

## HSE208 Notes

### Module 1 – Nervous System

#### **Nervous system overview**

- one of our whole-body regulatory systems
- uses tiny electrical impulses (action potentials) to communicate messages around the body
- These messages can travel from the periphery to the central nervous system (CNS), from one location within the CNS to another location within the CNS and from the CNS to the periphery
- The central nervous system (CNS) consists of:
  - brain
  - spinal cord
- The peripheral nervous system (PNS) contains:
  - the sensory (afferent)
  - somatic motor (efferent)
  - autonomic (efferent) divisions.

#### **Neurons and Glial Cells**

- ~100 billion neurons and glia cells
- glia 10x more numerous
- *neurons communicate!*
  - Electrical impulses
- Glial support the neurons

#### **Structure of Neurons**

- cell body
- dendrites
- axon hillock (initial segment)
- axon
- axon terminals (synaptic terminals)
- myelin
- nodes of Ranvier

#### **Cell membrane:**

- Selectively permeable barrier regulating exchange into and out of cell

#### **Cell body (Soma)**

- Site of integration of incoming signals and initiation of outgoing signals

#### **Dendrite**

- Receives incoming information

#### **Nucleus**

- Contains cellular DNA

#### **Axon Hillcock**

- Site of summation of action potentials before being transmitted to axon

### **Initial segment of axon**

- Site of action potential initiation

### **Axon**

- Carries action potentials away from cell body to different locations around body

### **Telodendria**

- Allows communication of signal from single neuron to multiple locations

### **Synaptic terminals**

- Site of information transmission from one cell to another

### **Oligodendrocyte**

- Produces myelin sheath for neurons located within the central nervous system

### **Functions of Neurons**

- facilitate the movement of electrical impulses (action potential)
- cells for rapid communication
- axon is responsible for transmitting action potential

### **Classification of Neurons**

- shape
  - bipolar
  - unipolar
  - multipolar
- function
  - afferent
  - efferent
  - interneuron
- type
  - Neuron
    - stellate
    - pyramidal
  - Glial cell
    - astrocyte
    - oligodendrocyte
    - microglia
    - macrophage
- Locus
  - Central
  - Peripheral
  - Presynaptic
  - Postsynaptic

## Function Category of Neurons

- afferent
  - sensory neuron
  - cell body is in the dorsal root ganglion and the central axon terminal is in the spinal chord
  - convey information from the tissues and organs of the body towards the CNS
  - transmit information into the CNS from receptors at their peripheral endings
  - single process from the cell body splits into a long peripheral process (Axon) that is in the PNS and a short central process (Axon) that enters the CNS
- efferent
  - motor neuron
  - convey information away from the CNS to effector cells like muscle, gland or other cell types
  - transmit information out of the CNS to effector cells, particularly muscles, glands, neurons and other cells
  - cell body with multiple dendrites and a small segment of the axon are in the CNS; most of the axon is in the PNS
- interneuron
  - function as integrators and signal changers
  - connect neurons within the CNS
  - integrate groups of afferent and efferent neurons into reflex circuits
  - lie entirely within the CNS
  - account for > 99% of all neurons

## Locus Category of Neurons

- presynaptic
  - conducts a signal toward a synapse
- postsynaptic
  - conducts signals away from a synapse
  - post ganglionic sympathetic neuron onto a smooth muscle cell does not have acetylcholine as its primary neurotransmitter
  - blood barrier
  - regulates what substances get through the blood and what does not

## Types of Glial Cells

- Oligodendrocytes
  - Forms the myelin sheath of CNS axons
- Astrocytes
  - Helps regulate the composition of the extracellular fluid in the CNS by removing potassium ions and neurotransmitters around the synapses
  - Stimulates the formation of tight junctions between the cells that make up the walls of the capillaries found in the CNS
    - this forms the blood-brain barrier, which is a more selective filter for exchanged substances than is present between the blood and most other tissues
  - sustain the neurons metabolically e.g. by providing glucose and removing the secreted metabolic waste product ammonia
  - ECF composition, blood-brain barrier

- Microglia
  - Specialized, macrophage-like cells that perform immune functions in the SNS
  - Also contribute to synapse remodeling and plasticity
  - macrophage-like
- Ependymal cells
  - line fluid filled cavities within the brain and spinal cord
  - regulate the production and flow of cerebrospinal fluid

### **Myelin Sheath**

- concentric layers of membrane that insulate axons
- increase the speed and efficiency at which action potentials travel along axons (saltatory conduction)
- Consist of 20 to 200 layers of highly modified plasma membrane wrapped around an axon by a nearby supporting cell
- Allows electrical impulses to transmit quickly and efficiently along the nerve cells
- In the brain and spinal cord, these myelin-forming cells are a type of glial cell called Oligodendrocytes
- In the PNS, glial cells called Schwann cells form individual myelin sheaths surrounding 1 to 1.5 mm long segments at regular intervals along some axons
- Formed by;
  - Oligodendrocytes = CNS
  - Schwann cells = PNS
 (collectively called glial cells)

### **Multiple Sclerosis**

- MS is an autoimmune disease that attacks the myelin sheath
- Scarring forms in myelinated nerves
  - This scarring only affects myelin within the CNS
- Myelin becomes inflamed, detached and destroyed
- Can occur at multiple sites in the CNS
- Leaves scarring over axon: sclerosis = scar
- Disrupts ability of impulses to travel along axons
- Symptoms depend on nerves affected
- Test for MS:
  - Rapid response tasks (measure reaction time)
  - Rapid coordination of peripheral body parts (e.g. fine tapping task)
  - Reading/detection of colours (Except blurring of fine visual details)