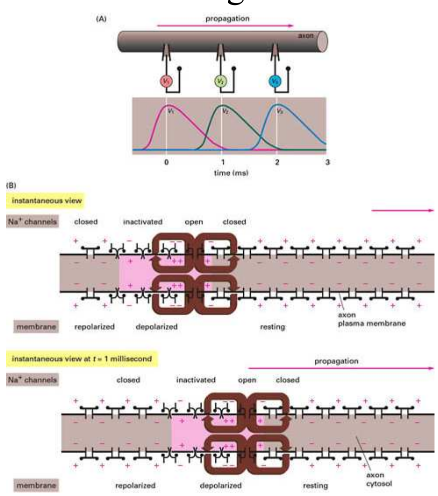
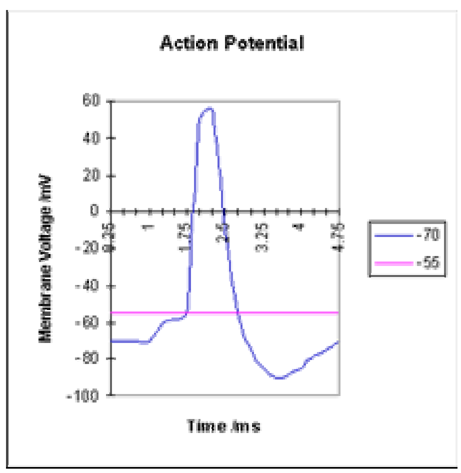
1.3 use diagrams to explain the mechanism of how a nerve impulse is initiated and propagated in a myelinated neurone. Include the following terms; threshold stimulation. Ion pump, local circuit, salutatory conduction, and refractory period.

The plasma membrane of neurons, like all other cells, has an unequal distribution of ions and electrical charges between the two sides of the membrane. The outside of the membrane has a positive charge, inside has a negative charge. This charge difference is a resting potential and is measured in millivolts. Passage of ions across the cell membrane passes the electrical charge along the cell. The voltage potential is -65mV (millivolts) of a cell at rest (resting potential). Resting potential results from differences between sodium and potassium positively charged ions and negatively charged ions in the cytoplasm. Sodium ions are more concentrated outside the membrane, while potassium ions are more concentrated inside the membrane. This imbalance is maintained by the active transport of ions to reset the membrane known as the sodium potassium pump (**ion pump**). The sodium-potassium pump maintains this unequal concentration by actively transporting ions against their concentration gradients.

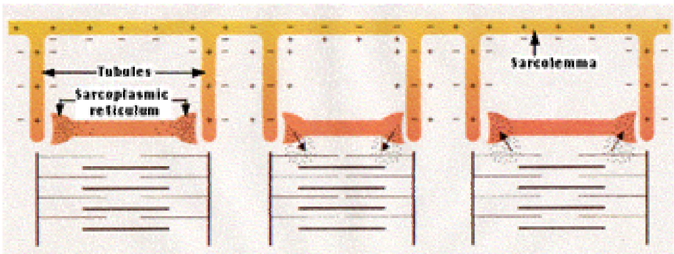


Changed polarity of the membrane, the action potential, results in propagation of the nerve impulse along the membrane. An action potential is a temporary reversal of the electrical potential along the membrane for a few milliseconds. When depolarisation of the **stimulation** site reaches a certain level this is called the **threshold**. Sodium gates and potassium gates open in the membrane to allow their respective ions to cross. Sodium and potassium ions reverse positions by passing through membrane protein channel gates that can be opened or closed to control ion passage. Sodium crosses first. At the height of the membrane potential reversal, potassium channels open to allow potassium ions to pass to the outside of the membrane. Potassium crosses second, resulting in changed ionic distributions, which must be reset by the continuously running sodium-potassium pump. Eventually enough potassium



ions pass to the outside to restore the membrane charges to those of the original resting potential. The cell begins then to pump the ions back to their original sides of the membrane.

The action potential begins at one spot on the membrane, but spreads to adjacent areas of the membrane, propagating the message along the length of the cell membrane. Electrical current can only leave the axon at the nodes of Ranvier where the axon is uncovered. The regions between the nodes do not produce any impulses, but allows ordinary electrical conduction as in a **local circuit**.



