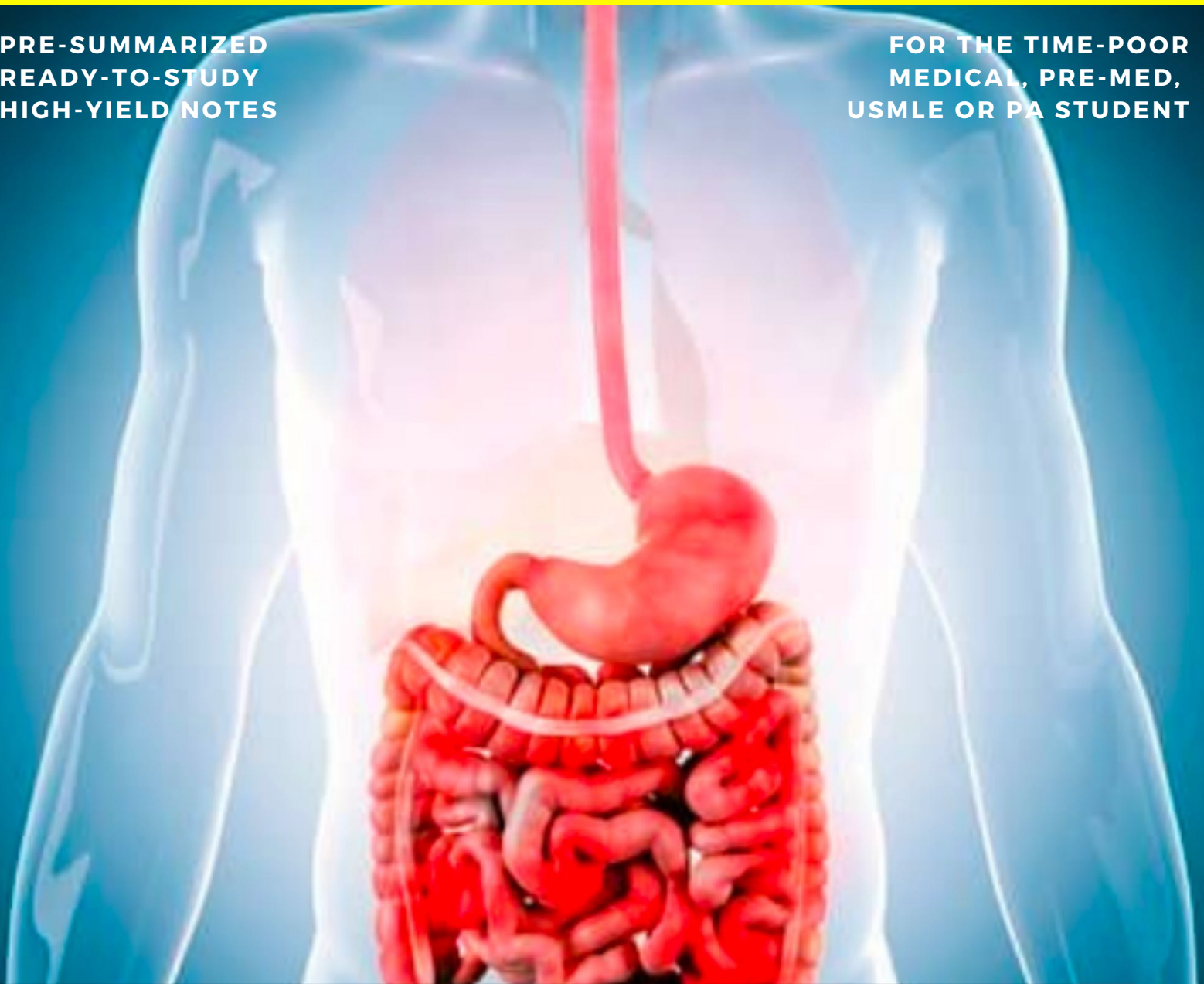


# **ANATOMY, PHYSIOLOGY & PATHOLOGY NOTES OF THE GASTROINTESTINAL SYSTEM**

## **FOURTH EDITION**

**PRE-SUMMARIZED  
READY-TO-STUDY  
HIGH-YIELD NOTES**

**FOR THE TIME-POOR  
MEDICAL, PRE-MED,  
USMLE OR PA STUDENT**



**210 PAGES**



## A Message From Our Team

Studying medicine or any health-related degree can be stressful; believe us, we know from experience! The human body is an incredibly complex organism, and finding a way to streamline your learning is crucial to succeeding in your exams and future profession. Our goal from the outset has been to create the greatest educational resource for the next generation of medical students, and to make them as affordable as possible.

In this fourth edition of our notes we have made a number of text corrections, formatting updates, and figure updates which we feel will enhance your study experience. We have also endeavoured to use only open-source images and/or provide attribution where possible.

**If you are new to us, here are a few things to help get the most out of your notes:**

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## Table Of Contents:

**What's included:** Ready-to-study anatomy, physiology and pathology notes of the gastrointestinal system presented in succinct, intuitive and richly illustrated downloadable PDF documents. Once downloaded, you may choose to either print and bind them, or make annotations digitally on your ipad or tablet PC.

### Anatomy & Physiology Notes:

- GENERAL OVERVIEW OF THE GASTROINTESTINAL SYSTEM
- GASTROINTESTINAL MOTILITY
- GI TRACT SECRETIONS
- GI TRACT ABSORPTIONS
- SPECIFIC STRUCTURES ALONG THE GASTROINTESTINAL TRACT
- HEPATOBIILIARY ANATOMY & PHYSIOLOGY:
- NUTRITION BASICS

### Pathology Notes:

- DYSPHAGIA & ACHALASIA
- OESOPHAGITIS
- OESOPHAGEAL VARICES
- MALLORY WEISS TEAR
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- GORD – GASTRO OESOPHAGEAL REFLUX DISEASE, BARRETT'S OESOPHAGUS & OESOPHAGEAL TUMOURS
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- HELICOBACTER PYLORI
- GASTRIC CANCER
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- CONGENITAL PANCREATIC ABNORMALITIES
- PANCREATITIS
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- FAMILIAL LIVER DISEASES
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- SECONDARY LIVER DISEASES
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- ASCITES
- PORTAL HYPERTENSION:
- LIVER CANCERS
- CHOLANGIOCARCINOMA (Bile Duct Carcinoma):
- GALLBLADDER CARCINOMA
- LIVER ABSCESES & CYSTS
- MECKEL'S DIVERTICULUM
- BOWEL OBSTRUCTIONS
- IRRITABLE BOWEL SYNDROME
- INFLAMMATORY BOWEL DISEASES
- DIVERTICULOSIS & DIVERTICULITIS
- APPENDICITIS
- POLYPS & COLON CANCER
- HIRSCHPRUNGS DISEASE

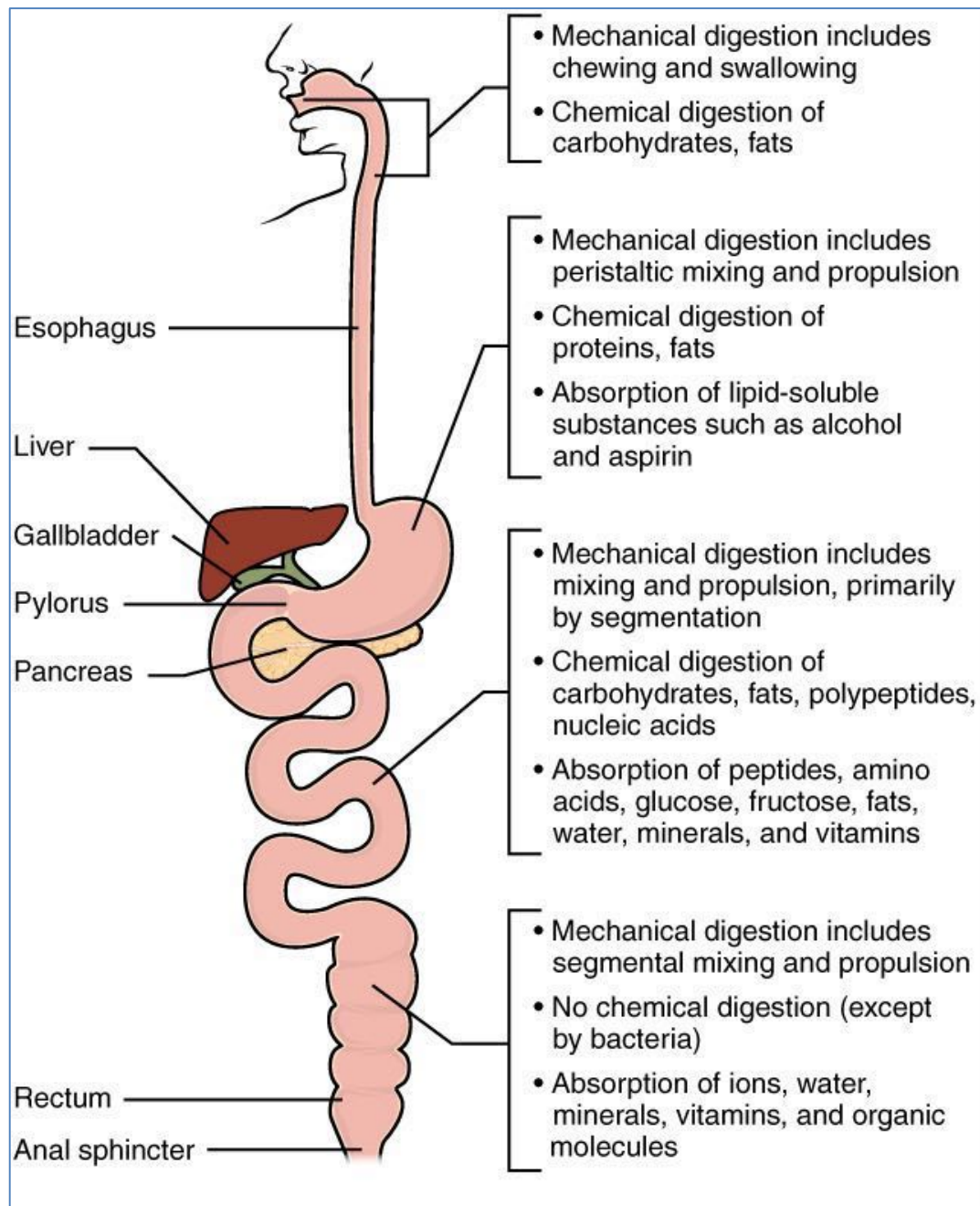
- ISCHAEMIC BOWEL
- PSEUDOMEMBRANOUS COLITIS
- RADIATION ENTERITIS
- RECTAL BLEEDING DDX
- HAEMORRHOIDS
- ANAL FISTULAE
- ANAL FISSURES
- PILONIDAL SINUS
- CARCINOID SYNDROME
- CYSTIC FIBROSIS
- GASTROENTERITIS
- PARASITIC GUT INFECTIONS
- ACUTE ABDOMEN

## **GENERAL OVERVIEW OF THE GASTROINTESTINAL SYSTEM**

## GENERAL OVERVIEW OF THE GASTROINTESTINAL SYSTEM

### General Functions of the GIT:

- **Ingestion** of food (via mouth)
- **Mechanical breakdown** of food
- **Propulsion** – eg. Swallowing, movement through intestines etc.
- **Chemical Digestion**
  - Molecular breakdown
  - Via enzymes + acids
- **Secretion** (mucus/bile/alkaline)
- **Absorption**
  - Passage of nutrients from GI into blood/lymph
- **Excretion/Defecation**
  - Elimination of indigestible substances



