

Animal Physiology

Topic: Nervous System

Badiozaman Sulaiman

BSc.(UKM), MSc.(USM) – Molecular Biology

Department of Zoology

Faculty of Resource Science & Technology

Universiti Malaysia Sarawak



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At the end of the unit, you should be able to:

- 1. Discuss the coordination process in nervous system.**
- 2. Compare the invertebrate and vertebrate nervous organizations.**
- 3. Describe the somatic and autonomic nervous systems.**
- 4. Explain the function, structure and types of neurons**

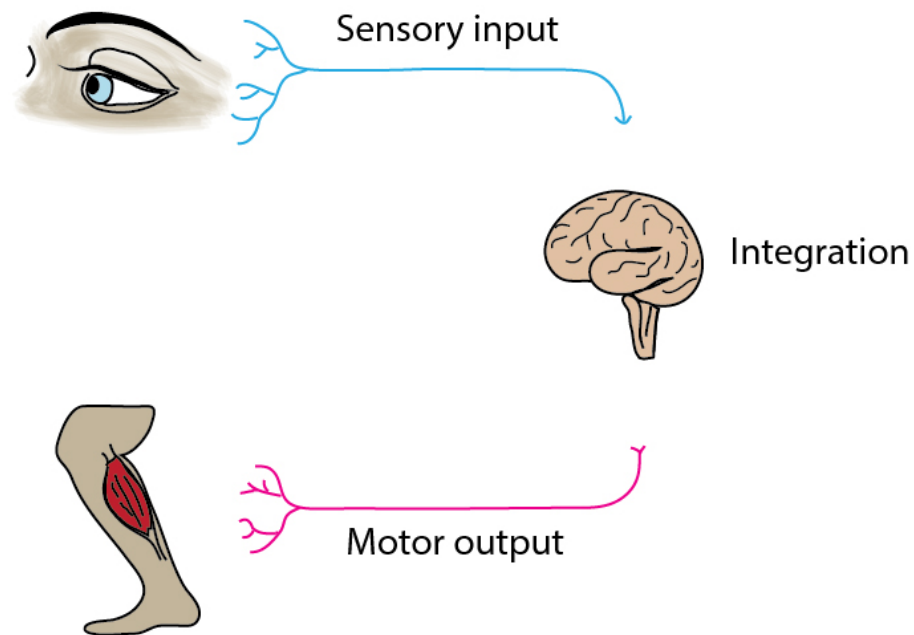


Nervous System

- Consists of neural network that **coordinate voluntary and involuntary actions** in the body.
- Coordination is carried out via **three overlapping functions**;
 - 1. Sensory input.**
 - 2. Integration.**
 - 3. Motor output.**



Coordination pathway



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Nervous organization - Invertebrate

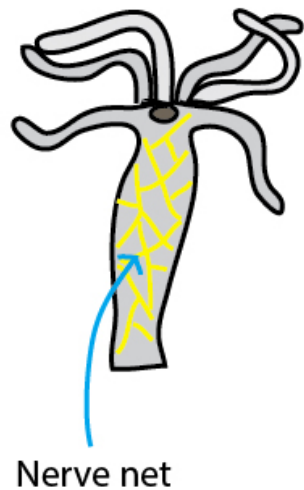
- The complexity of nervous organization in an organism determines its capacity for integration.
- Brain, which is the center for integration, is formed from concentration of neurons in the head region = **cephalization**.
- Simple invertebrates such as hydra (cnidarian) and starfish (echinoderm) are lacking of cephalization.



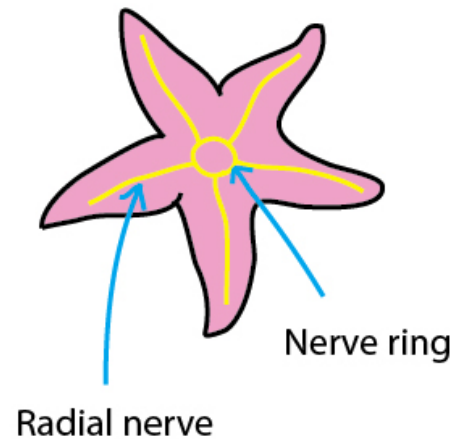
Cephalization

- Cephalization start to appears in flatworm (planarian) and higher invertebrates (annelid, arthropod, mollusk).

