BHARATHIDASAN UNIVERSITY

Tiruchirappalli- 620024,
Tamil Nadu, India

Programme: M.Sc., Biomedical science

Course Title : Stem Cell Biology & Tissue Engineering

Course Code : 18BMS48C14

Unit-IV

TOPIC: Embryonic stem cell

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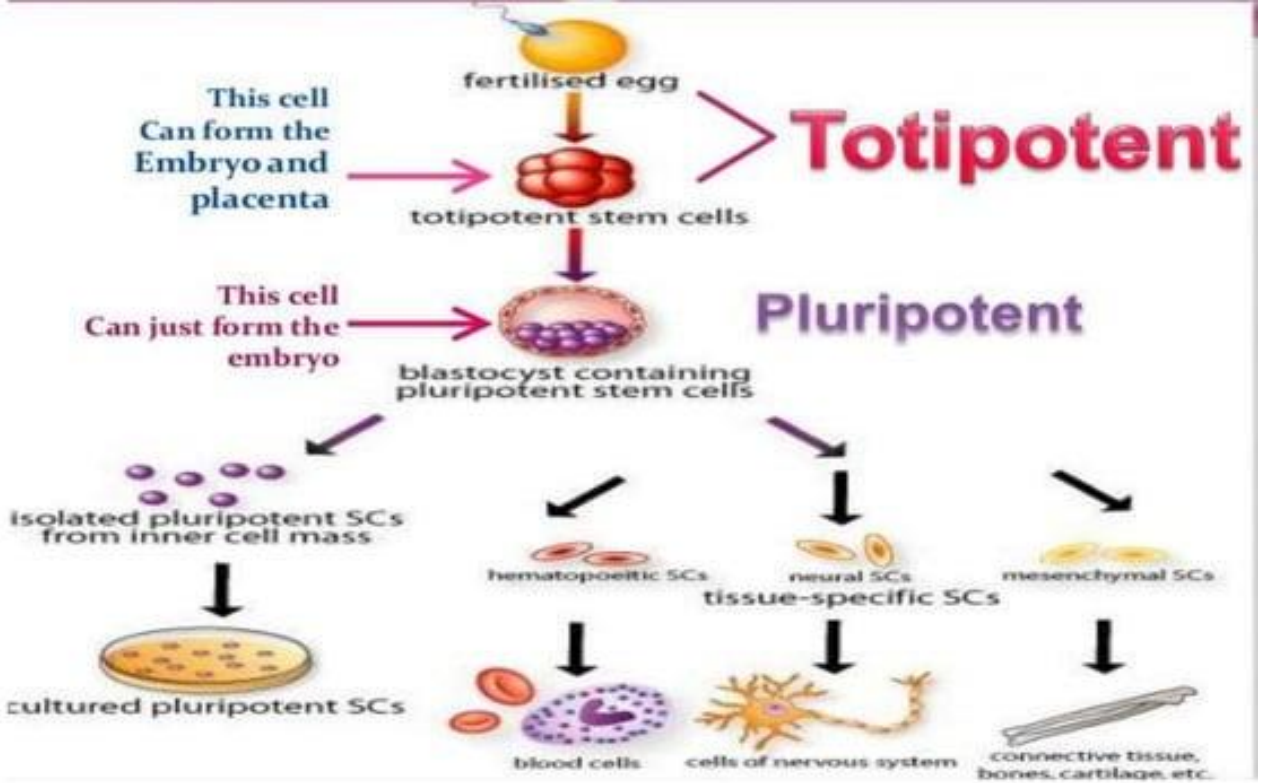
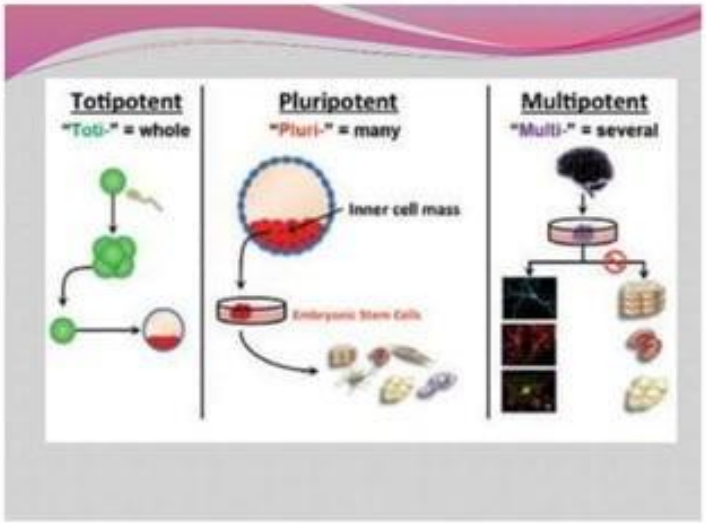
Embryonic stem cell