## Structural Overview:

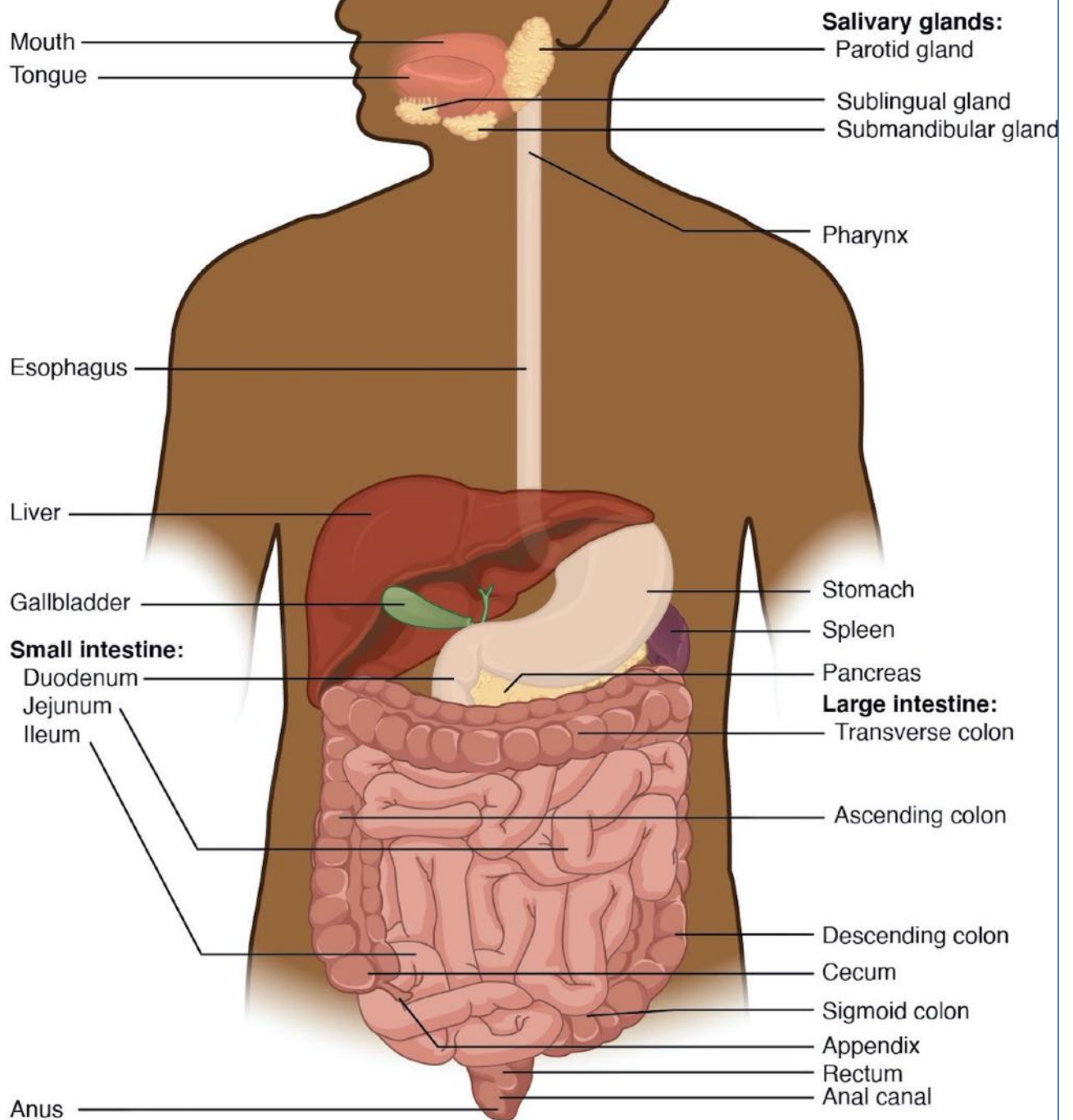
### The Alimentary Canal (9m approx)

- **Mouth**
- **Pharynx**
- **Oesophagus**
  - 25 cm long
  - Stratified Squamous
  - Upper 1/3 = striated muscle
  - Lower 2/3 = smooth muscle
- **Stomach**
- **Small intestine**
  - Duodenum
  - Jejunum
  - Ileum
- **Large intestine**
  - Vermiform appendix
  - Cecum
  - Ascending Colon
  - Transverse Colon
  - Descending Colon
  - Sigmoid Colon
  - Rectum
- **Anus**

### Accessory Digestive Organs

- **Teeth**
- **Tongue**
- **Salivary Glands**
  - Parotid
  - Sublingual
  - Submandibular
- **Glandular Organs**
  - Liver
  - Pancreas
- **Gallbladder**





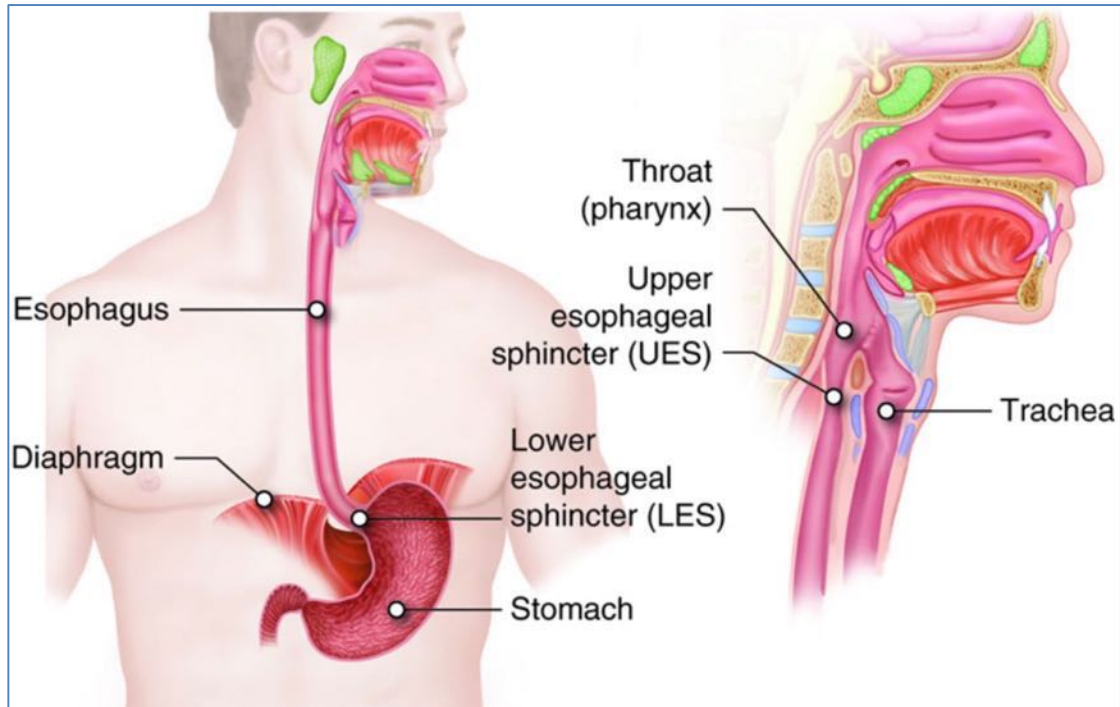
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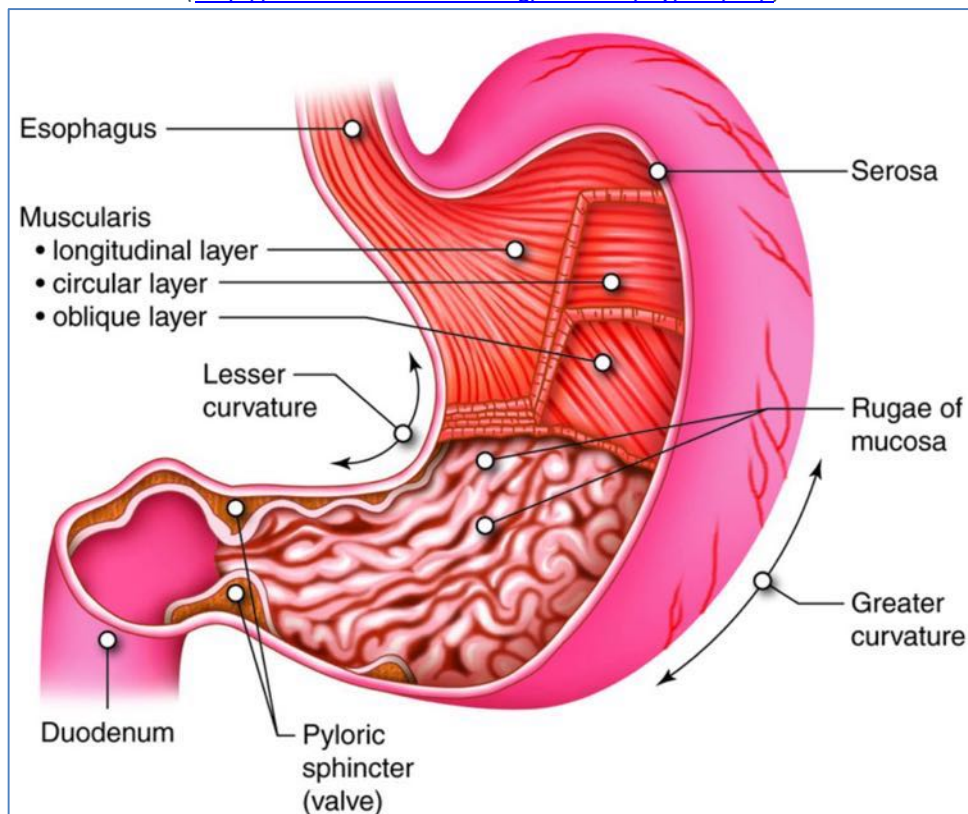
## Specialised Structures

- **Sphincters**

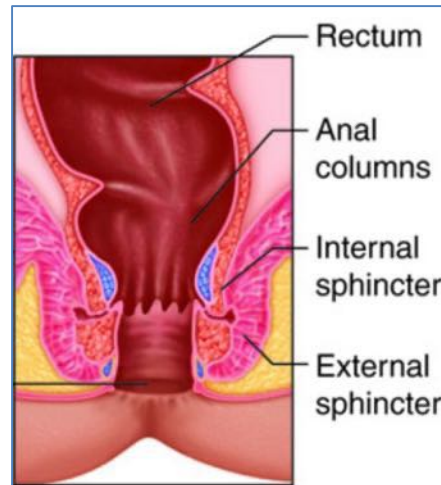
- Upper Oesophageal
- Lower Oesophageal
- Pyloric
- Ileocecal
- Internal Anal
- External Anal



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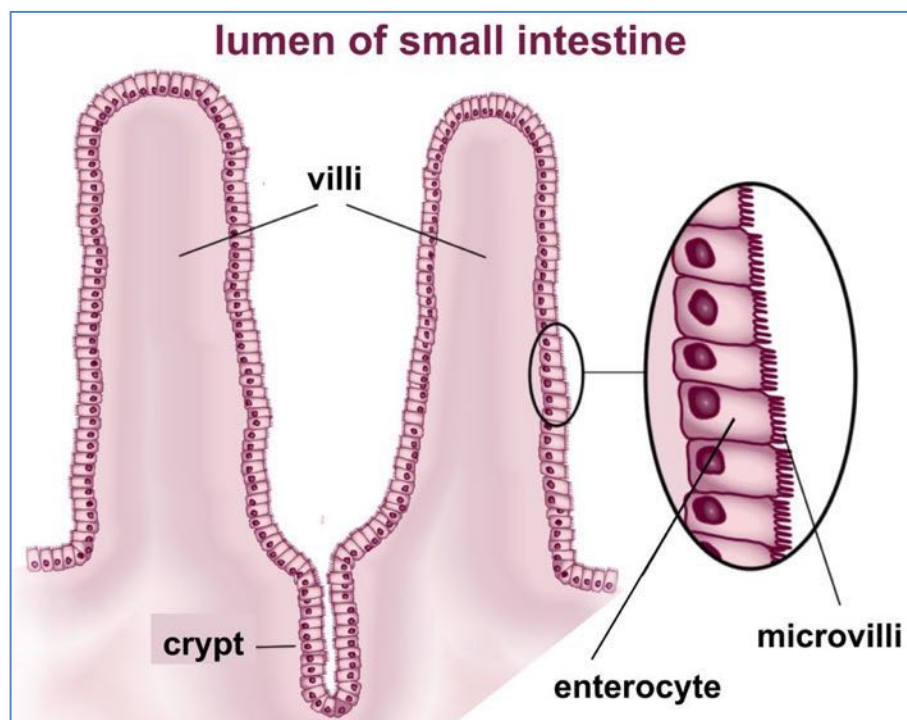


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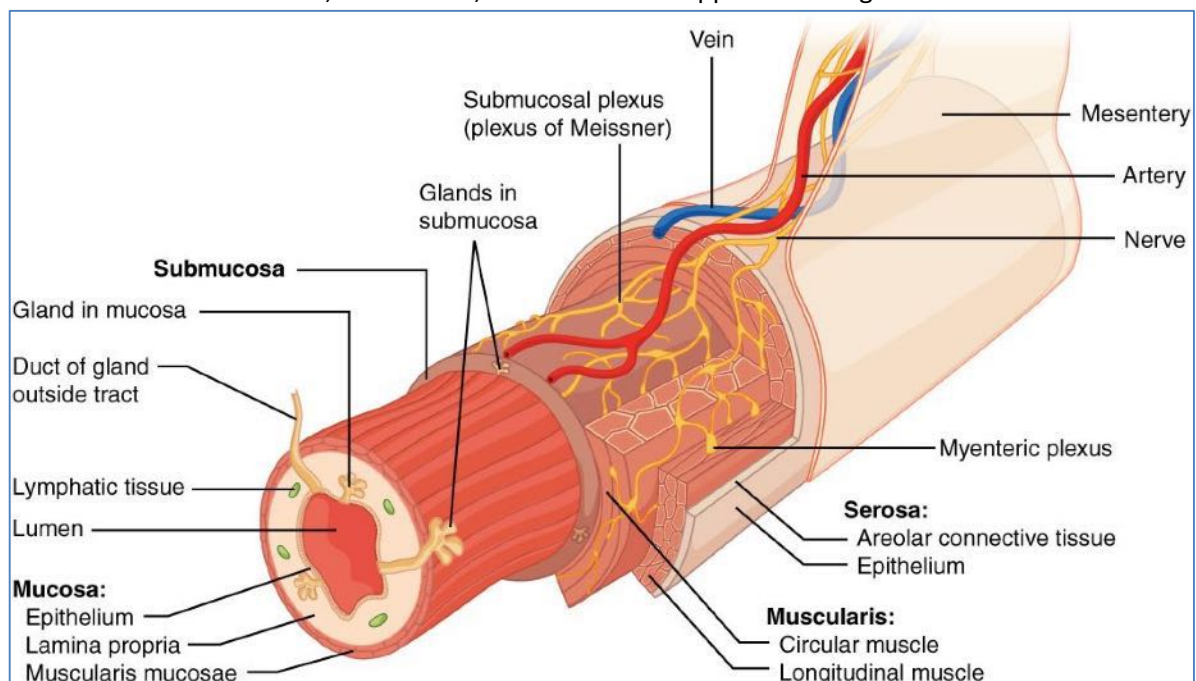
- **Pacemaker Zones:**
  - Set basic electrical rhythm
  - Controls rate of peristalsis in particular areas.
    - Stomach: 3 per min
    - Duodenum: 9-12 per min
    - Large Intestines: 2 per hour
- **Temporary Storage Sites:**
  - Mouth
  - Stomach
  - Colon
  - Rectum
- **Plicae, Villi & Microvilli:**
  - Increase surface area of absorptive areas
  - More effective absorption



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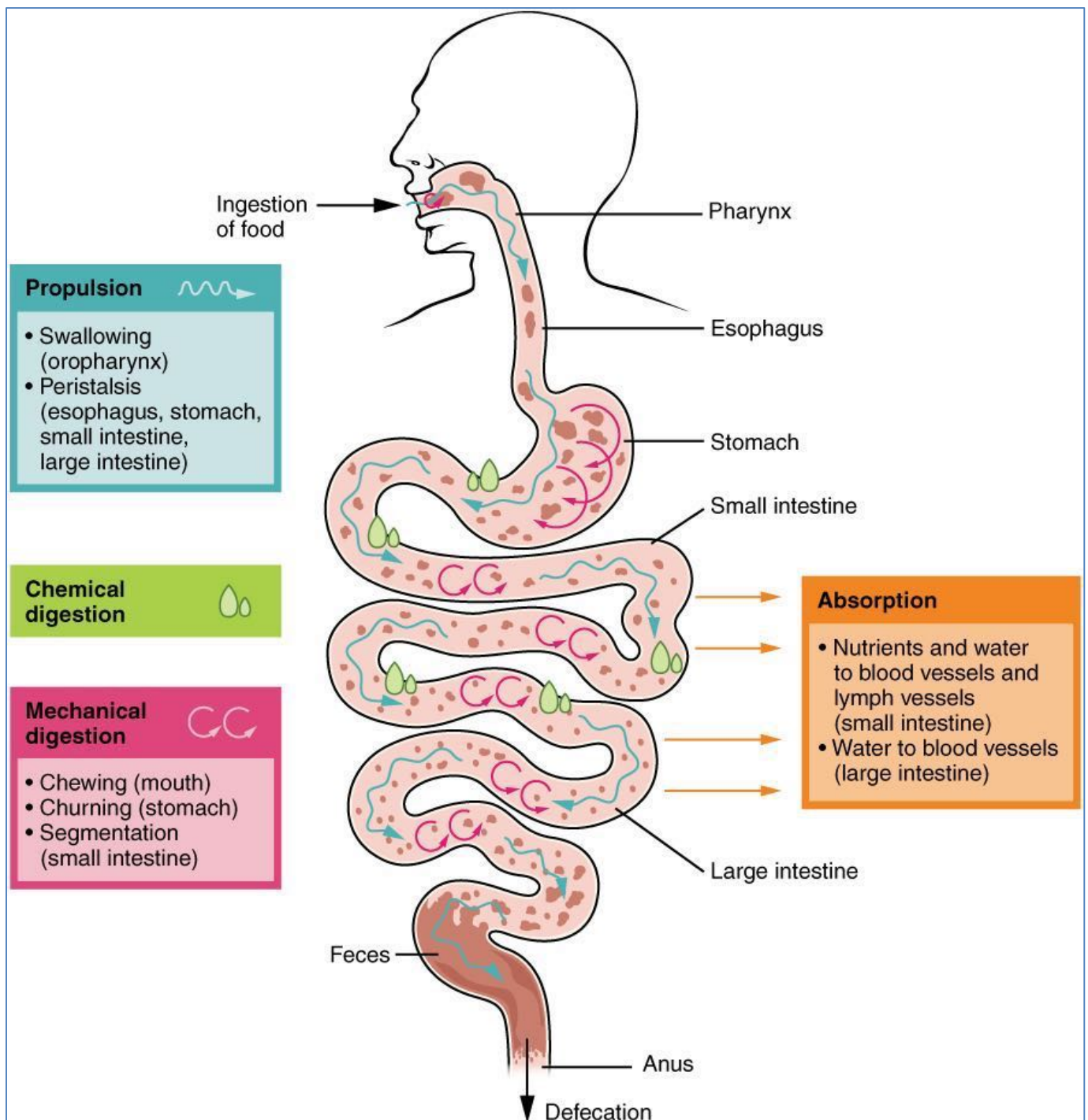
#### 4 Layers of GIT Lining (Histology & Function):

- **1. Mucosa**
  - **Histology:**
    - Folds (plicae)
    - Epithelium (simple columnar + goblet)
    - Lamina Propria (loose areola tissue)
    - Muscularis mucosae (smooth muscle)
  - **Functions:**
  - Secretion of mucin, digestive enzymes & hormones
  - Absorption of nutrients & fluids.
  - Protection from:
    - Acid
    - Bacteria
    - Mechanical stresses
- **2. Submucosa:**
  - **Histology:**
    - Dense conn. Tissue
    - Nerves
    - Blood vessels
    - Glands
  - **Functions:**
    - Vasculates & innervates GI tract wall
- **3. Muscularis:**
  - **Histology:**
    - Circular smooth muscle
    - Longitudinal smooth muscle
  - **Functions:**
    - Responsible for peristalsis
    - Forms sphincters (valves) – control passage of food
- **4. Serosa/Peritoneum**
  - **Histology:**
    - Areolar Connective Tissue
    - Mesothelium (single layered squamous epithelium)
    - (Dual layered peritoneum = mesentery)
  - **Functions:**
    - Lubrication, vasculature, innervations & support of GI organs



## Digestion Phases & Enzymes:

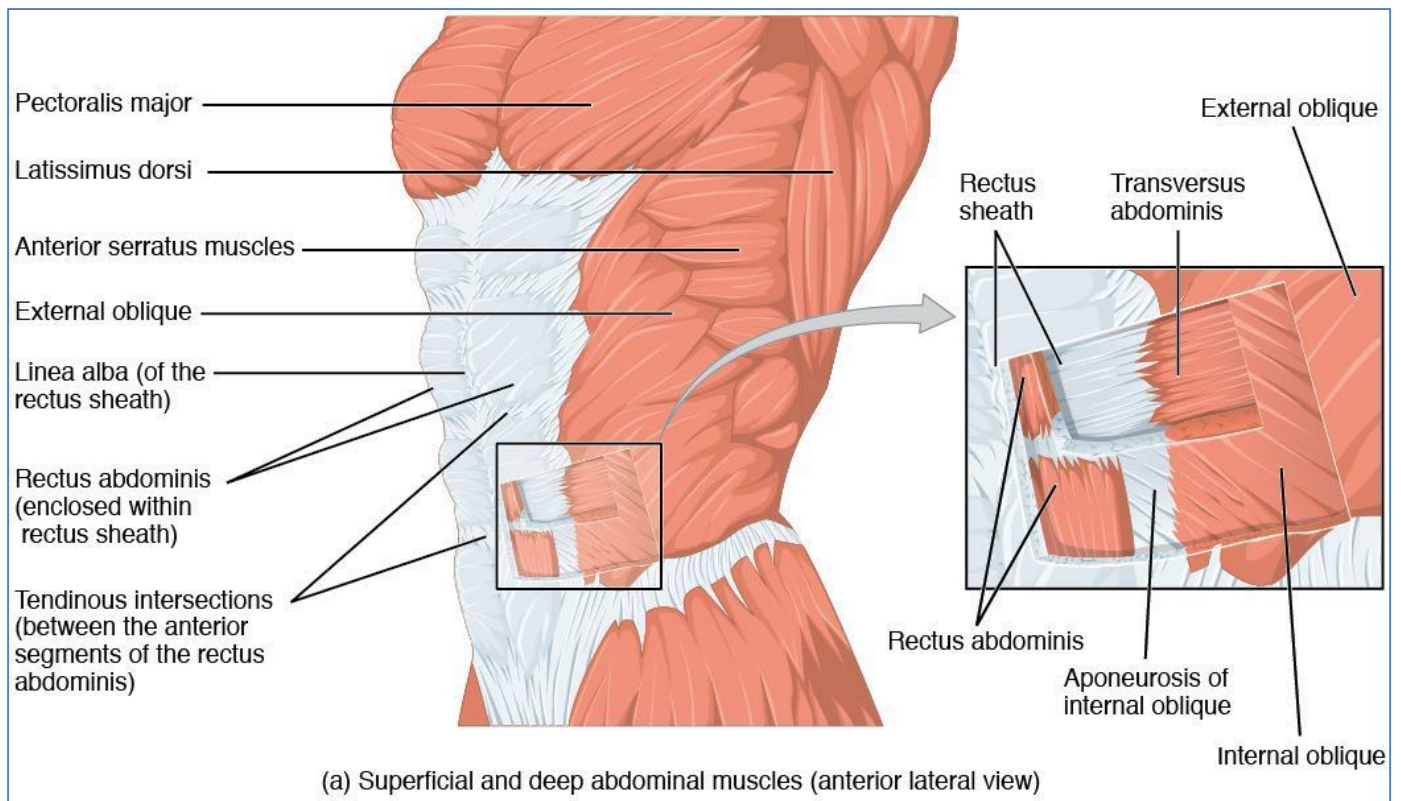
- **Mechanical Digestion:**
  - o Chewing
  - o Stomach
- **Chemical Digestion:**
  - o Saliva – Salivary Amylase (Simple Carb Digestion)
  - o Stomach – Acid + Pepsin (Protein Digestion)
  - o Liver – Bile (Fat Emulsification)
  - o Pancreatic Amylase – (Carb Digestion)
  - o Pancreatic Lipase – (Fat Digestion)
  - o Pancreatic Proteases – (Protein Digestion)
  - o Pancreatic Nucleases – (DNA/RNA Digestion)
- **Intestinal Absorption:**
  - o Fluid + Nutrients → Blood Vessels
  - o Fluid + Fats → Lymph Vessels





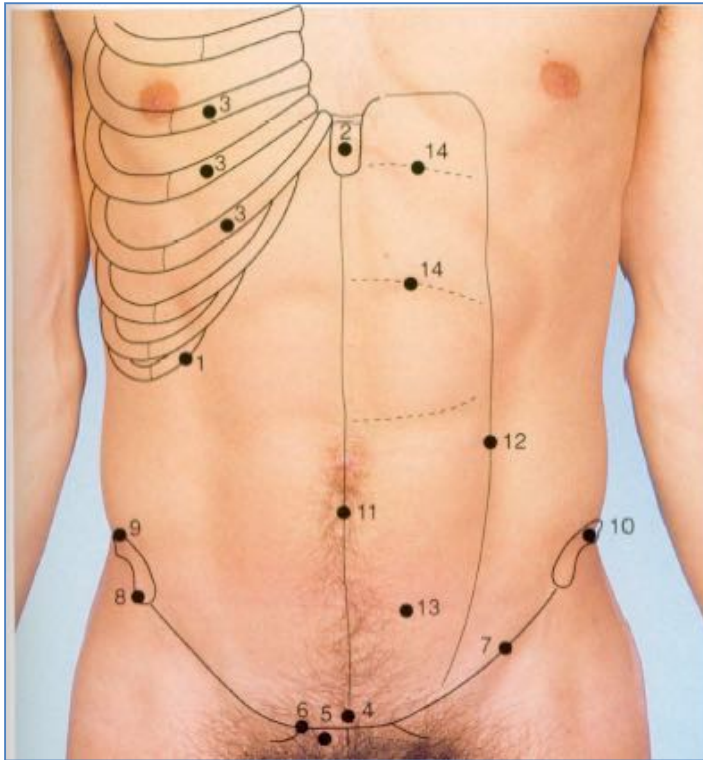
## **Abdominal Cavity:**

- **Boundaries:**
  - Diaphragm of lungs (**thoracic diaphragm**)
  - Broad Ligament of Pelvis
- **Layers of Abdominal Wall**
  - **Skin**
  - **Superficial Fascia**
    - Fatter Layer
    - Membranous Layer
  - **3 Muscle Layers – Separated by Deep Fascia**
    - Deep Fascia
    - External Oblique Muscle
    - Deep Fascia
    - Internal Oblique Muscle
    - Deep Fascia
    - Transverse Abdominal Muscle
    - Transversalis Fascia
  - **Parietal Peritoneum**
  - **Muscles**



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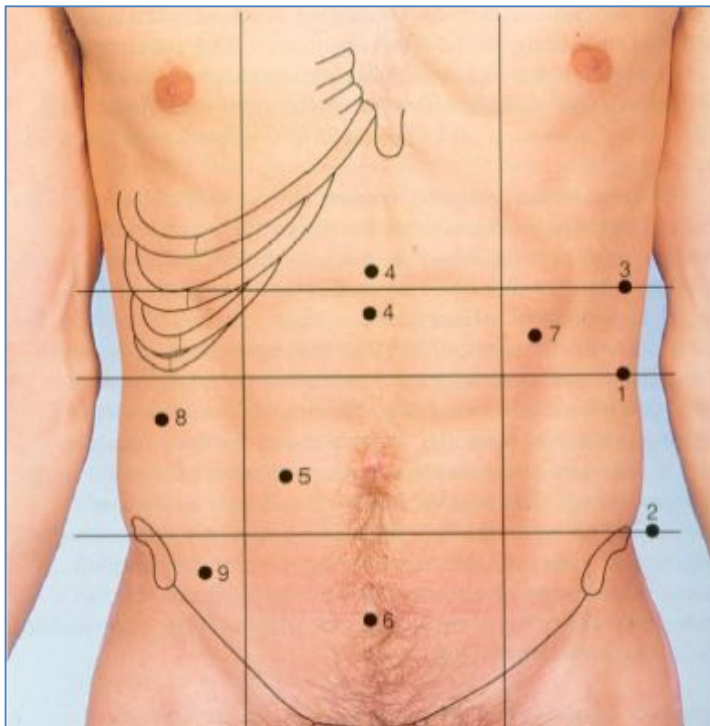
- **Bones & Surface Landmarks:**



1. Costal margin
2. Xiphisternum
3. Costal cartilages 5-7
4. Symphysis pubis
5. Body of pubis
6. Pubic tubercle
7. Inguinal ligament
8. Anterior superior iliac spine
9. Iliac crest
10. Iliac tubercle
11. Linea alba
12. Linea semilunaris
13. Rectus abdominis muscle
14. Tendinous intersections

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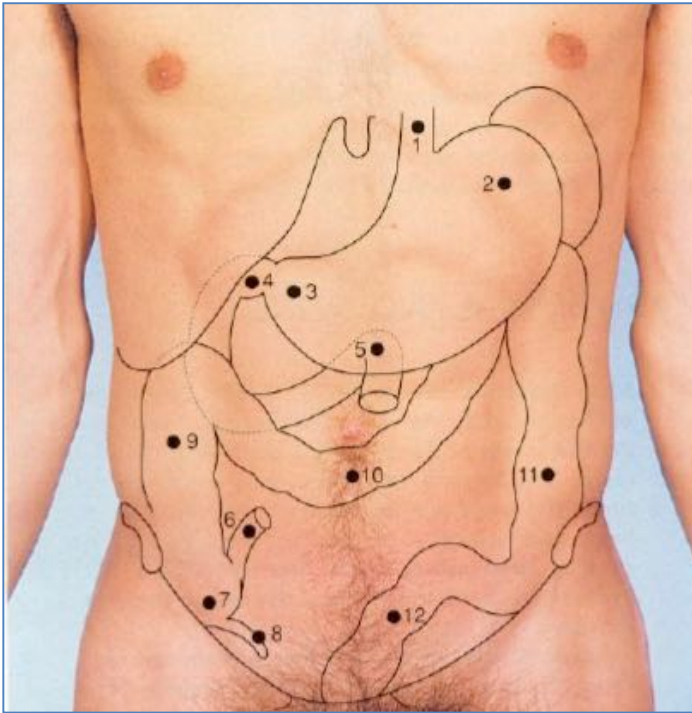
- **Regions:**



1. Subcostal plane
2. Transtubercular plane
3. Transpyloric plane
4. Epigastrium
5. Umbilical
6. Suprapubic
7. Hypochondrium
8. Lumbar
9. Iliac

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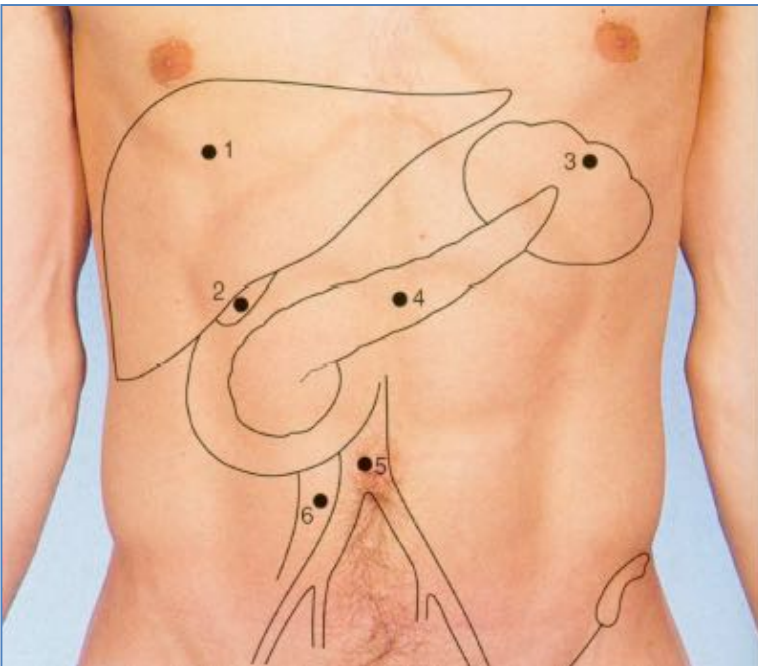
- **Placement of Abdominal Organs**



1. Esophagus
2. Stomach
3. Pyloric antrum
4. Duodenum
5. Duodenojejunal flexure
6. Terminal ileum
7. Caecum
8. Appendix
9. Ascending colon
10. Transverse colon
11. Descending colon
12. Sigmoid colon

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- **Placement of Accessory Structures**



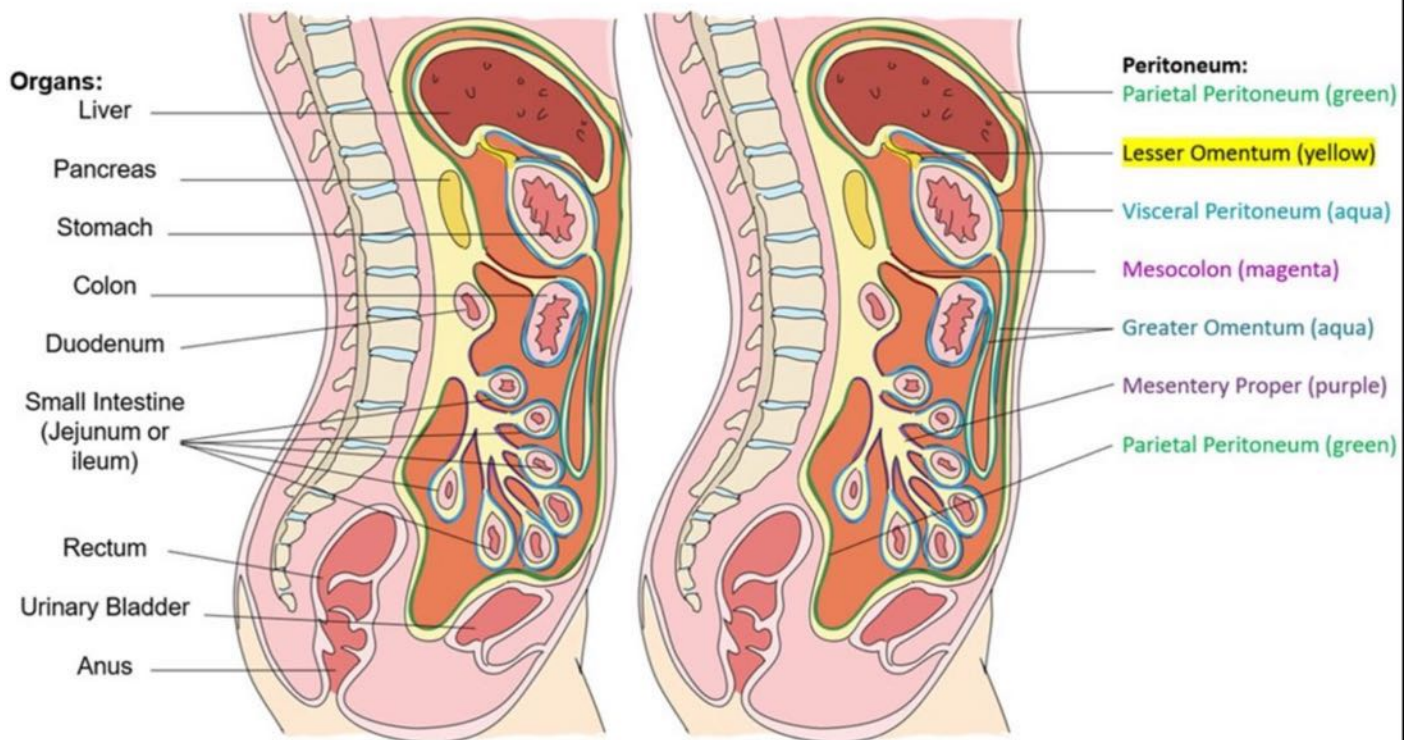
1. Liver
2. Gall Bladder
3. Spleen
4. Pancreas

Unattributable



## The Peritoneum:

- The slippery **serous membrane** of the abdomio-pelvic cavity:
  - **Visceral Peritoneum**
    - Covers external surfaces of most digestive organs
  - **Parietal Peritoneum**
    - Lines the body cavity wall
- **Peritoneal Cavity:**
  - The slit-like potential space between the 2 peritoneum.
  - Contains serous fluid (secreted by serous membranes)
    - Lubricates the mobile digestive organs
  - can be divided into the **greater and lesser peritoneal sacs**.
    - The **greater sac** comprises the majority of the peritoneal cavity.
    - The **lesser sac** (also known as the omental bursa) is smaller and lies posterior to the stomach and lesser omentum.
- **Mesenteries:**
  - Sheets of double-layered peritoneum
  - Connects digestive organs to the body wall
  - Contains blood vessels, nerves & lymphatics
  - **Lesser Omentum**
    - Lesser Curvature of Stomach
  - **Greater Omentum**
    - Greater Curvature of Stomach
  - **Transverse Mesentery**
    - Transverse Colon
  - **Mesocolon**
    - Ascending Colon
    - Descending Colon
  - **Mesentery Proper**
    - Jejunum
    - Ileum