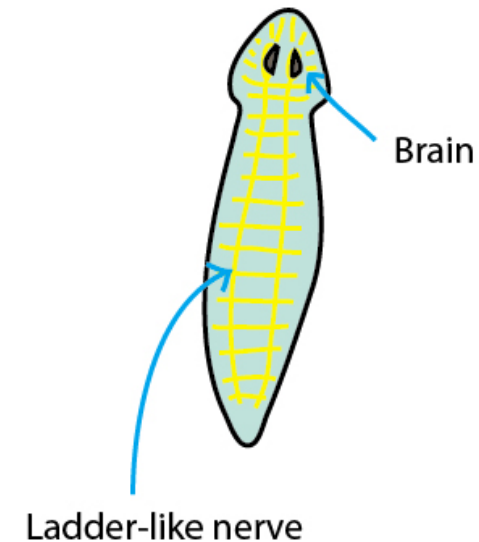
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Hydra



Starfish



Flatworm

Nervous organization - Vertebrate

- The vertebrate exhibits **high degree of cephalization and elaborate nervous system.**
- Organization of the vertebrate nervous system can be classified into **two components:**
 - 1. Central nervous system (CNS).**
 - 2. Peripheral nervous system (PNS).**

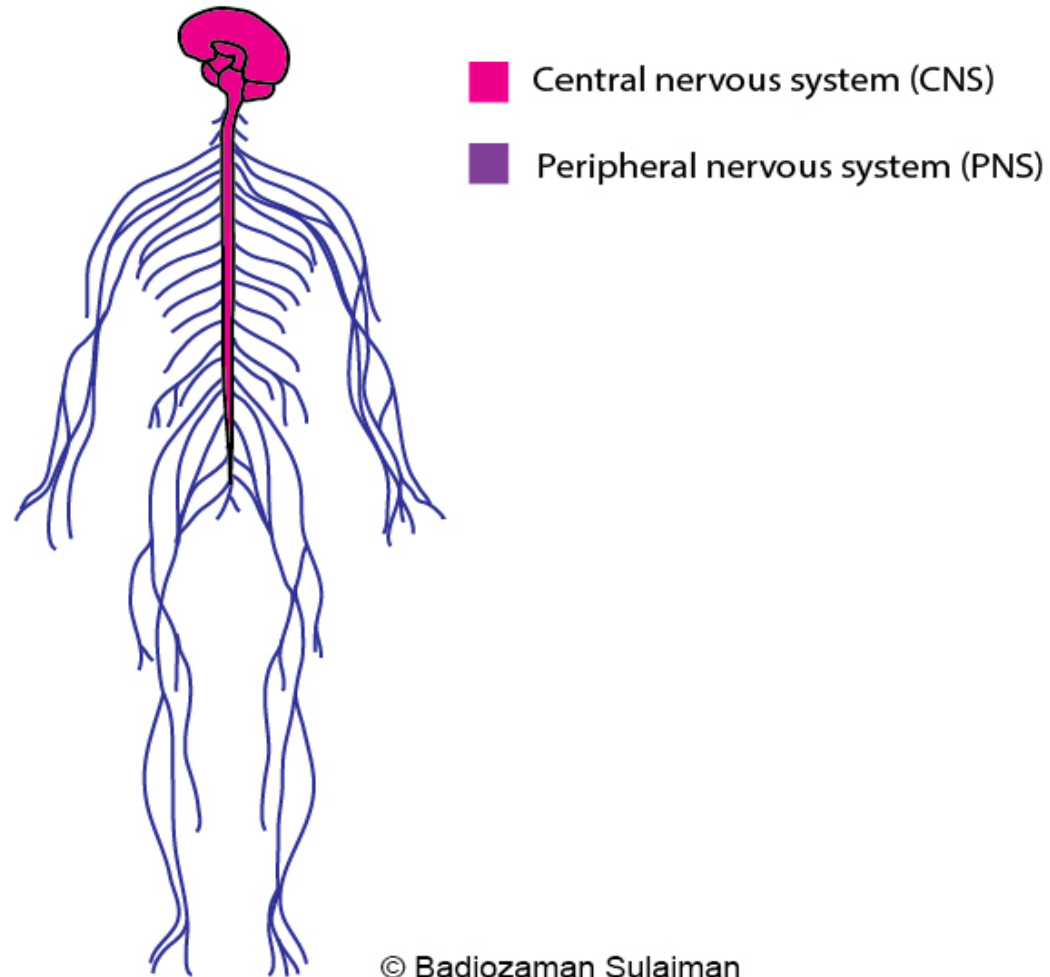


Nervous organization – Vertebrate (continue)

- The CNS consist of **brain** and **spinal cord**.
 - It receives sensory formation from the PNS, performs integration and initiates motor command.
- The PNS consist of **all the nerves that branched out from the CNS**.
 - It carries sensory information to the CNS, and sends motor command to the muscles and glands.



CNS and PNS



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Control system

- In the PNS, sensory information is conveyed through the **sensory (afferent) neurons** and motor command is conveyed through the **motor (efferent) neurons**.
- The motor neurons are functionally divided into two categories:
 - **Somatic nervous system** that regulate **voluntary actions** such as walking.
 - **Autonomic nervous system** that regulate **involuntary actions** such as hormone secretion and peristalsis.



Division of the autonomic system

- The autonomic nervous system have of **two divisions** that control opposite reactions:
 - **Parasympathetic Division**
 - Promotes responses that are associated with a **relaxed state**.
 - E.g. causes the pupil to constrict and promotes digestion.
 - **Sympathetic Division**
 - Promote responses that are associated with an **active state**.
 - Crucial in the **fight or flight** situation.
 - E.g. inhibits digestion process and accelerates heartbeat.



Neuron

- Neuron (or nerve cell) is the **structural and functional unit** of the nervous system.
- Sensory information and motor command are conveyed through a neural network in the form of **nerve impulse**.
- The neuron constitute of three parts:
 1. **Dendrites** – the portion of neuron that **receives nerve impulse** from sensory receptor or other neurons.
 2. **Cell body** - the main body that contains nucleus and organelles.
 3. **Axon** – the portion of the neuron that **conveys nerve impulse** to another neuron or target cells.

