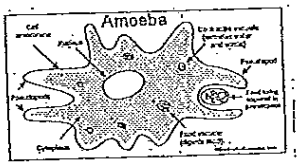
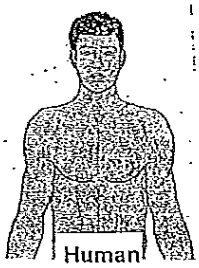
Name _____ Period _____ Date _____

Differentiation and Growth

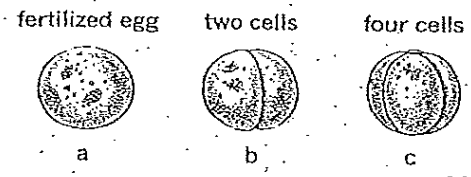


Every living thing has at least one cell. Some living things exist as one single cell (a protist), while others have trillions of cells (a human).

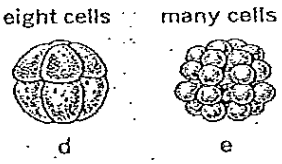


All human life begins when the nucleus of the male sex cell (sperm) fuses with the nucleus of the female sex cell (egg/ova). This process is called *"fertilization"*. The resulting fertilized egg cell is called the *"zygote"*. About 30 hours later, the zygote divides into 2 new "daughter cells" using the three steps of the cell cycle (interphase, mitosis, and cytokinesis).

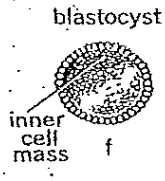
Picture 1: a, b, and c
These are all cells or groups of cells which could become one individual if they stay together or separate individuals if the cells separate. All of these cells have total potential and all the genes are active.



Picture 2: d, e
By the third or fourth day, there is a solid ball-shaped group of 16 cells. These cells can become any kind of cells BUT they can no longer become a complete individual if separated. They seem to have biological or chemical need to be next to other cells to determine what type of cell they will become. This is the very beginning of differentiation. A few genes must be turned off at this point.
These cells are called stem cells.



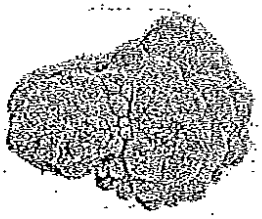
Picture 3
The outer circle of cells is forming the protective, fluid filled sac called the amniotic sac. This is not actually a part of the embryo. The inner cell mass will become the embryo, umbilical cord, and placenta. Cells here are more specialized so even more genes are being "turned off". The cells have different shapes and sizes.



By 6 days (many divisions later) real changes can be seen. At about this time, the developing organism is now called an *"embryo"*. Since the cells grow before they divide, the *embryo* begins to increase in size. ***Cell growth alone, however, would produce only a formless mass of cells!***

The developing *embryo* has formed three different layers of cells. These layers will eventually form all the tissues, organs, and systems of the body:

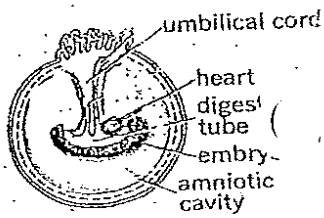
- One layer will form the brain, spinal cord, hair, nails, lenses of the eye, lining of the mouth, and the outer skin layer.



- A second layer will form the bones, muscles, reproductive organs, kidneys, circulatory system, and the inner skin layer.

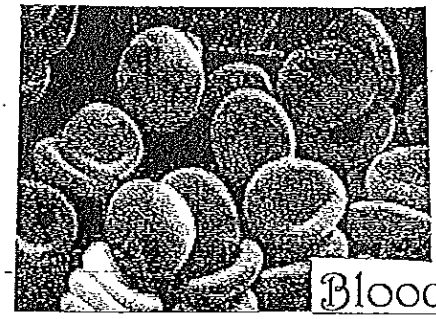
- The third layer will form the bladder, liver, pancreas, lungs, and the lining of the digestive tract.

