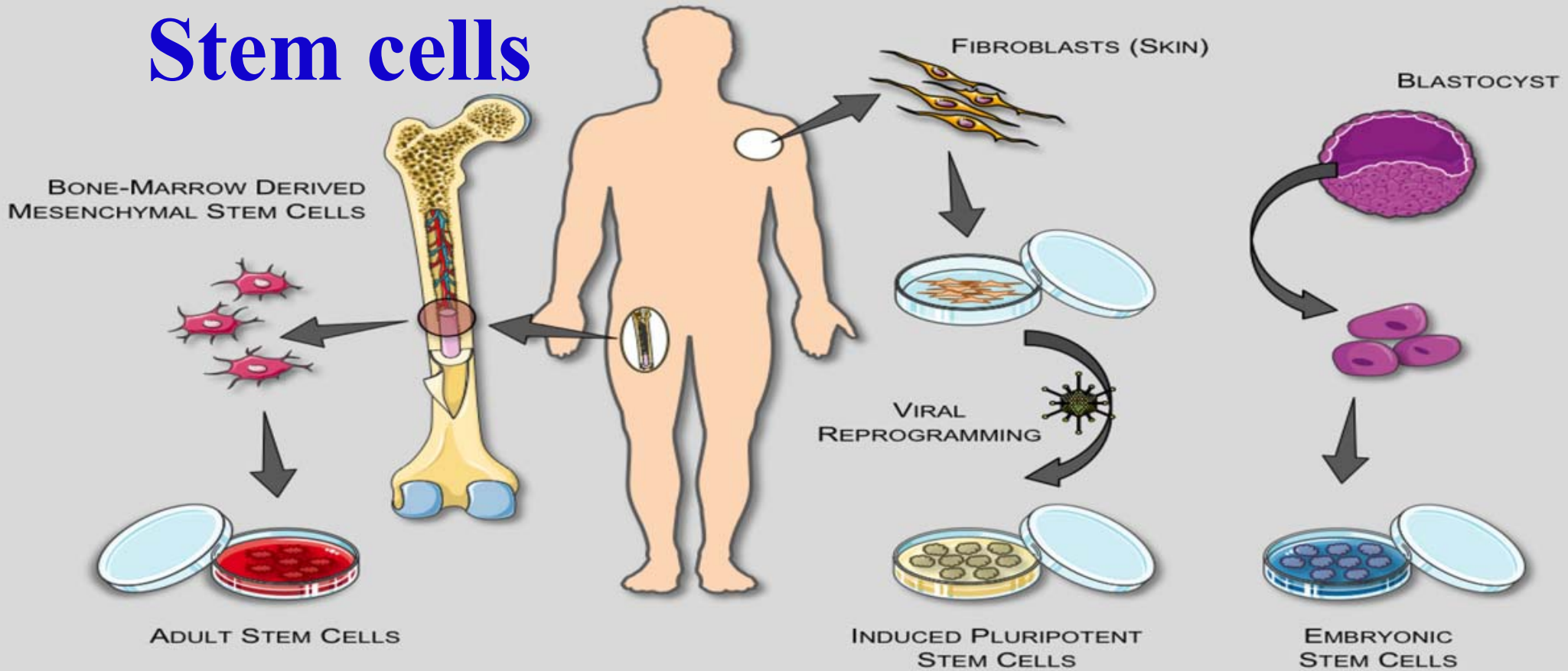
A microscopic view of numerous cells, likely yeast or similar microorganisms, showing a clear blue nucleus within a lighter, textured cytoplasm. The cells are arranged in a somewhat regular pattern, filling the frame.

