BMD ENG 301Quantitative Systems Physiology (Nervous System)

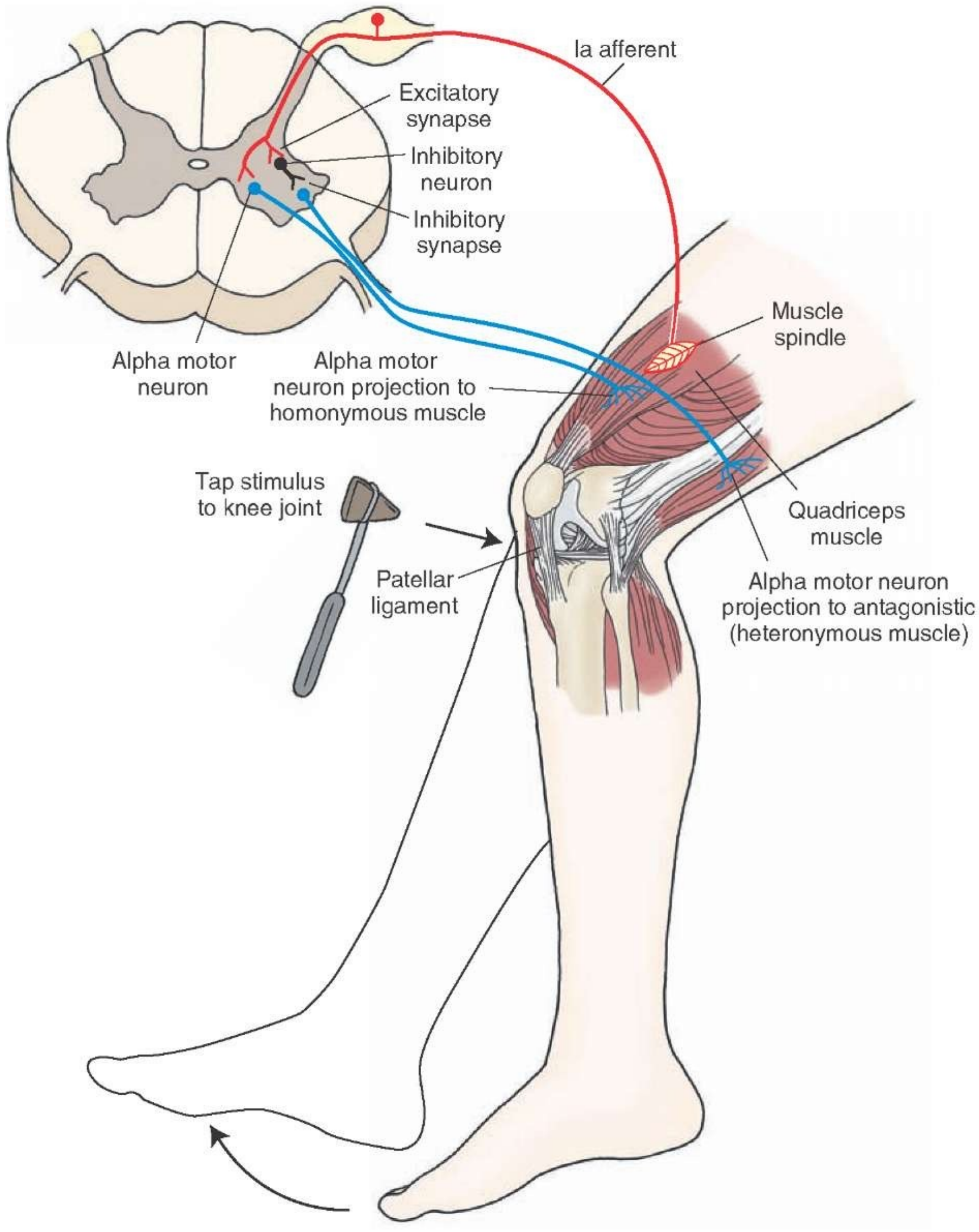
Lecture 15: Neural Circuits
2022_v1

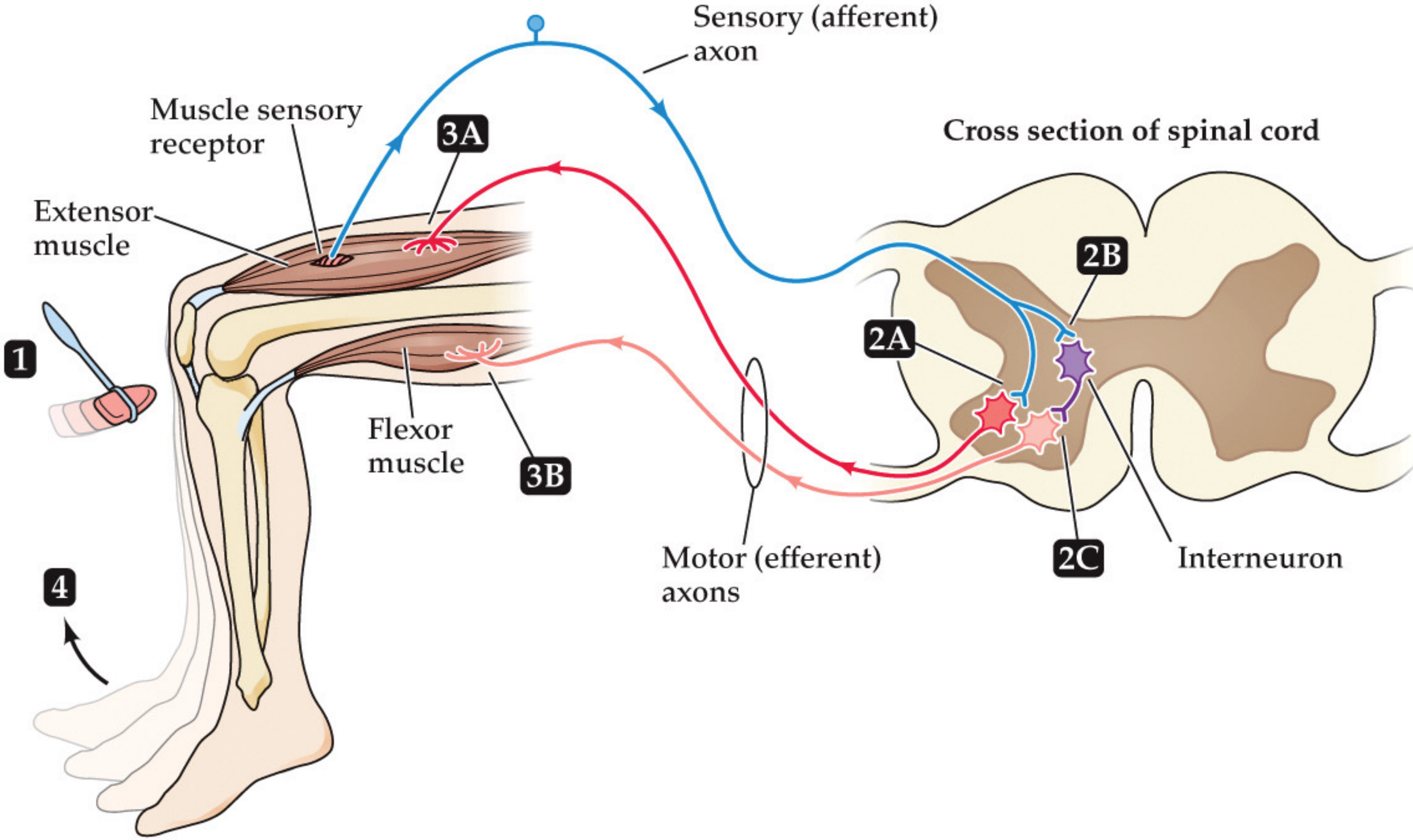
Professor Malcolm MacIver

Neural Circuits

- A step on the road to a neural system
- Neural computation
- Emergent property – can do more than what a single neuron can do

Spinal Cord


Ia afferent
Excitatory synapse
Inhibitory neuron
Inhibitory synapse
Muscle spindle
Alpha motor neuron
Alpha motor neuron projection to homonymous muscle
Quadriceps muscle
Tap stimulus to knee joint
Patellar ligament
Alpha motor neuron projection to antagonistic (heteronymous muscle)



1 Hammer tap stretches tendon, which, in turn, stretches sensory receptors in leg extensor muscle.

2A Sensory neuron synapses with and excites motor neuron in the spinal cord.

2B Sensory neuron also excites spinal interneuron.

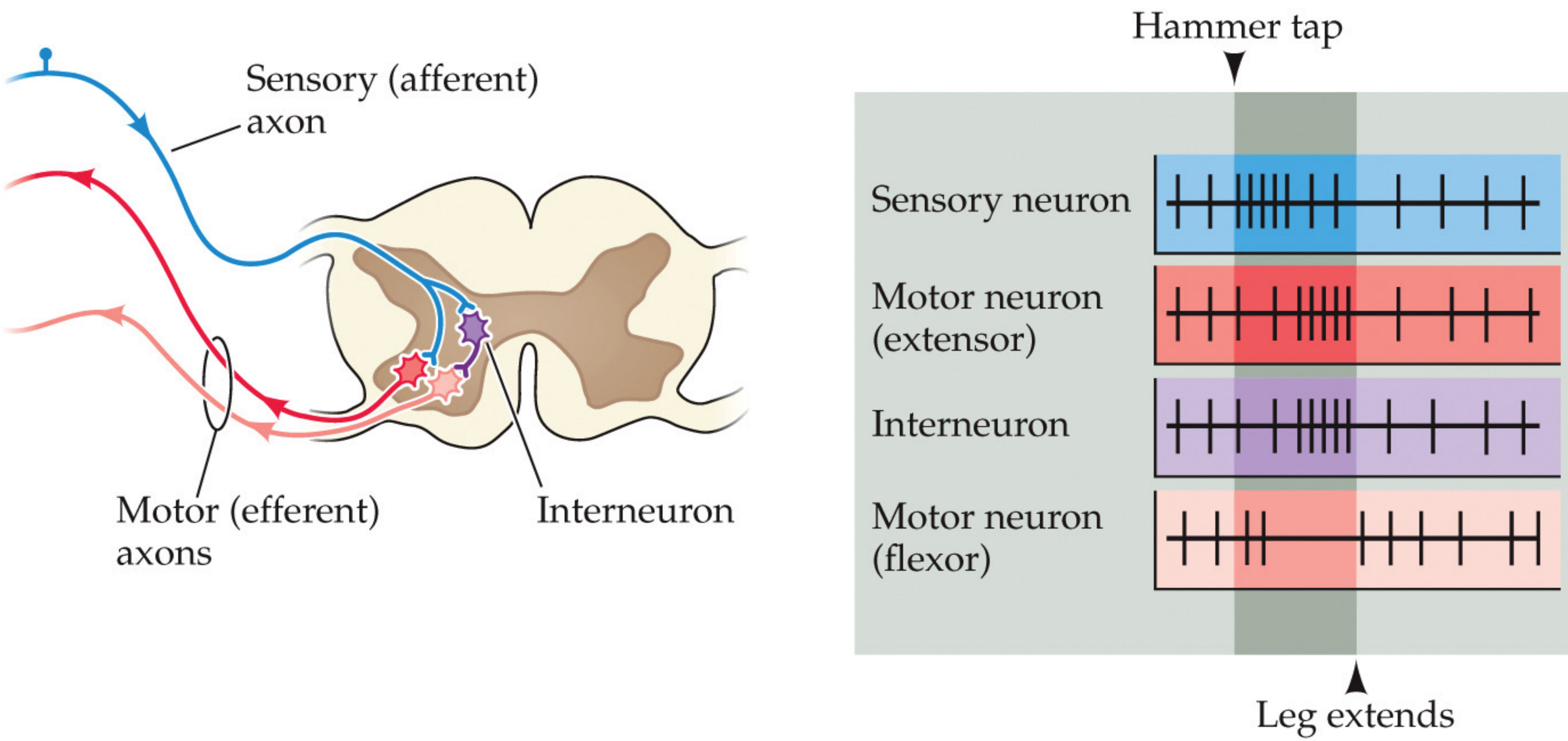
2C Interneuron synapse inhibits motor neuron to flexor muscles.

