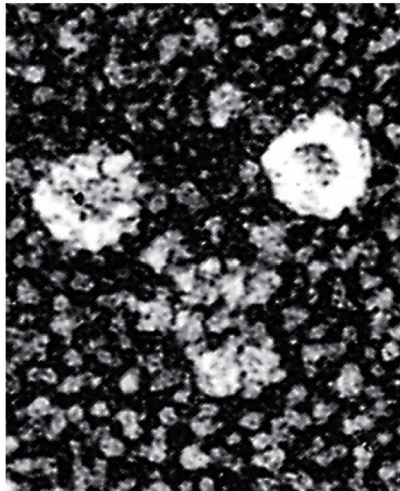


10 nm

Figure 16-58b *Molecular Biology of the Cell* (© Garland Science 2008)

**cytoplasmic dynein**

**ciliary dynein**



25 nm

Figure 16-59 *Molecular Biology of the Cell* (© Garland Science 2008)

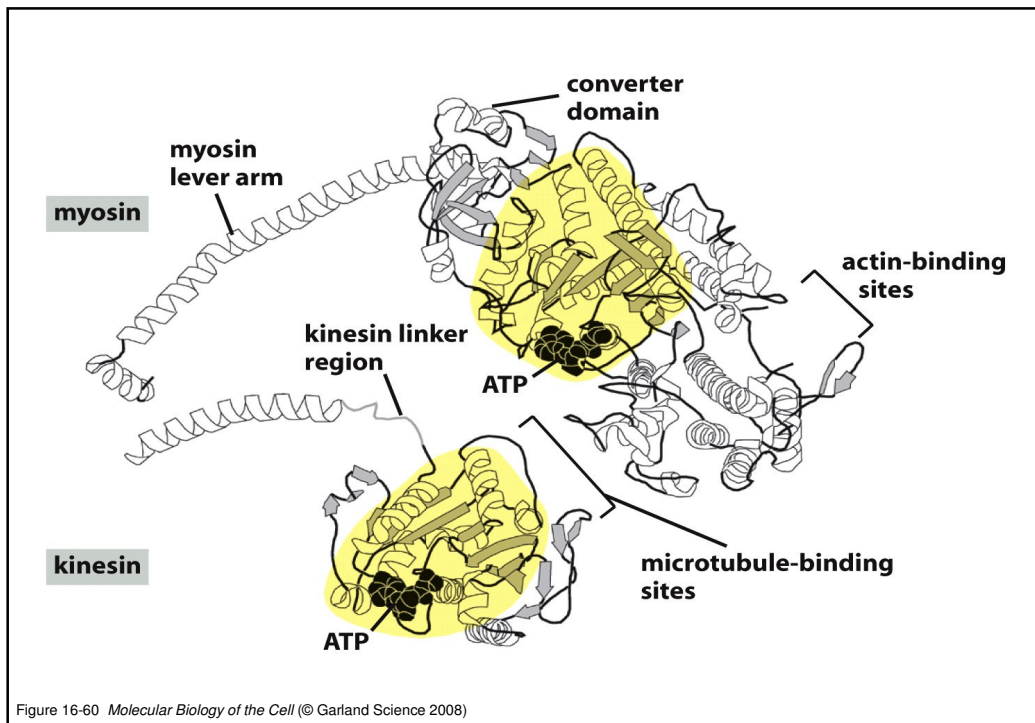


Figure 16-60 *Molecular Biology of the Cell* (© Garland Science 2008)

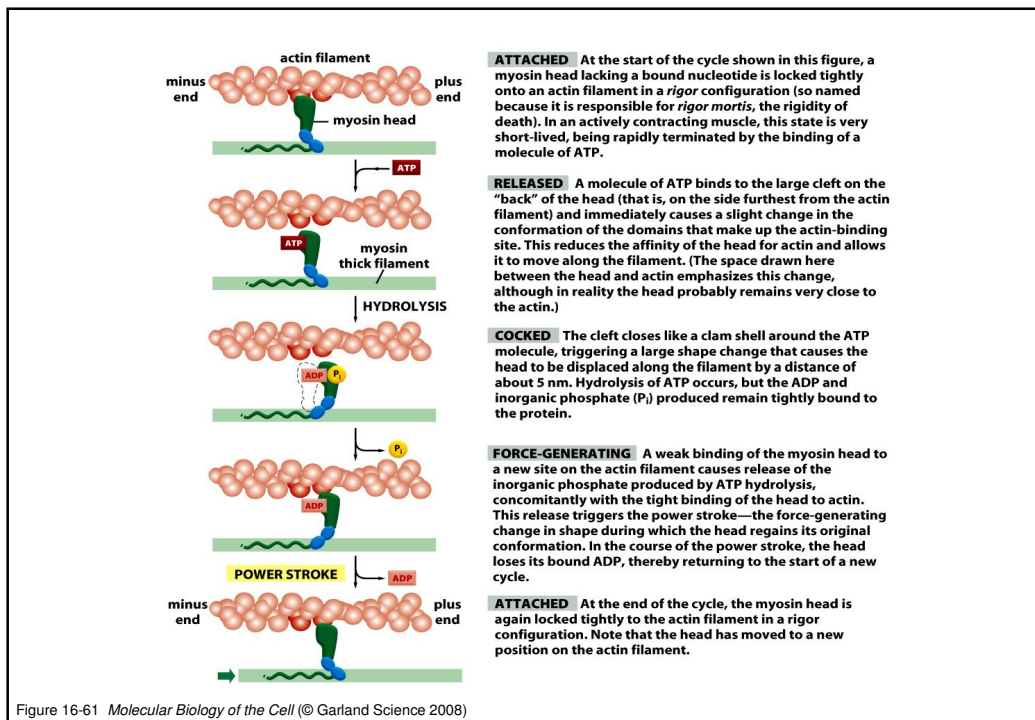
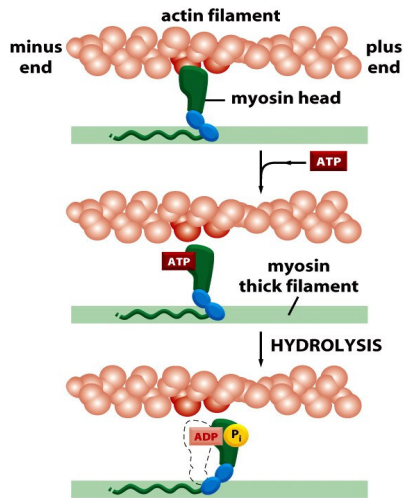


Figure 16-61 *Molecular Biology of the Cell* (© Garland Science 2008)

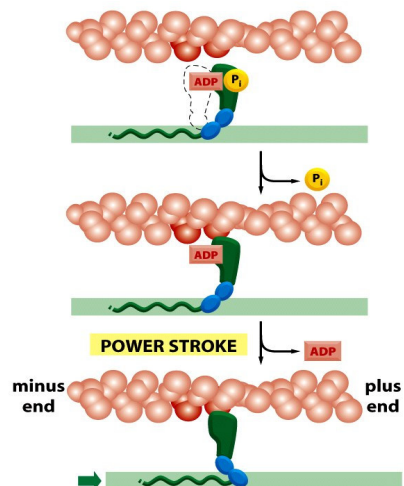


**ATTACHED** At the start of the cycle shown in this figure, a myosin head lacking a bound nucleotide is locked tightly onto an actin filament in a *rigor* configuration (so named because it is responsible for *rigor mortis*, the rigidity of death). In an actively contracting muscle, this state is very short-lived, being rapidly terminated by the binding of a molecule of ATP.

**RELEASED** A molecule of ATP binds to the large cleft on the “back” of the head (that is, on the side furthest from the actin filament) and immediately causes a slight change in the conformation of the domains that make up the actin-binding site. This reduces the affinity of the head for actin and allows it to move along the filament. (The space drawn here between the head and actin emphasizes this change, although in reality the head probably remains very close to the actin.)

**COCKED** The cleft closes like a clam shell around the ATP molecule, triggering a large shape change that causes the head to be displaced along the filament by a distance of about 5 nm. Hydrolysis of ATP occurs, but the ADP and inorganic phosphate (P<sub>i</sub>) produced remain tightly bound to the protein.

Figure 16-61 (part 1 of 2) *Molecular Biology of the Cell* (© Garland Science 2008)

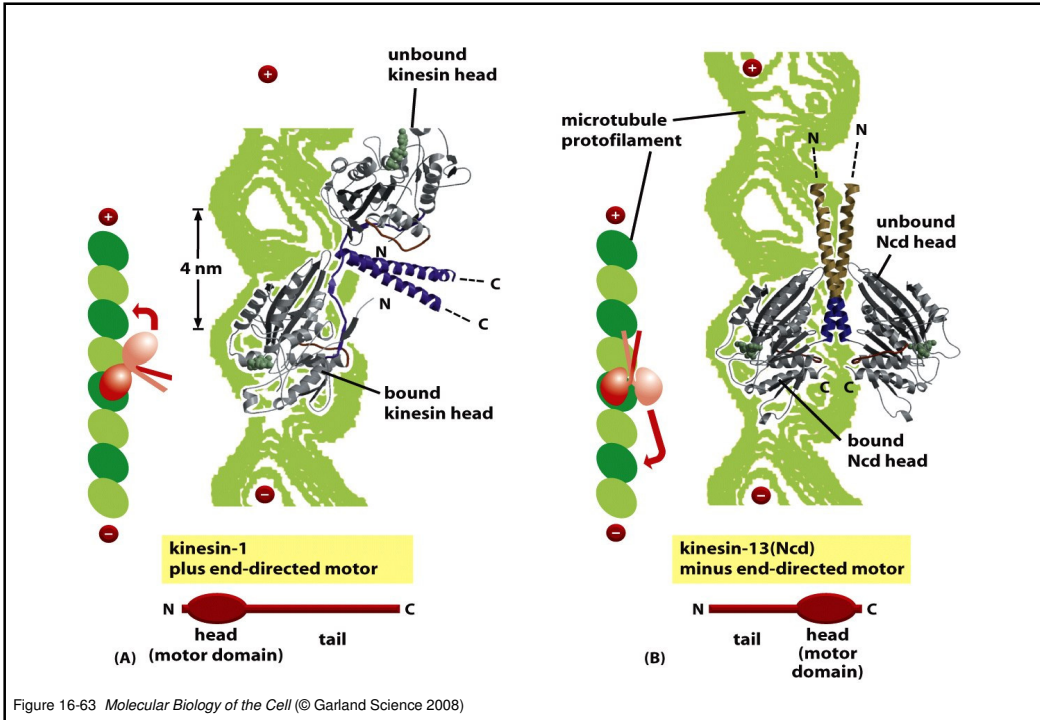
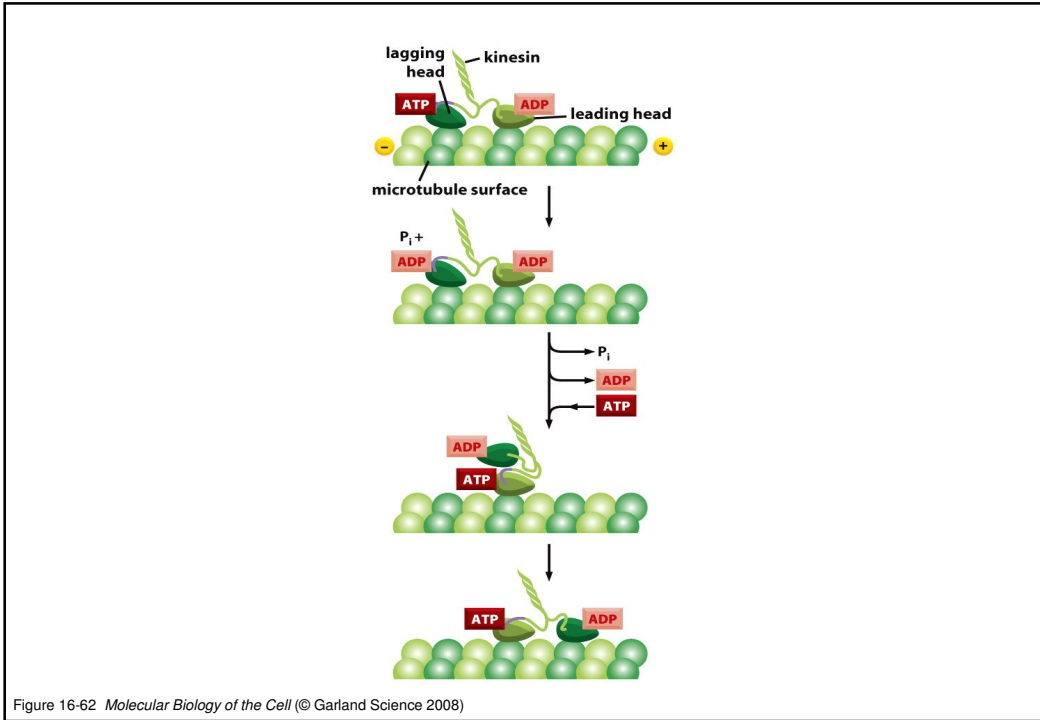


**COCKED** The cleft closes like a clam shell around the ATP molecule, triggering a large shape change that causes the head to be displaced along the filament by a distance of about 5 nm. Hydrolysis of ATP occurs, but the ADP and inorganic phosphate (P<sub>i</sub>) produced remain tightly bound to the protein.

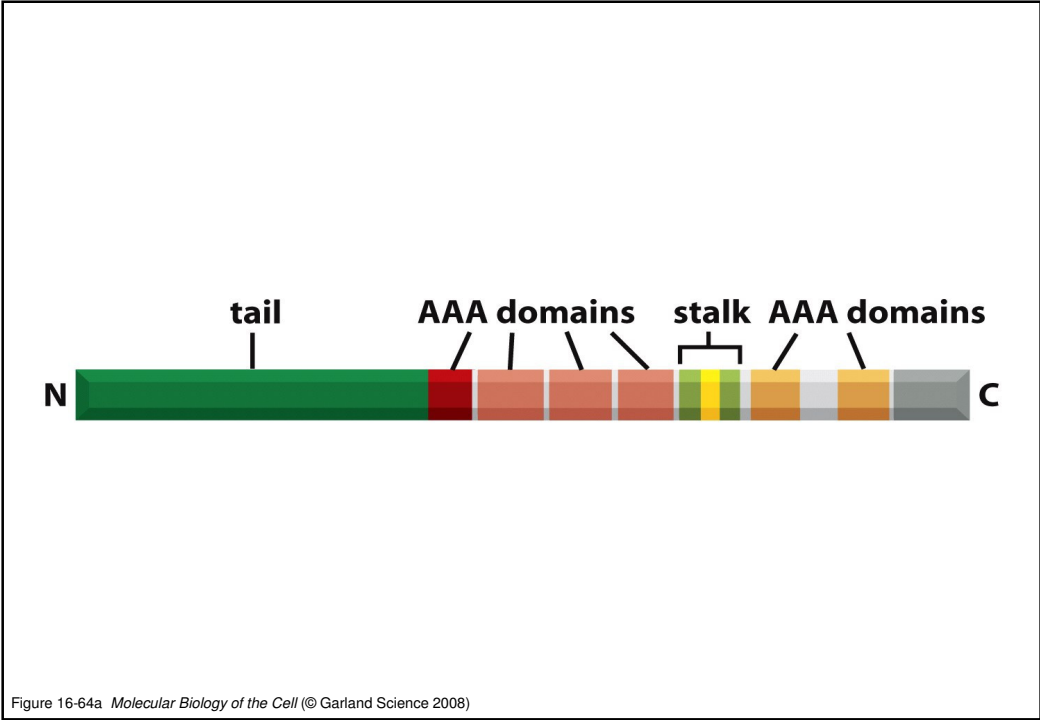
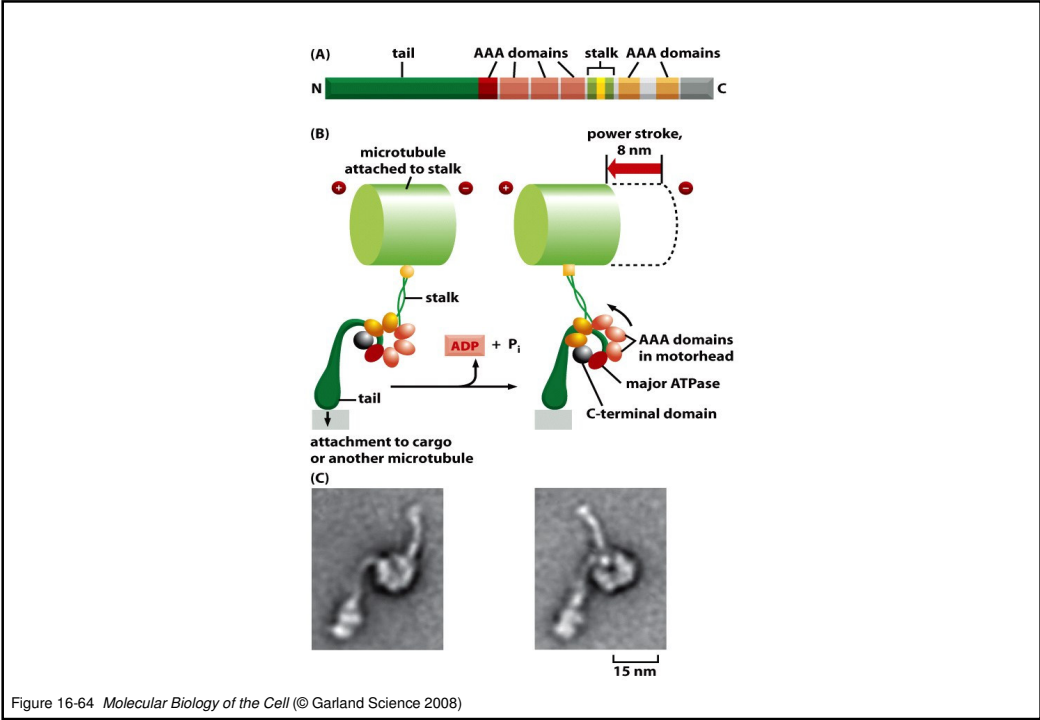
**FORCE-GENERATING** A weak binding of the myosin head to a new site on the actin filament causes release of the inorganic phosphate produced by ATP hydrolysis, concomitantly with the tight binding of the head to actin. This release triggers the power stroke—the force-generating change in shape during which the head regains its original conformation. In the course of the power stroke, the head loses its bound ADP, thereby returning to the start of a new cycle.

