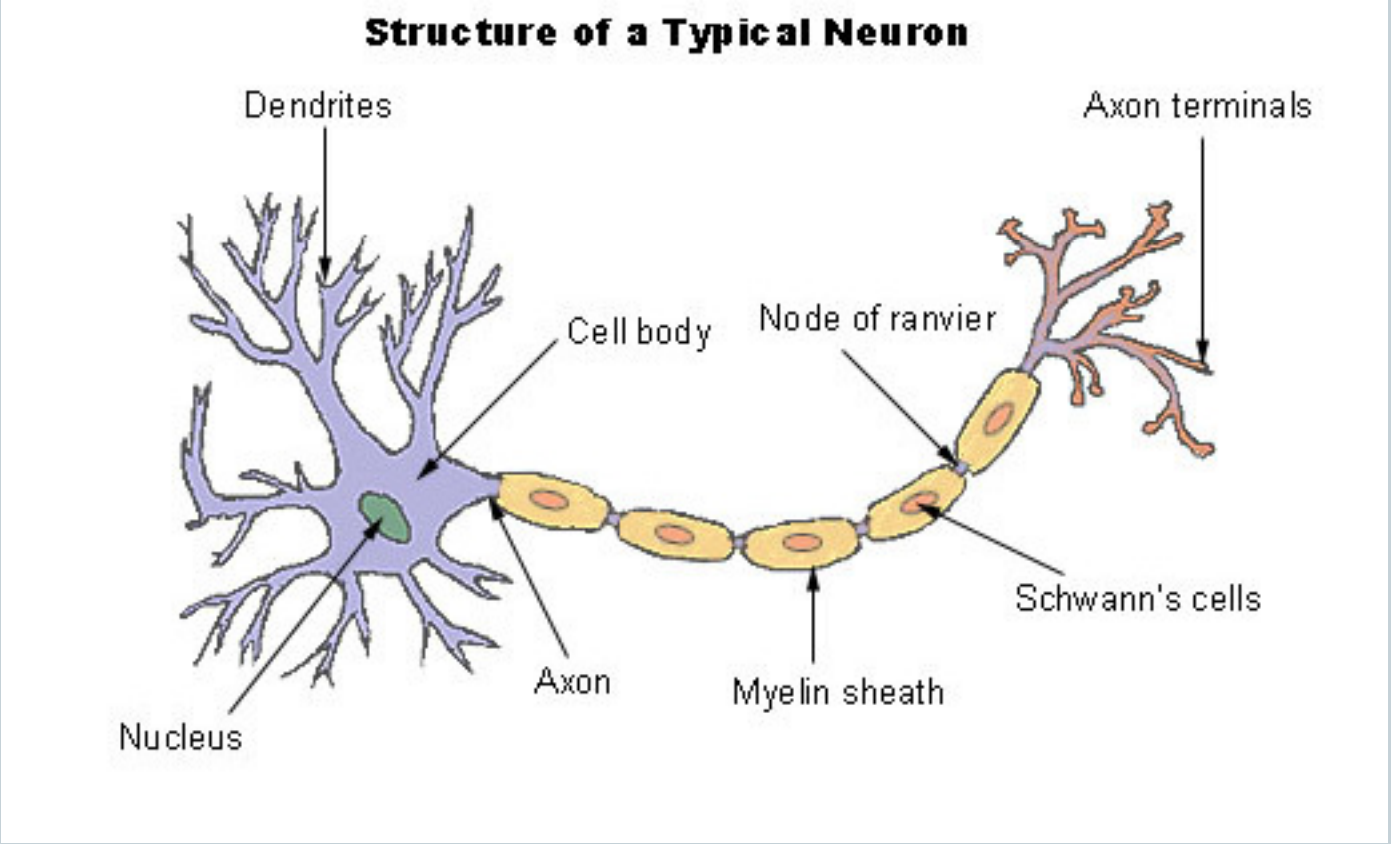
Nervous System

C11: ANALYZE THE TRANSMISSION OF A NERVE IMPULSE

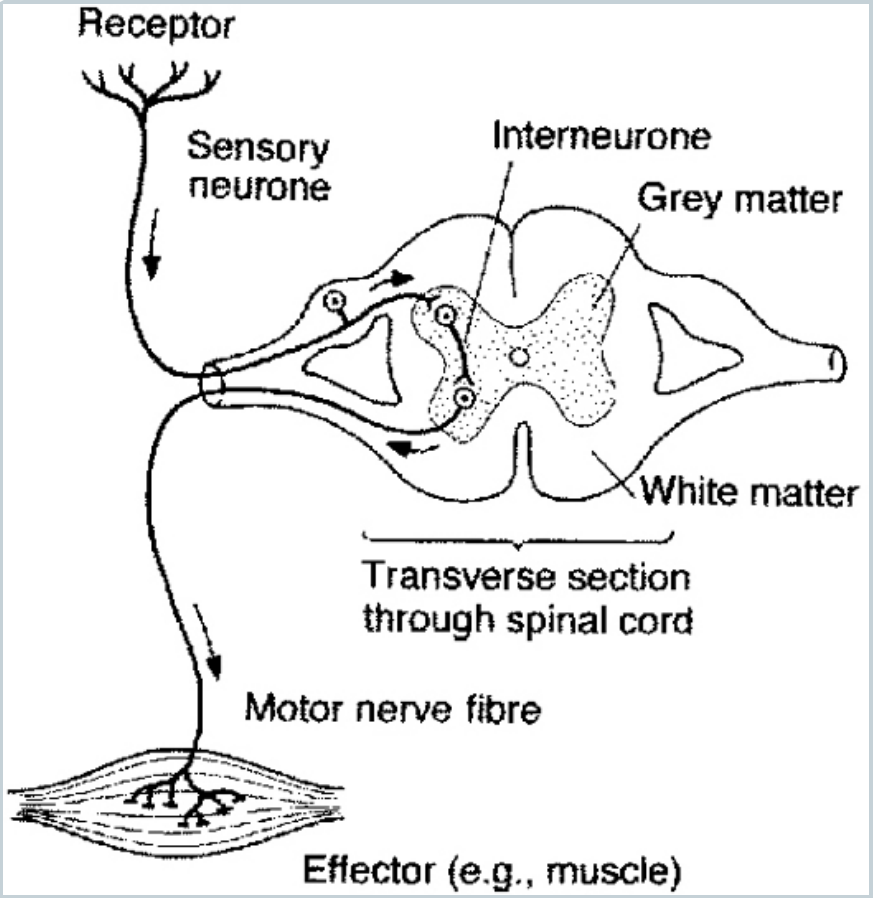
Structure of a Neuron

- 3 main parts: dendrite, cell body, & axon



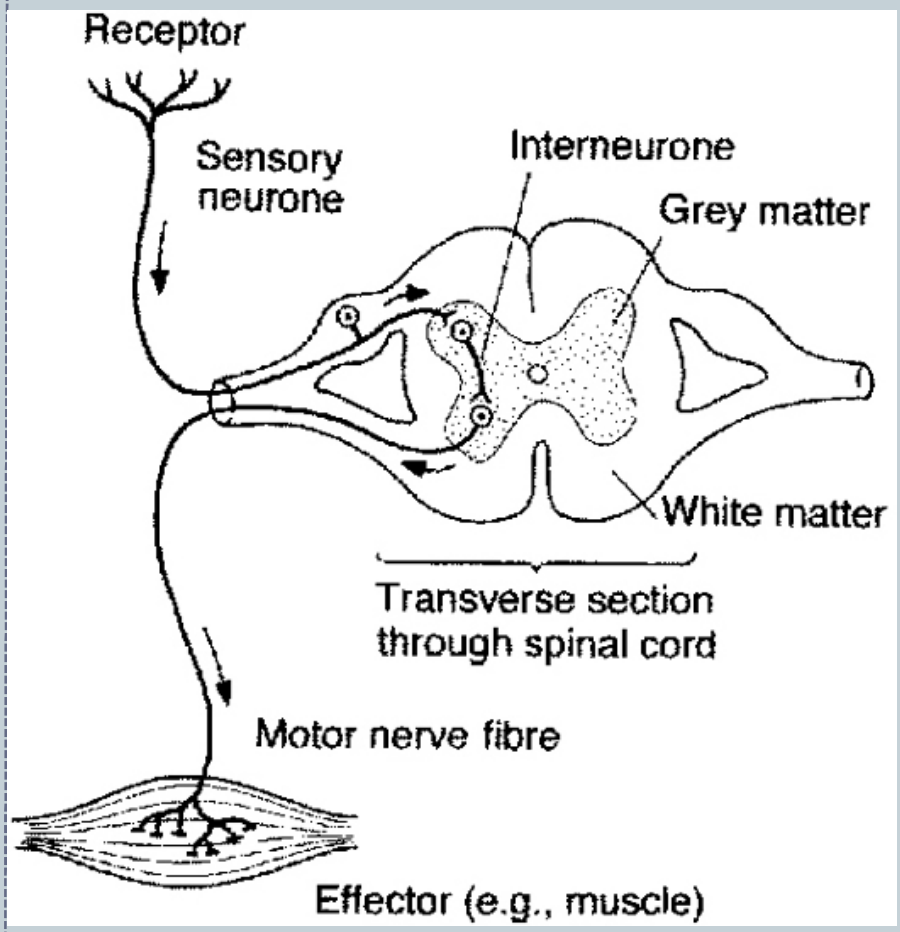
Sensory Neurons

- Have long dendrite(s) & short axon
- Conduct nerve impulses to the spinal cord
- The cell body & dendrite are located outside the spinal cord



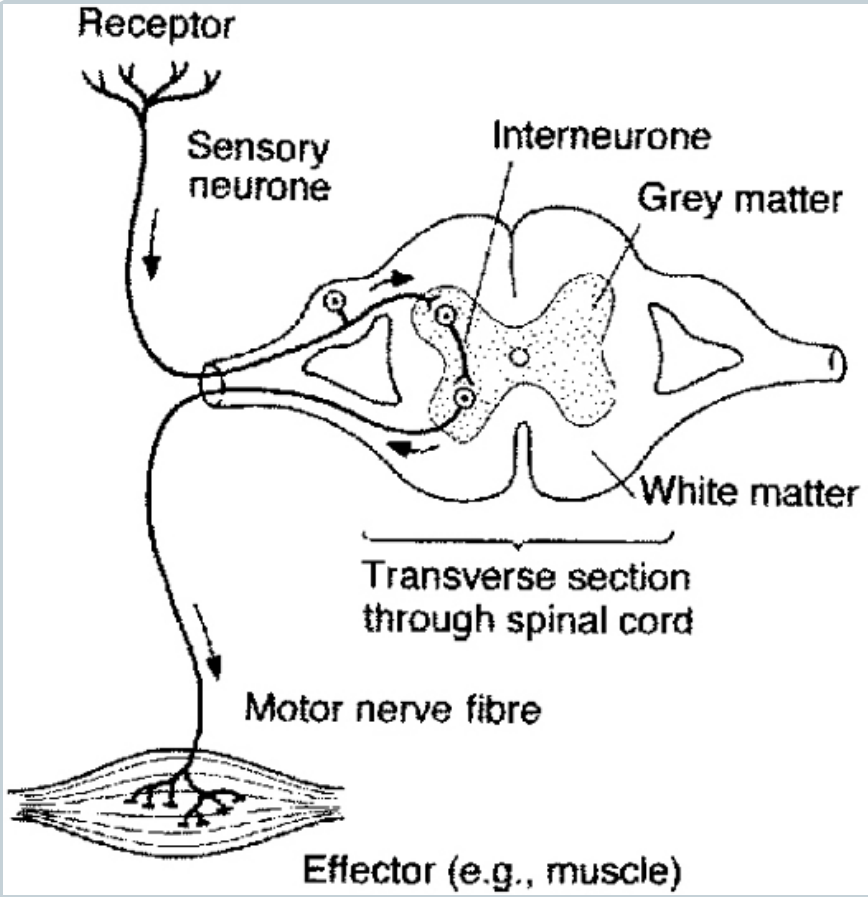
Interneurons

- Have short dendrite(s) and long or short axon
- Connect the sensory neuron to the appropriate motor neuron
- Located entirely within the central nervous system



Motor Neurons

- Have short dendrite(s) & long axon
- Conduct the nerve impulse to an effector (muscle or gland)
- Dendrites and cell body located in the spinal cord
- Axon is outside the spinal cord

