Harvard-MIT Division of Health Sciences and Technology

HST.121: Gastroenterology, Fall 2005

Instructors: Dr. Jonathan Glickman

Overview of Gastrointestinal Embryology

The Primitive Gut

- The primitive gut forms during the 4th week of gestation when the flat embryonic disc folds in median and horizontal planes to form a tubular structure that incorporates part of the yolk sac into the embryo

- Ventral folding of lateral sides forms the midgut

- Ventral folding of cranial and caudal ends (head and tail folds) form the foregut and the hindgut

Folding of the Embryonic Disc

Figure removed due to copyright reasons. Please see:

Moore, Keith L., and T. V. N. Persaud. *The Developing Human: Clinically Oriented Embryology*. Philadelphia, PA: W.B. Saunders Company, 1998. ISBN: 0721669743.

Formation of human gastrointestinal tract (A)

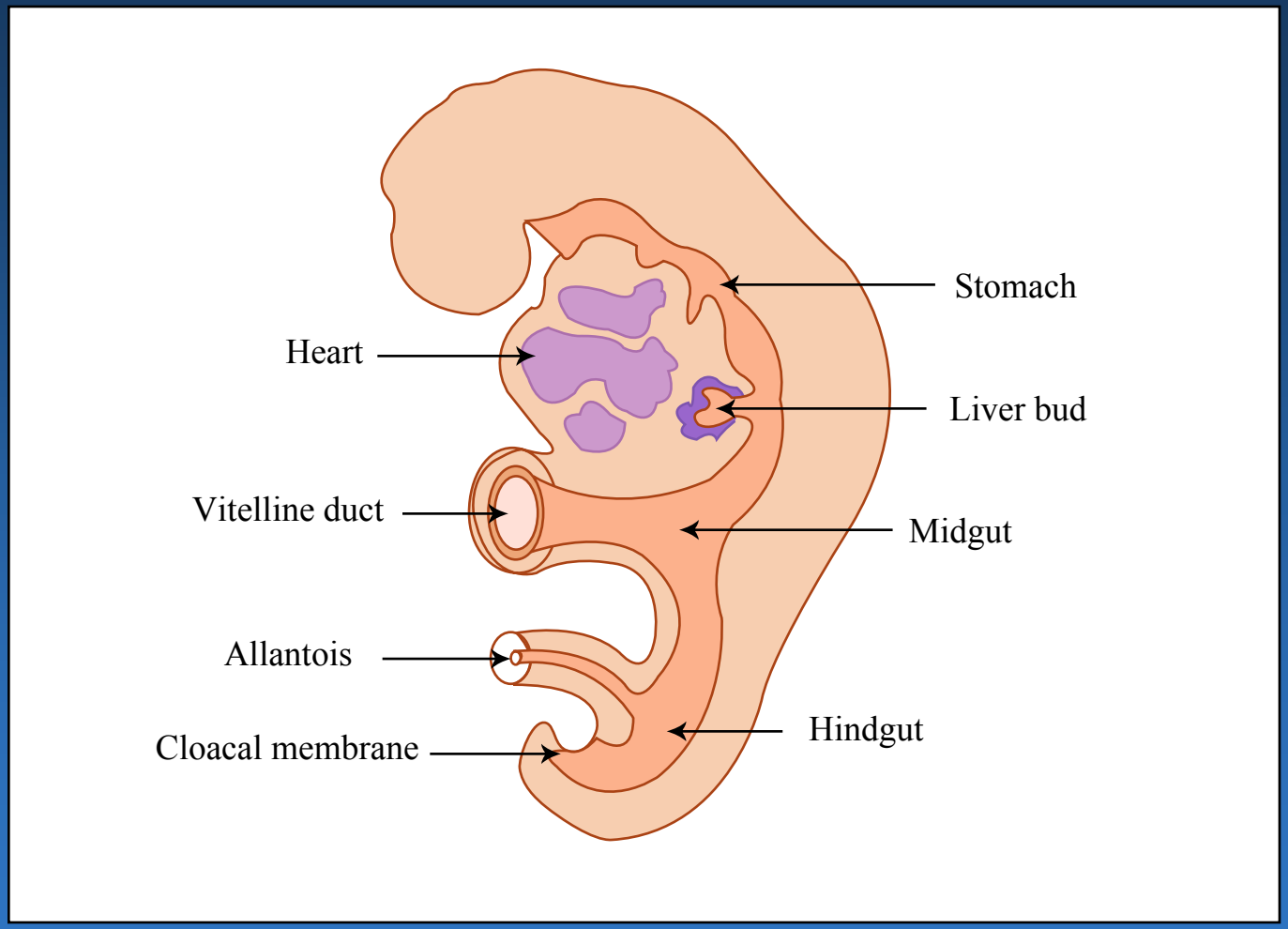


Image by MIT OCW.