3A Motor neuron conducts action potential to synapses on extensor muscle fibers, causing contraction.

3B Flexor muscle relaxes because the activity of its motor neurons has been inhibited.

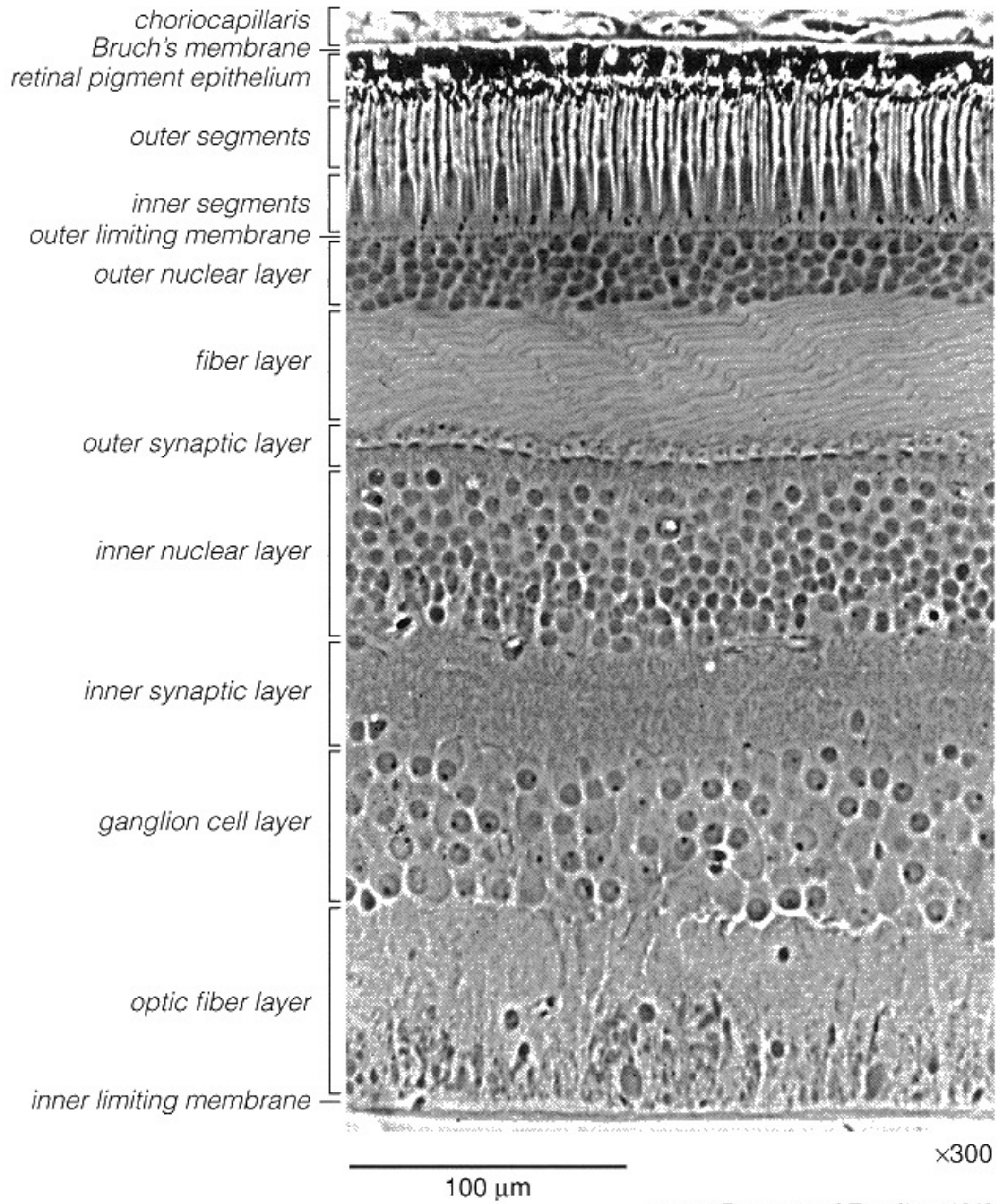
4 Leg extends.

