ANSWERS

Neurons & Nerve Transmission

Q1. Define the term 'action potential'.

The rapid depolarisation and repolarisation of the cell membrane / axon.

Q2. Complete the table below:

State	Membrane Potential (mV)	Event/s *(describe membrane proteins involved, movement of ions etc.)*
Rest / Polarised	-70mV	- more Na^+ outside, compared to inside. - high conc. of K^+ inside. - more -ive inside due to natural 'leakage' of ions across membrane (more K^+ leaks out) + due to Na/K pump (3xNa^+ out, 2xK^+ in)
Depolarisation	-70 → -55 → +30mV	- stimulus triggers Na^+ channels to open. - if exceeds threshold, voltage-gated Na^+ channels open + Na^+ enter. - becomes more +ive inside.
Repolarisation	+30 → -70 mV	- voltage-gated Na^+ channels close, voltage-gated K^+ channels open + K^+ ions more out - becomes more -ve inside membrane
Hyperpolarisation	-70 → -90 mV	- potassium channels slow to close, so more K^+ move out. - more -ive inside. - returns to RMP due to sodium-potassium pump and leakage channels (ions move).

Q3. All neurons have a threshold potential. Describe the events that occur to bring the membrane to the threshold potential. following a stimulus the

(1) - Sodium channels open + Na^+ enter

(2) - if there is enough Na^+ entering it will cause the potential to rise to -55mV (which is the threshold)

(3) once the threshold is exceeded, the rest of voltage-gated Na^+ channels open + an A.P will occur.

Q4. Explain what the refractory period is and how long it lasts for.

- The time (following a stimulus) during which a nerve cell cannot be stimulated again / A.P. cannot occur.

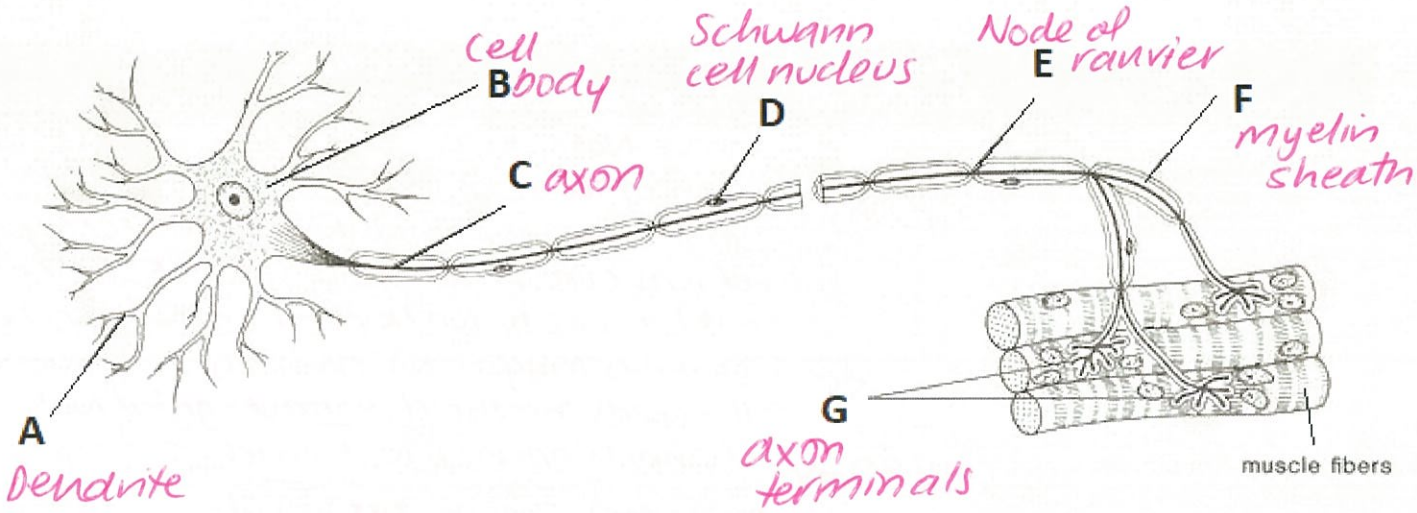
- lasts from -55mV (threshold) till when returns to RMP. approx 2.5-3m/s. (NOTE: you could show this on a graph)

Q5. a) Give the structural and functional classification of the neuron pictured below.

