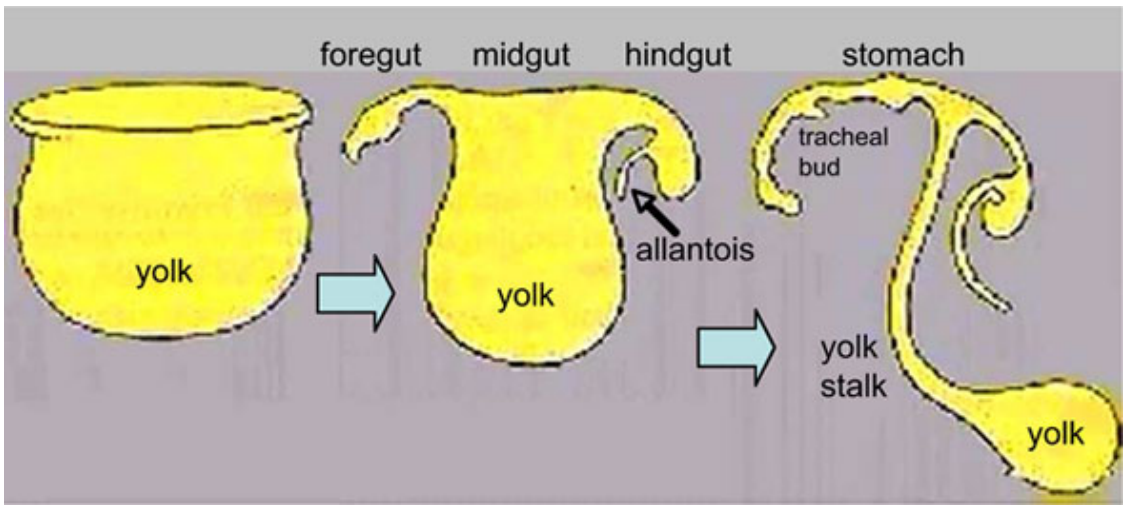
BGD Lecture - Gastrointestinal System Development

ExpandEmbryology - 28 Apr 2019 Expand to Translate
Google Translate - select your language from the list shown below (this will open a new external page)
العربية | català | 中文 | 中國傳統的 | français | Deutsche | עברית | हिंदी | bahasa Indonesia | italiano | 日本語 | 한국어 | မြန်မာ | Pilipino | Polskie | português | ਪੰਜਾਬੀ ਦੇ | Română | русский | Español | Swahili | Svensk | ไทย | Türkçe | | اردو ייִדיש | Tiếng Việt These external translations are automated and may not be accurate. (More? About Translations)

Introduction

This lecture introduces the early development of the Gastrointestinal Tract (acronym **GIT**). Note that the oral cavity and pharynx will be covered in detail in the later Lecture and Practical on head and face development.

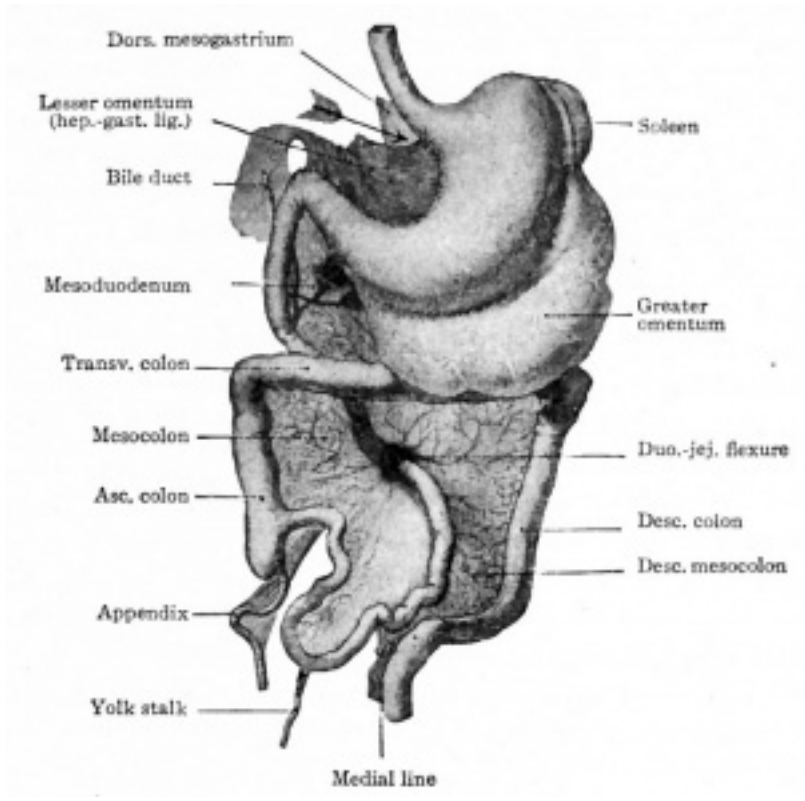


1 Minute Embryology
UNSW theBox

ExpandLecture Archive
Links: 2018 | 2018 PDF 2017 PDF | 2016 | 2016 PDF | 2015 | 2015 PDF | 2014 | 2014 PDF | BGDB Practical - GIT | 2013 Lecture | 2012 Lecture | Link to Learning Activity | Upper GIT Histology - support page

Lecture Objectives

- Understanding of germ layer contributions
- Understanding of the folding
- Understanding of three main embryonic divisions
- Understanding of associated organ (liver, pancreas, spleen) development
- Brief understanding of mechanical changes (rotations)
- Brief understanding of gastrointestinal tract abnormalities



Historic drawing of the developing gastrointestinal tract (Kollman)

CollapseTextbooks

Hill, M.A. (2019). *UNSW Embryology* (19th ed.) Retrieved April 28, 2019, from https://embryology.med.unsw.edu.au

GIT Links: Introduction | Medicine Lecture | Science Lecture | endoderm | mouth | oesophagus | stomach | liver | gallbladder | Pancreas | intestine | mesentery | tongue | taste | enteric nervous system | Stage 13 | Stage 22 | gastrointestinal abnormalities | Movies | Postnatal | milk | tooth | salivary gland | BGD Lecture | BGD Practical | GIT Terms | Category:Gastrointestinal Tract

GIT Histology Links: Upper GIT | Salivary Gland | Smooth Muscle Histology | Liver | Gallbladder | Pancreas | Colon | Histology Stains | Histology | GIT Development

ExpandHistoric Embryology - Gastrointestinal Tract

1878 Alimentary Canal | 1882 The Organs of the Inner Germ-Layer The Alimentary Tube with its Appended Organs | 1902 The Organs of Digestion | 1903 Submaxillary Gland | 1906 Liver | 1907 Development of the Digestive System | 1907 Atlas | 1907 23 Somite Embryo | 1908 Liver and Vascular | 1910 Mucous membrane Oesophagus to Small Intestine | 1910 Large intestine and Vermiform process | 1911-13 Intestine and Peritoneum - Part 1 | Part 2 | Part 3 | Part 5 | Part 6 | 1912 Digestive Tract | 1912 Stomach | 1914 Digestive Tract | 1914 Intestines | 1914 Rectum | 1915 Pharynx | 1915 Intestinal Rotation | 1917 Entodermal Canal | 1918 Anatomy | 1921 Alimentary Tube | 1932 Gall Bladder | 1939 Alimentary Canal Looping | 2008 Liver | 2016 GIT Notes | Historic Disclaimer

Human Embryo: 1908 13-14 Somite Embryo | 1921 Liver Suspensory Ligament | 1926 22 Somite Embryo | 1907 23 Somite Embryo | 1937 25 Somite Embryo | 1914 27 Somite Embryo | 1914 Week 7 Embryo

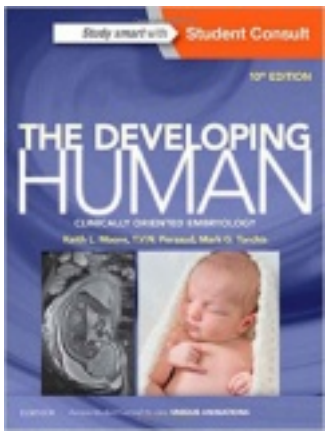
Animal Development: 1913 Chicken | 1951 Frog

Moore, K.L., Persaud, T.V.N. & Torchia, M.G. (2015). *The developing human:*

clinically oriented embryology (10th ed.). Philadelphia: Saunders. (links only function with UNSW connection)

Chapter 11 Alimentary System

ExpandThe Developing Human: Clinically Oriented Embryology (10th edn)



UNSW Students have online access to the current 10th edn. through the UNSW Library subscription (with student Zpass log-in).

APA Citation: Moore, K.L., Persaud, T.V.N. & Torchia, M.G. (2015). *The developing human: clinically oriented embryology* (10th ed.). Philadelphia: Saunders.

Links: PermaLink | UNSW Embryology Textbooks | Embryology Textbooks | UNSW Library

1. Introduction to the Developing Human
2. First Week of Human Development
3. Second Week of Human Development
4. Third Week of Human Development
5. Fourth to Eighth Weeks of Human Development
6. Fetal Period
7. Placenta and Fetal Membranes
8. Body Cavities and Diaphragm
9. Pharyngeal Apparatus, Face, and Neck
10. Respiratory System
11. Alimentary System
12. Urogenital System
13. Cardiovascular System
14. Skeletal System
15. Muscular System
16. Development of Limbs
17. Nervous System
18. Development of Eyes and Ears
19. Integumentary System
20. Human Birth Defects
21. Common Signaling Pathways Used During Development
22. Appendix : Discussion of Clinically Oriented Problems

Schoenwolf, G.C., Bleyl, S.B., Brauer, P.R., Francis-West, P.H. & Philippa H. (2015). *Larsen's human embryology* (5th ed.). New York; Edinburgh: Churchill Livingstone.(links only function with UNSW connection)

Chapter 14 Development of the Gastrointestinal Tract

ExpandLarsen's Human Embryology (5th edn)

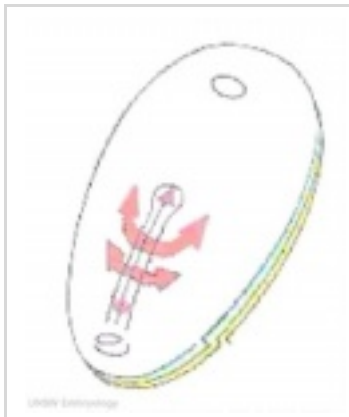
UNSW students have full access to this textbook edition through UNSW Library subscription (with student Zpass log-in).

APA Citation: Schoenwolf, G.C., Bleyl, S.B., Brauer, P.R., Francis-West, P.H. & Philippa H. (2015). *Larsen's human embryology* (5th ed.). New York; Edinburgh: Churchill Livingstone.