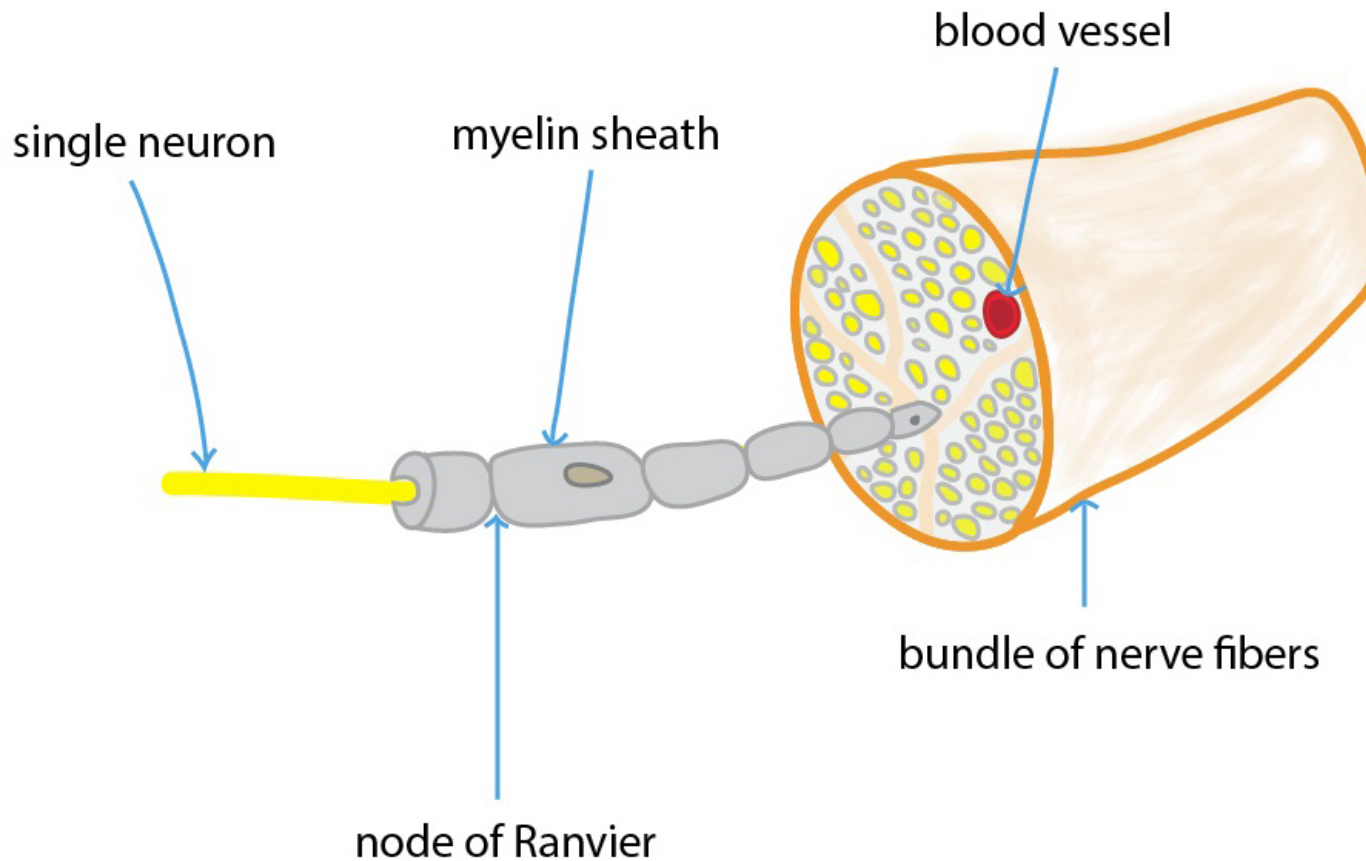


Neuron (continue)

- In myelinated neurons, the axons are covered with insulating layer called the **myelin sheath**.
- The myelin sheath is formed from membranes of tightly spiraled **neuroglia** - cells that provide support and nourishment to the neuron.
 - In PNS, the **Schwann cells** perform this function.
 - The gap between myelin sheath is called the **nodes of Ranvier** or **neurofibril nodes**.
- The neurons are bundled together into **nerve fibers**.
 - A single nerve network contain several bundles of nerve fibers wrapped together.



Nerve fibers



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Types of neurons

- **Sensory (afferent) neurons** carry nerve impulses from sensory receptors to the CNS.
 - Sensory receptors may be a part of sensory neuron itself (e.g. pain receptor) or a specialized cell that forms a synapse with a sensory neuron.
- **Interneurons** convey nerve impulses between various parts of the CNS.
- **Motor (efferent) neurons** deliver nerve impulses from CNS to muscles or glands.
 - Have many dendrites and a single axon.
 - Cause muscle to contract or glands to secrete.



Further reading:

Reece, Urry, Cain, Wasserman, Minorsky & Jackson. (2013). Campbell Biology (10th edition). Benjamin Cummings.

Willmer, Stone & Johnston. (2005). Environmental Physiology of Animals (2nd edition). Blackwell Publishing.