The Foregut

- The foregut gives rise to the:
  - Pharynx
  - Lower respiratory system
  - Esophagus
  - Stomach
  - Proximal duodenum
  - Liver and the biliary tree
  - Pancreas

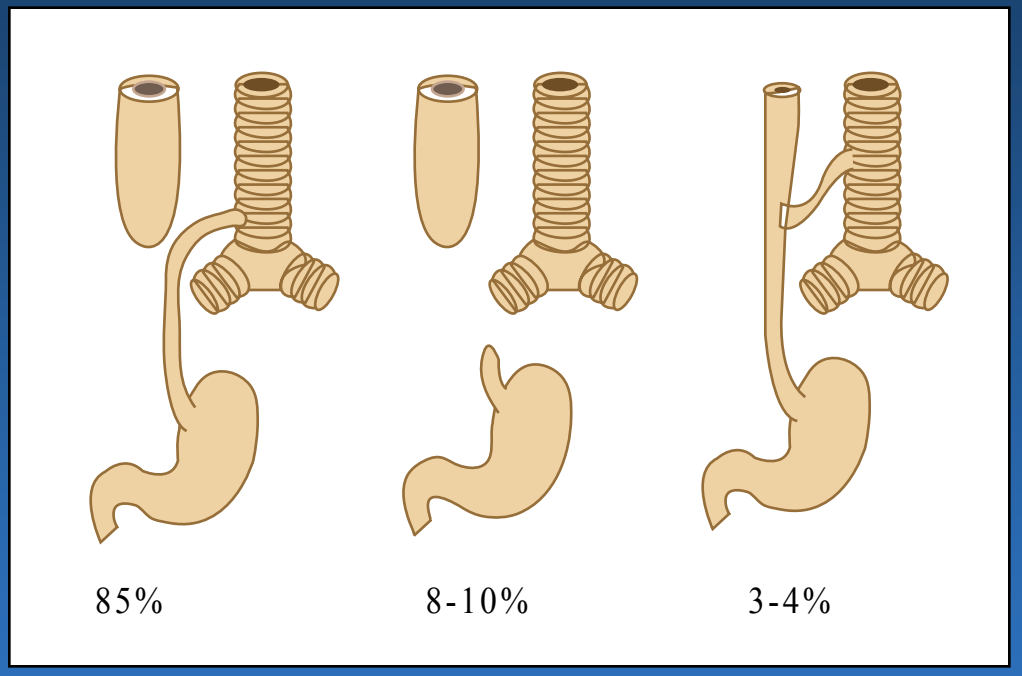
Partitioning of the foregut by the tracheoesophageal septum

Figure removed due to copyright reasons. Please see:

Sadler, Thomas W. *Langman's Medical Embryology*. 6th ed. Philadelphia, PA: Lippincott Williams & Wilkins, 1990. ISBN: 0683074938.

Errors of the Foregut Development

Errors in partitioning of the laryngo-tracheal tube from the esophagus by the tracheo-esophageal septum result in various forms of esophageal atresia and tracheo-esophageal fistulas or *EA/TEF* (1 in 3000-4500 live births, M>F)



