


# BGD Lecture- GIT Development

**Movie: Embryo Development**



Movie: development.mov  
<http://anatomy.med.unsw.edu.au/cbl/embryo/Movies/Movies.htm>

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BEGINNINGS GROWTH AND DEVELOPMENT

**Development of the Gastrointestinal Tract**



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**Lecture Overview**



- Gastrointestinal Tract
  - Trilaminar embryo contribution
    - Endoderm, splanchnic mesoderm, neural crest
    - Yolk sac, fore-, mid-, hind-gut
  - Membranes, oral, cloacal
  - Folding, rotation, herniation
  - Mesentery, blood supply
- Tract
  - Esophagus, stomach, small intestine (ileum), large intestine (colon)
- Associated organs
  - Liver, gall bladder, pancreas, spleen


Lecture Slides (WebCT)  
<http://embryology.med.unsw.edu.au/Medicine/BGDlectureGIT.htm>

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**Key References: UNSW Embryology**

- This is a key educational resource developed for learning concepts in embryological development
  - <http://embryology.med.unsw.edu.au/>
- Class Notes
  - Class resource page designed to link with lecture and practical support materials for new medical curriculum
  - <http://embryology.med.unsw.edu.au/class.htm#BGD>



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**Key Ref: Developmental Biology**

- 6th ed. Gilbert, Scott F. Sunderland (MA): Sinauer Associates, Inc.; c2000
- This is a searchable online textbook covering development in all species
- Textbook Online
  - <http://www.ncbi.nlm.nih.gov:80/books/bv.fcgi?call=bv.View..ShowTOC&rid=dbio.TOC&depth=2>

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**Background Reading**

- Endoderm Development
- Mesoderm Development
  - Lateral plate mesoderm
    - Splanchnic mesoderm
  - Intraembryonic coelom
- Head Development
  - Formation of pharynx
- Neural Crest
  - Nerve plexus

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**GIT System**

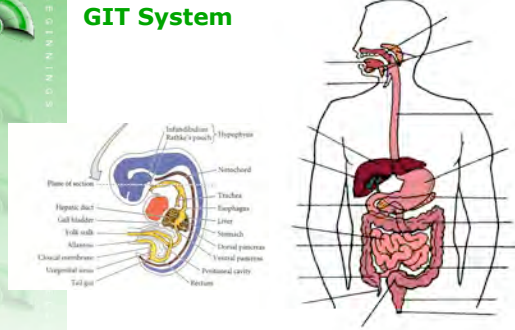


Image: Dev Biol. (Gilbert) ch15f27.jpg

Image: Merriam-Webster Medical Dictionary

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**Trilaminar Contribution**

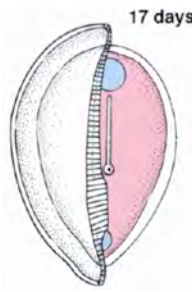
- Overview
  - simple tube converted into a complex muscular, glandular and duct network with associated organs
- Endoderm
  - epithelium of tract
  - glands
- Mesoderm
  - Splanchnic
    - muscular wall, connective tissue
- Ectoderm
  - Neural Crest
    - Muscular wall neural plexus

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**Gastrulation**

- Endoderm Layer
  - Early cells migrate adjacent to epiblast
  - line Primary Yolk sac to form Yolk Sac
- Mesoderm Layer
  - Later cells migrate
  - intraembryonic mesoderm
  - migrate laterally, rostrally, caudally
  - continues until week 4
- ECM adhesive pathways

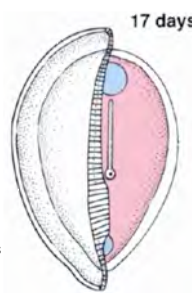


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**Membranes- Ectoderm/Endoderm**

- Rostrocaudal axis
  - ectoderm and endoderm without mesoderm
  - form ends of gut tube
- Buccopharyngeal membrane
  - Rostral (head)
    - breaks down to form oral cavity
- Cloacal membrane
  - Caudal (tail)
    - breaks down to form anus, urinary and genital openings