Structural: Multipolar

Functional: Motor (from CNS to effector)

b) Label structures (A-G).

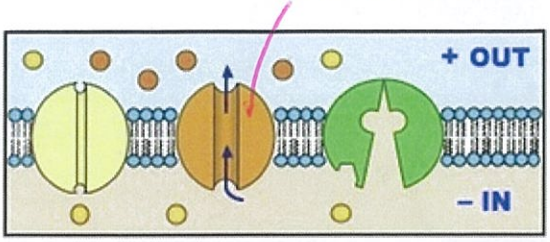


Q6. Contrast between nerve transmission along a myelinated and an unmyelinated fibre.

	Myelinated	Unmyelinated
Type of Transmission	Saltatory conduction	Continuous conduction
Structures involved	- Nodes of ranvier, - myelin - only sections of axon	- the entire axon - Does not have myelin + nodes. o.r.
Description of process	A.P. jumps from one node of ranvier to the next as ions cannot flow where myelin is present.	Depolarisation in one section, triggers depolarisation in adjacent section. A.P. travels along entire length of axon membrane
Speed of transmission	faster (up to 140m/s)	slower (up to 2m/s)
locations	white matter	Grey matter

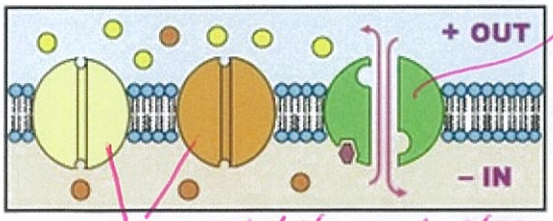
(will learn this after Chap. 4)

Q7. The following diagrams show different phases of nerve transmission (not in any particular order). Identify the state/phase for each.



voltage-gated K+ channel

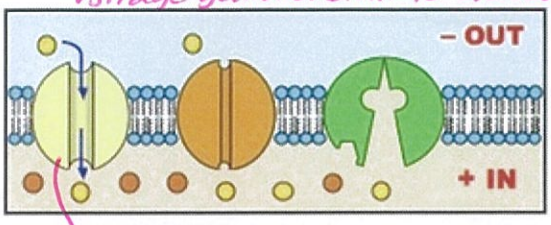
a) Repolarisation



Na/K pump.

b) Resting Membrane Potential / Polarised.

voltage gated channels closed.



c) Depolarisation

voltage gated Na+ channel

Q8. Complete the table below:

Structural Classification of Neurons

Type of Neuron	Number of dendrites connecting with the cell body	Number of axons	Examples
Bipolar	one	one	neurons in eye, ear + nose.
Multipolar	Many	one	motor (mos interneurons
Pseudounipolar	nil	one (which divides into two)	Sensory
Unipolar	nil	one	Not in humans

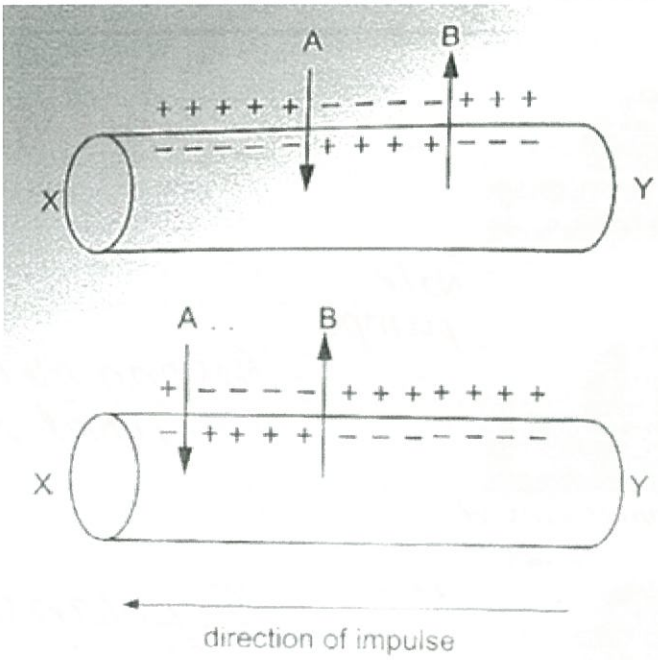
Q9. State the function/s of

a) Motor neurons:
carry nerve impulse from CNS (central nervous system) to effectors

b) Sensory neurons:
carry nerve impulses from receptors to CNS

c) Interneurons:
relay impulses between sensory and motor neurons (found in CNS).

