

CAMPBELL BIOLOGY IN FOCUS

URRY • CAIN • WASSERMAN • MINORSKY • REECE

38

Nervous and Sensory Systems

Lecture Presentations by
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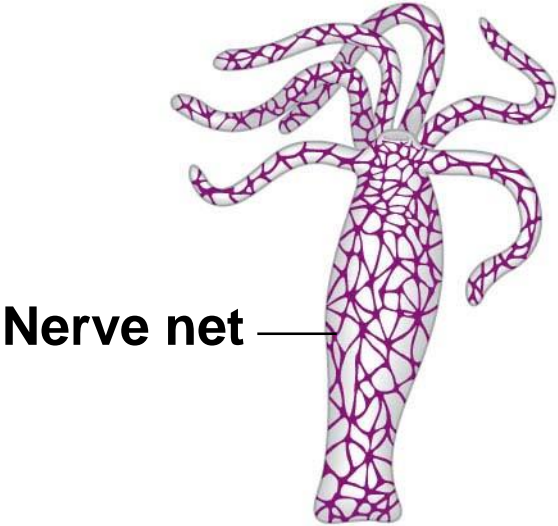
Command and Control Center

- Gathering, processing, and organizing information are essential functions of all nervous systems
- The human brain contains about 100 billion neurons organized into circuits
- Connections between regions of the brain are mapped using the expression of random combinations of colored proteins in neurons

Concept 38.1: Nervous systems consist of circuits of neurons and supporting cells

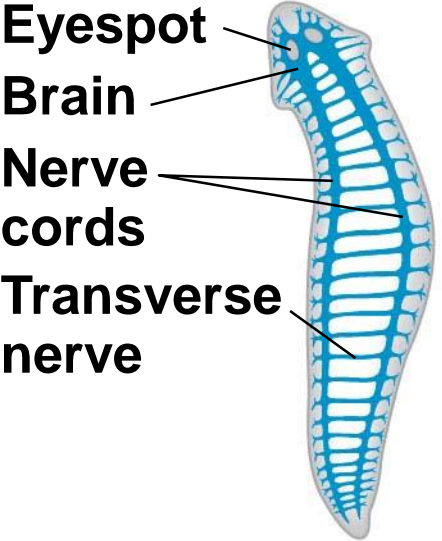
- Hydras, jellies, and cnidarians are the simplest animals with nervous systems
- In most cnidarians, interconnected nerve cells form a **nerve net**, which controls contraction and expansion of the gastrovascular cavity

Figure 38.2



Nerve net

(a) Hydra (cnidarian)



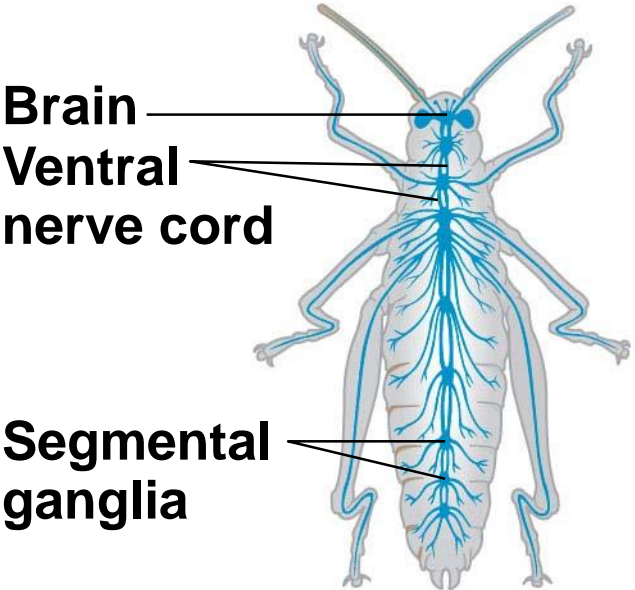
Eyespot

Brain

Nerve cords

Transverse nerve

(b) Planarian (flatworm)

