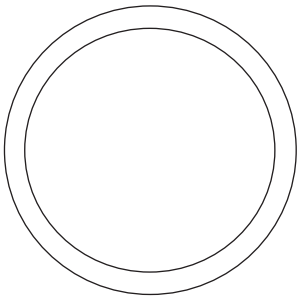
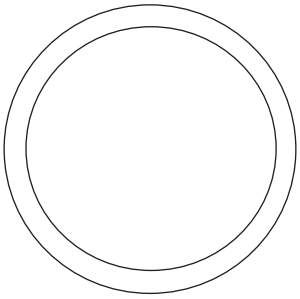
EMBRYOLOGY: WEEK 1 ("Pre-embryo" stage)

The zygote is a TOTIPOTENT cell. ("Toti" means "totally" and "potent" means "powerful or capable.") In what sense is this cell totally powerful? It can turn into ANY type of human cell, even supporting cells such as the placenta and amniotic sac. All the DNA in this cell is open and accessible. None of it is methylated or closed in any way. As the embryo develops, the cells will become less "potent" and will have much of their DNA closed.

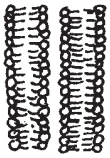
DAY 1

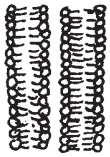


DAY 2



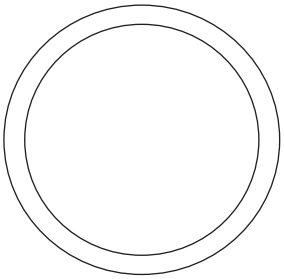
Embryonic cells stick to each other with GAP JUNCTIONS.





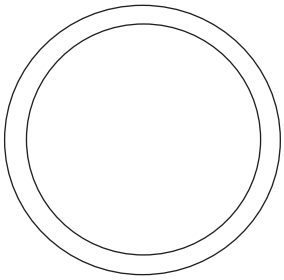
The zygote takes an entire day to make the first division.
This split is called _____.

DAY 2.5



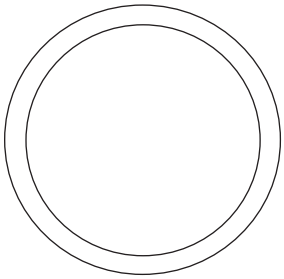
Cells are getting smaller while overall size is staying the same.

DAY 3

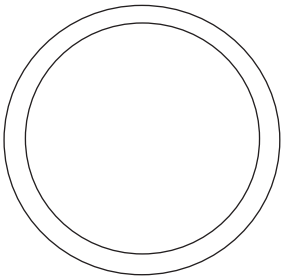


This is a critical stage for unknown reasons. Some embryos don't make it past this stage.

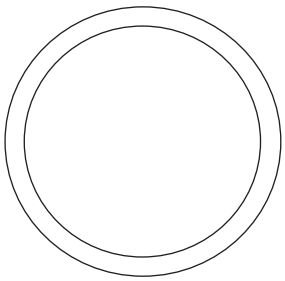
DAY 4



DAY 5



DAY 6



These cells are _____ and are often the ones harvested for use in embryonic stem cell research.

DAY 6 or 7

Blastocyst secretes enzymes that soften the zona pellucida, then it enlarges suddenly and breaks free.

Map of where this is happening:

AMAZING FACT: The first week is the same for ALL placental mammals, regardless of how long the gestation period is. (mice: 3 wks, elephants: 2 yrs)
SECOND AMAZING FACT: Some mammals can pause pregnancy at this stage and hold the embryo for several months, waiting for the right season.

26: EMBRYOLOGY: WEEK 2

At the start of week 2, the pre-embryo implants into the ***endometrium*** (lining of the uterus). Once it implants, it will officially graduate to being called an embryo. The cells of the embryo need an outside source of energy by this point. They have used up most of the energy that was stored by the ovum. (Remember, the ovum had a rich supply of fats and sugar in the cytosol. Also, remember how large the ovum was. The ovum would not have had enough energy to produce hundreds of cells the same size as itself, but since these embryonic cells kept getting smaller and smaller, there was enough energy to go around.)