Links: PermaLink | UNSW Embryology Textbooks | Embryology Textbooks | UNSW Library

1. Gametogenesis, Fertilization, and First Week
2. Second Week: Becoming Bilaminar and Fully Implanting
3. Third Week: Becoming Trilaminar and Establishing Body Axes
4. Fourth Week: Forming the Embryo
5. Principles and Mechanisms of Morphogenesis and Dysmorphogenesis
6. Fetal Development and the Fetus as Patient
7. Development of the Skin and Its Derivatives
8. Development of the Musculoskeletal System
9. Development of the Central Nervous System
10. Development of the Peripheral Nervous System
11. Development of the Respiratory System and Body Cavities
12. Development of the Heart
13. Development of the Vasculature
14. Development of the Gastrointestinal Tract
15. Development of the Urinary System
16. Development of the Reproductive System
17. Development of the Pharyngeal Apparatus and Face
18. Development of the Ears
19. Development of the Eyes
20. Development of the Limbs

ExpandGastrointestinal Tract Movies



Week 3 Mesoderm

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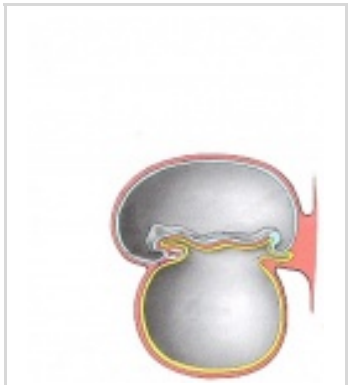

Week 3

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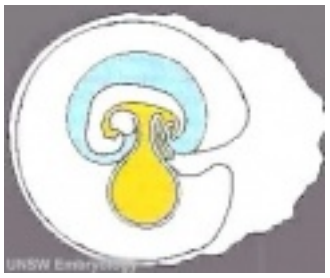

Amniotic Cavity

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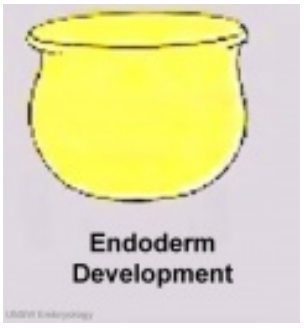

Endoderm

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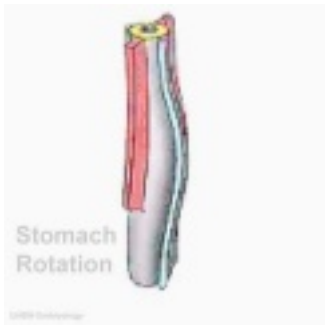

Stomach Rotation

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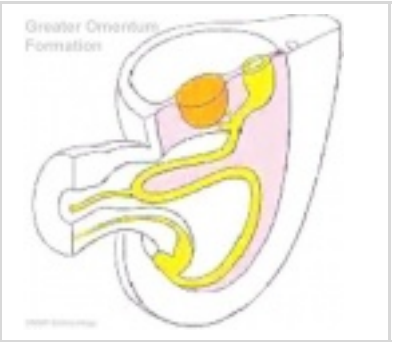
Tract Growth

Page | Play

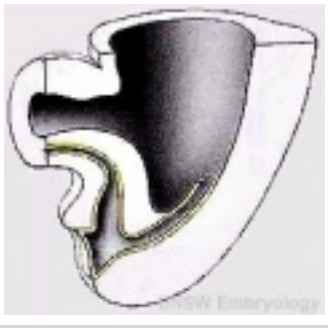


Greater Omentum

Page | Play

Lesser sac

Page | Play



Urogenital Septum

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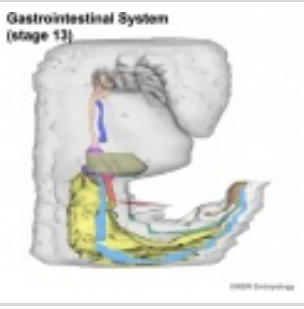

GIT Stage 13

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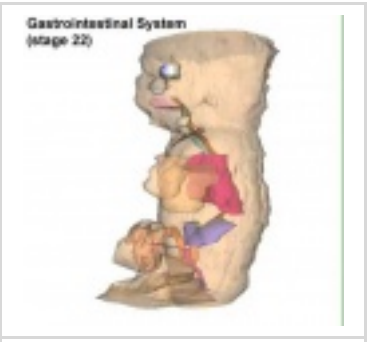

GIT Stage 22

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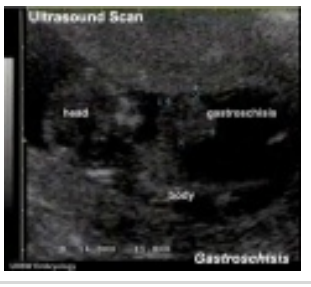

Gastroschisis

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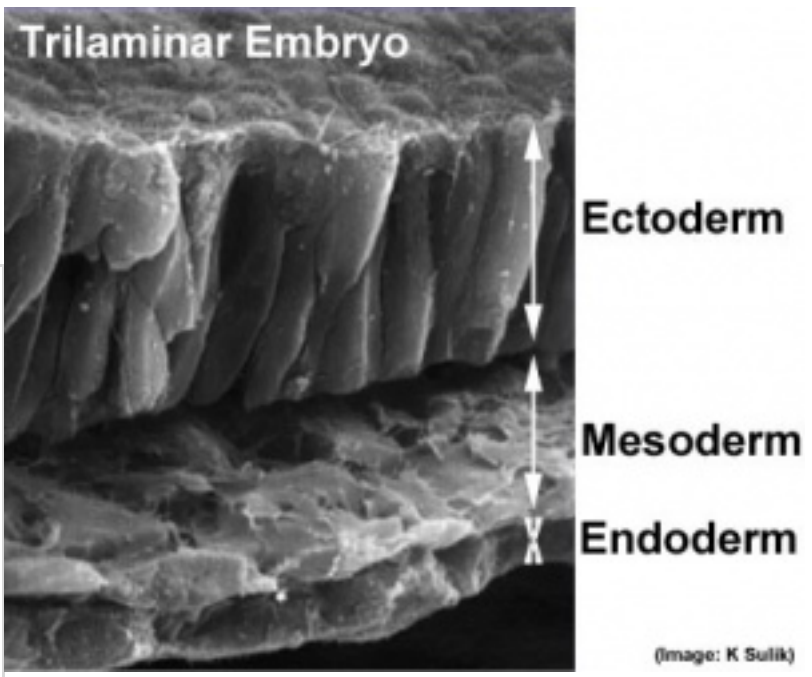
Week 3

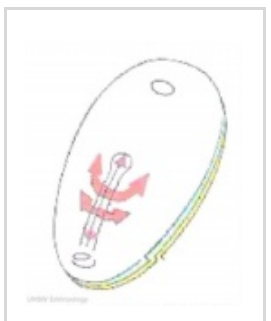
(Gestational age **GA** 5 weeks)

Gastrulation

Week 3 the term "gastrulation " means "gut formation" and is the generation of the **3 germ layers**.



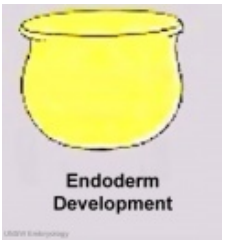
Trilaminar embryo 3 germ layers.



- **endoderm** - epithelium and associated glands, organs
- **mesoderm** (splanchnic) - mesentry, connective tissues, smooth muscle, blood vessels,

Week 3 Mesoderm Page | Play	organs • **ectoderm** (neural crest) - enteric nervous system Both endoderm and mesoderm will contribute to associated organs.

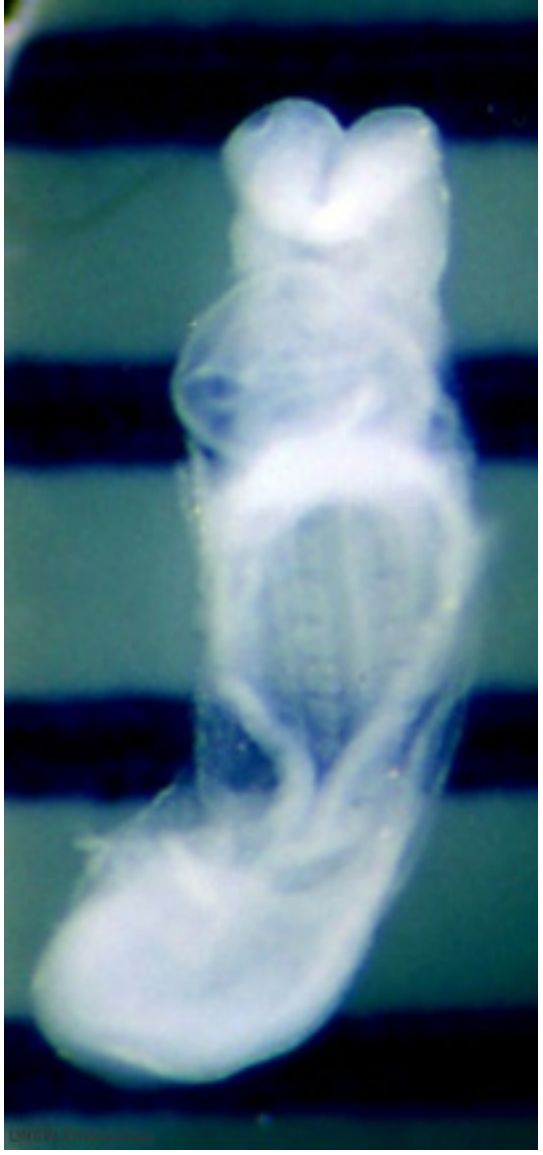
Folding

Week 3to 4 folding of the embryonic disc forms the primitive gut tube. Folding ventrally around the notochord, running rostro-caudally in the midline. In relation to the notochord: • **Laterally** (either side of the notochord) lies mesoderm. • **Rostrally** (above the notochord end) lies the buccopharyngeal membrane, above this again is the mesoderm region forming the heart. • **Caudally** (below the notochord end) lies the primitive streak (where gastrulation occurred), below this again is the cloacal membrane. • **Dorsally** (above the notochord) lies the neural tube then ectoderm. • **Ventrally** (beneath the notochord) lies the mesoderm then endoderm.	 **Endoderm** Page | Play	 **Amniotic Cavity** Page | Play

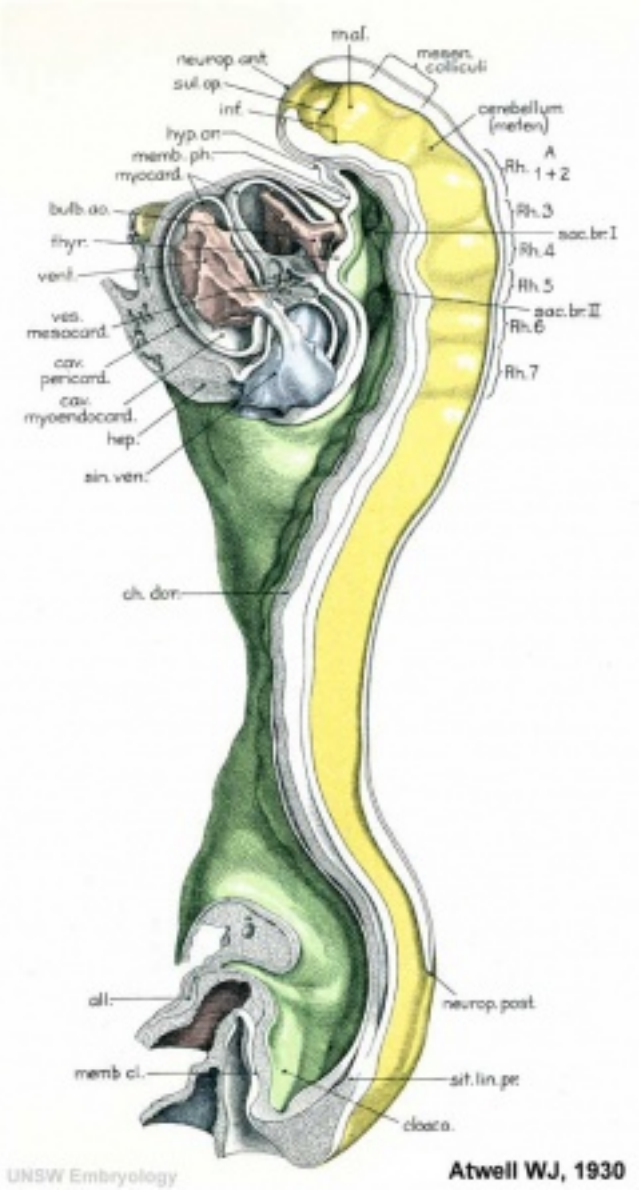
The ventral endoderm (shown yellow) has grown to line a space called the yolk sac. Folding of the embryonic disc "pinches off" part of this yolk sac forming the first primitive gastrointestinal tract.

