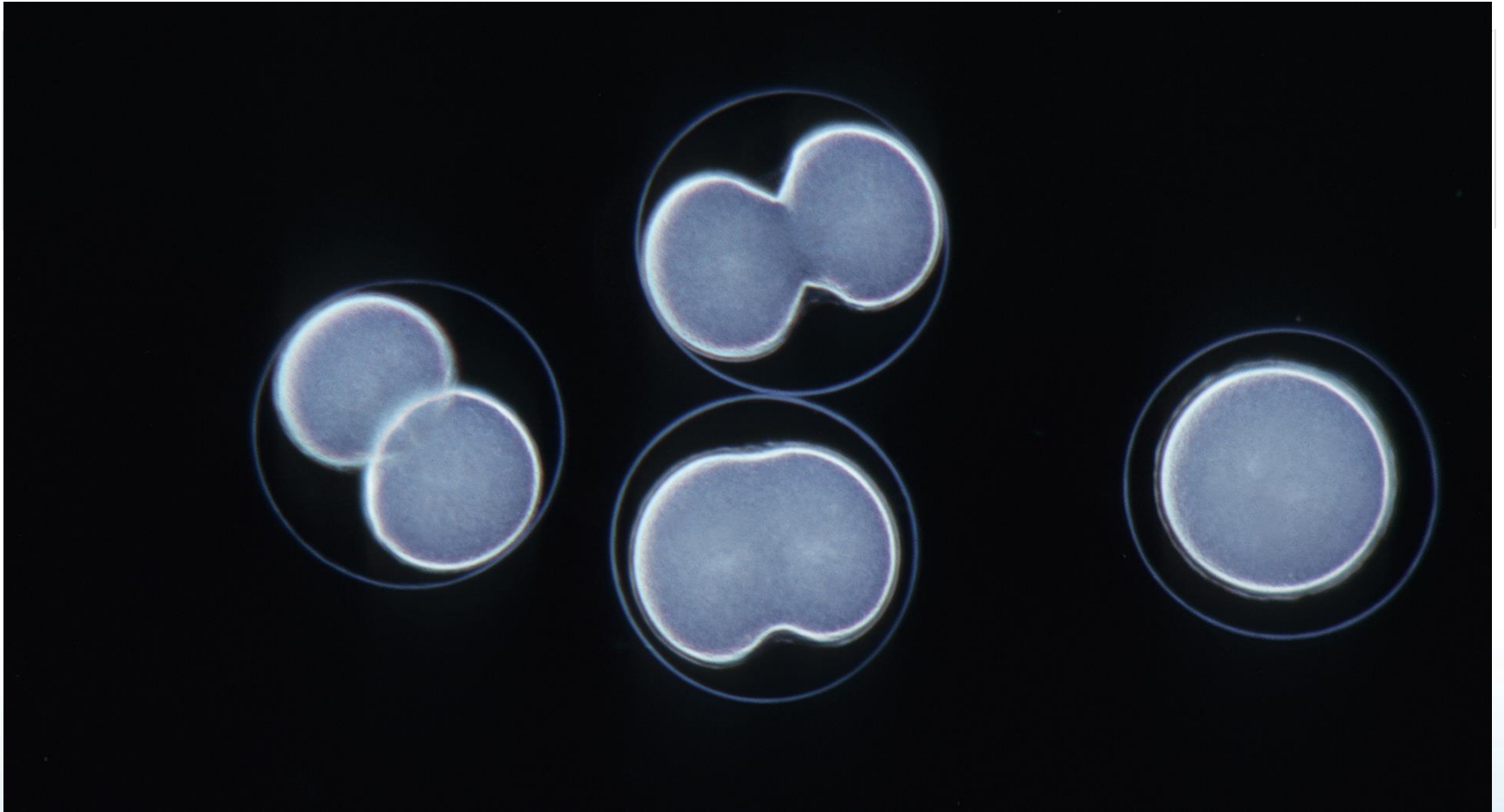


# Cell Differentiation



# From One Cell to Many

Remember we started out as one cell. Our cells keep splitting until it makes an organism. An embryo is defined as the developing stage of a multicellular organism.

