

HUMAN ANATOMY

Class Notes

Date: 7th March to 8th June 2019

DIGESTIVE SYSTEM:

Digestive system consists of two main parts:

- **Gastrointestinal Tract (GI Tract)**: consists of three main parts, starting and ending to anal opening. The three main parts are:

- **Foregut** (the anterior part of the alimentary canal, from the mouth to the duodenum): consisting of five parts:

① ▪ **Rima oris**: opening of the mouth which is located between the lips

② ▪ **Oral cavity** (mouth): consists of two parts:

- **Oral Vestibule / Vestibular part**: located anterior to teeth and gums, anterior and lateral walls of oral vestibule are lips and cheeks respectively, posterior wall consists of teeth and gums.
- **Oral Cavity Proper**: located posterior to teeth and gums, anterior and lateral walls of oral cavity proper are teeth and gums.

gums and teeth both anterior and posterior

The superior wall of oral cavity proper is the **palate** which is divided into two parts namely, **hard and soft palates**.

The hard palate (anterior region) is made of:

- **palatine process of maxilla**, and
- the **horizontal palate of palatine bone**.

The soft palate / palatal velum (posterior region of oral cavity proper) is formed by **four paired** and **one unpaired** muscles:

- **tensor veli palatini**,
- **levator veli palatini**,
- **palatoglossus** muscle,
- **palatopharyngeal** muscle,

and one unpaired muscle called **uvula** muscle.

Accessory organs:

- ① Teeth
- ② Tongue
- ③ Salivary glands
- ④ Liver
- ⑤ Gallbladder
- ⑥ Pancreas

Muscles helping swallowing and breathing are:

- 1) Musculus
- 2) Tensor palati (stretching)
- 3) Levator palati (elevating)
- 4) Palatoglossus
- 5) Palatopharyngeus
- 6) Uvulae

between palatoglossus and

palatopharyngeus is located **Palatine tonsils**

Organs of abdominal cavity are divided into 3 groups

- ① Intra peritoneal organs
- ② Meso peritoneal organs
- ③ Extra peritoneal organs

Floor of oral cavity:

- ① Mylohyoid
- ② Geniohyoid

Fouces
opening between oral cavity and pharynx.

The inferior wall of oral cavity proper is **oral diaphragm**, which is formed by two of suprahyoid muscles (~~digastric, stylohyoid~~, **geniohyoid**, and **mylohyoid** muscles). *Making the floor of oral cavity.*

The posterior wall of oral cavity proper has an opening called **isthmus faucium**, and it **connects the oral cavity to the pharynx**.

The isthmus faucium (located behind the mouth cavity, bounded superiorly by the soft palate, laterally by the palatoglossal arches, and inferiorly by the root of the tongue) is surrounded by

lymphoepithelial circle:

- **palatine tonsils**,
- **lingual tonsil**,
- **tubal tonsils**,
- **pharyngeal tonsils**

an important organ of immunity to prevent viruses and bacteria of going down the GI tract.

The **oral vestibule** and oral cavity are separated by teeth and gums.

- ③ Pharynx
- ④ Esophagus
- ⑤ Stomach

○ **Midgut** (the middle part of the alimentary canal, including (in vertebrates) the **small intestine**.): consisting of:

- **Small intestine:** *duodenum, jejunum, ileum*

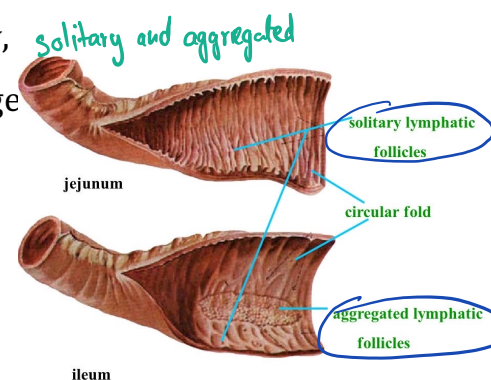
○ **Hindgut** (or epigaster, is the posterior (caudal) part of the alimentary canal): consisting of:

- **Large intestine:** *cecum, appendix, colon (ascending colon, transverse colon, descending colon, sigmoid colon)*, and **rectum** ending to **anus**

Wall of GI tract: consisting of four layers:

① ○ **Mucosa** of GI tract: innermost layer contains of:

- **folds** (plicae) which **increase the surface area for digestion**, and
- **lymphatic follicle** which are organs of immunity,
- **mucosal gland** that produce enzymes to help digest
- **mucosal villi** that are **projection for absorption**,



- **mucosal crypts** which are depression inside the wall increasing the surface area.

(Note: small intestine consists villi but the large intestine does not)

- ② ○ **Submucosa**: it is a portion of mucosa which separates mucosa from muscular coat *connects mucos layer to muscle layers*
- ③ ○ **muscularis / muscular coat**: consists of two layers:
 - **outer longitudinal layer** ← smooth muscle has 2 layers
 - **inner circular layer** (except stomach), ← contraction

skeletal (voluntary muscles)

1) Oral cavity

2) Pharynx

3) upper 1/3 of esophagus

4) Rectus

Muscular coat of stomach contains of three layers:

- outer (longitudinal layer)
- middle (circular layer)
- inner (oblique layer¹)

- ④ ○ **outer adventitia or serosa**: a superficial layer of portions of the GI tract that are suspended in the abdominal cavity. The serosa is a serous membrane composed of **areolar connective tissue** and **simple squamous epithelium** (mesothelium). The serosa is also called the *visceral peritoneum* because it forms a portion of the peritoneum. **The esophagus lacks a serosa**; instead, only a single layer of areolar connective tissue called the **adventitia** forms the superficial layer of this organ.

Note: From the embryological point of view (embryo position), there are anterior (liver), middle (stomach), and posterior (pancreas) appears in the development of the GI tract. However, in an adult human body, these sections are superior (liver), middle (stomach) and inferior (intestine).

- **Accessory Organs**: mainly glands (e.g. tongue, teeth, pancreas, liver, gallbladder, and salivary glands)

Tongue: contains skeletal muscle (voluntary muscle) and is inclusive of three parts:

- **Root** of the tongue
- **Body** of the tongue
- **Apex** of the tongue

↓
taste
speak
swallow
digest

Swallowing:

soft palate comes up, closing the nasal cavity.
epiglottis comes down, preventing food to get into the lungs.

Breathing:

soft palate comes down
epiglottis goes up, allowing for air.

¹ Only stomach has oblique layer

Root and **body** of the tongue are separated by **terminal sulcus** (groove). Tongue has superior surface which is called **dorsum linguae**², which is divided into the right and left part by the **median sulcus**, and it contains lingual papillae (contains taste buds).

We have five types of lingual papillae:

- ① **Filiform papillae**
 - ② **Fungiform papillae**
 - **Conical papillae**
 - ③ **Foliate papillae**
 - ④ **Vallate papillae** (circumvallate papillae): the largest papillae that are located in front of the terminal sulcus.
- located on the **dorsal surface** of the tongue
- located on the **margins** of the tongue
- sweet, salt*
sweet, salt
Bitter

The inferior surface of the tongue is separated from the superior surface by the margins of the tongue. It contains **frenulum** and **fimbriate plicae**. We have **fimbriated folds** under the tongue and lips.

Sublingual
Under the tongue, there are **sublingual plica** (fold) and **sublingual papilla** which are called **caruncula sublingualis**.

Muscles of the tongue are divided into two groups:

- **Intrinsic muscles:** originated from tongue and inserted to the tongue, responsible to change the shape of the tongue. They are **four paired** muscles:
 - The superior longitudinal muscle
 - The inferior longitudinal muscle
 - The transversus muscle
 - The verticalis muscle
- **Extrinsic muscles:** originated from bones and inserted to the tongue. They are:
 - Genioglossus muscle
 - Hyoglossus muscle (often including Chondroglossus muscle)
 - Styloglossus muscle: originated from styloid process
 - Palatoglossus muscle

Salivary Glands: Although the oral cavity contains mucosae which include salivary glands to secrete saliva, but for the purpose of digestion we need more saliva. There are **three paired salivary glands** on both the RHS and the LHS namely:

- ① **Parotid glands:** the **largest glands**, located on the **mandibular ramus** and the **masseter muscle**. It is divided into two parts: **superficial and deep parts**. They

² Tongue in Latin is Lingua and in Greek is Glossa (e.g. glossitis referred to as inflammation of the tongue)

Each secretes saliva into the oral cavity via a parotid duct that pierces the buccinator muscle to open into the vestibule opposite the second maxillary (upper) molar tooth.

produce saliva and they have parotid ducts (exocrine gland) which penetrates buccinator muscle and enters the oral vestibula and opens into the mouth on the inner surface of the cheek, usually opposite the maxillary (superior) second molar tooth.

submandibular triangle

2 Submandibular glands: located in the submandibular trunk, and submandibular duct opens into ^{under the tongue into the sublingual papillae} caruncula sublingualis papillae.

3 Sublingual glands: the smallest gland, located under the tongue, containing the main/major duct which opens into caruncula of the submandibular duct, and it has approximately 18-20 small ducts which open into sublingual plica (fold).

Teeth:

We have two types of teeth:

Maxillary (upper) molars have 3 roots
Mandibular (lower) molar have 2 roots.

- **deciduous teeth:** a.k.a milk teeth, and they are 20 in number
- **permanent teeth:** in adulthood, there are 32 in number, and they are embedded into two arches:

- **superior dental arch:** 16 teeth
- **inferior dental arch:** 16 teeth

these teeth are divided into four groups:

- **incisor teeth:** each arch has four incisors (total 8), two to the left and two to the right (on each arch: 2×central incisors, 2×lateral incisors). They have one root.
- **canines:** each arch has two canines (total 4), one on the right and one on the left. They have one root.
- **premolars:** (a.k.a bicuspid) each arch has four premolars (total 8), two on each side. (on each arch: 2×first premolars, 2×second premolars). They have one root. But only superior first premolar root is bifurcate (divides into two parts in the apex region).
- **molars:** each arch has six molars (total 12), three on each side (on each arch: 2×first molars, 2×second molars, 2×third molars/wisdom tooth).

pointed surface used to tear and shred food.

Superior molars have three roots and inferior molars have two roots.