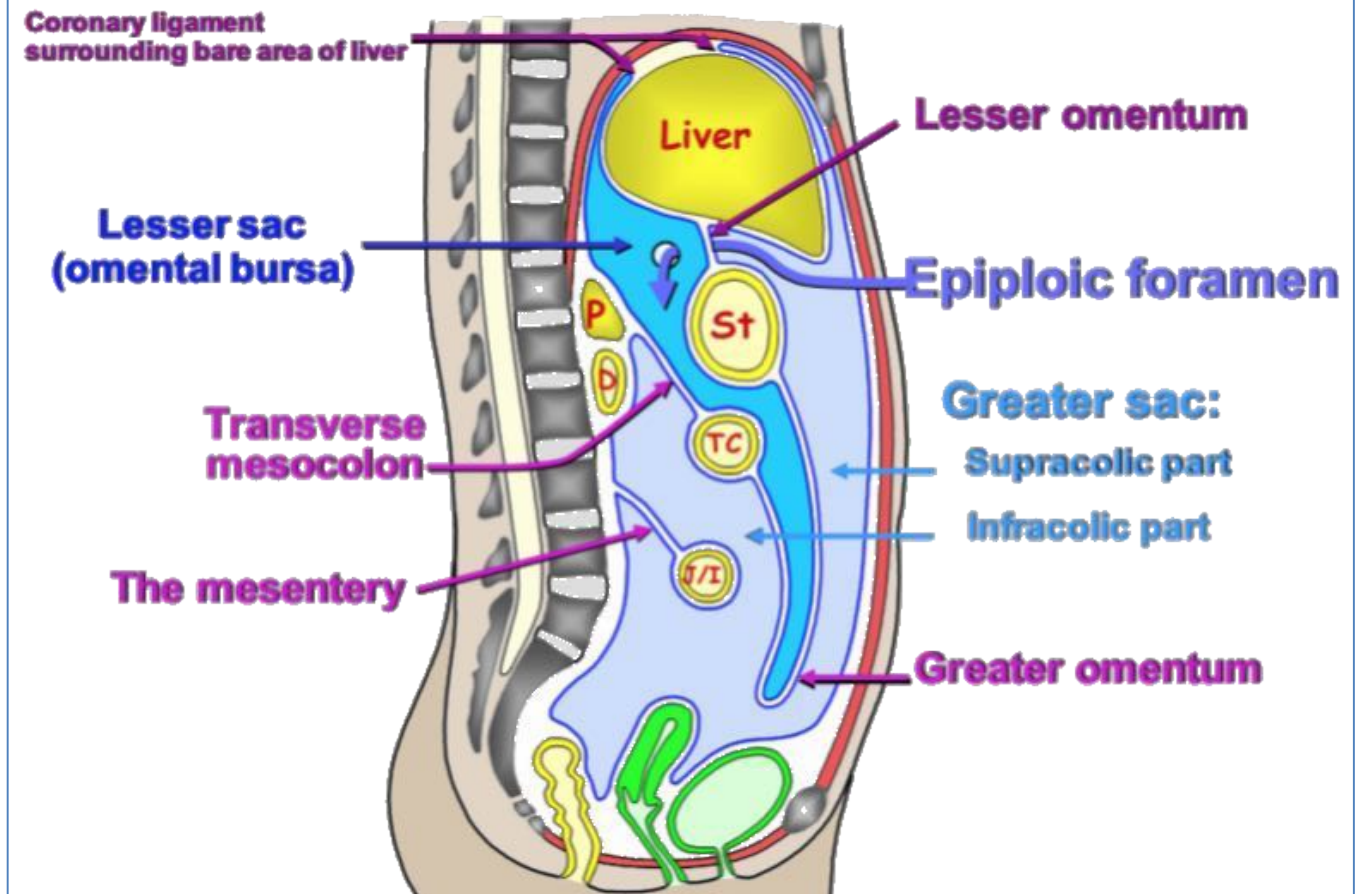


"Midsagittal View of Peritoneum" by KL Nguyen is a derivative from the original work of Daniel Donnelly is licensed under CC BY 4.0)

### Subdivisions of the Peritoneal Sac & Cavity:

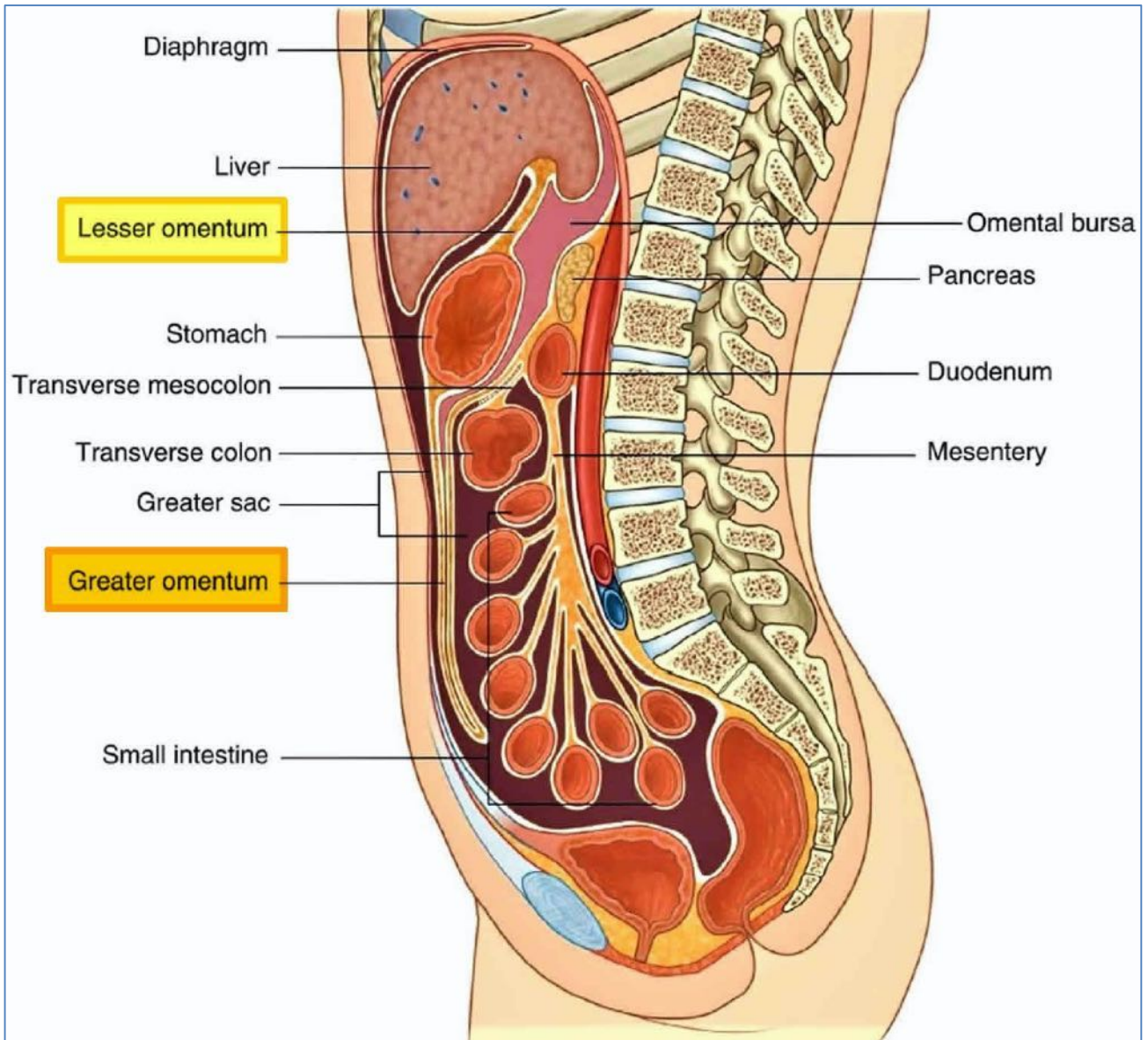
- **Greater Sac**
  - Supracolic Compartment
  - Infracolic Compartment
- **Lesser Sac**
  - Omental Bursa

## Subdivisions of the Peritoneal Sac & Cavity



Unattributable

- **Intra Vs. Retro – Peritoneal Organs:**
  - **Intra:** Inside the peritoneal cavity & suspended by mesentery.
    - Stomach
    - Gallbladder
    - Jejunum
    - Ileum
    - Cecum
    - Transverse Colon
    - Sigmoid Colon
  - **Retro:** Posterior to (outside) the peritoneal cavity adhered to the dorsal abdominal wall.
    - Parts of duodenum
    - Most of pancreas
    - Ascending & Descending Colon
    - Rectum