NEUROSCIENCE 6e, Figure 1.7

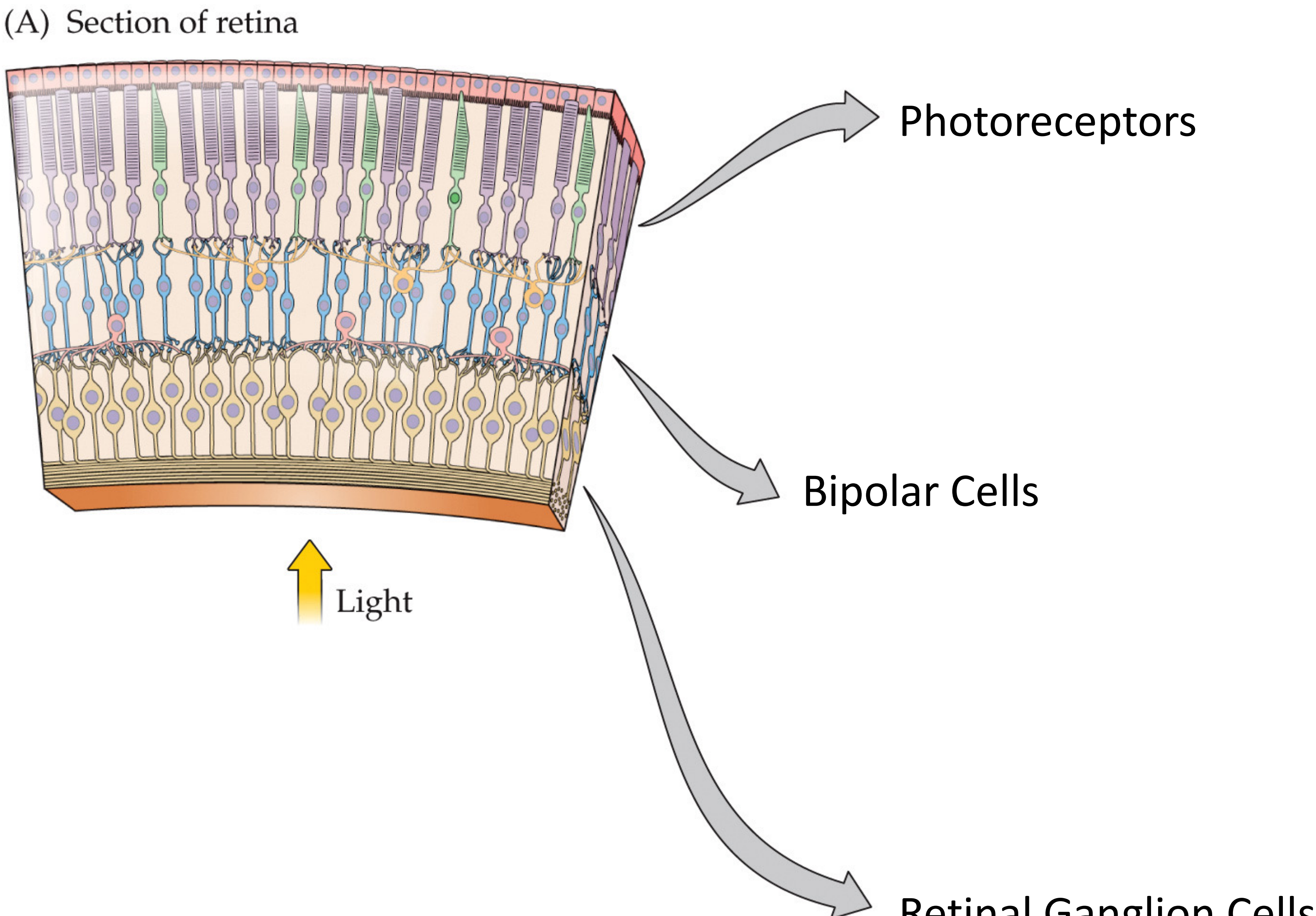


NEUROSCIENCE 6e, Figure 1.8

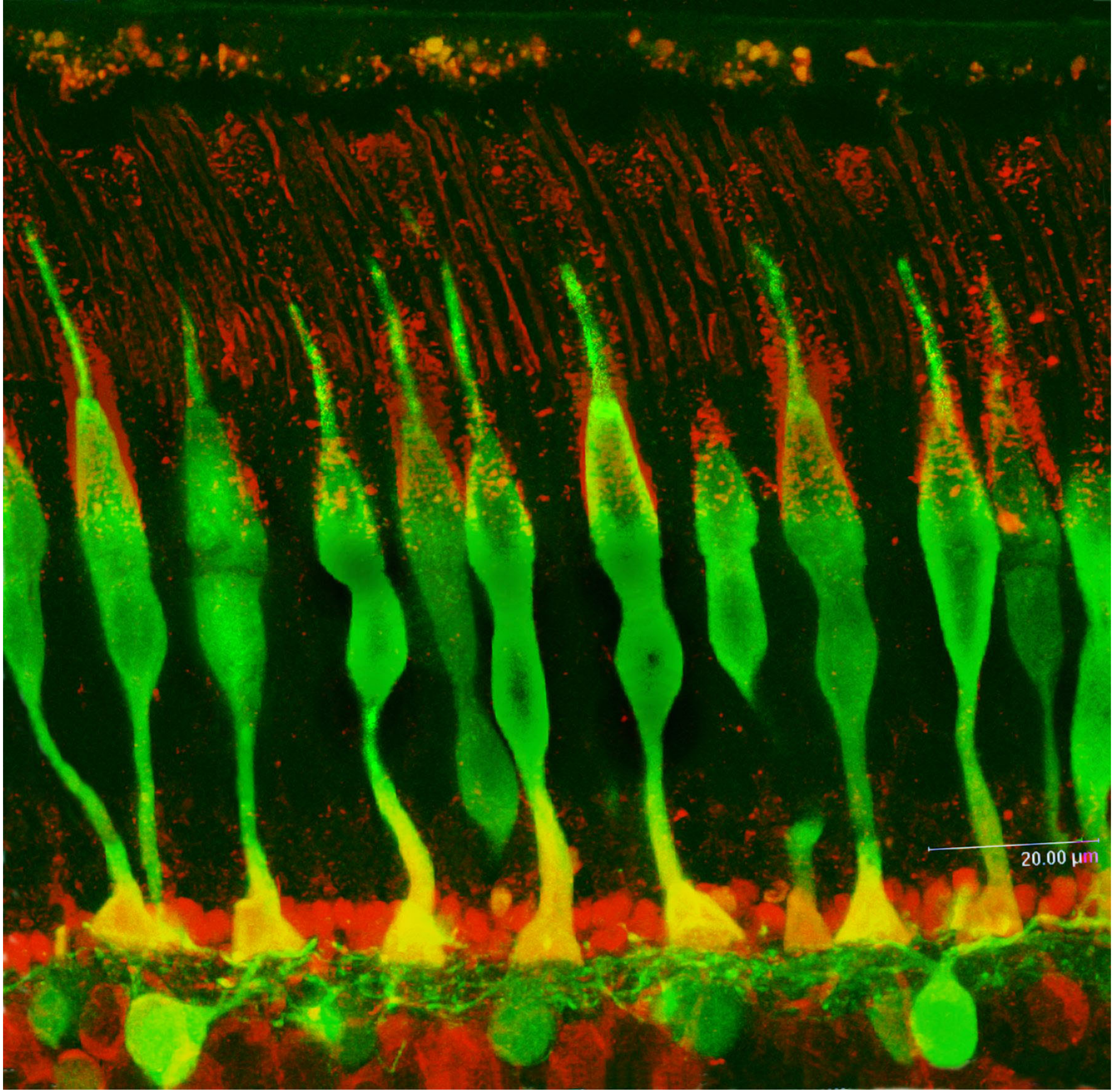
Retina

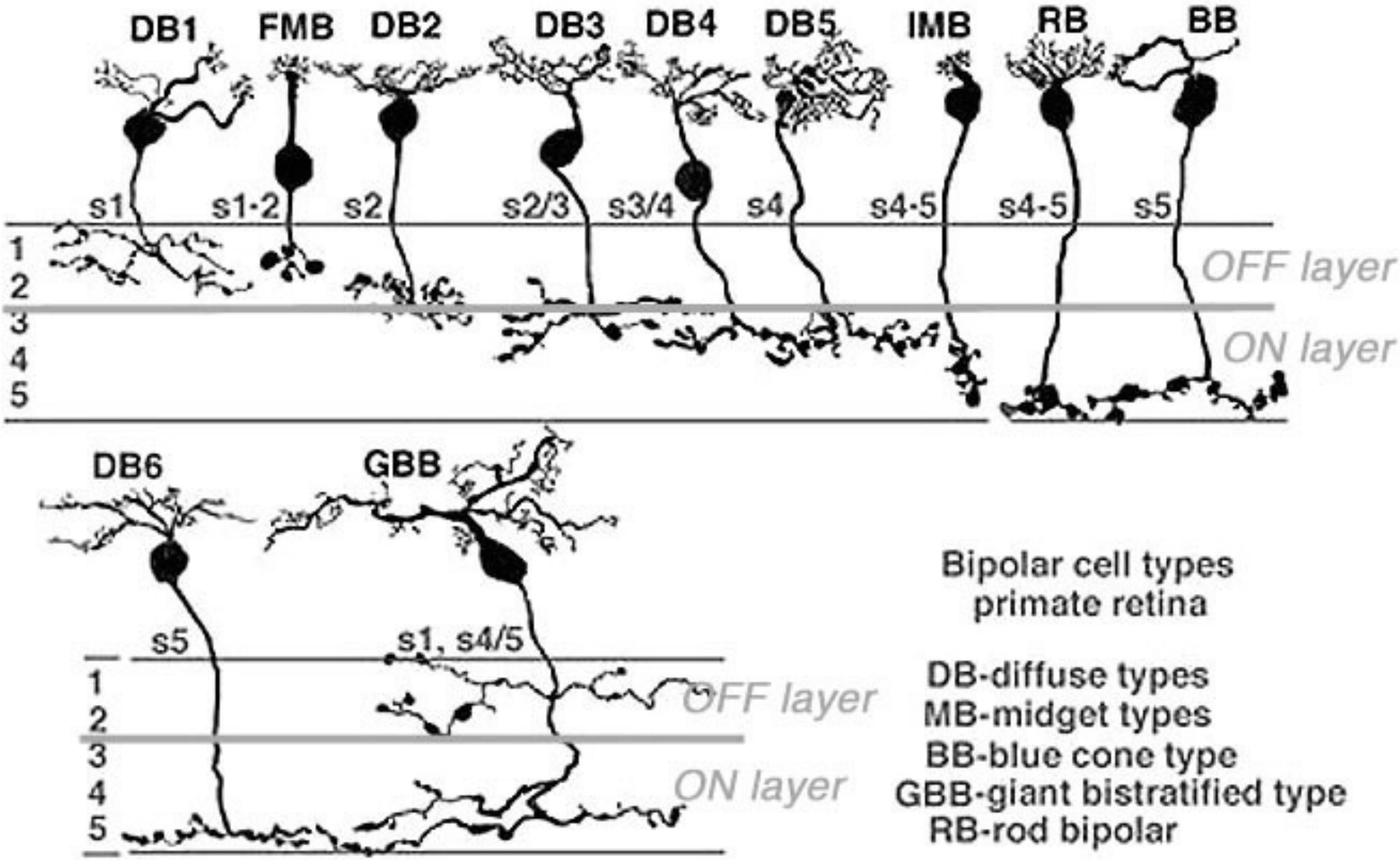


source: Boycott and Dowling, 1969



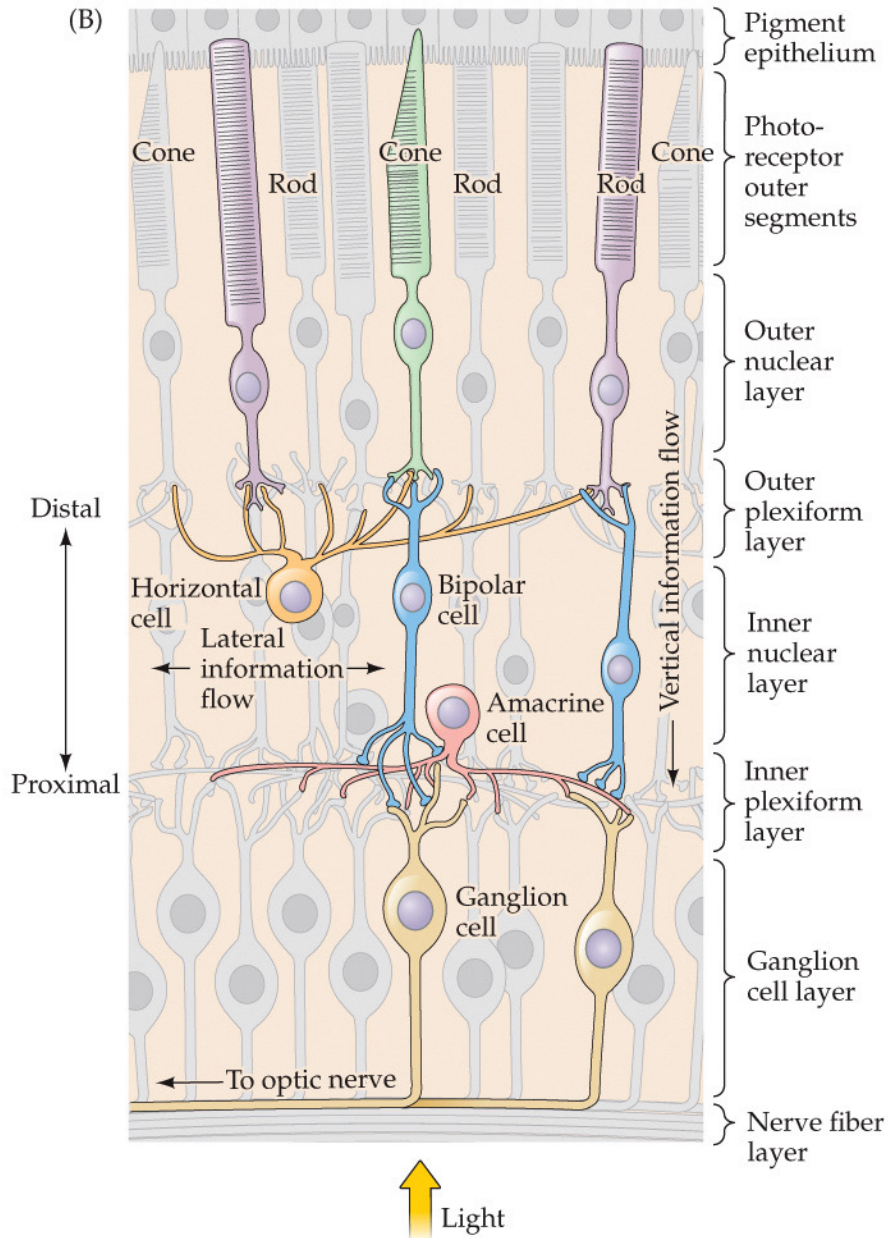
NEUROSCIENCE 6e, Figure 11.5 (Part 1)