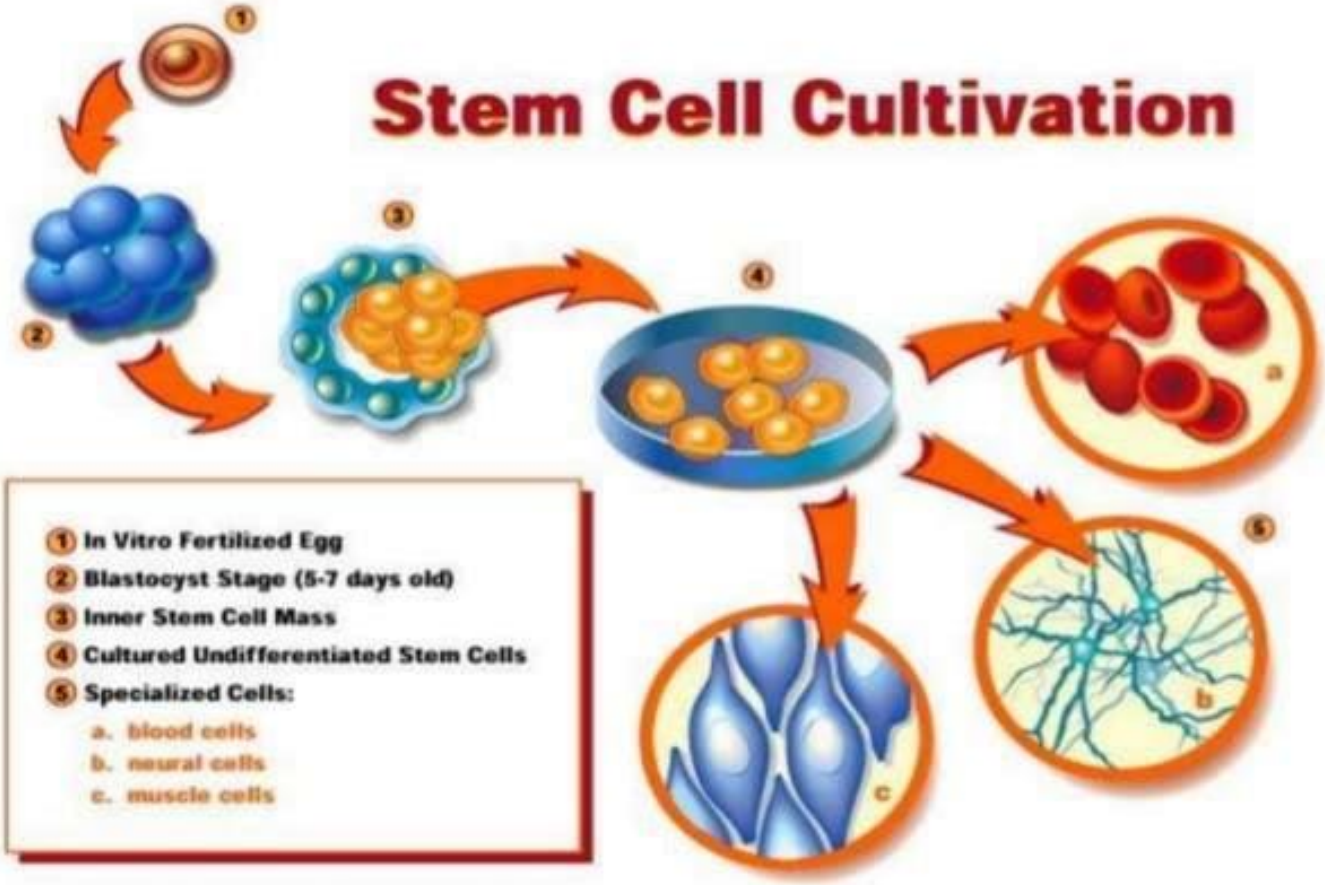


OVERALL VIEW OF THE EMRYONIC DEVELOPMENT :

