**Key Knowledge: Scanning tunnelling microscope**



**Setup**:

* A very fine conducting probe is used to scan a small area of the surface of a metallic or semi-conducting sample
* Probe is positioned so that the tip of the probe is 1 nm above the surface
* There is a very small voltage between probe tip and the sample surface

**Operation:**

* Creates image using a phenomenon called ***quantum tunnelling***
* Quantum tunnelling relies on the wave-like nature of electrons. The de Broglie wavelength of an electron in a metal at room temperature is ~1 nm which is equal to the gap
* Some of the electrons will move between the tip of the probe and the sample surface
* The potential difference across the probe-tip and sample surface makes sure that electrons only move in one direction
* There is a small but finite probability that electrons jump the gap

**Modes of operation**

1. Constant height mode:
🡪 height of probe is kept constant during scanning
🡪 only undulation in surface sample affect the size of the gap
🡪 the smaller the gap the more electrons that tunnel
🡪 size of recorded current in probe increases or decreases depending on the size of gap
🡪 tunnelling current is sensitive to changes of gap width of order 0.001 nm
🡪 variation of current with time enables surface to be mapped out
2. Constant current mode:
🡪 current in probe is kept constant
🡪 height of probe is moved accordingly to maintain constant current
🡪 variations of vertical height of tip with time enable image of surface to be created