Embryonic vs Adult Stem Cells - *Pros & Cons*

Adult Stem Cells

Advantages	Disadvantages
• **Already 'specialised'** - *induction of differentiation into specific cell types will be easier.* • **Plasticity** - *Recent evidences suggest wider than previously thought ranges of tissue types can be derived.* • **No Immune-rejection** - *if used in autologous transplantations.* • **No Teratomas** - *unlike ES cells.* • **No Ethical Controversy** - *sourced from adult tissues.*	• **Minimal quantity** - *number of isolatable cells may be small.* • **Finite life-span** - *may have limited life-span in culture.* • **Ageing** - *stem cells from aged individuals may have higher chance of genetic damage due to ageing.* • **Immunogenic** - *potential immune-rejection if donor cells are derived from another individual.*

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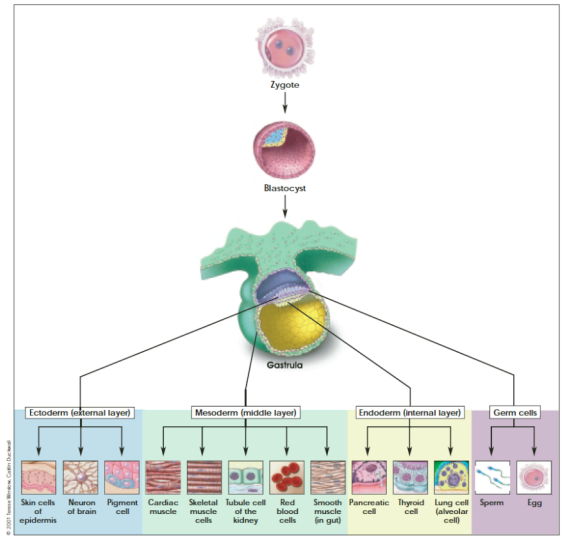
What is a Stem Cell? - *Pluripotency*



1 Cell
(Zygote - fertilised egg)

6,000,000,000 cells
(230 different cell types)

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What makes Stem Cells "Stem Cells"?

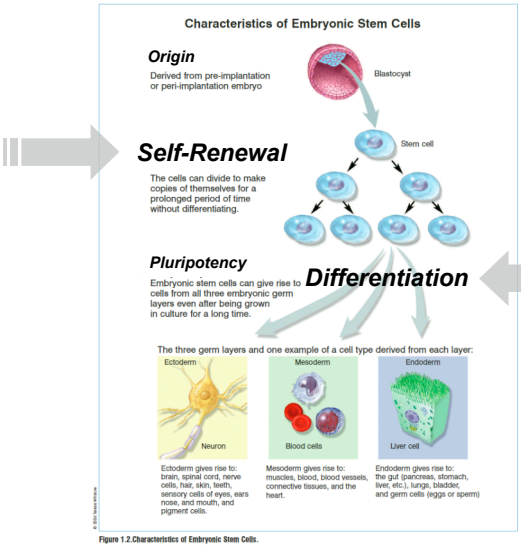

Figure 1.2.Characteristics of Embryonic Stem Cells.

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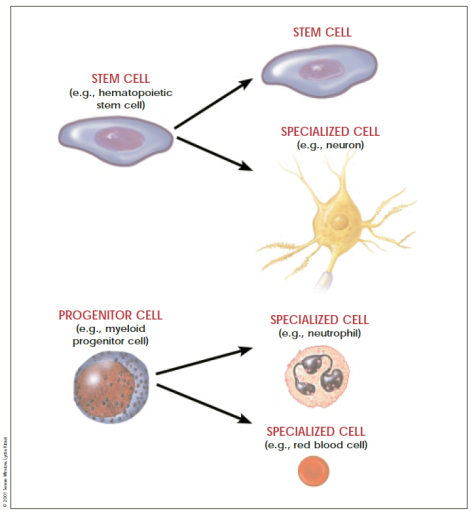
What makes Stem Cells, 'Stem Cells'?



Self-Renewal
through Asymmetric Cell Division

Differentiation
via Multipotent Progenitors

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Self-Renewal vs Differentiation

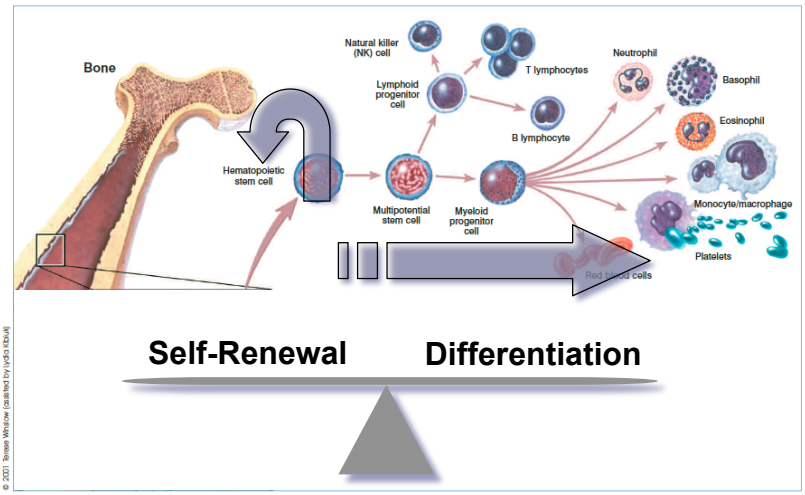
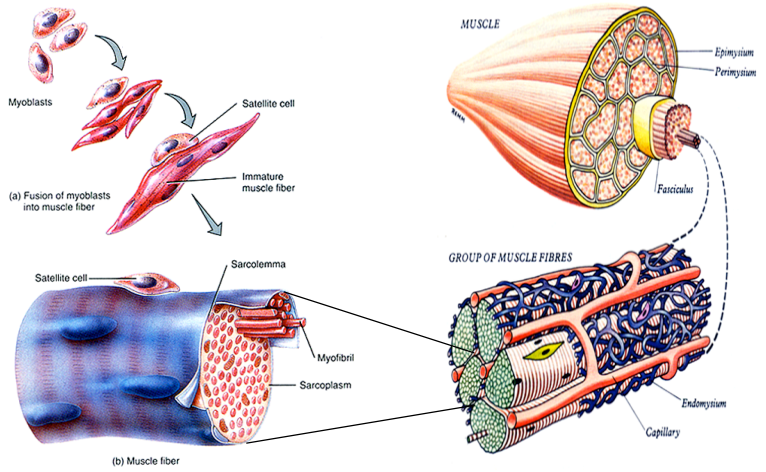


Figure 2.1. Hematopoietic and stromal cell differentiation.

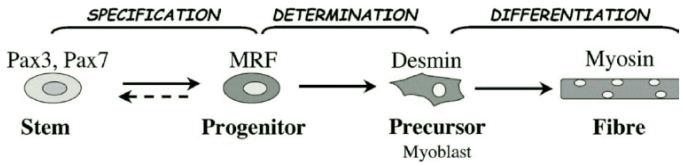
Skeletal Muscle Biology



Myogenic Lineage

Paired-box transcription factors
Pax3, Pax7

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



Tajbakhsh *Exp Cell Res* 2005

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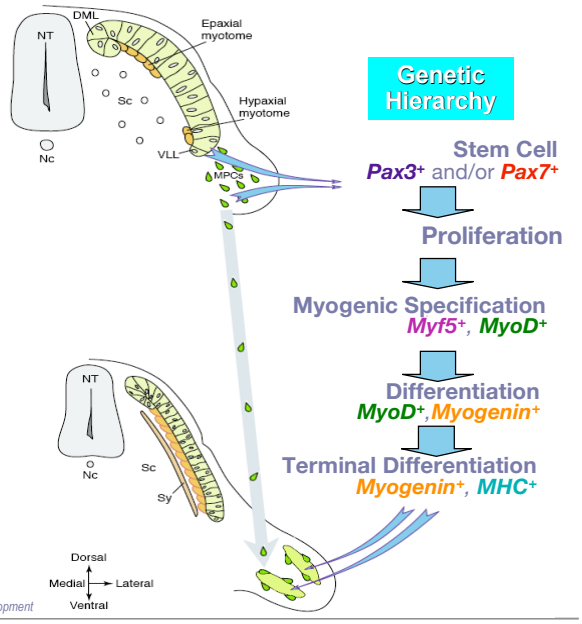
Myogenic Lineage