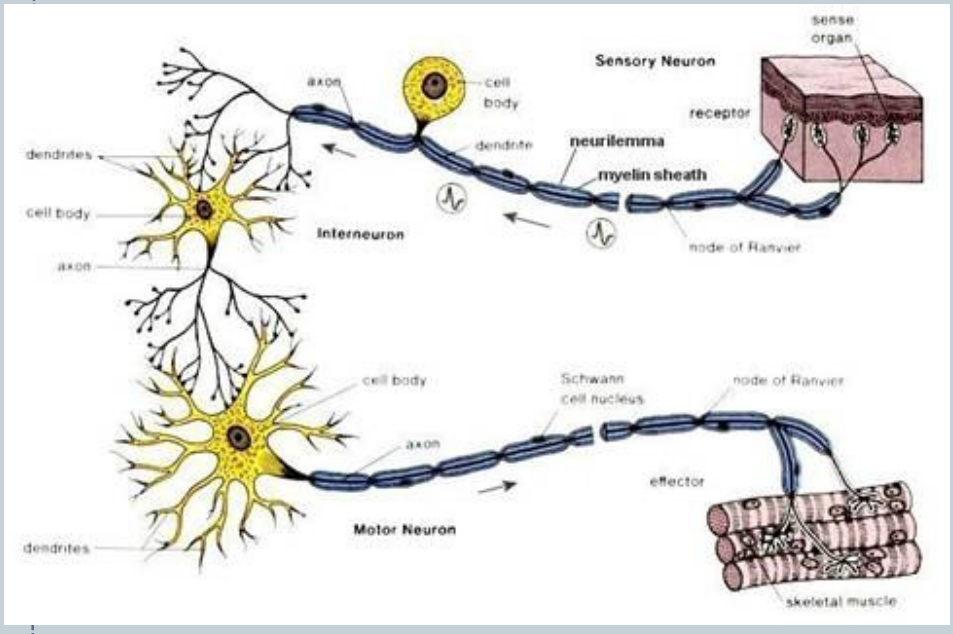


Reflex Arc 1

- Reflex actions are protective mechanisms
- They are automatic and do not involve the brain
- This results in quick responses
- The fact that a reflex has occurred is messaged to the brain after the fact by a separate neuron.

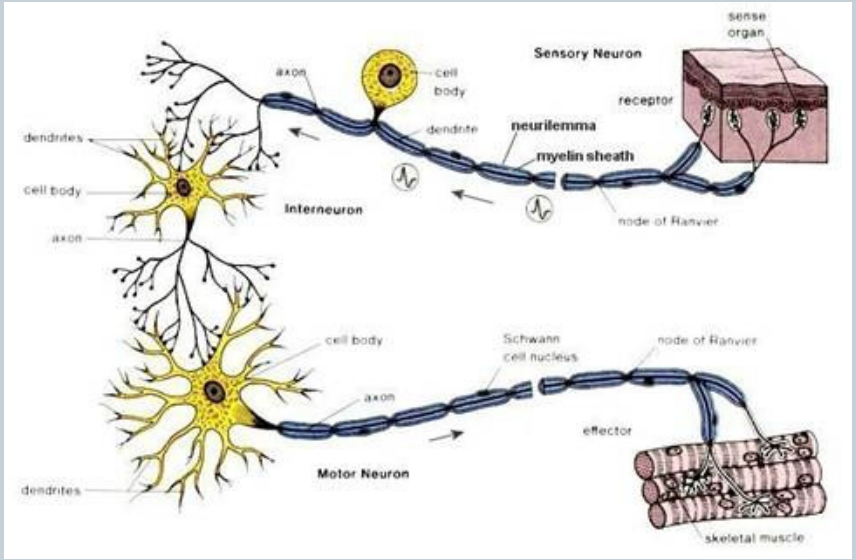
Reflex Arc 2

- Receptor detects a stimulus. If the stimulus exceeds a threshold value an impulse results.
- Impulse travels from dendrite of sensory neuron through the cell body and to the end of the axon.
- Impulse is passed to the dendrite of interneuron → cell body → axon