Week 4

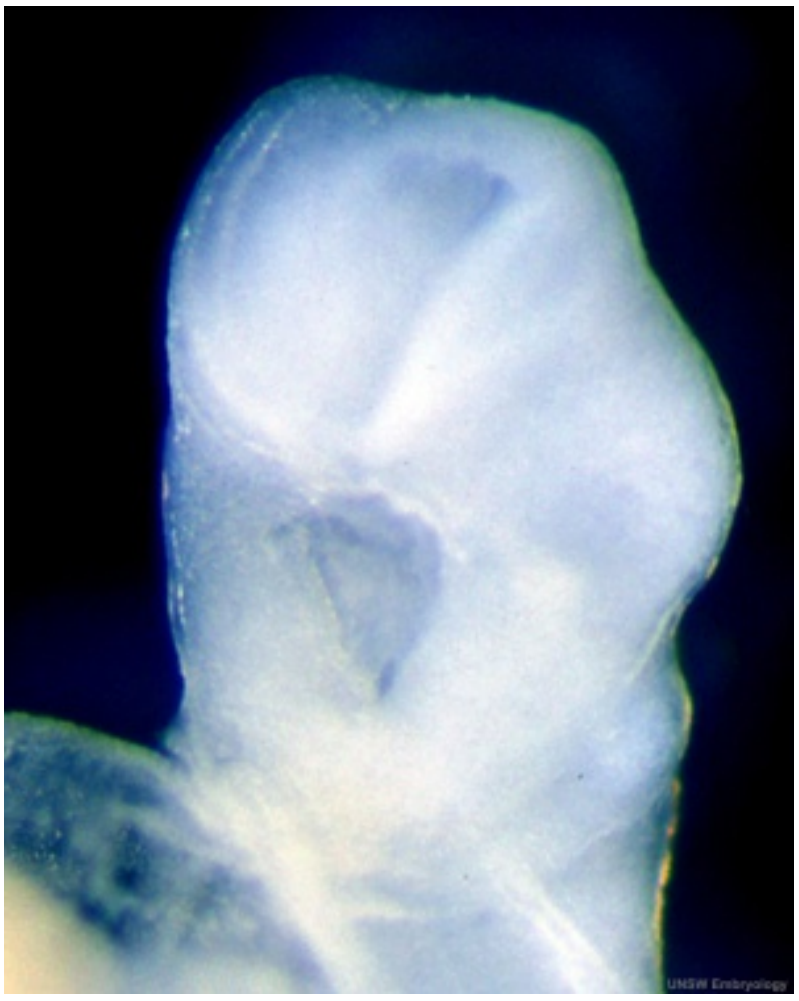
(Gestational age **GA** 6 weeks) Carnegie stage 11



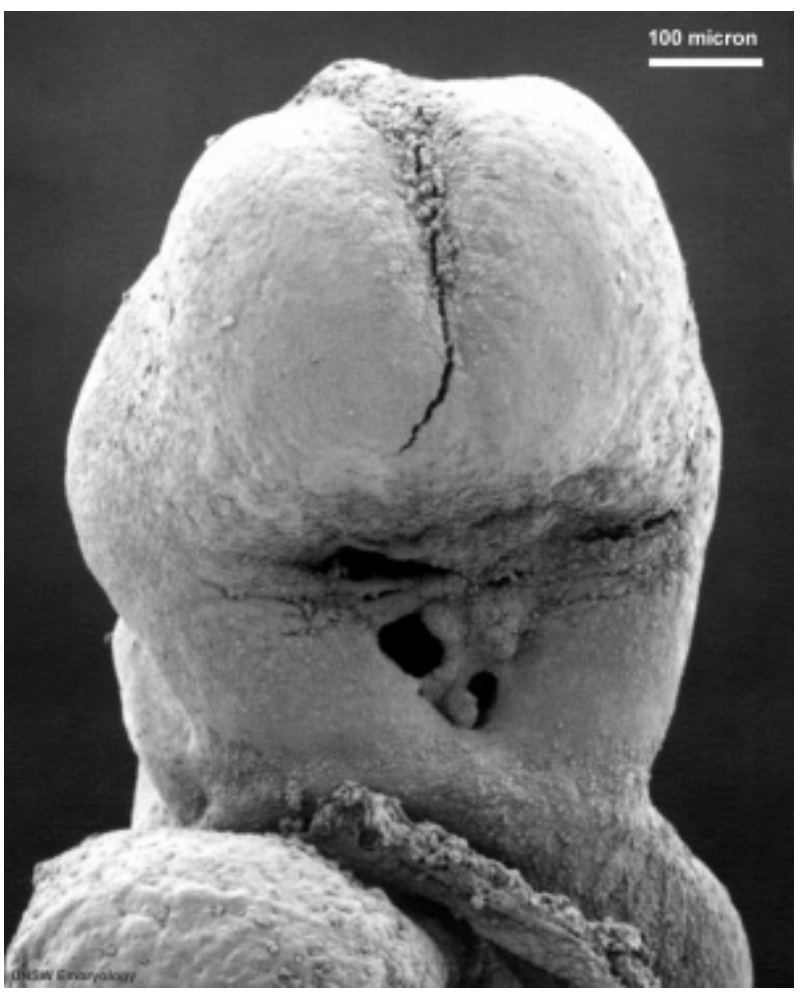
Embryo (stage 11 ventral view)



Embryo (midline section)



Stomodeum



Buccopharyngeal membrane

Coelomic Cavity

Mesoderm differentiates and lateral plate cavity forms the 3 main body cavities.

- The mesoderm initially undergoes segmentation to form paraxial, intermediate mesoderm and **lateral plate mesoderm**.
- Paraxial mesoderm segments into somites and lateral plate mesoderm divides into somatic and **splanchnic mesoderm**.
- The space forming between them is the **coelomic cavity**, that will form the 3 major body cavities (pericardial, pleural, **peritoneal**)
- Most of the gastrointestinal tract will eventually lie within the peritoneal cavity.

- **Mesoderm and Ectoderm Cartoons**

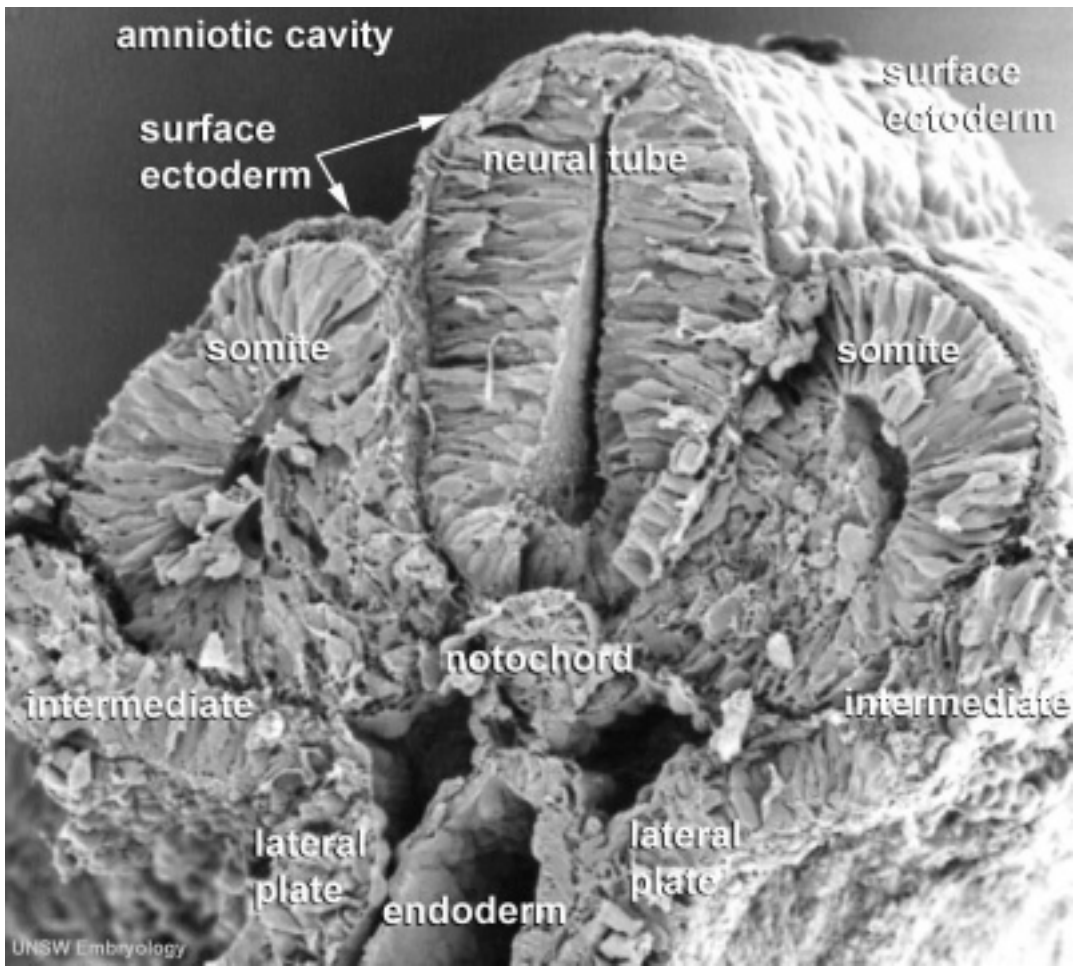
- Trilaminar Embryo

- Paraxial and Lateral Plate

- Somites

- Somatic and Splanchnic

(only the righhand side is shown, lefthand side would be identical)