20.00 µm

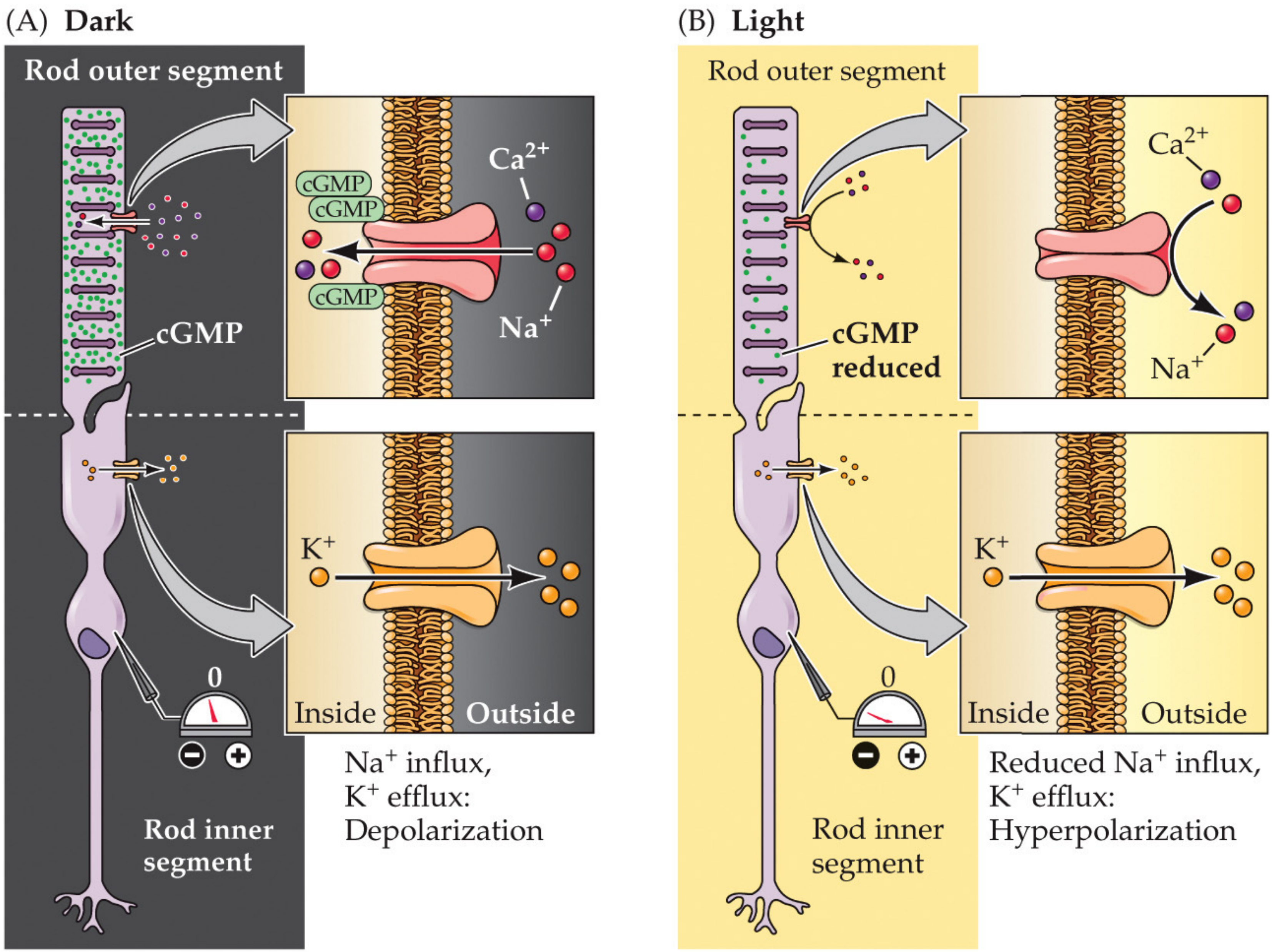


Bipolar cell types in human retina. (From Golgi staining).

(webvision.med.utah.edu)

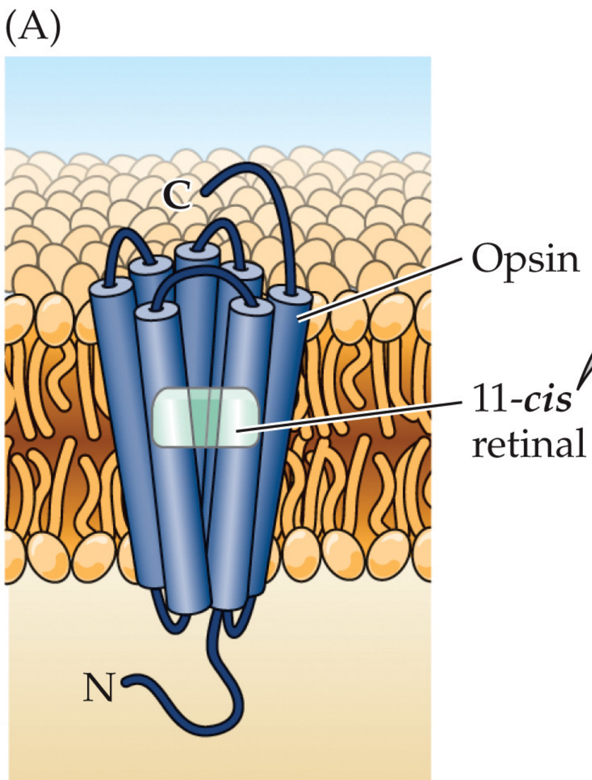


NEUROSCIENCE 6e, Figure 11.5 (Part 2)



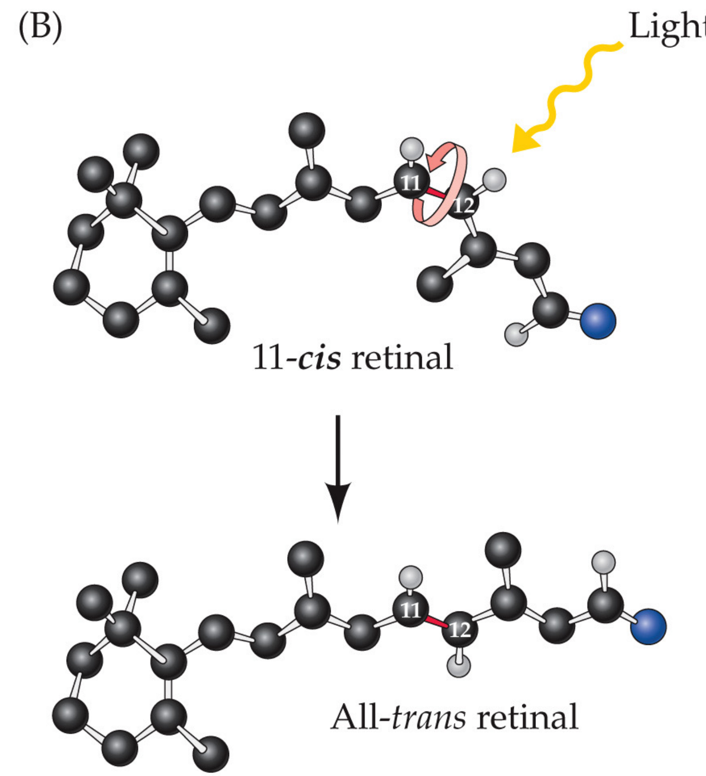
NEUROSCIENCE 6e, Figure 11.8

Less NT (glutamate) release in light



After Oyster (1999) and Stryer (1986).

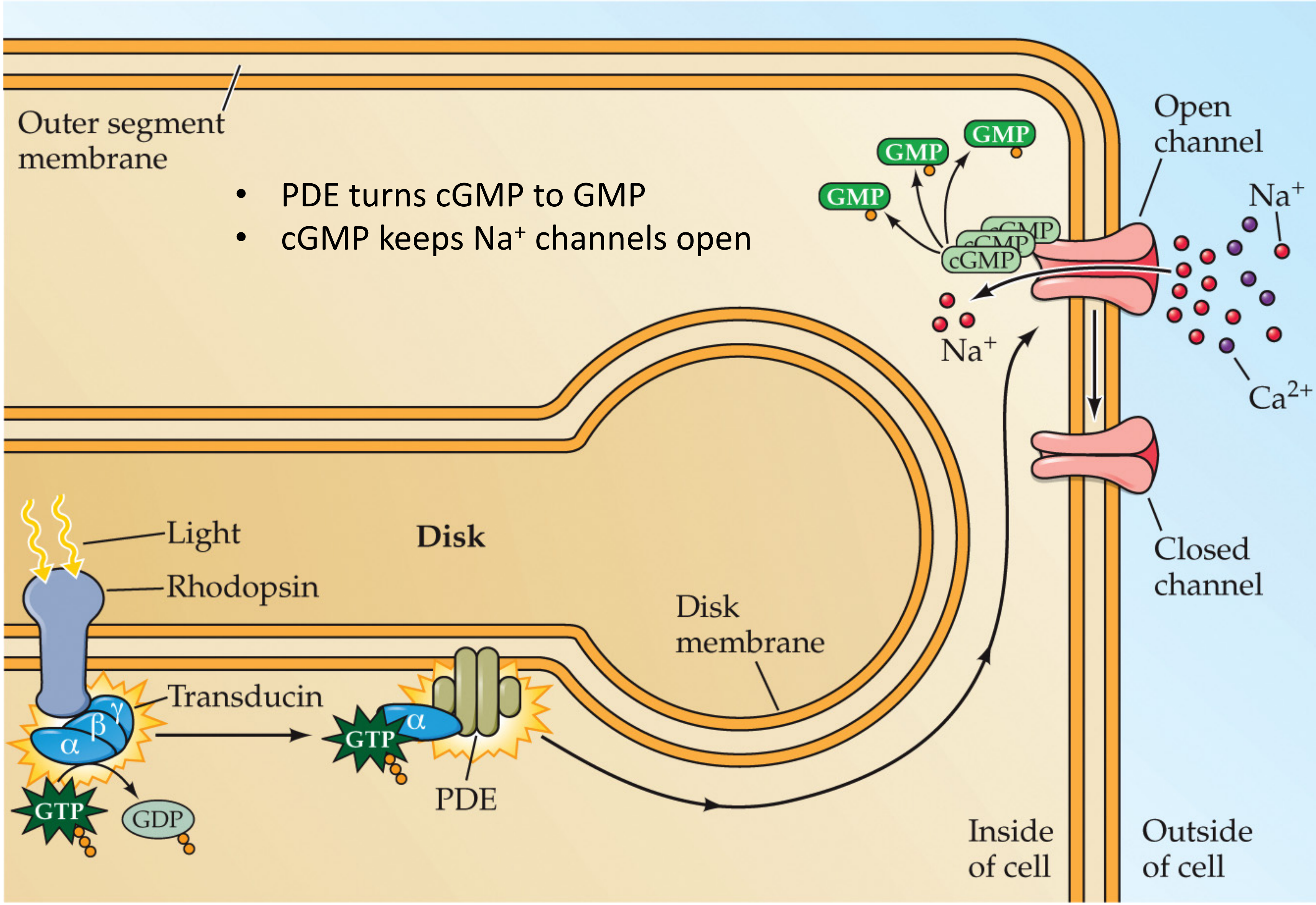
NEUROSCIENCE 6e, Figure 11.9 (Part 1)



