

Chapter 6

Neurulation

6.1. Amphian Tubulation and the Neurula Stage

Tubulation is the process of tube formation which occurs in several tissues as gastrulation is completed. During tubulation the endoderm moves up along the sides to form a tube, the gut, and the mesoderm moves between the endoderm and ectoderm. As tubulation is completed the embryo is now at the neural plate stage (neurula) and is ready for the formation of the primary organ rudiments.

The endoderm has now moved up over the roof of the archenteron and connected to make an enclosed tube. The prospective notochord forms a dorsal rod, the notochord. The mesoderm on both sides of the notochord pinches off into separate segments called somites. The somites are separate from each other and from the notochord, but remain connected to the lateral mesoderm by a strand of cells known as the **stalk of the somite**. The lateral and ventral mesoderm does not segment into somites and is known as the lateral plates. These lateral plates split down the middle into two layers:

1. the layer on the outside next to the ectoderm is the parietal layer (somatic mesoderm).
2. the layer on the inside, next to the gut, is the visceral layer (splanchnic mesoderm).
3. The cavity between these layers is the coelom.

So far we have described tubulation for the endodermal gut and for the formation of the coelom from the lateral plates. The neuroectoderm & ectoderm also undergo tubulation.

6.2. Formation of Neural Plate

The formation and closing of the **neural plate** is called **neurulation**. The embryo during the time it has the neural plate is referred to as the **neurula**. The neuroectoderm sits atop the notochord and somites, the prechordal plate and the foregut endoderm. This neuroectoderm thickens and becomes known as the neural plate. The edges of the neural plate further thicken to form ridges (neural folds) and a furrow (the neural groove) appears longitudinally down the center of the neural plate. The neural folds move up toward each other and eventually meet, while the neural groove becomes deeper, resulting in the formation of the **neural tube**. The ectoderm forms a continuous sheet over the neural tube, The neural tube becomes the **brain** and **spinal cord**. The hollow center of the neural tube remains as the **ventricles** of the brain and the **central canal** of the spinal cord. The neural tube is broadest at the anterior end, where it will become the brain, and narrows at the posterior end, where it will become the spinal cord.

At the crests of the neural folds are some special cells. Collectively these cells are referred to as the **neural crest**. At the closure of the neural tube these cells are left between the ectoderm and neural tube. The cells of the neural crest play a vital role in the development of numerous structures, as will be discussed later.

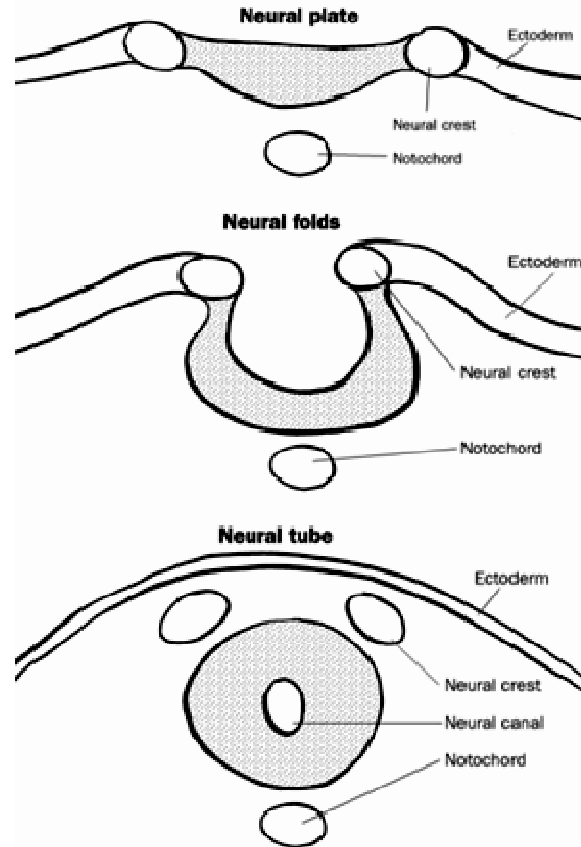


Fig. 6.1. Neurulation

Metazoan Animals can be divided into Deuterostomes and Protostomes. In **Protostomes** (*Gk. first + mouth*) the mouth forms at or near the blastopore. In **Deuterostomes** (*Gk. second + mouth*) the anus forms at or near the blastopore and the mouth forms from a new, second opening. In *anurans* (frogs & toads) the blastopore closes and the anus forms from a new opening slightly below the old blastopore, but in *Urodeles* (salamanders) the anus forms directly from the blastopore. During neurulation the embryo has been elongating antero-posteriorly and compressing laterally. Above the blastopore, an outgrowth (the **tail bud**) forms, which becomes the rudiment of the tail of the tadpole.

6.3. Chick Tubulation

As Chick development proceeds the neural plate forms the neural tube and the general body ectoderm (epidermis) closes over the top of the neural tube. The somites form on both sides of the notochord. The lateral plate mesoderm splits into an upper **parietal (or somatic)** layer and a lower **visceral (or splanchnic)** layer, forming the **coelom** in between. With further development the primary organ rudiments begin to form. The mesoderm forms the notochord, somites, the nephrotomes (primary kidney) lateral plates, and the major blood vessels. The cavity of the gut begins to form by the folding of the endoderm. Initially, the gut forms a tube only in the anterior & posterior portions leaving the midgut open and continuous with the underlying yolk which is surrounded by the yolk sac. The **anterior and posterior intestinal portals** are the openings from the midgut into the closed foregut and hindgut, respectively.