

Chapter 12

Development of Endodermal Organs

The tube-shaped endoderm develops into the pharynx, the respiratory organs, the gut and the digestive glands (liver, gall bladder, pancreas).

12.1. Gut Formation Review

In the vertebrates which have holoblastic cleavage (*viz. cyclostomes, ganoid fishes, lungfish, and amphibians*) the roof of the archenteron is mesodermal and the floor is endodermal. The endoderm then moves up & fuses dorsally, forming an enclosed tube, the gut. In birds and mammals, the roof of the gut rests directly on the yolk sac cavity. The roof at the anterior end then moves ventrally and unites mid-ventrally forming a closed tube. The edge where the closed **foregut** leads into the open portion of the gut is the **anterior intestinal portal**. Similarly, the **hindgut** closes by moving in an anterior direction. It starts later and is smaller than the foregut. The edge where the closed hindgut leads into the open portion of the gut is the **posterior intestinal portal**. The **midgut** is the portion of the gut which opens into the yolk sac cavity. It becomes smaller as the two intestinal portals advance toward each other. Eventually the opening between the gut cavity and yolk sac cavity becomes reduced to the narrow yolk stalk.

12.2. The Development of Gut (Alimentary Canal)

The **gut (alimentary canal)** in the vertebrates undergoes differentiation into regions (*mouth, pharynx, esophagus, stomach, large & small intestines*). It does this by folding and by constricting in some areas and expanding in others.

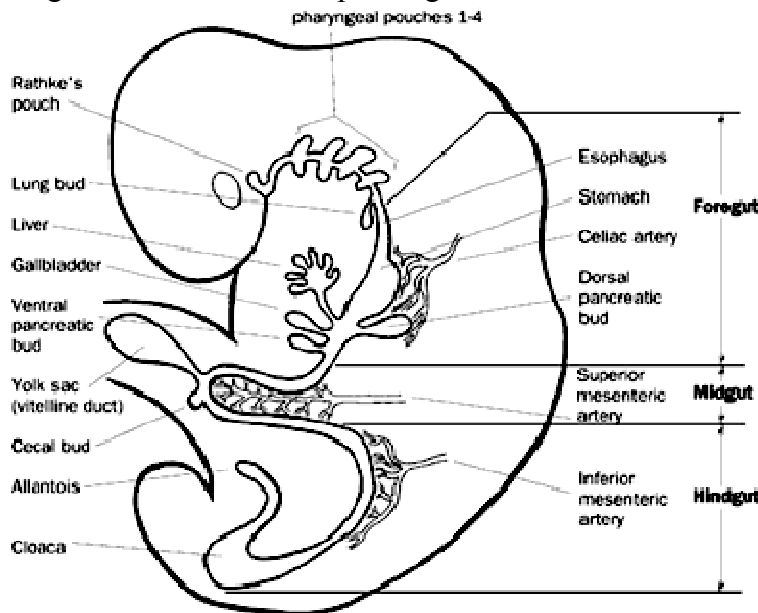


Fig.12.1. Primitive Digestive Tract

The variety in vertebrate alimentary canals is considerable. The foregut and hindgut are at first blind pouches with no **exterior openings**. The **mouth** opening appears relatively late in development. The front of the foregut makes contact directly with the ectoderm; there is no mesoderm between them in that region. Where the foregut contacts the ectoderm, the ectoderm invaginates forming a pit-like depression called the **stomodeum**. The ectodermal epithelium fuses with the endodermal epithelium to form the **oropharyngeal membrane**, which later perforates allowing the mouth to communicate with the exterior. Therefore, most of the mouth is lined with ectoderm which blends into the endodermal lining of the rest of the gut. The **anus** perforates in a similar manner, with the formation of a **proctodeum** (instead of a stomodeum). Thus, part of the rectum lining is ectodermal.

12.3. Endoderm-Lined Organs

Several **endoderm-lined organs** form as diverticula from the gut. Usually, the organ tissue (surrounding the endodermal ducts) is made from mesenchyme. In the pharyngeal region, a series of evaginations appear, which bulge toward the exterior. These are the **pharyngeal (branchial) pouches**. As the pharyngeal pouches approach the ectoderm, corresponding **pharyngeal (branchial) grooves (or clefts)** appear on the exterior surface of the embryo. Where the endodermal pouches and ectodermal grooves meet they fuse to form the **branchial membranes**. When the branchial membranes perforate they form **gill slits**, which open to the outside. In aquatic animals, gill filaments form on the gill clefts. In the **amniotes**, **4 pair of pharyngeal pouches** form but do not function in respiration. The first 3 pair open to the exterior and then quickly close again. The 4th pair remain closed.

1. The **1st pair** of pharyngeal pouches becomes the **auditory (eustachian, pharyngotympanic) tubes**, which connect the pharynx and middle ear.
2. The **2nd pair** develop into the **palatine tonsils**.
3. The **3rd pair** give rise to the **thymus and two parathyroid glands**.
4. The **4th pair** give rise to **two parathyroid glands** and the **ultimobranchial bodies**, made of C (clear) cells, which secrete the hormone, **calcitonin**.

In mammals, the C cells migrate to the thyroid gland and spread out between the follicles (interfollicular tissue).

The **thyroid gland** develops as a ventral evagination from the floor of the pharynx. The **liver** develops from an evagination from ventral side of the duodenum. This evagination gives rise to the liver and remains attached to the duodenum as the **bile duct**. The pancreas develops from dorsal & ventral evaginations from the duodenum. These remain separate in the dogfish, but in amphibians and amniotes they fuse to form a single pancreas. The **pancreatic duct** attaches to the duodenum, ventrally.

12.4. Development of Respiratory Organs

Just posterior to the branchial region, the **lungs** develop from a ventral evagination of the alimentary canal. The evagination bifurcates repeatedly forming the **trachea, bronchi, bronchioles, and alveoli**. The remainder of the lung tissue is derived from mesenchymal mesoderm.