



Student Notes

ANATOMY

1st Edition

ABDOMEN & PELVIS



Preface

Agam is a group of budding medicos, who are currently doing their under graduation in various Medical Colleges across Tamil Nadu and Pondicherry. The group was initiated on 18th November 2017, in the vision of uniting medicos for various social and professional causes.

We feel delighted to present you Agam Anatomy notes prepared by Agam Divide and Rule 2020 Team to guide our fellow medicos to prepare for university examinations.

This is a reference work of 2017 batch medical students from various colleges. The team took effort to refer many books and make them into simple notes. We are not the authors of the following work. The images used in the documents are not copyrighted by us and is obtained from various sources.

Dear readers, we request you to use this material as a reference note, or revision note, or recall notes. Please do not learn the topics for the 1st time from this material, as this contain just the required points, for revision.

Acknowledgement

On behalf of the team, Agam would like to thank all the doctors who taught us Anatomy. Agam would like to whole heartedly appreciate and thank everyone who contributed towards the making of this material. A special thanks to Srivardhany Bhaskar and M. Snaha, who took the responsibility of leading the team. The following are the name list of the team who worked together, to bring out the material in good form.

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ABDOMEN ESSAY QUESTIONS

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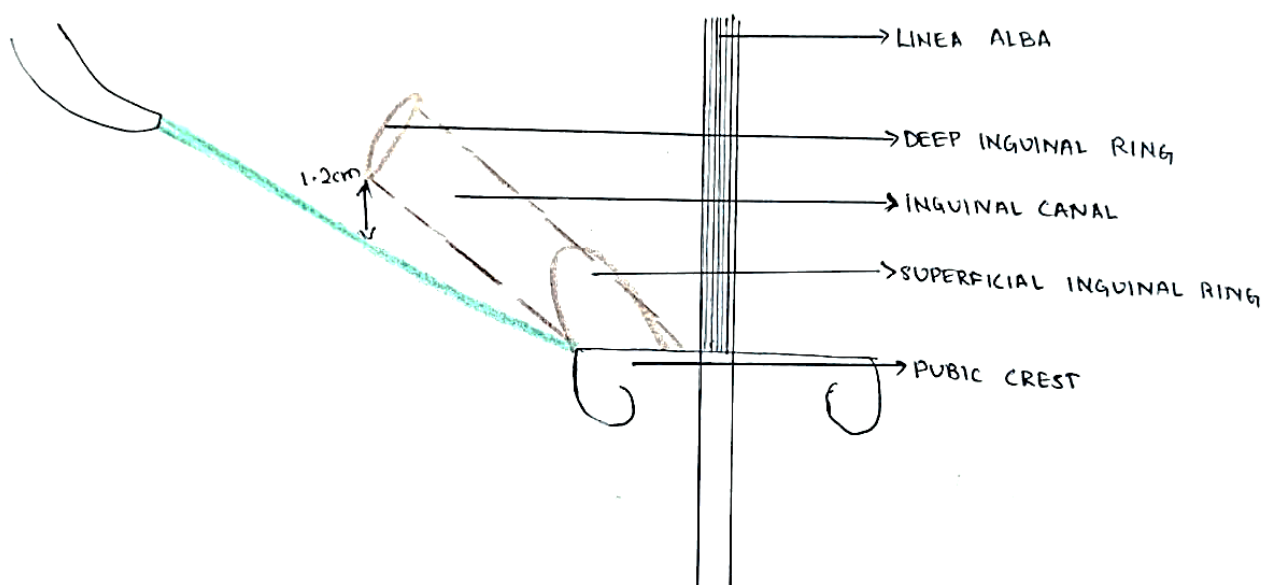
1. INGUINAL CANAL

INTRODUCTION

- It is an oblique intermuscular passage in the lower part of the anterior abdominal wall.
- It's about 4 cm long & is directed downwards.
- It is formed due to the descent of testis into the scrotum and ovary into the pelvis during fetal development.

EXTENT

- From the deep inguinal ring to superficial inguinal ring.
- **DEEP INGUINAL RING** is an oval opening in the fascia transversalis half inch above the mid inguinal point.
- **SUPERFICIAL INGUINAL RING** is a triangular gap in the aponeurosis of external oblique and lies above and lateral to the pubic crest.
- **BASE OF THE TRIANGLE** is formed by pubic crest.
- The two sides of triangle form the lateral & medial margins of opening. It's 2.5 cm long & 1.2 cm broad at the base.
- The margins are referred to as **CRURA** which beyond the Apex of triangle are united by intercrural fibres.



BOUNDARIES OF INGUINAL CANAL

ANTERIOR

- **IN WHOLE EXTENT:**
 1. Skin
 2. Superficial fascia
 3. External oblique aponeurosis
- **IN IT'S LATERAL 1/3RD:**
 1. Internal oblique aponeurosis and muscle fibers

POSTERIOR

- **IN WHOLE EXTENT:**
 1. Fascia transversalis
 2. Extraperitoneal tissue
 3. Parietal peritoneum
- **IN IT'S MEDIAL 2/3RD:**
 1. Conjoint tendon, medial two third
 2. At its medial end by reflected part of inguinal ligament.

ROOF

- Arched fibers of internal oblique and transversus abdominis muscles.

FLOOR

- Grooved upper surface of inguinal ligament
- Abdominal surface of the lacunar ligament in the medial end.

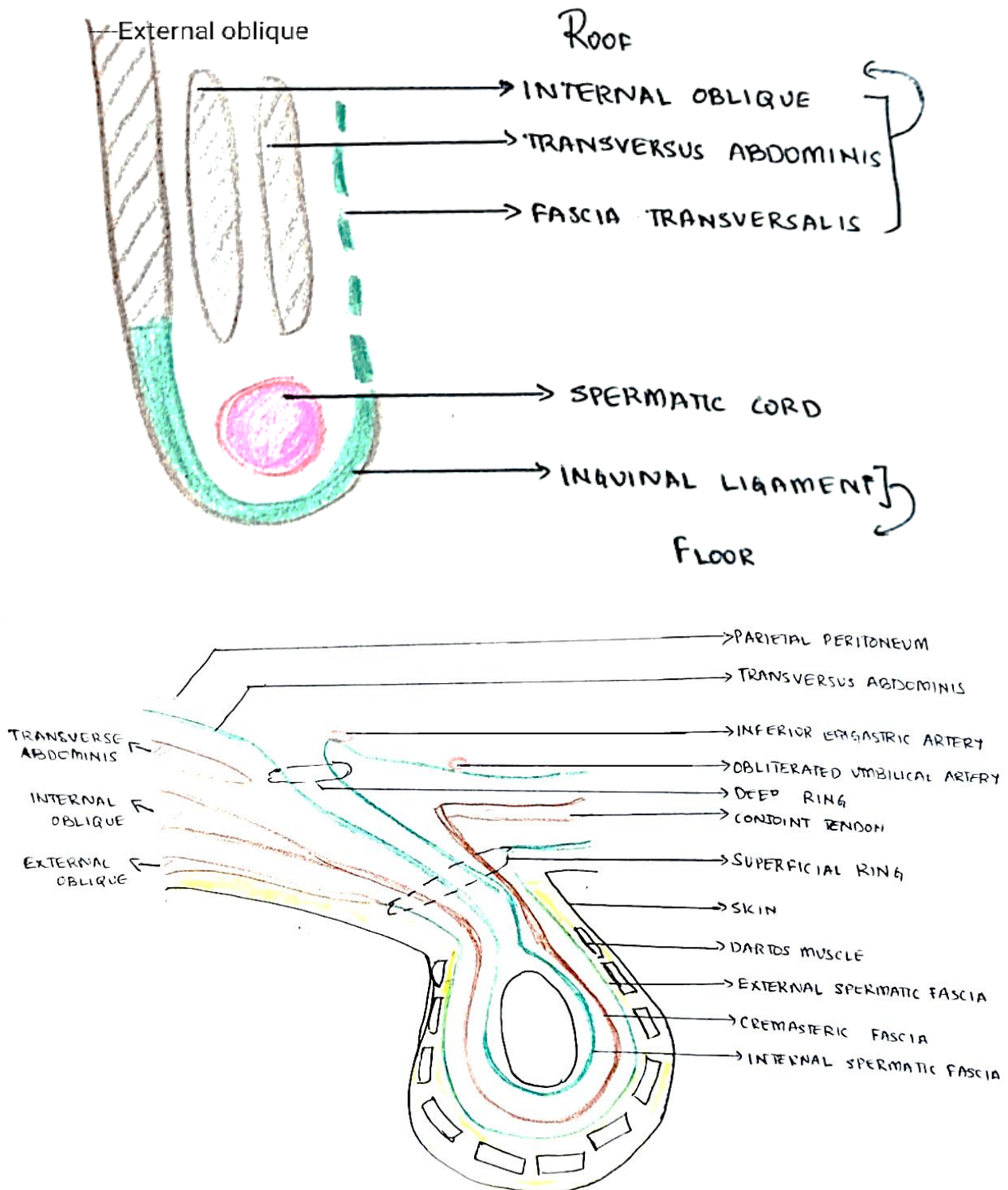
CONTENTS OF INGUINAL CANAL

IN MALE:

1. **SPERMATIC CORD** – complete content
2. **ILIOINGUINAL NERVE** – partial content

IN FEMALE:

1. **ROUND LIGAMENT OF UTERUS** - complete content
2. **ILIOINGUINAL NERVE** - partial content



SPERMATIC CORD

- It consists of all the structures that pass to and fro from the testis through inguinal canal.

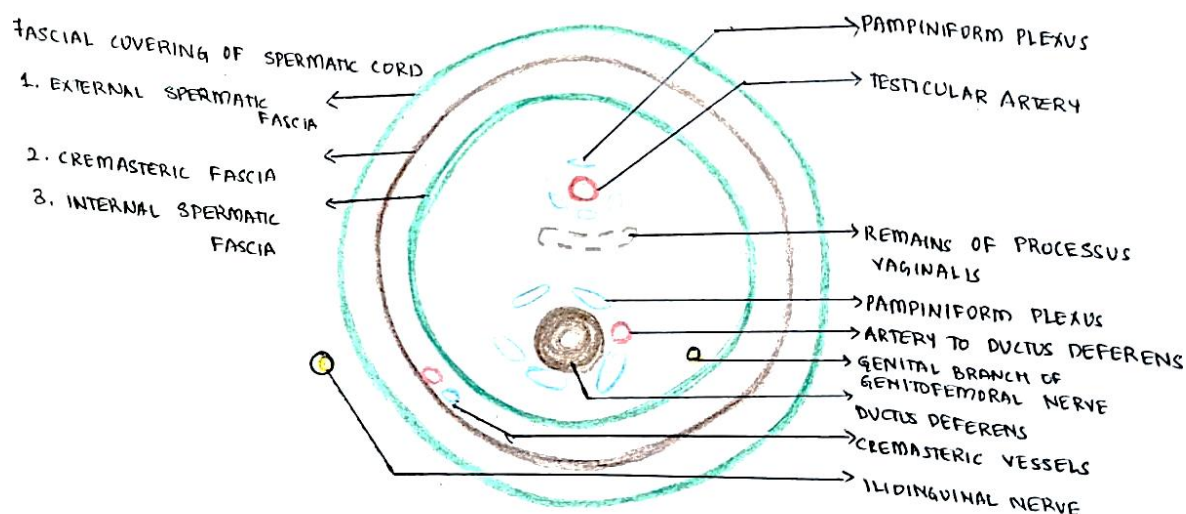
CONTENTS:

1. DUCTUS DEFERENS

2. CAT ARTERIES - Cremasteric artery (branch of inferior epigastric A.), artery to ductus deferens (branch of inferior vesical artery), testicular artery (branch of abdominal aorta)
3. Pampiniform venous plexus
4. Remains of processus vaginalis
5. NERVE SUPPLY - Genital branch of genitofemoral nerve, sympathetic fibres accompanying arteries to ductus deferens, visceral afferent nerve fibres.
6. LYMPHATICS - from testis & drain into pre & para-aortic lymph nodes.

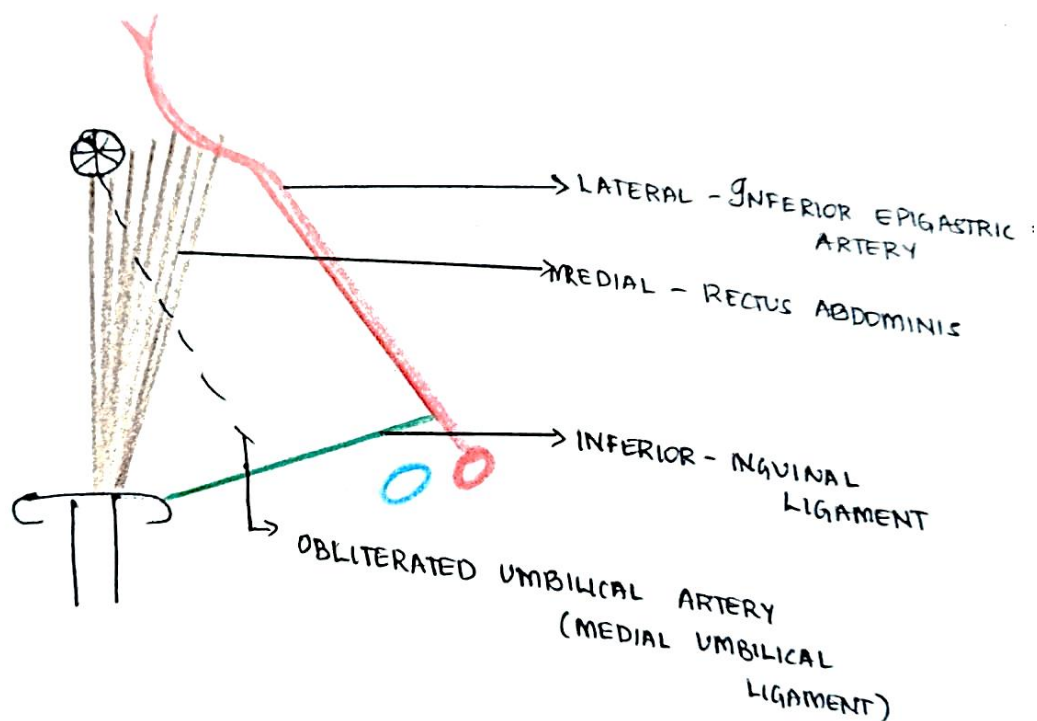
COVERINGS:

1. INTERNAL SPERMATIC FASCIA - derived from fascia transversalis
2. CREMASTERIC FASCIA - it consists of loops of skeletal muscle fibres united by areolar tissue. The muscle fibres are derived from internal oblique muscle
3. EXTERNAL SPERMATIC FASCIA - derived from aponeurosis of external oblique muscle.



MECHANISMS TO PREVENT HERNIATION

- As the inguinal region is a region of weakness, there are many safety mechanisms to prevent this
 - FLAP-VALVE MECHANISM**: when intra-abdominal pressure is raised, the anterior wall and posterior wall approximates like a flap. This is due to obliquity of inguinal canal.
 - SLIT-VALVE MECHANISM**: contraction of the external oblique close the superficial inguinal ring like a slit valve.
 - BALL-VALVE MECHANISM**: contraction of the cremaster muscle pulls the testis up and the superficial inguinal ring is plugged.
 - SHUTTER MECHANISM**: when the internal oblique muscle contracts (It forms the anterior wall, roof and the posterior wall), it pulls the roof down on the floor like a shutter.
 - HORMONES**: they maintain the tone of inguinal musculature.
 - SUPERFICIAL INGUINAL RING**: is guarded from behind the conjoint tendon & reflected part of inguinal ligament, deep inguinal ring is guarded from the front by fleshy fibres of internal oblique muscle.



HELSELBACH'S TRIANGLE OR INGUINAL TRIANGLE

BOUNDARIES:

- MEDIAL - lower 5 cm of rectus abdominis muscle,
- LATERAL - inferior epigastric artery,
- INFERIOR - medial half of the inguinal ligament
- The FLOOR OF TRIANGLE is covered by peritoneum, extraperitoneal tissue, fascia transversalis. Medial part of floor - strengthened by conjoint tendon & lateral part of floor is weak, hence direct inguinal hernia usually occurs through this part.
- The MEDIAL UMBILICAL LIGAMENT divides the triangle into medial and lateral parts

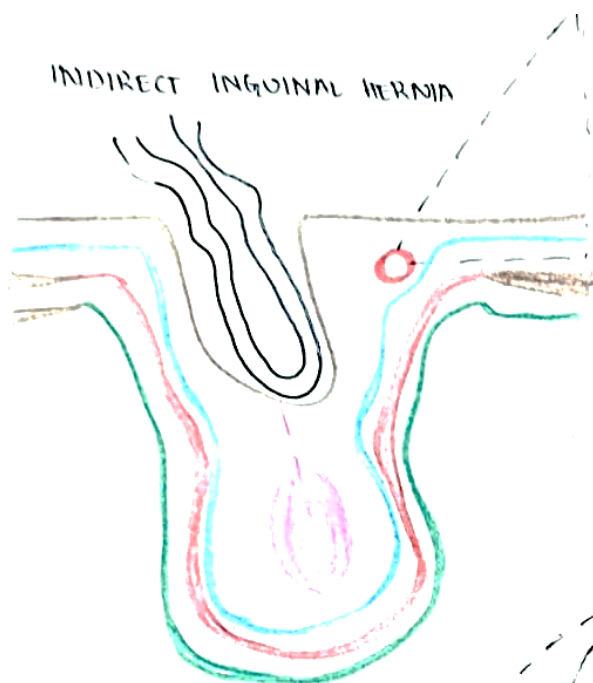
CLINICAL ANATOMY

INGUINAL HERNIA

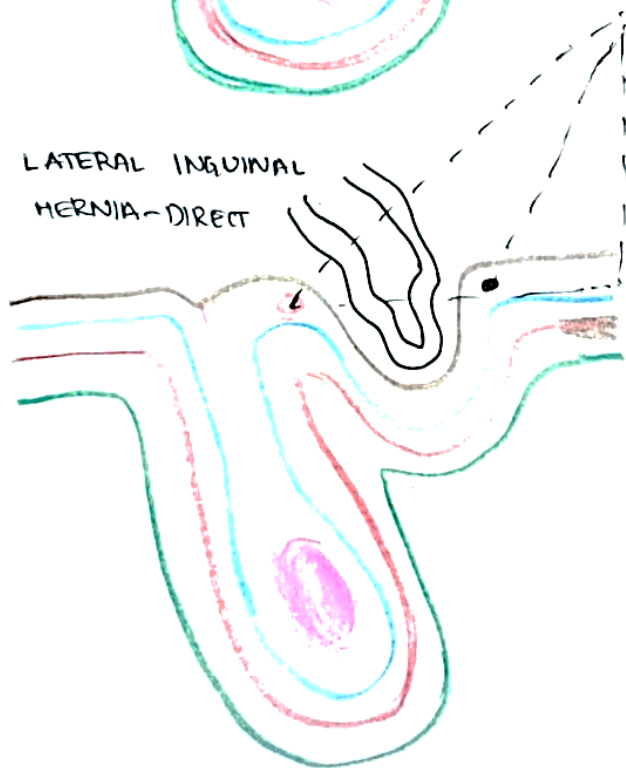
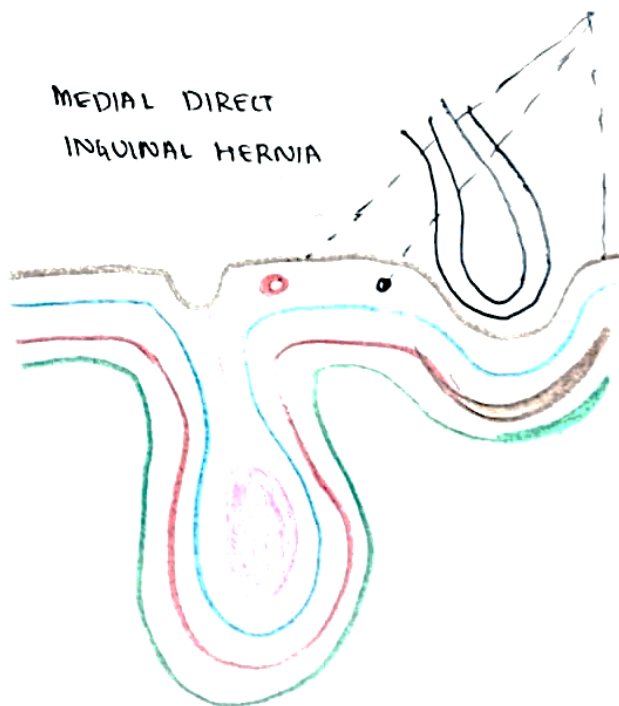
- Protrusion of abdominal viscera through inguinal wall or inguinal canal is called inguinal hernia.
- There are two types of inguinal hernias, direct and indirect.
- Further direct is divided into medial and lateral based on its position with respect to the medial umbilical ligament. (obliterated umbilical arteries)

	<u>INDIRECT INGUINAL HERNIA</u>	<u>DIRECT INGUINAL HERNIA</u>
SITE OF PROTRUSION	It enters the inguinal canal by passing through deep inguinal ring	Directly by pushing the posterior wall of inguinal canal
SHAPE	Pear shaped	Globular shaped
EXTENT	Mostly reaches till the scrotum	Doesn't reach till the scrotum
DIRECTION	Directed downward, forward and medial (through inguinal ring)	Directed forward straightly
NECK OF HERNIAL SAC	Outside the Hesselbach's triangle	Inside the Hesselbach's triangle
REDUCIBILITY	Irreducible sometimes	Reducible
AGE GROUP	Young age	Middle and old age
INTERNAL RING OCCLUSION TEST	Positive, if deep inguinal ring is occluded and the person coughs, herniation doesn't occur, as herniation occurs through inguinal canal	Negative, if deep inguinal ring is occluded and the person coughs, herniation occurs
COVERINGS	• Skin • External spermatic fascia • Cremasteric fascia • Internal spermatic fascia • Extraperitoneal tissue	• Skin • External spermatic fascia • Cremasteric fascia (lateral direct hernia) and conjoint tendon (medial direct hernia) • Fascia transversalis • Extraperitoneal tissue

INDIRECT INGUINAL HERNIA



- TESTIS
- EXTERNAL SPERMATIC FASCIA
- CREMASTERIC FASCIA
- INTERNAL SPERMATIC FASCIA
- FASCIA TRANSVERSALIS
- → OBLITERATED UMBILICAL ARTERY
- → INFERIOR EPIGASTRIC ARTERY

LATERAL INGUINAL
HERNIA-DIRECTMEDIAL DIRECT
INGUINAL HERNIA

2. DUODENUM

- The duodenum is the 1st, widest & shortest part of small intestine.
- It extends from pylorus to duodenojejunal flexure.
- It is 25 cm in length. it is retroperitoneal except the proximal 2.5cm.
- Its main function is digestion and mixing of chyme with bile and pancreatic juices.

SHAPE AND LOCATION

- It is 'c' shaped, its concavity encloses the head of pancreas.
- It is located in the abdominal cavity above the level of umbilicus opposite to L1, L2, L3 vertebrae.

PARTS

It is divided into 4 parts,

1. Superior /1st part [2 in]
2. Descending/2nd part [3 in]
3. Horizontal/3rd part [4 in]
4. Ascending/4th part [1 in]

1st PART

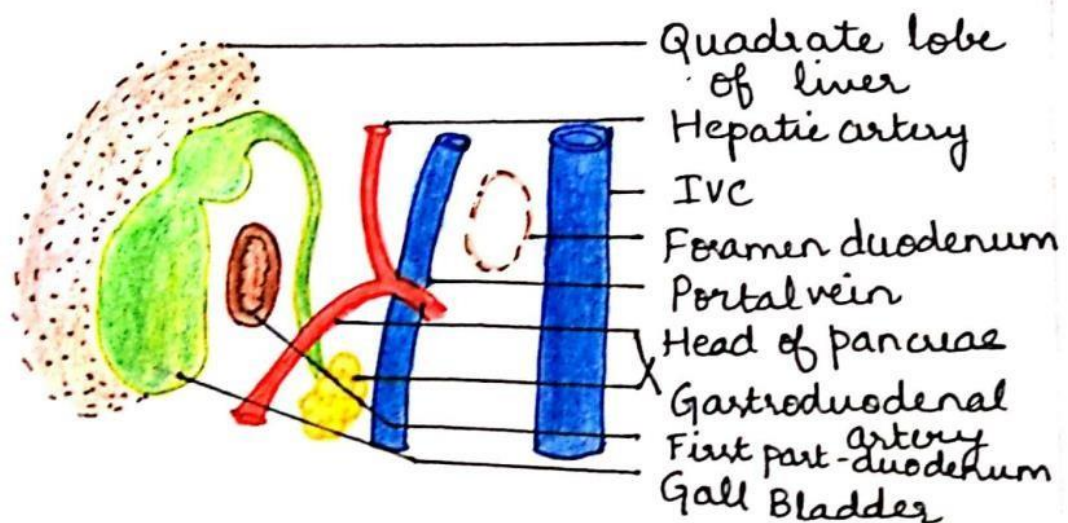
COURSE

It begins at pylorus runs upward, backward and reaches the neck of the gallbladder, where it curves downwards [**Superior duodenal flexure**] and continuous with 2nd part.

FEATURES

- It develops from foregut
- It is retroperitoneal, so freely movable.
- It is devoid of circular folds
- It is supplied by the branches of coeliac trunk.

ANTERIOR RELATIONS OF FIRST PART OF DUODENUM



RELATIONS:

- Anterior: quadrate lobe of liver.
- Posterior: portal vein, gastroduodenal artery, common bile duct.
- Superior: epiploic foramen
- Inferior: head and neck of pancreas

2ND PART:

COURSE:

- It begins at superior duodenal flexure, passes downward till the lower border of L3 vertebrae.
- It curves towards the left [inferior duodenal flexure] to continuous with the 3rd part

FEATURES:

- Upper half develops from foregut and lower half from midgut
- It lies behind the transverse mesocolon.
- It receives bile duct, the chief and accessory pancreatic duct.
- It is the only part of intestine supplied by double rows of vasa recta from anterior and posterior pancreaticoduodenal arterial arcades.

RELATIONS:

1. **ANTERIOR**: gallbladder, right lobe of liver, transverse mesocolon (commencement), coils of small intestine.
2. **POSTERIOR**: right kidney, right renal vessels, inferior vena cava [IVC], right psoas major muscle.
3. **MEDIAL**: head of pancreas.
4. **LATERALLY**: from below upward ascending colon, right colic flexure, right lobe of liver.

3RD PART

COURSE:

- It runs horizontally to the left side over the lower part of L3 vertebrae, then curves upward and continuous with 4th part.

RELATION:

- **ANTERIOR**: Root of mesentery, superior mesenteric vessels, coils of jejunum
- **POSTERIOR**: right psoas major, right ureter, right gonadal vessels, IVC, abdominal aorta
- **SUPERIOR**: head of pancreas with its uncinat process
- **INFERIOR**: coils of jejunum.

4TH PART

COURSE:

It runs upward upto the upper border of L2 vertebrae.

It runs ventrally to become continuous with the jejunum.

RELATION:

- Anterior: transverse colon, transverse mesocolon.
- Posterior: left psoas major, inferior mesenteric vein, left sympathetic chain, left gonadal vessels
- Superior: body of pancreas
- On the left: left kidney and ureter
- On the right: upper part of root of mesentery.

INTERIOR OF DUODENUM:

- The mucous membrane of the duodenum presents circular folds [valves of Kerckring], from 2nd part.
- The interior part of duodenum presents the following features,
- Major duodenal papilla: It is a conical projection on the posteromedial wall, situated 8-10 cm distal to pylorus. Common hepatopancreatic duct opens here.
- Minor duodenal papillae: It is small conical projection 2cm proximal to major duodenal papilla. The accessory pancreatic duct opens here.
- Arch of plica semicircularis: The plica semicircularis forms an arch above the major duodenal papilla.
- Plica longitudinalis: It is a vertical tortuous fold of mucous membrane extending downwards from major duodenal papillae.

DUODENAL RECESSES

- At duodenojejunal junction, small pockets of peritoneum called the recesses occur.
- **SUPERIOR DUODENAL RECESS**: it lies in the left upper end of the fourth part of duodenum behind the superior duodenojejunal peritoneal fold with its orifice looking downwards.
- **INFERIOR DUODENAL RECESS**: it lies below the superior recess behind the inferior duodenojejunal peritoneal fold with its orifice looking upward.
- **PARADUODENAL RECESS**: it is the lowest one, present behind the Paraduodenal fold of the peritoneum, left of the fourth part with its orifice facing medially. Paraduodenal fold contains inferior mesenteric vein.
- **RETRODUODENAL RECESS**: it is the largest one, it lies behind the 3rd and 4th part of duodenum with its orifice looking down and left

ARTERIAL SUPPLY:

- The upper part of duodenum as develops from foregut it is supplied by branches of coeliac trunk
- The lower part as develops from midgut supplied by branches of superior mesenteric artery.

SUPERIOR PANCREATICODUODENAL ARTERY:

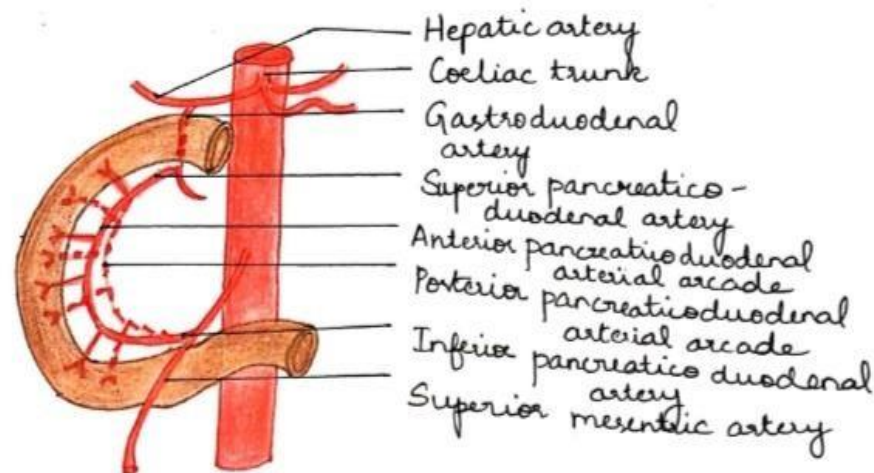
- It is a branch of gastroduodenal artery.
- [coeliac trunk → hepatic artery → gastroduodenal artery → pancreaticoduodenal artery]

INFERIOR PANCREATICODUODENAL ARTERY:

- A branch of superior mesenteric artery.
- The above two arteries divides into anterior and posterior branches.

- The respective branches of superior and inferior pancreaticoduodenal arteries anastomose to form anterior and posterior arterial arcades.
- Anterior arcade supplies the anterior part & posterior arcade supplies the posterior part.

ARTERIAL SUPPLY OF DUODENUM PANCREATODUODENAL ARTERIAL ARCADES



Scanned with CamScanner

SUPRADUODENAL ARTERY OF WILKIE:

- It is a branch of gastroduodenal artery and supplies anterosuperior & posterosuperior surfaces of 1st part of duodenum.

RETRODUODENAL BRANCHES OF THE GASTRODUODENAL ARTERY

- It supply first part of duodenum.

BRANCHES FROM THE RIGHT GASTROEPIPLOIC ARTERY

- It supply first part of duodenum.

ARTERY FROM THE FIRST JEJUNAL BRANCH OF SUPERIOR MESENTERIC ARTERY

- It supplies fourth part of duodenum.

VENOUS DRAINAGE:

- The veins are corresponding to the arteries and superficial to them
- They drain into splenic, superior mesenteric, portal veins

LYMPHATIC DRAINAGE:

- Lymph vessels follows the arteries and drains into the pancreaticoduodenal nodes along the inner curve of duodenum.
- From there, efferents drain into coeliac, superior mesenteric lymph nodes, ultimately into cisterns chyli via intestinal lymph trunk.

NERVE SUPPLY:

- Sympathetic nerves are from T6-T9 segments of spinal cord.
- Parasympathetic nerves from coeliac and superior mesenteric plexus.

CLINICAL:

DUODENAL ULCER:

- It is an inflammatory erosion of duodenal mucosa. It commonly occurs in 1st part, as it receives acidic chyme from stomach as it is supplied by series of end arteries. In barium meal X Ray of abdomen, first part of duodenum presents as triangular shadow called as duodenal cap / bulb.
- When duodenal ulcer is present, duodenal cap becomes deformed.

DUODENAL INJURIES:

- The 3rd part is more vulnerable to external injury as it is crushed between the vertebral column and the anterior abdominal wall.

DUODENAL DIVERTICULUM:

- It is congenital and mostly occurs in the medial wall of 2nd part of duodenum.

REFERRED PAIN:

The pain arising from duodenum is poorly localized & referred to the central epigastrium.

3. STOMACH

PRESENTING FEATURES

LOCATION

- Epigastric region
- Left hypochondrium
- Umbilical region

EXTERNAL FEATURES OF STOMACH

TWO ENDS:

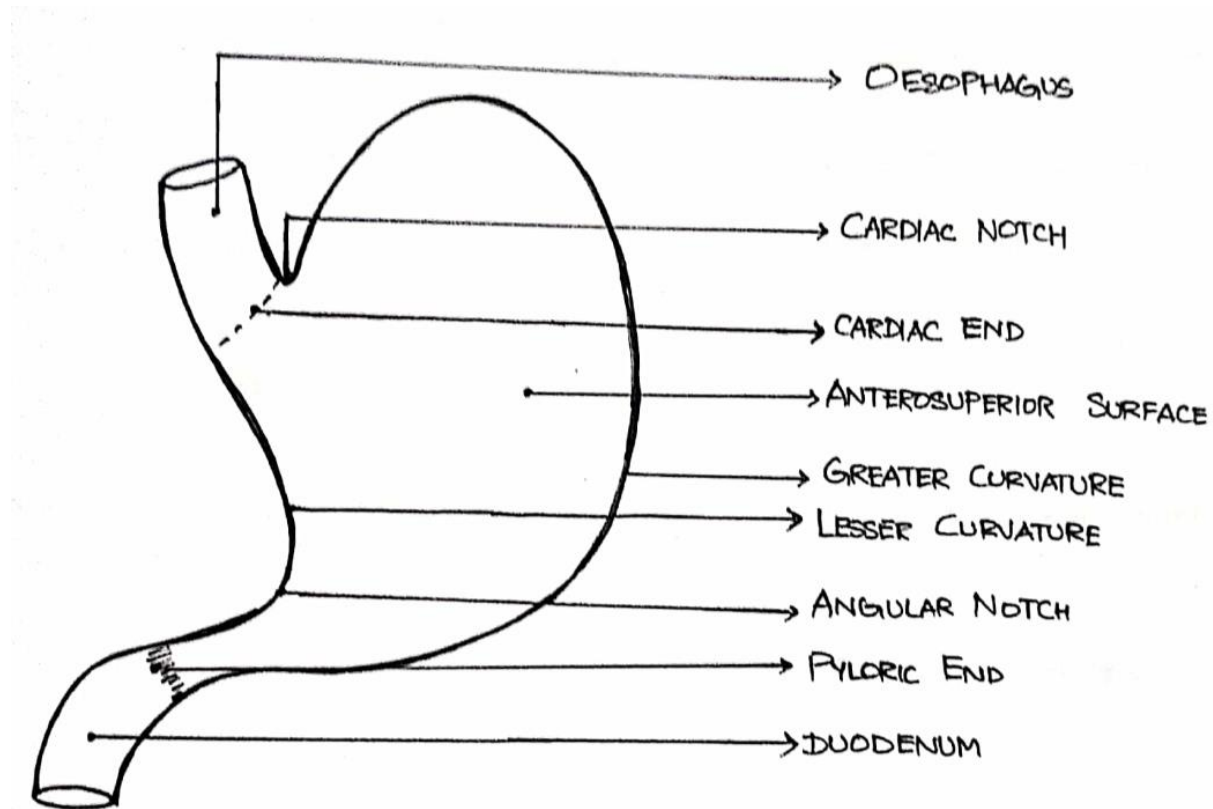
- A. **CARDIAC END** – upper/proximal end
 - Joins with lower end of Oesophagus
 - Left of midline at the level of T11 vertebra
- B. **PYLORIC END** – lower / distal end
 - Joins with first part of duodenum
 - Just right to midline at the level of L1 vertebral level
 - Thicker due to presence of pyloric sphincter

TWO CURVATURES:

- A. **GREATER CURVATURE** – represents left border of stomach
 - Gives attachment to greater omentum
- B. **LESSER CURVATURE** – represents right border
 - Gives attachment to lesser omentum
 - **ANGULAR NOTCH** (incisura angularis)– most dependent part

TWO SURFACES:

- A. **ANTEROSUPERIOR SURFACE** – forward and upward
- B. **POSTEROINFERIOR SURFACE** – backward and downward



THREE PARTS:

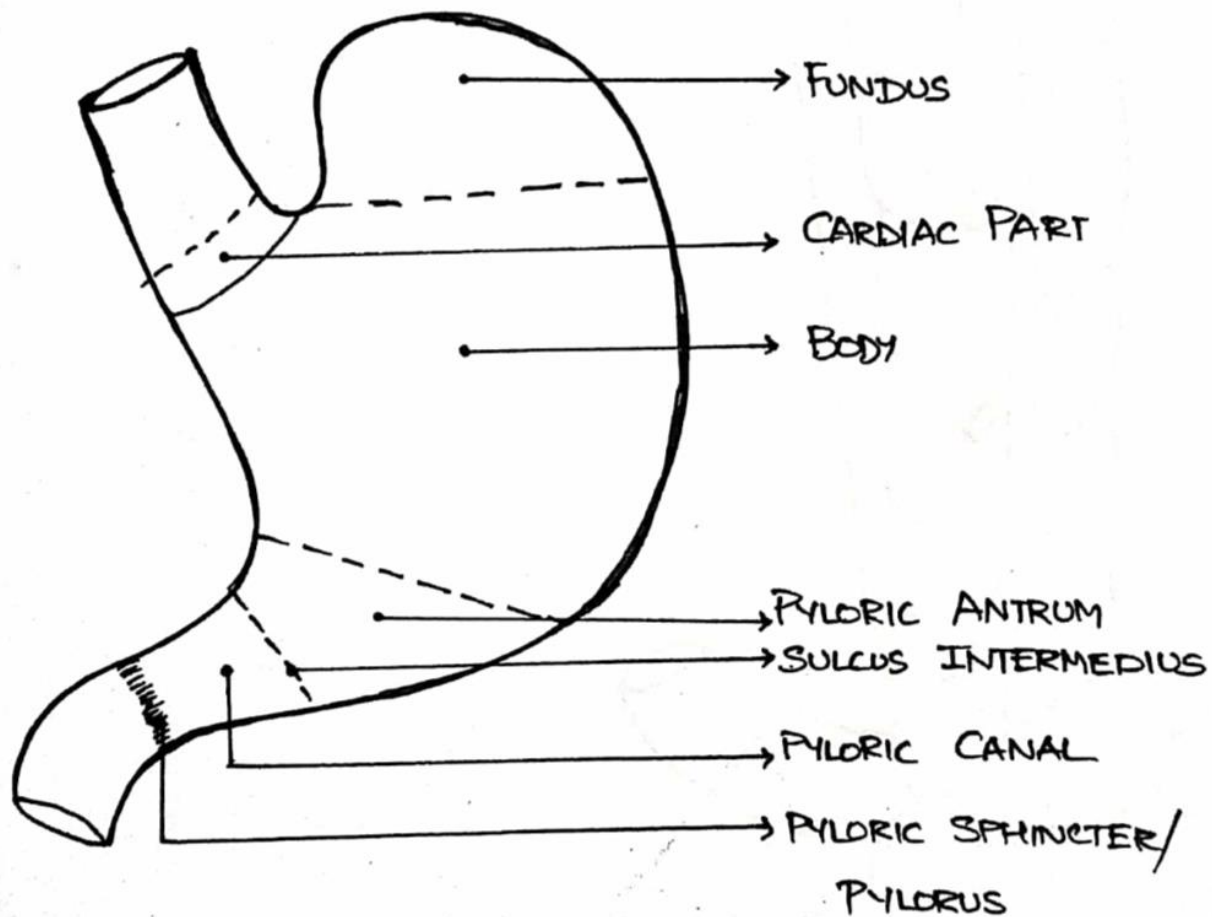
A. FUNDUS

- Upper part of stomach (above the horizontal imaginary line drawn at cardiac end)
- Normally filled with air
- Located just below left dome of diaphragm

B. BODY OF STOMACH

- Main part of stomach
- Between fundus and pylorus
- Can be distended along greater curvature

C. PYLORUS



- Lower part of stomach from angular notch to gastroduodenal junction
- Pylorus has 3 parts

PYLORIC ANTRUM

PYLORIC CANAL – lies on head and neck of pancreas

PYLORIC SPHINCTER – circular muscles thickening in this region

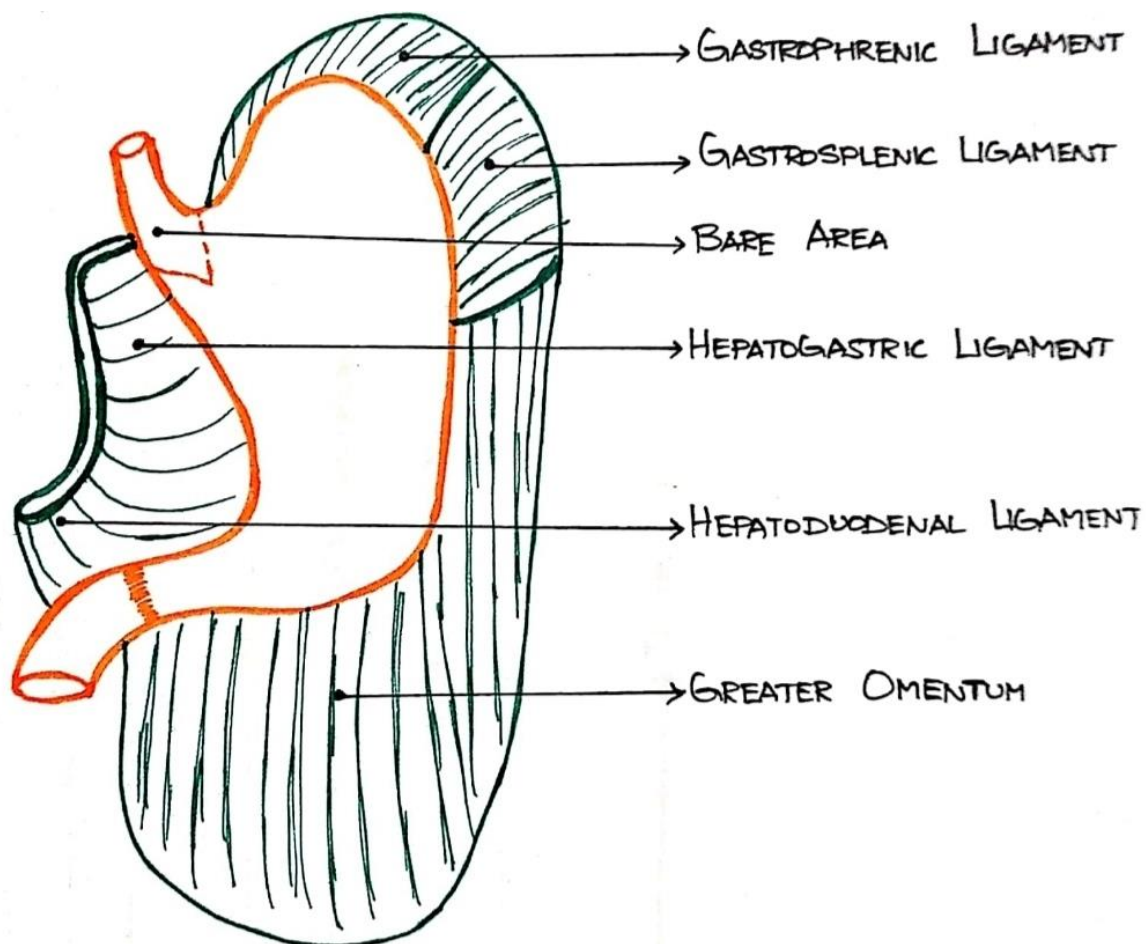
PERITONEAL RELATIONS

A. BARE AREA OF STOMACH – Part of stomach where blood vessels run along its curvatures and a small area near cardiac orifice – are not related to peritoneum

B. RELATED TO LEFT CRUS OF DIAPHRAGM

C. 4 PERITONEAL RELATIONS

1. **LESSER OMENTUM** – Attached from lesser curvature of stomach to liver
2. **GREATER OMENTUM** – Attached from lower $\frac{2}{3}$ rd of greater curvature to transverse colon
3. **GASTROSPLENIC LIGAMENT** – Attached from upper $\frac{1}{3}$ rd of greater curvature (fundus) to hilum of spleen
4. **GASTROPHRENIC LIGAMENT** – Attached from uppermost part of fundus to diaphragm

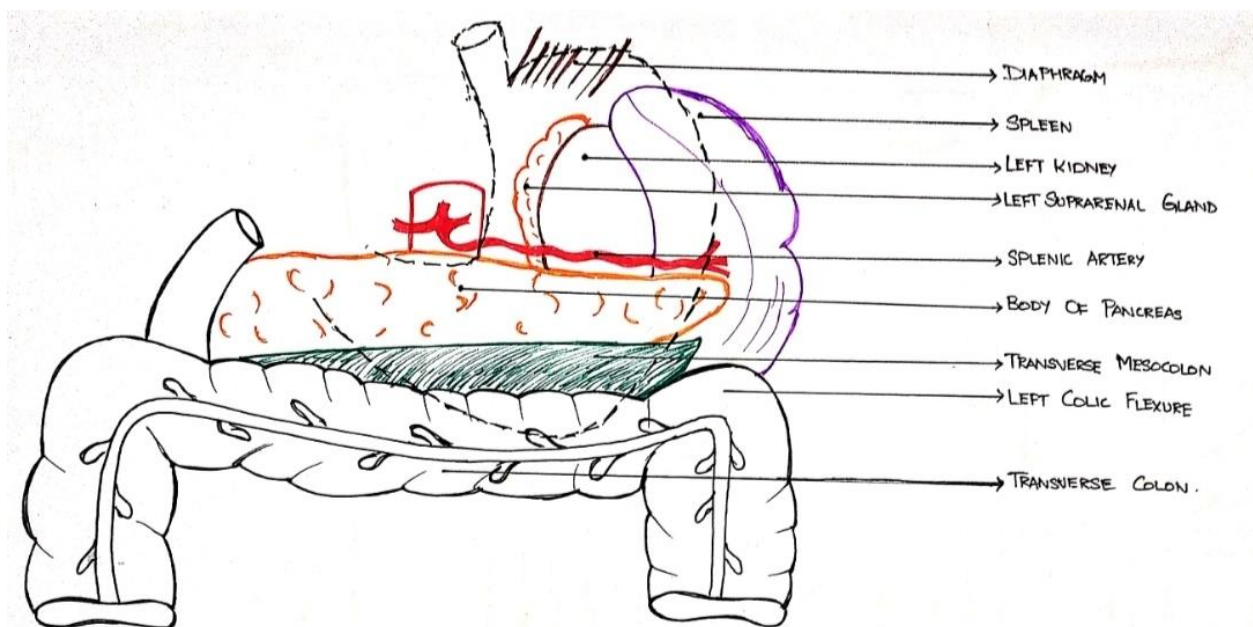


VISCERAL RELATIONS

ANTERIOR VISCERAL RELATIONS

- Right side related to GASTRIC IMPRESSION OF LEFT LOBE OF LIVER
- Near the pylorus to QUADRATE LOBE OF LIVER
- DIAPHRAGM
- ANTERIOR ABDOMINAL WALL

***GASTRIC TRIANGLE** – It is a triangular area of stomach in contact with the anterior abdominal wall. It is bounded on the left side by left costal margin, on the right side by lower border of liver, inferiorly by transverse colon. In complete esophageal obstruction, gastrostomy is performed in this area to feed the patient.



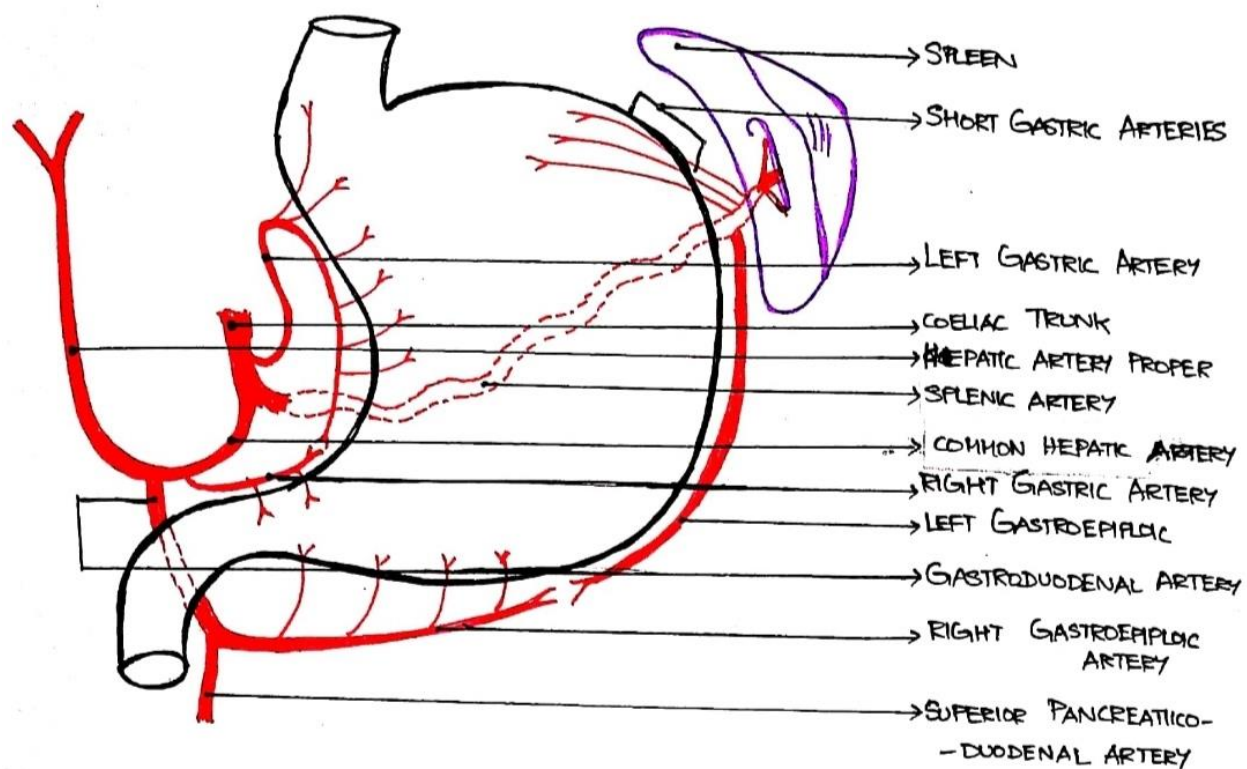
POSTERIOR VISCERAL RELATIONS

STOMACH BED STRUCTURES

1. Diaphragm (left dome)
2. Spleen
3. Splenic artery
4. Splenic flexure of colon
5. Suprarenal gland (left)
6. Kidney (left)
7. Pancreas (body)
8. Mesocolon (Transverse mesocolon)

(Mnemonic: Dr. S4 Kills Patient Mercilessly)

BLOOD SUPPLY OF STOMACH



ARTERIAL SUPPLY = 5 arteries

1. LEFT GASTRIC ARTERY

- Direct branch from **coeliac trunk**

2. RIGHT GASTRIC ARTERY

- Branch from **Common hepatic artery** - branch of coeliac trunk
- Anastomose with left gastric artery along lesser curvature of stomach

3. RIGHT GASTROEPIPLOIC ARTERY

- Branch from **gastroduodenal artery** - branch of common hepatic artery of coeliac trunk

4. LEFT GASTROEPIPLOIC ARTERY

- Branch of **splenic artery** - branch of coeliac trunk
- Anastomoses with right gastroepiploic artery along greater curvature

5. SHORT GASTRIC ARTERIES

- Branch of **splenic artery** - branch of coeliac trunk
- Supply fundus of stomach.

VENOUS DRAINAGE

1. All veins of stomach directly or indirectly drains into **PORTAL VEIN**
2. **Right and left gastric veins** - portal vein
3. **Left gastroepiploic and short gastric veins** - **SPLENIC VEIN**
4. **Right gastroepiploic vein** - **SUPERIOR MESENTERIC VEIN**
5. **PREPYLORIC VEIN / VEIN OF MAYO** - drains into Right gastric vein. It runs in front of pylorus & helps to identify it during surgery.

LYMPH DRAINAGE

- Clinically lymph drainage is important, carcinoma of stomach mainly spreads through lymphatics to regional lymph nodes

Stomach is divided into 4 regions

1. First imaginary vertical line divides stomach into right 2/3rd & left 1/3rd
2. Horizontal imaginary line divides right 2/3rd into upper 2/3rd (**REGION 1**) and (**REGION 3**) lower 1/3rd
3. Left 1/3rd into (**REGION 2**) upper 1/3rd and (**REGION 4**) lower 2/3rd

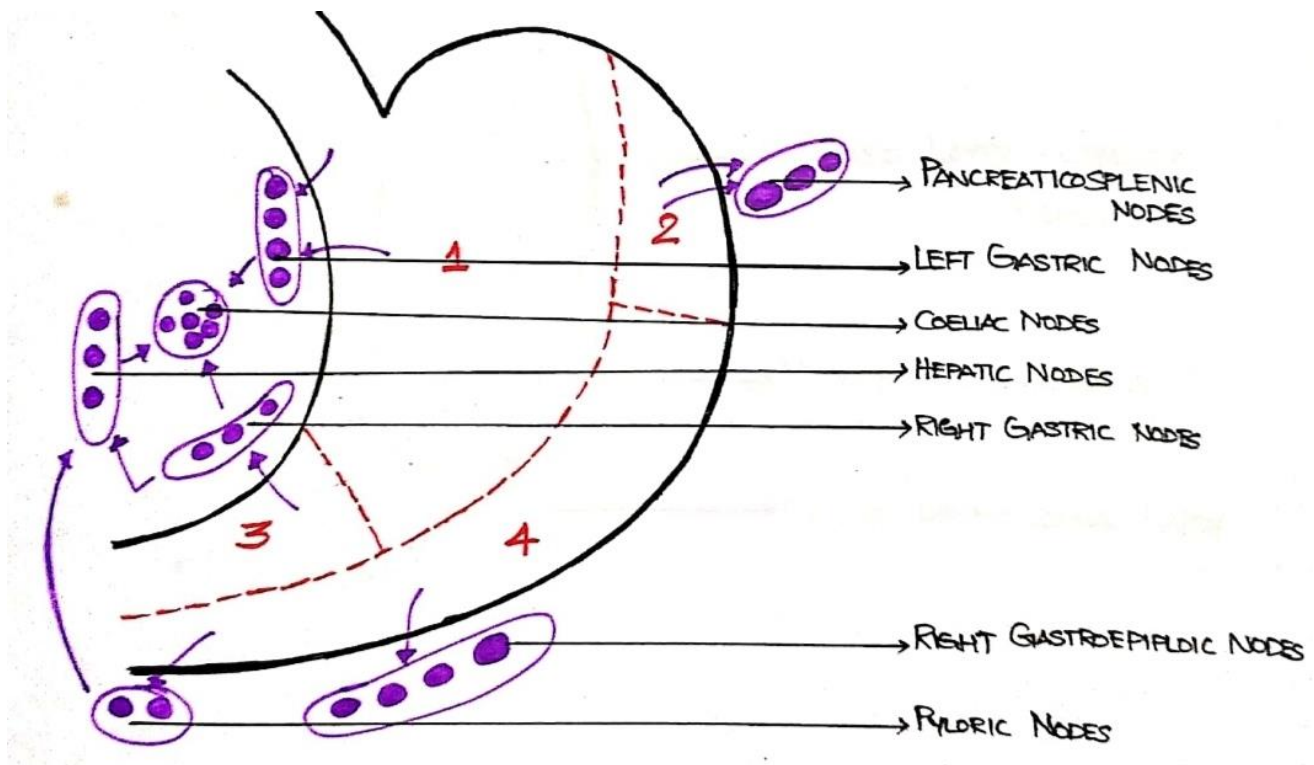
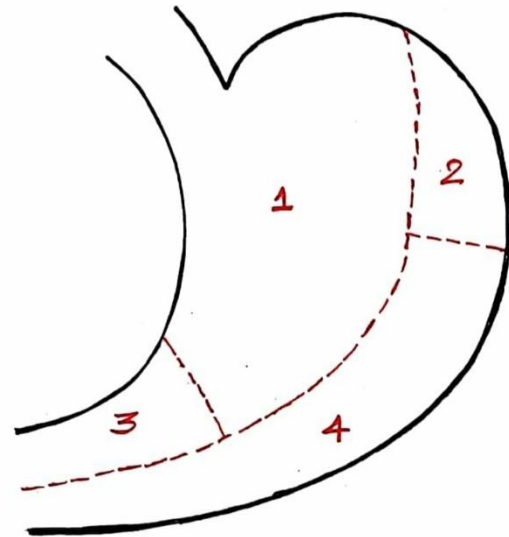
AREA 1 = left gastric nodes

AREA 2 = pancreaticosplenic nodes

AREA 3 = right gastric nodes

AREA 4 = right gastroepiploic nodes and pyloric nodes

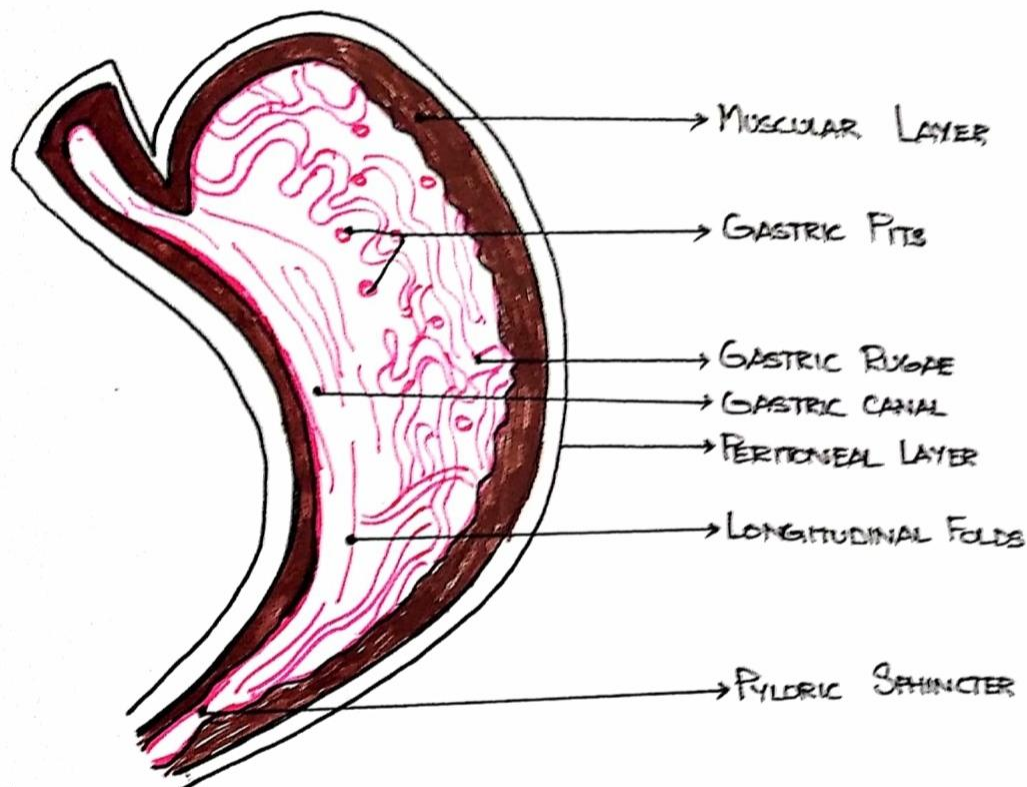
- All these will drain into **COELIAC NODES** which in turn is drained in to cisterna chyli via intestinal lymph trunk



INTERIOR OF STOMACH

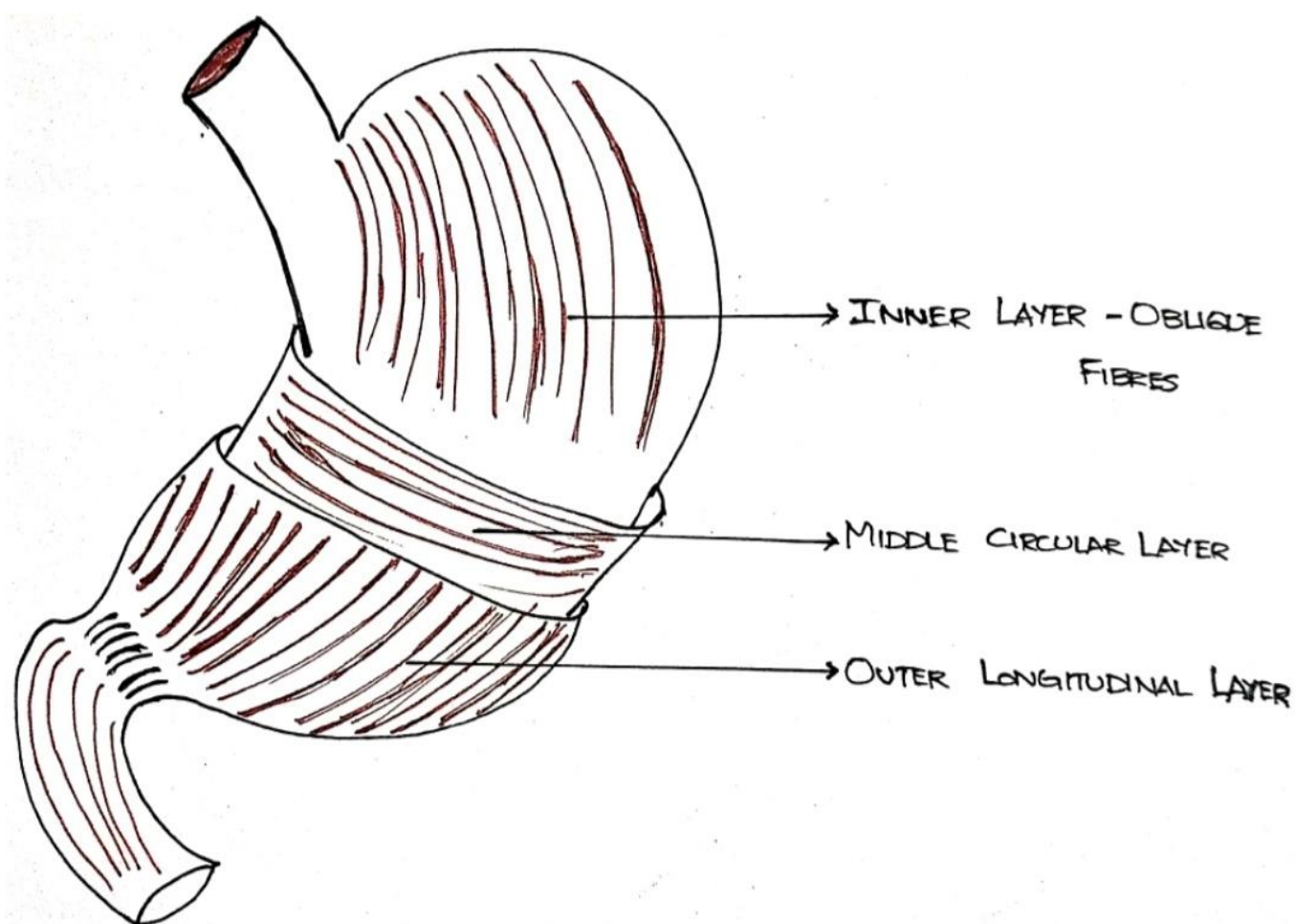
- **GASTRIC RUGAE** - temporary mucous folds of stomach. They are longitudinal along lesser curvature & irregular in remaining part.
- **GASTRIC PITS** - small depressions on mucosal surface in which gastric glands open

- **GASTRIC CANAL /CANAL OF MAGENSTRASSE** -Longitudinal furrow between longitudinal folds of mucosa along lesser curvature
- Allows rapid passage of swallowed liquids along lesser curvature
- Vulnerable part to ulceration



MICROANATOMY OF STOMACH

- Wall of stomach has 4 coats:
 1. **SEROUS COAT** - formed by peritoneum
 2. **MUSCULAR COATS**
 3. **OUTER LONGITUDINAL MUSCLE**- at pyloric end divides into superficial and deep fibres
 4. **MIDDLE CIRCULAR MUSCLE**- at pyloric end thickens to form pyloric sphincter along with deep fibres of longitudinal coat
- Inner oblique muscle layer
- Submucosal coat
- Inner mucous coat



APPLIED ASPECTS

GASTRIC ULCER - more common along lesser curvature (around angular notch)

GASTRIC CANCER- mainly spreads through lymphatics

- More common along greater curvature
- Enlarged and palpable left supraclavicular nodes called **VIRCHOW'S NODES - TROISIER'S SIGN**

GASTRECTOMY- surgical removal of stomach in carcinoma

VAGOTOMY - surgical procedure of **CUTTING VAGAL NERVES**

TO CURE CHRONIC DUODENAL ULCER - 2 types

1. **TRUNCAL VAGOTOMY** - anterior and posterior Vagal trunks are cut at lower end of esophagus above origin of hepatic and coeliac branches
2. **SELECTIVE VAGOTOMY**- anterior and posterior vagal trunks are cut below origin of hepatic and coeliac branches

Gastric emptying is affected

HIGHLY SELECTIVE VAGOTOMY-

- **PARIETAL CELLS OF STOMACH ARE DENERVATED BY CUTTING.**
- Anterior gastric branches of anterior nerve of Latarjet
- Posterior gastric branches of posterior nerve of Latarjet and nerve of Grassi
- **ADVANTAGES**: Nerves of Latarjet and their antral branches are preserved, so gastric emptying remains normal

GASTRIC PAIN - Referred to epigastric region supplied by T6 to T10 spinal segments.

