Development of digestive system

The primitive gut tube (fig 1) is formed from the incorporation of the **dorsal part of the yolk sac** into the embryo as a result of the **craniocaudal folding** and **lateral folding** of the embryo. The primitive gut tube extends from the **oropharyngeal membrane** to the **cloacal membrane** and is divided into the **foregut, midgut, and hindgut**.

Histologically, the general plan of the adult gastrointestinal tract consists of a mucosa (epithelial lining and glands, lamina propria, and muscularis mucosae), submucosa, muscularis externa, and adventitia or serosa. Embryologically, **the epithelial lining and glands of the mucosa are derived from endoderm**, whereas the **other components are derived from visceral mesoderm**. Early in development, the epithelial lining the gut tube proliferates rapidly and obliterates the lumen. Later, recanalization occurs.

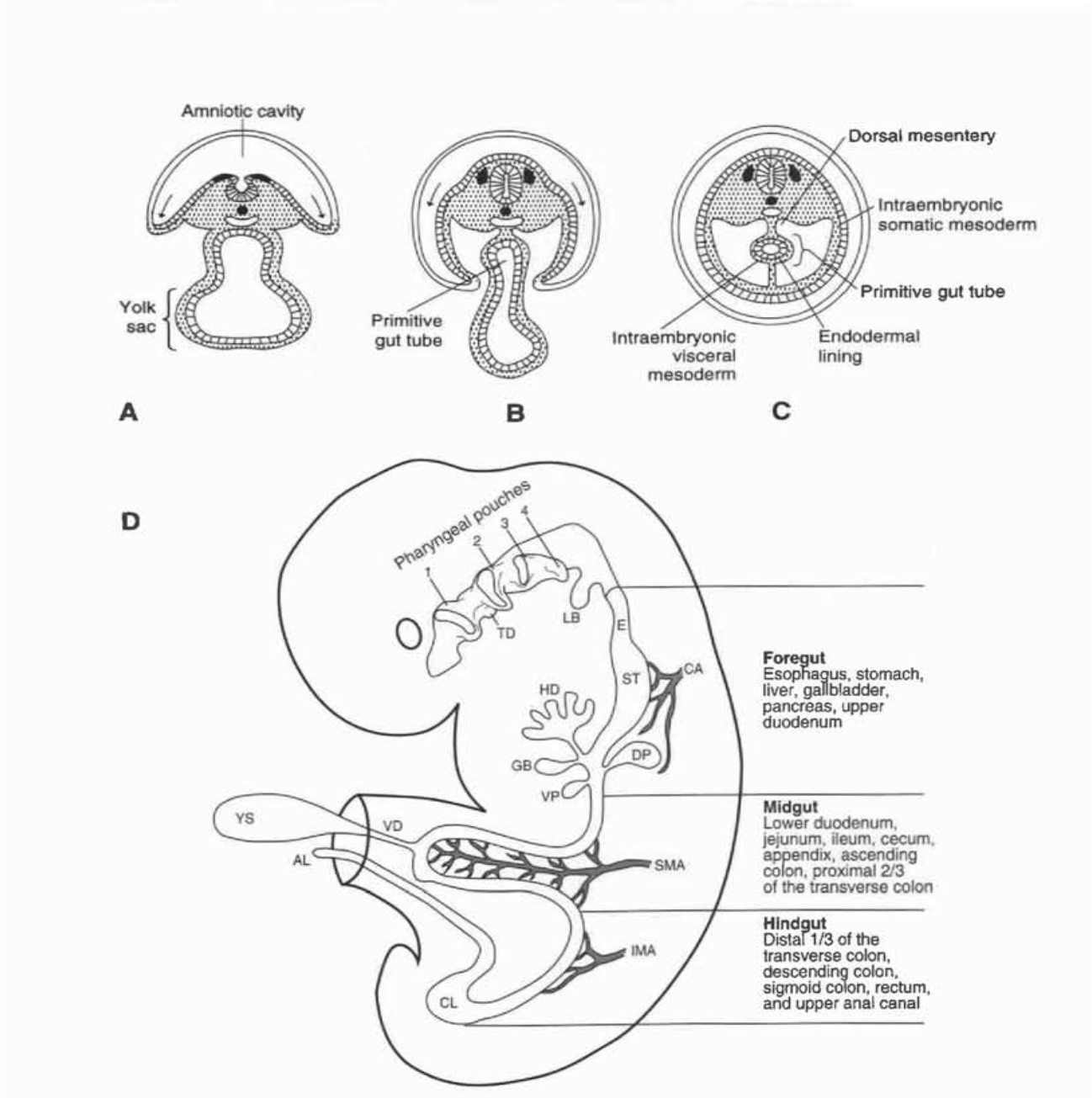


Figure 1. (A, B, C) Cross sections of an embryo showing the formation of the primitive gut tube. (D) Development of gastrointestinal tract showing the foregut, midgut, and hindgut along with the adult derivatives. The entire length of the endodermal gut tube is shown from the mouth to the anus. The fates of the lung bud (LB), pharyngeal pouches *(1, 2, 3, 4),* and thyroid diverticulum (TD) are covered in later chapters. *AL* = allantois; CA = celiac artery; *CL* = cloaca; *DP* = dorsal pancreatic bud; *E* = esophagus; *GB* = gallbladder; *HD* = hepatic diverticulum; *IMA* = inferior mesenteric artery; SMA = superior mesenteric artery; ST = stomach; *VD* = vitelline duct; *VP* = ventral pancreatic bud; YS = yolk sac. (E) Diagram showing the general plan of histologic and embryologic organization of the adult gastrointestinal tract

I - Derivatives of the Foregut

A. Esophagus

