### Embryonic vs Adult Stem Cells - Pros & Cons

#### Adult Stem Cells

<table>
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<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<td>- Already ‘specialised’ - induction of differentiation into specific cell types will be easier.</td>
<td>- Minimal quantity - number of isolatable cells may be small.</td>
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<td>- Plasticity - Recent evidences suggest wider than previously thought ranges of tissue types can be derived.</td>
<td>- Finite life-span - may have limited life-span in culture.</td>
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<td>- No Immune-rejection - if used in autologous transplantations.</td>
<td>- Ageing - stem cells from aged individuals may have higher chance of genetic damage due to ageing.</td>
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<td>- No Teratomas - unlike ES cells.</td>
<td>- Immunogenic - potential immune-rejection if donor cells are derived from another individual.</td>
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<td>- No Ethical Controversy - sourced from adult tissues.</td>
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#### What is a Stem Cell? - Pluripotency

1 Cell (Zygote - fertilised egg)

6,000,000,000 cells (230 different cell types)
What makes Stem Cells “Stem Cells”?

Self-Renewal
Pluripotency
Differentiation

Characteristics of Embryonic Stem Cells

Origin
The cells can divide to make clones of themselves for a very long time without differentiating.

Self-Renewal

Differentiation

What makes Stem Cells, ‘Stem Cells’?

Self-Renewal
through Asymmetric Cell Division

Differentiation
via Multipotent Progenitors
**Self-Renewal vs Differentiation**

Figure 2.1. Hematopoietic and stromal cell differentiation.

**Skeletal Muscle Biology**
Myogenic Lineage

Paired-box transcription factors
Pax3, Pax7

Basic helix-loop-helix (bHLH) transcription factors
Myogenic Regulatory Factors (MRFs)
MyoD, Myf-5, MRF-4, myogenin

Paired-box transcription factors
Pax3, Pax7

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Stem
Progenitor
Precursor
Myoblast
Fibre

Tajbakhsh Exp Cell Res 2005
Developing Muscles from Rat Hindlimb

Cryostat Section  Isolated Cells

Triple Immuno-labeling:
Pax3+
Pax7+
Pax3+ Pax7+ MRFs+ (MyoD+Myf-5+myogenin)

Pax3+
Pax7+
Pax3+ Pax7+ Pax3+ MRFs+ Pax7+ MRFs+ Pax3+ Pax7+ MRFs+

Developing Muscles from Rat Hindlimb

Symmetric vs Asymmetric Division

Stem Cell
Pax3* and/or Pax7*

Proliferation Pax7*

Myogenic Specification MyoD*

Differentiation MyoD* Myogenin*

Terminal Differentiation Myogenin*, MHC*
Adult Muscle Stem (Satellite) Cells

Symmetric vs Asymmetric Division

Symmetric Division

Asymmetric Division
Symmetric vs Asymmetric Division

Asymmetric Cell Division - Stem Cell Hallmark

Environmental Asymmetry

Divisional Asymmetry

Differentiated Cell

Differentiated Cell
Divisional Asymmetry

A. Extrinsic Regulation

Engineering the ‘Niche’...
- adding growth factors & cytokines.
- changing surface properties of the culture dish.
- co-culture with ‘feeder’ cells.
- co-culture with scaffolding or matrix.
- activation of transcription factors.

B. Intrinsic Regulation

Stem Cells - Therapeutic Applications

1. Generation of cells/tissues for Cell-Based Therapies
Stem Cells - **Therapeutic Applications**

2. Drug discovery/screening through safer and cheaper testing using human cells.

3. Study the mechanisms of human development, stem cell differentiation and function.

4. Study the mechanisms to understand and treat birth abnormalities.