

Application Syllabus

Stem Cells – Summary

Learning Outcomes:

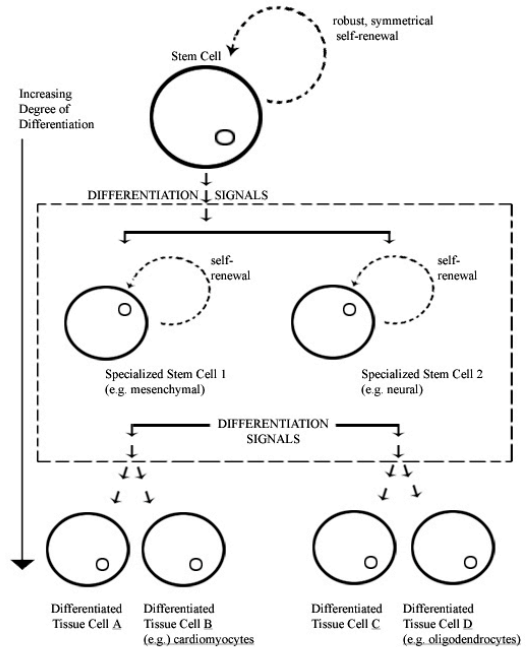
- Explain the unique features of stem cells
- Explain the normal functions of stem cells in a living organism using appropriate examples to illustrate.

Two distinct populations:

- Embryonic
- Adult

Unique Properties:

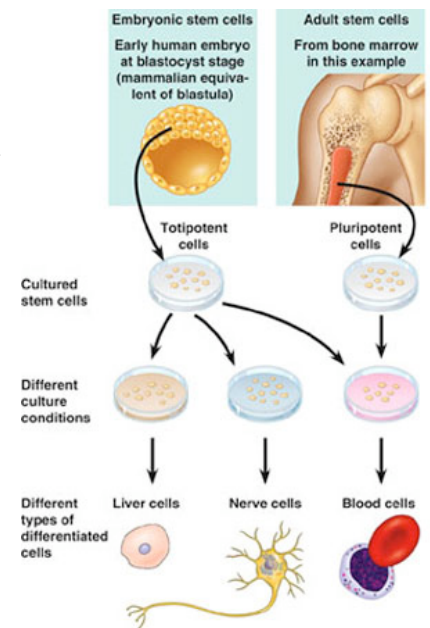
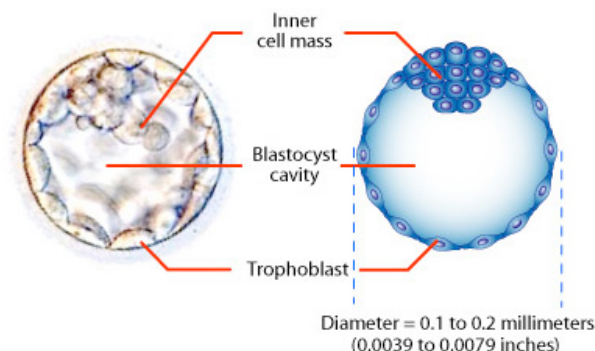
- Unspecialized
- Able to undergo extensive proliferation and self renewal
- Able to differentiate to produce specialized cells



STEM CELL DIVISION		Proliferation	Maintenance of developmental potential
Stem → Stem + Stem	Symmetric Self Renewal	✓	✓
Stem → Stem + Progenitor	Asymmetric Self Renewal	✓	✓
Stem → Progenitor + Progenitor	Lack of Self Renewal	✓	X
Stem → X	Lack of Self Renewal	X	✓

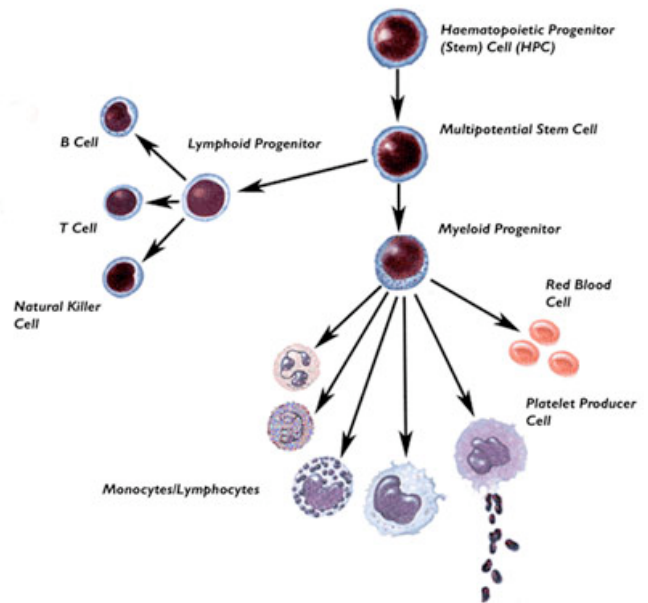
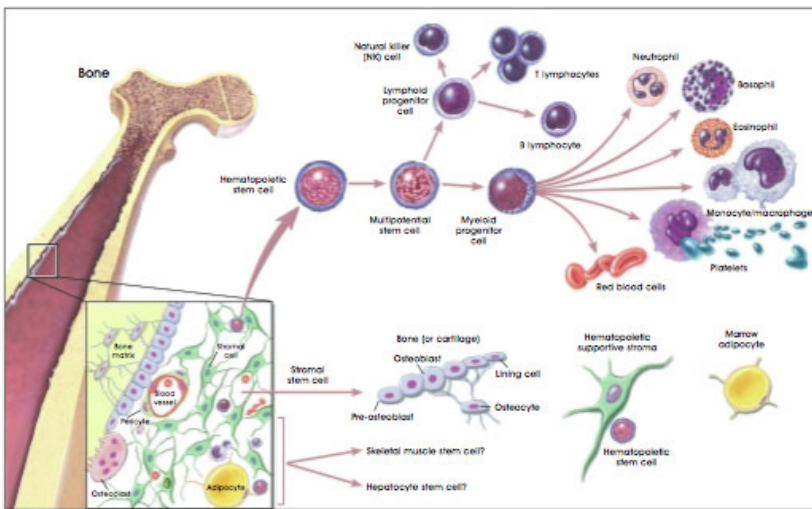
Source:

- Embryonic Stem Cells [**pluripotent**]
 - Blastocyst, developed from zygote after 4-5th day of fertilisation.
 - *** inner cell mass alone cannot form an organism – placenta, supporting tissues (developed from trophoblast) are needed.



- **Adult Stem Cells [multipotent]**

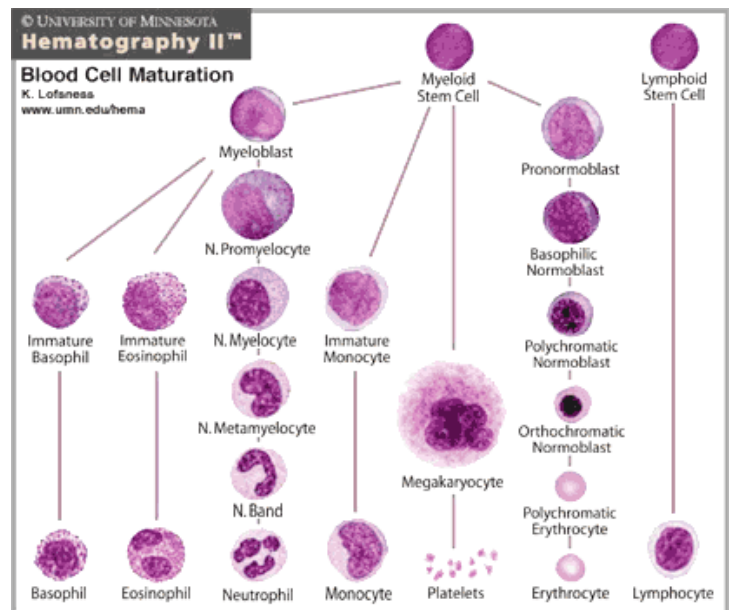
- Descendents of pluripotent stem cells
- Small number (1 in 10 000 – 15 000) in various tissues (bone marrow, blood, cornea and retina, intestine, liver, muscles, nervous system, brain, skin, pancreas, etc...)
- Main purpose – to replace cells lost to tissue damage or injury
- Brain
 - Songbirds have large amount of neurons that die and are replaced each year.
 - Mice
- Bone marrow
 - Hematopoietic stem cells



- Epidermis
- Epithelium of intestine

Plasticity

- Once believed that an adult stem cell could only produce the cell types of the tissue in which it resides (e.g. neural stem cells only give neurons), but now, upon research with mice, they can differentiate into different types of cells. (e.g neural stem cells can now differentiate into skeletal muscle cells when injected into muscles)
- Suggests importance of signalling cues from the environment to determine the type of cell an adult stem cell will differentiate into.



Differentiation Potential	Number of cell types	Example of stem cell	Cell types resulting from differentiation	Source
Totipotential	All	Zygote (fertilized egg), blastomere	All cell types	[m1]
Pleuripotential	All except cells of the embryonic membranes	Cultured human ES cells	Cells from all three germ layers	[m2]
Multipotential	Many	Hematopoietic cells	skeletal muscle, cardiac muscle, liver cells, all blood cells	[m3]
Oligopotential	Few	Myeloid precursor	5 types of blood cells (Monocytes, macrophages, eosinophils, neutrophils, erythrocytes)	[m4]
Quadripotential	4	Mesenchymal progenitor cell	Cartilage cells, fat cells, stromal cells, bone-forming cells	[m5]
Tripotential	3	Glial-restricted precursor	2 types of astrocytes, oligodendrocytes	[m6]
Bipotential	2	Bipotential precursor from murine fetal liver	B cells, macrophages	[m7]
Unipotential	1	Mast cell precursor	Mast cells	[m8]
Nullipotential	None	Terminally differentiated cell e.g. Red blood cell	No cell division	