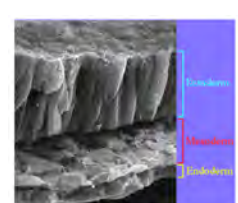


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**Germ Cell Layers**

- Ectoderm
  - nervous system, epidermis epithelia
- Mesoderm
  - muscle, skeleton, connective tissue
- Endoderm
  - gastrointestinal tract epithelia, respiratory tract, endocrine

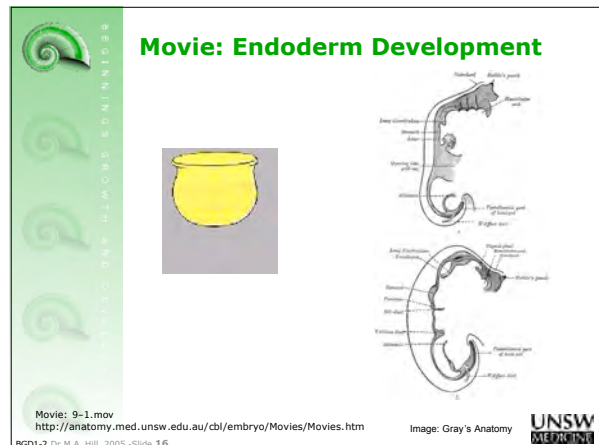
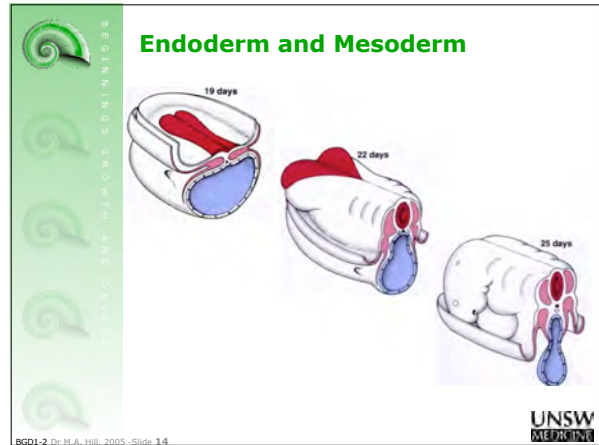
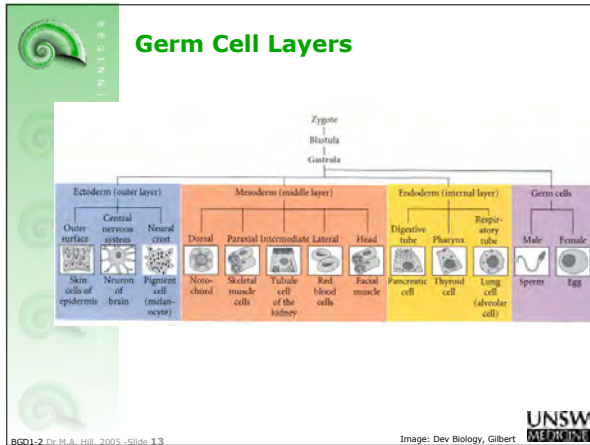


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Image: Embryo Images

# BGD Lecture- GIT Development



# BGD Lecture- GIT Development

## Embryonic Endoderm

- Forms the linings of two tracts (tubes)
- Digestive tract
  - Buds from this tube form the liver, gallbladder, and pancreas
- Respiratory tract
  - outgrowth of the digestive tract
  - bifurcates into two lungs
- Pharynx
  - common chamber in anterior region
  - outpockets generate
    - tonsils, thyroid, thymus, parathyroid glands

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## Movie: Yolk Sac / Endoderm

Early Late

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Movie: based on Larsen

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## GIT- Early Parts

- 4th week- 3 parts
  - Foregut
  - Midgut
  - Hindgut
- 2 specialized regions
  - buccopharyngeal membrane
  - cloacal membrane
    - apposition of ectoderm with endoderm
    - cloaca not just GIT

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## Early GIT

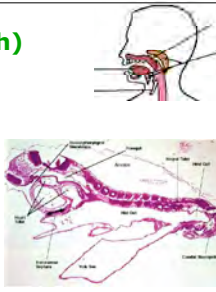
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Image: Dev Biol. (Gibert) ch1526.jpg