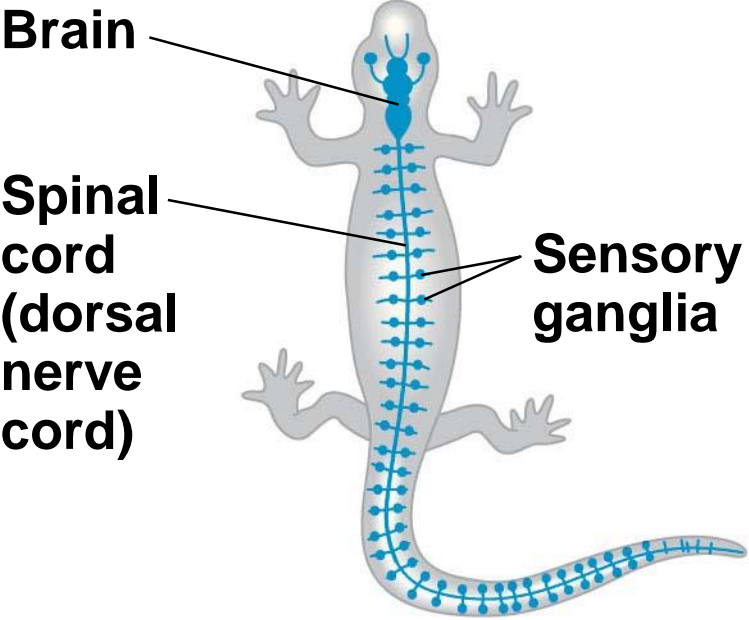


Brain

Ventral nerve cord

Segmental ganglia

(c) Insect (arthropod)



Brain

Spinal cord (dorsal nerve cord)

Sensory ganglia

(d) Salamander (vertebrate)

- In more complex animals, the axons of multiple nerve cells are often bundled together to form **nerves**
- These fibrous structures channel and organize information flow through the nervous system
- Animals with elongated, bilaterally symmetrical bodies have even more specialized systems

- Cephalization is an evolutionary trend toward a clustering of sensory neurons and interneurons at the anterior
- Nonsegmented worms have the simplest clearly defined **central nervous system (CNS)**, consisting of a small brain and longitudinal nerve cords

- Annelids and arthropods have segmentally arranged clusters of neurons called ganglia
- In vertebrates
 - The CNS is composed of the brain and spinal cord
 - The **peripheral nervous system (PNS)** is composed of nerves and ganglia

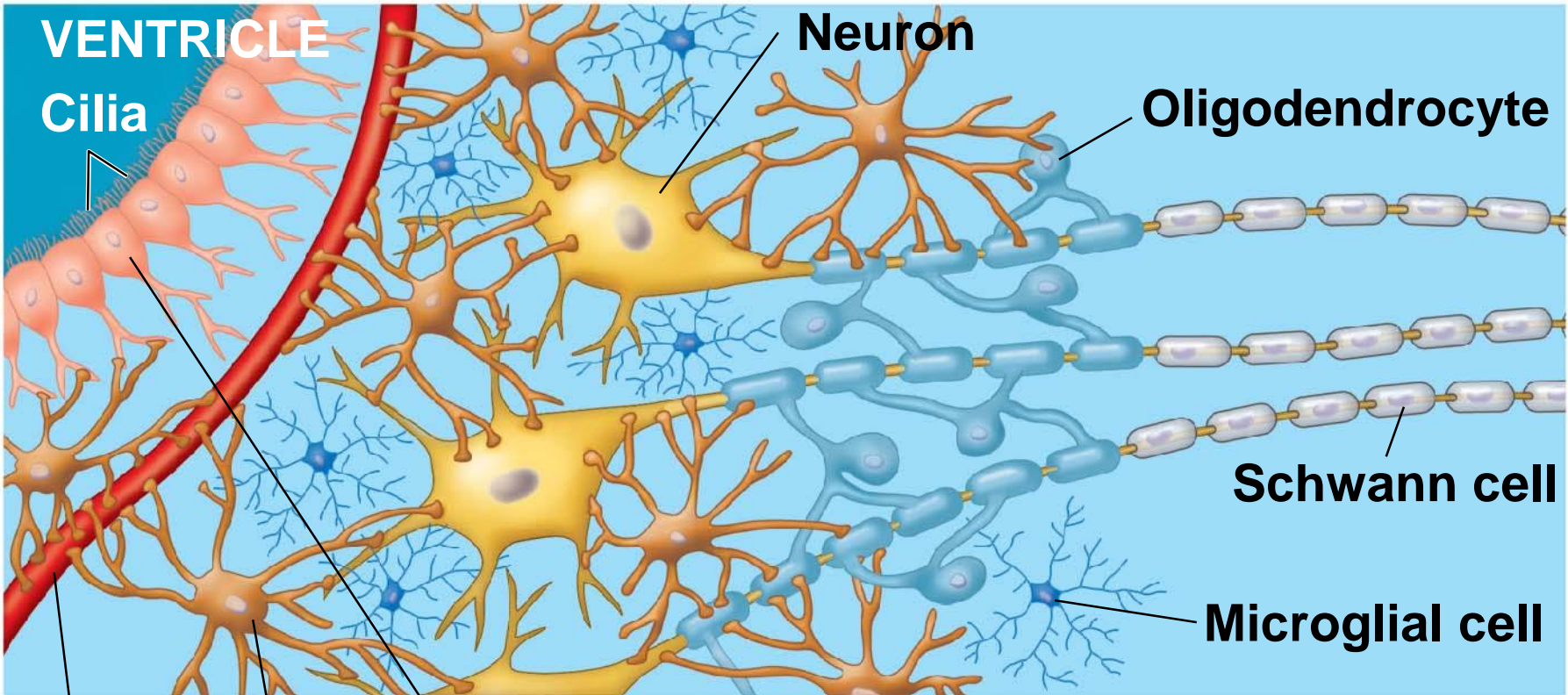
Glia

- Vertebrates and most invertebrates have **glial cells**, or **glia**, in addition to neurons
- Glia have numerous functions to nourish, support, and regulate neurons
 - Embryonic radial glia form tracks along which newly formed neurons migrate
 - Astrocytes (star-shaped glial cells) induce cells lining capillaries in the CNS to form tight junctions, resulting in a blood-brain barrier

