

7th Grade Science Content Standard Textbook Gaps

1. f. *Students know* that as multicellular organisms develop, their cells differentiate.

In most multicellular organisms there is a division of labor among cells. Some cells in humans are brain cells; others are stomach, skin, or muscle cells. Although those cells are clearly different, their ancestry can be traced back to a single fertilized egg. During the development of an embryo, some cells become fixed in their developmental program and are said to be **differentiated**. For example, cells that will eventually divide to give rise to the stomach and intestines are distinguished at a very early stage from cells that will divide to give rise to the central nervous system and eyes. At later stages of development, a more fine-grained differentiation takes place. For example, some cells in the retina of the eye become rod cells (for vision **Chapter 4** in dim light) and others become cone cells (for color vision). After differentiation, most cells in humans lose the ability to become other types of cells.

In plants the cells often retain the ability to **differentiate** into other tissues. For example, a leaf of an African violet can set roots in soil and develop into a new plant. Although the leaf is clearly differentiated, it is not fixed in its developmental potential in the way that animal cells typically are (an exception being the animal's germ cells that lead to eggs and sperm).

Background for Teachers:

As far as we can tell, cells start to become different as soon as you can see any type of structure in the developing embryo (or, in reality, perhaps just before that). A ball of cells produces a bulge on one side. The cells making the bulge are somehow different than the ones not making the bulge and will end up as different types of cells. For instance, in human embryos the bulge becomes the spinal cord and nervous system.

Another interesting related tidbit is that certain forms of cancer are the result of differentiated cells in an organism "forgetting" what they are supposed to be and start rapidly reproducing as undifferentiated cells. Stem cells are also undifferentiated. This turns out to be one of the concerns with stem cell research. Major work in stem cell research is being done using cells from either umbilical cord or from the more controversial source: embryos discarded from infertility clinics.

In experiments using embryonic stem cells to repair damaged heart muscle cells (in animal studies), stem cells turned into healthy heart muscle cells. But, there was a tendency for the stem cells to revert back to their undifferentiated state (i.e., become cancerous). I heard this from a researcher who is doing work using adult stem cells. Yes, adults apparently have circulating stem cells that perform the task of tissue repair naturally. By harvesting and concentrating adult stem cells, he hopes these "more mature cells" will be able to make repairs without reverting back to the undifferentiated state. His reasoning is that these cells are working in the way they naturally function and are somehow better at fitting into damaged tissue, differentiating to match the surrounding cells, and *staying that way*.

It seems that plants are able to manage to "undifferentiate" or "re-differentiate" cells in ways that we cannot. Good thing, too! A plant may need to send out roots from a stem if the water/soil level rises, but I personally have no desire to grow an extra leg out of my hip.

Ideas for Students:

The focus of this in the Framework is that students simply need to be aware that developmentally, all organisms begin as a single, undifferentiated cell. As that cell replicates, it produces other undifferentiated cells. At some point, the cells begin to become different (differentiate) and will end up as completely different types of cells: muscle cells, bone cells, nerve cells, skin cells, etc.

A fun activity might be to have students think of useful things they might try to do if they could "re-differentiate" some of their cells like plants do. What problems might some of these ideas create for clothing manufacturers? A more serious approach would be to have a Socratic Seminar on the issues and ethics of stem cell research using an article that summarizes the current research.