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### Oral Cavity (mouth)

- formed following breakdown of buccopharyngeal membrane
  - oropharyngeal, oral
- formed mainly by pharynx lying within pharyngeal arches
  - opening of GIT means that it contains amniotic fluid, which is also swallowed later in development

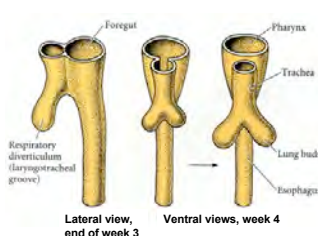


Covered in Head Development Lecture/Practical

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### Foregut Bifurcation



Partitioning of foregut into esophagus and respiratory diverticulum during week 3 and 4 of human gestation. (After Langman 1981.)


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Image: Dev Biol. (Gibert) ch1931.jpg

### Movie: GIT Canalization

- week 5 - endoderm in GIT wall proliferates
- week 6- totally blocked (occluding)
- over next two weeks tissue degenerates reforming a hollow gut tube
- week 8- GIT endoderm a tube once more
- Process is called recanalization
  - hollow, then solid, then hollow again
- Abnormalities
  - lead to duplications or stenosis



canalization

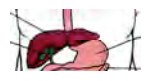
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Movie: based on Larsen

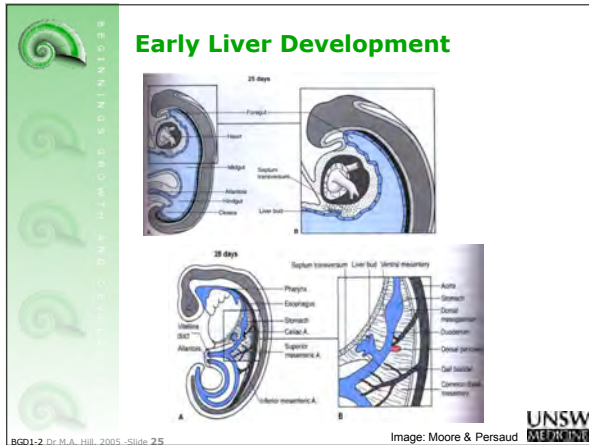
### Liver

- Arises at embryonic junction
- externally is where ectoderm of amnion meets endoderm of yolk sac
- internally is where the foregut meets the midgut
  - Septum transversum
  - mesenchymal structure of transverse septum provides a support within which both blood vessels and liver begin to form



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**Liver Bud**

- differentiates to form the hepatic diverticulum and hepatic primordium
  - generates the gall bladder then divides into right and left hepatic buds
- 3 connecting stalks
  - cystic duct
  - hepatic ducts
    - fuse to form bile duct

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**Hepatic Bud**

- Left Hepatic Bud
  - left lobe
  - quadrate
  - caudate
    - both q and c anatomically Left
- Right Hepatic Bud
  - right lobe
- Embryonic liver also involved in blood formation
  - Haemopoiesis
  - after yolk sac acting as primary site

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**Liver Structural Origins**

- Hepatic Buds
  - hepatocytes
  - produce bile from week 13
    - meconium of newborn
- Vitelline Veins
  - sinusoids
- Mesenchyme
  - connective tissue
  - Kupffer cells

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### Stomach Development

- During week 4
  - tube begins to dilate
  - forming an enlarged lumen in the tube
- Dorsal border grows more rapidly than ventral
  - establishes greater curvature of stomach
- Second rotation (90 degrees) occurs on longitudinal axis

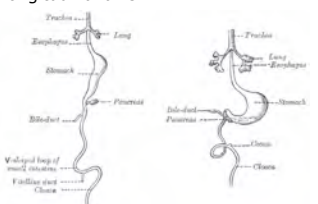


Image: Gray's Anatomy

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### Movie: Stomach Development