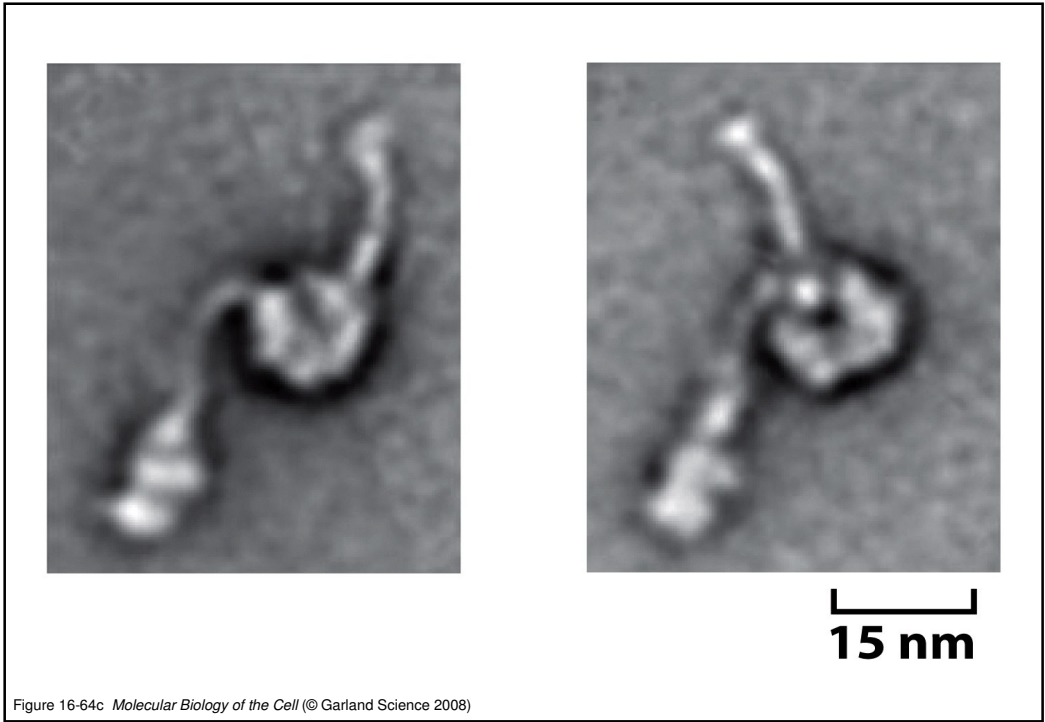
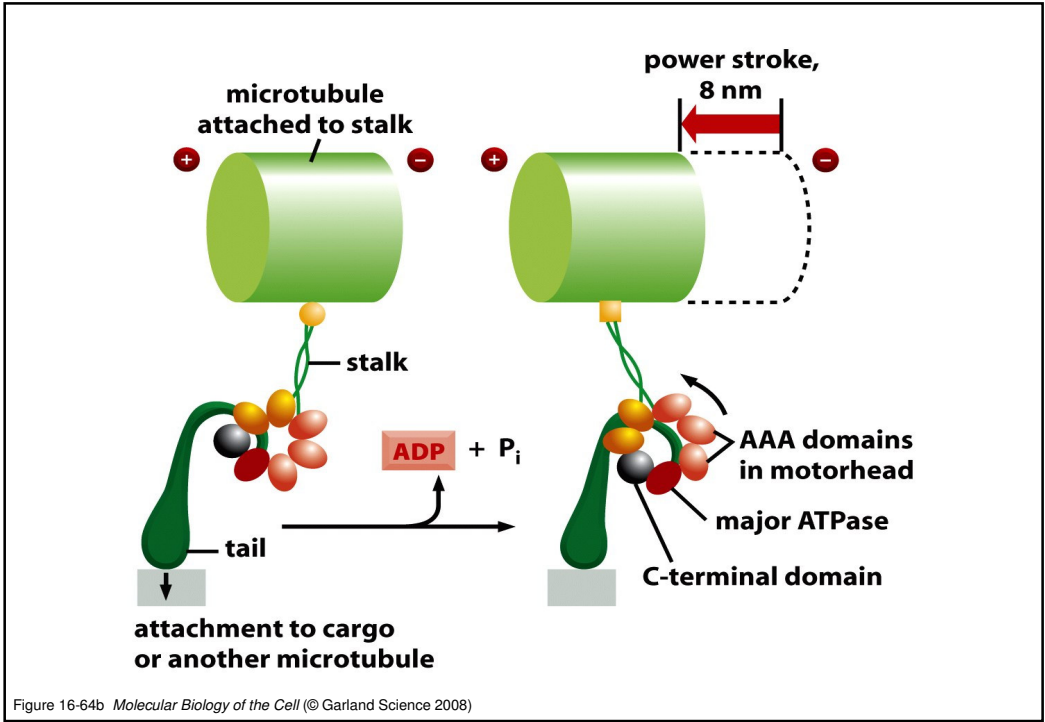
**ATTACHED** At the end of the cycle, the myosin head is again locked tightly to the actin filament in a *rigor* configuration. Note that the head has moved to a new position on the actin filament.

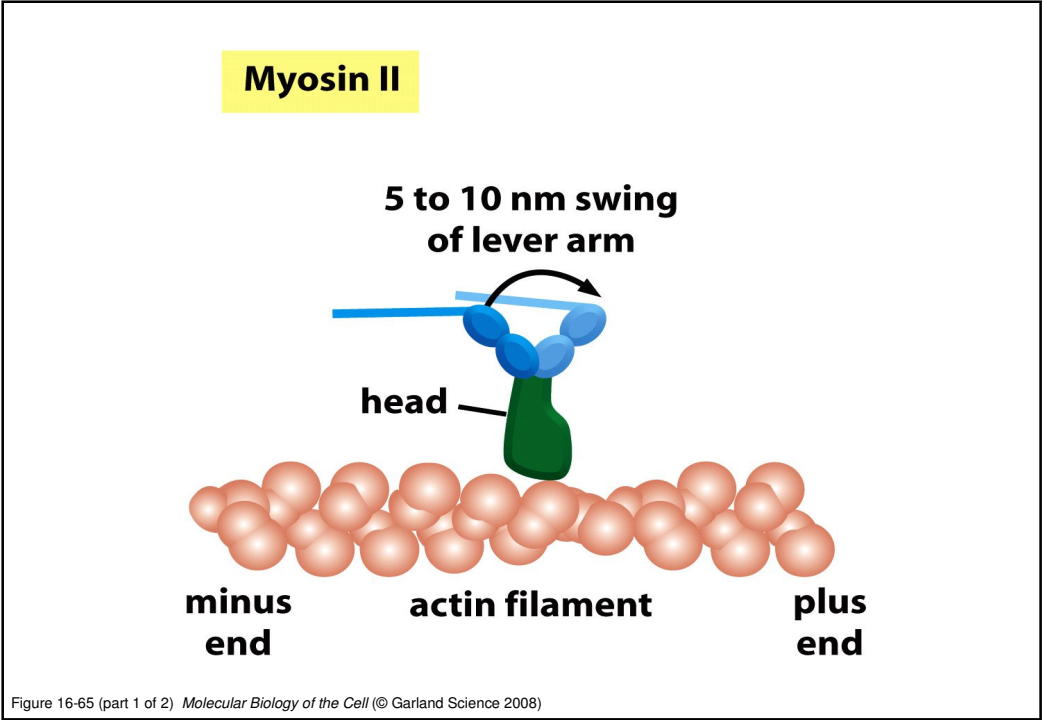
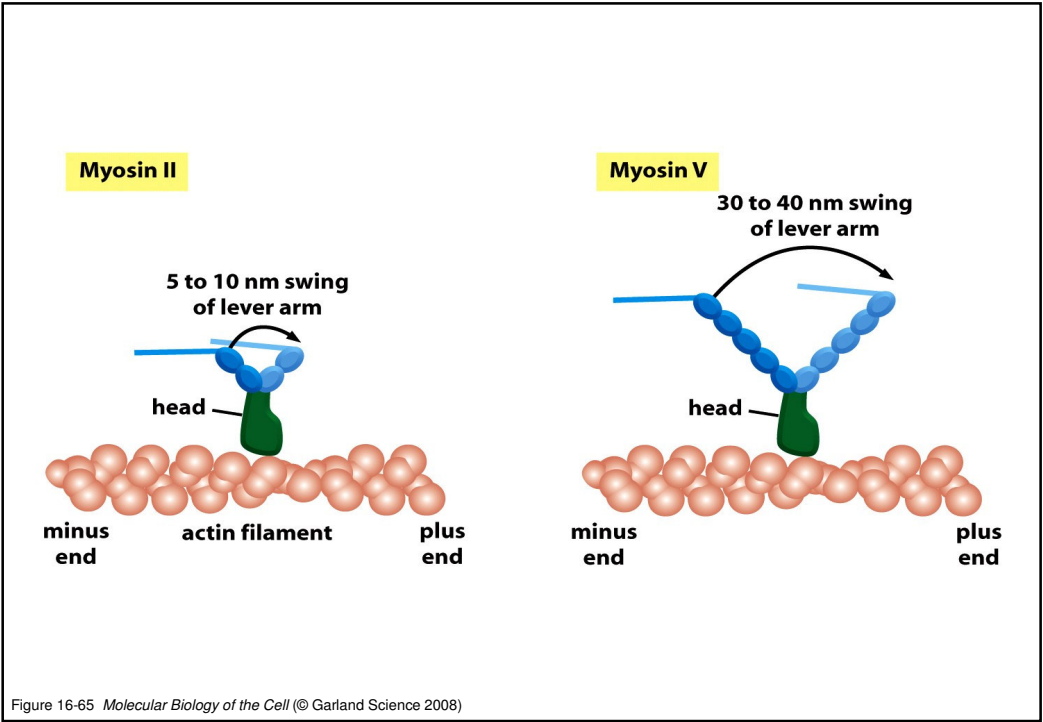
Figure 16-61 (part 2 of 2) *Molecular Biology of the Cell* (© Garland Science 2008)

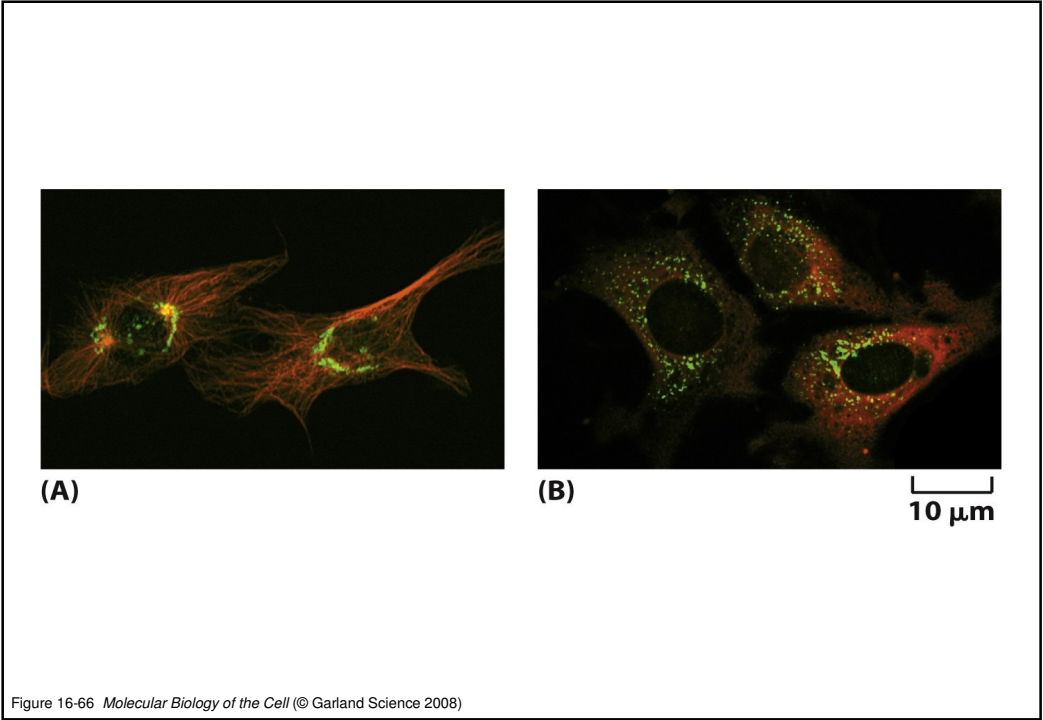
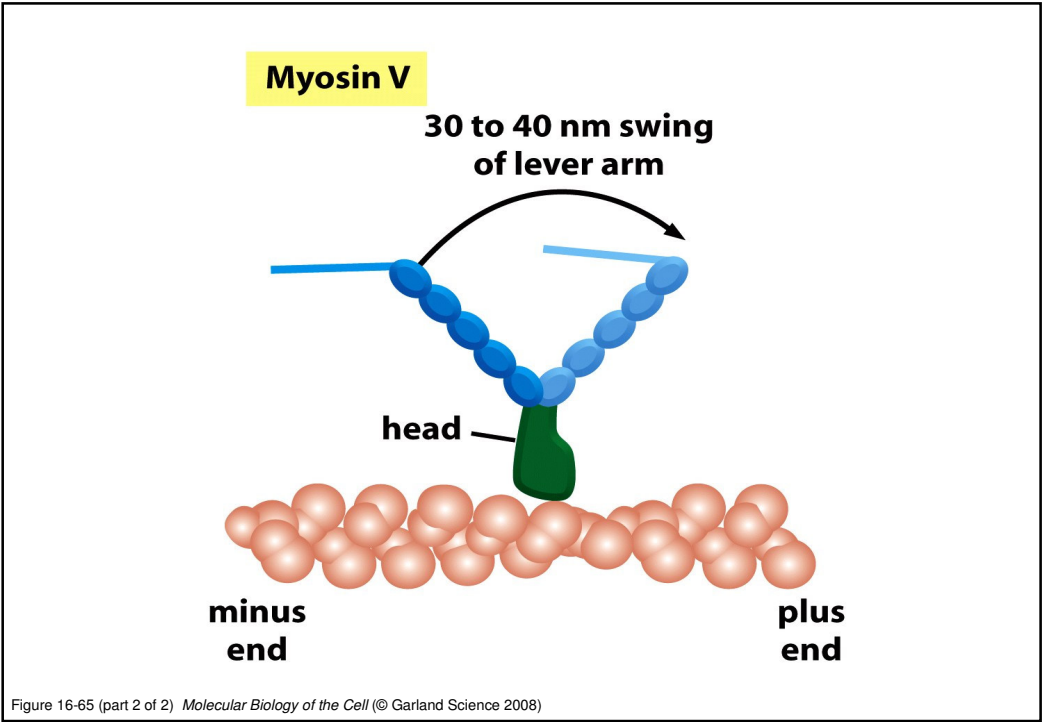


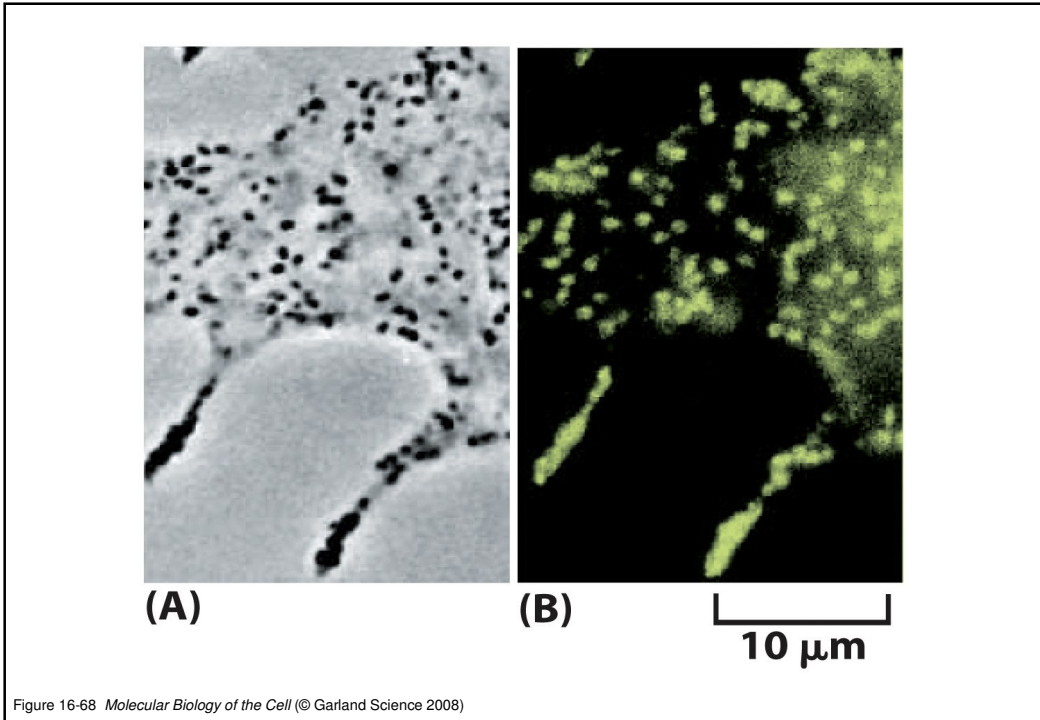
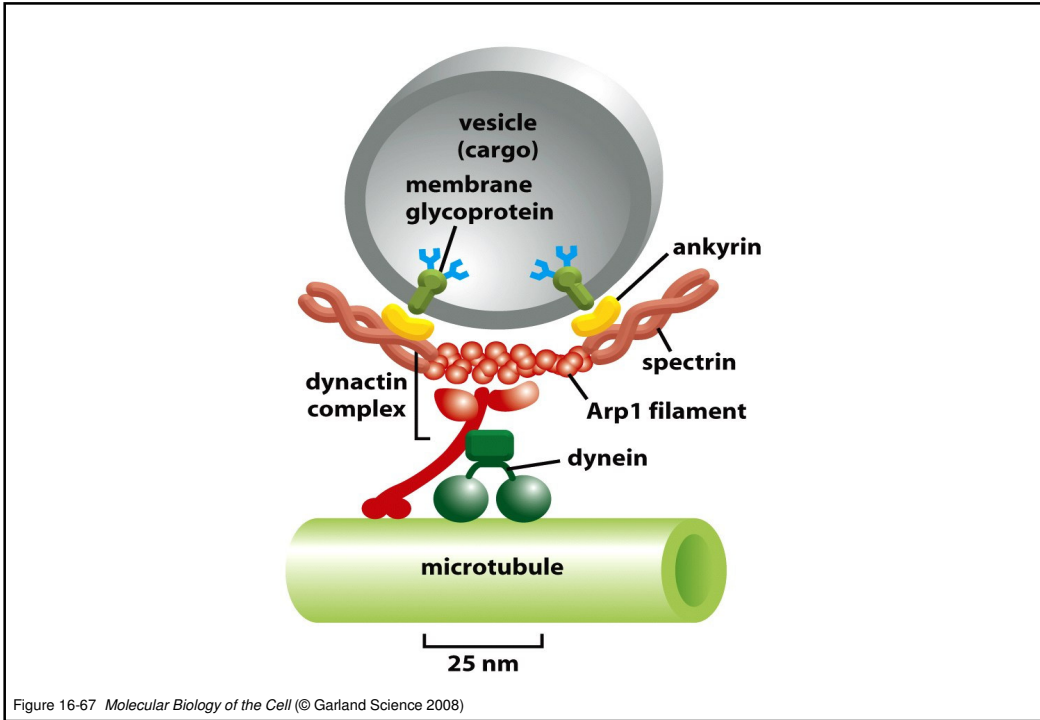












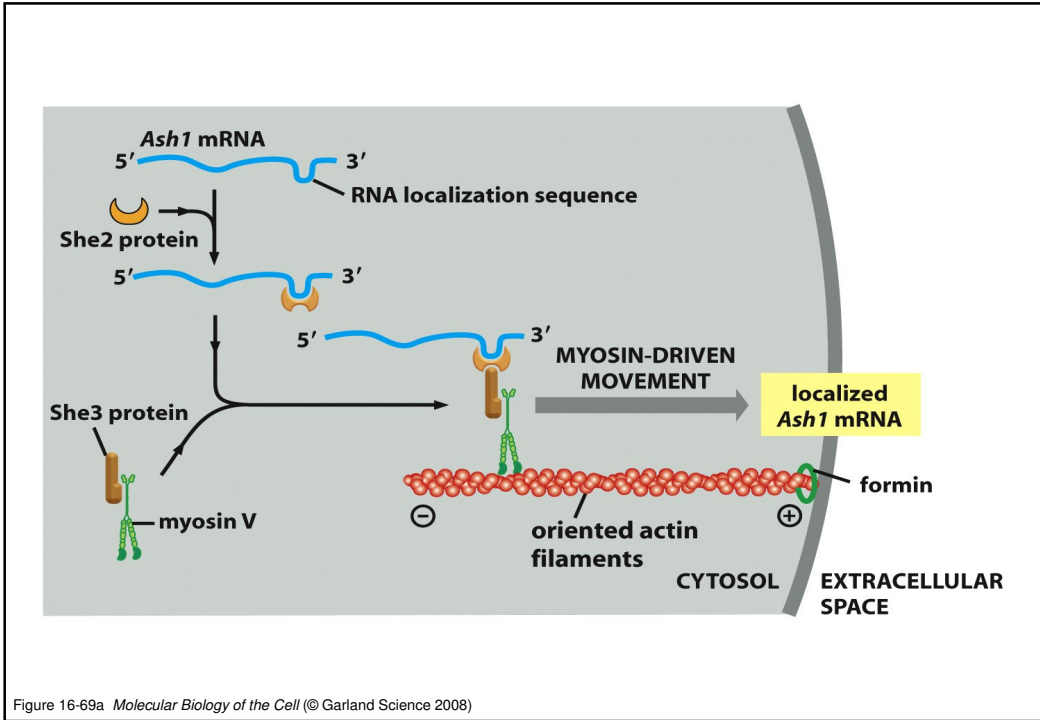


Figure 16-69a *Molecular Biology of the Cell* (© Garland Science 2008)