After Oyster (1999) and Stryer (1986).

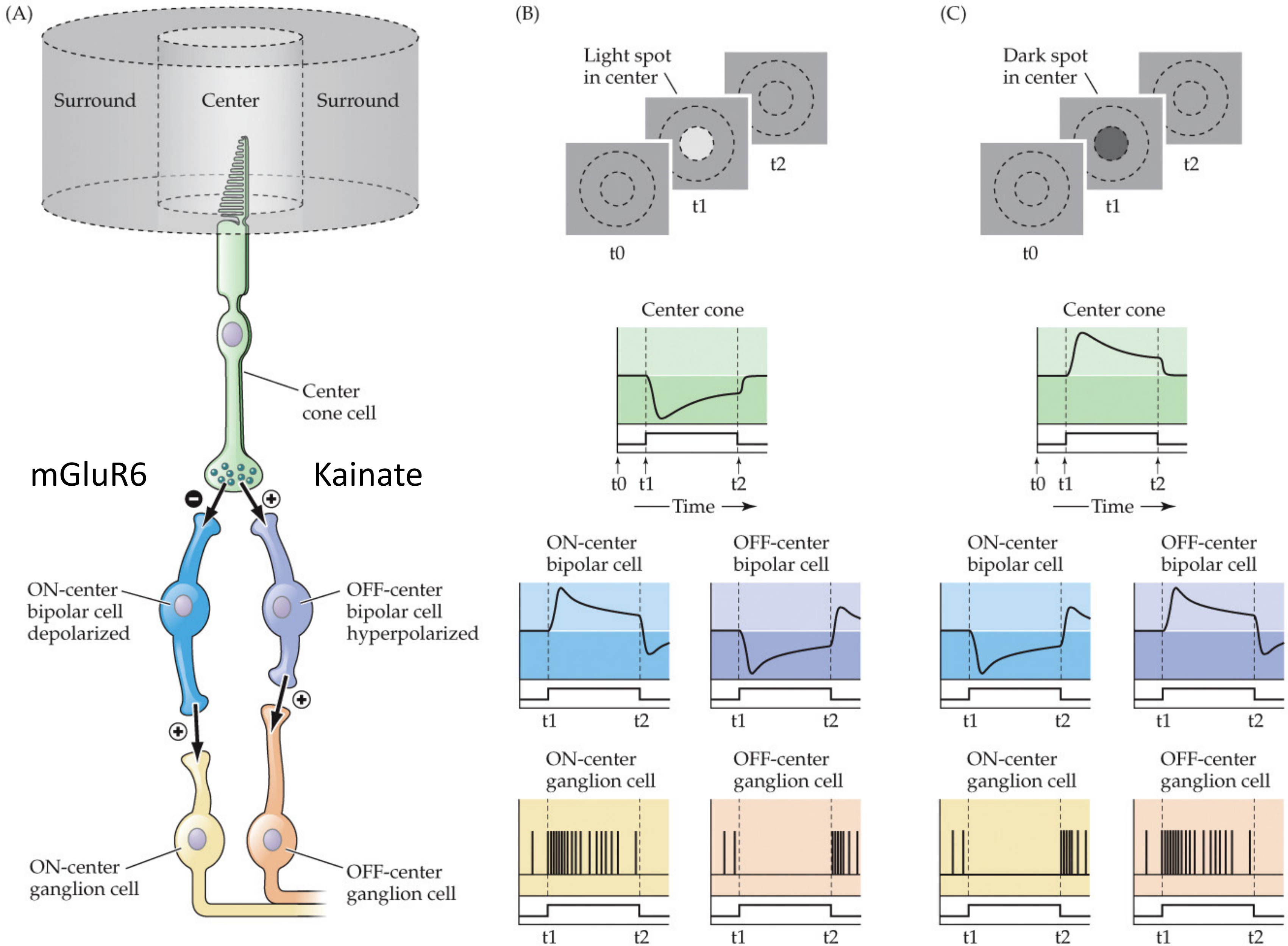
NEUROSCIENCE 6e, Figure 11.9 (Part 2)

(C)



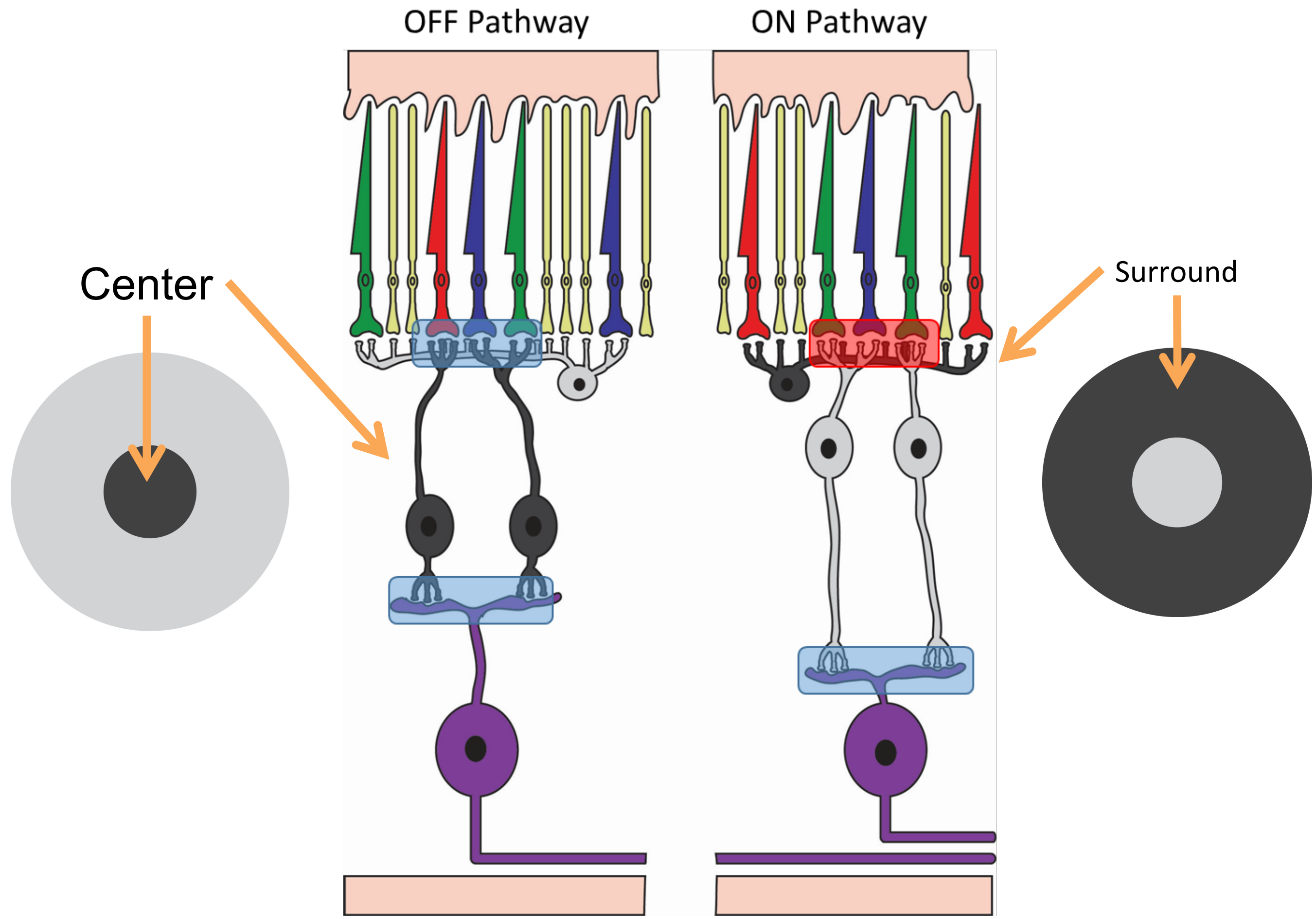
- PDE turns cGMP to GMP
- cGMP keeps Na^+ channels open