Intraembryonic coelom

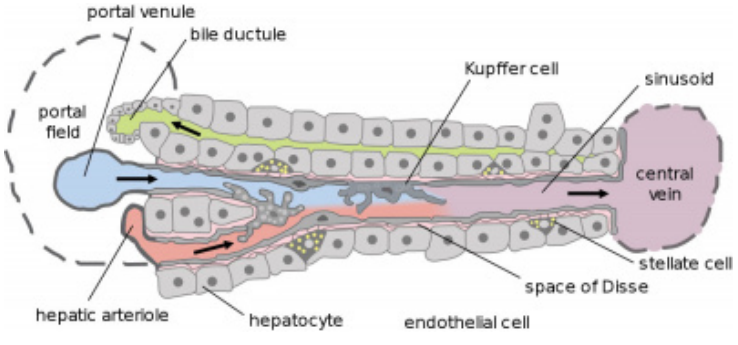
Liver Development

Both endoderm and splanchnic mesoderm at the level of the transverse septum. Vascular development in mesoderm. (week 4, **GA** week 6)

- Stage 11 - hepatic diverticulum development
- Stage 12 - cell differentiation, septum transversum (mesoderm) forming liver stroma, hepatic diverticulum (endoderm) forming hepatic trabeculae
- Stage 13 - epithelial cord proliferation enmeshing stromal capillaries

- **Size** - the liver initially occupies the entire anterior body area.
- **Hepatoblast** - endoderm the bipotential progenitor for both hepatocytes and cholangiocytes.
- **Vascular** - mesoderm blood vessels enter the liver (3 systems: systemic, placental, vitelline)
- **Sinusoids** - first blood vessels from vessels in septum transversum mesenchyme. 3 Venous tributaries (right and left placental vein and the single vitelline vein[1]). Initially continuous endothelium, become fenestrated in fetal period and reticular development ongoing.

ExpandAdult liver



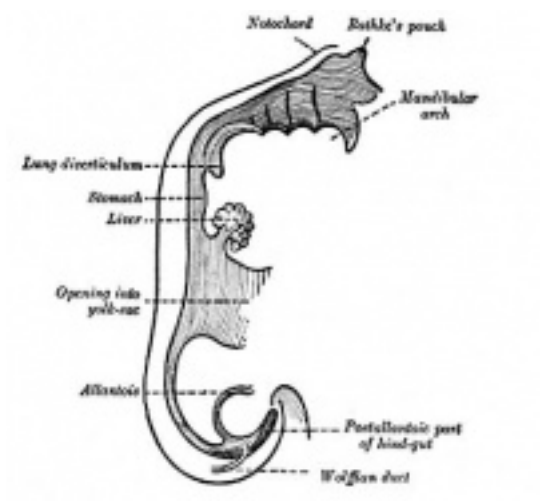
Adult Liver Cells

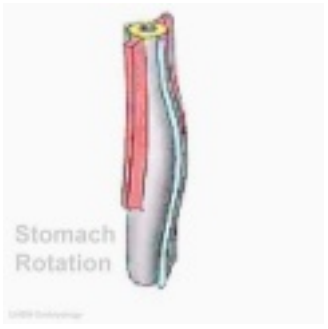
1. hepatocytes - form 80% of liver, functional cells
2. cholangiocytes - epithelial cells that line the bile ducts
3. stellate cells - mesenchymal cells in the space of Disse
4. Kupffer cells - liver macrophage in the sinusoids[2]

Adult Liver Histology (covered in Medicine HM)

-00:00

Stomach





Stomach Rotation

Page | Play

Contributions - endoderm (epithelium and glands); mesoderm (connective tissue, smooth muscle and blood vessels); ectoderm (enteric nervous system)

- During week 4 at the level where the stomach will form the tube begins to dilate, forming an enlarged lumen.
- The dorsal border grows more rapidly than ventral, which establishes the greater curvature of the stomach.
- A second growth rotation (of 90 degrees) occurs on the longitudinal axis establishing the adult orientation of the stomach.

ExpandForegut - Week 4 (stage 13)
Sagittal MRI scan through the human embryo showing the anatomical arrangement of the pharynx, foregut and stomach. **Click Here** to play on mobile device

Week 5

(GA 7 weeks)

Liver - vascular channels enlarge, haematopoietic function

Canalization

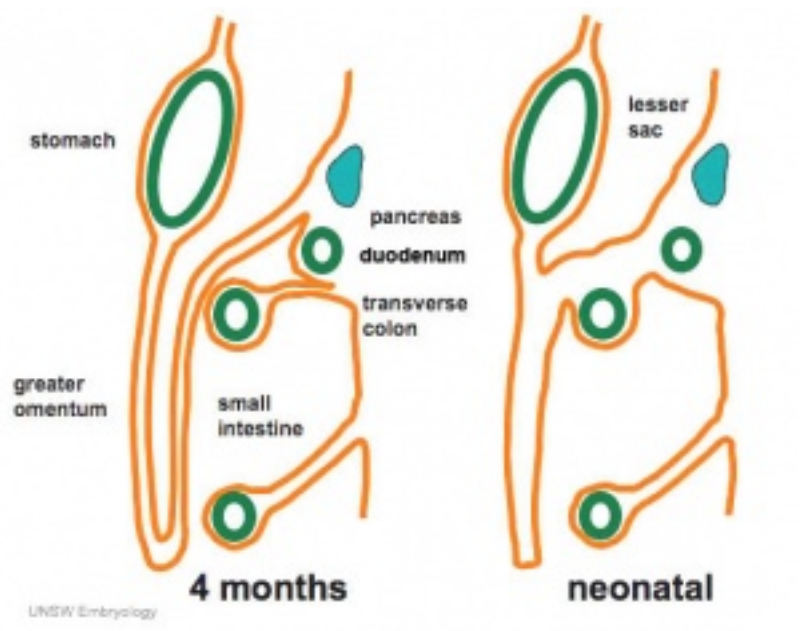
Tract Growth

Page | Play

- Beginning at week 5 endoderm in the GIT wall proliferates
- By week 6 totally blocking (occluding)
- over the next two weeks this tissue degenerates reforming a hollow gut tube.
- By the end of week 8 the GIT endoderm tube is a tube once more.
- The process is called recanalization (hollow, then solid, then hollow again)
- Abnormalities in this process can lead to abnormalities such as atresia, stenosis or duplications.

Mesentery Development

- Ventral mesentery lost except at level of stomach and liver.
  - contributing the lesser omentum and falciform ligament.
- Dorsal mesentery forms the adult structure along the length of the tract and allows blood vessel, lymph and neural connection.
- At the level of the stomach the dorsal mesogastrium extends as a fold forming the greater omentum
  - continues to grow and extend down into the peritoneal cavity and eventually lies anterior to the small



Greater Omentum

Greater Omentum

Page | Play

Lesser

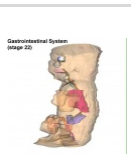
sac [Page](#) | [Play](#)	intestines. ◦ This fold of mesentery will also fuse to form a single sheet. **Spleen** • Mesoderm within the dorsal mesogastrium (week 5) form a long strip of cells adjacent to the forming stomach above the developing pancreas. • Vascular and immune organ, no direct GIT function.

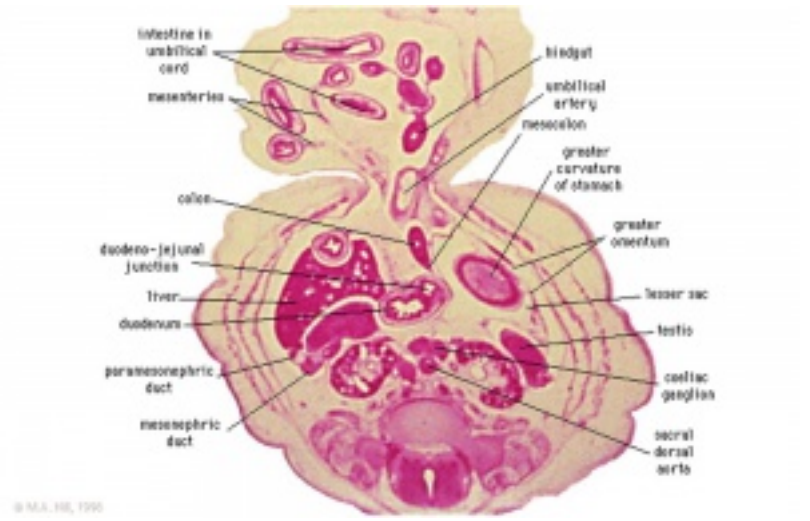
[Foregut - thyroid](#)

Week 8 - 10

([GA](#) 10-12 weeks)

Intestine Herniation

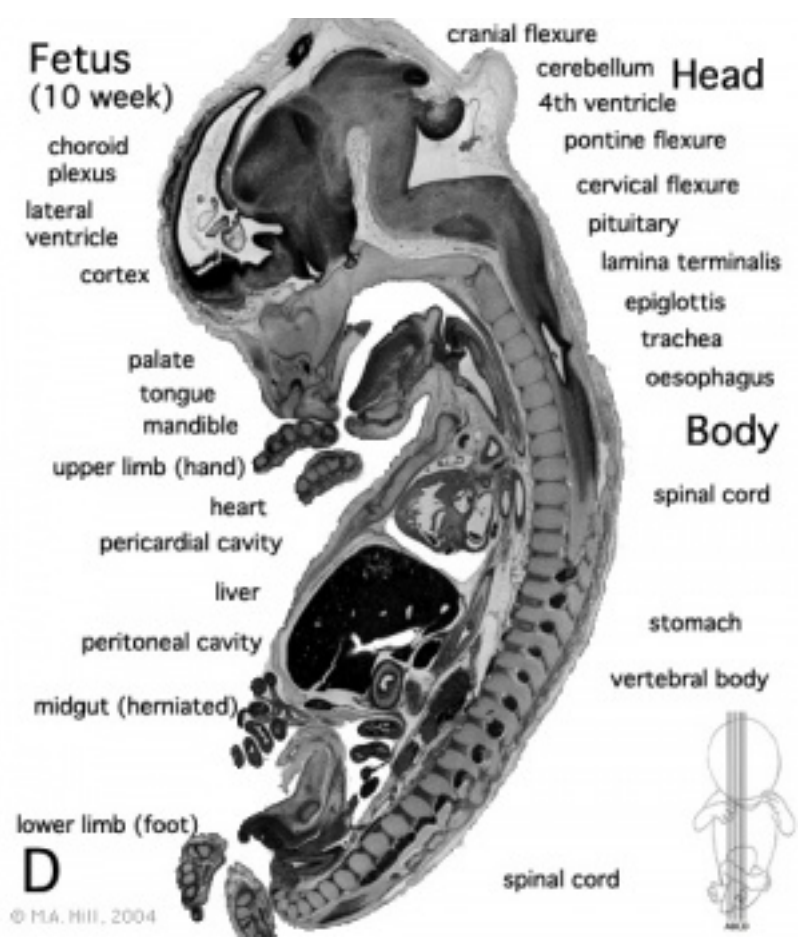
 **GIT Stage 22** [Page](#)	• [neural crest](#) migration into the wall forms enteric nervous system (peristalsis, secretion) • midgut grows in length as a loop extending ventrally, returning as hindgut • connected by dorsal mesentery • rotates to form adult anatomical position