The embryo needs to tap into the mother's supply of nutrients. Food and oxygen are brought into the uterus by tiny capillaries in the endometrium. (The endometrium also contains glands that produce a temporary supply of nutrients for the embryo.) The mother's capillaries come very close to the embryo, but the mother's blood will never actually touch the embryo. This is good because once the embryo develops a blood supply of its own, it might not be the same blood type as the mother's. Different types of blood (A, B, AB, O and Rh factor) can have bad reactions when mixed. We will learn about blood types in a future lesson.

The side of the blastocyst that touches the endometrium starts growing cells that look like they have little fingers, called ***villi***. These villi quickly begin growing into the endometrium. We call this process ***implantation***. (If the blastocyst was a plant, the villi would be the roots.) Scientists consider implantation to be the official start of pregnancy. And to celebrate, we can stop saying "pre-embryo" and begin using the term "embryo."

The outside "shell" of the embryo is now called the ***chorion***. This word comes from Greek and means "the outer membrane that covers a baby." Since villi are structures we find in other cells of the body, we should really call these villi the ***chorionic villi***. The place where the chorionic villi come very close to the mother's capillaries will grow to become the ***placenta***. It is important to note that the placenta is a combined structure: one half is from the mother and one half is from the baby.

The chorionic villi began secreting digestive enzymes that eat away at the endometrial cells around them. They dissolve a little hole for the embryo to snuggle into, and the endometrium eventually closes in around it. This provides extra security for the tiny embryo. The mother can jog and dance and bounce up and down all she wants to and the embryo is safe.

The chorionic villi have yet another important function. These cells secrete a hormone called ***HCG*** (human chorionic gonadotropin), which acts as a chemical messenger. HCG goes to the ovaries and tells the ovarian cells to secrete a hormone that will prevent the endometrium from being flushed out as it usually is every month. (This hormone is called ***progesterone***. "Pro" means "for" and "gester" means "gestation." Progesterone promotes pregnancy by keeping the endometrium alive and well.) Most pregnancy tests are testing for the presence of HCG in the mother's blood or urine. If the level of HCG is not quite high enough at the time the mother does a pregnancy test, the result might be a "false negative." Pregnancy tests rarely give a "false positive" because if HCG is detected, it most certainly means that there are little chorionic villi producing it. (It's interesting to think that since all cells in the body have identical DNA, then every cell in the body has the information needed to produced HCG. However, as we learned, most information is permanently locked away by methylation. The information needed to make HCG is only opened by these cells at this particular time. DNA has timing mechanisms built into it!)

Now the inner cell mass begins to change. It organizes into two layers called the ***epiblast*** and the ***hypoblast***. (This is called the ***bilaminar disc***.) A cavity begins to grow next to the epiblast and becomes the ***amniotic cavity***, which will eventually give rise to the amniotic sac. On the other side of the hypoblast, another cavity forms, which we call the ***yolk sac***. Obviously, since newborn babies don't have yolk sacs, this structure will be temporary.

A big change comes when the 2-layer disc turns into a 3-layer disc. This process is not shown in the drawing, but is discussed in the video. The cells in the middle of the epiblast begin dividing quickly and then moving (yes, moving) into the space between the two layers, creating a third middle layer.

A space also begins to open up just inside the outer layer, creating a cavity all around what used to be the blastocyst. We call this the ***chorionic cavity***. This is also a temporary structure that will not be seen by the time the baby is born.

The three layers are often called the ***germ layers***. ("Germ," in this sense, means "seed." These are the little "seeds" that will grow into a complete human body.) These layers are like a little stack of pancakes. The top pancake is called the ***ectoderm*** and it will grow into the outer layer of skin (epidermis), hair, nails, and the entire nervous system including the brain. The middle layer is called the ***mesoderm*** and it will become muscles, bones, connective tissue, blood, kidneys, bladder, gonads, heart, lymph system, spleen, and the bottom layer of skin (dermis). The bottom layer is the ***endoderm*** and it will become the inner lining of the digestive tract, the lining of the lungs, the liver and pancreas, and many glands including the thyroid and thymus. (We'll meet the thymus when we study white blood cells in lesson 44.) The formation of the 3-layer germ disc is often referred to as ***gastrulation***.

In the middle of the mesoderm there is a little dot that represents something called the ***notochord***. We will learn more about the notochord in the next lesson.

Cancers are often classified as sarcomas or carcinomas. ***Sarcomas*** occur in body parts that can be traced back to the mesoderm. Most childhood cancers fall into the sarcoma category. ***Carcinomas*** are cancers in tissues that came from the ectoderm or the endoderm. Adults are more likely to get carcinomas. Tumors and other cancers are caused by cells that don't know when to stop dividing. Cancer cells keep dividing and dividing and dividing, and body parts begin to malfunction as a result.

EMBRYOLOGY: WEEK 3

NOTE: In this drawing we will focus on just the 3-layer germ disc. The disc is still inside the chorion, but we won't see the chorion in this drawing. We will see it again in drawing 28.

TOP VIEW OF 3-LAYER DISC:

(1) Notochord and primitive streak
Notochord secretes SHH protein.

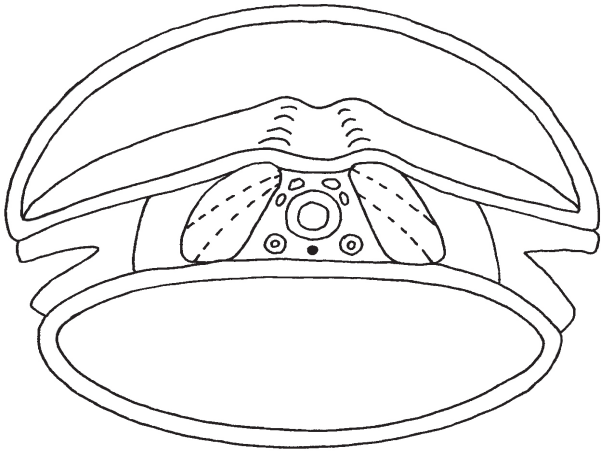
(2) Neural groove forms

(3) Neural tube begins

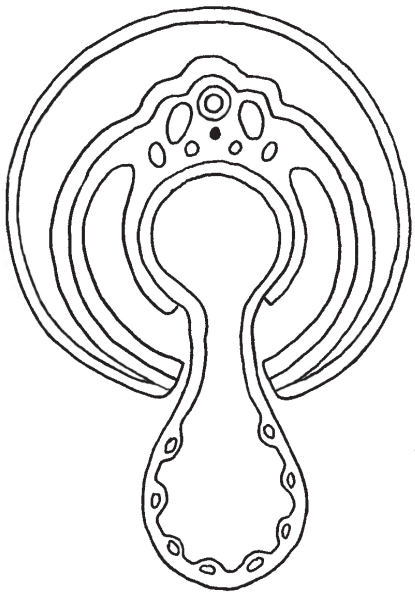
(4) Neural tube will become brain and spinal cord. Neural crests will be peripheral nervous system and more.

(5) Mesoderm begins to differentiate and heart tubes appear

Here we see the 3-layer disc with amnion and yolk sac.

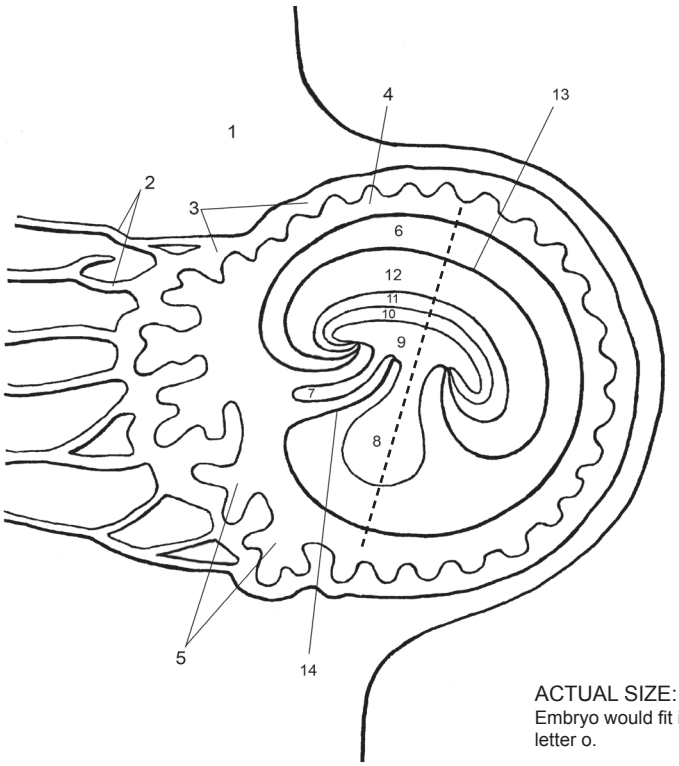


(6) "Somites" appear. (Future spine and associated muscles)
Mesoderm continues to differentiate and the ends split.