Q10. The next two multiple choice questions refer to the diagram shown below, which represents a nerve impulse moving along the axon of a neuron. The flow of ions across the axon membrane is represented by arrows.



i) Which of the following is correct?

a) Arrow A represents potassium ions
b) Arrow B represents chloride ions
c) Arrow A represents sodium ions.
d) Arrow B represents calcium ions

ii) What is occurring between arrows A and B?

a) Action potential
b) Resting state
c) Repolarisation
d) myelination

Q11. Multiple sclerosis causes demyelination of nerve cells in the brain and spinal cord. Using your knowledge of nerve transmission, explain why the nerve cells in a person with this condition would unable to communicate effectively with one another.

- No myelin / loss of myelin will affect nerve transmission
- Myelin normally speeds up transmission, therefore in multiple sclerosis a person has slower than normal nerve transmission,
  → if travels to muscles = loss of muscular control / weakness of muscles.

Q12. Describe what is meant by the 'all or none response' and explain why it is that we are able to distinguish between stimuli of different intensities.

- The strength of the stimulus is not related to the size of the response.
- An A.P. will either occur (same way each time - if threshold exceeded) or not at all (if threshold not exceeded.
- Different intensities due to:
  - strong stimulus trigger more nerve fibers (number of fibres stimulated
  - strong impulses produce more impulses in a given time than a weak stimulus

Nerve Transmission – Fill in the blanks

- The potential for a neuron at rest is _-70mV_. The resting membrane potential is generated by differences in the ion concentrations of _extracellular_ fluids and _intracellular_ fluids, and the differential permeability of the membrane to those ions.
- The resting membrane potential is 'maintained' by passive _leakage_ channels and the _sodium_-_potassium_ pump (which ejects three _Na+_ out of the cell, to every two _K+_ back into the cell).
- During rest _voltage_-_gated_ channels are closed.
- A _stimulus_ will cause some _sodium_ channels to open and _sodium_ ions enter the cell.
- If there is enough sodium ions entering this will cause the membrane potential to rise to _-55mV_. This is known as the _threshold_ potential. Once the threshold is exceeded more sodium _voltage_-_gated_ channels open, causing a great influx of _sodium_ ions.
- During _depolarisation_, the inside becomes more _positive_ in relation to outside and the voltage rises quickly to _+30mV_.
- As soon as the voltage reaches +30mV, _sodium_ channels close and _potassium_ voltage-gated channels open causing _potassium_ ions to diffuse out of the neuron. This is known as _repolarisation_. During this phase the inside becomes _negative_ once again and the outside _positive_.
- During repolarisation the _potassium_ channels close _slowly_, allowing more _potassium_ ions to diffuse out of the membrane. This brings the potential below resting membrane potential. This dip in voltage is known as _hyperpolarisation_. The neuron then returns to resting potential.
- The depolarisation-repolarisation is known as an _action potential_.
- Once a section has undergone an action potential, it cannot be _stimulated_ again. This is known as a _refractory_ period.
- A refractory period ensures that an action potential does not _occur again_, but instead keep going in _one_ direction, from _dendrite_ to _axon_ terminals.
- If the axon is _myelinated_, then the action potential takes place between Schwann cells at the _nodes of ranvier_ at a much _faster_ rate. The name for this type of transmission is called _Saltatory conduction_.
- If the axon is _unmyelinated_, then the action potential occurs down the _entire_ length of the axon, as _depolarisation_ in one section triggers _depolarisation_ in the adjacent section. This type of nerve transmission is called _continuous conduction_.

NOTE: more K^+ leaks out due to more K^+ leakage channels

change direction OR