4. PORTAL VEIN:

The blood from

1. Abdominal part of alimentary canal
2. Pancreas
3. Gallbladder
4. Spleen

Is conveyed to the liver by the portal vein

It is called the portal vein because its main tributary, the superior mesenteric vein, begins in one set of capillaries and a portal vein ends another set of capillaries in the liver.

FORMATION

It is formed by the union of superior mesenteric and splenic veins behind the neck of pancreas at the level of 2nd lumbar vertebrae.

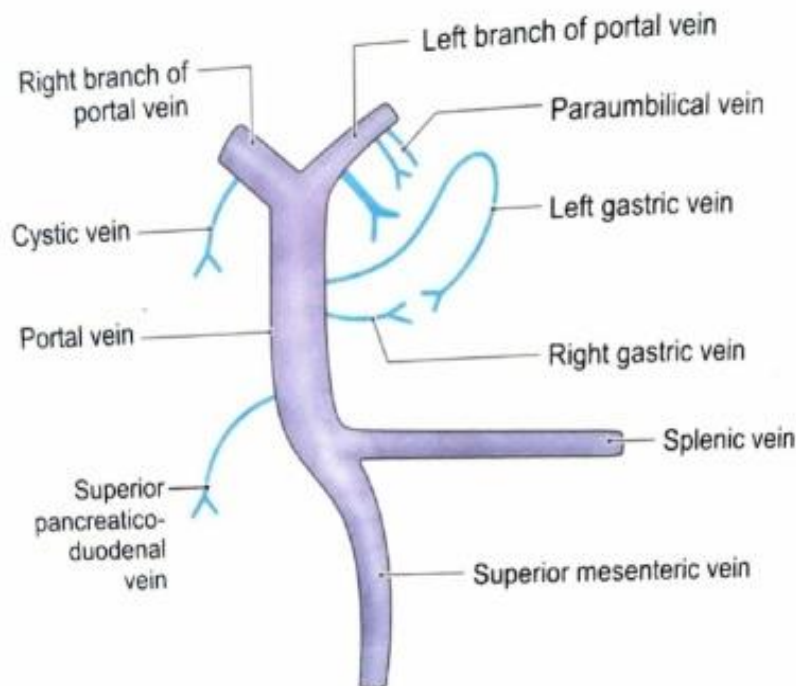
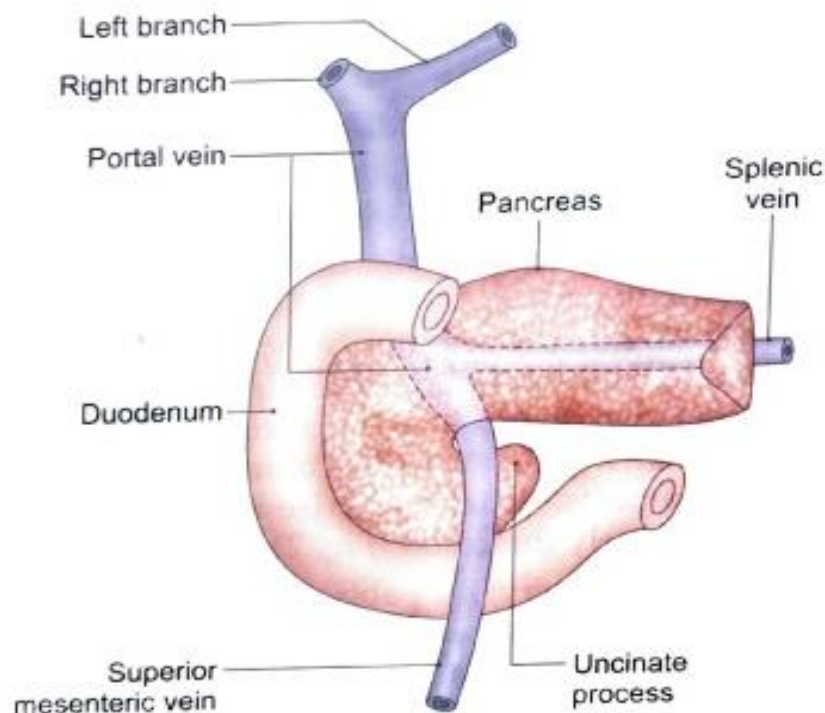


Fig. 21.13: Formation of portal vein

COURSE

It runs upwards and little to the right, first behind the neck of the pancreas, next behind the first part of the duodenum, and lastly in the right free margin of the lesser omentum.

Blood of superior mesenteric vein drains into right lobe. Blood of splenic and inferior mesenteric vein drains into left lobe. This is called 'streamline flow'.



TERMINATION

- The vein insert the right end of the porta hepatis by dividing into right and left branches which enter the liver.

RELATIONS

INTRADUODENAL PART

ANTERIORLY: neck of pancreas

POSTERIORLY: inferior vena cava

RETRODUODENAL PART

ANTERIORLY

1. First part of duodenum
2. Bile duct
3. Gastroduodenal artery

POSTERIORLY: Inferior vena cava

SUPRADUODENAL PART

ANTERIORLY

1. Hepatic artery
2. Bile duct (within free margin of the lesser omentum)

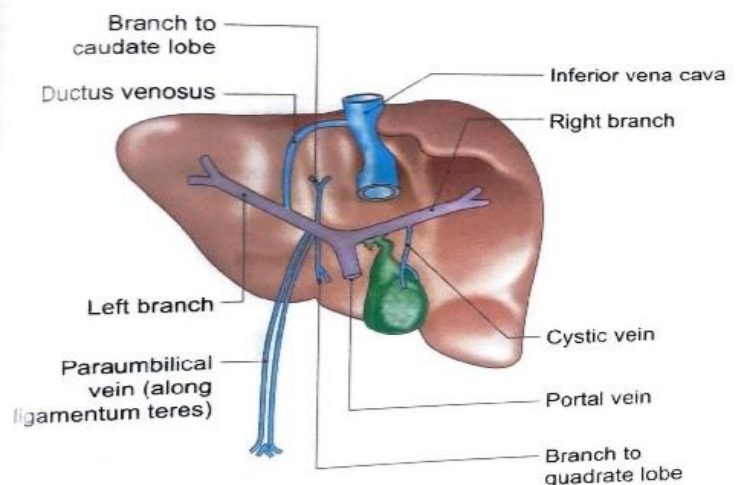
POSTERIORLY: inferior vena cava separated by epiploic foramen

INTRAHEPATIC COURSE

After entering the liver each branch divides and redivides along with the hepatic artery to end ultimate clean the hepatic sinusoids where the portal venous blood mixes with the hepatic arterial blood.

BRANCHES

1. The right branch is shorter and wider than the left branch. After receiving the systemic vein, it enters the right lobe of the liver
2. The left branch is longer and narrower than the right branch. It traverses the porta hepatis from its right end to the left end and furnishes branches to the caudate and quadrate lobe. Just before entering the left lobe of the liver it receives during fetal life
 - a. Paraumbilical vein along the ligamentum teres
 - b. Ductus venosus along the ligamentum venosum



TRIBUTARIES

1. Left gastric vein
2. Right gastric vein
3. Superior pancreaticoduodenal vein
4. Cystic vein in its right branch
5. Para umbilical veins in its left branch

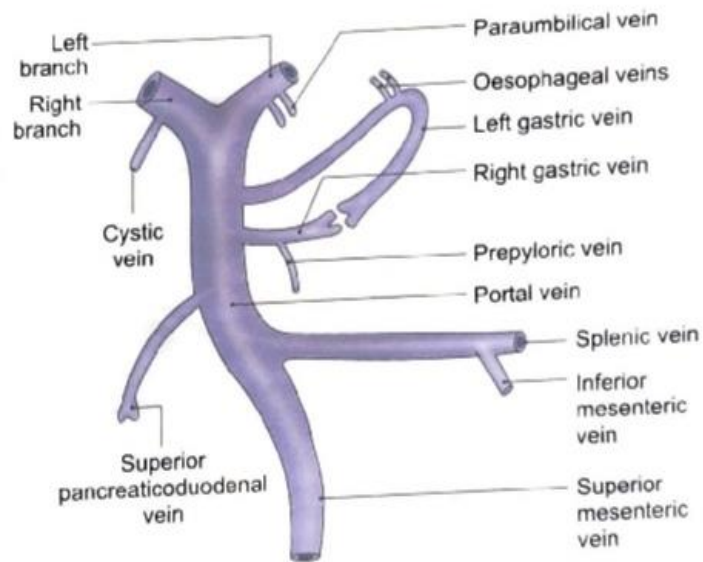
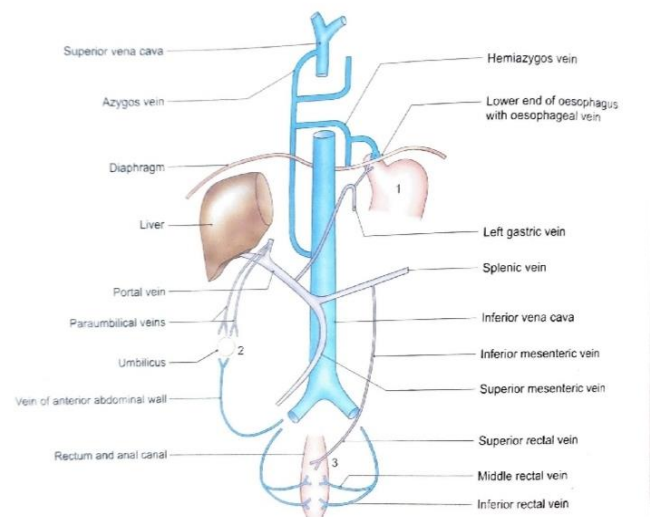
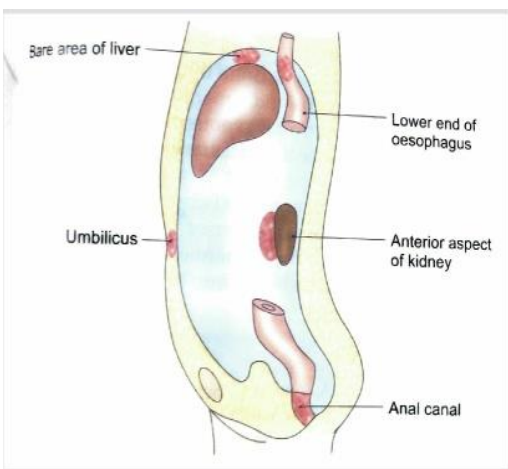


Fig. 21.15: Tributaries of the portal vein

PORTOSYSTEMIC/PORTOCAVAL COMMUNICATION



SITES OF PORTOCAVAL/PORTOSYSTEMIC ANASTOMOSIS				
SR. NO.	POSITION	PORTAL VEIN	SYSTEMIC VEIN	CLINICAL CONDITIONS
1	LOWER END OF OESOPHAGUS	Left gastric	Esophageal veins	In liver cirrhosis these tributaries anastomose giving rise to esophageal varices. These varices may rupture to cause hematemesis.
2	LOWER END OF RECTUM	Superior rectal	Middle and inferior rectal veins	Liver cirrhosis causes anastomosis between superior rectal and other rectal veins. These and anastomosing veins result in piles or hemorrhoids.
3	UMBILICUS	Para umbilical	Above-superior epigastric lateral thoracic Below-superficial epigastric inferior epigastric Side-posterior intercostal and lumbar	In liver cirrhosis the paramedical veins open up to transfer portal venous blood into systemic circulation. It results in caput medusae.
4	POSTERIOR ABDOMINAL WALL	Splenic	Left renal vein	It may get injured in procedures done in these areas.

5	BARE AREA OF LIVER	Portal radicles	Diaphragmatic	There is some anastomosis between portal vein and systemic veins. No significance
6	FALCIFORM LIGAMENT	Para umbilical	Diaphragmatic	
7	LIGAMENTUM VENOSUM	Left branch of portal	Inferior vena cava	It may be accompanied by other congenital anomalies

APPLIED ANATOMY

1. **PORTAL PRESSURE**: normal pressure in the portal vein is about 5-15 mm Hg. It is usually measured by splenic puncture and recording the intrasplenic pressure
2. **PORTAL HYPERTENSION** (pressure above 40 mm Hg). It can be caused by
 - a. Cirrhosis of liver
 - b. Banti's disease
 - c. Thrombosis of portal vein
3. Since the blood flow in portal vein is slow and streamlined the toxic infective substances absorbed from small intestine pass via the superior mesenteric vein into the right lobe of liver leading to toxic changes for amoebic abscess in right lobe. The blood lacking in amino acids which is absorbed via the inferior mesenteric vein affect the left lobe leading to its fibrosis or cirrhosis

5. VERMIFORM APPENDIX

DESCRIPTION

- Vermiform appendix is a narrow worm-like diverticulum.
- Arises from the posteromedial wall of the caecum about 2 cm below the ileocecal junction

DIMENSIONS

- **LENGTH**: from 2 to 20 cm (average 9 cm)
- **AVERAGE WIDTH**: about 5 mm.
- **DIAMETER** of lumen varies with age and is more in children than adult and often obliterated after mid-adult life.
- Length varies with age- longer in children than in adults.

PARTS

It presents three parts—base, body, and tip

- **BASE**: The base is attached to the posteromedial wall of the caecum about 2 cm below the ileocecal junction.
- All the three taeniae of caecum converge to the base of the appendix guiding to the surgeon to search for the appendix during appendicectomy.
- **BODY**: The body is a narrow tubular part between the base and the tip.
- **TIP**: The tip is the least vascular distal blind end. It may be directed in various directions.

SURFACE ANATOMY

- The base of the appendix is marked on the surface by a point 2 cm below the intersection between the transtuberular plane and the right midclavicular line (right lateral plane)
- The point representing the base on the surface (vide supra) and McBurney's point are in close approximation topographically

- Therefore, clinicians equate the surface marking of the appendix to McBurney's point.

POSITIONS

- Usually lies in the right iliac fossa.
- Base of appendix is fixed

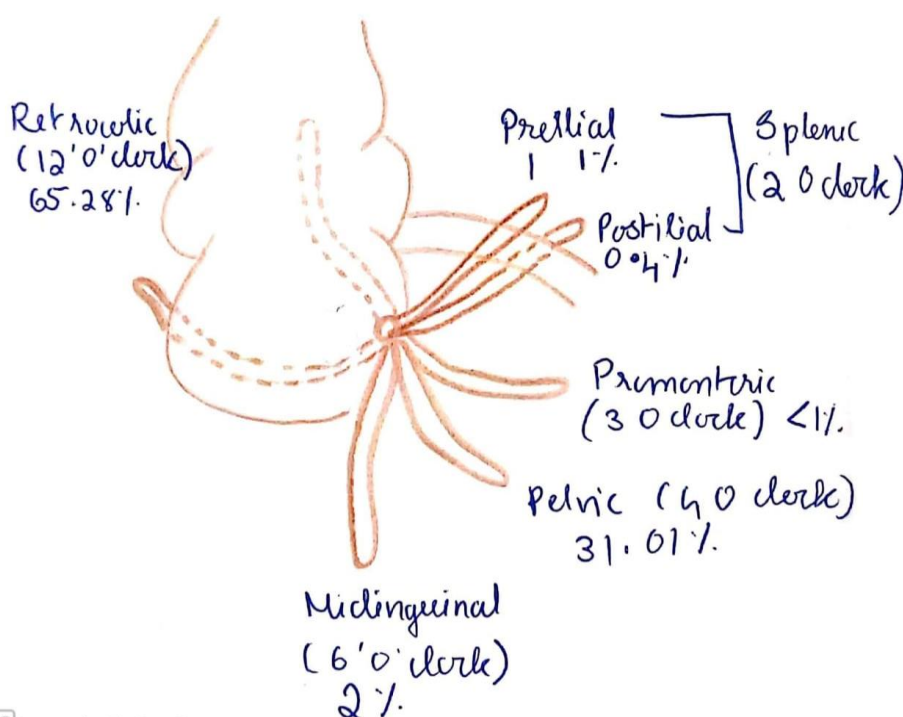
POSITION OF TIP OF APPENDIX

1. **PARACOLIC (11 O'CLOCK) POSITION**: The appendix passes upward on the right side of the ascending colon in 2% of the cases.

2.

RETROCAECAL/RETROCOLIC (12 O'CLOCK) POSITION:

- The appendix passes upward behind the caecum and the ascending colon
- commonest position (65.28%)



3. **SPLENIC (2 O'CLOCK) POSITION**:

- The appendix passes upward and medially in front of (pre-ileal) or behind (post-ileal) the terminal part of the ileum.
- The tip of appendix points toward the spleen.
- The pre-ileal position is the most dangerous because inflammation from the appendix spreads into the general peritoneal cavity.
- pre-ileal - 1% of the cases
- post-ileal in 0.4% of the cases.

4. **PROMONTERIC (3 O'CLOCK) POSITION**: The appendix passes horizontally toward the sacral promontory. very rare (less than 1%).

5. **PELVIC (4 O'CLOCK) POSITION**:

- The appendix descends downward and medially, and crosses the pelvic brim to enter the true pelvis.
- In females, it may be related to the right uterine tube
- second commonest position (31.01%).

6. **MIDINGUINAL/SUBCAECAL (6 O'CLOCK) POSITION**:

- The appendix passes vertically downward below the caecum (subcaecal) and points toward the inguinal ligament.
- in 2% of the cases.

DEVELOPMENT

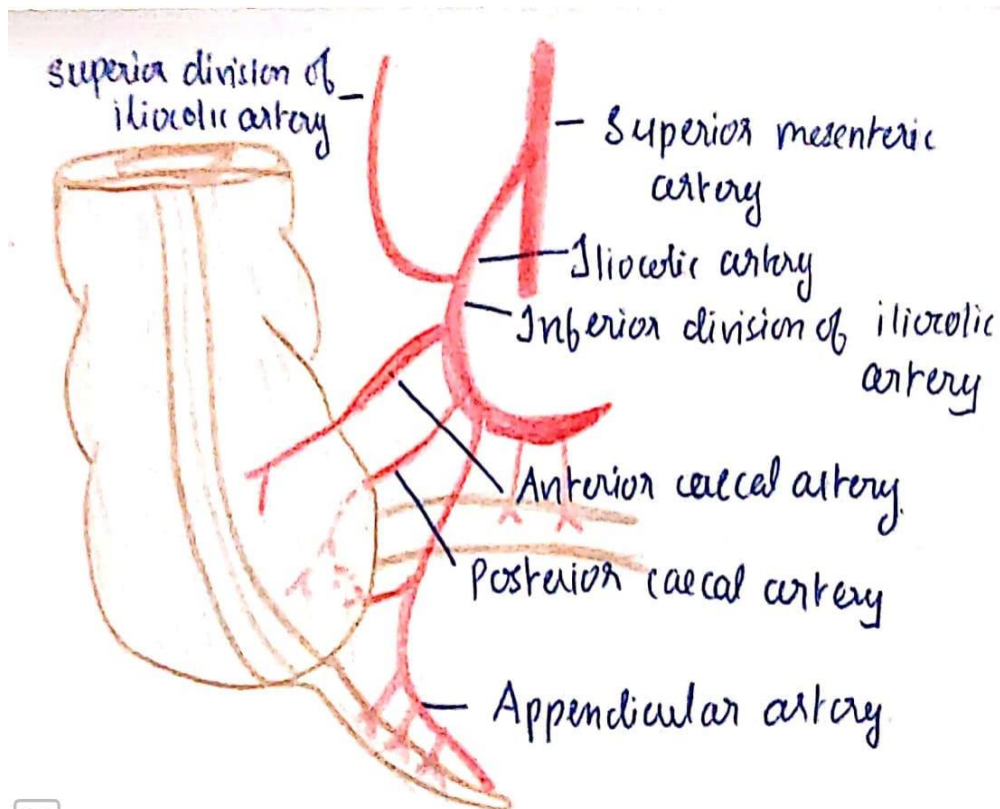
- The caecum and appendix develop from caecal bud that arises from postarterial segment of midgut loop (near its apex).
- After the return of herniated midgut loop in the abdominal cavity, the caecal bud occupies the subhepatic position.
- When the postarterial segment of midgut loop elongates to form ascending colon, the caecal bud gradually descends to reach the right iliac fossa.
- arrest of its descent leads to subhepatic position of caecum and appendix.
- The inflammation of subhepatic appendix causes pain and tenderness in the right hypochondrium and may mimic acute cholecystitis (inflammation of the gall bladder).

PERITONEAL RELATIONS

- It is suspended by a small triangular fold of the peritoneum derived from the posterior/left layer of mesentery of the ileum- mesentery of appendix or mesoappendix.
- appendicular vermiform appendix is an intraperitoneal structure

- artery runs within the free margin of mesoappendix
- Occasionally the mesoappendix fails to reach the apex of appendix.

ARTERIAL SUPPLY



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- The appendix is supplied by a single appendicular artery, a branch of inferior division of ileocolic artery
- It passes behind the terminal part of the ileum to enter the mesoappendix and runs in its free margin to reach the tip of appendix which is the least vascular part.
- When the mesoappendix is short, the appendicular artery rests directly on the appendicular wall near the tip of appendix.
- In appendicitis, this part of the artery is affected and thrombosed, leading to gangrenous change in the tip which may perforate.

VENOUS DRAINAGE

- The vein corresponds to the artery and drains into the superior mesenteric vein which in turn drains into the portal vein.

LYMPHATIC DRAINAGE

- The lymph vessels of the appendix drain into ileocolic lymph nodes directly or through appendicular nodes in the mesoappendix.

NERVE SUPPLY

- Sympathetic nerve supply carries the pain sensations from the appendix-derived from the T10 spinal segment via lesser splanchnic nerve and superior mesenteric plexus.
- Hence, pain referred to the umbilical region.
- Parasympathetic nerve supply is derived from both vagus nerves.

APPLIED ANATOMY

APPENDICITIS:

- The inflammation of the appendix is called appendicitis.
- Acute appendicitis is a common occurrence and is a surgical emergency.
- commonly occurs due to obstruction of its lumen by fecaliths or edema.
- The initial pain of appendicitis is the referred pain and is felt in the umbilical region because both have same segmental nerve supply (i.e., T10 spinal segment).
- Gradually the pain is localized in the right iliac fossa.
- It is due to involvement of local parietal peritoneum in the region of right iliac fossa.

- The overlying musculature undergoes spasm causing guarding of anterior abdominal wall.
- On palpation maximum tenderness is elicited at McBurney's point which is marked on the surface by a point at the junction of medial two-third and lateral one-third of a line extending from the umbilicus to the right anterior superior iliac spine.

PSOAS TEST IN APPENDICITIS:

- When the appendix is retrocaecal in position it lies on and irritates the right psoas major when inflamed (appendicitis).
- The forced extension of the right thigh in such patients causes increase in pain in the right iliac fossa.

OBTURATOR TEST IN APPENDICITIS:

When the appendix is pelvic in position, it may irritate the obturator internus muscle. The flexion and medial rotation of the right thigh on the abdomen causes pain in the lower abdomen.

APPENDECTOMY:

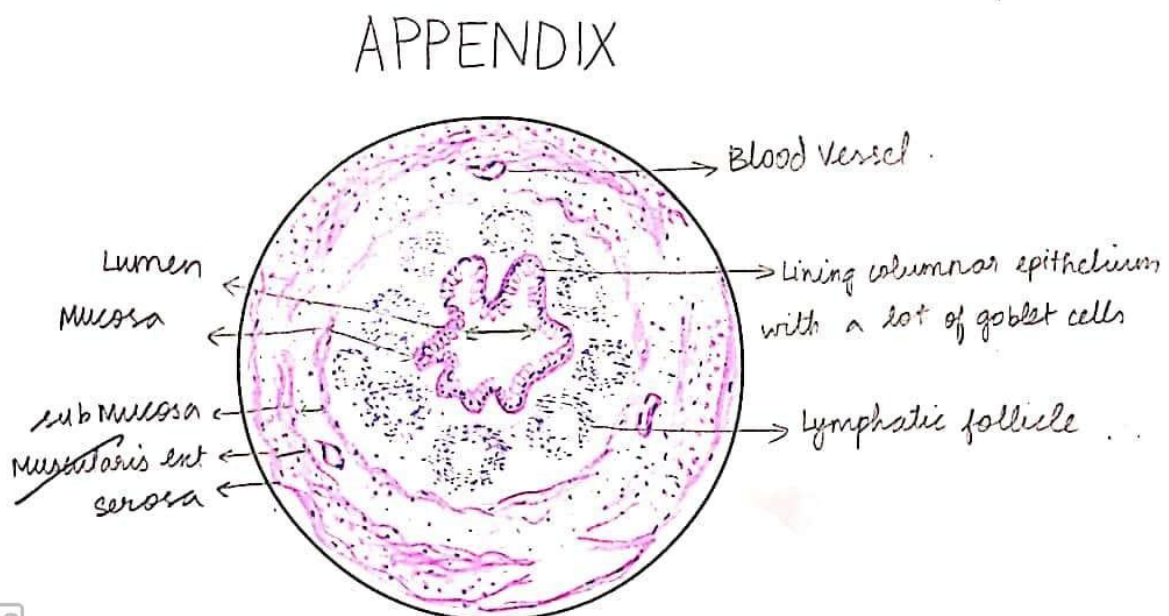
The incision for appendectomy is purely based on the anatomy of the anterior abdominal wall. A gridiron (5 shape of a cross beam) incision is given in the right iliac fossa.

1. The three flat muscles are split along the direction of their fibres.
2. The fascia transversalis and parietal peritoneum are incised together.
3. The appendix is delivered through the wound and cut at its base and removed.

MICROSCOPIC STRUCTURE

- The appendix has relatively small angulated circular lumen as compared to its thick wall.

- The wall of the appendix consists of four layers from within outwards, these are: mucosa, submucosa, muscular layer, and serosa.
 - A. **MUCOSA**: The surface of the mucous membrane is lined by the simple columnar cells and numerous goblet cells.
 - a. It is devoid of villi.
 - b. The intestinal glands (crypts of Lieberkühn) are few and short.
 - B. **SUBMUCOSA**: It contains a ring of large lymphoid follicles with germinal centers. Hence, the appendix is commonly considered as an abdominal tonsil.
 - C. **MUSCLE LAYER**: It consists of outer longitudinal and inner circular layers of smooth muscle.
 - D. **SEROSA**: It is made up of visceral peritoneum.
- Muscularis mucosa is disrupted by lymphatic nodules.



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6. SUPERIOR MESENTERIC ARTERY

- It is the artery of mid – gut.
- It supplies the derivatives of mid – gut such as
 1. Lower part of duodenum (below opening of bile duct).
 2. Jejunum.
 3. Ileum.
 4. Caecum.
 5. Ascending colon.
 6. Right $\frac{2}{3}$ rd of transverse colon.
 7. Lower $\frac{1}{2}$ of head of pancreas.

ORIGIN

- Ventral branch of abdominal aorta.
- At L1 vertebral level.
- 1 cm below coeliac trunk.
- Behind the body of pancreas.

COURSE

- Runs downwards & towards right with convexity towards the left.
- lies in front of the uncinate process of pancreas & 3rd part of duodenum.
- Enters the root of the mesentery.

TERMINATION

- By anastomosing with a branch of the ileocolic artery.

RELATIONS

ABOVE THE ROOT OF MESENTERY

ANTERIORLY

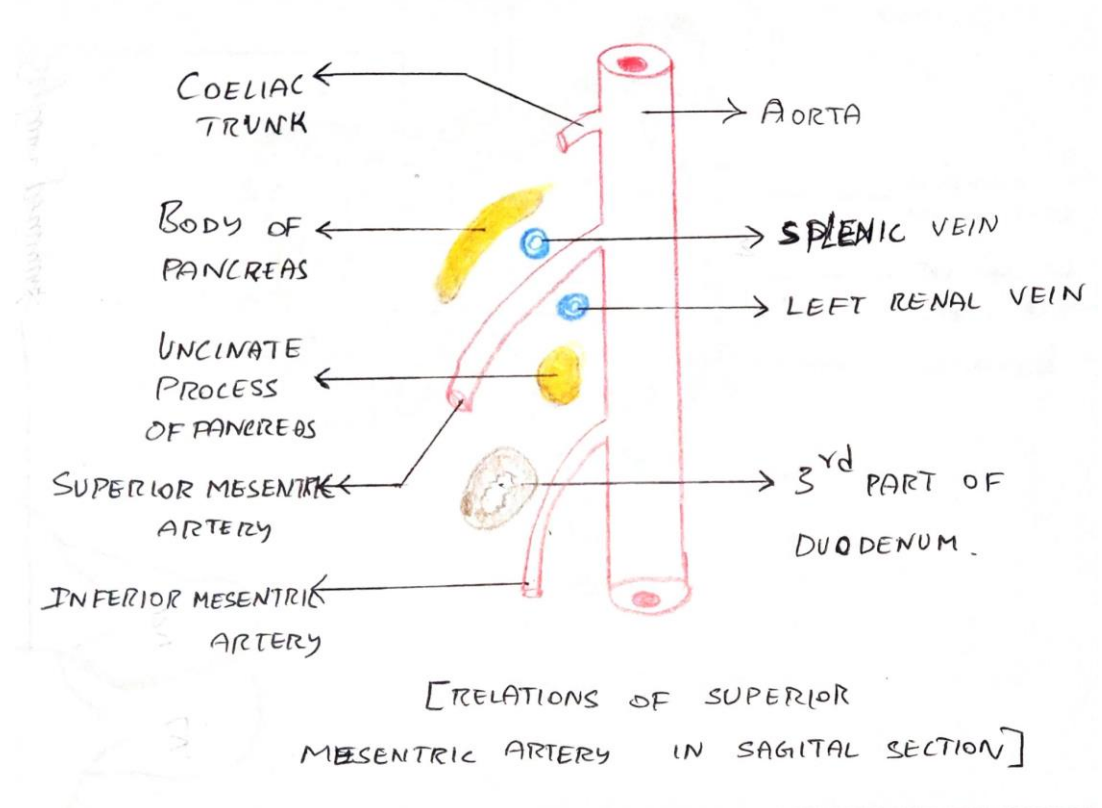
1. Body of pancreas.
2. Splenic Vein.

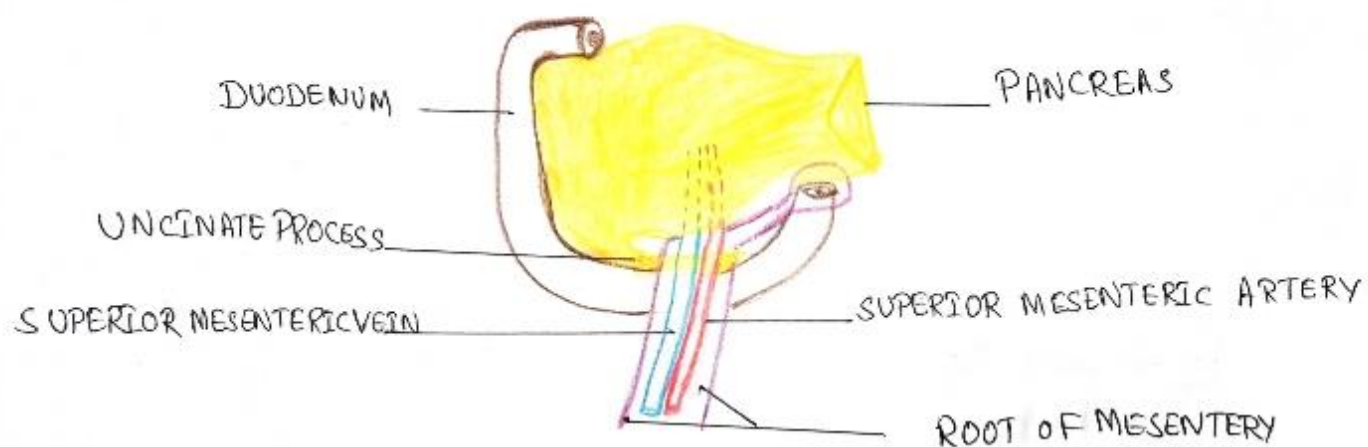
POSTERIORLY

1. Abdominal aorta.
2. Left renal Vein.
3. Uncinate process of pancreas.
4. 3rd part of duodenum.

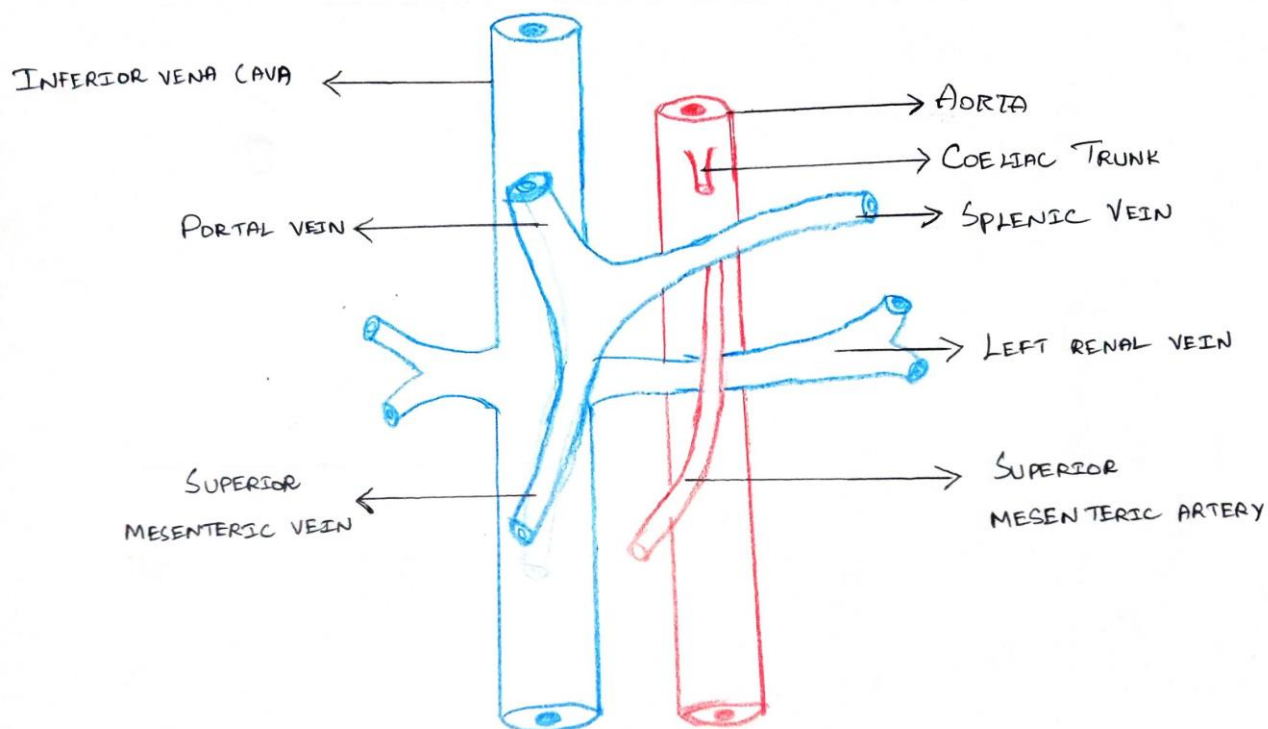
WITHIN THE ROOT OF THE MESENTERY

- Lies in between the 2 layers of mesentery.
- Posteriorly –
 1. Inferior vena cava.
 2. Right psoas.
- Right side – accompanied by superior Mesenteric Vein.
- Surrounded by the superior mesenteric plexus of nerves.





[ANTERIOR VIEW WITH PANCREAS & DUODENUM
IN PLACE]



[ANTERIOR VIEW SHOWING RELATIONS OF VESSELS]

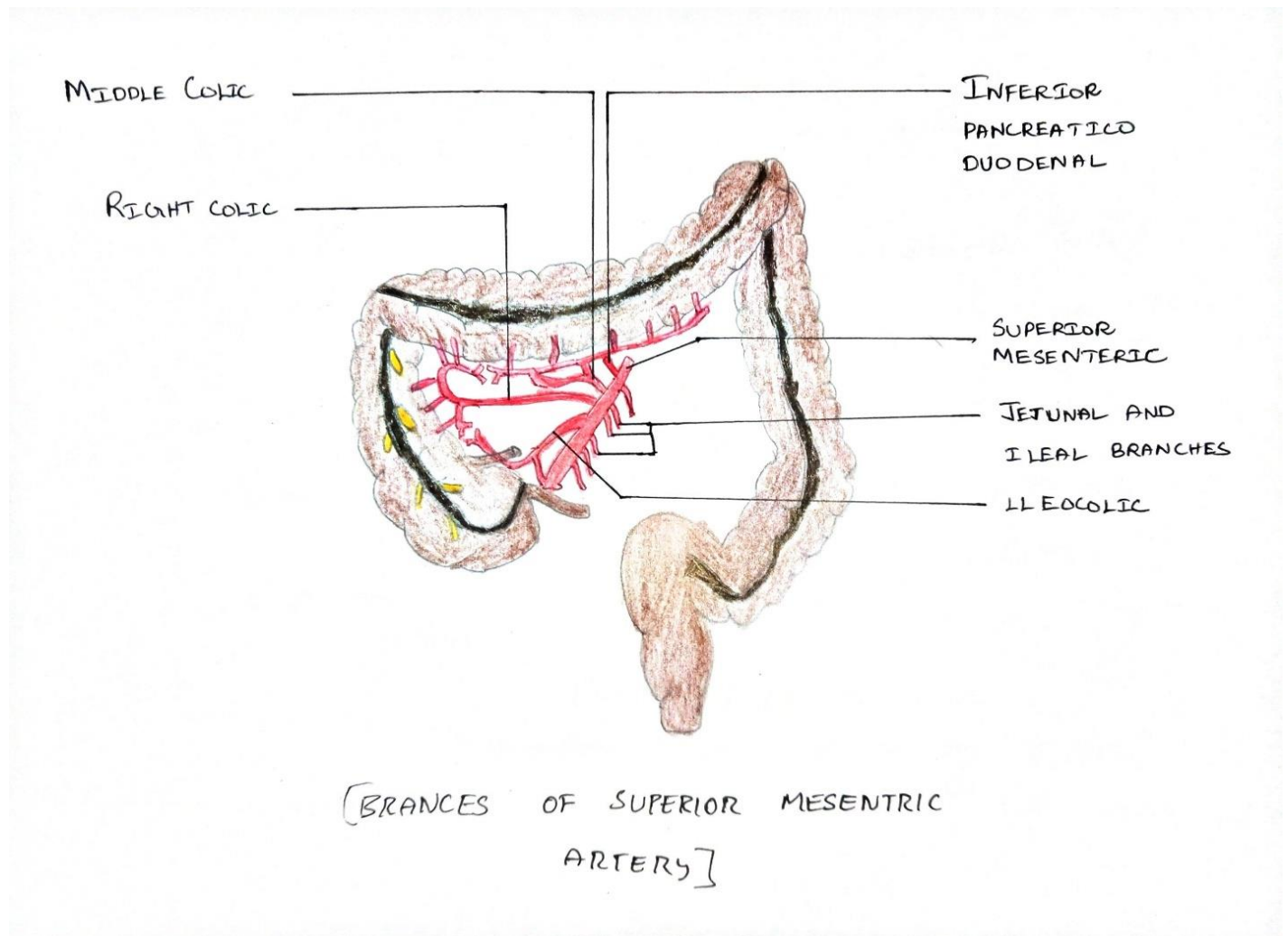
BRANCHES

➤ 5 sets of branches from right and left side such as –

FROM RIGHT SIDE

1. INFERIOR PANCREATICO-DUODENAL ARTERY

- At upper border of 3rd part of duodenum.
- Divides into Anterior & Posterior branches and runs in the pancreatico-duodenal groove.
- **SUPPLIES:** lower part of head of pancreas & duodenum.
- Ends by anastomosing with superior pancreatico-duodenal artery.



2. **MIDDLE COLIC ARTERY** –

- Arises just below the pancreas.
- Runs downwards forwards in transverse mesocolon.
- Divides into –
 1. **RIGHT BRANCH** – anastomosing with right colic artery.
 2. **LEFT BRANCH** – anastomosing with left colic artery.
- **SUPPLIES:** Transverse mesocolon.

3. **RIGHT COLIC ARTERY** –

- Arises near the middle of the concavity of the superior Mesenteric Artery.
- Passes towards right behind the peritoneum.
- Divides into –
 1. **ASCENDING BRANCH** – anastomosing with middle colic artery.
 2. **DESCENDING BRANCH** – anastomosing with ileocolic artery.
- **SUPPLIES:** upper $\frac{2}{3}$ rd of Ascending colon & the right colic flexure.

4. **ILEOCOLIC ARTERY** –

- Runs downwards & right.
- Divides into –
 1. **SUPERIOR BRANCH** – anastomosing with right colic artery.
 2. **INFERIOR BRANCH** –
 - ✓ anastomosing with termination of superior Mesenteric Artery.
 - ✓ Ascending colic branch to Ascending colon.
 - ✓ Anterior & Posterior caecal branches to Caecum.
 - ✓ Appendicular branch to appendix.
 - ✓ Ileal branch to terminal portion of the Ileum.

FROM LEFT SIDE

JEJUNAL & ILEAL BRANCHES

- 12 to 15 in number.
- Run between 2 layers of mesentery towards the gut.
- Jejunal branches –
 1. 1 to 2 Arterial arcades.
 2. Long vasa recta.
- Ileal branches –
 3. 3 to 4 Arterial arcades.
 5. Short vasa recta.

APPLIED ANATOMY

SUDDEN OCCLUSION

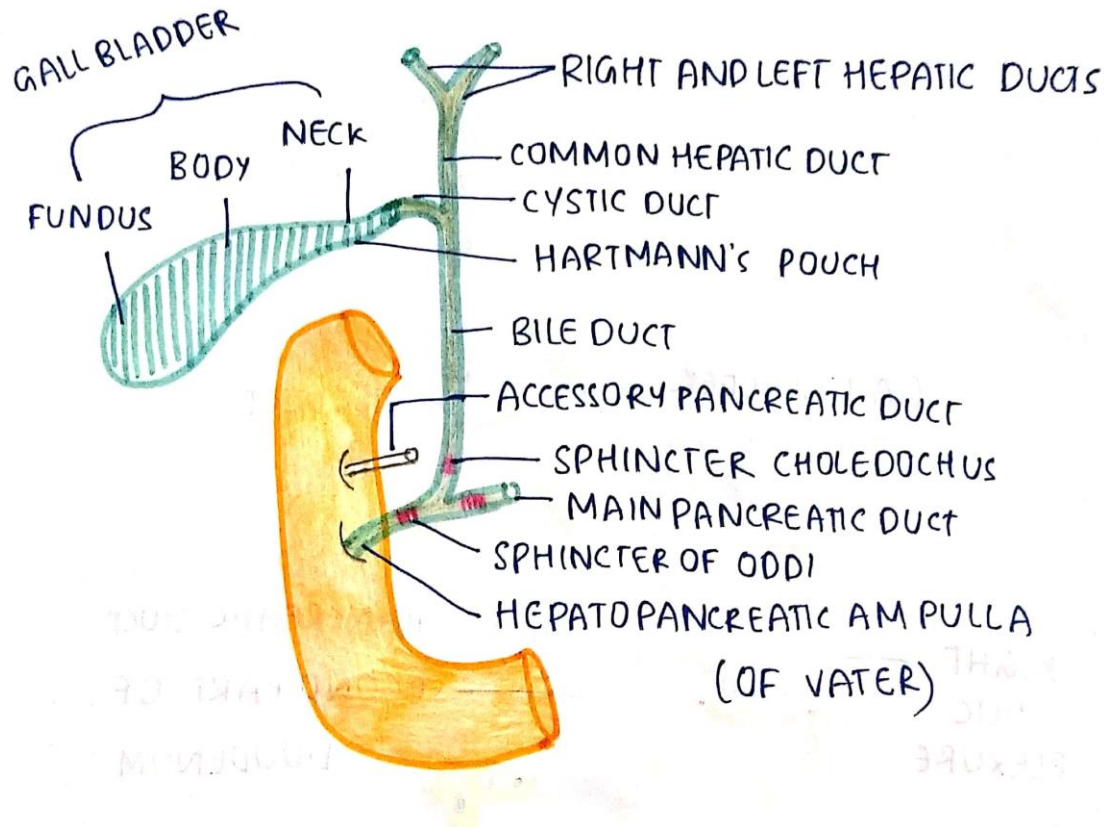
- Due to embolism or thrombosis.
- Followed by a rapidly spreading form of intestinal obstruction due to hemorrhagic infarction of the involved gut.

OBSTRUCTION OF 3RD PART OF DUODENUM

- It lies between the abdominal aorta and superior mesenteric artery.
- Duodenum acts like a nut between tongs formed by aorta and the artery.

7. EXTRAHEPATIC BILIARY APPARATUS

- The extrahepatic biliary apparatus receives the bile from liver, stores and concentrates it in the gallbladder, and transmits it to the second part of the duodenum when required.

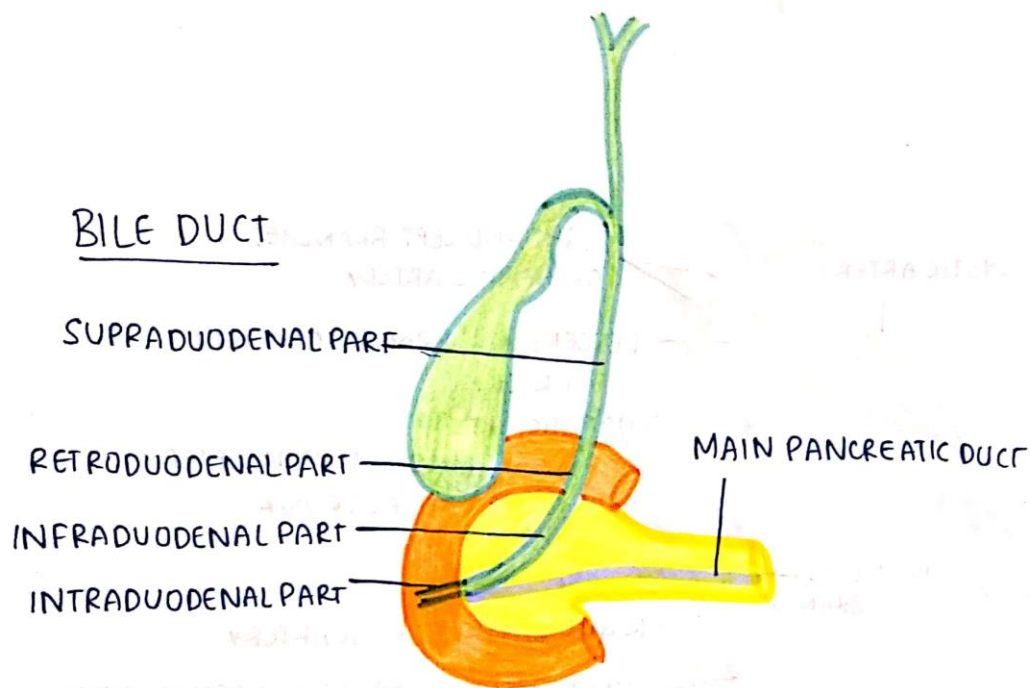


PARTS/COMPONENTS:

- RIGHT AND LEFT HEPATIC DUCTS:** The right and left hepatic ducts from the right and left lobes of the liver emerge through porta hepatis and unite near its right end to form the common hepatic duct.
- COMMON HEPATIC DUCT:** It passes downward for about 2.5 cm and then joined on its right side by the cystic duct to form the common bile duct. The angle between the cystic duct and the common hepatic duct is acute and is called cystohepatic angle.
- CYSTIC DUCT:** The cystic duct is about 3-5 cm long and runs in the lesser omentum with common hepatic duct just below porta hepatis

and joins it at an acute angle to form the bile duct. The mucous membrane lining the interior of the cystic duct is thrown into a series of crescentic folds (5–10 in number). They project into the lumen forming a spiral fold called “spiral valve (of Heister)” The valve of Heister keeps the duct open so that bile can pass through it both in and out of the gallbladder. When the CBD is closed at its inferior end, the bile secreted by the liver fills the duct and passes through the cystic duct into the gallbladder. When the CBD is open, the bile flows into it from the common hepatic and cystic ducts. The flow of bile is augmented by the contraction of the gallbladder. It is coordinated by the relaxation of sphincter of CBD under the influence of cholecystokinin, a hormone released by the duodenal mucosa.

4. **BILE DUCT** (common bile duct): It is formed near the porta hepatis by the union of cystic and common hepatic ducts. It is usually 7.5 cm (3 inches) long and about 6 mm in diameter. It is divided into four parts:
 - a. Supraduodenal part.
 - b. Retroduodenal part.
 - c. Intraduodenal (or pancreatic) part.
 - d. Intraduodenal part.

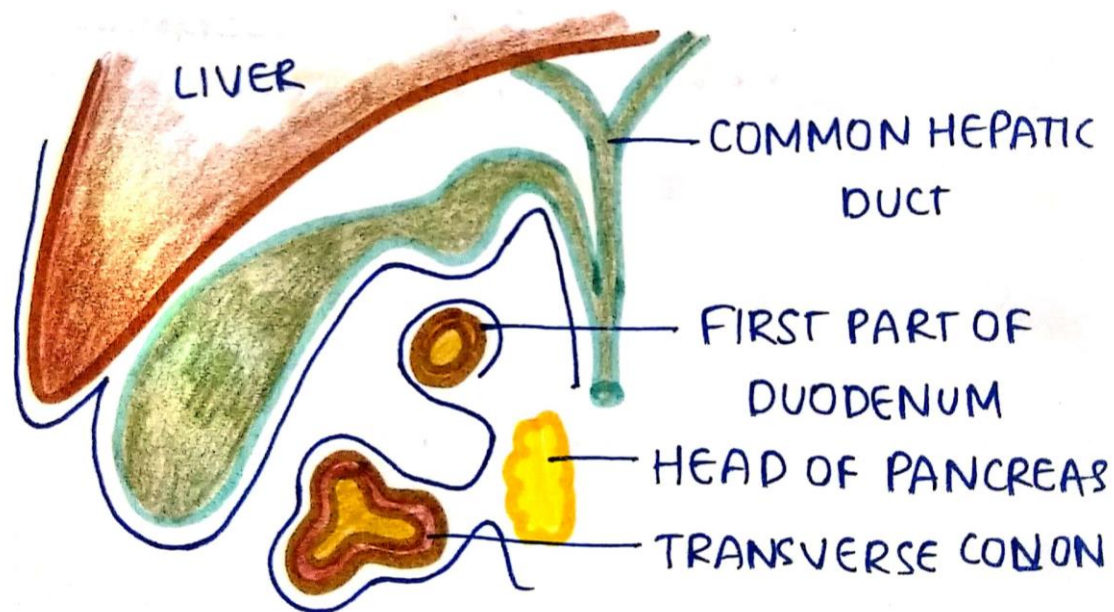


5. **GALLBLADDER**: The gallbladder is an elongated pear-shaped sac of about 30–50 ml capacity. It stores and concentrates the bile and discharges it into the duodenum by its muscular contraction. Radiopaque substances, which are excreted in the bile, are also concentrated in it. Therefore, they are used to demonstrate radiographically (cholecystography) the cavity of gallbladder and its ability to concentrate and contract. The gallbladder lies in the fossa for gallbladder on the inferior surface of the right lobe of the liver along the right edge of the quadrate lobe. It extends from the right extremity of porta hepatis to the inferior border of the liver. It is usually attached to the liver substance by connective tissue and has venous communications with it. But it may be suspended from the liver by a short mesentery, or partly buried in it. Its length is 10 cm and its width is 3 cm (at its widest part).

PARTS AND RELATIONS:

The gallbladder is divided into the following three parts: fundus, body, and neck.

- A. **FUNDUS**: It is the expanded blind end of the organ. It projects from the inferior border of the liver and touches the anterior abdominal wall at the tip of the right 9th costal cartilage, deep to the point where the right linea semilunaris meets the costal margin.
- B. **BODY**: It is directed upward, backward, and to the left to join the neck at the right end of the porta hepatis.
- C. **NECK**: It is the narrow upper end of the gallbladder lying near the right end of the porta hepatis. It joins the cystic duct and its junction with this duct is marked by a constriction.



PERITONEAL RELATIONS:

FUNDUS:

- It is completely surrounded by peritoneum.
- It is related anteriorly to the anterior abdominal wall and posteriorly to the transverse colon.
- It is continuous through the body of the gallbladder with the narrow neck.

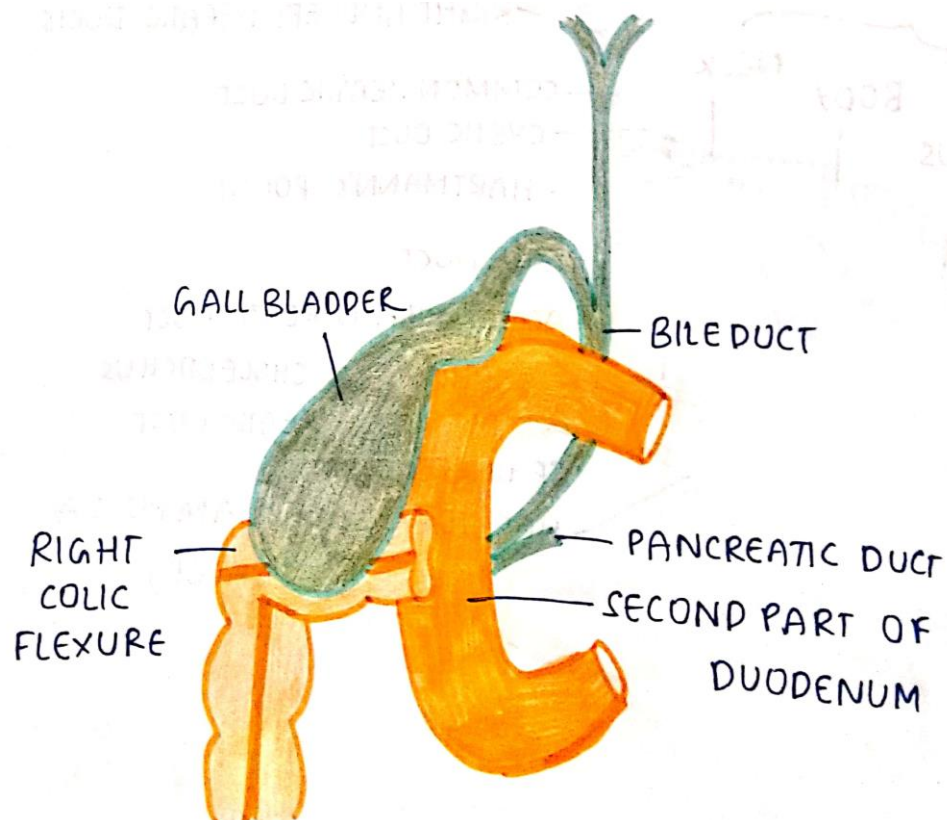
BODY:

- Its upper surface is related directly to the liver and is devoid of the peritoneum.
- Its undersurface is covered by the peritoneum and is related to the second part of the duodenum.

NECK:

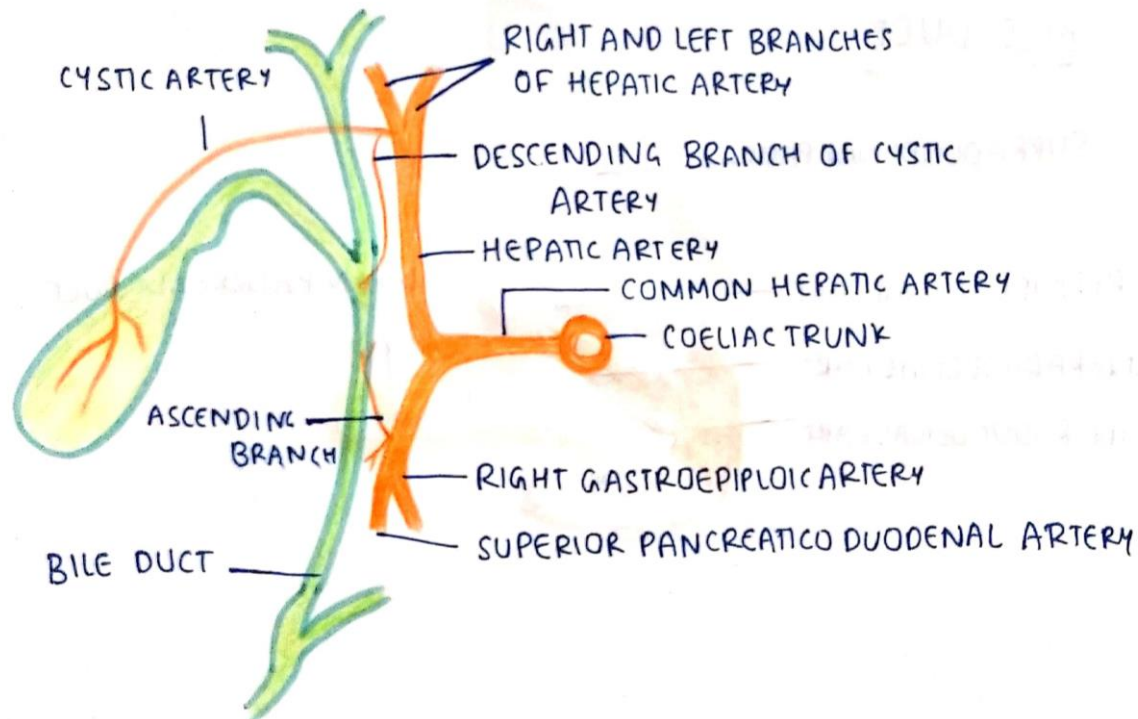
- It is attached to the liver by loose areolar tissue in which cystic artery is embedded.

- It is related inferiorly to the first part of the duodenum.
- Its posteromedial wall shows a pouch-like dilatation (Hartmann's pouch) directed downward and backward.
- The gall stones lodged in this pouch may cause adhesion with the first part of the duodenum and may perforate it.
- The neck turns sharply downward to become continuous with the cystic duct.



ARTERIAL SUPPLY

- The gallbladder is supplied by the cystic artery (a branch of right hepatic artery).
- It may arise from the main trunk of the hepatic artery, from the left hepatic artery, or from the gastroduodenal artery.



VENOUS DRAINAGE:

- The venous drainage of the gallbladder is twofold:
 - A. By the cystic vein, which drains into the portal vein
 - B. By a number of small veins, which pass from the superior surface of the gallbladder to the liver through the gallbladder bed to drain into the hepatic veins.

LYMPHATIC DRAINAGE:

1. The majority of lymph vessels from the gallbladder drain into (a) the cystic lymph node of Lund, located in the Calot's triangle and (b) the node alongside the upper part of the bile duct (node at the anterior border of epiploic foramen), which finally drains into the coeliac group of lymph nodes.
2. Few lymph vessels from the upper surface of gallbladder directly communicate with subscapular lymph vessels of the liver

APPLIED ANATOMY:

HORMONAL CONTROL OF GALLBLADDER EMPTYING: When the food rich in fat enters the duodenum, the duodenal cells liberate a hormone called cholecystokinin (CCK). This hormone is carried to the gallbladder and causes its contraction. There is a reflex mediation, when the gallbladder contracts, the sphincter of Oddi relax. Thus, concentrated bile is emptied into the gallbladder.