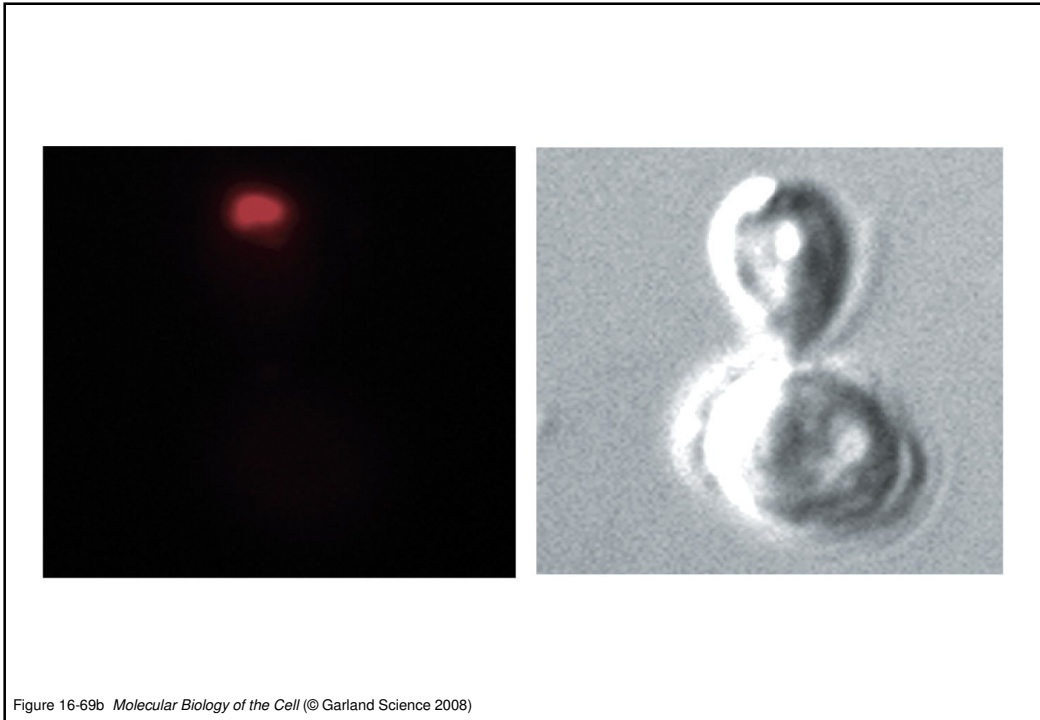
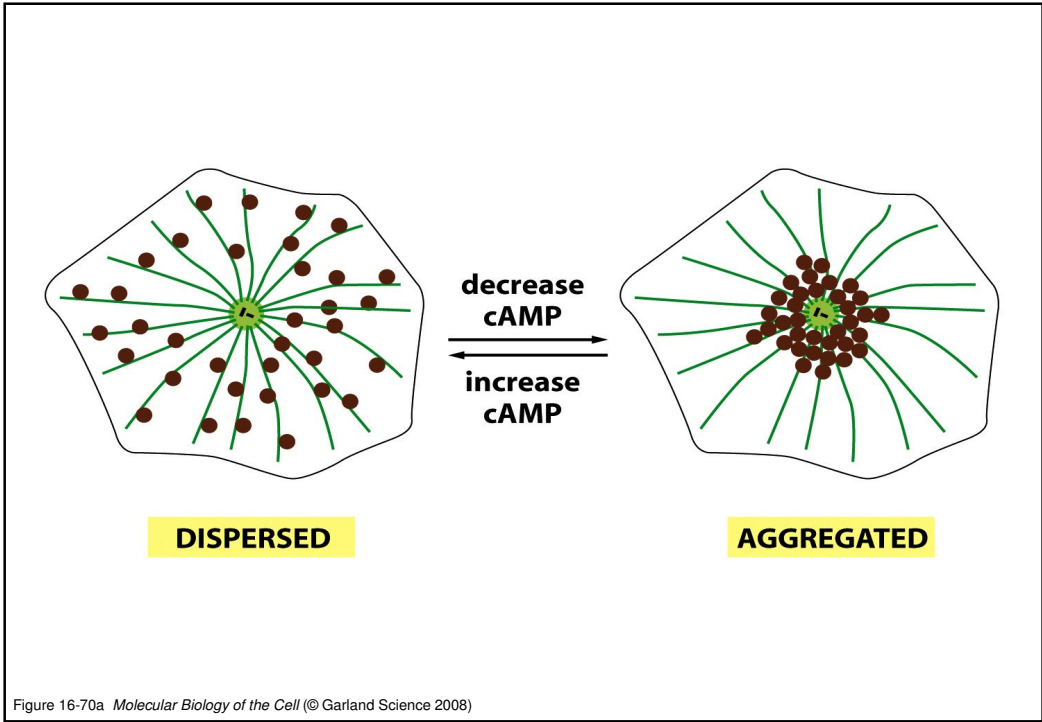
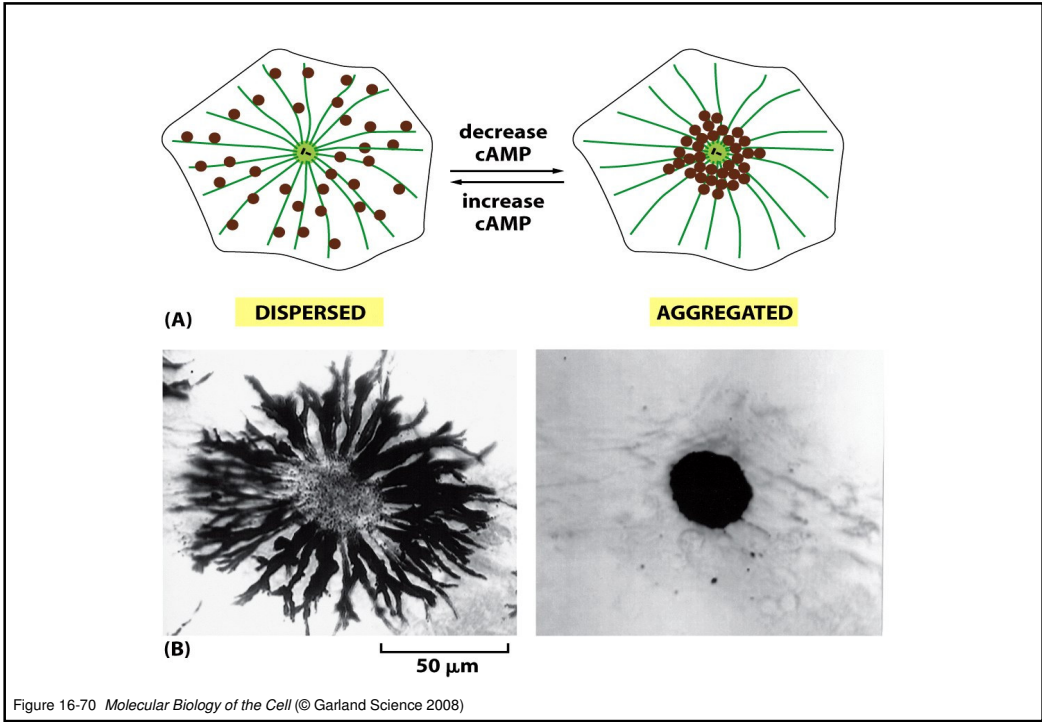


Figure 16-69b *Molecular Biology of the Cell* (© Garland Science 2008)



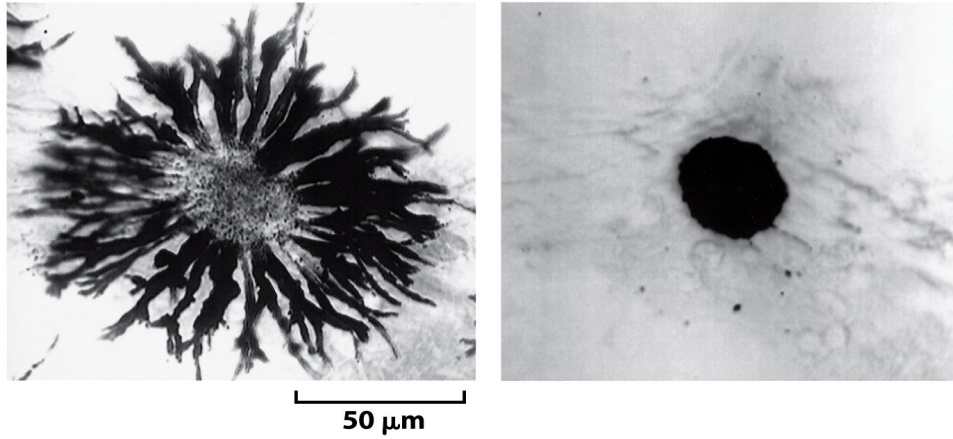


Figure 16-70b *Molecular Biology of the Cell* (© Garland Science 2008)

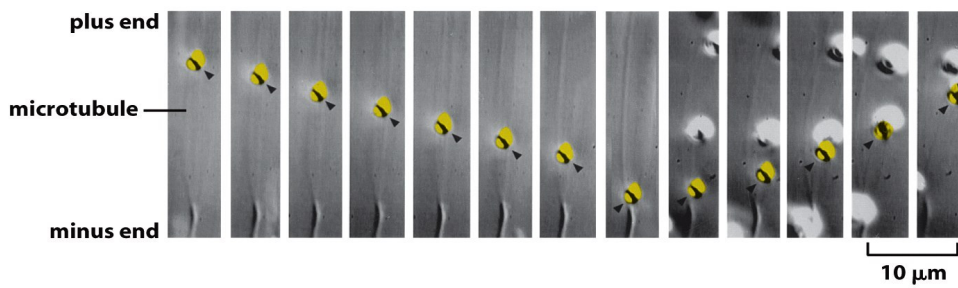
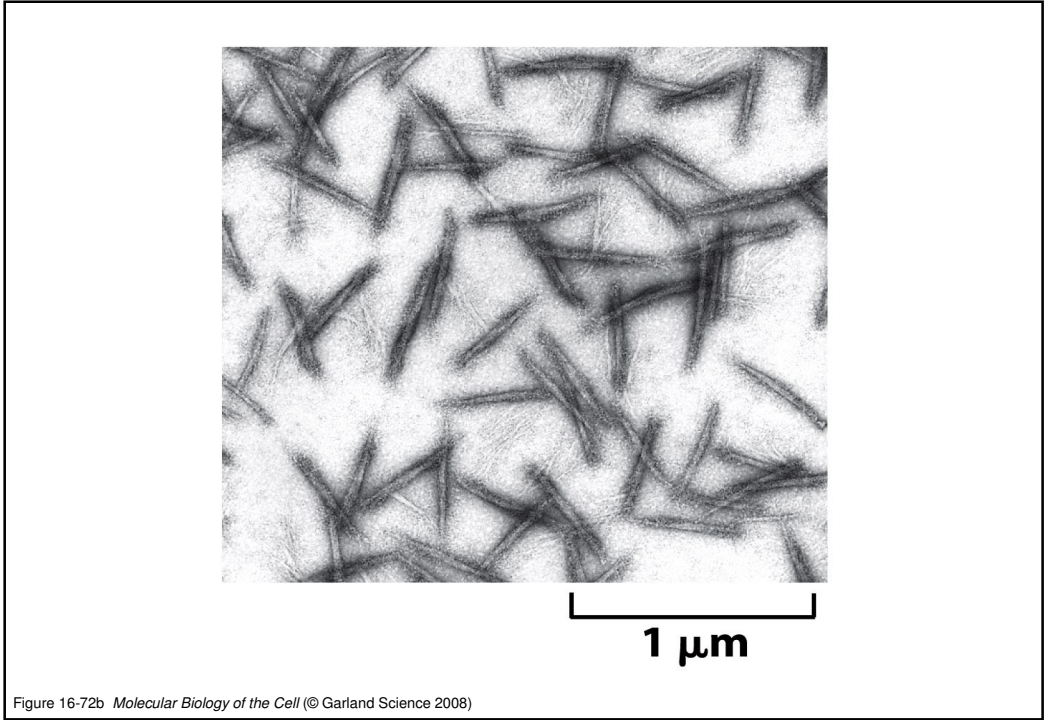
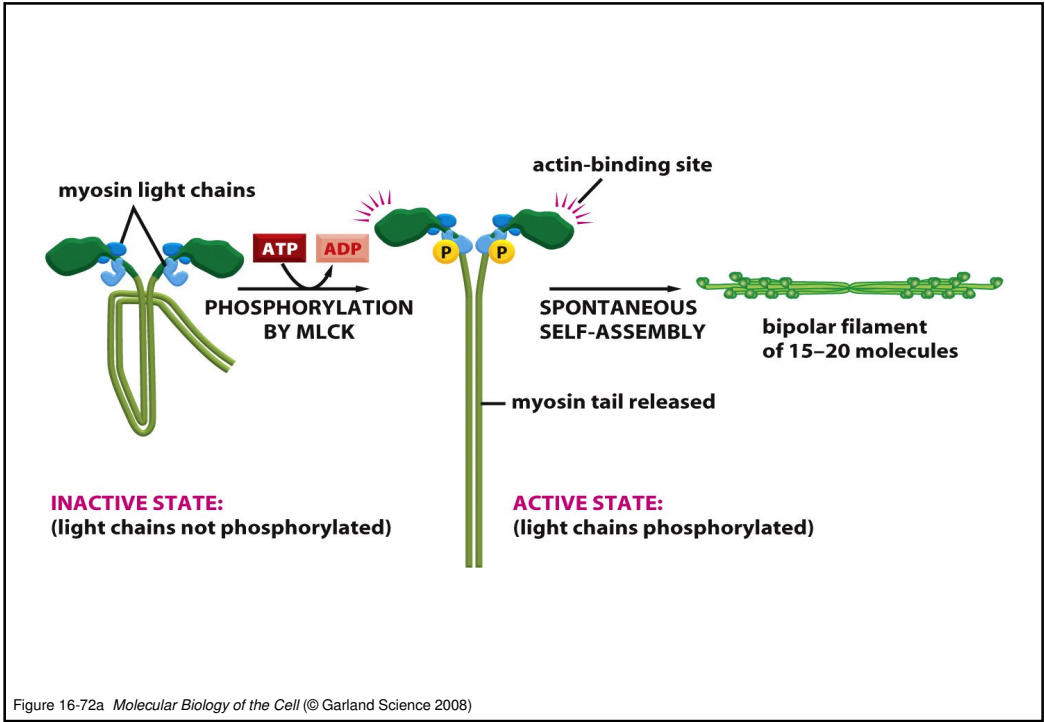
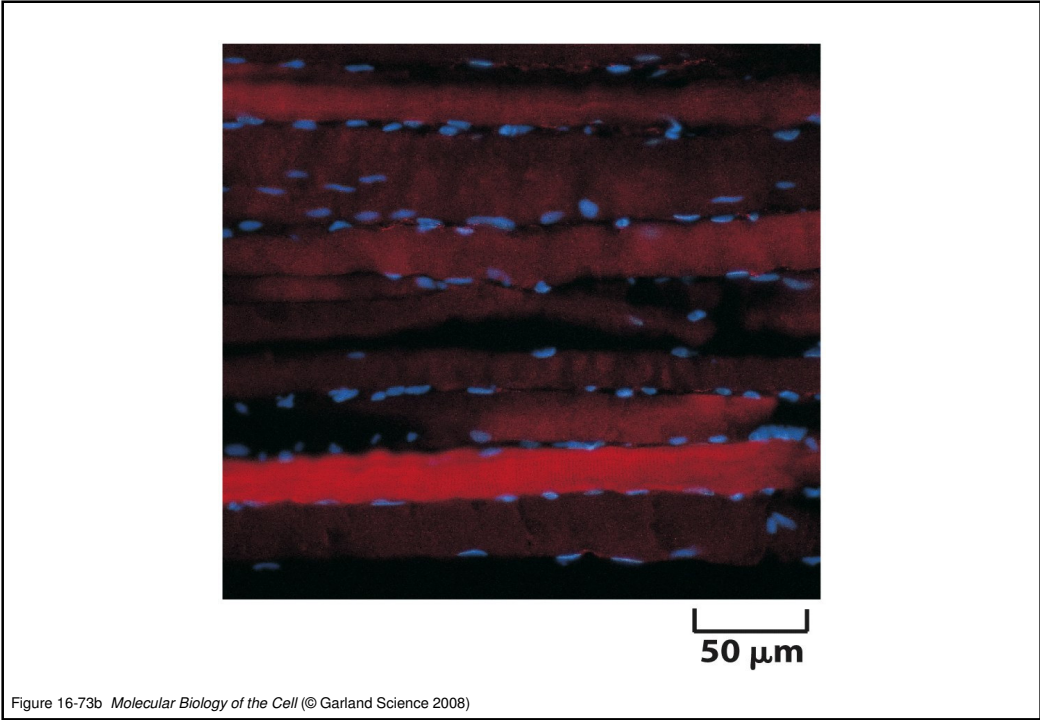
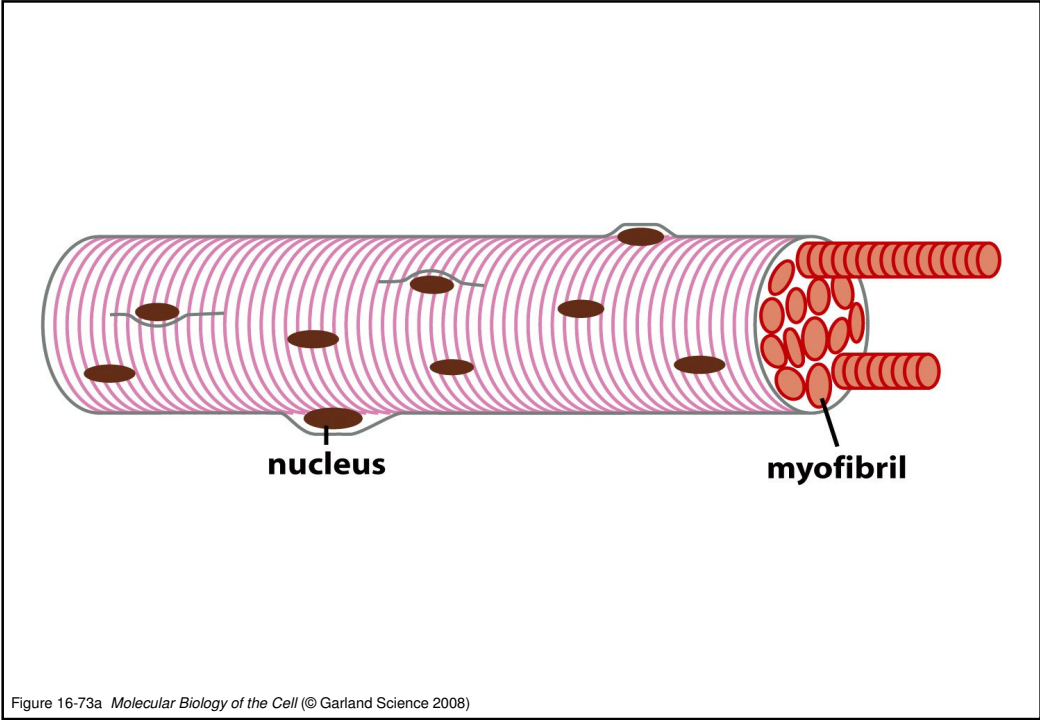


Figure 16-71 *Molecular Biology of the Cell* (© Garland Science 2008)