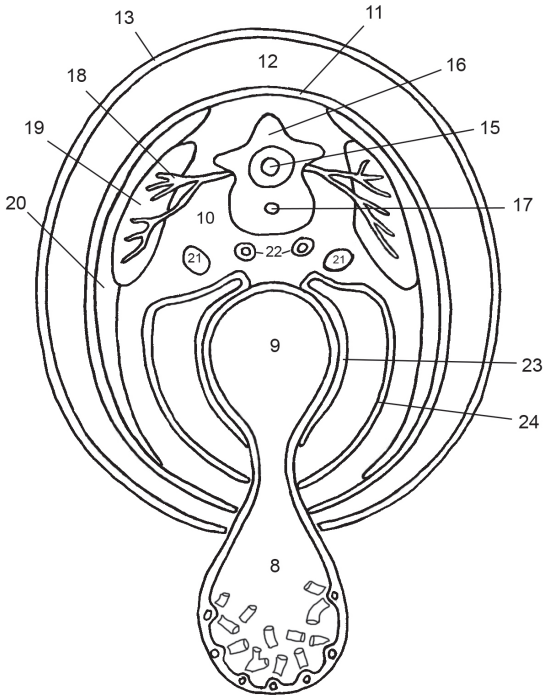
(7) The embryo curls, forming the gut tube and the amniotic sac. Blood islands appear in the yolk sac and will become complete little sections of vessel, with red blood cells already inside.

21 DAYS SAGGITAL CROSS SECTION



ACTUAL SIZE: 1 mm
Embryo would fit into this letter o.

21 DAYS TRANSVERSE CROSS SECTION



1) _____
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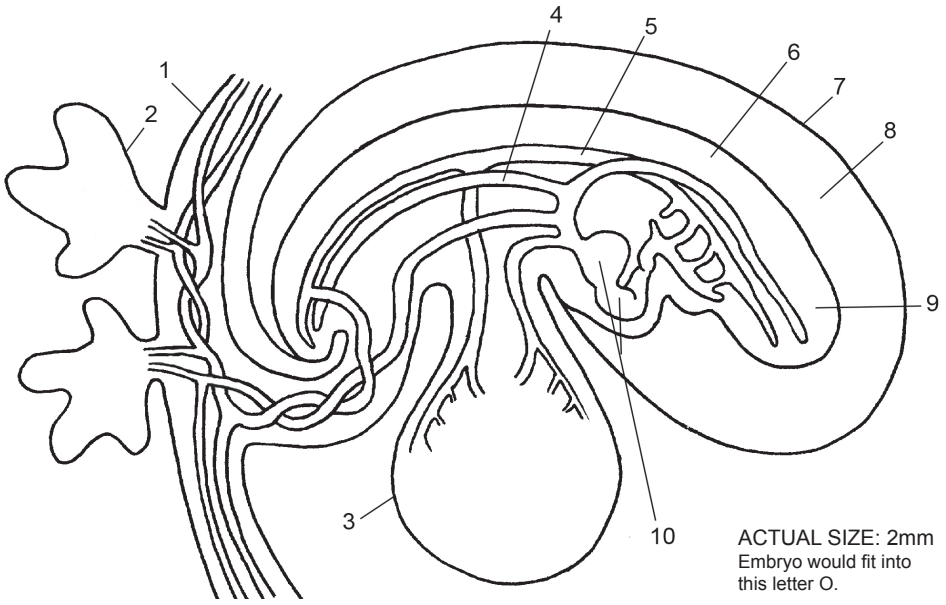

ACTUAL SIZE: 2mm
Embryo would fit into this letter O.