ARTERIAL SUPPLY OF THE COMMON BILE DUCT (CBD) is clinically important because if the anastomosis between the superior and inferior pancreaticoduodenal arteries is poor, the ligation of superior pancreaticoduodenal artery during surgery can lead to gangrene of the common bile duct.

CHOLECYSTITIS: The cholecystitis is the inflammation of the gallbladder. It may be acute or chronic.

A. ACUTE CHOLECYSTITIS:

- It occurs usually in adult women and is characterized by (i) sudden pain in the hypochondrium referred to the inferior angle of the right scapula or to the tip of right shoulder, (ii) vomiting, and (iii) positive Murphy's sign—if the finger is pressed under the right costal margin at the tip of the 9th costal cartilage when the patient is asked to take a deep breath, she/he feels sharp pain and winces with a "catch" in the breath as the diseased gallbladder meets the examining finger.
- The symptoms of cholecystitis are aggravated on taking fatty meals because the gallbladder contracts to pour the bile into the duodenum when fat reaches the duodenum.
- Fat in the duodenum induces liberation of a local hormone cholecystokinin-pancreozymin (CCK-PZ), which reaches the gallbladder through the blood stream and stimulates its contraction.

B. **CHRONIC CHOLECYSTITIS**

- It usually leads to formation of stones in the gallbladder (cholelithiasis): It usually occurs typically in fat, fertile, flatulous female of forty (5F).

REFERRED PAIN OF GALLBLADDER:

- In acute cholecystitis, the inflammation of the gallbladder may cause irritation of the subdiaphragmatic parietal peritoneum, which is supplied in part by the phrenic nerve (C3, C4, and C5 spinal segments).
- This may lead to referred pain over the tip of the right shoulder for being supplied by the supraclavicular nerves (C3 and C4 spinal segments).

BILIARY COLIC:

- It is usually caused by the spasm of smooth muscle of the gallbladder wall in an attempt to expel the gallstone.
- It is intermittent and is most intense when stone (calculus) is impacted either at the terminal end of cystic duct or at the lower end of the bile duct because the smooth muscle everywhere in the biliary duct system is sparse except at the terminal portions of the cystic and bile ducts.
- The afferent fibres from the gallbladder enter the thoracic segments of spinal cord (T7–T9), hence referred pain is felt in the right upper quadrant or epigastrium (T7–T9) dermatomes.

OBSTRUCTION OF CBD:

- The obstruction of CBD usually occurs due to gallstones, pancreatic carcinoma, or enlarged neoplastic hepatic lymph nodes.
- It causes obstruction to bile flow, which leads to jaundice.

COURVOISIER'S LAW:

- This law states that the obstructive jaundice with distended and palpable gallbladder is most likely due to extrinsic obstruction of CBD (e.g., carcinoma of head of pancreas).

- On the contrary, obstructive jaundice with non-distended, non-palpable gallbladder is due to an intrinsic obstruction of CBD (e.g., impaction by gallstones) because in this case previous cholecystitis makes the gallbladder fibrotic and contracted.

IMAGING OF THE BILIARY TRACT:

- a) **CHOLECYSTOGRAPHY**: Gallbladder is not opaque to X-ray, but when certain radiopaque dyes are given by either mouth or intravenous injection they are excreted by the liver from blood into bile and reach the gallbladder. In the gallbladder, the dye is concentrated and thus the gallbladder becomes opaque to X-rays.
- b) **ULTRASOUND**: The ultrasonography is a noninvasive imaging technique to visualize the gallbladder and other components of the biliary apparatus. This technique has largely replaced the cholecystography.
- c) **ENDOSCOPIC RETROGRADE CHOLANGIOPANCREATOGRAPHY** (ERCP): In this technique, under direct vision through a fibre-optic endoscope, a catheter is inserted into the hepatopancreatic ampulla and radiopaque contrast medium is injected, and bile and pancreatic ducts are visualized.
- d) **MAGNETIC RESONANCE IMAGING**: The bile and pancreatic ducts can now also be visualized by the noninvasive magnetic resonance imaging (MRI) technique.

8. LIVER

LOCATION:

- Occupies
 1. Right hypochondrium
 2. Upper part of epigastrium
 3. Part of the left hypochondrium up to the left lateral line.
- Extends upward under the rib cage as far as the
 1. 5th rib anteriorly - right side
 2. left 5th intercostal space anteriorly - left side.

EXTERNAL FEATURES:

- The wedge-shaped liver presents 2 well-defined surfaces – ‘
 - A. **DIAPHRAGMATIC SURFACE**: Convex and extensive. Dome-shaped. Includes smooth peritoneal areas, rough bare area. Inferior vena cava- embedded in deep sulcus- left part of bare area; Sulcus- roofed by fibrous tissue- Ligament of IVC- contain hepatic tissue → converting sulcus into tunnel. Peritoneal ligaments- coronary, left triangular, right triangular, falciform
 - B. **VISCERAL SURFACE**: Relatively flat or concave. Separated in front from diaphragmatic surface- sharp inferior border, behind from diaphragm- posterior layer of coronary ligament. Features- Fossa for gallbladder, Fissure for ligamentum teres hepatis, Porta hepatis. Covered by peritoneum except at fossa for gallbladder, porta hepatis.
- 2 surfaces meet in front at sharp inferior border –
- Rounded laterally- separates right lateral surface from inferior surface
- Thin and sharp medially- separates anterior surface from inferior surface

Presents 2 notches

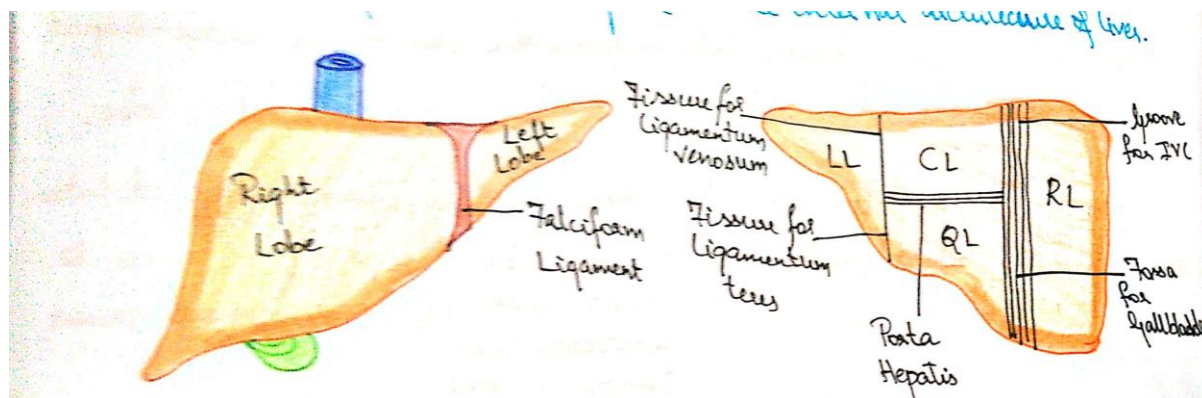
- A. **NOTCH FOR LIGAMENTUM TERES OR INTERLOBAR NOTCH**: located just right of median plane.
- B. **CYSTIC NOTCH**: Located 5cm- right of median plane, Corresponds to fundus of gallbladder.

- In epigastrium- extends from 9th right costal cartilage to 8th left costal cartilage ➔ ascends sharply to the left.
- In median plane- lies in transpyloric plane.

LOBES OF LIVER

ANATOMICAL LOBES:

- A. On **DIAPHRAGMATIC SURFACE** - liver is divided into 2 lobes- right & left- by the attachment of falciform ligament; Right lobe- forms base of liver, approx. six times larger than left lobe.
- B. On **VISCERAL SURFACE** - divided into 4 lobes ➔ Right, Left, Quadrate, Caudate ➔ by fissures and fossae; Fissures & fossae form H-shaped figure; **RIGHT LOBE**- right of fossa for gallbladder; **LEFT LOBE**- left of fissure for ligamentum teres & ligamentum venosum; **QUADRATE LOBE**- between fossa for gallbladder & fissure for ligamentum teres below porta hepatis; **CAUDATE LOBE**- between groove for IVC & fissure for ligamentum venosum above porta hepatis.



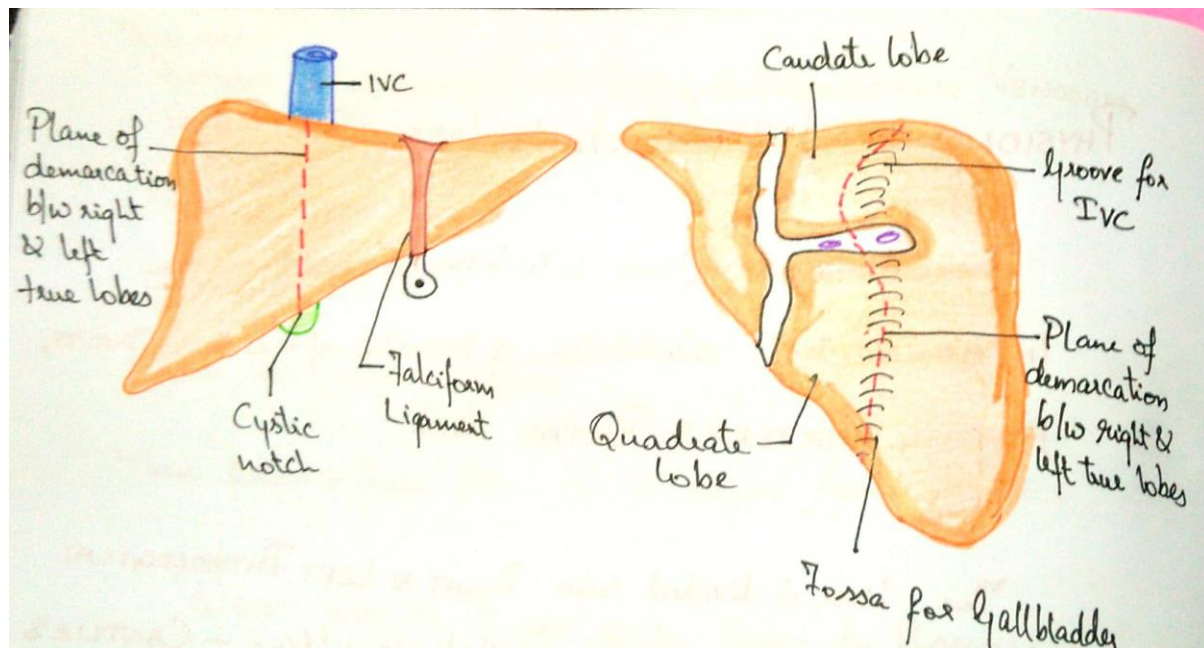
PHYSIOLOGICAL LOBES:

- Also called Functional (or) True lobes
- Division is based on intrahepatic distribution of branches of Bile ducts, Hepatic artery, Portal vein

- Divided into right & left lobes- imaginary sagittal plane/line- Cantlie's plane/line
- On posteroinferior surface- passes through fossa for gallbladder- to groove for IVC
- On anterosuperior surface- passes from IVC to cystic notch- present a little to the right of falciform ligament
- Both lobes are approx. equal in size
- Each lobe has its own primary branch of hepatic artery & portal vein & drained by its own hepatic duct.

SEGMENTAL RESECTION-

- Hepatic segments are not well defined as the bronchopulmonary segments
- A true lobe- rather than a segment- should be resected in most instances of partial hepatectomy
- A large volume of liver can be removed safely- healthy hepatocytes have great regenerative capacity
- Liver can regrow to its original size within 6-12 months.



PERITONEAL RELATIONS:

- Most of the liver is covered by peritoneum.
- Areas not covered by peritoneum:
 - A. Bare area of liver: Triangular area on posterior aspect of right lobe
 - B. Fossa for gallbladder: On inferior surface of liver between right & quadrate lobes
 - C. Groove for IVC: On posterior surface of right lobe
 - D. Groove for ligamentum venosum
 - E. Porta hepatis.

LIGAMENTS:

FALSE LIGAMENTS:

FALCIFORM LIGAMENT

- Sickle-shaped fold of peritoneum connecting the liver to undersurface of diaphragm and anterior abdominal wall up to umbilicus

CORONARY LIGAMENT

- Triangular fold of peritoneum
- Connecting bare area of liver to diaphragm
- Consists of 2 layers-
 - A. Upper
 - B. Lower
- Upper layer is reflected from diaphragm to live
- Lower layer is reflected from liver to upper end of kidney
- When traced on right side- layers continuous with right triangular ligament
- When traced on left side-
 - A. Upper layer continuous with right layer of falciform ligament
 - B. Lower layer continuous with peritoneal reflection along right border of caudate lobe

RIGHT TRIANGULAR LIGAMENT

- Small triangular fold of the peritoneum
- Connects right lateral surface of liver to diaphragm
- Encloses apex of bare area of liver

LEFT TRIANGULAR LIGAMENT:

- Smaller triangular fold of peritoneum
- Connects upper surface of left lobe to diaphragm
- When traced to left side- both layers come close to each other → form free margin
- When traced to right side-
 - A. Upper layer is continuous with left layer of falciform ligament
 - B. Lower layer is continuous with anterior layer of lesser omentum along left margin of fissure for ligamentum venosum

LESSER OMENTUM:

- Fold of peritoneum connecting lesser curvature of stomach and proximal 1 in of duodenum to visceral surface
- Hepatic attachment is J-shaped with
 - A. Vertical limb- attached- margins of fissure for ligamentum venosum
 - B. Horizontal limb- attached- margins/lips of porta hepatis.

TRUE LIGAMENTS

A. LIGAMENTUM HEPATIS TERES:

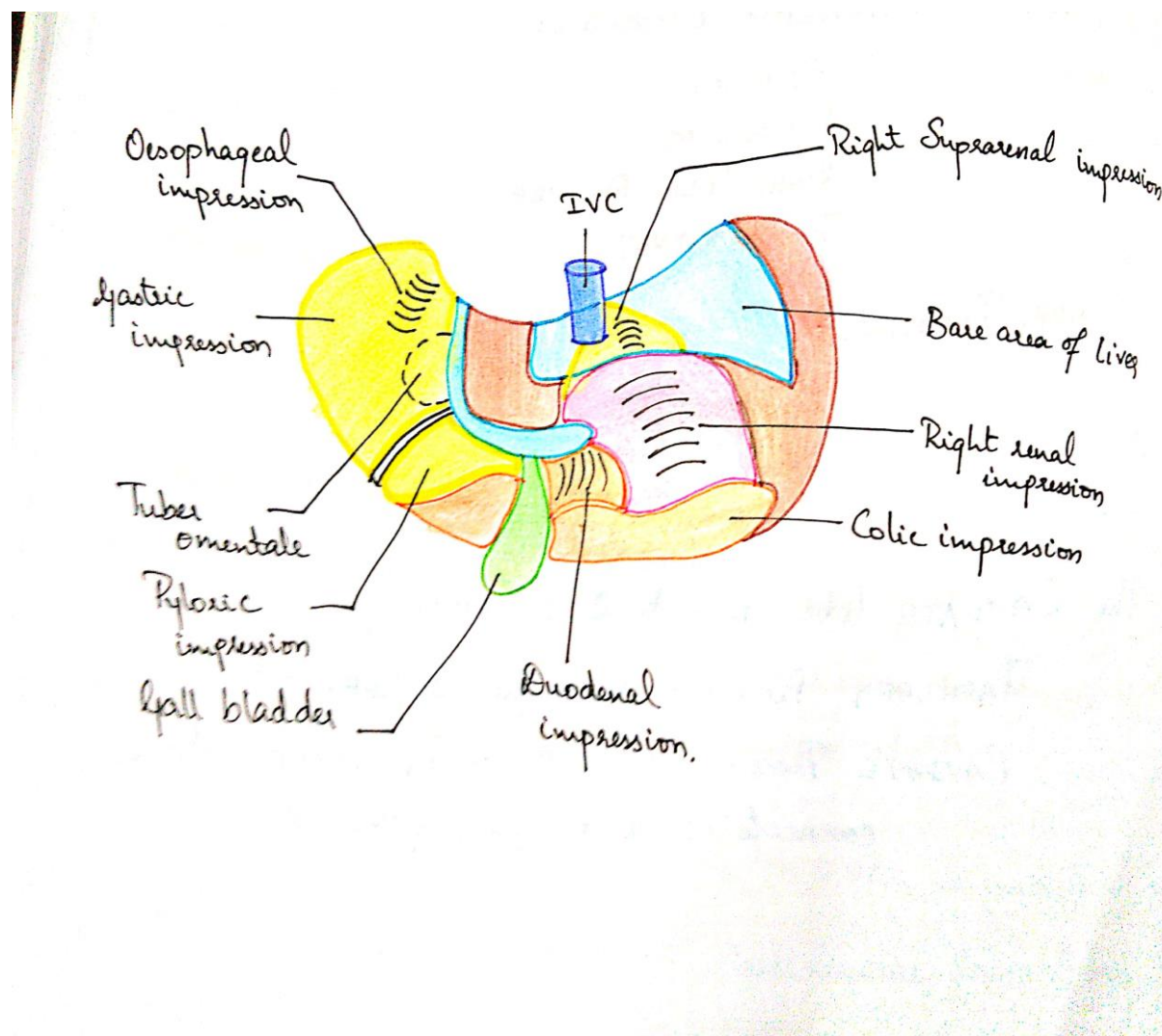
- Remnant of obliterated left umbilical vein
- Extends from umbilicus to left branch of portal vein

B. LIGAMENTUM VENOSUM:

- Remnant of obliterated ductus venosus
- In fetal life- connects left branch of portal vein with IVC.

RELATIONS

SURFACE		RELATIONS
DIAPHRAGMATIC (PARIETAL)	a) <u>SUPERIOR SURFACE</u> of diaphragm intervening	• Corresponding lung & pleura on either side • Pericardium & heart in the center
	b) <u>ANTERIOR SURFACE</u>	• Xiphoid process • Anterior abdominal wall
	c) <u>RIGHT LATERAL SURFACE</u> with diaphragm intervening	• Lung & pleura in the upper 1/3rd • Costodiaphragmatic recess in the middle 1/3rd • 10th & 11th ribs in the lower 1/3rd
	d) <u>POSTERIOR SURFACE</u> 1. With peritoneum intervening 2. With peritoneum not intervening	• Abdominal part of esophagus • Right suprarenal gland • Inferior vena cava
VISCERAL (INFERIOR)	a) With peritoneum intervening	• Stomach • Duodenum • Right colic flexure • Right kidney
	b) With peritoneum not intervening	• Gallbladder



ARTERIAL SUPPLY:

HEPATIC ARTERY

- In a normal adult- nearly $\frac{1}{3}^{\text{rd}}$ of cardiac output passes through the liver
- 20% is delivered through hepatic artery.

VENOUS DRAINAGE:

- Venous blood to liver is supplied by portal vein.
- 80% blood supplied is delivered through portal vein

- Most of the venous blood from liver is drained by 3 hepatic veins:
 1. **LEFT HEPATIC VEIN**- between medial & lateral segments of Lt true lobe
 2. **MIDDLE HEPATIC VEIN**- between true right & true left lobes
 3. **RIGHT HEPATIC VEIN**- between anterior and posterior segments of the true right lobe.
- These veins do not have extrahepatic course.
- Emerge in upper part of groove for IVC ➡ open directly in the IVC ➡ just below the central tendon of the diaphragm.
- 3 veins may enter IVC independently- left & middle veins usually join ➡ only 2 major veins join IVC

PERISINUSOIDAL CELLS:

- Hepatic stellate cells (or) Ito cells
- Pericytes found in the perisinusoidal space of liver (or) space of Disse- a small area between the sinusoids and hepatocytes.
- Major cell type involved in liver fibrosis ➡ formation of scar tissue in response to liver damage.

9. SPLENIC ARTERY

INTRODUCTION:

- Supplies the spleen
- Largest branch of celiac trunk
- Tortuous in its course to allow for movement of spleen

COURSE:

- Arises from celiac trunk ➡ Passes through the lienorenal ligament ➡ Reaches the hilum of the spleen ➡ Divides into 5 or more branches ➡ Enter spleen to supply it ➡ Divides repeatedly to form straight vessels- PENICILLI ➡ Divide into ELLIPSOIDS & ARTERIAL CAPILLARIES ➡
- **CLOSED THEORY:** ➡ Capillaries continuous with venous sinusoids in red pulp ➡ sinusoids join together to form veins
- **OPEN THEORY:** ➡ Capillaries- end ➡ Open into red pulp ➡ Blood enters sinusoids through walls
- Compromise theory:

CIRCULATION

- **OPEN**- Distended spleen
- **CLOSED**- Contracted spleen

SEGMENTATION

- On the basis of its blood supply- spleen- segmented-
 1. Superior Vascular
 2. Inferior Vascular
- 2 segments are separated by an avascular plane.
- Each segment may be subdivided into
 - 1-2 disc-like middle segments
 - 1 cap-like pole segment

BRANCHES

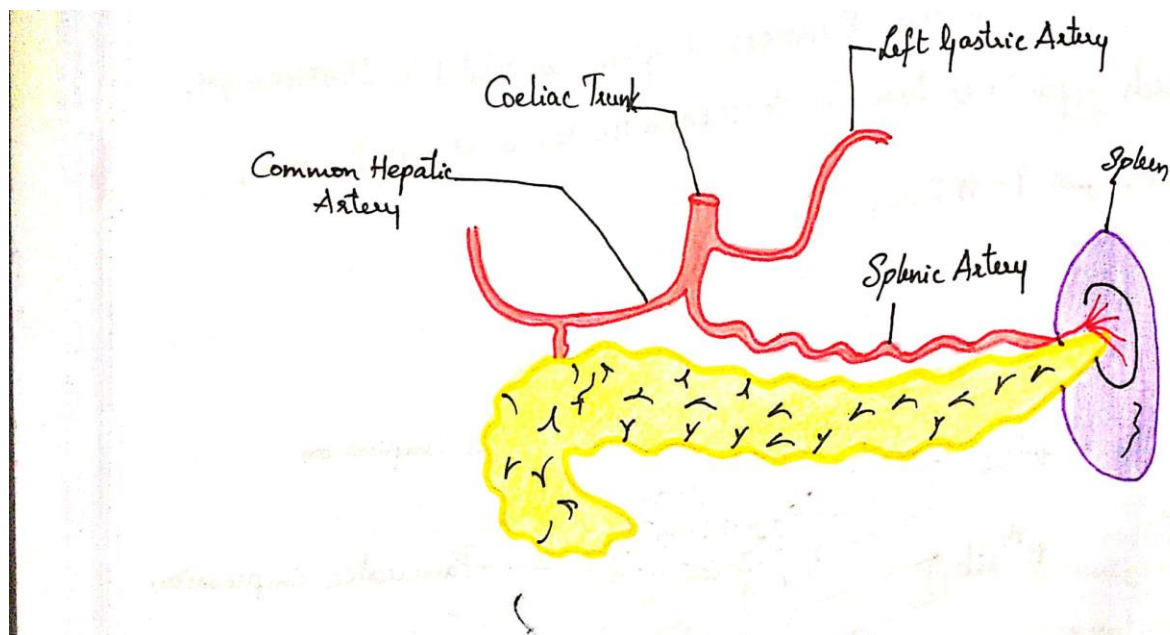
Apart from terminal branches, Splenic artery gives the following branches:

- Numerous branches to pancreas
- 5-7 short gastric branches
- Left gastroepiploic artery

CLINICAL CORRELATION

SPLENIC INFARCTION:

- Smaller branches of splenic artery are end arteries.
- Their obstruction → embolism → results in splenic infarction.
- Causes referred pain in left shoulder → KEHR'S SIGN



10. PANCREAS

INTRODUCTION:

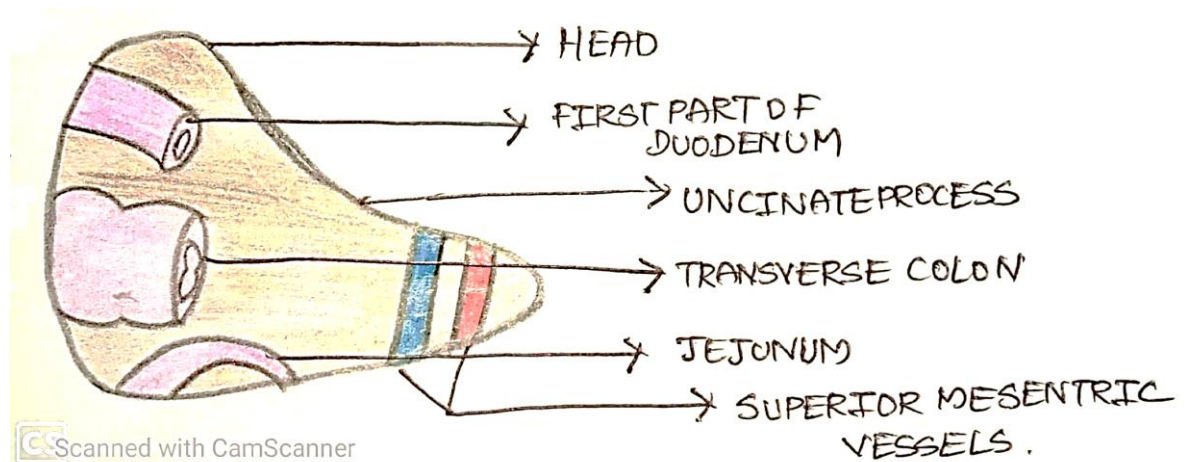
- Pancreas is a J-shaped or Retort shaped organ.
- It lies transversely across the posterior abdominal wall at the level of L1 and L2.
- Entire organ lies posterior to stomach separated from it by lesser sac.
- It is partly **exocrine** -secretes digestive juice
- And partly **endocrine**- secretes hormone insulin.

PARTS OF PANCREAS (FROM RIGHT TO LEFT):

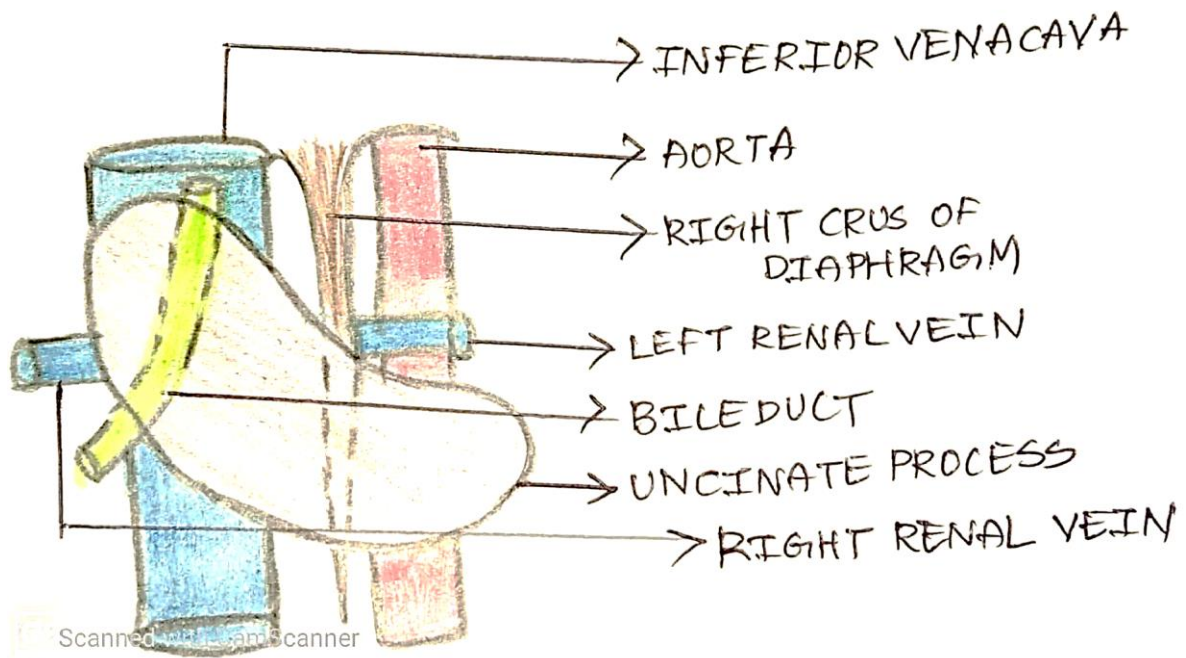
HEAD OF PANCREAS:

- It is enlarged and lies in the concavity of duodenum.
- External features:
 - **Three borders:**
 1. Superior
 2. Right lateral
 3. Inferior border
 - **Two surfaces:**
 1. Anterior
 2. Posterior
 - **Uncinate process:** Projects from lower part of head towards left.
- **Relations:**
 - ✓ Superior Border- related to first part of duodenum and superior pancreaticoduodenal artery.
 - ✓ Inferior border – related to third part of duodenum and inferior pancreatico-duodenal artery
 - ✓ Right lateral border- related to second part of duodenum, terminal part of bile duct, anastomosis between two pancreatico-duodenal arteries.
 - ✓ Relations of surfaces of follows:

ANTERIOR SURFACE:

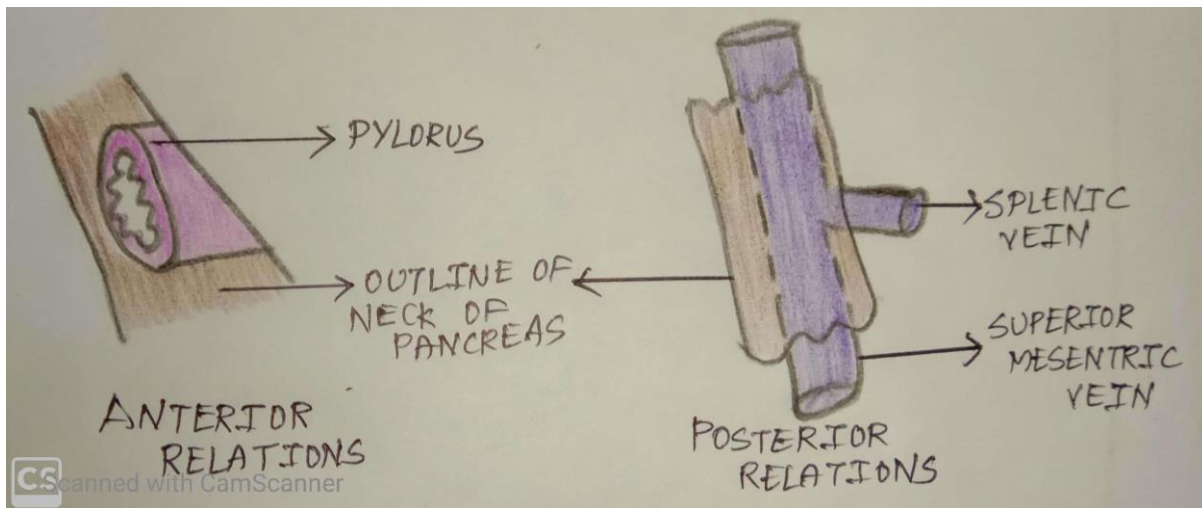


POSTERIOR SURFACE:



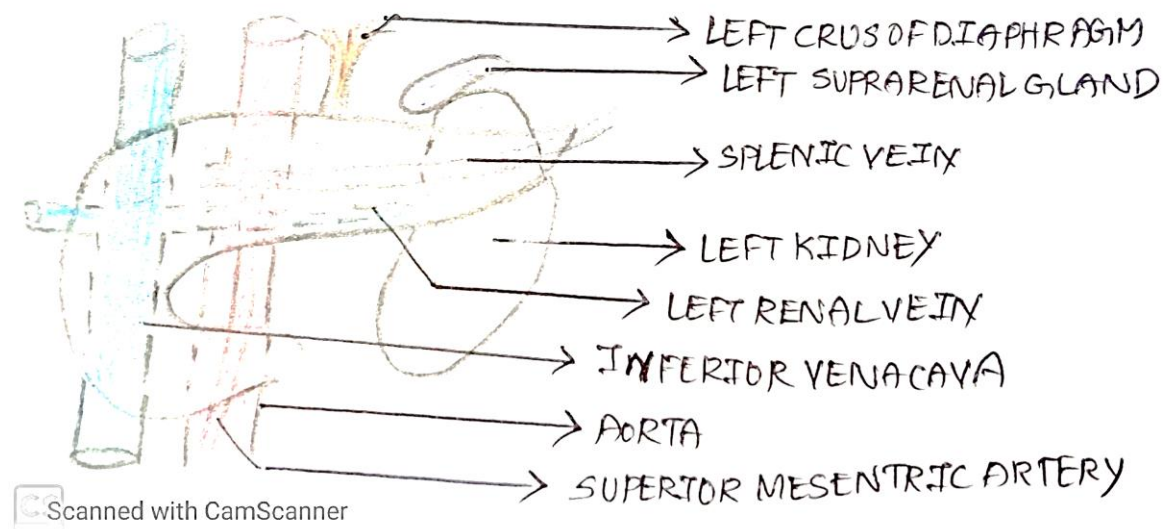
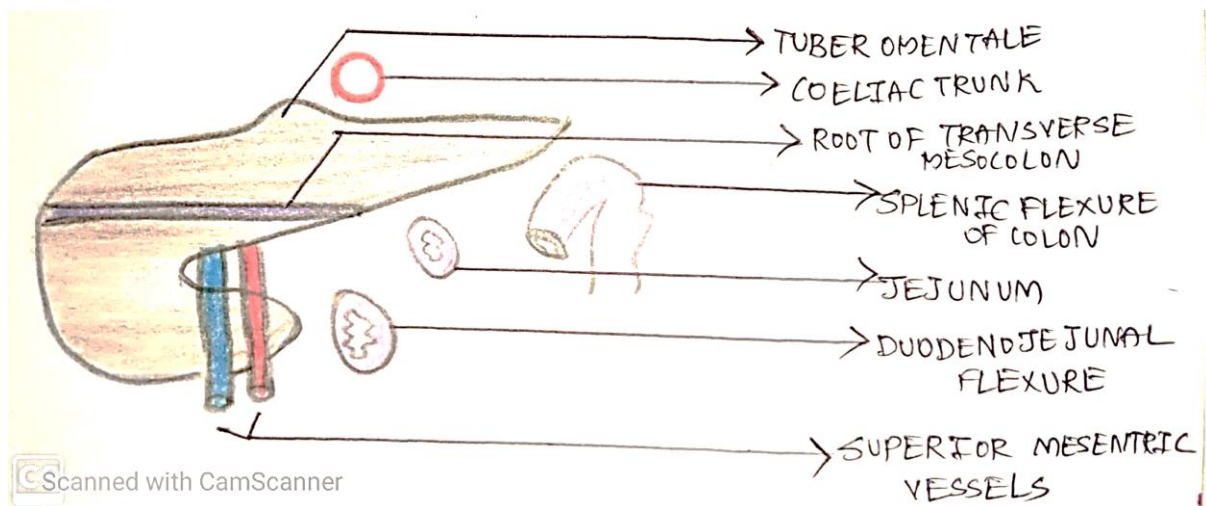
NECK OF PANCREAS

- It is a constricted part between head and body.
- It is directed forwards, upwards and to left
- It has two surfaces – Anterior and posterior and its relations are as follows.



BODY OF PANCREAS:

- It is elongated and passes towards left with slight upward and backward inclination.
- **Features:**
 - It is triangular in cross-section.
 - Three borders:
 - ✓ Anterior
 - ✓ Superior
 - ✓ Inferior
 - **Tuber omentale:** A part of body of pancreas that projects upwards beyond the rest of a superior border, a little left to the neck.
- **Relations of the borders:**
 - Anterior border- Related to root of transverse mesocolon
 - Superior Border- Related to coeliac trunk, hepatic artery, splenic artery.
 - Inferior border – Related to superior mesenteric vessels.



- It has three surfaces:
 - a) Anterior surface** – concave, covered by peritoneum and related to lesser sac and to stomach.
 - b) Posterior surface** – Devoid of peritoneum and its relations are
 - c) Inferior surface** – covered by peritoneum and related to duodeno-jejunal flexure, jejunum, left colic flexure.

TAIL OF PANCREAS

- It is the left end of pancreas
- It lies in the Ileo-renal ligament along with splenic vessels.
- It comes in contact with lower part of gastric surface of spleen.

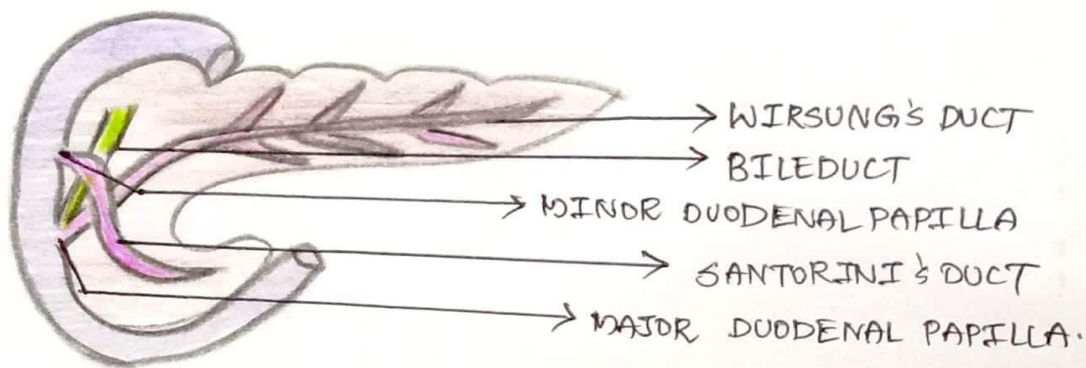
DUCTS OF PANCREAS: Exocrine pancreas is drained by two ducts:

A. MAIN PANCREATIC DUCT OF WIRSUNG:

- It begins in tail and traverses the whole length of the gland near its posterior surface.
- At neck it turn downwards and to right to pierce the second part of duodenum along with bile duct, forming hepato-pancreatic ampulla of after, which opens by a narrow mouth on the summit of major duodenal papilla, 8-10 cm distal to pylorus.
- It receives tributaries throughout its length at right anyone to its long axis in a herring bone pattern.
- Seen in 90 percent of the cases.

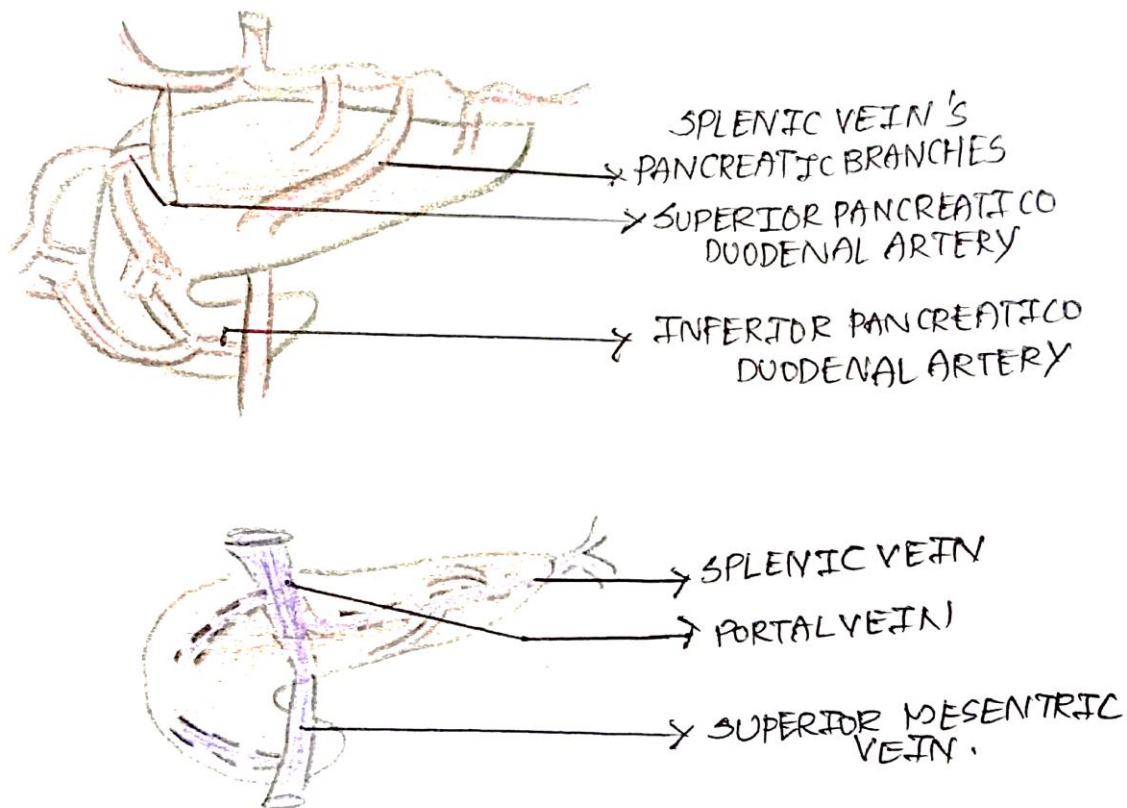
B. ACCESSORY PANCREATIC DUCT OF SANTORINI:

- It begins in the lower part of head and then runs upward and medially, crossing in front of main pancreatic duct.
- Opens in second part of duodenum on the summit of minor duodenal papilla about 2-3cm above major duodenal papilla.
- In 40 percent cases communicates with main duct.



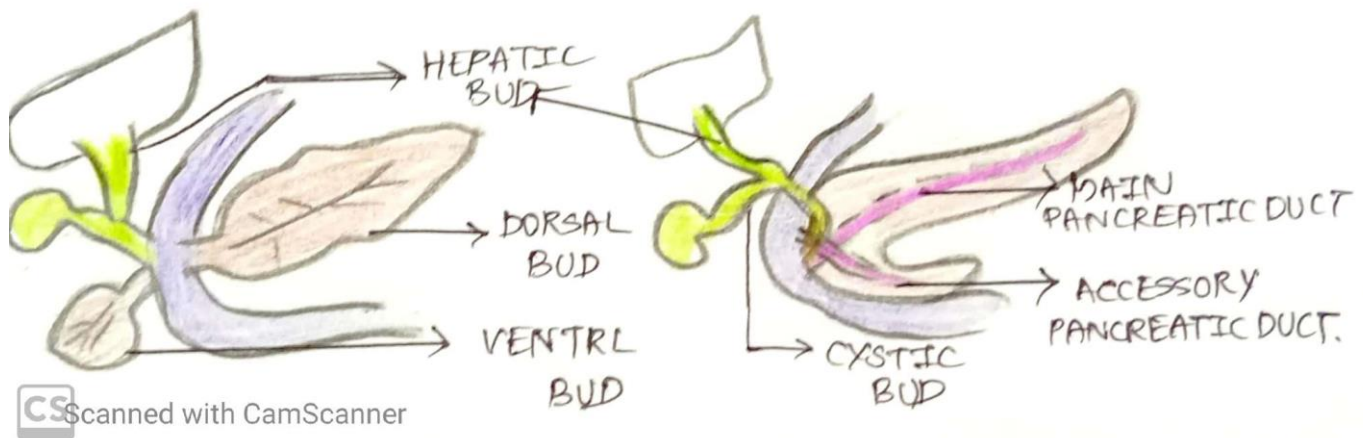
BLOOD SUPPLY

✓ Mentioned in diagram:



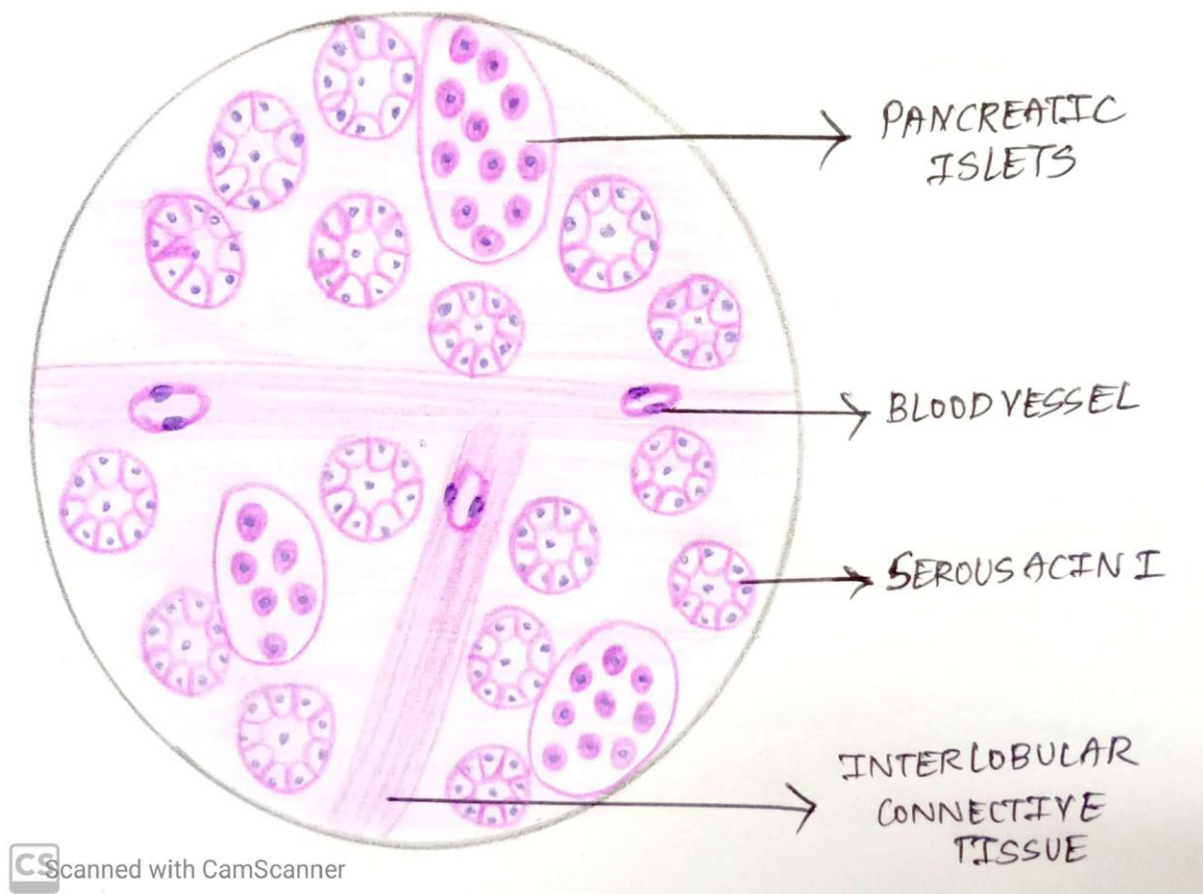
DEVELOPMENT

- ❖ It arises as a
 - a) **LONG DORSAL BUD** -Part of head, Neck, tail.
 - b) **SMALL VENTRAL BUD** -Inferior part of head, uncinate process.
- ❖ The ventral bud rotates dorsally to fuse with dorsal bud forming pancreas.
- ❖ The duct of ventral bud tap the duct of dorsal pancreatic bud near its neck and opens into duodenum as main pancreatic duct.
- ❖ The proximal part of dorsal pancreatic duct forms accessory duct.



HISTOLOGY

- **EXOCRINE PART** -Serous gland - Made up of tubular acini lined by pyramidal cells with basal round nuclei, containing zymogen granules.
- **ENDOCRINE PART**- Made up of Islets of Langerhans
 - ✓ It is distributed throughout the pancreas, numerous in tail region
 - ✓ It has different type of cells:
 1. Alpha A1 cells- secretes serotonin and pancreatic gastrin
 2. Alpha A2 cells- secretes Glucagon, alpha cells are acidophilus and granular
 3. Beta cells-secretes insulin, basophilic and granular.



APPLIED ASPECTS:

1. **CARCINOMA OF PANCREAS** – common in head of pancreas, it gives a pressure over bile duct placed posteriorly causes obstructive jaundice also pressure in portal vein causes ascites.
2. **ANNULAR PANCREAS**– It is a congenital anomaly where ring of pancreatic tissue surrounds the duodenum and obstruct it...

11.KIDNEY

INTRODUCTION

- Kidneys are retroperitoneal organs resting on posterior abdominal wall
- Located in lumbar region
- Vertebral levels - T12 to L3
- Right kidney is slightly lower than left kidney due to the position of liver

EXTERNAL FEATURES

TWO POLES (ENDS)

- Upper pole (Broad) - T12 level; Related to suprarenal gland
- Lower pole (Narrow) - L3 level

TWO BORDERS

- Medial border - Convex near poles and concave at the middle; Presents hilum in the middle
- Lateral border - Concave

TWO SURFACES

- Anterior surface - convex
- Posterior surface - Flat; Lies on Posterior abdominal wall

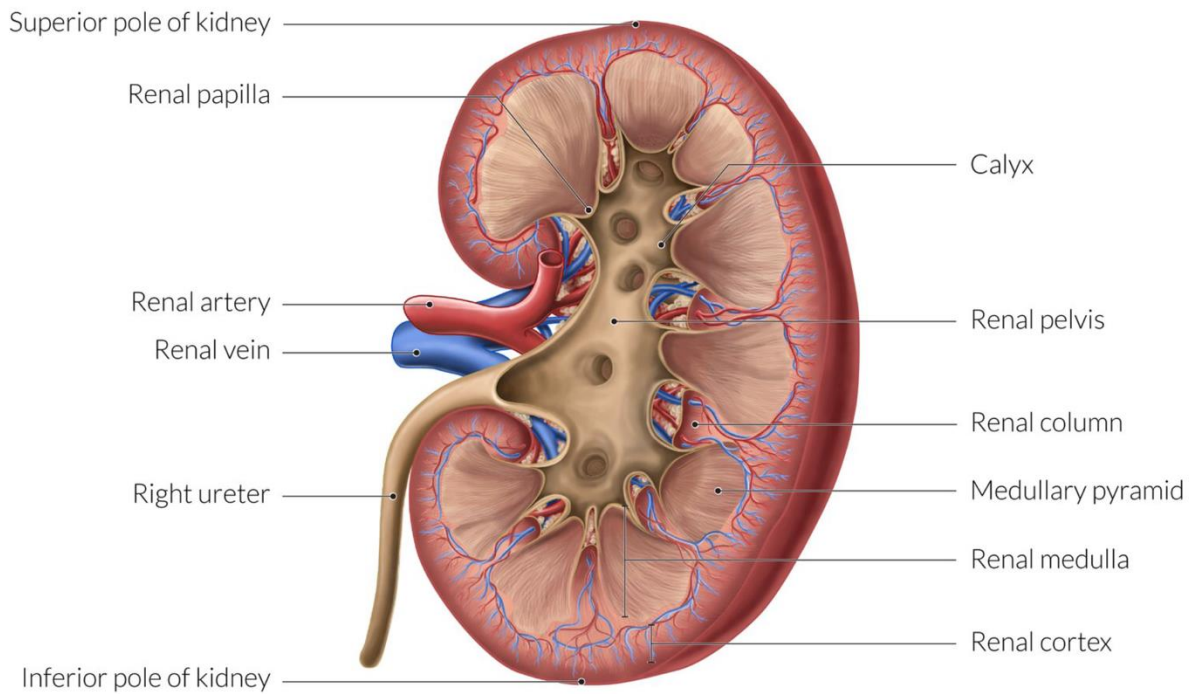
HILUM

- Vertical slit in the middle of medial border at L1 level
- Structures arranged from anterior to posterior - (VAP)

RENAL VEIN

RENAL ARTERY

RENAL PELVIS

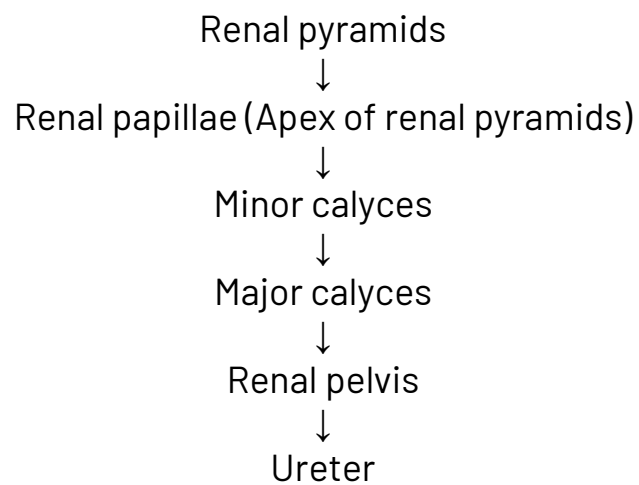


INTERIOR OF KIDNEY

OUTER CORTEX

- Located below renal capsule
- Forms renal columns b/w renal pyramids

INNER MEDULLA



COVERINGS OF KIDNEY

A. FIBROUS CAPSULE (TRUE CAPSULE)

- Formed by condensation of connective tissue
- Stripped off in normal kidneys
- Tightly adherent in inflamed kidneys

B. PERIRENAL FAT (PERINEPHRIC FAT)

- Lies b/w fibrous capsule and renal fascia
- Depletion causes floating kidneys (hypermobility) leading to ureter kinking

C. RENAL FASCIA (FALSE CAPSULE/FASCIA OF GEROTA)

- Anterior layer - Fascia of Toldt; Posterior layer - Fascia of Zuckerkandl
- Tracing of renal fascia /Extension of renal fascia
 1. **SUPERIOR** - Two layers encloses adrenal gland; Continues with diaphragmatic fascia
 2. **INFERIOR** - Fuses with iliac fossa
 3. **LATERAL** - Fuses with fascia transversalis
 4. **MEDIAL** - Fuses with connective tissue of abdominal aorta and inferior Vena Cava

D. PARARENAL FAT (PARANEPHRIC FAT)

- ❖ Forms cushion of kidneys (fills paravertebral gutter)

RELATIONS OF KIDNEY

ANTERIOR RELATIONS

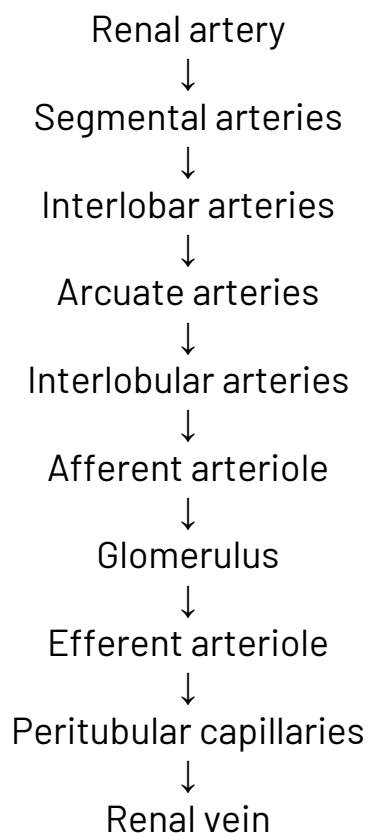
<u>COMMON RELATIONS</u>	<u>RIGHT KIDNEY</u>	<u>LEFT KIDNEY</u>
Suprarenal area	Right suprarenal gland	Left suprarenal gland
Jejunal area (medial)	Jejunum	Jejunum
Colic area (Lateral)	Hepatic colic flexure	Splenic colic flexure
<u>SPECIFIC RELATIONS</u>	Right lobe of liver	Spleen
	Second part of duodenum	Stomach
		Pancreas

POSTERIOR RELATIONS

FOUR MUSCLES	THREE NERVES	ONE OR TWO RIBS
Diaphragm	Subcostal nerve	Right kidney - 12th rib Left kidney - 11th and 12th ribs
Quadratus lumborum	Iliohypogastric nerve	
Psoas major	Ilioinguinal nerve	
Transversus abdominis		

BLOOD SUPPLY

- **RENAL ARTERY** - Direct branch of abdominal aorta
- **RENAL VEIN** - Drains into inferior Vena Cava



SURFACE MARKING - MORRIS PARALLELOGRAM (ON THE BACK)

- **FIRST HORIZONTAL LINE** - T 11 spinal level
- **SECOND HORIZONTAL LINE** - L 3 spinal level
- **FIRST VERTICAL LINE** - 2.5 cm from median line
- **SECOND VERTICAL LINE** - 9 cm from median line

DEVELOPMENT

Embryonic Structures	Adult Derivatives
Ureteric bud (from mesonephric duct)	Ureter Renal Pelvis Major Calyces Minor Calyces Collecting ducts Collecting Tubules
Metanephric Blastema (also k/a Metanephros or permanent kidney)	Renal glomerulus Bowman's capsule Proximal convoluted tubule Loop of Henle Distal convoluted tubule

- **METANEPHROS** - Excretory component; Ureteric bud - Collecting component
- After formation in the sacral region (pelvic region), kidneys ascend to lumbar region

CONGENITAL ANOMALIES

1. **RENAL AGENESIS** - Absence of kidney(s) due to Ureteric bud under development
2. **HORSE SHOE KIDNEY**
 - Fused lower poles of kidney
 - Ascent of horse shoe kidney is prevented by inferior mesenteric artery at L3/L4 level
 - Most common congenital renal anomaly

3. **PELVIC KIDNEY** - Kidneys are retained in pelvic region
4. **ACCESSORY RENAL ARTERIES** (More than one renal artery) - Most common renal vascular anomaly

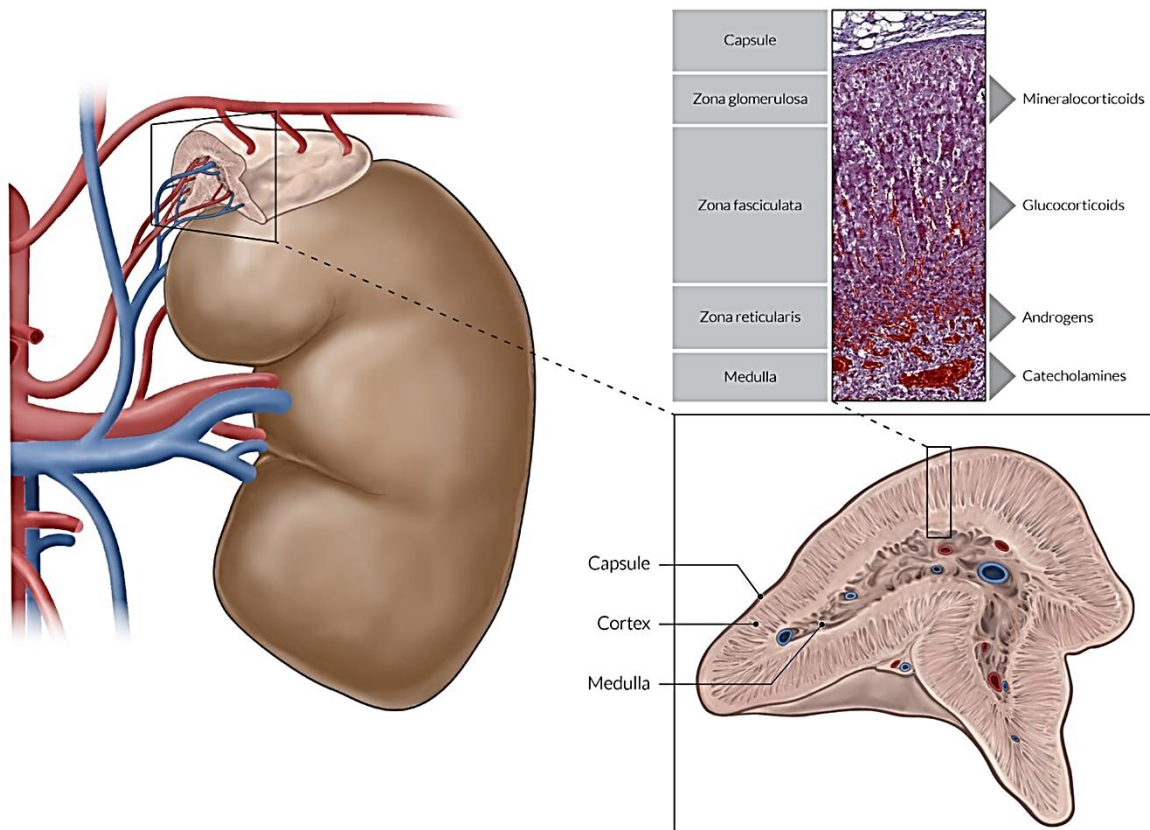
CLINICAL NOTES

1. **RENAL TRANSPLANTATION** - Left kidney is preferred as the left renal vein is longer
2. **NUTCRACKER SYNDROME** - Compression of left renal vein and duodenum (D3) b/w superior mesenteric artery and abdominal aorta
3. **RENAL SURGERY** - Approach from posterior abdominal wall
4. **RENAL ANGLE** -
 - Angle between lower border of 12th rib and lateral border of erector spinae
 - Site of tenderness in renal pathologies (Murphy's punch sign)

12. SUPRA RENAL GLAND:

MICROSCOPIC STRUCTURE:

- Connective tissue surrounds the capsule.
- Cortex and medulla are differentiated.
- Cortex with the outer zona glomerulosa, middle zona fasciculata and inner zona reticularis.
- Medulla has large chromaffin cells in groups separated by sinusoids.
- Hormone produced are
 1. Mineralocorticoid called aldosterone
 2. Glucocorticoid called cortisone and cortisol
 3. Sex hormones are estrogen and androgen
 4. Catecholamines are adrenaline and noradrenaline



DEVELOPMENT

- The adrenal gland is composed of two embryologically distinct tissues, the cortex and medulla, arising from the mesoderm and neuroectoderm, respectively.
- An isolated clump of cells appears within the urogenital ridge, known as the adrenal-gonadal primordium.
- This tissue gives rise to the fetal adrenal cortex and to Leydig cells.
- At 7 weeks of gestation, sympatho-adrenal cells migrate into the adrenal primordium.
- In later stages of embryonic development, the cortex engulfs, and ultimately encapsulates the entire medulla.

CLINICAL ANATOMY

ADDISON'S DISEASE:

- It occurs due to chronic insufficiency of cortical secretion.
- Clinically, it presents as (a) muscle weakness and wasting, (b) increased pigmentation of skin, (c) low blood pressure, and (d) restlessness and tiredness, etc.

CUSHING SYNDROME:

- It occurs due to hypersecretion of the adrenal cortex.

CAUSES:

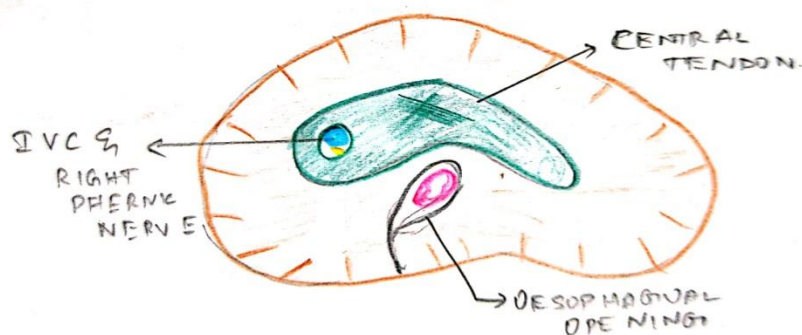
1. Obesity involving the face (moon face), neck, and abdomen
2. Hypertension
3. Hirsutism
4. Masculization (virilism) in female and feminization in male, and
5. Adrenogenital syndrome in children.

