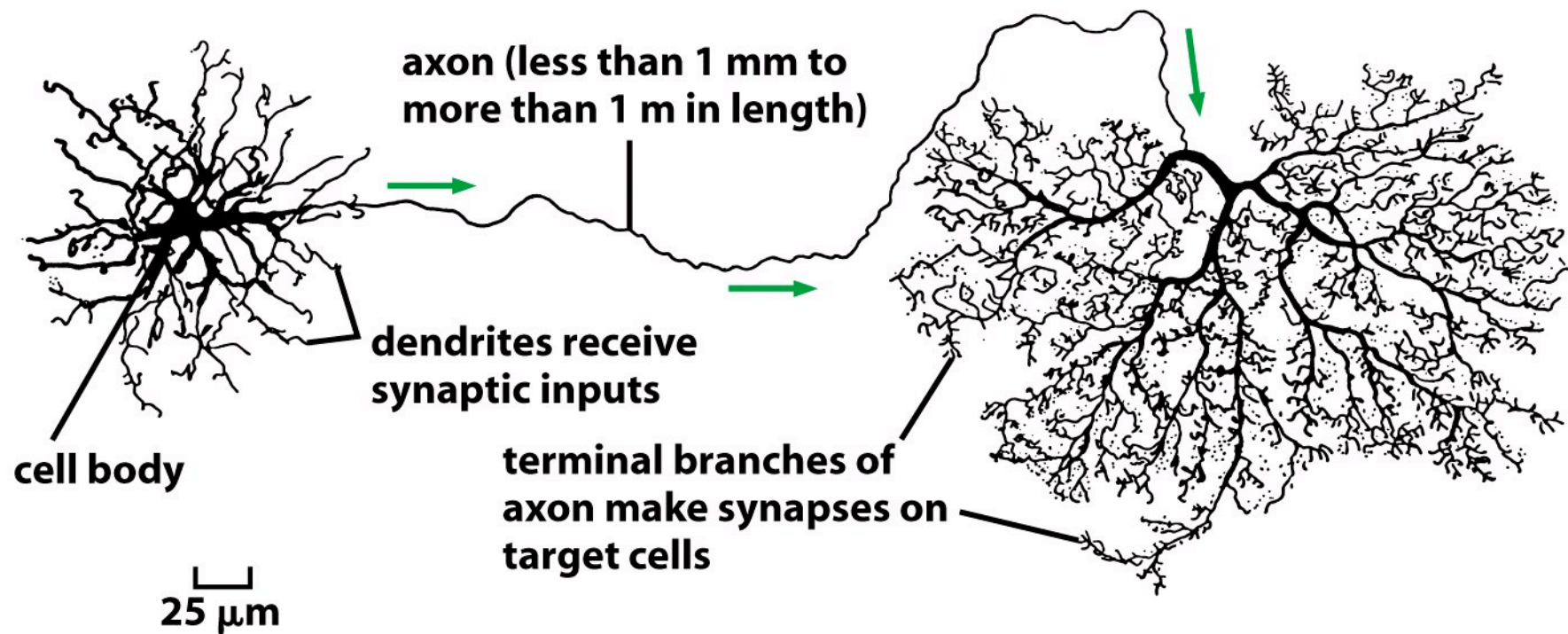


[http://www.sumanasinc.com/webcontent/  
animations/content/  
neuronal\\_development.html](http://www.sumanasinc.com/webcontent/animations/content/neuronal_development.html)

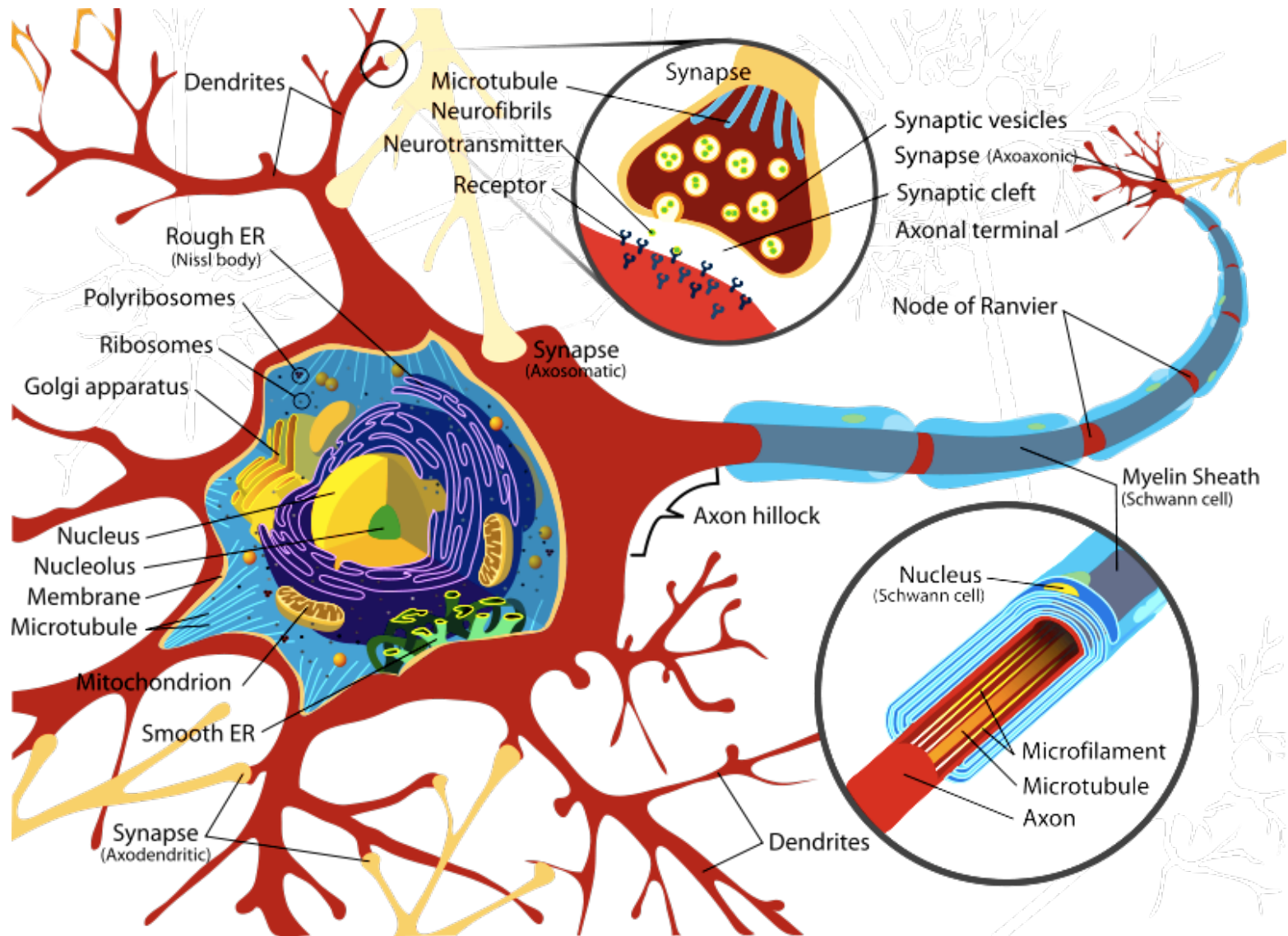
# Nervous system

- Different classes of neurons
- Glial cells
- Sensory cells
- Muscles

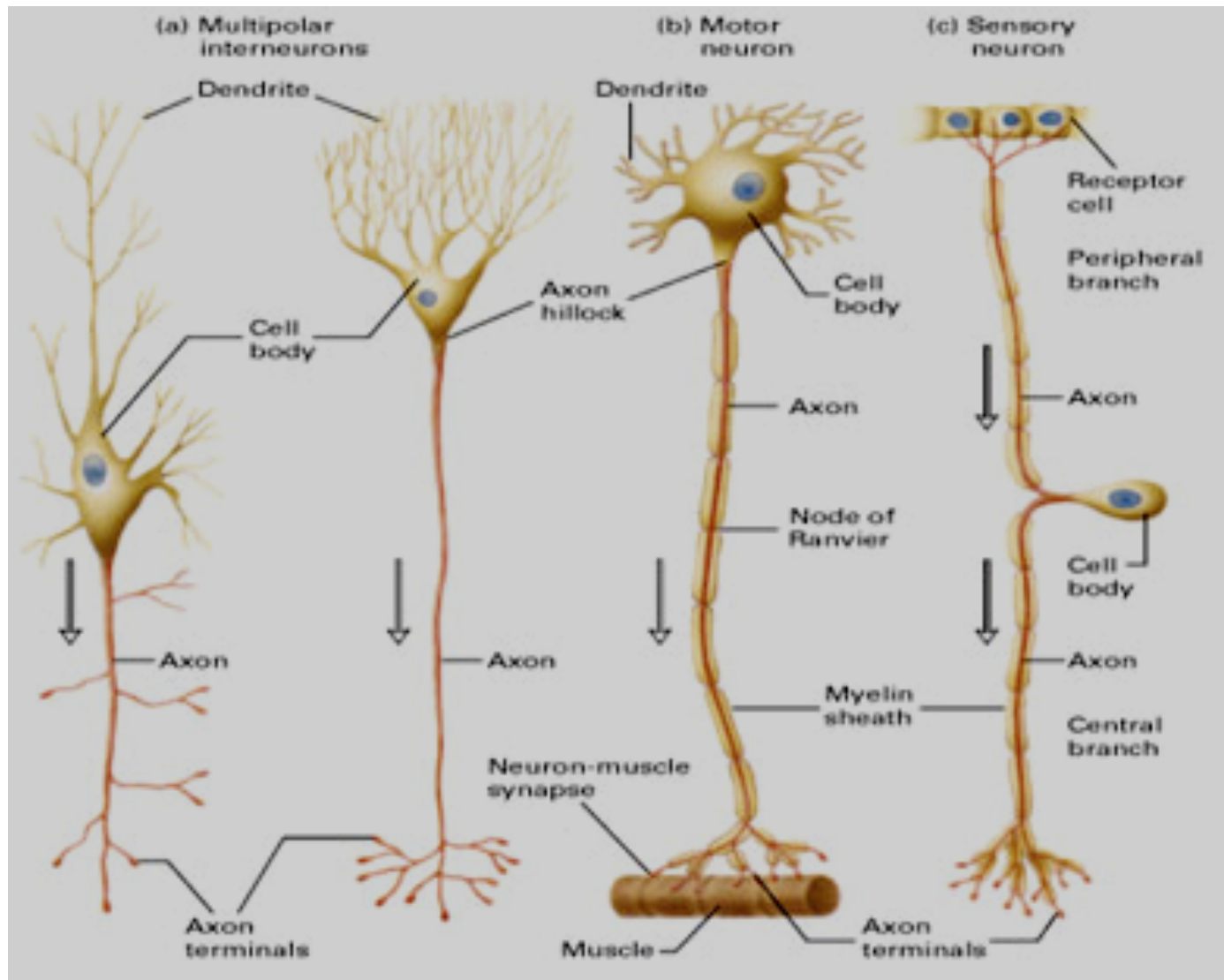


**Figure 22–93 A typical neuron of a vertebrate. The arrows indicate the direction in which signals are conveyed.** The neuron shown is from the retina of a monkey. The longest and largest neurons in a human extend for about 1 million mm and have an axon diameter of 15 mm. (Drawing of neuron from B.B. Boycott, in *Essays on the Nervous System* [R. Bellairs and E.G. Gray, eds.]. Oxford, UK: Clarendon Press, 1974.)

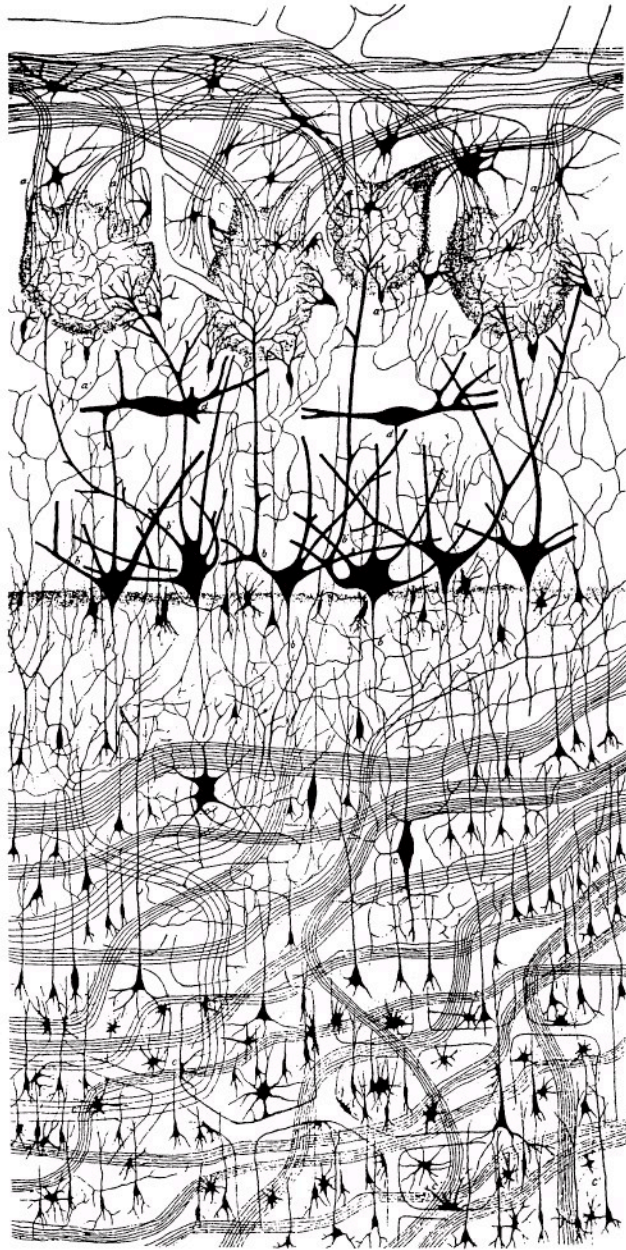
# Structure of a neuron



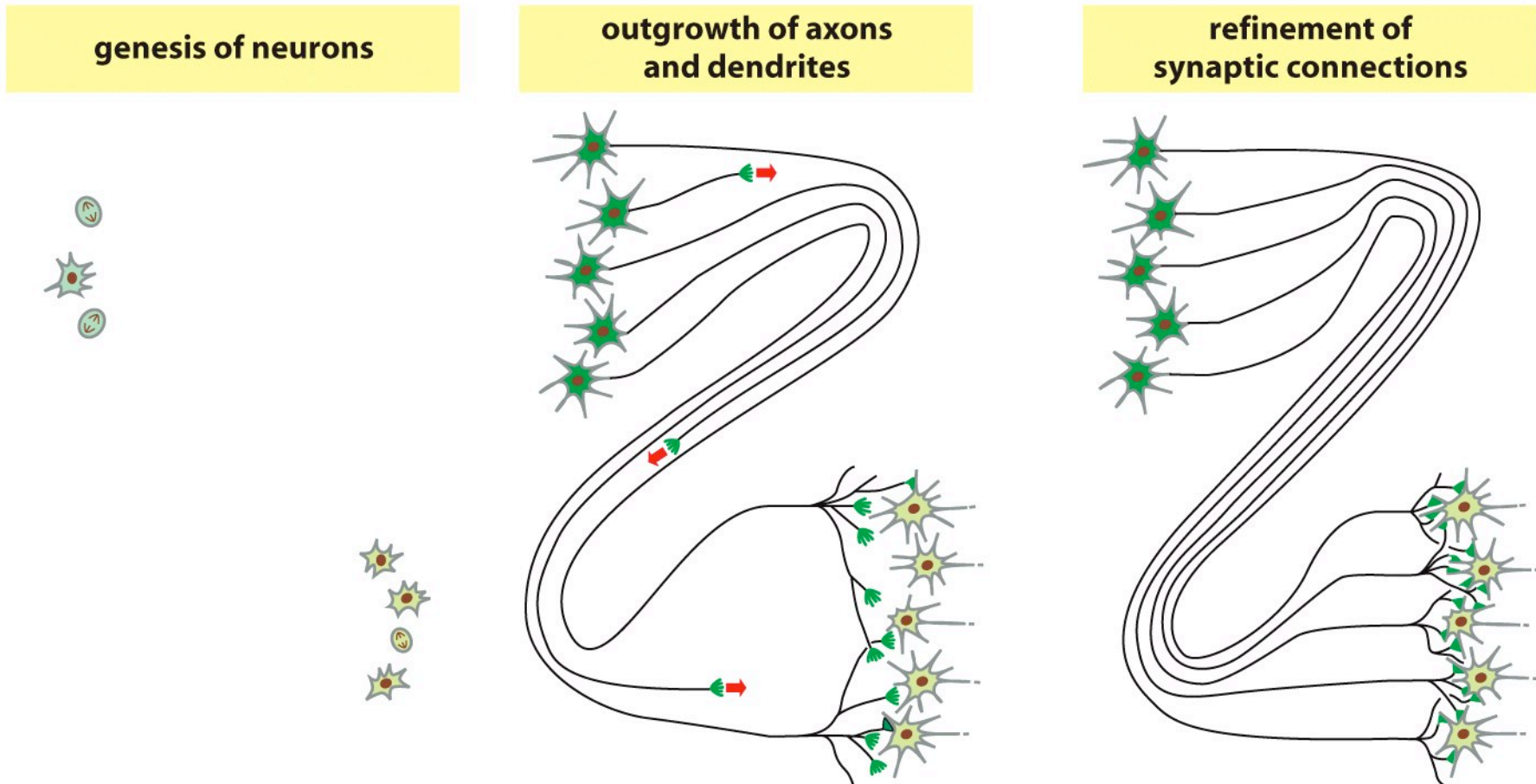
# Different types of neurons







**Figure 22–94 The complex organization of nerve cell connections.** This drawing depicts a section through a small part of a mammalian brain—the olfactory bulb of a dog, stained by the Golgi technique. The black objects are neurons; the thin lines are axons and dendrites, through which the various sets of neurons are interconnected according to precise rules. (From C. Golgi, *Riv. sper. freniat. Reggio-Emilia* 1:405-425, 1875; reproduced in M. Jacobson, *Developmental Neurobiology*)



**The three phases of neural Development.**

Neurons are almost always produced in association with **glial cells**, which provide a supporting framework and create an enclosed, protected environment in which the neurons can perform their functions.

## refinement of synaptic connections

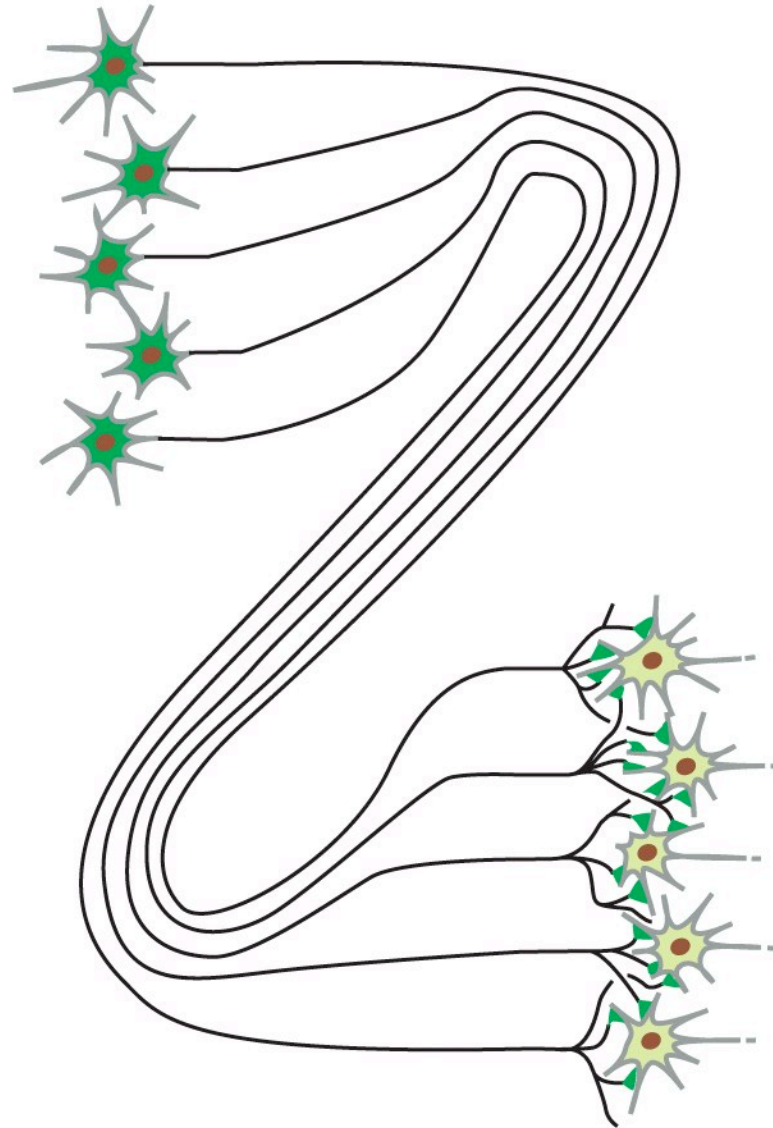
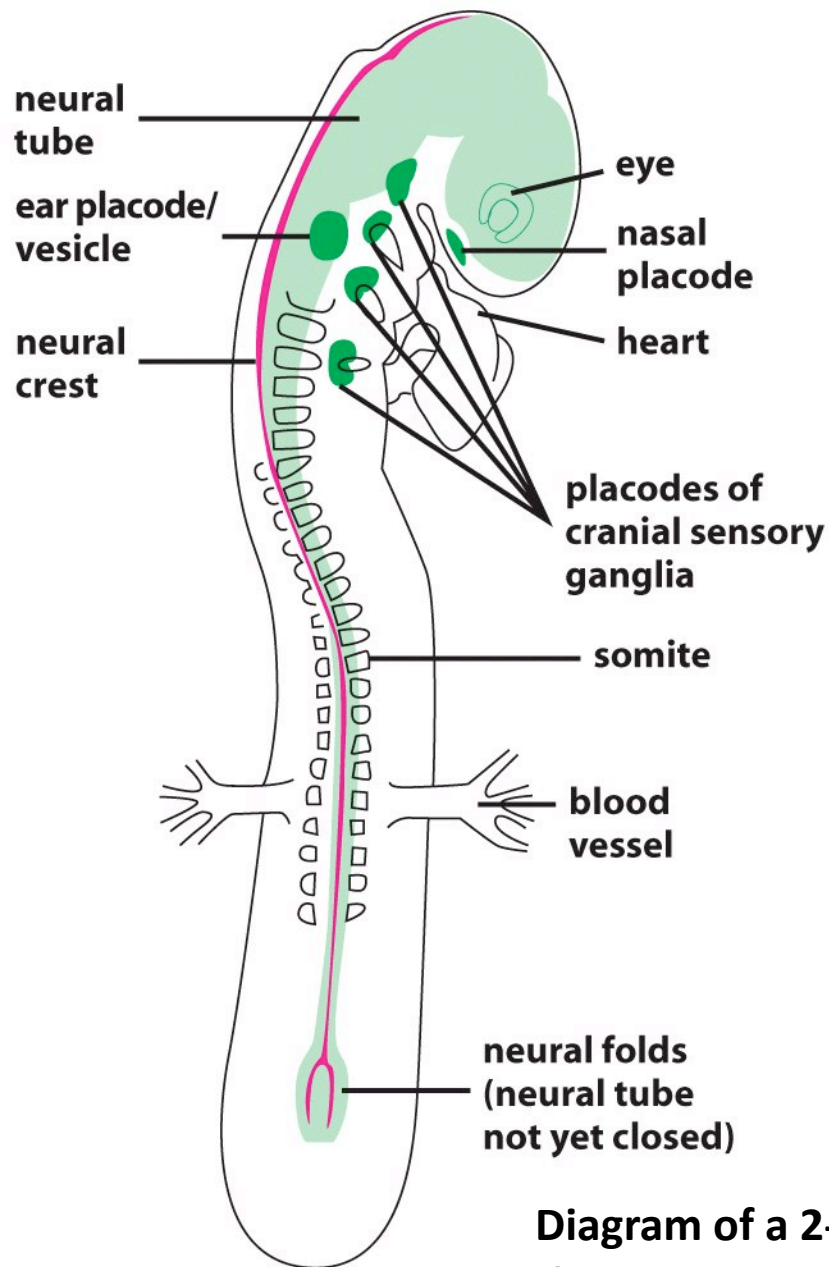


Figure 22-95 (part 3 of 3) *Molecular Biology of the Cell* (© Garland Science 2008)





Neurons and glial cells of the **central nervous system** (including the spinal cord, the brain, and the retina of the eye) derive from the part of the ectoderm that rolls up to form the **neural tube**.

