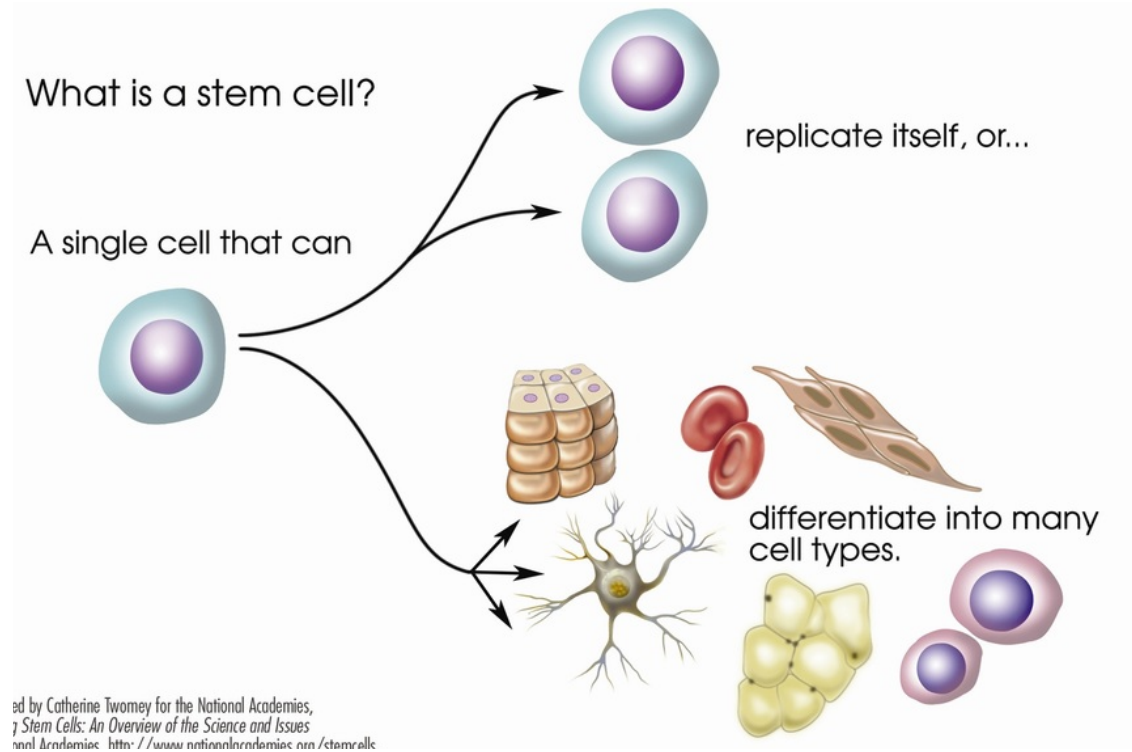
Unit 2

THE MOLECULAR AND BIOCHEMICAL BASIS OF AN ORGANISM

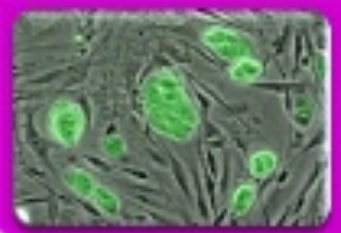
- Stem cells and their applications

What are Stem Cells

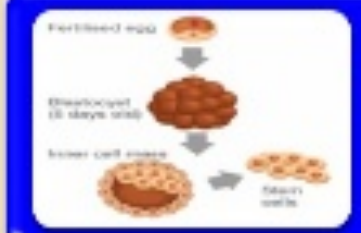
Stem cells are relatively ‘unspecialized’ cells that have the unique potential to develop into ‘specialized’ cell types in the body (for example, blood cells, muscle cells or nerve cells). They occur at all stages of human development, from embryo to adult, and in many tissues of the body.



General properties of Stem Cells



Stem cells are unspecialized cells



Stem cells can divide and renew themselves for long periods of time

Stem cells can divide and become specific specialized cell types of the body

Stem cells can replace dying, old or damaged cells

TYPES OF STEM CELLS

SOURCE

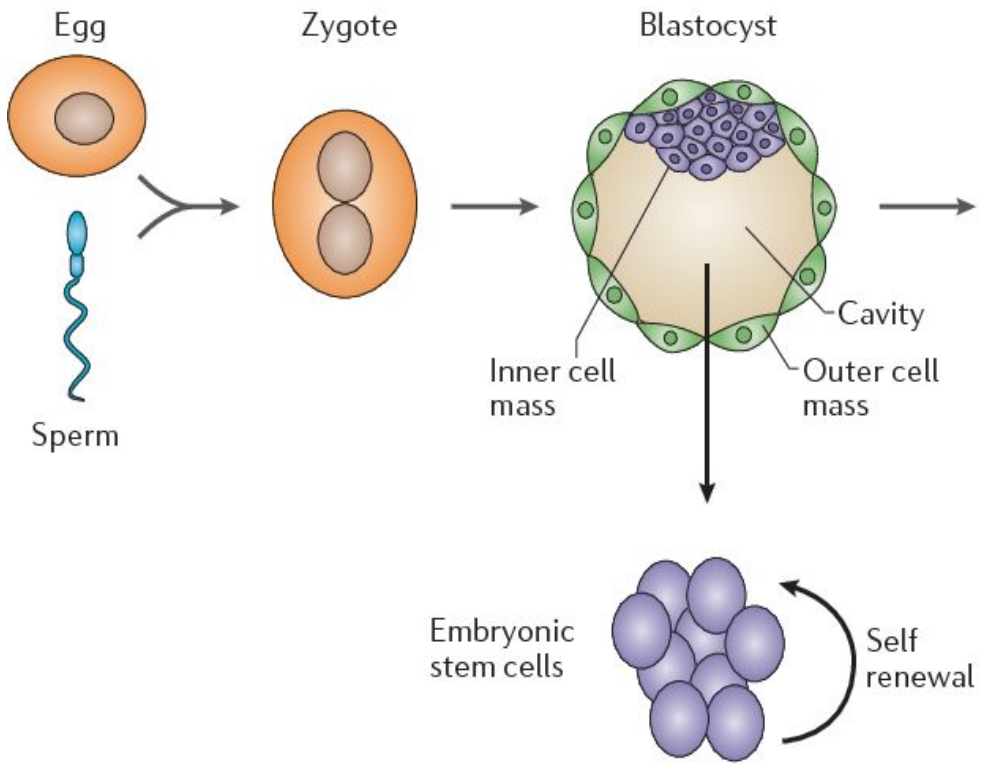
1. ADULT STEM CELLS
2. EMBRYONIC STEM CELLS

POTENCY

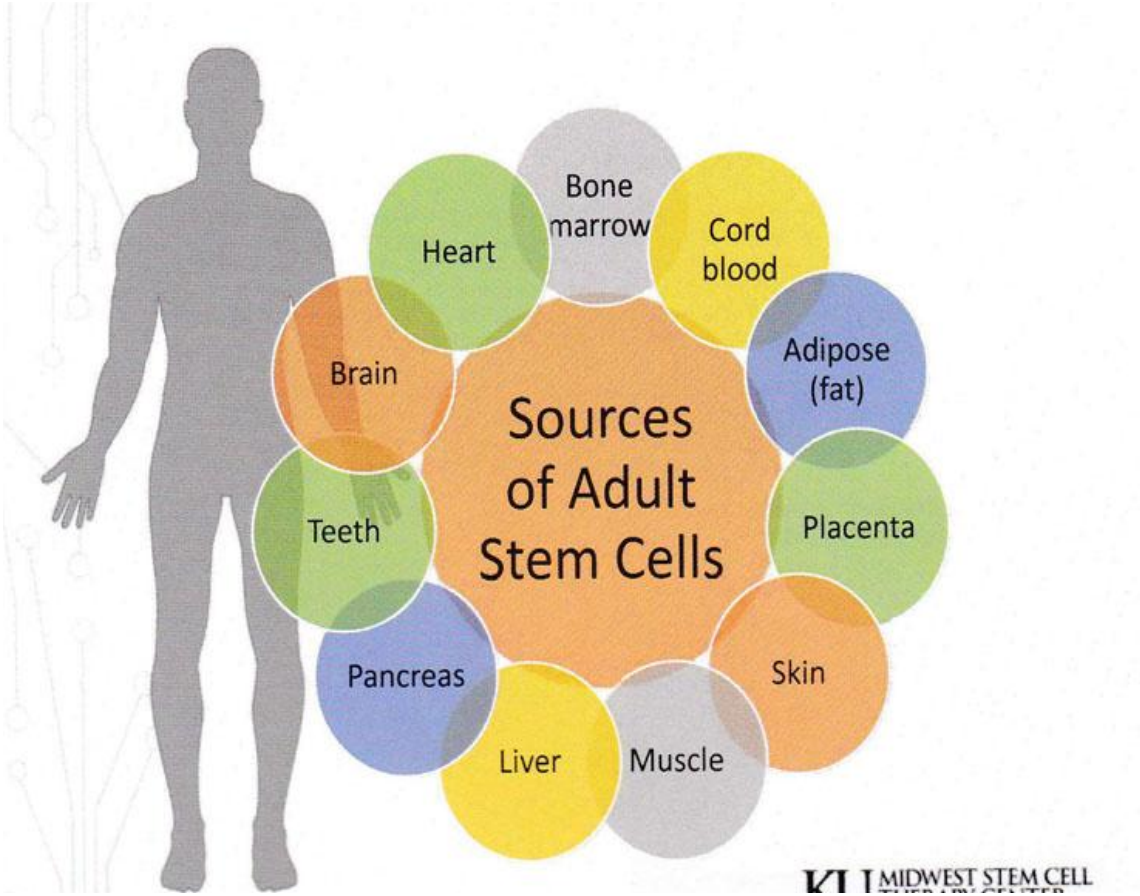
1. TOTIPOTENT
2. PLURIPOTENT
3. MULTIPOTENT

CLASSIFCATION BASED ON SOURCES

Embryonic stem cells



Adult stem cells



DIFFERENCES

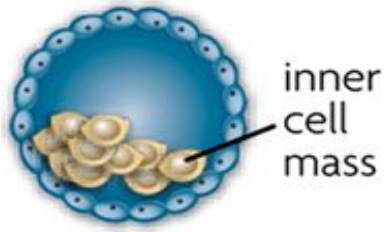
EMBRYONIC STEM CELLS	ADULT STEM CELLS
FLEXIBLE	LESS FLEXIBLE
IMMORTAL	MORTAL
AVAILABLITY	LIMITED QUANTITY
IMMUNOGENIC	NON IMMUNOGENIC
TUMORIGENIC	NON TUMORIGENIC
ISOLATION LEADS TO DESTRUCTION OF EMBRYO	RELATIVE EASE OF PROCUREMENT

CLASSIFICATION ON POTENCY

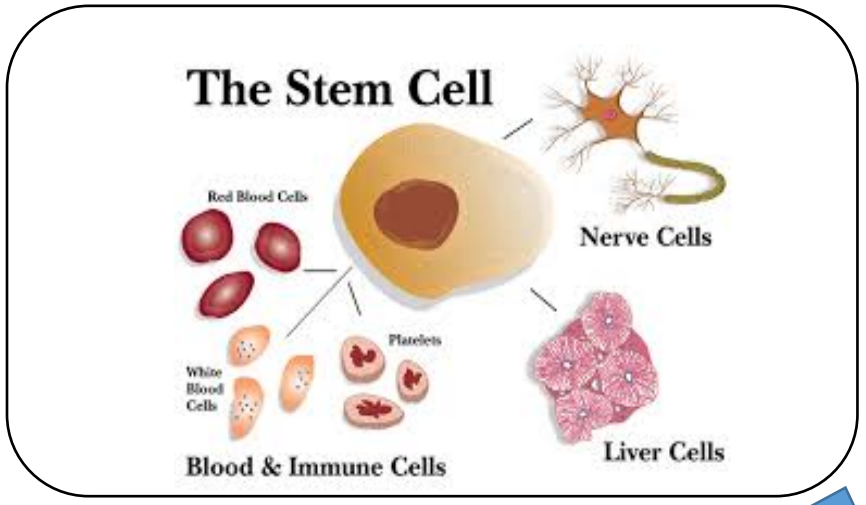
Totipotent: growing into any other cell type

Pluripotent: growing into any cell type but a totipotent cell

Multipotent: growing into cells of a closely related cell family

Class	totipotent	pluripotent	multipotent
Type of cell	fertilized egg 	embryonic stem cell 	adult stem cell (example from blood) 
Can give rise to	all cells	almost any cell	closely related cells
Example	new organism	neurons, skin, muscle, kidney, cartilage, bone, liver, pancreas	red blood cells, platelets, white blood cells

APPLICATION OF STEM CELLS

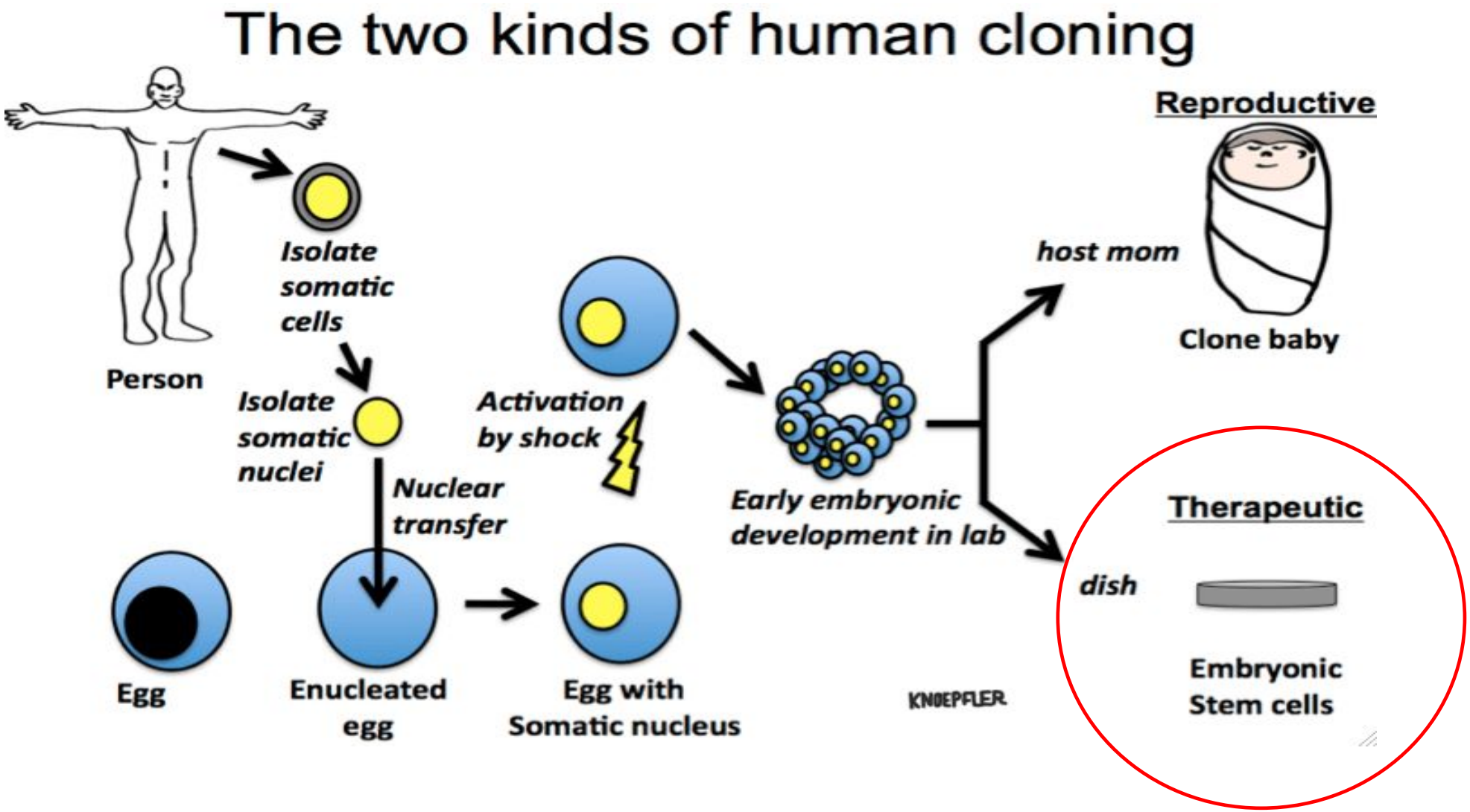


Therapeutic cloning

Regenerative medicine

Gene delivery

1. THERAPEUTIC CLONING (Somatic Cell Nuclear Transfer)



Therapeutic cloning:

- Nucleus from adult human cell transferred to enucleated egg
- Resulting embryo cells used to produce differentiated cells for transplantation therapy.
- Bypasses problem of tissue rejection

Problems with therapeutic cloning:

- Low efficiency of generating embryos by somatic cell nuclear transfer.
- Ethical concerns:
  - Possible cloning of humans (**reproductive cloning**),
  - destruction of embryos