ADRENALECTOMY: (bilateral removal of the adrenal glands)

- It is sometimes done in advanced and inoperable cases of carcinoma breast and prostate.
- The suprarenal vein must be ligated before manipulating the gland so that catecholamines do not escape in the circulation.
- The right adrenal gland is more difficult to approach than the left because part of it lies posterior to the inferior vena cava.
- Pheochromocytoma is a tumor of the adrenal medulla.
- The signs and symptoms are produced due to bursts of epinephrine and norepinephrine.
- **CAUSES:**
 1. Paroxysms of hypertension
 2. Palpitation
 3. Headache
 4. Excessive sweating and pallor of the skin

13. DIAPHRAGM

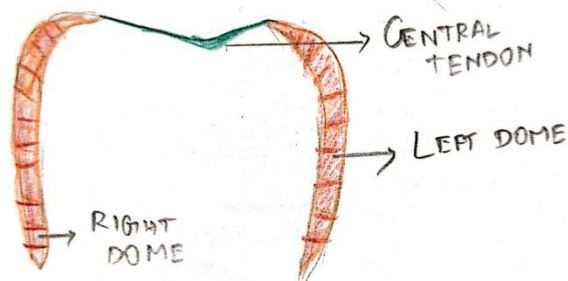
- DIAPHRAGM is a fibromuscular sheet, is a dome shaped muscle.
- Separate thoracic cavity from abdominal cavity.
- Important function is respiration.



PARTS AND ATTACHMENT

ORIGIN - group into three parts

1. Sternal
2. Costal
3. Lumbar

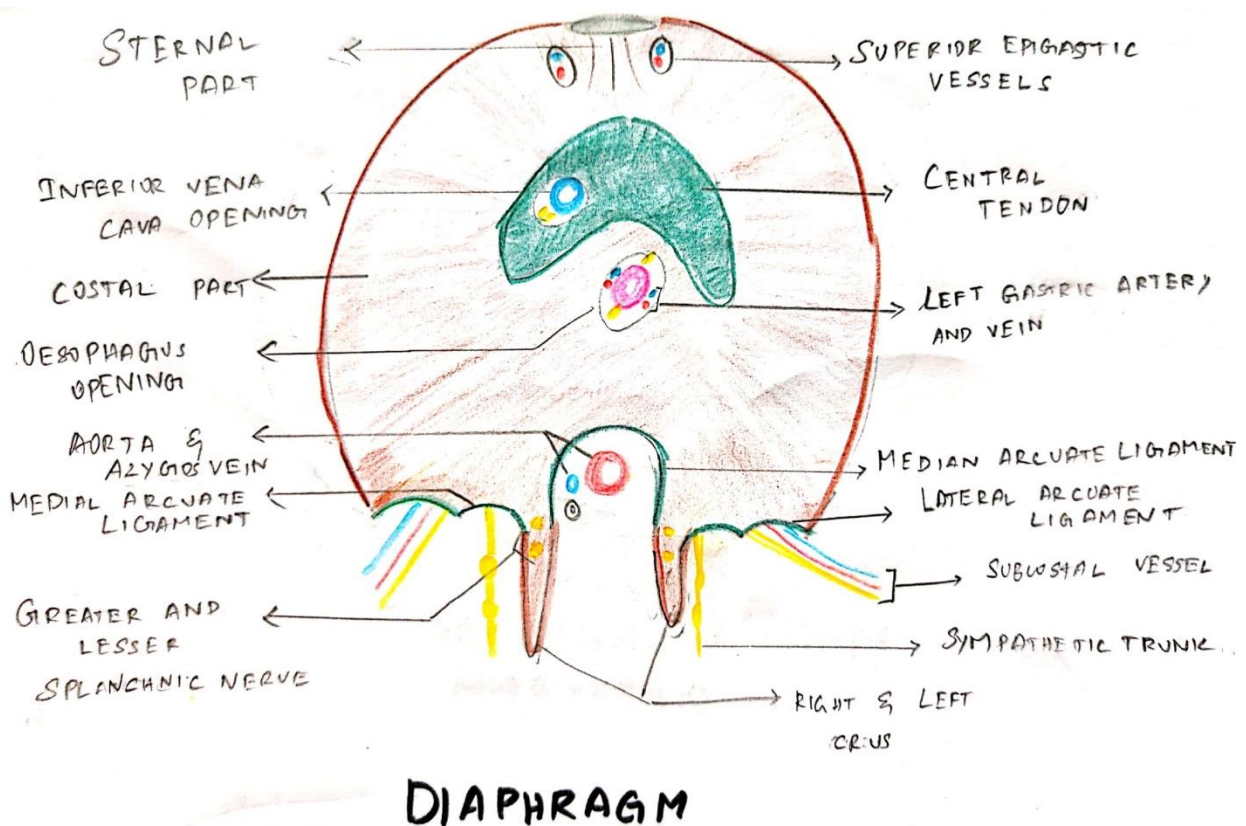


STERNAL PARTS	COSTAL PARTS	LUMBAR PARTS
Arise from back of xiphoid process.	Arise from lower six ribs, cartilage, forms right and left dome.	Arise by means of right and left crura and arcuate ligament.

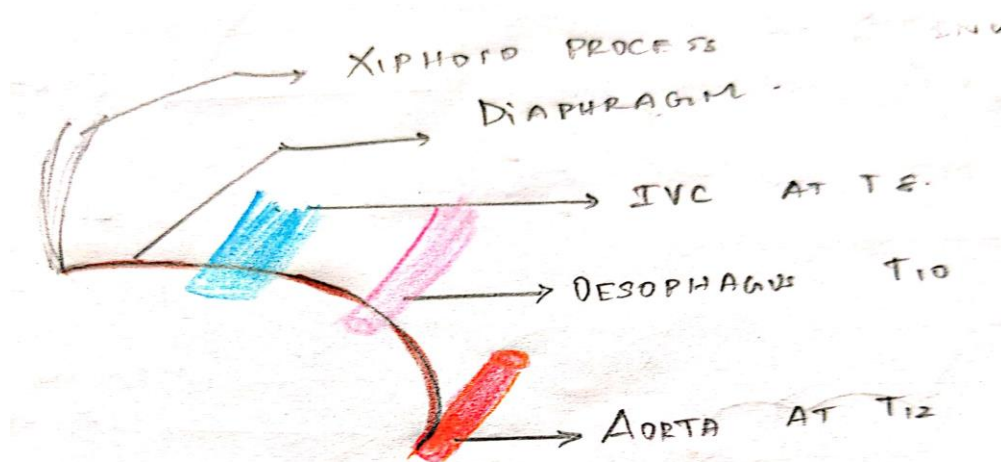
CRURA AND ARCUATE LIGAMENT

1. **RIGHT CRUS** arise from upper 3 lumbar vertebrae and intervening intervertebral disc.
2. **LEFT CRUS** arise from the corresponding part of upper two lumbar vertebrae.
3. **MEDIAN ARCUATE LIGAMENT**: arched fibrous band stretching between upper ends of crura.
4. **MEDIAL ARCUATE LIGAMENT** - Upper margin of psoas sheath. Extends from body of L2 to transverse process of L1.
5. **LATERAL ARCUATE LIGAMENT**- upper margin of fascia covering quadratus lumborum. Extend from tip of transverse process of L1 to 12th rib.

INSERTION - Central tendon of diaphragm - trifoliate in shape (3 leaflet - Central, right and left posterior leaflets)



OPENING - MAJOR AND MINOR



MAIN OPENING OF DIAPHRAGM

MAJOR OPENING	SITUATION	SHAPE	STRUCTURE PASSING	LOCATION
VENA CAVAL	T8	Quadrangular	IVC, right phrenic nerve	Right of median plane
OESOPHAGEAL	T10	Elliptical	Oesophagus, Vagal trunks, Esophageal branches of left gastric artery.	Left of median plane.
AORTIC	T12	Rounded	Aorta, thoracic duct, azygos vein	In the midline

MINOR OPENING

- Sympathetic trunk-pass behind medial arcuate ligament
- Superior epigastric vessel – Through Space of Larry.
- Musculophrenic artery – Gaps between slips of origin from 7th to 8th ribs.
- Intercostal nerve and vessels pass through gaps between adjoining costal slips.
- Subcostal nerves and vessels – deep to lateral arcuate ligament.
- Hemiazygos vein – through left crus of diaphragm.
- Greater, lesser and least splanchnic nerve – pierce crus of diaphragm.

SURFACE AND RELATION

SUPERIOR SURFACE – pleura and lung, pericardium

INFERIOR SURFACE – liver (R), fundus of stomach (L), spleen, kidney, suprarenal

BLOOD SUPPLY AND NERVE SUPPLY

VASCULAR SUPPLY

- Superior and inferior phrenic artery.
- Pericardiophrenic arteries.
- Musculophrenic arteries.
- Superior epigastric artery.
- Lower five intercostal and subcostal artery.
- Phrenic vein

NERVES SUPPLY

- Motor by phrenic nerve.
- Sensory by lower six intercostal nerves.

DEVELOPMENT

- Septum transversum
- Pleuroperitoneal membrane
- Lateral thoracic wall
- Dorsal mesentery of esophagus

ACTION

- Muscle of inspiration.
- Muscle of abdominal strain.
- Weight lifting muscle.
- Thoraco- abdominal pump.
- Compress the blood in inferior vena cava.
- Compress lymph vessel in thoracic duct – prevent backflow.

APPLIED

HICCUP

- Shoulder tip pain.
- Unilateral paralysis of diaphragm – Damage to phrenic nerve.
- Diaphragmatic hernia: either congenital or acquired.

CONGENITAL HERNIA

- Retrosternal hernia.
- Posterolateral hernia.
- Para esophageal hernia.

ACQUIRED HERNIA

- Traumatic hernia.
- Hiatal hernia.

ABDOMEN –SHORT ANSWERS

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1. TRIANGLE OF MARCILLE

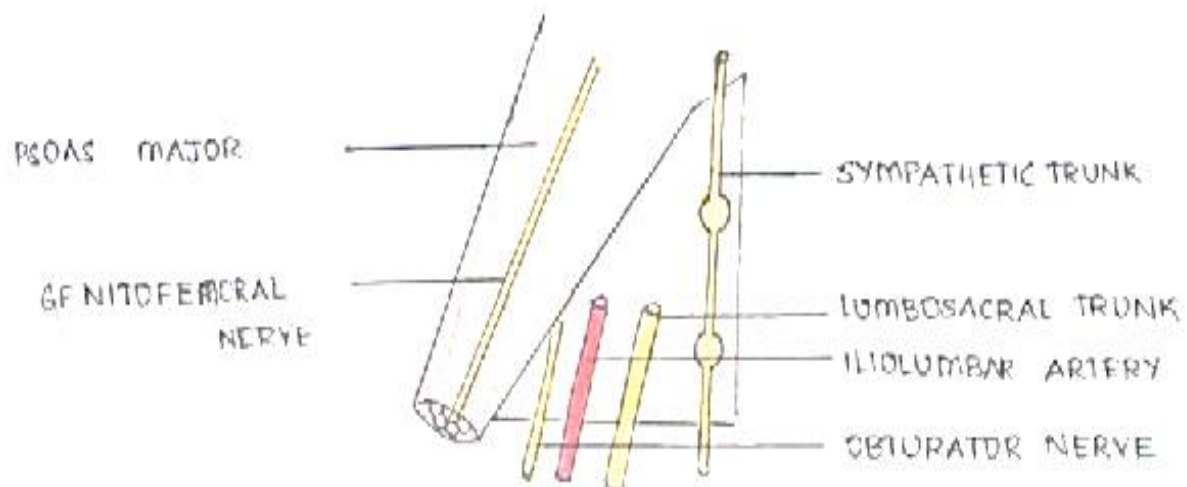
- Also called as **LUMBOSACRAL TRIANGLE**
- A triangular interval on each side of the body of L5 vertebra
- Apex directed upward

BOUNDARIES:

1. **MEDIALY** - body of L5 vertebra
2. **LATERALLY** - medial border of psoas major
3. **INFERIORLY / BASE** - Ala of sacrum
4. **APEX** - junction of psoas and body of L5 vertebra
5. **FLOOR/POSTERIOR WALL** - Transverse process of L5 vertebra and iliolumbar ligament

CONTENTS:

- From medial to lateral sides, these are:
 1. Sympathetic trunk
 2. Lumbosacral trunk
 3. Iliolumbar artery
 4. Obturator nerve



2. MUSCLES WITHIN RECTUS SHEATH

- Rectus sheath is an aponeurotic sheath enclosing
 - Rectus abdominis
 - Pyramidalis (if present)

<u>MUSCLE</u>	<u>ORIGIN</u>	<u>INSERTION</u>	<u>NERVE SUPPLY</u>
<u>RECTUS ABDOMINIS</u>	By 2 tendinous heads: (a) lateral head from lateral part of pubic crest (b) medial head from anterior surface of pubic symphysis	(a) 5th, 6th and 7th costal cartilages (along a horizontal line) (b) xiphoid process	Lower 6 or 7 thoracic nerves (anterior rami of T7 - T12)
<u>PYRAMIDALIS</u>	(a) anterior surface of body of pubis (b) anterior pubic ligament	Into linea alba	Subcostal nerve (T12)

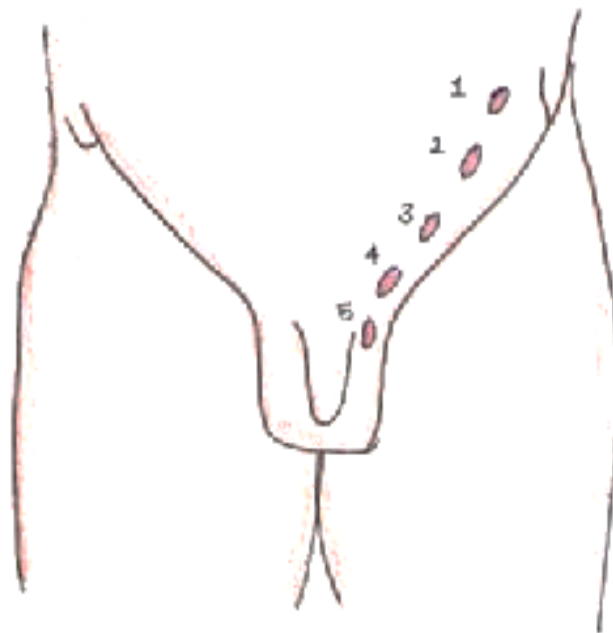
- Rectus abdominis flexes the trunk or lumbar spine
- Pyramidalis is said to be tensor of linea alba, but the need for such action is not clear

3. CONTENTS OF SPERMATIC CORD

- The spermatic cord is a collection of structures that pass to and fro from testis through the inguinal canal.
- It extends from the deep inguinal ring to the posterior border of the testis and is covered by three fascial layers.
- The spermatic cord consists of the following six groups of structures:
 1. Ductus deferens, in the posterior part.
 2. Three arteries:
 - a. Testicular artery, from abdominal aorta.
 - b. Cremasteric artery, from inferior epigastric artery.
 - c. Artery to ductus deferens, from inferior vesical artery
 3. Veins, the pampiniform venous plexus.
 4. Lymphatics, especially from testis draining into pre- and para-aortic nodes, and some from the coverings draining into external iliac nodes.
 5. Nerves, genital branch of genitofemoral nerve and sympathetic fibres which accompany the arteries.
 6. Remains of processus vaginalis.

4. CRYPTORCHIDISM

- Incomplete descent of testis
- In this condition, the testis, during its descent, although it travels through its normal path but fails to reach the base of the scrotum
- Thus, it may be found:
 1. Within the abdomen
 2. At the deep inguinal ring
 3. Within the inguinal canal
 4. At the superficial inguinal ring
 5. High up in the scrotum

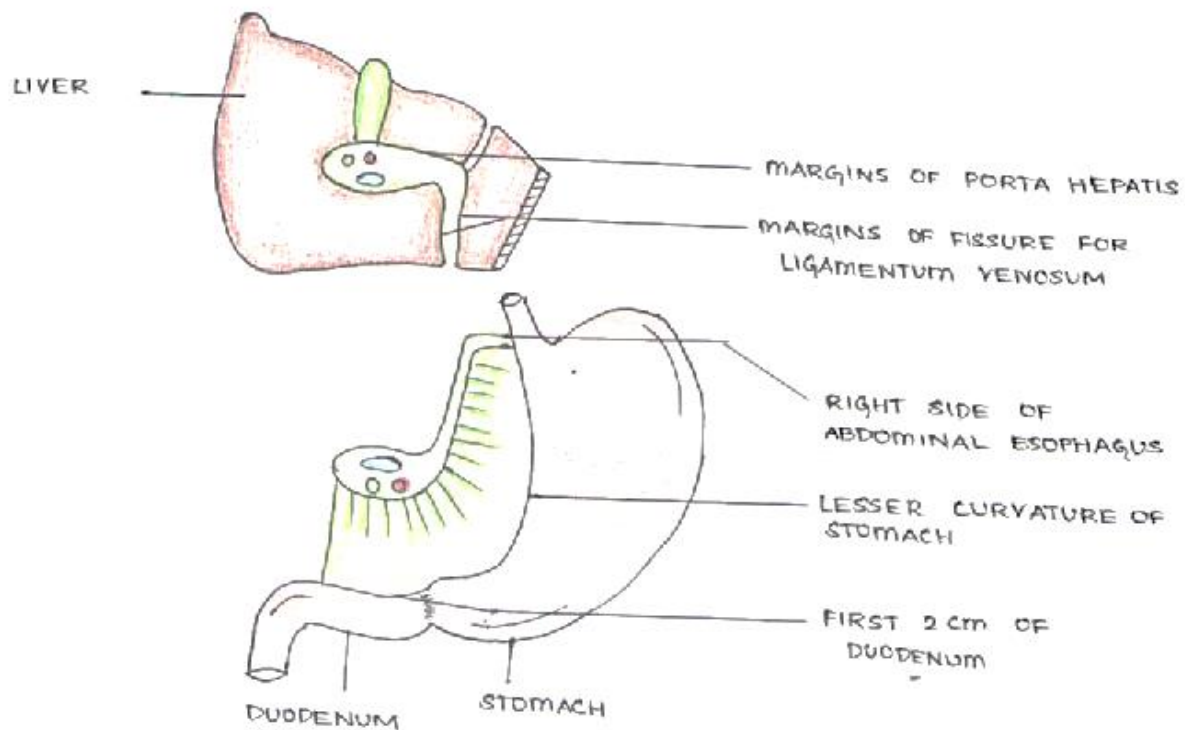


COMPLICATIONS OF CRYPTORCHIDISM:

- Spermatogenesis often fails to occur in undescended testis.
- An undescended testis is more likely to develop a malignant tumor than a normal testis. The condition may be surgically corrected.

5. STRUCTURES IN THE FREE BORDER OF LESSER OMENTUM

- The right free margin of the lesser omentum contains:
 1. Portal vein
 2. Hepatic artery and bile duct anterior to the portal vein, with duct to the right of the artery.
 3. Autonomic nerves.
 4. Lymphatic and lymph nodes.

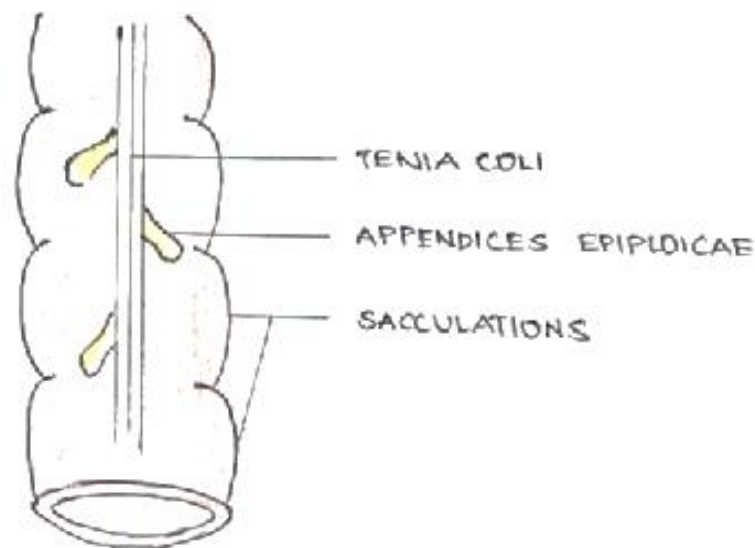


6. TAENIA COLI

- These are ribbon-like bands of the longitudinal muscle coat.
- These bands converge proximally at the base of the appendix and spread out distally to become continuous with the longitudinal muscle coat of rectum.
- Thus, taeniae coli are present on all parts of colon and caecum.

LOCATION:

- In the caecum, and descending colon, the positions of taeniae are anterior (taeniae libera), posteromedial (taeniae mesocolica), and posterolateral (taeniae mentalis).
- But in the transverse colon the corresponding positions are inferior, posterior, and superior, respectively.



7. ARTERIAL SUPPLY OF TRANSVERSE COLON

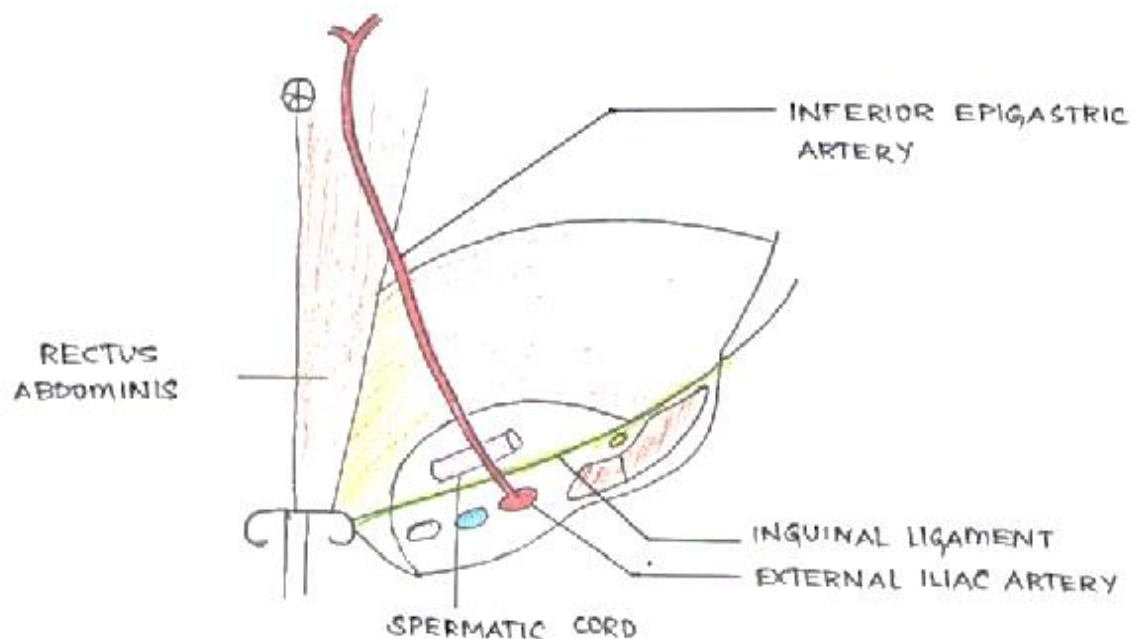
1. **RIGHT 2/3RD** - middle colic artery
2. **LEFT 1/3RD** - left colic artery

8. HESSELBACH'S TRIANGLE

- The inguinal triangle is situated deep to the posterior wall of the inguinal canal;
- Hence, it is seen on the inner aspect of the lower part of the anterior abdominal wall.

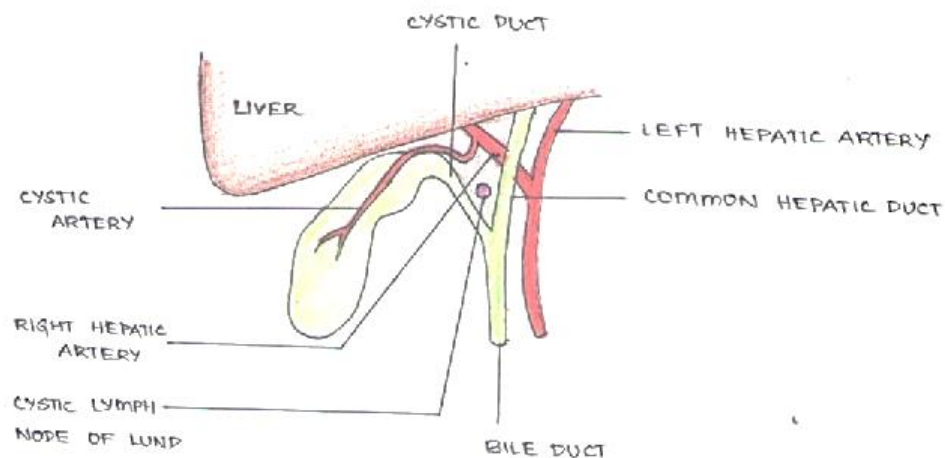
BOUNDARIES:

1. **MEDIALY** - lower 5 cm of lateral border of rectus abdominis muscle
2. **LATERALLY** - inferior epigastric artery
3. **INFERIORLY** - medial half of inguinal ligament
4. **FLOOR** - peritoneum, extraperitoneal tissue and fascia transversalis



9. CALOT'S TRIANGLE

- Also known as **CYSTOHEPATIC TRIANGLE**.
- It is in this triangle that most of aberrant segmental right hepatic ducts and arteries are usually encountered.
- Identification of calot's triangle and its contents helps the surgeon to locate the pedicle of gallbladder and its ligation in cholecystectomy.
- Errors in gallbladder surgery often occur from failure to appreciate the common variations of the extrahepatic biliary system.
- This occurs especially when the right hepatic artery in this triangle presents a caterpillar-like loop called **MOYNIHAN'S HUMP**, which may be inadvertently clamped, ligated along with cystic pedicle, and cut leading to profuse bleeding.



BOUNDARIES:

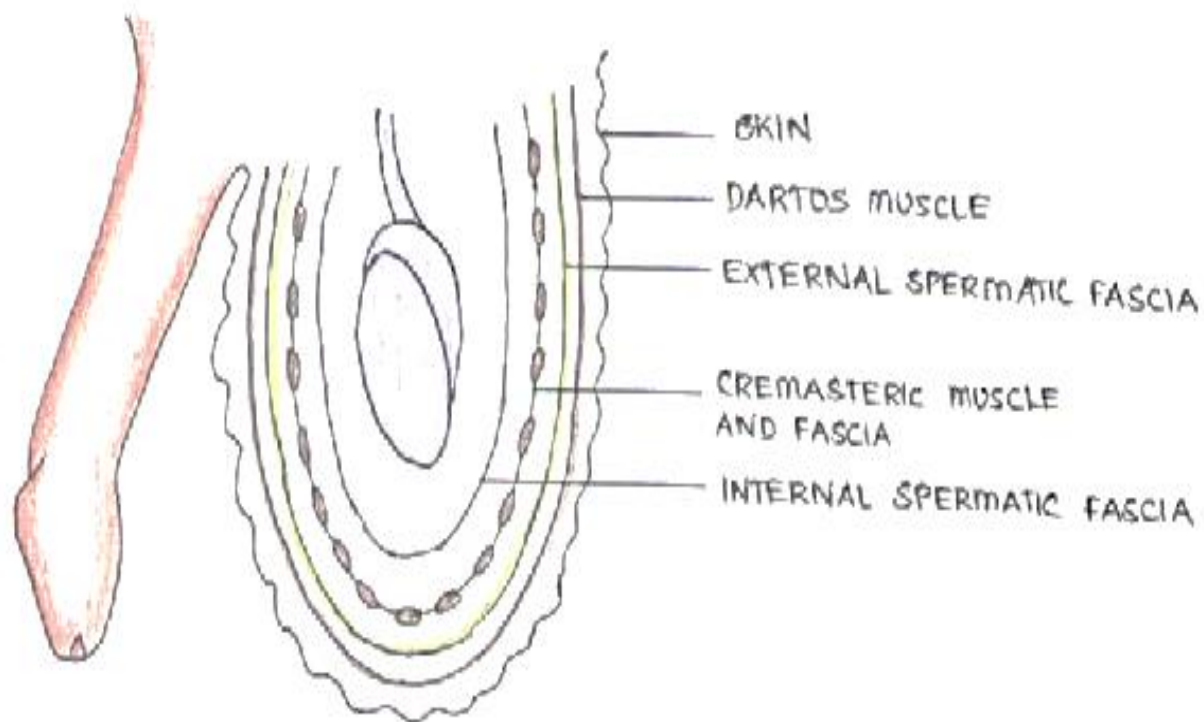
1. **RIGHT** - cystic duct
2. **LEFT** - common hepatic duct
3. **ABOVE** - inferior surface of liver
4. **APEX** - faces downwards; between cystic and common bile duct

CONTENTS:

- Right hepatic artery
- Cystic artery
- Cystic lymph node of Lund

10. DARTOS MUSCLE

- Replaces the superficial fascia of scrotal wall
- Made of smooth muscles
- Helps to regulate the temperature of testicle
- It is supplied by the sympathetic fibres through genital branch of the genitofemoral nerve

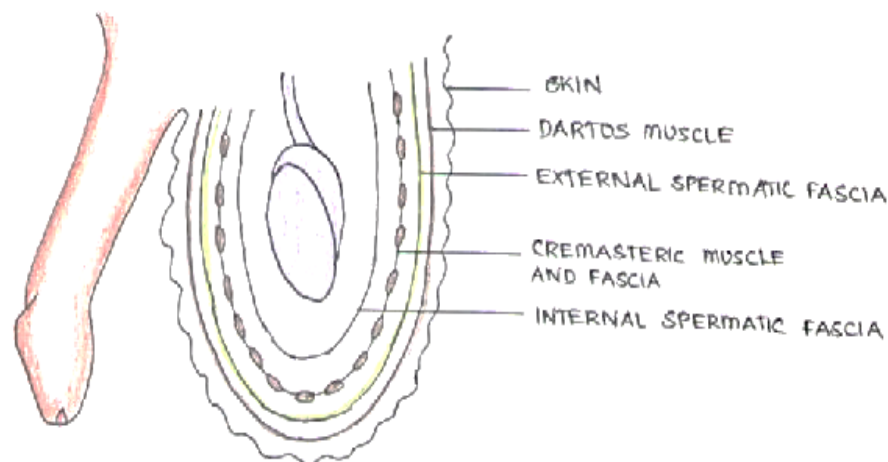


11. CONJOINT TENDON

- The fleshy fibres of internal oblique muscle, arises from inguinal ligament, arch over the inguinal canal and its contents, and then descend to be inserted on to the pubic tubercle and pecten pubis.
- These fibres fuse with the corresponding tendinous fibres of the transverse abdominis muscle to form the conjoint tendon.
- This conjoint tendon is inserted into the pubic crest and medial part of the pecten pubis.

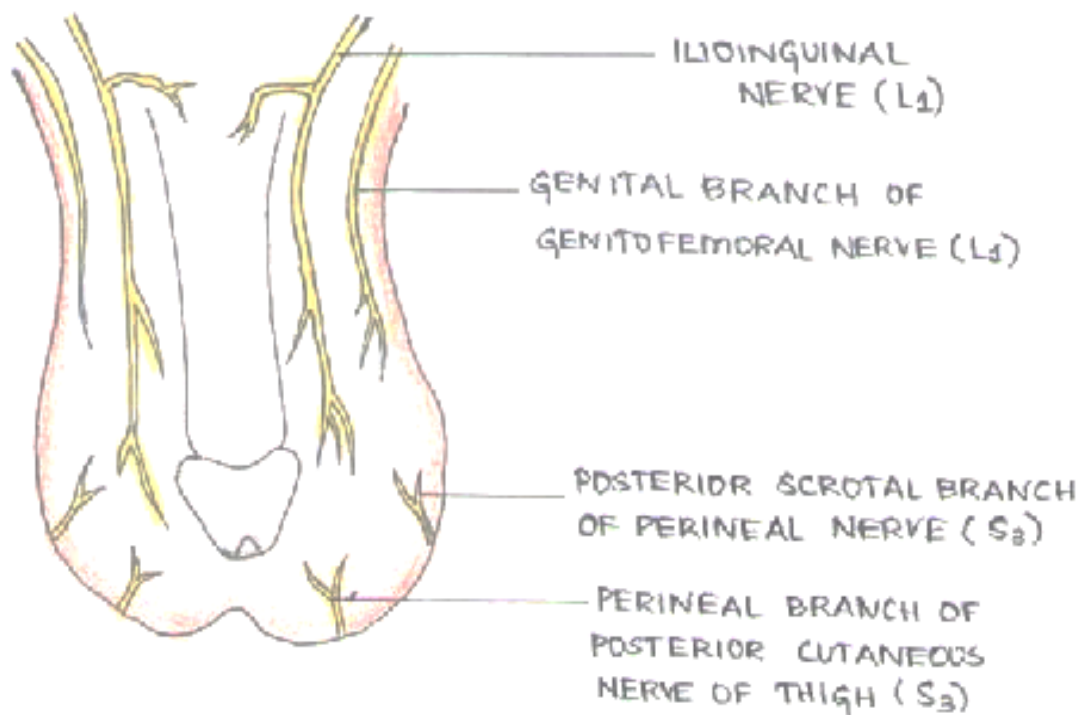
12. SCROTUM - LAYERS & NERVE SUPPLY

- The scrotal wall from without inward is made up of the following 5 layers:
 1. Skin
 2. Dartos muscle (which replaces the superficial fascia)
 3. External spermatic fascia
 4. Cremasteric muscle and fascia
 5. Internal spermatic fascia



NERVE SUPPLY:

1. Anterior one-third of the scrotum is supplied by ilioinguinal nerve (L1) and genital branch of genitofemoral nerve (L1).
2. Posterior two-third of the scrotum is supplied by the posterior scrotal branches of the perineal nerve (S3) and perineal branch of the posterior cutaneous nerve of the thigh (S3).
3. The involuntary dartos muscle is supplied by the sympathetic fibres through genital branch of the genitofemoral nerve.



13. DIFFERENCE BETWEEN JEJUNUM AND ILEUM

<u>FEATURES</u>	<u>JEJUNUM</u>	<u>ILEUM</u>
<u>WALLS</u>	Thicker and more vascular	Thinner and less vascular
<u>LUMEN</u>	Wider and often found empty (diameter=4cm)	Narrower and often found full (diameter=3.5cm)
<u>CIRCULAR FOLDS / VALVES OF KERCKRING</u>	Longer and closely set	Smaller and sparsely set
<u>VILLI</u>	More, larger, thicker and leaf like	Less, shorter, thinner and finger like
<u>PEYER'S PATCHES</u>	Small, circular, and few in number, and found only in distal part of jejunum	Large, oval, and more in number, and found throughout the extent of ileum being maximum in the distal part
<u>MESENTERY</u>	Contains less fat and becomes semi translucent between the vasa recta called peritoneal windows	Contains more fat and there are no peritoneal windows between the vasa recta
<u>ARTERIAL ARCADES</u>	1 or 2 rows with long vasa recta	4 or 5 rows with short vasa recta

14. MCBURNEY'S POINT

- It is a point at the junction of medial 2/3rd and lateral 1/3rd of the line extending from the umbilicus to the anterior superior iliac spine (spinoumbilical line).
- The base of appendix lies deep to this point.

15. MURPHY'S SIGN

- It is a point where linea semilunaris meets the right subcostal margin. It corresponds to the tip of the 9th costal cartilage.
- The fundus of gall bladder lies deep to this point.

16. COURVOISIER'S SIGN / LAW

- This law states that the obstructive jaundice with distended and palpable gallbladder is most likely due to extrinsic obstruction of CBD (e.g., carcinoma of head of pancreas).
- On the contrary, obstructive jaundice with non-distended, non-palpable gallbladder is due to an intrinsic obstruction of CBD (e.g., impaction by gallstones) because in this case previous cholecystitis makes the gallbladder fibrotic and contracted.

17. POLICEMAN OF ABDOMEN: GREATER OMENTUM

- It protects the peritoneal cavity from infection due to the presence of a large number of macrophages.
- It limits the spread of infection.
- The greater omentum moves to the site of infection and seals it off from the surrounding areas.
- It also moves to the site of perforation of gut to plug the gap to prevent the leakage of contents of gut in the peritoneal cavity.
- For this reason, greater omentum is often termed the "policeman of abdomen."

18. BRANCHES OF EXTERNAL ILIAC ARTERY

1. Inferior epigastric
2. deep circumflex iliac arteries

19. TRANSPYLORIC PLANE

- The transpyloric plane, also known as **ADDISON'S PLANE**, is an **IMAGINARY HORIZONTAL PLANE**, located halfway between the suprasternal notch of the manubrium and the upper border of the symphysis pubis at the level of the first lumbar vertebrae, L1.

20. STRUCTURES CROSSED BY THIS PLANE

1. Pylorus of stomach
2. Fundus of stomach
3. Neck of pancreas
4. Hila of kidneys
5. Origin of Superior Mesenteric artery
6. Formation of portal vein
7. Root of transverse colon
8. Cisterna chyli
9. DJ flexure
10. Termination of spinal cord
11. Fundus of gallbladder
12. 2nd part of duodenum

21. SPACE OF RETZIUS

- Also called the RETROPUBIC SPACE.

BOUNDARIES

- The posterior aspect of symphysis **pubis & adjoining posterior wall of rectus sheath** ANTERIORLY
- **The pubic rami & obturator internus muscle** LATERALLY
- Inferolateral surfaces of the urinary bladder POSTERIORLY
- SUPERIORLY by the reflection of peritoneum from the Superior surface of urinary bladder to posterior aspect of anterior abdominal wall upto umbilicus.
- INFERIORLY by puboprostatic / pubovesical ligaments

CONTENTS

1. Retropubic pad of fat & prostatic venous plexus in males
2. The anterior aspects of the proximal urethra and extraperitoneal portions of the bladder are seen upon exposure of the retropubic space.

PELVIS ESSAYS

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1. TESTIS

EXTERNAL FEATURES:

The testis has:

A. 2 POLES

- a. Upper
- b. Lower

B. 2 BORDERS

- a. Anterior
- b. Posterior

C. 2 SURFACES

- a. Medial
- b. Lateral

The upper & lower poles –

- Convex
- Smooth

UPPER POLE –

- Provides attachment to the spermatic cord
- Provides attachment to Appendix of Testis – a remnant of Paramesonephric duct.

ANTERIOR BORDER –

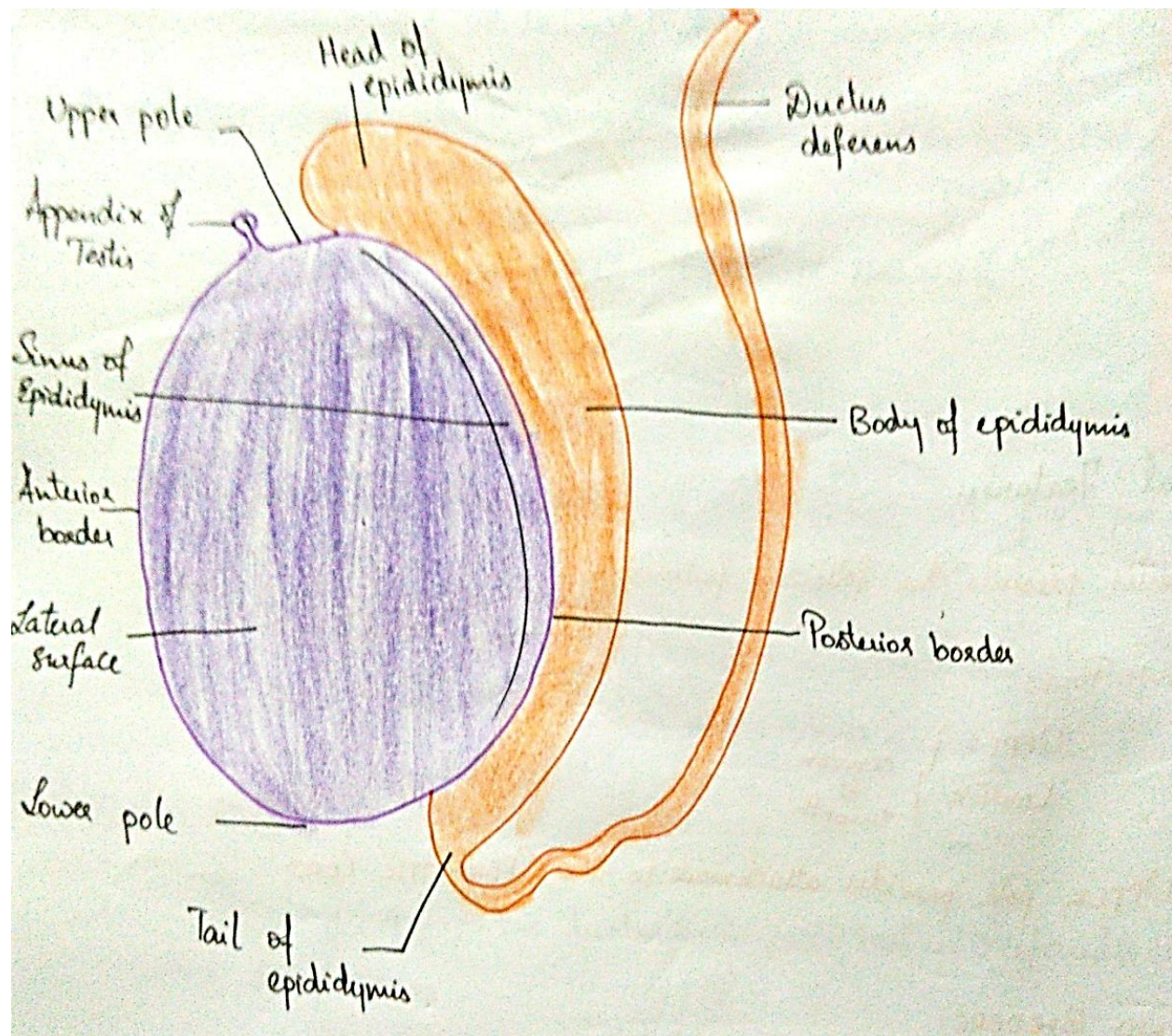
- Convex
- Smooth
- Fully covered by tunica vaginalis

POSTERIOR BORDER -

- Straight
- Partially covered by tunica vaginalis
- Epididymis lies along its lateral aspect - Medial surface of epididymis - separated from testis by extension of cavity of tunica vaginalis => Extension - called Sinus of Epididymis.

MEDIAL & LATERAL SURFACES -

- Convex
- Smooth



COVERINGS:

- Testis – covered by layers of scrotum + 3 coats
- The 3 coats are – Tunica vaginalis + Tunica albuginea + Tunica vasculosa

A. TUNICA VAGINALIS

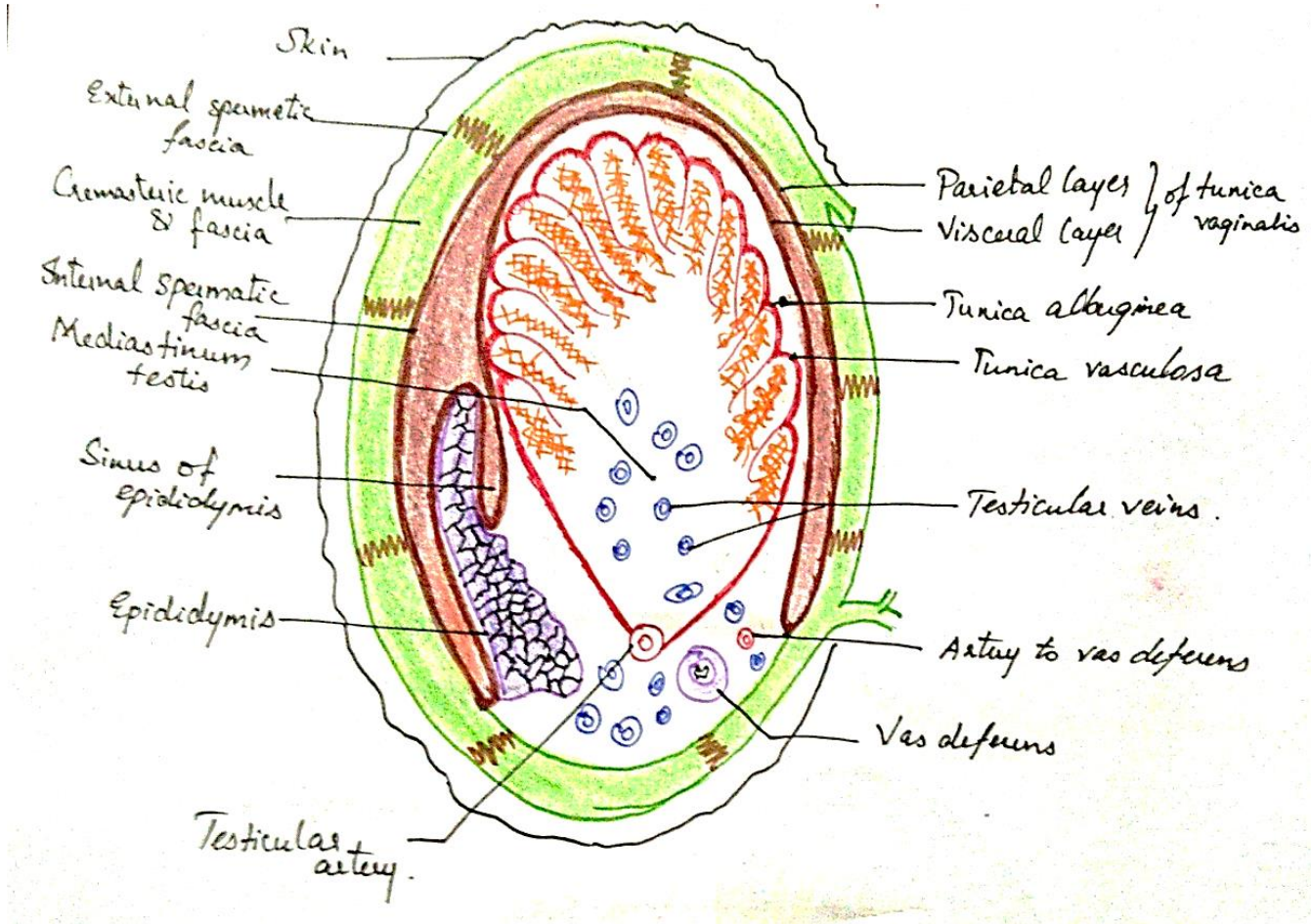
- Represents lower persistent portion of processus vaginalis
- Invaginated by testis from behind ➡ Parietal layer + Visceral layer + Cavity in between.
- Covers whole testis, except posterior border.

B. TUNICA ALBUGINEA

- Dense, white, fibrous coat
- Covers testis completely
- Covered by visceral layer of T. vaginalis except posteriorly => Posteriorly – testicular vessels & nerves enter gland
- Posterior border – thickened to form Mediastinum testis – incomplete vertical septum, wider above
- Numerous septa extend from mediastinum to inner surface => incompletely divide testis into 200-300 lobules.

C. TUNICA VASCULOSA

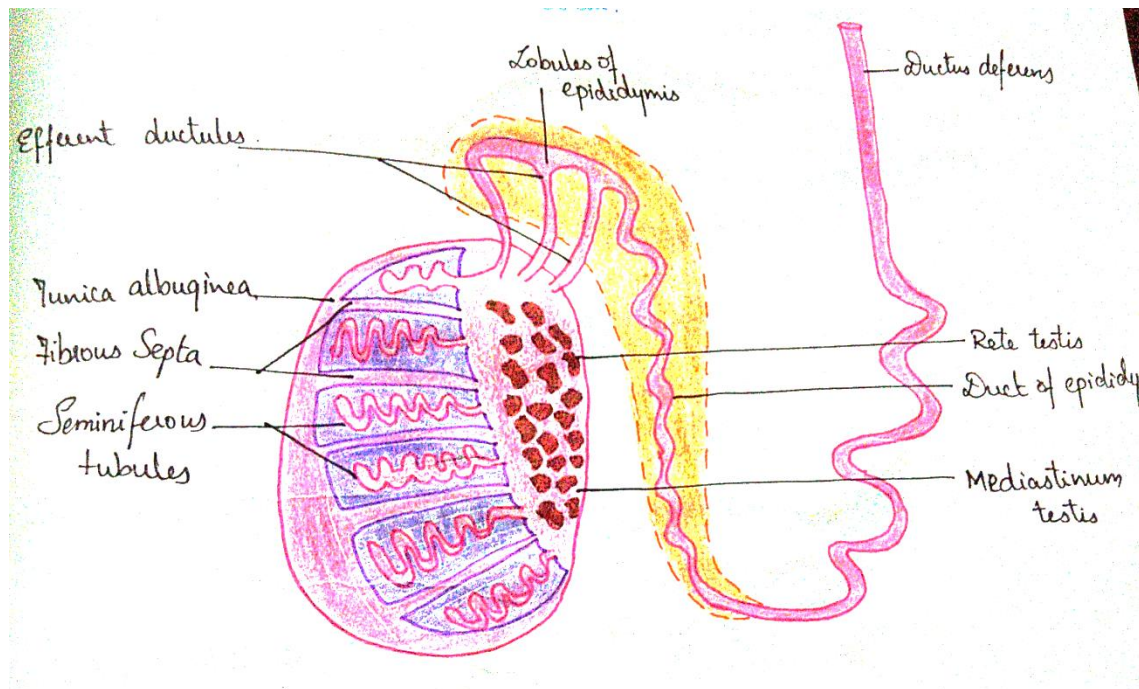
- Innermost
- Vascular coat
- Lining lobules of testis.



STRUCTURE

- Glandular part consists of 200-300 lobules.
- Each lobule - 2-3 seminiferous tubules.
- Each tubule -
 - highly coiled on itself
 - When stretched ➡ measures about 60 cm in length & 0.2 mm in diameter
 - Lined by cells ➡ represent stages in formation of spermatozoa.

SEMINIFEROUS TUBULES ➔ join together at apices of lobules ➔ form 20-30 straight **LOBULES** ➔ enter mediastinum ➔ straight lobules anastomose with each other ➔ form **RETE TESTIS** – network of tubules ➔ give rise to 20-30 efferent ductules ➔ emerge near upper pole of testis ➔ enter epididymis ➔ each tubule ➔ highly coiled ➔ forms lobe of head of epididymis ➔ Tubules combine ➔ end in a **SINGLE DUCT** – coiled on itself ➔ form **BODY** & **TAIL OF EPIDIDYMIS** ➔ continuous with ductus deferens.

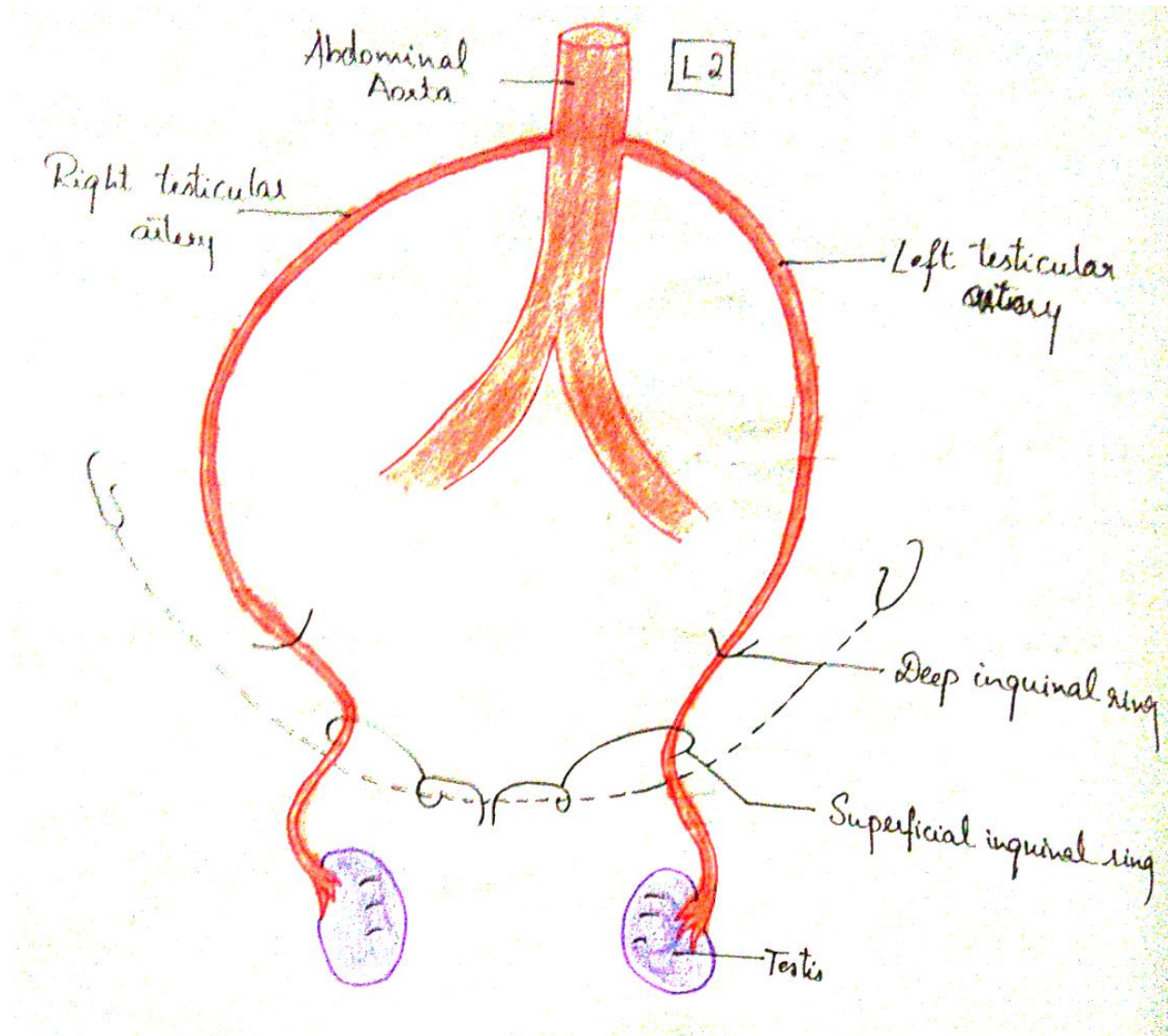


ARTERIAL SUPPLY:

TESTICULAR ARTERY

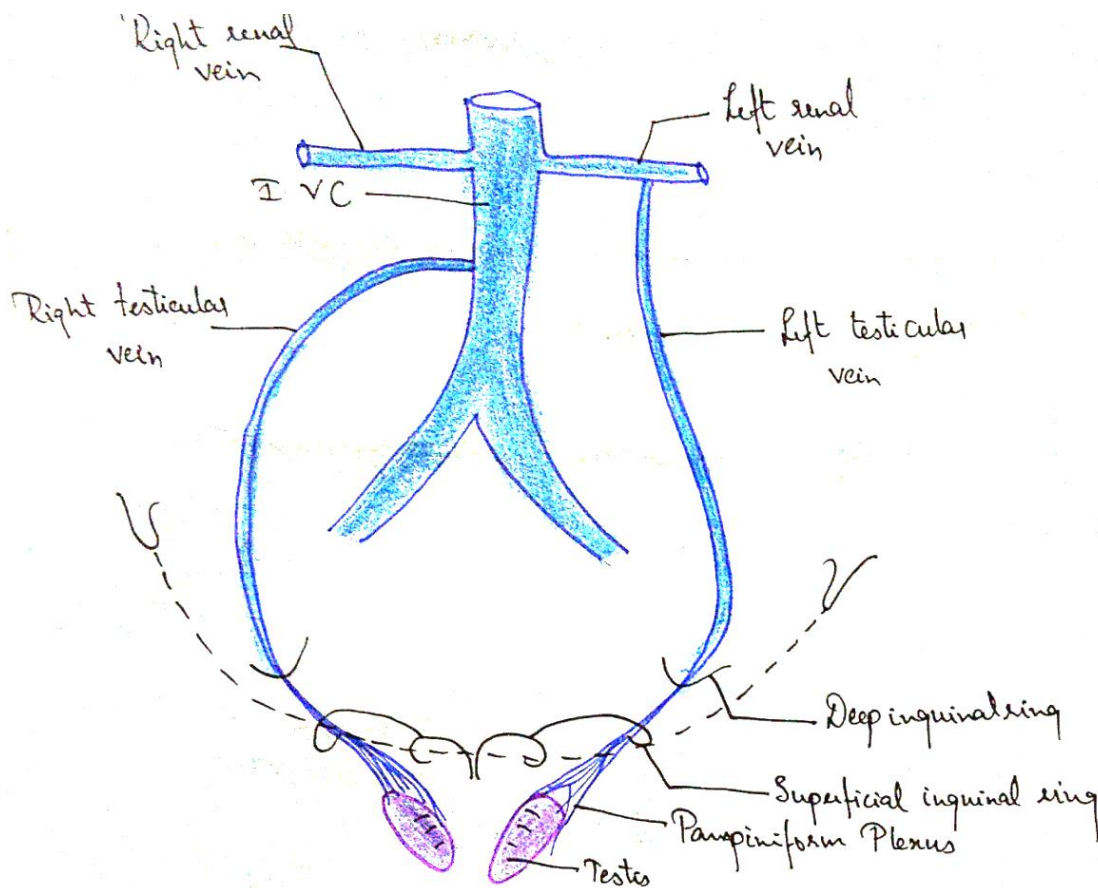
- Branch of abdominal aorta
- Given off at level of L2 vertebra
- Descends on posterior abdominal wall ➔ reaches deep inguinal ring ➔ enters spermatic cord

- At posterior border of testis – divides into branches
- Small branches – enter posterior border
- Larger branches – medial & lateral – pierce tunica albuginea ➔ run on surface of testis ➔ ramify in tunica vasculosa.



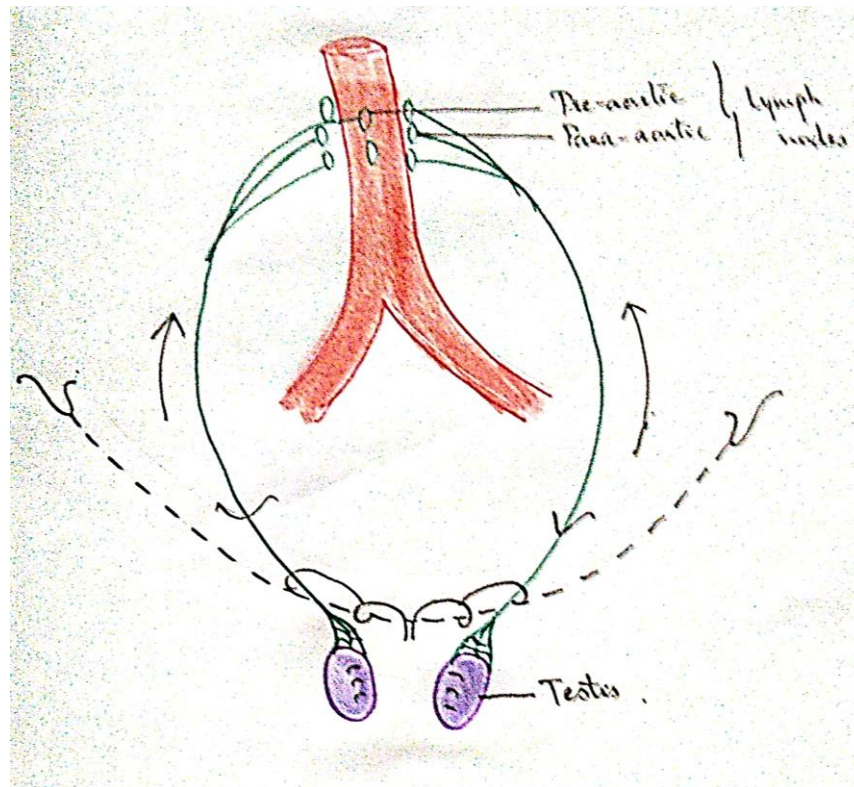
VENOUS DRAINAGE:

- Veins emerging from testis – form Pampiniform plexus
 - Anterior part of plexus – around testicular artery
 - Middle part of plexus – around ductus deferens and its artery
 - Posterior part of plexus – isolated
 - Plexus condenses into:
 - A. 4 veins – superficial inguinal ring
 - B. 2 veins – deep inguinal ring
 - C. These veins accompany testicular arteries.
- Ultimately one vein is formed- drains into
 - A. inferior vena cava on right side
 - B. left renal vein on left side.



LYMPHATIC DRAINAGE:

Lymphatics from testis ➡ ascend along testicular vessels ➡ At level of L2 vertebra ➡ Drain into **PREAORTIC** and **PARAAORTIC GROUPS OF LYMPH NODES**.



DEVELOPMENT:

- Spermatogenic series of cells - derived from endoderm of dorso-caudal part of yolk sac.
- Cells of Sertoli are derived from epithelial cells, i.e., celomic epithelium.
- Leydig cells - Mesodermal in origin.

DESCENT OF TESTIS:

- Testis develop in relation to the developing mesonephros, at the level of segments T10-T12 ➡ Descend to reach scrotum during 2nd month of IUL ➡ Reach iliac fossa by 3rd month ➡ Rest at deep inguinal ring from 4th to 6th month ➡ Traverse inguinal canal during 7th month ➡ Reach superficial inguinal ring by 8th month ➡ Reach bottom of scrotum by 9th month.

PROCESSUS VAGINALIS

- **EXTENSION OF PERITONEAL CAVITY –**
 - A. precedes descent into scrotum
 - B. Closes above testis.
- Descent does not occur after one yr. of age.

