Starting at 6:10

Lecture 2: Introduction to Regenerative Biology

MCB 198 - Ronit Nath, Marcela Perez, Atticus Fisher

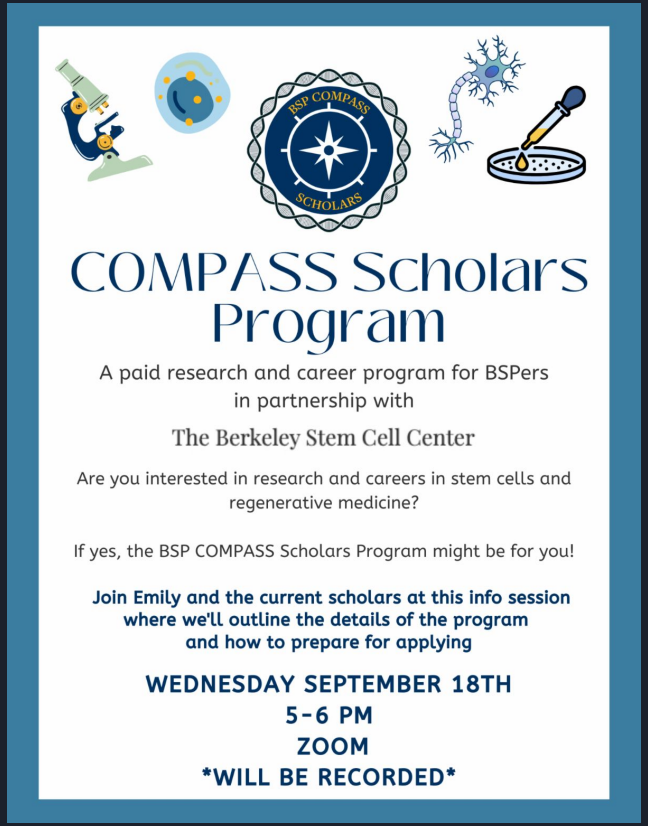
Administrative Notes

1. Enrollment: last day to add/drop is Wednesday
    a. Ensure you have 2 units: you are in both the lecture and a discussion section
2. Discussion starts this week
    a. Wednesday: Wheeler 126, **3-4pm**
    b. Friday: Dwinelle 247, **12-1pm**
3. Assignments start this week
    a. Reflection: Due before lecture 9/25
    b. Quiz: Taken in-class during your discussion section

More Admin Notes

1. Join discord →
2. Message @Ronit Nath with course questions
3. Email ronitnath@berkeley.edu with course questions
4. Slides will be posted later tomorrow

Regenerative Medicine Research Opportunity



- Biology Scholars Program!
  - bsp.berkeley.edu
- Get matched to a stem cell lab
- 2 year program, begins summer 2025.
- Direct mentorship, ideal candidates are 1st or 2nd year students
- No GPA requirement, paid opportunity!

Lecture Theme

induced Pluripotent Stem Cells

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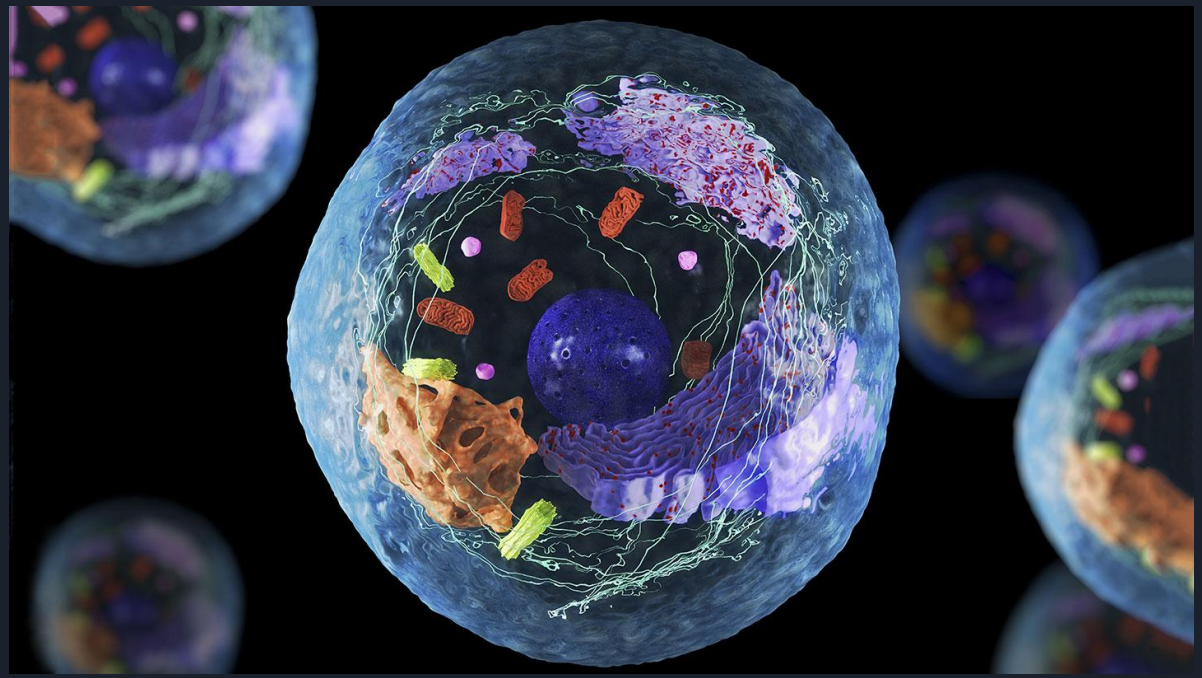
Research

↓

Developmental Biology

induced
Pluripotent
Stem **C**ell
(iPSC)

Stem Cell



Key Factors:

1. Potency:

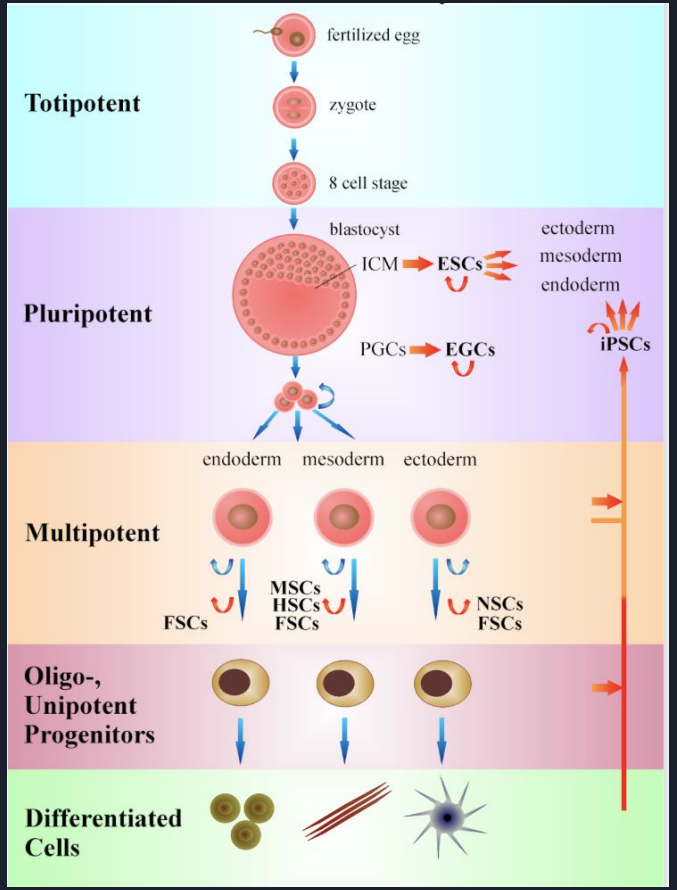
   The ability for a cell to differentiate into different types of cells

2. Self-renewal:

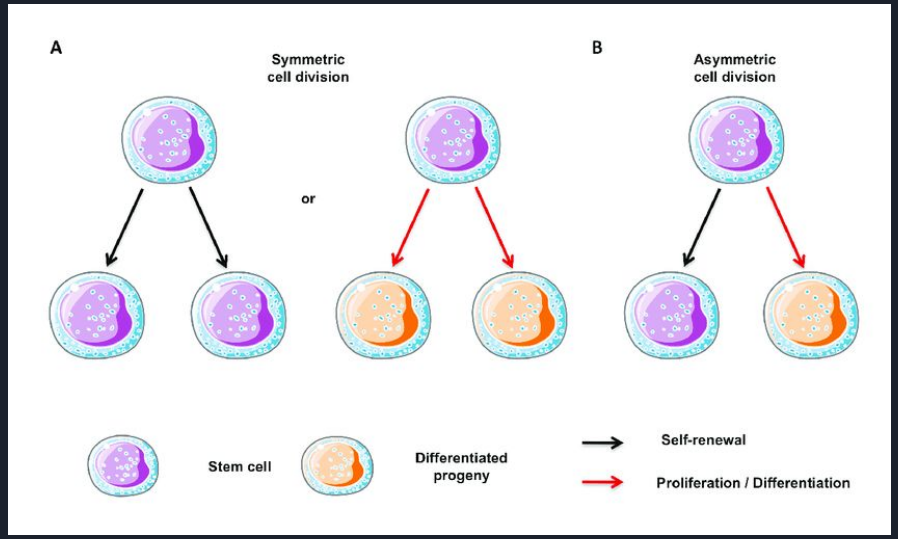
   The ability for a cell to give rise to another cell of its own type

Potency
(Pluripotent)

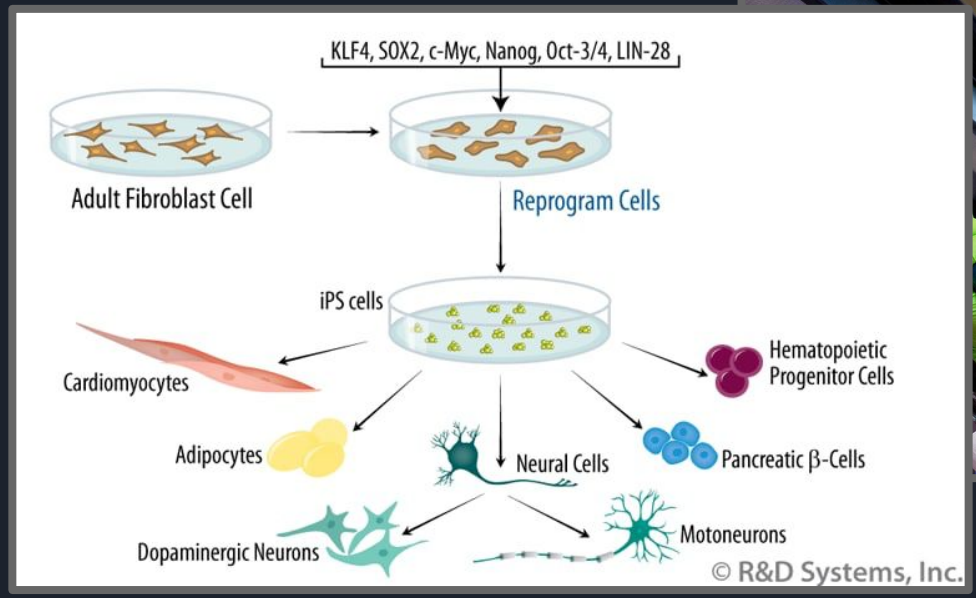
1. Totipotent
2. Pluripotent
3. Multipotent
4. Oligopotent
5. Unipotent

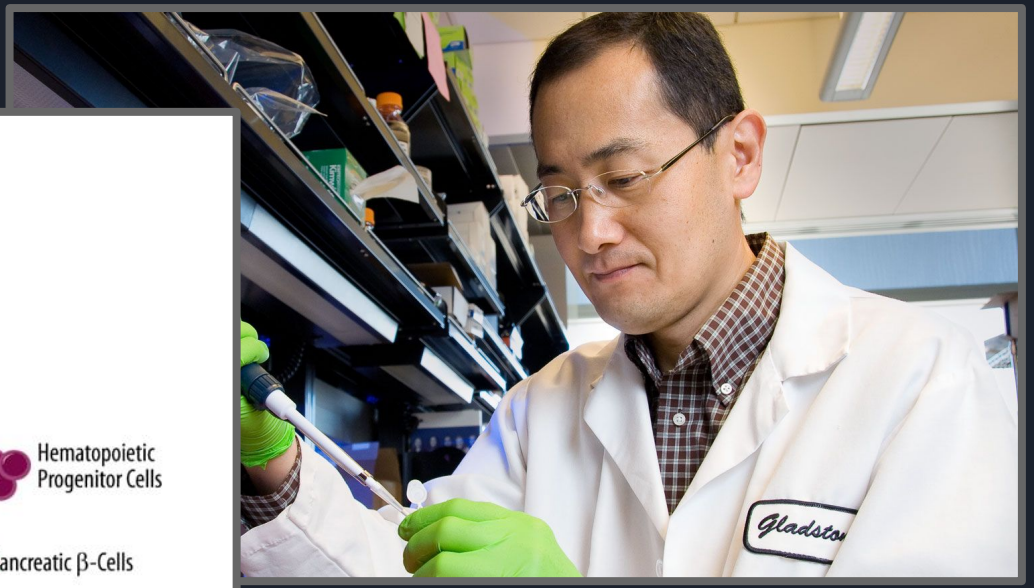


Self-Renewal



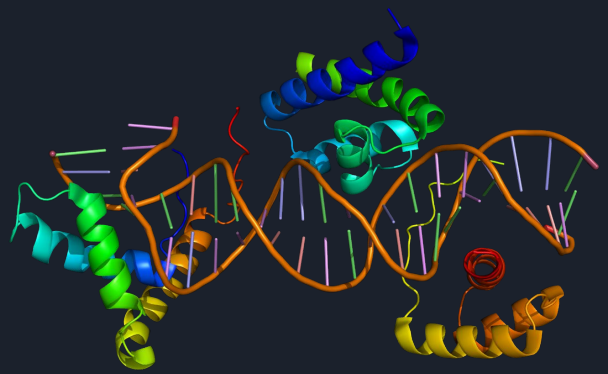
Induced

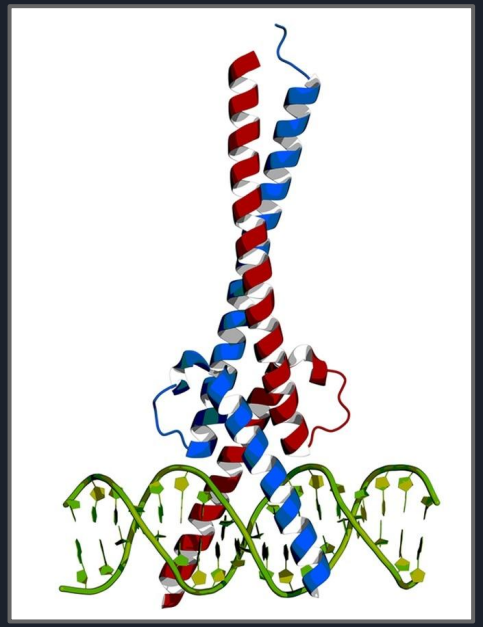

KLF4, SOX2, c-Myc, Nanog, Oct-3/4, LIN-28
Adult Fibroblast Cell
Reprogram Cells
iPS cells
Cardiomyocytes
Hematopoietic Progenitor Cells
Adipocytes
Neural Cells
Pancreatic β-Cells
Dopaminergic Neurons
Motoneurons
© R&D Systems, Inc.



Yamanaka Factors

1. Oct3/4 (Pou5f1)
2. Sox2
3. Klf4
4. c-Myc





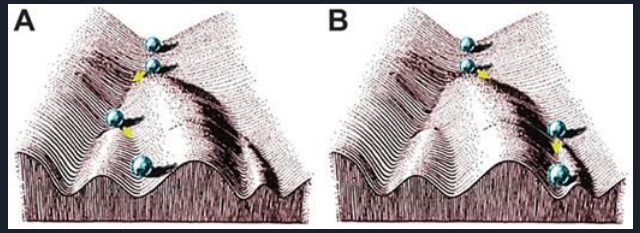
induced **P**luripotent **S**tem **C**ell
iPSC

- Induced
  - Created via Yamanaka factors
- Pluripotent
  - Able to differentiate into any type of cell derived from the three germ layers
- Stem Cell
  - Has the properties of potency and self-renewal

Research

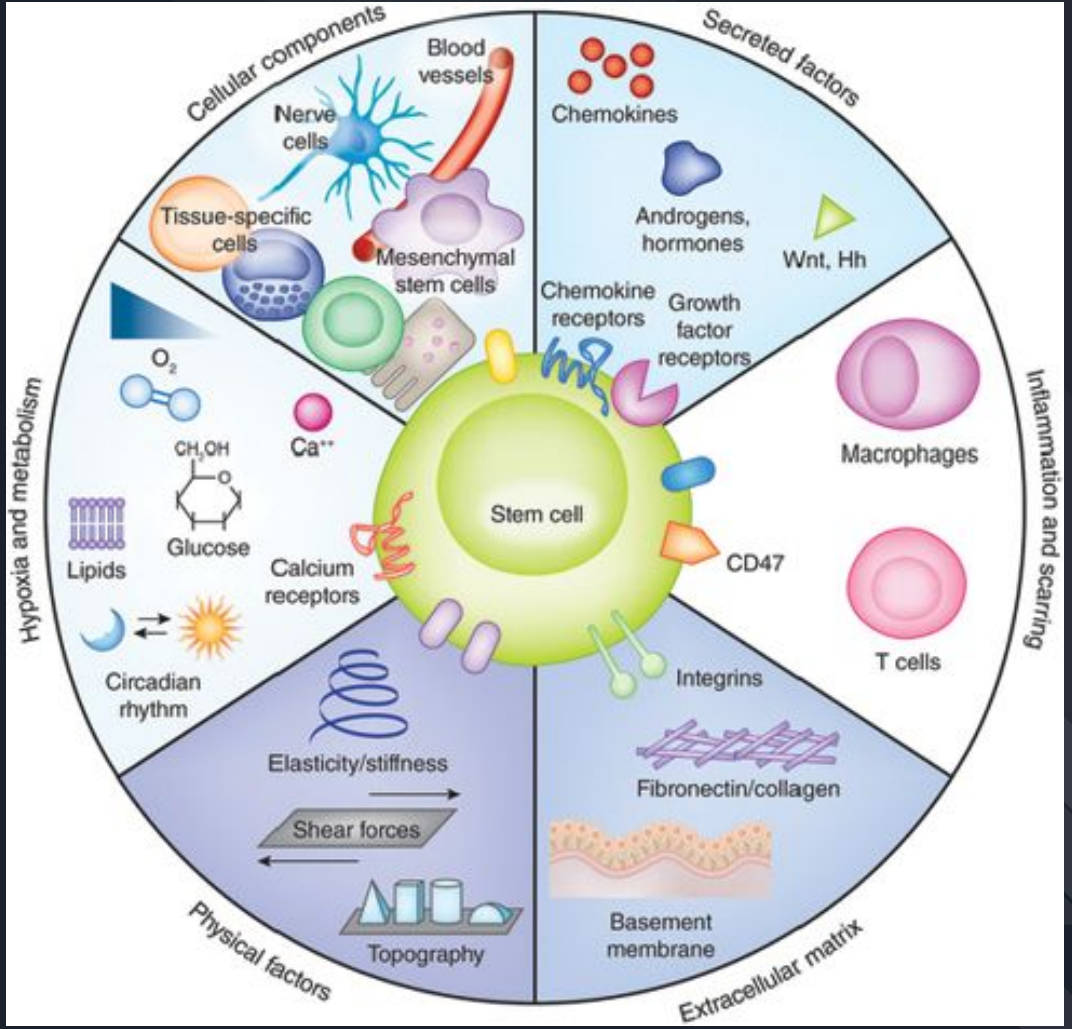
Organoids

Gene Expression

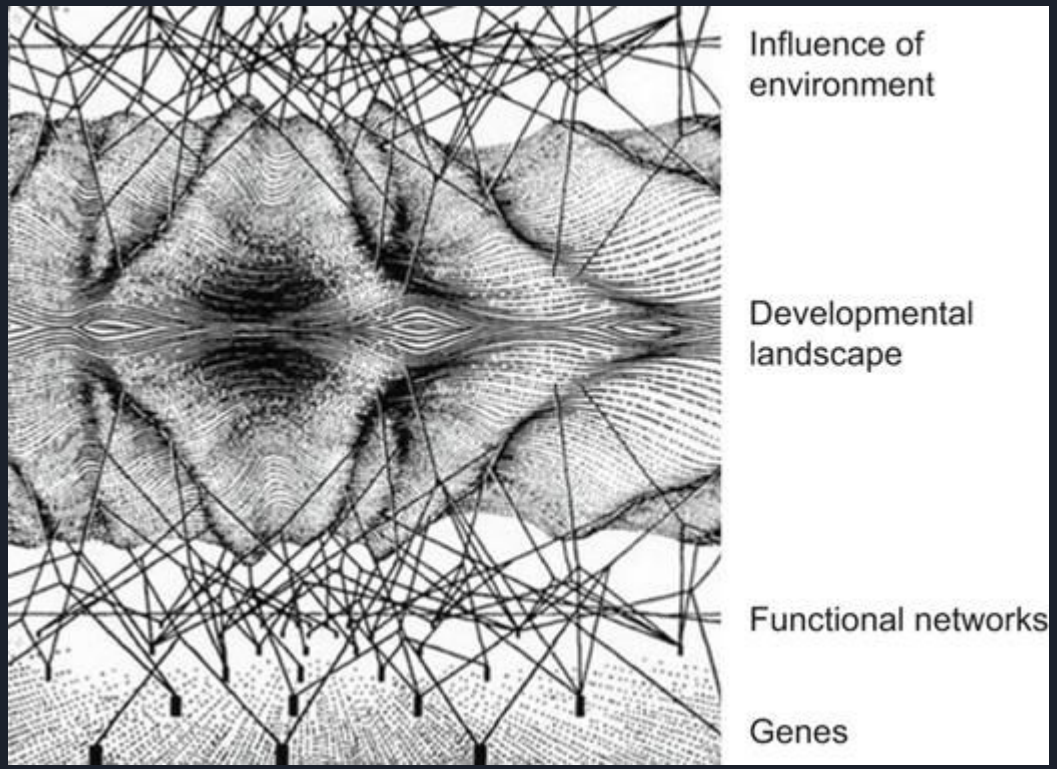


- Transcriptome:
  - Complete set of RNA transcripts present in a cell at a given time
- Proteome:
  - Complete set of proteins expressed by an organism
- Epigenetics:
  - Study of heritable traits, or a stable change of cell function, that happen without changes to the DNA sequence.

Gene Expression Pathways

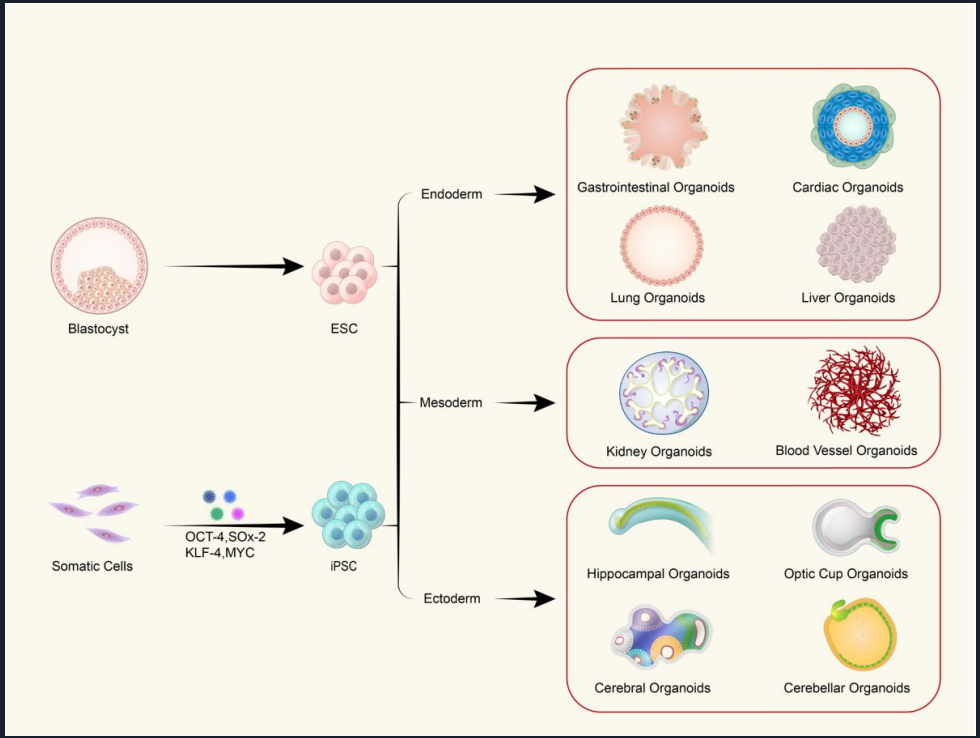


From the Literature



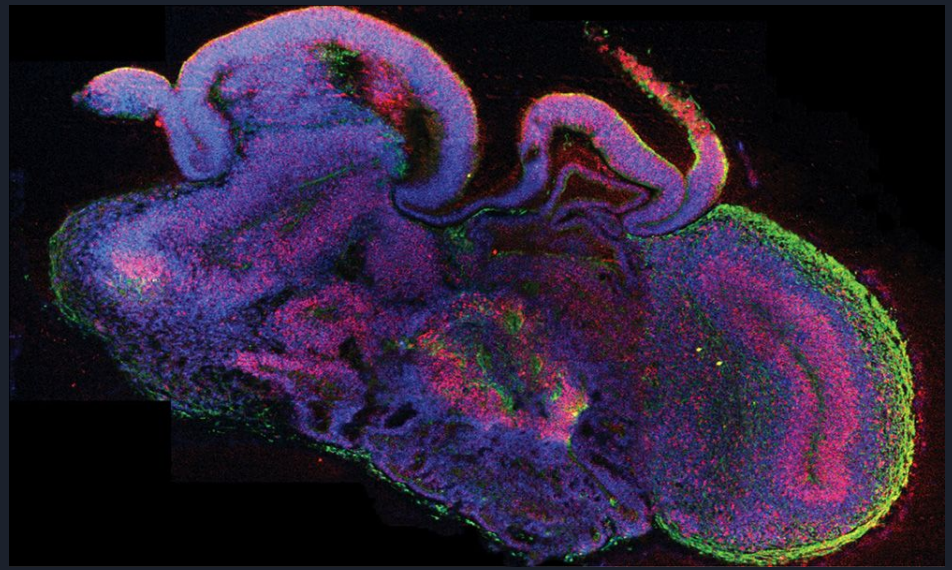
Organoids

- 3D structures grown from stem cells which mimic architecture and cellular composition of an organ
- Built through self-organization and through 3D-scaffolding
- Experimental applications



Research Applications of Organoids

- Provide human-specific models that better represent in vivo physiology than 2D cultures
- Allow study of development and disease processes in human tissues
- Lack some cell types and full organ complexity found in vivo
- Variability between organoids can be a challenge for reproducibility



Research

Spemann-Mangold

Spemann-Mangold experiment

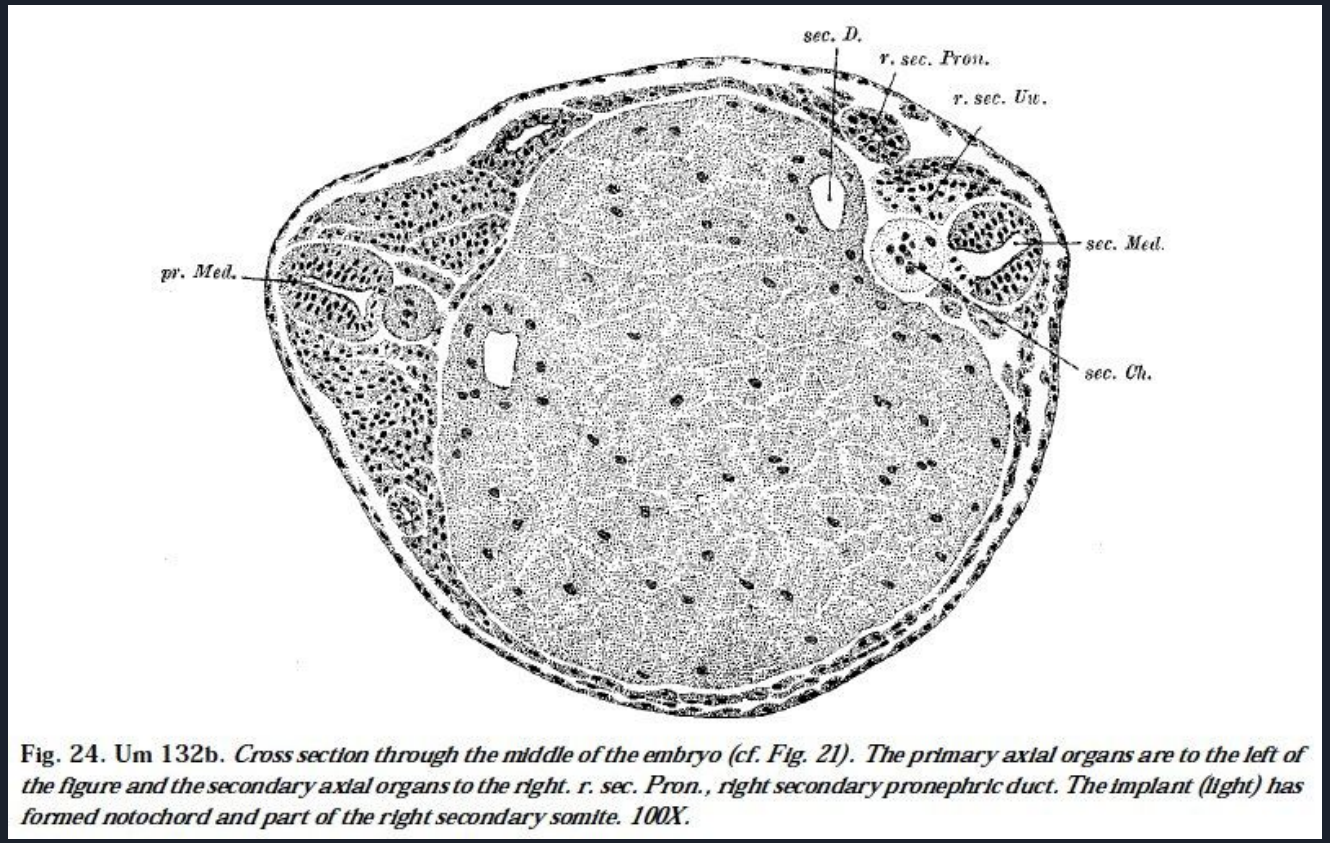
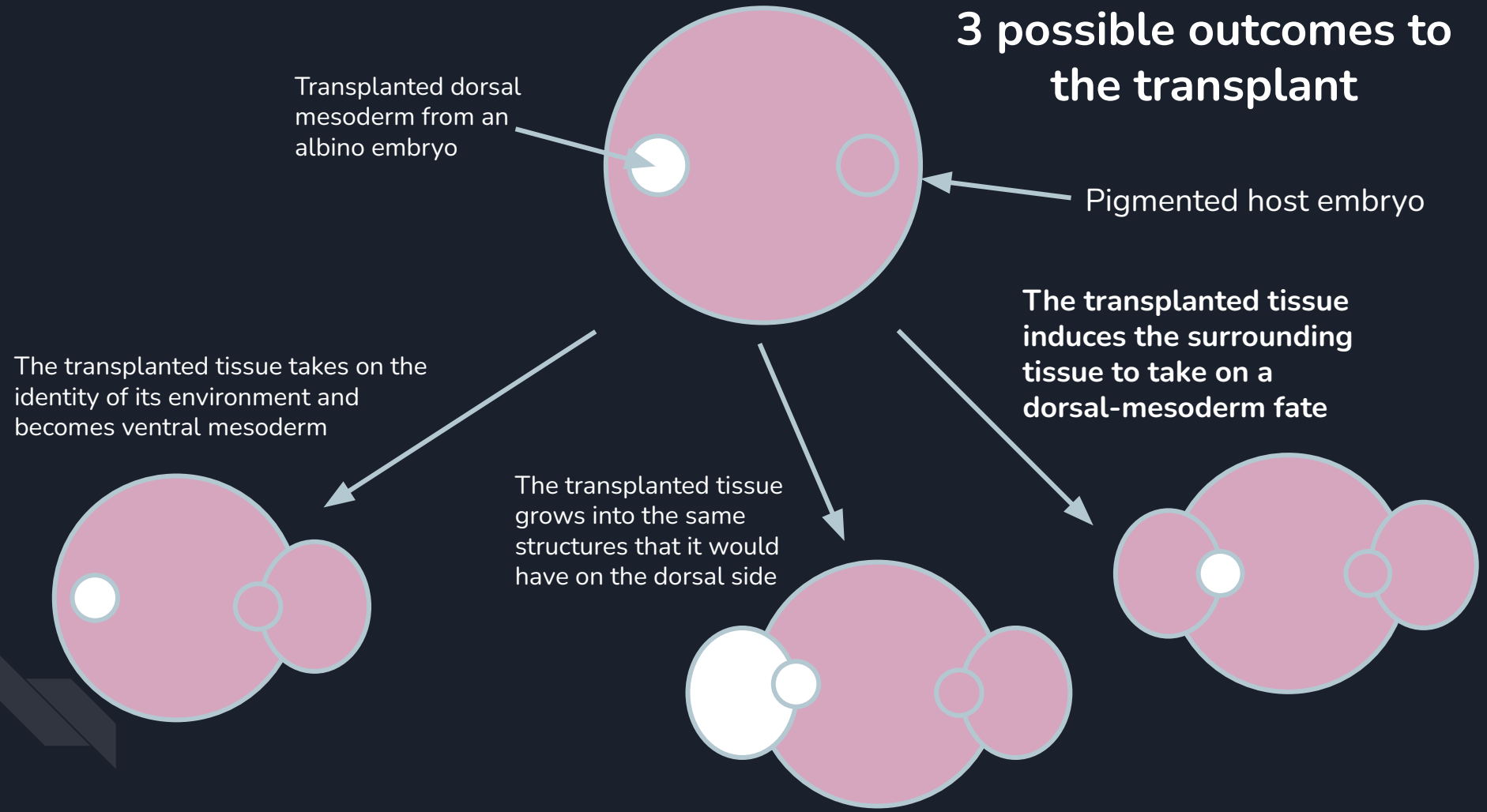
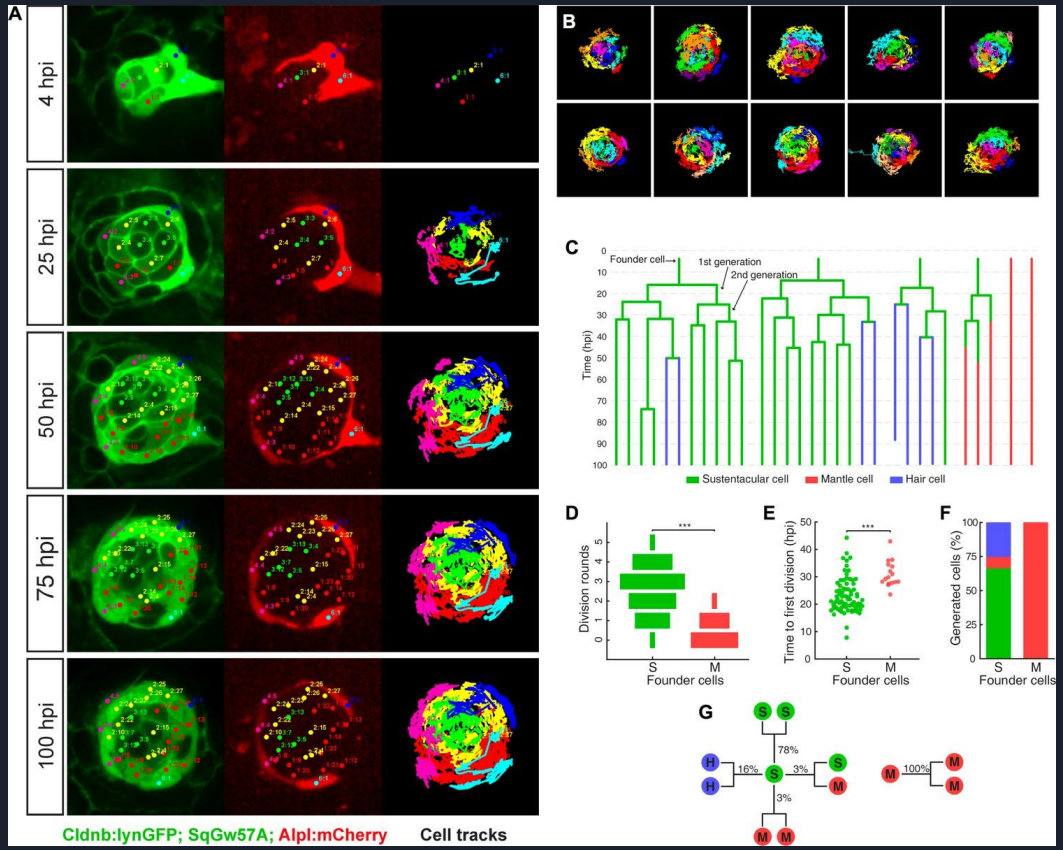


Fig. 24. Um 132b. *Cross section through the middle of the embryo (cf. Fig. 21). The primary axial organs are to the left of the figure and the secondary axial organs to the right. r. sec. Pron., right secondary pronephric duct. The implant (light) has formed notochord and part of the right secondary somite. 100X.*

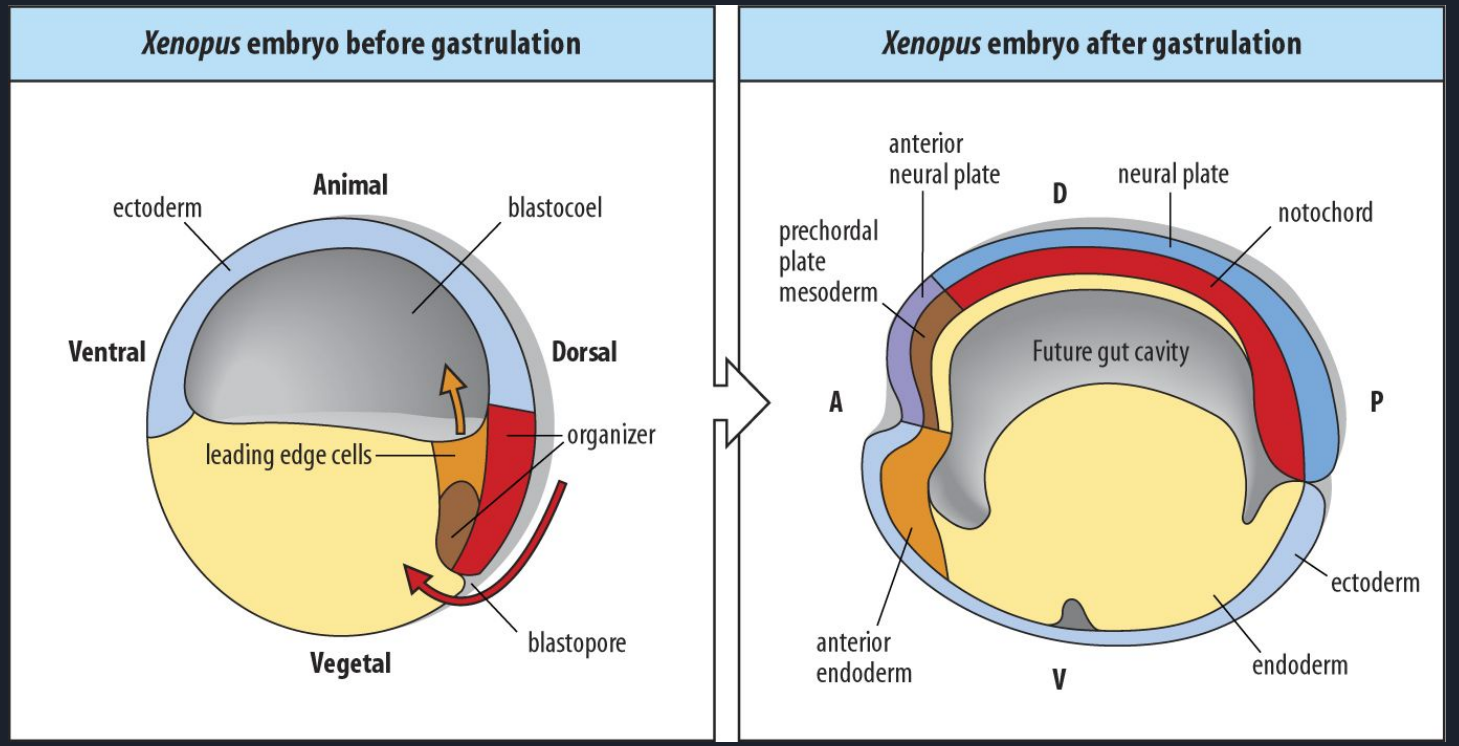
3 possible outcomes to the transplant



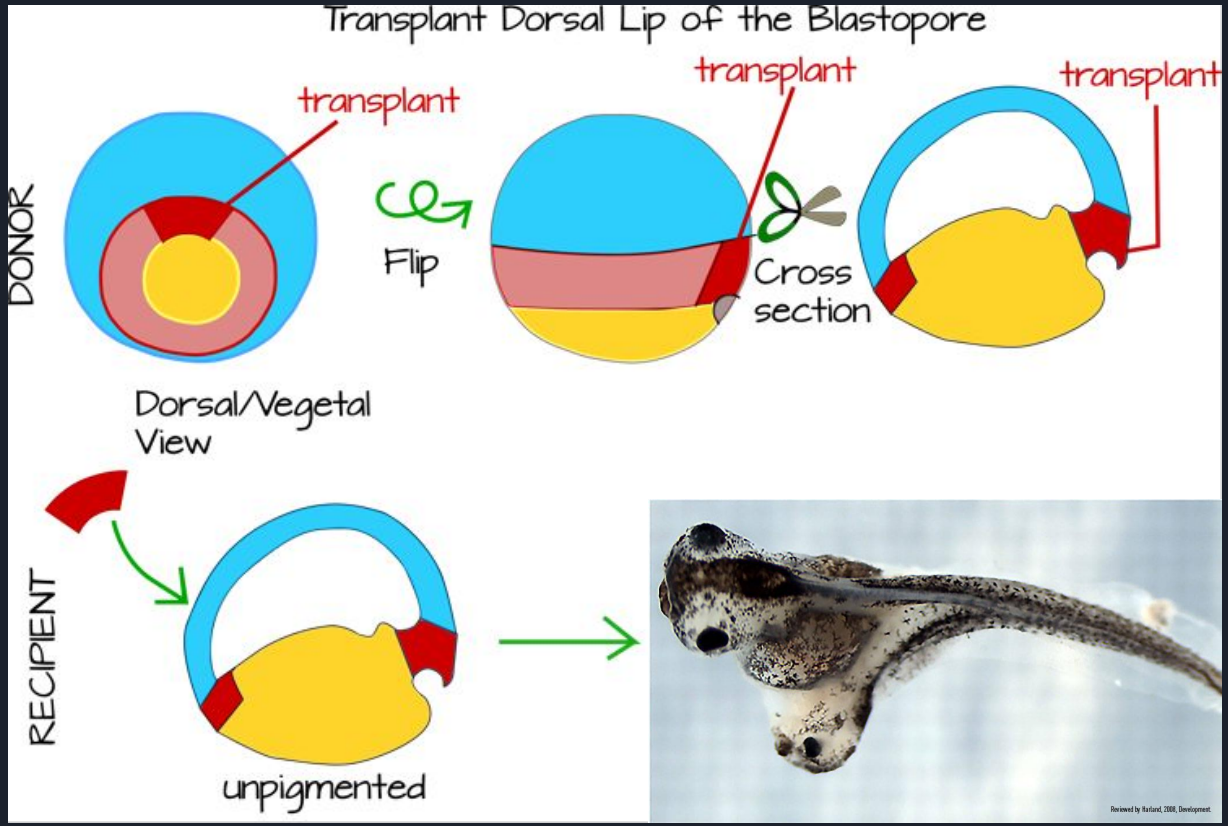


Live cell-lineage tracing and machine learning reveal patterns of organ regeneration
Oriol Viader-Llargués Valerio Lupperger Laura Pola-Morell

Typical Development



Functional Explanation



Developmental Biology

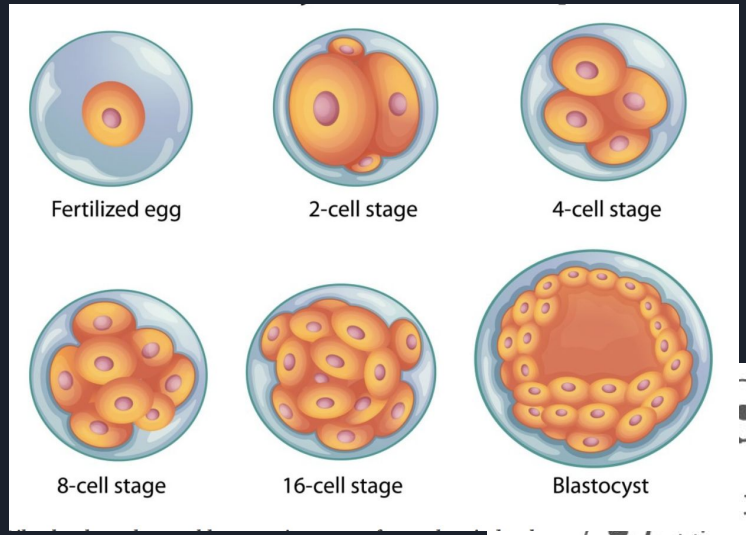
From Fertilized Egg to Blastocyst

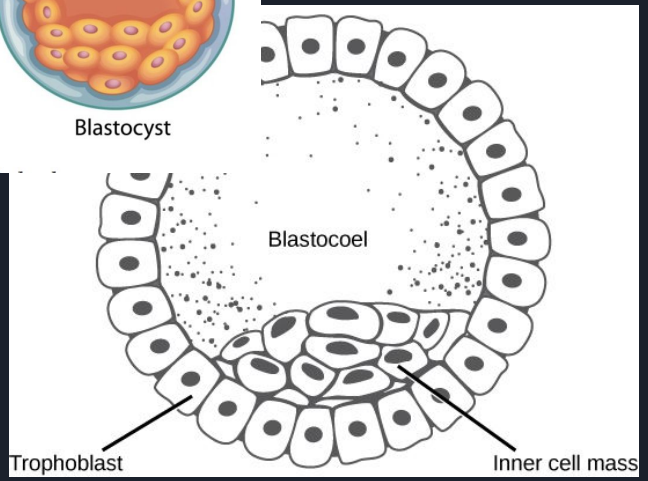
ESCs: Embryonic stem cells

Blastocyst: forms 5-6 days after the sperm fertilizes the egg. Hollow ball of rapidly dividing cells. Has fluid-filled cavity called blastocoel.

Inner group of cells will become the embryo and outer will become the cells that nourish and protect (trophoblast).

14 day limit after fertilization for research use, Bioethics Unit will go further into this! :)



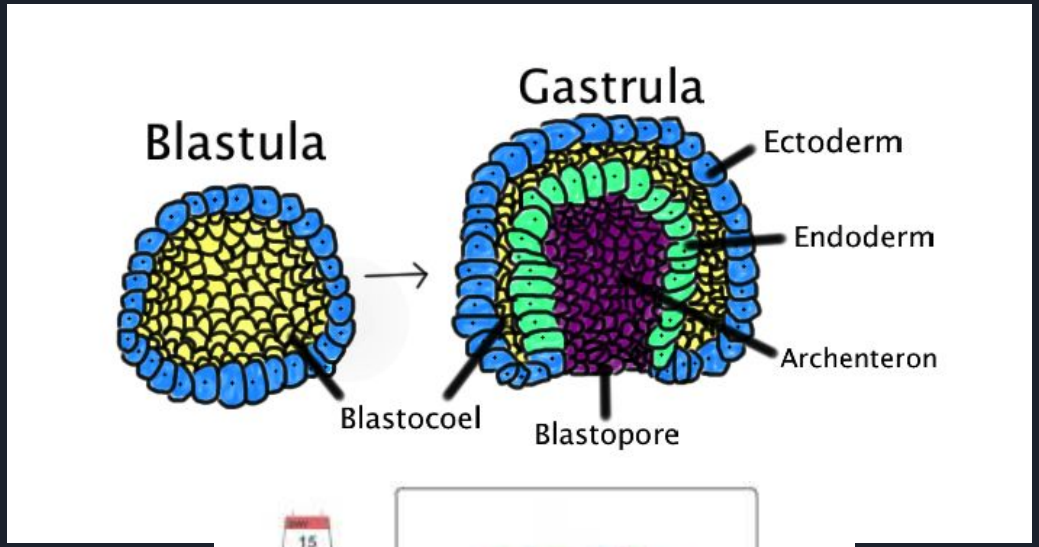


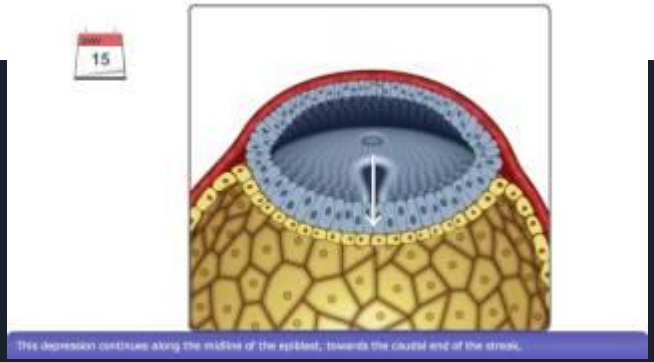
Blastocyst to Gastrulation

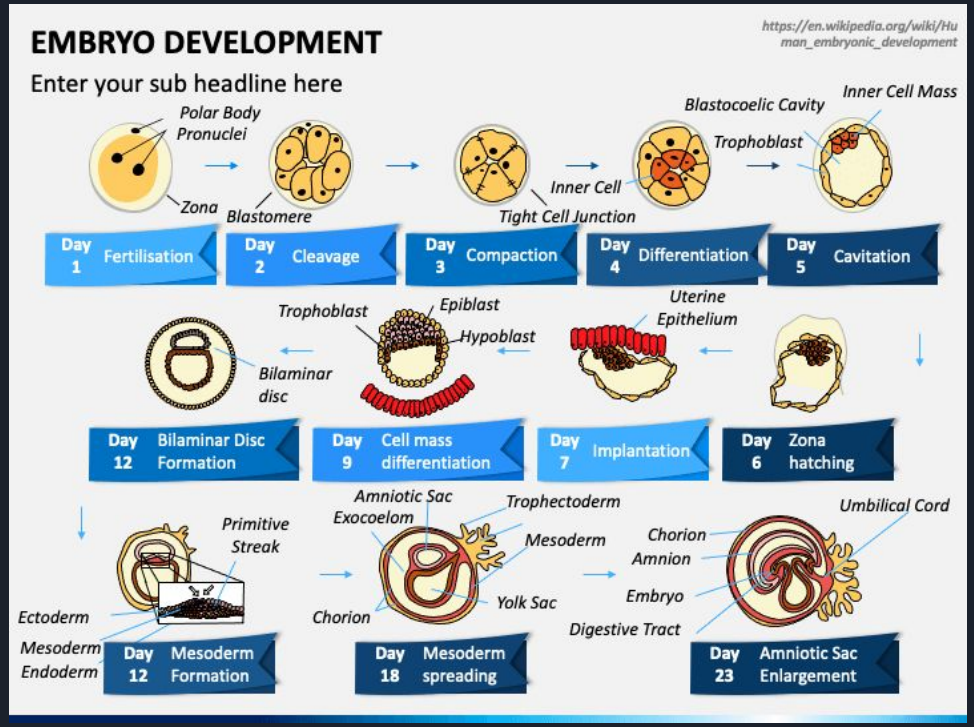
Gastrulation begins with the primitivative strea:

- found in the epiblast layer of the blastocyst
- defines the major body axes of the embryo (divides it into caudal and cranial ends)
- Expands to form primitive node, a depression within the structure

Gastrula layers is formed when the blastocyst fold into itself with the help of the primitive node





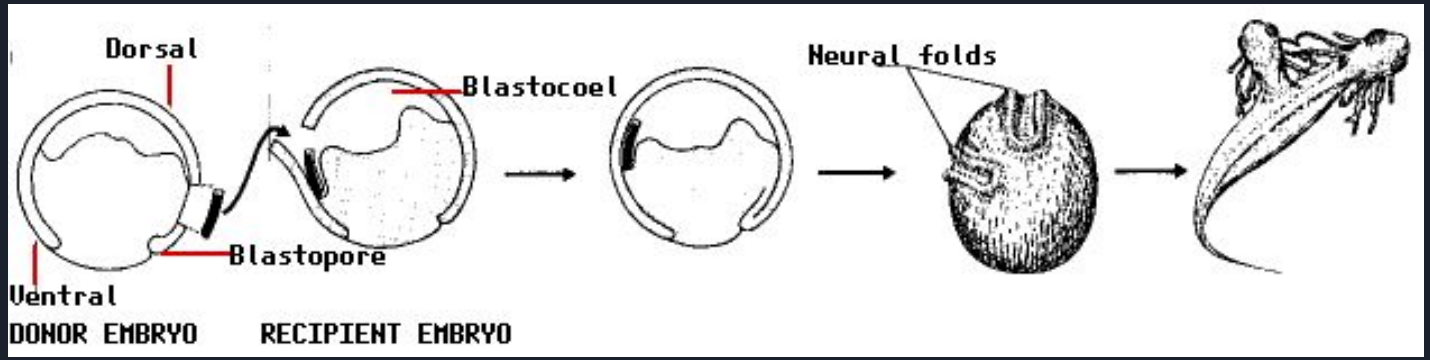


As the days after fertilization progress, cell differentiation continues with cells dividing into different structures of the organism.

What happens if cells in day 23 are switched around?

Spemann-Mangold Experiment

In 1924 Spemann and Mangold performed this experiment with salamander embryos to determine what guides the fate of cells in early embryonic development. The took a piece of the cell from the section of the donor cell that they knew gave rise to the dorsal portion of the organism and implanted it in the ventral side of the donor. This gave rise to conjoined salamander twins.



Questions?

Remember to join discussion sections this week!

What are the ways the niche of the stem cells contribute to the fate of the cell?