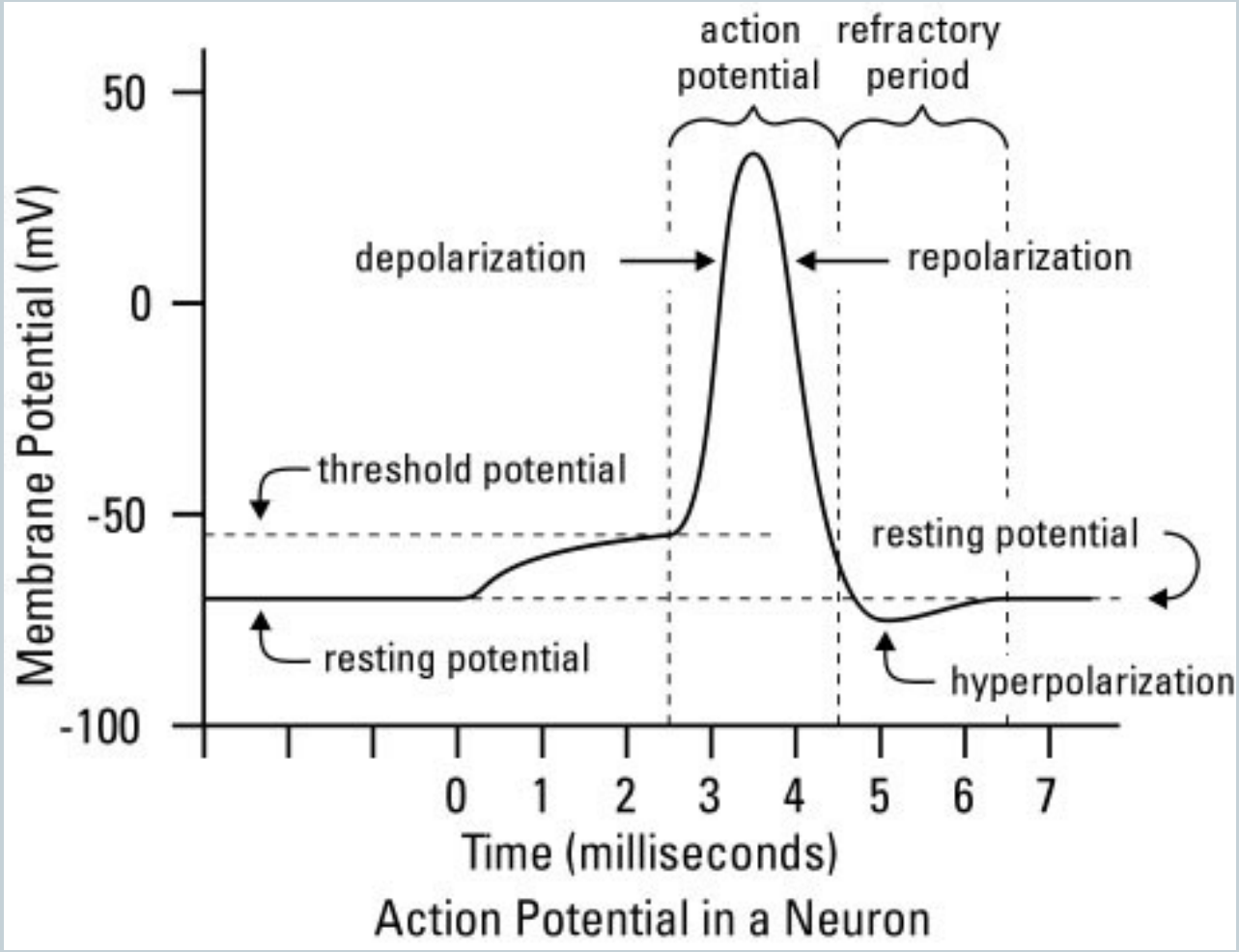


Reflex Arc 3

- Impulse is transferred to dendrite of motor neuron → cell body → axon
- Impulse reaches the effector and causes a response
- If effector is a muscle then movement occurs
- If effector is a gland a substance is secreted