1. **Development.** The foregut is divided into the esophagus dorsally and the trachea ventrally by the tracheoesophageal folds, which fuse to form the tracheoesophageal septum. The esophagus is initially short but lengthens with descent of the heart and lungs. During development, the endodermal lining of the esophagus proliferates rapidly and obliterates the lumen; later recanalization occurs (fig 2).

2. Sources. The stratified squamous epithelium, mucosal glands, and submucosal glands of the definitive esophagus are derived from endoderm. The lamina propria, muscularis mucosae, submucosa, skeletal muscle and smooth muscle of muscularis externa, and adventitia of the definitive esophagus are derived from visceral mesoderm.

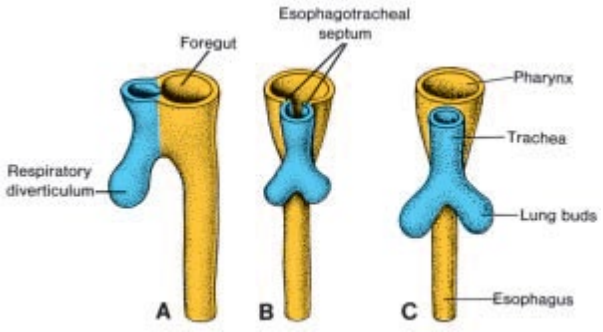


Figure 2 Successive stages in development of the respiratory diverticulum and esophagus through partitioning of the foregut. **A.** At the end of the third week (lateral view). **B** and **C.** During the fourth week (ventral view).

B. Stomach

1. **Development**. A fusiform dilatation forms in the foregut in week 4; this gives rise to the primitive stomach. The dorsal part of the primitive stomach grows faster than the ventral part, resulting in the greater and lesser curvatures, respectively. The primitive stomach rotates 90° clockwise around its longitudinal axis. The 90° rotation affects all foregut structures and is responsible for the adult anatomic relationship of foregut viscera(fig 3)

2. Sources. Surface mucous cells lining the stomach, mucous neck cells, parietal cells, chief cells, and enteroendocrine cells comprising the gastric glands of the definitive stomach are derived from endoderm. The lamina propria; muscularis mucosae; submucosa; the outer longitudinal, middle circular, and inner oblique layers of smooth muscle of the muscularis externa; and the serosa of the definitive stomach are derived from visceral mesoderm.