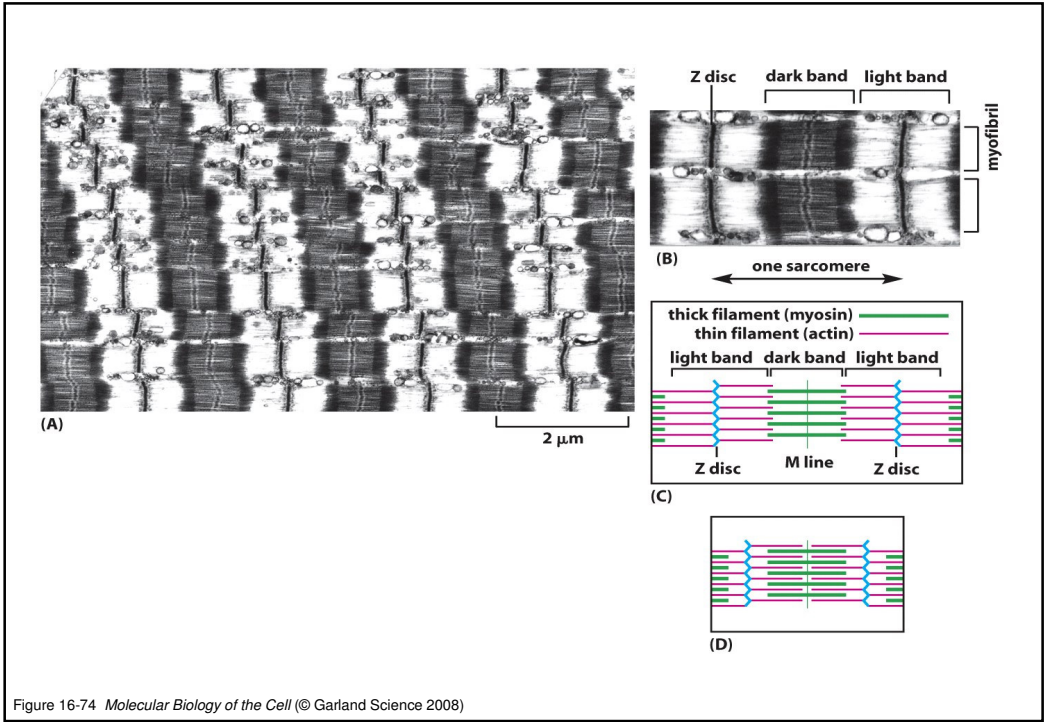


Figure 16-74 *Molecular Biology of the Cell* (© Garland Science 2008)

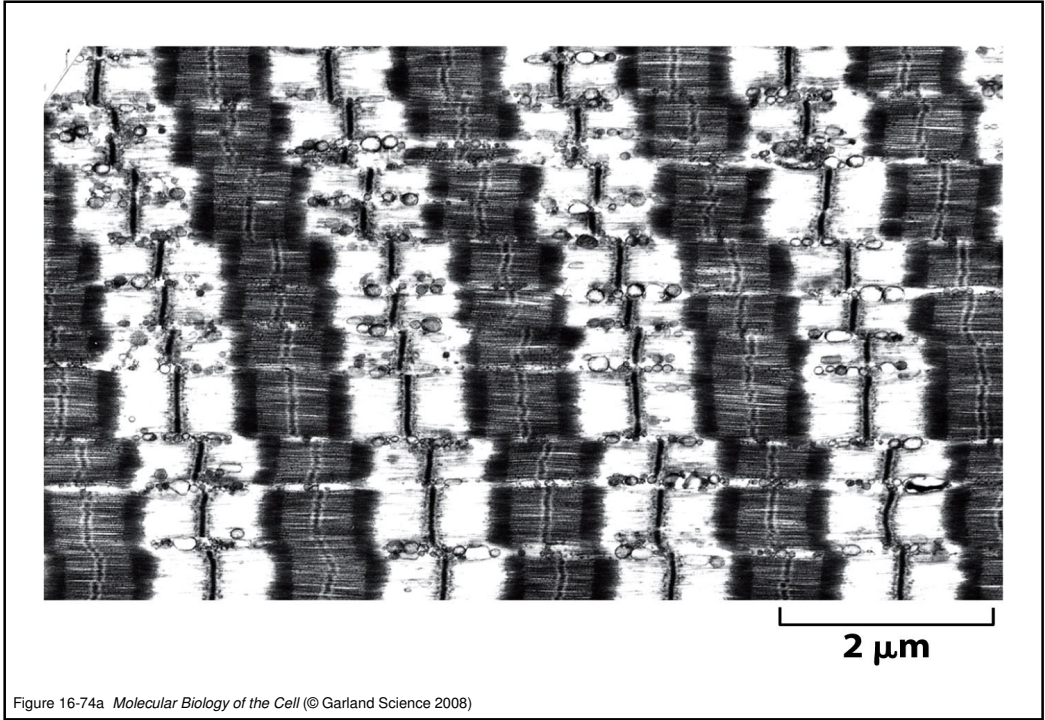
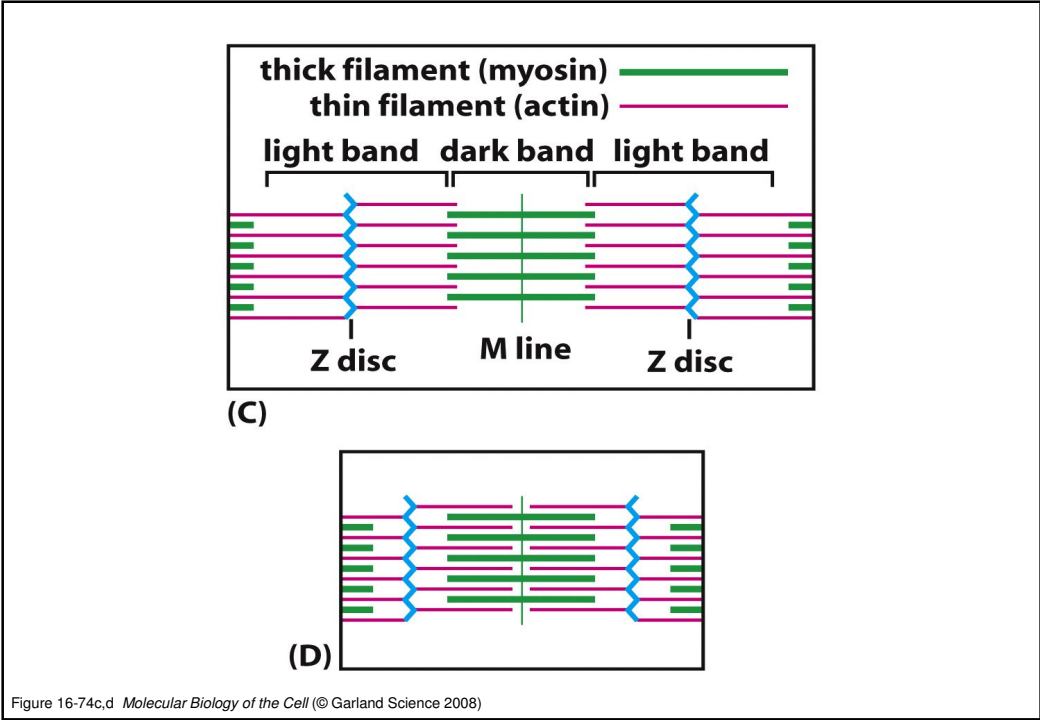
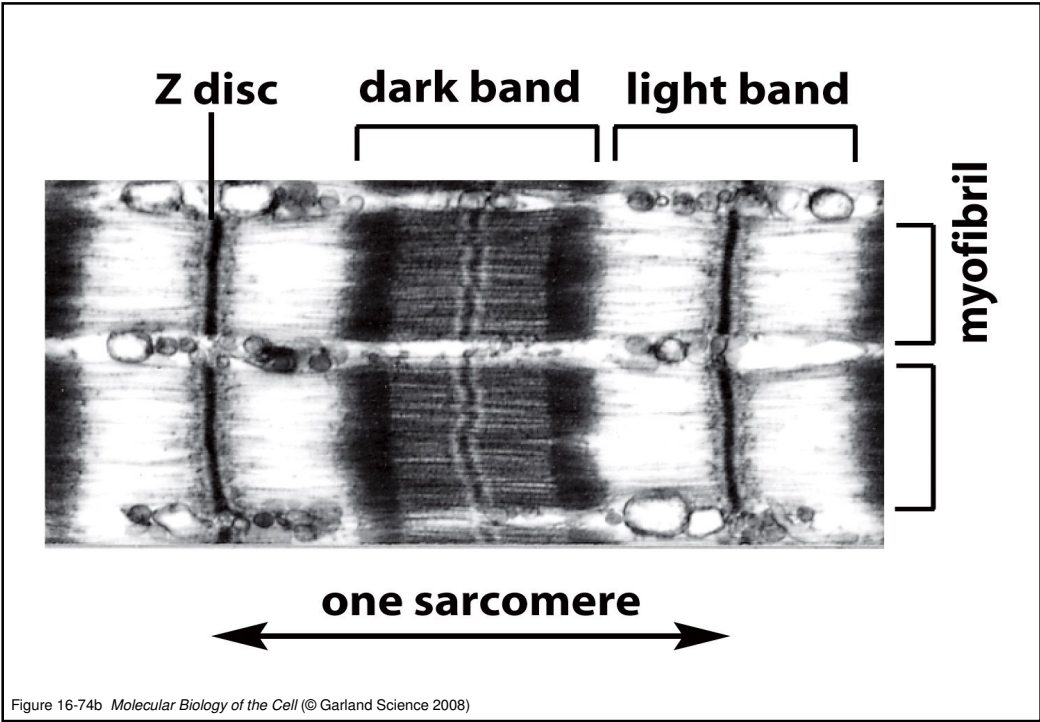


Figure 16-74a *Molecular Biology of the Cell* (© Garland Science 2008)



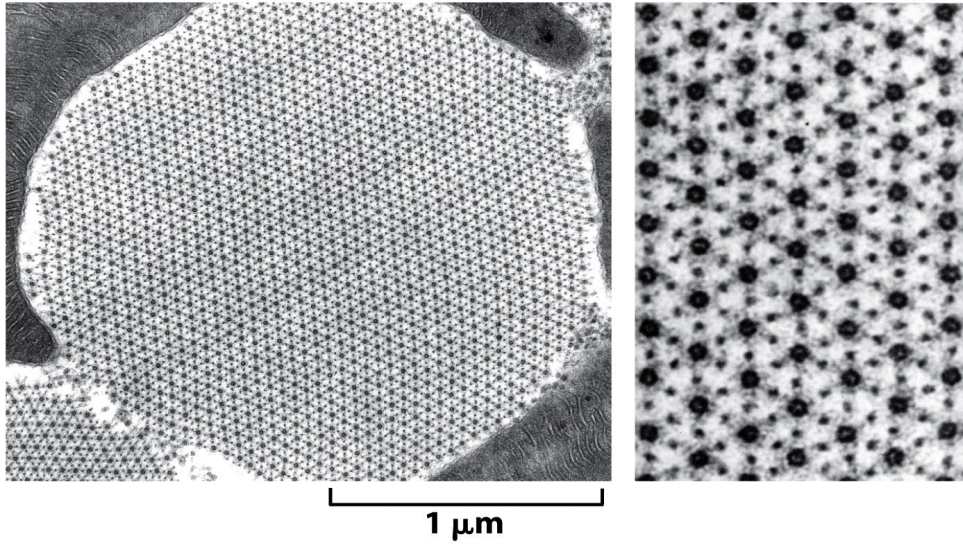


Figure 16-75 *Molecular Biology of the Cell* (© Garland Science 2008)

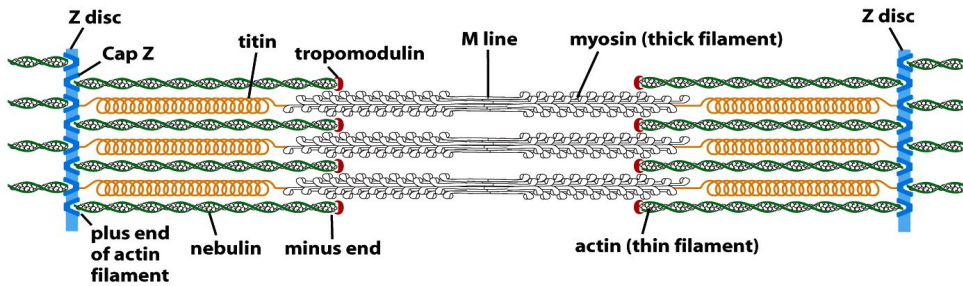
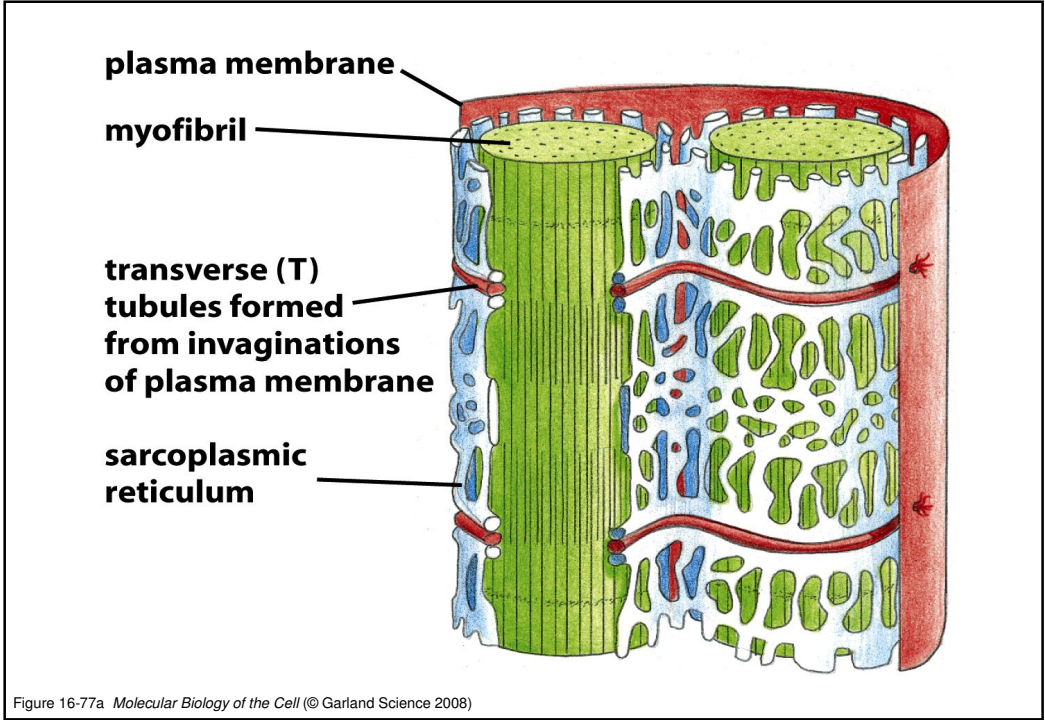
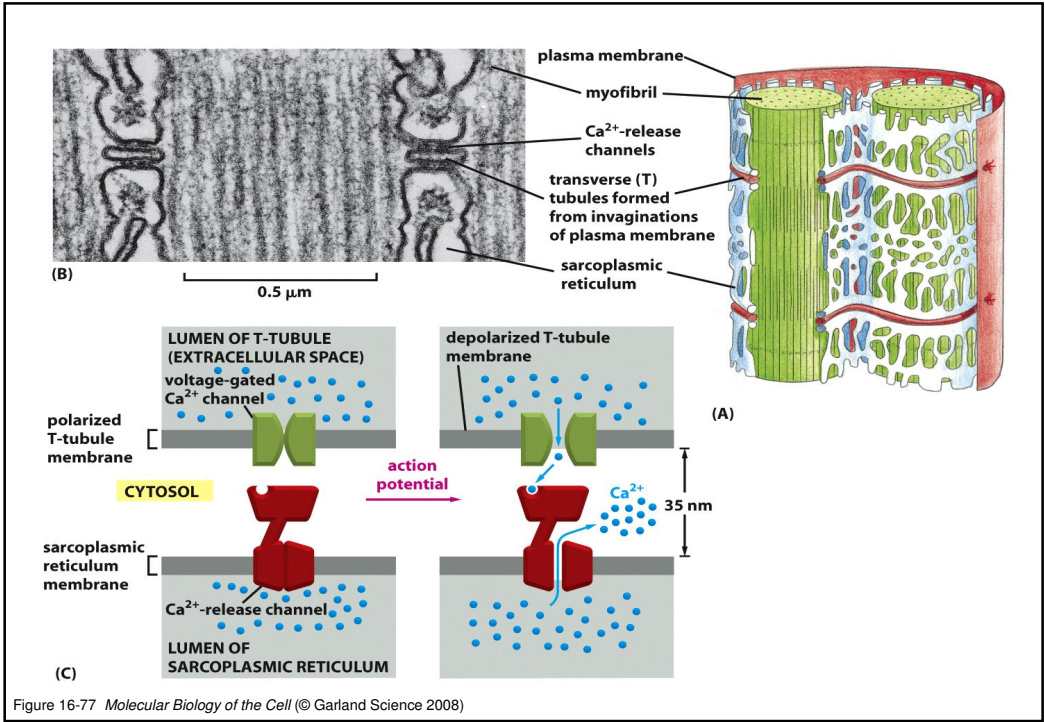


Figure 16-76 *Molecular Biology of the Cell* (© Garland Science 2008)



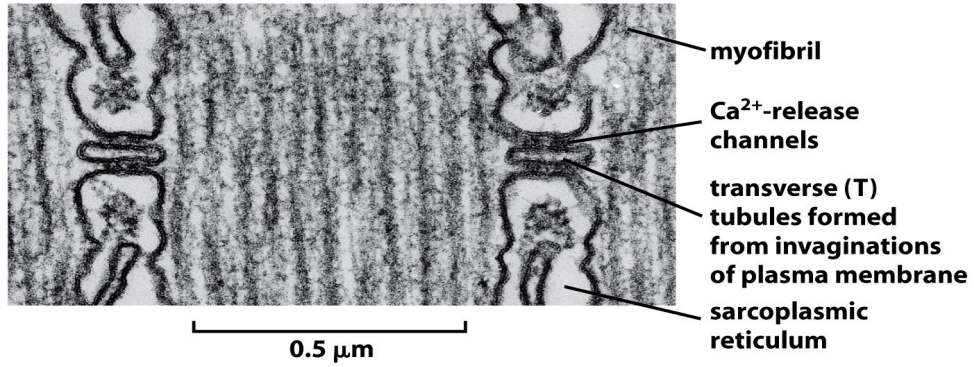


Figure 16-77b *Molecular Biology of the Cell* (© Garland Science 2008)

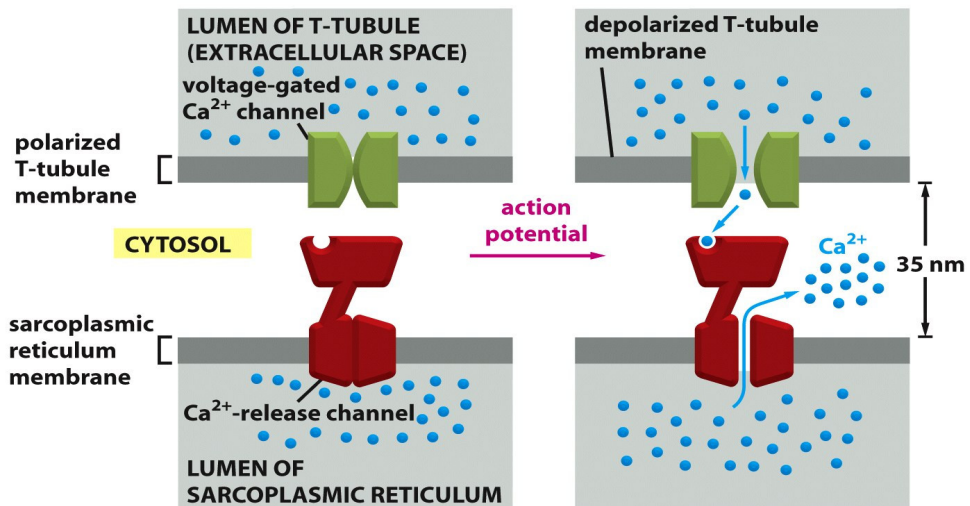
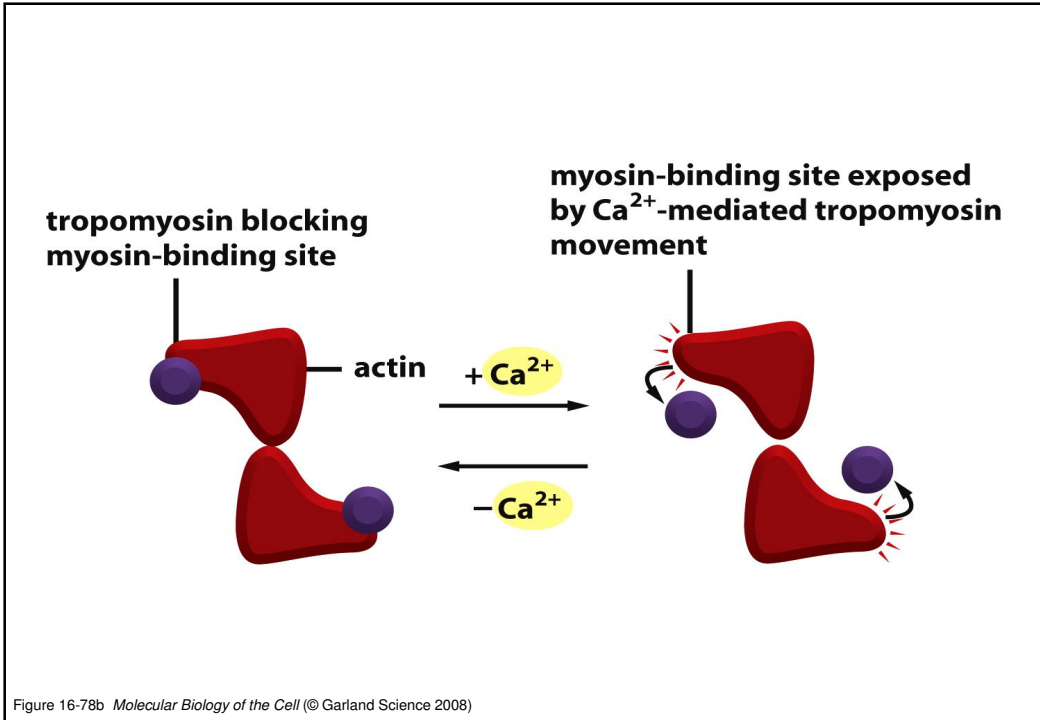
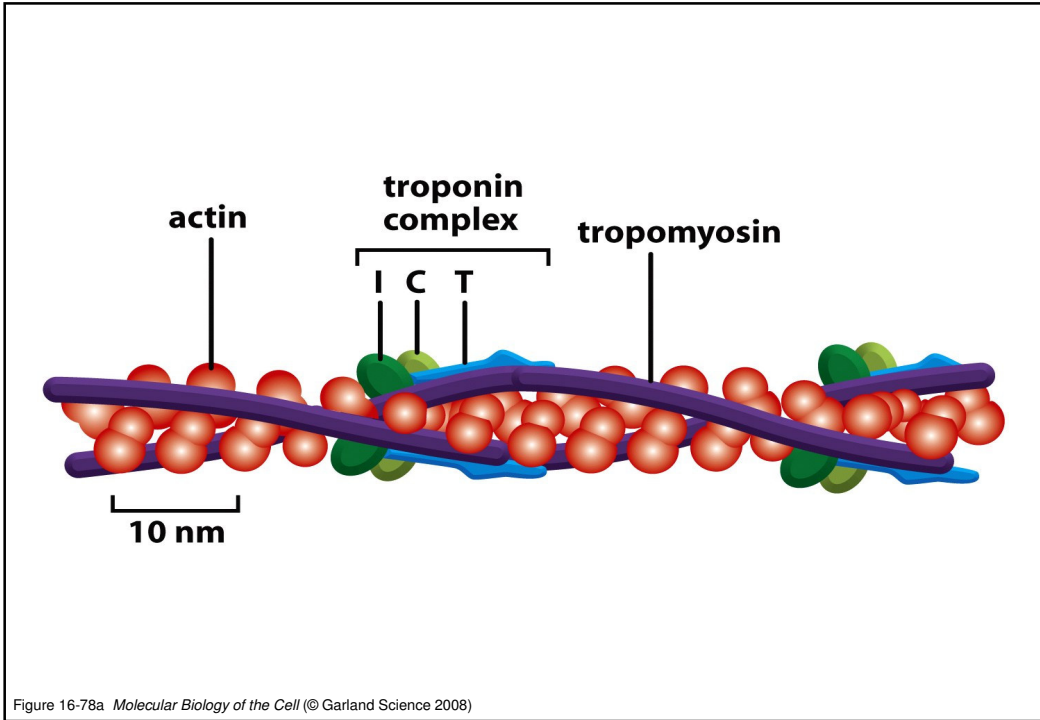
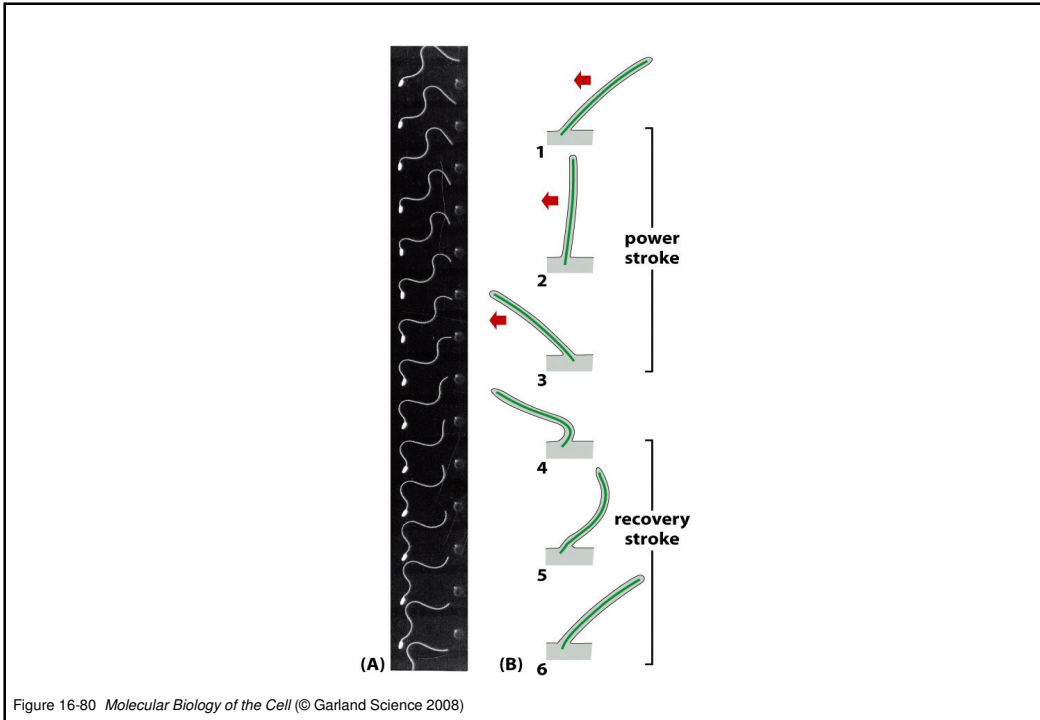
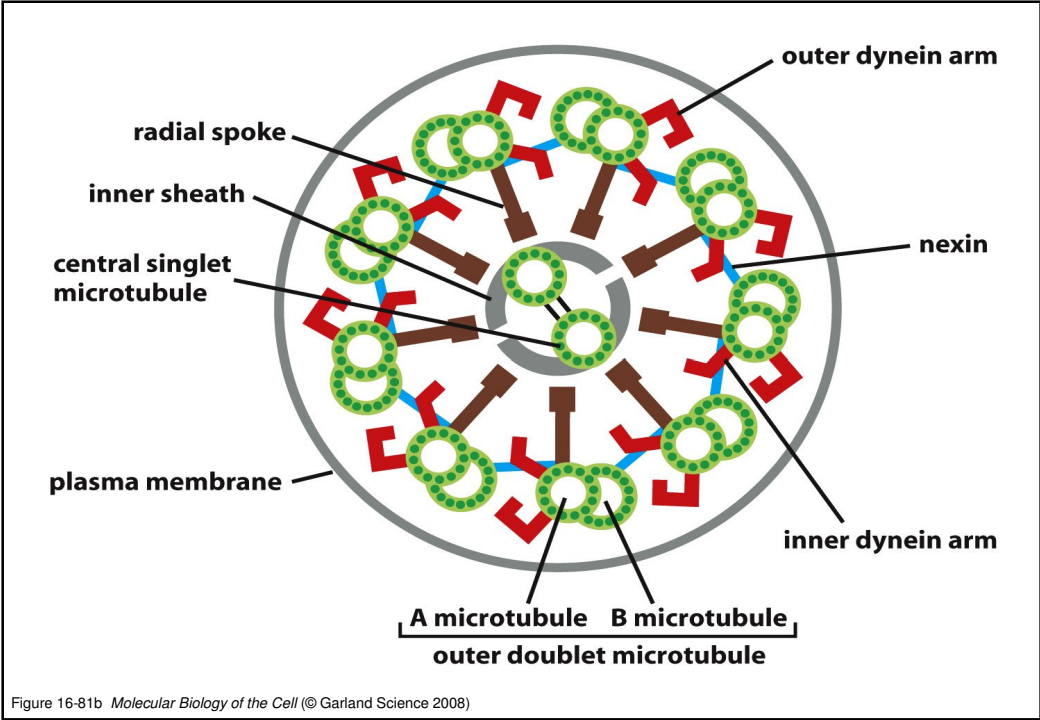
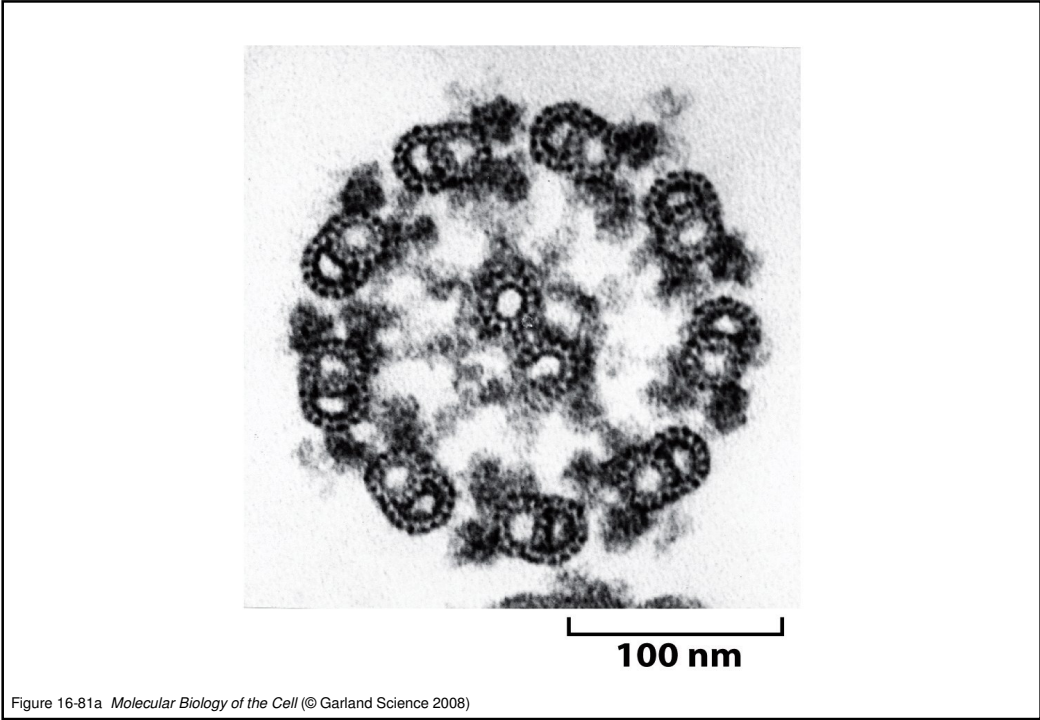


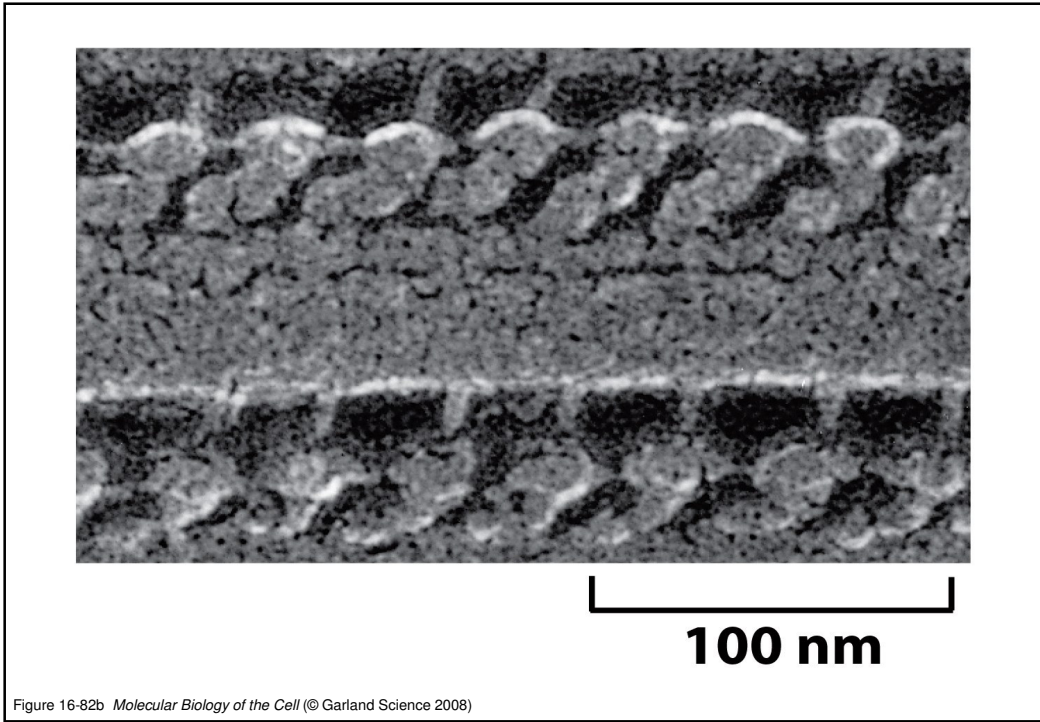
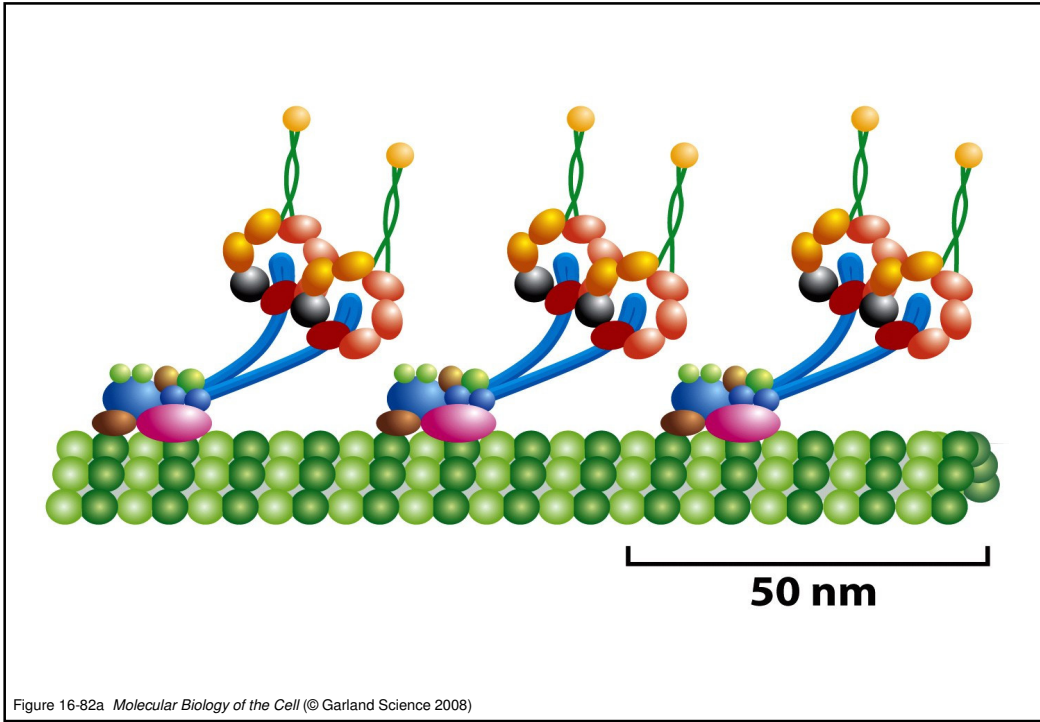
Figure 16-77c *Molecular Biology of the Cell* (© Garland Science 2008)

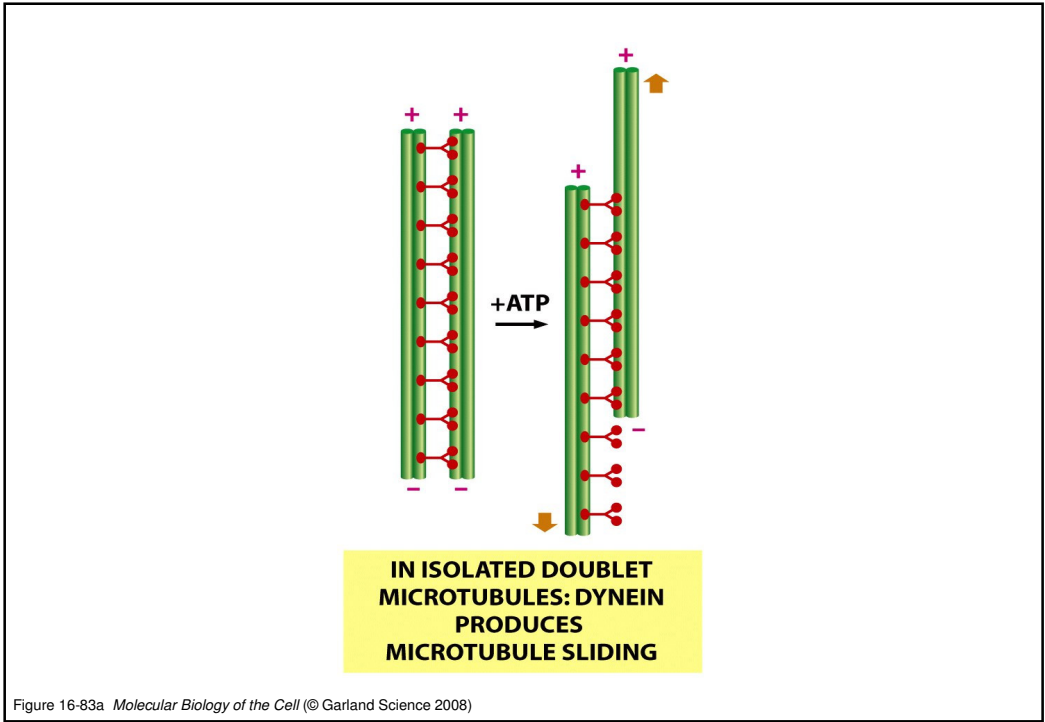
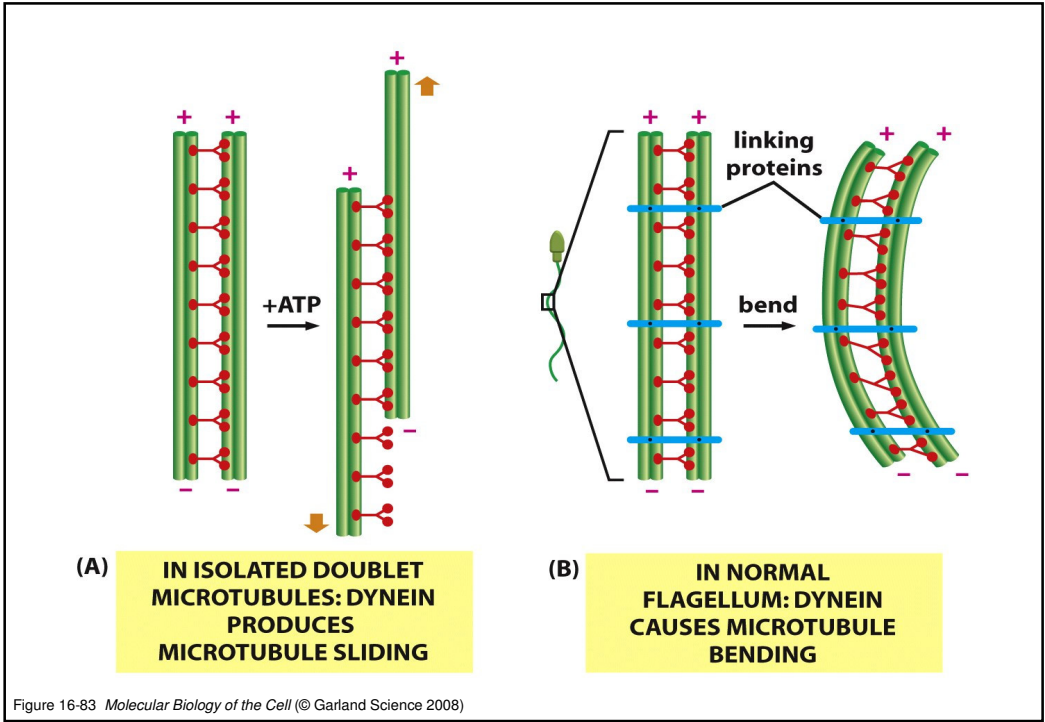