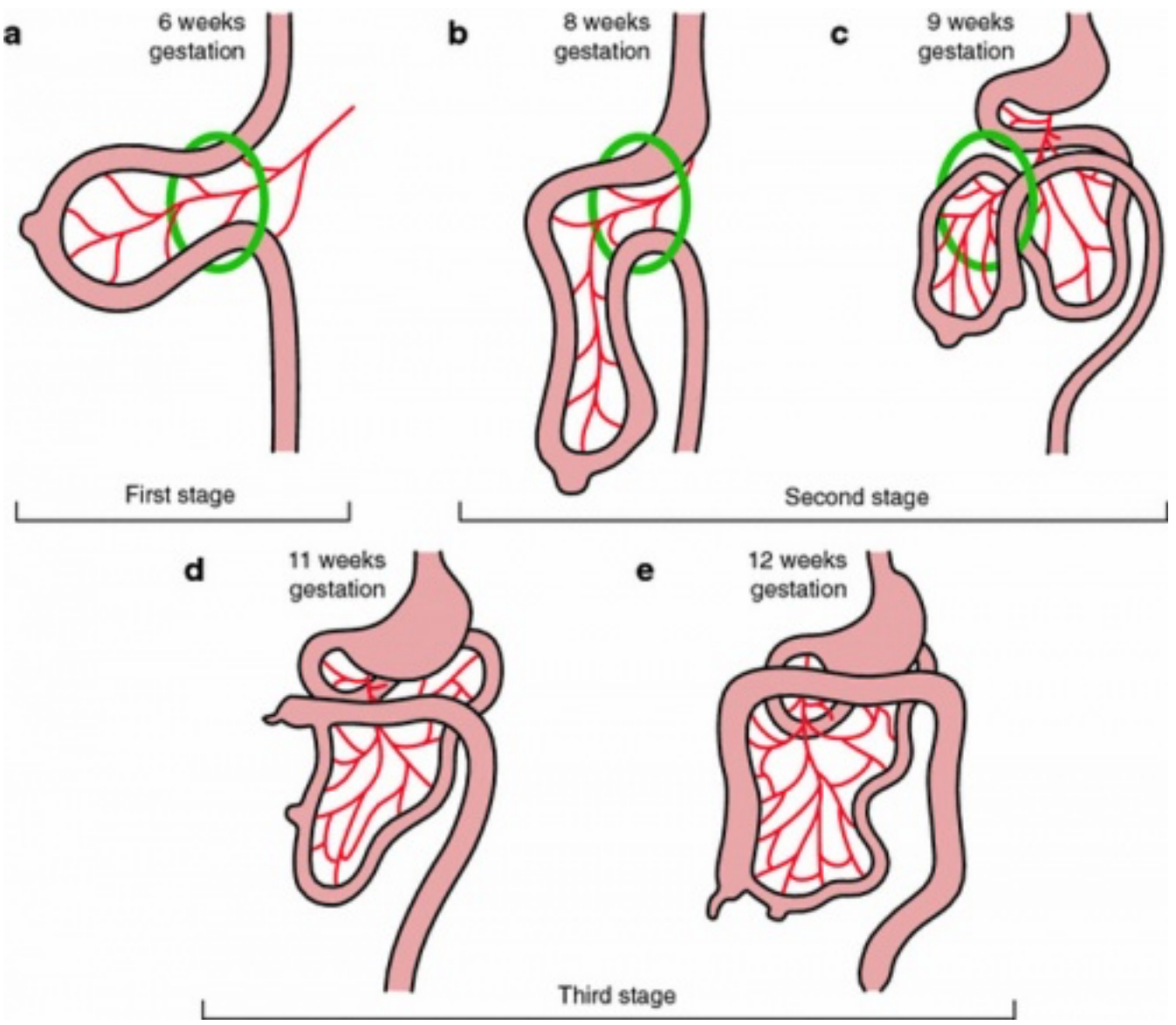
Week 8 herniated midgut

| Play	(abnormalities of rotation) • continued body growth "engulfs" the intestine by about week 11.

Intestine Rotation



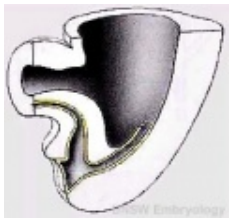
Week 10



Normal intestinal rotation (note these are gestational age **GA** weeks)[3]

Hindgut

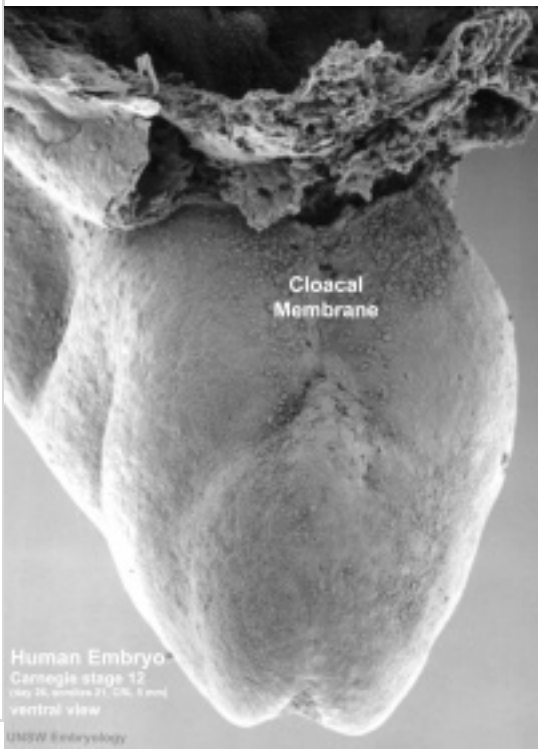
	• Initially the **cloaca** (endoderm)



Urogenital Septum

Page | Play

- forms a common urinary, genital, GIT space
- This is divided by formation of a **septum** into anterior urinary and dorsal rectal (superior Tourneux fold; lateral Rathke folds)
- hindgut - distal third transverse colon, descending and sigmoid colon, rectum.
- anal pit - distal third of anorectal canal (ectoderm)

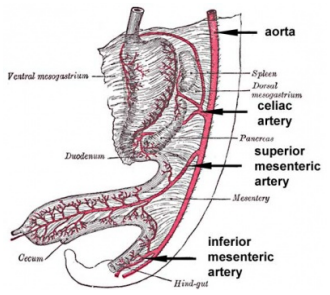


Cloacal membrane (Week 4, Stage 12)

Gastrointestinal Tract Divisions

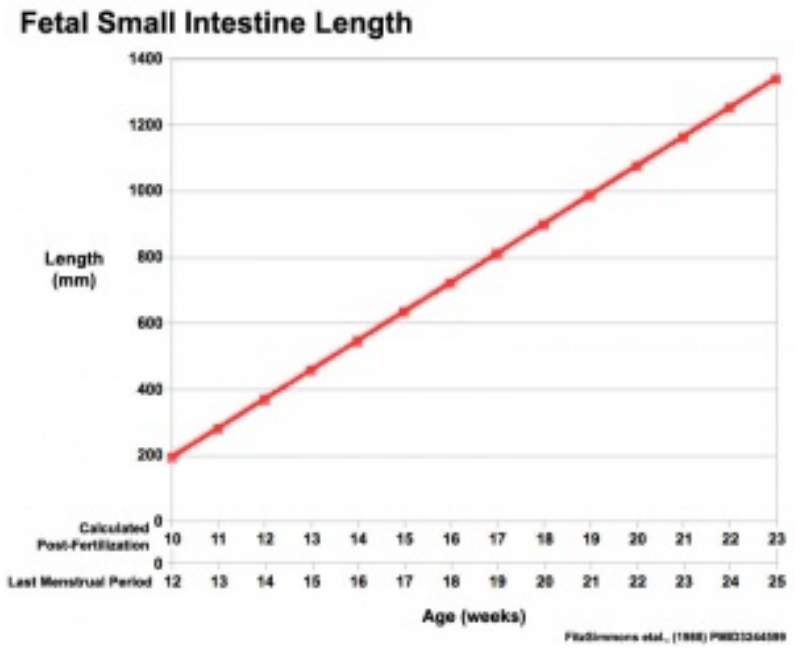
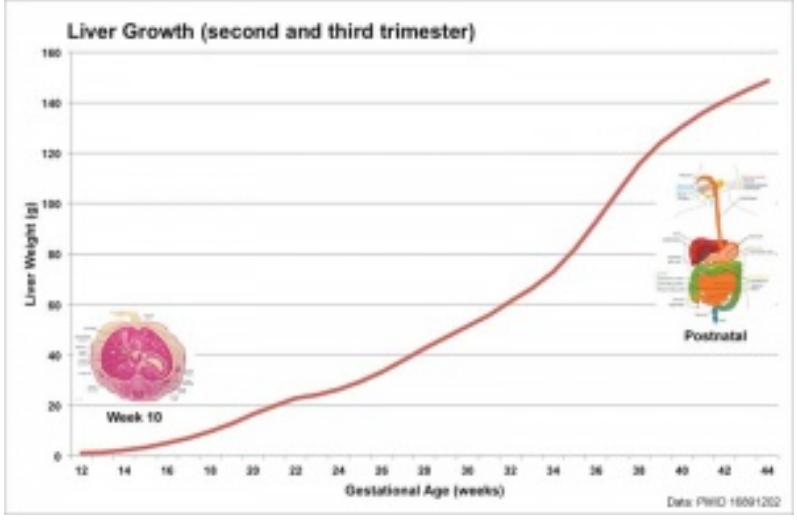
During the 4th week the 3 distinct portions (fore-, mid- and hind-gut) extend the length of the embryo and will contribute different components of the GIT. These 3 divisions are also later defined by the vascular (artery) supply to each of theses divisions.