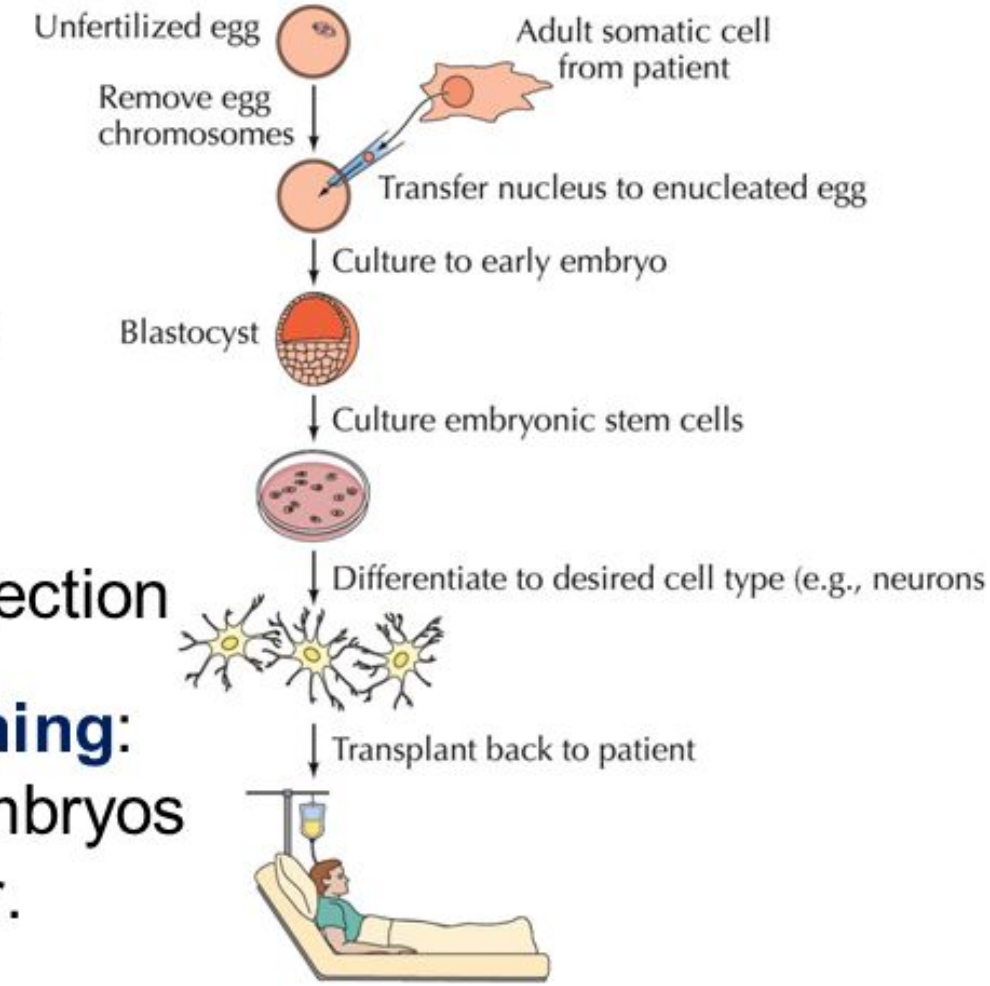


Fig. 17.26 therapeutic cloning for personalized tissue transplants

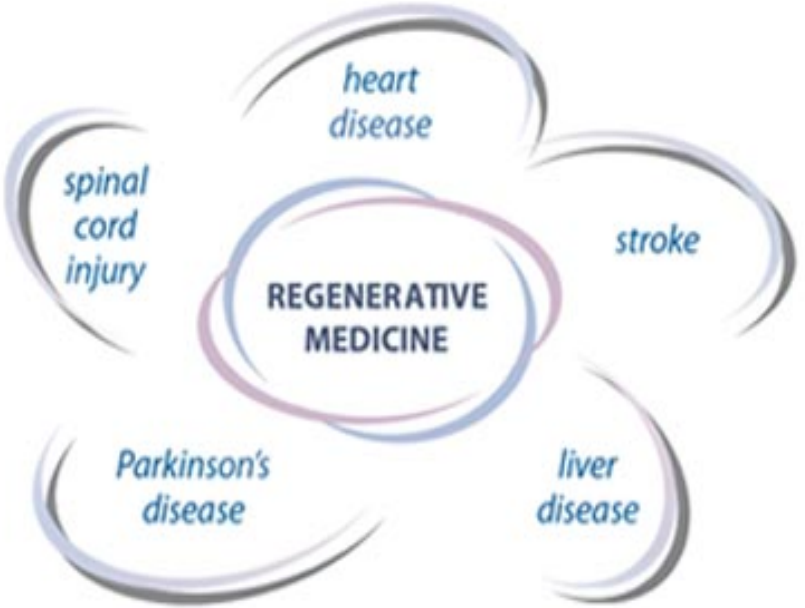
2. REGENERATIVE MEDICINE

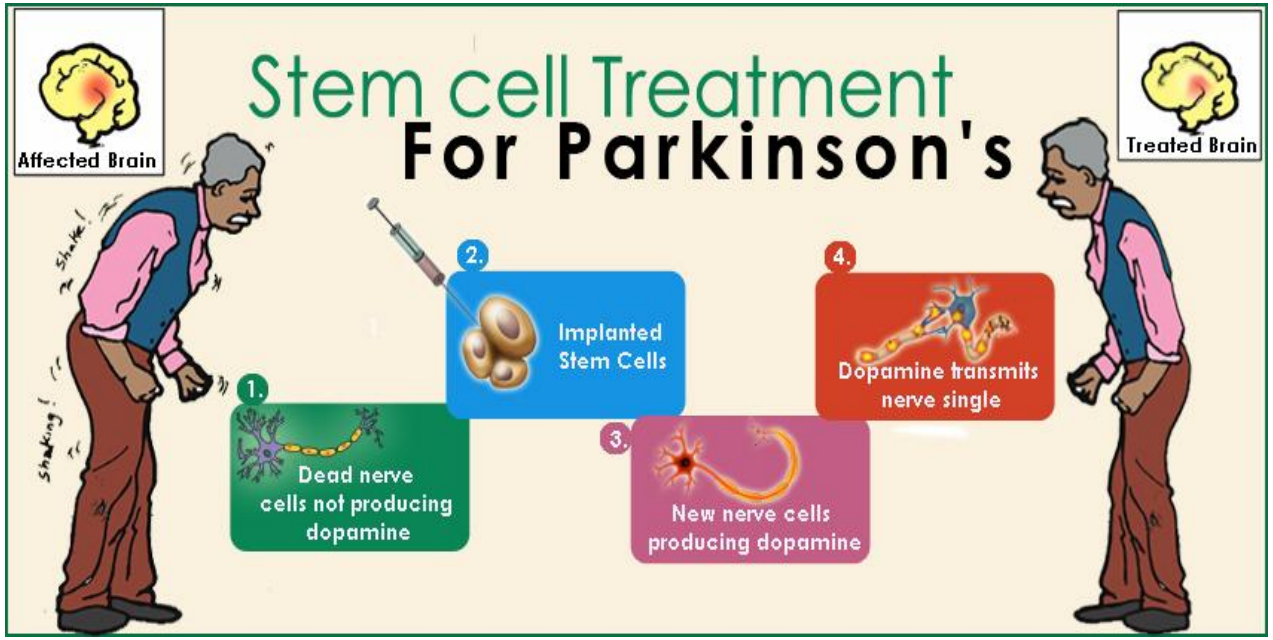
Regenerative medicine is the "process of replacing or regenerating human cells, tissues or organs to restore or establish normal function".

First cells are isolated.

Then the isolated cells are manipulated expanded and or organs are generated from reprogrammed cells.