Modified from Tajbakhsh (2003)
Current Opinion in Genetics & Development

Genetic Hierarchy

Stem Cell
***Pax3*⁺ and/or *Pax7*⁺**

Proliferation

Myogenic Specification
***Myf5*⁺, *MyoD*⁺**

Differentiation
***MyoD*⁺,*Myogenin*⁺**

Terminal Differentiation
***Myogenin*⁺, *MHC*⁺**

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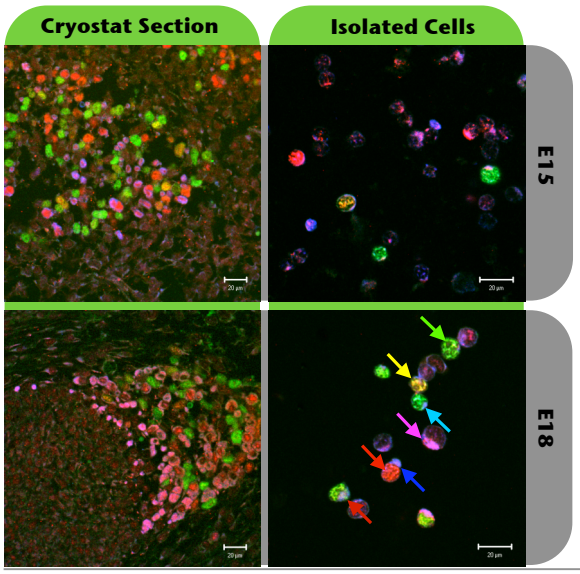
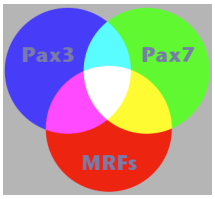
Developing Muscles from Rat Hindlimb



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



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

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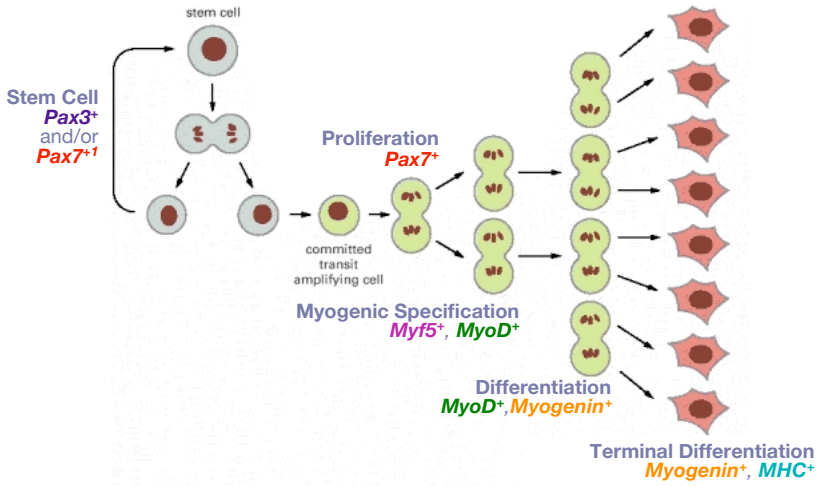
Symmetric vs Asymmetric Division



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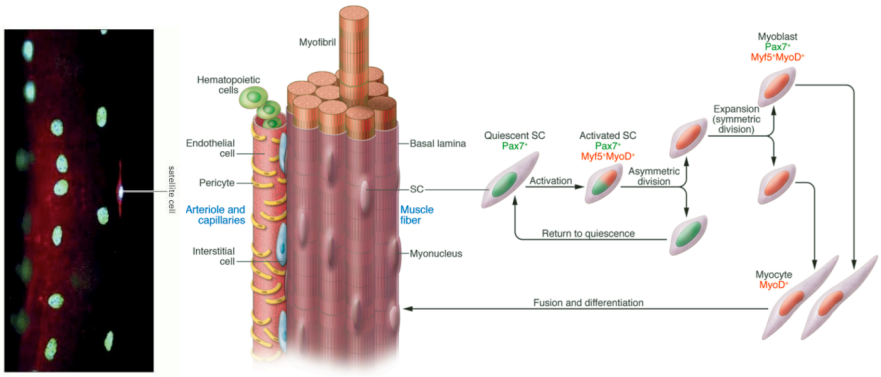
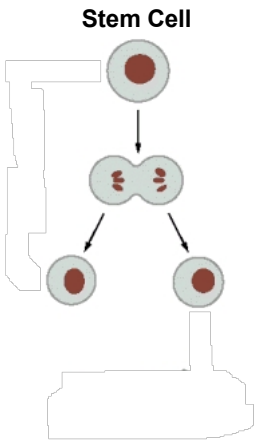
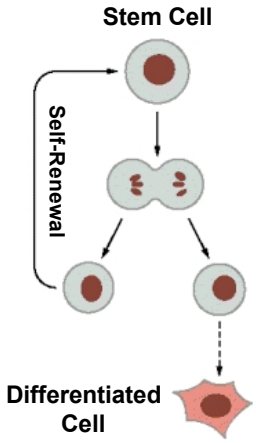
Adult Muscle Stem (Satellite) Cells