1. **Foregut** - celiac artery (Adult: pharynx, esophagus, stomach, upper duodenum, respiratory tract, liver, gallbladder pancreas)
2. **Midgut** - superior mesenteric artery (Adult: lower duodenum, jejunum, ileum, cecum, appendix, ascending colon, half transverse colon)
3. **Hindgut** - inferior mesenteric artery (Adult: half transverse colon, descending colon, rectum, superior part anal canal)



Gastrointestinal Tract Blood Supply

Fetal

	
Small Intestine length (mm)	Liver Growth (weight grams)
	1 to 124 grams (birth)

Liver

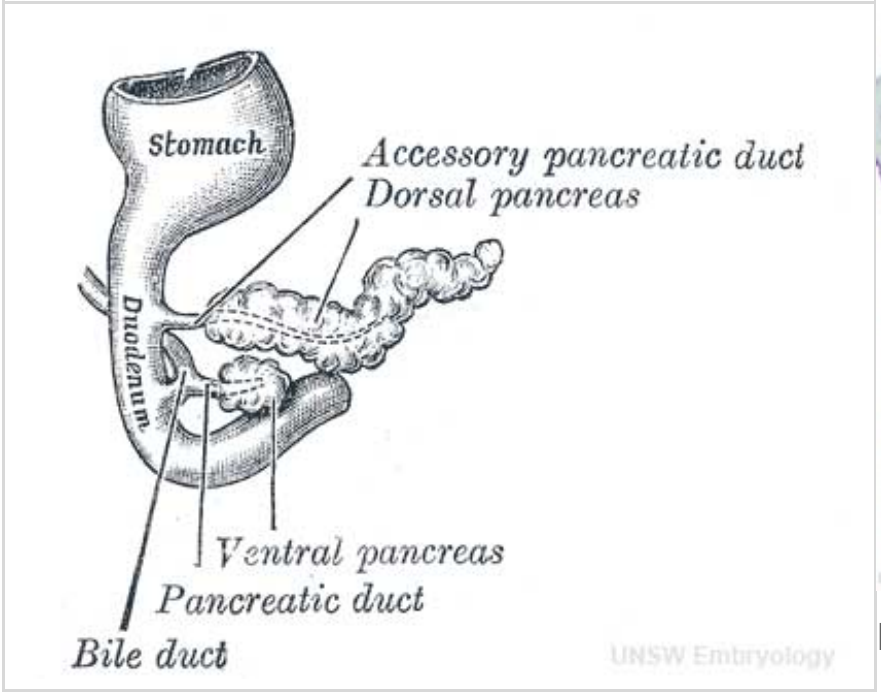
- Differentiates to form the hepatic diverticulum and hepatic primordium, generates the gall bladder then divides into right and left hepatic (liver) buds.
- Hepatic Buds - form hepatocytes, produce bile from week 13 (forms meconium of newborn)
    - Left Hepatic Bud - left lobe, quadrate, caudate (both q and c anatomically Left) caudate lobe of human liver consists of 3 anatomical parts: Spiegel's lobe, caudate process, and paracaval portion.
    - Right Hepatic Bud - right lobe
- Bile duct - 3 connecting stalks (cystic duct, hepatic ducts) which fuse.
- Early liver also involved in **blood formation**, after the yolk sac and blood islands acting as a primary site.

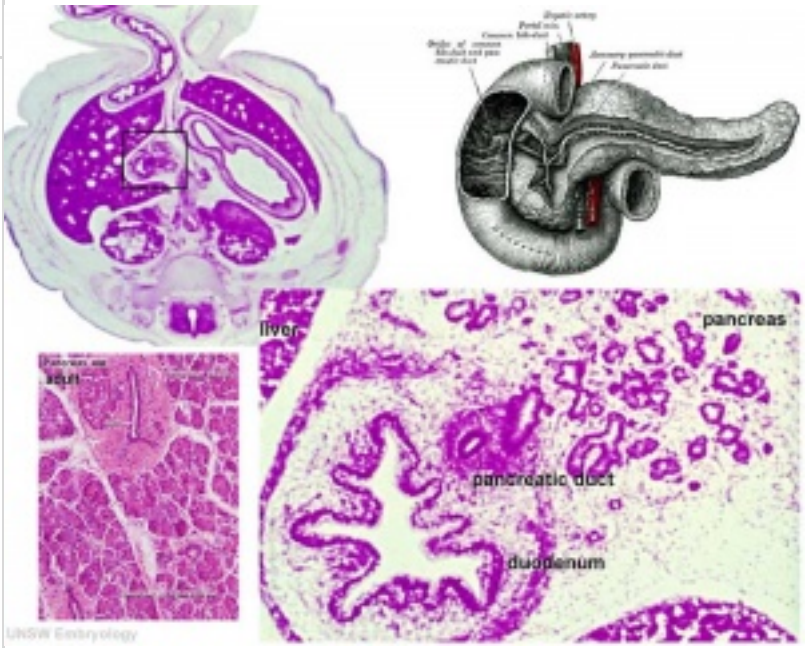
Liver Development

Pancreas

ExpandPancreas - ventral and dorsal

buds

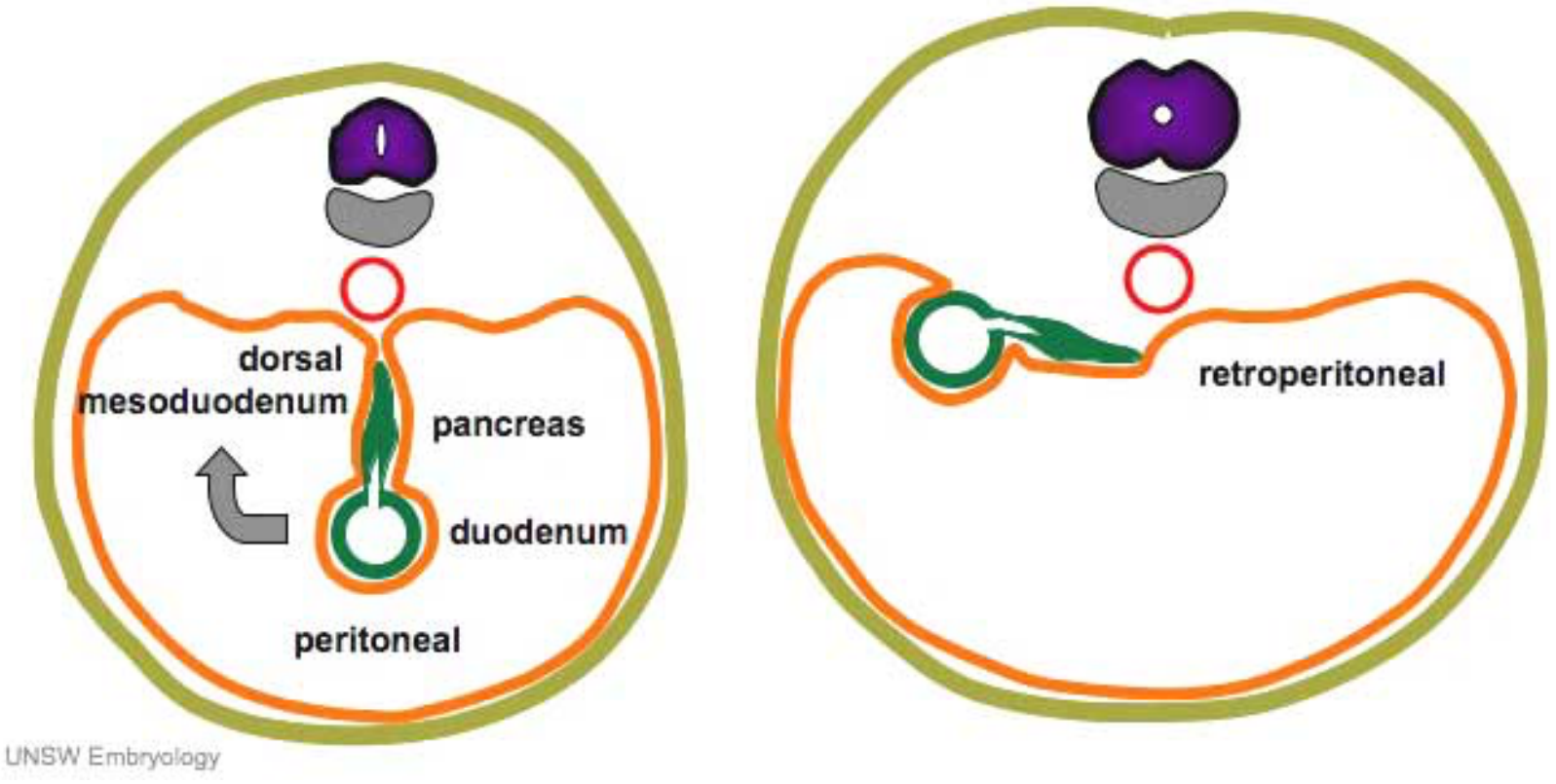




Pancreas (week 8)

- Pancreatic buds - endoderm, covered in splanchnic mesoderm
- Pancreatic bud formation – duodenal level endoderm, splanchnic mesoderm forms dorsal and ventral mesentery, **dorsal bud** (larger, first), **ventral bud** (smaller, later)
- Duodenum growth/rotation – brings ventral and dorsal buds together, fusion of buds, exocrine function (postnatal function)
- Pancreatic duct – ventral bud duct and distal part of dorsal bud
- Pancreatic islets - endocrine function (**week 10** onwards)

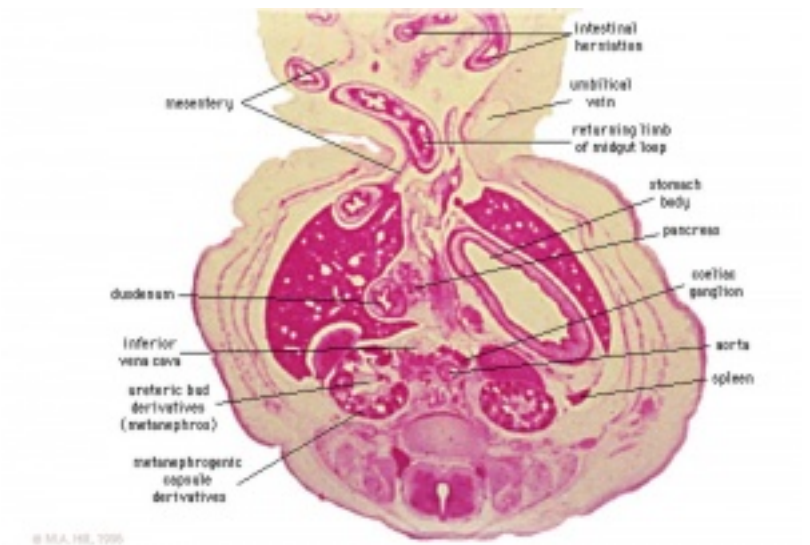
(Note - covered again in Endocrine Development)



[Pancreas Development]

Spleen

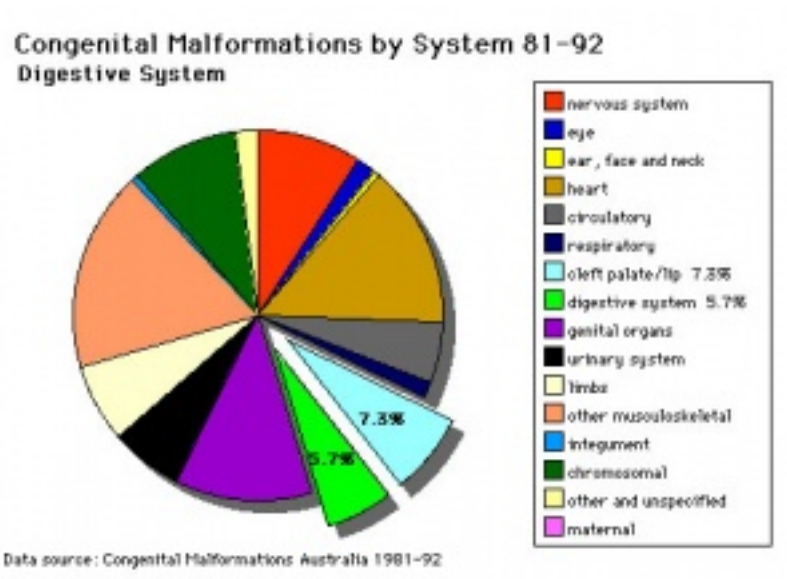
- Mesoderm within the dorsal mesogastrium form a long strip of cells adjacent to the forming stomach above the developing pancreas.
- The spleen is located on the left side of the abdomen and has a role initially in blood and then immune system development.
- The spleen's haematopoietic function (blood cell formation) is lost with embryo development and lymphoid precursor cells migrate into the developing organ.
- Vascularization of the spleen arises initially by branches from the dorsal aorta.