2 incisors
1 Canines
2 premolars
3 molars

in one quadrant

$$8 \times 4 = 32$$

$$5 \times 4 = 20$$

5

-pre-molar

-wisdom

2 cusps and 1 root used for crushing and grinding.

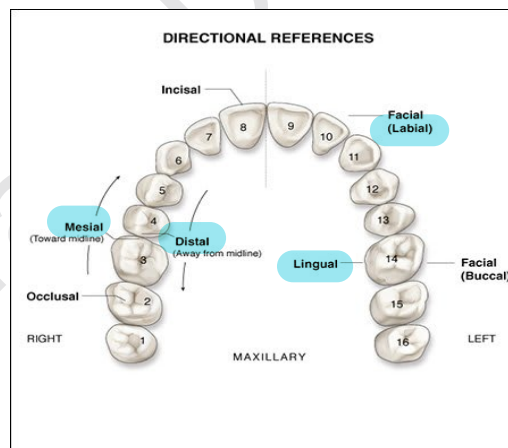
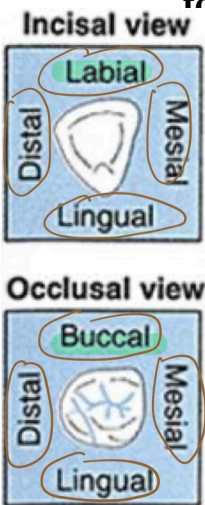
Each tooth consists of

- **crown:** covered by **enamel** (enamelum) which is white in colour and visible.
- **neck**
- **root:** covered by **cementum** which is yellow in colour, and has an **apex** (apex has an **apical foramen:** passage for blood vessels, lymphatic vessels and nerves)

Under enamel and cementum is **dentin**, inside the dentin in the **crown region** we have **pulp cavity**, and in the **root region** we have **root canal**. Pulp cavity and root canal are filled by **pulp** (soft region of tooth which consists of blood vessels and lymphatic vessels, and nerve. These vessels enter and leave through the apical foramen)

Teeth have five surfaces:

- **External / Vestibular** surface (faces towards the vestibular part)
- **Inner / Lingual** surface (faces to the tongue)
- **Medial / Mesial** surface
- **Distal** surface
- **Occlusal** surface: faces opposite, superior to inferior and vice versa, **occlusal surface of the incisors is a line for mastication / cutting**, and **occlusal surface of molars are for chewing.**



Maxillary (upper) molars have three roots; mandibular (lower) molars have two roots.

The formula of the teeth in **adult:**

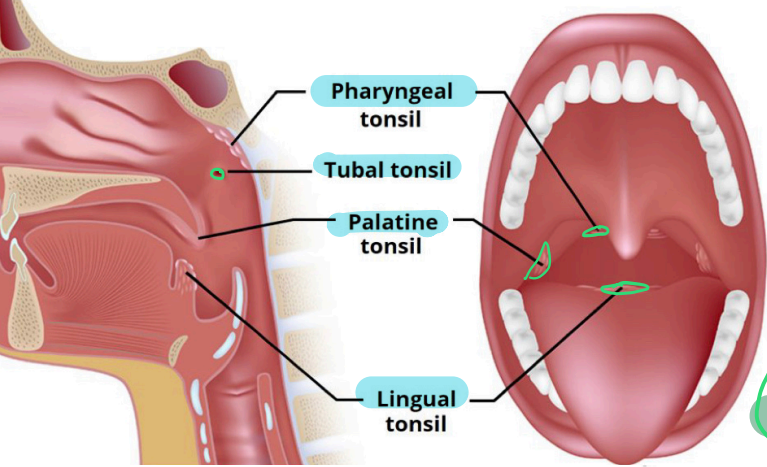
$8 \times 4 = 32$

3	2	1	2	2	1	2	3
molars	premolars	canine	incisors	incisors	canine	premolars	molars

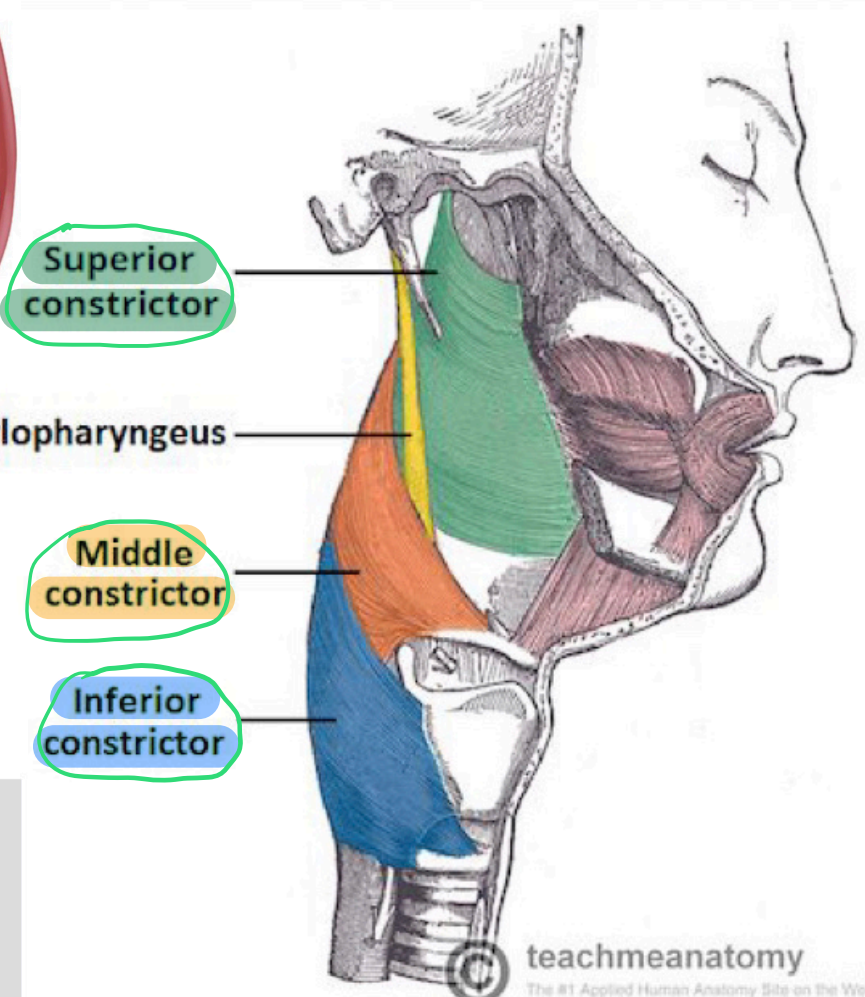
The formula of the teeth in **children:**

2	0	1	2	2	1	0	2
molars	premolars	canine	incisors	incisors	canine	premolars	molars

$5 \times 4 = 20$



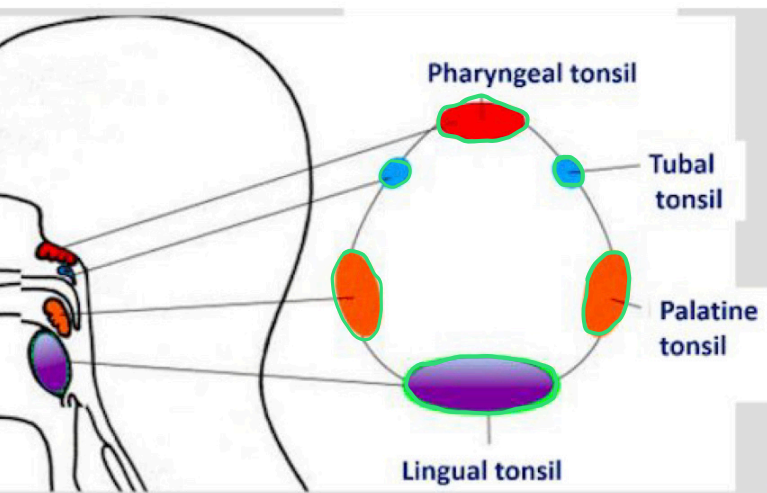
Pharyngeal tonsil
Tubal tonsil
Palatine tonsil
Lingual tonsil



Superior constrictor
Stylopharyngeus
Middle constrictor
Inferior constrictor

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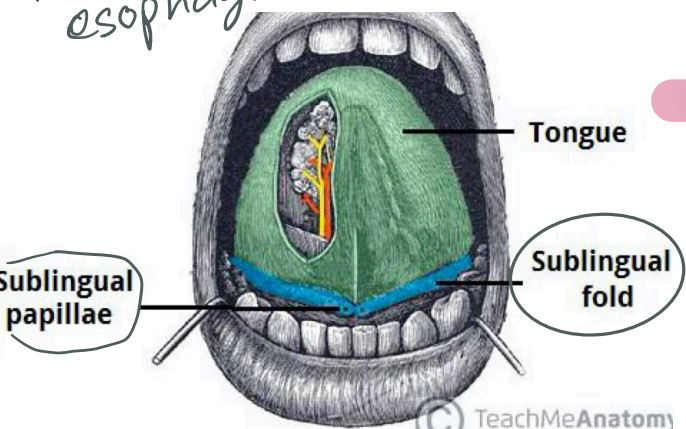
Waldeyer's ring



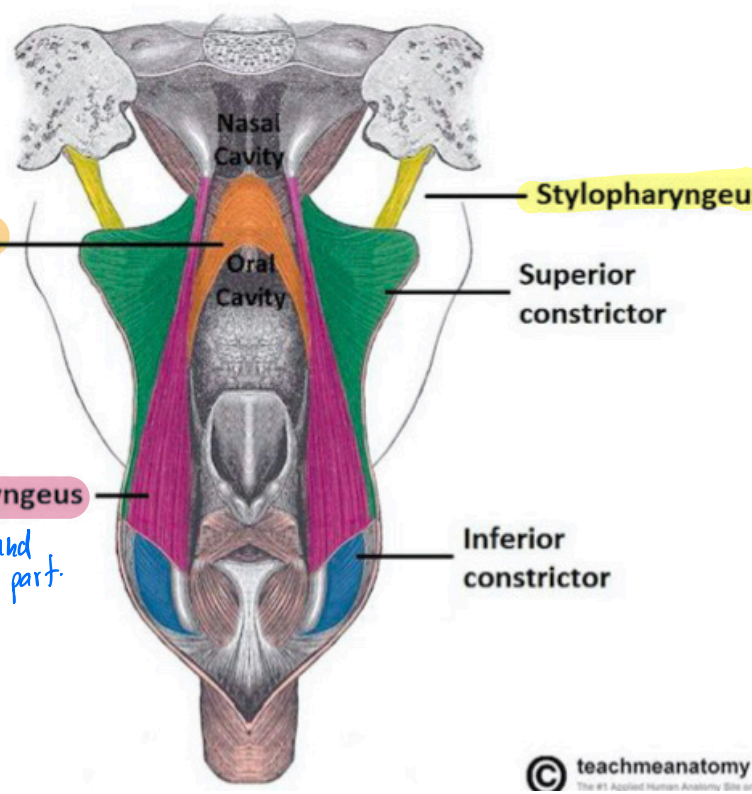
Pharyngeal tonsil
Tubal tonsil
Palatine tonsil
Lingual tonsil

pharynx extends from occipital bone to C-6 - T10-11
base of the skull

starts esophagus



Tongue
Sublingual papillae
Sublingual fold



Palatopharyngeus
Salpingopharyngeus
Stylopharyngeus
Superior constrictor
Inferior constrictor

pharynx and cartilage part.