Figure 38.3

CNS

PNS



VENTRICLE

Cilia

Neuron

Oligodendrocyte

Schwann cell

Microglial cell

Capillary

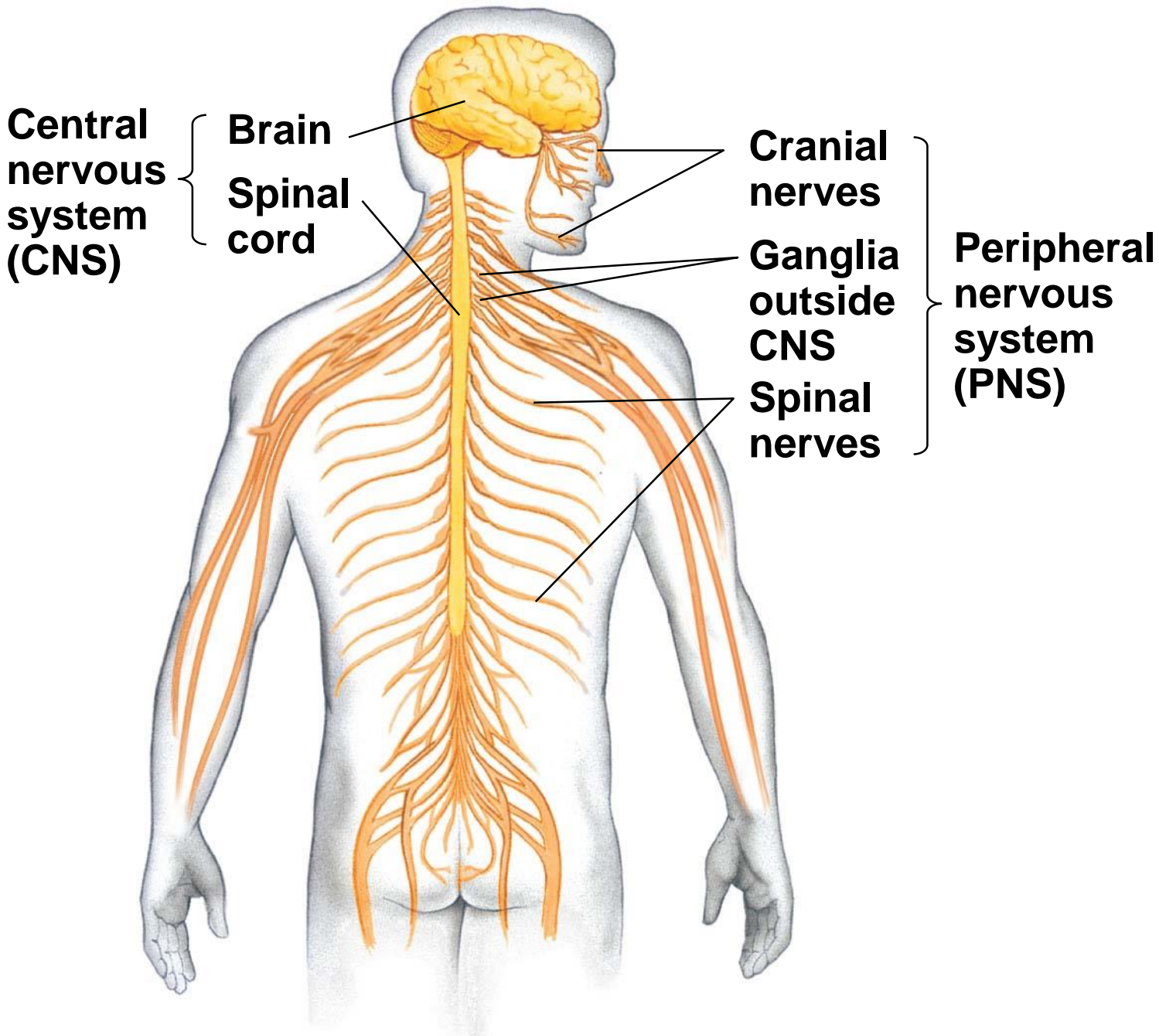
Ependymal cell

Astrocyte

Organization of the Vertebrate Nervous System

- The spinal cord runs lengthwise inside the vertebral column (the spine)
- The spinal cord conveys information to and from the brain
- It can also act independently of the brain as part of simple nerve circuits that produce **reflexes**, the body's automatic responses to certain stimuli