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Tracheoesophageal fistula

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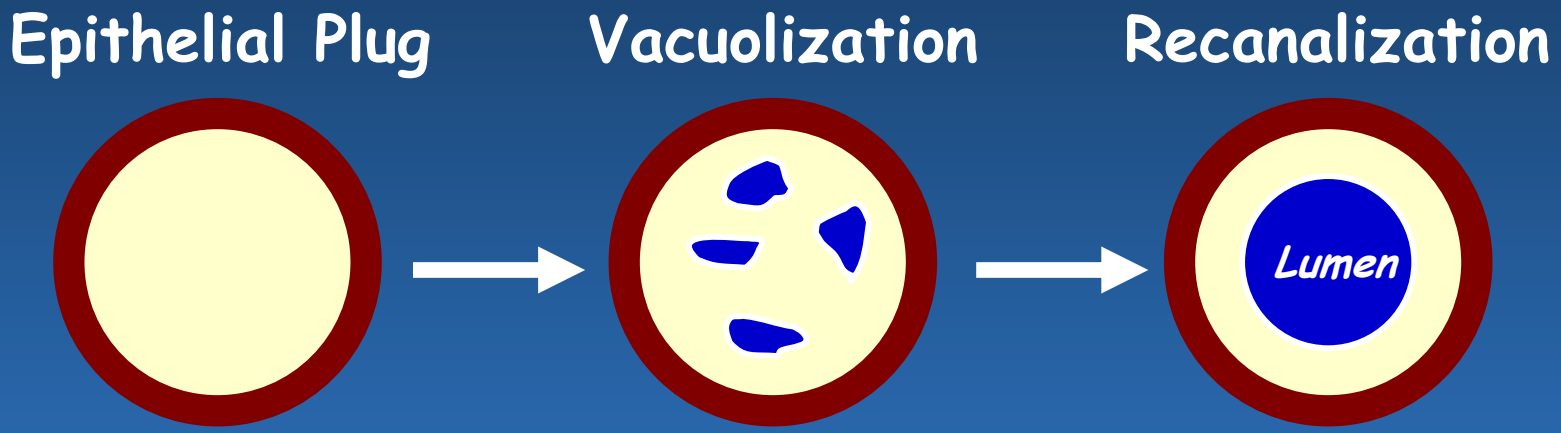
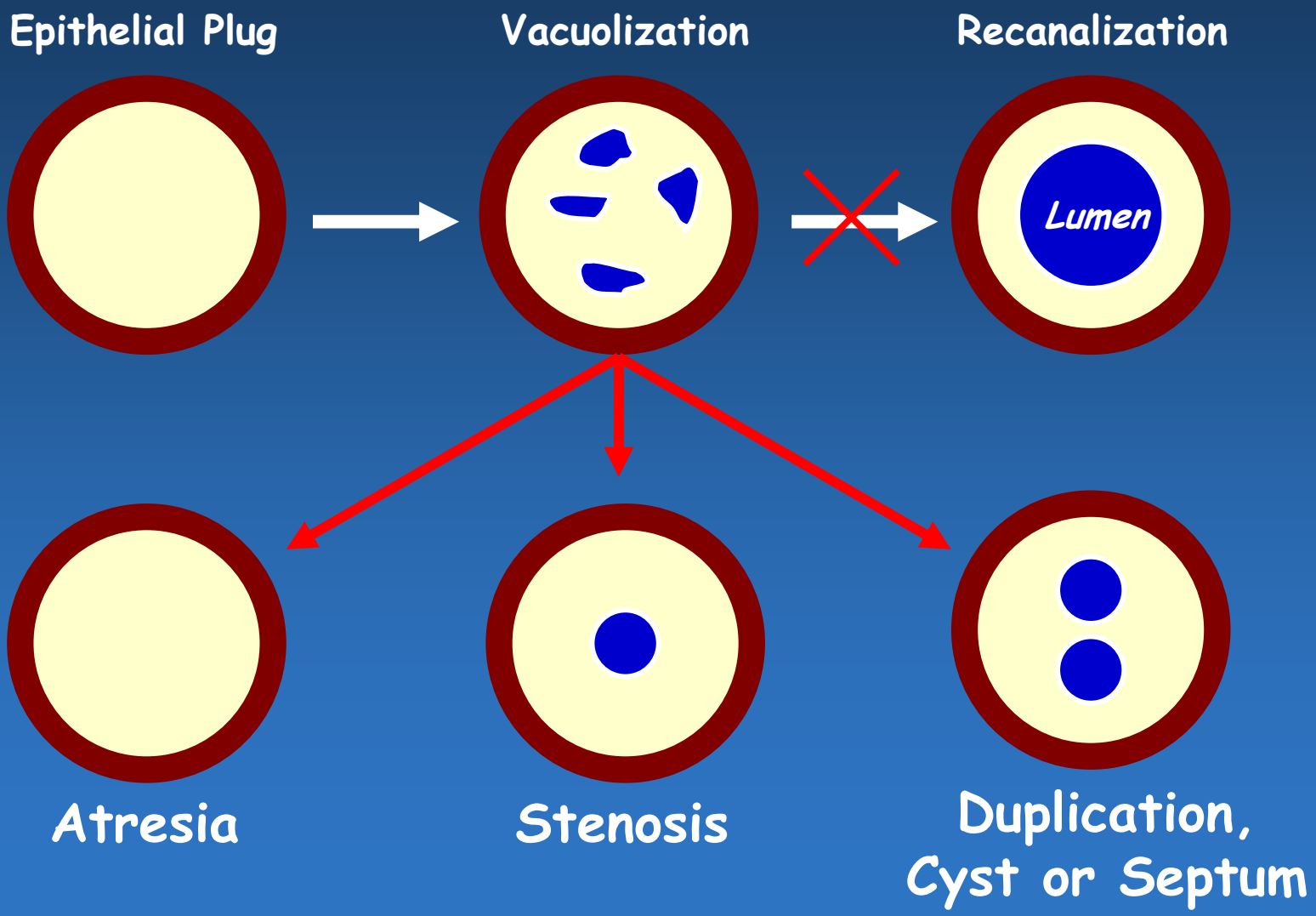
Development of the Lumina