**Peripheral nervous system** derive mainly from the neural crest

**Diagram of a 2-day chick embryo, showing the origins of the nervous system.**

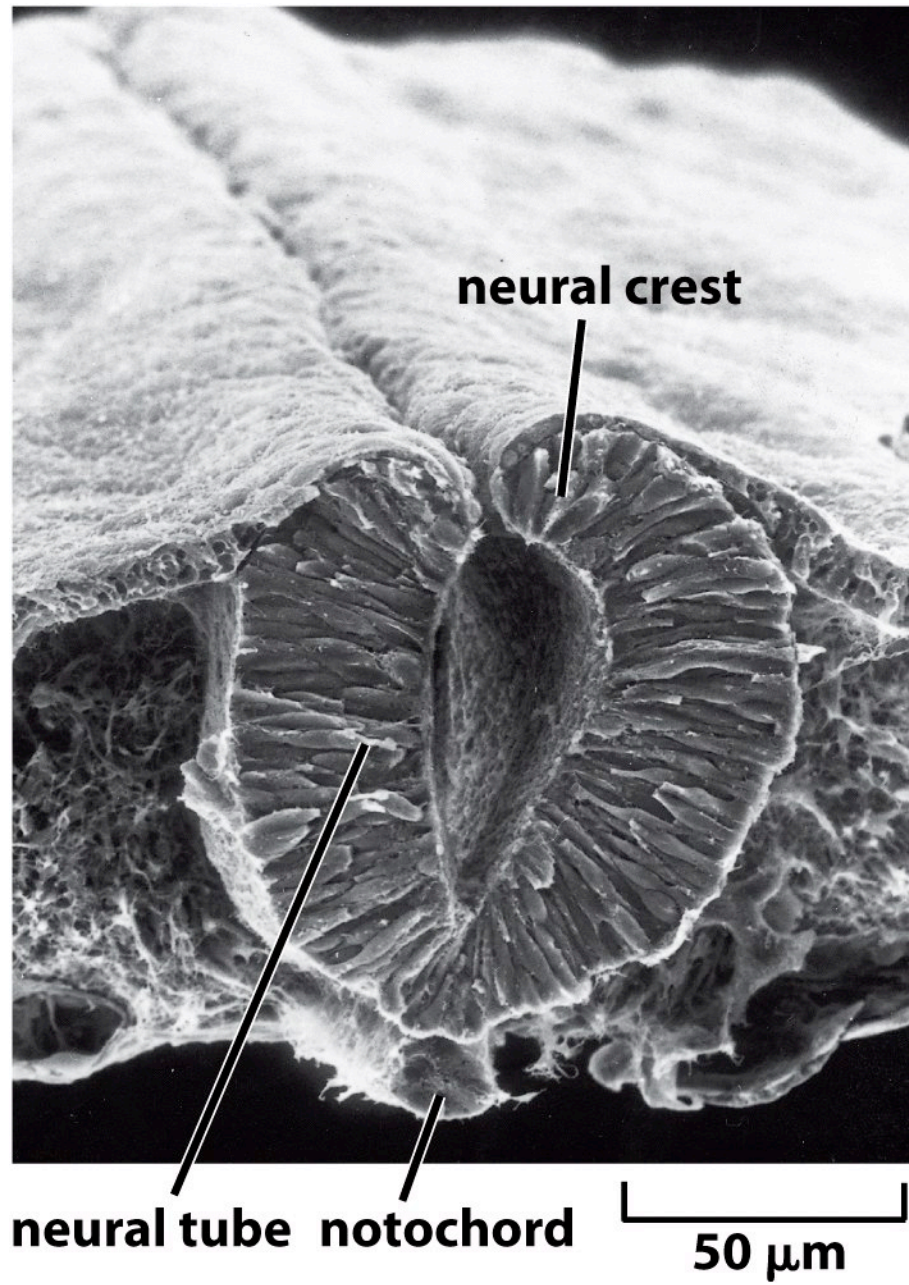
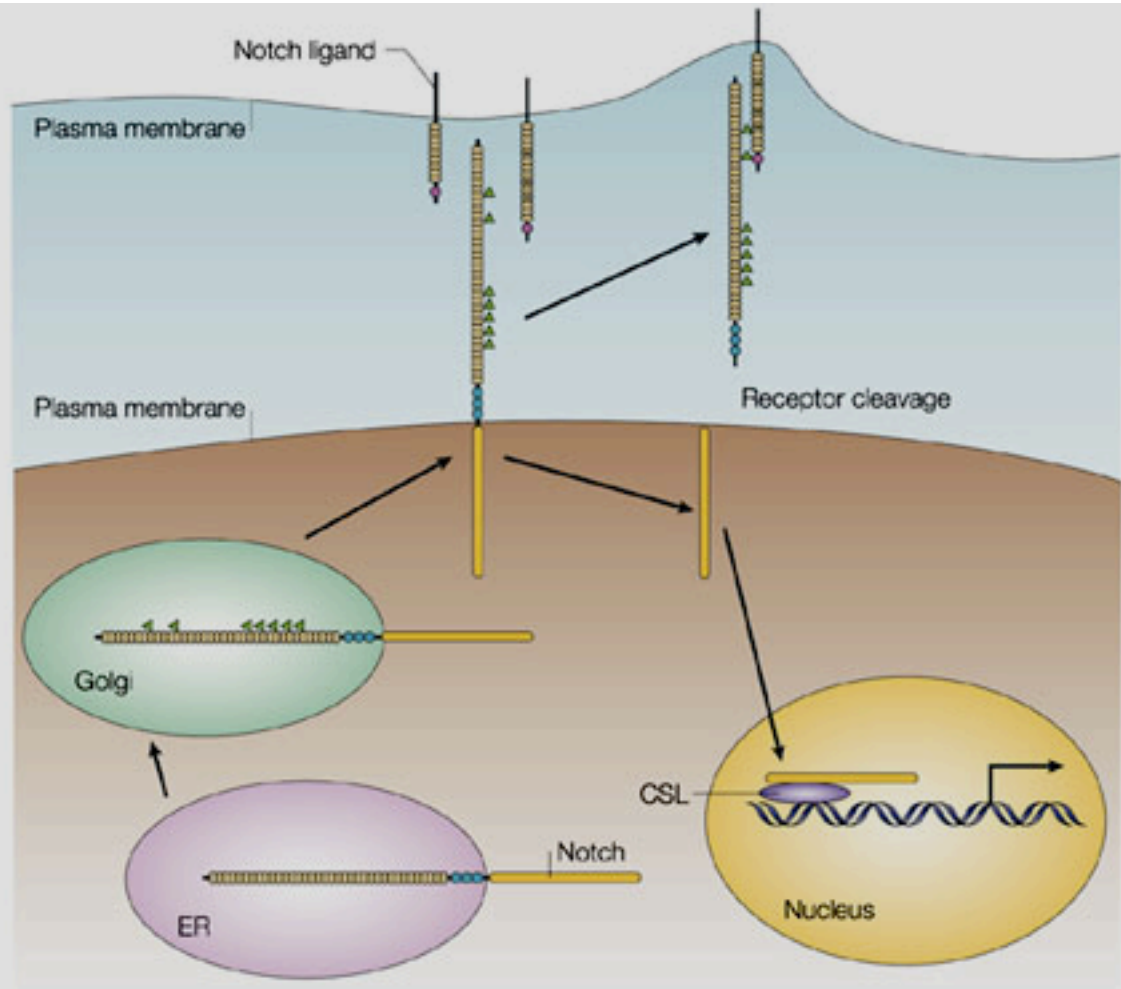


Figure 22-97 *Molecular Biology of the Cell* (© Garland Science 2008)

# Neuronal development

- Neuronal epithelium
- Progenitors of neurons and glial cells
- Delta-notch signaling critical for this development



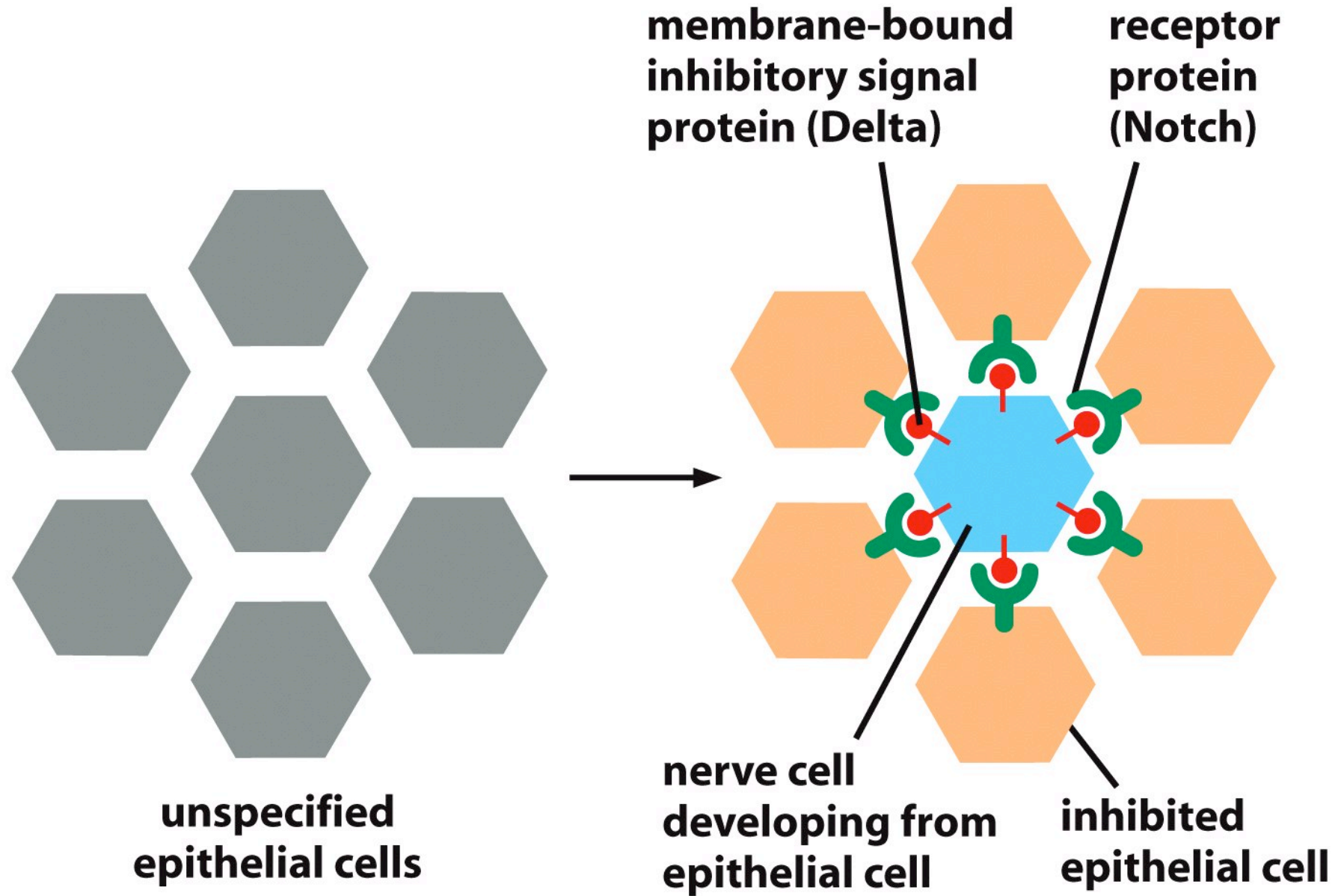


Figure 15-75 *Molecular Biology of the Cell* (© Garland Science 2008)