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Pharynx:

Pharynx is a **mixed organ**, because it is both a **digestive** and a **respiratory** organ. Because food goes from oral cavity to pharynx and then to esophagus, and air goes from nasal cavity to pharynx and then to larynx.

It is located **posterior to oral cavity**, and **inferior posterior to nasal cavity**.

Superior boundary (region) of pharynx, attaches to **inferior wall of sphenoid sinus**, inferiorly it descends to **C6 vertebra**.

Pharynx consist of 3 parts:

- 1) **superior** part which is called **nasopharynx** *Nose*
- 2) **middle** part which is called **oropharynx** *Oral cavity*
- 3) **inferior** part which is called **laryngopharynx** *Larynx*

Above
Below lower border of soft palatin and hyoid bone *laryngopharynx*
nasopharynx

Wall of pharynx contains **7** openings:

- **nasopharynx** contains **4** openings:
 - two **choanae** openings that connect **nasal cavity** to **nasopharynx**
 - two **pharyngeal** openings (pharyngeal ostium of auditory tubes, the auditory tubes connect pharynx to tympanic cavity for pressure balance)
- **oropharynx** contains **1** opening called **isthmus faucium**
- **laryngopharynx** contains **2** openings:
 - **laryngeal** opening
 - **esophageal** opening

7 openings inside pharynx

<i>2- nasal</i>
<i>1- oral</i>
<i>1- larynx</i>
<i>1- esophagus</i>
<i>2- ear</i>

Wall of the pharynx consist of 4 layers:

- | | |
|----------------------|-----------------------------|
| <i>1- mucosa</i> | <i>2- submucosa</i> |
| <i>3- muscularis</i> | <i>4- outer: adventitia</i> |

Pharynx 7 openings:

<i>4</i>	<i>in nasopharynx</i>
<i>1</i>	<i>in oropharynx</i>
<i>2</i>	<i>in laryngopharynx</i>
<i>1</i>	<i>in esophageal opening</i>

Mucosa of nasopharynx is covered by **ciliated epithelium** (because nasopharynx is only a respiratory region)

Mucosa of nasopharynx is made by the following structures:

An **elevation** called **torus tubarius**, **posterior** to torus tubarius, there is a **depression** called **pharyngeal recesses**, **superior** to torus tubarius is **plica salpingopalatine**, and **inferior** to torus tubarius is **plica salpingopharyngeal**.

Mucosa of oropharynx is covered by **columnar epithelium** and in the oropharynx mucosa, we have the following structure:

- **plica glossoepiglottic mediana** (one unpaired)
 - **plicae glossoepiglottic lateralis** (paired)
- } between them there are depressions called vallecula epiglottis.

Muscular coat of pharynx consists of two layers

- Outer longitudinal: is covered by adventitia
- Inner circular: circular layer **makes 3 constrictor muscles: superior, middle and inferior** constrictor muscles. Circular layer also **makes 2 extrinsic muscles:**
 - **stylopharyngeus** muscle, and *Palatopharyngeus*
 - **salpingopharyngeus** muscle. *pharynx and cartilage part.*

Esophagus: is a muscular tube, approximately 25cm, starts from pharynx at C6, descends to thoracic cavity, passes through esophageal hiatus, descends to abdominal cavity, and enters the stomach. *25cm*

It consists of 3 parts:

- **Superior** is **cervical part: from C6 to T2**
- **Thoracic** part from **T2 to T10** in the esophageal hiatus of diaphragm
- **Abdominal** part from **esophageal hiatus to stomach.**

Esophagus has 3 constriction and 2 dilation

Constrictions:

- 1- At C6
- 2- At T4, T5: at this location **trachea bifurcates** and **aortic arch** cross esophagus.
- 3- In esophageal hiatus

Between these constrictions we have 2 dilations.

Wall of esophagus consist of four layers:

Mucosa: contains 7 to 10 longitudinal folds, and mucosal glands

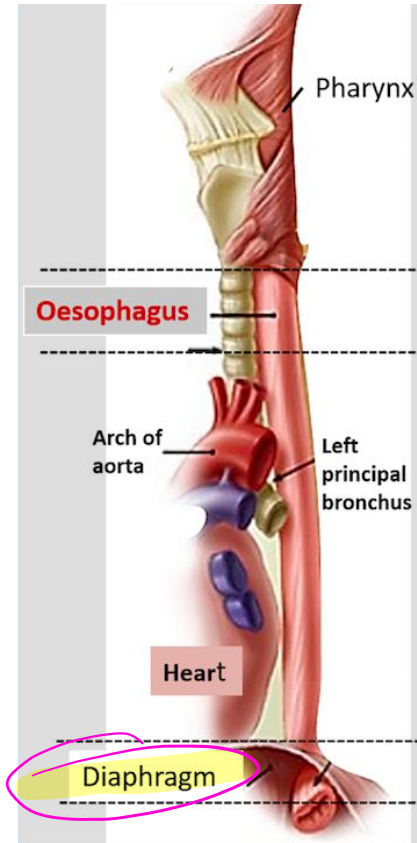
Muscular coat: consists of longitudinal and circular layer. circular layer makes **sphincter of esophagus**. In **cervical region**, esophagus contains **skeletal muscles**, from thoracic smooth.

Outer coat: cervical and thoracic are covered by adventitia, abdominal part by serosa.

Syntropy: it is relation between organs. Syntropy of esophagus: trachea located in front of esophagus, aortic arch crosses and descending part goes latero-posterior of esophagus and it tends cranial nerve (vagus nerve).

Below the diaphragm
- peritoneum

Above the diaphragm
- adventitia



C6-T2

Cervical part

T2-T10

Thoracic part

Abdominal part

- C-6
- Diaphragm
- T5

The muscularis of the superior third of the esophagus is skeletal muscle, the intermediate third is skeletal and smooth muscle, and the inferior third is smooth muscle.

Stomach:

Stomach is located in the abdominal cavity; superior region is epigastria region.

- $\frac{3}{4}$ of the stomach is in the **left hypochondriac** region, and
- $\frac{1}{4}$ of the stomach is in the **middle** of the **epigastria** region.

extends from
T11 - L1

Stomach has **anterior wall** and **posterior wall**, and when they join they make **lesser curvature** which faces right and up, and **greater curvature**, faces left and down.

Stomach consists of four parts:

- 1- **cardiac part** which contains **cardiac opening of esophagus**
- 2- **fundus part** which is the **superior** region
- 3- **body** which is the **largest** portion
- 4- **pyloric part** which consists of **pyloric antrum** and **pyloric canal**, and pyloric part ends into **pyloric sphincter** between stomach and duodenum.

R Hypochondrium	epigastrium	L Lumbar
R Lumbar	Umbilical	L Lumbar
R Iliac	Hypogastrium	L Iliac

On the stomach, there is a **cardiac notch** (incisura) **between cardiac part and fundus**, and **angular notch** between **body and pyloric portion**.

Wall of stomach consist of four layers:

- 1- Mucosa
- 2- Submucosa
- 3- Muscularis
- 4- Serosa or Peritoneum

Mucosa of stomach contains **irregular folds**, and **longitudinal folds along lesser curvature**.

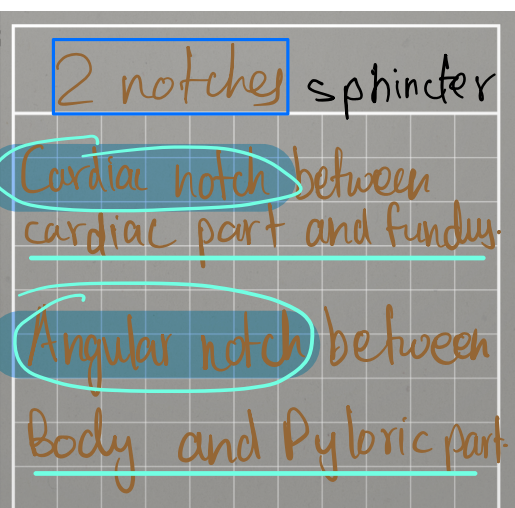
These folds are continuation of esophageal longitudinal folds. Mucosa contains mucosal glands (**called gastric glands**) that produce **enzymes mainly pepsinogen** which becomes into pepsin and digest proteins, and hydrochloric acid which makes acidity and help pepsinogen to become pepsin, and **mucus** which protects mucosa from acidic region.

Mucosa contains **depressions** called **gastric pits** which are **structural and functional unit of stomach**, because **ducts of gastric glands** open into gastric pits and gastric juice goes to gastric pits.

Muscular coat: there are three layers,

- 1- outer longitudinal,
- 2- middle circular
- and 3- inner oblique layer.

Outer covering is serosa also called peritoneum (**stomach is intraperitoneal organ, covers fully by peritoneum**). Peritoneum makes ligaments between s



ulcer of the duodenum?

note Ligaments of the stomach are:

- 1) Hepatogastric ligament
- 2) Gastrophrenic ligament
- 3) Gastrosplenic ligament
- 4) Gastropancreatic
- 5) Gastrocolic

Ligaments of stomach are:

- **hepatogastric ligament** between liver and stomach
- **gastrocolic ligaments**,
- **gastrosplenic ligament**,
- **gastropancreatic ligament**, and
- **gastrophrenic ligament**.

