



## **UNIT ONE: EMBRYONIC STEM CELLS LESSON**

### **IN VITRO FERTILIZATION AND EMBRYONIC DEVELOPMENT**

### **PREIMPLANTATION GENETIC DIAGNOSIS**

By Kathy Keeran, Lonnie Simonson, Laurel Barchas

#### **CALIFORNIA STANDARDS:**

Biology/Life Sciences

2d. Students know new combinations of alleles may be generated in a zygote through the fusion of male and female gametes (fertilization).

3. A multicellular organism develops from a single zygote, and its phenotype depends on its genotype, which is established at fertilization.

#### **GOALS:**

##### **Understand natural fertilization and in vitro fertilization**

Understand the stages of early development and how they relate to stem cells

#### **OBJECTIVES:**

1. The student will demonstrate an understanding of the difference between natural fertilization and in vitro fertilization.
2. The student will be able to explain the differences between the morula and the blastocyst and understand how each relates to embryonic and fetal development.
3. The student will be able to explain the in vitro fertilization procedure in general terms from ovulation induction through embryo transfer.
4. The student will be able to describe the origin of pluripotent stem cells (inner cell mass) and their importance in medicine. Students will distinguish between totipotent and pluripotent stem cells.
5. The student will be able to describe how embryonic stem cell lines are developed.
6. The student will be able to explain Pre-implantation Genetic Diagnosis (PGD).
7. The student will be able to recognize areas of debate regarding the ethics of pre-implantation genetic diagnosis and stem cell research.



## OUTLINE OF UNIT

### I. INVITATION:

#### ***A. Writing Activity: Assess pre-lesson knowledge***

1. Describe natural fertilization
2. What is infertility?
3. How did the “Octomom” become the mother of eight babies?
4. Draw what you think a five day-old human embryo looks like.
5. Have you ever heard about stem cells? If so, what have you heard about them?

#### ***B. Discuss Octomom, the movie My Sisters Keeper***

Use the following as stimuli for discussion.

See Bibliography for web addresses to clips

View clips about Octomom in this order

1. OCTOMOM COMPLAINT
2. NADIA SULEMAN AND DR PHIL

View clips about My Sister’s Keeper in this order

1. MYSISTERSKEEPER
2. What Can I Do For You CLIP
3. INTERVIEW JODIPICOULT

### II. EXPLORATION

#### ***A. Natural Fertilization***

1. Lecture: Natural Fertilization - with graphic organizer “Human Fertilization and Development”
  - a. Download Appendix A: power point [presentation](#)
  - b. Download Appendix A: [Unit One Natural Fertilization student worksheet](#)
  - c. Download Appendix A: [Unit One Natural Fertilization teacher version](#)
  - d. Download Appendix A: [Additional graphics, interactive animations, and lessons on embryonic and fetal development](#)
2. Animation of Human Development and Stem Cells (HHMI, at this [link](#))



3. Choose one of the lab activities below:

- a. Sea Urchin [Embryology Lab](#)
- b. Virtual sea urchin [fertilization and development lab](#) (Click on fertilization and development to begin the interactive animation.)
- c. Sea urchin slides (Carolina catalogue #NP309702 Sea Urchin Development through blastula stage) and "Sea Urchin Development Microscope Lab"
  - i. Download Appendix B sea urchin microscope lab [graphic organizer](#)

4. Play dough modeling activity – with graphic organizer "Draw Embryonic Development"

[Download Appendix C: Playdough-modeling Activity](#)

Emphasize stages/sites at which totipotent and pluripotent stem cells occur.

### ***B. In Vitro Fertilization***

1. "In Vitro Fertilization" graphic organizer
  - a. Download Appendix D: [student graphic organizer](#)
  - b. Download Appendix D: [teacher answer sheet](#)
2. View clips of IVF in this order (see Bibliography for urls):
  - 1<sup>st</sup> - IVF and ICSI
  - 2<sup>nd</sup> - 3D animation of ICSI
  - 3<sup>rd</sup> - Intra-Cytoplasmic Sperm Injection
3. Assessment: Written comparison of natural and in vitro fertilization and description of the location of embryonic (pluripotent) stem cells.

### ***C. Pre-implantation Genetic Diagnosis and Stem Cells***

1. Discuss characteristics of totipotent and pluripotent stem cells and formation of stem cell lines. Discuss ability of stem cells to differentiate, and how this is useful medically. Use background information and this animation to develop discussion materials. Students should take notes in journal or write three questions they have as discussion progresses. Students then view the animation and answer their questions from animation or further discussion. (HHMI, or at following [link](#))



Thought questions:

How could scientists develop tissue for a patient? What are problems with transplanting foreign tissue into a patient? How might scientists get around this?

2. Jigsaw of articles activity/homework assignment: students are assigned to read abstract and summaries of scientific journal articles. Students can answer associated questions in journals; during class students get in “expert groups” to talk about questions, then break into “teaching groups” to share information from the articles listed.

- a. Download appendix E: [jigsaw general instructions](#)
- b. Download summaries of research papers:

Group 1 reads:

Thompson: [\*Embryonic Stem Cell Lines derived from Human Blastocysts\*](#)

Group 2 reads:

Finkel: [Stem Cells Without Killing Embryos](#). (This is an EASY e-magazine article, not a paper summary. It can be read as is.)

Group 3 reads:

Damewood: [Ethical Implications of a New Application of Preimplantation Diagnosis](#)

Vastag: [Merits of Embryo Screening Debated](#)

Group 4 reads:

American Society for Reproductive Medicine: [Preimplantation Genetic Testing: a Practice Committee Opinion](#)

Group 5 reads:

Hoffman: [Cryopreserved embryos in the United States and their availability for research](#).



### III. APPLICATION

A. Discuss ethics of PGD after the above jigsaw activity; in the context of a teacher-presented standalone lecture; or a policy forum. Students should each write two potential ethics problems after hearing jigsaw presentations. In an A, B Interview, each student should present the two ethics questions to a partner. Each partner describes the ethics questions of his/her partner with larger group. The discussion proceeds following this activity. Teacher writes points of view on overhead or the board.

B. Finish with a ranking exercise – Review the following policy options for regulating PGD (from Vastag article) then ask students to rank these policy options using the “Pre-implantation Genetic Diagnosis (PGD) Policy Options In-Vitro Fertilization and Embryonic Development Application” graphic organizer.

- a. Download Appendix F: [policy options ranking sheet](#)

### IV. ASSESSMENT

Have students answer the following questions on the “In-Vitro Fertilization and Embryonic Development Assessment”

1. Compare and contrast natural fertilization, in vitro fertilization, and in vitro fertilization with intracytoplasmic sperm injection.
2. How do the morula and the blastocyst relate to embryonic and fetal development?
3. How did the Octomom have eight babies?
4. If Octomom and her doctors had followed the guidelines for the maximum number of embryos to be implanted, what could have happened to the remaining (unimplanted) embryos?
5. What are pluripotent stem cells and why are they important in medicine?
6. Compare how scientists would derive a totipotent stem cell line from a morula versus a pluripotent stem cell line from a blastocyst.
7. What is Preimplantation Genetic Diagnosis (PGD) and how might it help a family choosing in vitro fertilization?
8. How do stem cells relate to PGD?
9. What are some drawbacks of PGD?

- a. Download Appendix G: [Unit Assessment](#)