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### Movie: Lesser Sac Development



superior

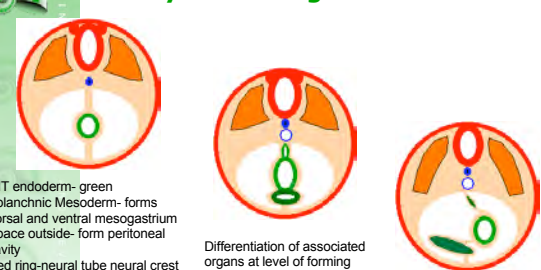
ventrolateral view

Movie: based on Larsen

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### Embryonic Mesogastrium



GIT endoderm- green  
Splanchnic Mesoderm- forms dorsal and ventral mesogastrium  
Space outside- form peritoneal cavity  
Red ring- neural tube neural crest  
Blue ring- notocord  
Orange- somites

Differentiation of associated organs at level of forming stomach occurs both dorsally (spleen) and ventrally (liver)  
Large blue ring- dorsal aorta  
Dark green ring- Liver

Continued growth of GIT and organs leads to organ movements and bending of tract.

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### Pancreas Development

- arises from 2 sources
  - the hepatic diverticulum (ventral)
  - the duodenum (dorsal)
- differentiates to establish specific cells for endocrine and exocrine function

In most individuals, the dorsal pancreatic bud loses its duct into the duodenum; however, in about 10% of the population, the dual duct system persists.

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Image: Dev Biol, (Gilbert) ch15f29.jpg

### Spleen Development

- spleen arises in week 5
  - within dorsal mesogastrum as proliferating mesenchyme
- Hemopoietic function
  - Cells arise from yolk sac wall
  - spleen generates both red and white cells in the 2nd trimester

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Images: Embryo Images

### Midgut Herniation

- Much of the midgut is herniated at the umbilicus
  - external to abdomen through development until week 11
  - rotation of midgut occurs to place elongating GIT in correct abdominal position with its associated mesentery
    - Dorsomesogastrium

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### Midgut Herniation

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Image: Gray's Anatomy

**Movie: GIT Rotation**

A simplified cartoon showing Midgut Rotation during Development.

rotation

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BGD1-2, Dr M.A. Hill, 2005, Slide 37 Movie: UNSW Embryology

**Movie: Cloaca**

- Common urogenital sinus

Cloaca development      Cloacal division

(Covered in Sexual Differentiation Practical)

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**Vitelline Blood Vessels**

- cover entire surface of yolk sac
- connect to embryo through yolk stalk
- Arteries
  - arises from dorsal aorta
  - contribute to adult GIT arteries
- Veins
  - empty into sinus venosus
  - contribute to the adult portal system

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**GIT Blood Supply**

- Foregut
  - celiac artery
- Midgut
  - superior mesenteric artery
- Hindgut
  - inferior mesenteric artery

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## GIT Mesenteries

- common dorsal mesentery
  - generate the mesenteries of the GIT

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## GIT Mesenteries

- ventral mesentery
  - contributes to the lesser omentum and falciform ligament

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## Stage 13/14 GIT Overview

Pig Gastro Intestinal Tract

Bifurcation of pharynx  
Anterior (respiratory)  
Posterior (oesophagus)

Stomach forming  
beneath lung buds  
adjacent to developing  
liver.

Below stomach GIT has  
a large dorsal mesogastrium  
and finer ventral mesogastrium.  
Associated with tract is  
large portal blood vessel from  
vitelline circulation.

Bottom curvature of embryo.  
Mesentery association with GIT  
shows extensive vitelline vessels  
running out through the umbilicus  
Hindgut, ending at the common  
urogenital sinus, the cloaca.

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## References Online

- UNSW Embryology
  - <http://anatomy.med.unsw.edu.au/cbl/embryo/embryo.htm>
- GIT Development
  - <http://anatomy.med.unsw.edu.au/cbl/embryo/Notes/git.htm>
- Embryo Images
  - GIT Development
- [http://www.med.unc.edu/embryo\\_images/unitdigest/digest\\_htms/digestoc.htm](http://www.med.unc.edu/embryo_images/unitdigest/digest_htms/digestoc.htm)
- NCBI- Bookshelf
  - Developmental Biology (Gilbert)
  - Chapter 15

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