- It begins at fertilization and lasts about 8 weeks (then moves into fetal stage).

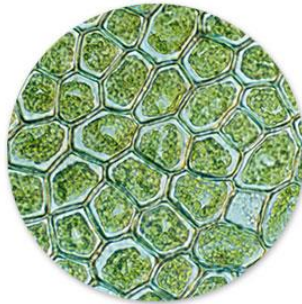
During the development of an organism, cells differentiate to become more specialized for a particular function.

**Differentiation:** the process by which cells become specialized into many distinct cell types.

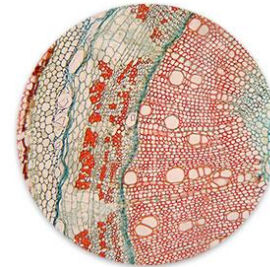
Absorbs  
water from  
ground



Carry out  
photosynthesis

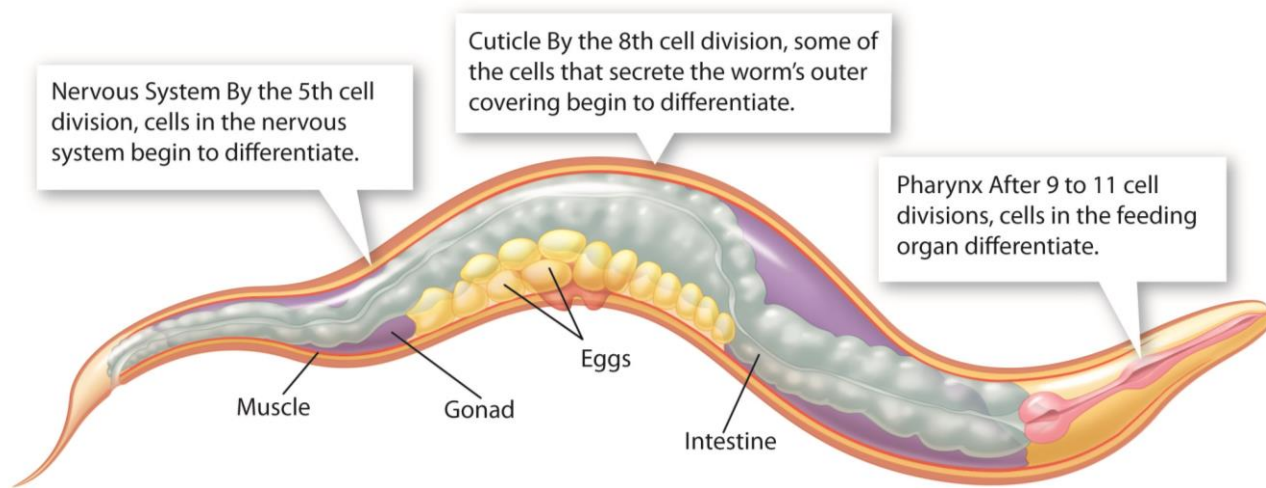


Transport  
materials



# Mapping Differentiation

The process of differentiation determines a cell's ultimate identity, such as nerve or muscle cell. For some organisms, like this worm, the cell's role is determined at specific points in the development.



Differentiation in other organisms, including mammals, go through a more flexible process controlled by a number of factors in the embryo, many that are still being understood. Once an adult cell reaches a point of completion in differentiation, the cell can no longer turn into other cells.