26-28 DAYS
SAGGITAL CROSS SECTION
SHOWING VASCULARIZATION

1) _____
2) _____
3) _____
4) _____
5) _____
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7) _____
8) _____
9) _____
10) _____

END OF WEEK 4 (28 DAYS)
SAGGITAL SECTION

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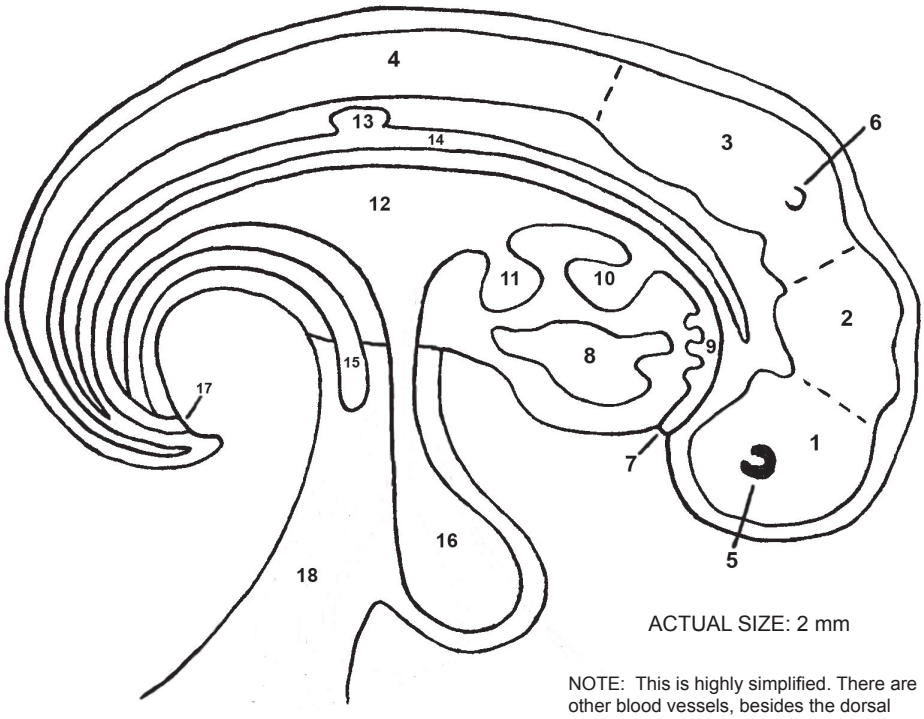

ACTUAL SIZE: 2 mm

NOTE: This is highly simplified. There are other blood vessels, besides the dorsal aorta, but they are not shown. The heart has large vessels coming out of it. There are also tiny vessels connecting to sacs and cord.

END OF WEEK 5 (33-35 DAYS) EXTERNAL VIEW

1) _____
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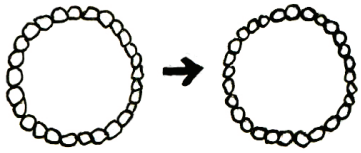
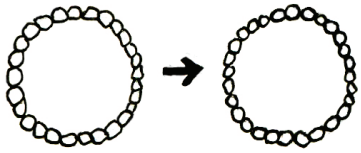
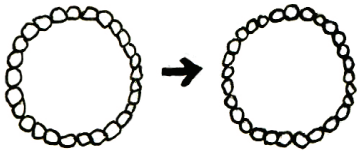
6) _____
7) _____
8) _____
9) _____
10) _____
11) _____
12) _____

TWINS!

Visual	Description	How many amniotic sacs?	How many placentas?	Result
	2 eggs, 2 sperm			
	1 egg, 2 sperm			
	1 egg, 1 sperm Zygote splits during first cleavage			
	1 egg, 1 sperm Morula splits			
	1 egg, 1 sperm Inner cell mass splits			
	1 egg, 1 sperm Bi-layer disc splits			
	1 egg, 1 sperm Bi-layer disc almost splits but not completely			
	2 eggs, 2 sperm Zygotes merge together. (Resulting individual will have 2 genomes.)			
	1 egg, 1 sperm One of the pluripotent cells mutates, then all of its “daughter” cells will carry that mutation.			