**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

**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**

<table>
<thead>
<tr>
<th>Example</th>
<th>Condition</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stargardt's disease</td>
<td>Macular degeneration</td>
<td>Replace defective retinal cells</td>
</tr>
<tr>
<td>Parkinson's disease</td>
<td>Death of nerve tissue</td>
<td>Replace damaged nerve cells</td>
</tr>
<tr>
<td>Leukemia</td>
<td>Cancer of the blood</td>
<td>Replacement of bone marrow</td>
</tr>
</tbody>
</table>

**Ethics of Stem Cell Use**

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

**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**

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**Types of Stem Cells**

- Embryonic Stem Cells
- Totipotent
- Pluripotent
- Fetal Stem Cells
- Multipotent
- Adult Stem Cells
- Unipotent

**Nucleus Micrograph:**

- Heterochromatin (inactive)
- Euchromatin (active)