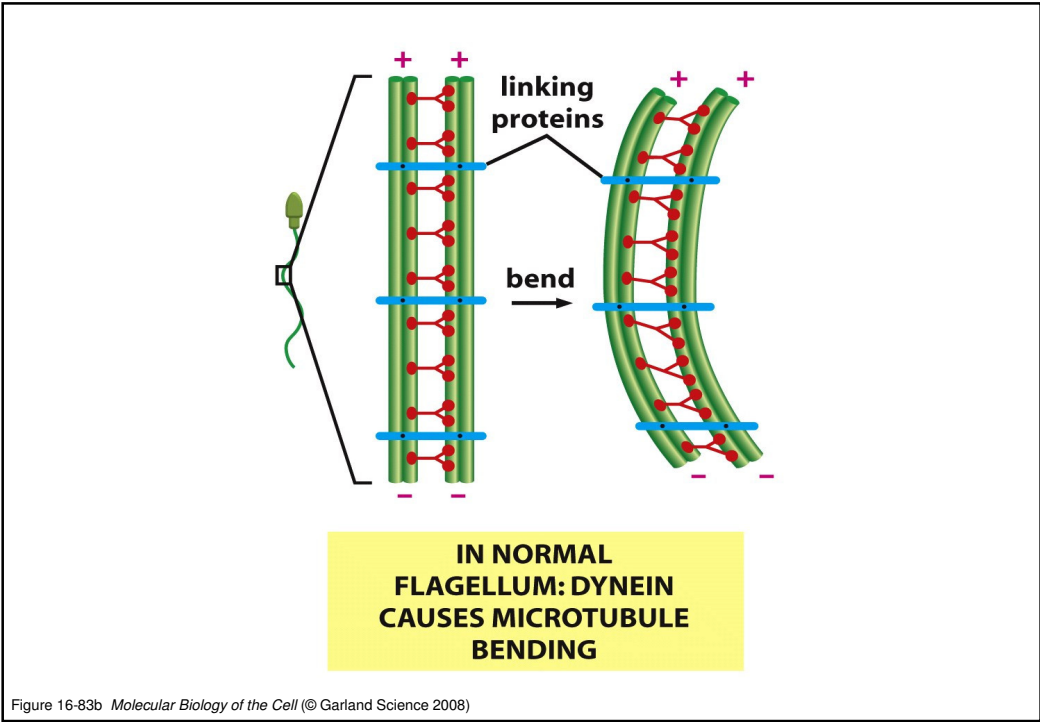


Figure 16-83b *Molecular Biology of the Cell* (© Garland Science 2008)

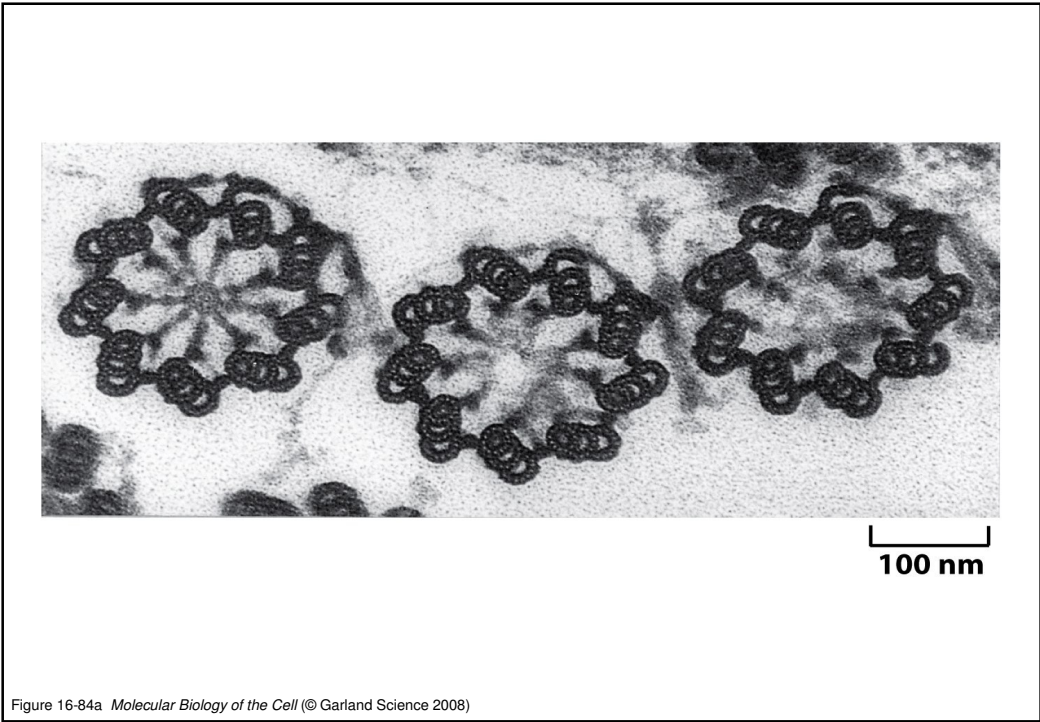
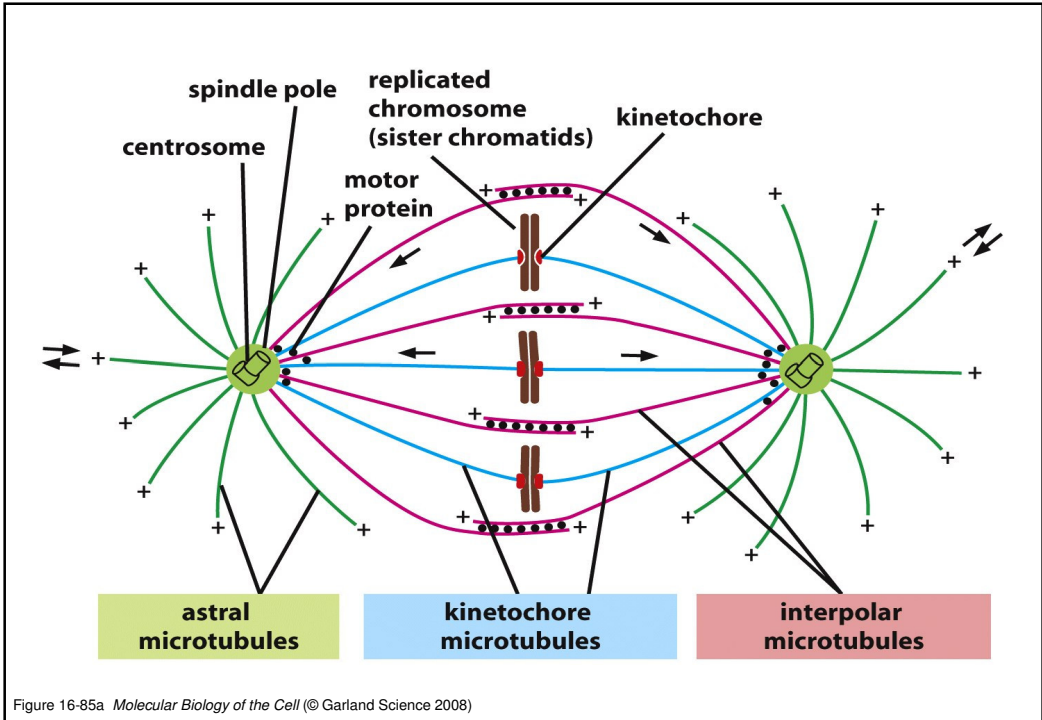
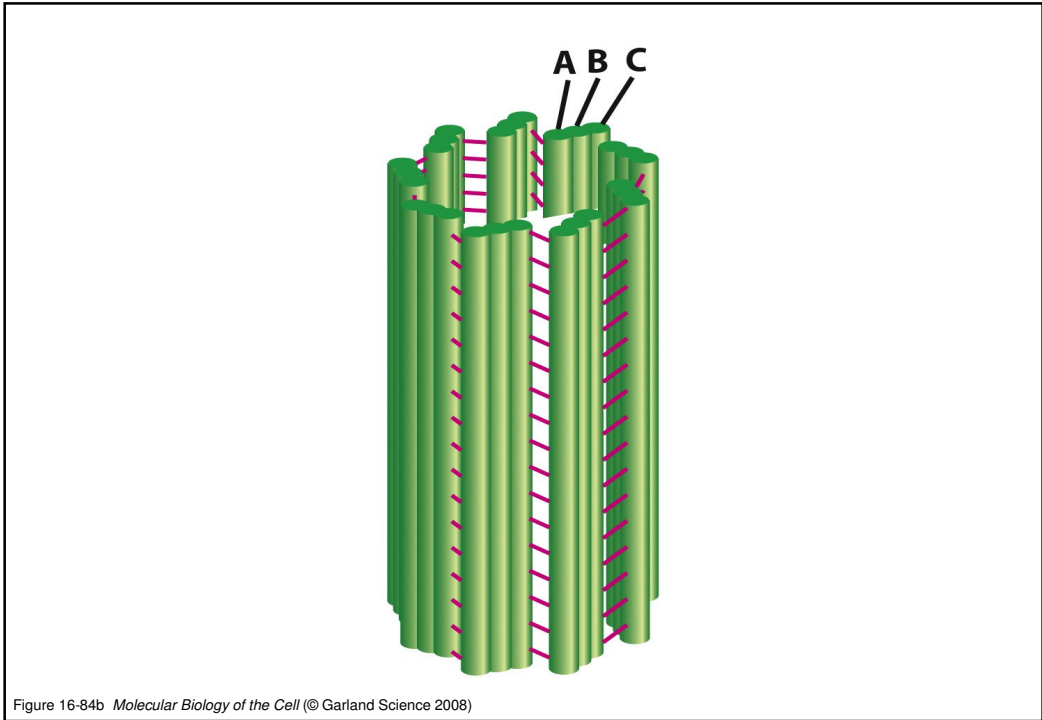
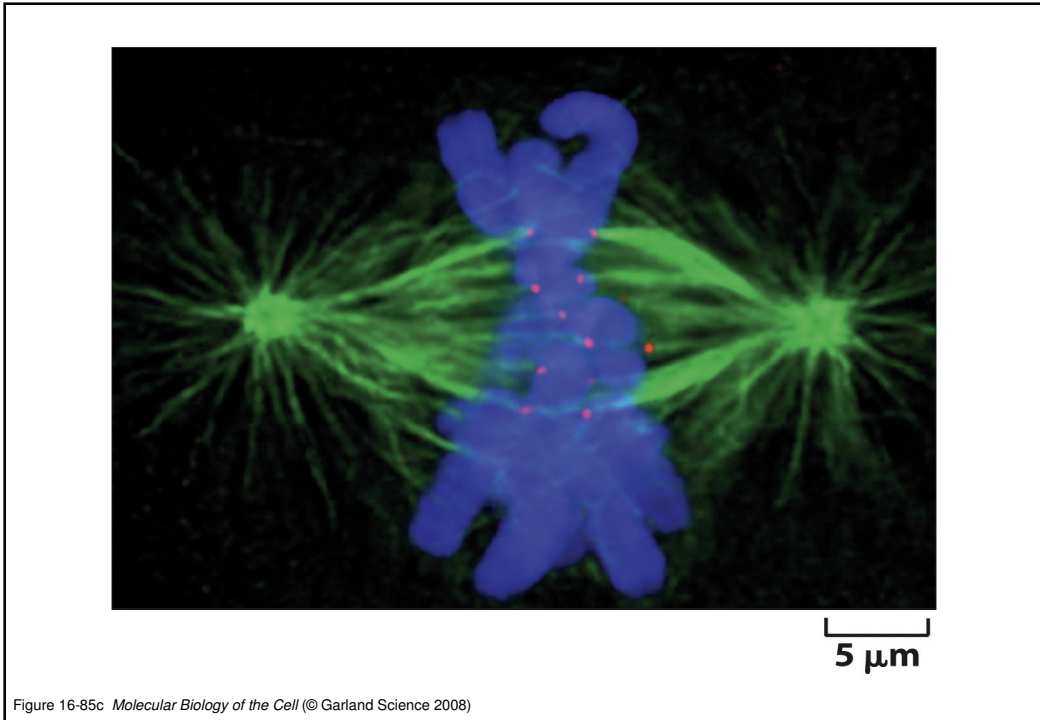
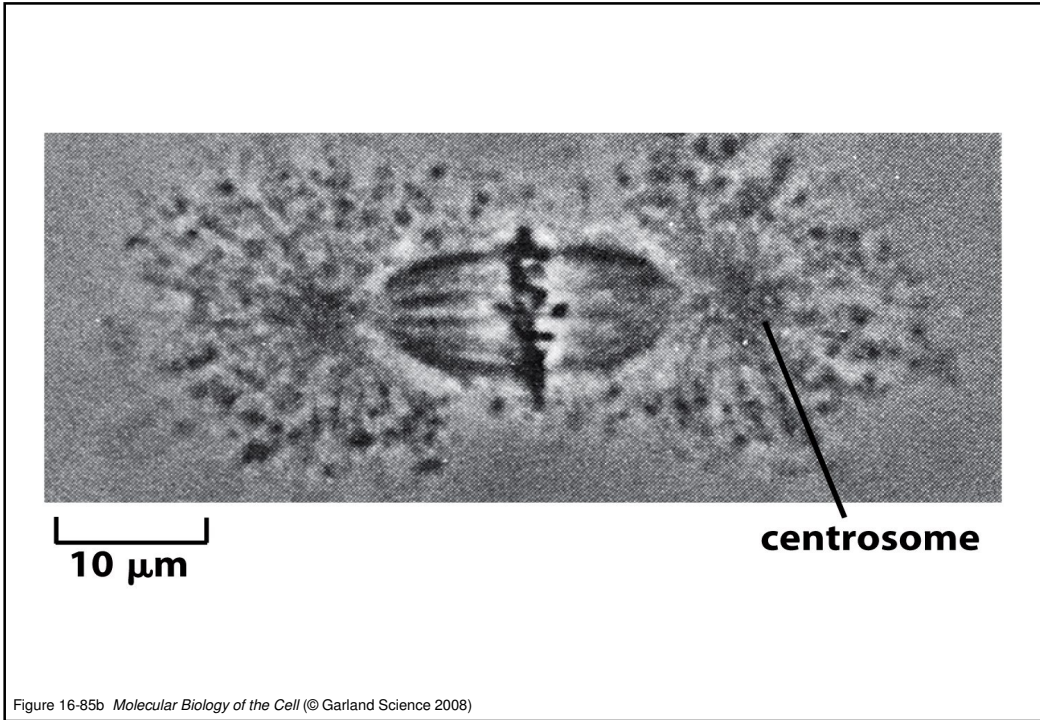
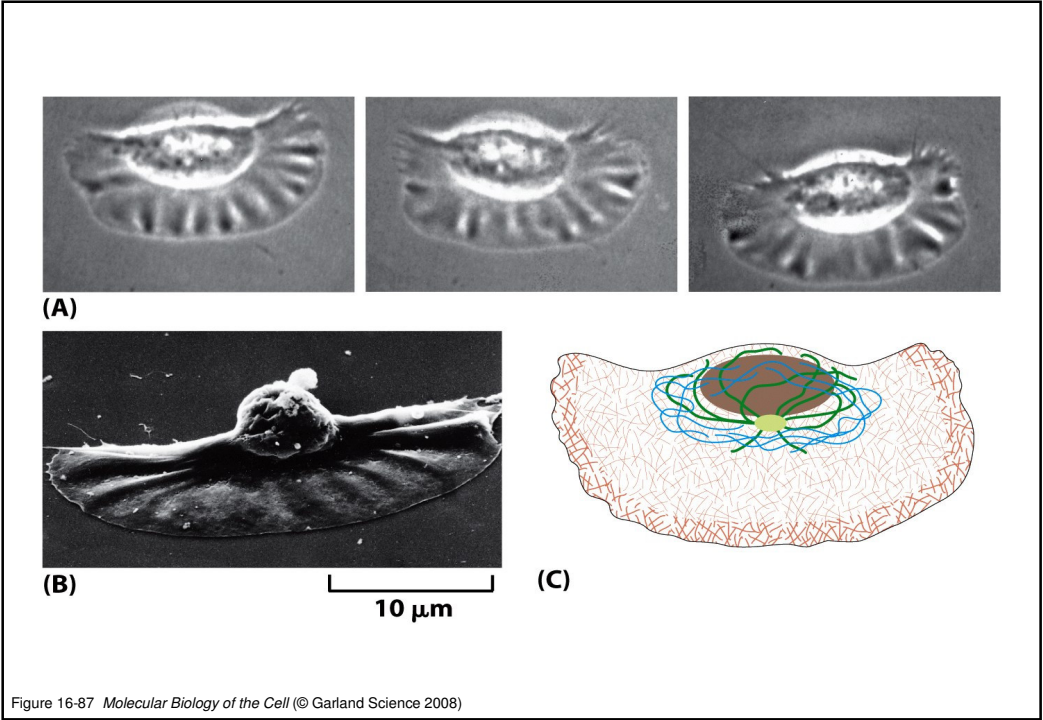
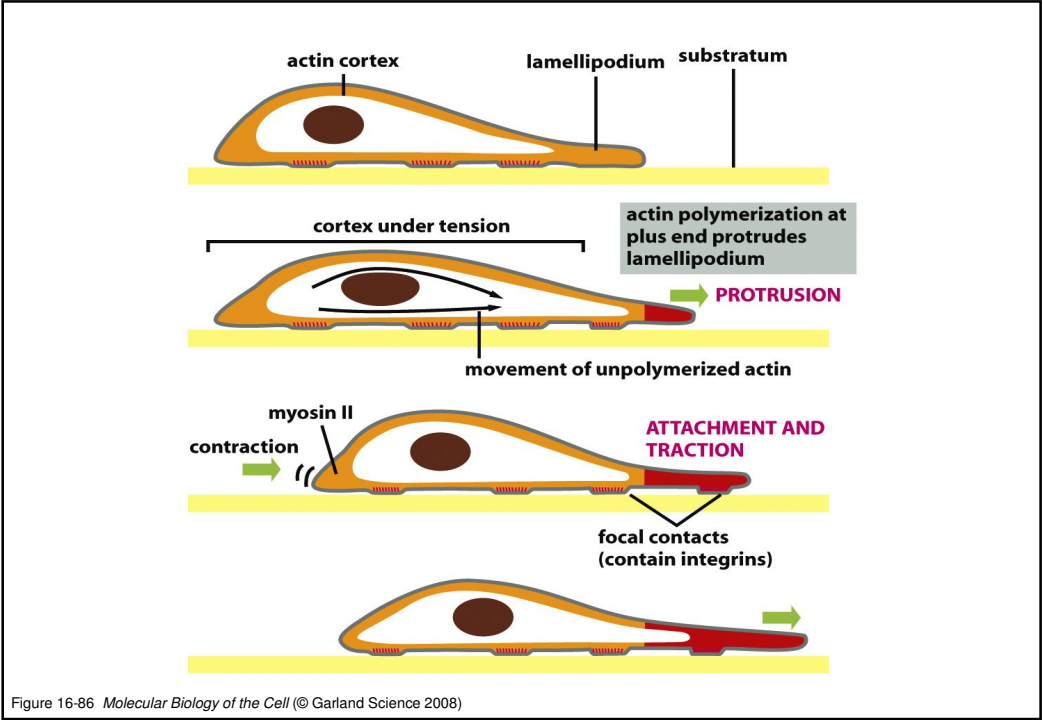