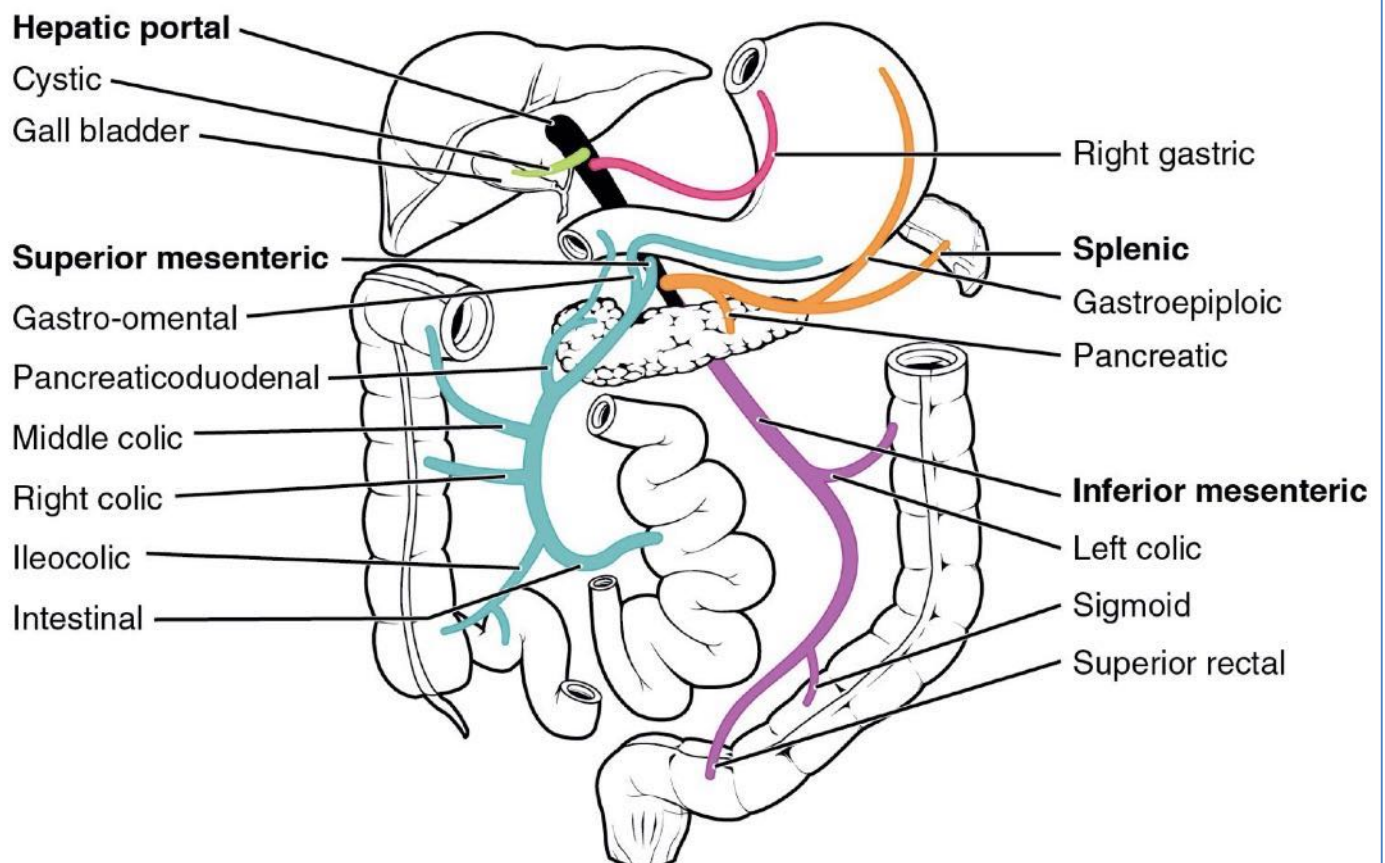


Source: <https://healthjade.net/omentum/>



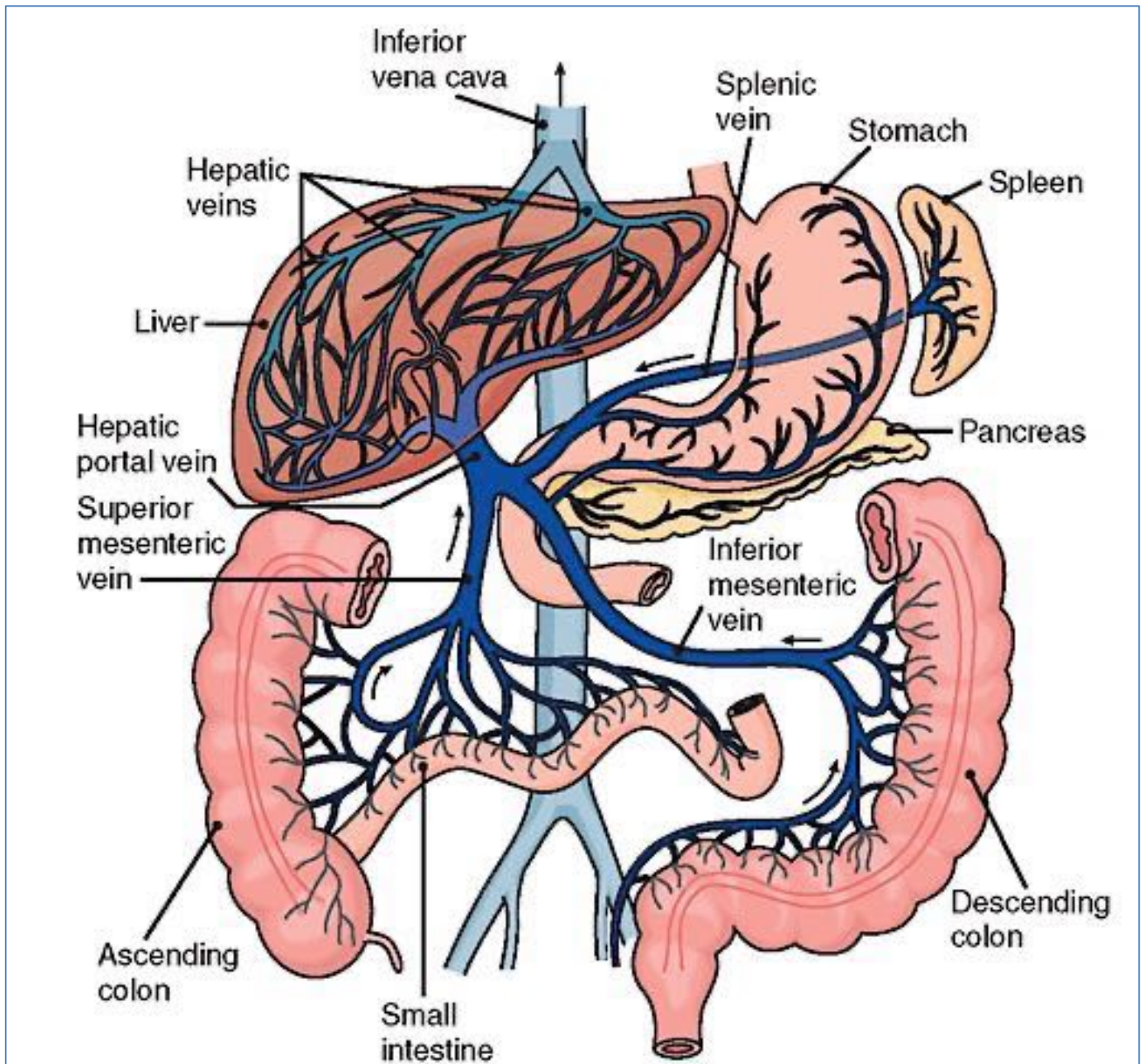
## Arterial Supply of GIT:

- **Foregut:**
  - **Celiac Trunk**
    - Pharynx
    - Oesophagus
    - Stomach
    - Upper Duodenum
    - Respiratory tract (incl. Lungs)
    - Liver
    - Gallbladder
    - Spleen
    - ½ of Pancreas
- **Midgut:**
  - **Superior Mesenteric**
    - ½ of Pancreas
    - Lower duodenum
    - Jejunum
    - Ileum
    - Cecum
    - Appendix
    - Ascending colon
    - 1<sup>st</sup> 2/3 of transverse colon
- **Hindgut:**
  - **Inferior Mesenteric**
    - Last 1/3 of transverse colon
    - Descending colon
    - Sigmoid colon
    - Rectum
    - Upper anal canal



## Venous Drainage of GIT

- Foregut:
  1. Portal Vein → Liver
  2. Left Gastric → Portal
  3. Right Gastric → Portal
  4. Splenic Vein → Portal
- Midgut:
  - Superior Mesenteric → Portal
- Hindgut:
  - Inferior Mesenteric → Splenic → Portal

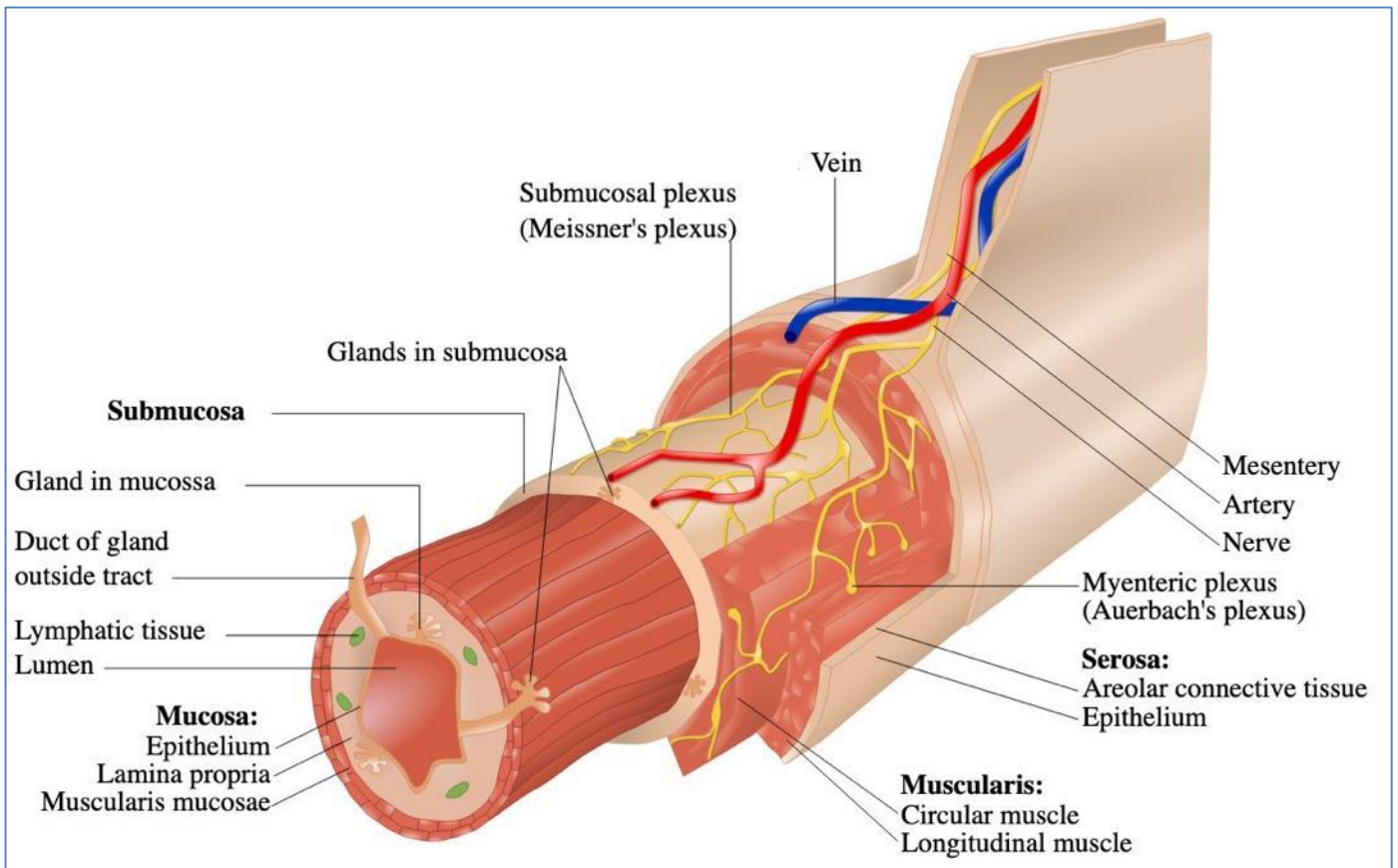


Source: <http://sapre.egre.mohammedshrine.org/hepatic-portal-vein-diagram.html>

## Innervation of GIT:

- **Intrinsic Innervation:**

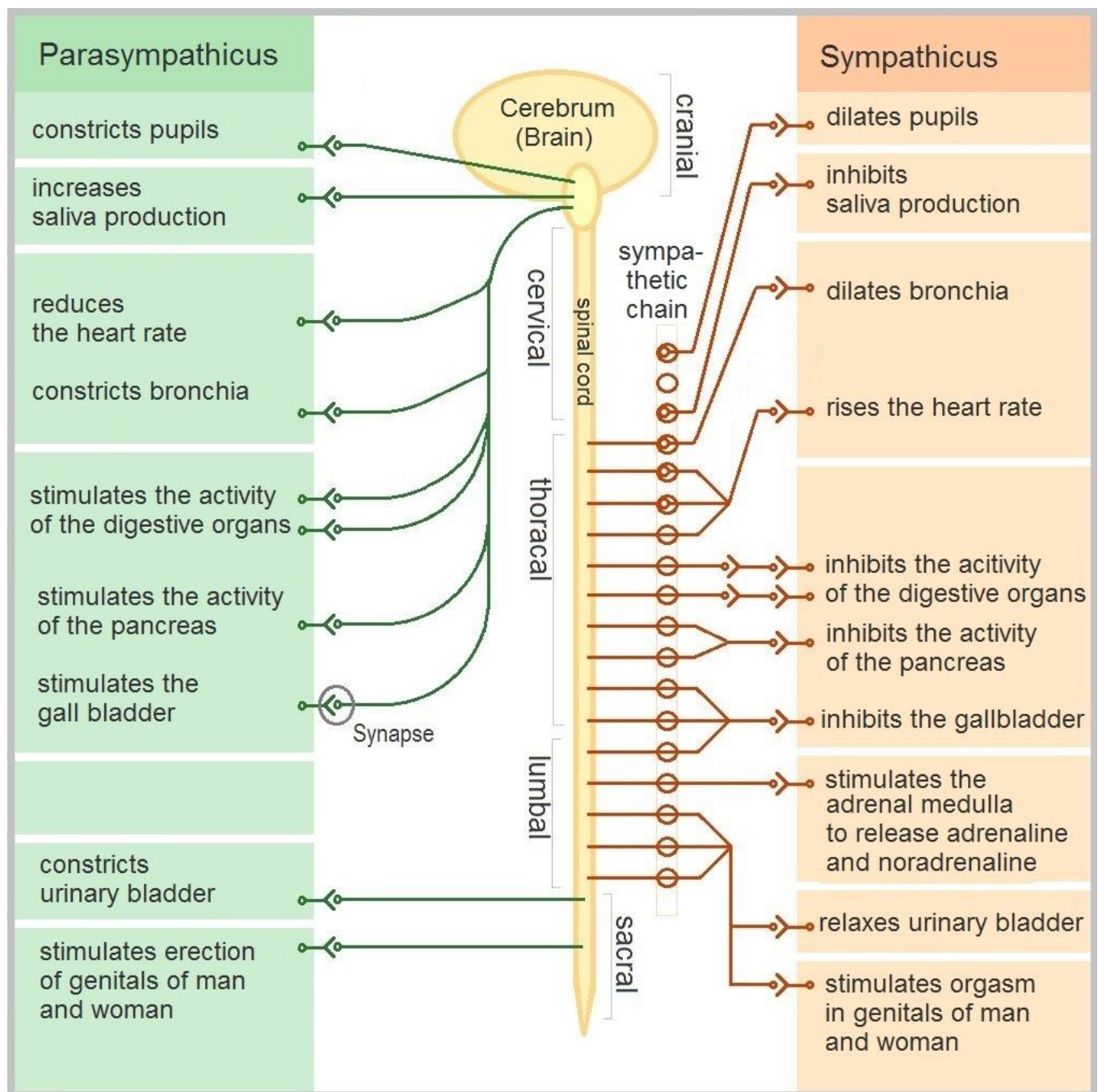
- From plexus between the 2 layers of the muscularis externa
- Also from plexus in submucosa
- Runs from Oesophagus all the way to the Rectum



