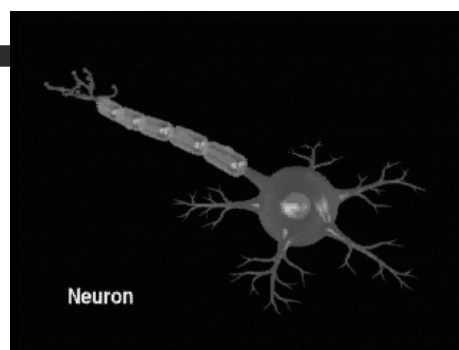


THE NERVOUS SYSTEM II: The Action Potential



Maria Counce
7th November 2009

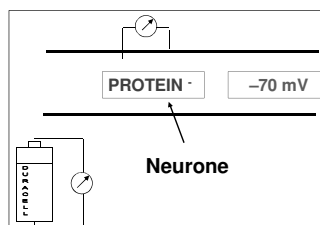
THE NEURONE



Neuron

THE ACTION POTENTIAL

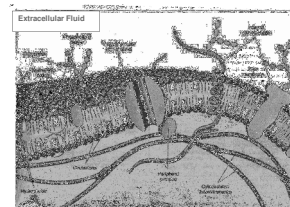
INSIDE OF A
NEURONE IS
NEGATIVELY
CHARGED WITH
RESPECT TO THE
OUTSIDE
-70 MILLIVOLTS



THE RESTING MEMBRANE POTENTIAL

Cell membranes are
SELECTIVELY
PERMEABLE

ie. they control the
movement
of chemicals in and
out of the cell



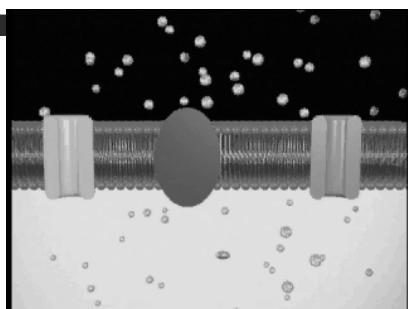
THE RESTING MEMBRANE POTENTIAL

- The nerve cell contains more **POTASSIUM** ions (K^+) than outside (extracellular fluid)
- The nerve cell contains less **SODIUM** ions (Na^+) than outside

THE RESTING MEMBRANE POTENTIAL

- There is some exchange of sodium and potassium ions across the cell membrane (sodium IN; potassium OUT of the cell).
- This movement is counteracted by the **SODIUM-POTASSIUM EXCHANGE PUMP**

THE RESTING MEMBRANE POTENTIAL



THE RESTING MEMBRANE POTENTIAL

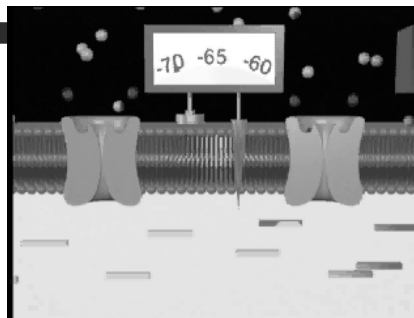
- Nerve cell membranes are **EXCITABLE** - ie. their membrane permeability may change in response to a stimulus
- This occurs through the opening of gates or channels in the cell membrane

THE ACTION POTENTIAL

In response to a stimulus:

- 1) The cell membrane **DEPOLARISES** – sodium ions enter the cell

THE ACTION POTENTIAL: DEPOLARISATION

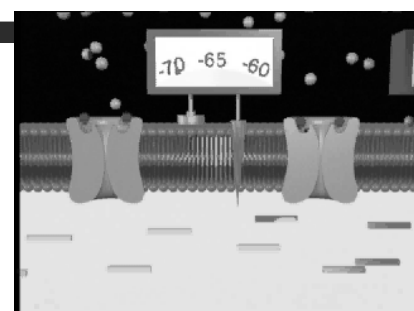


THE ACTION POTENTIAL

- 2) Depolarisation **PROPAGATES** along the cell membrane

- 3) The cell membrane then **REPOLARISES** – potassium ions move out of the cell.

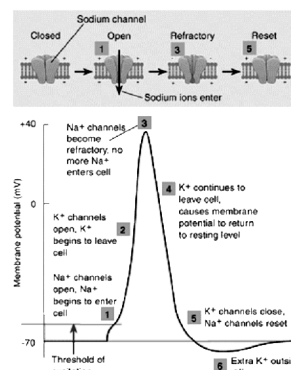
THE ACTION POTENTIAL



THE ACTION POTENTIAL

- After repolarisation, the neurone's chemical balance has changed – the levels of sodium and potassium ions across the cell membrane are now equal (ie. There is no longer a concentration gradient for Na^+ or for K^+).
- During this time the neurone cannot be stimulated
- This is the **REFRACTORY PERIOD**.

The Movements of Ions During the Action Potential



THE REFRACTORY PERIOD

During the refractory period:

- Sodium ions are pumped **OUT** of the cell
 - Potassium ions are pumped **INTO** the cell
- by the sodium-potassium exchange pump until the resting state is regained

HOW ARE NEURONES STIMULATED?

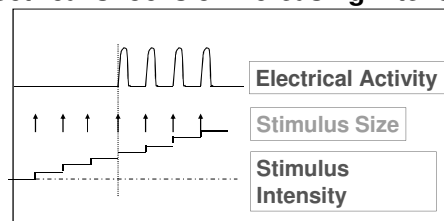
- By stimulation of a sense organ
- By stimulation of one nerve by another

HOW ARE NEURONES STIMULATED?

- Types of stimulus:
 - MECHANICAL - Touch, pressure, vibration
 - THERMAL - Temperature - hot/ cold
 - CHEMICAL - Taste, smell, CO₂, O₂, Na⁺, chemicals released by other nerves
 - ELECTROMAGNETIC - Light

HOW ARE NEURONES STIMULATED?

Stimulate one end of a neurone with electrical shocks of increasing intensity



HOW ARE NEURONES STIMULATED?

- Stimulus will not result in an action potential until it reaches a **THRESHOLD INTENSITY**
- Increasing stimulus size will **NOT** increase action potential size – the “**ALL OR NOTHING LAW**”.

HOW DO WE JUDGE STIMULUS STRENGTH?

- **IMPULSE FREQUENCY** – The number of action potentials in a given time
- As **STIMULUS STRENGTH INCREASES, IMPULSE FREQUENCY INCREASES**