Syntropy: relations between organs. organs that are located near stomach are pancreas inferior posterior of stomach, liver, diaphragm, spleen, transverse colon, left kidney and left adrenal gland.

Small intestine:

Function is absorption

Consist of 3 part:

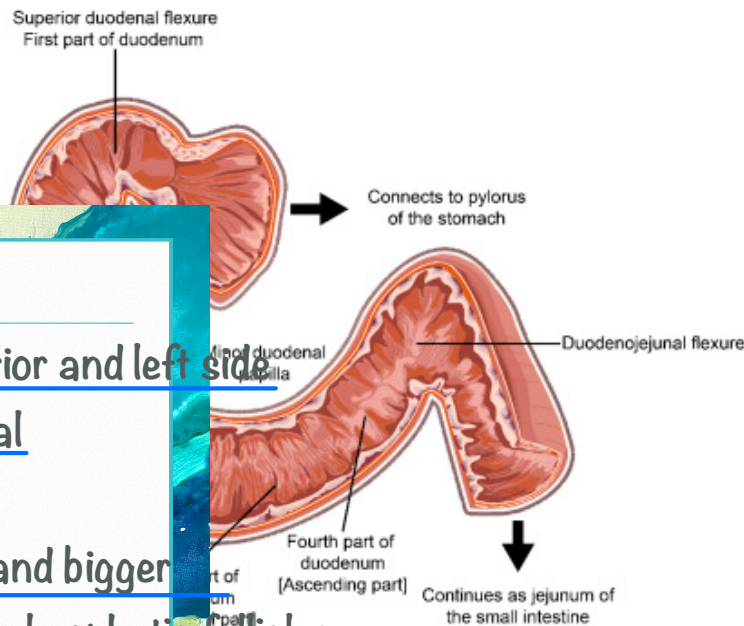
1. duodenum
2. jejunum
3. ileum

Duodenum:

It is the first portion of the small intestine and **starts from pyloric sphincter** of stomach (starts from T12 or L1 vertebrae).

Consist of:

- **superior part**
- **descending part** (descends to L3 vertebra)
- **horizontal part**
- **ascending part** (connects to jejunum at L2 vertebra)



Differences

- ① Jejunum is situated superior and left side
- ② Jejunum makes horizontal
- ③ wall of jejunum is thicker
- ④ jejunum are finger-like and bigger
- ⑤ Jejunum contains solitary lymphatic follicles

flexora of duodenum:

- ✓ **duodenojejunal flexora** is situated between jejunum and duodenum (ascending part).
- ✓ **superior duodenal flexora** (between superior and descending part of duodenum).
- ✓ **inferior duodenal flexora** (between descending and horizontal part of duodenum).

A part of duodenum surrounds the head of pancreas.

Wall of duodenum consist of 4 layers:

- **Mucosa**: contain "C" shape folds and one long **Longitudinal fold in descending portion of duodenum**. At the inferior end of Longitudinal fold **major duodenal papillae** and superior to major duodenal papillae, we have **minor duodenal papillae** are located.

Common bile ducts and pancreatic ducts combine with each other and make **Hepatopancreatic ampulla of Vater** which opens into major duodenal papillae. **Sphincter of oddi** is located in junction of hepatopancreatic ampulla and major duodenal papilla of duodenum.

Accessory pancreatic ducts open into minor duodenal papillae.

Mucosa of duodenum consist of glands (intestinal glands and duodenal glands which are called **Brunner glands**), foliate villi (small).

- **submucosa**
- **muscularis coat**: outer longitudinal and inner circular layer
- **outer adventitia** (serosa): **superior and ascending part of duodenum** are covered by **peritoneum** so these 2 parts are **intraperitoneal** portions but **descending part** is **extraperitoneal** portion and is fixed on posterior abdominal wall.

papillae are in 2nd descending portion.

Duodenum totally is mesenterium but in detail some parts are extraperitoneal and some intra peritoneal.

syntropy (relation between organs) of duodenum:

Right kidney, right adrenal gland, pancreas, liver, gall bladder, colon, inferior vena cava

The duodenum consists of 4 parts:

1. Superior T12
2. Descending L3 *descending part has major and minor duodenal papilla*
3. Horizontal L3
4. Ascending L2 - jejunum

Has 3 flexures: superior flexure - between superior and descending part, inferior flexure - between descending and horizontal part and duodenojejunal - between duodenum and jejunum.

Wall of the duodenum contains of 4 layers: mucosa, submucosa, muscularis and adventitia (partly serosa). The mucosa contains C-shaped folds and longitudinal fold in the descending part. At the end of longitudinal fold is major duodenal papilla, superiorly is minor duodenal papilla.

The submucosa of the duodenum contains duodenal glands, also called Brunner's glands, which secrete an alkaline mucus that helps neutralize gastric acid in the chyme. The muscularis of the small intestine consists of two layers of smooth muscle. The outer, thinner layer contains longitudinal fibers; the inner, thicker layer contains circular fibers. Except for a major portion of the duodenum, the serosa (or visceral peritoneum) completely surrounds the small intestine. Duodenum is retroperitoneal organ.

Smooth

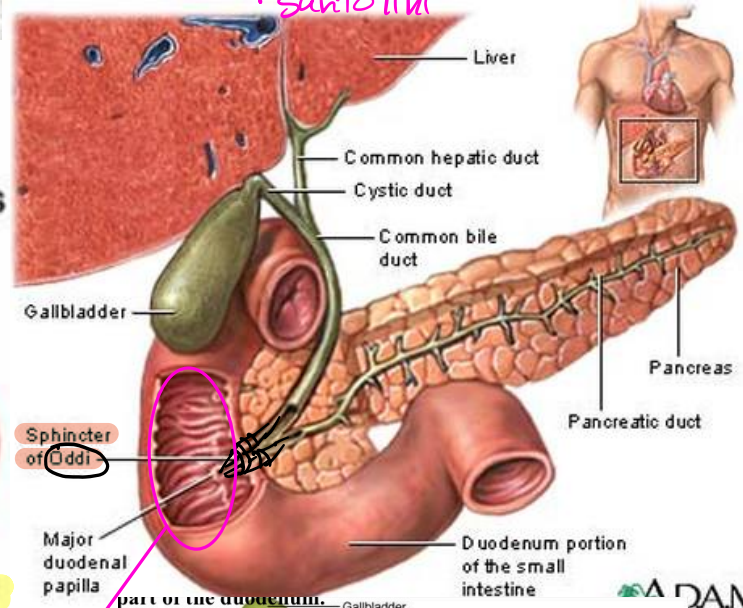
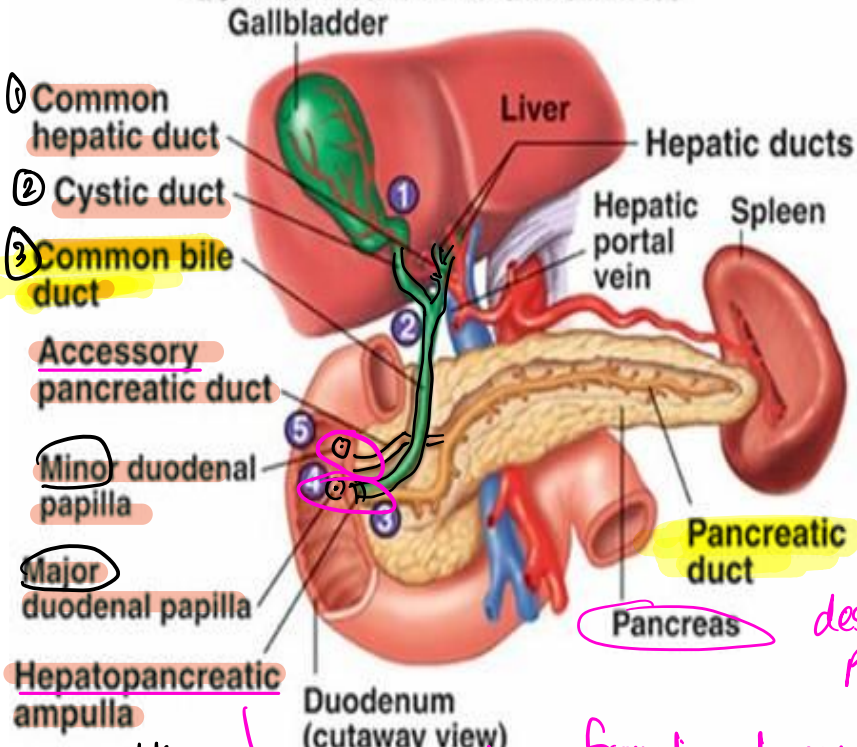
- Inner circular
- Outer longitudinal
- serosa / peritoneum

Duodenum

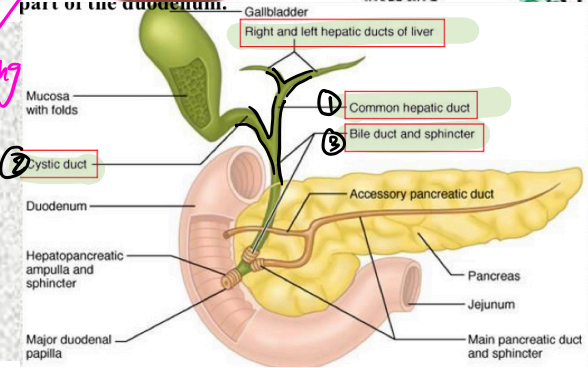
ductus colodocus:

- ① versome duct (main)
- ② pancreini duct (accessory)
santoliki

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descending part



Oddi sphincter

made by: from liver to pancreas to s-I

- Common hepatic duct
- Cystic duct
- Common bile duct

The jejunum and ileum are intraperitoneal parts of the small intestine, they are covered by peritoneum. The jejunum is located superior and left to the ileum, the wall of the jejunum is thicker, loops of the jejunum are horizontal, loops of ileum vertical.

intra-

Wall consists of 4 layers: mucosa, submucosa, muscularis and serosa(peritonem). Mucosa of the jejunum and ileum contains circular folds, glands, projections of the mucosa - villi for absorption (jejunum contains the longest and largest fingerlike villi, ileum conical), cripts.