Picture 4: g, h
In these two pictures we can begin to see areas that will develop into specific organ systems in the embryo. Each one of these areas is made of millions of cells. There are many kinds of cells here and many different types still to form. More and more genes are being turned off inside each cell. By about 2 weeks after fertilization, all the major parts of the body have started to form! The *embryo* is less than 5mm long!!



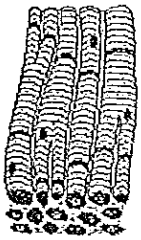
Cell division happens a lot in cells that are least specialized; therefore, cells in a developing embryo divide at a very rapid rate. However, as the embryo matures, and the cells become more "specialized", the rate of mitosis decreases. The changing of unspecialized embryonic cells into specialized cells, tissues, and organs that make up an organism is called "differentiation". Differentiated cells can only become one kind of cell; undifferentiated cells can become many different types of cells. Completely undifferentiated cells are also called stem cells – these cells have the ability to become any type of cell. What a stem becomes is strongly influenced by what type of cell it is near. Put it near an intestinal cell and that is what it becomes.

As you already know, not all your cells look or act the same. You have about 200 different kinds of cells, and each is specially shaped to do its own job. Cells in the small intestine have micro-villi to increase their surface area and absorb more nutrients; nerve cells are very long and thin so they can send impulses quickly, etc.

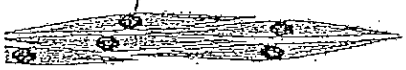


Blood Cells

Muscle Cells



smooth muscle—present in digestive tract, bladder, arteries, and veins. It is composed of thin elongated cells (not striated), each of which has one nucleus.



Keep in mind that all your somatic cells were produced by mitosis, the process that ensures that each new cell receives the same number and kind of chromosomes as the original parent cell. As a result, all your somatic cells have identical DNA, coding for the same information.

Somatic cells can vary in their appearance and function because the cells **DO NOT USE all the information found in their DNA!**

For example, nerve cells have the same DNA and "genes" that your muscle cells use to produce "muscle proteins". BUT,nerve cells DON'T USE THOSE GENES. In some way, those genes are *"turned off"* in the nerve cells.