Cell Biology and Physiology
ZOO (242)

Stem cells



Introduction

- **The human body is composed of many different types of cells**
 - e.g. muscle cells, skin cells, liver cells, cardiovascular cells, etc.
 - These cells are called specialised cells or mature cells that perform specific functions.
 - Specialised cells arise from the differentiation of unspecialised cells during embryological development.
- **Not all cells have the same potential**
 - Some cells remain “immature”—these are called stem cells

Stem cells are multi-talented. They can:

Self-renew

a stem cell can reproduce itself by cell division



Differentiate

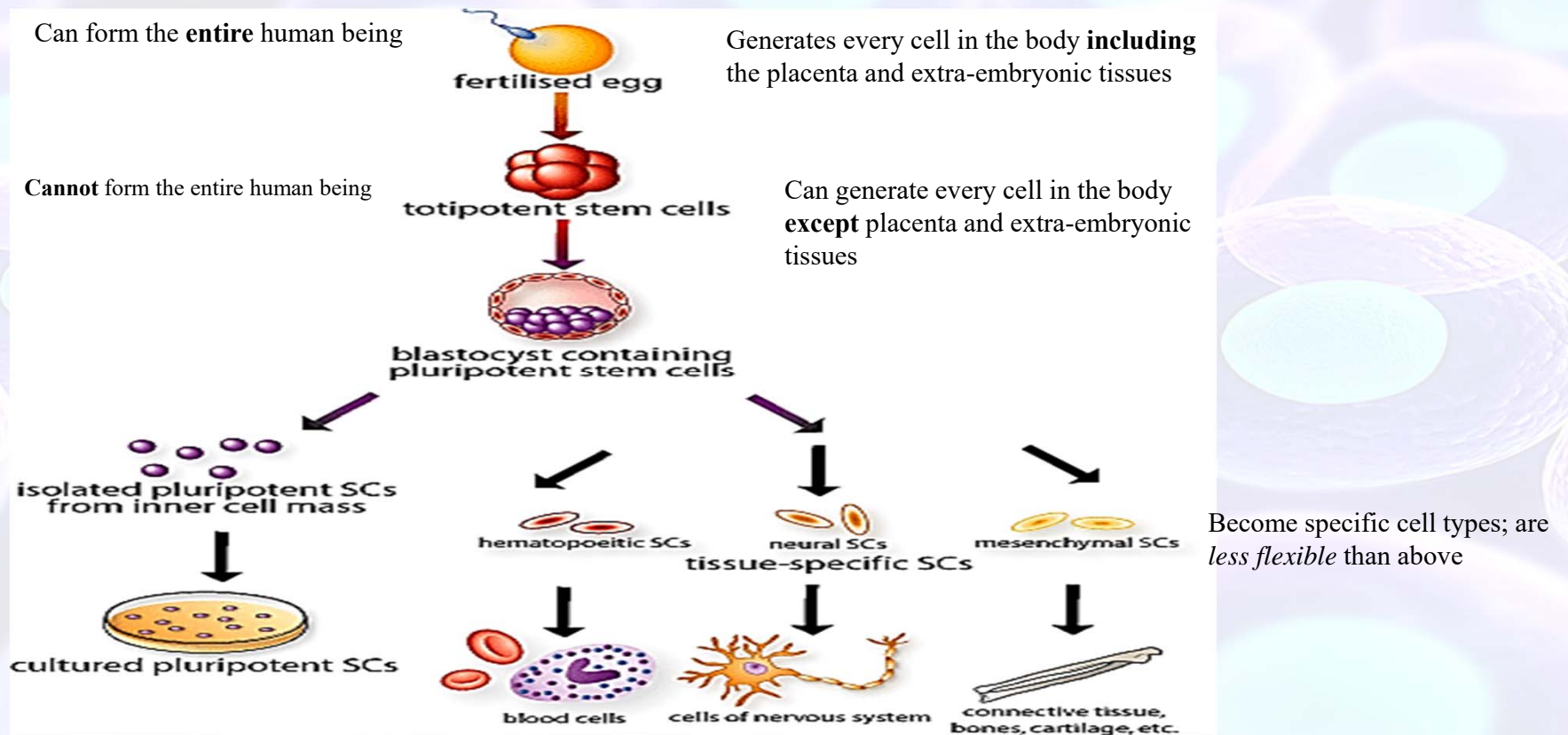
a stem cell can specialize into a particular type of *somatic* cell