CAUSES OF DESCENT:

- a) **HORMONES** – including
 - male sex hormone produced by testis
 - maternal gonadotropins
- b) **DIFFERENTIAL GROWTH OF BODY WALL**
- c) **FORMATION OF GUBERNACULUM –**
 - a band of loose tissue extending from lower pole of testis to scrotum
 - Helps in descent
 - Remaining part after descent – Ligament of scrotum
- d) **INTRA-ABDOMINAL TEMPERATURE & INTRA-ABDOMINAL PRESSURE.**

HISTOLOGY:

- Sections of seminiferous tubules lined by spermatogonia, different stages of spermatocytes and Sertoli cells.
- Interstitial cells of Leydig seen in between tubules.
- Connective tissue covering – T. albuginea

SERTOLI CELLS/ SUSTENTACULAR CELLS

- Tall columnar
- Pale stained
- Prominent nucleolus
- Reach lumen
- Functions – support, nutrition, phagocytosis, secretion of hormones

SPERMATOGONIA

- Germ cells
- Lie near basal membrane
- Undergo mitosis to form primary spermatocytes

PRIMARY SPERMATOCYTES

- Large cells
- Each – undergoes meiosis- form 2 secondary spermatocytes

SECONDARY SPERMATOCYTES

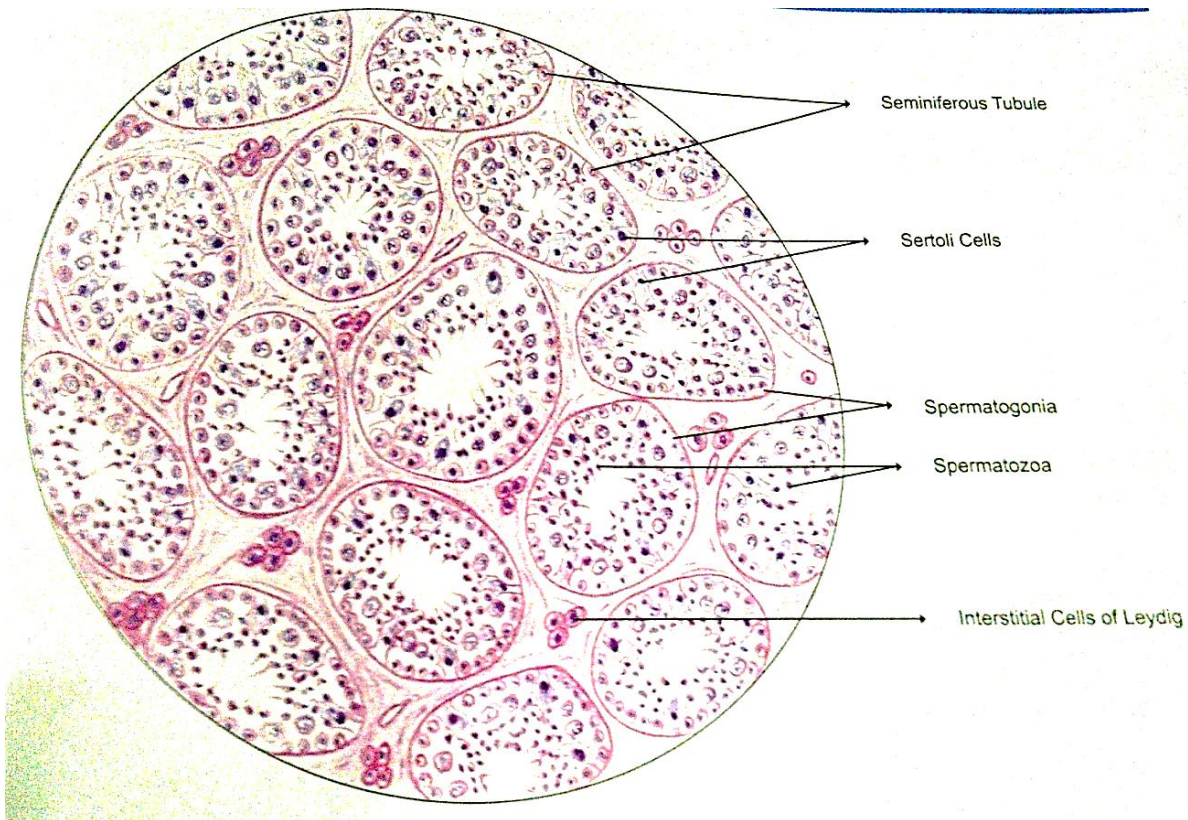
- Smaller
- Each – undergoes meiosis- form 2 spermatids

SPERMATIDS

- Round cells.
- Embedded in apical part of Sertoli cells.
- Undergo morphological changes to form spermatozoa by spermiogenesis.
- Spaces between seminiferous tubules contain loose connective tissue with blood vessels & interstitial cells of Leydig.

INTERSTITIAL CELLS OF LEYDIG

- Round, large cells
- Secrete testosterone.



CLINICAL CORRELATION:

HYDROCELE –

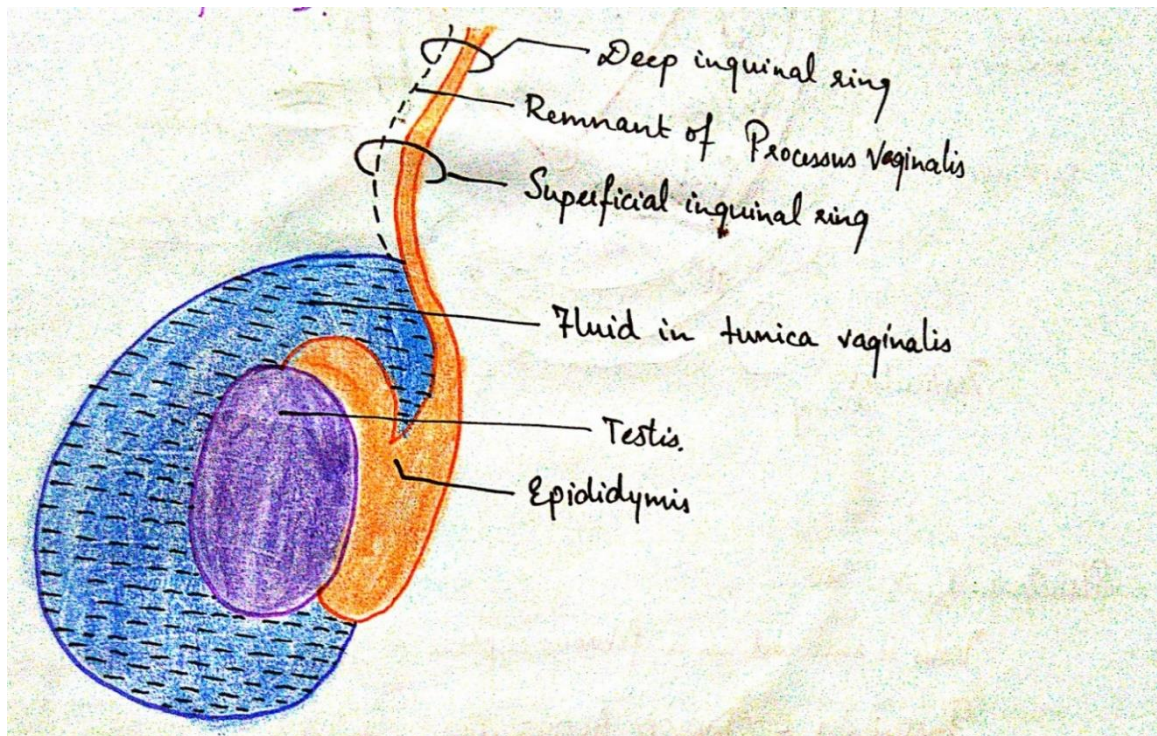
- Accumulation of fluid within T. vaginalis
- Fluid may collect following inflammation of testis because T. vaginalis is closely related to the front and side of the testis but most of the hydroceles are idiopathic
- Fluid can be removed by inserting a fine trocar & canula through the scrotal skin.

➤ **CANULA TRAVERSES**

- A. Skin
- B. Dartos Muscle
- C. External Spermatic Fascia
- D. Cremasteric Muscle & Fascia
- E. Internal Spermatic Fascia
- F. Parietal Layer of Tunica Vaginalis

➤ **TYPES**

- A. Vaginal
 - B. Infantile
 - C. Congenital/ Communicating
 - D. Hydrocele of cord
- Collection of blood in T. vaginalis is called **HEMATOCELE**.
- Collection of pus in T. vaginalis is called **PYOCELE**.



VARICOCELE –

- Veins of Pampiniform plexus become dilated, tortuous and elongated
- Commonly affects adolescents & young adults
- Mostly occurs on left side – Left testicular vein drains at a right angle in the left renal vein ➡ Venous pressure is high in left testicular vein
- Compression of left testicular vein – due to loaded constipated sigmoid colon
- Blockage of entry of left testicular vein in left renal vein may sometimes occur by the growth in malignant tumor of left kidney
- Clinically presents –
 1. Vague, dragging sensations & aching pain in the scrotum
 2. On palpation – veins of pampiniform plexus feels like 'bag of worms'

MONORCHISM – unilateral absence of testis

ANORCHISM – bilateral absence of testis

CRYPTORCHIDISM –

- Undescended testis
- **MAY LIE IN**
 1. Lumbar
 2. Iliac
 3. Inguinal
 4. Upper scrotal Regions
- **FEATURES –**
 1. Testis may complete descent after birth
 2. Spermatogenesis may fail to occur
 3. Malignant tumor more prone to develop
 4. Can be surgically corrected.

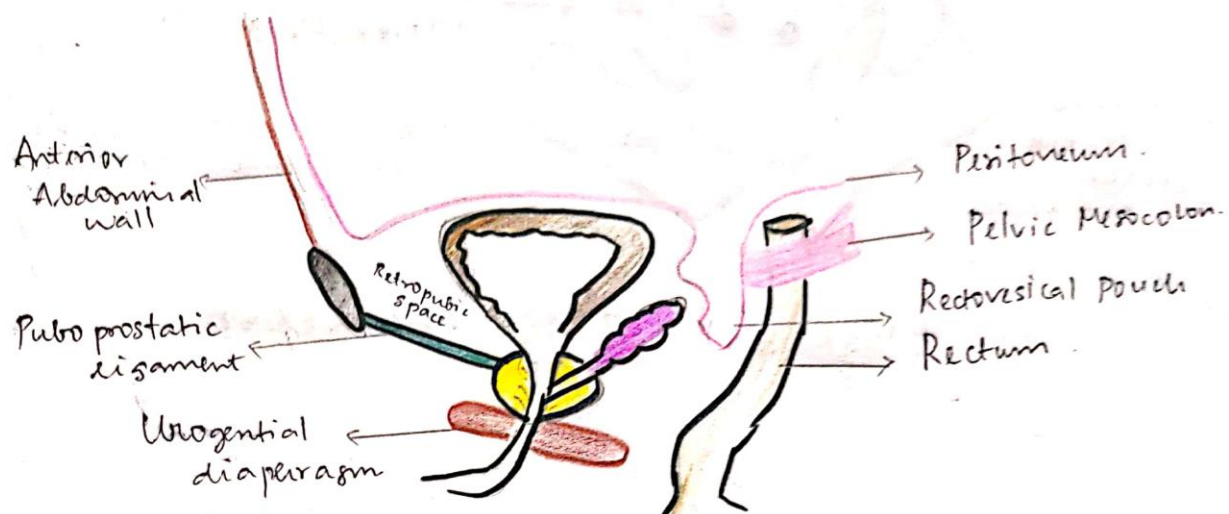
ECTOPIC TESTIS -

- Testis may occupy an abnormal position due to deviation from normal route of descent
- **MAY BE:**
 1. under the skin of lower part of abdomen
 2. under skin of front of thigh
 3. in femoral canal
 4. under skin of penis
 5. in perineum behind scrotum
- **FEATURES -**
 1. Testis is fully developed
 2. Usually accompanied by indirect inguinal hernia
 3. May be divorced from epididymis which may lie in scrotum.

2. URINARY BLADDER

INTRODUCTION

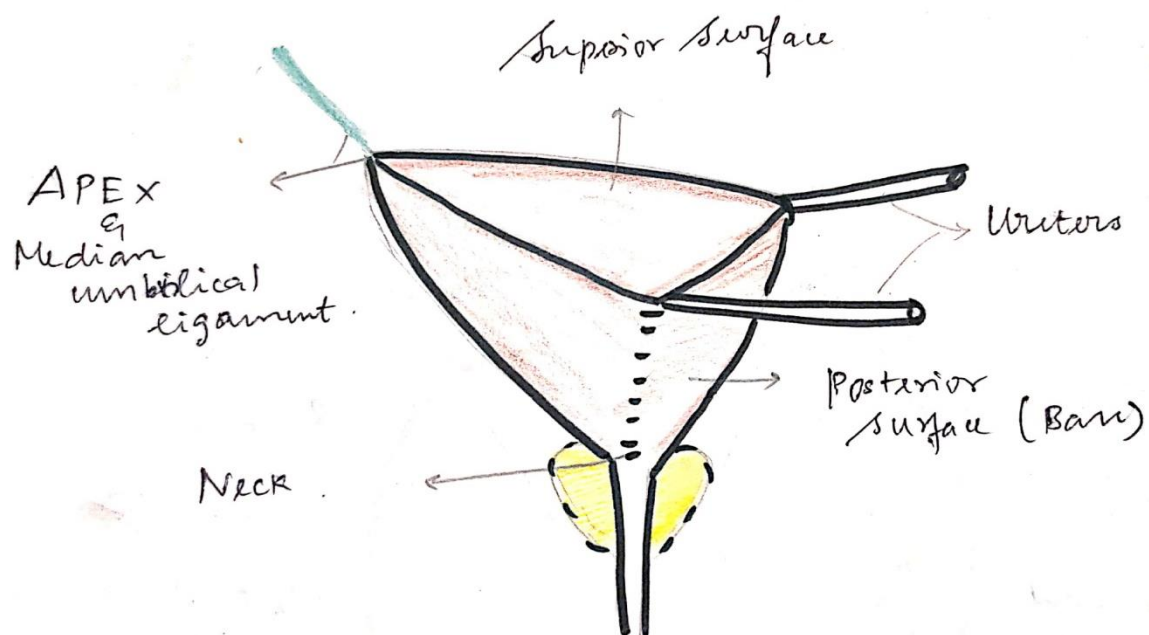
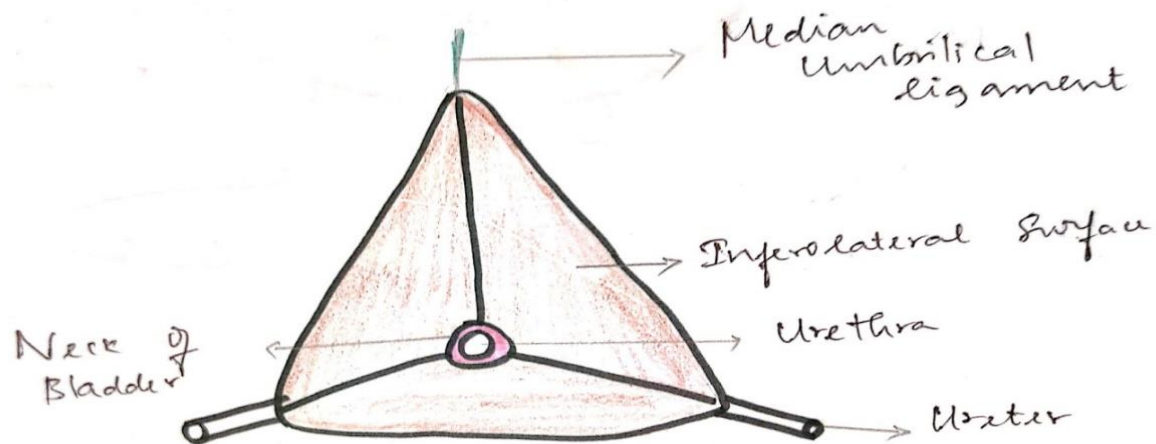
- Temporary store house of urine, empties through urethra.
- Lies behind pubic symphysis in sub-peritoneal portion.
- **CAPACITY** - vary 120ml to 320ml, mean capacity - 220ml, filling beyond 220ml causes micturate, filling upto may be tolerate but causes referred pain in anterior abdominal wall and perineum, penis.



LOCATION OF URINARY BLADDER
IN MALE

PARTS, EXTERNAL FEATURES AND RELATION

- Empty bladder - tetrahedral shape
- Empty bladder has following feature
 1. Apex, base, neck
 2. Three surface -superior, two inferolateral
 3. Four border - anterior, posterior two laterals
- Full bladder - Ovoid shaped
 1. Apex, neck
 2. Two surface - anterior and posterior

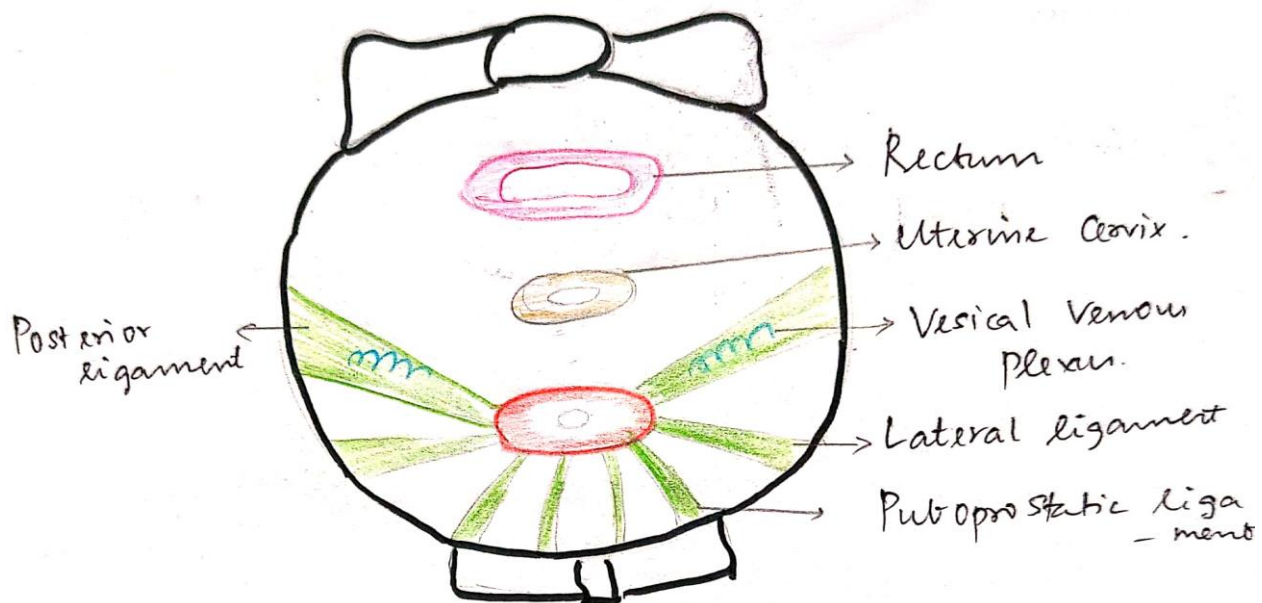


PARTS	RELATION
APEX	Median Umbilical Ligament
BASE	Rectovesical Pouch in Male Vesicouterine Pouch in Female Vas Deferens and Seminal Vesicle
NECK	Prostate Gland in Male Pelvic Fascia in Female
SUPERIOR SURFACE	Peritoneal Cavity Coils of Ileum, Sigmoid Colon Uterine Cervix in Female
INFEROLATERAL SURFACE	Retropubic Space Puboprostatic Ligament Obturator Internus Levator Ani Muscle

LIGAMENTS

Two types - true and false ligament

<u>TRUE LIGAMENT (9)</u>	<u>FALSE LIGAMENT (7)</u>
CONDENSATION OF PELVIC FASCIA	FORMED BY PERITONEAL FOLD
1. Lateral ligament 2. Puboprostatic ligament 3. Median umbilical ligament 4. Posterior ligament	1. Median umbilical fold 2. Medial umbilical fold 3. Lateral false ligament 4. Posterior false ligament



FIXATION OF BLADDER

1. At neck, where its continuity with prostate and urethra
2. Fixation by ligament

INTERIOR OF BLADDER

- In an empty bladder - greater part of mucosa shows rugae.
- Trigone of bladder - triangular area formed by opening of trigone (superior) and urethra (inferior)

FEATURES OF TRIGONE

- A. ANTEROINFERIOR ANGLE - formed by internal orifice of urethra.
- B. TWO POSTERIOR ANGLE - formed by opening the ureter.
- C. UVULA VESICAE - elevation in mucous membrane lies in internal ureteric orifices, produced by the median lobe of prostate.
- D. INTERURETERIC RIDGE - forms superior boundary of trigone and connect two ureteric orifices, produced by continuation into bladder wall of inner longitudinal coat of ureter, lateral end of ridge - ureteric fold.
- E. TWO URETERO-URETHRAL RIDGE - extend from ureteric orifice to urethral orifice.

BLOOD SUPPLY, NERVE SUPPLY, LYMPHATIC DRAINAGE

<u>ARTERIAL SUPPLY</u>	<u>VENOUS SUPPLY</u>
1. Superior vesical artery 2. Inferior vesical artery (male) or Uterine and vaginal artery (female)	1. Vesical venous plexus (inferolateral surface)

<u>NERVE</u>	<u>ITS SUPPLIES</u>
Parasympathetic efferent fibres (S2 to S4) or nervi erigentes	Motor to detrusor muscle
Sympathetic efferent -T11 -L2	Motor to periprostatic sphincter
Somatic pudendal nerve	Sphincter urethra
Sensory nerve	Pain sensation

<u>LYMPHATICS</u>	Mostly drain into external iliac node Few drains into internal iliac node, lateral aortic node
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HISTOLOGY

- A. **BLADDER WALL** compose of mucous membrane, muscular coat adventitia.
- B. **MUCOUS MEMBRANE** - consist of transitional epithelium, trigone, many fold
- C. **MUSCULAR COAT**
 1. Constitutes detrusor muscle
 2. Outer and inner longitudinal layer
 3. Middle circular layer
- D. **ADVENTITIA** - fibroelastic fibres

DEVELOPMENT

- Bladder develop from upper part of urogenital sinus
- Apex develop from proximal part of allantoic diverticulum
- Mucous membrane of trigone from mesoderm of mesonephric duct
- Mucous membrane remain from endoderm of vesicourethral part of cloaca.
- Muscle and serous coat from splanchnic layer of lateral plate of mesoderm.

APPLIED

1. **CYSTOSCOPE** - for examination
2. **SUPRAPUBIC CYSTOSTOMY** - treatment for drainage purpose
3. **NEUROGENIC BLADDER** - defect in neural mechanism result loss of neural control of micturition such as atonic bladder,
4. **CONGENITAL ANOMALIES** - defective obliteration of urachus
5. Urachus fistula, urachal cyst, urachus sinus

3. MALE URETHRA

INTRODUCTION:

- 18-20 cm
- Extends from internal urethral orifice in bladder to the external meatus at the end of the penis

PARTS OF URETHRA:

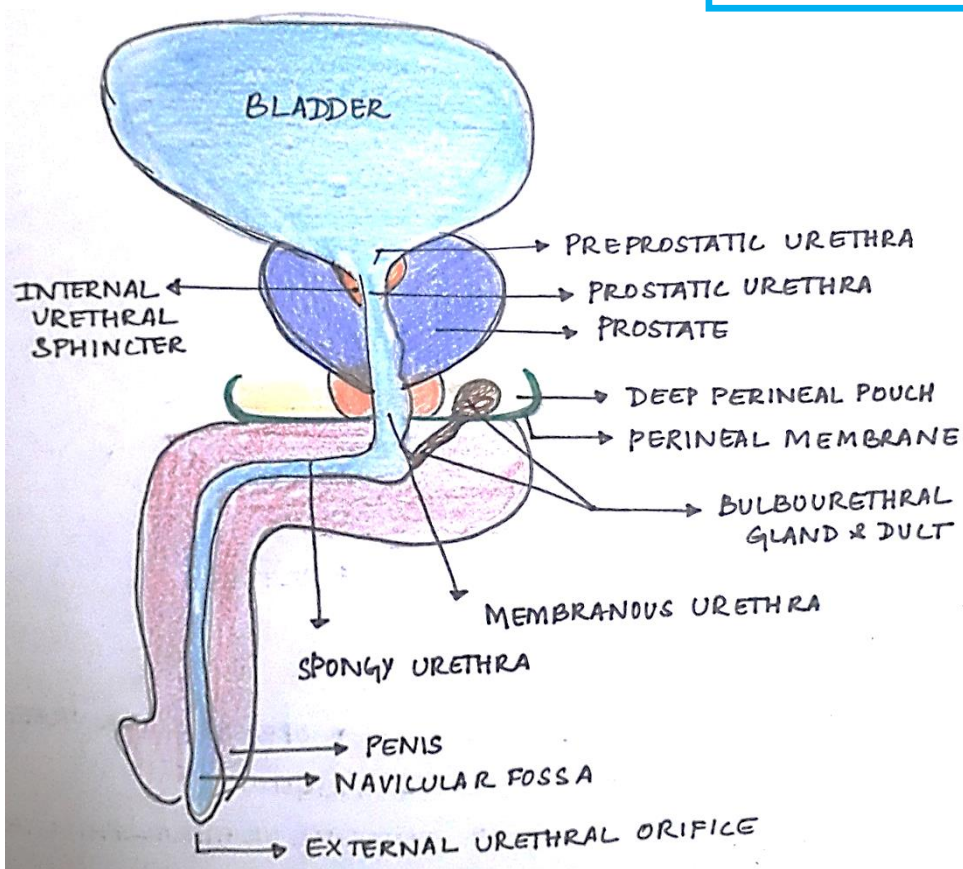


ANTERIOR:

- 16cm long
- Lies within perineum proximally and pelvis distally
- Surrounded by corpus spongiosum

POSTERIOR:

- 4 cm long
- Lies in pelvis proximal to corpus spongiosum
- Acted upon by urogenital spincter mechanism



ANTERIOR URETHRA

A. BULBAR URETHRA

- Surrounded by bulbospongiosus
- Wide part of urethra
- Contains openings of bulbourethral glands

B. PENILE URETHRA

- Narrow, slit like
- Diameter of 6mm
- It is dilated at its termination within the glans penis and dilation is called navicular fossa
- Epithelium presents orifice of numerous small glands and follicles situated in the submucous tissue called the urethral glands.
- Also contains a no of small pit like recess or lacuna. Largest is present in the roof of navicular fossa.

POSTERIOR URETHRA

PREPROSTATIC PART:

- 1-1.5 cm
- From bladder neck to verumontanum.
- Surrounded by proximal urethral sphincter
- Contraction of pre-prostatic urethra serves to prevent retrograde flow of ejaculate through proximal urethra in to bladder

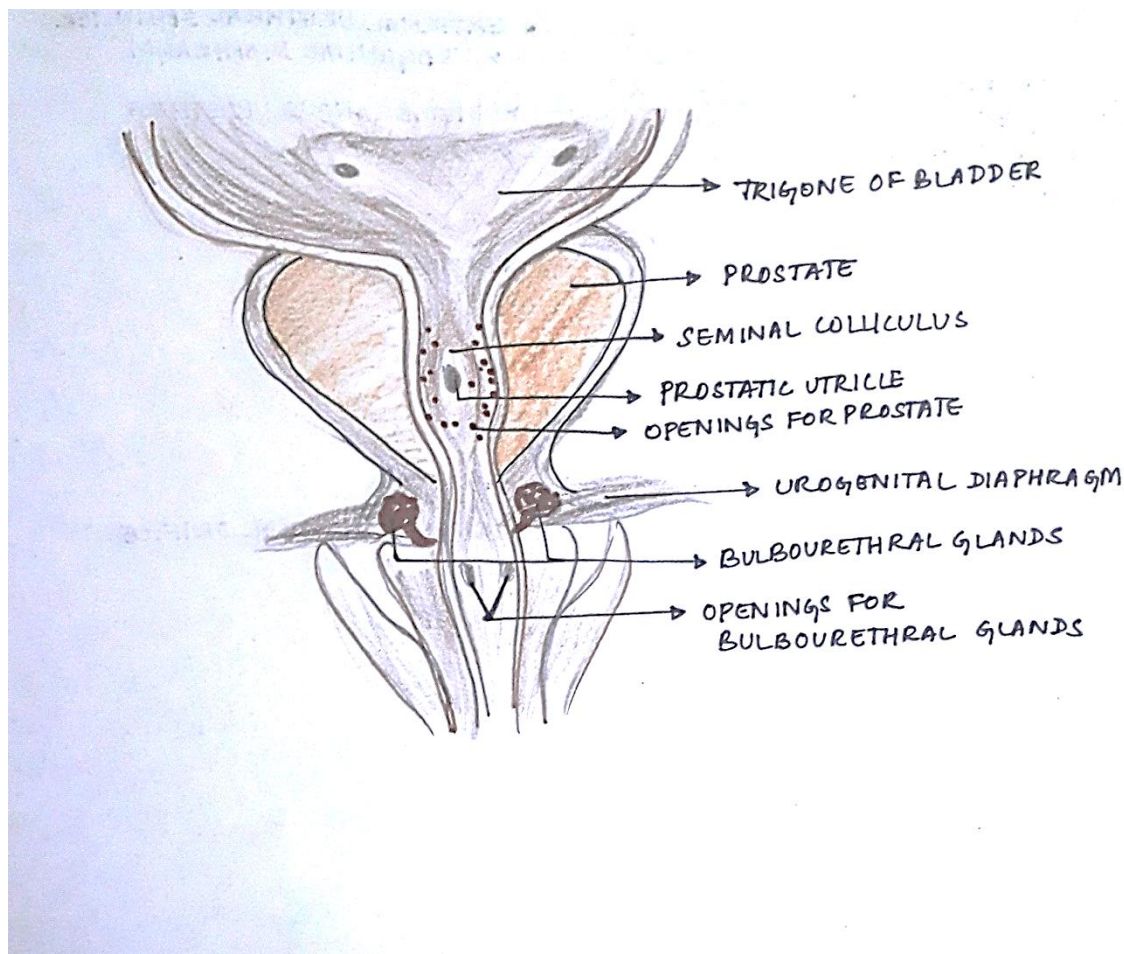
PROSTATIC PART:

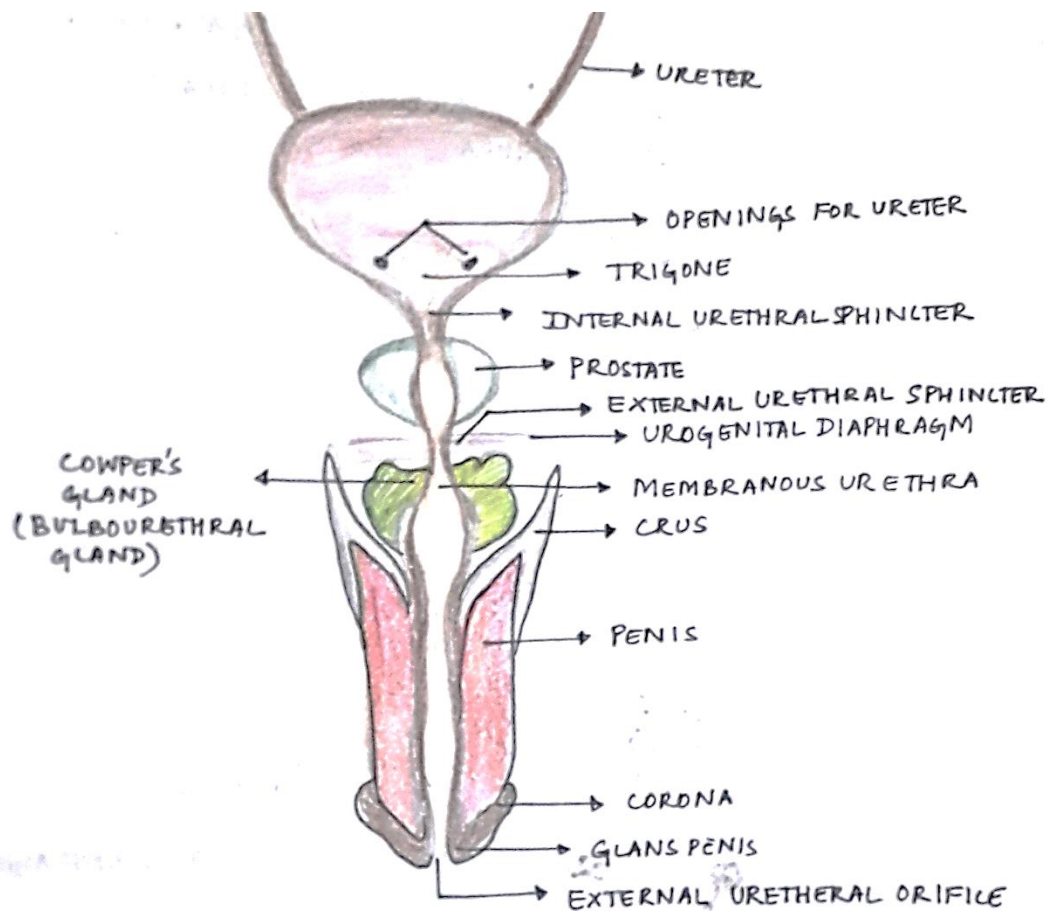
- 3-4 cm
- Tunnels through the substance of prostate closer to anterior than the posterior surface of gland
- Throughout its length, the posterior wall has a midline ridge called urethral crest.
- On each side, there is shallow depression called prostatic sinus

- There is an elevation called verumontanum. It contains slit like orifice of prostatic utricle.
- On both sides of or just within this orifice are the two small openings of the ejaculatory duct.

MEMBRANOUS PART:

- 1.5 cm
- Shortest, least dilatable
- Wall of membranous urethra, i.e., part of external or distal urethral sphincter mechanism.
- Its muscle coat is separated from epithelium by narrow layer of fibroelastic connective tissue.
- Muscle coat consists of relatively thin layer of bundles of smooth muscle, which are continuous proximally with those of prostatic urethra and a prominent outer layer of the circularly oriented striated muscle fibres which form external urethral sphincter.





ARTERIES:

- Urethral artery
- Dorsal penile artery via circumflex branches

VENOUS DRAINAGE:

- **ANTERIOR URETHRA** → dorsal vein of penis → internal pudendal vein → Prostatic venous plexus → internal iliac veins
- **POSTERIOR URETHRA** → prostatic and vesical venous plexus → internal iliac veins

LYMPHATICS:

- **POSTERIOR URETHRA** → internal iliac
- **ANTERIOR URETHRA** → accompany that of glans → deep inguinal

NERVE SUPPLY

- Prostatic plexus supplies smooth muscle of prostate and prostatic urethra.
- Greater cavernous nerves are sympathetic to preprostatic sphincter
- Parasympathetic nerves are from 2nd to 4th sacral segments.
- rhabdospincter is supplied by neurons in Onuf's nucleus situated in 2nd sacral segment; fibres pass via perineal branch of pudendal nerve

CLINICALS:

- A. **TRAUMATIC URETHRA** injured by fall astride or straddle results in injury to penile urethra in the perineum.
- B. **EXTRAVASION OF URINE IS PREVENTED BY:**
 - Post by perineal membrane
 - Laterally by ischiopubic rami
 - Above by lesser pelvis by intact perineal membrane

4. UTERUS

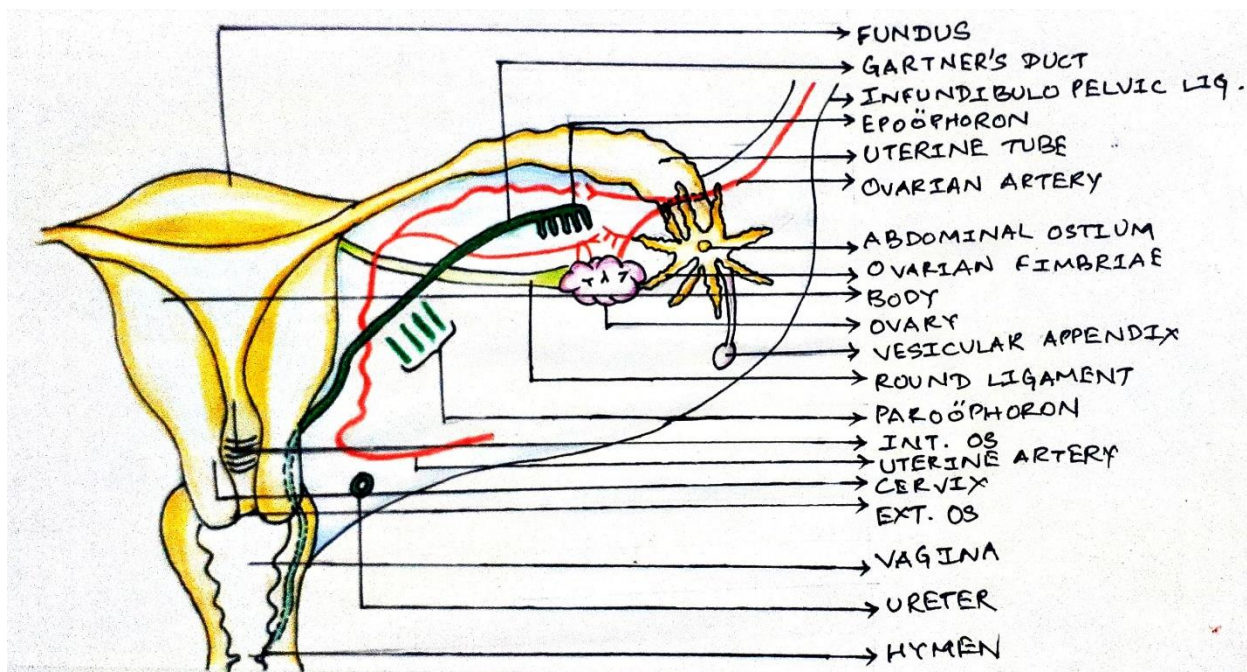
INTRODUCTION: It is the child bearing organ in females, situated in pelvis between Bladder and rectum. It is also called hystera and womb in layman's language.

MEASUREMENTS: -

- **SHAPE** - pyriform.
- **LENGTH** - 7.5cm.
- **BREATH** - 5cm.
- **THICKNESS** - 2.5cm
- **WEIGHT** - 30 to 40 grams.

POSITION

situated in the pelvis between bladder and rectum.



EXTERNAL FEATURES

- **UPPER** expanded part called body.
- **CERVIX** – lower cylindrical part.
- **ISTHMUS** – circular constriction at the junction of the body and cervix.
- **CORNUA** – superolateral angle of the body of uterus. The uterine tube, ligaments of ovary and broad ligaments are attached to it on each side.

PARTS:

FUNDUS

- Free upper end of uterus.
- Lies Above the openings of the Uterine tubes.
- It is convex like a dome.

BODY WITH TWO SURFACES

- Anterior or vesical surface –
 - It is flat.
- Posterior or intestinal surface –
 - It is Convex.

LATERAL BORDER

- rounded and convex.

CERVIX

- Lower cylindrical part of uterus.
- 2.5 cm long.
- Slightly wider in the middle than at Either ends.
 - SUPRA VAGINAL** – upper part of cervix above the vagina.
 - VAGINAL PART** – Lower part of cervix projecting into the vagina.

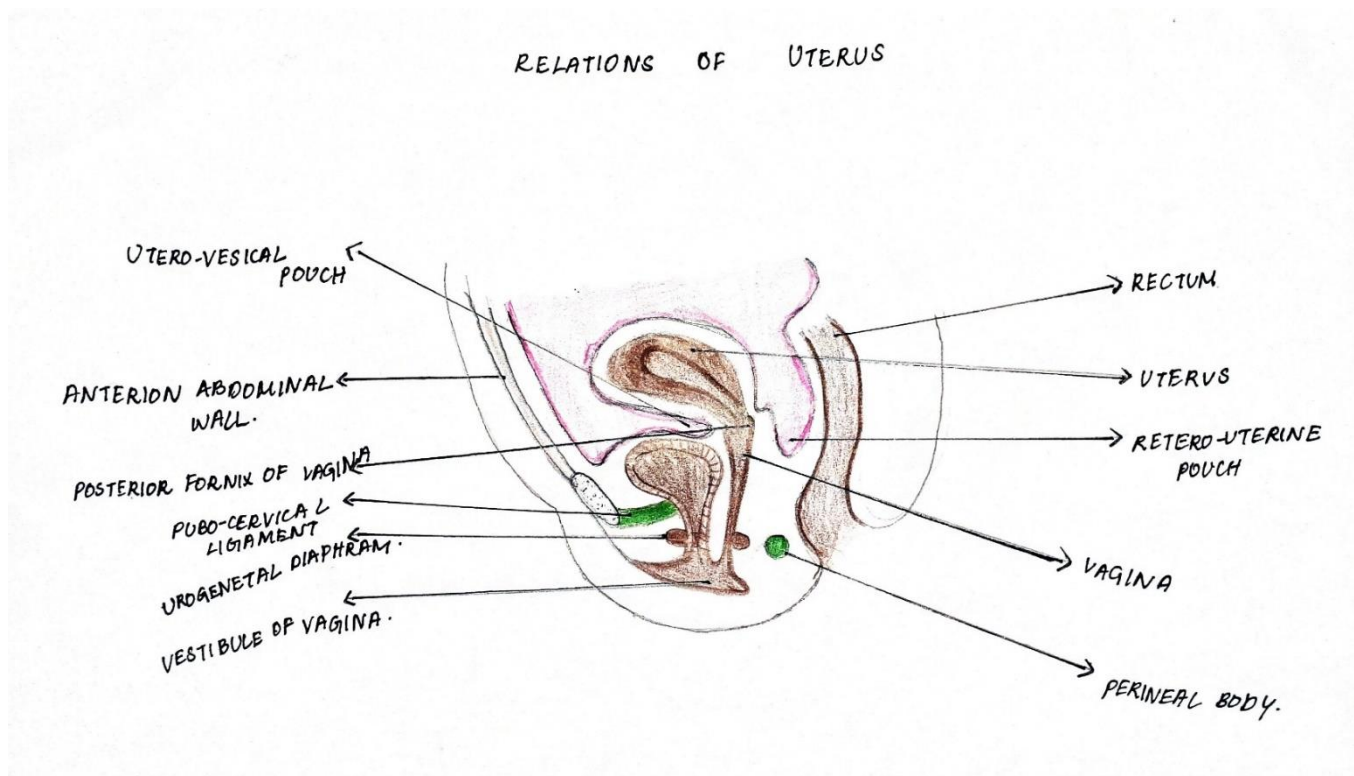
CAVITIES

BODY OF UTERUS:

1. **SAGITTAL SECTION:** - it is a mere slit because the uterus is compressed anteroposteriorly.
2. **CORONAL SECTION:** triangular in shape. Apex directed downwards.

CERVICAL CANAL:

- Fusiform in shape
- Canal is flattened before backwards.
- It shows mucosal folds like branches of tree called the arbor vitae uteri.



RELATIONS

FUNDUS

- It is covered by peritoneum.
- Directed forwards when the bladder is empty.

BODY

A. ANTERIOR OR VESICAL SURFACE OF BODY

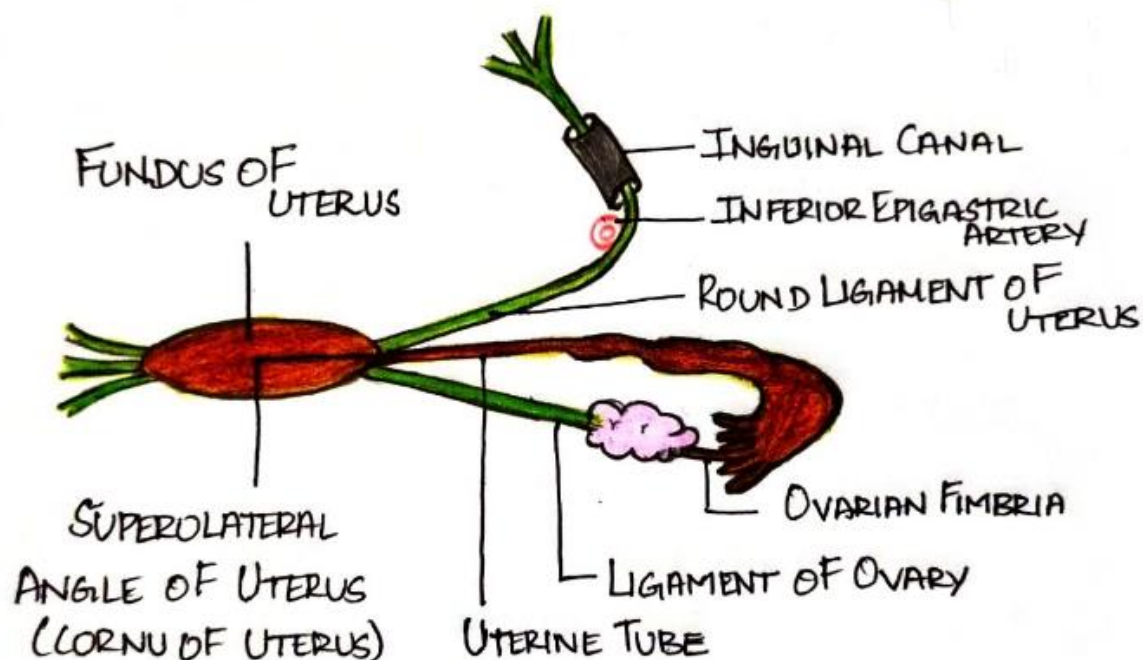
- Anteriorly – urinary bladder.
- Covered by peritoneum and forms the posterior wall or superior wall of the uterovesical pouch.

B. POSTERIOR OR INTESTINAL SURFACE

- Posteriorly – coils of the terminal ileum and sigmoid colon.
- Covered with peritoneum and forms anterior wall of rectouterine pouch.

C. LATERAL BORDER

- Attachment to broad ligament of uterus.
- Upper end has the opening of uterine tube –
 1. Anteroinferiorly – round ligament of uterus
 2. Posteroinferiorly – ligament of ovary.
- Uterine artery ascends along the later border.



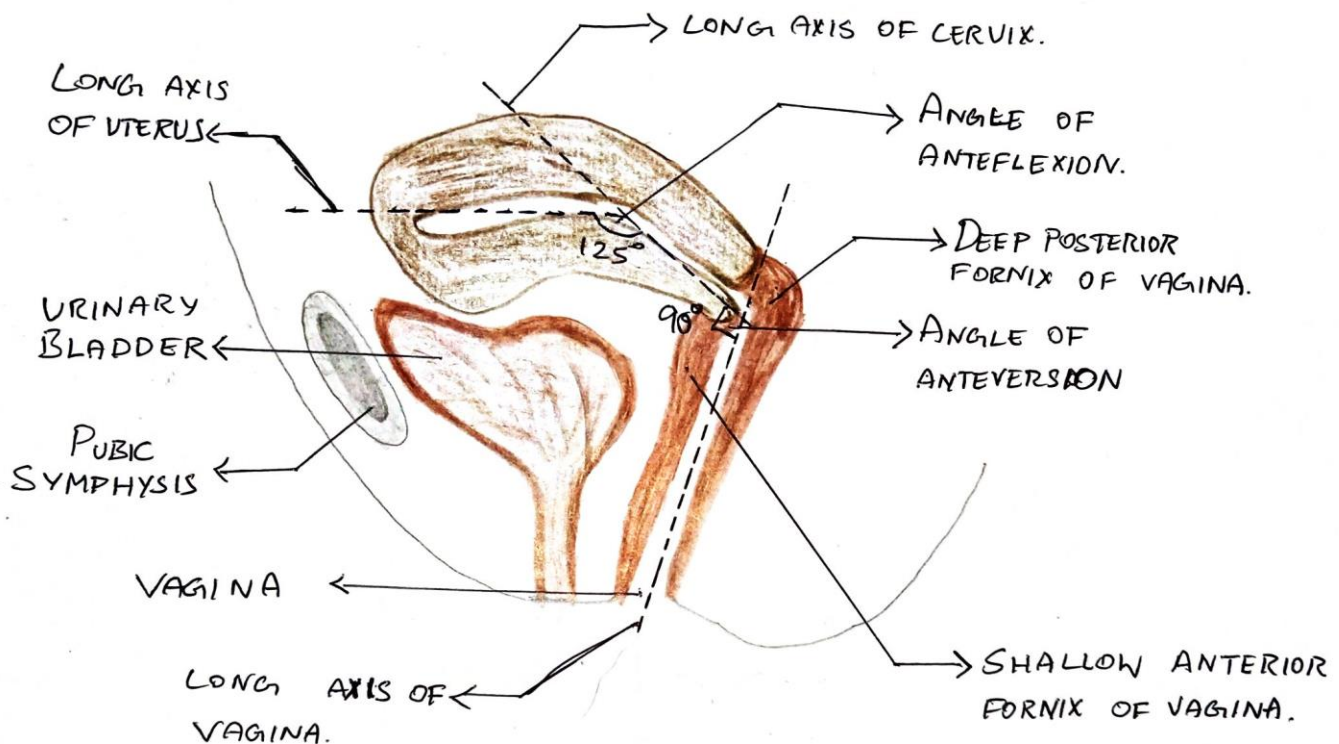
CERVIX

1. SUPRA VAGINAL PART

- Anteriorly – bladder.
- Posteriorly – rectouterine pouch, coils of intestine and rectum.
- On each side – ureter, uterine artery, parametrium.

2. VAGINAL PART

- Projects into the anterior wall of vagina.
- Related to the vaginal fornix – the spaces between it and the vaginal wall.



AXIS

A. ANTEVERSION

- Long axis of uterus forms 90° angle with the long axis of vagina.
- Forward tilting of uterus relative to vagina.

B. RETROVERSION – backward tilting of uterus relative to vagina.

C. ANTEFLEXION

- Slight flexion of the uterus at the level of internal os of cervix.
- Angle of anteflexion is 125°

D. DEXTROROTATION – uterus is normally deviated to right side.

COMMUNICATIONS

- **SUPERIORLY** - on each side with uterine tube.
- **INFERIORLY** - apex of the cavity of body continues with, cervical canal via internal os and cervical canal communicates with vagina via external os.

SUPPORTS OF UTERUS

PRIMARY SUPPORT –

A. MUSCULAR OR ACTIVE SUPPORTS.

1. Pelvic diaphragm - resists any rise in the intra-abdominal pressure.
2. Perineal body - fibromuscular node to which ten muscles are attached.
3. Distal urethral sphincter mechanism. -support the uterus indirectly

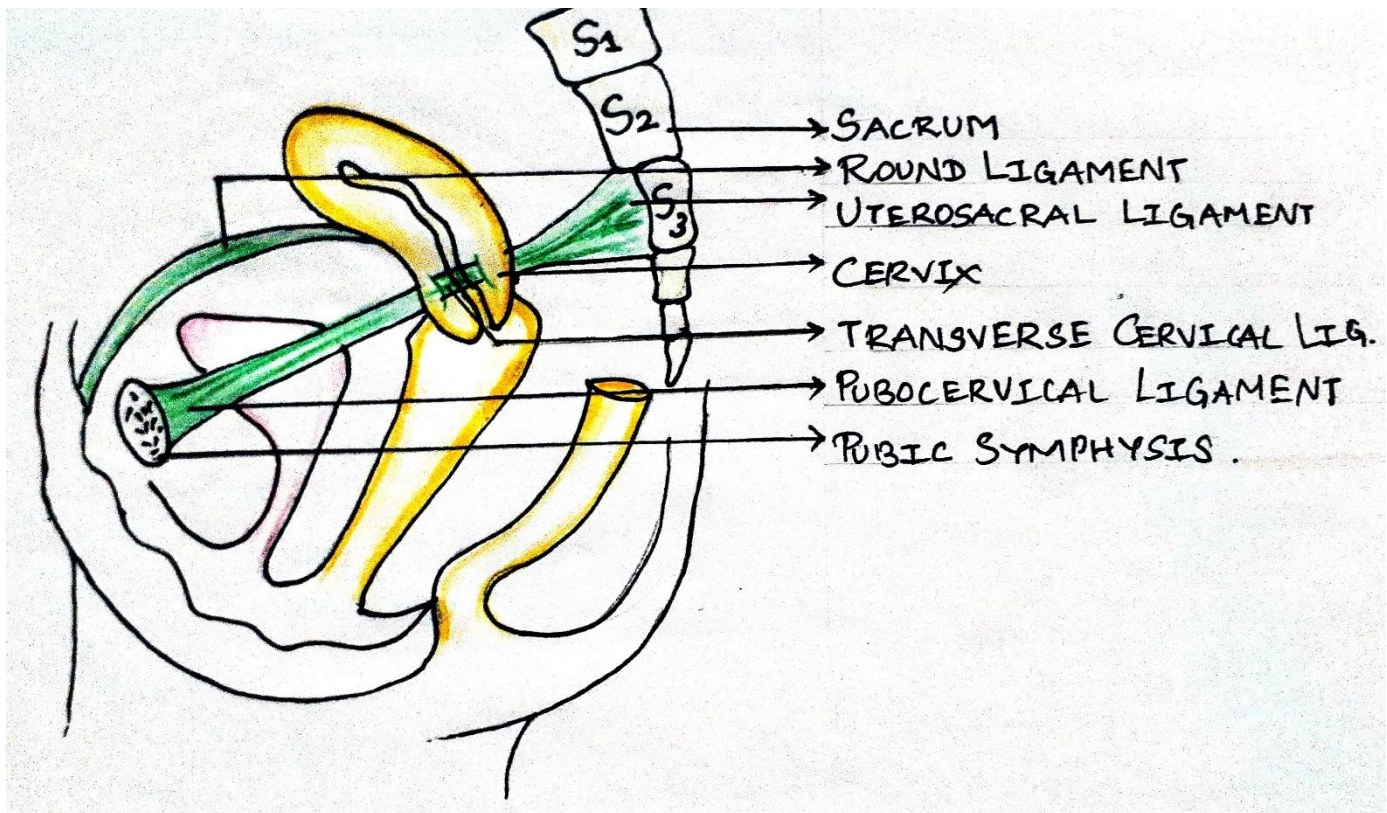
B. FIBROMUSCULAR OR MECHANICAL SUPPORTS.

1. Uterine axis.
2. Pubocervical ligaments
3. Transverse cervical ligament of Mackenrodt
4. Uterosacral ligaments - pulls cervix backwards.
5. Round ligament of uterus- maintains the angle of anteversion.

SECONDARY SUPPORTS –

Peritoneal ligament such as:

1. Broad ligaments.
2. Vesicouterine Pouch.
3. Rectovaginal pouch.



LIGAMENTS OF UTERUS

PERITONEAL LIGAMENTS – (peritoneal folds)

1. ANTERIOR LIGAMENT – uterovesical Pouch.
2. POSTERIOR LIGAMENT – rectovaginal pouch
3. BROAD LIGAMENTS ON EACH SIDE – Attaches the uterus to the lateral Pelvic wall

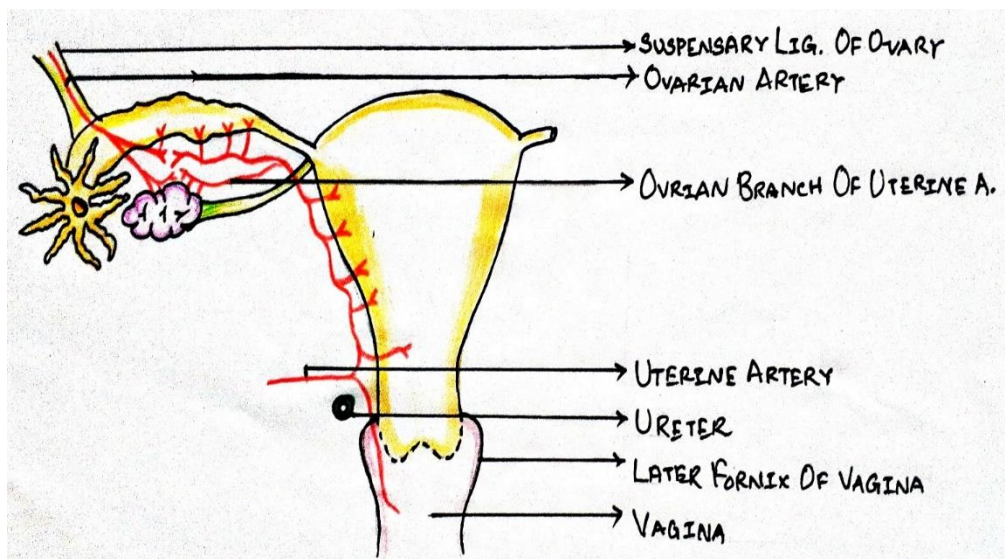
FIBROMUSCULAR LIGAMENTS –

1. ROUND LIGAMENT UTERUS – Fibromuscular flat bands, begins from Lateral angle of uterus passes forwards and laterally and traverses inguinal canal and merges with the areolar tissue of labium majus.
2. TRANSVERSE CERVICAL LIGAMENT – fan-shaped condensations of the endopelvic fascia. They connect lateral aspect of cervix and upper vaginal wall to lateral pelvic wall.
3. UTEROSACRAL LIGAMENT – condensation of endopelvic fascia. They connect cervix to the periosteum of the sacrum.

BLOOD SUPPLY

ARTERIAL SUPPLY:

- Chiefly by two uterine arteries.
 1. Branch of anterior division of internal iliac artery.
 2. Markedly enlarge during pregnancy.
 3. Has a tortuous course which allows expansion of uterus during pregnancy without stretching of artery.
- Partly by ovarian arteries.



VENOUS DRAINAGE:

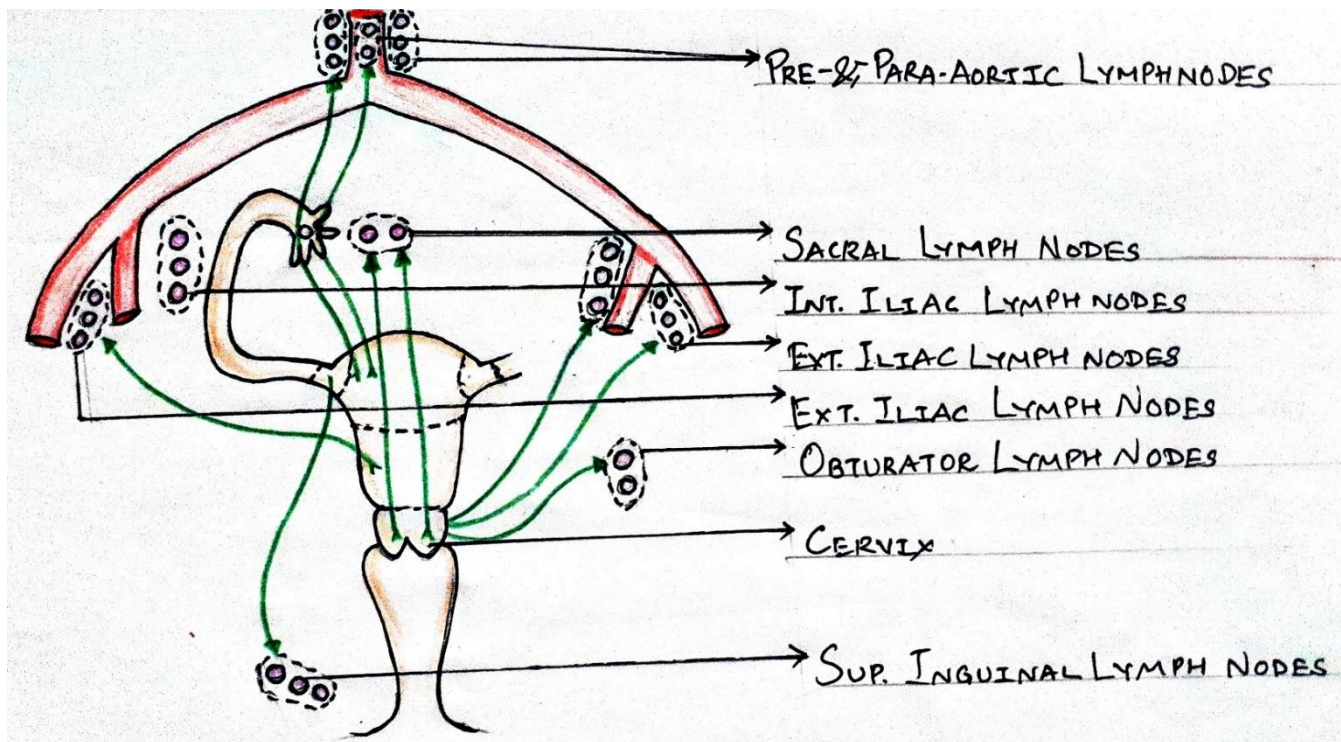
- Venous plexus along the lateral border of uterus.
- It drains via uterine, ovarian and vaginal veins into internal iliac veins.

LYMPHATIC DRAINAGE

- Endometrial, myometrial and sub-peritoneal lymphatic plexus drain into the lymphatic on the side of uterus.
 1. **UPPER LYMPHATIC** from fundus – aortic nodes and partly superficial inguinal nodes.
 2. **MIDDLE LYMPHATICS** – external iliac nodes.
 3. **LOWER LYMPHATICS** – internal iliac nodes and sacral nodes.

DEVELOPMENT

- Epithelium of uterus – fused paramesonephric duct.
- Myometrium – surrounding mesoderm.



MICROSCOPIC ANATOMY

Three layers:

- **ENDOMETRIUM** – inner mucous membrane undergoes cyclic changes.
- **MYOMETRIUM** – thickest layer made of outer and inner longitudinal and middle thick circular muscle coat with lots of arterioles.
- **OUTER COVERING** – serous lining of peritoneum.

APPLIED ASPECTS

- INTRAUTERINE CONTRACEPTIVE DEVICE – it is used to prevent implantation of fertilized oocyte.
- Uterus is the common site of formation of fibroid.
- CERVICAL CARCINOMA – most common cancer in females (11%).
- Fundus and upper part of uterus is the common site of implantation.