Nerve Impulse Graph

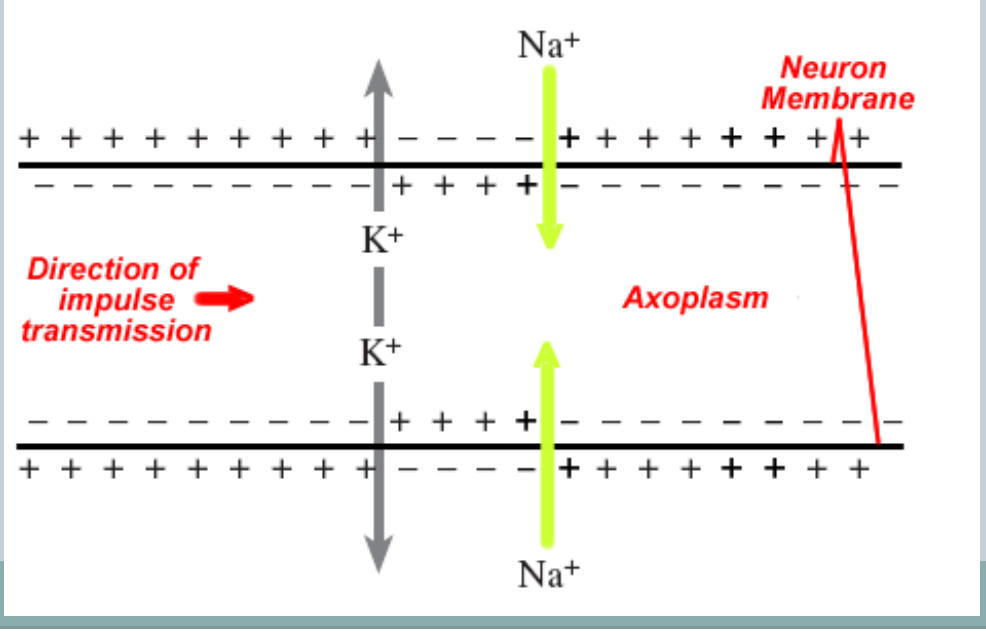


Resting Potential

- Na^+ is outside the axomembrane
- K^+ and –ve ions are inside the neuron
- The axoplasm has a slight negative charge relative to the outside of the neuron (-65mV)
- The axomembrane is not permeable to Na^+ or K^+
- Na/K pumps establish and maintain the ion distribution of resting potential
- Neurons function on an ‘all-or-nothing’ response
- If a stimulus exceeds the threshold value an impulse is generated (if not nothing happens)

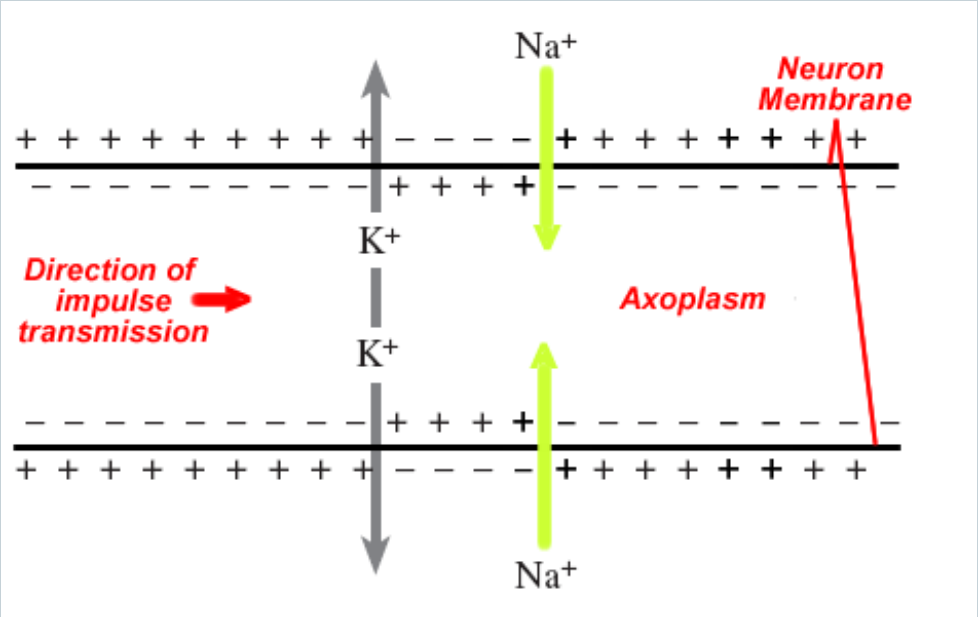
Action Potential

- A stimulus greater than the threshold value disrupts the resting potential & the axomembrane becomes permeable to Na^+ → sodium gates open & Na^+ rushes into the neuron making the axoplasm +ve (+40mV) compared to the outside. This is **depolarization** (upswing)