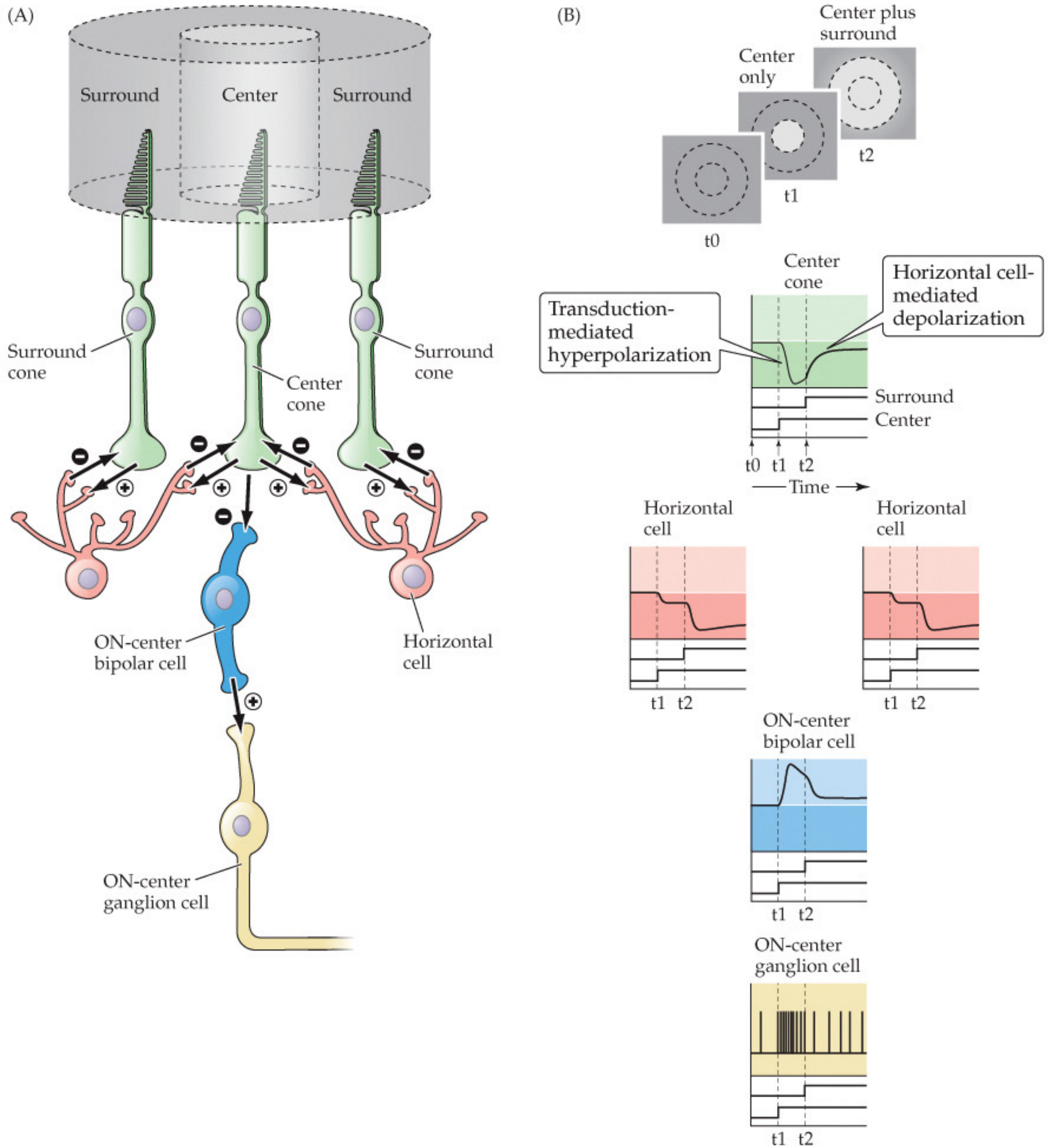
NEUROSCIENCE 6e, Figure 11.9 (Part 3)