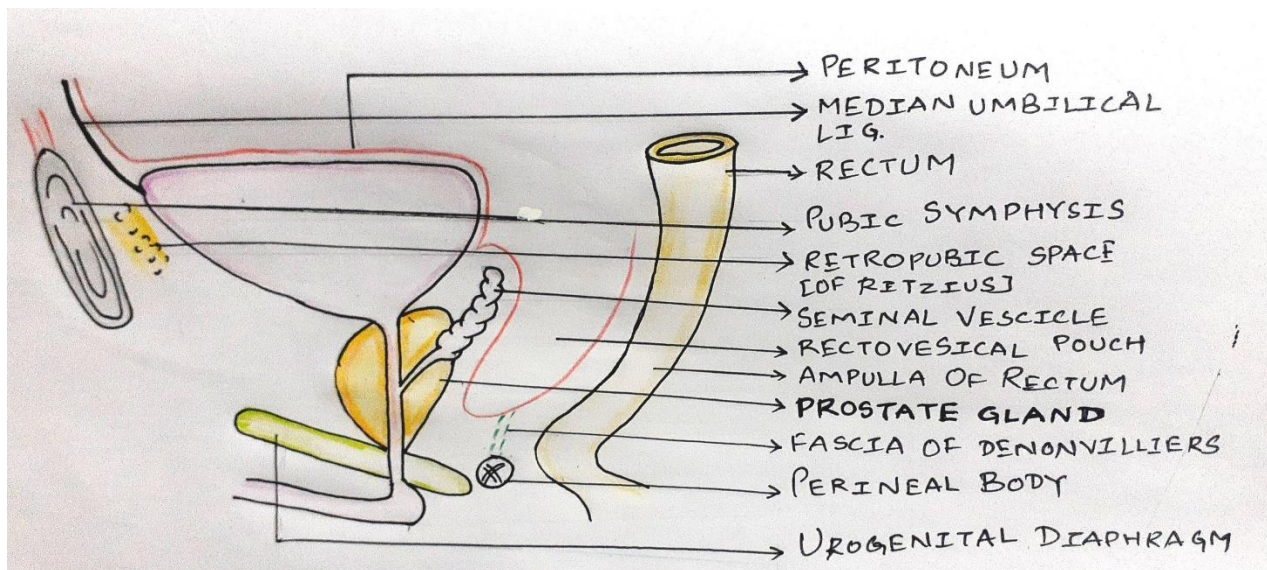
5. PROSTATE

INTRODUCTION:

- It is an accessory gland of male reproductive system
- Secretions add bulk to seminal fluid
- It's is firm due to dense fibromuscular stroma
- In female it is represented by paraurethral glands of Skene

SITUATION:

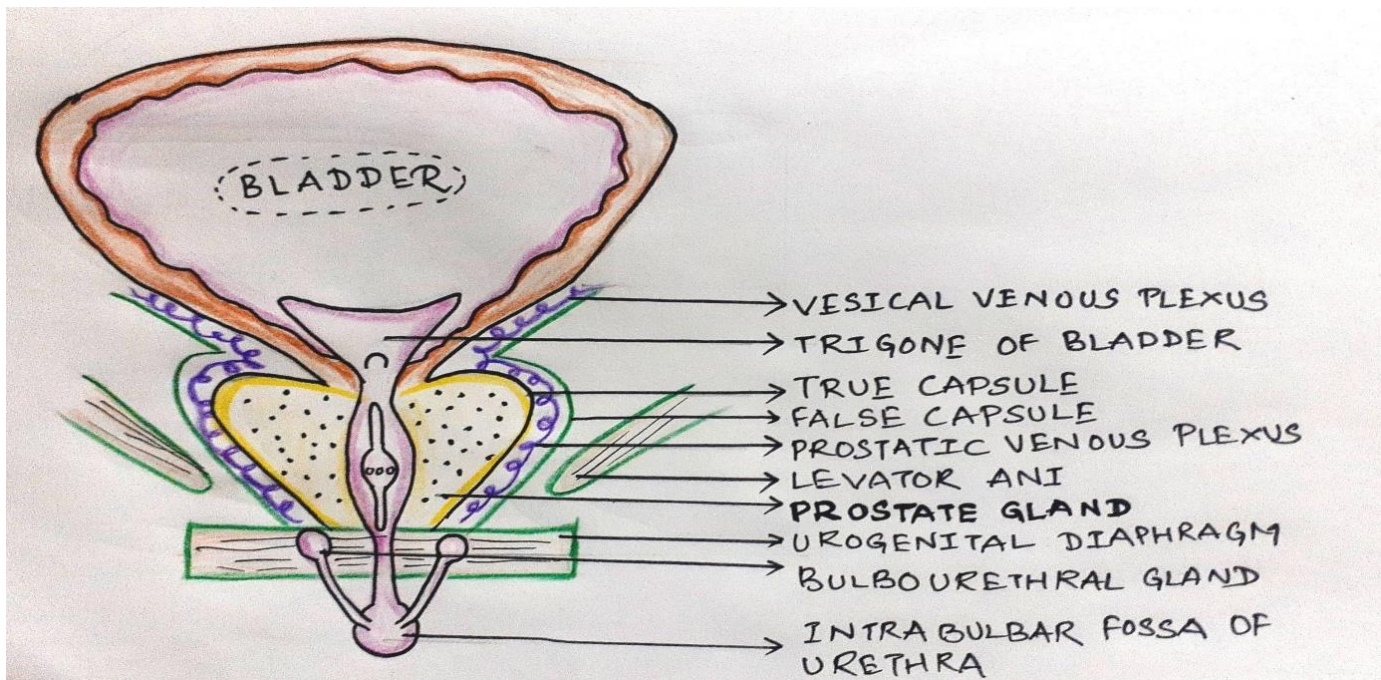
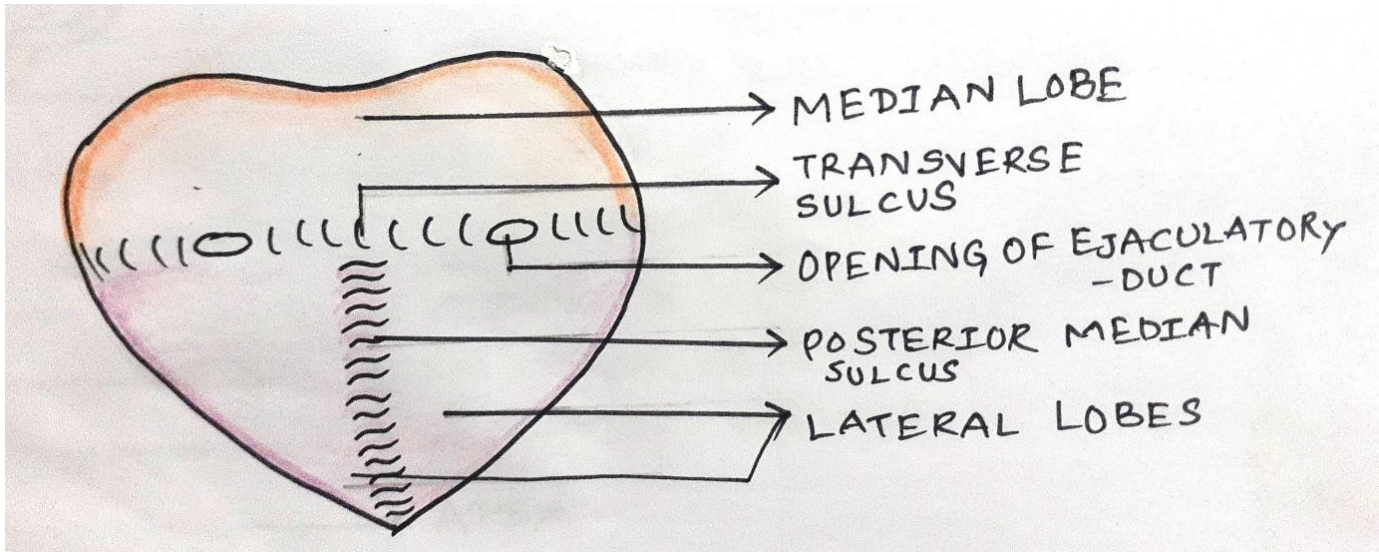
- Lies in the lesser pelvis, below the neck of urinary bladder, behind downwards the lower part of public symphysis and upper part of public arch.
- It lies in front of ampulla of rectum



EXTERNAL FEATURES:

- **SHAPE:** inverted cone

- **SIZE:** 4cm (transverse width at base), 3cm vertical length, 2cm AP thickness
- **WEIGHT:** 8 g
- **GROSS FEATURE:** apex directed downwards, a base, four surfaces - ant., post. & two inferolateral



RELATIONS

APEX:

- Directed downwards surrounds the junction of prostatic and membranous parts of posterior urethra
- Separated from anal canal by perineal body

BASE:

- Directed upwards, and is structurally continuous with the neck of the bladder.
- The junction is marked by a circular groove which lodges venules of the vesical and prostatic plexuses

SURFACES:

1. ANTERIOR SURFACE

- It is narrow and convex from side to side
- It lies 2cm behind the public symphysis with retropubic fat intervening
- Its upper part is connected to the public bones y puboprostatic ligaments
- The lower end of this surface is pierced by the urethra
- Lower end of urethra emerges from this surface anterosuperior to the apex of the gland
- This surface is composed of fibrous tissue

2. POSTERIOR SURFACE

- It is triangular-shaped.
- Flattened from side to side and convex from above downwards
- It is separated from the rectum by the fascia if Denon Villiers which is obliterated rectovesical pouch of peritoneum
- Near its upper border it is pierced on each side of median plane by ejaculatory duct.
- This surface lies 4cm from the anus, can be easily palpated on digital examination through rectum

3. **INFEROLATERAL SURFACES:**

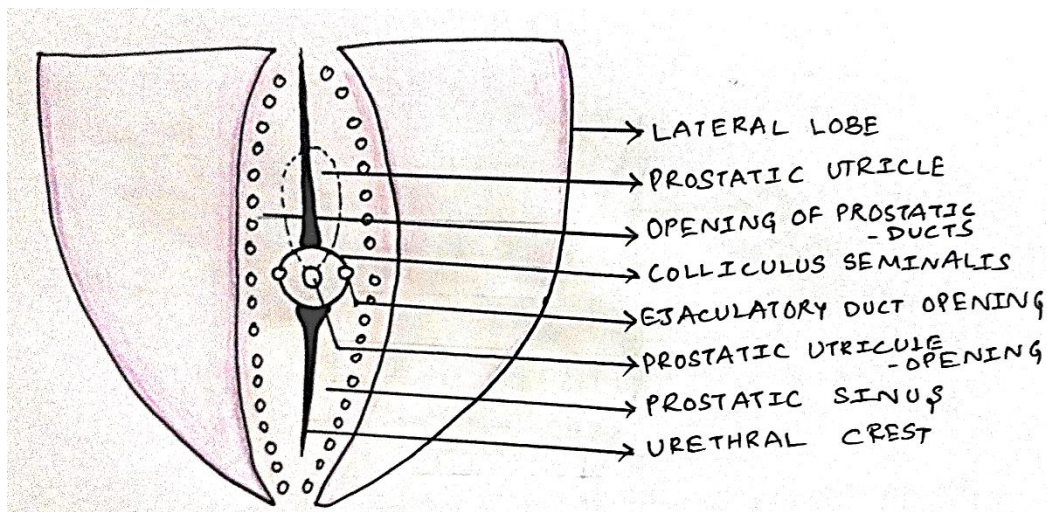
- Related to side walls of pelvis.
- Anterior fibres of levator ani enclose the gland in pubourethral sling.
- They are separated from the muscle by a plexus of veins embedded in its sheath

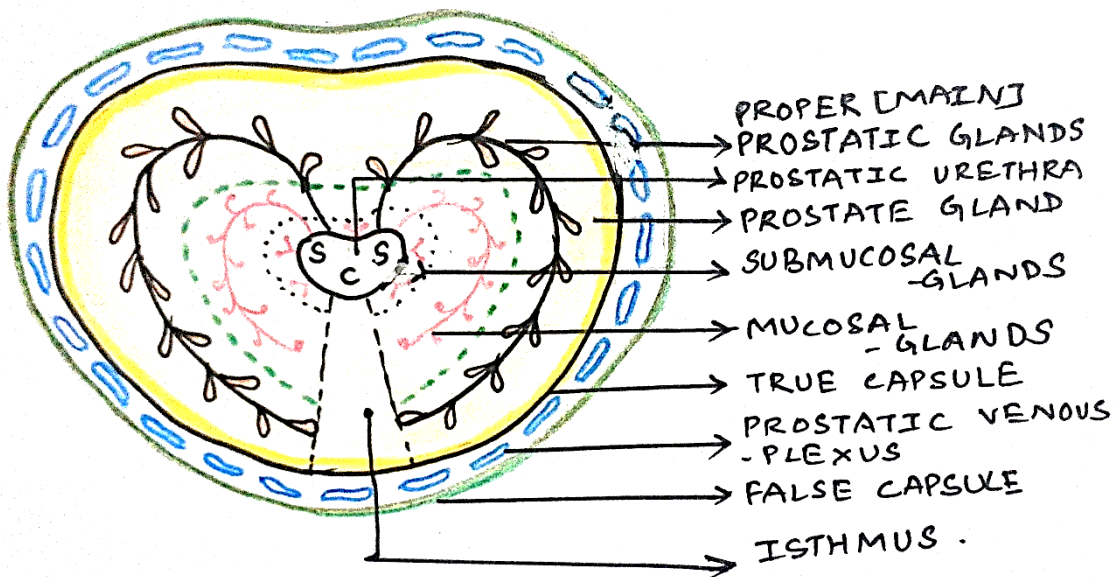
SURGICAL SIGNIFICANCE

- **PERIPHERAL ZONE** has 70% of glandular tissue, it is situated posteriorly and is cancer vulnerable
- **CENTRAL ZONE** constitutes 25% of glandular tissue situated posterior to urethral lumen and above the ejaculatory ducts, the two zones are like an egg in its egg cup. The central zone is not involved in disease and is of wolffian duct origin
- There is a **PERI-URETHRAL TRANSITION ZONE** around five percent where benign prostatic hyperplasia arises, the central zone and transition zone constitutes 'the central gland'

LOBES:

- It was earlier described to be of 5 lobes
- Those were anterior, posterior, median and two laterals
- As of now glandular tissue is divided into three lobes namely: two lateral and one median.





STRUCTURAL ZONES OF PROSTATE:

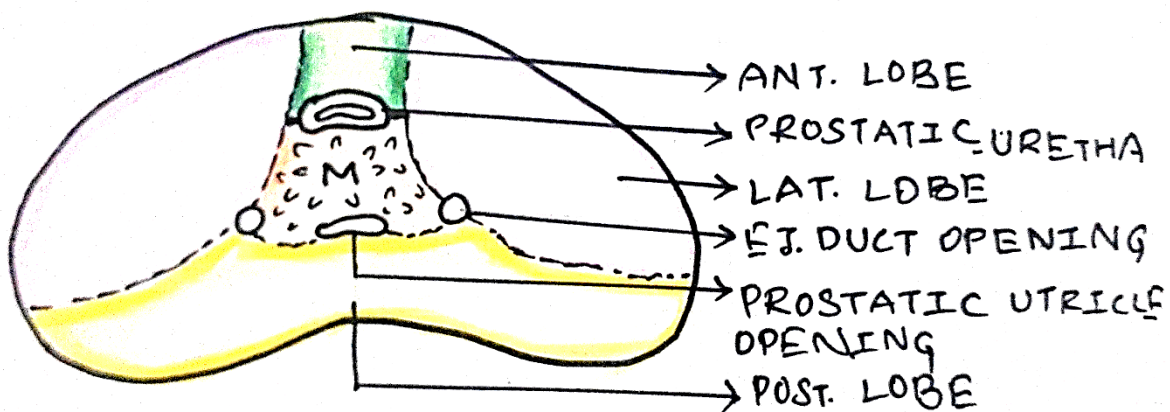
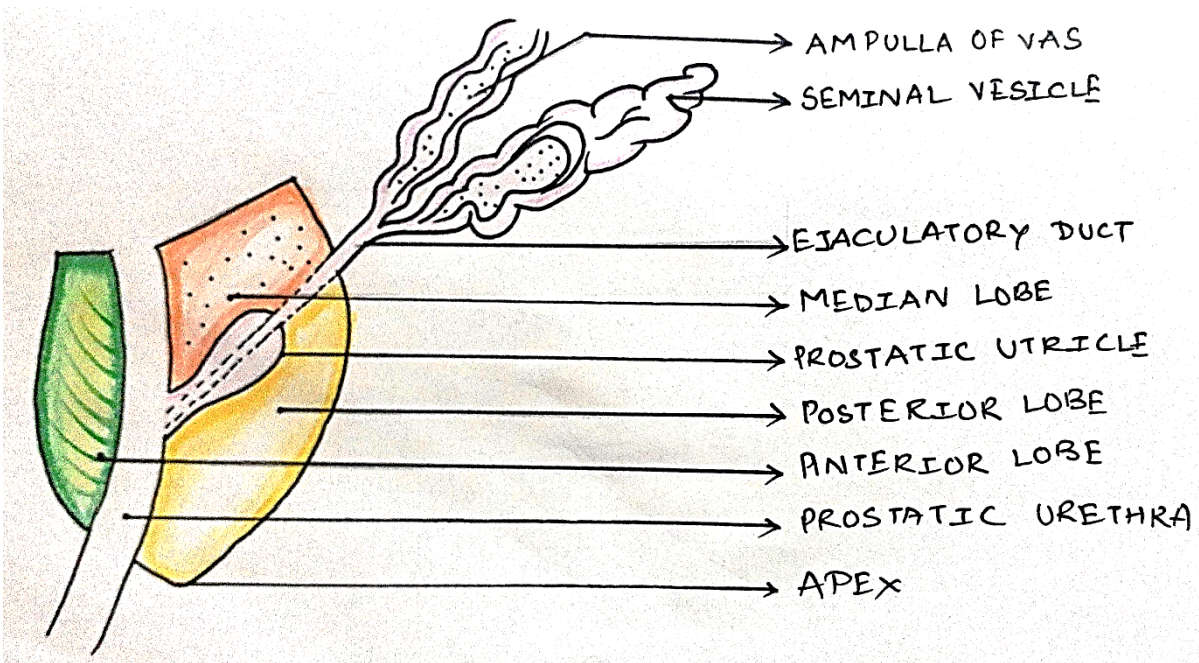
Histologically, prostate do not show lobar pattern but show two well-defined concentric zones with ill-defines capsule (zones are absent anteriorly)

OUTER LARGER ZONE:

- Composed of large branched glands, the ducts of which curve backwards and open mainly into prostatic sinuses.
- This zone is frequently the cite of carcinoma.

INNER SMALLER ZONE:

- Composed of submucosal glands opening in prostatic sinuses, and a group of short, simple mucosal glands surrounding the upper part of urethra.
- These zones are typically prone to benign hypertrophy.



CAPSULES:

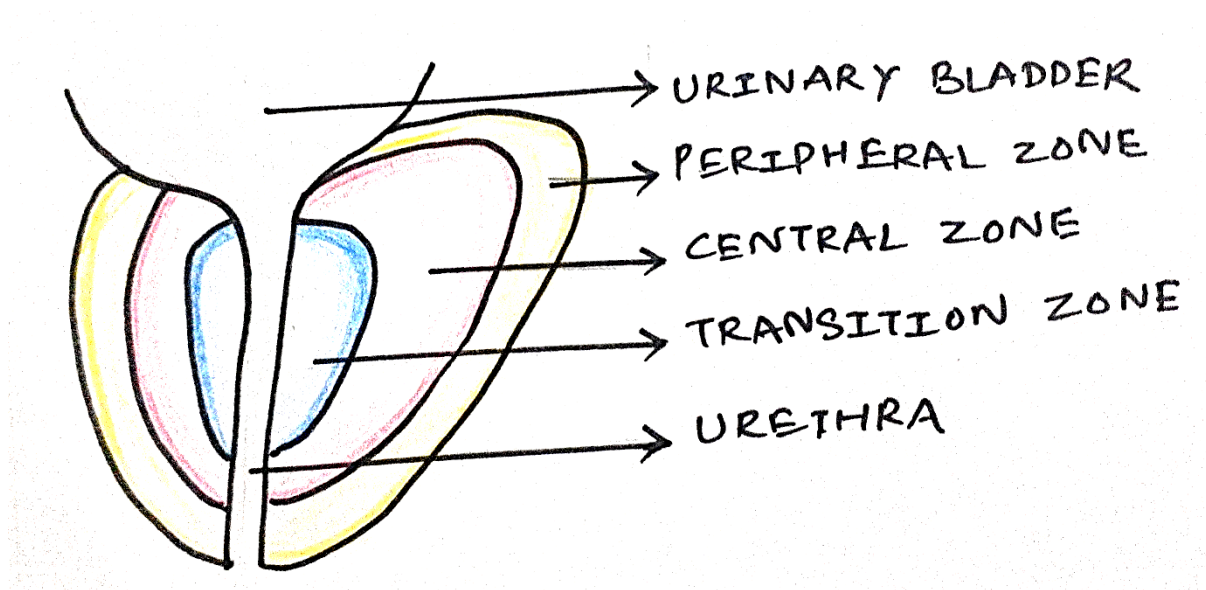
There are two types of capsules in prostate: true and false

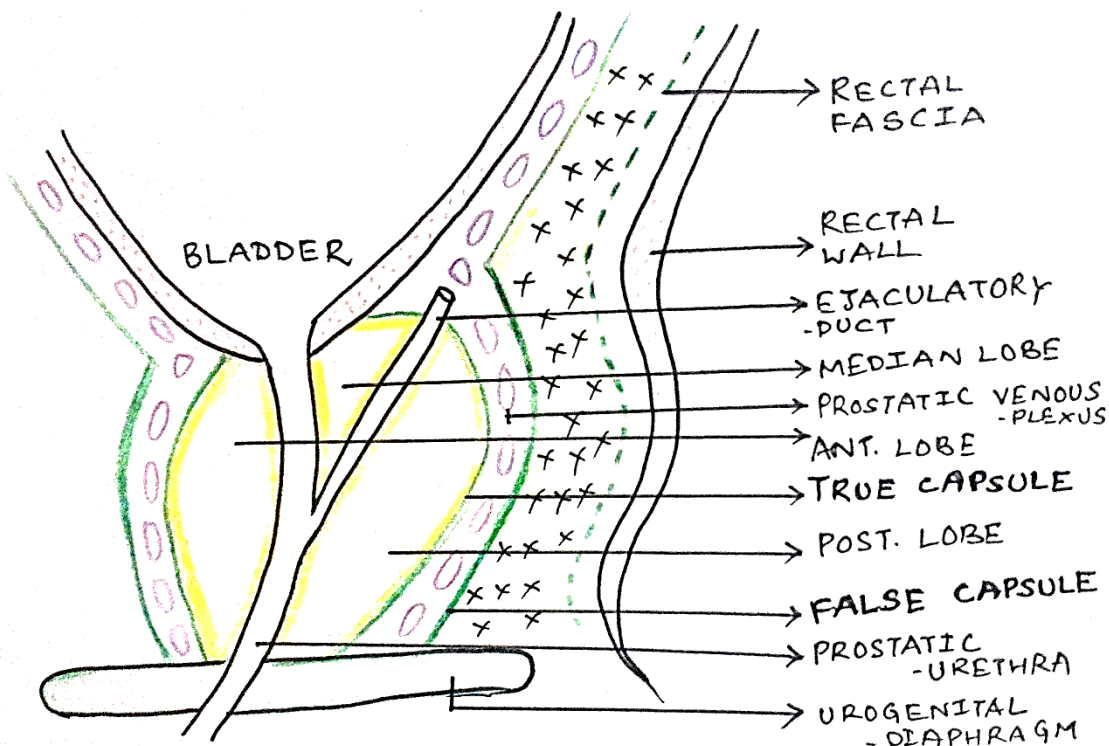
TRUE CAPSULE:

- Condensation of peripheral part of the gland.
- It is fibromuscular in structure and is continuous with stroma of gland.
- The venous plexus lies between true and false capsules.

FALSE CAPSULE:

- Lies outside true capsule.
- Derived from endopelvic fascia.
- Anteriorly, continuous with puboprostatic ligament
- On each side, the prostatic venous plexus embedded in between false and true capsules
- Posteriorly it is avascular and is formed by rectovesical fascia of Denonvilliers.
- A pair of medial puboprostatic ligament extend from false capsule to back of public bone
- The medial pair lies near the apex while lateral pair is close to the base.
- These four ligaments support the gland





BLOOD SUPPLY

ARTERIAL SUPPLY:

- Supplied by branches from inferior vesical, middle and internal pudendal arteries.
- Branches of these arteries form a large outer or subscapular plexus, and a small inner or periurethral plexus.
- The greater part of the gland is supplied by subscapular plexus.

VENOUS DRAINAGE:

- Veins form a rich supply around sides and base of gland.
- The plexus communicates with the vesical plexus and with internal pudendal vein, and drains into the vesical and internal iliac veins.
- Valveless communication exist between the prostatic and vertebral venous plexuses through which prostatic carcinoma can spread to the vertebral column and to the skull

APPLIED ANATOMY:

SENILE ENLARGEMENT OF PROSTATE:

- After 50 years of age, prostate is often enlarged due to benign hypertrophy or due to formation of an adenoma
- This causes retention of urine due to distortion of urethra
- Enlargement of the median lobe not only projects into bladder, but forms a sort of valve over the internal urethral orifice, so that more patient strains, more it obstructs
- Urine passes when the patient relaxes
- Digital examination of rectum is very helpful in diagnosis of an enlarged prostate
- Removal of such prostate called prostatectomy- relieves urinary obstruction
- During removal the enlarged gland is enucleated leaving behind both the capsules and venous plexus between them
- Prostate can be removed through bladder (transvesical), through prostatic capsule (retropubic), or through perineum and fascia of Denonvilliers (perineal approach) or through urethra (TUR- transurethral resection)

PROSTATITIS

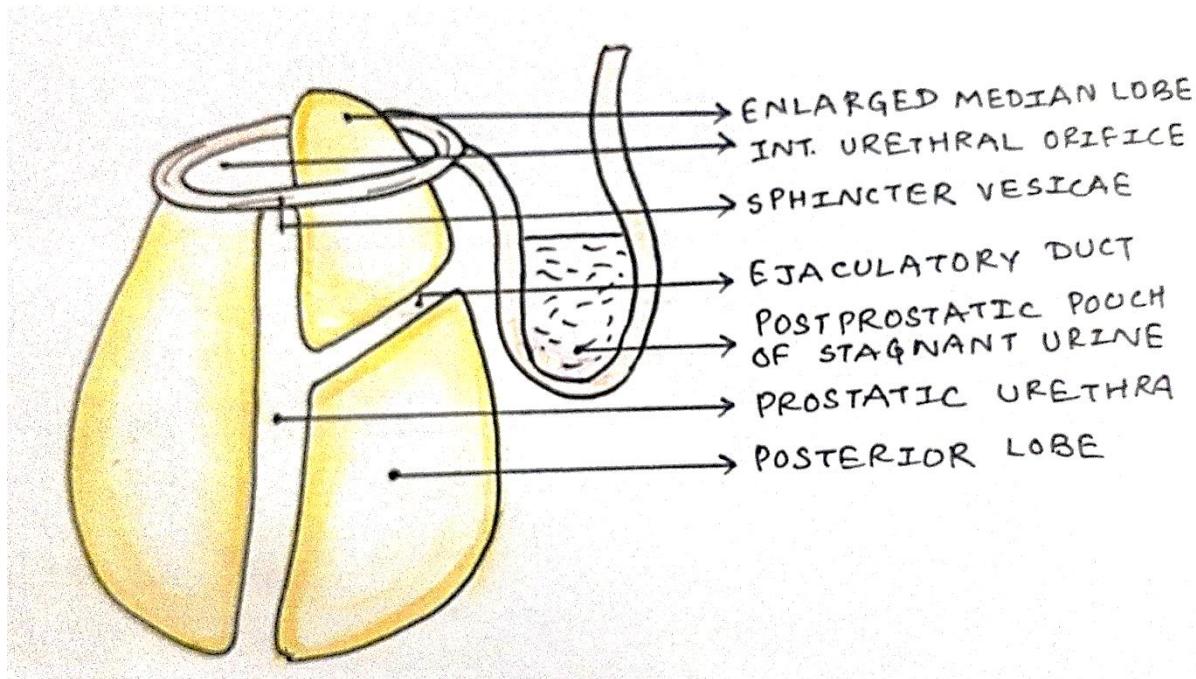
- It is an inflammation of prostate.

ACUTE PROSTATITIS

- It is a secondary to gonococcal urethritis and chronic prostatitis may be secondary to tuberculous infection of epididymis, seminal vesicle and bladder

BENIGN PROSTATIC HYPERPLASIA:

- Occurs in periurethral zone
- Carcinoma of prostate occurs in peripheral zone



CARCINOMA:

- Common site is prostate, and occurs after 50-55 years.
- In addition to urinary obstruction, it causes pain in perineum, low backache or sciatica.
- Rectal examination reveals an irregular hard and fixed prostate.
- Metastatic spread occurs to the vertebral column through the valveless connections between prostatic and vertebral venous plexuses.

AGE CHANGES IN PROSTATE:

AT BIRTH:

- Prostate small in size, and is made up mainly of stroma in which a simple duct system is embedded

- During first 6 weeks after birth, the epithelium of the ducts and of the prostatic utricle undergoes hyperplasia and squamous metaplasia, under the stimulation of maternal estrogens
- Thereafter, upto 9 years changes are negligible, after 9 upto 14 years the duct system becomes more elaborate by formation of side buds, and gland slowly increases in size.

AT PUBERTY:

- Male hormones bring about rapid changes in the gland
- In about a year, it becomes double its prepubertal size due to rapid growth of the follicles and condensation and reduction of the stroma

FROM 20 TO 30 YEARS

- There is a marked proliferation of the glandular elements with infoldings of the glandular epithelium into the lumen of the follicles, making them irregular.

FROM 30 TO 45 YEARS:

- Size of prostate remains constant, and involution starts
- The epithelial infoldings gradually disappear and amyloid bodies increase in number

FROM 45 TO 50 YEARS:

- Either enlarge (benign hypertrophy) or reduce in size (Senile atrophy) or undergo malignant changes

6. RECTUM

INTRODUCTION

- Rectum is the distal part of large intestine between sigmoid colon and anal canal.
- It is devoid of taenia coli, sacculations, appendices epiploicae - the cardinal features of large intestine.
- Rectum's distension initiates desire to defecate.
- Anteroposterior and Lateral Curvatures.

ANTEROPosterior CURVATURES:

- Upper sacral curvature and lower perineal curvature.
- Lower perineal is maintained by puborectal sling.

LATERAL CURVATURES

- Three in number, two convexity to the right and one to the left.
 1. UPPER LATERAL CURVE to the right at the junction of S3, S4 vertebra
 2. MIDDLE LATERAL CURVE to the left at sacrococcygeal junction. It is the most prominent curvature
 3. LOWER LATERAL CURVE to the right at the level of tip of coccyx.

RELATIONS

PERITONEAL RELATIONS:

1. UPPER ONE THIRD, covered with peritoneum on front and sides.
2. MIDDLE ONE-THIRD, covered with peritoneum only on front.
3. LOWER ONE-THIRD, not covered by peritoneum at all.

C) PERITONEAL RELATIONS (CROSS SECTIONS)

a) UPPER 1/3rd



b) MIDDLE 1/3rd



c) LOWER 1/3rd



ANTERIOR RELATIONS:

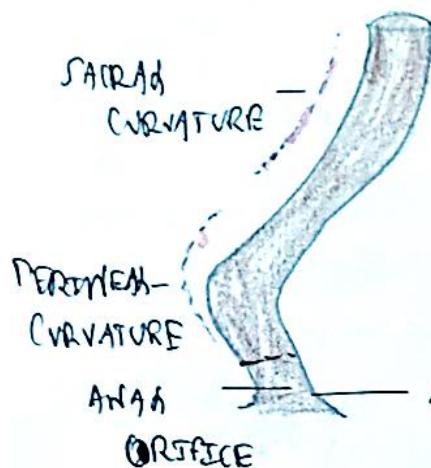
- Differ in male and females

A. MALES:

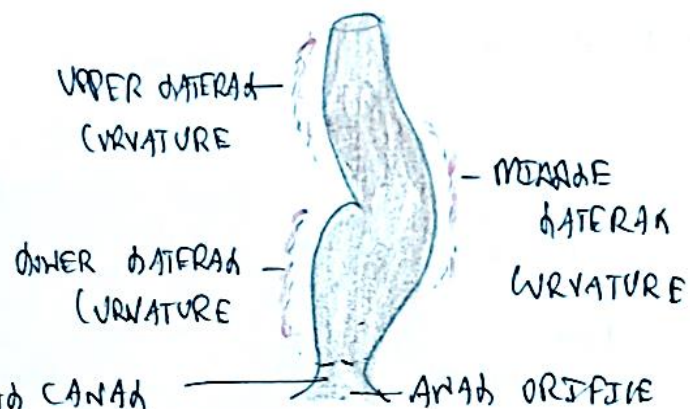
- Upper 2/3rd: Rectovesical pouch and coils of SI and Sigmoid colon.
- Lower 1/3rd: Base of urinary bladder, Ureters, Seminal Vesicles, Ampulla of vas deferens, Prostate.

B) CURVATURES (FLEXES)

a) ANTEROPOSTERIOR



b) LATERAL



B. FEMALES:

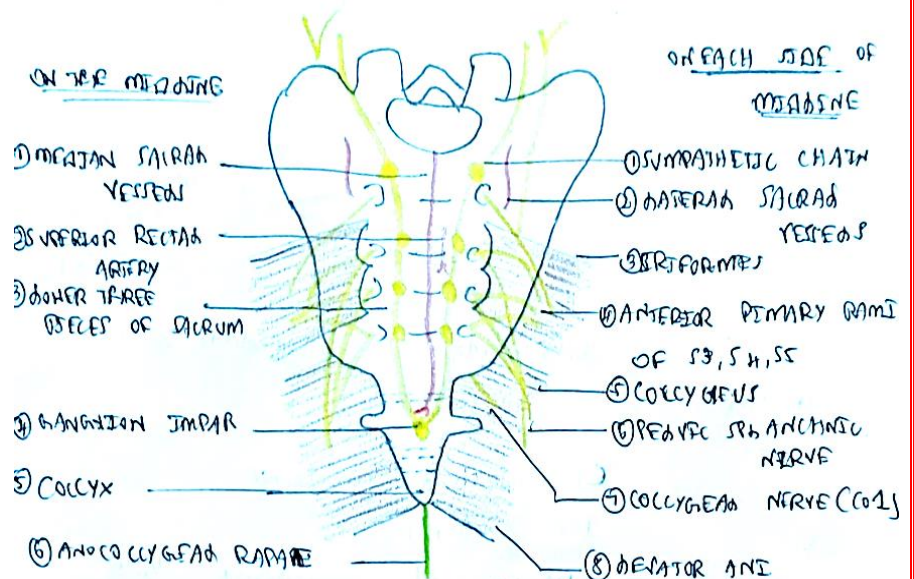
1. Upper 2/3rd: Rectouterine pouch and coils of SI and Sigmoid colon within it.
2. Lower 1/3rd: Vagina (lower part).

POSTERIOR RELATIONS:**IN THE MIDLINE:**

1. Lower 3 pieces of sacrum
2. Coccyx
3. Anococcygeal raphe
4. Ganglion impar
5. Medial sacral vessels
6. Superior rectal artery
7. Fascia of Waldeyer.

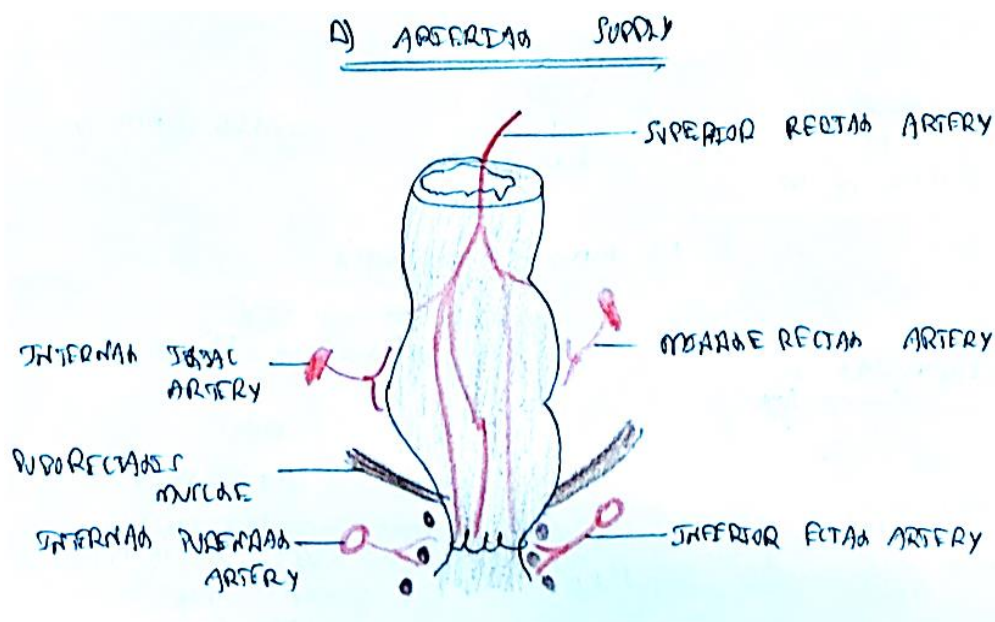
ON EACH SIDE OF MIDLINE:

1. Piriformis
2. Coccygeus
3. Levator ani
4. Sympathetic chains
5. Pelvic splanchnic nerves
6. Lateral sacral vessels
7. Anterior primary Rami of S3, S4, S5
8. Coccygeal nerve.

C) POSTERIOR RELATIONS:

ARTERIAL SUPPLY:

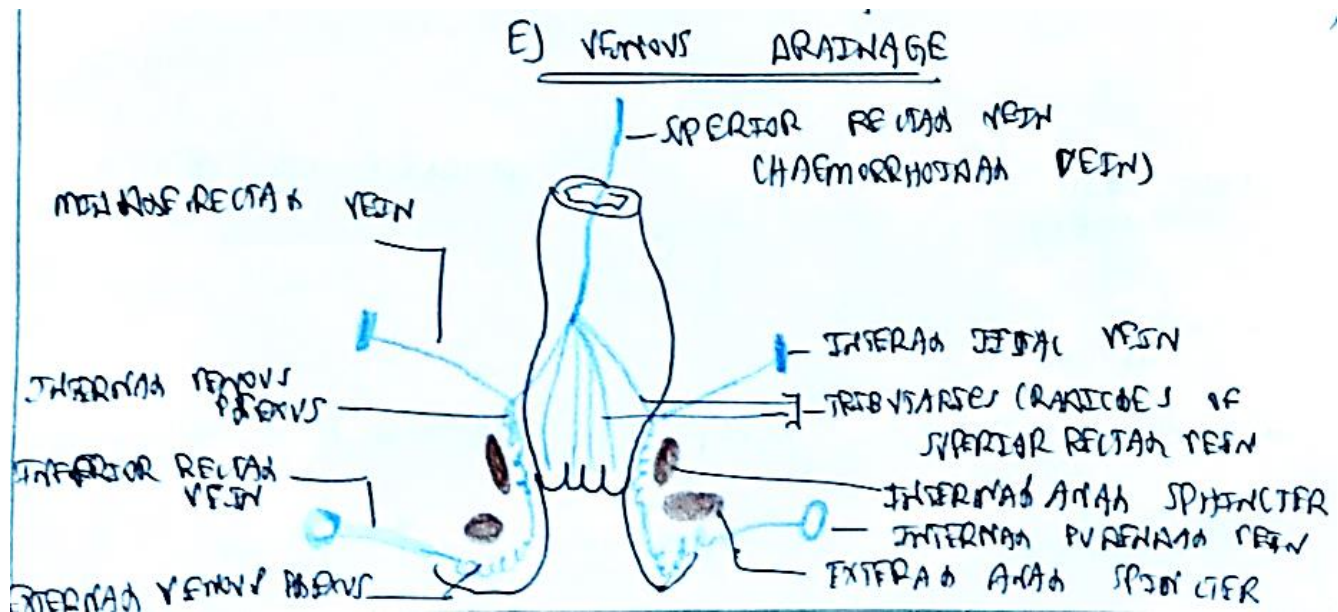
1. **SUPERIOR RECTAL ARTERY**, chief artery of rectum, continuation of the Inferior Mesenteric Artery.
2. **MIDDLE RECTAL ARTERY**, (2 in number), Each is branch of anterior division of internal iliac artery - unimportant as supply only superficial coats of rectum
3. **INFERIOR RECTAL ARTERY**, (2 in number), each is branch of internal pudendal artery.
4. **MEDIAN SACRAL ARTERY**, branch of abdominal aorta - supplies posterior wall of anorectal junction.



VENOUS DRAINAGE

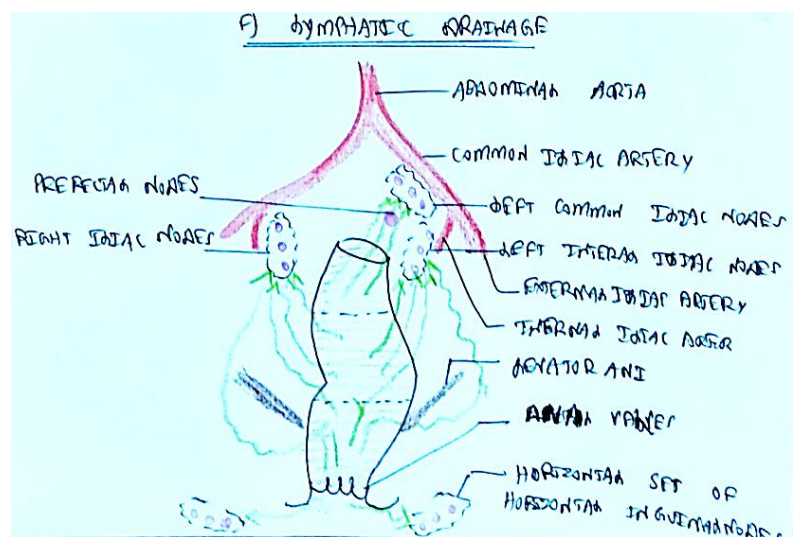
The rectal veins arise from internal and external venous plexus of the rectum and anal canal.

1. Superior Rectal Vein or Hemorrhoidal vein, Drains into portal circulation via superior mesenteric veins.
2. Middle and Inferior Rectal Veins, drains into iliac veins and drains into IVC.



LYMPHATIC DRAINAGE:

- Lymphatics from upper half drains into **INFERIOR MESENTERIC NODES**, a few vessels intercepted by pararectal lymph nodes situated on each side of the rectosigmoid junction.
- Lymphatics from lower half accompany middle rectal vessels and drain into **INTERNAL ILIAC NODES**.



APPLIED ANATOMY

LYMPHATICS OF RECTUM:

- Lymphatics of rectum are mostly arranged longitudinally in contrast to most of small and large intestines, where they are arranged transversely around the gut.
- Therefore, when carcinoma of rectum spreads along the lymphatics, it does not cause rectal obstruction unlike the rest of the gut.

PROLAPSE OF THE RECTUM

- Through anus, may be complete or incomplete.

INTERIOR

- TEMPORARY FOLDS are mostly longitudinal and found in lower part of rectum. They disappear when rectum distends.
- PERMANENT FOLDS (Houston's valves) - contain muscle and mucosa, become prominent when rectum is distended.
- Four in number.
 1. FIRST FOLD - near upper end, projects from right to left.
 2. SECOND FOLD - (1 inch) above the third fold, projects from left.
 3. THIRD FOLD is the largest, projects from right along concavity of middle curvature.
 4. FOURTH FOLD, projects from left, about (1 inch) below the third valve.

DEVELOPMENT:

- It is derived from the primitive rectum, i.e., dorsal subdivision of cloaca.
- Upper part of rectum is derived from hindgut proximal to cloaca.

CONGENITAL ANOMALY

- INCOMPLETE SEPARATION OF CLOACA - rectum may communicate with urinary bladder, urethra or vagina, or may open onto perineum at an abnormal site.

7. ANAL CANAL

INTRODUCTION

- The anal canal is about 3.8 cm long terminal part of the large intestine.
- It is situated below the pelvic diaphragm in the anal triangle between the ischiorectal fossae.
- It extends downward and backward from anorectal flexure (Half an inch below and 1 inch in front of the coccyx) to anus.

EXTENT

- The anal canal extends from the anorectal junction to anus

RELATIONS

ANTERIOR

A. IN MALE

1. Perineal body
2. Membranous urethra
3. Bulb of the penis

B. IN FEMALE

1. Perineal body
2. Lower part of the vagina

POSTERIOR

1. Anococcygeal ligament
2. Tip of the coccyx

LATERAL

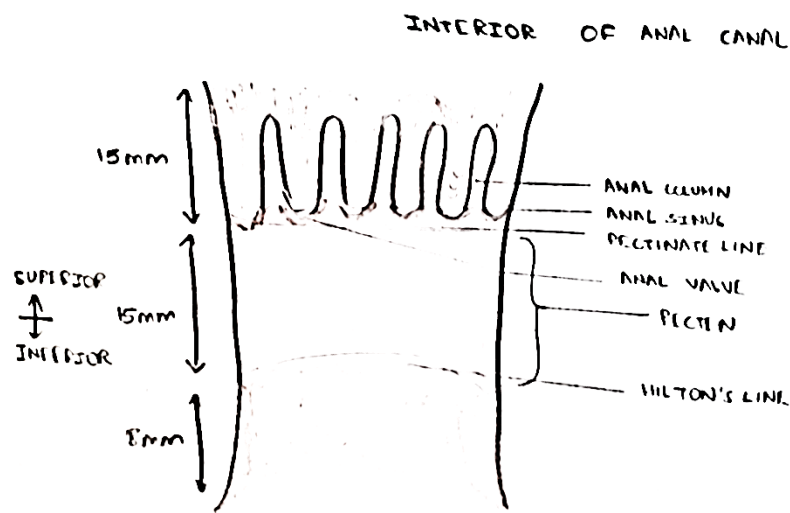
Ischioanal fossa

ALL AROUND

Sphincter muscles

INTERIOR OF ANAL CANAL

- The interior of anal canal is divided into upper and lower parts by the pectinate line, which represents the site of attachment of anal membrane in embryonic life.



CHARACTERISTIC FEATURES OF THE UPPER PART

- Lined by the mucous membrane with simple columnar epithelium. It is reddish in colour due to rich blood supply.
- Mucous membrane shows 6-10 longitudinal folds called anal columns of Morgagni.
- Anal valves together form a transverse line all around the anal canal. This is the pectinate line.

CHARACTERISTIC FEATURES OF THE LOWER PART

- Upper 15 mm called pecten/transitional zone.
- Lined by mucous membrane, which is bluish in appearance due to the presence of rich venous plexus underneath.
- Mucosa is less mobile as compared to that above the pectinate line.

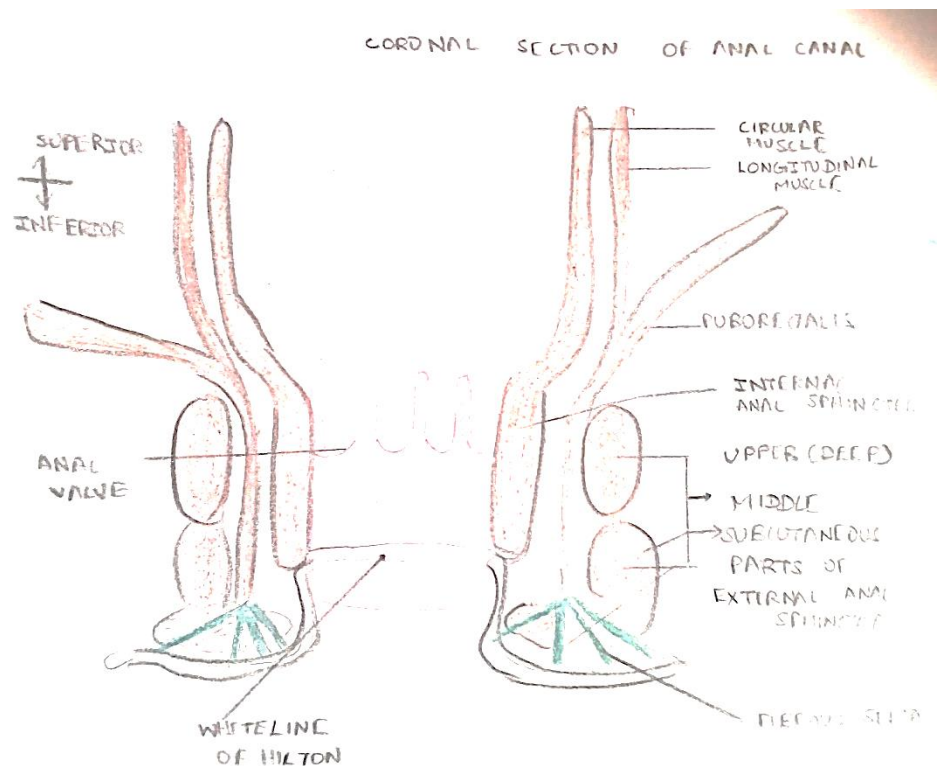
- Limited below by Hilton's line, which corresponds to inter-sphincteric groove.
- Lined by stratified squamous epithelium without sebaceous or sweat glands.
- Lower 8 mm called cutaneous part
- Lined by true skin containing sweat glands, sebaceous glands, and hair.
- Lining epithelium is stratified squamous keratinized.

ANAL SPHINCTERS

- They form the powerful sphincteric mechanisms of the Gastrointestinal tract.
- There are two anal sphincters
 - A. Internal anal sphincter (Involuntary)
 - B. External anal sphincter (Voluntary)

A. INTERNAL ANAL SPHINCTER

- It is formed by the thickened circular smooth muscle coat of rectal wall surrounding the upper 3/4th of the anal canal.
- It extends from anorectal junction to intersphincteric groove (Hilton's line) of the anal canal.



- It is surrounded by the deep and superficial parts of the external anal sphincter.
- It is supplied by autonomic fibres, hence involuntary in nature.

B. EXTERNAL ANAL SPHINCTER

- It is a muscular ring that surrounds the entire length of the anal canal. It is divided into three parts.

DEEP PART:

- It completely encircles the upper part of the anal canal and has no bony attachment.
- The puborectalis blends with the deep part of external sphincter behind and forms a sling around the anorectal junction, which is attached anteriorly to the back of the pubis.
- In the resting state, the anorectal tube is angled forward at this level, and contraction of puborectalis sling will increase this angle, an important factor in the continence mechanism.

SUPERFICIAL PART:

- It is elliptical in shape and lies below the deep part. It arises from tip of coccyx and anococcygeal body behind.
- It sweeps forwards around the sides of lower part of internal sphincter to get inserted into the perineal body.

SUBCUTANEOUS PART:

- It lies below the internal sphincter in the perianal space and encircles the anal orifice.
- It has no bony attachment. It is traversed by fibroelastic septa derived from conjoint longitudinal coat of anal wall.
- The external anal sphincter is made up of striated muscle and supplied by somatic nerves, inferior rectal nerve, and perineal branch of the 4th sacral. It is therefore under voluntary control.

ARTERIAL SUPPLY

- Above the pectinate line, by the superior rectal artery, a continuation of inferior mesenteric artery.
- Below the pectinate line, by the inferior rectal artery, a branch of the internal pudendal artery.

VENOUS DRAINAGE

- Venous blood from above the pectinate line is passed through internal rectal venous plexus into superior rectal vein, a tributary of portal vein.
- Venous blood from below the pectinate line is drained into inferior rectal vein, a tributary of systemic vein.

NERVE SUPPLY

- Above the pectinate line by autonomic nerve; hence, anal canal above this line is insensitive to pain.
- Below the pectinate line by inferior rectal nerve, a branch of pudendal nerve (somatic nerve); hence, anal canal below the pectinate line is sensitive to pain.

LYMPHATIC DRAINAGE

- Above the pectinate line into internal iliac lymph nodes.
- Below the pectinate line into superficial inguinal lymph nodes (horizontal set).

APPLIED ANATOMY

INTERNAL PILES

- These are saccular dilatations of internal rectal venous plexus.
- They occur above the pectinate line and painless.
- For this reason, internal piles remain asymptomatic for a long time till they become big enough to rupture and cause painless bleeding per rectum.

EXTERNAL PILES

- These are dilatations of external venous plexus.
- They lie below the pectinate line and are sensitive to touch, pain and temperature.

ANAL FISSURE

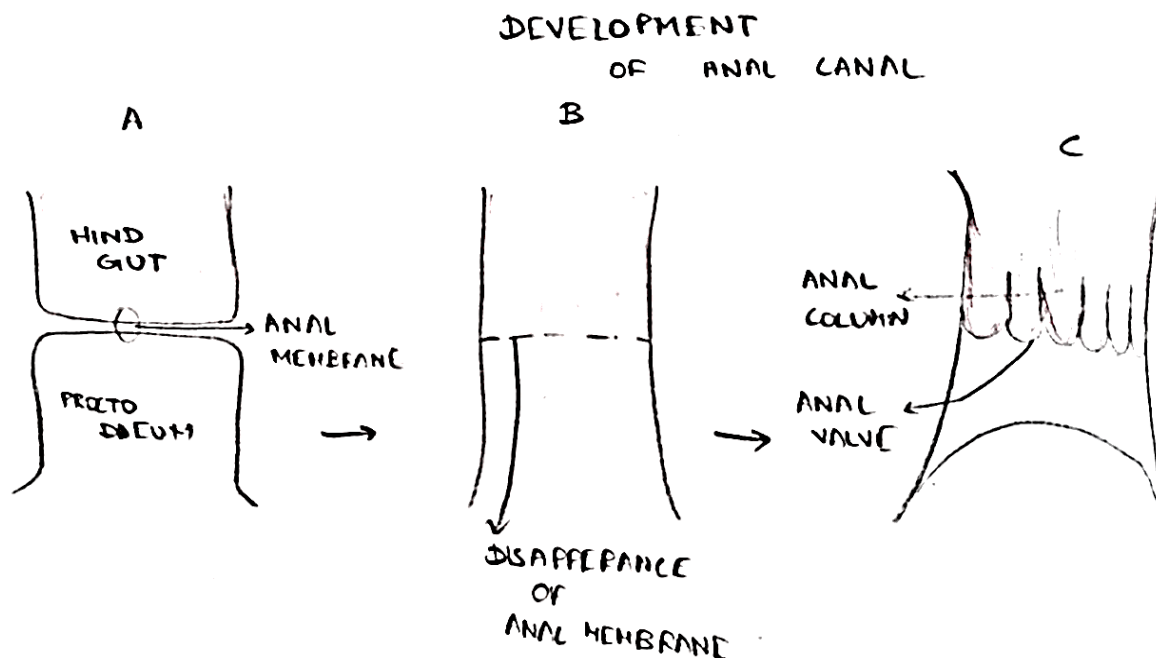
- The faecolith catching on the fold of the mucous membrane (anal valves) and dragging it down rupture the valves and form an elongated ulcer called anal fissure.

ANAL FISTULAE

- The infection of anal sinus due to impaction of faecal matter may cause an abscess in the wall of the anal canal.
- canal. Which finds its way both into ischiorectal fossa and perianal skin, forming anal fistula.

DEVELOPMENT

- The anal canal develops in the 7th week of intrauterine life (IUL) from two sources:
 1. UPPER 2/3RD develops from primitive rectum, hence endodermal in origin.
 2. LOWER 1/3RD develops from anal pit/Proctodeum, hence ectodermal in origin



CONGENITAL ANOMALIES

- Imperforate anus, it occurs when the membrane fails to break down due to abnormal development of urorectal septum.
- Anal agenesis, in this condition, the anal canal ends blindly.

8. PELVIC DIAPHRAGM

INTRODUCTION:

- The pelvic floor is formed by the pelvic diaphragm which is a muscular partition between the true pelvis above and the perineum below.
- It represents a gutter as it slopes from either side towards the median plane.
- It is incomplete anteriorly to allow passage for the urethra in the males, and the urethra and vagina in the females.

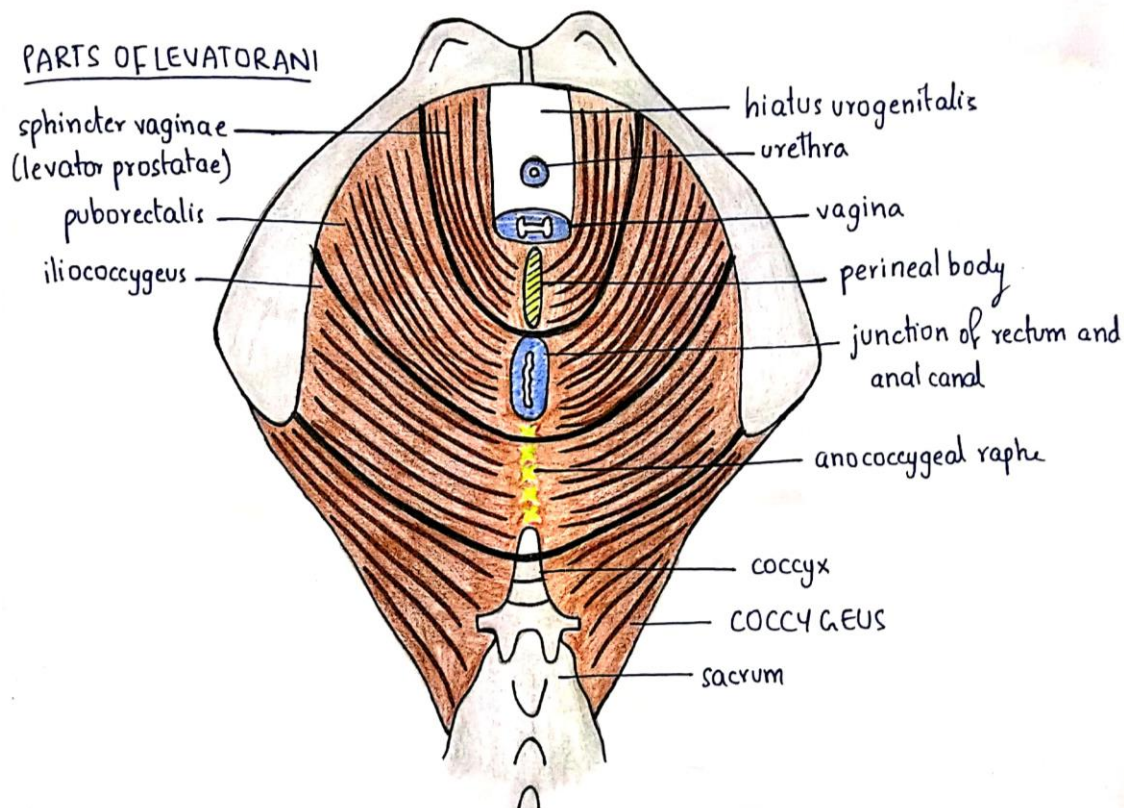
FORMATION:

- The pelvic diaphragm is formed by the large levator ani and small coccygeus muscles of two sides and their covering fasciae.
- **EVOLUTION OF THE PELVIC DIAPHRAGM:** In quadrupeds, the muscles of pelvic diaphragm are the muscles of tail. The anterior portion of levator ani is called pubococcygeus which pulls the tail forward, and posterior portion iliococcygeus moves the tail sideways. In human being, with the assumption of upright posture, the pubococcygeus and iliococcygeus together form the levator ani and ischiococcygeus persists as coccygeus muscle.

OPENINGS:

The pelvic diaphragm presents the following openings:

1. **HIATUS UROGENITALIS:** It is a triangular gap between the anterior fibres of the two levator ani muscles. It transmits the urethra in male, and the urethra and vagina in female. The hiatus urogenitalis is closed from below by the urogenital diaphragm.
2. **HIATUS RECTALIS:** It is a round opening between the perineal body and the anococcygeal raphe. It provides passage to the anorectal junction.



RELATIONS:

- The pelvic diaphragm closes off the pelvic outlet. The pelvic outlet (pelvic diaphragm) is bounded:
 1. **ANTERIORLY** by the arcuate or inferior pubic ligament.
 2. **POSTERIORLY** by the coccyx.
 3. **ON EACH SIDE** by the ischiopubic rami or the side of the pubic arch, the ischial tuberosities and the sacrotuberous ligaments.
 4. **SUPERIORLY** by the pelvic cavity.
 5. **INFERIORLY** by the perineum.

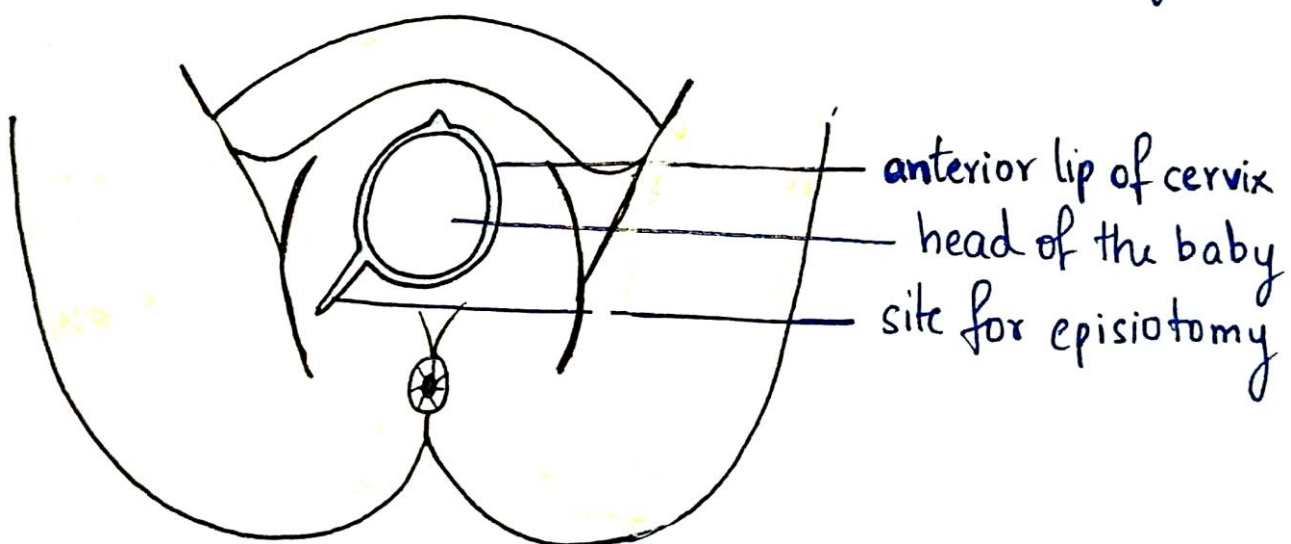
FUNCTIONS:

1. The pelvic diaphragm provides **PRINCIPAL SUPPORT** to abdominopelvic viscera (bladder, intestines, uterus etc.) through their tonic contraction.

2. **RESISTANCE** to increases in intra-abdominal pressure during activities such as coughing or lifting heavy objects.
3. **URINARY AND FAECAL CONTINENCE** as the muscle fibres have a sphincter action on the rectum and urethra. They relax to allow urination and defecation.
4. **PARTURITION** as the pelvic diaphragm also have a sphincter effect on the vagina.

APPLIED ANATOMY

- During the second stage of labor, the head of the baby on reaching the pelvic floor rotates from earlier transverse position to anteroposterior position. The head then passes through the anterior hiatus of the levator ani to reach the perineum and the deliver.