Spleen week 8 stage 22 embryo

Gastrointestinal Tract Abnormalities

ExpandUSA Statistics		
USA Selected Abnormalities (CDC Nat estimates for 21 selected major birth de 2004–2006)		
Birth Defects	Cases per Births (1 in ...)	Es A N of
anencephaly	4,859	85
spina bifida without anencephaly	2,858	1,4
encephalocele	12,235	34
Anophthalmia/microphthalmia	5,349	78
patent ductus arteriosus/common truncus	13,876	30
transposition of the great vessels	3,333	1,2
Tetralogy of Fallot	2,518	1,6



Australian Statistics Gastrointestinal Tract - Abnormalities

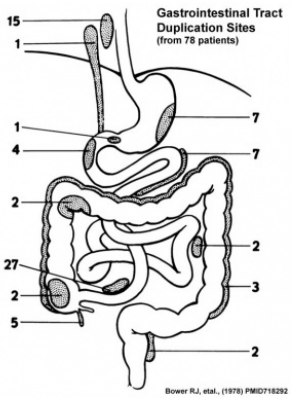
atrial septal defects/ventricular septal defects	2,122	1,9
hypoplastic left heart	4,344	96
cleft palate without cleft lip	1,574	2,6
cleft lip with and without cleft palate	940	4,4
Esophageal atresia/tracheoesophageal fistula	4,608	90
Rectal and large intestinal atresia/stenosis	2,138	1,9
Reduction deformity, upper limbs	2,869	1,4
Reduction deformity, lower limbs	5,949	70
gastroschisis	2,229	1,8
omphalocele	5,386	77
Diaphragmatic hernia	3,836	1,0
Trisomy 13	7,906	52
Trisomy 21 (Down syndrome)	691	6,0
Trisomy 18	3,762	1,1

Links: Human Abnormal Development Birth Defects - Data & Statistics | USA Statistics | Victoria 2004 | USA 2006 | 2010

gastrointestinal abnormalities

Lumen Abnormalities

There are several types of abnormalities that impact upon the continuity of the gastrointestinal tract lumen, named by by anatomical location and type.



Atresia

- Interruption of the lumen(esophageal atresia, duodenal atresia, extrahepatic biliary atresia, anorectal atresia)

Stenosis

- Narrowing of the lumen (duodenal stenosis, pyloric stenosis)

Duplication

- Incomplete recanalization resulting in parallel lumens, this is really a specialized form of stenosis.

Meckel's Diverticulum

- This abnormality is a very common (incidence of 1 – 2% in the general population) and results from improper closure and absorption of the vitelline duct during early development.
  - vitelline duct (omphalomesenteric duct, yolk stalk) is a transient developmental duct that connects the yolk to the primitive GIT.

Meckel's Diverticulum

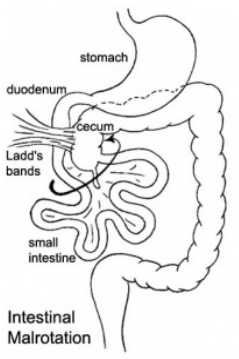
Intestinal Malrotation

Presents clinically in symptomatic malrotation as:

- Neonates - bilious vomiting and bloody stools.
- Newborn - bilious vomiting and failure to thrive.
- Infants - recurrent abdominal pain, intestinal obstruction, malabsorption/diarrhea, peritonitis/septic shock, solid food intolerance, common bile duct obstruction, abdominal distention, and failure to thrive.

Ladd's Bands - are a series of bands crossing the duodenum which can cause duodenal obstruction.

Links: Intestinal Malrotation

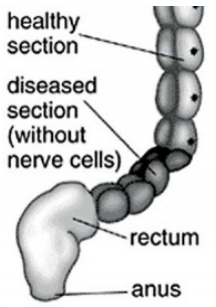


Intestinal malrotation

Intestinal Aganglionosis

(intestinal aganglionosis, Hirschsprung's disease, aganglionic colon, megacolon, congenital aganglionic megacolon, congenital megacolon)

- A condition caused by the lack of enteric nervous system (neural ganglia) in the intestinal tract responsible for gastric motility (peristalsis).
- Neural crest cells
    - migrate initially into the cranial end of the GIT.
    - migrate during embryonic development caudally down the GIT.
- Aganglionosis typically at the anal end of GIT.
    - increased severity as it extends cranially.



Gastroschisis

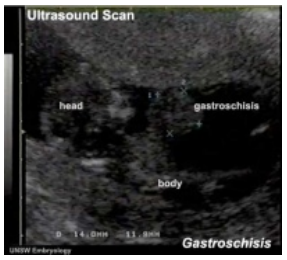
Gastroschisis (omphalocele, paraomphalocele, laparoschisis, abdominoschisis, abdominal hernia) is a congenital abdominal wall defect which results in herniation of fetal abdominal viscera (intestines and/or organs) into the amniotic cavity.

Incidence of gastroschisis has been reported at 1.66/10,000, occuring more frequently in young mothers (less than 20 years old).

By definition, it is a body wall defect, not a gastrointestinal tract defect, which in turn impacts upon GIT development.

This indirect developmental effect (one system impacting upon another) occurs in several other systems.

- **Omphalocele** - appears similar to gastroschisis, herniation of the bowel, liver and other organs into the intact umbilical cord, the tissues being **covered by membranes** unless the latter are ruptured.



Gastroschisis movie page

Polyhydramnios

Amniotic fluid volume is regulated in part in the fetus by swallowing and absorption. Gastrointestinal disorders (such as duodenal atresia, esophageal atresia, gastroschisis, and diaphragmatic hernia) can alter this regulation leading to excess or insufficient amniotic fluid levels.

Polyhydramnios (amniotic fluid disorder, hydramnios) refers to an excess

volume of amniotic fluid (ICD - O40 Polyhydramnios Incl.: Hydramnios).

Final Thoughts- After Birth

Remember that the GIT does not function until after birth consider:

- **metabolic disorders** discovered by neonatal diagnosis
- **Commensal bacteria** populating the sterile GIT.
- **Neonatal feeding** difficulties due to cleft lip and cleft palate.
- **Nutrition** for ongoing postnatal development.

Links: gastrointestinal abnormalities

ExpandGastrointestinal Tract Terms

- **allantois** - An extraembryonic membrane, endoderm in origin extension from the early hindgut, then cloaca into the connecting stalk of placental animals, connected to the superior end of developing bladder. In reptiles and birds, acts as a reservoir for wastes and mediates gas exchange. In mammals is associated/incorporated with connecting stalk/placental cord fetal-maternal interface.

- **amnion** - An extra-embryonic membrane, ectoderm and extraembryonic mesoderm in origin, also forms the innermost fetal membrane, that produces amniotic fluid. This fluid-filled sac initially lies above the trilaminar embryonic disc and with embryoic disc folding this sac is drawn ventrally to enclose (cover) the entire embryo, then fetus. The presence of this membrane led to the description of reptiles, bird, and mammals as amniotes.

- **amniotic fluid** - The fluid that fills amniotic cavity totally encloses and cushions the embryo. Amniotic fluid enters both the gastrointestinal and respiratory tract following rupture of the buccopharyngeal membrane. The late fetus swallows amniotic fluid.

- **atresia** - is an abnormal interruption of the tube lumen, the abnormality naming is based upon the anatomical location.

- **buccal** - (Latin, *bucca* = cheek) A term used to relate to the mouth (oral cavity).

- **bile salts** - Liver synthesized compounds derived from cholesterol that function postnatally in the small intestine to solubilize and absorb lipids, vitamins, and proteins. These compounds act as water-soluble amphipathic detergents. liver

- **buccopharyngeal membrane** - (oral membrane) (Latin, *bucca* = cheek) A membrane which forms the external upper membrane limit (cranial end) of the early gastrointestinal tract. This membrane develops during gastrulation by ectoderm and endoderm without a middle (intervening) layer of mesoderm. The membrane lies at the floor of the ventral depression (stomodeum) where the oral cavity will open and will breakdown to form the initial "oral opening" of the gastrointestinal tract. The equivilent membrane at the lower end of the gastrointestinal tract is the cloacal membrane.

- **celiac artery** - (celiac trunk) main blood supply to the foregut, excluding the pharynx, lower respiratory tract, and most of the oesophagus.

- **cholangiocytes** - epithelial cells that line the intra- and extrahepatic ducts of the biliary tree. These cells modify the hepatocyte-derived bile, and are regulated by hormones, peptides, nucleotides, neurotransmitters, and other molecules. liver

- **cloaca" - (cloacal cavity) The term describing the common cavity into which the intestinal, genital, and urinary tracts open in vertebrates. Located at the caudal end of the embryo it is located on the surface by the cloacal membrane. In many species this common cavity is later divided into a ventral urogenital region (urogenital sinus) and a dorsal gastrointestinal (rectal) region.**

- **cloacal membrane** - Forms the external lower membrane limit (caudal end) of the early gastrointestinal tract (GIT). This membrane is formed during gastrulation by ectoderm and endoderm without a middle (intervening) layer of mesoderm. The membrane breaks down to form the initial "anal opening" of the gastrointestinal tract.

- **coelomic cavity** - (coelom) Term used to describe a space. There are extra-embryonic and intra-embryonic coeloms that form during vertebrate development. The single intra-embryonic coelom forms the 3 major body cavities: pleural cavity, pericardial cavity and peritoneal cavity.

- **crypt of Lieberkühn** - (intestinal gland, intestinal crypt) intestinal villi epithelia extend down into the lamina propria where they form crypts that are the source of epithelial stem cells and immune function.

- **duplication** - is an abnormal incomplete tube recanalization resulting in parallel lumens, this is really a specialized form of stenosis. (More? Image - small intestine duplication)

- **enteric nervous system** - (ENS) neural crest in origin, both neurons and glia. Regulates gastrointestinal tract: motility, secretion and blood flow.

- **esophageal** - (oesophageal)

- **esophageal atresia** - (oesophageal atresia, atresia of oesophagus) group of congenital anomalies with an interruption in the continuity of the oesophagus, with or without persistent communication with the trachea. (More? gastrointestinal abnormalities | **ICD-11** **LB12.1** Atresia of oesophagus Medline Plus)

- **foregut** - first embryonic division of gastrointestinal tract extending from the oral (buccopharyngeal) membrane and contributing oesophagus, stomach, duodenum (to bile duct opening), liver, biliary apparatus (hepatic ducts, gallbladder, and bile duct), and pancreas. The forgut blood supply is the celiac artery (trunk) excluding the pharynx, lower respiratory tract, and most of the oesophagus.

- **galactosemia** - Metabolic abnormality where the simple sugar galactose (half of lactose, the sugar in milk) cannot be metabolised. People with galactosemia cannot tolerate any form of milk (human or animal). Detected by the Guthrie test.

