Nervous Tissue

Dr. Archana Rani
Associate Professor
Department of Anatomy
KGMU UP, Lucknow
Introduction

- Property of irritability and conductivity
- Respond to various types of stimuli
- Distributed throughout the body as an integrated network
- Made up of 2 cell types:
  (a) Nerve cells (neurons)
  (b) Glial cells (neuroglia)
The Neuron

• Excitable, independent anatomic and functional units with complex morphological characteristics.

• Neurons = nerve cells
  – Cells specialized to transmit messages
  – Major parts of neuron:
    • Cell body — nucleus and metabolic center of the cell (main part of nerve cell)
    • Processes — fibers that extend from the cell body
      – can be microscopic or up to 3-4 feet in length
Anatomy of a Neuron

- Dendrite
- Cell body
- Mitochondrion
- Nissl substance
- Axon hillock
- Axon
- Collateral branch
- Neurofibrils
- Nucleus
- One Schwann cell
- Node of Ranvier
- Schwann cells, forming the myelin sheath on axon
- Axon terminal

(a)

(b)

Cell body
Nucleus
Dendrite
Nerve Cell Body (Perikaryon or Soma)

- Contains the nucleus and a nucleolus
- Major biosynthetic center
- Focal point for the outgrowth of neuronal processes
- Absence of centrioles (hence its amitotic nature)
- Prominent basophilic Nissl bodies (rough ER)
- Contains an axon hillock – cone-shaped area from which axons arise
- Cytoskeleton of neuron is formed by microtubules & neurofilaments
Processes

• Arm like extensions from the soma
• Nerve fibre: term used for nerve cell process
• Two types of processes: axons and dendrites
• Myelinated axons are called tracts in the CNS and nerves in the PNS
Dendrites

• Short, tapering processes
• Branch extensively to form “Dendritic tree”
• They are the receptive or input regions of the neuron
• Absence of Golgi complexes
Axon

- Slender processes of uniform diameter arising from the axon hillock
- Axon hillock lacks RER, ribosomes & Nissl substance
- Nissl substance is also absent in cytoplasm of axon
- Usually there is only one unbranched axon per neuron
- Axon terminals (terminal boutons)
- Axolemma
- Axoplasm
Axons: Function

• Generate and transmit action potential
• Secrete neurotransmitters from the axonal terminals
• Movement along axons occurs in two ways
  – Anterograde — toward the axon terminal
  – Retrograde — toward the cell body
Classification of Neuron

• **Structural:**
  – Multipolar — three or more processes
  – Bipolar — two processes (axon and dendrite)
  – Unipolar (pseudounipolar)— single, short process (usually dendrite)
  – Anaxonic
Structural Classification of Neurons

(a) Anaxonic neuron

(b) Bipolar neuron

(c) Unipolar neuron

(d) Multipolar neuron
Classification of Neuron (contd...)

• Functional:
  – Sensory (afferent) — transmit impulses toward the CNS
  – Motor (efferent) — carry impulses toward the body surface
  – Interneurons (association neurons) — any neurons between a sensory and a motor neuron
Synapse

- Specialized region of contact between two neurons
- Nerve impulse is transmitted from one neuron to another through neurotransmitters
- 3 varieties: axodendritic, axosomatic, axoaxonic
- Parts: presynaptic part, synaptic cleft, postsynaptic part
Myelin

• Myelin sheath — whitish, fatty material covering axons
  — protects/insulates the cells and increases the transmission rate of nerve impulses

• Myelin is produced by Schwann cells in PNS and Oligodendrocytes in CNS

• Nodes of Ranvier — gaps in myelin sheath along the axon
The Neuroglia

- Supporting cells in the Central Nervous System (CNS) are grouped together as Neuroglia.
- Neuroglia literally means “nerve glue”.
- The function of neuroglia is to support, insulate, and protect the delicate neurons of the brain.
- In H & E staining, only their nuclei can be seen.
- Capable of multiplying in mature nervous tissue.
- Cannot generate or transmit the impulse.
Types of Neuroglia in CNS

• Astrocytes
  – Star-shaped cells
  – Processes have expanded ends that attach to the walls of blood capillaries
  – 2 types: Protoplasmic (in grey matter) and fibrous (in white matter)
  – Control the chemical environment of the brain (forming blood-brain barrier)
Microglia

- Spiderlike phagocytes (white blood cells)
- Dispose of debris like dead brains cells and bacteria
Ependymal cells

- Lines the cavities of the brain and spinal cord
- Circulate cerebrospinal fluid by beating their cilia
- Arranged in a single layer
- Ciliated cuboidal or columnar shaped
Oligodendrocytes

- Small, round cells with few cytoplasmic processes
- Produce myelin sheaths
- Myelin is a fatty, insulation covering the nerve cells; allows the electrical signal to transmit faster (like wire coating)
Types of Neuroglia in PNS

- **Satellite cells**
  - Surround the nerve cells of ganglia
  - Flattened cells with prominent nuclei
  - Insulate & support neurons of ganglia

- **Schwann cells**
  - Form myelin sheath in the peripheral nervous system
  - Flattened cells with flattened nucleus

---

(e) Sensory neuron with Schwann cells and satellite cells
Myelin
Clinical Application

• Gliomas
• Schwannoma
• Medulloblastoma
Multiple Sclerosis

- Affects the ability of nerve cells in the brain and spinal cord to communicate with each other.

- The body's own immune system attacks and damages the myelin.
Nerve fibres

• Axon enveloped by special ectodermal sheaths
• Surrounding plasma membrane is termed the axolemma
• Structurally, surrounded by 3 connective tissue sheaths:
  Endoneurium, perineurium and epineurium
References


MCQ

- The structural and functional unit of nervous system:
  1. Nerve cell
  2. Dendrites
  3. Axon
  4. Neuroglia
MCQ

• Nissl bodies are aggregation of:
  1. Mitochondria
  2. Rough endoplasmic reticulum
  3. Smooth endoplasmic reticulum
  4. Golgi apparatus
MCQ

• The cell responsible for formation of blood-brain barrier is:

1. Astrocyte
2. Oligodendrocyte
3. Ependymal cells
4. Microglia
MCQ

• The cell responsible for formation of myelin sheath in peripheral nervous system:
  1. Schwann cell
  2. Ependymal cell
  3. Oligodendrocyte
  4. Satellite cells
The phagocytic activity is a feature of:
1. Astrocyte
2. Oligodendrocyte
3. Microglia
4. Schwann cell