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- **Extrinsic Innervation:**
  - From **Sympathetic Splanchnic nerves**
  - From **Parasympathetic Vagus (CNS)**

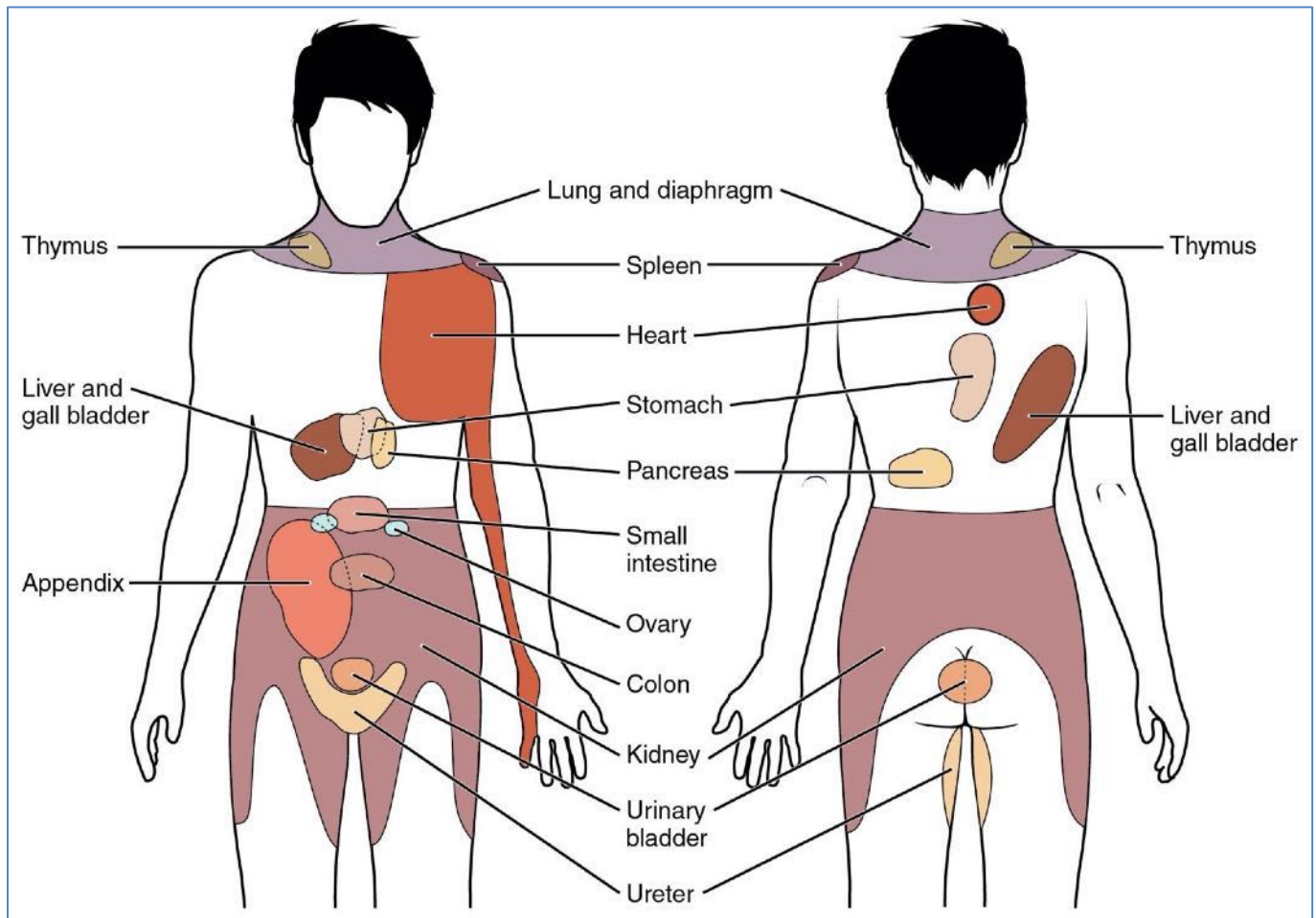


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- **Referred Pain:**

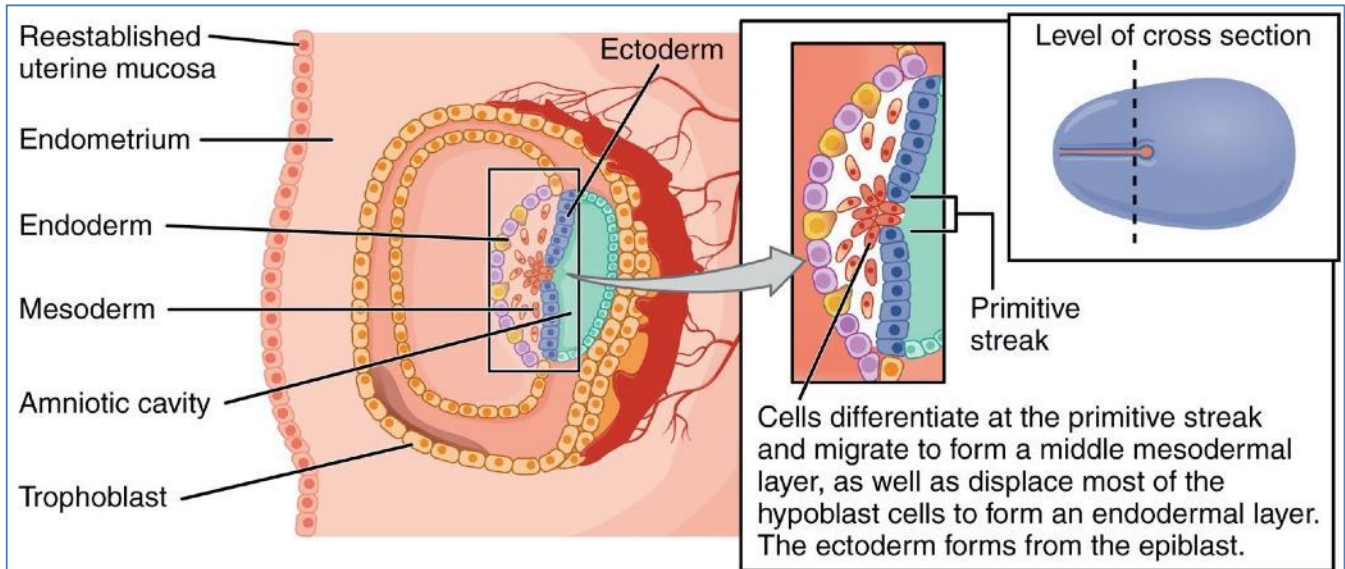
- Pain felt at a site away from the location of affected organ
- Due to lack of dedicated sensory pathways from internal organs.
- Pain is relayed to areas of skin and muscle instead.
- Known as “viscera-somatic convergence.”



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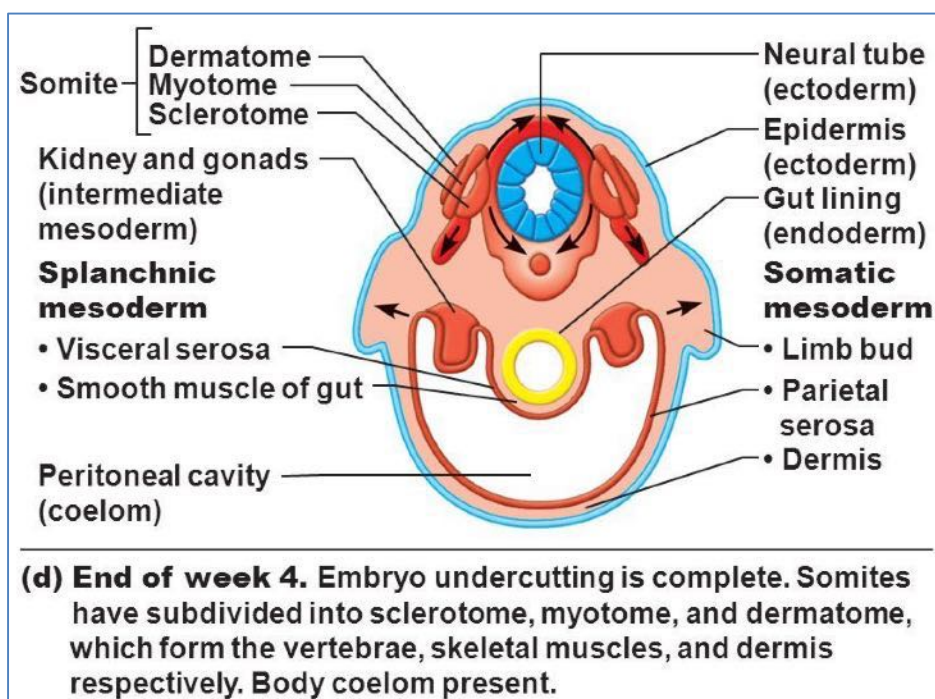
## Embryonic Development of GIT:

- **Week 3:**
  - **3 Primary Germ Layers:**
    - Ectoderm
    - Mesoderm
    - Endoderm



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- **Week 3 – 4:**
  - **GIT develops from the Endoderm & Mesoderm:**
    - **Endoderm:**
      - The epithelial lining of the primitive gut (alimentary tube)
    - **Mesoderm:**
      - The rest of the wall:
        - Submucosa
        - Muscularis Externa



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- **Week 4 – 8:**

- **Openings of GIT:**

- **Mouth:**

- The end of the **foregut merges with the ectoderm** on the head of the embryo at the “**stomodeum**”.
      - Forms the **oral membrane** – later breaks to form the mouth opening.

- **Anus:**

- The end of the **hindgut merges with the ectoderm** on the tail of the embryo at the “**proctodeum**”. (procto = anus)
      - Forms the **cloacal membrane** – later breaks through to form the anus.

- **Budding of Glandular Organs:**

- **Salivary Glands** - foregut

- **Liver** - midgut

- **Pancreas** – midgut

- Glands retain their connections, which later become ducts to GIT.