TYPES AND ORIGIN OF STEM CELLS

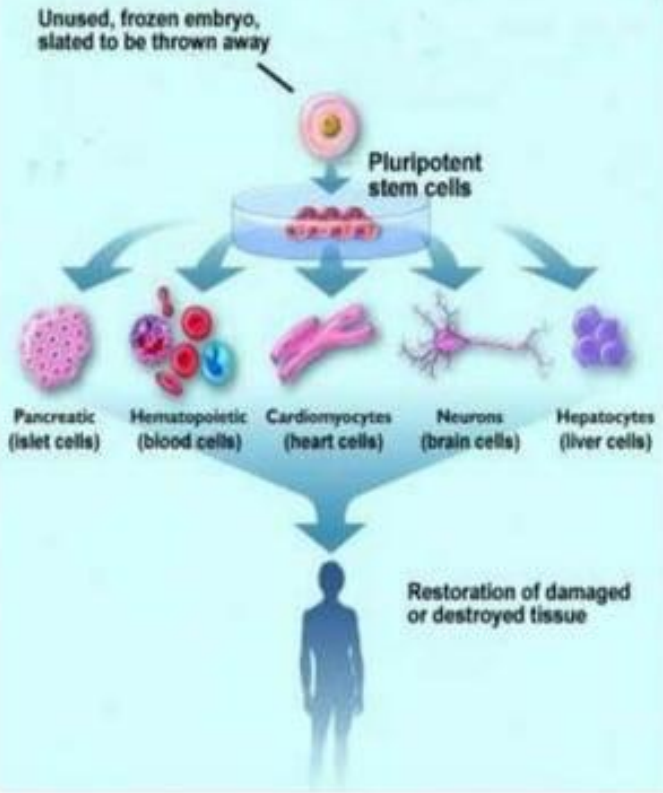


Stem Cell Cultivation

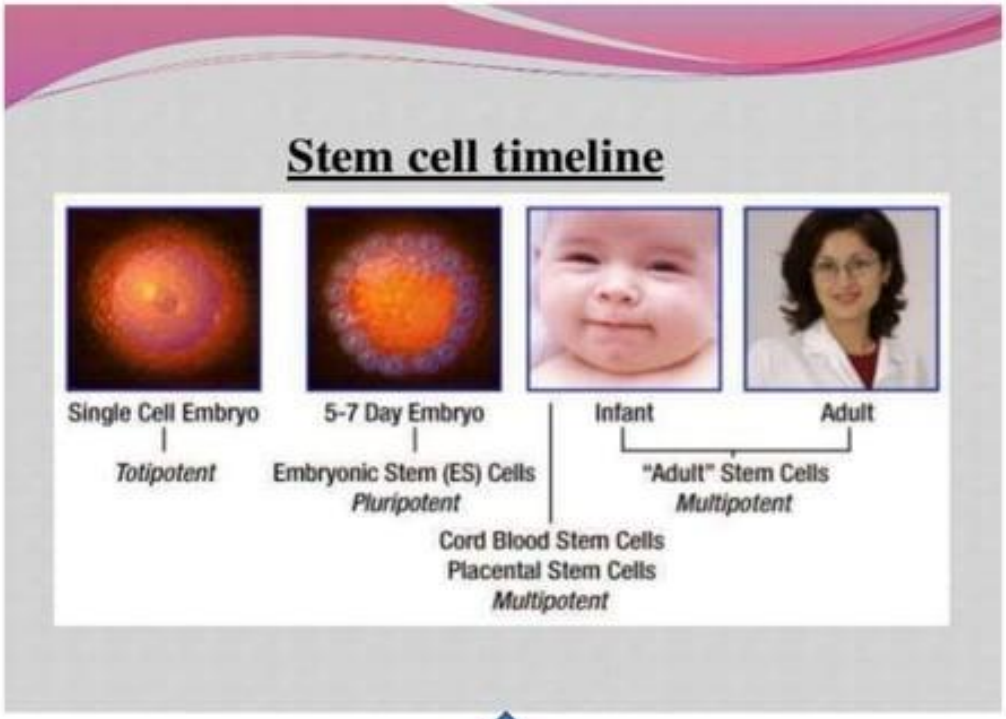


1. In Vitro Fertilized Egg
2. Blastocyst Stage (5-7 days old)
3. Inner Stem Cell Mass
4. Cultured Undifferentiated Stem Cells
5. Specialized Cells:
   a. blood cells
   b. neural cells
   c. muscle cells

Stem Cells From In Vitro Fertilization (IVF)



- Tens of thousands of frozen embryos are routinely destroyed when couples finish their treatment.
- These surplus embryos can be used to produce stem cells.
- Regenerative medical research aims to develop these cells into



SINGLE CELL TO AN ADULT

SOURCE AND SIGNIFICANCE

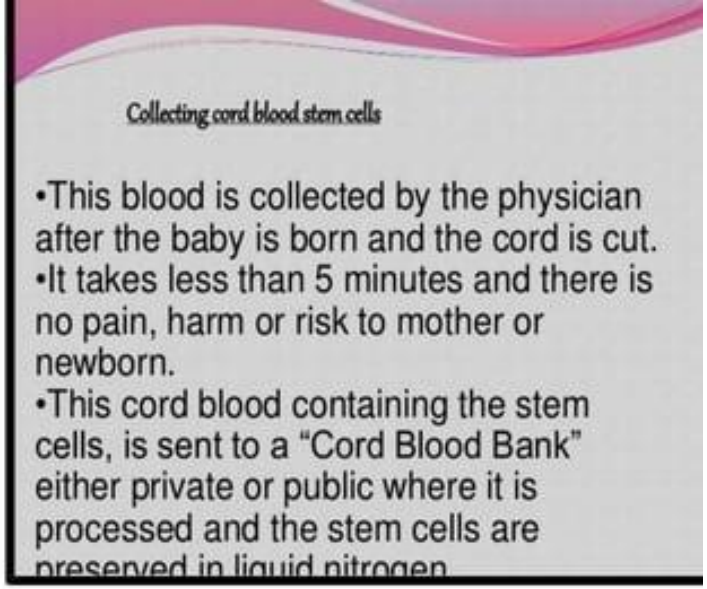
Significance – eliminate infection by viruses or other mouse molecules

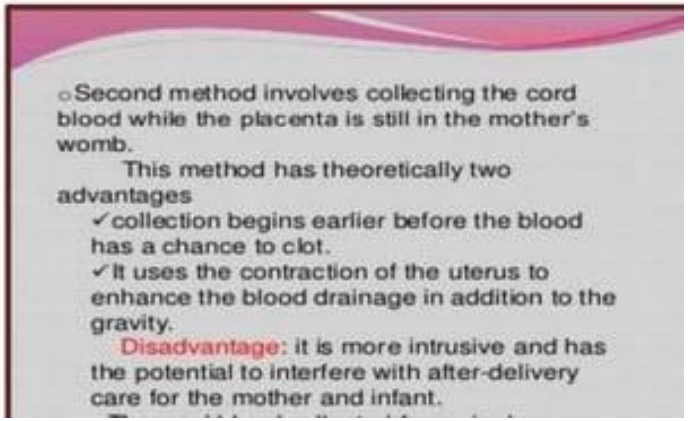
•ES cells are removed gently and plated into several different culture plates before crowding occurs

Cord Blood

•Umbilical cord blood is also known as placental blood.
•It is the blood that flows in the circulation of the developing fetus in the womb.
•After the baby's birth, the left over blood in the umbilical cord and placenta is called cord blood.
•This blood is a rich source of stem

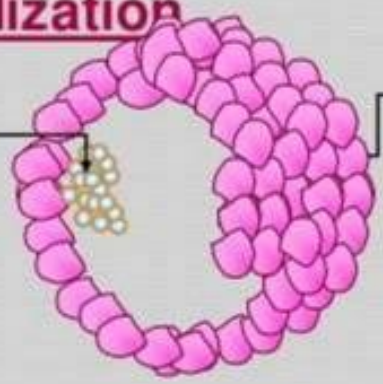
HOW TO COLLECT STEM CELLS





A primer on Human Embryonic Stem Cells

Blastocyst -
from In Vitro Fertilization Clinic

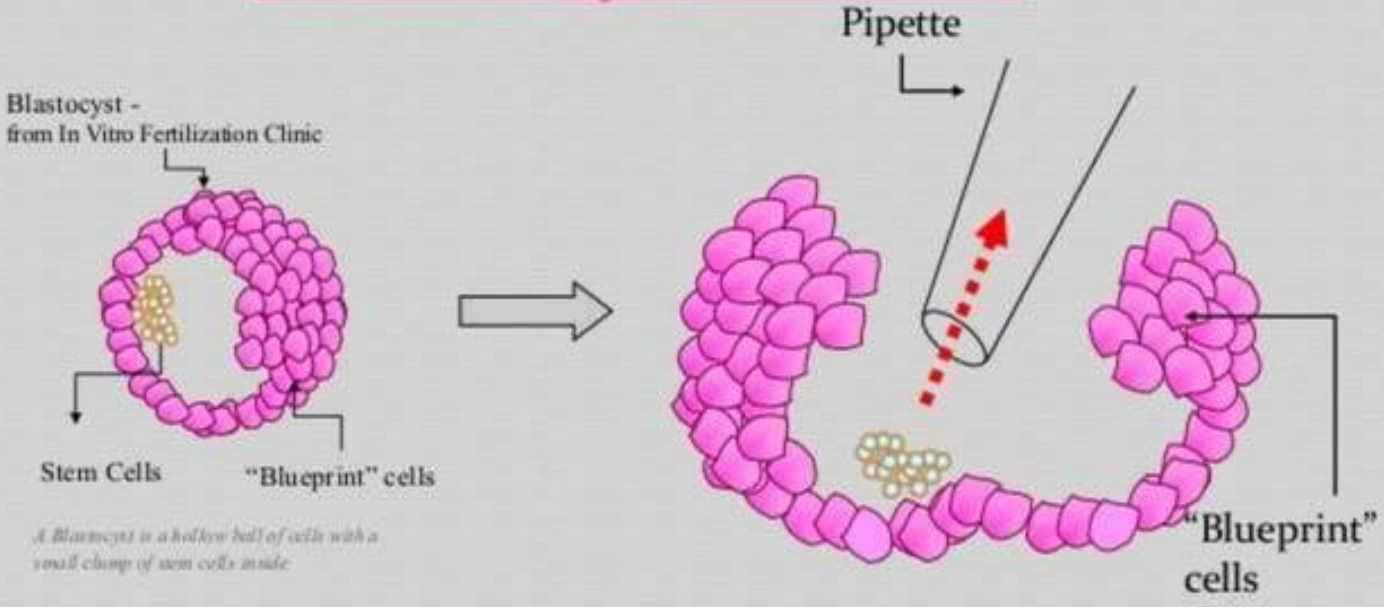


Inner Cell Mass (Stem Cells)