# Stem Cells and Development

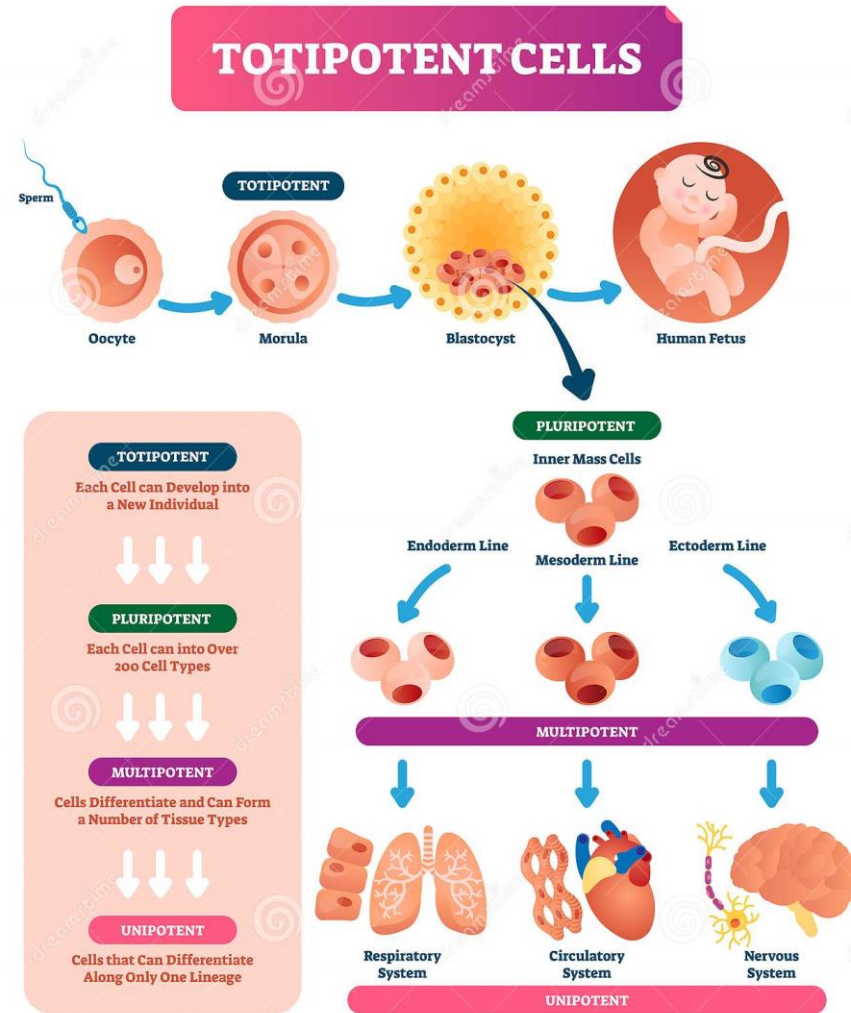
Stem cells are the unspecialized cells from which differentiated cells develop.