Properties of a stem cell

- The classical definition of a stem cell requires that it possess two properties
- **Self-renewal:** the ability to go through numerous cycles of cell division while maintaining the undifferentiated state.
- **Potency:** the capacity to differentiate into specialized cell types. In the strictest sense, this requires stem cells to be either totipotent or pluripotent—to be able to give rise to any mature cell type, although multipotent or unipotent progenitor cells are sometimes referred to as stem cells.

- **Potency definition**
- Potency specifies the differentiation potential (the potential to differentiate into different cell types) of the stem cell.
- **Totipotent (omnipotent) stem cells** can differentiate into embryonic and extraembryonic cell types. Such cells can construct a complete, viable organism. These cells are produced from the fusion of an egg and sperm cell. Cells produced by the first few divisions of the fertilized egg are also totipotent.
- **Pluripotent stem cells** can differentiate into nearly all cells, i.e. cells derived from any of the three germ layers.
- **Multipotent stem cells** can differentiate into a number of cell types, but only those of a closely related family of cells. Examples include hematopoietic stem cells that specialize into various blood cells.
- **Unipotent cells** can produce only one cell type, their own, but have the property of self-renewal, which distinguishes them from non-stem cells (e.g. progenitor cells, muscle stem cells).



Types of stem cells

- There are two broad types of stem cells:

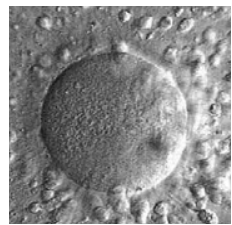
- I. Embryonic stem cells

- II. Adult stem cells,

- 1- **Embryonic stem cells**

An embryonic stem cell is derived from a group of cells called the inner cell mass, which is part of the early (4- to 5-day) embryo called the blastocyst. Once removed from the blastocyst, the cells of the inner cell mass can be cultured into embryonic stem cells.

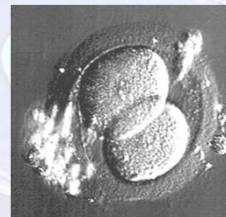
Embryonic stem cell



egg



fertilised egg



2-cell

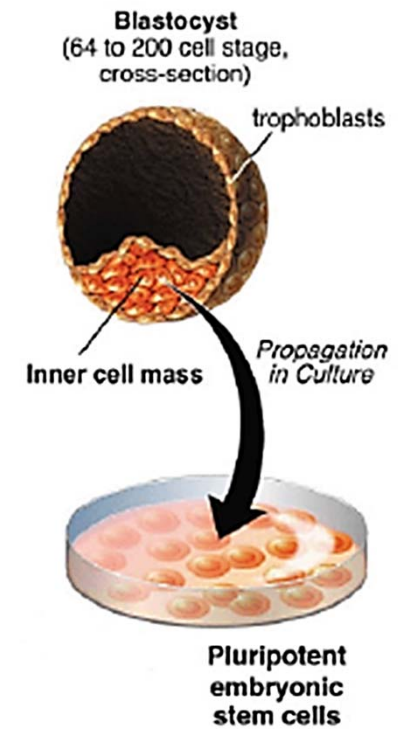
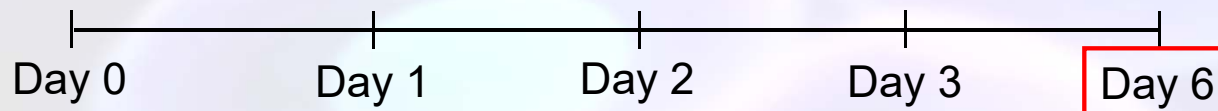


