TOPIC 1.1: CELL SPECIALIZATION

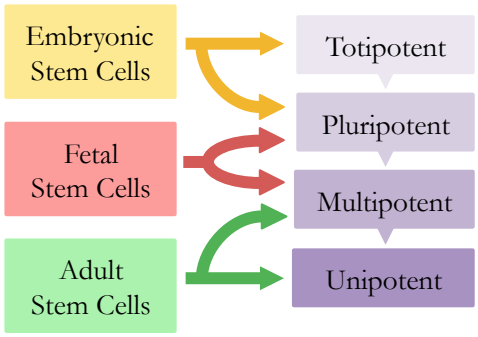
Stem Cells

Stem cells are unspecialised cells that have two key qualities:

1. **Self-Renewal** – They can continuously divide and replicate
2. **Potency** – They have the capacity to differentiate

There are four main types of stem cells during human development:

- Totipotent – Can form any cell type, as well as extra-embryonic tissue
- Pluripotent – Can form any cell type (e.g. embryonic stem cells)
- Multipotent – Can differentiate into closely related cell types
- Unipotent – Cannot differentiate, but are capable of self-renewal



Types of Stem Cells

Stem Cell Therapy

Stem cells can replace damaged or diseased cells with healthy ones

The therapeutic use of stem cells involves:

- Harvesting stem cells from appropriate sources
- Using biochemical solutions to trigger cell differentiation
- Surgically implanting new cells into patient's own tissue
- Suppressing the host immune system to prevent rejection
- Monitoring new cells to ensure they do not become cancerous

Therapeutic Examples

Example	Condition	Treatment
Stargardt's disease	Macular degeneration	Replace defective retinal cells
Parkinson's disease	Death of nerve tissue	Replace damaged nerve cells
Leukemia	Cancer of the blood	Replacement of bone marrow

Ethics of Stem Cell Use

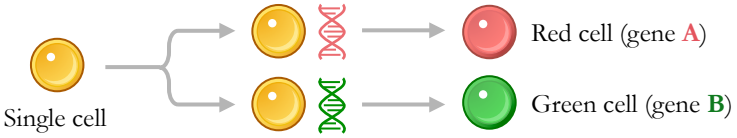
Source	Growth Potential	Tumour Risk	Harvesting	Disadvantages
Embryo	High (pluripotent)	Higher risk	Can be generated artificially by SCNT	Requires destruction of the embryo (results in the loss of a *potential* life)
Umbilical Cord Blood	Low (multipotent)	Lower risk	Easily obtained and stored / preserved	Cells must be stored from birth at cost (raises issues of financial accessibility)
Adult Tissue	Low (multipotent)	Lower risk	Invasive to extract	May be restrictions in scope / availability

Differentiation

All cells of an organism contain an identical genome – each cell contains the entire set of genetic instructions for that organism

Differentiation involves the expression of some genes and not others in the cell's genome (i.e. selective gene expression)

The activation of different genes within a given cell will cause it to develop differently from other cells (i.e. cell specialisation)



Gene Packaging

Within the nuclei of eukaryotic cells, gene instructions (DNA) are packaged with proteins as chromatin

- Active genes are loosely packed as **euchromatin**
- Inactive genes are packed tight as **heterochromatin**

Nucleus Micrograph: