

STEM CELLS

PART A: Basics of human embryology

Websites:

<http://www.hhmi.org/biointeractive/human-embryonic-development>

<http://www.hhmi.org/biointeractive/differentiation-and-fate-cells>

These two videos give an overview of the early stages of human development.

<http://www.visembryo.com/baby/>



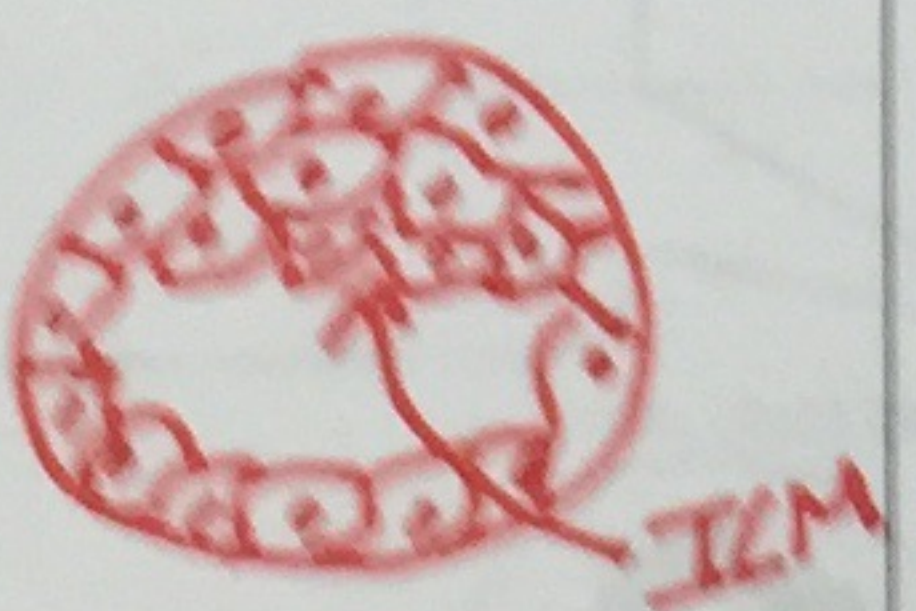
Click on the cell in the lower left corner of the diagram by the number 1. This will show you a picture of a fertilized egg. After that, click the next button above each diagram to advance through human development. You'll only need to proceed through Carnegie Stage 6.

<http://www.explorestemcells.co.uk/TotipotentStemCells.html>

Read through the two pages to familiarize yourself with the different types, or potencies of stem cells.

Questions:

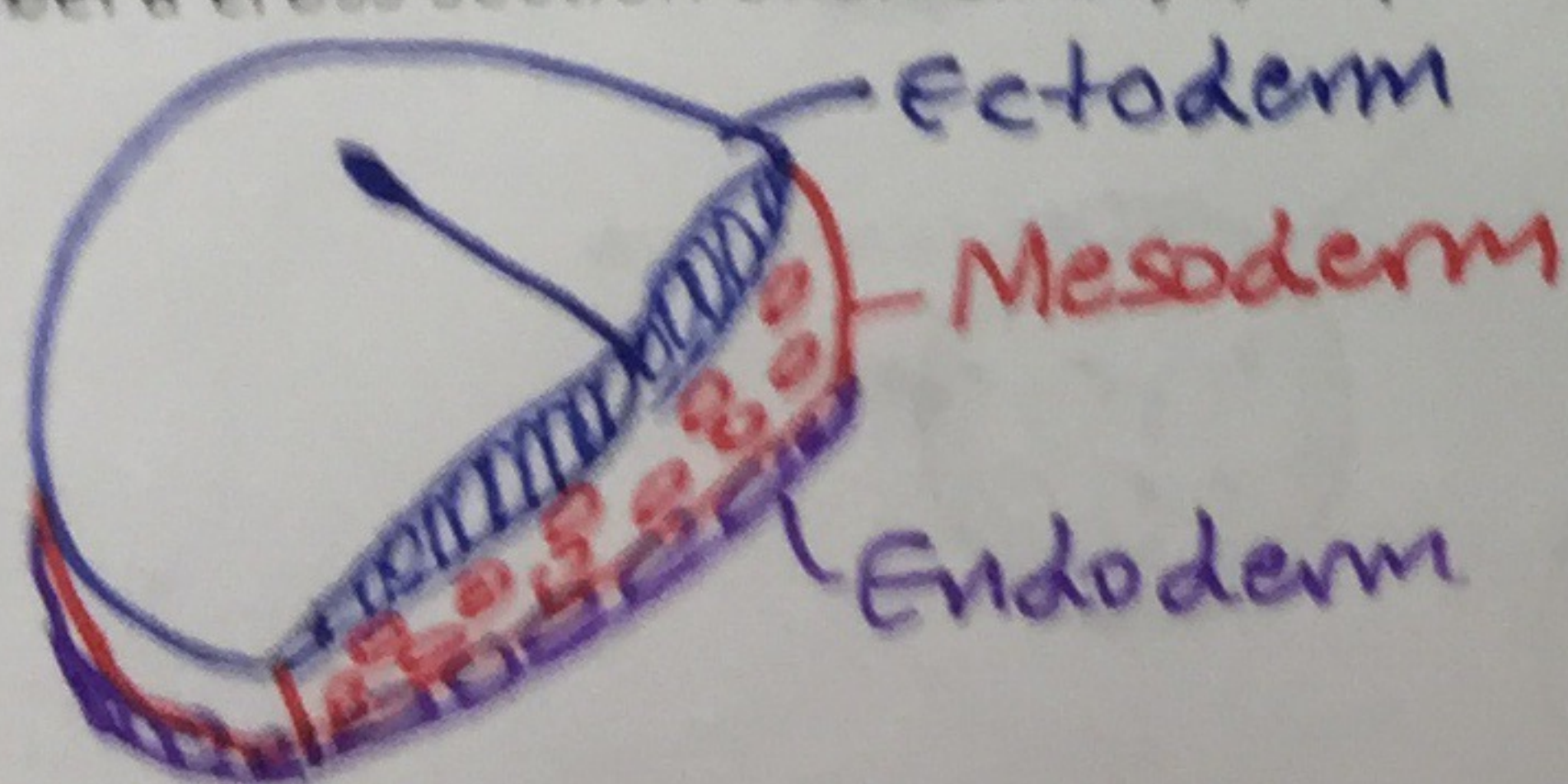
1. Sketch and write a 1 sentence description of the following stages of human development:

Stage	Sketch	Description
Zygote		Fertilized egg cell
Morula		8-16 cells (3-4 days post fertilization)
Blastocyst		200-300 cells (5-6 days post fertilization)

2. What is the ICM and where is it found?

Mass of cells inside early embryos
Contains embryonic stem cells

3. Draw and label a cross section of an embryo, depicting the three embryonic tissue layers.



4. What organs develop from each of the following embryonic tissues?

a. Ectoderm

Nervous tissue

Skin

b. Mesoderm

Muscle + Connective tissue

Bones + Blood

c. Endoderm

Lining of digestive tract

5. Explain these terms and describe when (and where) in human development they occur?

a. Totipotent

- Can produce all / any differentiated cell
- Zygote is only cell that can do this

b. Pluripotent

- A stem cell that can differentiate into endo, meso or ectoderm
- Present in morula + blastocyst in different continuums.

c. Multipotent

- A cell that can differentiate into multiple, but limited cell types
- Found in many but not all cell types.

OP

Stop! Show your teacher your work before you continue to the next section!

PART B: Stem Cells and Differentiation

Websites:

<http://learn.genetics.utah.edu/content/stemcells/scintro/>

This website use animations to introduce stem cell biology and the differences between embryonic and somatic (adult) stem cells.

<http://www.eurostemcell.org/films#story>

This 15-minute film provides an engaging, accessible and visually stunning introduction to the world of stem cell research.

<http://learn.genetics.utah.edu/content/stemcells/sctypes/>

View the animations to learn about differentiation and types of somatic stem cell niches.

Questions:

1. What is cell differentiation? How many differentiated cell types exist in the adult human body?

Cell changing from one type to another
(specializing)

200 different types

2. What are the two essential characteristics of stem cells?

- Long term self renewal (can divide w/o limit)
- Ability to differentiate

3. How are somatic (adult) stem cells different from embryonic stem cells?

Found in adults
No longer pluripotent, but multipotent

4. Where are somatic stem cells found in the body?

Brain, bone, blood, skeletal muscle, teeth, heart, liver



Stop! Show your teacher your work before you continue to the next section!

PART C: Medical and Research Applications of Stem Cells

Websites:

<http://www.eurostemcell.org/films#cellfate>

Watch the first seven minutes to learn how specialized cells develop from stem cells.

<http://learn.genetics.utah.edu/content/stemcells/sctoday/>

Read about use of somatic stem therapy to cure leukemia.

<http://www.hhmi.org/biointeractive/stem-cell-based-therapies>

<http://learn.genetics.utah.edu/content/stemcells/scfuture/>

These animations and text explain how stem cells can be used to cure disease.

<https://www.youtube.com/watch?v=0XCKveOPxfo>

<http://www.blindness.org/stargardt-disease>

Watch the video and read the summary article describing Stargardt disease.

[http://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(14\)61376-3/abstract](http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(14)61376-3/abstract)

Read the abstract providing an overview of how stem cells have been used to treat Stargardt disease.

Questions:

1. What is regenerative medicine?

Process of replacing, engineering or regenerating human cells, tissues or organs to restore/establish normal function

2. Describe an example of how stem cells can be used in regenerative medicine?

Bone Marrow Transplant

→ replace bone marrow stem cells that cause leukemia w/ new + normal stem cells.

3. What are hematopoietic stem cells? What cell types are derived from hematopoietic stem cells?

→ Stem cell that can differentiate into all the different cells that make up our blood.

(adult somatic stem cell)

4. What is leukemia? How can hematopoietic stem cells be used in the treatment of leukemia?

Cancer
of White
Blood cells

Get rid of all abnormal cells in bone marrow through chemotherapy & replace them w/ cells from a healthy, matching donor

5. The umbilical cord contains hematopoietic stem cells. Are these cells totipotent, pluripotent or multipotent?

~~Pluripotent~~
Multipotent

6. Why might understanding stem cells improve our understanding and treatment of cancer?

Cancer cells share properties w/ stem cells such as self-renewal. Cancers have stem cell like cells that fuel the growth of the cancer. Typically cancers return because the stem cells present in malignant tumors aren't killed.

7. What is the cause of ~~effect~~ Stargardt disease?

- Genetic

- Vision loss is caused by death of photoreceptor cells in the retina.

8. How have stem cells been used to treat Stargardt disease?

Human stem cells have been transformed into retinal pigment epithelial cells & injected into the retina of people w/ the disease.

STOP

Stop! Show your teacher your work before you continue to the next section!

PART D: The stem cell controversy

Websites:

<http://www.pbs.org/wgbh/nova/sciencenow/3209/04.html>

Watch the video that presents an overview of stem cell biology with an emphasis on the social and political controversy.

Questions:

1. How might embryonic stem cells be used to treat diabetes?

Insulin producing cells of the pancreas are destroyed by the patient's immune system.

Embryonic stem cells could be coaxed into differentiating into these insulin producing cells - grown in culture & then transplanted into the patient.

2. What is "embryo cloning" and how is it done?

• Cloning of an embryo

• Through somatic cell nuclear transfer (SCNT)

Remove the nucleus from a fertilized egg & replace it w/ the nucleus from a cell of the organism you want to clone.

3. How might embryonic stem cells created in "embryo cloning" be used to treat disease?
could provide a variety of cell & tissue types which could be used for organ repair / transplantation

4. Why do scientists want to observe formation of "sick cells?"

*To see how the cells develop incorrectly -
When they first start acting wrong.*

5. Summarize the arguments that embryonic stem cell research should not be done.

- Embryos are harvested / destroyed*
- Safety concerns*
- Could abuse → create human clones*

Cloning

1. Definition:

2. Reproductive cloning generates an animal that has the _____ as another currently or previously existing animal.

a. Natural reproductive cloning occurs in _____ reproduction, when the embryo splits in two to produce identical _____.

b. Natural reproductive cloning of organisms also occurs when organisms reproduce without having sex

(_____)

i. Single cell organisms (Bacteria, amoeba)

ii. Anemones and hydra

iii. Stick bugs

iv. Some lizards, snakes and frogs

v. Some plants

3. Methods of Cloning of Organisms

a. _____

i. Artificially splitting a single embryo at a very early stage of development.