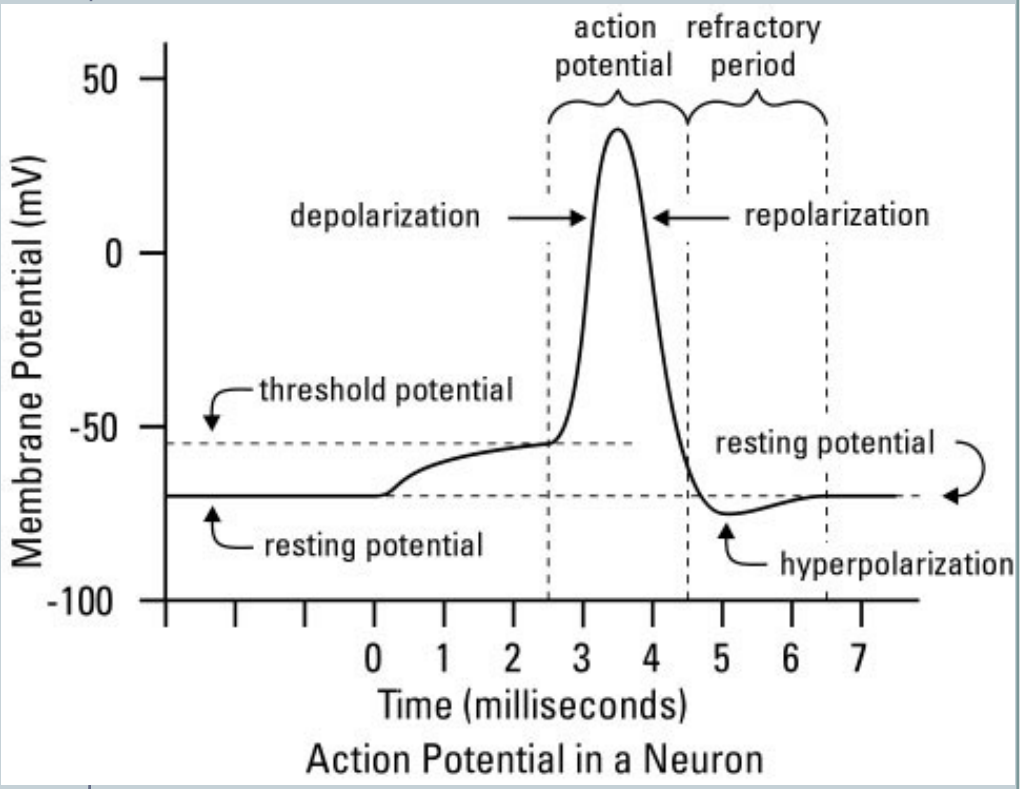
Repolarization

- Na^+ gates close and 'potassium gates' open
- K^+ moves outside the neuron restoring the polarity of the membrane (**repolarization** or downswing)



Refractory Period

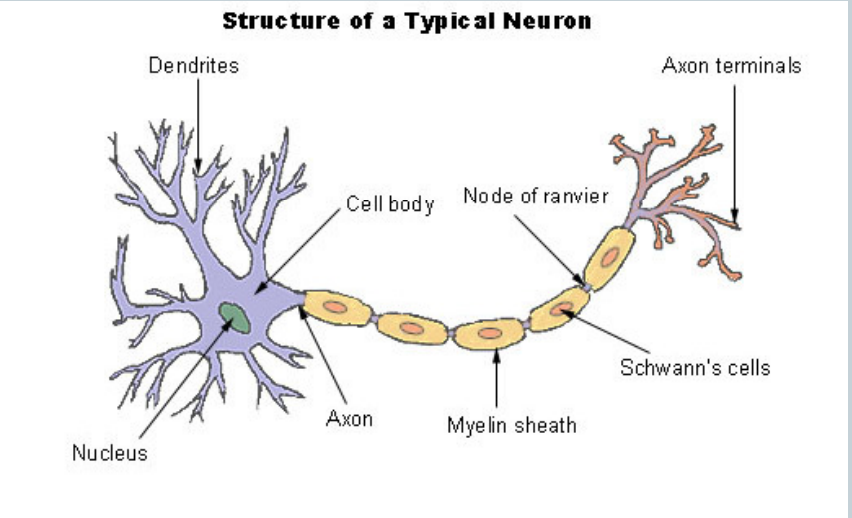
- The sodium/potassium pumps return Na^+ to the outside of the axomembrane and K^+ to the axoplasm (inside the axomembrane)
- This ‘re-sets’ the neuron to its original resting potential



Action Potential in a Neuron

Speed of Nerve Impulse Transmission

- Most long nerve fibres are surrounded by a myelin sheath made up of Schwann Cells
- This increases the speed of nerve transmission
- The gaps between the Schwann Cells are called nodes of Ranvier
- The nerve impulse jumps from node to node (saltatory transmission)



Synaptic Transmission

- Once a nerve impulse reaches the end of a neuron's axon it must be transmitted across a gap to the next nerve cell's dendrite.
- The gap between the axon of one nerve and the dendrite of the next is called the synaptic gap or synaptic cleft.