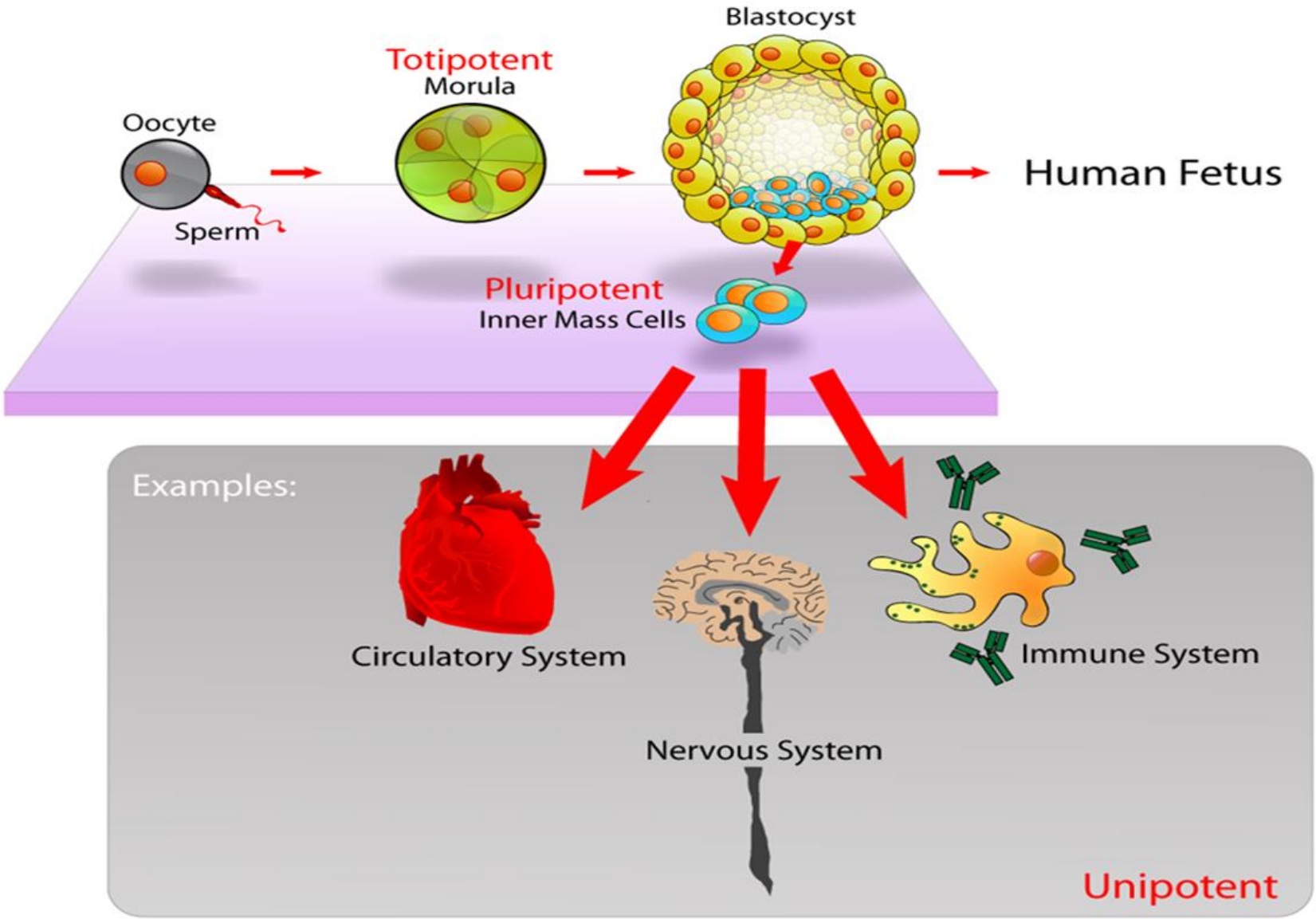
Stem Cells

UNDIFFERENTIATED CELLS WITH POTENTIAL

What Are Stem Cells and How Do They Relate to Development?

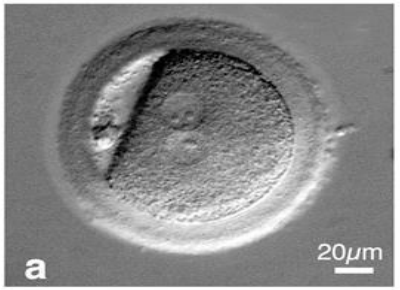
- Stem cells are immature cells that have the potential to differentiate into specialized cells which have a distinct function.
- There are 2 types of human stem cells:
  a. those associated with the embryo (or **embryonic**)
  b. those associated with the adult (or **somatic**)

Classification of Embryonic Stem Cells

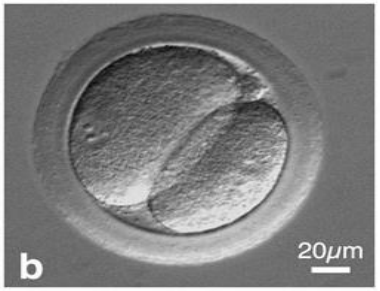


Development of the Zygote into a Blastocyst

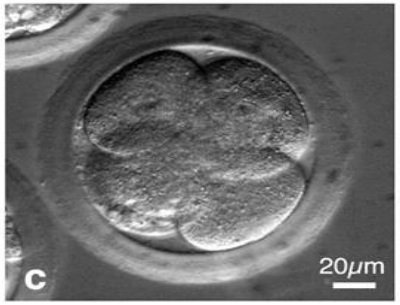
a) Zygote (fertilization)