- **gastric transposition** - clinical term for postnatal surgery treatment for esophageal atresia involving esophageal replacement. Typically performed on neonates between day 1 to 4. (More? gastrointestinal abnormalities | PMID 28658159

- **gastrointestinal divisions** - refers to the 3 embryonic divisions contributing the gastrointestinal tract: foregut, Midgut and hindgut.

- **gastrula** - (Greek, *gastrula* = little stomach) A stage of an animal embryo in which the three germ layers (endoderm/mesoderm/ectoderm) have just formed. All of these germ layers have contributions to the gastrointestinal tract.

- **gastrulation** - The process of differentiation forming a gastrula. Term means literally means "to form a gut" but is more in development, as this process converts the bilaminar embryo (epiblast/hypoblast) into the trilaminar embryo (endoderm/mesoderm/ectoderm) establishing the 3 germ layers that will form all the future tissues of the entire embryo. This process also establishes the the initial body axes. (More? gastrulation)

- **Guthrie test** - (heel prick) A neonatal blood screening test developed by Dr Robert Guthrie (1916-95) for determining a range of metabolic disorders and infections in the neonate. (More? Guthrie test)

- **hindgut** - final embryonic division of gastrointestinal tract extending to the cloacal membrane and contributing part of the transverse colon (left half to one third), descending colon, sigmoid colon, rectum, part of anal canal (superior), urinary epithelium (bladder and most urethra). The

hindgut blood supply is the inferior mesenteric artery.

- **inferior mesenteric artery** - main blood supply to the hindgut
- **intestinal perforation** - gastrointestinal abnormality identified in neonates can be due to necrotizing enterocolitis, Hirschsprung's disease or meconium ileus.
- **intraembryonic coelom** - The "horseshoe-shaped" space (cavity) that forms initially in the third week of development in the lateral plate mesoderm that will eventually form the 3 main body cavities: pericardial, pleural, peritoneal. The intraembryonic coelom communicates transiently with the extraembryonic coelom.
- **meconium ileus** intestine obstruction within the ileum due to abnormal meconium properties.
- **mesentery** - connects gastrointestinal tract to the posterior body wall and is a double layer of visceral peritoneum.
- **mesothelium** - The mesoderm derived epithelial covering of coelomic organs and also line their cavities.
- **Midgut** - middle embryonic division of gastrointestinal tract contributing the small intestine (including duodenum distal bile duct opening), cecum, appendix, ascending colon, and part of the transverse colon (right half to two thirds). The midgut blood supply is the superior mesenteric artery.
- **neuralation** - The general term used to describe the early formation of the nervous system. It is often used to describe the early events of differentiation of the central ectoderm region to form the neural plate, then neural groove, then neural tube. The nervous system includes the central nervous system (brain and spinal cord) from the neural tube and the peripheral nervous system (peripheral sensory and sympathetic ganglia) from neural crest. In humans, early neuralation begins in week 3 and continues through week 4.
- **neural crest** - region of cells at the edge of the neural plate that migrates throughout the embryo and contributes to many different tissues. In the gastrointestinal tract it contributes mainly the enteric nervous system within the wall of the gut responsible for peristalsis and secretion.
- **peritoneal stomata** - the main openings forming the pathways for drainage of intra-peritoneal fluid from the peritoneal cavity into the lymphatic system.
- **pharynx** - uppermost end of gastrointestinal and respiratory tract, in the embryo beginning at the buccopharyngeal membrane and forms a major

arched cavity within the phrayngeal arches.

- **recanalization** - describes the process of a hollow structure becoming solid, then becoming hollow again. For example, this process occurs during GIT, auditory and renal system development.

- **retroperitoneal** - (retroperitoneum) is the anatomical space (sometimes a potential space) in the abdominal cavity behind (retro) the peritoneum. Developmentally parts of the GIT become secondarily retroperitoneal (part of duodenum, ascending and descending colon, pancreas)

- **somitogenesis** The process of segmentation of the paraxial mesoderm within the trilaminar embryo body to form pairs of somites, or balls of mesoderm. A somite is added either side of the notochord (axial mesoderm) to form a somite pair. The segmentation does not occur in the head region, and begins cranially (head end) and extends caudally (tailward) adding a somite pair at regular time intervals. The process is sequential and therefore used to stage the age of many different species embryos based upon the number visible somite pairs. In humans, the first somite pair appears at day 20 and adds caudally at 1 somite pair/4 hours (mouse 1 pair/90 min) until on average 44 pairs eventually form.

- **splanchnic mesoderm** - Gastrointestinal tract (endoderm) associated mesoderm formed by the separation of the lateral plate mesoderm into two separate components by a cavity, the intraembryonic coelom. Splanchnic mesoderm is the embryonic origin of the gastrointestinal tract connective tissue, smooth muscle, blood vessels and contribute to organ development (pancreas, spleen, liver). The intraembryonic coelom will form the three major body cavities including the space surrounding the gut, the peritoneal cavity. The other half of the lateral plate mesoderm (somatic mesoderm) is associated with the ectoderm of the body wall.

- **stomodeum** - (stomadeum, stomatodeum) A ventral surface depression on the early embryo head surrounding the buccopharyngeal membrane, which lies at the floor of this depression. This surface depression lies between the maxillary and mandibular components of the first pharyngeal arch.

- **stenosis** - abnormal a narrowing of the tube lumen, the abnormality naming is based upon the anatomical location.

- **superior mesenteric artery** - main blood supply to the Midgut.

- **viscera** - the internal organs in the main cavities of the body, especially those in the abdomen, for example the Template:Intestines.

- **visceral peritoneum** - covers the external surfaces of the intestinal tract and organs within the peritoneum. The other component (parietal

peritoneum) lines the abdominal and pelvic cavity walls.

- **yolk sac** - An extraembryonic membrane which is endoderm origin and covered with extraembryonic mesoderm. Yolk sac lies outside the embryo connected initially by a yolk stalk to the midgut with which it is continuous with. The endodermal lining is continuous with the endoderm of the gastrointestinal tract. The extra-embryonic mesoderm differentiates to form both blood and blood vessels of the vitelline system. In reptiles and birds, the yolk sac has a function associated with nutrition. In mammals the yolk sac acts as a source of primordial germ cells and blood cells. Note that in early development (week 2) a structure called the "primitive yolk sac" forms from hypoblast, this is an entirely different structure.

- **yolk stalk** - (vitelline duct, omphalomesenteric duct, Latin, vitellus = yolk of an egg) The endodermal connection between the midgut and the yolk sac. See vitelline duct.

ExpandOther Terms Lists

Terms Lists: ART | Birth | Bone | Cardiovascular | Cell Division | Endocrine | Gastrointestinal | Genital | Genetic | Head | Hearing | Heart | Immune | Integumentary | Neonatal | Neural | Oocyte | Palate | Placenta | Radiation | Renal | Respiratory | Spermatozoa | Statistics | Tooth | Ultrasound | Vision | Historic | Drugs | Glossary

Additional Information

Additional Information - *Content shown under this heading is not part of the material covered in this class. It is provided for those students who would like to know about some concepts or current research in topics related to the current class page.*

The following concepts were not covered in this lecture. Some will be introduced in the associated practical and some will be covered in the BGD Head Development component: mouth | tooth | salivary gland
References

1. ↑ Hikspoors JPJM, Peeters MMJP, Mekonen HK, Kruepunga N, Mommen GMC, Cornillie P, Köhler SE & Lamers WH. (2017). The fate of the vitelline and umbilical veins during the development of the human liver. *J. Anat.* , *231*, 718-735. PMID: 28786203 DOI.
2. ↑ Dixon LJ, Barnes M, Tang H, Pritchard MT & Nagy LE. (2013).

Kupffer cells in the liver. *Compr Physiol* , *3*, 785-97. PMID: 23720329 DOI.
3. ↑ Martin V & Shaw-Smith C. (2010). Review of genetic factors in intestinal malrotation. *Pediatr. Surg. Int.* , *26*, 769-81. PMID: 20549505 DOI.
4. ↑ Bower RJ, Sieber WK & Kiesewetter WB. (1978). Alimentary tract duplications in children. *Ann. Surg.* , *188*, 669-74. PMID: 718292

Terms

Gastrointestinal Tract Development

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- **foregut** - The first of the three part/division (**foregut** - midgut - hindgut) of the early forming gastrointestinal tract. The foregut runs from the buccopharyngeal membrane to the midgut and forms all the tract (esophagus and stomach) from the oral cavity to beneath the stomach. In addition, a ventral bifurcation of the foregut will also form the respiratory tract epithelium.
- **gastrula** - (Greek, *gastrula* = little stomach) A stage of an animal embryo in which the three germ layers ([E#endoderm|endoderm]/mesoderm/ectoderm) have just formed.
- **gastrulation** - The process of differentiation forming a gastrula. Term means literally means "to form a gut" but is more in development, as this process converts the bilaminar embryo (epiblast/hypoblast) into the trilaminar embryo (E#endoderm endoderm/mesoderm/ectoderm) establishing the 3 germ layers that will form all the future tissues of the entire embryo. This process also establishes the the initial body axes.
- **hindgut** - The last of the three part/division foregut - midgut - **hindgut**) of the early forming gastrointestinal tract. The hindgut forms all the tract from the distral transverse colon to the cloacal

membrane and extends into the connecting stalk (placental cord) as the allantois. In addition, a ventral of the hindgut will also form the urinary tract (bladder, urethra) epithelium.

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pairs eventually form.

- **splanchnic mesoderm** - Gastrointestinal tract (endoderm) associated mesoderm formed by the separation of the lateral plate mesoderm into two separate components by a cavity, the intraembryonic coelom. Splanchnic mesoderm is the embryonic origin of the gastrointestinal tract connective tissue, smooth muscle, blood vessels and contribute to organ development (pancreas, spleen, liver). The intraembryonic coelom will form the three major body cavities including the space surrounding the gut, the peritoneal cavity. The other half of the lateral plate mesoderm (somatic mesoderm) is associated with the ectoderm of the body wall.
- **stomodeum** - (stomadeum, stomatodeum) A ventral surface depression on the early embryo head surrounding the buccopharyngeal membrane, which lies at the floor of this depression. This surface depression lies between the maxillary and mandibular components of the first pharyngeal arch.

ExpandOther Terms Lists

Terms Lists: ART | Birth | Bone | Cardiovascular | Cell Division | Endocrine | Gastrointestinal | Genital | Genetic | Head | Hearing | Heart | Immune | Integumentary | Neonatal | Neural | Oocyte | Palate | Placenta | Radiation | Renal | Respiratory | Spermatozoa | Statistics | Tooth | Ultrasound | Vision | Historic | Drugs | Glossary

BGDB: Lecture - Gastrointestinal System | Practical - Gastrointestinal System | Lecture - Face and Ear | Practical - Face and Ear | Lecture - Endocrine | Lecture - Sexual Differentiation | Practical - Sexual Differentiation | Tutorial

Glossary Links

Glossary: A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | Numbers | Symbols | Term Link

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