Figure 16-84a *Molecular Biology of the Cell* (© Garland Science 2008)









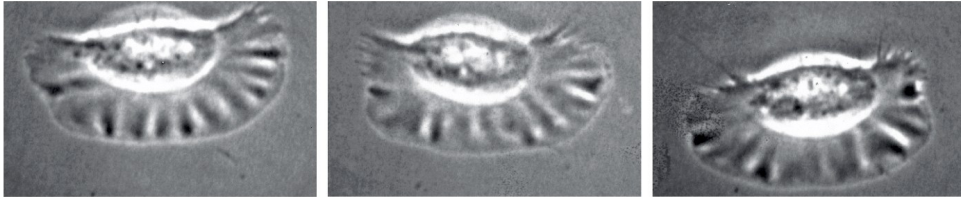
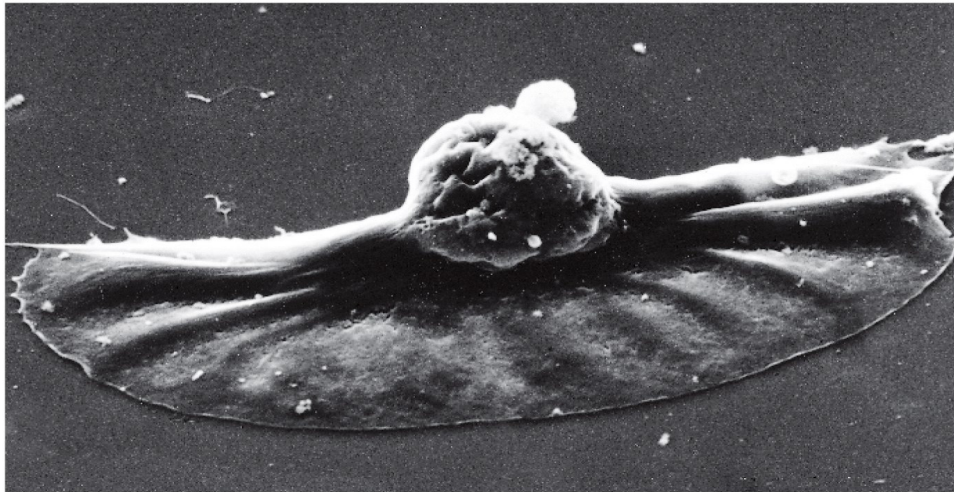
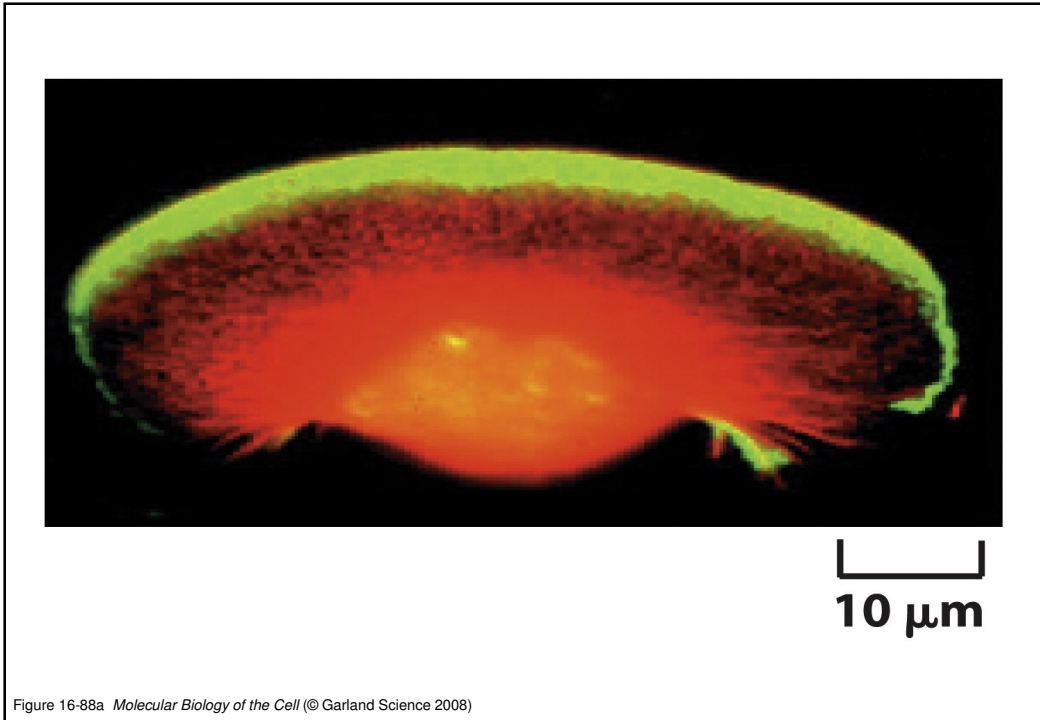
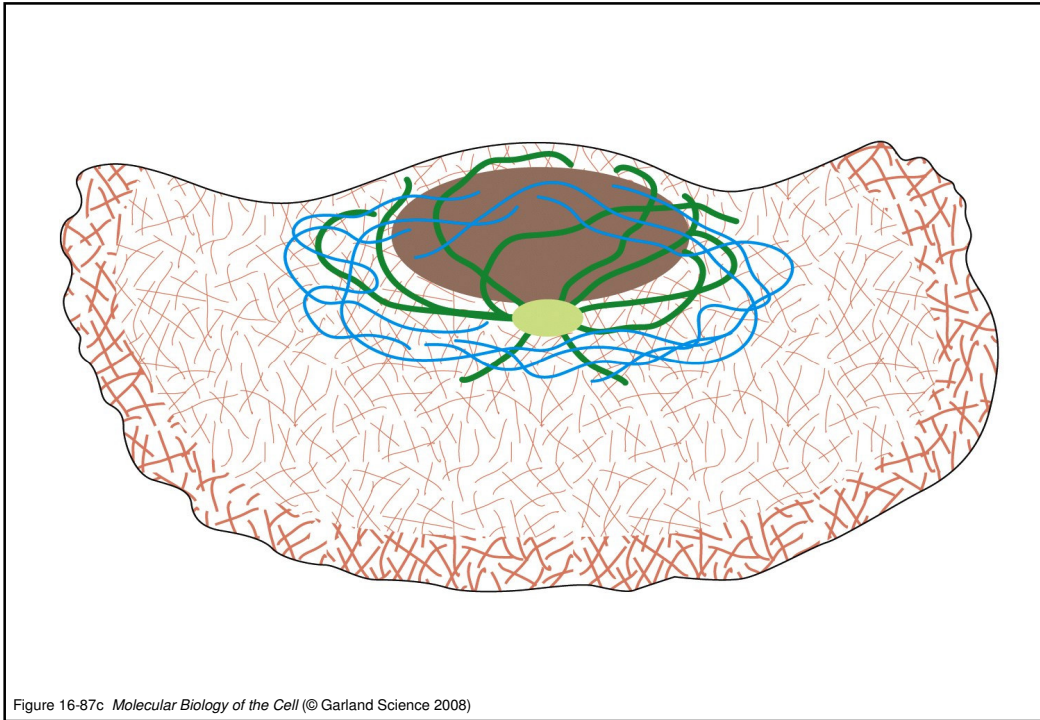


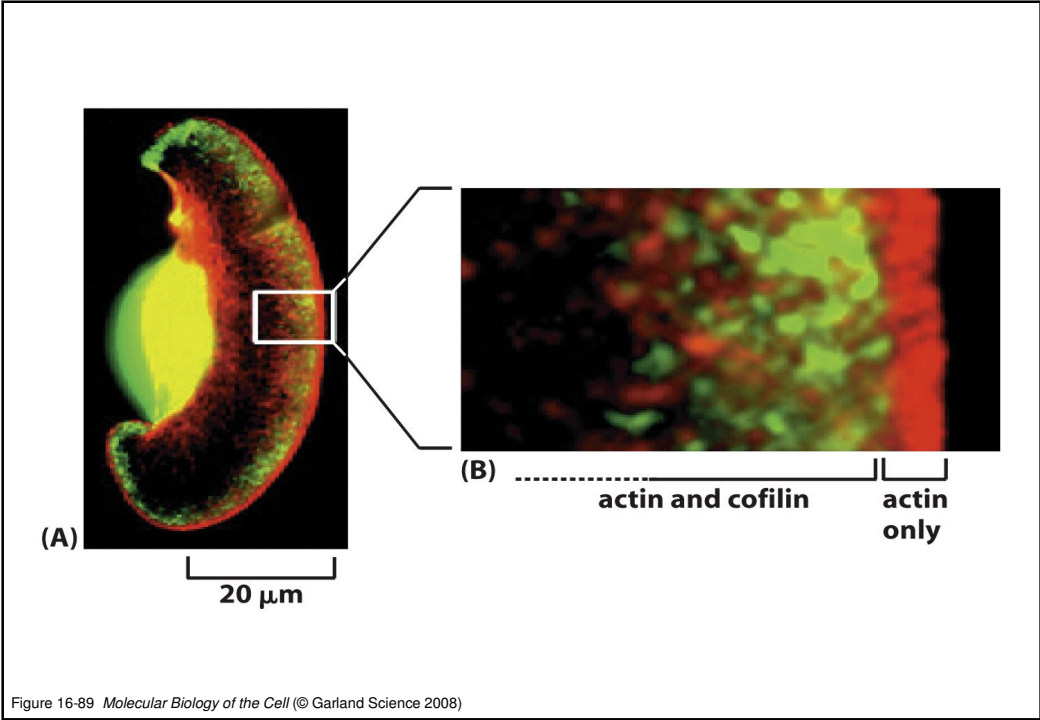
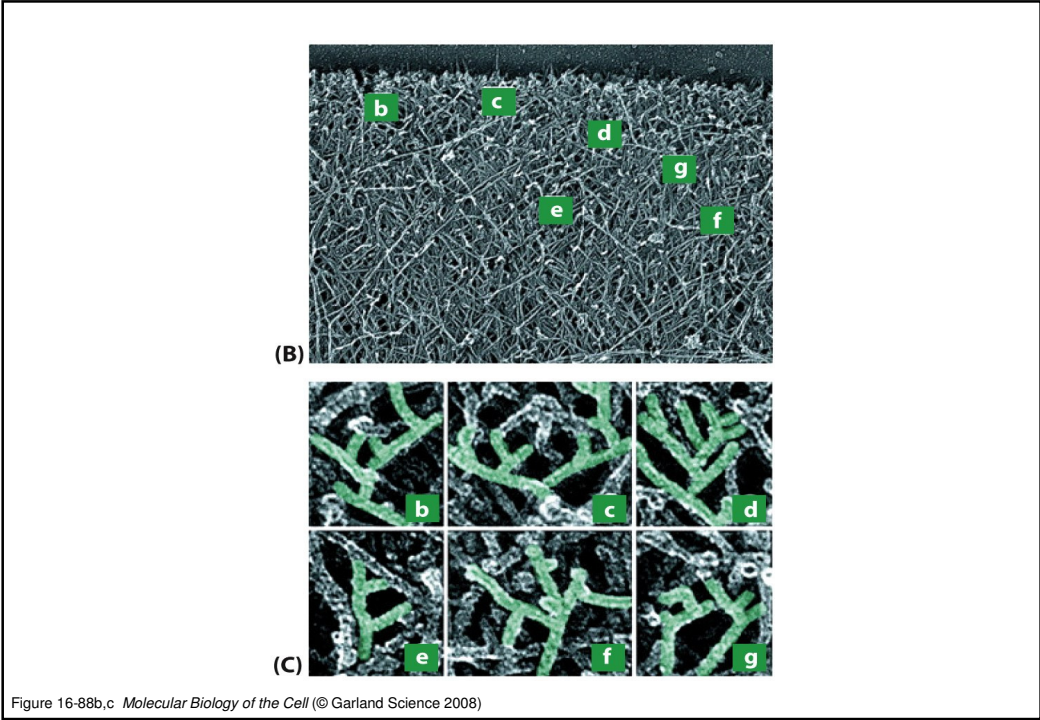
Figure 16-87a *Molecular Biology of the Cell* (© Garland Science 2008)

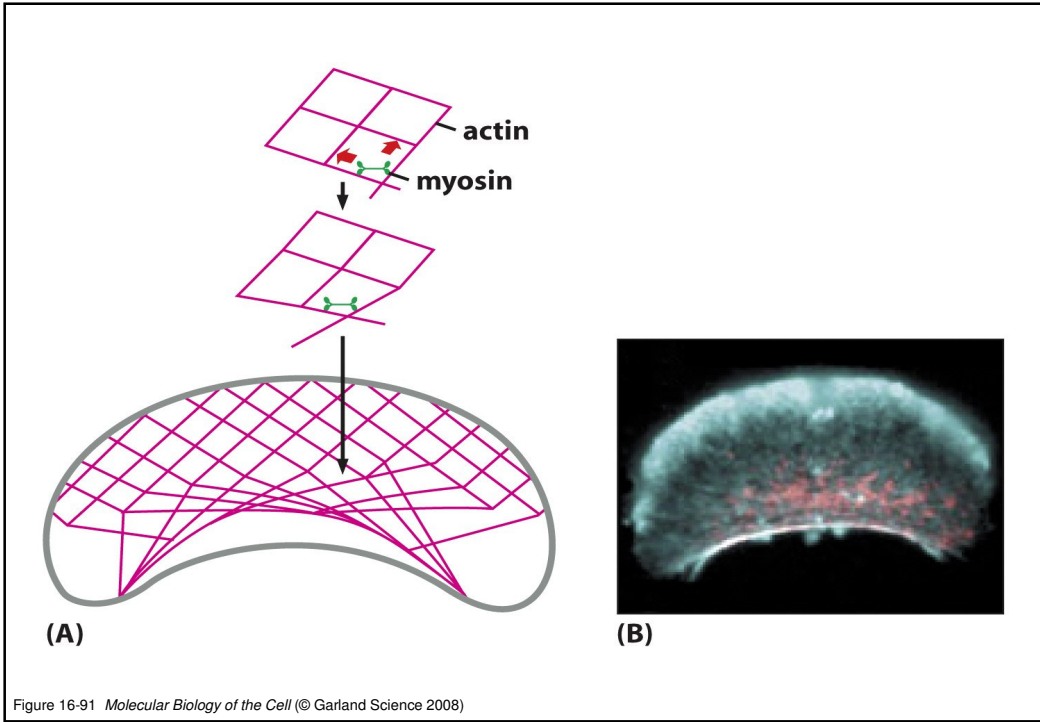
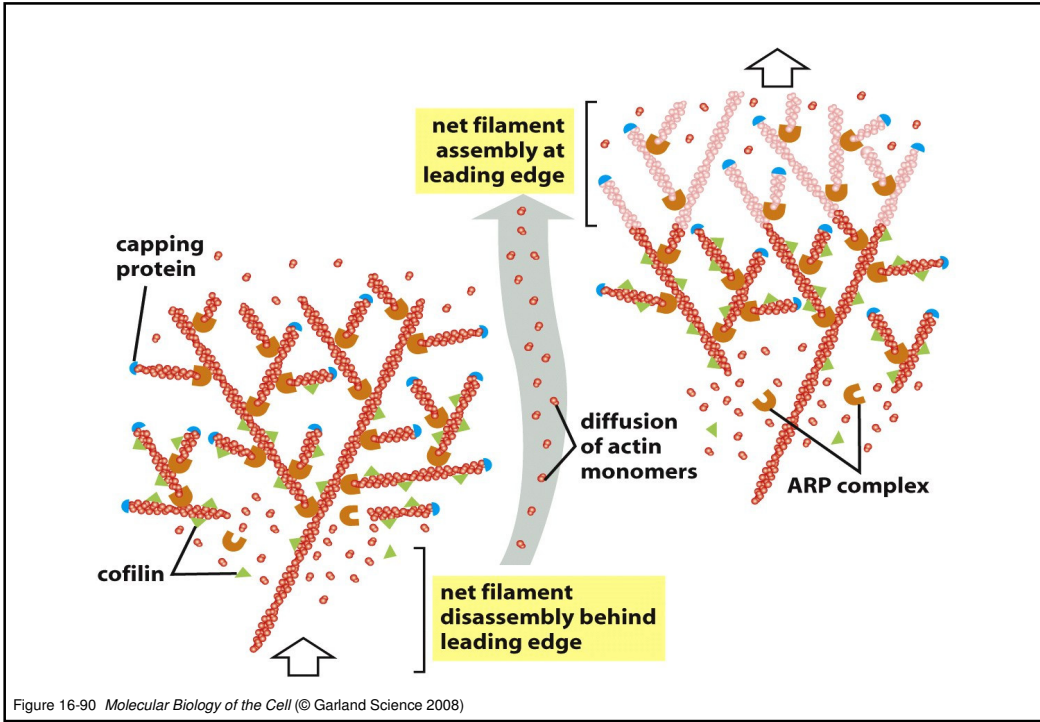


10  $\mu\text{m}$

Figure 16-87b *Molecular Biology of the Cell* (© Garland Science 2008)







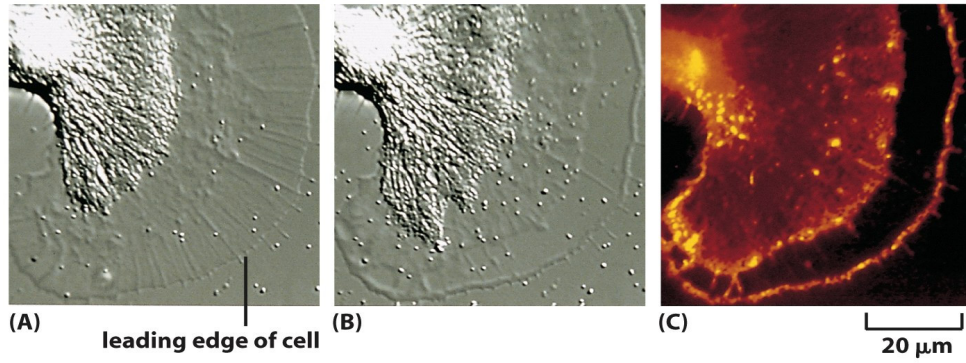


Figure 16-92a-c *Molecular Biology of the Cell* (© Garland Science 2008)

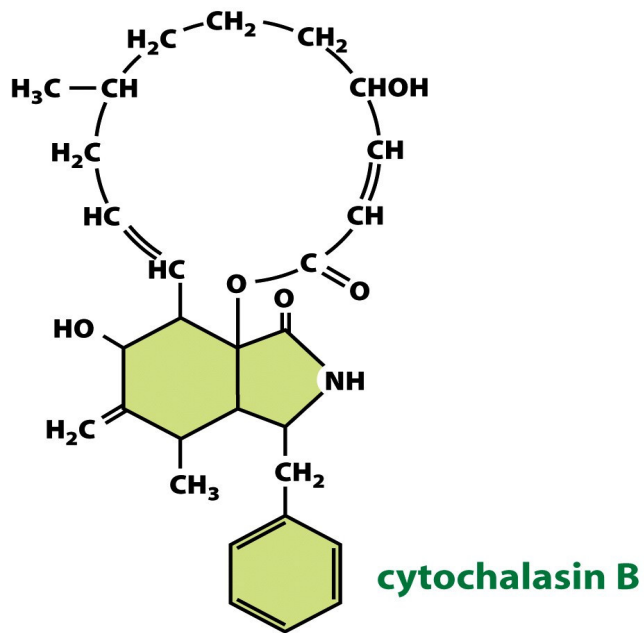


Figure 16-92d *Molecular Biology of the Cell* (© Garland Science 2008)