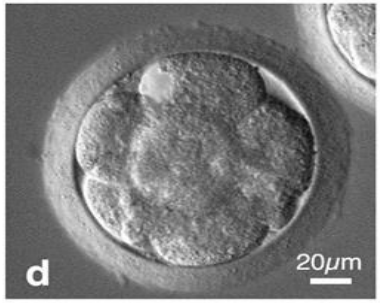
b) 2-Cell Embryo



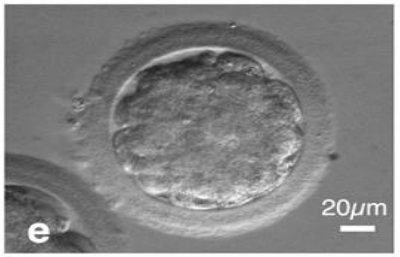
c) 4-Cell Embryo



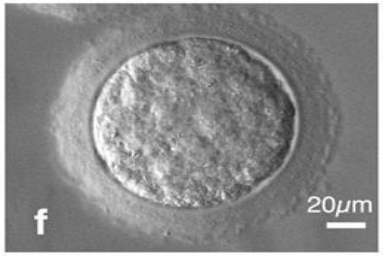
d) 8-Cell Embryo



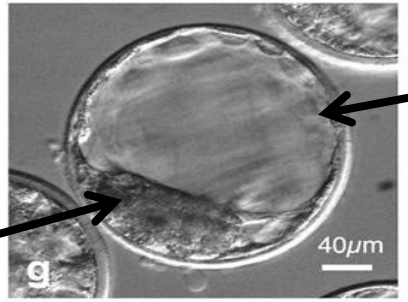
e) 16-to 32-Cell Embryo



f) Morula



g) Blastocyst – Can Implant in Uterus

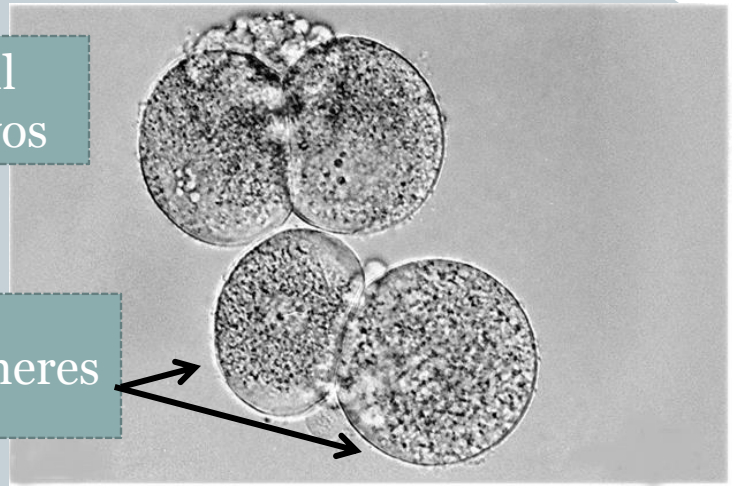


Trophectoderm (Forms the Placenta)

Inner Cell Mass (Forms the Fetus)

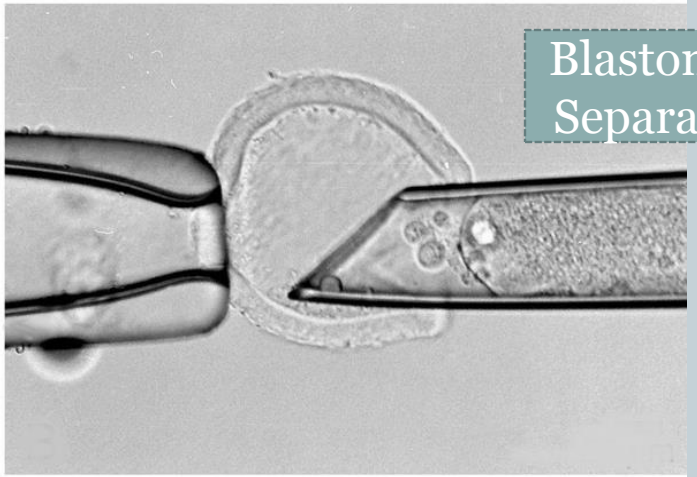
Photos: Dr. Shoukhrat Mitalipov, PhD, ONPRC

Each Blastomere (Cell from a 2- to 8-Cell Embryo) Can Become an Individual (Blastocyst)

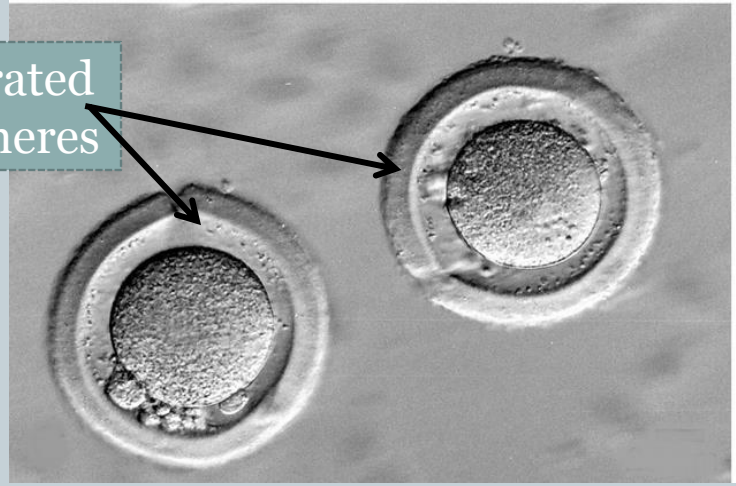


2-Cell Embryos

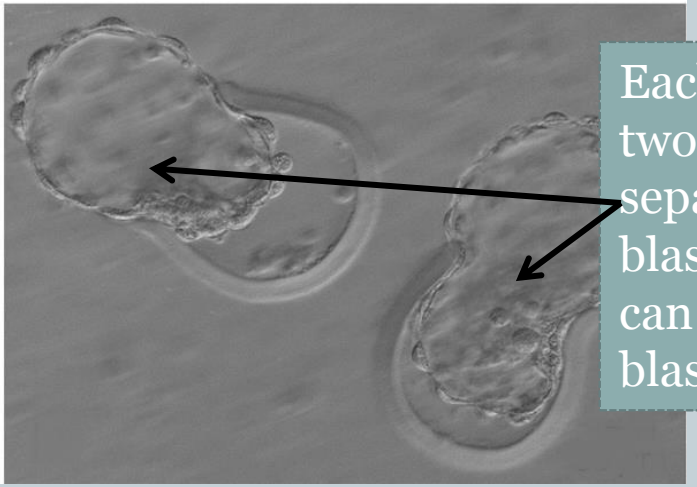
Blastomeres



Blastomere Separation



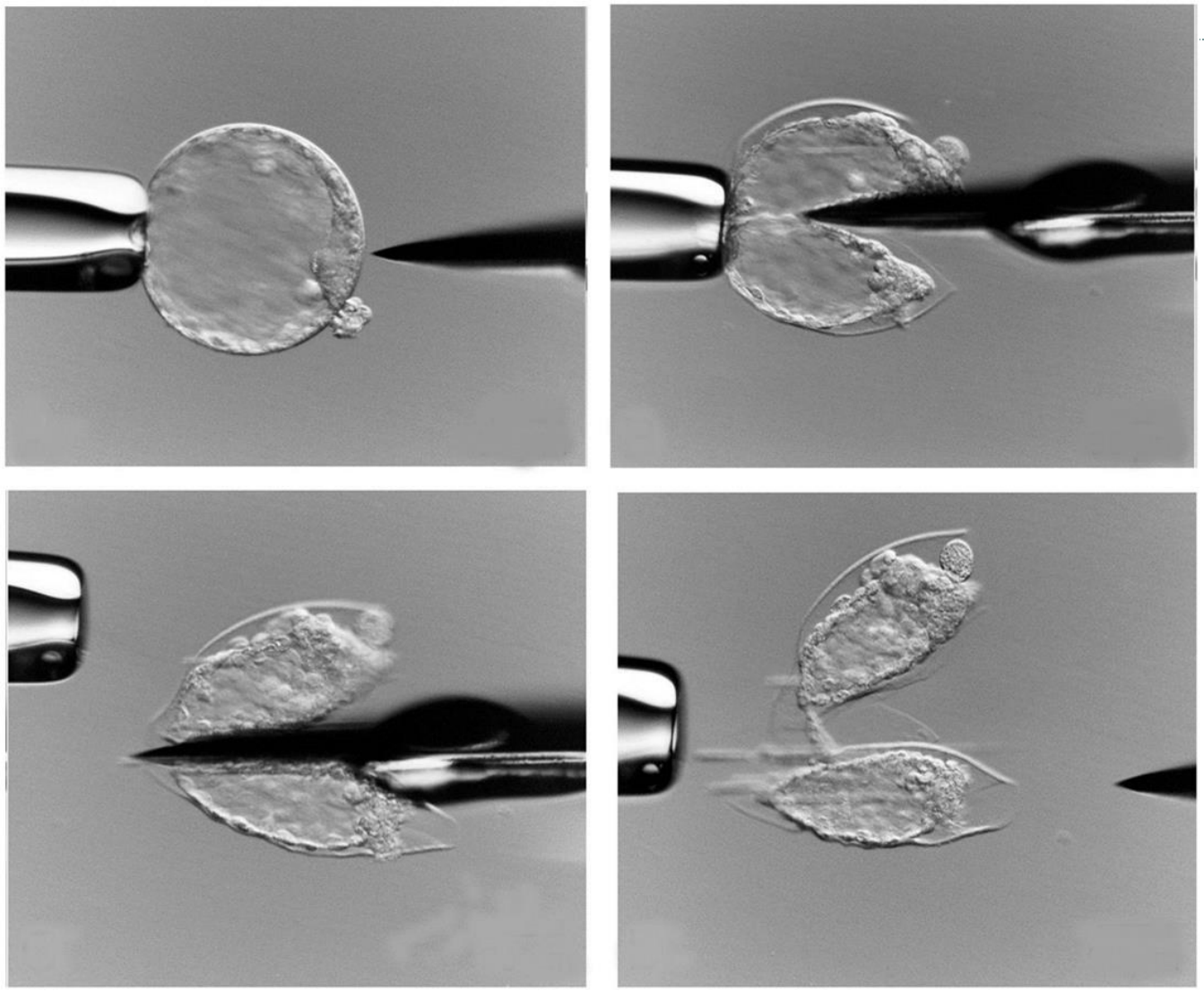
2 Separated Blastomeres



Each of the two separated blastomeres can form a blastocyst.

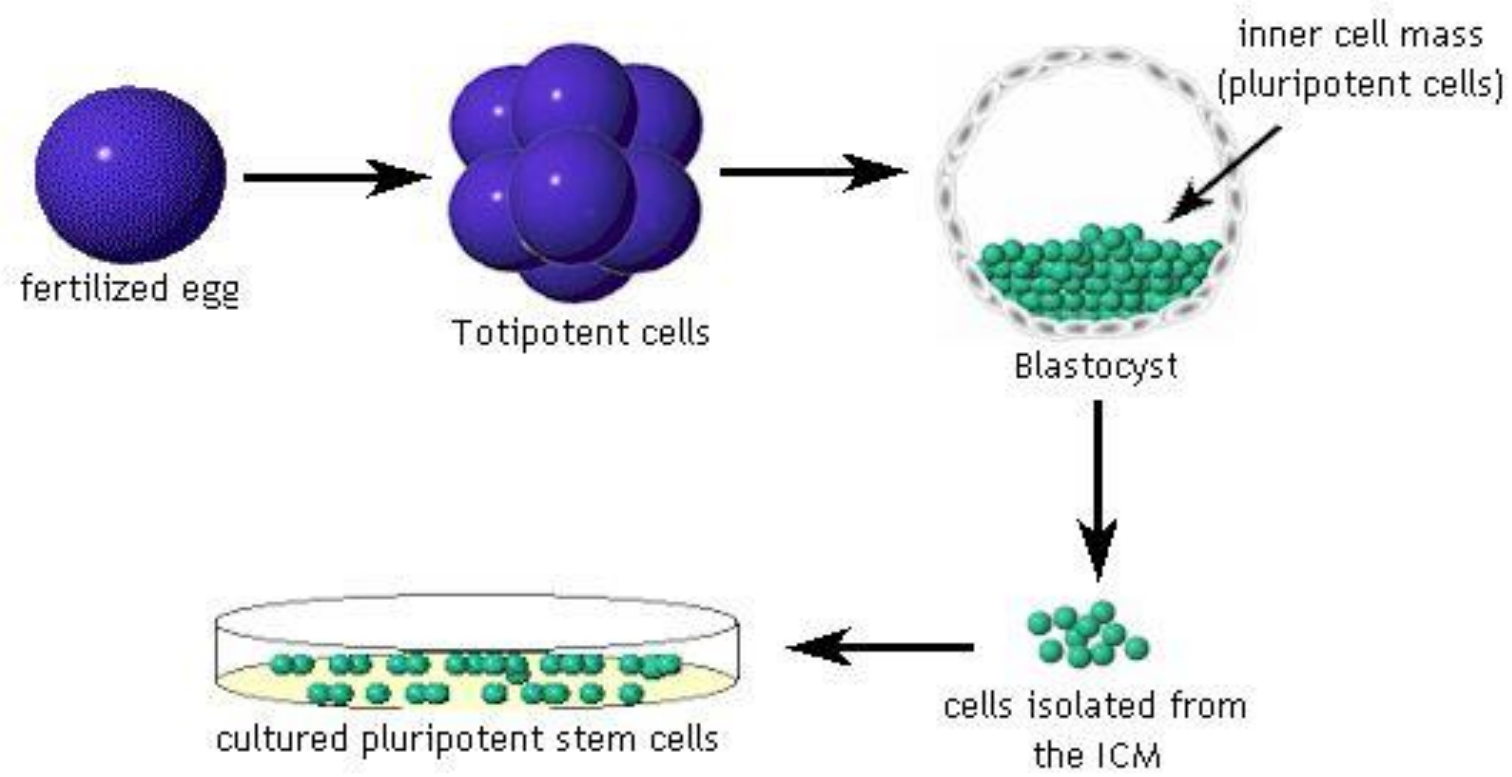
Photos: Don Wolf, PhD, ONPRC

Blastocyst Splitting Into Two Potential Individuals – Development Is Less Successful