Figure 38.4



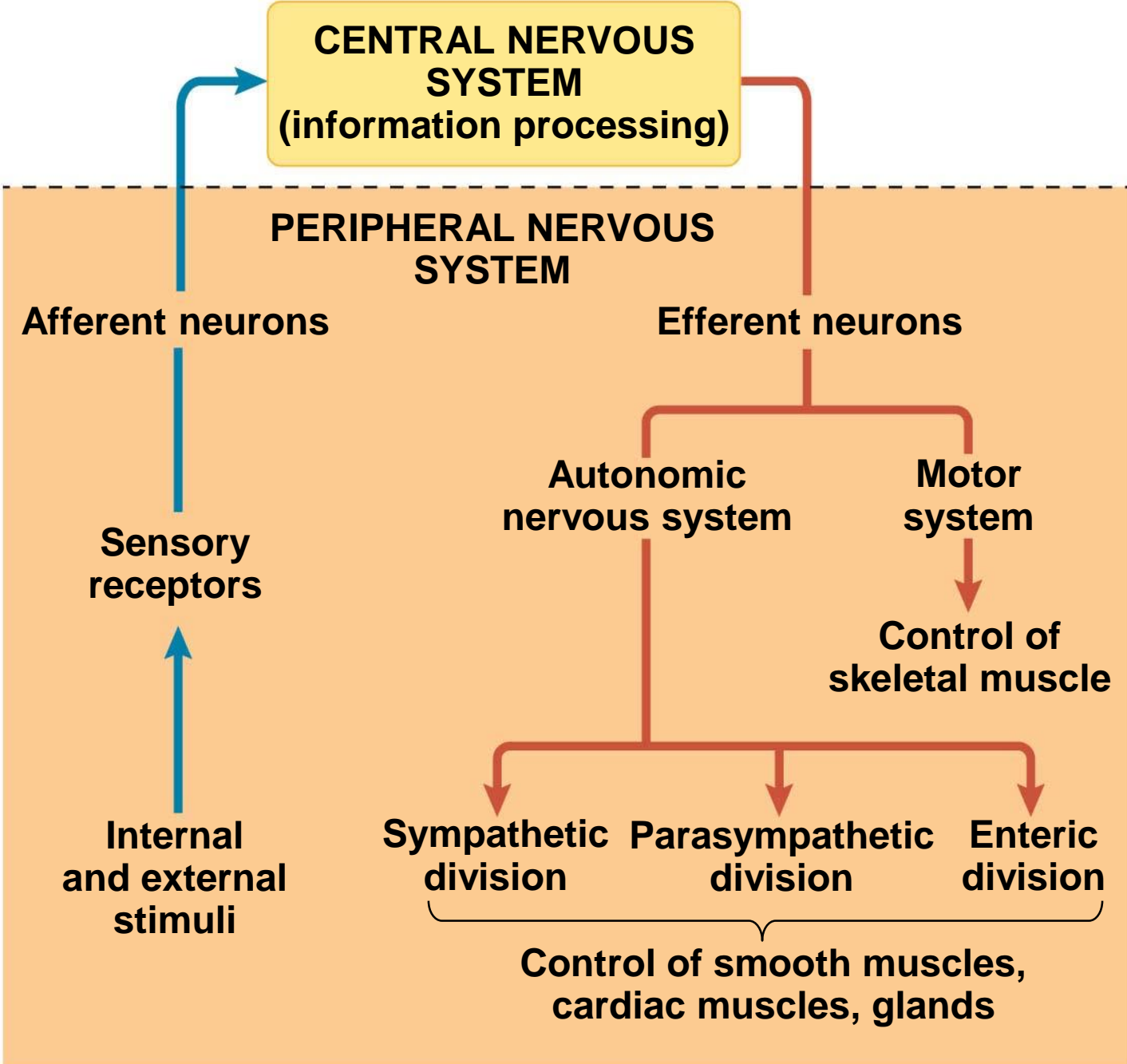
- The brain and spinal cord contain
 - **Gray matter**, which consists mainly of neuron cell bodies
 - **White matter**, which consists of bundles of myelinated axons

- The CNS contains fluid-filled spaces called ventricles in the brain and the central canal in the spinal cord
- Cerebrospinal fluid is formed in the brain and circulates through the ventricles and central canal and drains into the veins
- It supplies the CNS with nutrients and hormones and carries away wastes

The Peripheral Nervous System

- The PNS transmits information to and from the CNS and regulates movement and the internal environment
- In the PNS, afferent neurons transmit information to the CNS and efferent neurons transmit information away from the CNS

Figure 38.5



- The PNS has two efferent components: the motor system and the autonomic nervous system
- The **motor system** carries signals to skeletal muscles and can be voluntary or involuntary
- The **autonomic nervous system** regulates smooth and cardiac muscles and is generally involuntary