NEUROSCIENCE 6e, Figure 11.18

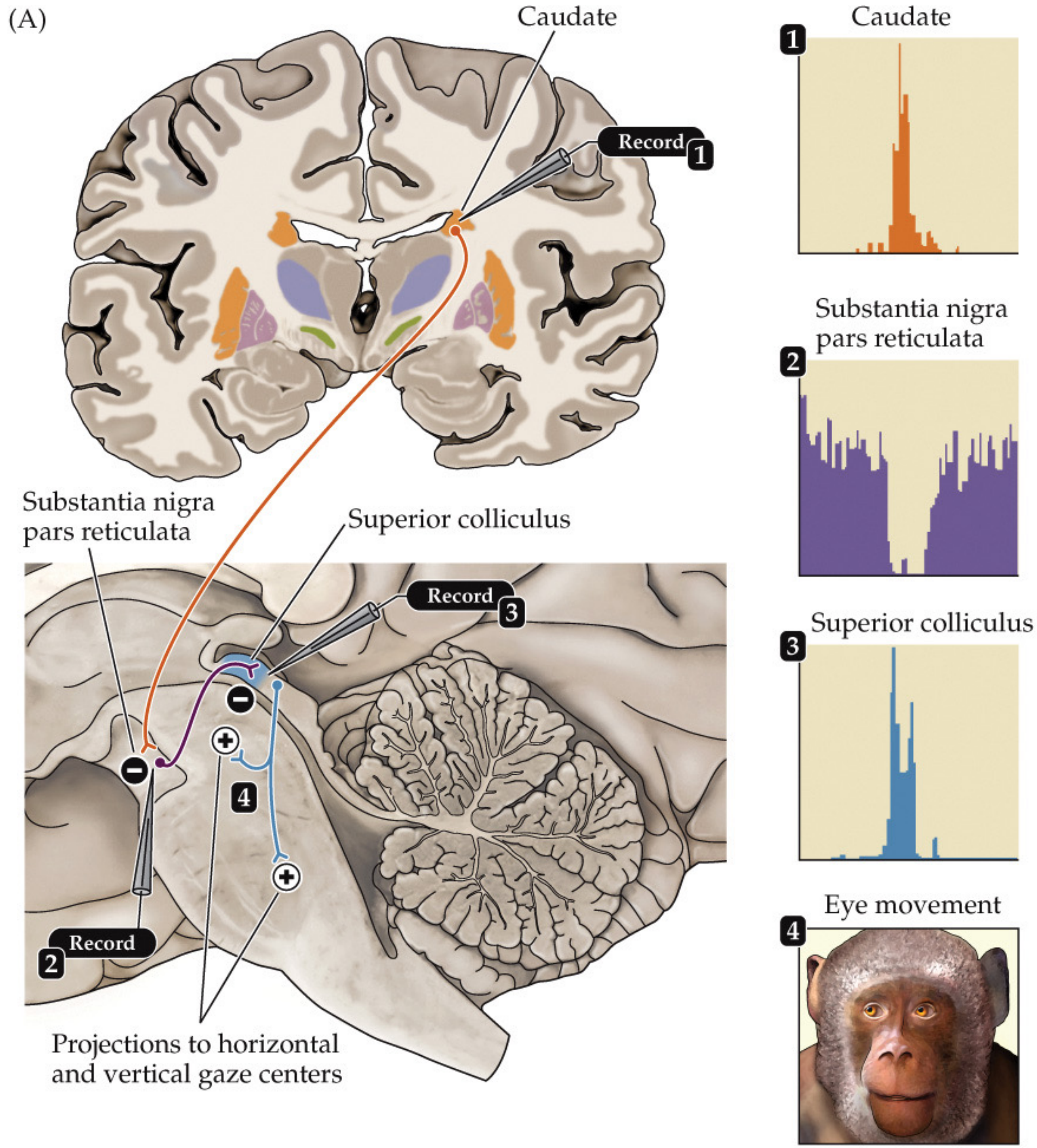
OFF and ON retinal pathways





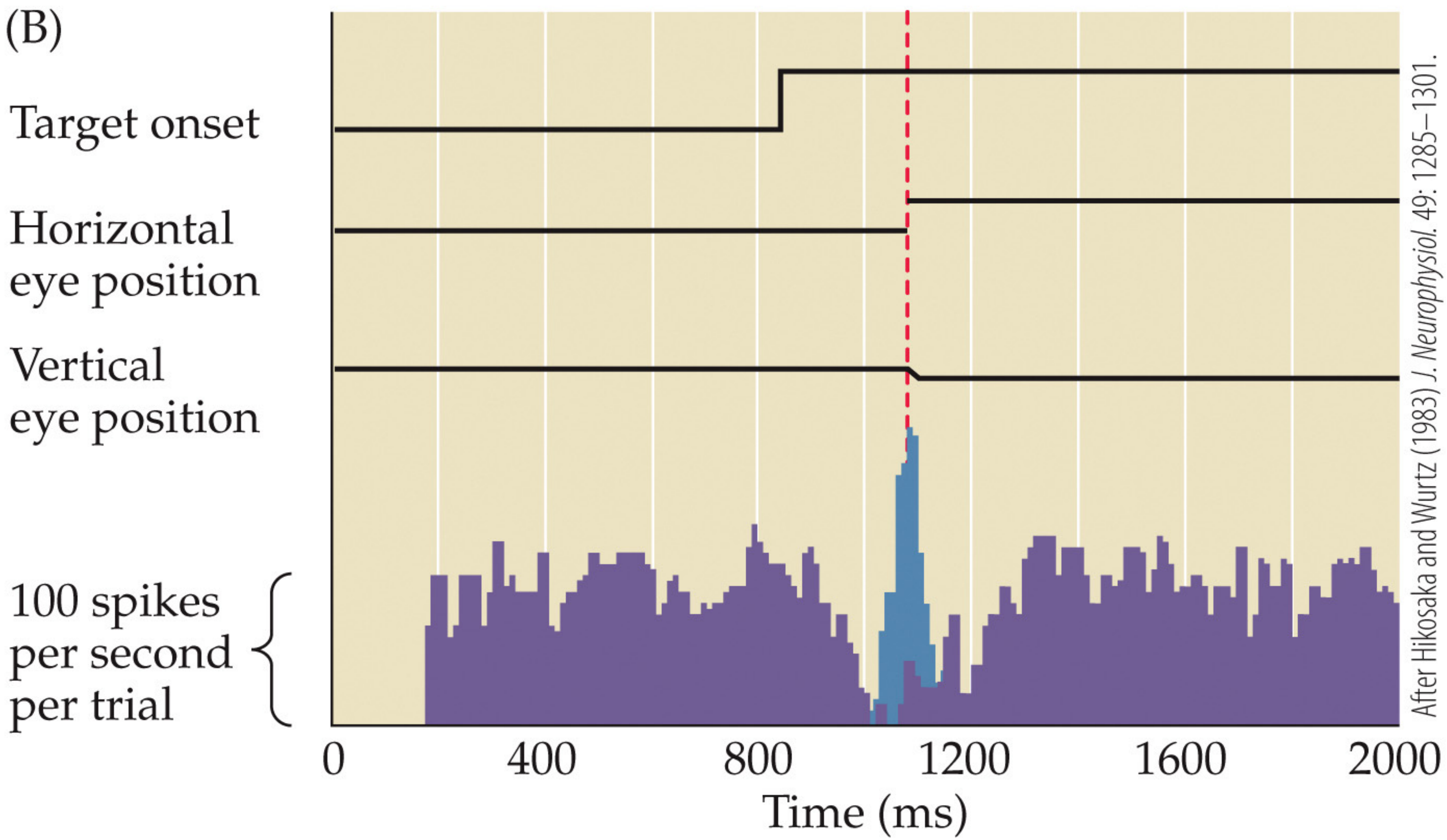
NEUROSCIENCE 6e, Figure 11.21

Basal Ganglia



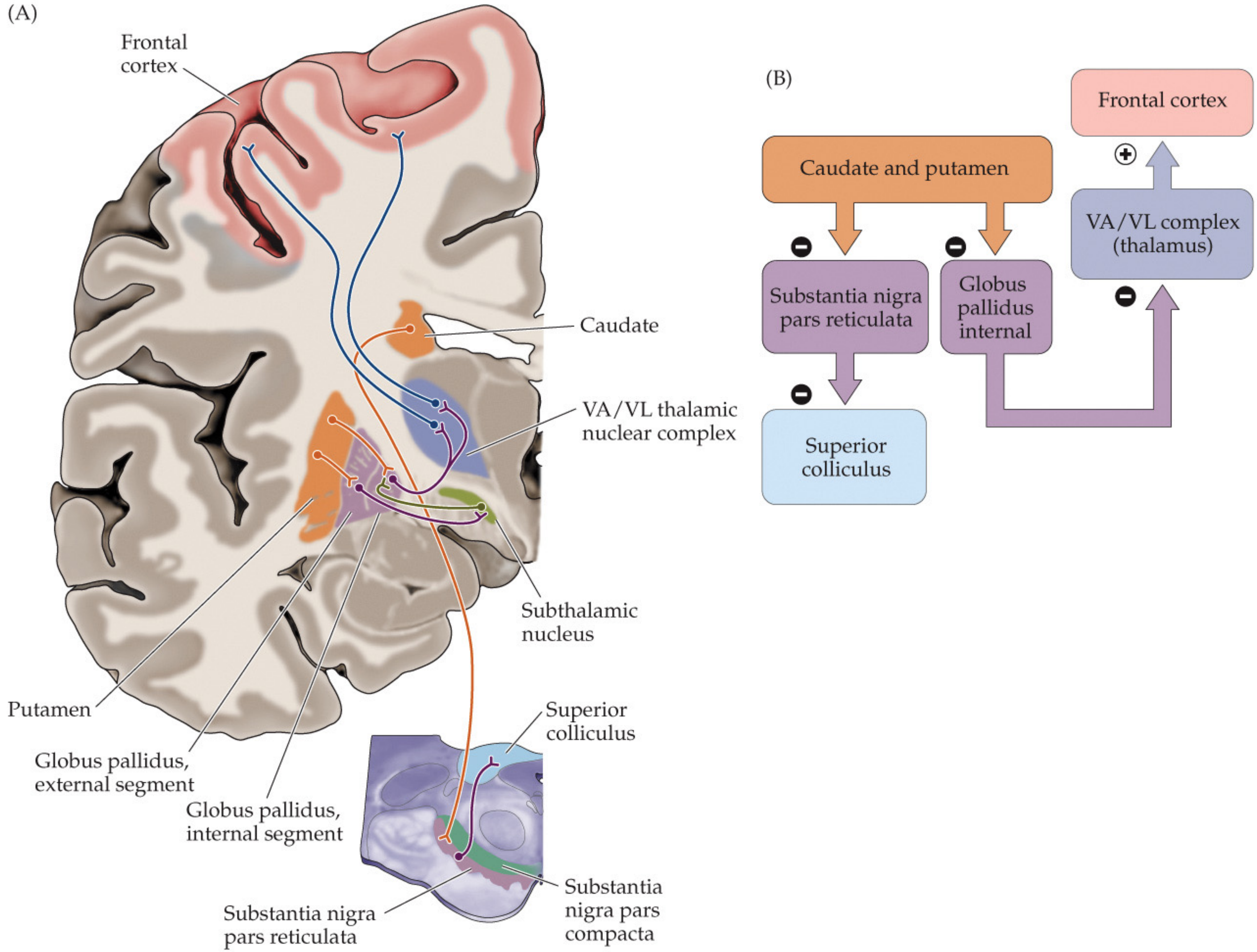
Graph 1 after Hikosaka and Wurtz (1986) *Exp. Brain Res.* 63: 659–662; Graphs 2–3 after Hikosaka and Wurtz (1983) *J. Neurophysiol.* 49: 1285–1301.

NEUROSCIENCE 6e, Figure 18.6 (Part 1)



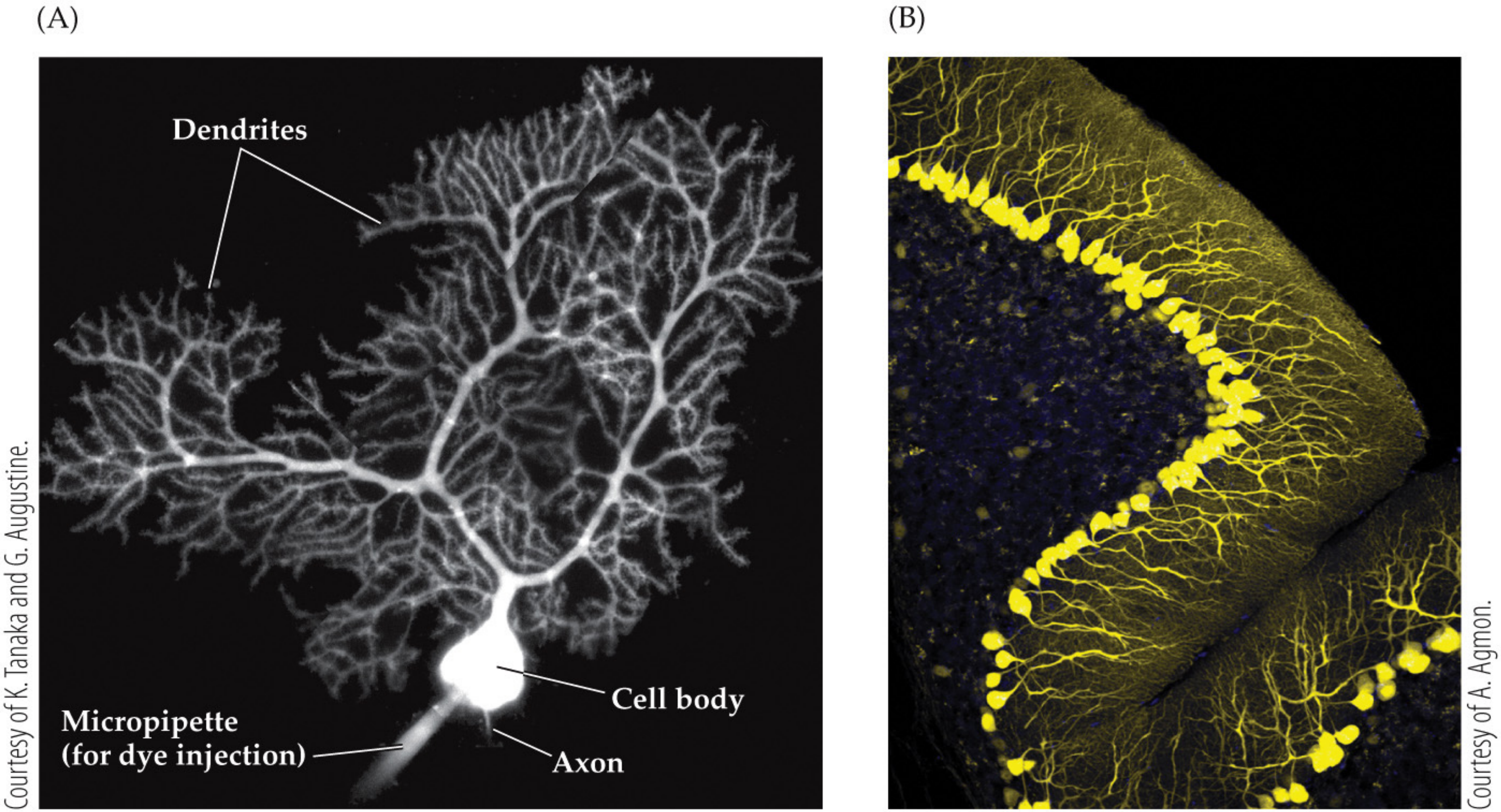
NEUROSCIENCE 6e, Figure 18.6 (Part 2)

Disinhibition from the neurons of the Substantia Nigra Pars Reticulata leads to firing of neurons in the Superior Colliculus that drives an eye movement