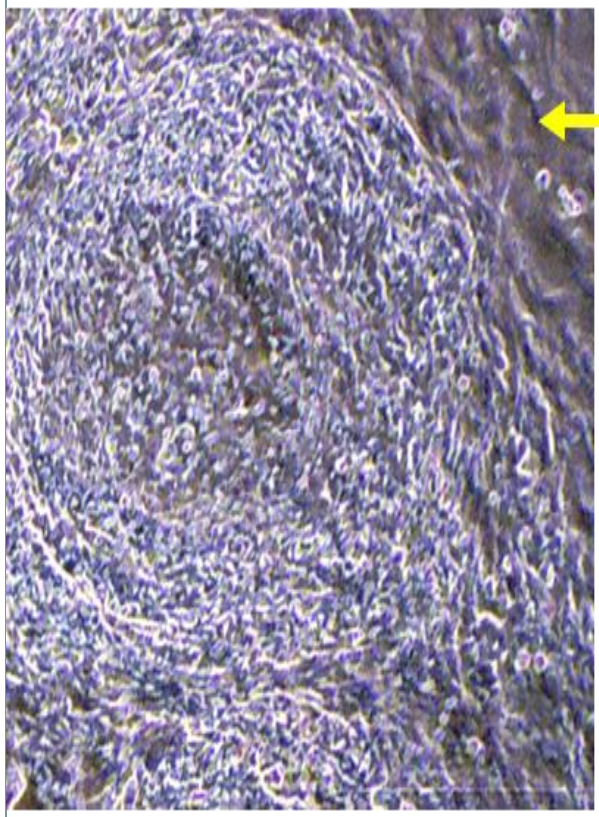
Photos: Don Wolf, PhD, ONPRC

Rhesus Monkey Embryonic Stem Cell Derivation



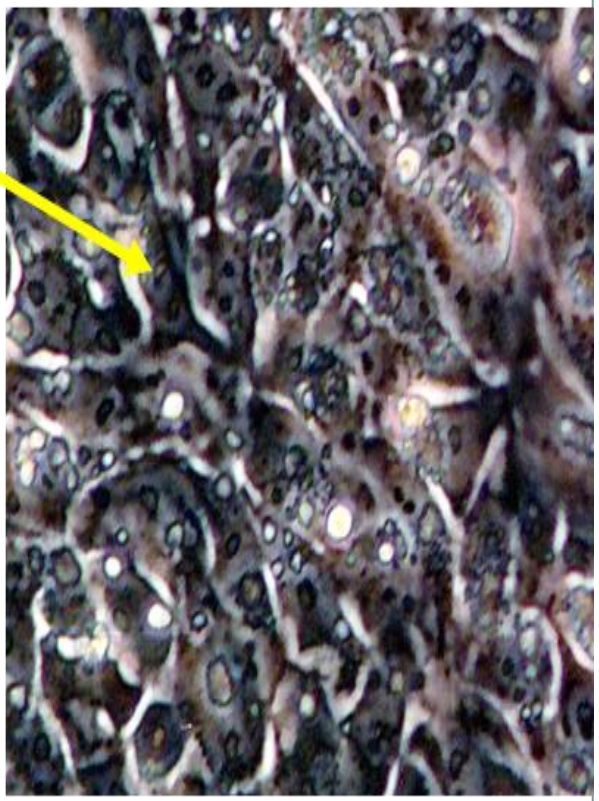
Drawing: Don Wolf, PhD, ONPRC

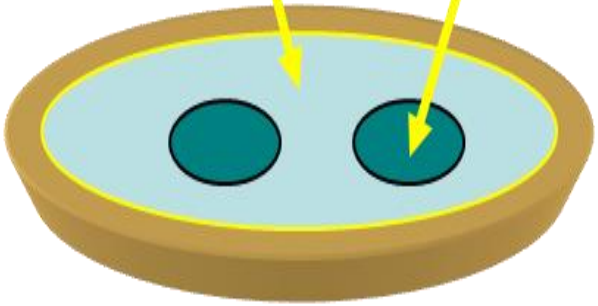
Embryonic Stem Cells Can Incorporate Into Host Embryos



Mouse Embryonic Fibroblast (feeder cells)

Monkey ES Cells





Photos & Graphics: Dr. Don Wolf, PhD, ONPRC

Adult Stem Cells

- Adult stem cells include:

i) hematopoietic stem cells which give rise to all of the types of blood

ii) mesenchymal stem cells which give rise to osteocytes, chondrocytes, adipocytes, and other connective tissue

iii) neural stem cells which give rise to neurons, astrocytes, and oligodendrocytes

iv) epithelial stem cells which give rise to cells lining the digestive tract such as absorptive cells, goblet cells, Paneth cells, and enteroendocrine cells

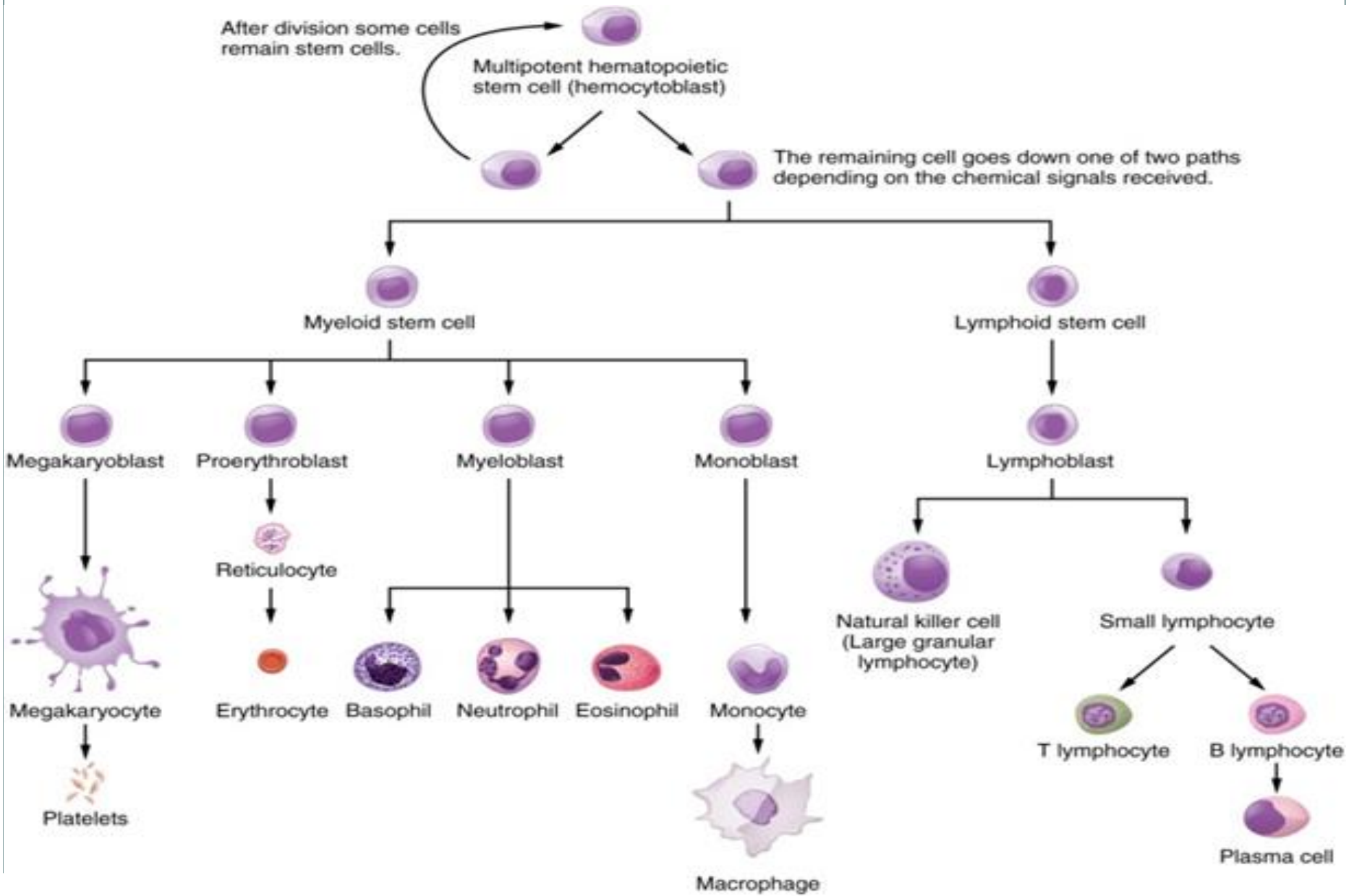
v) skin stem cells which occur in the basal layer of the epidermis and at the base of the hair follicles and give rise to new epidermal layers of skin.

