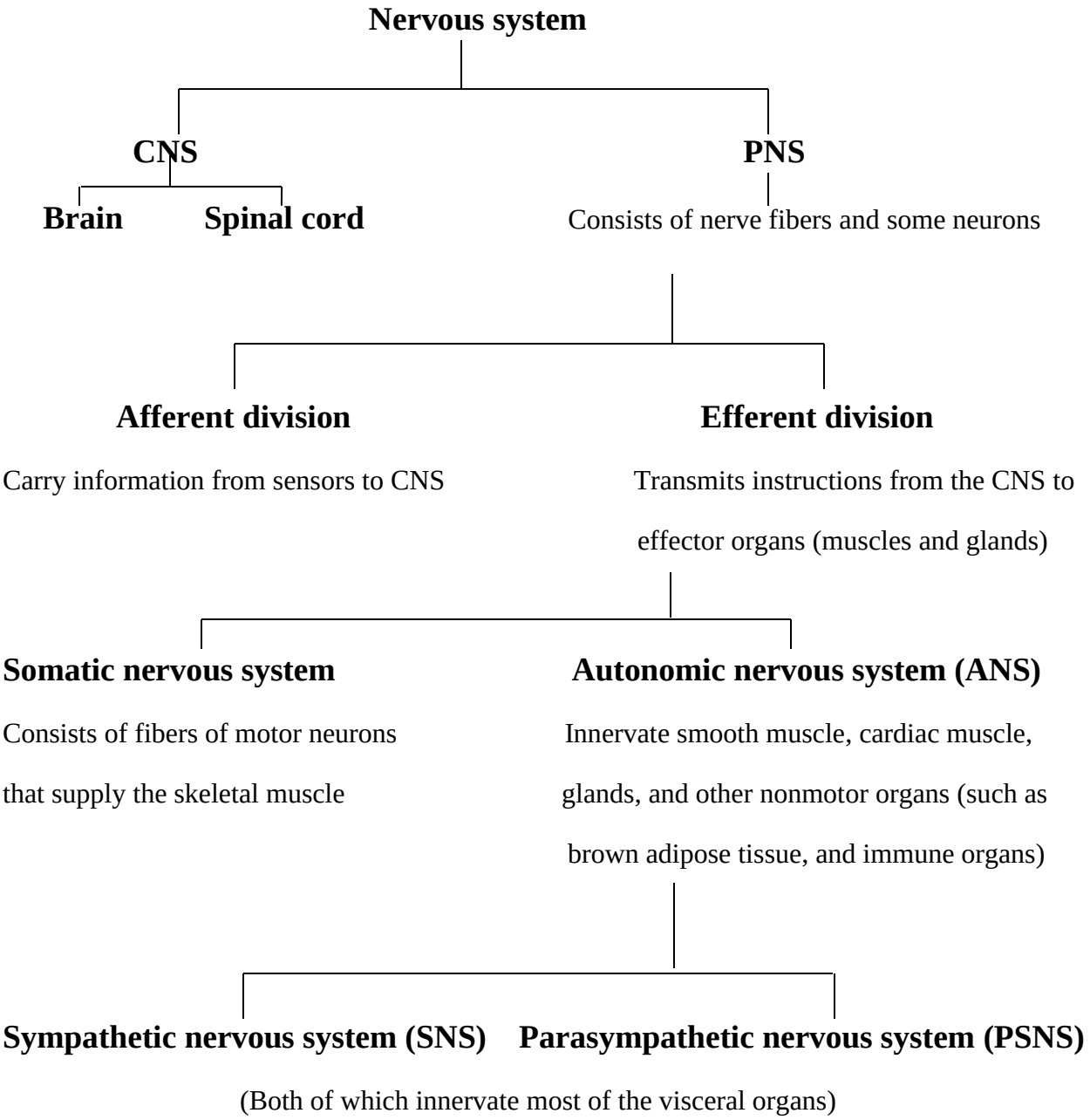
Animal physiology- /2021-2022

Lecture 5

Nervous system

Nervous system is an organ system composed of the brain, spinal cord, nerves, and ganglia, specialized for rapid communication of information.The nervous system is organized into central nervous system (CNS) and Peripheral nervous system (PNS), and each of these is further divided as shown below:



Structural diversity in neurons

Neurons are classified structurally according to the number of processes extending from the soma (fig.5-1)

1- **Multipolar neurons**: have one axon and multiple dendrites. This is the most common type of neuron and includes most neurons of the brain and spinal cord.