Abnormal Development of the Lumina



Jejunoileal atresia

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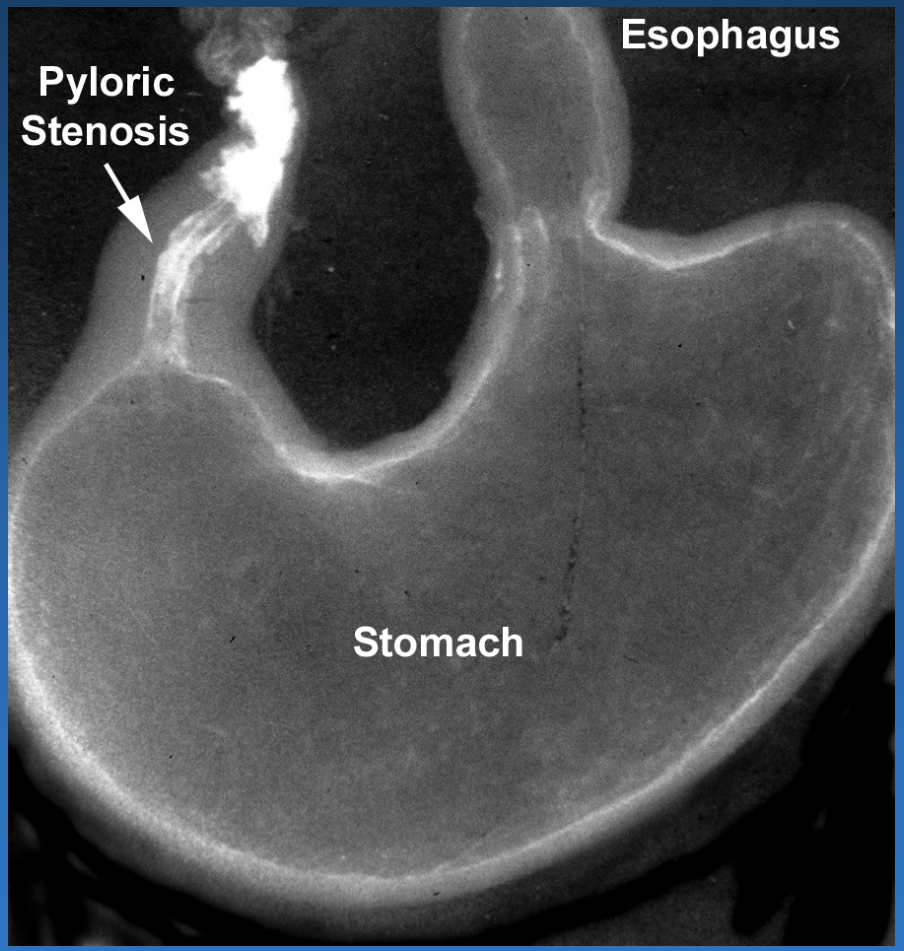
Congenital Hypertrophic Pyloric Stenosis