8-cell



blastocyst

Inner cell mass

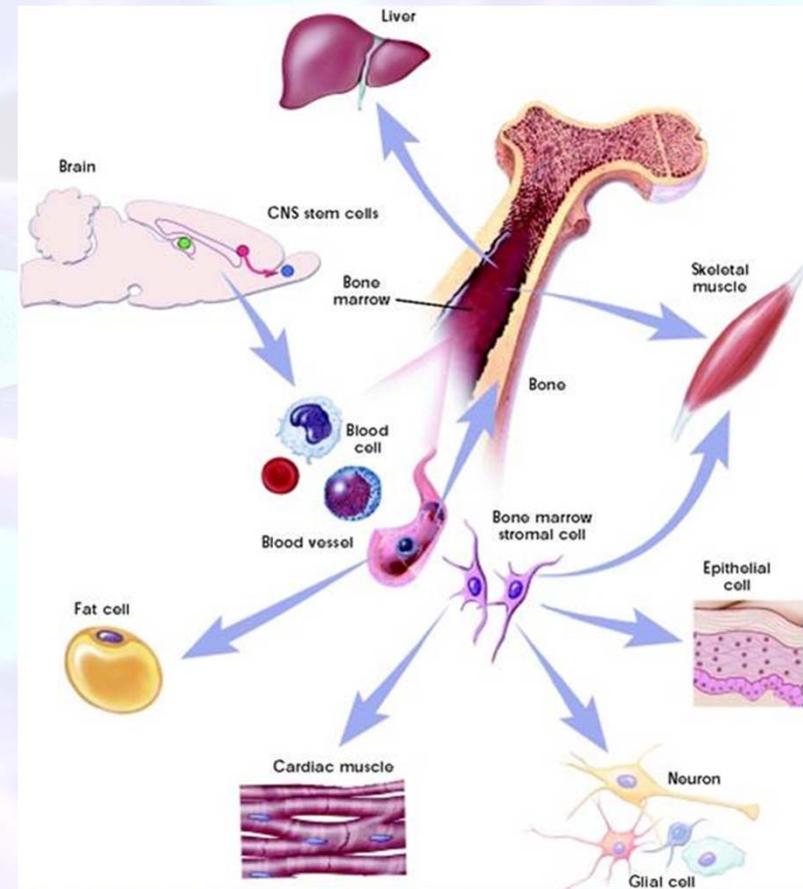


PROPERTIES OF AN EMBRYONIC STEM (ES) CELL

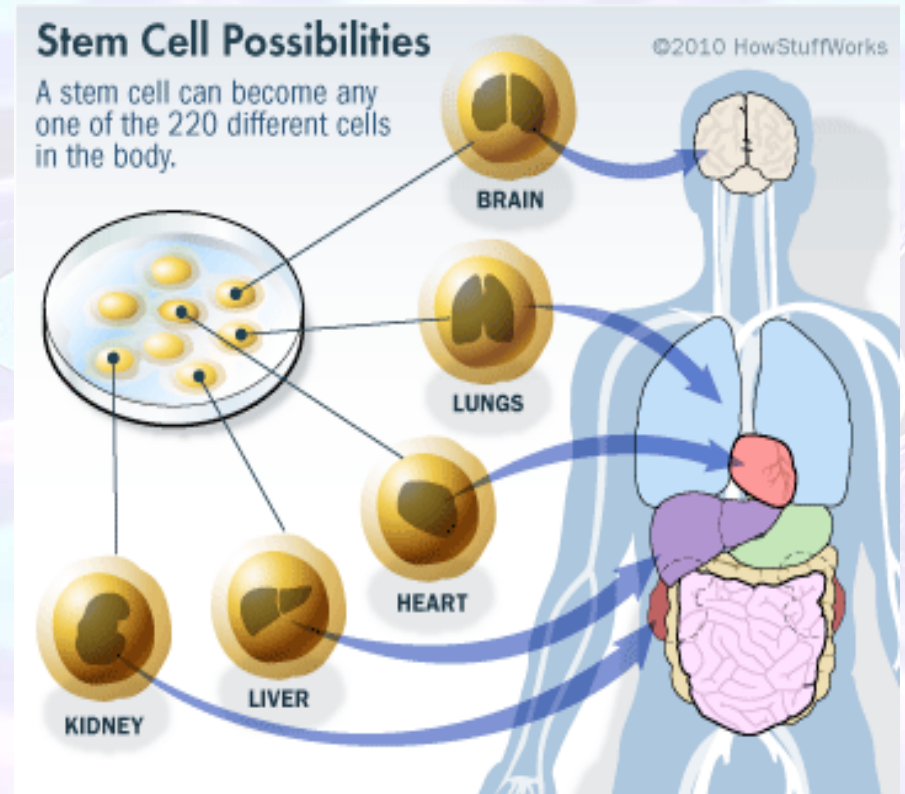
- Derived from the **inner cell mass/epiblast of the blastocyst**
- Capable of undergoing an unlimited number of symmetrical divisions without differentiating (long-term self-renewal).
- Exhibit and maintain a stable, **full (diploid)**, normal complement of chromosomes (karyotype).
- Pluripotent ES cells can give rise to differentiated cell types that are derived from all three primary germ layers of the embryo (endoderm, mesoderm, and ectoderm).
- Can be induced to continue proliferating or to differentiate