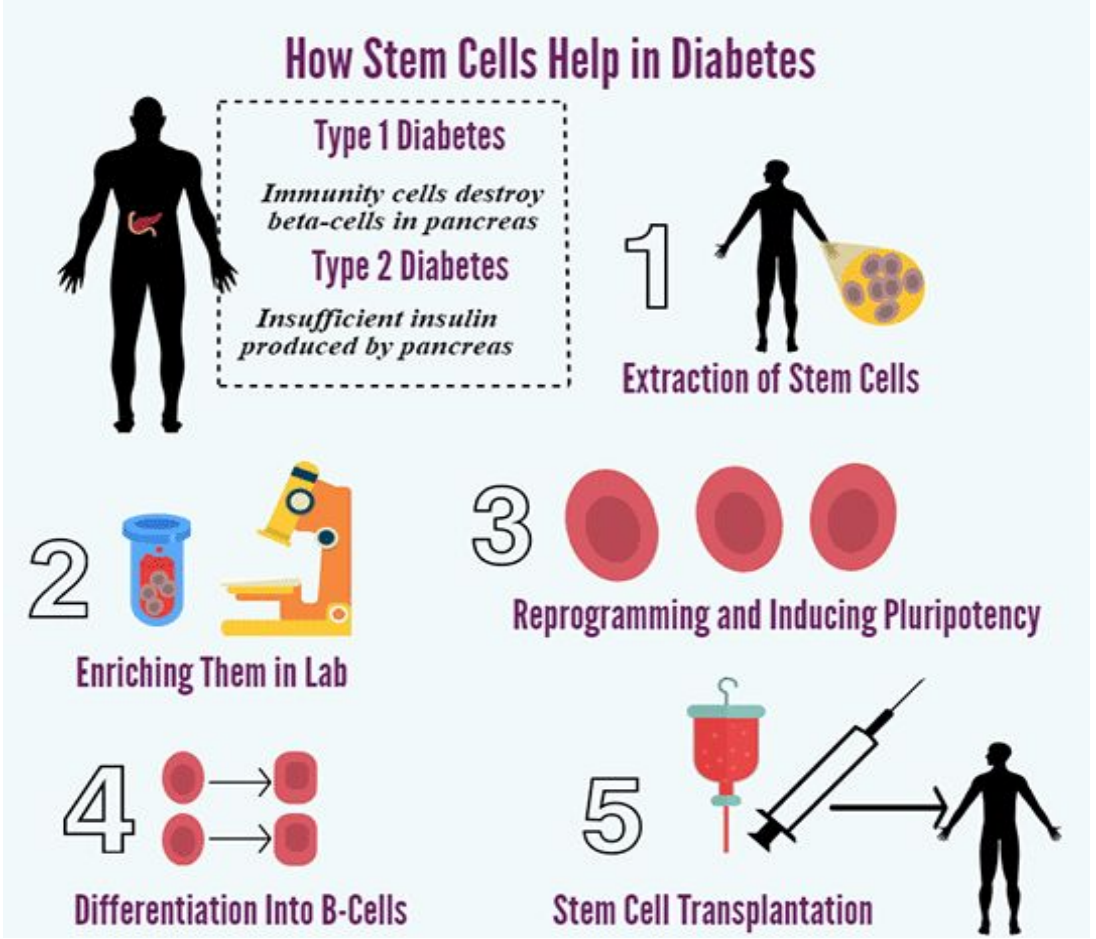
The modified cells are transplanted into patients.





STEM CELLS FOR POLIO TREATMENT

- A virus attacks cells in the spinal cord
  - Signal no longer sent to muscles in the leg
  - Muscle wasting occurs
- Stem cell treatment could
  - encourage new spinal neurons to grow
  - help new muscle to grow

