25: EMBRYOLOGY: WEEK 1

The zygote cell is ***totipotent***. ("Toti" means "totally" and "potent" means "powerful or capable.") This cell is capable of becoming any type of human cell, even supporting cells such as the placenta or the amniotic sac. All of its DNA is open; nothing is methylated or closed. It takes an entire day for the zygote to go through mitosis. The two nuclei of the gametes must fuse together and function as one complete cell. This first division is called ***cleavage***. ("Cleave" means "split.") The two resulting cells are joining together by ***gap junctions***. A junction is a place where things are joined. Gap junctions are protein gadgets that might remind you a bit of a sewing bobbin. There are two plates with a tube in the middle. The hollow tube allows the cytosol from the cells to flow back and forth. This allows the cells to communicate. Chemicals made by one cell can flow into another, so the cells "know" what their neighbors are doing. (We will see gap junctions again when we look at cardiac (heart) cells. The gap junctions allow the cells in the heart to all beat together in unison.)

On day 2 the cells go through mitosis again, making 4 cells. The zona pellucida is still there, so the cells can't get larger. These four cells don't take up any more space than the one zygote did. The cells divide again, making a clump of 8 cells. This turns out to be a critical stage in development and some pre-embryos don't make it past this stage. We know this because of research done during "in vitro" fertilization where eggs and sperm are mixed in a test tube and researchers can watch this whole process happen right before their eyes. They've noticed that some pre-embryos don't develop beyond this point. They'd like to know why this happens so that they can make good choices about which pre-embryos to select for putting into the mother's uterus. But as of the writing of this text, they still have not figured it out.

When the cells divide again, there are enough of them now to make a little clump that looks a bit like a mulberry or raspberry. Since the Greek word for mulberry is "morus" the stage was named the ***morula*** stage. By the time the morula has 32 cells, the ones at the very center might be having a hard time getting enough oxygen. The cells are receiving oxygen (and getting rid of carbon dioxide) by simple diffusion. The cells on the outer edge are getting plenty of oxygen. The ones in the center are in danger of not getting enough. (No cell in our bodies is more than a very short distance from a capillary. That's how many capillaries we have!) Since there are no capillaries yet, this ball of cells must use another strategy. What happens is that it becomes hollow.

The next stage is called the ***blastula*** or ***blastocyst***. ("Blast" means "bud," those things that plants make that turn into flowers and leaves. In this case, the bud will turn into a human being.) The ball becomes hollow and filled with fluid (mostly water). The fluid can flow around and carry oxygen to all the cells.

On approximately day 6 (some charts say day 5) the blastocyst will start to grow and little lump called the ***inner cell mass***. The cells that stay in the outer ring will become a supporting structure called the chorion. These inner cells will differentiate into the placenta, several sacs, and the baby. These inner cells are ***pluripotent cells***. They have undergone a very small amount of differentiation (methylation) but almost all of their DNA is still open. They have many ("pluri") options still open. These are the cells that stem cell researchers like to harvest. ("Stem cells" are cells that have not completely differentiated into a type of body cell. More on stem cells in a future lesson.) Of course, doing this on a human pre-embryo is very controversial. Fortunately, however, the pre-embryos of other mammals (and even some invertebrates such as the sea urchin) can be used for embryology research. In fact, most of what we know about embryology comes from research on non-human embryos.

On day 6 (some charts might say 5 or 7), the embryo finally "hatches" out of the zona pellucida. The cells of the blastula secrete enzymes that soften the zona pellucida, then the blastula has a growth spurt and gets larger very quickly, popping the z.p. The blastula is now free to start growing larger.

It is interesting to note that this first week is pretty much the same for all mammals. This is amazing when you think that a mouse has a gestation period of only 3 weeks. That leaves only 2 weeks to go from the blastula to a baby mouse that has most of the same inner organs that we do! Also, it is interesting to note that some animals (including bears, kangaroos and roe deer) are able to pause gestation at this point and hold the embryo for up to several months until the right season of the year comes around.

Finally, we need to know where this is happening. This whole process takes place in the tube that connects the ovary to the uterus. Ovulation is when an ovum leaves the ovary and gets picked up by the "fingers" of the ***fallopian tube***. The ovum is fertilized by sperm soon after it enters the tube. The sperm must swim all the way up the tube so that only the strongest sperm will survive. This whole first week of development happens as the zygote travels down the fallopian tube towards the uterus. Tiny hairs called ***cilia*** beat in the direction of the uterus, pushing the pre-embryo along. If the cilia are not able to do this fast enough and the pre-embryo gets stuck in the tube, this is called an ***ectopic pregnancy***. ("Ecto" means "outside," in this case meaning outside of the uterus.) This condition is very painful and is life-threatening for the mother. A surgeon must remove the pre-embryo from the tube. Most of the time, the pre-embryo travels down the tube just fine, and enters the uterus on day 5 or 6. It floats around for a while until it bumps into the lining of the uterus and sticks there. When it sticks to the lining of the uterus, it will implant there and begin a new stage of development. If the pre-embryo does not stick anywhere, it will be flushed out of the body when the woman begins to menstruate. (Menstruation is when the temporarily thickened lining dissolves and drains out.) A woman (or any mammal) is not technically pregnant until the embryo implants into the wall of the uterus.