2- **Bipolar neurons:** have one axon and one dendrite. Examples include olfactory cells of the nasal cavity, some neurons of the retina, and sensory neurons of the inner ear.

3- **Unipolar neurons**: have only a single process leading away from the soma. They are represented by the neurons that carry sensory signals to the spinal cord. These neurons are also called *pseudounipolar* because they start out as bipolar neurons in the embryo, but their two processes fuse into one as the neuron matures.

4- **Anaxonic neurons**: have multiple dendrites but no axon. They communicate through their dendrites and do not produce action potentials. Some anaxonic neurons are found in the brain and retina.

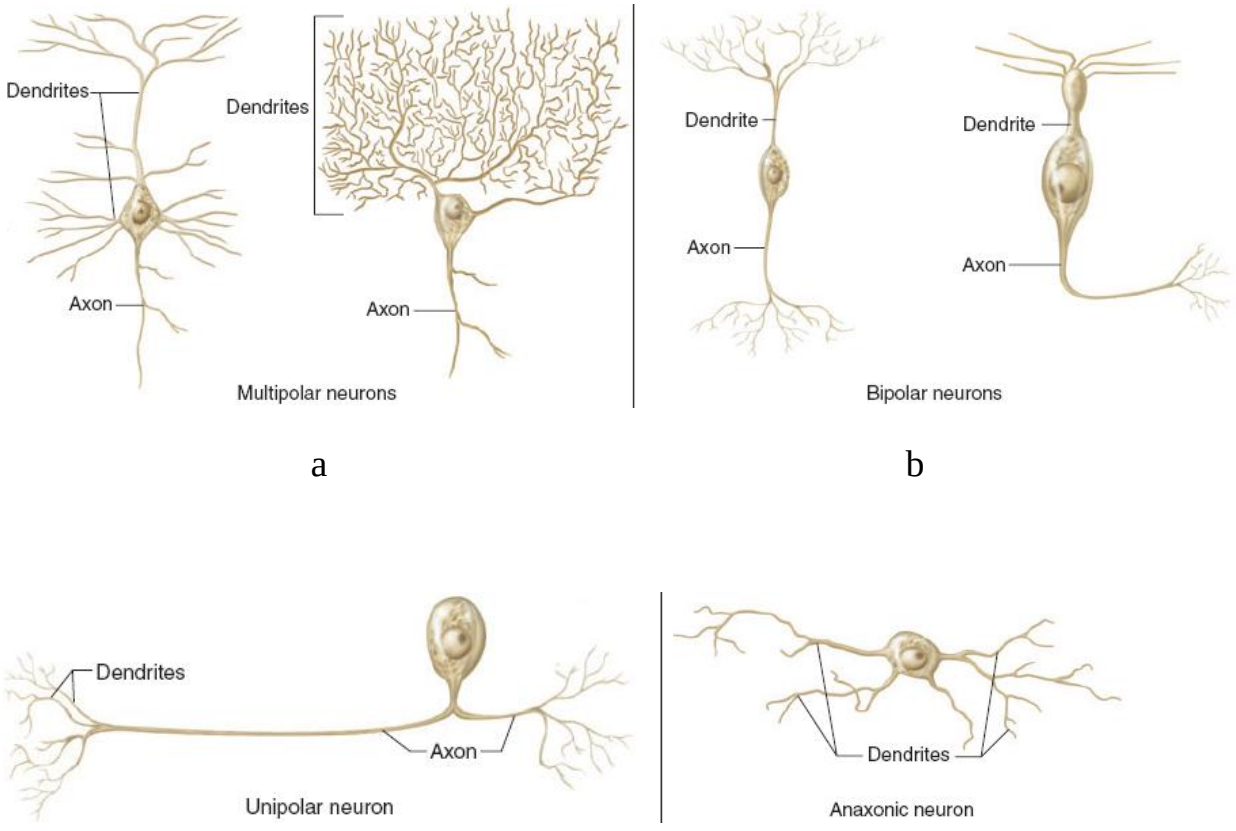


Figure 5-1: Variation in neuronal structure**.** a-Two multipolar neurons of the brain (left to right) - a pyramidal cell and Purkinje cell. b-Two bipolar neurons-(left to right) a bipolar cell of the retina and an olfactory neuron. c- a unipolar neuron of the type involved in the senses of touch and pain. d- an anaxonic neuron (amacrine cell) of the retina.

Functional classes of neurons

There are three general classes of neurons (fig. 5-2)

1- **Afferent neurons**: are specialized to detect stimuli such as light, heat, pressure, and chemicals. Transmit information about them to the CNS. Some sensory receptors, such as pain and smell receptors, are themselves neurons. In other cases, such as taste and hearing, the receptor is a separate cell that communicates directly with a sensory neuron (fig. 5-3).

