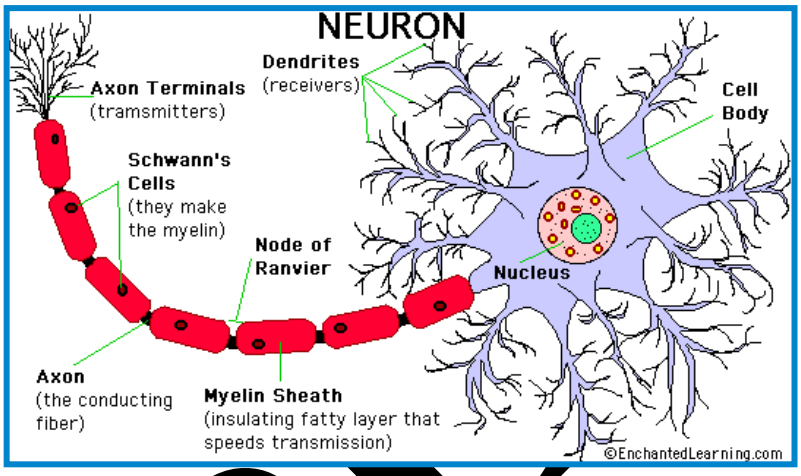
# Advanced Human Bioscience SUMMARY NOTES

## Topic 1: Introduction to the Nervous System

❖ **Name the parts of a generalised neuron & indicate the input, output and integration areas of the neuron.**




➢ Neurons are the functional cell of the nervous system that transmit electrochemical messages called **nerve impulses** or **action potentials** to other neurons and effectors (muscles or glands).

Parts of a neuron:

➢ ***Cell body*** *(or soma)*: contains relatively large nucleus with a prominent nucleolus and produces proteins needed for other parts of the neuron. Cluster of cell bodies = ganglia.

➢ ***Dendrites:*** [INPUT] highly branched 'finger-like' projections that receive information from other neurons.

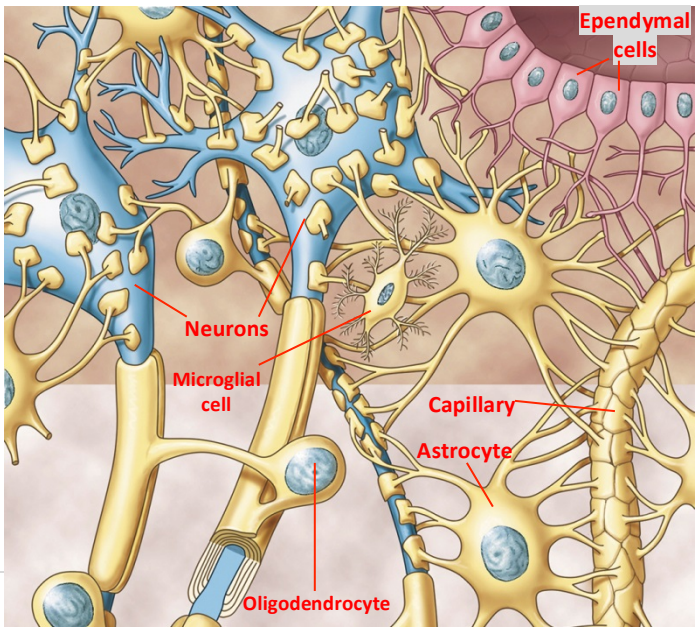
➢ ***Axons***: [INTEGRATION] long nerve fibre that are capable of propagating electrical impulses known as action potential through the from cell body to axon terminal (*Electrical impulses rarely travel the other way). Cluster of neuron axons = nerves

➢ ***Axon terminal***: [OUTPUT] nerve endings that make synaptic contacts with other neurons and effector cells, they also contain various kinds of neurotransmitters (chemicals which convey the message across the synapse).

➢ ***Myelin sheath***: the insulating covering around axons which increases the speed at which electrical impulses travel along the neuron (*Not all neurons have a myelin sheath, only the ones that need fast electrical impulses).

➢ A single neuron may receive many inputs (inhibitory or excitatory) to produce a single output response (action potential/nerve impulse).
  - This allows large amounts of info to be processed very quickly and acted upon.

❖ **List the roles of glial cells in the nervous**




➢ The nervous system also contains specialised Glial cells which protect and support neurons.

There are four types of neuroglia:

➢ **Astrocytes**:
  - Structural support
  - Formation of scar tissue
  - Transport of substances between blood vessels and neurons

- Communication with one another and with neurons
- Mop up excess ions and neurotransmitters
- Induce synapse formation.

➢ **Oligodendrocytes**:
- Form myelin sheaths in the brain and spinal cord (e.g. multiple sclerosis = myelin sheath deteriorates and signals slower)
- Produce nerve growth factors

➢ **Microglia**:
- Structural support
- Phagocytosis (immune protection as normal body immune cells don't get into the CNS).

➢ **Ependymal cells**:
- Form a porous layer through which substances diffuse between the interstitial fluid of the brain and spinal cord and the cerebrospinal fluid.