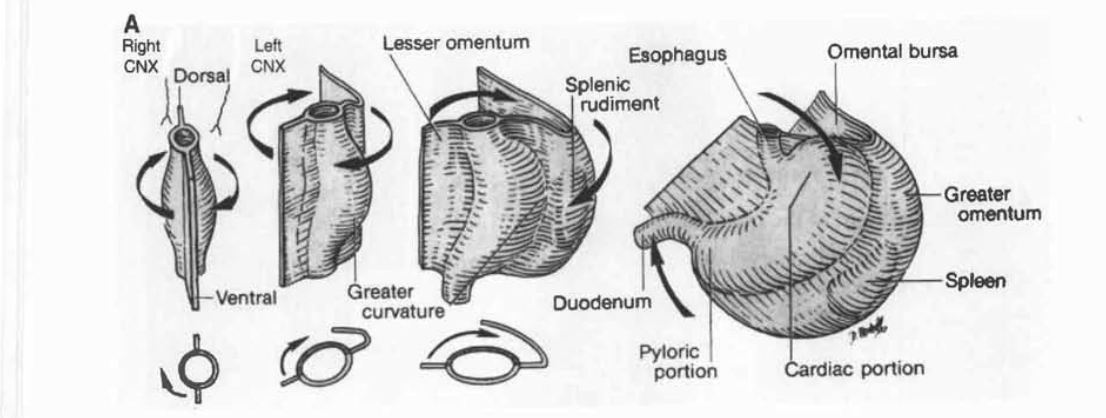


Figure 3: Diagram depicting the development and 90° rotation of the stomach from week 4 through week 6.

C. Liver

1. Development: The endodermal lining of the foregut forms an outgrowth (hepatic diverticulum) through induction by fibroblast growth factors. The hepatic diverticulum sends hepatic cell cords into the surrounding mesoderm called the septum transversum. As the liver bulges into the abdominal cavity, the septum transversum is stretched to form the ventral mesentery. The septum transversum also plays a role in the formation of the diaphragm, which explains the close adult anatomic relationship of the liver and diaphragm (fig 4)

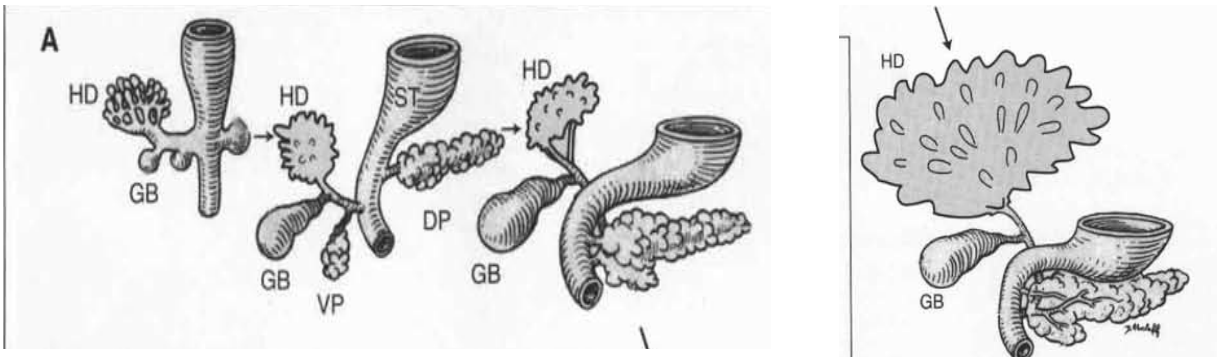


Figure 4 Sequence of events in the development of the hepatic diverticulum *(HD)* and gallbladder rudiment *(GB)* from week 4 through week 7. *DP* = dorsal pancreatic bud; *ST* = stomach; *VP* = ventral pancreatic bud.