2-**Interneurons (association neurons)**: lie entirely within the CNS. They receive signals from many other neurons and carry out the integrative function of the nervous system—that is, they process, store, and remember information and "make decisions" that determine how the body responds to stimuli. About 90% of our neurons are interneurons.

3- **Efferent neuron**s: send signals predominantly to muscle and gland cells, the effectors that carry out the body's responses to stimuli.

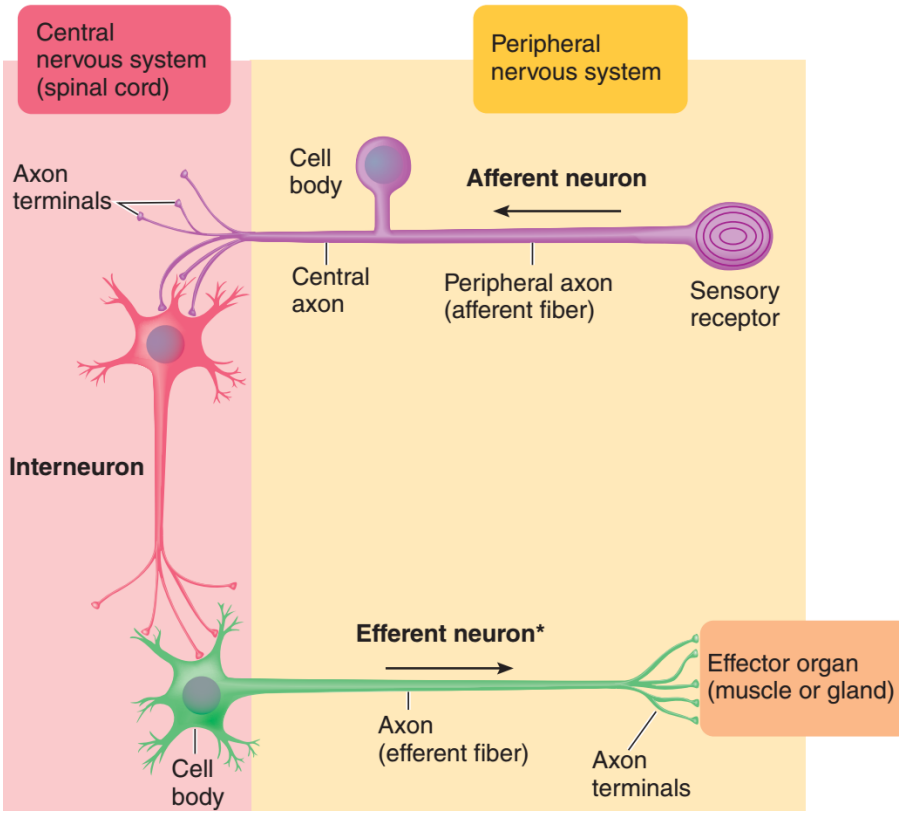
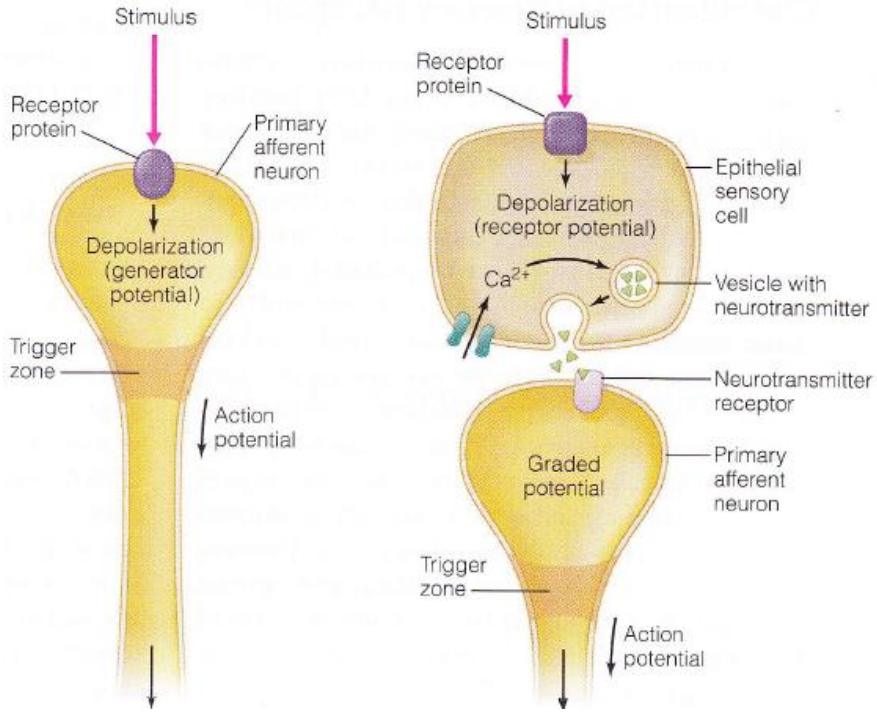