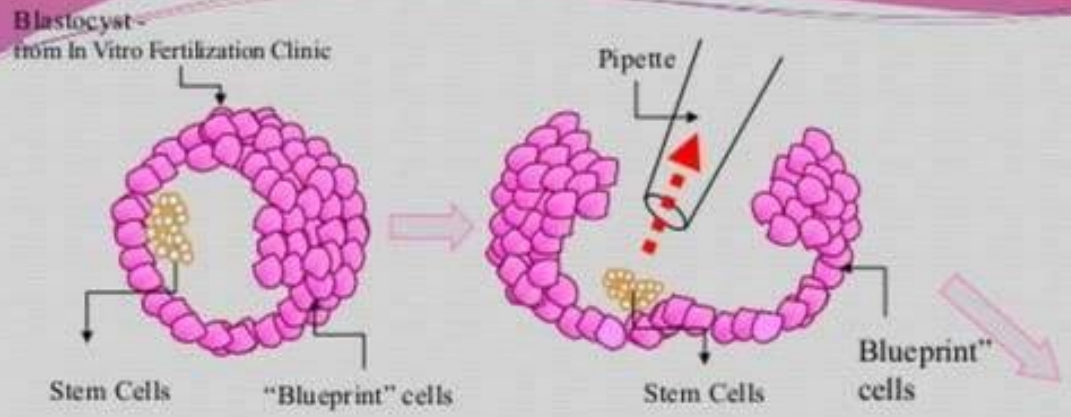
"Blueprint" cel

A Blastocyst is a hollow ball of cells with a small clump of stem cells inside

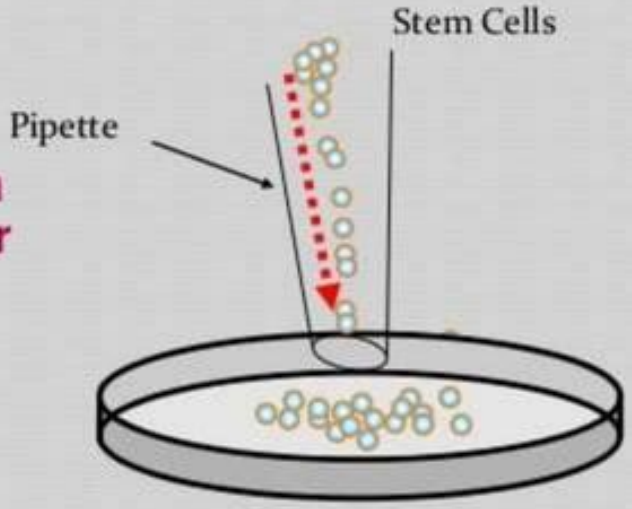
Human Embryonic Stem Cells



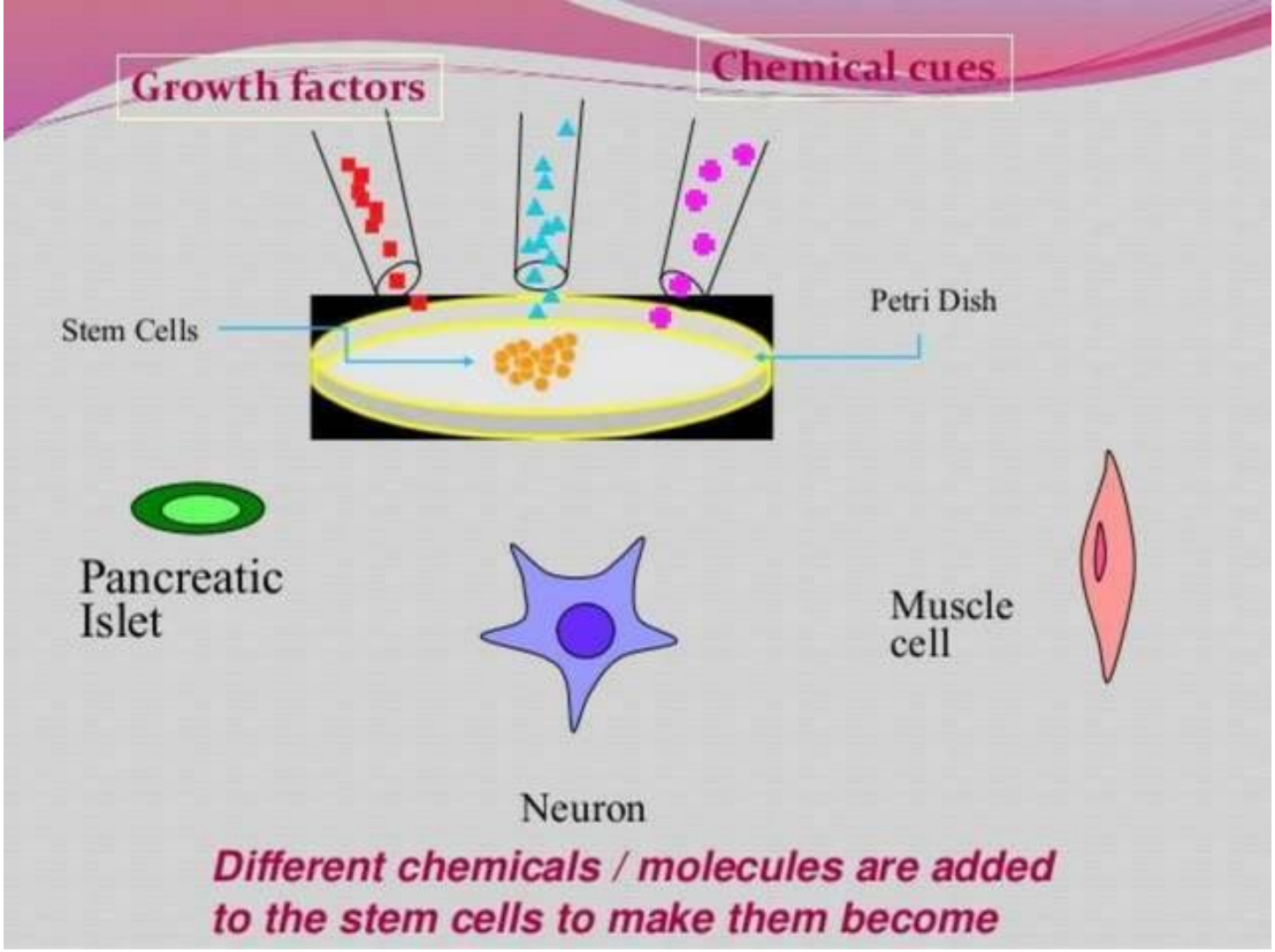
To remove the stem cells, the Blastocyst is opened and the stem cells removed with a pipette