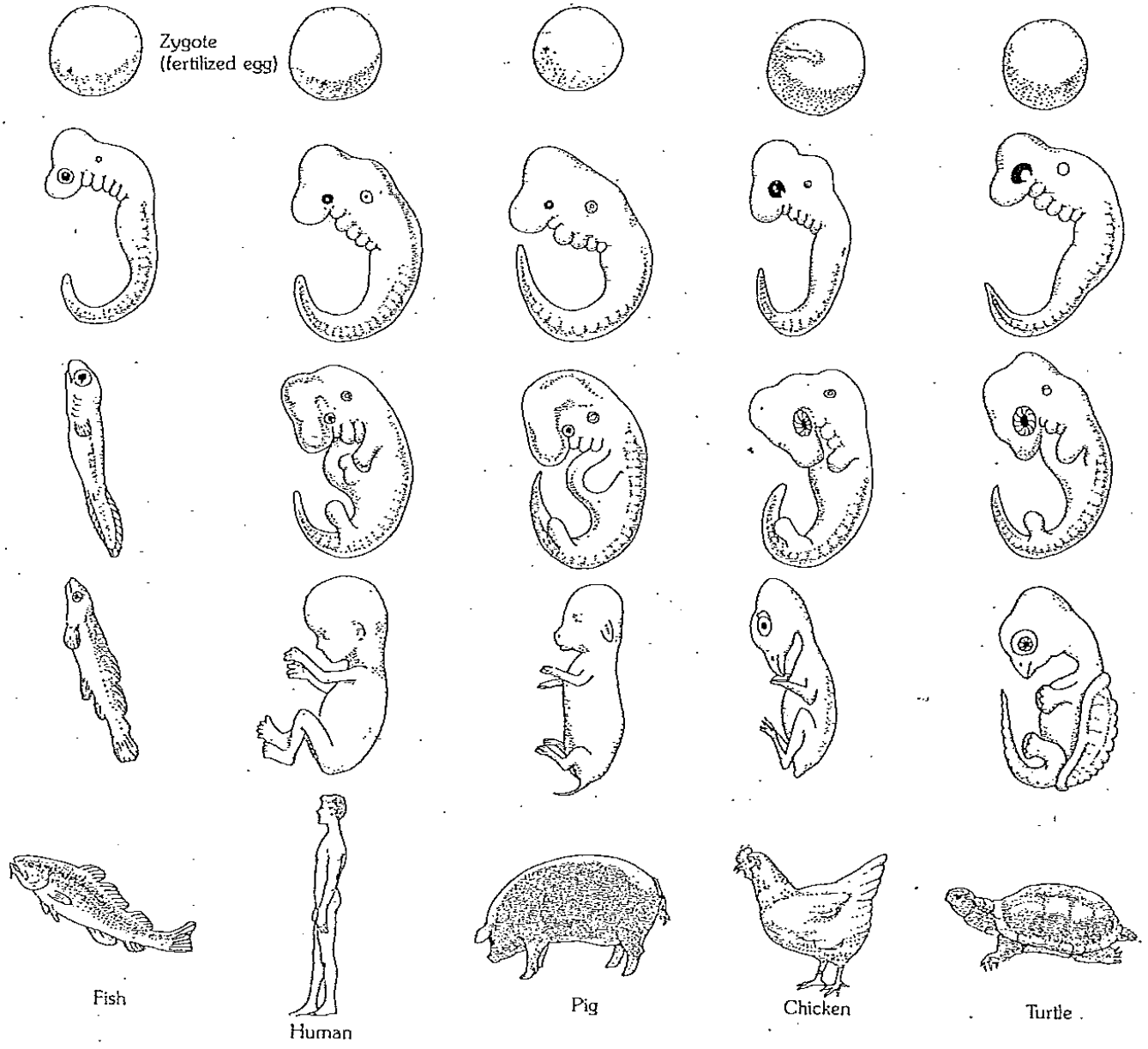
On the other hand, the genes that are *"turned on"* in nerve cells, are *"turned off"* in muscle cells! *Different types of cells "turn on" and "turn off" certain genes. As a result, cells develop into various types – or *"differentiate"*.

Scientists still don't know for certain how this all works, but from their research, it appears that there are specific genes called *"regulator genes"* that determine which genes are "turned on" or "turned off" in a cell. They still are not sure how these *"regulator genes"* are able to control other genes.

Ontogeny is the development of an organism from fertilized egg to adult. Phylogeny is the evolutionary history of a species or other taxonomic group. In 1866, Ernst Haeckel proposed the principle "ontogeny recapitulates phylogeny," which means that developing embryos repeat the evolutionary history of their ancestors in some way.

Scientists have compared the embryos of the different kinds of vertebrates shown below. In such studies an interesting pattern has emerged. All of these organisms are similar to each other early in their embryonic development. For example, in early stages of development all of these animals have tails. The embryos become progressively different from each other as development proceeds.

Embryonic development of five animals



Students usually find it interesting that human embryos possess gill slits at an early stage of development, and occasionally a human baby is born with openings in the neck. Some human babies have even been born with tails.

Life Science – 7th Grade **Differentiation and Growth**

Name: _____ Date: _____ Period:_____

Now that you have learned about mitosis and meiosis, it is time to apply these ideas to **OUR** development from a single cell to many – forming an embryo. Please answer the questions below based on the *Differentiation and Growth* reading from class.

1. What is fertilization?

2. What occurs within the first 30 hours after a zygote is formed?

3. What is differentiation?

4. If a cell has become more specialized, what has it done?

5. What type of cell is considered "undifferentiated" and why is this so remarkable?

6. The cells that make up your skin and your heart have the exact same DNA. Why do they look so different and have such different functions?

7. Many times throughout the reading, genes are referred to as being "active" or "turned off". What does this mean?

Just one more on the back!

8. How are genes turned on and off?