Figure 5-2: Structure and location of the three functional classes of neurons.



(a) Sensory receptor neuron (b) Epithelial sensory receptor cell

Figure 5-3: The types of sensory receptors

Properties of neurons

These cells have three fundamental physiological properties

1- **Excitability (irritability)**: Neurons possess excitability, the ability to respond to environmental changes (stimuli).

2- **Conductivity**: Neurons respond to stimuli by producing traveling electrical signals that quickly reach other cells at distant locations.

3- **Secretion**: Neurons secrete neurotransmitters to stimulate next cells.

Types of neuroglia (glial cells)

Neuroglia protect the neurons and aid their function. In fact, neuroglia far outnumber neurons in most organisms. For example 90% of the cells in the human brain are neuroglia. There are six types of neuroglia. Four types occur in the CNS (fig.5-4) and two types in PNS (fig.5-5).

Neuroglia of CNS

1- **Oligodendrocytes:** Form myelin in brain and spinal cord.

2- **Astrocytes:** Cover brain surface and nonsynaptic regions of neurons; form supportive frame work in CNS; induce formation of blood-brain barrier; nourish neurons; produce growth factors that stimulate neurons; remove neurotransmitters and K from ECF of brain and spinal cord; help to regulate composition of ECF; form scar tissue to replace damaged nervous tissue; Enhance synapse formation; Communicate by chemical means among themselves, and with neurons and may influence synaptic signaling.

3- **Ependymal cells**: Line cavities of brain and spinal cord; secrete and circulate cerebrospinal fluid. Serve as neural stem cells with the potential to form new neurons and glial cells.
4- **Microglia**: Phagocytize and destroy microorganisms, foreign matter, and dead nervous tissue. Release nerve growth factor.

Neuroglia of PNS

1- **Schwann cells**: Form neurilemma around all PNS nerve fibers and myelin around most of them; aid in regeneration of damaged nerve fibers.
2- **Satellite cells**: Surround somas of neurons in the ganglia; function uncertain.