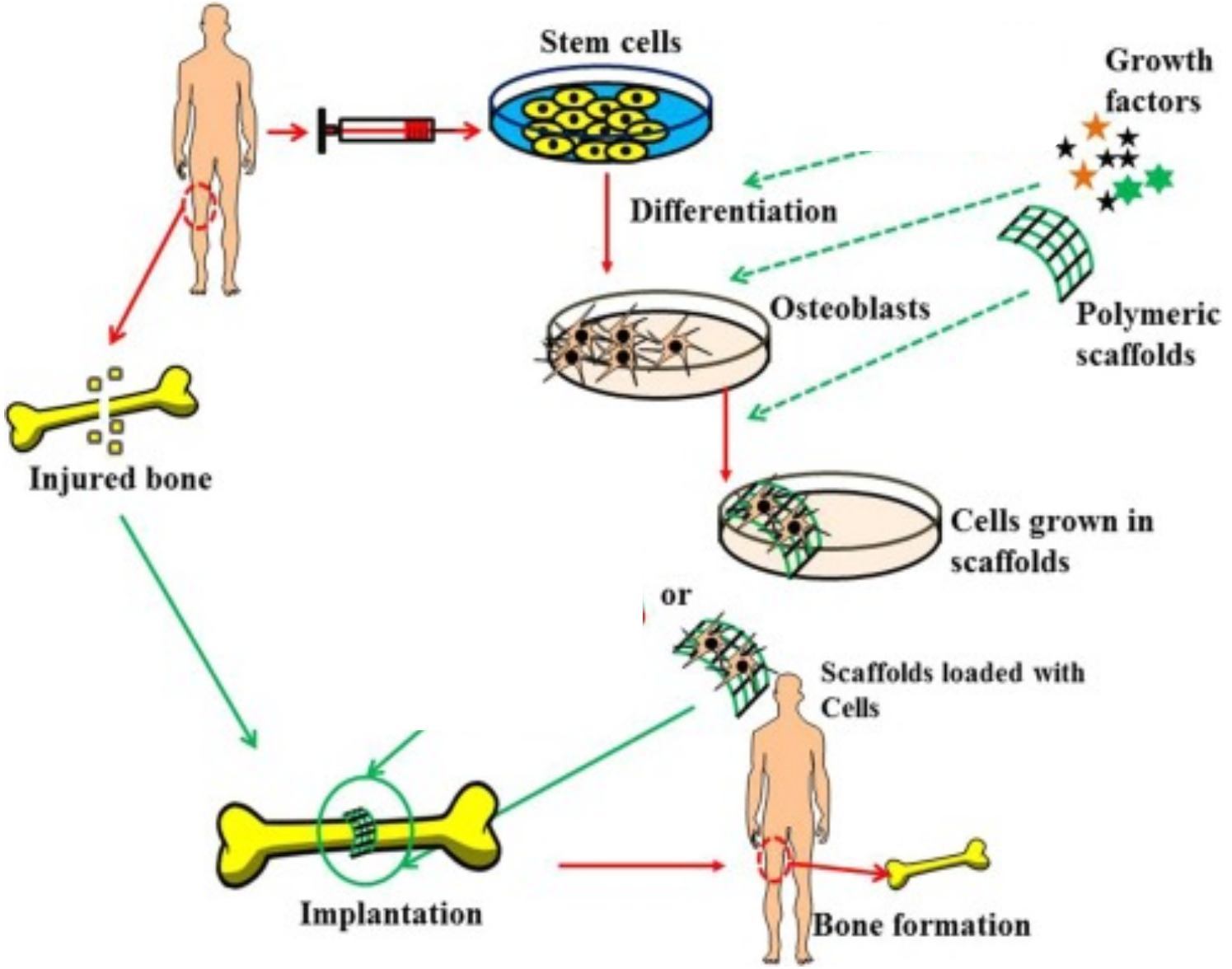


Autologous (originating from your own body) stem cell therapy has become very promising. A recent study showed patients receiving injections with adult stem cells were able to go as long as 4 years without having to rely on insulin shots

BONE TISSUE ENGINEERING

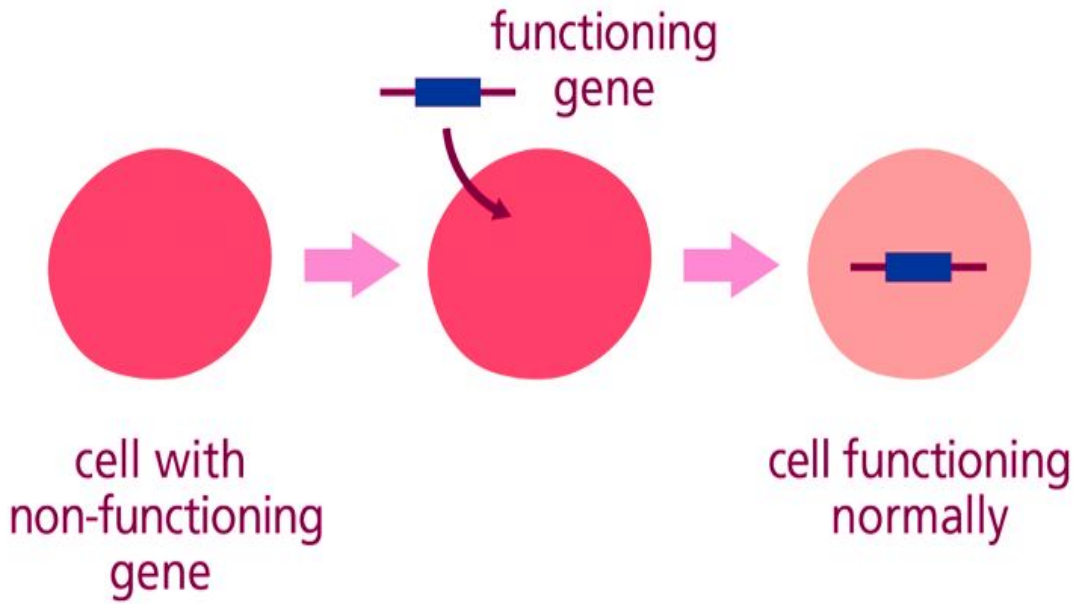
- Emerging interdisciplinary field for development of substitutes that restore and maintain the function of human bone tissues.

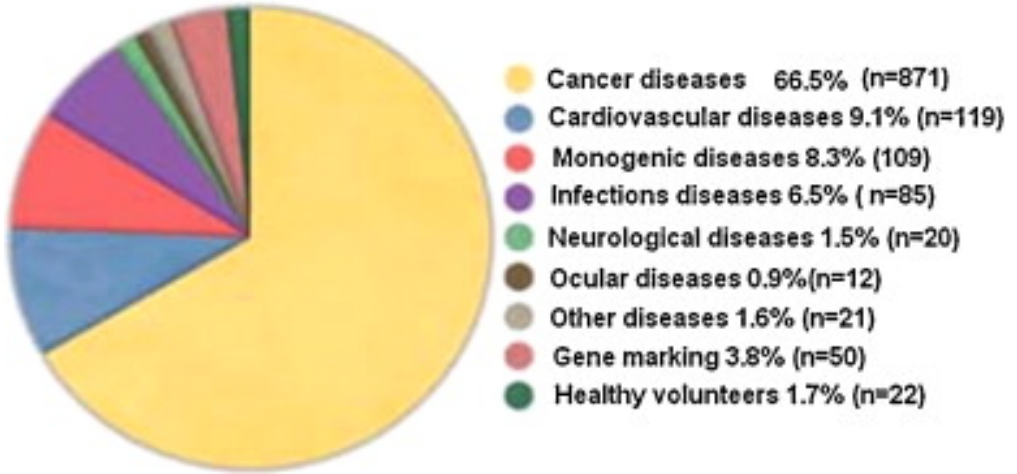
- Types of graft materials include autologous bone (bone from same patient), allogenic bone (from a donor) or a wide range of natural or synthetic biomaterials like metals, ceramics etc.