Mucosa contains Solitary lymphatic follicles (nodules), they are most numerous in the jejunum. Groups of lymphatic nodules referred to as aggregated lymphatic follicles, or Peyer's patches are present in the ileum.

The muscularis of the small intestine consists of two layers of smooth muscle. The outer, thinner layer contains longitudinal fibers; the inner, thicker layer contains circular fibers. Except for a major portion of the duodenum, the serosa (or visceral peritoneum) completely surrounds the small intestine.

In the 2% of people between the jejunum and ileum is projection called diverticulum of Meckel.

40-50 cm before ceum

↳ longer

small intestine: mesentery

Jejunum and Ileum:

are **mesenterial parts** of small intestine and also **intraperitoneal part** of small intestine. They are fully covered by peritoneum, which makes mesentery.

Mesentery is a double layer of visceral peritoneum, which covers intestine, and in posterior side of abdominal region attaches to posterior abdominal wall and contains blood vessels, lymphatic vessels and nerves.

In 1-2% of people, between jejunum and ileum, there is a kind of mucosa fold, is called **meckel's diverticulum** and separates jejunum and ileum.

Difference between jejunum and ileum:

- **Jejunum** is situated superior and **left side** of abdominal cavity but ileum situated inferior and right side of abdominal cavity.
- **Jejunum** makes horizontal (transvers) loops but ileum makes vertical loops.
- The **wall of jejunum is thicker** and because of abundance of blood vessels is pink.
- both contain circular folds (plicae) in mucosa, intestinal glands, villi (in **jejunum** are **finger-like and bigger** and in ileum are **conical, small villi**), crypts depression in mucosa
- **Main difference:** jejunum contains **solitary lymphatic follicles** and ileum contains **aggregated lymphatic follicles (Peyer's patches)**.

Aggregated lymphatic follicles can determine Jejunum and ileum.

Large Intestine:

Consists of:

① **Cecum:** the first segment of large intestine, which is located in the **right hypogastric region (ileocecal region)**, because ileum enters the cecum, and between them is **ileocecal**

valve Cecum has projections called **vermiform appendix**, which **connects to cecum** through the **ostium** of appendix vermiform.

Appendix vermiform contains **lymphoid tissue** (organ of immunity system). Inflammation of appendix is called **appendicitis**, and removal of appendix, is called **appendectomy**.

③ **colon:** Cecum superiorly becomes into the **ascending colon** which **ascends** in the right aspect of the abdomen, and under the liver at the level of right tenth rib, it makes **right colic flexure**, and becomes into **transverse colon**, which goes from right to left, and it is the **longest**

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mesoappendix

on right side on right iliac fossa

transverse and sigmoid colon has: **mesocolon**

Appendix: **mesoappendix**

vitamin D manufacture, has bacteria, formation of feces

separated

narrower diameter
more absorption

opening from ileum into large intestine

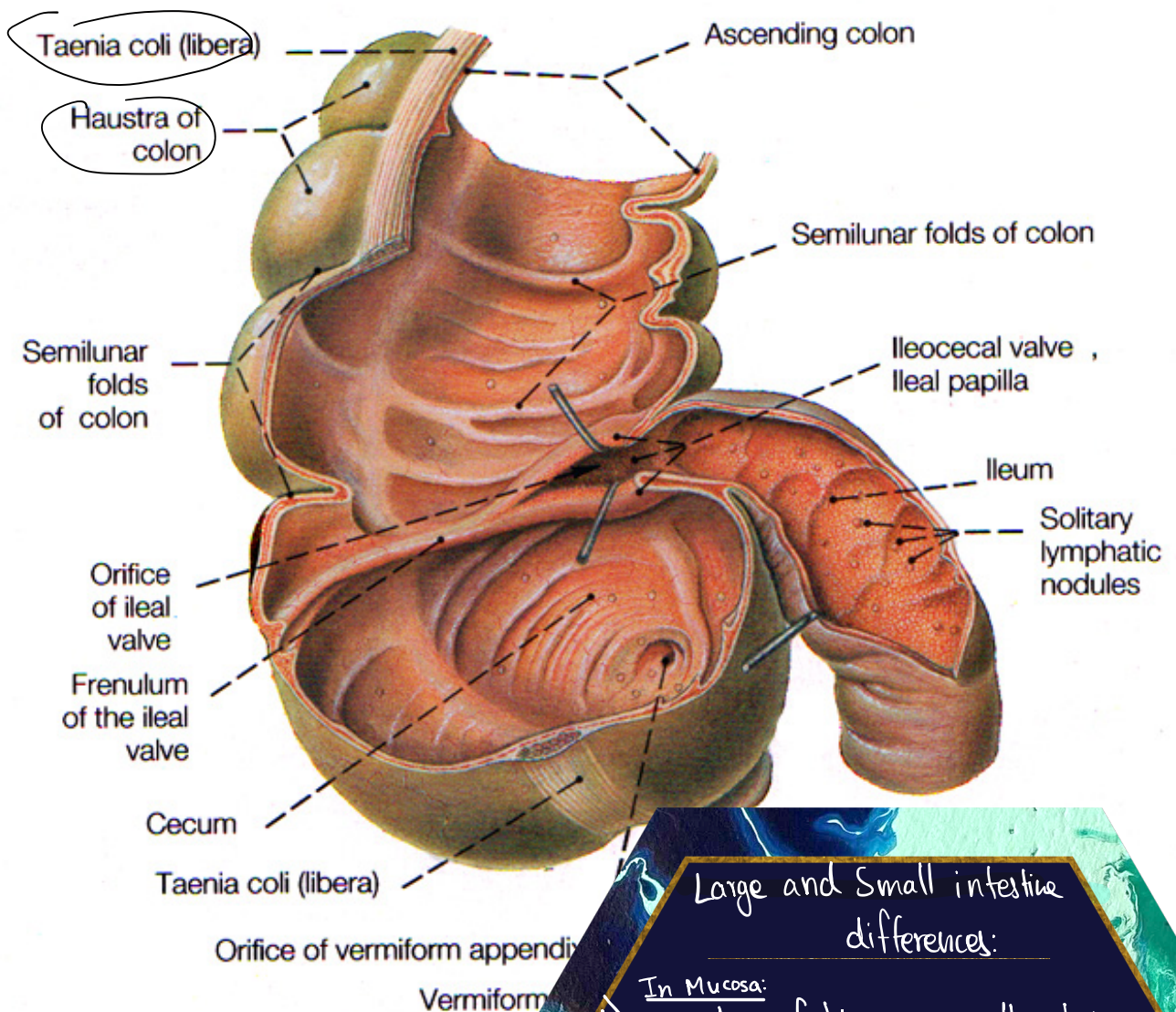
about 500 lymphatic follicles

portion, and the left side under the spleen makes left colic flexure at the level of left ninth rib. If it is at nine, it means right is inferior to left. (why? Because liver has occupied this region) After the left flexure, it becomes to descending colon which descends to the left aspect of abdomen, and at the level of iliac crest it becomes into the sigmoid colon which descends to the pelvic cavity, and at the level of S3 it becomes into rectum. left iliac crest

Wall of Cecum and Colon:

Consist of four layers:

① **Mucosa:** it is the inner most layer, contains semilunar folds, each circle has three semilunar folds. They are separated by taenia coli. It has crypts but no villi. It also has mucosal glands.



Large and Small intestine differences:

In Mucosa:

- 1) - circular folds in small intestine
- semilunar folds in large intestine.

In Muscular:

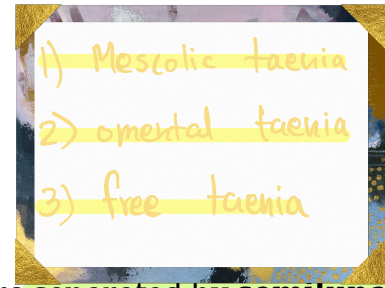
- 2) - Taenia coli in large intestine (longitudinal)
- Haustra coli only on large intestine

In serosa:

- 3) Epiploic appendages in large intestine

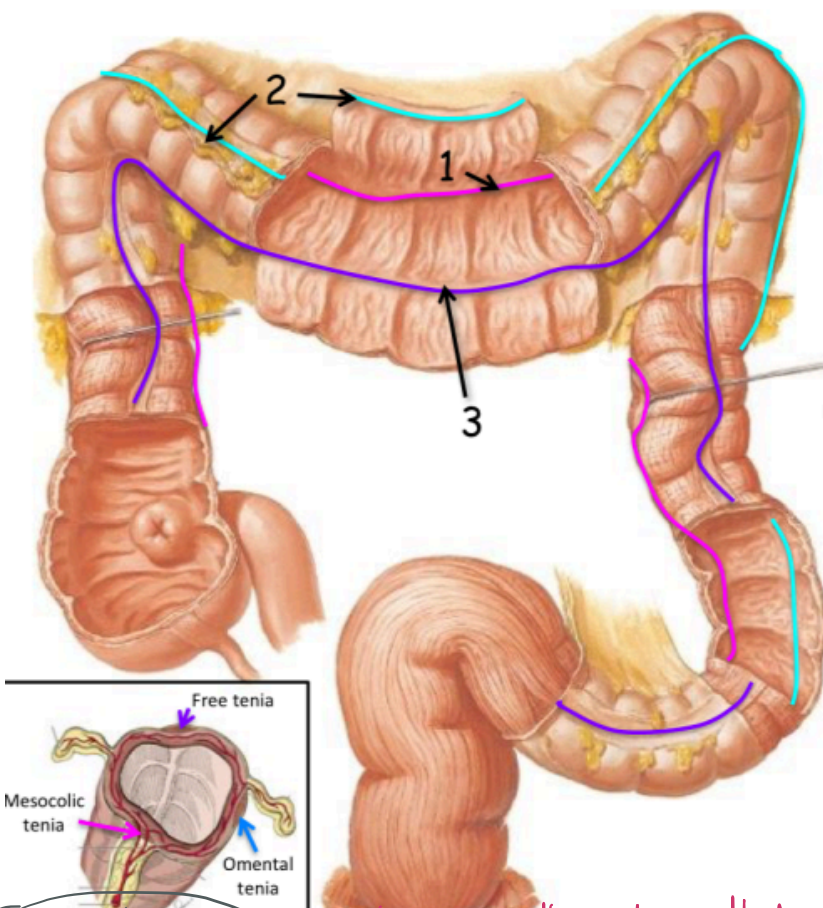
② **Muscular coat:** is very specific, and consist of **outer longitudinal** and **inner circular** layer. **Outer longitudinal makes three bent bundles of muscle fibers**, and they are called **taenia coli**. We have

- 1) • **taenia mesocolica.**
- 2) • **taenia omentalis, and**
- 3) • **taenia libera.**



Circular layer makes projections called haustra coli, they are separated by **semilunar folds**. It means that semilunar folds are **visible from the external surface** too. circular folds of small intestine are not visible from external surface.