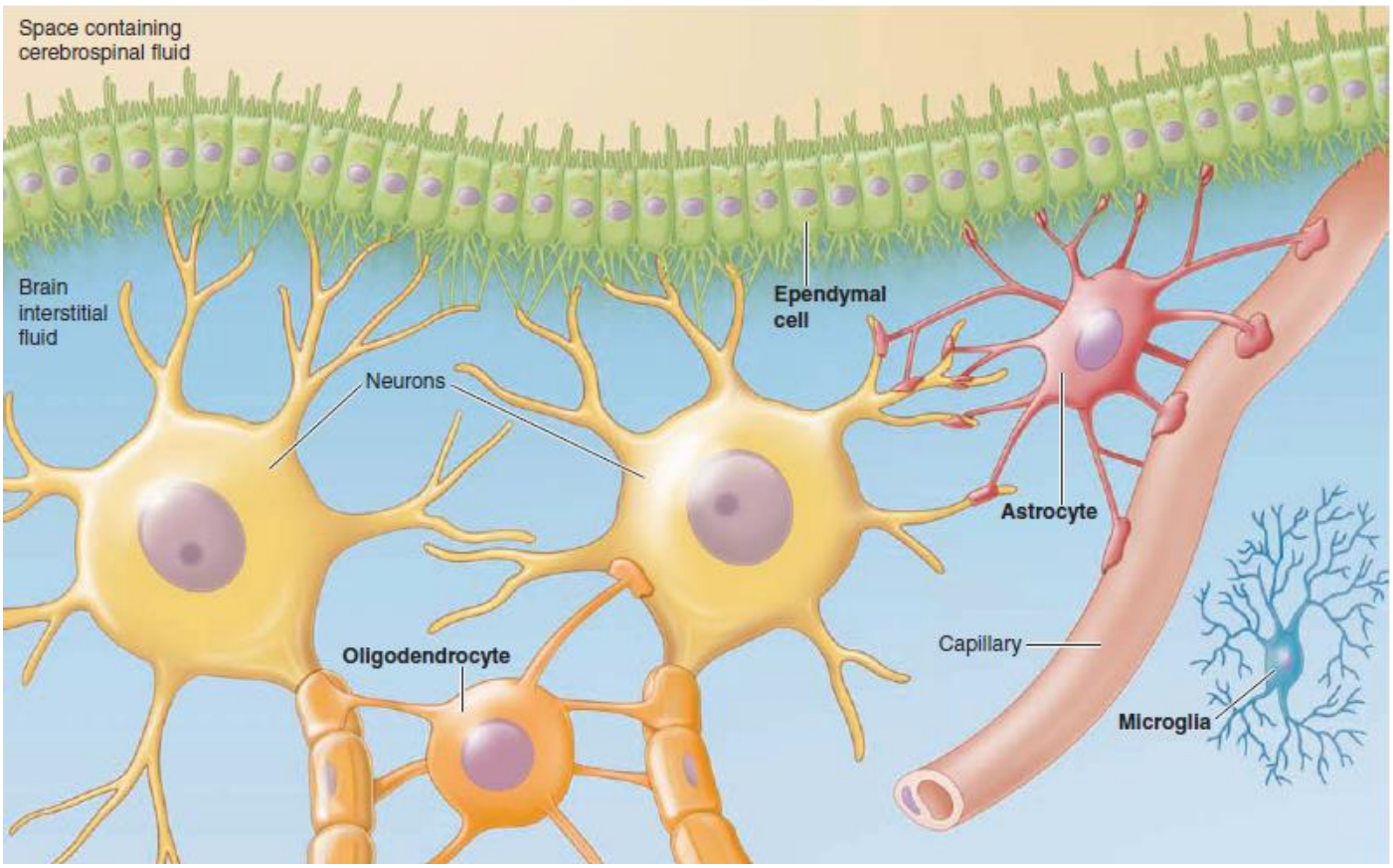


Figure 5-4: Neuroglia of the Central Nervous System.

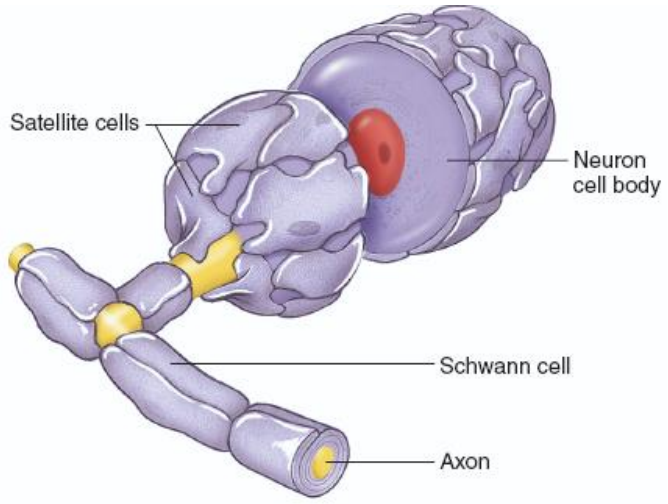


Figure 5-5: Neuron cell bodies within ganglia are surrounded by satellite cells

Types of nerve fibers

The conduction of action potential (nerve impulse) occurs in myelinated nerve fiber is much faster than that in unmyelinated nerve fiber. Among various myelinated nerve fiber, thicker the fiber or greater the internodal distance, greater is the conduction velocity. Thus on the basis of their diameter and conduction velocity, nerve fibers have classified as follows:

Nerve Fibre Type	Function	Fibre Diameter (μm)	Conduction Velocity (m/s)
A (myelinated)			
α	Proprioception, somatic motor	12–20	70–120
β	Touch, Pressure	5–12	30–70
γ	Motor to muscle spindles	3–6	15–30
σ	Pain, cold and touch	2–5	12–30
B (myelinated)	Preganglionic autonomic	<3	3–15
C (unmyelinated)	Postganglionic autonomic, pain, temperature	0.3–1.0	<2–5

Proprioceptor: A sensory receptor of the muscles, tendons, and joint capsules that detects muscle contractions and joint movements.

Questions

1- True or False: Anaxonic neurons are found only in the brain
2- What are the functions of a- Motor neurons b- Astrocytes
3- Draw the following with labeling a- Purkinje cell b- oligodendrocyte
4- Why brain tumors usually do not yield to chemotherapy and must be treated with radiation or surgery.
5- Define Proprioceptors

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