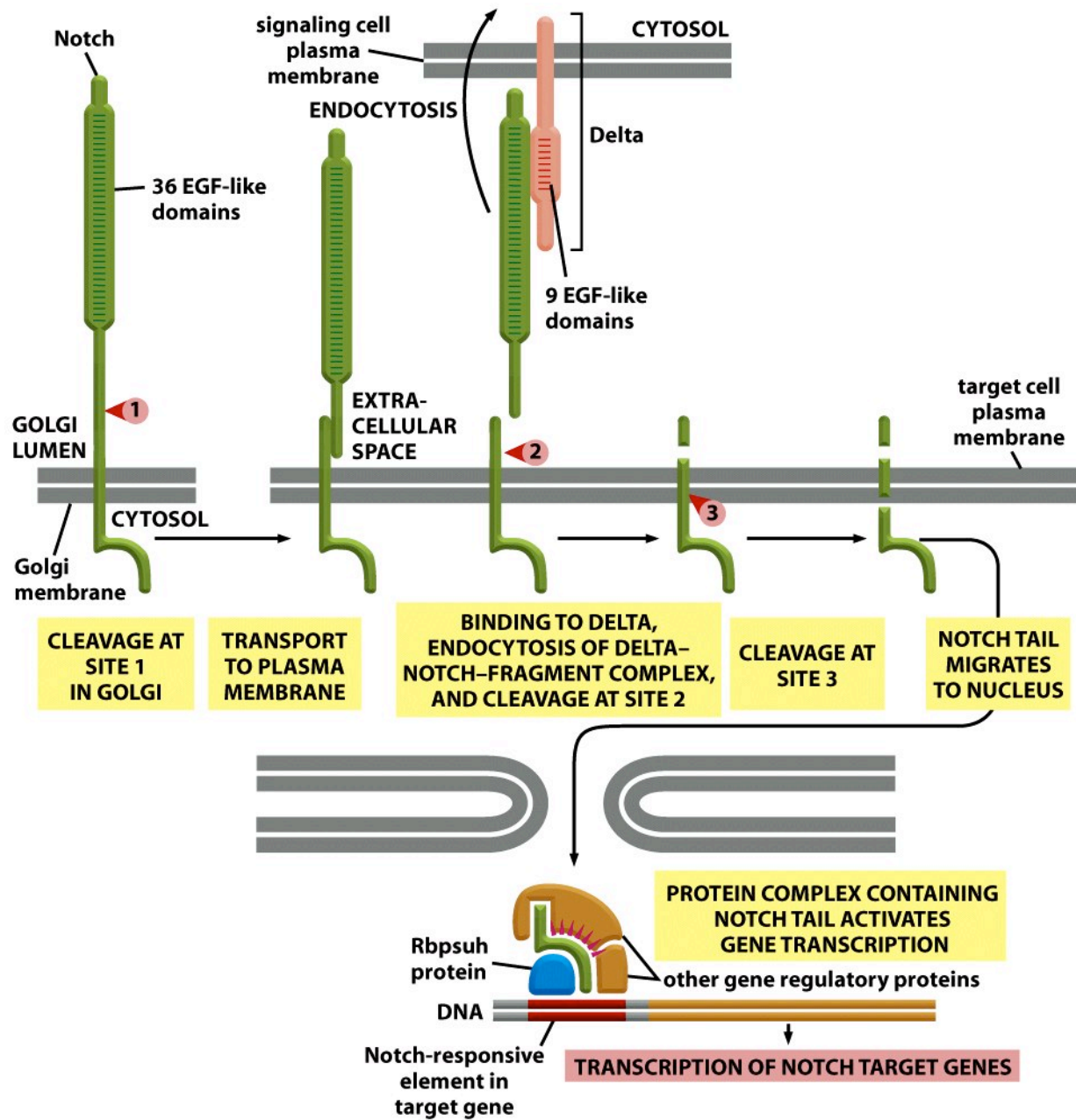


Figure 15-76 *Molecular Biology of the Cell* (© Garland Science 2008)

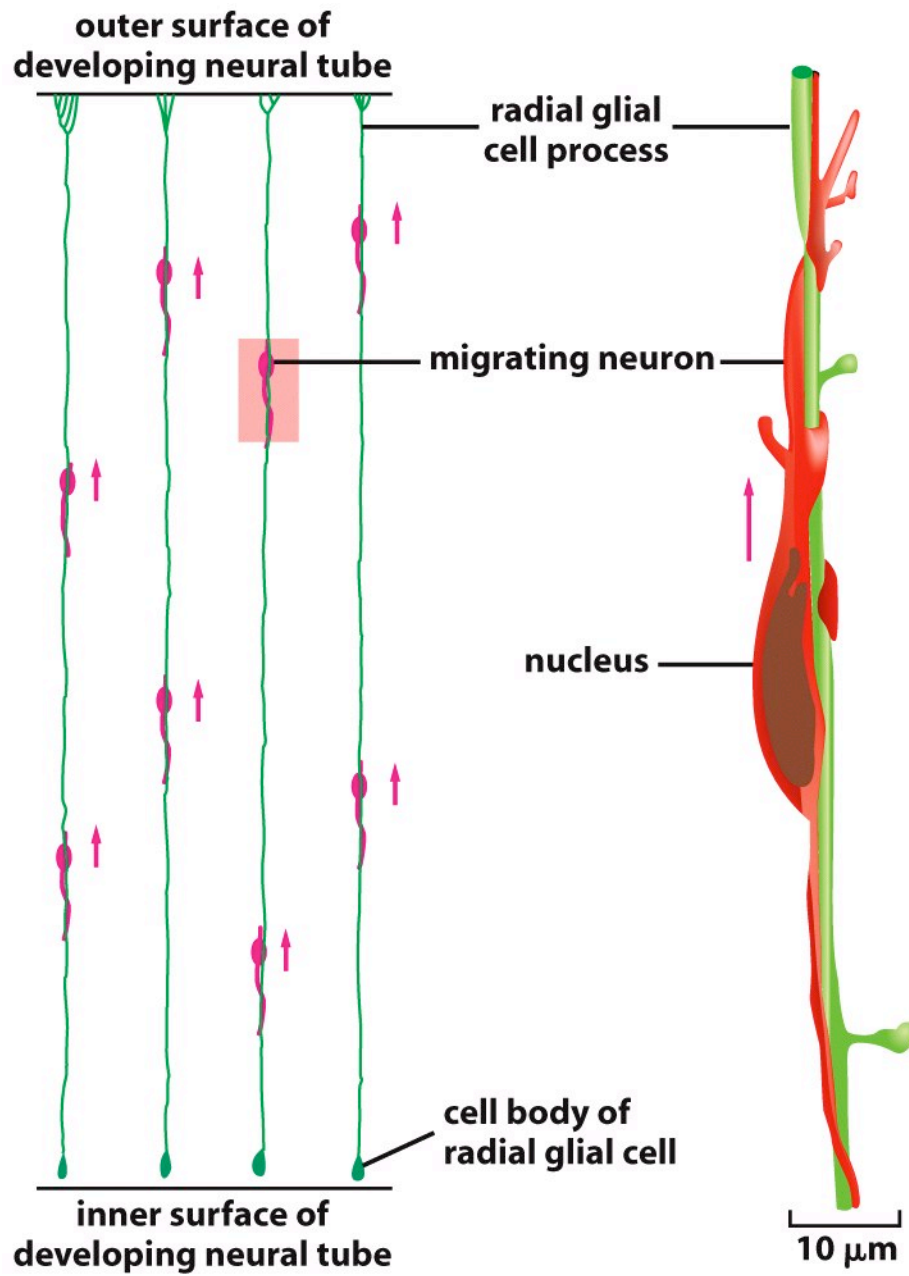


Figure 22-98 *Molecular Biology of the Cell* (© Garland Science 2008)

