Published in final edited form as:

Am Biol Teach. 2008 ; 70(2): 77–78. doi:10.1662/0002-7685(2008)70[77:MEESCC]2.0.CO;2.

MODELING EARLY EMBRYOLOGY & STEM CELL CONCEPTS

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Stem cells self-renew and also have the potential to give rise to daughter cells that can differentiate into many types of cells. In this activity, students make play dough models of early embryonic development. These models help visualize where embryonic stem cells come from and how their potential to develop into different types of cells changes over time. Student handouts to accompany this activity (which is part of a larger stem cell curriculum) can be found at <https://www.nwabr.org/teacher-center/stem-cell-research#overview>.

Materials

- four different colors of play dough
- paper plates to represent Petri dishes
- paper clips
- straws

Procedure

Demonstrate the steps as students make their own models.

Zygote (Figure 1)

Use a single color to make both an egg (the size of a ping pong ball) and a much smaller sperm cell. Mix them together to form a zygote on a “Petri dish,” representing *in vitro* fertilization. The “tail” of the sperm drops off and does not enter the egg.

Early Cell Divisions

Divide the zygote in half, making two spheres. Divide each of those two cells in half, then each of those in half again, until there are 16 cells.

Morula (Figure 2)

Push the 16 cells together to form a sphere (morula). Through this stage, the cells are considered *totipotent* - if separated, any one of them could become a complete individual.

Blastula (Figure 3)

The blastula stage occurs 3–14 days after fertilization. The mammalian blastula is often referred to as a **blastocyst**. Pick a new color, make a sphere the size of a ping pong ball, then flatten the ball into a bowl. The bowl represents pre-placental cells. In real life, they form a hollow ball; the bowl represents a cut-away view (see Figure 3). Use the end of a straw to make indentations that look like cells.

Make pea-sized spheres to represent the cells growing inside the hollow ball. These are the cells of the inner mass (“embryonic stem cells”). The cells have already gone through one “fate decision.” The cells that make the hollow ball can only become placenta. The cells of the inner mass are *pluripotent*; they can become any type of cell in the body *except* placenta.

At this point, an **embryonic stem cell line** could be made by transferring cells from the inner cell mass to a culture dish and growing them in a medium that provides support and nutrients.

Gastrula (Figure 4)

Make a new early placental bowl in the same color as the previous one. The next steps involve making a three-layered ball. Take the original embryo color and form a pea-sized ball. Flatten a marble-sized piece of a new color and wrap that around the ball. Add a different-colored layer around the outside. Use an open paper clip to cut through the center of the gastrula to show the three different layers.

The gastrula is *multipotent*. The early placenta cells can still only become placenta. The inner cell mass has undergone another fate decision and has differentiated into three layers: endoderm, mesoderm, and ectoderm. Stem cells in these layers are restricted in their ability to differentiate - they can only become cells of the type found in that layer. This limitation is a hallmark of an adult stem cell.

Discuss the limitations of the model, including:

- The simulation shows only discrete points in time rather than continuous development.
- The different colors may give the wrong idea about origins of cells—all of the colors originate from the original zygote.
- Students cannot see the spherical nature of the pre-placenta.

Optional

Have students bring their blastulas in their Petri dishes and place them in the freezer, much as blastocysts created by *in vitro* fertilization are frozen for storage.

Acknowledgments

The development of this activity was made possible by Collaborations to Advance Understanding of Science and Ethics (CAUSE, 2 R25 RR016284-04), a Science Education Partnership Award from the National Center for Research Resources, a component of the National Institutes of Health.

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Figure 1.
Zygote

Figure 2.
Morula

Figure 3.
Blastula

Figure 4.
Gastrula