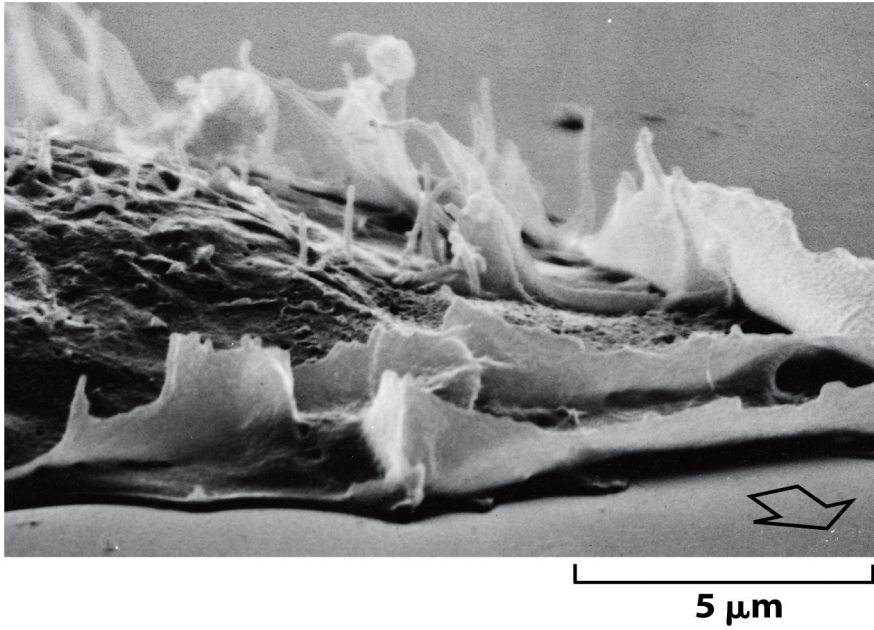


Figure 16-93 *Molecular Biology of the Cell* (© Garland Science 2008)

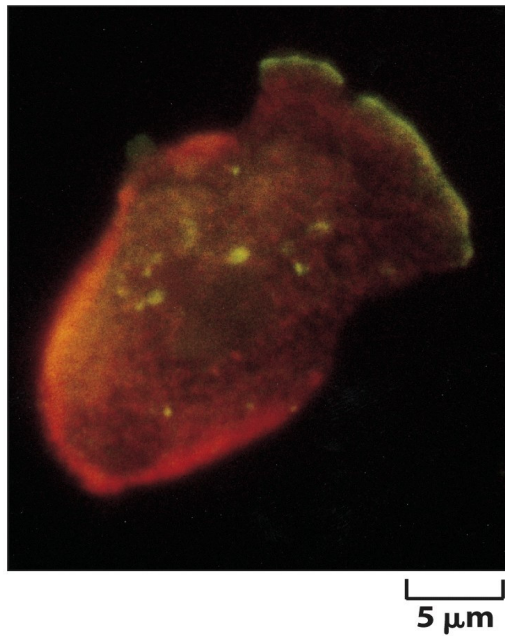
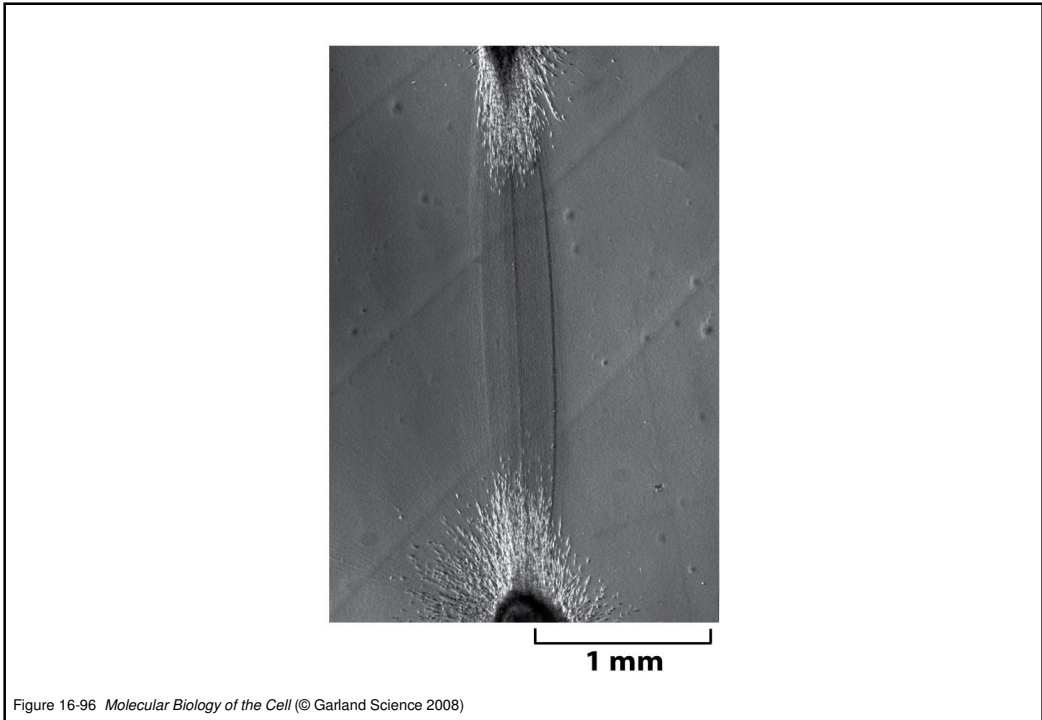
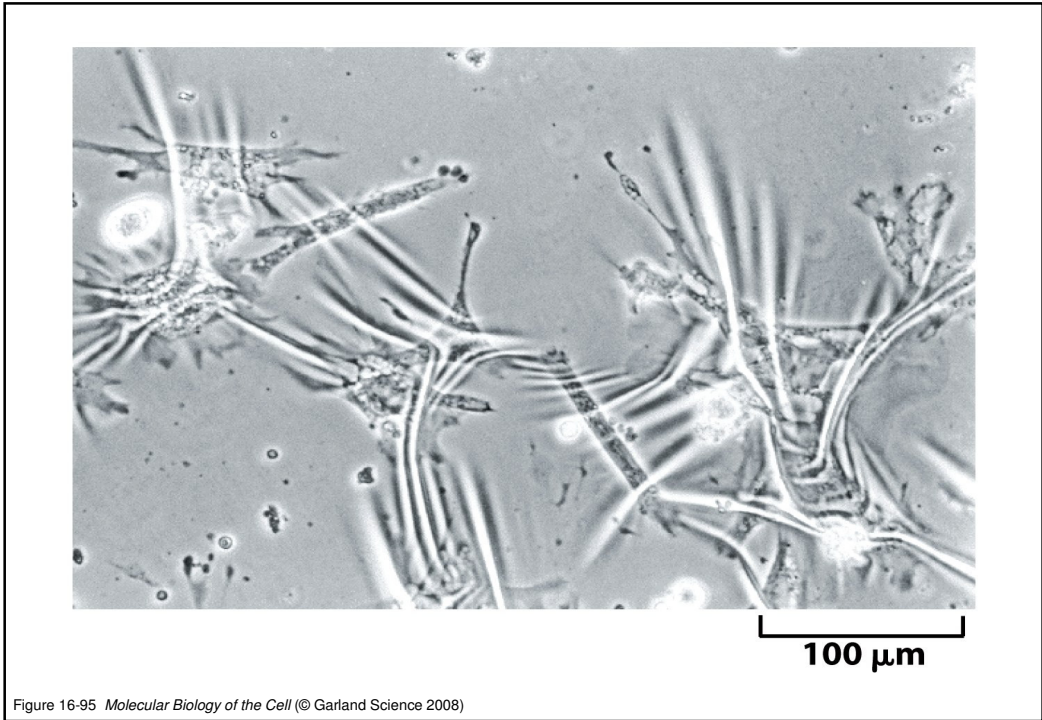
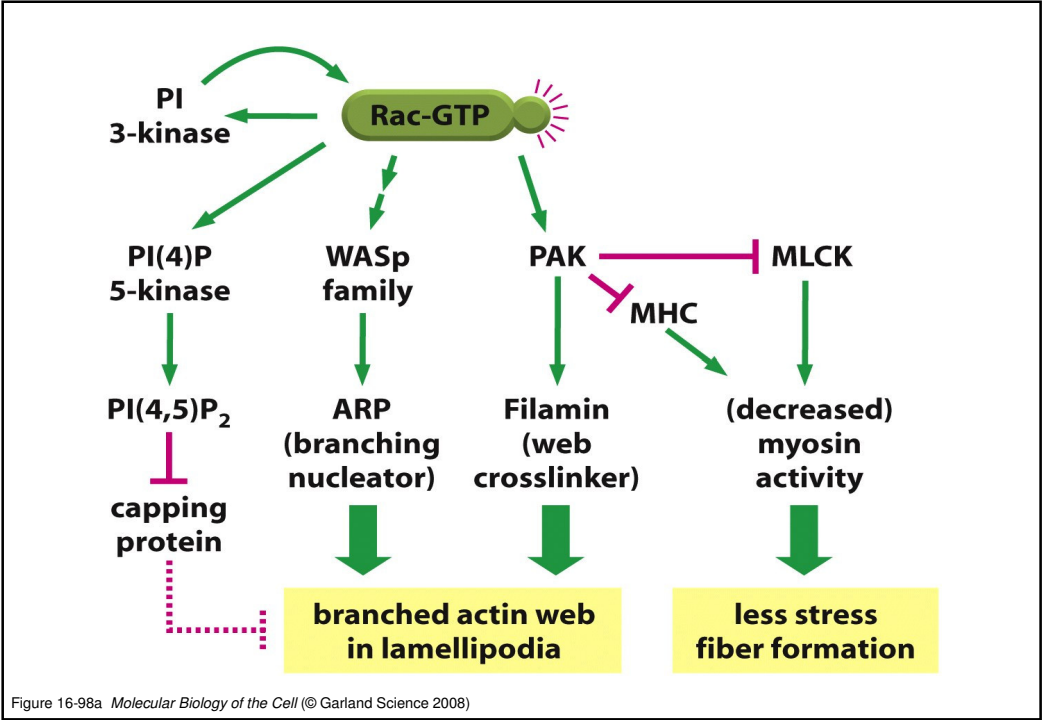
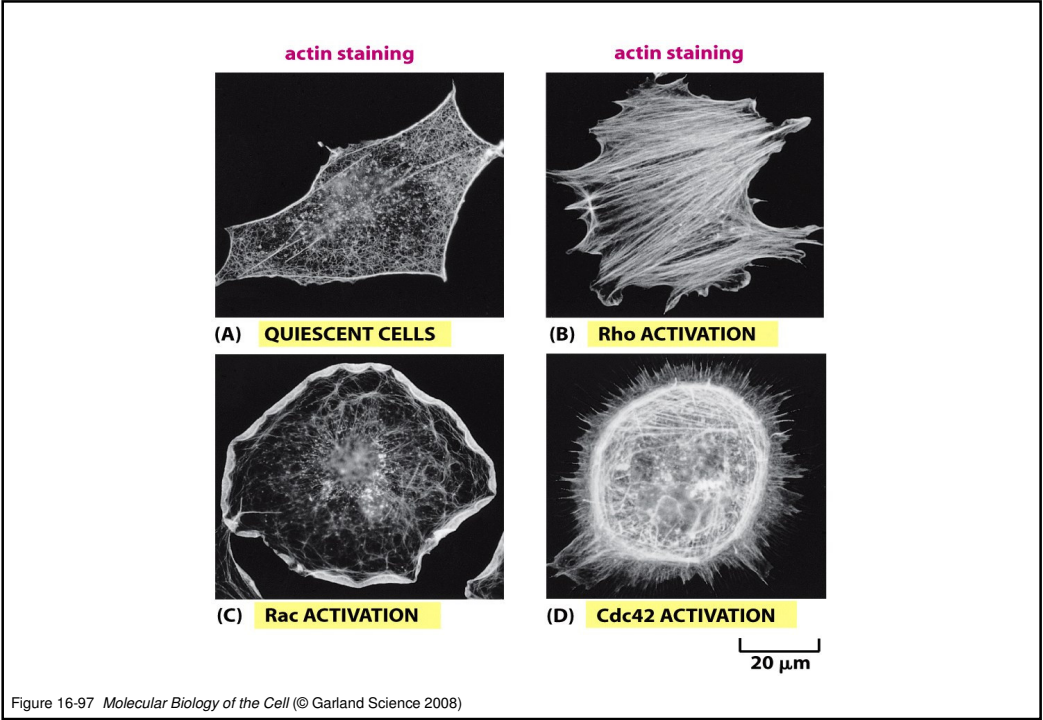
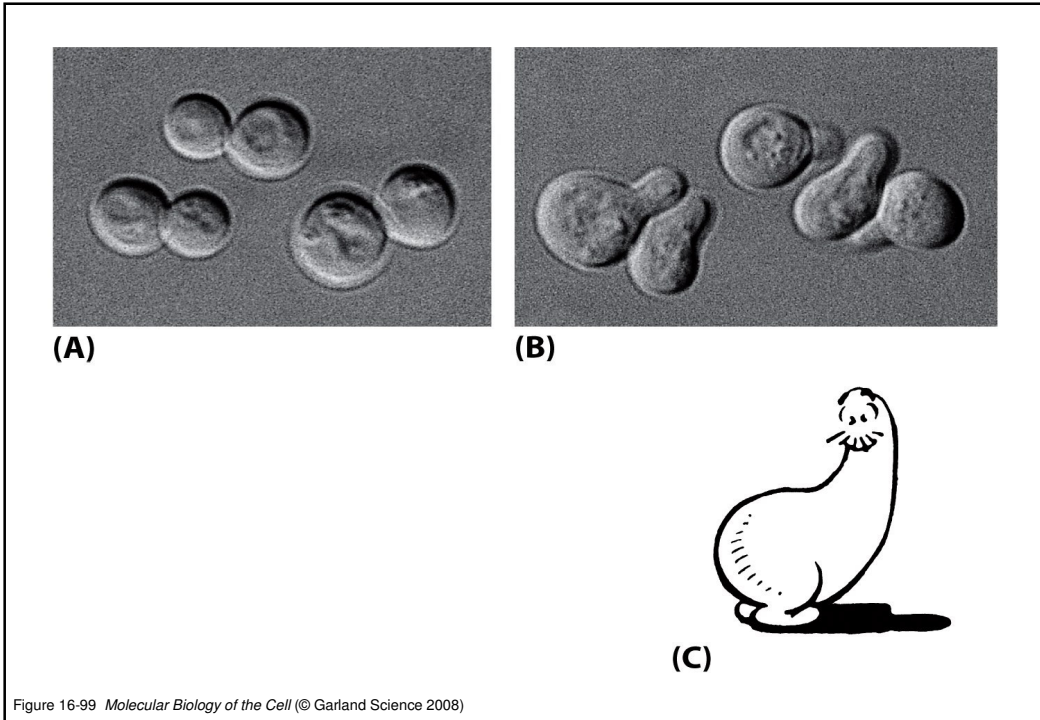
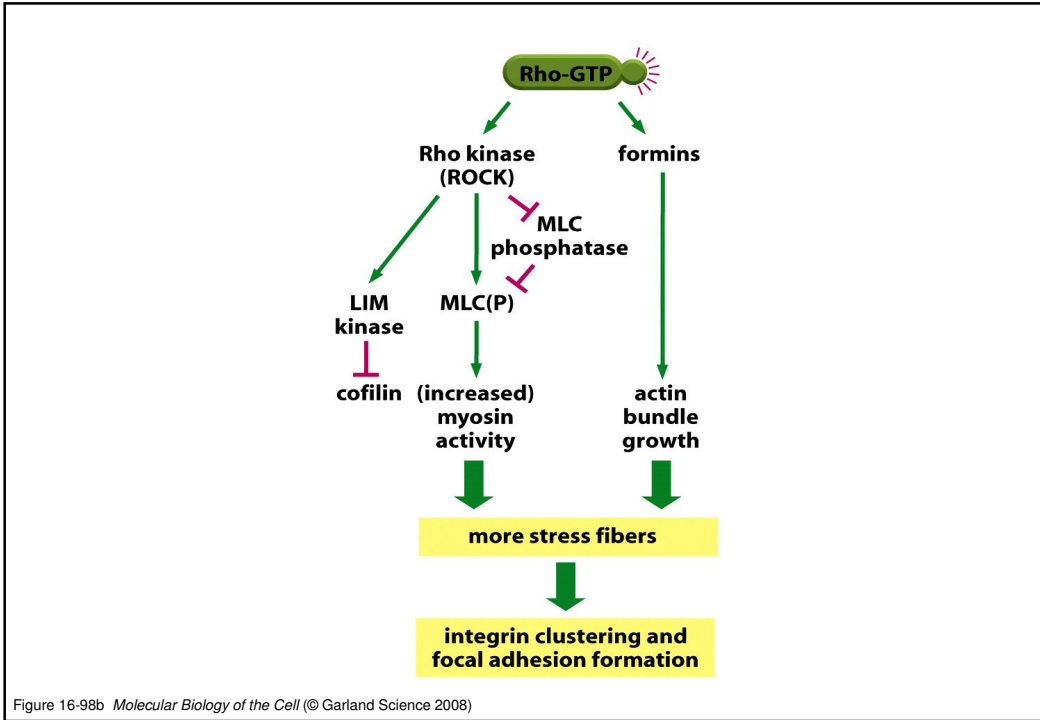


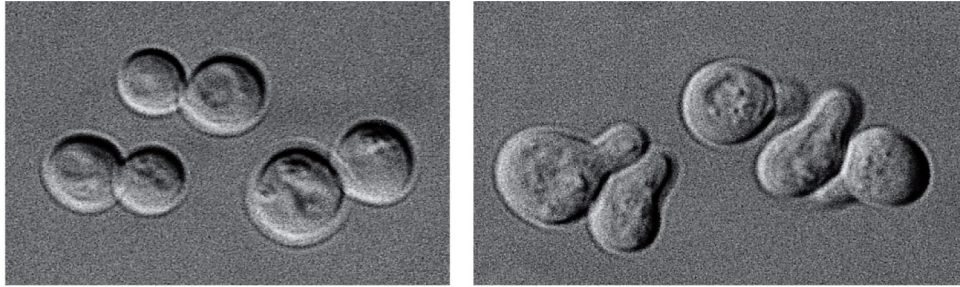
Figure 16-94 *Molecular Biology of the Cell* (© Garland Science 2008)











**(A)**

**(B)**

Figure 16-99a,b *Molecular Biology of the Cell* (© Garland Science 2008)

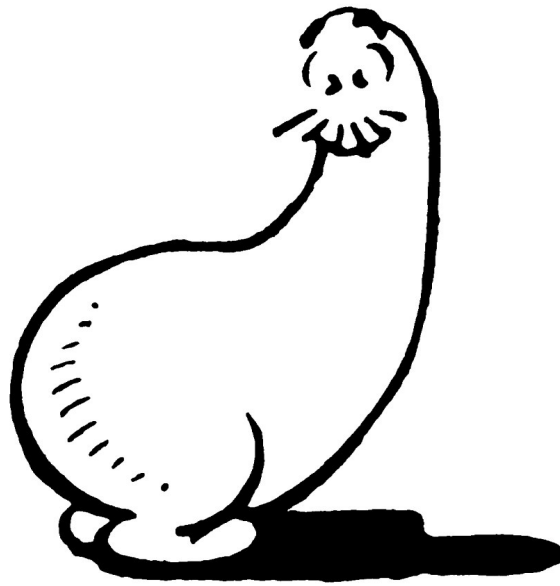


Figure 16-99c *Molecular Biology of the Cell* (© Garland Science 2008)