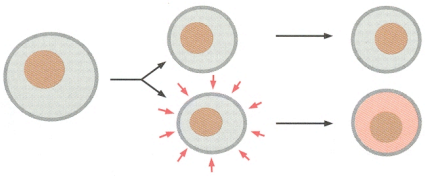
Symmetric vs Asymmetric Division



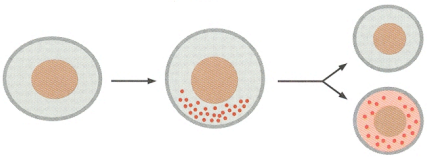


Symmetric Division **Asymmetric Division**

Symmetric vs Asymmetric Division



symmetric division : sister cells become different as result of influences acting on them after their birth



asymmetric division : sister cells born different

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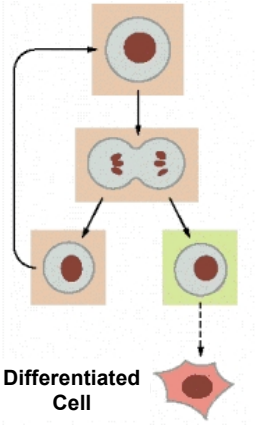
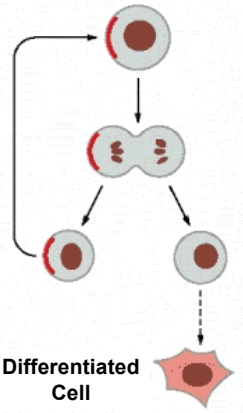
Asymmetric Cell Division - *Stem Cell Hallmark*

Environmental Asymmetry



Divisional Asymmetry



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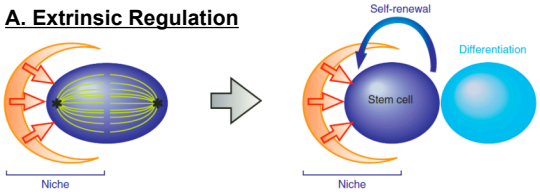
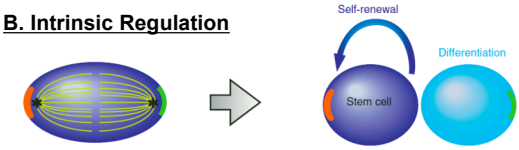
Divisional Asymmetry

A. Extrinsic Regulation



B. Intrinsic Regulation



Yamashita *Cold Spring Harb Perspect Biol* 2010

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.

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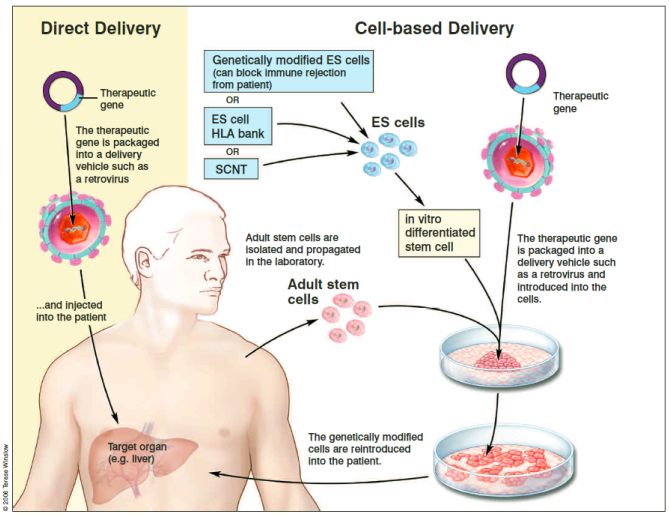
Stem Cells - *Therapeutic Applications*

1. Generation of cells/tissues for Cell-Based Therapies



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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.