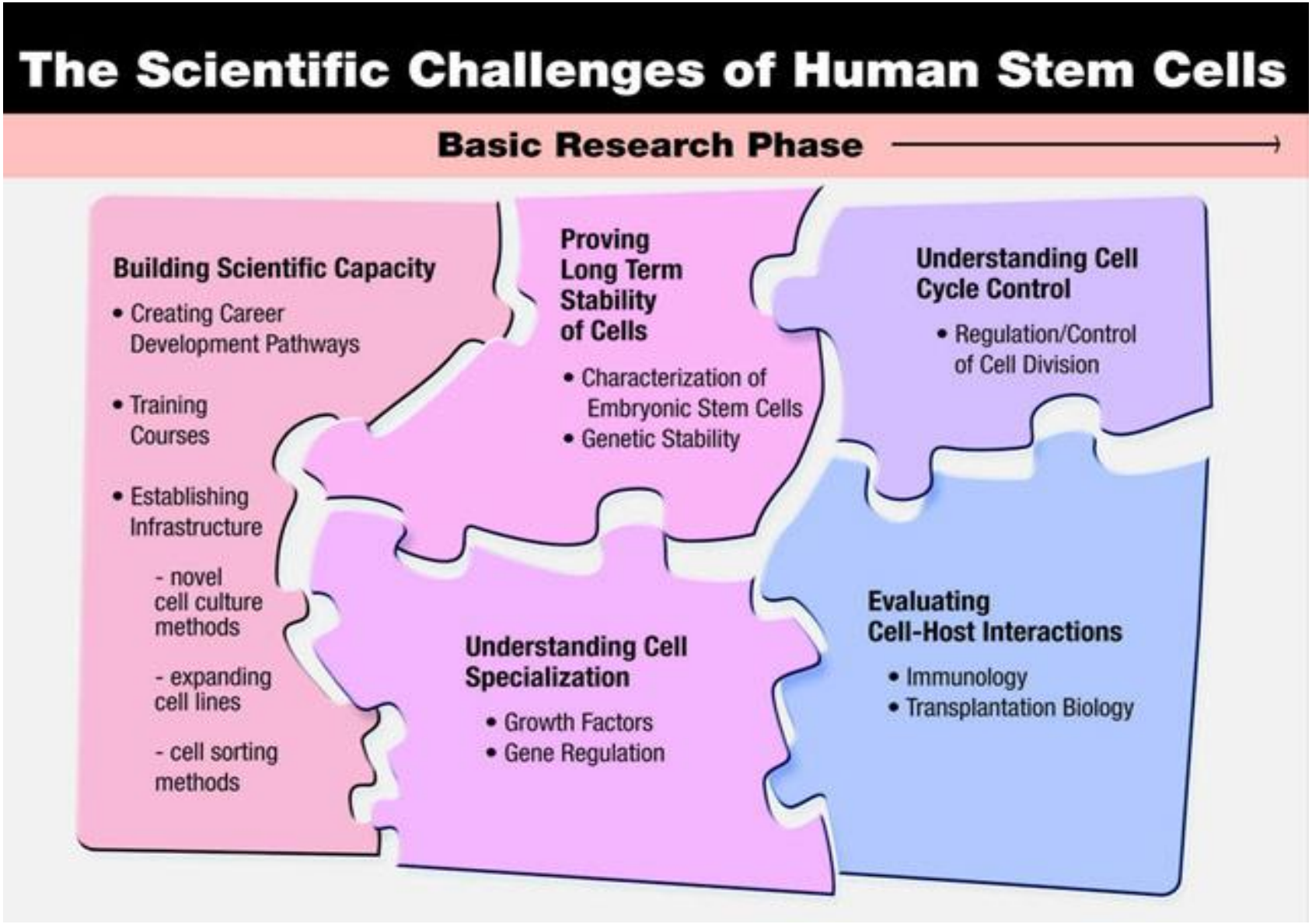
- Also included in the category of adult stem cells are cord blood stem cells in the umbilical cord of a baby which give rise to platelets, red and white blood cells, and mesenchymal cells.

Use of Human Adult Stem Cell Therapy

- In 1968, human adult stem cells were used in the first successful bone marrow transplant.
- The process includes irradiating the bone marrow to destroy the faulty stem cells (often causing cancer) and replacing them with normal bone marrow stem cells from a healthy and immune compatible donor.
- Today, bone marrow is transplanted routinely to treat a variety of blood and bone marrow diseases, blood cancers, and immune disorders.

