

27: EMBRYOLOGY: WEEK 3

In this drawing, we will focus only on the 3-layer “germ” disc. The disc is still inside the chorion (formerly blastocyst) but it will be too complicated to draw the chorion in all of these drawings. This is typical of embryology drawings, though. They often show just the 3 layers developing. So your drawings will match many of those you might see in a text or on the Internet.

First, let’s take a look at the disc from the top. The ectoderm (in blue) is defined as the top layer and the endoderm is then the bottom layer. The bottom layer will eventually curl around to be inside. If the germ disc was already a person, it would be lying on its stomach. The blue layer would be the back (**dorsal** side), and the yellow endoderm would be the stomach (**ventral**) side. Dorsal and ventral are good words to know when studying anatomy. (The word *dorsal* comes from the Latin “dorsum” meaning “back,” and the word *ventral* comes from the Latin word “venter” meaning “belly.”) Not only do we need top and bottom, we also need to determine left and right, and head and feet.

A little streak begins to form at one end of the disc. This is called the **primitive streak** and it is the very beginning of determining the general body plan. (Sometimes they say this already begins while the disc is still in the 2-stage layer.) At the top of the streak is a little place called the **primitive pit** and above that is a place called the **primitive node**. The side with the primitive streak will be the side that eventually turns into the legs and feet. Above the primitive streak is the end that will become the head. And since we now have head and feet, back and stomach, we can imagine the baby lying on its stomach with its head toward the top of the page, so the left and right sides of the body correspond to the left and right sides of the paper. We will now imagine that we have cut a cross section through the disc and we will look at the inside.

(1) This picture shows the three layers with the **notochord** dot in the middle of the mesoderm. The notochord area will be the “foreman” of the body building process and will tell the other cells where to go and what to become. The notochord secretes a protein called **SHH** that acts as a chemical messenger telling the other cells what to do. **SHH** stands for **Sonic HedgeHog**. Yes, the cartoon character. When this protein was first discovered, they collected some of it and then put it into a fruit fly embryo to see what would happen. The fly ended up being covered with long spikes, like a hedgehog. The cartoon character called Sonic the Hedgehog happened to be popular at that time, so the scientists couldn’t resist using the name. Then they found other similar proteins, and classified all of them as “hedgehog” proteins. There’s Desert HH, and Indian HH, named after species of real hedgehogs.

(2) The SHH tells cells in the primitive streak to form a groove (the **primitive groove**). This is often called the **neural groove** because it will become the **neural tube**.

(3) The neural groove deepens and begins rolling into a tube. The process of forming the neural tube is called **neurulation**. (So we’ve got blastulation, then gastrulation, then neurulation.)

(4) The **neural tube** separates from the top layer so that it is embedded in the mesoderm. The cells that were in the top of the fold, (the “crest” of the fold) now migrate down toward the neural tube and are called the **neural crest cells**. They will develop into various type of cells, but mainly they will become nerves and nerve bundles (**ganglia**) in places such as between the spinal vertebrae, in the digestive system, around the heart, and in the head and face. Some of these cells will turn into connective tissues and bones in and around these nerve centers, including the tiny bones of the inner ear. Oddly enough, a few neural crest cells will decide not to become nerves at all and will become **melanocytes**, pigment-producing cells in the bottom layer of the skin. A **neural plate** now becomes visible on the top of the ectoderm. This is the area where the spine forms.

If the neural tube does not close up all the way, but remains open at some point, (like in picture 3), various birth defects will occur. The most well-known of these defects is **spina bifida**. Part of the soft spinal cord never gets covered with protective bone, so the baby is born with what looks like a soft lump on its back. Corrective surgery can be done to try to correct this problem, but the child can still have lasting health issues due to this defect. We know that a lack of **folic acid** (in the B vitamin family) can cause this birth defect. Pregnant women are encouraged to take vitamin supplements that have a high level of folic acid.

(5) Bumps called **somites** begin to appear and the neural plate continues to grow. The somites have areas that will differentiate into the dermis, muscle, and bone of the spine and rib cage. We also see the beginnings of the heart tubes. The heart begins as two tubes that eventually join together. The ends of these tubes will become the large blood vessels on the top and bottom of the heart.

(6) The ends of the mesoderm begin to split, with the top part destined to become an outer “bag” around the organs (made of connective tissue and called the peritoneum), and also appendages (arms and legs). The bottom part becomes all the connective tissues “bags” that will surround the organs in the body cavity.

(7) The disc begins to curl (**embryonic folding**), with the yellow endoderm layer forming the **gut tube** (which will turn into the inner layer of the digestive system). The inside of the yolk sac begins to grow little clumps of cells called blood islands. Each island will turn into a piece of blood vessel, complete with blood cells already inside them. Then the tiny pieces will join up to form a network. The network will grow and then spread into the embryo, joining with other blood vessels that are starting to develop in and around the heart and kidneys. The yolk sac will eventually shrink and disappear.