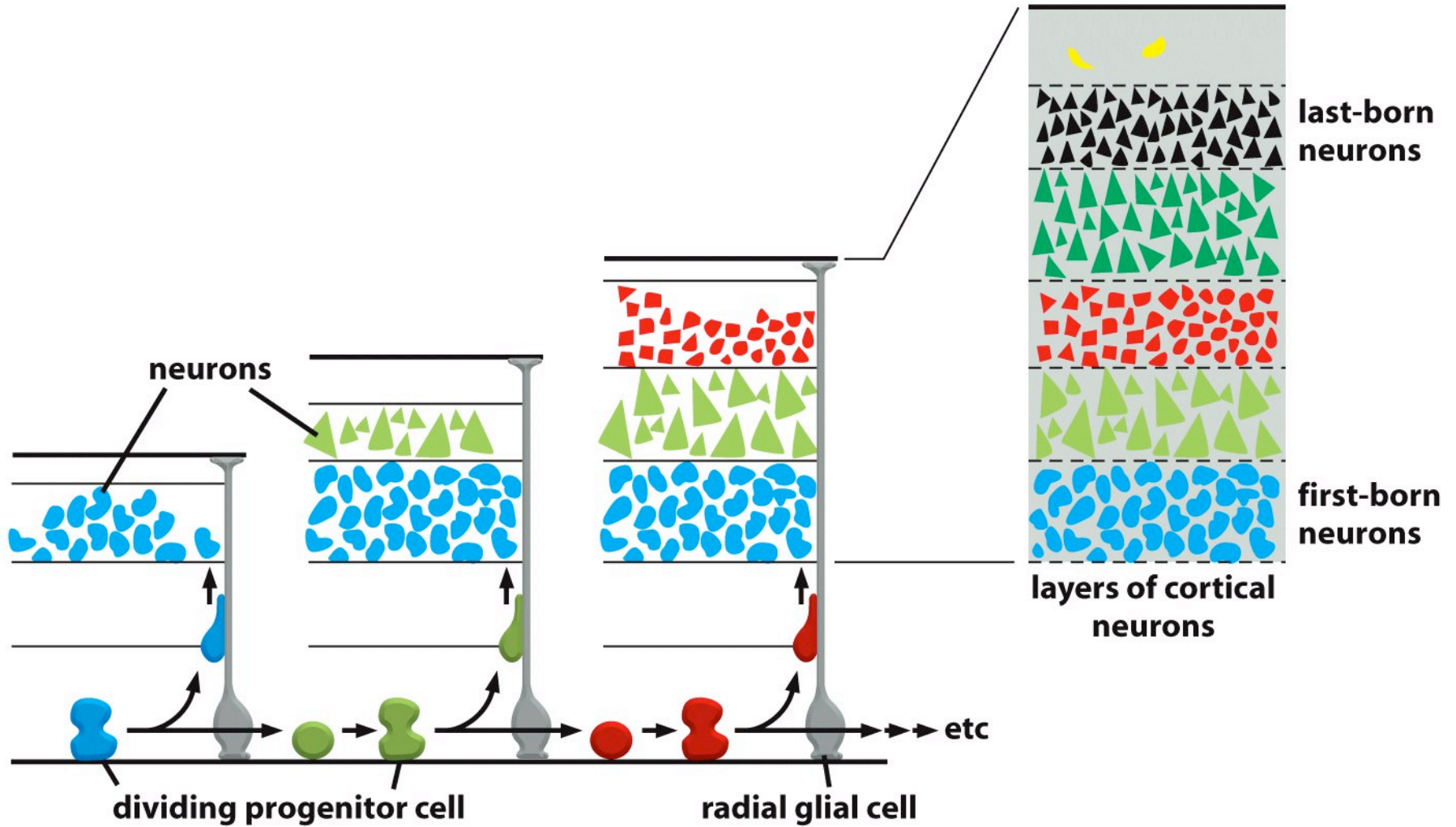
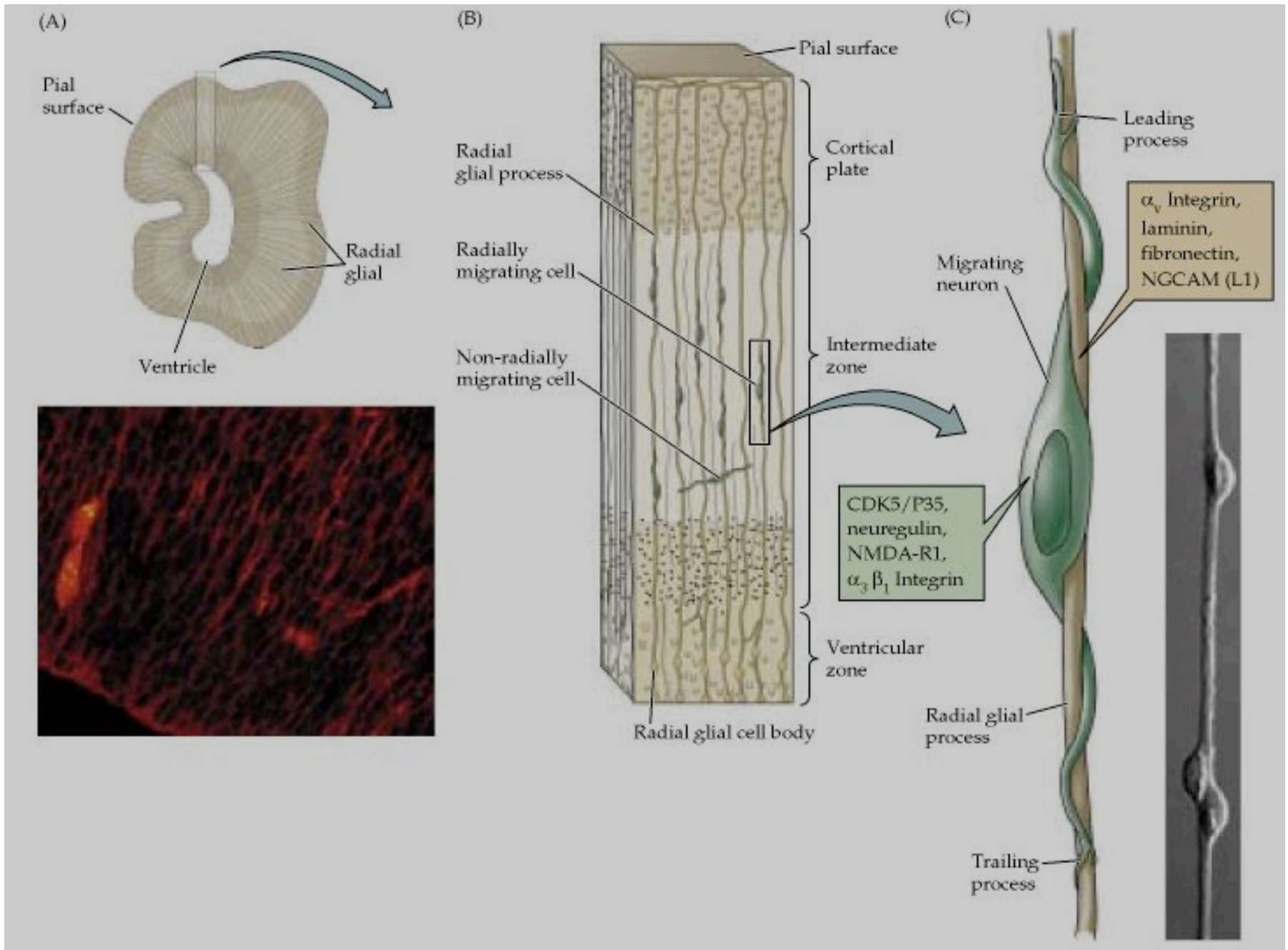
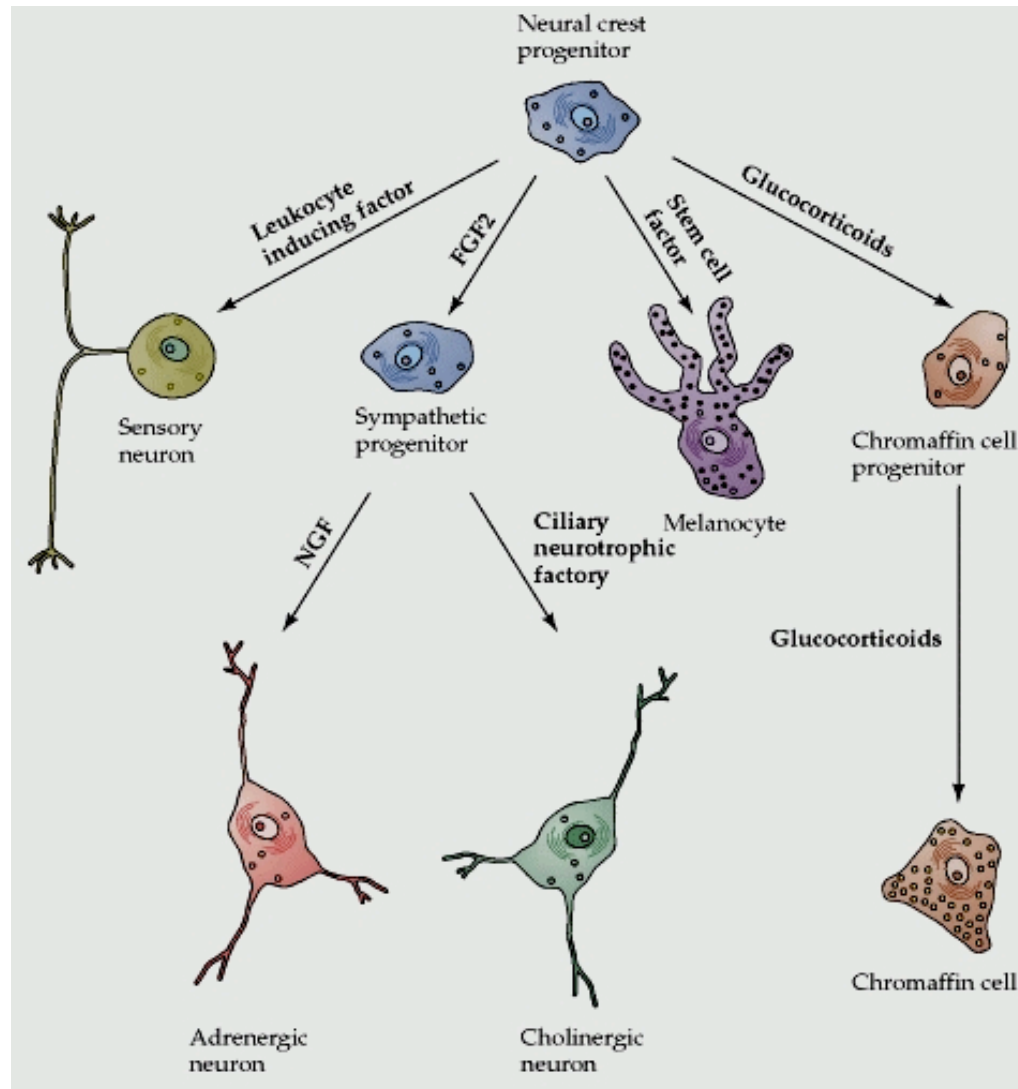


Figure 22-99 *Molecular Biology of the Cell* (© Garland Science 2008)



# Cell signaling during migration



<http://www.ncbi.nlm.nih.gov/>



# Gene expression and neuronal fate

- Motor neurons – express *Islet/Lim* family of *hox* genes
- Expression of different members of this family of transcription factors results specific motor neurons.
- If the pattern of gene expression is artificially altered, the neurons project to different target muscles.

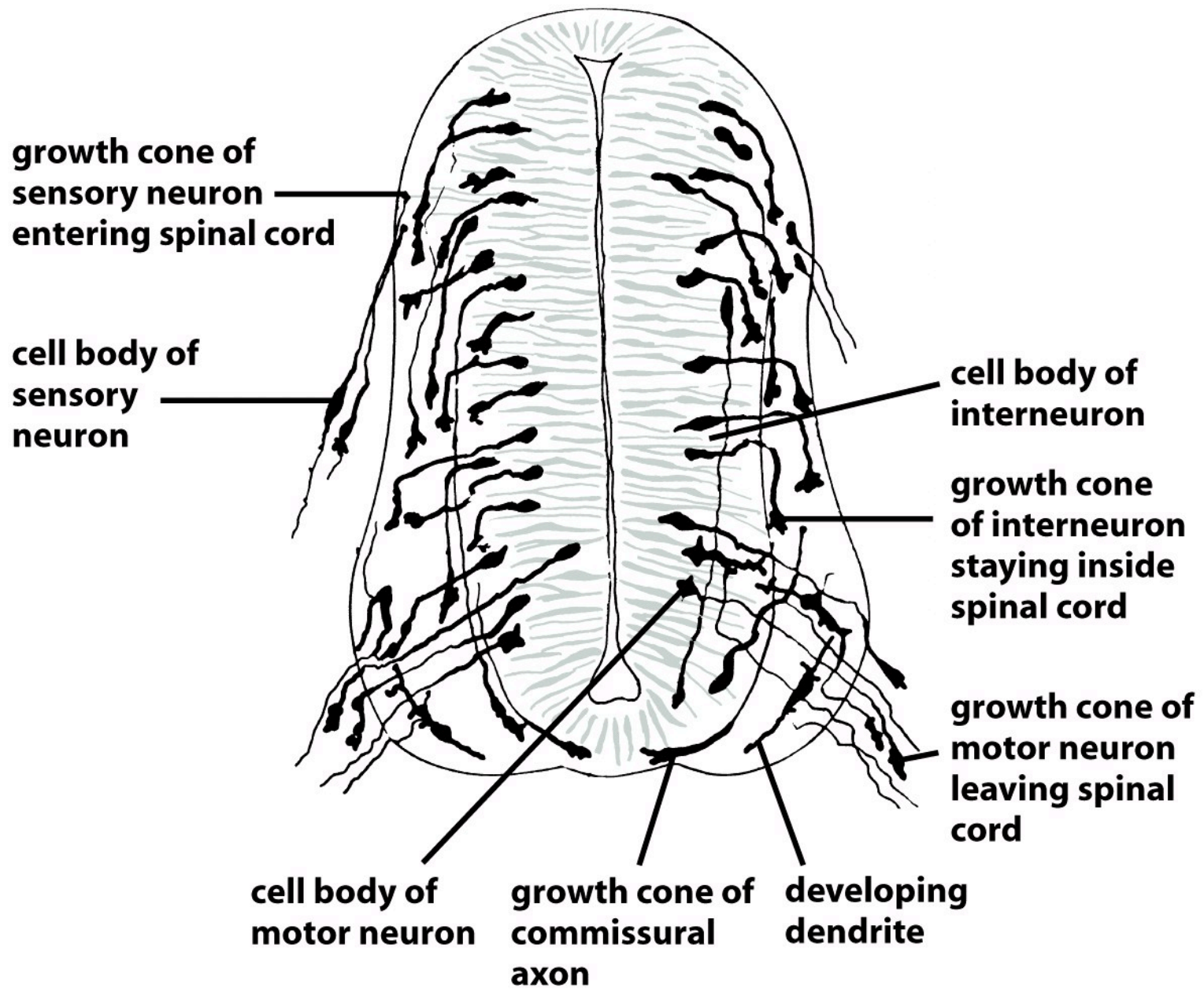
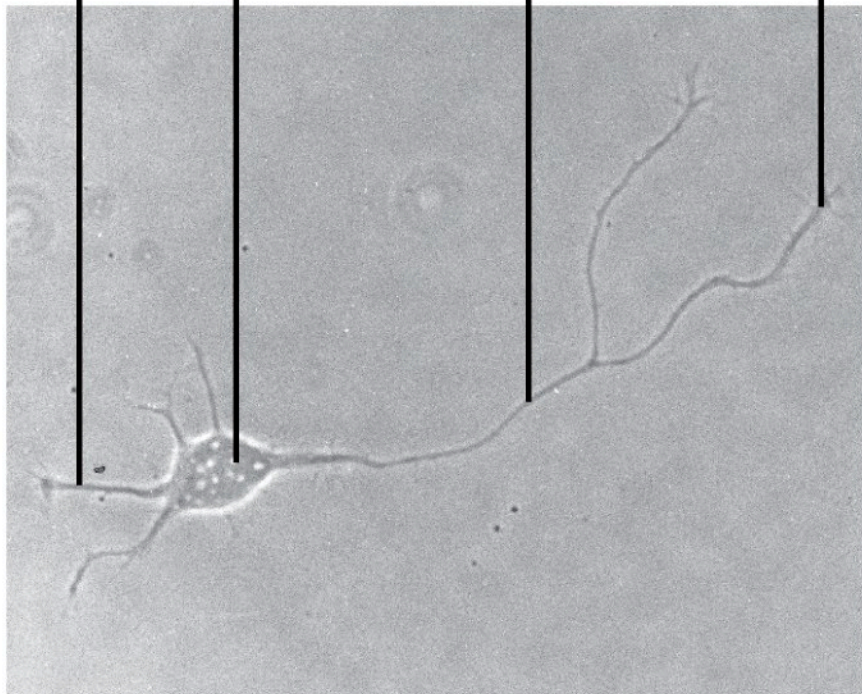