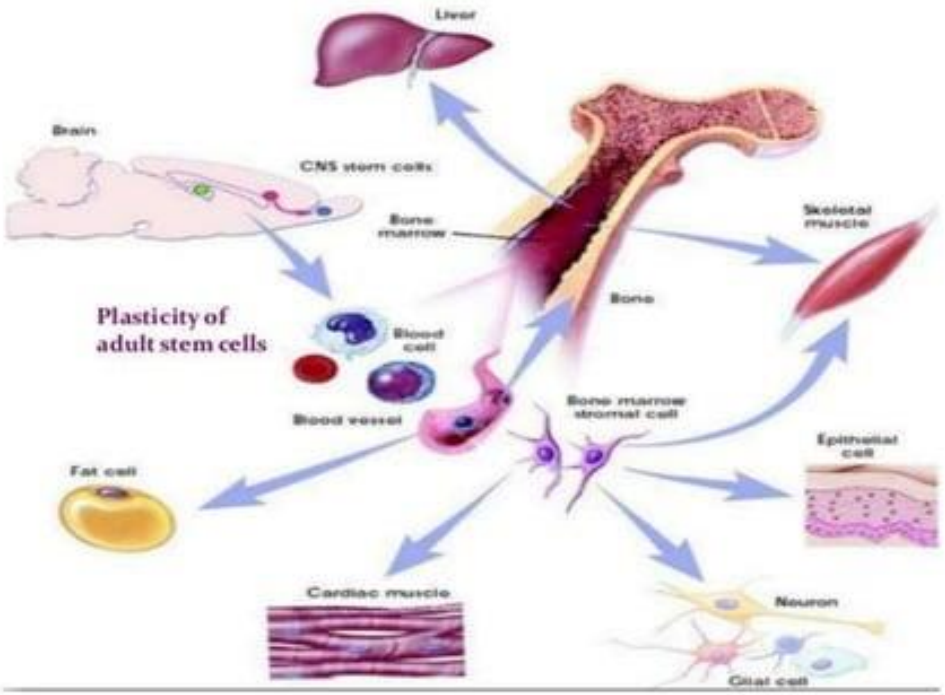
A Blastocyst is a hollow ball of cells with a small clump of stem cells inside



The stem cells are placed in a dish and are fed and cared for (each blastocyst = 1 stem cell line)


Growth factors
Chemical cues
Stem Cells
Petri Dish
Pancreatic Islet
Neuron
Muscle cell
Different chemicals / molecules are added to the stem cells to make them become

ORIGIN OF STEM CELLS TO TARGET SITE



Type I Diabetes

- Pancreatic cells do not produce insulin.
- Basic research focused on understanding how embryonic stem cells might be trained to become pancreatic islets cells needed to secrete insulin.