Errors of the Foregut Development

- ***Congenital Hypertrophic Pyloric Stenosis*** **is the most common congenital anomaly of the stomach and occurs in 1-8:1000 live births with a 4-6:1 M:F ratio**

- **Pyloric stenosis is a multifactorial and progressive disease that classically presents with non-bilious projectile vomiting in the first few weeks of life**

The Liver and the Pancreas

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Errors in Pancreatic Development

- Annular pancreas
- Pancreas divisum
- Ectopic pancreatic tissue

The Midgut

- The midgut gives rise to:
  - Distal duodenum
  - Jejunum and ileum
  - Appendix
  - Ascending colon
  - Proximal transverse colon

Epithelial cytodifferentiation

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Intestinal epithelial differentiation

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The Midgut Rotation

- The midgut forms a U-shaped loop that herniates into the umbilical cord during the 6th weeks of gestation
- While in the umbilical cord, the midgut loop rotates 90 degrees
- During the 10th week of gestation, the midgut loop returns to the abdomen, rotating an additional 180 degrees

Errors in Midgut Rotation

Anything can happen, but it usually doesn't!

Errors in Midgut Development

- ***Omphaloceles*** **result from failure of the intestines to return to the abdominal cavity**

- ***Umbilical hernias*** **occur when intestines do return to the abdomen, but later herniate through the umbilicus**

- ***Gastroschisis*** **is a linear defect of the abdominal wall that permits extrusion of the viscera *without* involving the umbilicus**

Infant with gastroschisis

Image removed due to copyright reasons.

Infant with omphalocele

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DIFFERENCES BETWEEN GASTROSCHISIS AND OMPHALOCELE

	Gastroschisis	Omphalocele
Maternal age	Younger	Older
Associated anomalies	10% (usually intestinal atresia)	50% (structural and chromosomal)
Sac covering abdominal contents	No	Yes
Liver out through abdominal wall defect	No	Often
Intestinal dysfunction (hypomotility and malabsorption)	Yes	No

Remnants of the omphalomesenteric duct (yolk stalk) are found in 1-4% of infants, making them the most common congenital anomaly of the GI tract

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Meckel's Diverticulum

- Meckel's or ileal diverticulum accounts for up to 80% of omphalomesenteric remnants
- Typical Meckel's diverticulum measures 3-5 cm, and is located in the anti-mesenteric wall of the ileum 40-50 cm from the ileocecal valve
- Most symptomatic cases present in childhood
- The M:F incidence ratio is ~1, but there is a 3:1 M:F ratio in clinically symptomatic cases

The Hindgut

- **The hindgut gives rise to:**
  - **Distal transverse colon**
  - **Descending colon, sigmoid, and rectum**
  - **Proximal anal canal (superior to the pectinate line)**

- **The caudal part of the hindgut known as the *cloaca*, is divided by the urorectal septum into the urogenital sinus and the rectum**

Partitioning of the Cloaca by the Urorectal Septum

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Errors in Hindgut Development

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Philadelphia, PA: W.B. Saunders Company, 1998. ISBN: 0721669743.

Hirschsprung's Disease

- **HD is the partial or total absence of autonomic ganglia resulting from failure of migration of the neural crest cells into the colonic wall during 5th-7th week of gestation**
- **With an incidence of 1 in 5000 liver births, HD is the most common cause of neonatal colonic obstruction, and can result in *congenital megacolon***
- **HD has been associated with several genetic abnormalities including Trisomy 21, mutations of the RET gene and the endothelin receptor type B gene**

Intraoperative photograph of Hirschsprung's disease

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Hirschsprung's Disease

Figure removed due to copyright reasons. Please see:

Fenoglio-Preiser, Cecilia M., et al. *Gastrointestinal Pathology*. Philadelphia, PA: Lippincot Williams & Wilkins, 1998. ISBN: 0397516401.

Hirschsprung's- submucosal plexus

Three common operations for Hirschsprung's disease

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