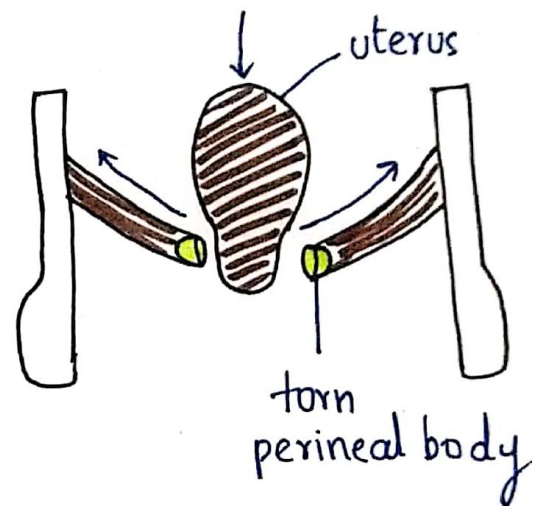
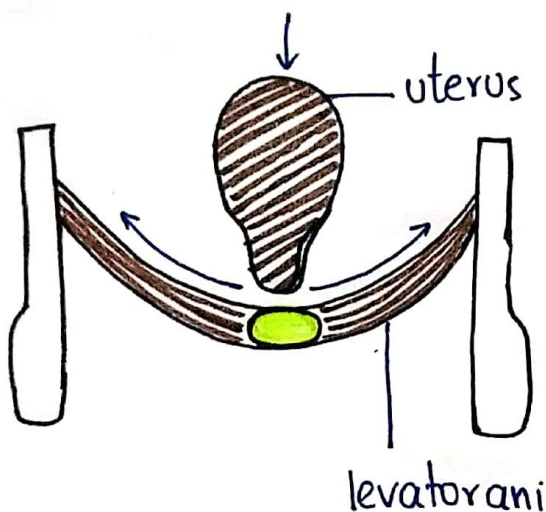


INJURY OF PELVIC DIAPHRAGM:

- The pelvic diaphragm may be injured (tearing of perineal body) during difficult vaginal childbirth.
- As a result, it becomes weak and can no longer provide sufficient support to the pelvic viscera.
- This may lead to uterine, vaginal or even rectal prolapse.

EPISIOTOMY:

- It is a surgical incision of the perineum and the posterior vaginal wall generally done by an obstetrician during second stage of labor to quickly enlarge the opening for the **baby** to pass through.



STRUCTURES PASSING THROUGH IT:

- Structures passing through the pelvic floor/pelvic diaphragm are:
 1. Urethra
 2. Anal canal
 3. Vagina (in female)

9. OVARY

INTRODUCTION:

- Ovaries – female gonads
- Almond shaped

LOCATION –

- Each ovary lies in ovarian fossa on lateral pelvic wall
- Ovarian fossa bounded:
 1. **ANTERIORLY** – obliterated umbilical artery
 2. **POSTERIORLY** – ureter & internal iliac artery

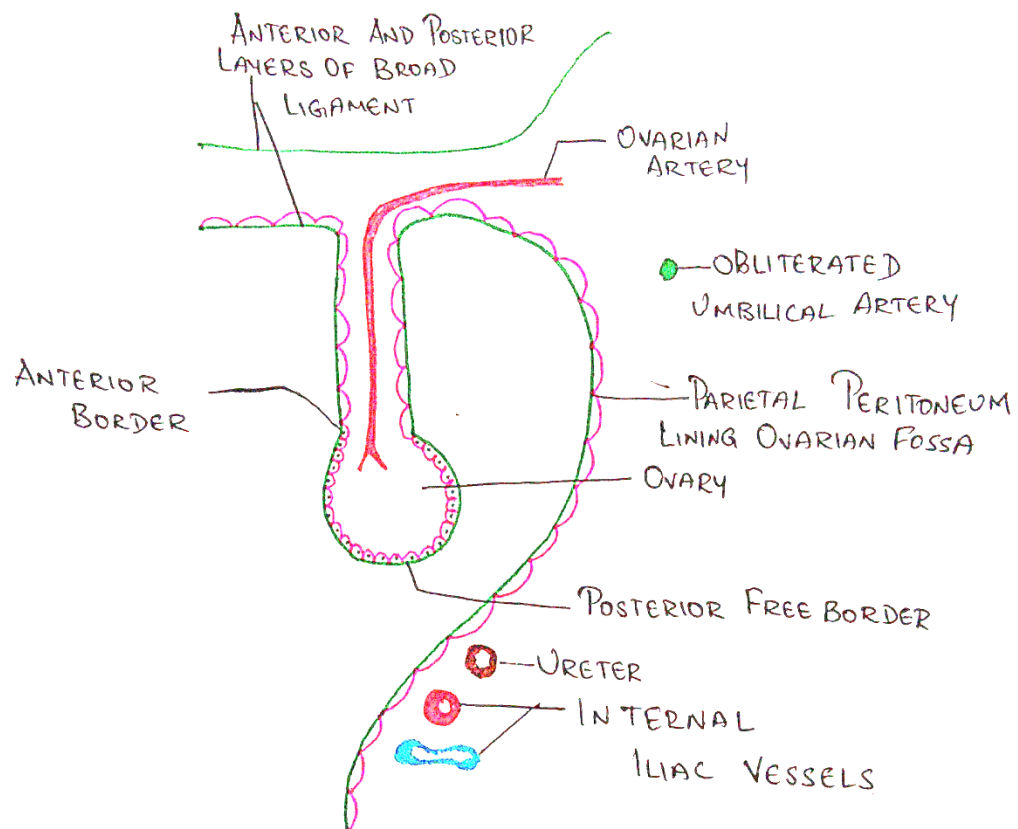
POSITION –

- Variable.
- In **NULLIPAROUS WOMEN** – long axis ➞ nearly vertical ➞ Upper pole & lower pole present.
- In **MULTIPAROUS WOMEN** – long axis ➞ horizontal ➞ Upper pole points laterally, Lower pole points medially.

EXTERNAL FEATURES

- Before onset of ovulation –
 - smooth surfaces
 - greyish-pink in color
- After puberty –
 - uneven surface
 - color changes from pink to grey
- Each ovary –
 - 2 poles or extremities:
 1. Upper or tubal pole
 2. lower or uterine pole

- 2 borders:
 1. Anterior or mesovarian border
 2. Posterior or free border
- 2 surfaces:
 1. Lateral
 2. Medial



RELATIONS

PERITONEAL RELATIONS

- Ovary is almost entirely covered with peritoneum, except along the mesovarian border → Here – 2 layers of covering peritoneum are reflected onto posterior layer of broad ligament of uterus
- Connected to posterior border of broad ligament by mesovarium – short fold of peritoneum.
- Squamous epithelium of mesovarium is continuous with cuboidal epithelium of ovary.
- Mesovarium transmits vessels & nerves to & from ovary.
- Suspensory ligament of ovary (or) Infundibulopelvic ligament
 1. Distinct fold formed by lateral part of broad ligament of uterus
 2. Contains ovarian vessels & nerves
- Lateral part of broad ligament – extent –
 - A. From:
 1. Infundibulum of uterine tube
 2. Upper pole of ovary
 - B. To:
 1. external iliac vessels.

VISCERAL RELATIONS

1. UPPER OR TUBAL POLE

- Broader than lower pole
- Related to
 1. Uterine tube
 2. External iliac vein
- Right ovary – related to appendix in pelvic position
- Provides attachment to
 1. Ovarian fimbria
 2. Suspensory ligament of ovary

2. LOWER OR UTERINE POLE:

- Narrower than upper pole
- Related to pelvic floor
- Connected to lateral angle of uterus – posteroinferior to uterine tube attachment – by ligament of ovary
- Ligament lies between 2 layers of broad ligament of uterus & contains some smooth muscle fibers

3. ANTERIOR OR MESOVARIAN BORDER:

- Straight
- Related to
 1. Uterine tube
 2. Obliterated umbilical artery
- Attached to back of broad ligament of uterus by mesovarium – forms hilus of ovary

4. POSTERIOR OR FREE BORDER:

- Convex
- Related to
 1. Uterine tube
 2. Ureter

4. LATERAL SURFACE:

- Related to ovarian fossa – lined by parietal peritoneum
- Parietal peritoneum separates ovary from obturator vessels and nerve

5. MEDIAL SURFACE:

- Largely covered by uterine tube
- Peritoneal recess between mesosalpinx and this surface – Ovarian bursa

- Only lower pole & lateral surfaces are not related to uterine tube, remaining 2 borders, upper pole and medial surface are related to the tube.

ARTERIAL SUPPLY

A. OVARIAN ARTERY –

- Arises from abdominal aorta just below renal artery ➡ descends over posterior abdominal wall ➡ enters suspensory ligament of ovary ➡ sends branches to ovary through mesovarium ➡ continues medially through broad ligament of uterus ➡ anastomose with uterine artery
- Also supplies:
 1. Uterine tube
 2. Side of uterus
 3. Ureter

B. UTERINE ARTERY – gives some branches → reach ovary through mesovarium.

VENOUS DRAINAGE

- Veins emerge at hilus.
- Form pampiniform plexus around artery ➡ condenses into single ovarian vein near pelvic inlet ➡ ascends on posterior abdominal wall ➡ drains into:
 1. Inferior vena cava on right side
 2. Left renal vein on left side.

LYMPHATIC DRAINAGE

- Lymphatics from ovary ➡ Communicate with lymphatics from uterine tube and fundus of uterus ➡ ascend along ovarian vessels ➡ drain into lateral aortic & preaortic nodes.

NERVE SUPPLY:

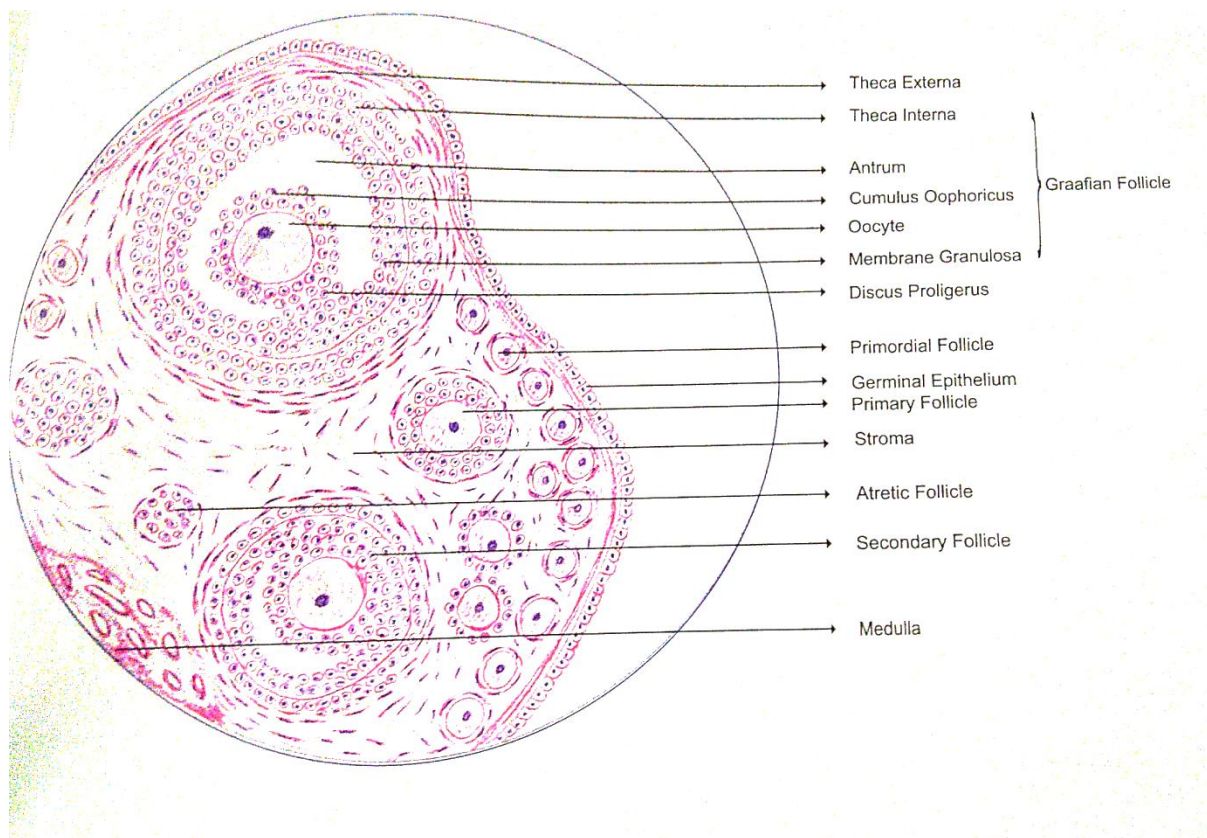
- Ovarian plexus –
 - derived from
 1. Renal plexus
 2. Aortic plexus
 3. Hypogastric plexus
 - accompanies ovarian artery.

- contains both sympathetic & parasympathetic nerves.
- Sympathetic nerves (T10, T11) – afferent for pain + efferent or vasomotor.
- Parasympathetic nerves (S2, S3, S4) are vasodilator.

HISTOLOGY

- Surface lined by germinal epithelium made of cuboidal cells- below this lies connective tissue covering called tunica albuginea
- Section of ovary divides into outer cortex & inner medulla –
- Cortex ➔ contains follicles in different stages of development separated by stroma
 1. **PRIMORDIAL FOLLICLE** – primary oocyte surrounded by flat stromal cells
 2. **PRIMARY FOLLICLE** – primary oocyte surrounded by columnar cells
 3. **SECONDARY FOLLICLE** – primary oocyte surrounded by several layers of follicular cells + fluid filled follicular cavity
 4. **GRAAFIAN FOLLICLE** –
 - Follicular cavity increases in size
 - Oocyte becomes eccentrically located surrounded by cumulus oophorus.
 - Attached to wall of follicle by discus proligerus.
 1. Surrounding stromal cells form theca interna
 2. Fibers form theca externa
 3. Follicular cells and theca secrete estrogen
 - **CORPUS LUTEUM** – after ovulation-
 1. follicular wall collapses
 2. follicular cells enlarge
 3. cytoplasm filled with yellow pigment – lutein
 4. secretes progesterone

- **STROMA** – contains
 1. fusiform mesenchyme cells
 2. smooth muscles
 3. reticular fibers
- **MEDULLA** – contains connective tissue with blood vessels, smooth muscles.



CLINICAL CORRELATION:

- **DETERMINATION OF OVULATION** – In cases of sterility, ovulation can be determined by repeated ultrasonography.

- **PROLAPSE OF OVARIES** – Ovaries are frequently displaced to the pouch of Douglas where they can be palpated by per vaginal (PV) examination.
- **OVARIAN CYSTS** –
 - Developmental arrests of ovarian follicles may result in formation of one or more small ovarian cysts
 - Multiple small theca lutein cysts involve both ovaries in cases with Stein – Leventhal syndrome
 - Syndrome is characterized by
 1. mild hirsutism
 2. deep voice
 3. secondary amenorrhea
 4. cystic enlargement of both ovaries.
- **CARCINOMA OF OVARY** –
 - Common
 - 15% of all cancers
 - 20% of gynecological cancers.
- Ovaries are commonest site for endometriosis; endometrial cysts in ovary are called chocolate cysts.

PELVIS – SHORT ANSWERS

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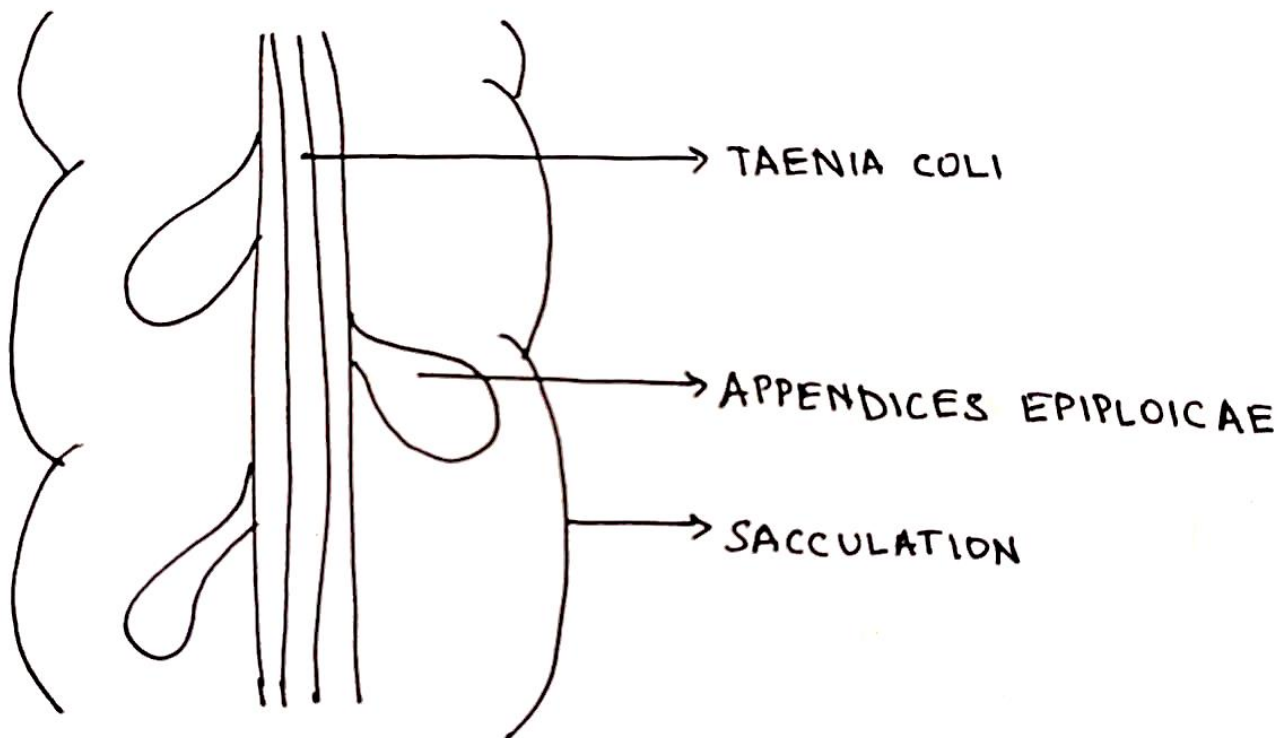
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1. CARDINAL FEATURES OF LARGE INTESTINE

- The large intestine has three cardinal features SAT
- T- **TENIAE COLI**- These are ribbon like band of longitudinal muscle coat. They are three in number. They are present on all the parts of colon and caecum.
- S- **SACCULATION/HAUSTRATIONS**- These are a series of dilatations in the wall of the large intestine. This gives the characteristic puckered appearance of the large intestine.
- A- **APPENDICES EPIPLOICAE**- These are small fat filled bags of visceral peritoneum attached to the tenia of large intestine. They are most numerous on the sides of sigmoid colon and posterior surface of the transverse colon.



2. MARGINAL ARTERY OF DRUMMOND

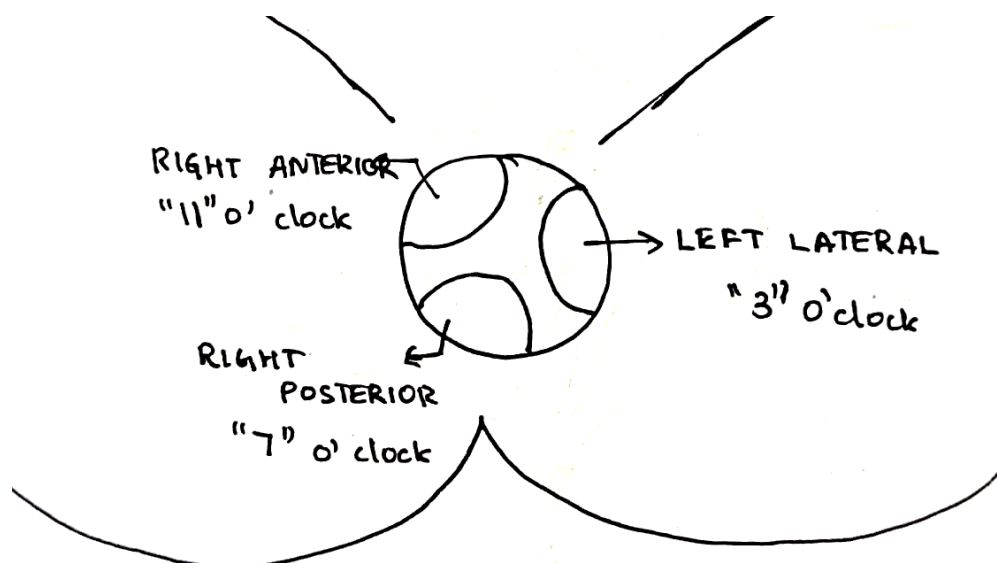
- It is a circumferential anastomotic arterial channel close to the inner margin of the colon.
- It extends from ileocecal junction to the rectosigmoid junction.
- The anastomoses are between branches of colic branches of superior mesenteric artery and inferior mesenteric artery.

1. ROUND LIGAMENT OF UTERUS:

- It is called ligament teres uteri
- They are two in number, 10-12 cm long, fibromuscular bands
- Location: Between the two layers of the broad ligament
- Uterus - attached to the lateral angle of the uterus -> runs between the two layers of the broad ligament -> winds around the lateral side of inferior epigastric artery -> enters the deep inguinal ring -> runs in the inguinal canal -> emerges the superficial inguinal ring -> splits to form many numerous fibrous band -> merges with the fibro areolar tissues of the labium majus
- It is a true ligament and maintains the anteversion and anteflexion of the uterus

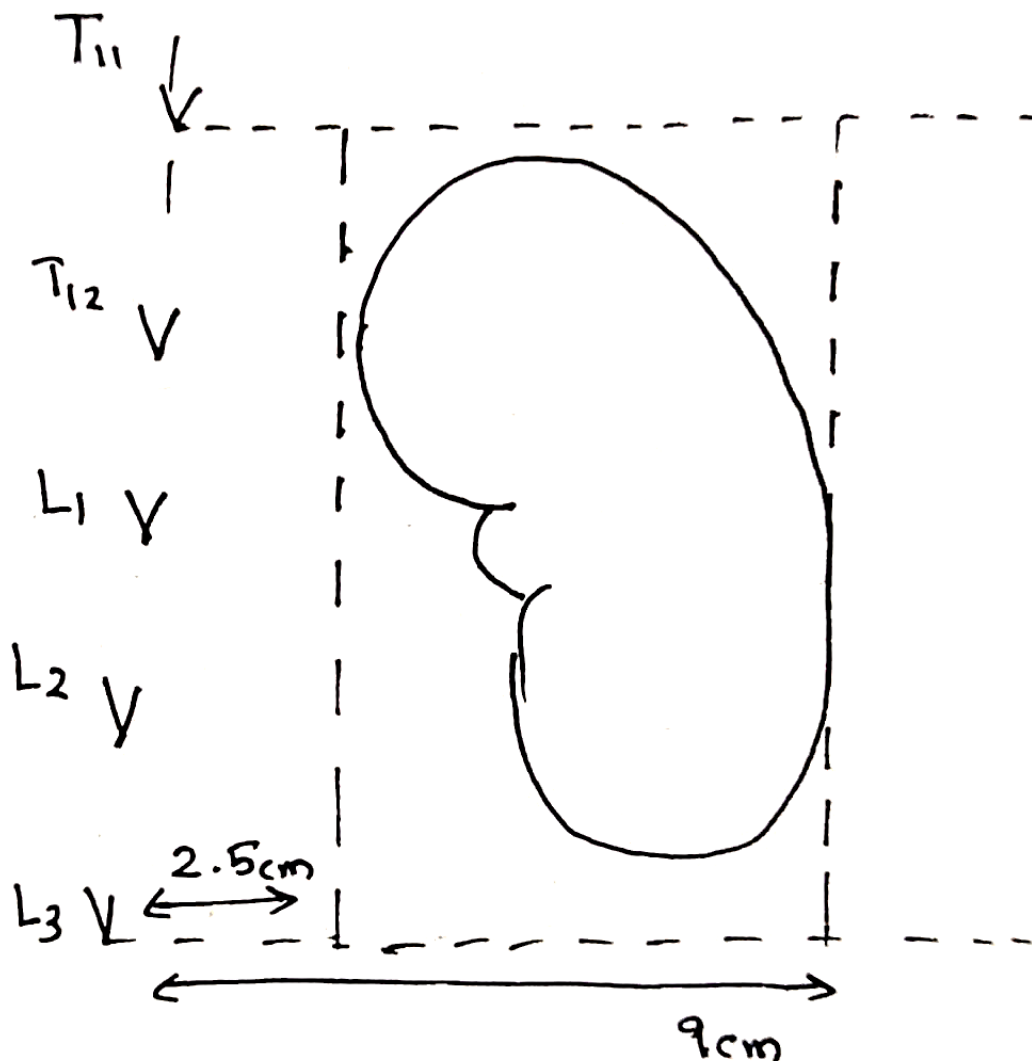
2. POSITION OF HEMORRHOIDS:

- Location of primary hemorrhoids (formed due to dilatations of main tributaries of superior rectal vein): 3 o'clock, 7 o'clock and 11 o'clock positions of the anal wall, when viewing the internal of anal canal in lithotomy position.
- Secondary hemorrhoids are the hemorrhoids in position other than the above-mentioned positions.



3. MORRISON'S PARALLELOGRAM

- It is the surface marking of the kidney on the back of the body
- The upper horizontal line is drawn at the level of spine of T11
- The lower horizontal line is drawn at the level of spine of L3
- The medial vertical line is drawn 2.5 cm away from posteromedian plane
- The lateral vertical line is drawn 9 cm away from posteromedian plane



4. OPENINGS OF DIAPHRAGM AND THEIR LEVELS

- The main three large openings on the diaphragm are:
 1. **VENA CAVA OPENING**- at the level of T8, it is quadrilateral and allows the passage of right phrenic nerve and the inferior vena cava
 2. **OESOPHAGUS OPENING**- at the level of T10, it is elliptical and allows the passage of the left gastric vessels, Oesophagus and both the vagal trunks
 3. **AORTA OPENING**- at the level of T12, it is rounded and allows the passage of the aorta, thoracic duct and the azygous vein.

5. CONTENTS OF BROAD LIGAMENT

- **ONE TUBE**- uterine tube
- **TWO LIGAMENTS**- round ligament of uterus, ligament of ovary
- **TWO ARTERIES**- uterine artery, ovarian artery
- **TWO PLEXUS OF NERVES**- Uterovaginal plexus, ovarian plexus
- **THREE EMBRYOLOGICAL REMNANTS**- Epoophoron and its duct (Gartner's duct), paroophoron, vesicular appendages
- **OTHER STRUCTURES**- lymph vessels and lymph nodes, fibro-areolar tissue

6. PERINEAL BODY LOCATION IN FEMALE & ITS IMP.:

- It is a wedge-shaped mass of fibromuscular tissue

LOCATION: In the midline at the junction of urogenital triangle and the anal triangle, between the vaginal orifice and the anal orifice

IMPORTANCE: Ten muscles converge at the perineal body. The muscles are:

1. Two superficial transverse perineal muscles
 2. Two deep transverse perineal muscles
 3. Two bulbospongiosus muscles
 4. Two levator ani muscles
 5. One sphincter ani externus
 6. One longitudinal muscle coat of anal canal
- **CLINICAL:** Damage to the perineal body will lead to prolapse of the uterus, bladder and rectum.

7. CORPUS LUTEUM:

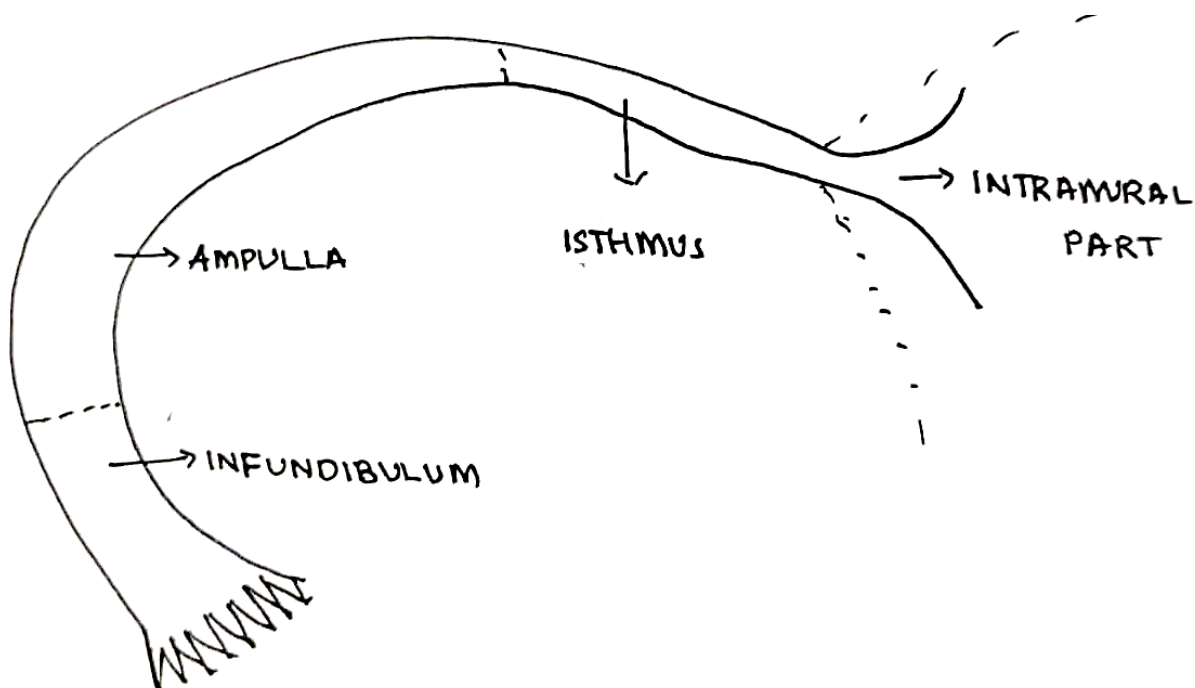
- The empty graafian follicle is converted into a mass of specialized yellow tissue called corpus luteum
- It produces hormones like progesterone and estrogen
- Regression of the corpus luteum, leads to the regression of the hormones and will lead to onset of menstruation if fertilization doesn't occur

8. HYMENAL MEMBRANE

- It is mostly an incomplete mucosal fold around the vaginal cavity close to the external orifice of the vagina.
- It may differ in shape from woman to woman, the common shapes are annular, crescentic or cribriform.
- This may or may not rupture during coitus.
- Rarely it is a complete membrane and obstructs the discharge of the blood during menstruation and is called haematocolpos.

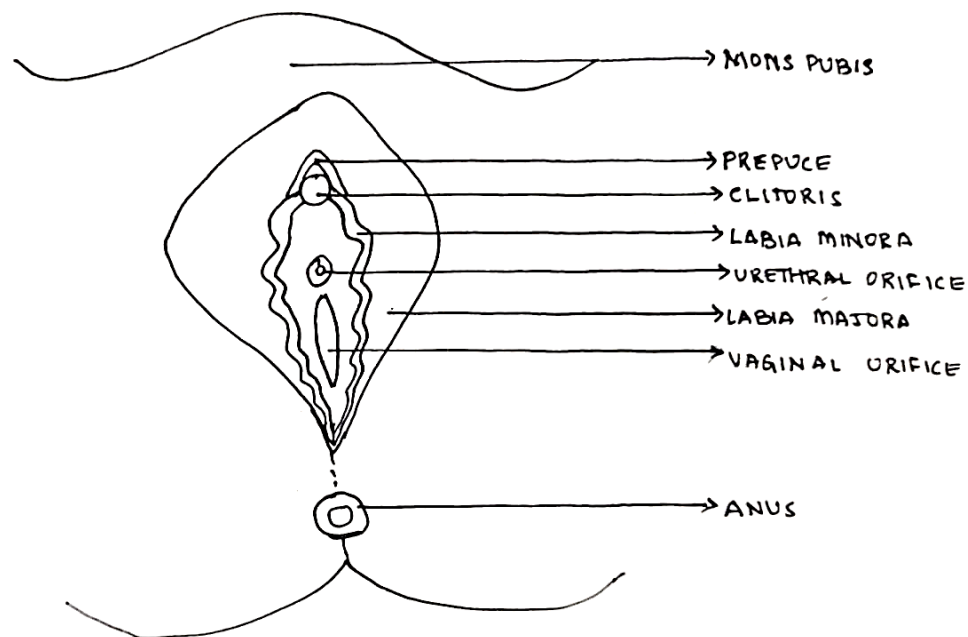
9. FALLOPIAN TUBE PARTS

- The fallopian tube consists of four main parts.
- From lateral to medial they are, infundibulum, ampulla, isthmus and intramural.
- The **INFUNDIBULUM** is funnel shaped, its extremities consist of fimbria, that receive the ovum.
- The **AMPULLA** is the widest part, it is the site of fertilization.
- The **ISTHMUS** is the narrowest part.
- The **INTRAMURAL PART** is the interstitial part that traverses the uterine wall at the junction of the fundus and the body.



10. VULVA PARTS

- The external female genitalia are together called the vulva.
- It consists of the vestibule of the vagina, mons pubis, labia majora, labia minora and the clitoris.
- The **VESTIBULE OF THE VAGINA**, is the elliptical space between the labia minora. It consists of the urethral orifice and the vaginal orifice. It also contains the openings of the glands of Bartholin and glands of skene.
- **MONS PUBIS** is the fat padded area above the pubic symphysis, it acts as cushion during coitus.
- The **LABIA MAJORA** are folds of hairy skin that lies lateral to the vestibule of the vagina and the labia minora.
- The **LABIA MINORA** are the folds of hairless mucosa that lies just medial to the labia majora. They are continuous anteriorly with the prepuce and frenulum of the clitoris.
- **CLITORIS** is a small erectile tissue located at the anterior margin of the vestibule of the vagina. It is homologous to the penis in the male. It is richly supplied by the sensory receptors.



11. ARTERIES OF SPERMATIC CORD

1. **TESTICULAR ARTERY**: branch of the aorta that arises just inferiorly to the renal arteries
2. **CREMASTERIC ARTERY AND VEIN**: supplies the cremasteric fascia and muscle
3. **ARTERY TO THE VAS DEFERENS**: a branch of the inferior vesicle artery, which arises from the internal iliac.

12. VARIOCELE

- Dilatation and tortuosity of the pampiniform plexus and so also of the testicular veins.
- Seen commonly in men aged 15-20 years and rarely after 40years
- Occur in 15-20% of all males and 40% of all infertile males
- Normal small vessels of plexus is 0.5-1.5 mm. when diameter becomes greater than 2mm then it is varicocele.
- Seen commonly on the left side –
 1. Longer
 2. Enters at right angle to the renal vein
 3. Left testicular artery arching over it
 4. A loaded sigmoid colon
 5. Compressed between the aorta and SMA

CLINICAL FEATURE

1. swelling
2. bug of worms feeling
3. aching pain in groin and scrotum
4. on lying down, it get reduced.

TREATMENT usually includes varicocelectomy

13. TESTES COVERING

The testes is covered by three coats:

1. **TUNICA VAGINALIS** – represents the lower persistent portion of the processus vaginalis. It is invaginated by the testis from behind and, therefore has a parietal and a visceral layer with a cavity in between. It covers the whole testes, except for its posterior border.
2. **TUNICA ALBUGINEA** – It is a dense, white fibrous coat covering the testes all around. The posterior border is thickened to form an incomplete vertical septum, called the mediastinum testes. Numerous septa extend from the mediastinum to the inner surface of tunics, they completely divide the testes into 200-300 lobules.
3. **TUNICA VASCULOSA** – It is the innermost, vascular coat of testes lining its lobules.

14. CREMASTRIC MUSCLE

- It is the thin fascial muscle of the spermatic cord derived from internal oblique muscle aponeurosis.
- Its arterial supply is from the cremasteric artery, a branch of the inferior epigastric artery.
- Like the testes, venous blood drains into the pampiniform plexus.
- It is innervated by sympathetic and somatic fibres of the genital branch of the genitofemoral nerve.
- It shows cremasteric reflex, i.e., ipsilateral contraction of muscle and testes upon stroking the skin of the medial upper thigh.
- It is important in spermatogenesis and thermoregulation.

15. SPACES RELATED TO ANAL CANAL

1. **PERIANAL SPACE** – around anus below transverse septum
2. **ISCHIORECTAL SPACE** – posteriorly around anorectal region via deep postanal space
3. **SUPRALEVATOR SPACE** – posteriorly around rectum via presacral space

16. SACROTUBEROUS LIGAMENT

- One of the pelvic ligaments, it is 6.4-9.4 cm in length, located between the sacrum and ischial tuberosity.
- The proximal broad base attaches to the posterior superior iliac spine and long post sacroiliac ligament.
It descends inferiorly and laterally and spans to insert into the ischial tuberosity into its medial side.
- It assist in pelvic stability.
- It is considered to be linked with pudendal nerve entrapment.

17. NERVUS ERIGENTES

- The pelvic splanchnic nerve is also known as nervi erigentes
- These are preganglionic parasympathetic nerve fibres that arise from S2, S3, S4 nerve roots of the sacral plexus.
- These nerves form the parasympathetic portion of the autonomic nervous system in the pelvis.

18. STRUCTURE PASSING THROUGH INLET OF PELVIS

1. SIGMA WITH THE ROOT OF THE MESOSIGMA (which is at the level of left sacroiliac joint)
2. The URETER
3. The VAS DEFERENS
4. Sometimes even CAECUM and the APPENDIX descend into the pelvis from the right iliac fossa, near the right sacroiliac joint.
5. The BLADDER tends to protrude beyond the upper strait when the bladder is full.
6. The PARIETAL PERITONEUM turns out to be the deepest parietal structure the crosses the upper pelvic narrow.

19. CONJOINT LONGITUDINAL COAT

- Formed by fusion of puborectalis and longitudinal muscle coat of rectum.
- Lies between the external and internal anal sphincters.
- Divides the fibroelastic septa
- Most lateral part of these septa forms perianal fascia.

20. HILTON'S LINE AND IMPORTANCE

- A cutaneous line is also called Hilton's line or interspinchtric groove, is a boundary in the anal canal.
- It is slightly below the pectinate line and a landmark between internal and external anal sphincter muscles.
- It represents the transition point from non-keratinized stratified squamous epithelium of the anal canal to keratinized stratified squamous epithelium of the anus and parietal skin.
- In live persons, the color of the line is white, hence the alternative name.

21. PUBIC SYMPHYSIS

- It is a midline secondary amphi-arthrodial cartilaginous joint of the bony pelvis, uniting both pubic bones.
- It is reinforced by four strong ligaments- superior, inferior, anterior and posterior pubic ligaments.
- It is mainly supplied by obturator and inferior epigastric arteries.
- Supplied by branches of the pudendal and /or genitofemoral and/or iliohypogastric/ilioinguinal nerves.

22. POSITION OF HAEMORRHOIDS

- Internal hemorrhoids are varicosities of tributaries of superior rectal vein.
- Veins at 3,7 and 11o' position are more liable.
- Occurrence above pectinate line, pain less.

23. BATSON'S PLEXUS

- Batson venous plexus, also known as Batson veins, are a network of veins with no valves that connect deep pelvic veins draining the bladder, prostate, and rectum to the internal vertebral venous plexus.
- These veins provide a route for spread of pelvic cancer metastases or infections to the spine.

24. PERRECTAL EXAMINATION

- Per rectal examination is done for the diagnosis of prostatic carcinoma.
- Examination reveals irregular hard fixed prostate, and absence of median groove on the posterior surface.

25. SPERMATIC CORD

- Collection of structures passing to and fro from testis through inguinal canal

EXTENT: from deep inguinal ring to posterior surface of testis

CONTENTS:

- **DUCTUS DEFERENS**
- **ARTERIES** - Testicular artery, Cremasteric artery, Artery to ductus deferens
- **VEINS** - Pampiniform plexus
- **LYMPHATICS** from testis
- **NERVES** - Genital branch of genitofemoral nerve, sympathetic nerves
- Remains of **PROCESSES VAGINALIS**

26. EPOOPHORAN AND PAROOPHORAN

- **EPOOPHORAN** and **PAROOPHORAN** are the Vestigial remnants of mesonephric tubules in females
- Located in broad ligament of uterus

27. BLOOD SUPPLY OF SUPRARENAL GLAND

ARTERIAL SUPPLY (Three arteries for each gland)

- ❖ **SUPERIOR SUPRARENAL ARTERY** - Branch of inferior phrenic artery
- ❖ **MIDDLE SUPRARENAL ARTERY** - Branch of abdominal aorta
- ❖ **INFERIOR SUPRARENAL ARTERY** - Branch of renal artery

VENOUS DRAINAGE (One vein for each gland)

1. **RIGHT SUPRARENAL VEIN** - Drains into IVC
2. **LEFT SUPRARENAL VEIN** - Drains into left renal vein

28. TYPES OF BONY PELVIS

GYNAECOID PELVIS (NORMAL)

- Transverse diameter > Anteroposterior diameter
- Suitable for baby delivery

ANDROID TYPE (MALE TYPE)

- Anteroposterior diameter > Transverse diameter
- Results in obstructed labor

PLATYPELLOID TYPE (FLAT PELVIS)

- Transverse diameter >> Anteroposterior diameter
- Difficulty in delivery

ANTHROPOID TYPE (APE TYPE)

- Anteroposterior diameter >> Transverse diameter
- Difficulty in delivery

29. PERINEAL POUCHES AND ITS CONTENTS

DEEP POUCH:

- The perineal membrane is pierced by urethra in males, urethra and vagina in females.
- Above the perineal membrane the urethra is surrounded by external urethral sphincter.
- The external sphincter is contained within a thin fascia, which continuous with the posterior edge of the perineal membrane and it is attached at the sides to the ischiopubic rami.
- This fascial capsule is termed as deep perineal pouch.

BOUNDARIES:

- It is bounded by
 1. **INFERIORLY** – perineal membrane.
 2. **SUPERIORLY** – superior fascia of urogenital diaphragm.
 3. **LATERALLY** – inferior part of obturator fascia.

STRUCTURES WITHIN THE DEEP POUCH:

<u>MALE</u>	<u>FEMALE</u>
Membranous urethra	Urethra and vagina
Deep transverse perineal muscle and sphincter urethrae muscle	Deep transverse perineal muscle and sphincter urethrae muscle
Bulbourethral glands	No glands
Branches of internal pudendal artery [arteries to penis]	Branches of internal pudendal artery [arteries to clitoris]
Branches of pudendal nerve [dorsal nerve of penis]	Branches of the pudendal nerve [dorsal nerve of clitoris]

- The membranous layer of Scarpa's fascia in perineum fuses with the posterior edge of perineal membrane. This perineal part is called as Colle's fascia.
- Thus, superficial perineal pouch is formed between the perineal membrane and Colle's fascia.

- It is bounded by
 1. **SUPERIORLY** – perineal membrane.
 2. **INFERIORLY** – Scarpa's fascia, Colle's fascia.
 3. **LATERALLY** – inferior part of obturator fascia.

STRUCTURES WITH SUPERFICIAL POUCH:

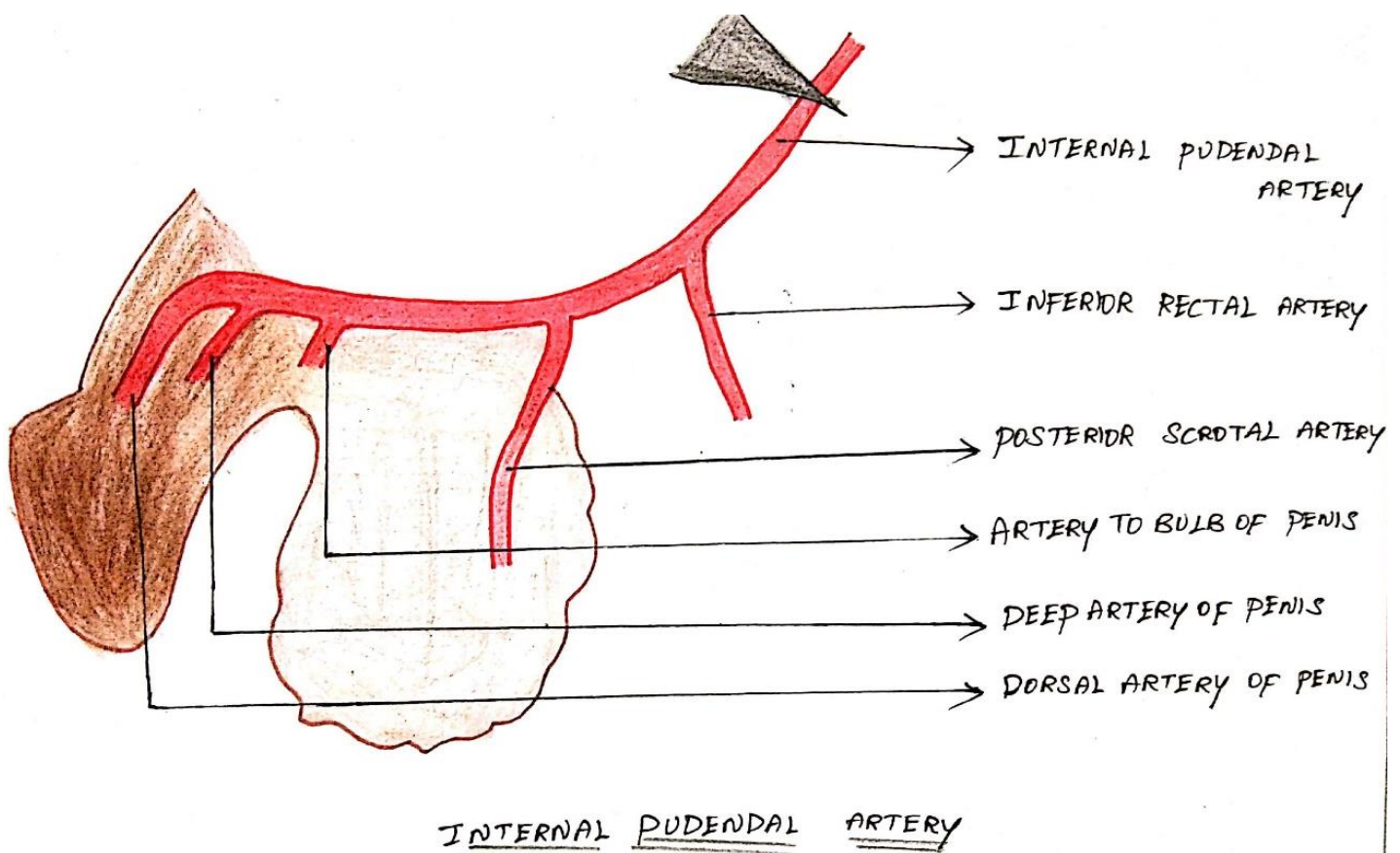
<u>MALE</u>	<u>FEMALE</u>
Root of penis	Root of clitoris
Bulb of penis covered by the bulbospongiosus muscles	Bulb of vestibule covered by bulbospongiosus muscle
crura of penis covered by the ischiocavernosus muscle	crura of clitoris covered by the ischiocavernosus muscle
Ducts of bulbourethral glands	Greater vestibular glands
Urethra	Urethra
<u>BRANCHES OF INTERNAL PUDENDAL ARTERY</u> 1. Perineal artery 2. Dorsal artery of penis 3. Deep artery of penis	<u>BRANCHES OF INTERNAL PUDENDAL ARTERY</u> 1. Perineal artery 2. Dorsal artery of clitoris 3. Deep artery of clitoris
<u>BRANCHES OF PUDENDAL NERVE</u> 1. Perineal nerve 2. Dorsal nerve of penis	<u>BRANCHES OF PUDENDAL NERVE</u> 1. Perineal nerve 2. Dorsal nerve of clitoris

30. INTERNAL PUDENDAL ARTERY

- It is one of the two terminals of the anterior division of internal iliac artery.

COURSE

- It leaves the pelvis through greater sciatic foramen below the piriformis
- It crosses the dorsal surface of ischial spine and enters the perineum through lesser sciatic foramen.
- It passes through the pudendal canal.



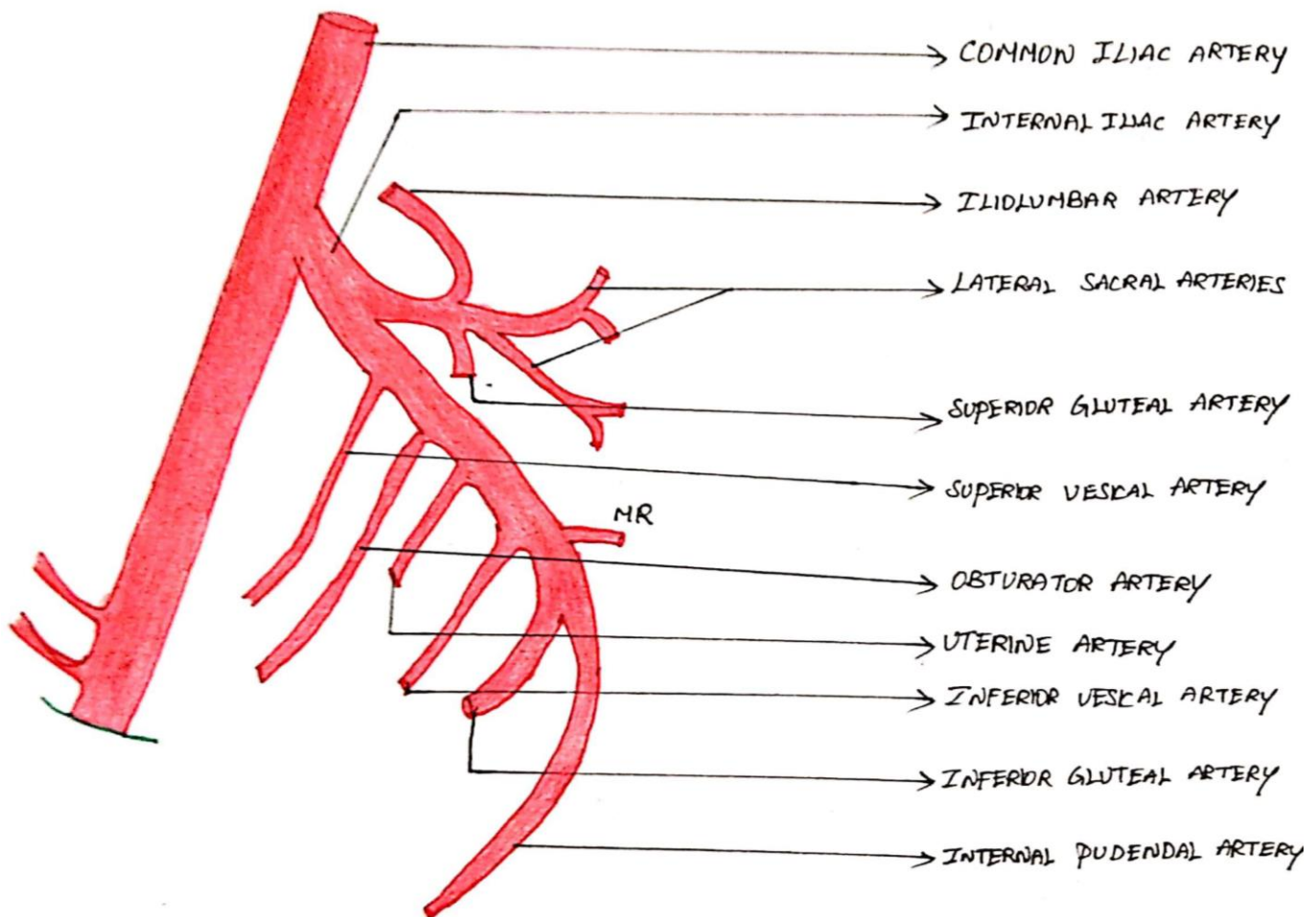
BRANCHES

1. **INFERIOR RECTAL ARTERY**: Arises in the pudendal canal, accompanies the internal pudendal nerve, supply the structures in the perineal region
2. **PERINEAL BRANCH**: Arises in the pudendal canal, enters the superficial perineal pouch, it divides into transverse perineal artery and two posterior scrotal/labial arteries.
3. **ARTERY TO THE BULB AND URETHRA**: Arises in the deep perineal pouch, supplies the erectile tissue of the bulb of penis/vestibule and urethra.
4. **DEEP ARTERY OF PENIS/CLITORIS**: supplies the erectile tissue and corpora cavernosa.
5. **DORSAL ARTERY OF PENIS/CLITORIS**: runs on the dorsal surface of penis and clitoris beneath the Buck's fascia lateral to deep dorsal vein, medial to dorsal nerve of penis. supplies prepuce and glans of penis.

31. INTERNAL ILIAC ARTERY

- It is one of the two terminals of common iliac artery.
- In the upper margin of the greater sciatic foramen, it divides into anterior and posterior divisions.

INTERNAL ILIAC ARTERY



MR - MIDDLE RECTAL ARTERY

BRANCHES OF ANTERIOR DIVISION

1. **SUPERIOR VESICAL ARTERY**: It is the persistent proximal part of umbilical artery in fetus. It supplies the upper part of the urinary bladder.
2. **OBTURATOR ARTERY**: It passes along the lateral wall of the pelvis and leaves it through the obturator canal. It gives a pubic branch which anastomoses with the branch of inferior epigastric artery on the body of the pubis.
3. **UTERINE ARTERY**: It ascends upwards along the lateral margin of the uterus, the runs along the uterine tube and anastomoses with ovarian artery.
4. **INFERIOR VESICAL ARTERY /VAGINAL ARTERY**: It supplies the base of the bladder, prostate, seminal vesicles in males. It supplies bladder and vagina in females.
5. **MIDDLE RECTAL ARTERY**: it is a small branch passes medially to the rectum.
6. **INFERIOR GLUTEAL ARTERY**: It is the largest branch; it passes between the ventral rami of S1 and S2 nerves to enter the gluteal region through greater sciatic foramen.
7. **INTERNAL PUDENDAL ARTERY**: It is the principal artery of the perineum. It enters the perineum through lesser sciatic foramen.

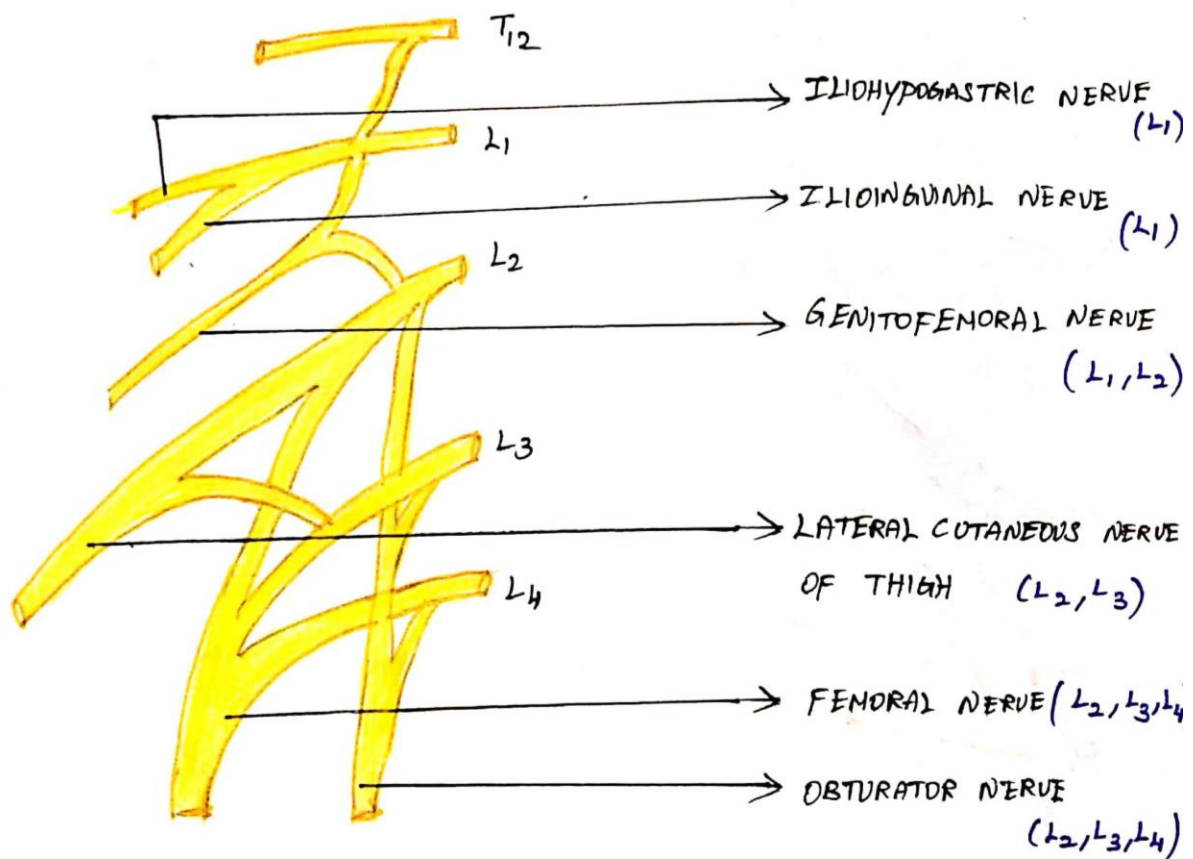
BRANCHES OF POSTERIOR DIVISION

1. **ILIOLUMBAR ARTERY**: It ascends across the sacroiliac joint to reach behind the psoas major. It divides into lumbar and iliac branches.
2. **LATERAL SACRAL ARTERIES**: There are upper and lower lateral sacral arteries on each side. Their branches enter the anterior sacral foramina supplies its contents and emerge through dorsal sacral foramina and supplies the muscles, skin on the dorsum of sacrum.
3. **SUPERIOR GLUTEAL ARTERY**: It leaves the pelvis through the greater sciatic foramen along the superior gluteal vessel.

32. LUMBAR PLEXUS

- It is formed by the union of ventral rami of L1-L3 lumbar nerves and a larger upper part of the ventral ramus of L4 nerve.
- The lower Part of the ventral ramus of L4 and ventral ramus of L5 nerve forms lumbosacral trunk. The ventral ramus L4 is called as nervi furcalis -a link between lumbar and sacral plexus.

LUMBAR PLEXUS



BRANCHES:

- The ventral ramus of L1 supplemented by a twig from T12 nerve divides into upper and lower branch.
- The upper branch gives rise to Iliohypogastric and ilioinguinal nerves.
- The smaller branch joins with a twig from L2 nerve and forms genitofemoral nerve.
- The L2, L3, L4 nerves divide into ventral and dorsal divisions.
- The dorsal divisions unite to form the Femoral nerve.
- The ventral divisions unite to form the Obturator nerve.
- Femoral nerve and Obturator nerve are principal nerves of lumbar plexus.

COURSE AND DISTRIBUTION OF BRANCHES:

1. ILIOHYPOGASTRIC:

- It emerges beneath the lateral border of the psoas major, pierces transverse abdominis and runs into anterior abdominal wall.
- It supplies skin of gluteal region and anterior abdominal wall in the hypogastric region.

2. ILIOINGUINAL NERVE:

- It has same course of Iliohypogastric nerve.
- It gives motor innervation to internal oblique and transverse abdominis muscle.
- Sensory innervation to skin on upper medial aspect of thigh, scrotum in males, mons pubis and labium majus in females

3. GENITOFEMORAL NERVE:

- It passes through the psoas and divides above the inguinal ligament into genital and femoral branch.

4. LATERAL CUTANEOUS NERVE OF THIGH:

- It emerges beneath the lateral border of psoas major.
- It enters the thigh by passing through the inguinal ligament.
- It provides cutaneous innervation to upper lateral aspect of thigh.

33. THORACOLUMBAR FASCIA

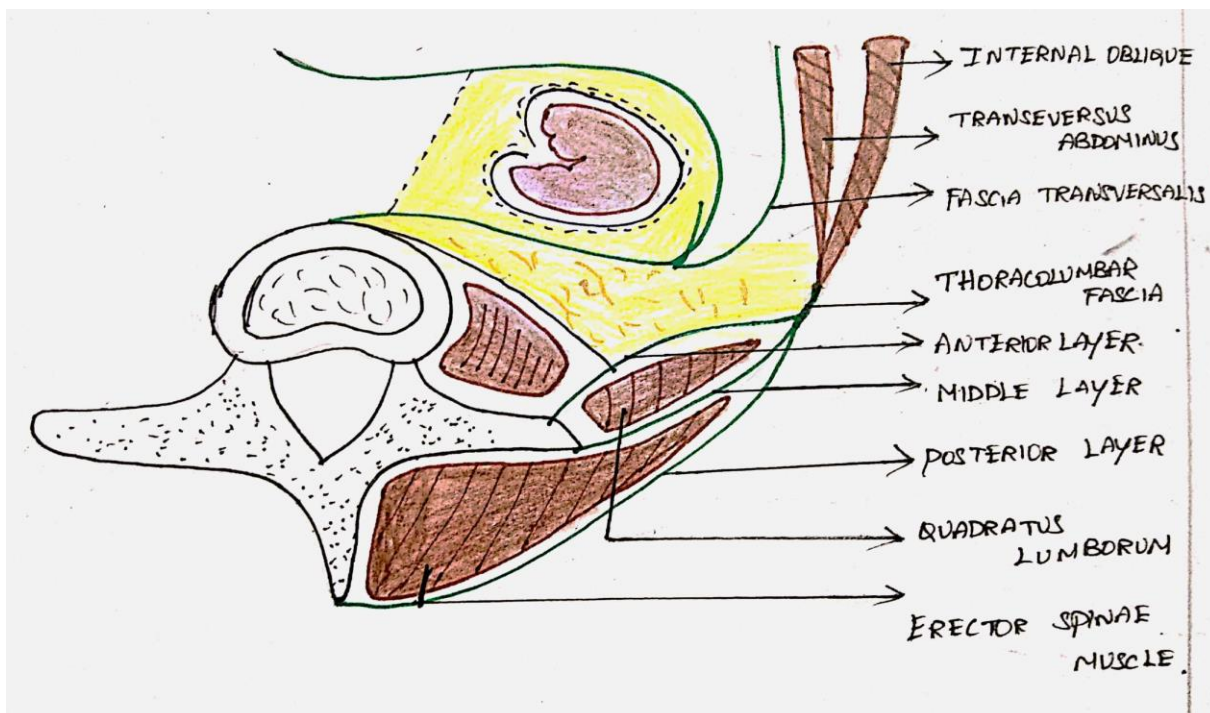
- It is the deep fascia on back of the trunk.
- It binds the erector spinae to the posterolateral surfaces of the vertebral column.
- It is divided into thoracic and lumbar parts.

LUMBAR PART:

- It consists of three layers anterior, middle and posterior.
- The middle and posterior layer are thick and strong.
- Quadratus lumborum muscle lies between anterior and middle layers.
- Erector spinae and transverse spinalis muscles lie between middle and posterior layers.
- The 3 layers fuse laterally and gives origin to internal oblique and transverse abdominis muscle.

ATTACHMENT OF THE ANTERIOR AND MIDDLE LAYER:

- **ABOVE:** Attaches to transverse process of 1st lumbar vertebrae, laterally to the 12th rib.
- **BELOW:** To the iliolumbar ligament and iliac crest.
- **MEDIALY:** To the transverse process of lumbar vertebrae.