**Totipotent:** can develop into any type of cell in the body

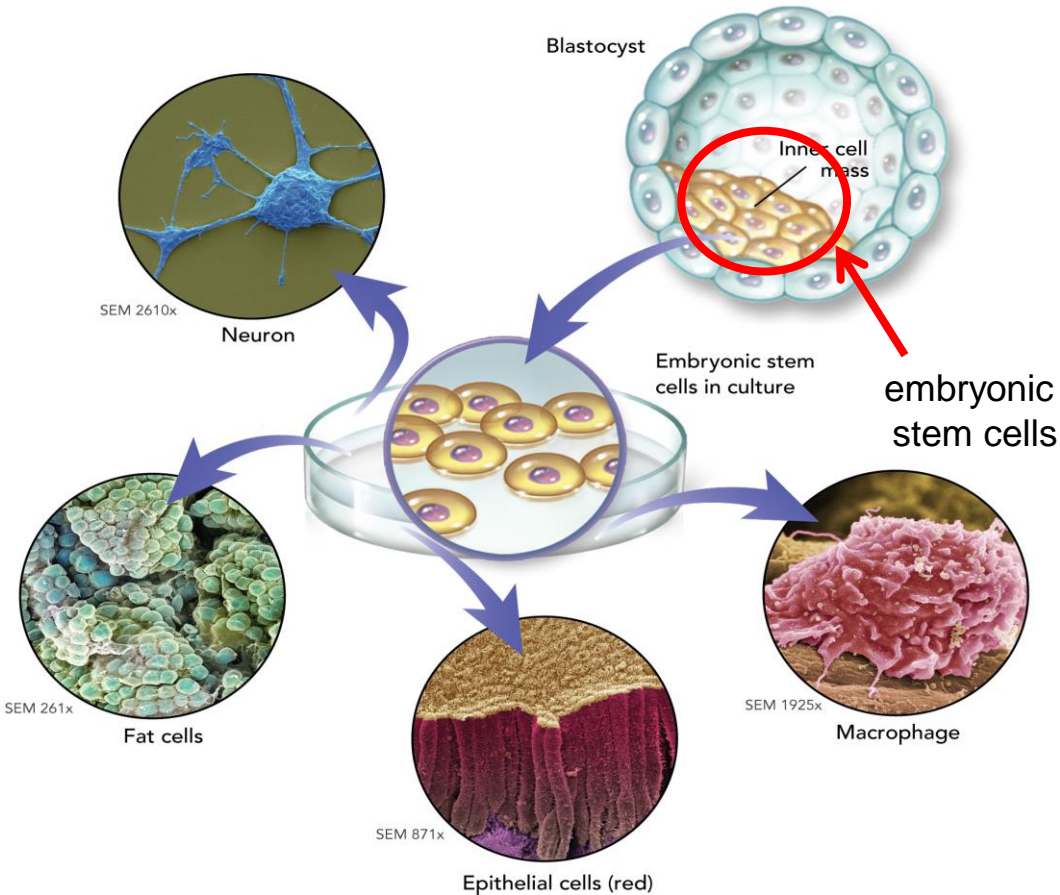
- Able to do everything

**Blastocyst:** a hollow ball of cells with a cluster of cells inside known as the inner cell mass

**Pluripotent:** cells that are capable of developing into most, but not all, of the body's cell types



# Embryonic Stem Cells

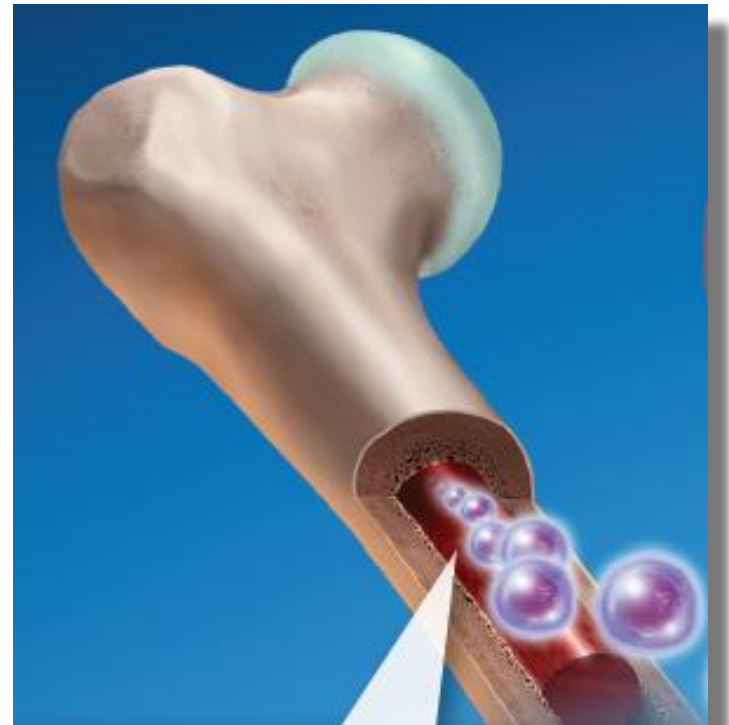


**Stem cells:** cells that sit at the base of a branching “stem” of development from which different cells form

- Found in early embryo
- Also found in many places in the adult body (bone marrow)

# Adult Stem Cells

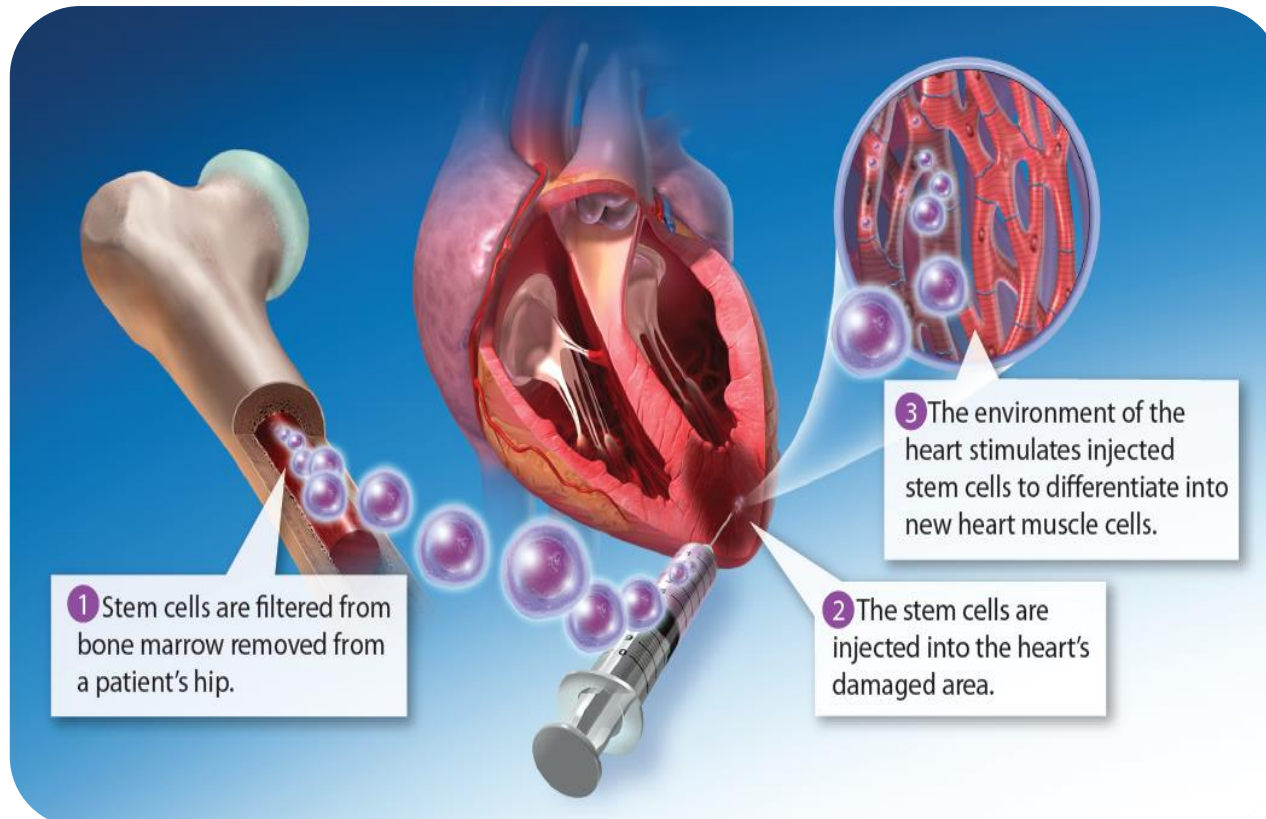
- **Multipotent:** limited potential to develop into many different types of differentiated cells
  - Limited to replacing cells in the tissues where they are found
- Mainly found in bone marrow, hair follicles
- Also, some in brain, heart, and skeletal muscle



# Regenerative Medicine

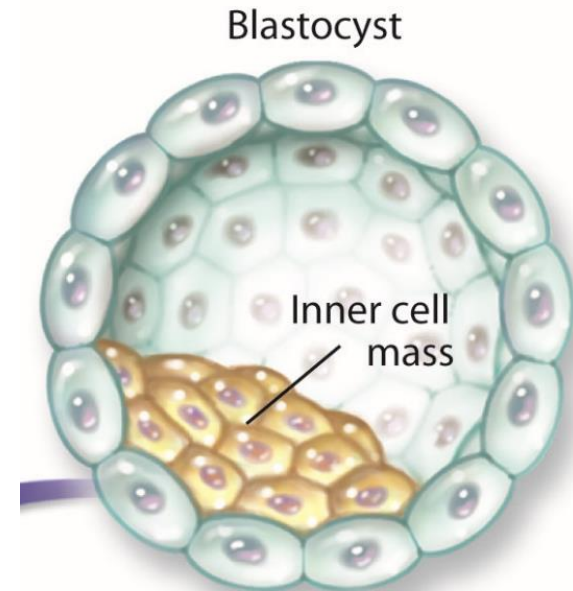
Undifferentiated cells are used to repair or replace damaged cells and tissues.

- Heart attacks destroy cells in heart muscles
- Strokes injure brain cells
- Spinal cord injuries causes paralysis by breaking the connection between nerve cells



# Ethical Issues

- Human **adult** stem cells can be harvested from a willing donor. This is rarely controversial but has raised a few ethical questions.
- Human **embryonic** stem cell research is controversial because there is the destruction of an embryo.
  - Arguments for and against involve ethical issues of life and death.
  - Both groups have said it would be unethical





# Induced Pluripotent Stem Cells

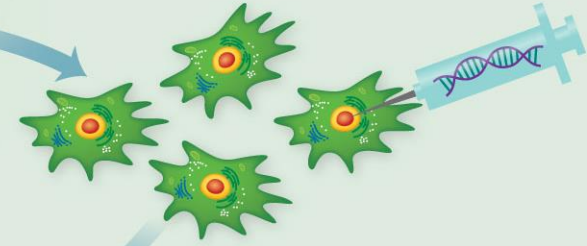
Called iPS cells

Under certain conditions, iPS cells may replace embryonic stem cells

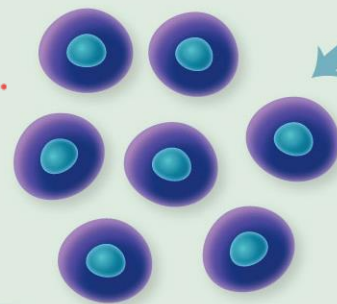


## 1 Genes are added to adult cells

Dr. Yamanaka introduced four transcription factor genes into mouse skin fibroblasts.

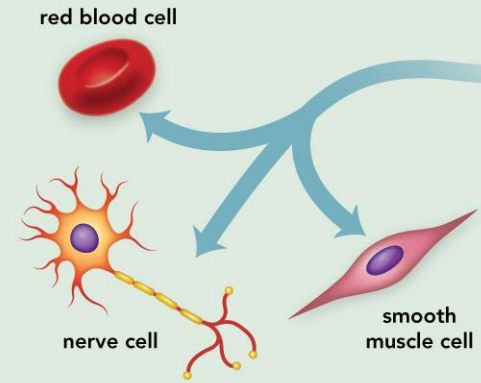


## 2 They display properties similar to embryonic stem cells.



His work potentially could solve the ethical problems of embryonic stem cell research.

## 3 They now have the capacity to develop into a number of specialized cell types.



When injected into an embryo, the new stem cells (called *induced pluripotent stem cells*) can differentiate into any type of cell found in an adult organism.

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# Regenerative Medicine

- Regenerative medicine makes use of stem cells to repair or replace damaged cells and tissues.
  - Scientists have developed laboratory “recipes” that can remake cells into other cell types.
  - One promising treatment is with macular degeneration (clinical trial)
  - There is always risk – transplanted cells may behave in unpredictable ways by differentiating into unwanted cell types or grow into a tumor