Figure 22-100 *Molecular Biology of the Cell* (© Garland Science 2008)

dendrite cell body axon growth cone

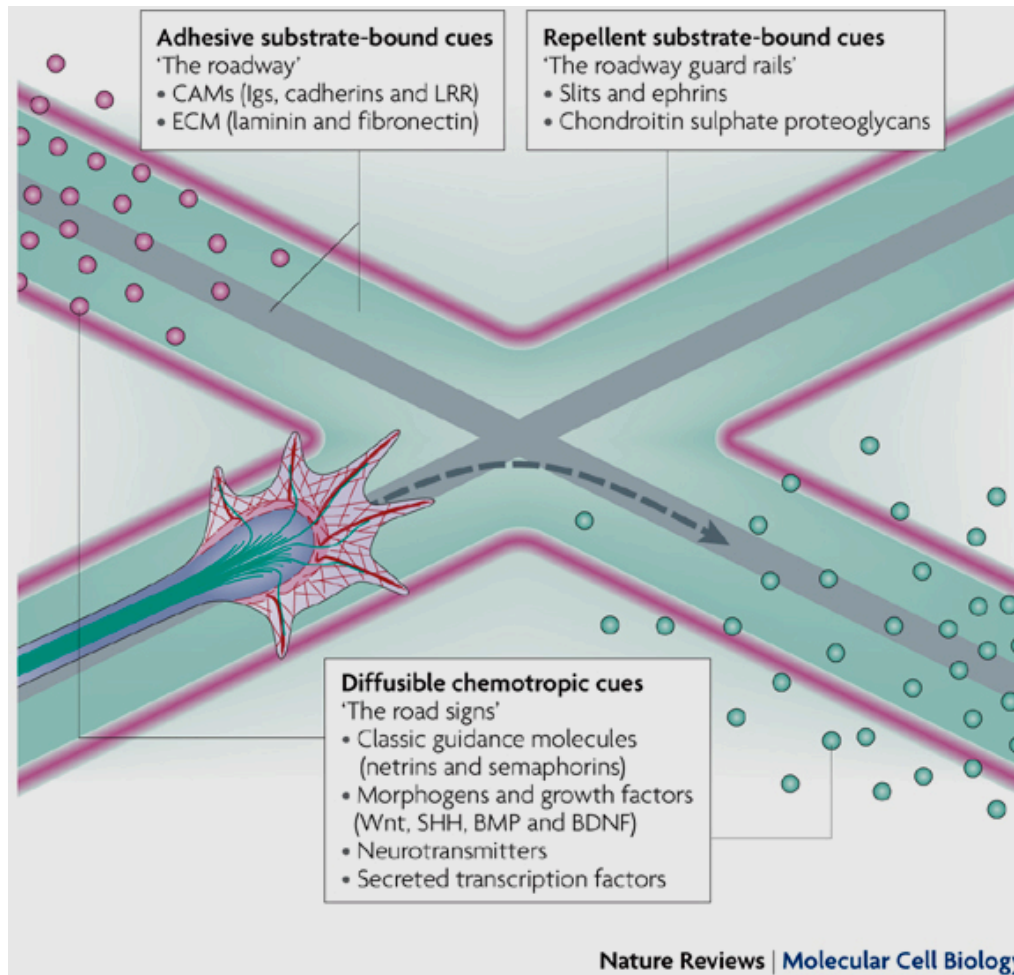


(A)



(B)

10  $\mu\text{m}$

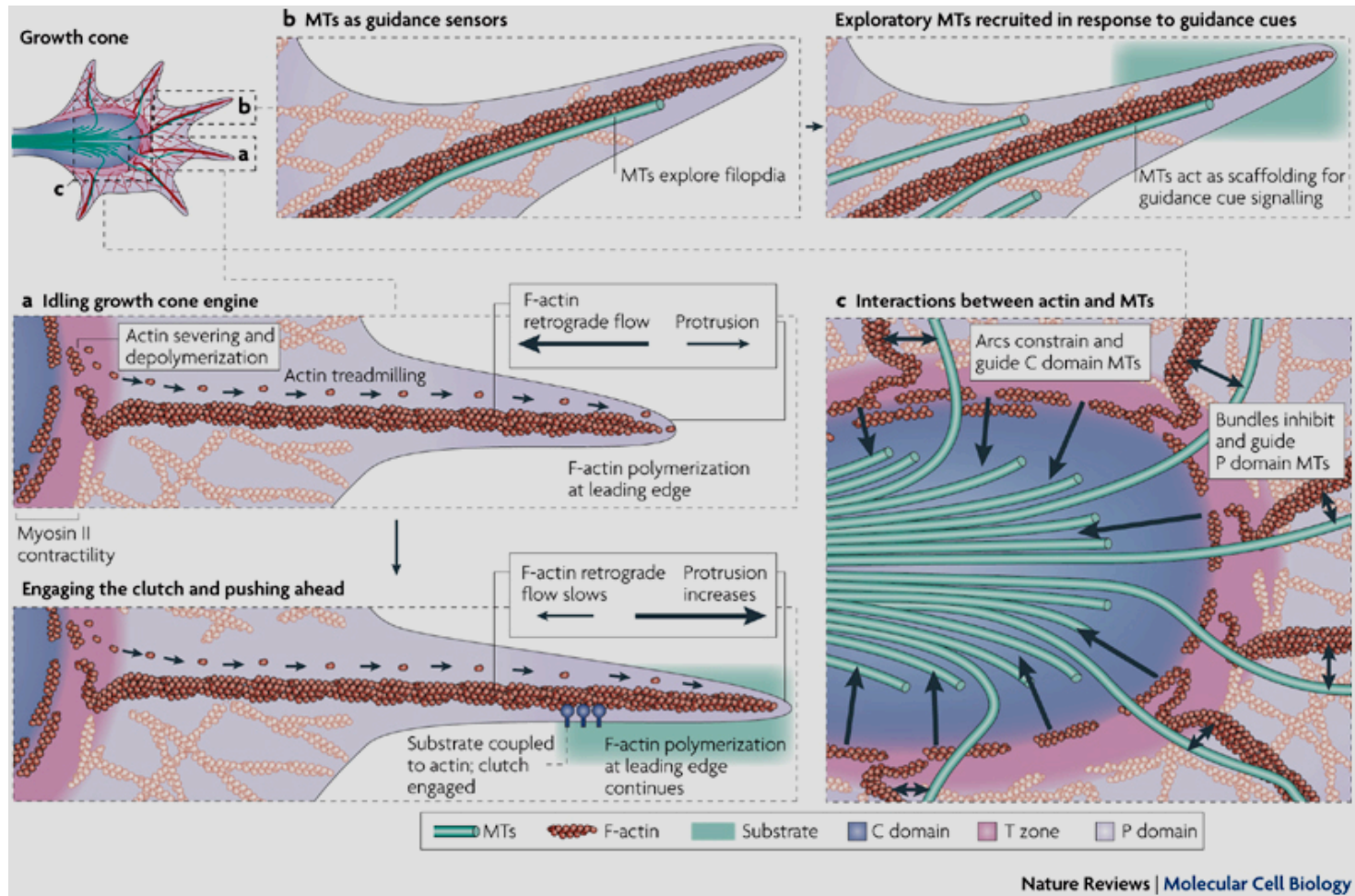




# Environmental cues the direct growth cone

- -Adhesive molecules like transmembrane cell adhesion molecules (CAMs)
- Complex extracellular matrix (ECM) like laminin and fibronectin.
- Anti-adhesive surface-bound molecules such as slits, ephrins and chondroitin sulphate proteoglycans
- Diffusible chemotropic cues such as netrins and semaphorins
- Morphogens such as Wnt, sonic hedgehog (SHH) and bone morphogenetic protein (BMP)
- Growth or neurotrophic factors such as brain-derived neurotrophic factor (BDNF), and neurotransmitters