Large Intestine Features: Teniae Coli



- Three distinct bands of smooth muscle that run longitudinally
 - Converge at the appendix!
1. **Mesocolic tenia:**
The transverse and sigmoid mesocolon attach
 2. **Omental tenia:**
The omental appendices attach
 3. **Free tenia:**
Neither mesocolon or appendices attach and this band can be followed on the surface of the colon
- The teniae coli contract lengthwise to form **haustra**.

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Serosa layer: contains small pouches called **epiploic appendages**

③ **Outer cover:** cecum is 50-50. 50% is **intraperitoneal** (fully covered by peritoneum) and 50% is **mesoperitoneal** (partially covered by peritoneum). **Appendix is always intraperitoneal.**

Outer covering of the Colon:

Ascending and descending colon are both **mesoperitoneal**, and they are fixed on the posterior abdominal wall (that's why they are in the vertical position). Adventitia is attached

to the posterior abdominal wall. They are mesoperitoneal, anterolaterally are covered by peritoneum and posterior part is covered by adventitia.

Transverse and Sigmoid colon: they are intraperitoneal, they are fully covered by peritoneum and they have mesocolons, like mesentery in small intestine. Mesocolon is attached to posterior abdominal wall.

Rectum:

is the last portion of the GI tract which is located in the pelvic cavity, and starts at S3 where sigmoid colon becomes into rectum, and descends in front of sacrum, and coccyx, and ends in the anal opening.

Rectum consists of two parts:

- superior is ampulla part and
- inferior is anal canal

Wall of rectum consist of four layers:

Mucosa of ampulla part: contains irregular folds and three to five transverse folds, which make the spiral rectoanal sphincter. It contains mucosal glands.

Mucosa of anal canal: contains longitudinal folds which are called anal colon, and they are permanent folds, and between anal colons are depression called anal sinuses. It also contains mucosal glands. *changes the diameter for feces to pass*

Muscular coat: consist of outer longitudinal and inner circular layer. Inner circular layer is good developed in the anal region, and makes internal anal sphincter which is an

involuntary sphincter, and is formed by smooth muscles. This sphincter is surrounded by external anal sphincter. External anal sphincter is a voluntary sphincter and is formed by *saricated* skeletal muscle of perineum, which is inferior wall of pelvic cavity.

Outer covering:

- superior 1/3 is intraperitoneal,
- middle 1/3 is mesoperitoneal and
- inferior 1/3 is *retro*peritoneal.

Syntropy of rectum:

Posterior to rectum are sacrum and coccyx, and anterior to rectum in males is urinary bladder, prostate gland and seminal vesicles and in females are uterus and vagina.

6 Intercostal
7I - 11 Intercostal space

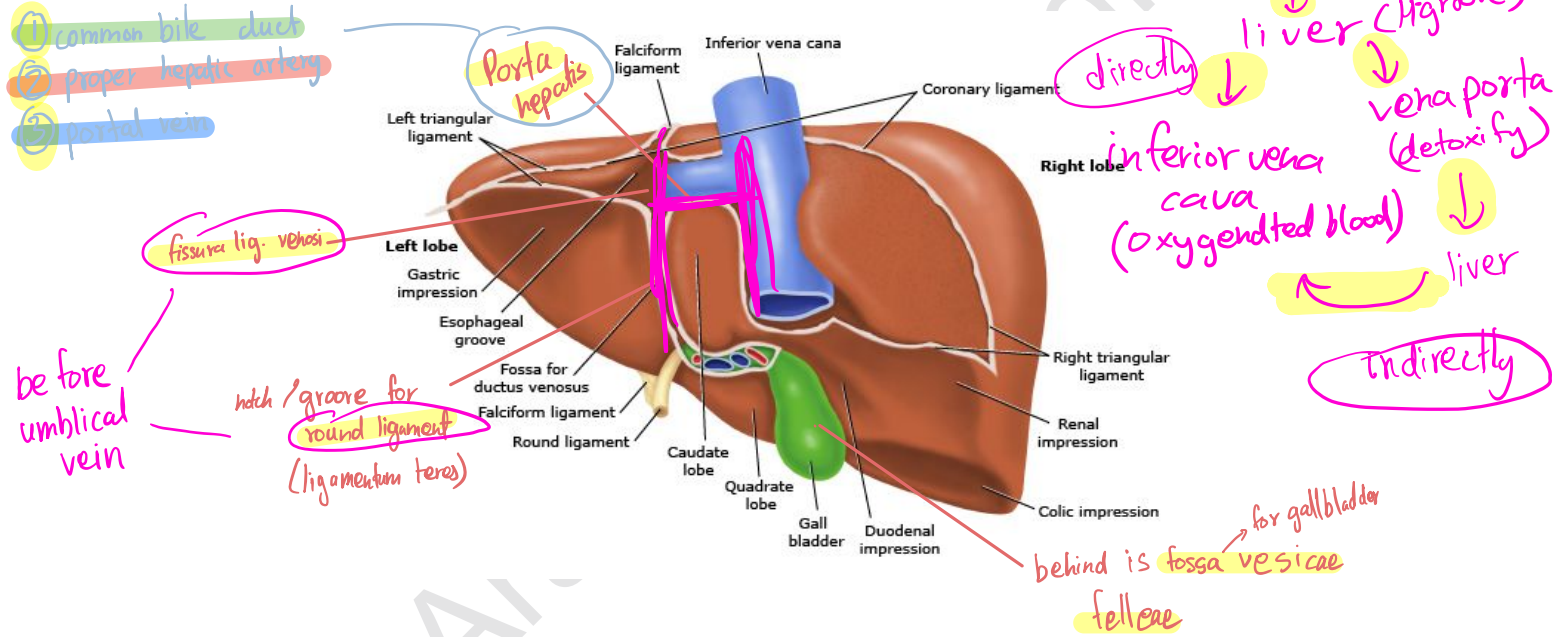
Liver: Produces bile

Liver is the largest gland of our body, which is located in the epigastrium (superior abdomen)

- 3/4 of the liver is in the **right hypochondriac region**, and *small part in the L Hypochon-*
- 1/4 of the liver is in the **middle epigastria region**.

Liver has **diaphragmatic surface** which is very large and is facing to the diaphragm and consists of **anterior**, **superior** and **posterior** surfaces, and also has an **inferior** surface which is called **visceral surface** faces to the organs. *diaphragmatic surface*

The **visceral surface** of the liver has four lobes: **right lobe, left lobe, caudate lobe, and quadrate lobe**. These lobes are separated by grooves (sulcus) that make letter H. Left line of letter H contains of sulcus of Venus ligament and sulcus of **teres ligament**. Right portion of the letter H contains sulcus of inferior vena cava and fossa for gallbladder. Between them is central line (central line of H) which connect right and left, and makes porta hepatis. *umbilical vein*



Porta hepatis means door of the liver, and consists of 4 main structures:

- proper hepatic artery:** which enters and supplies blood to the liver
- hepatic portal vein:** carries venous blood from unpaired abdominal organs (e.g. intestine, stomach, digestive organs except spleen). The venous blood contains a lot of toxins. **Hepatic portal vein brings this blood to the liver and detoxifies the toxins and the clean blood will go to the inferior vena cava directly**
- common hepatic duct:** carries bile from the liver and join with cystic duct to form **common bile duct** which opens in the major duodenal papilla, and
- lymphatic vessels** (structures of organ hepatis)

digestive organs
↓
takes blood from digestive organs below the diaphragm including spleen except urinary and reproductive organs

Liver has many functions but as digestive gland it **produces bile** which participate in the lipid metabolism.

Liver is a **parenchymal organ** (glandular tissue) which is soft, and organs that communicate with liver makes **depressions called impression**. For example, we have:

- esophageal impression,
- gastric impression,
- duodenal impression,
- colic impression,
- renal impression (with right kidney),
- suprarenal impression (with adrenal gland).

Liver is covered by peritoneum, and it is an **intraperitoneal organ**, but it has a small region on the posterior side called **area nodal (bare area)** which is not covered by peritoneum and is attached to the posterior abdominal wall. **porta hepatis is not covered by peritoneum.**

Outer covering of liver is peritoneum, under the peritoneum is **subserosa coat**, and under subserosa coat is **perivascular fibrous capsule** which directly covers liver and it makes septum (meaning they are septa).

Septa goes inward to the liver and divides the liver into **lobus**. Lobus contains **hepatocytes**, that make the **structural and functional unit of the liver**.

Central vein is located in the **centre of lobus**. Venous blood which contains toxins goes to lobus, hepatocytes detoxify these toxins and then the clean blood goes to central vein.

Central vein goes to **sublobular veins** and sublobular veins join to form 2 to 4 (mainly 3) **hepatic veins**. The hepatic veins enter the **inferior vena cava** and carries this clean blood.

Between lobus, we have hepatic triads (means 3), which contains

- interlobular artery,
- **interlobular vein**, and
- interlobular ductus (bile ductus).

when standing in the corridor with rooms on side
when in middle of corridor - **interlobular vein**
when open the door and in the class - **interlobular vein**
gaining knowledge - **central vein**
when leaving the class - **sublobular vein**

Interlobular ductus carries bile from lobus, and they join to form right and left hepatic ducts.