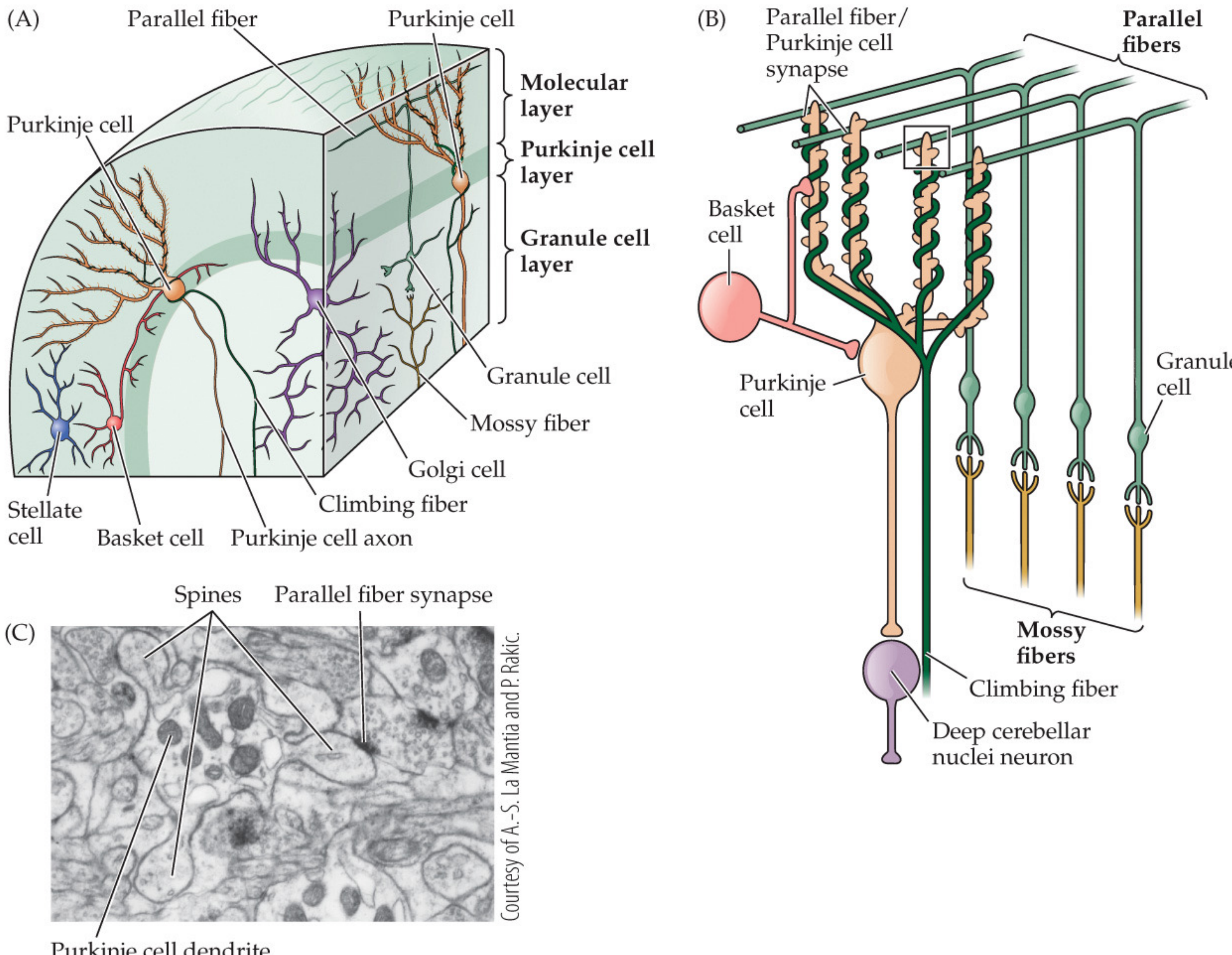
NEUROSCIENCE 6e, Figure 18.4

Cerebellum

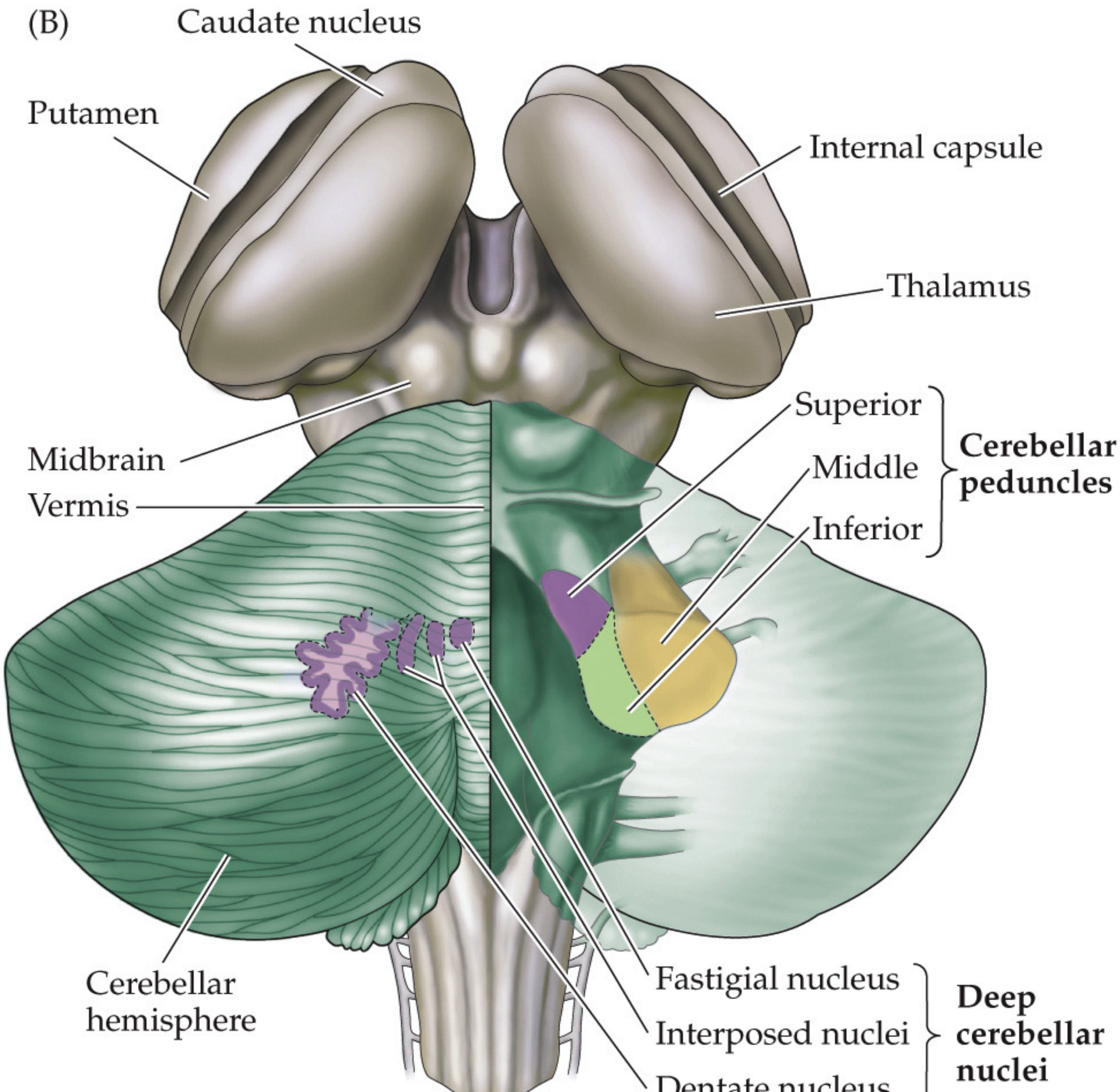


NEUROSCIENCE 6e, Figure 19.8

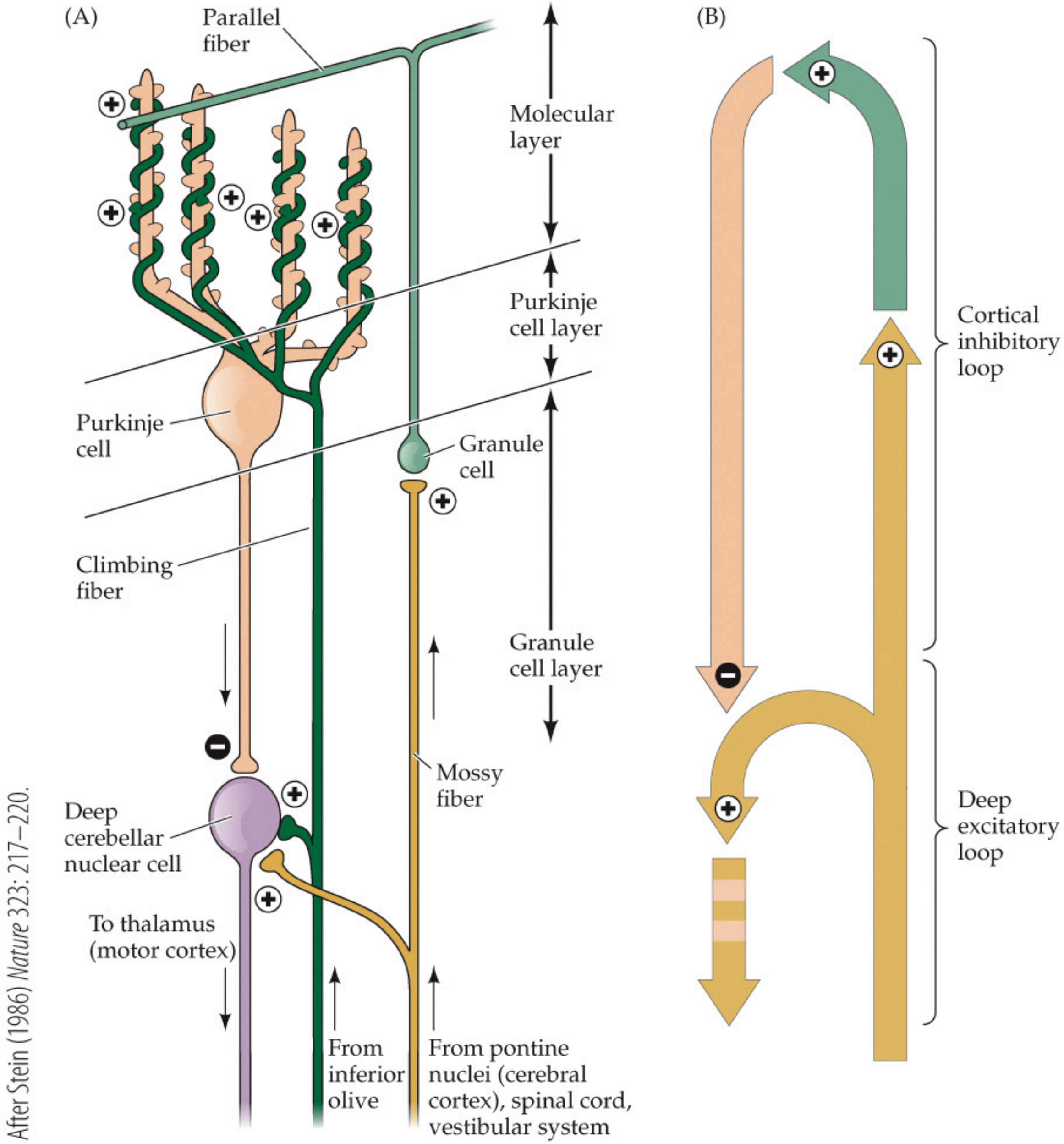
Purkinje Cells



NEUROSCIENCE 6e, **Figure 19.9**



NEUROSCIENCE 6e, Figure 19.1 (Part 2)



NEUROSCIENCE 6e, **Figure 19.10**