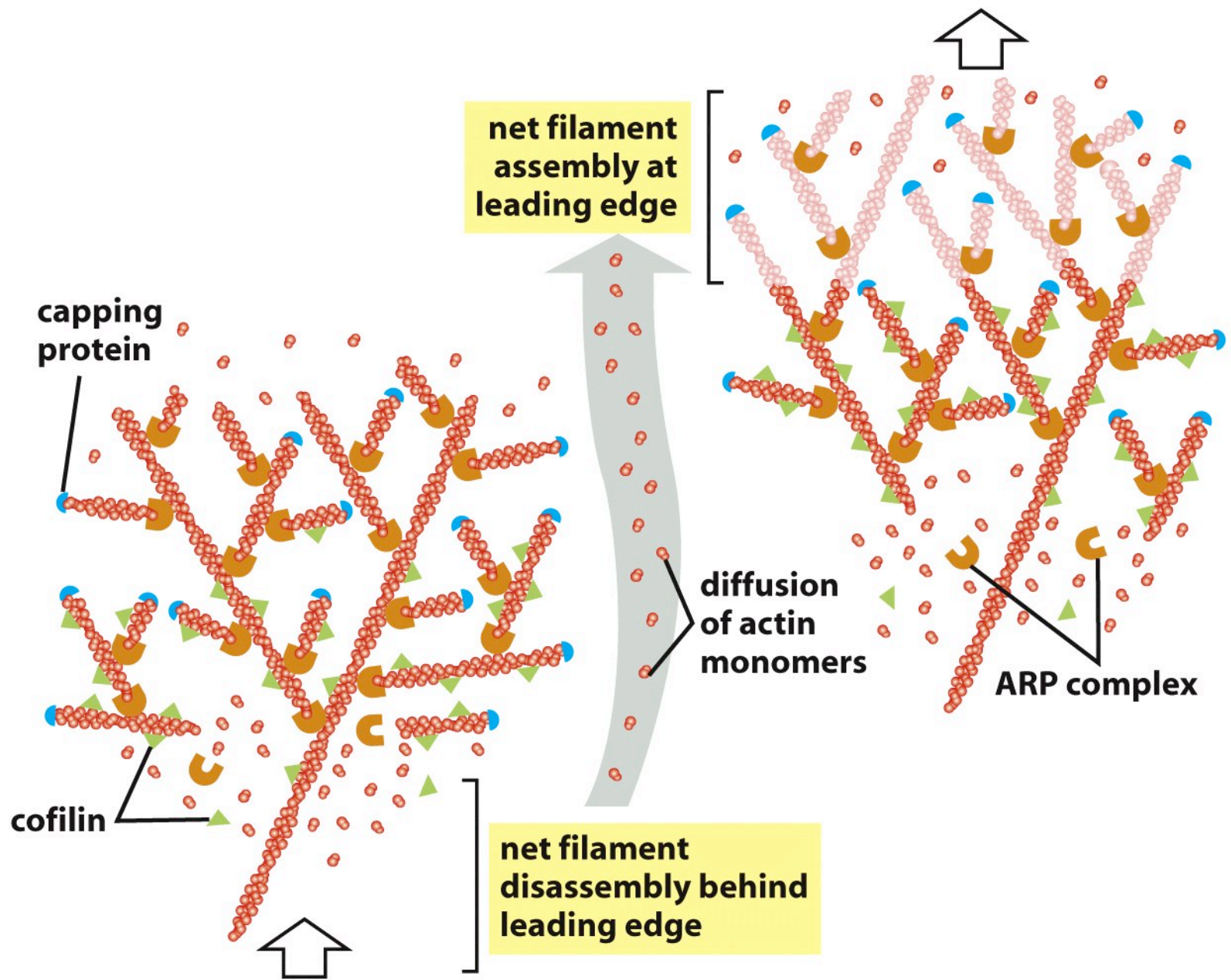
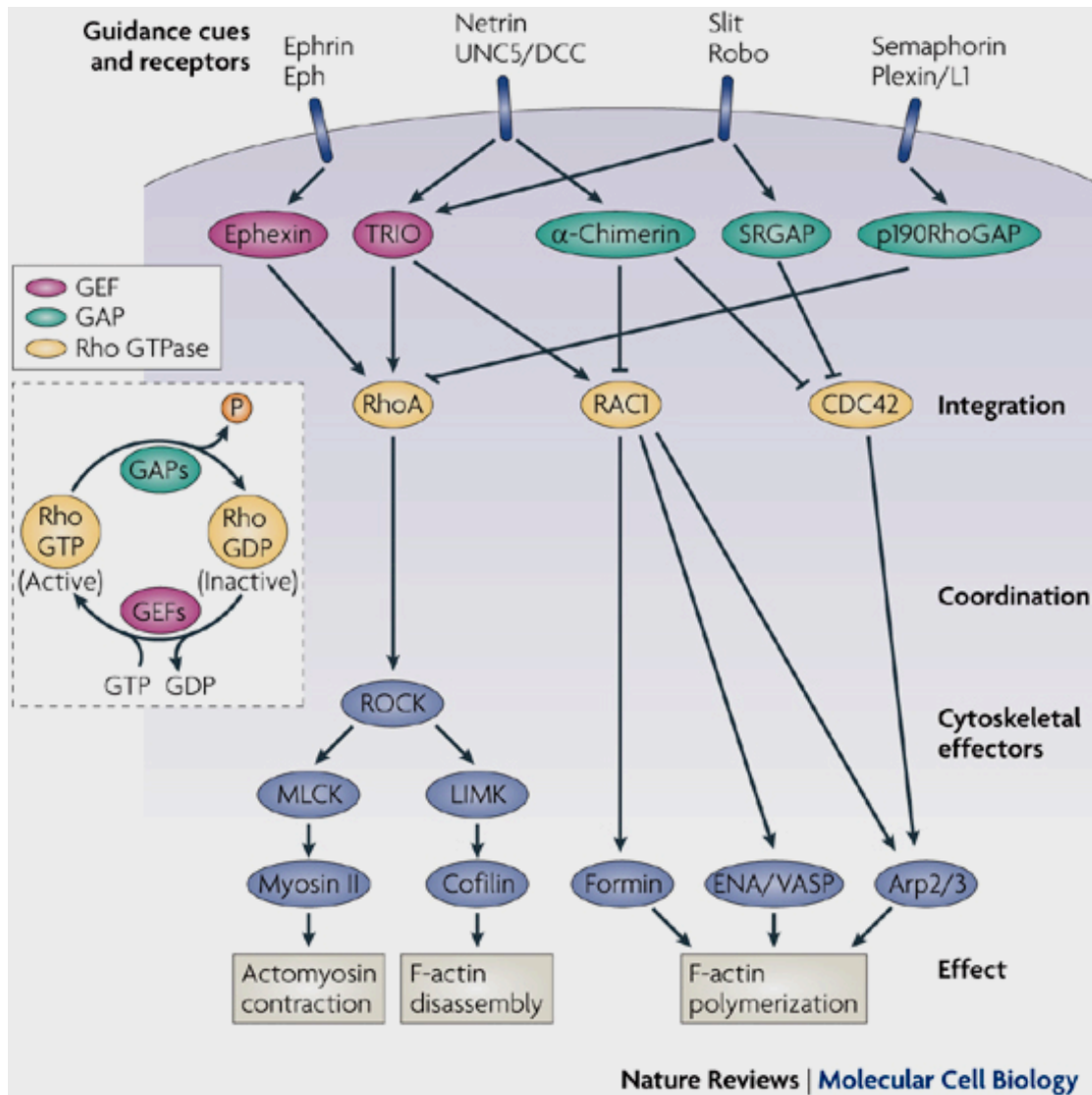


Figure 16-90 *Molecular Biology of the Cell* (© Garland Science 2008)



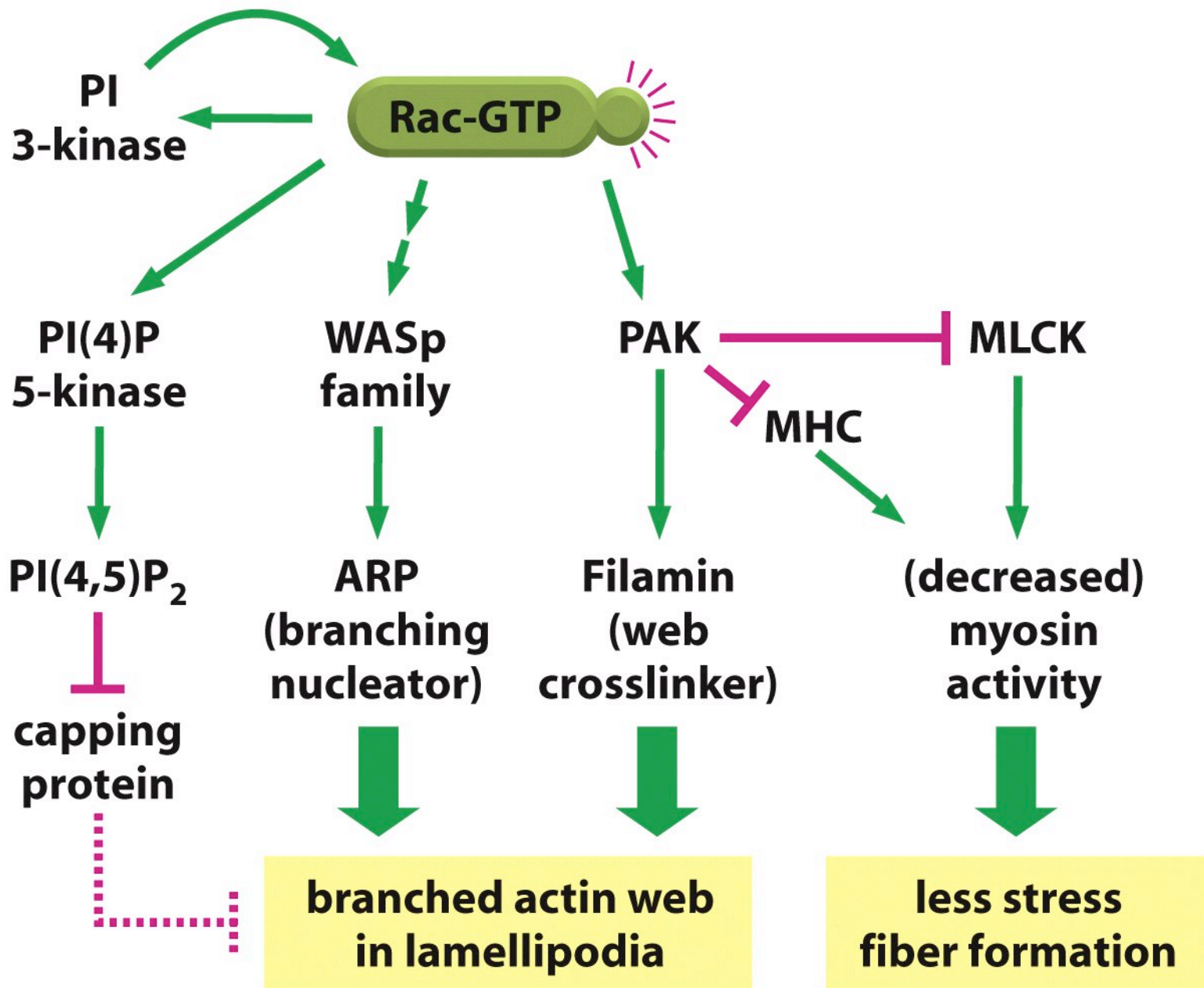


Figure 16-98a *Molecular Biology of the Cell* (© Garland Science 2008)



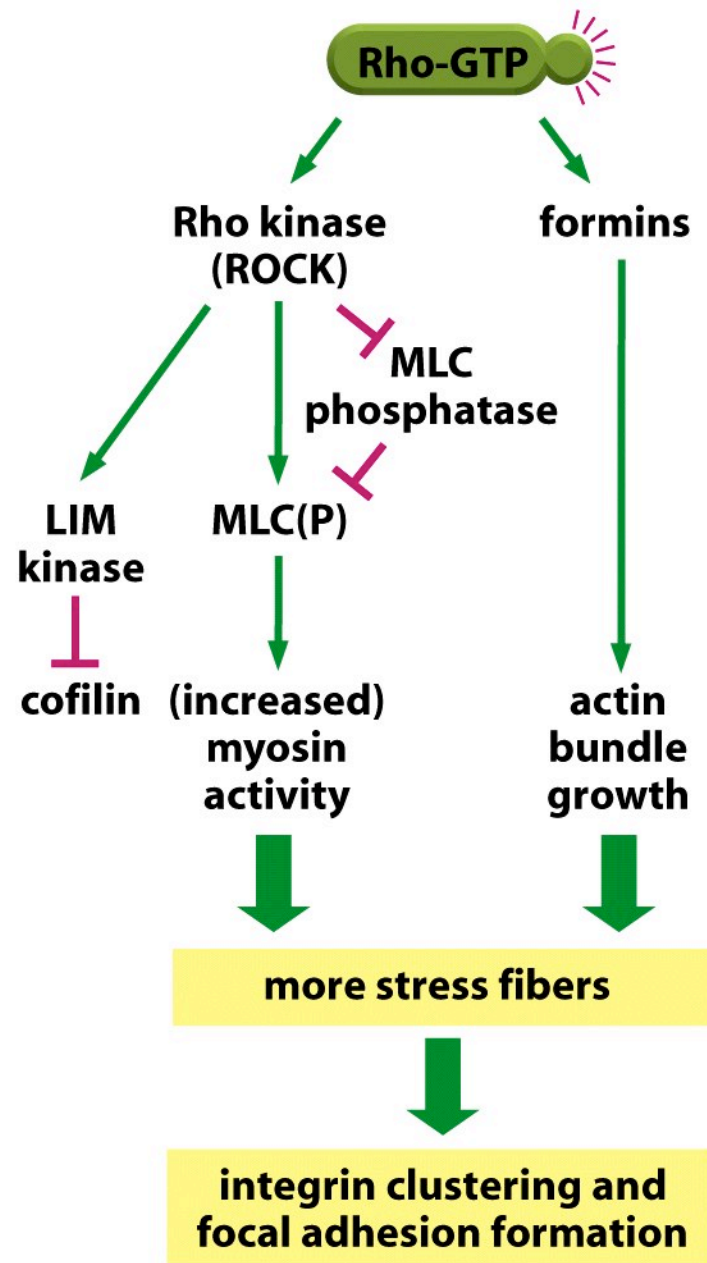


Figure 16-98b *Molecular Biology of the Cell* (© Garland Science 2008)