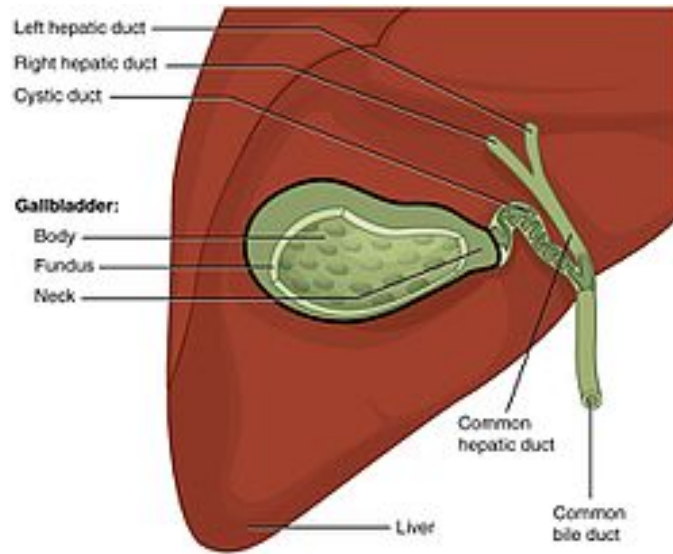
But in some persons, we have 4 right and left hepatic ducts plus right and left **caudate ducts**.

All of these ducts join to form the common hepatic duct which leaves liver to **porta hepatis**.

Then they join with cystic duct of gallbladder to make common bile duct which open to major duodenal papilla.

Exception: but rest opposite pulmonary system
artery: deoxygenated blood
vein: oxygenated blood

Umbilical vein
carry oxygenated blood to liver and reach vena cava inferior



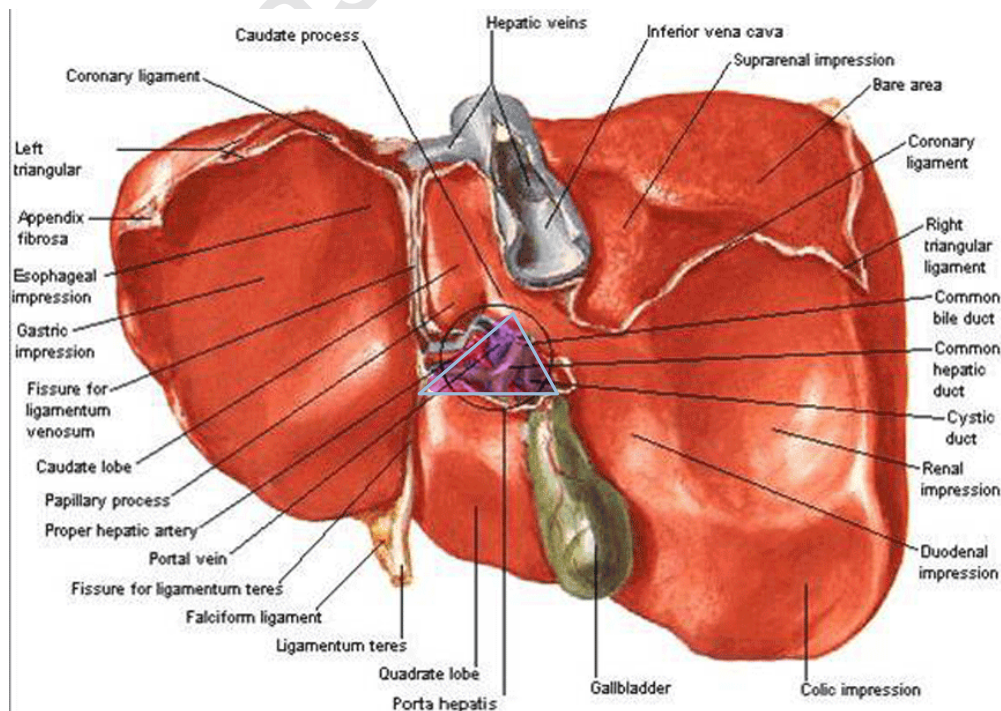
For fixation of organs (e.g. liver): intra-abdominal pressure which is made by abdominal muscles.

Organs that communicate with liver and ligaments, liver has the following 8 ligaments:

- coronary ligament, *between diaphragm and liver*
- falciform ligament, *lies between 2 lobes*
- right and left triangular ligaments, (counts 2 ligaments)
- hepatogastric ligament, *between liver and stomach*
- hepatoduodenal ligament, *between liver and duodenum*
- hepatocolic ligament, and *between liver and transverse colon*
- hepatorenal ligament, *between liver and kidney*

} diaphragmatic surface

They are very important for the fixation of the liver.



Gallbladder:

stores bile

Mucosa muscle serosa layers

Gallbladder is a reservoir for bile. Because bile is produced by liver during day and night (24 hours). However, pancreas secretes secretion after eating. Bile is reserved in the gallbladder which is located on the **visceral surface** of the liver in the **fossa of gallbladder**.

Gallbladder consist of 3 parts: **fundus, body and neck**. Neck becomes into **cystic duct** which joins with **common hepatic duct** to form **common bile duct**.

Wall of gallbladder consists of four layers:

Mucosa of gallbladder contains irregular folds, and in the **neck region it contains spiral folds** to form **spiral sphincter**.

contains spiral folds

Muscular coat: it mainly contains **circular muscles** and outer **covering is peritoneum**.

Pancreas:

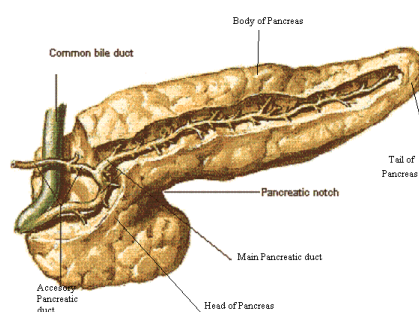
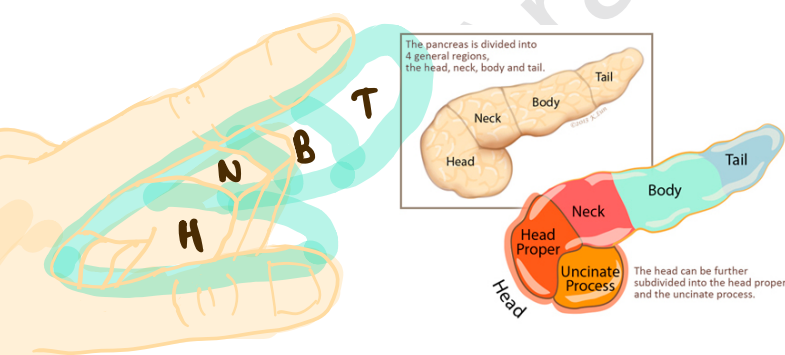
between T11-T12 lower border L1-L2

pancreas is a **mixed organ** (gland), because it is **exocrine and endocrine**. As exocrine it produces **enzymes** for everything (proteins, carbohydrates, and lipids), and as endocrine it produces **insulin** and **glucagon**, and regulates the sugar level of the blood.

As an **exocrine gland**, Pancreas has **pancreatic duct** which combines with the **common bile duct** to make **hepatopancreatic ampulla of Vater** that opens into the major duodenal papilla, and **only in the head region contains accessory ducts** which opens into the minor duodenal papilla.

and uncinat process (has exo and endocrine ability)

Pancreas consists of **head, neck, body and tail**. Head has projection called **processus uncinatus** (uncinate process) which is separated by **pancreatic notch**. Tail attaches to spleen and contains **islets (islands) of Langerhans** that produce **hormones** in **endocrine portion**.



Pancreas has **anterior, posterior, and inferior surfaces** and **anterior, superior and inferior margins**. It is covered by **adventitia**, and it is a **retroperitoneal organ**, which is behind the peritoneum and **except tail which is mesoperitoneal**, and it consists of **lobus**, which have ductus, this ductus enters the pancreatic ducts which opens to the major duodenal papilla.

Peritoneum:

It is a **serous coat** which **covers the abdomen**. there are 3 types of peritoneum:

1. **peritoneum**: (peritoneum of serous coat) which covers **abdominal cavity**
2. **pleura**: covers lungs
3. **pericardium**: covers heart

all these serous coats have 2 layers:

1. **parietal layer**: covers **walls** (e.g. peritoneum covers abdominal cavity)
2. **visceral layer**: covers **organs**

between parietal and visceral layers is **peritoneal cavity**. peritoneal cavity contains only a small amount of **serous fluid** which lubricate these layers to reduce friction.

peritoneum makes 2 structure:

1. **mesentery**: is a double layer of visceral peritoneum which **covers intestine then attaches to posterior abdominal wall** and contains blood vessels, lymphatic vessels and nerves. mesentery is between intestine and posterior abdominal wall. we have

mesentery of jejunum, ileum and in colon is called mesocolon of transvers colon, sigmoid colon, **mesoappendix**. **mesentery is between organ and abdominal wall.**

2. **omentum**: it is a double layer of visceral peritoneum which is located **between organs** (not between organ and abdominal wall). there are

- **lesser omentum**: lesser omentum is located between **liver and lesser curvature of stomach and duodenum**. it starts from liver and goes to stomach (reverse in some books!).

- **greater omentum**: greater omentum is double layer between **greater curvature of stomach and pubic symphysis**. *holds heat*

Covers abdominal organs

lesser omentum has 3 ligaments. it is a **thickened real** ligament (it is thicker than peritoneum):

- **hepatogastric ligament**
- **hepatoduodenal ligament**: it is the most important ligament because it covers anatomical structures of porta-hepatis.
- **hepatocolic ligament**

lesser omentum contain an opening called **foramen epiploicum (epiploic foramen)** which is very important because it connects **omental bursa** to **general peritoneal sac**.