2-Adult stem cell.

- An adult stem cell is an undifferentiated (unspecialized) cell that is present in a differentiated (specialized) tissue, renews itself, and becomes specialized to yield all of the specialized cell types of the tissue from which it is originated.
- Adult stem cells are capable of making identical copies of themselves for the lifetime of the organism. This property is referred to as “self-renewal.”



- Adult stem cells usually divide to generate **progenitor or precursor** cells, which then differentiate or develop into “**mature**” cell types that **have characteristic shapes and specialized functions**, e.g., muscle cell contraction or nerve cell signaling.



Adult stem cell

- There are three known accessible sources of autologous adult stem cells in humans:
 1. **Bone marrow**, which requires extraction by harvesting, that is, drilling into bone (typically iliac crest).
 2. **Adipose tissue (lipid cells)**, which requires extraction by liposuction.
 3. **Blood**, which requires extraction through apheresis, wherein blood is drawn from the donor (similar to a blood donation), and passed through a machine that extracts the stem cells and returns other portions of the blood to the donor.
- Stem cells can also be taken from **umbilical cord** blood just after birth.
- Adult stem cells are frequently used in medical therapies, for example in bone marrow transplantation. Stem cells can now be artificially grown and transformed (differentiated) into specialized cell types with characteristics consistent with cells of various tissues such as muscles or nerves

Embryonic Vs Adult Stem cells

• Embryonic stem cell

- Differentiate into any cell type
- Unlimited numbers, easy to isolate
- May Cause immune response

• Adult Stem cell

- Differentiate into some cell type limited outcome
- Limited numbers, More difficult to isolate
- Less likely to cause immune rejection, since the patients own cells can be used

Homework

- Write two of the stem cells applications?
- What is the cell signaling transduction? And write about the function of G couple protein?
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Summary

- **The human body is composed of specialised cells or mature cells that perform specific functions.**
- **Specialised cells arise from the differentiation of unspecialised cells during embryological development.**
- **Some cells remain “immature”—these are called stem cells.**
- **Stem cell has the capacity to differentiate into any specialized cell types.**
- **The sources for stem cell are embryonic stem cell and adult tissues.**

Resources

<http://www.isscr.org/public> Stem cell information for the public from the International Society for Stem Cell Research (ISSCR).

<http://www.nlm.nih.gov/medlineplus/stemcells.html> Medline Plus

<http://www.explorestemcells.co.uk> A United Kingdom–based resource for the general public that discusses the use of stem cells in medical treatments and therapies.

<http://www.stemcellresearchnews.com> A commercial, online newsletter that features stories about stem cells of all types.