❖ **Explain in broad terms, what a membrane potential is, and what is required for it to exist.**

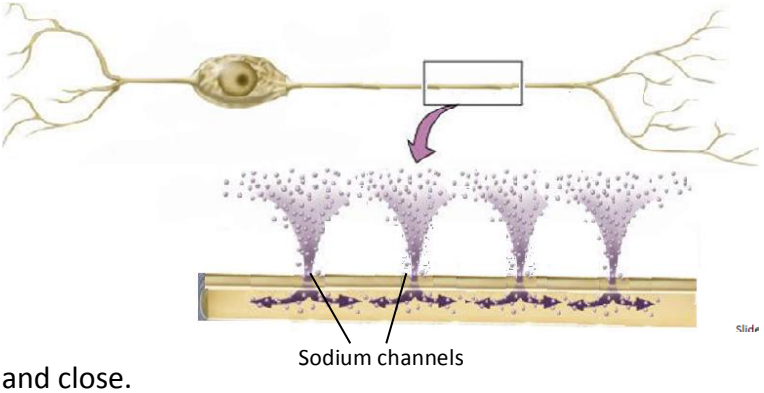
➢ All cells have a **membrane potential**, which is a difference in charge between the inside and outside of cells.
➢ Only nerve cells and muscle cells can rapidly change their membrane potential as a means of creating a signal. This means these are excitable cells.

➢ In rest state the inside of nerve cells are negative with respect to the outside of cells.
➢ The voltage arises from differences in concentration of the electrolyte ions $K^+$ and $Na^+$.
➢ Specific sodium channels and potassium channels are intrinsic to the membrane and selectively close and open to allow the passage of these ions across the membrane.

➢ At rest, sodium channels are mostly closed and potassium channels open, so potassium moves down the concentration gradient out of the cell making is less negative to the outside.
➢ This is known as resting membrane potential.
➢ The concentration gradient is maintained by active transport (using ATP) of sodium ions out of cell and potassium ions in.
➢ Known as the sodium-potassium pump.

❖ **Describe how depolarisation and repolarisation are achieved in a neurone.**

➢ **Depolarisation** is what allows neurons to signal, which is the rapid reversal of the membrane potential from its resting state.
➢ Sodium channels are open allowing sodium ions into the cell making it positive to the outside.
➢ After the signal, **repolarisation** occurs, where sodium channels close and potassium channels open allowing potassium to move out of cell and stop sodium moving into cell, creating a resting membrane potential again (negative inside).
➢ A "wave" of depolarisation and repolarisation moves rapidly along the axon of neurones and more sodium channels open and close.
➢ This process is known as **nerve impulses**.



- This electrical communication converts to chemical communication at the axon terminal where the arrival of the action potential triggers the release of a neurotransmitter into the synapse.
- This neurotransmitter diffuses across the synapse, binds to receptors on the other neuron and activating them and creating another action potential (message) which will travel down the axon.
- The message is then terminated as the neurotransmitter is deactivated by being transported back to the axon terminal.

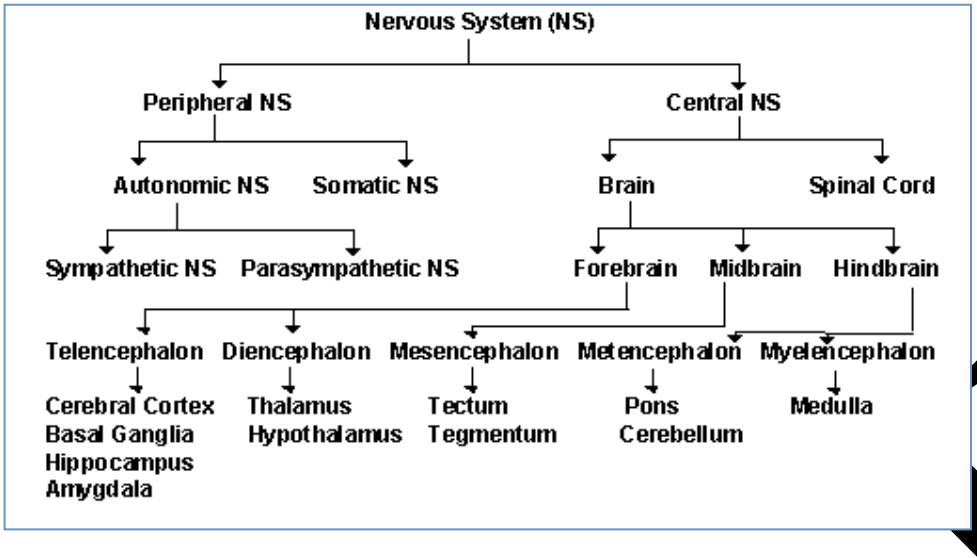
❖ **Explain briefly why myelin increases the rate of conduction of axons.**

- In an unmyelinated axon, the action potential travels along rapidly, but the sodium channels have to be opened all the way along to keep the action potential going. This channel opening takes time.
- Myelin creates a vacuum-like tunnel for the action potential to swiftly travel through before reaching a sodium channel that is further apart from the previous channel with the addition of myelin.