- **Stomach Appears**

- Different rates of growth causes rotation & greater/lesser curvatures

- **Respiratory Diverticulum**

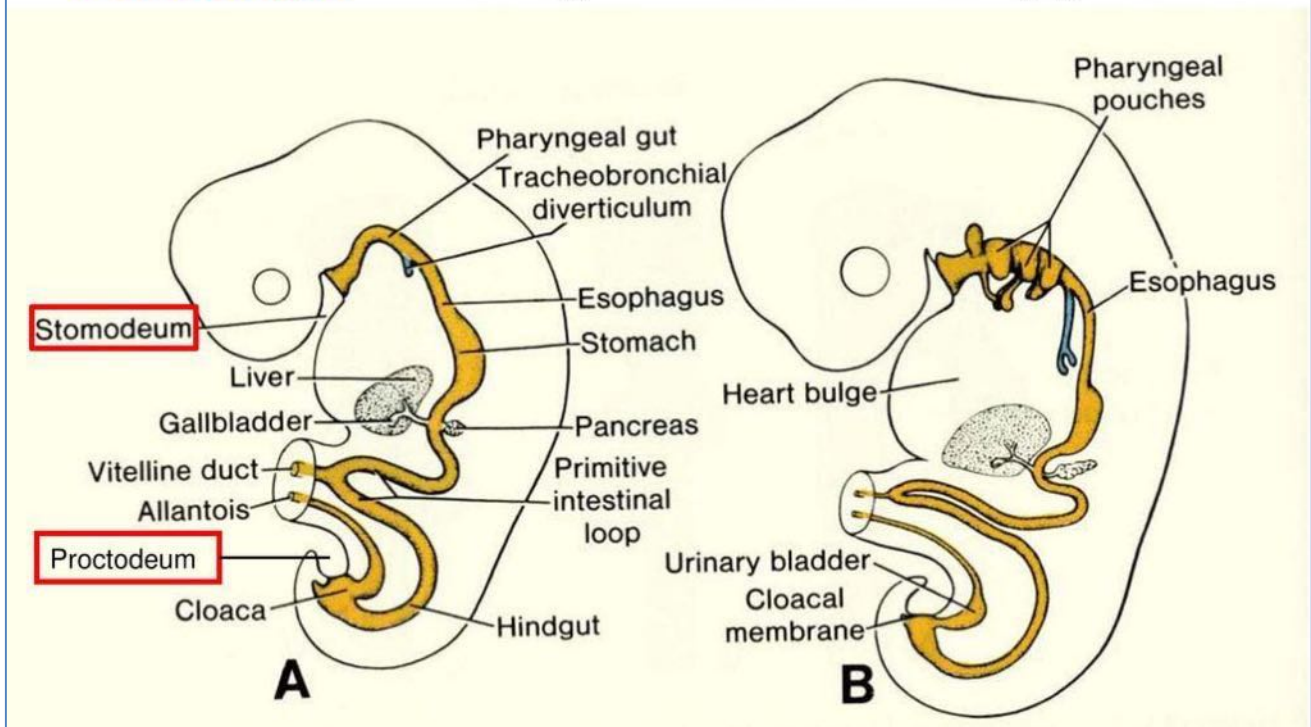
- **Dorsal Tube→Oesophagus**

- Rapidly lengthens with descent of heart & lungs

**Stomodeum** (primitive mouth) ⇒ the oral cavity + the salivary glands

**Proctodeum** ⇒ primitive anal pit

**Primitive gut** ⇒ whole digestive tube + accessory glands



Source: <https://slideplayer.com/slide/13069563/>

## GASTROINTESTINAL MOTILITY

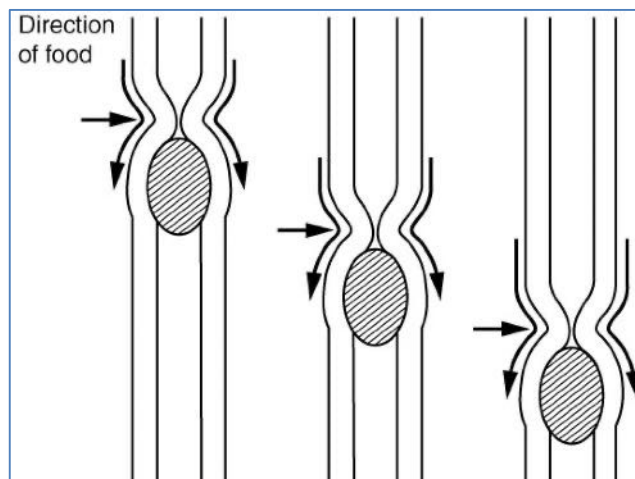
## GASTROINTESTINAL MOTILITY

### Motility Overview:

- Keeps things moving
- Food-matter must stay in specific places long enough → optimal digestion & absorption:
  - Oesophagus: 5-10s
  - Stomach: 1-3hrs
  - Small Intestine: 7-9hrs
  - Large Intestine: 25-30hrs      **Total: approx. 40hrs**
- **Involves Contraction & Relaxation of Muscles**
  - **Contraction:**
    - Mechanical digestion
    - Ensures contact between digest & epithelium
    - Propulsion of digest
    - Restriction of movement – Sphincters.
  - **Relaxation:**
    - Facilitates accommodation reflexes
    - Essential component of peristalsis
    - Essential component of swallowing
    - Opening of sphincters - movement

### Categories of Motility:

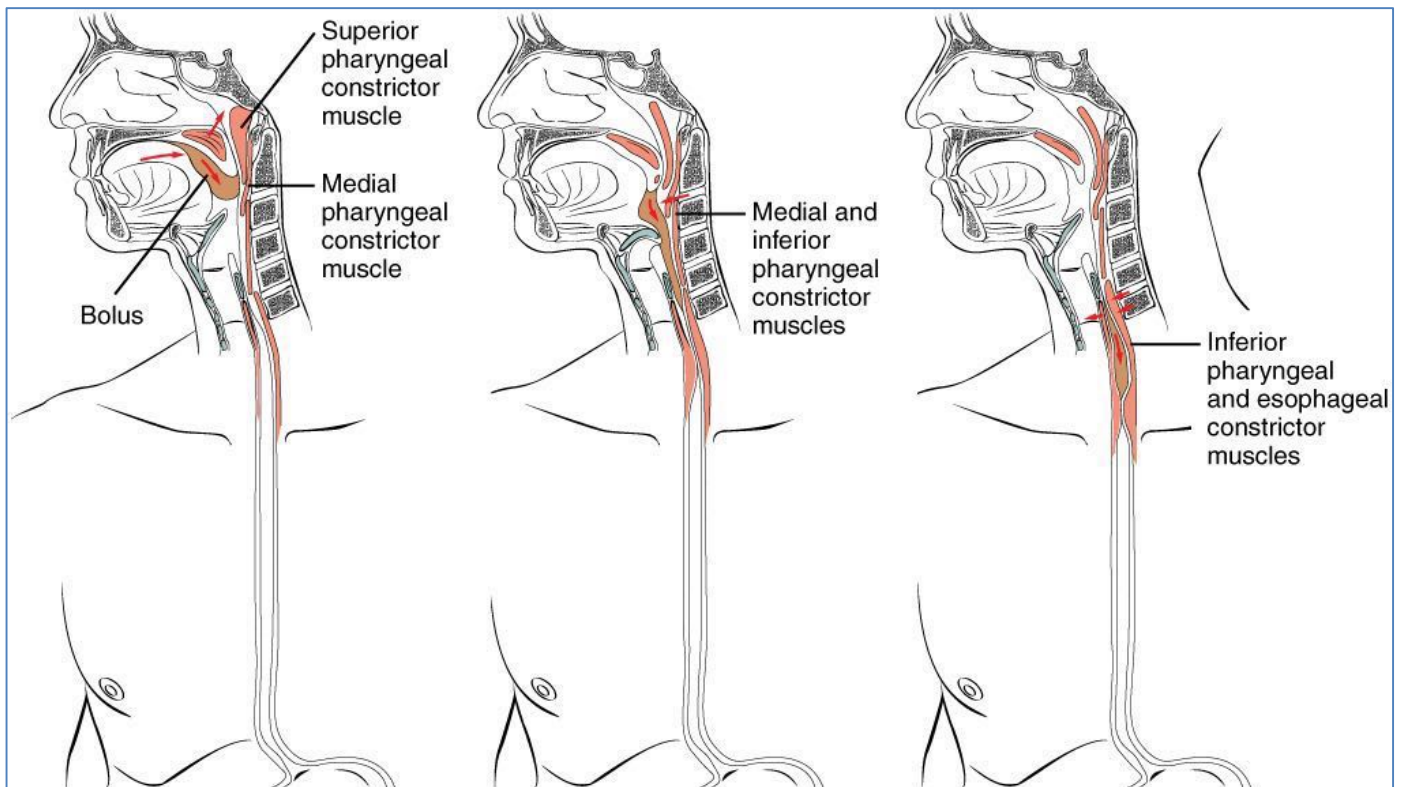
- **“Accommodation”**
  - Stretching – stomach
  - Smooth muscle relaxes
- **“Tonic Contraction”**
  - Continual partial contraction of GI Tract
- **“Peristalsis”** – Oesophagus (5-10sec), Stomach (1-3hrs).
  - Combination of Segmentation & Pendular Contraction.
  - **Segmentation**
    - Contractions of circular muscle
    - Follows no particular pattern – happens anywhere & anytime
    - Mixes GI Contents both backwards & forwards
    - Ensures all food contacts luminal wall → absorption
  - **Pendular Contractions**
    - Contractions of longitudinal muscles
    - Shortens & lengthens tube.
    - Similar to caterpillar action
- **“Migrating Motor Complex”** – Small Intestines (7-9hrs)
- **“Mass Movement”** – Large Intestines (25-30hrs)
- **“Defecation Reflex”** – Rectum & Anus (After 40hrs)





## Motility Mechanisms In Specific Places:

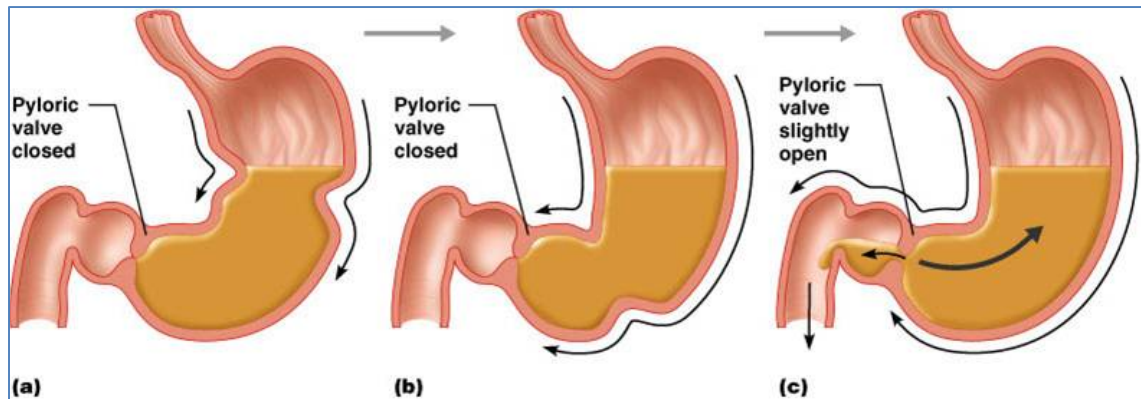
- **Oesophagus**
  - Peristalsis: *Deglutition* (swallowing)
    - **Buccal Phase**
      - Voluntary
      - Tip of tongue placed against hard palate
      - Tongue contracts → forces bolus of food into oropharynx
      - Food stimulates tactile receptors → start of Pharyngeal-oesophageal phase.
    - **Pharyngeal-Oesophageal Phase**
      - Involuntary – controlled by swallowing centre in medulla of brain-stem.
      - Once receptors are activated, respiration is inhibited:
        - Tongue blocks off mouth
        - Soft palate blocks off nasopharynx
        - Larynx rises → epiglottis covers its opening
      - Upper oesophageal sphincter relaxes → then tightens
      - Peristaltic contractions move bolus down oesophagus
      - Gastro-Oesophageal sphincter relaxes → food into stomach → then tightens



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- **Stomach**

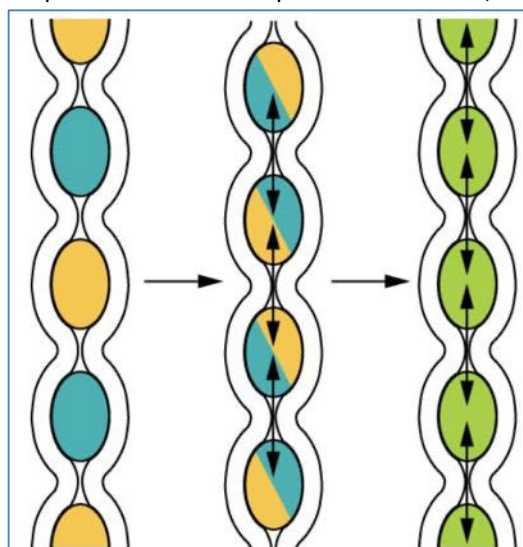
- **Peristalsis**
- Initiated by Cajal cells (pacemaker cells in longitudinal smooth muscle of fundus)
- Spontaneously depolarise & repolarise
- 3 waves per minute
- Waves move down body
- Waves gradually increase in intensity
- Very intense waves at pylorus – mashes food into chyme (homogenous solution)
- Usually each wave spits 3ml of chyme into duodenum



<https://www.austinncc.edu/apreview/PhysText/Digestive.html>

- **Small Intestine**

- **Segmentation** is the most common motion.
- Initiated by pacemaker cells in longitudinal smooth muscle layer
- 12-14 contractions / minute
- **Peristalsis: Migrating Motor Complex**
- Occurs after most nutrients have been absorbed.
  - Duodenal mucosa releases the hormone **motilin**.
  - →initiates peristalsis in duodenum → lasts for about 50-70cm then dies out.
  - Successive waves are initiated further along small intestines.
  - Hence the 'migrating' motor complex.
  - Takes approx 2 hrs for waves to reach ileocecal valve.
  - Process then repeats itself → sweeps food remnants, bacteria, etc.



**Figure 23.20 Segmentation** Segmentation separates chyme and then pushes it back together, mixing it and providing time for digestion and absorption.



- **Large Intestine**

- Inactive most of the time
- When presented with food → colon becomes motile
- Contractions are sluggish & short-lived
- ***Mass Movements***
- Long, slow-moving, but powerful contractile waves.
- Move over large areas of colon
- 3x Daily
- Force contents towards rectum

- **Rectum**

- Faeces are forced into rectum by Mass Movements.
- Rectum wall stretches → initiates defecation reflex:
- ***Defecation Reflex***
- Sigmoid-Colon & Rectum contracts + Internal Anal Sphincter relaxes
- Force on anal canal signals brain – ‘the urge’
- If defecation is delayed voluntarily, the defecation reflex dissipates within a few seconds.
- However with the next mass movement, the defecation reflex initiates again.

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