Boundaries of epiploic foramen: **anterior boundary** is formed by **hepatoduodenal ligament**, **posterior boundary** is formed by **hepatorenal ligament**, **superior** by **liver** and **inferior** by **duodenum**.

greater omentum starts from greater curvature of stomach then these 2 layers descend to pubic symphysis. it is anterior to loops of small intestine which is called **apron** and covers anteriorly the loops of small intestine and then in pubic region returns and ascends to connect to transvers colon. it covers transvers colon and makes mesocolon which attaches to the posterior abdominal wall. it means **greater omentum contains 4 layers**.

ligaments of greater omentum: it has 5 ligaments which all start from stomach:

- **gastrophrenic ligament**
- **gastrocolic ligament**
- **gastrosplenic ligament**
- **phrenicocolic ligament**
- **phrenicosplenic ligament**

} makes the greater omentum

note: phrenico means diaphragm

peritoneum makes bursa which is a space inside the peritoneum. we have:

- **pregastric bursa:** is located in the **left abdomen in front of the stomach** *in front of the stomach*
- **hepatic bursa:** is in the **right side of the abdomen near the liver** and they are separated by **falciform ligament** of the liver *a little to right*
- **omental bursa:** it is the **largest bursa** which is located **posterior to the stomach** *behind the stomach*

Anteriorly, wall of omental bursa is made by **posterior wall of stomach**, **superiorly** by the **lesser omentum** and **inferiorly** by the **gastrocolic ligament**. all of this is anterior wall which is from superior to inferior lesser omentum, posterior wall of stomach and gastrocolic ligament.

posterior wall is covered/filled by **parietal peritoneum**, **superior** wall by **liver** (caudate lob), **inferior** wall by **transvers colon**.

omental bursa has projections called **recesses**:

- **superior recesses**,
- **inferior recesses**, and
- **splenic (lienal) recesses**. *near the spleen*

between hepatoduodenal **epiploic foramen** is in the **lesser omentum** which connects the **omental bursa** to the **general peritoneal sac**.

omental bursa is behind the stomach for example if a patient has symptoms of peritonitis (inflammation of peritoneum) the inflammation can be seen by surgeon through this foramen (epiploic foramen).

peritoneum in abdominal cavity makes folds and recesses. It makes

- superior duodenal plica (fold)
- superior duodenal recesses
- inferior duodenal plica
- inferior duodenal recesses.

between ileum and cecum, we have **ileocecal recesses** that makes **intersigmoidal plica** and **many plicae and recesses**.

Plicae on the anterior wall of abdomen: *Internal Surface of the Anterior Abdominal Wall*
parietal peritoneum makes plicae between urinary bladder and umbilical region (umbilicus).

- **median umbilical plica**: is the remnant of urachus (it is in fetus as urinary it does not have urinary bladder).
 - **medial umbilical folds**: are the remnant of umbilical arteries in fetus.
 - **lateral umbilical folds**: contain inferior epigastric artery, and we have
 - *supra vesical fossa* *Above the urinary bladder*
 - **medial inguinal fossa**
 - **lateral inguinal fossa** } *where inguinal hernia is developed*
- between these plicae we have **depressions called fosse**, they are weak area of abdominal cavity (it is important for development of hernia).
- **supra basical fosse**: are medial inguinal fosse
 - **lateral inguinal fosse**: lateral inguinal fosse contains **internal ring of inguinal canal**.

these plicae are formed by parietal peritoneum on the anterior abdominal wall.

In males, in the **pelvic cavity** peritoneum descends to **anterior wall of rectum** and from rectum goes to **urinary bladder** to make **rectovesical pouch**.

in the female body between rectum and urinary bladder, we have uterus. **peritoneum makes 2 pouches in females whereas in male just one pouch:** → *rectovesical fossa*

rectouterine fossa: between rectus and uterus

1. **rectouterine pouch of Douglas:** connects to uteri tubes, and through uterus and vagina connects to external environment
vesicouterine fossa: uterus and urinary bladder
2. **vesicouterine pouch:**

in male the pouch is closed but in female is connected to environment.

abdominal organs are divided into 3 groups:

fully covered
1. **intraperitoneal organs:** are fully covered by peritoneum. they are **stomach, liver (except area nodosa), spleen, jejunum, ileum, 50% of cecum, always appendix, transvers colon, sigmoid colon** and superior 1/3 of rectum. → *beginning and ending*

all covered except 1 wall
2. **mesoperitoneal organs:** are partly peritoneal and partly adventitia. they are parts of **duodenum, ascending and descending colon, middle part 1/3 of rectum** and tail of pancreas. → *main part*

only 1 wall is covered
3. **extraperitoneal:** inferior 1/3 of rectum and we have organs that are located **behind of peritoneum**. they are called retroperitoneal for example **descending part of duodenum, pancreas, kidneys, adrenal glands and urethras**. → *not part of digestive system*

SOME DOUBTS!

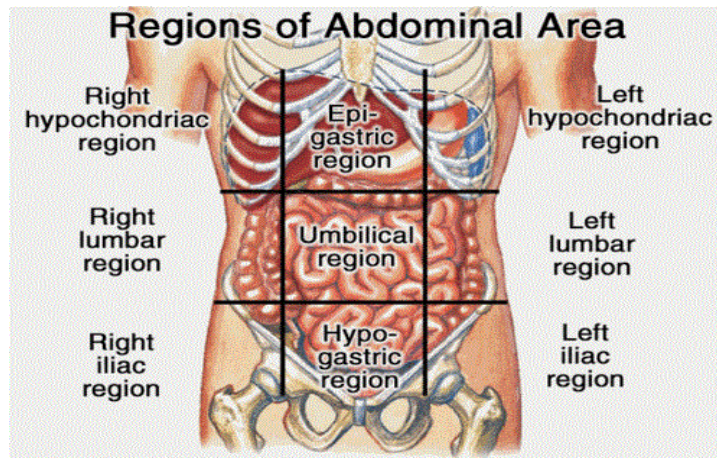
Difference between peritoneum and mesentery:

A mesentery is double layer of visceral peritoneum. It connects an intraperitoneal organ to (usually) the posterior abdominal wall. It provides a pathway for nerves, blood vessels and lymphatics to travel from the body wall to the viscera. The mesentery of the small intestine is simply called 'the mesentery'.

Difference between mesentery and mesocolon:

Mesentery is (anatomy) the membrane that attaches the intestines to the wall of the abdomen, maintaining their position in the abdominal cavity, and supplying them with blood vessels, nerves, and lymphatics while mesocolon is (anatomy) the part of the mesentery that attaches the colon to the abdominal wall.

Abdominal area:



• Borders: of omental bursa

• Superior wall: caudate lobe of the liver *upper*

• Anterior wall: Lesser omentum, posterior wall of the stomach, gastrocolic ligament, part of the greater omentum.

• Inferior wall: transverse colon *lower*

• Posterior wall: parietal layer of the peritoneum
(aorta, vena cava inferior, left adrenal gland, upper part of the left kidney, body of the pancreas)

epiglotic foramen

Foregut

-rima oris

vestibulum

cavum oris

pharynx

oesophagus

gaster

Midgut

duodenum

jejunum

ileum

Hindgut

cecum

appendix vermiformis

ascending colon

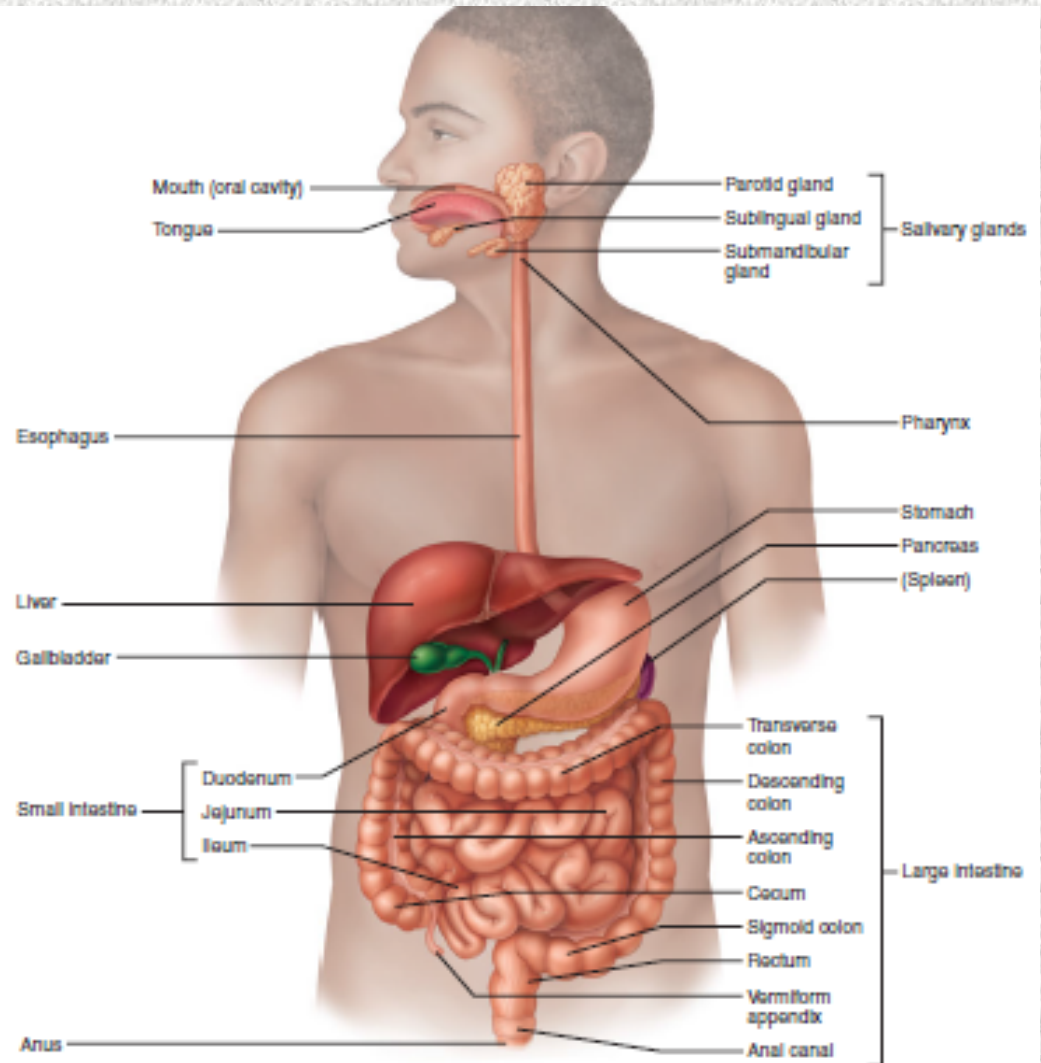
transvers colon

descending colon

Sigmoid colon

rectum

anus



URE 23.1 The alimentary canal and the accessory digestive organs. (See A Brief

Colon

- Cecum is intraperitoneal organ (sometimes mesoperitoneal)
- Appendix is intraperitoneal organ
- Ascending and descending colon are mesoperitoneal organs
- Transversers and sigmoid colon are intraperitoneal organs

