• Differences in plasma membrane permeability
  ▪ The membrane is **impermeable to large anionic proteins**, but is **quite permeable to Cl**-
  ▪ It is **slightly permeable to Na**
    • However, it is **25 times more permeable to K** than Na
    • The sodium-potassium pump stabilises the resting membrane potential by moving 3 sodium ions out and moves 2 potassium ions in
      o This removes one positive charge
  • See below, the different proteins in action:

![Diagram showing ion movements in the membrane](image)

o Membrane potential changes when:
  • The concentration of ions changes
  • The membrane permeability to ions changes

o The change in membrane potential can produce one of two signals:
  • Graded potential
    ▪ Incoming signals operating over short distances
  • Action potential
    ▪ Long-distance axon signal

o The membranes potential changes can be measured on a **voltage-time graph**:
  • The membrane is resting at -70mV
  • During **depolarisation**, both potassium and sodium channels open causing sodium to enter and potassium to leave
    ▪ At the **threshold** (~-55mV) positive feedback causes all sodium channels to open
  • At the peak of the action potential (+40mV), the sodium channels become refractory and so no more enters
  • During **repolarisation**, potassium continues to leave the cell, returning it to resting potential
  • When the membrane becomes **hyperpolarised**, potassium channels close and sodium channels reset in order to restore the membrane to its resting potential

  ![Voltage-time graph](image)

  o Action potentials are the primary way that neurones send long distance messages:
    • They **only occur in muscle cells and neurone axons**
    • Action potentials do not degrade over long distances unlike graded potentials