Multipotent and Oligopotent Somatic Stem Cells

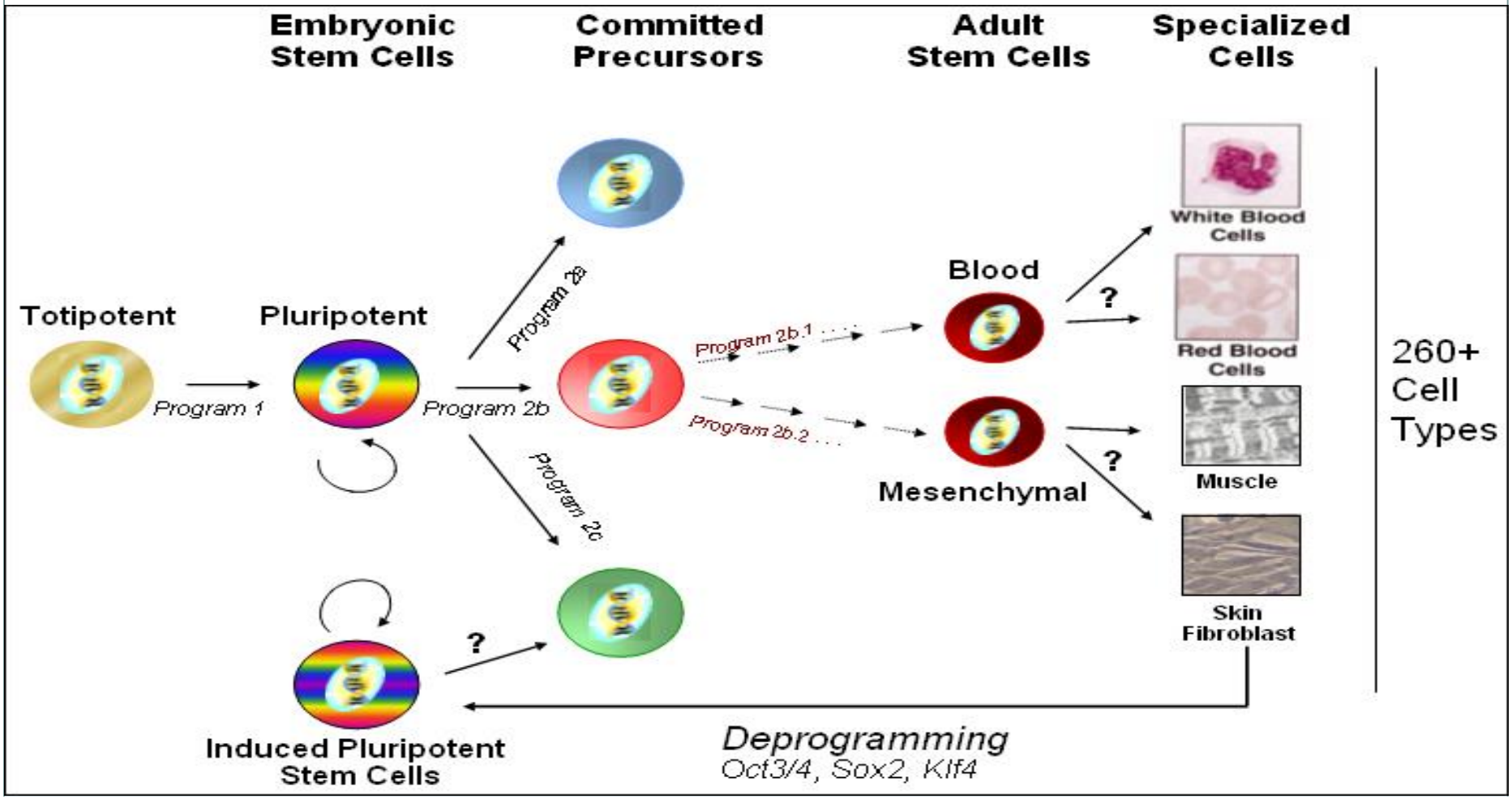




http://stemcells.nih.gov/info/media/pages/challenges.aspx

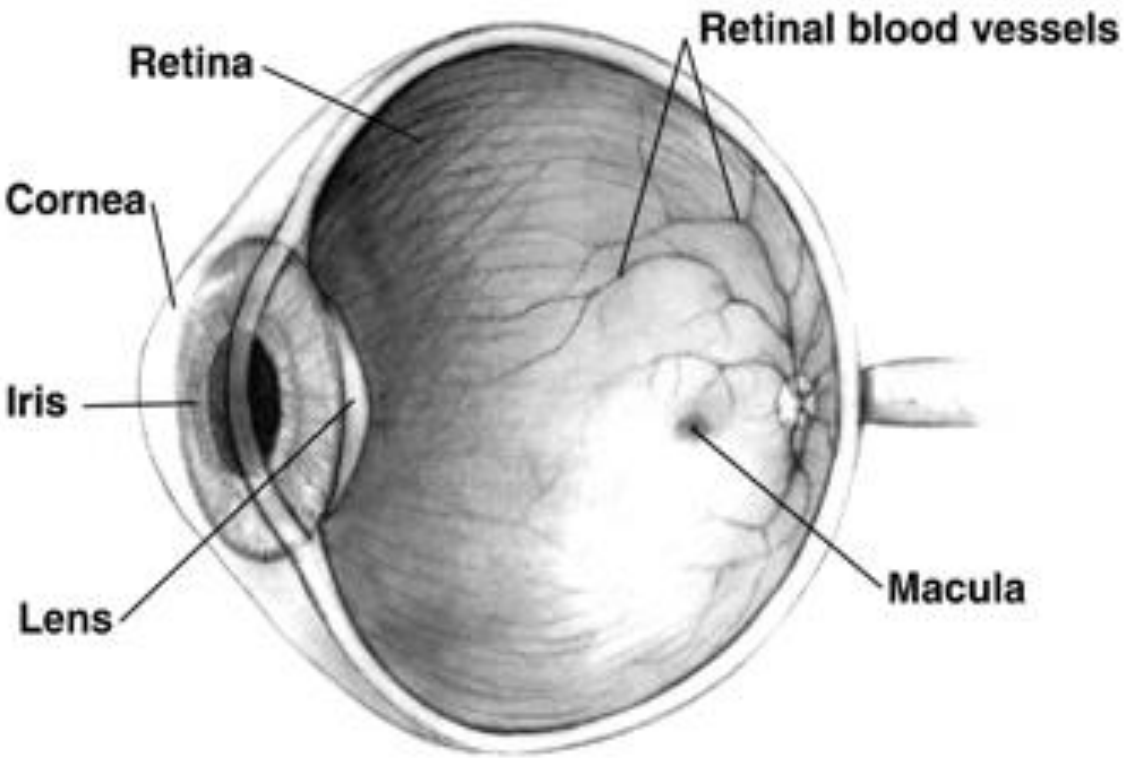
Embryonic Stem Cell Research

http://stemcells.nih.gov/policy/statements/pages/SC_2008.aspx

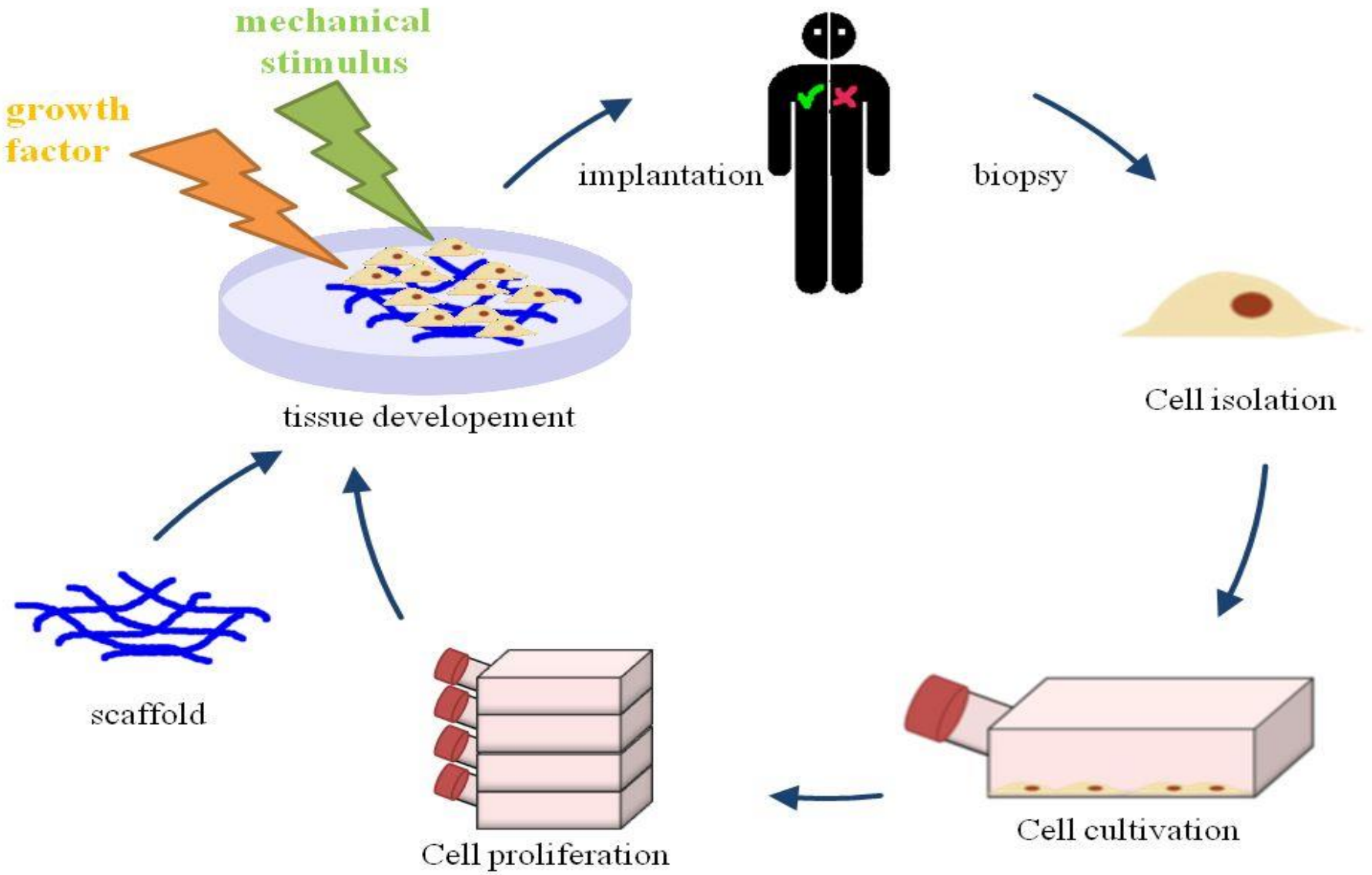


This diagram illustrates the range of stem cell potency, based upon the cells' state of differentiation. The more potent a cell, the less differentiated it is. The most differentiated cells are specialized cells, which have assumed only one fate from the more than 260 different types of specialized adult cells. Also illustrated is the deprogramming of specialized cells using "stemness" genes (Oct3/4, Sox2, and Klf4) to take them back to a pluripotent state, known as induced pluripotent stem cells.

The Goal of Stem Cell Research



Tissue Scaffolding



Other Potential Uses of Stem Cells

- Traumatic Brain Injury
- Stroke
- Alzheimer's Disease
- Parkinson's Disease
- Multiple Sclerosis (MS)
- Deafness
- Spinal Cord Injury
- Myocardial Infarction
- Liver Disease
- Diabetes
- Crohn's Disease
- Muscular Dystrophy (MD)
- Amyotrophic Lateral Sclerosis (ALS)
- Bone Marrow Transplant
- Osteoporosis
- Osteoarthritis
- Rheumatoid Arthritis (RA)