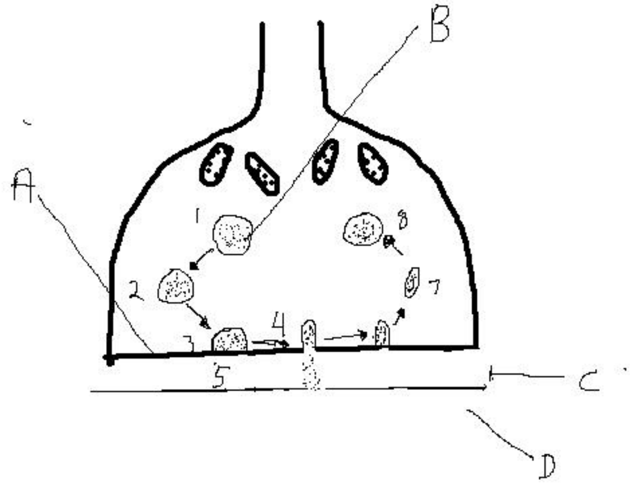
The T system and sarcoplasmic reticulum in resting muscle

An action potential reverses the polarity of the tubules releasing calcium ions (dots) from the sarcoplasmic reticulum. Their binding to troponin on the thin filaments "turns on" in interaction of actin and myosin, and the sarcomere shortens.

Restoration of normal polarity is followed by return of calcium to the sarcoplasmic reticulum and relaxation of the sarcomere.

So the distance between nodes is crossed almost instantaneously, the impulse jumps from one node to the next as it travels along. This process is called **salutatory conduction** and allows conduction speeds of up to 100 metres per second. After passage of the action potential, there is a brief period, the **refractory period**, during which the membrane cannot be stimulated. This prevents the message from being transmitted backward along the membrane

1.4 Study the following diagram and answer the questions that follow.

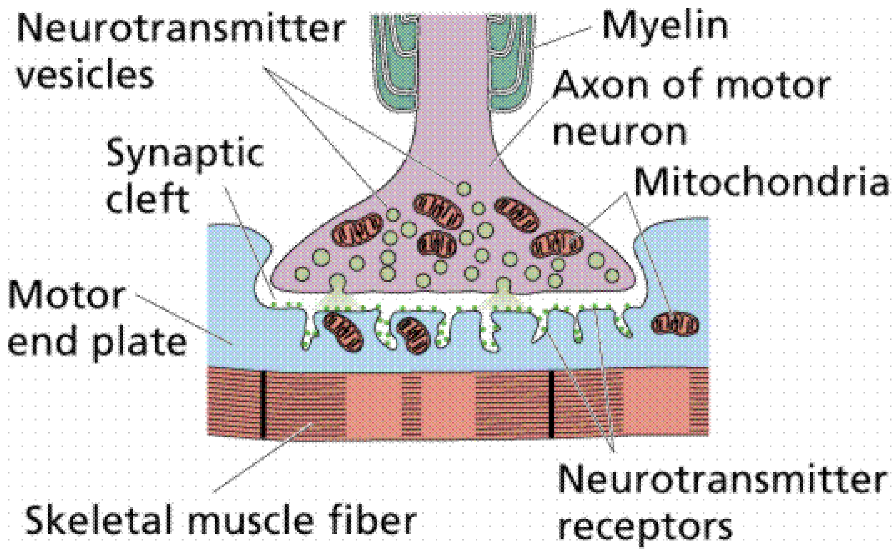


a. Name the structures labeled A, and explain their function.

This is the presynaptic membrane, as the action potential reaches the end of the first neurone; **Ca^{2+} channels** are also opened. Ca^{2+} flows into the cell and this induces several hundred vesicles containing the neurotransmitter to fuse with the presynaptic membrane. The neurotransmitter is then released into the synaptic cleft.

Explain how an impulse is transmitted from A to D in a cholinergic synapse.

The molecules of neurotransmitter bind with complementary receptors (similar to an enzyme and substrate fitting together) in the postsynaptic membrane. This makes the Na^+ channels open and depolarisation occurs in the postsynaptic membrane thus starting an action potential. This is shown below:



To stop the neurotransmitter continually generating action potentials either the neurotransmitter is actively absorbed back into the presynaptic neurone or an enzyme is released to break it down before reabsorb ion.

Synapses break up the flow of action potentials and so slow down the transmission of impulses but they are useful in that they ensure that the impulses travel only in one direction. They also allow neurons to connect via neurotransmitters with many, many other neurons. This increases the range of possible responses to any particular stimulus or group of stimuli.