❖ **Describe the following divisions of the nervous system & their relationships: Central & peripheral, Somatic & autonomic, Sensory & motor.**

*The nervous system is divided into two parts*:

- **Central Nervous System (CNS):**
  - The CNS consists of two parts:
    - Brain (external grey matter = cell bodies with internal white matter = axons)
    - Spinal cord (external white matter = axons with internal grey matter = cell bodies)
- **Peripheral Nervous System (PNS):**
  - The PNS consists of two parts:
    - Spinal nerves (31 pairs of nerves, each one emerging from different level of the spinal cord and supplying different segments of the body. Spinal nerves lead into peripheral nerves).
    - Cranial nerves (12 pairs of nerves, each emerge from different position in the brain supplying different structure or group of structures).
  - The PNS is divided into two main parts:
    - Somatic nervous system (SNS): controls skeletal muscle, joints, tendons and skin: things we **voluntarily** control.
    - Autonomic nervous system (ANS): control our autonomic (involuntary) activities in glands and organs. This ANS is divided into three parts:
      - Sympathetic ('fight or flight'): controls short-lived behaviour
        - E.g. increased HR, respiration rate, adrenalin released, slows down or turns off non-essential processes such as digestion & immune response to conserve energy in case needed.
      - Parasympathetic ('rest and digest'): maintains stable body functioning in normal conditions.
      - Enteric Nervous system: The enteric nervous system is a meshwork of nerve fibres that innervate the viscera (gastrointestinal tract, pancreas, gall bladder).




- The NS can be further divided into parts based on function:
  - **Motor**: efferent – responses going out from [illegible] to environment through:
    - Somatic motor functions:
      - Movement of skeletal muscles (e[illegible]phragm, [illegible]rynx)
      - Facial muscles
    - Autonomic motor functions:
      - Movement of sm[illegible]mus[illegible]es (e.g. blood vessels, airways, intestines)
      - Gland a[illegible]y
  - **Sensory**: afferent – str[illegible]ning in to [illegible]m environment through:
    - Somatic sensory fun[illegible]:
      - Senses i.e. *touch, taste, smell, hearing, vision and balance* (equilibrium in middle ear)
      - Joi[illegible]s and muscle length (stretch contraction).
    - Autonomic sensory [illegible]nctions:
      - Chemoreceptors (samples blood for $O_2$ & $CO_2$)
      - Stretch [illegible]ceptors (in hollow structures e.g. gut, bladder, uterus to check if full or empty).
      - [illegible]receptors (tests how stretched vessels are = monitors BP).

❖ **Describe the components of a reflex arc, using a simple reflex as an example.**

1. [illegible]ronment
2. Sensory receptors detect change
3. Change relayed to Central integrator (CNS) via sensory (effect) neurons
4. Action p[illegible]tial is transferred to motor (afferent) neuron through interneuron
5. Effectors then respond to stimuli

Example: Stretch reflex (somatic)

1. Muscle is stretched by hammer tapping tendon in knee
2. This stretching is detected by the sensory skeletal muscle in leg
3. Action potentials travel along the sensory neuron into the spinal cord
4. Sensory neuron synapses with a motor neuron in the grey matter of the spinal cord
5. Motor neuron to muscle generates action potentials which cause the muscle to contract and the leg kicks as a response to tapping.

# Topic 2: The peripheral nervous system

❖ **Name and briefly describe the function of each of the 12 cranial nerves.**

| | | |
|---|---|---|
| **I Olfactory** | **S** | Smell |
| **II Optic** | **S** | Vision |
| **III Occulomotor** | **M** | Eye movements- 'up/down/up-in', pupil constriction, raising eyelids |
| **IV Trochlear** | **M** | Eye movements-'down & in-diagonal' (superior oblique muscle) |
| **V Trigeminal** | **S&M** | Sensation to head & face, including gums and teeth<br>Movement of muscles of mastication |
| **VI Abducens** | **M** | Eye movements- 'out' (lateral rectus muscle) |
| **VII Facial** | **S&M** | Taste from anterior 2/3 of the tongue<br>Movement of muscles of facial expression |
| **VIII Auditory (vestibuloccoclear)** | **S** | Hearing, balance |
| **IX Glossopharyngeal** | **S&M** | Taste from posterior 1/3 of the tongue<br>Swallowing, salivary secret |
| **X Vagus** | **S&M** | Sensory & motor autonomic s to most org s |
| **XI Accessory** | **M** | Movement of neck , volu wallowing & vocal cords |
| **XII Hypoglossal** | **M** | Tongue movem ts. |

Cranial nerves acronym:

'Oh Once One Takes The Anatomy Final Very Go V ations Are Heavenly'

Sensory/motor or both: 'Some Say Marry M ney, But M B ther Says Big Brains Matter More'