D. Gallbladder and extrahepatic bile ducts

1. Development. The connection between the hepatic diverticulum and the foregut narrows to form the bile duct. An outgrowth from the bile duct gives rise to the gallbladder rudiment and cystic duct. The cystic duct divides the bile duct into the common hepatic duct and common bile duct.

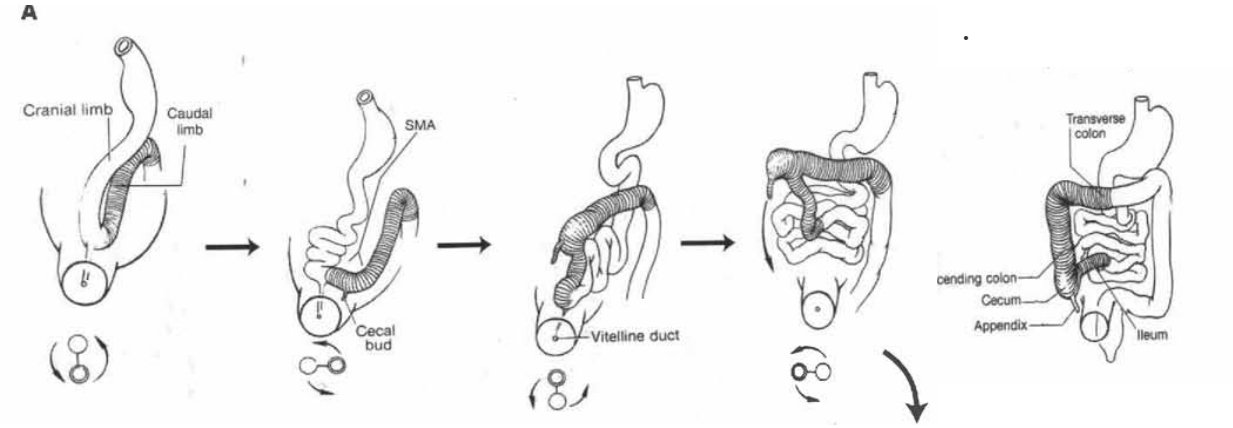
E. Pancreas (Figure 4)

1. The ventral pancreatic bud forms the uncinate process(having a hooked shape) and part of the head of the pancreas. The dorsal pancreatic bud forms the remaining part of the head, body, and rail of the pancreas. Acinar cells, duct epithelium, and islet cells are derived from endoderm.

II .Derivatives of the Midgut (Figure 5)

A- Lower duodenum: The lower duodenum develops from the **cranial portion** of the midgut.

B- **Jejunum, ileum, cecum, appendix, ascending colon, and proximal two thirds of the transverse colon**. The midgut loop consists of a cranial limb and a caudal limb. The cranial limb forms the jejunum and upper part of the ileum. The caudal limb forms cecum and appendix, lower part of the ileum, ascending colon, and proximal two thirds of the transverse colon.



(Figure 5)

III - Derivatives of the Hindgut

A. Distal third of the transverse colon, descending colon, sigmoid colon

The cranial end of the hindgur forms the distal third of the transverse colon, descending colon, and sigmoid colon.

B. Rectum and upper anal canal

The terminal end of the hindgut is a pouch called the cloaca. The cloaca is partitioned by the urorectal septum into the rectum, upper anal canal, and urogenital sinus.

IV - Anal Canal: The upper anal canal develops from the hindgut. The lower anal canal develops from the proctodeum, which is an invagination of surface ectoderm caused by a proliferation of mesoderm surrounding the anal membrane.

V - Mesenteries

The primitive gut tube is suspended within the peritoneal cavity of the embryo by the ventral mesentery and dorsal mesentery, from which all adult mesenteries are derived.