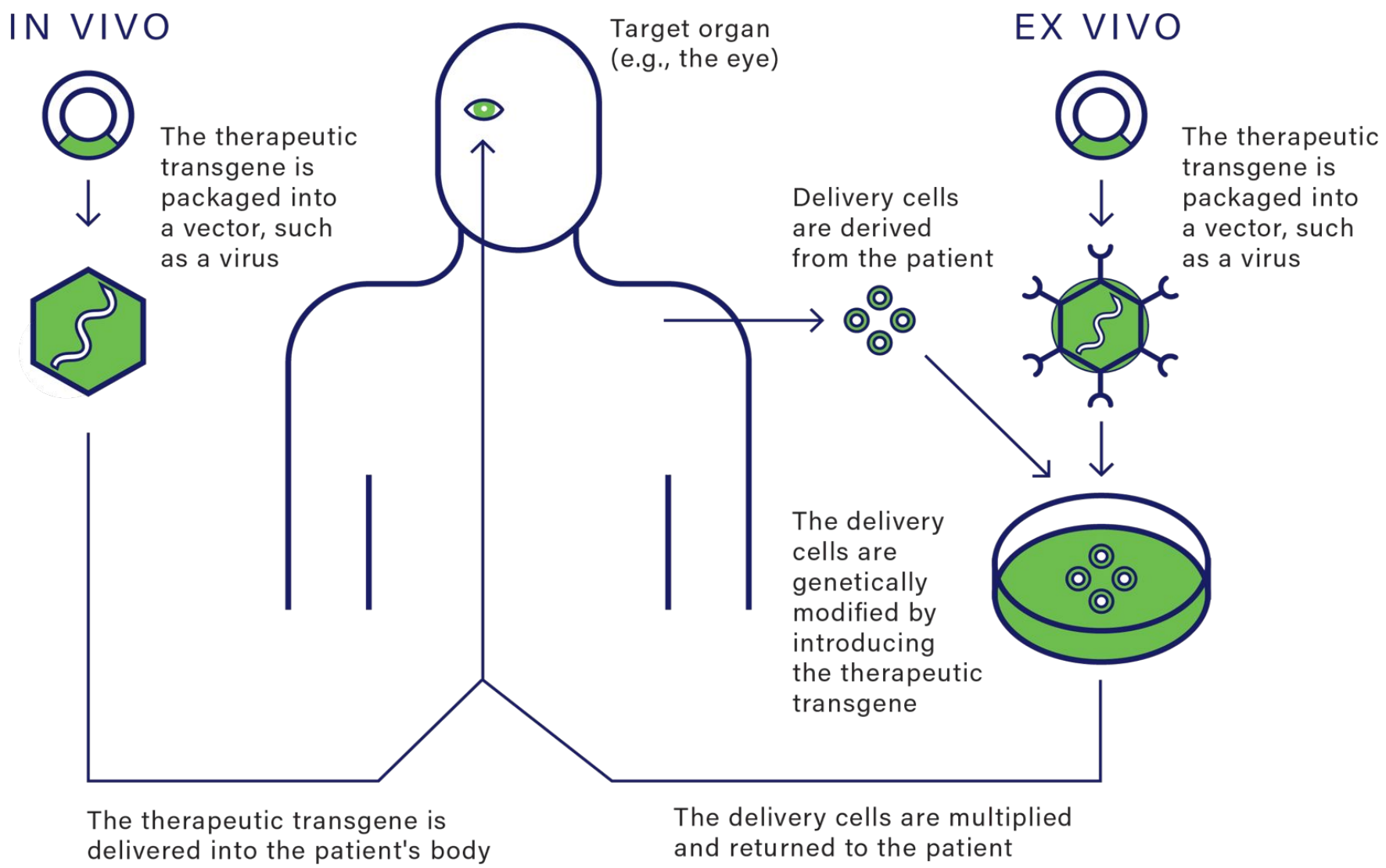
3. GENE THERPAY

- Gene therapy is insertion of genes into an individual's cells and tissue to treat a disease
- Mostly is being used to treat cancer, infectious diseases, heart diseases, arthritis, Alzheimer's disease etc.





STRATEGIES FOR GENE THERPAY



Questions

1. What are stem cells and what are their unique properties?
2. How stem cells classified are based on their source? What is the difference between adult and embryonic stem cells?
3. How stem cells classified are based on their potency?
4. Explain therapeutic cloning and how stem cell are helpful for it?
5. Explain the role of stem cells in regerative medicine using a example..