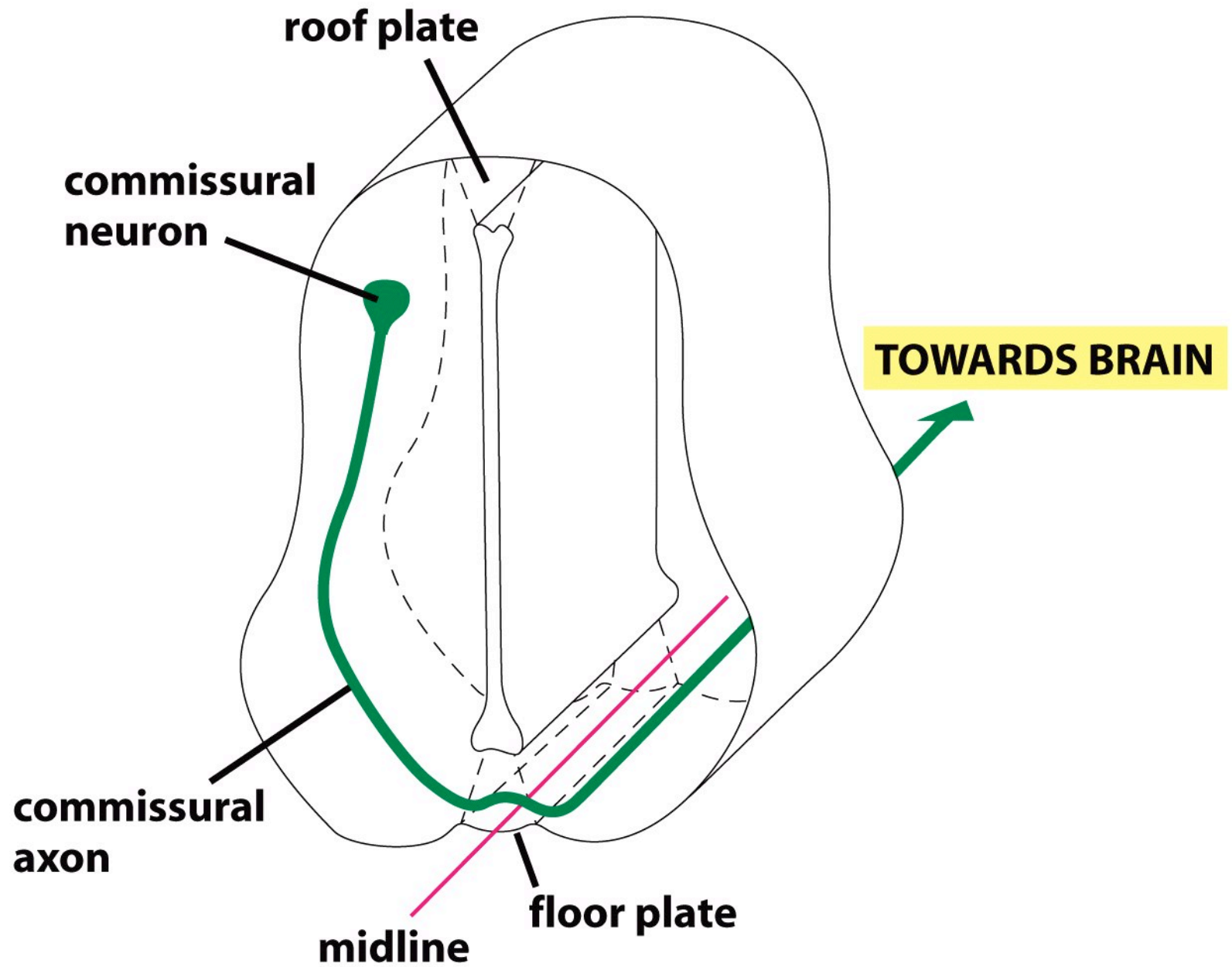


Figure 22-102a *Molecular Biology of the Cell* (© Garland Science 2008)

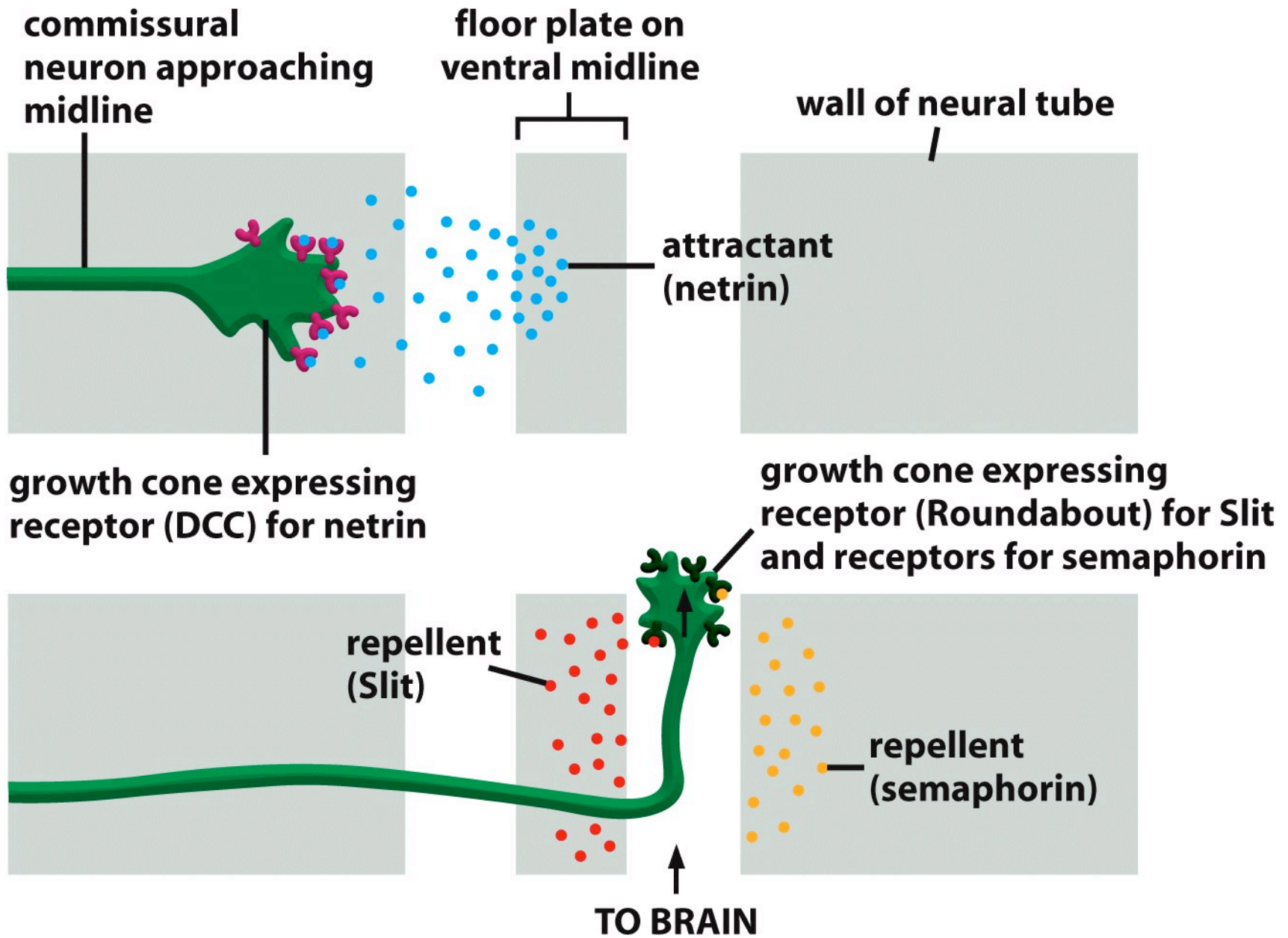
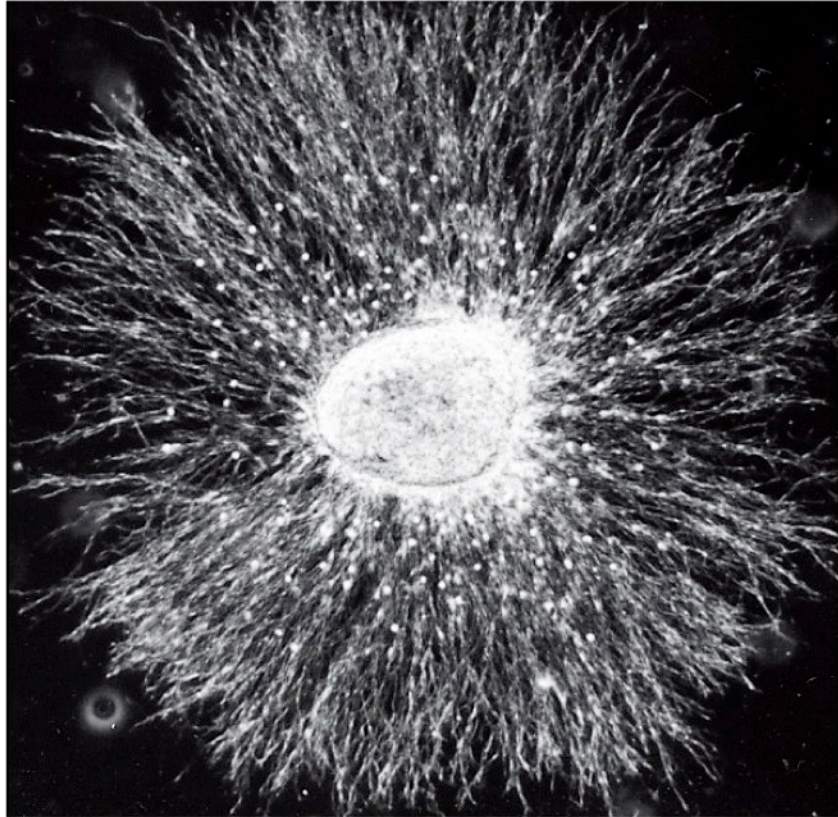
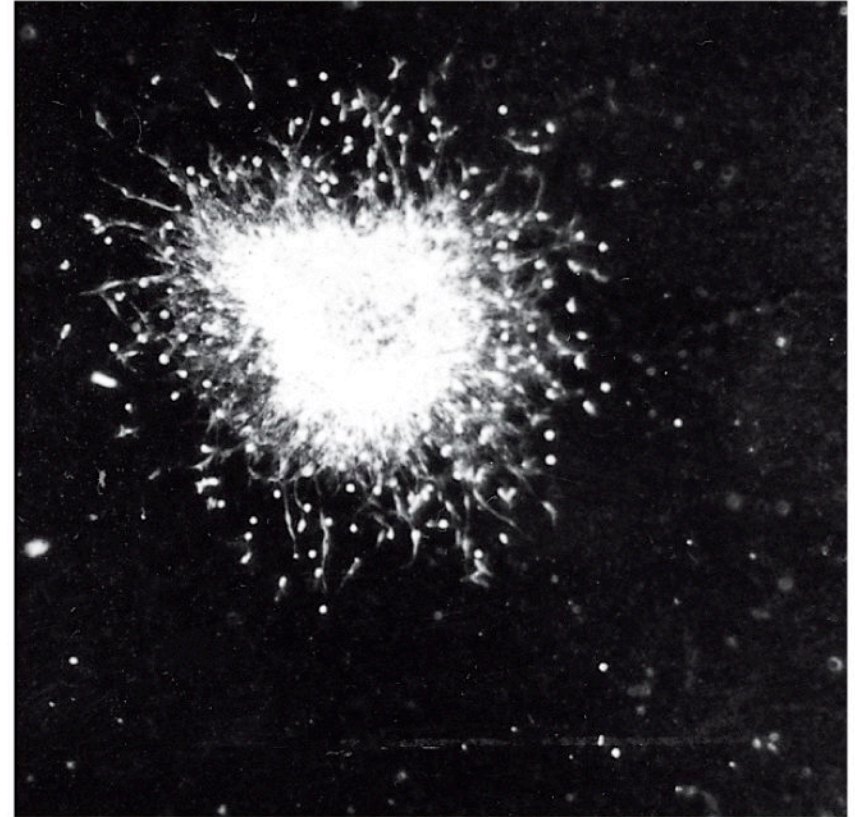


Figure 22-102b *Molecular Biology of the Cell* (© Garland Science 2008)



**NGF**



**control**