Cord Blood Collection

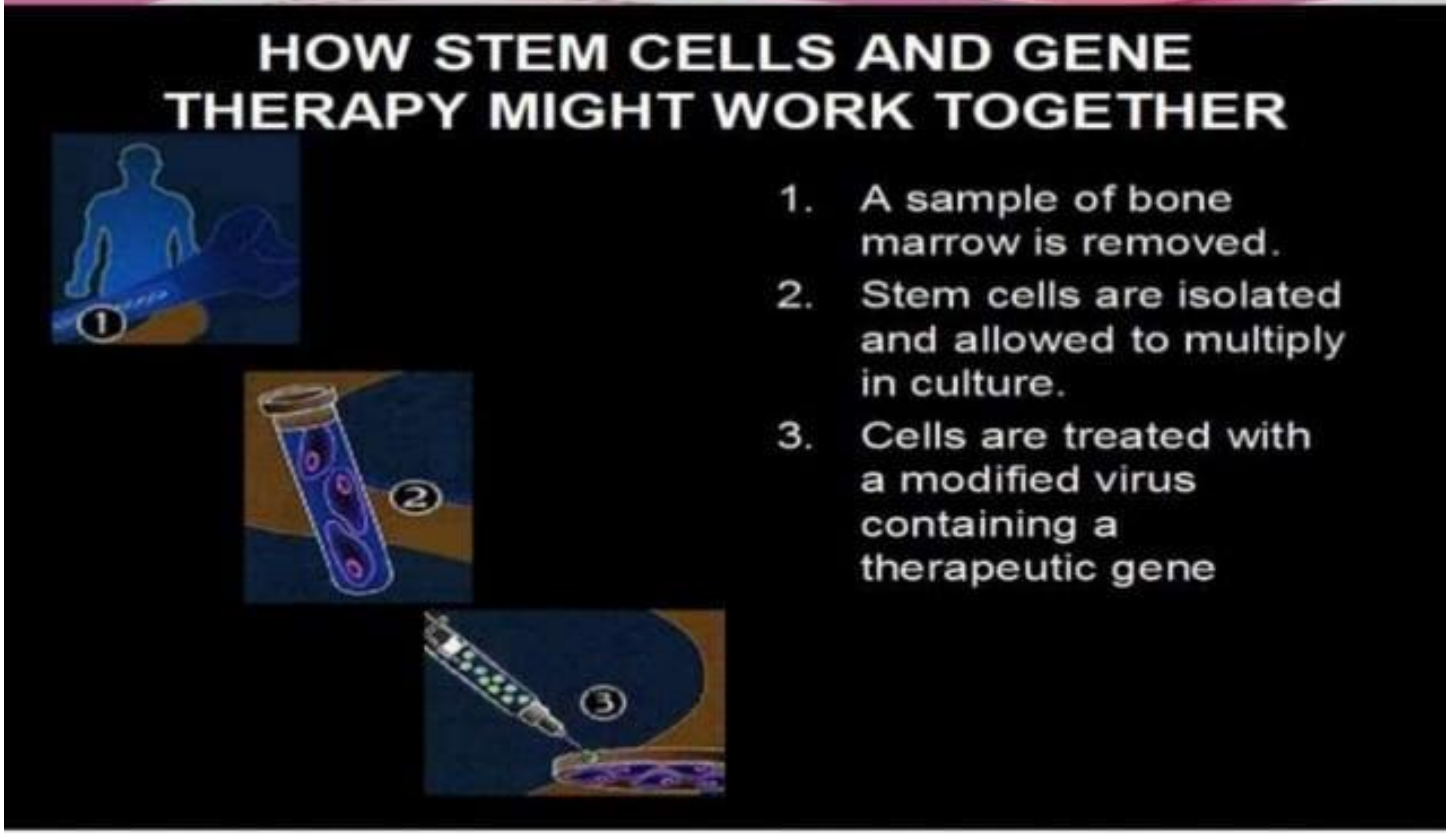
COLLECTION AND USES

Tissue Repair

- **Regenerate spinal cord, heart tissue or any other major tissue in the body.**

Heart Disease

- Adult bone marrow stem cells injected into the hearts arteries are believed to improve cardiac function in victims of heart failure or heart attack.



GENETICS AND STEM CELLS

HARVEST AND TECHNIQUE

How are embryonic stem cells harvested?

- Growing cells in the laboratory is called as **cell culture**.
- Human ES cells are derived from 4-5 day old blastocyst
- Blastocyst structures include:
  - -Trophoblast: outer layer of cells that surrounds the blastocyst & forms the placenta
  - -Blastocoel: ("blastoseel") the hollow cavity inside the blastocyst that will form body cavity
  - -Inner cell mass: a group of approx. 30 cells at one end of the blastocoel:

Cell Culture Techniques for ESC

- Isolate & transfer of inner cell mass into plastic culture dish that contains culture medium
- Cells divide and spread over the dish
  Inner surface of culture dish is typically coated with mouse embryonic skin cells that have been treated so they will not divide
- This coating is called a FEEDER LAYER
  - Feeder cells provide ES cells with a sticky surface for attachment
  - Feeder cells release nutrients
- Recent discovery: methods for growing embryonic

TYPES AND FUNCTION

Umbilical cord stem cells

Three important functions:

1. **Plasticity**: Potential to change into other cell types like nerve cells
2. **Homing:** To travel to the site of tissue damage
3. **Engraftment:** To unite with other tissues

Two types of pluripotent stem cells have been found -

•**Embryonic Stem (ES) Cells.** These can be isolated from the **inner cell mass** (ICM) of the blastocyst — the stage of embryonic development when implantation occurs. For humans, excess embryos produced during in vitro fertilization (IVF) procedures are used.

•**Embryonic Germ (EG) Cells.** are derived from the part of a human embryo or foetus

Embryonic vs. Adult Stem Cells

- **Totipotent**
  - **-Differentiation into ANY cell type**
- **Known Source**
- **Large numbers can be harvested from embryos**
- **May cause immune rejection**
  - **-Rejection of**

- Multi or pluripotent
  - Differentiation into some cell types, limited outcomes
- Unknown source
- Limited numbers, more difficult to isolate
- Less likely to cause immune rejection, since the patient's own cells can be used

RISKS AND DISORDERS

Indication for HSCT

- Neoplastic disorders
  - Hematological malignancies
    - Lymphomas (Hodgkin and non-Hodgkin)
    - Leukemias (acute and chronic)
    - Multiple myeloma
    - MDS
  - Solid tumors
- Non-neoplastic disorders
  - Aplastic anemia
  - Autoimmune diseases
  - Immunodeficiency
  - Inborn errors of metabolism

Clinical characteristics with various sources of stem cells

Cellular characteristic		source	
	Peripheral blood	Bone marrow	Cord blood
HLA Matching	**Close matching required**	**Close matching required**	**Less restrictive than other**
Engraftment	**Fastest**	**Intermediate**	**Slowest**
Risk of acute GVHD	**Same as in bone marrow**	**Same as in peripheral blood**	**Lowest**
Risk of chronic GVHD	**Highest**	**Lower than peripheral blood**	**Lowest**

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THANK YOU