ATTACHMENT OF THE POSTERIOR LAYER:

- **ABOVE**: Extends as the thoracic part of thoracolumbar fascia.
- **BELOW**: To the iliac crest.
- **MEDIALY**: To the spines of lumbar vertebrae.

THORACIC PART:

ATTACHMENTS

1. **ABOVE**: extends into the cervical region and fuse with fascia of the neck.
2. **MEDIALY**: To the spines of thoracic vertebrae.
3. **LATERALLY**: To the angles of ribs.

34. LEVATOR ANI

- The two levator ani are thin sheets of muscles.
- It separates the true pelvis from the ischiorectal fossa.

ORIGIN:

- It has a linear origin from pelvic surface of the pubis, tendinous arch of obturator foramen and pelvic surface of ischial spine.

INSERTION:

- The **ANTERIOR FIBRES** form a sling around prostate [levator prostate] or vagina [sphincter vaginae] and are inserted into the perineal body.
- The **INTERMEDIATE FIBRES** [puborectalis] form a sling around the anorectal junction and inserted into the anococcygeal raphe.
- The **POSTERIOR FIBRES** [iliococcygeus] are inserted into the anococcygeal raphe and the coccyx.

NERVE SUPPLY:

- Perineal branch of S4 from its pelvic surface.
- Perineal branch of pudendal nerve [S2, S3] from its perineal surface.

ACTIONS:

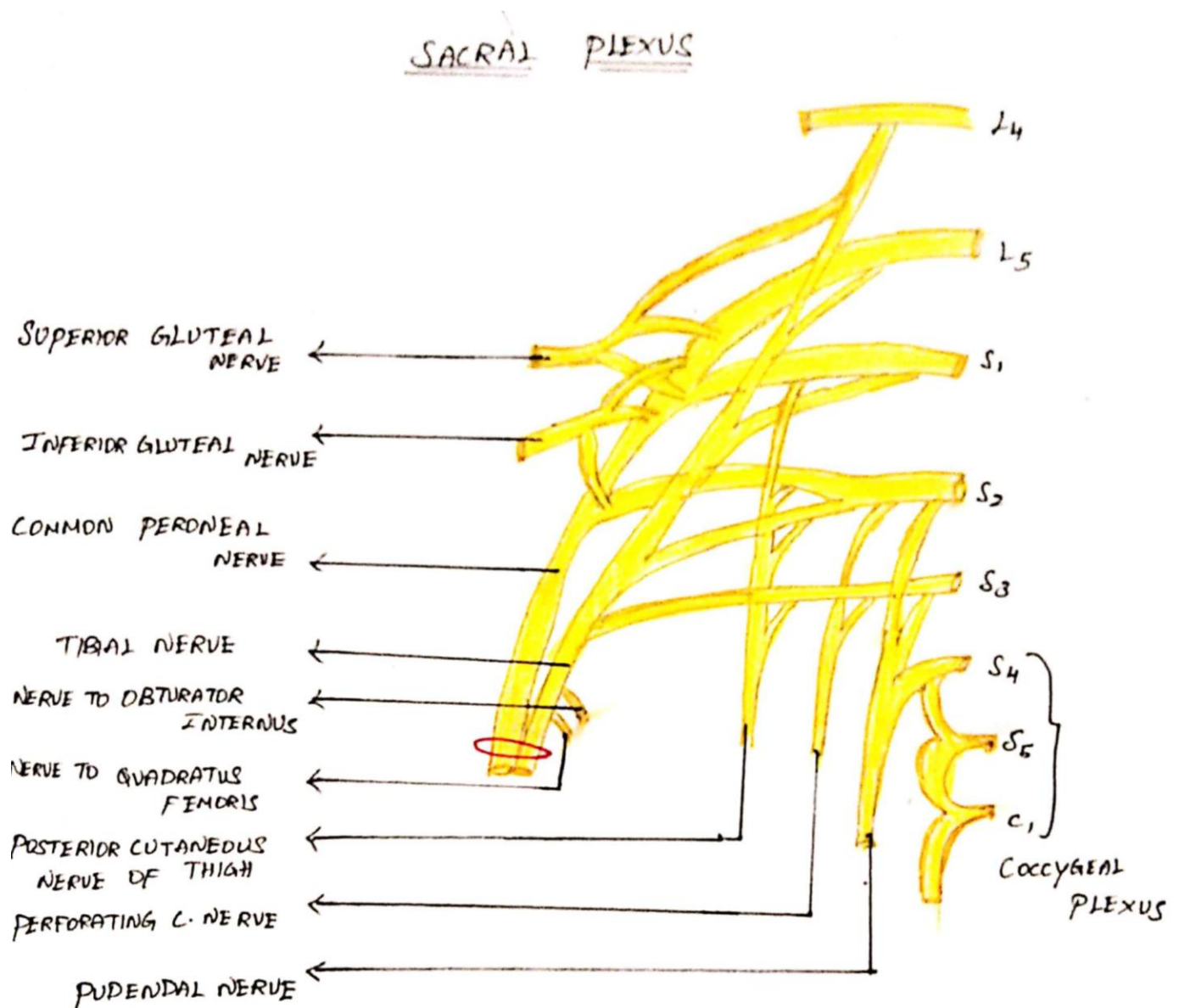
- It supports the pelvic viscera and resist intra-abdominal pressure during straining.
- They serve a sphincter action on the anorectal junction to maintain continence of feces.

CLINICAL:

LEVATOR ANI SYNDROME: It is characterized by intermittent burning pain of the rectal or perineal area due to spasm of the levator ani muscle.

35. SACRAL PLEXUS

- It is formed by the ventral rami of L4, L5, S1, S2, S3 nerves.
- The sacral plexus lies in front of the piriformis.
- The lumbosacral trunk and ventral rami of S1 nerve are separated by the superior gluteal vessels.
- The ventral rami of S1, S2 nerves are separated by the inferior gluteal vessels.



BRANCHES:

NERVES FROM ROOTS OF PLEXUS:

- **MUSCULAR BRANCHES** – to piriformis, levator ani and coccygeus.
- **PELVIC SPLANCHNIC NERVES** -they are slender branches from S2, S3 and S4. They provide outflow for parasympathetic system. They causes dilation of arteries of the erectile tissue of the penis and clitoris.

TERMINAL BRANCHES:

- **SCIATIC NERVE** -it contain two nerves common peroneal [L4, L4, S1, S2] and tibial nerve [L4, L5, S1, S2, S3] enclosed in a common sheath.
- **PUDENDAL NERVE** [ventral division of S2, S3, S4].

BRANCHES FROM PELVIC SURFACE:

- **NERVE TO QUADRATUS FEMORIS** [ventral divisions of L4, L5, S1].
- **NERVE TO OBTURATOR INTERNUS** [ventral divisions of L5, S1, S2].
- Both passes out of the pelvis through greater sciatic foramen.

BRANCHES FROM DORSAL SURFACE:

- **SUPERIOR GLUTEAL NERVE** [dorsal divisions of L4, L5, S1] It passes out the pelvis along with Superior gluteal artery above the piriformis.
- **INFERIOR GLUTEAL NERVE** [dorsal divisions of L5, S1, S2] It passes out the pelvis along with inferior gluteal artery below the piriformis.
- **POSTERIOR CUTANEOUS NERVE OF THIGH** [S1, S2, S3]
- **PERFORATING CUTANEOUS NERVE** [dorsal divisions of S2, S3]
- **PERINEAL BRANCH OF FOURTH SACRAL NERVE** -it supplies the external anal sphincter and skin around it.

36. GENITOFEMORAL NERVE

- It passes forward through the psoas pierces it and its covering.
- It runs on the anterior surface of the psoas near its medial border.
- Above the inguinal ligament it divides into genital and femoral branches.

FEMORAL BRANCH:

- It runs along the lateral side of external iliac artery.
- Then enters the femoral sheath and lies anterior to the femoral artery.
- It pierces the femoral sheath and supply the skin over the femoral triangle.

GENITAL BRANCH:

- It enters the deep inguinal ring and passes through the inguinal canal
- It passes along the spermatic cord in male and ligament of uterus in female.
- It supplies the cremaster muscle and skin of scrotum in males.
- It supplies skin of mons pubis and labium majus in females.

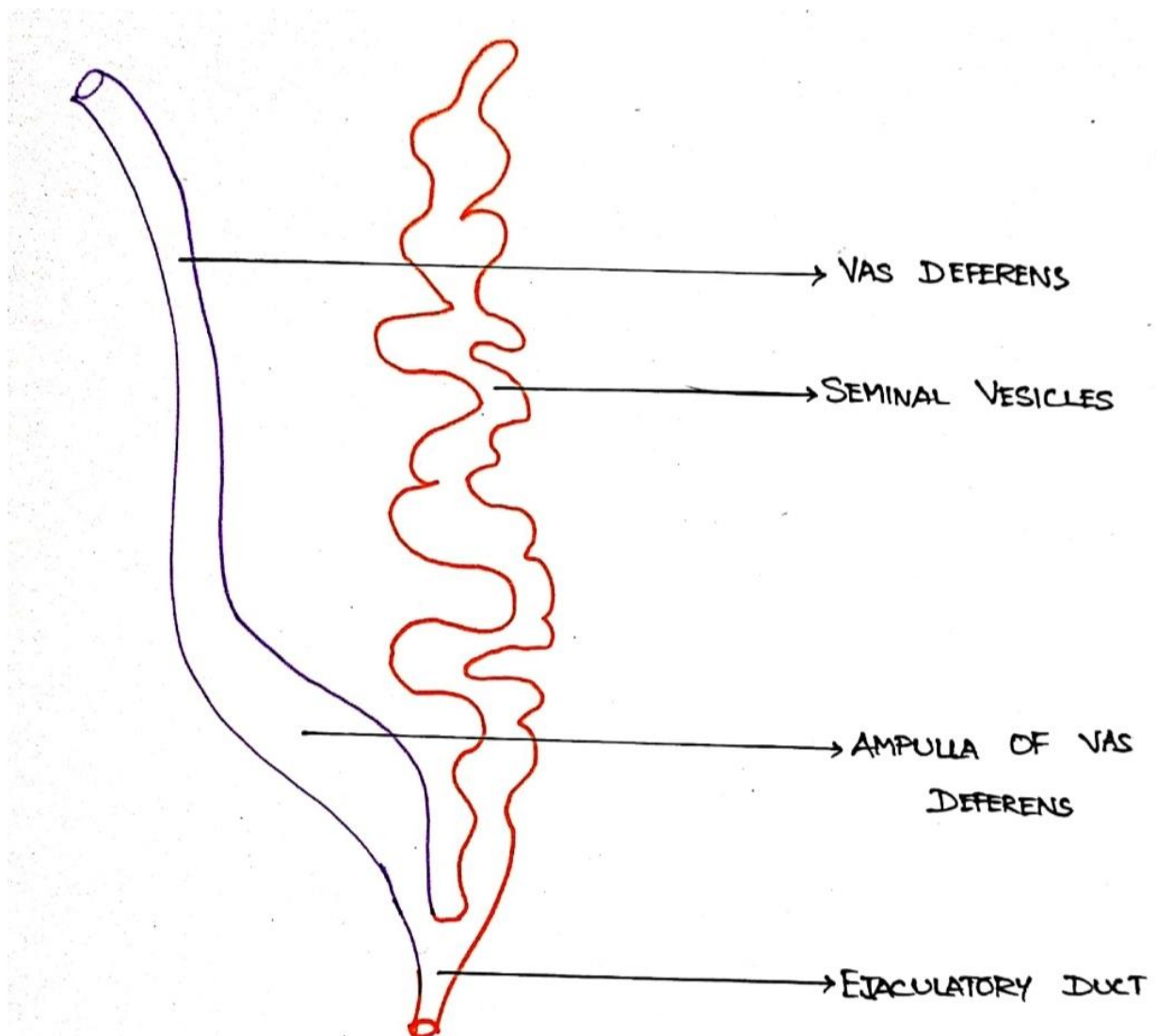
CLINICAL:

GENITOFEMORAL NERVE BLOCK:

- It is minimally invasive, non-surgical treatment for chronic pain.
- It help in diagnosis of chronic testicular groin, pelvic pain conditions.

37. SEMINAL VESICLES

- 2 Coiled sacculated tubes.
- 2 inches long.
- Lies extra peritoneally on each side at base of urinary bladder.
- Lateral to termination of vas deferens, in front of rectum.
- Lower narrow end of seminal vesicle (duct of seminal vesicle) joins duct of deferens to form **EJACULATORY DUCT**.
- Secretes seminal fluid - slightly alkaline, contains **fructose, choline and a coagulation enzyme - vesiculose**.



APPLIED ASPECTS

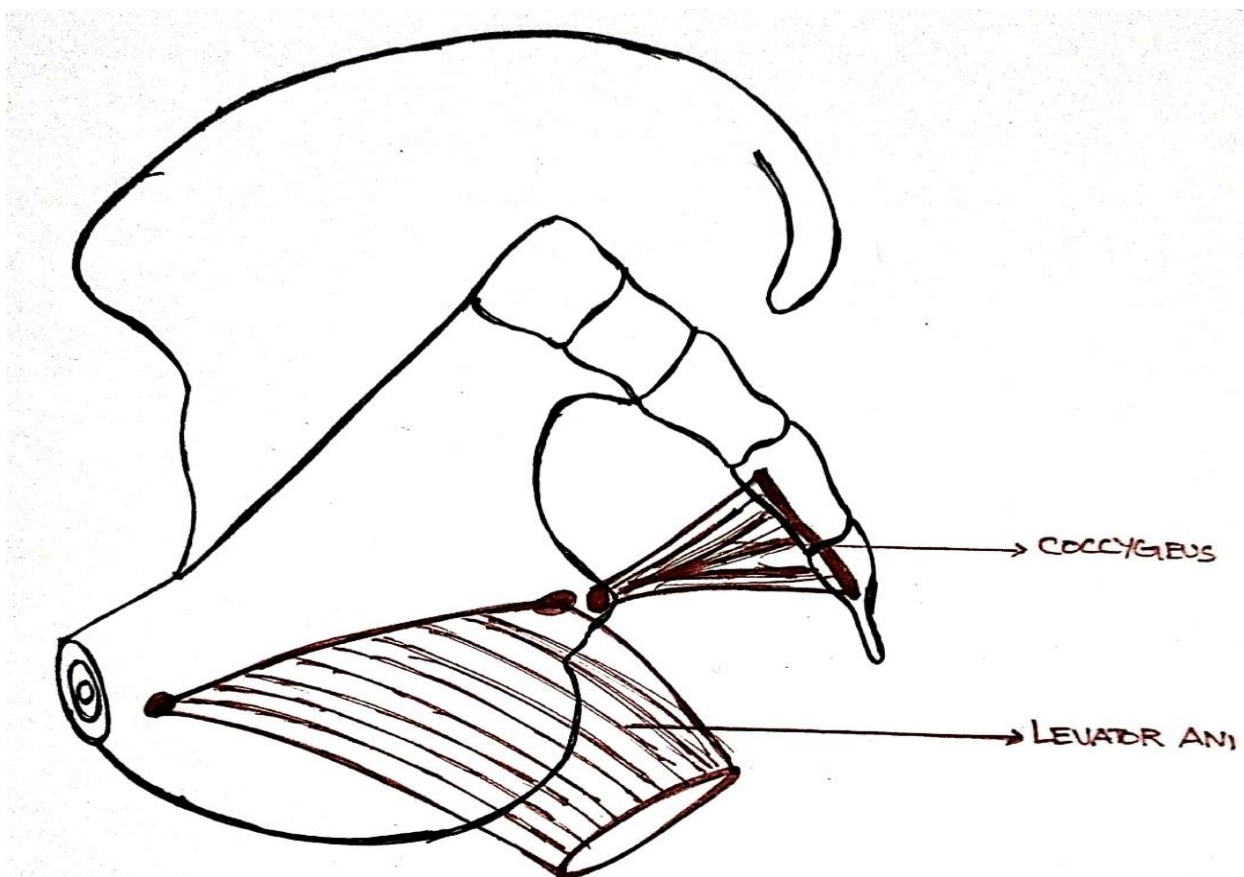
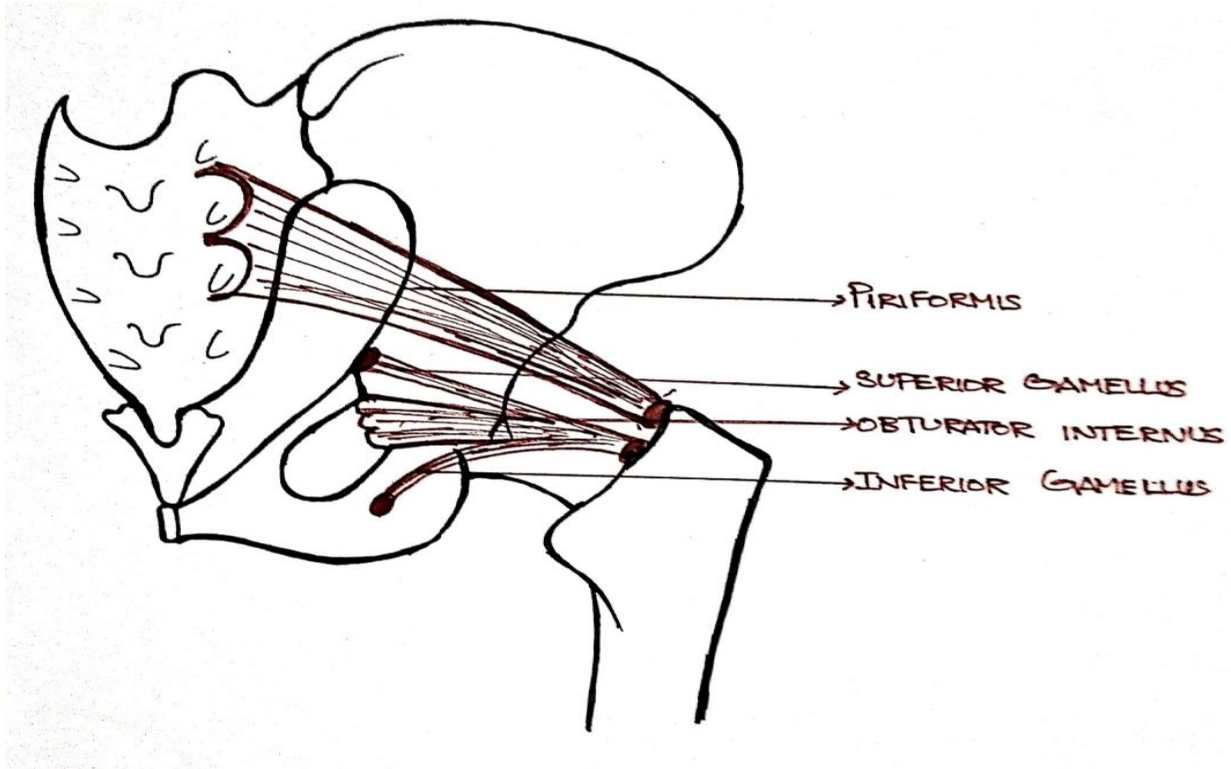
- Fructose is only produced by seminal vesicle in body.
- This provides a forensic evidence of occurrence of rape.
- **FLORENCE TEST** - **Choline crystals** provide preferred basis for determination of presence of seminal fluid.

MUSCLES OF PELVIS

1. Obturator internus
2. Piriformis
3. Levator ani
4. Coccygeus

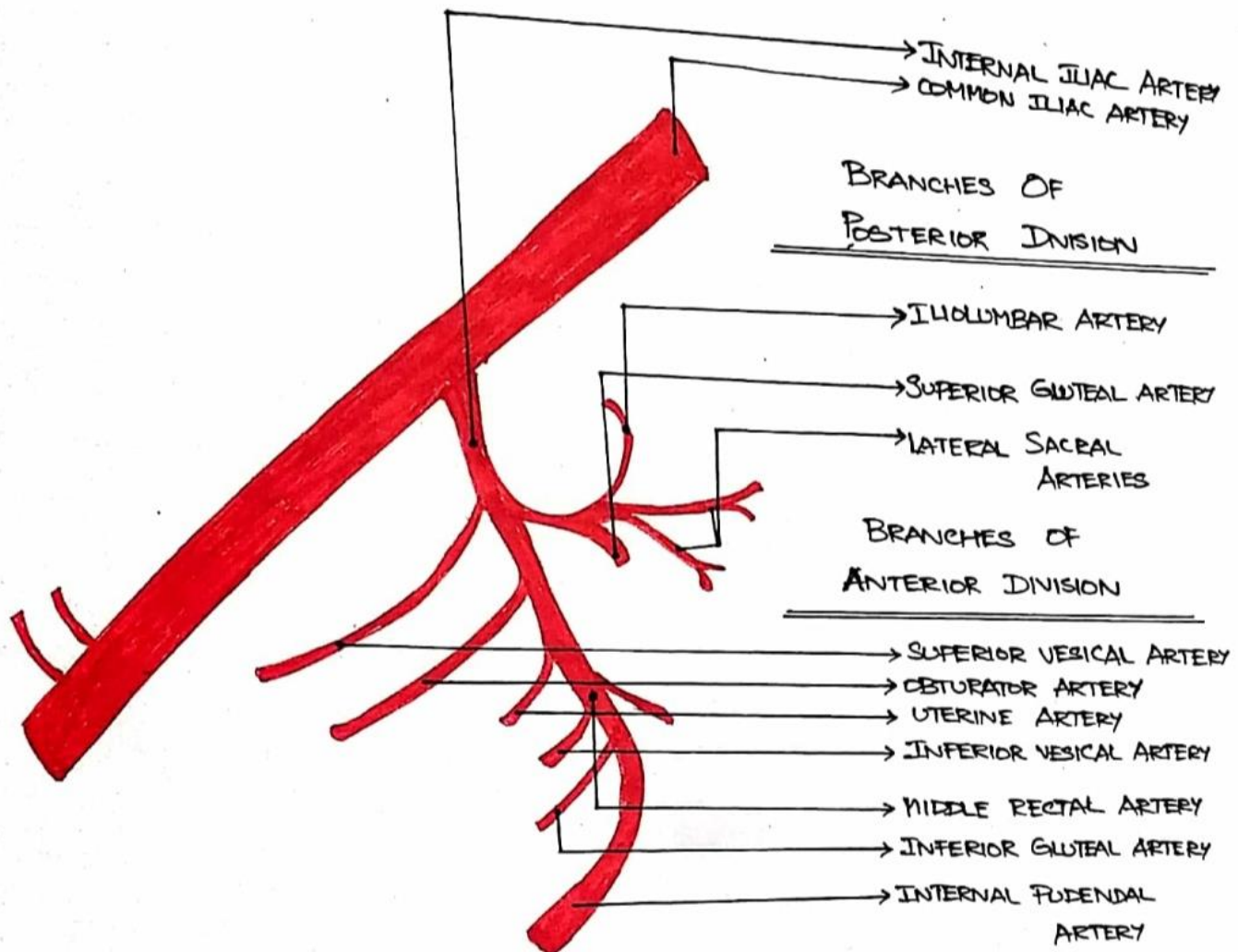
<u>MUSCLES</u>	<u>ORIGIN</u>	<u>INSERTION</u>	<u>NERVE SUPPLY</u>	<u>ACTION</u>
<u>OBTURATOR INTERNUS</u> Thick fan shaped muscle at lateral walls of pelvic walls	<u>ARISE FROM</u> Obturator membrane Margins of obturator foramen Pelvic surface of ilium between obturator foramen and greater sciatic notch	Strong tendon hooks around lesser sciatic notch, crosses hip joint to insert into medial surface of greater trochanter of femur	Nerve to obturator internus L5, S1, S2 from sacral plexus	Stabilize hip joint Lateral rotator of femur in erect posture Abductor of femur in flexed hip

<u>PIRIFORMIS</u> Triangular muscle one on either side on front of posterior wall of true pelvis	Arise from – pelvic surface of middle 3 pieces of sacrum by 3 digitations	Fibres converge Inferolaterally pass through greater sciatic notch, enters gluteal region, tendon insert into tip of greater trochanter of femur	Ventral rami of S1, S2 sacral nerves	Stabilize hip joint Lateral rotator of femur in extended hip Abductor in flexed hip
<u>LEVATOR ANI</u> 2 thin sheet of muscles form floor of true pelvis	Linear origin-pelvic surface of body of pubis, tendinous arch of obturator fascia, pelvic surface of ischial spine	<u>ANTERIOR FIBRES</u> sling around prostate (levator prostate) / around vagina (sphincter vaginae) inserted into perineal body <u>INTERMEDIATE FIBRES</u> puborectalis sling around anorectal junction inserted into anococcygeal raphe <u>POSTERIOR FIBRES</u> Iliococcygeus inserted into anococcygeal raphe and coccyx	Perineal branch of S4, perineal branch of pudendal nerve (S2, S3)	Support pelvis viscera Resist intraabdominal pressure Sphincteric action on anorectal junction to maintain continence of faeces in both sexes and vagina in female
<u>COCCYGEUS</u> small triangular muscle behind levator ani	Arises apex of ischial spine and Sacrospinous ligament	Side of last piece of sacrum and upper 2 pieces of coccyx	Ventral rami of S4, S5 sacral nerves	Support pelvic viscera Minor moves of coccyx



ARTERIES OF PELVIS

1. Superior Rectal Artery
2. Internal Iliac Artery
3. Median Sacral Artery
4. Ovarian Artery



SUPERIOR RECTAL ARTERY

- Continuation of inferior mesenteric artery.
- Supplies mucus membrane of rectum and upper half of anal canal.

INTERNAL ILIAC ARTERY

- One of the 2 terminal branches of common iliac artery.
- Passes down to pelvis to greater sciatic foramen, there it divides into anterior and posterior division.

BRANCHES OF ANTERIOR DIVISION

1. SUPERIOR VESICAL ARTERY

- Persistent proximal part of umbilical artery in fetus.
- Supply upper part of urinary bladder.

2. OBTURATOR ARTERY

- Runs forward along lateral wall of pelvis.
- Through obturator canal.
- Gives pubic branch anastomoses with pubic branch of inferior epigastric artery.
- This replace obturator artery (**accessory obturator artery**).

3. UTERINE ARTERY

- Runs medially on floor of pelvis.
- Along root of broad ligament.
- Cross ureter superiorly.
- Reach lateral fornix of vagina.
- Along lateral margin of uterus.
- Anastomose with ovarian artery.
- Gives vaginal branches.

4. INFERIOR VESICAL / VAGINAL ARTERY

- Runs to base of bladder.
- Supply base of bladder, prostate, seminal vesicles, ductus deferens in male.
- Supply Vagina and base of bladder in Female.

5. MIDDLE RECTAL ARTERY

6. INFERIOR GLUTEAL ARTERY

- Largest branch.
- Pass between ventral rami of S1, S2.
- Enters gluteal region via greater sciatic foramen.

7. INTERNAL PUDENDAL ARTERY

- **Principal artery of perineum.**
- Passes via greater sciatic foramen, along posterior surface of ischial spine.
- Enters perineum through lesser sciatic foramen.

BRANCHES OF POSTERIOR DIVISION

1. **ILIOLUMBAR ARTERY** – gives lumbar and iliac branches.
2. **SUPERIOR GLUTEAL ARTERY** – runs backwards leaves pelvis via greater sciatic foramen enters gluteal region.
3. **LATERAL SACRAL ARTERIES** – **upper and lower branches:** Supplies muscles and skin over dorsum of sacrum.
4. **MEDIAN SACRAL ARTERY**
 - Arise directly from abdominal aorta above its bifurcation.
 - It is a continuation of primitive dorsal aorta.
5. **OVARIAN ARTERY**
 - Arise from abdominal aorta at the level of L1 vertebra.
 - Runs downward.
 - Cross external iliac artery at pelvic brim.
 - Enters pelvis via suspensory ligament of ovary.
 - Supplies ovary and lateral 1/3rd of uterine tube.

38. PELVIC VISCERA

- Pelvic viscera includes urinary bladder, distal end of ureter, rectum and reproductive organs.
- Structural support is provided by bones and ligaments of pelvis.

RECTUM

- Has its peritoneal covering -upper 1/3rd on front and sides and middle 1/3rd on front.
- Transverse rectal folds.
- Passes through pelvic diaphragm to become anal canal.
- Has its blood supply and venous return.

ANAL CANAL

- Internal anal sphincter – has thickened smooth circular muscle.
- External anal sphincter – skeletal muscle.
- Anal columns.
- Pectinate line.

URINARY BLADDER

- Has its apex, base, neck.
- Trigone - Ureteric orifices, Internal urethral orifice.
- **Male urethra-** prostatic, membranous, penile.
- **Female urethra-** membranous.

FEMALE REPRODUCTIVE ORGANS

UTERUS

- Has its fundus, body, isthmus, cervix.
- Round ligament.
- Uterine artery over ureter.
- Anteversed and anteflexed posture.

UTERINE TUBE

- Isthmus, ampulla, infundibulum, fimbriae

OVARY

- Suspensory ligament of ovary
- Ovarian ligament

VAGINA

- Extends from cervix to vestibule.
- Vaginal fornices- anterior, posterior, lateral.

MALE REPRODUCTIVE ORGANS

TESTIS

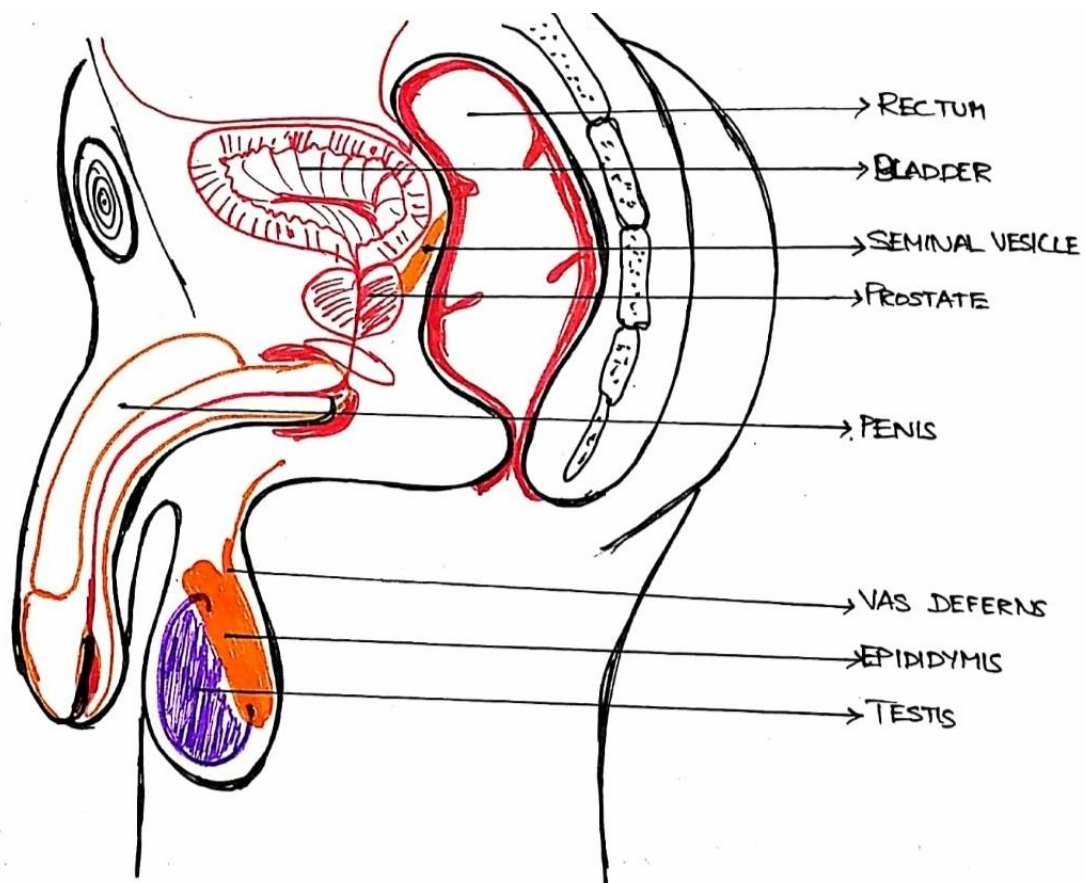
- Has seminiferous tubules.
- Epididymis.

SPERMATIC CORD

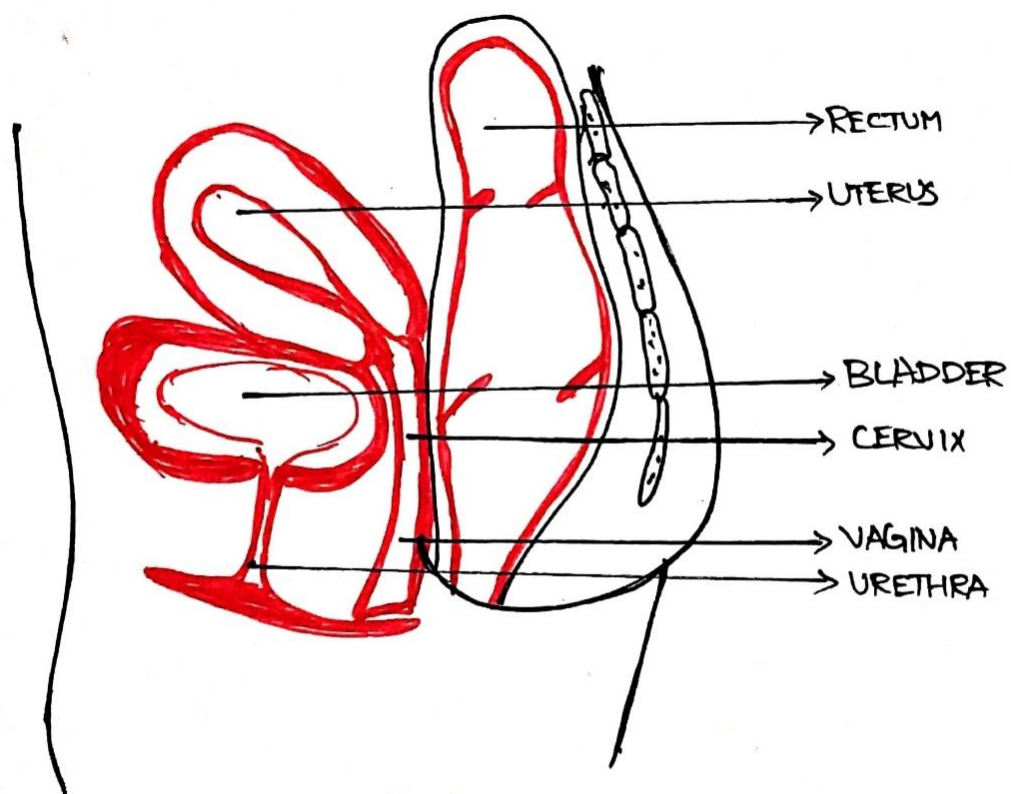
- Ductus deferens.
- Testicular artery.
- Pampiniform plexus of veins.

EJACULATORY DUCT

PROSTATE GLAND



MALE PELVIS



FEMALE PELVIS

39. PROSTATIC PART OF URETHRA

EXTERNAL FEATURES

- Widest and dilatable part of urethra
- 3 to 4 cm long
- Traverses through anterior surface of prostate

INTERNAL FEATURES (ON POSTERIOR WALL)

URETHRAL CREST

Median longitudinal mucous fold, which projects into the lumen causing the lumen to appear crescentic in transverse section

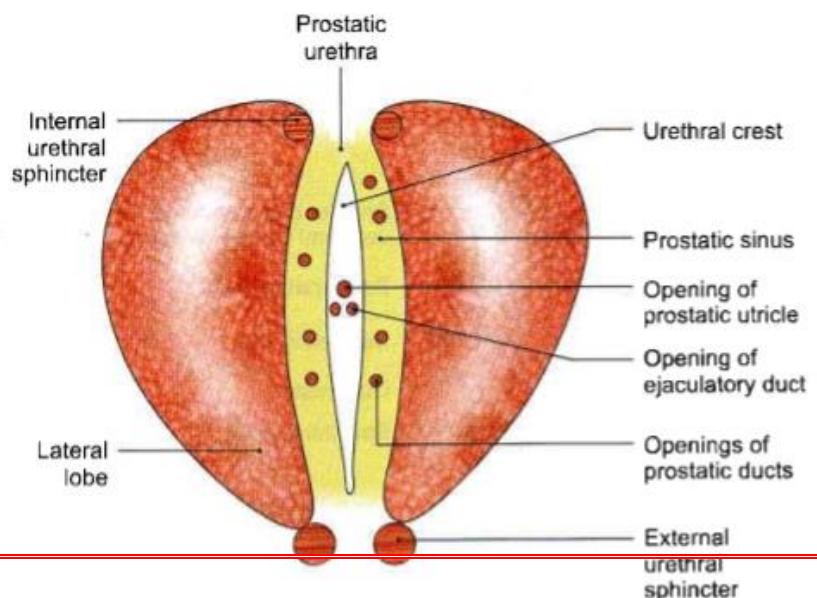
VERUMONTANUM (colliculus seminalis)-

1. Elevation in the middle of the urethral crest
2. Contains orifice of prostatic utricle
3. Opening of ejaculatory ducts on either side

PROSTATIC SINUSES - Openings of prostatic ducts

PROSTATIC UTRICLE -

- 6mm long
- runs upwards & backwards in the substance of prostate behind its median lobe
- walls composed of fibrous tissue, muscle fibres & mucous membrane
- developed from mesonephric ducts & is homologous with vaginal of female.



40. FEMALE URETHRA

- 4 cm long, 6mm in diameter.
- Extends from internal urethral orifice of bladder to external urethral orifice.
- Embedded in the anterior wall of vagina.
- Urethral orifice is located in front of vaginal orifice and behind glans clitoridis.
- **Urethral crest** – ridge possessed by anterior & posterior wall of the canal.
- Many minute urethral glands & pit-like recess or lacunae open into urethra.
- On each side, paraurethral duct runs & ends in a small aperture on lateral margins of external urethral orifice
- **ARTERIAL SUPPLY** – Superior vesical & vaginal arteries

Venous Drainage – Venous Plexus Around Urethra → Vesical Venous Plexus → Internal Pudendal Vein → Internal Iliac Vein

- **LYMPHATICS** – Internal & external iliac nodes
- **NERVE SUPPLY**
 1. **PARASYMPATHETIC** preganglionic fibres from S2-S4 of spinal cord
 2. **SOMATIC** fibres from S2-S4
 3. **SENSORY** fibres reaching S2-S4

CLINICAL NOTES

1. **EASIER CATHETERISATION OF FEMALE URETHRA** – Short and most dilatable
2. **URINARY TRACT INFECTIONS** – Shortness and closeness to anal orifice
3. **URINARY INCONTINENCE** – Tenuous external urethral sphincter

41. DIFFERENCES BETWEEN THE MALE & FEMALE URETHRA

MALE URETHRA	FEMALE URETHRA
• Transports both urine and semen	• Transports only urine
• Longer (20 cm)	• Shorter (4 cm)
• Diameter - 8 to 9 mm	• Diameter - 6 mm
• Opens at the tip of penis	• Opens in front of vaginal orifice
• Differentiated into three regions	• No morphological differentiation
• Path is curved & catheterization is difficult	• Path is straight & catheterization is easier
• Most affected by the passage of kidney stones	• Most affected by bacterial infections

42. BROAD LIGAMENT OF THE UTERUS

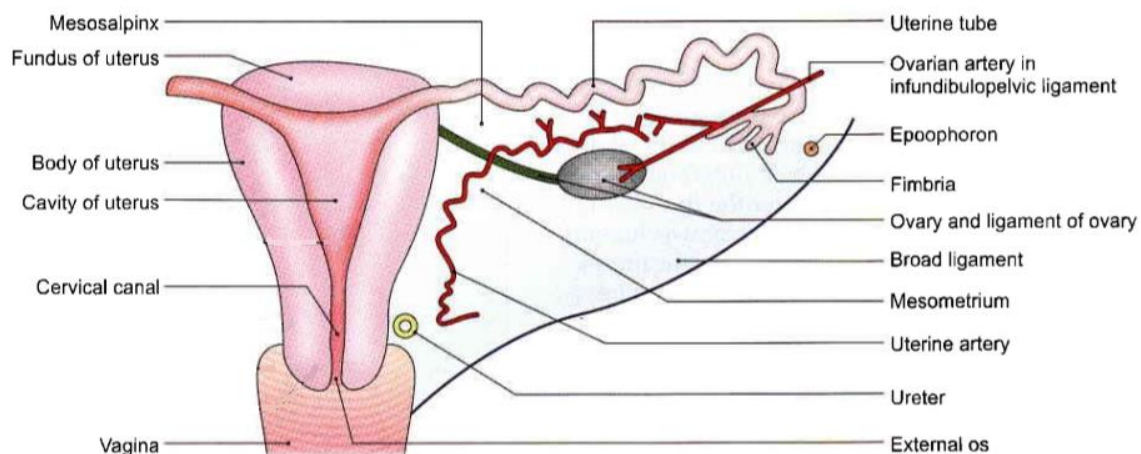
- Secondary support of uterus.
- Large peritoneal fold extending from lateral border of uterus to lateral pelvic wall
- When bladder is full, the ligament has anterior & posterior surfaces; upper, lower, medial, lateral borders.

PARTS:

1. **MESOVARIUM** – part of broad ligament lying between ovary & lateral angle of uterus
2. **MESOSALPINX** – part lying between uterine tube & ligament of ovary
3. **MESOMETRIUM** – part of broad ligament below the ligament of ovary
4. **SUSPENSORY LIGAMENT OF OVARY** (Infundibulopelvic ligament) – part stretches from upper pole of ovary & infundibulum of uterine tube to lateral pelvic wall

CONTENTS (mnemonic – FUR ROPE)

- Fallopian tube
- Round ligament of uterus
- Ligament of ovary
- Ovarian & uterine vessels
- Uterovaginal & ovarian nerve plexuses
- Paroophoron
- Epoophoron
- Lymph nodes & lymph vessels
- Parametrium present on the sides of the uterus



43. UTERINE TUBES (FALLOPIAN TUBES)

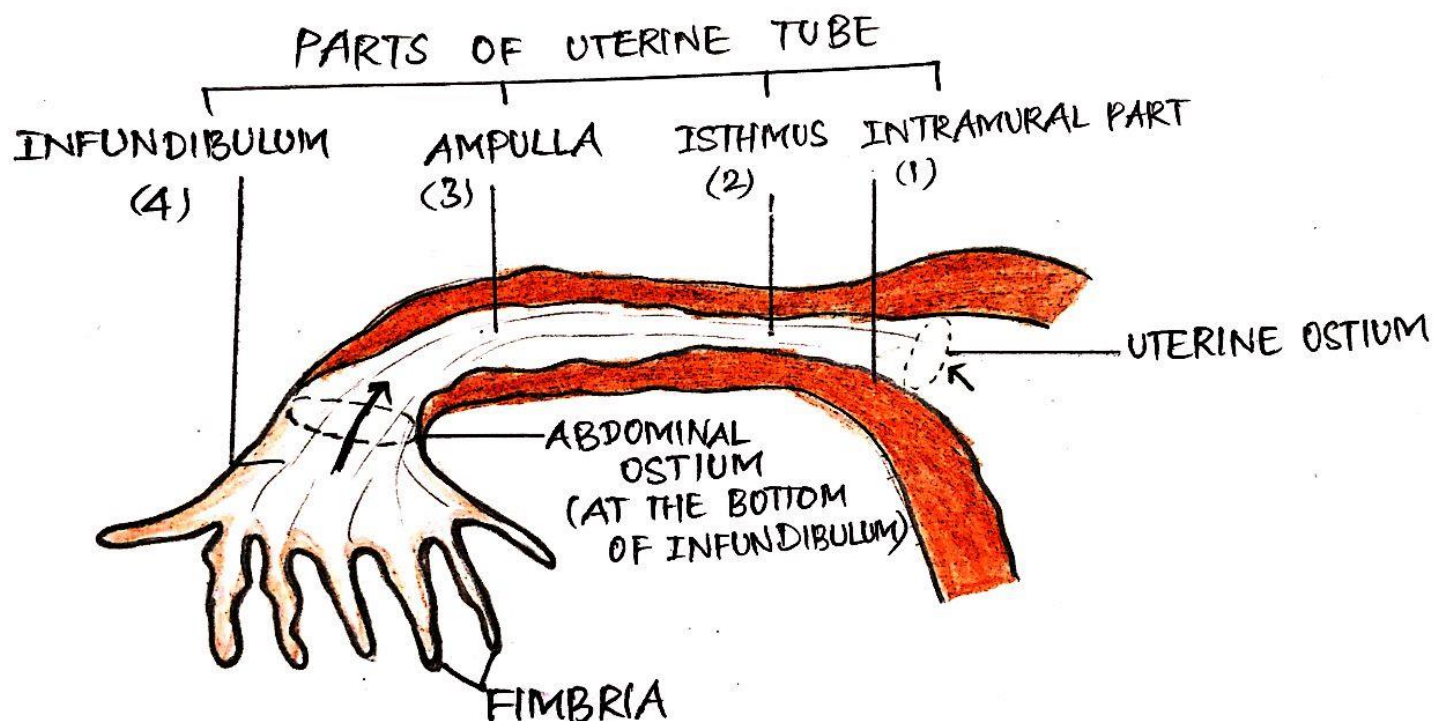
- They are pair of tortuous ducts which transmits ova from the ovaries to the uterus
- They are situated in the free upper margin of the broad ligament of uterus.

DIMENSIONS

- 10cm long.
- ostium is 3mm in diameter

EXTERNAL FEATURES

- Two Ends
- Four parts.



MEDIAL END:

- Opening into lateral angle of uterine Cavity by narrow uterine ostium (1mm)

LATERAL END (FIMBRIATED END):

- Communicate with peritoneal cavity by piercing posterior layer of Broad Ligament.
- It curves downwards and inwards Partly to encircle the ovary

PARTS – FROM LATERAL TO MEDIAL

INFUNDIBULUM (1cm long)

- Funnel -Shaped lateral most part
- It presents abdominal ostium
- It bears a number of finger-like processes called fimbriae one of the fimbriae is longer than the others and is attached to tubal pole of ovary.

AMPULLA (6-7cm long)

- Widest and longest part of the tube
- Thin walled, dilated & tortuous
- Site of fertilization of ovum

ISTHMUS (2- 3 cm)

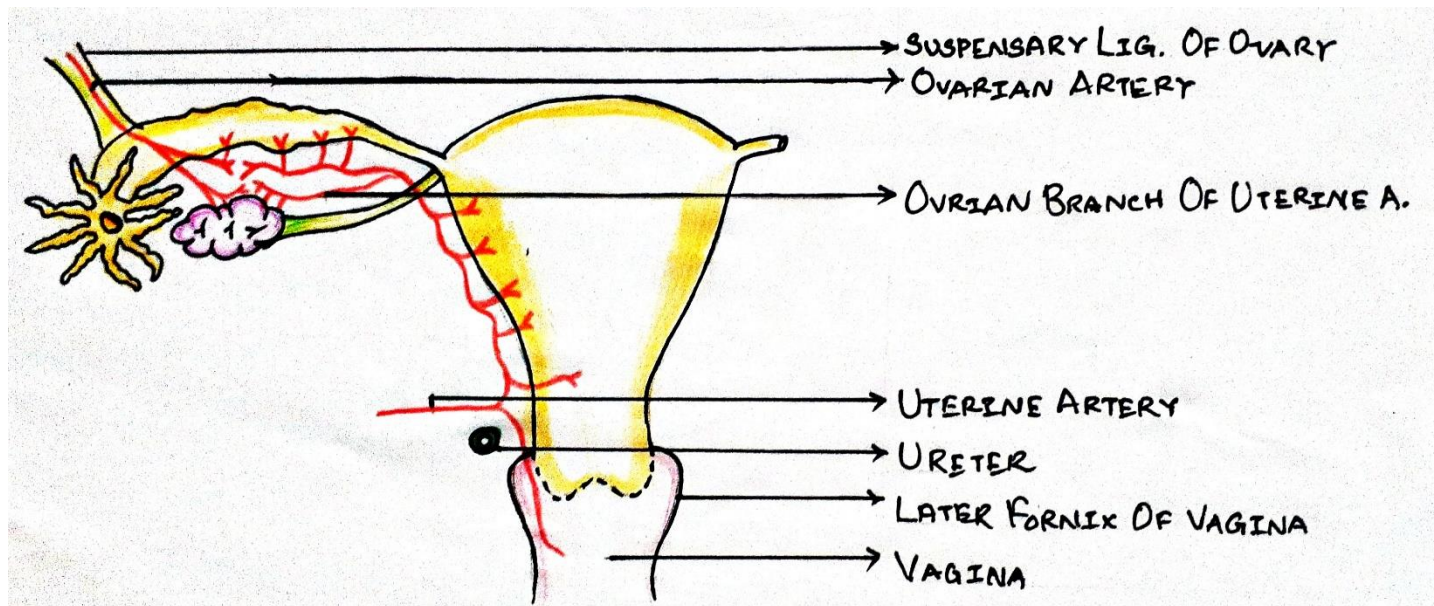
- Narrowest part
- Round and cord-like

INTRAMURAL / INTERSTITIAL/ UTERINE PART (1cm)

- Part of the tube which lies within the wall of uterus
- opens at superior angle of uterine cavity by a narrow uterine ostium

ARTERIAL SUPPLY

1. **UTERINE ARTERY** – Supplies medial 2/3rd
2. **OVARIAN ARTERY** – Supplies Lateral 1/3rd



VENOUS DRAINAGE

- Veins Corresponds arteries and runs parallel with it and drains into pampiniform plexus of ovary and into uterine veins.

LYMPHATICS

Most of the tubal lymphatics – preaortic & lateral aortic nodes

Lymphatics from isthmus – superficial inguinal nodes

NERVE SUPPLY

SYMPATHETIC

- From T10-L2 segments are derived from hypogastric plexuses
- They contain both visceral afferent & efferent fibres

PARASYMPATHETIC

- Vagus nerve for Lateral half of the tube.
- Pelvic splanchnic nerves (S2 - S4) Segment of Spinal cord for medial half.

HISTOLOGY

From Outside to inside,

- An outer serous Coat derived from peritoneum.
- The middle muscular coat is made up of Smooth muscle which is arranged into inner circular and outer longitudinal.
- The mucous membrane
 - Lined by Ciliated Columnar epithelium mixed with non-ciliated secretory cells/ Peg cells.
 - It has complicated folds.
 - There are 3-6 primary folds and Cilia tends to disappear.
 - In ampulla folds are more complex and has secondary and tertiary folds.

CLINICAL ANATOMY

SALPINGITIS: Inflammation of uterine tube.

TUBAL BLOCK is tested by

- Insufflation test or Rubin's test
- Hysterosalpingography.

ECTOPIC PREGNANCY

- Common in uterine tube

TUBECTOMY

- Operation for female Sterilization

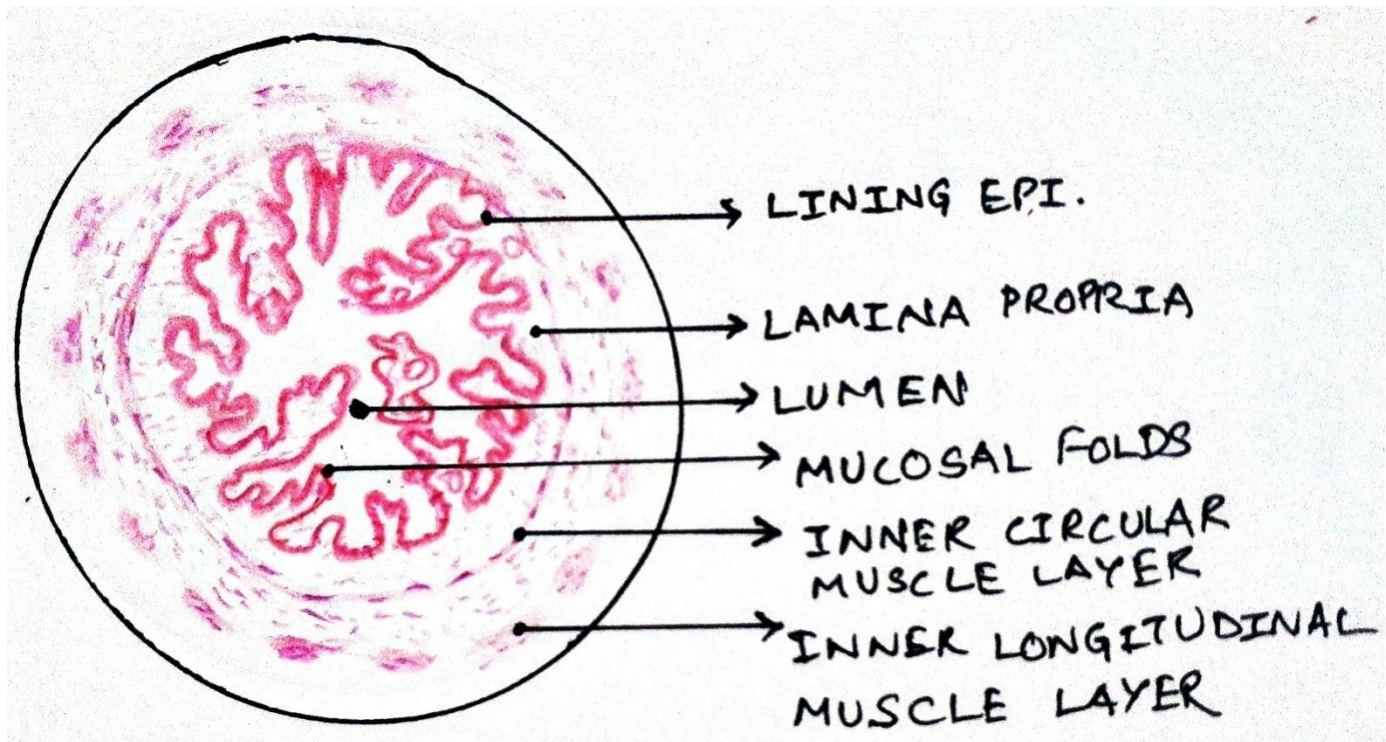
44. HISTOLOGY OF UTERINE TUBE

➤ Made up of 3 layers:

1. Mucosa
2. Muscle coat
3. Serosa

MUCOSA

- Three to six longitudinal folds, which give rise to a number of secondary and tertiary folds that almost fill the lumen of the tube.
- Lined by simple columnar epithelium.



The epithelium consist -

1. Ciliated cells help to move the ova, more prominent in proliferative phase.
2. Nonciliated secretory peg cells are longer than ciliated columnar cells.

MUSCULAR LAYER

- Made of outer longitudinal and inner circular layers of smooth muscles.
- Circular muscle is abundant at the isthmus where the lumen is narrow and acts as anatomical sphincter.

SEROSA LAYER

- Outermost layer consisting of mesothelium (peritoneum of broad ligament) & supported by connective tissue.
- Covers the entire tube except the lower border and the intramural part.

CLINICAL ANATOMY:

- Tubal obstruction forms one of the major causes of infertility in females.
- Surgical removal of uterine tube is called as salpingectomy.

45. VAGINA

DEFINITION

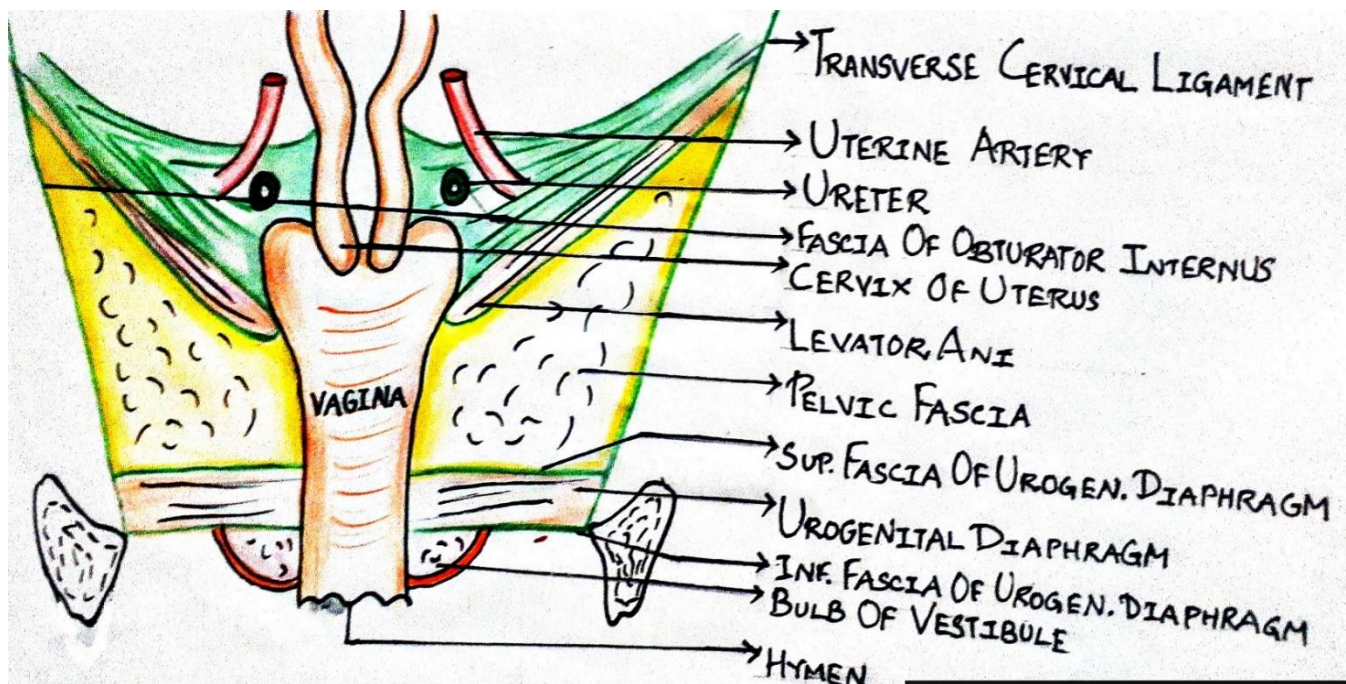
- Vagina is a fibromuscular canal, forming the female copulatory Organ.
- Vagina means a "sheath"

EXTENT AND SITUATION

- Extends from vulva to the uterus.
- Situated behind the bladder & the urethra, and in front of rectum & anal canal.

DIRECTION

- In Erect posture - directed upwards and backwards.
- Long Axis of uterus & Cervix forms angle of 90° with long axis of Vagina



SIZE

LENGTH

1. Anterior Wall-8cm.
2. Posterior Wall – 10cm.

WIDTH

1. diameter at upper end – 5cm.
2. Diameter at lower end – 2.5cm.

SHAPE

LUMEN OF VAGINA

1. **LOWER PART** – H-shaped
2. **MIDDLE PART** – Transverse Slit
3. **UPPER END** – Round / Circular.

FORNICES OF VAGINA

- The circular area of vaginal lumen around the cervix is called Fornix.

FOUR PARTS

1. **ANTERIOR FORNIX** – lies in front of cervix & is the shallowest
2. **POSTERIOR FORNIX** – lies behind the cervix & is the deepest
3. **LATERAL FORNICES** – lie on each side of cervix

RELATIONS

ANTERIOR WALL

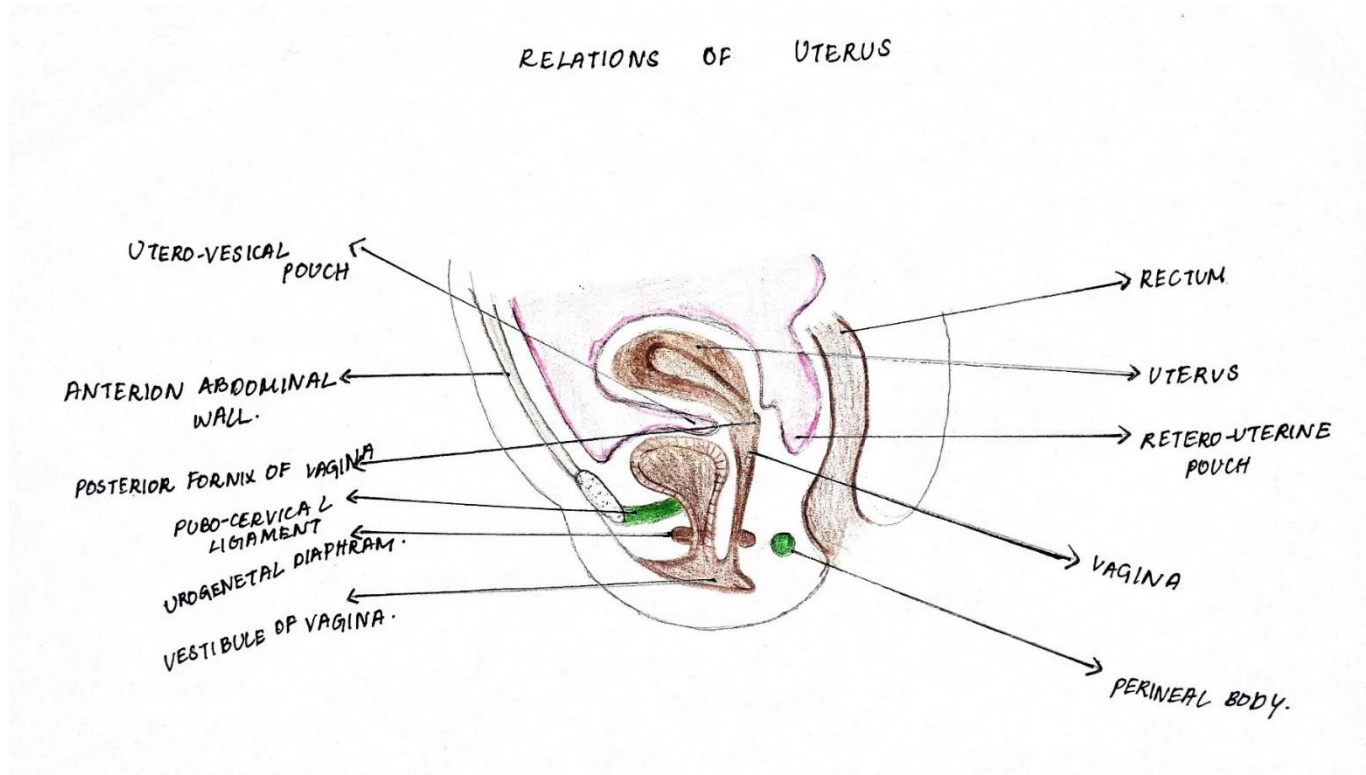
- Upper half is related to base of the bladder.
- Lower half to the urethra.

POSTERIOR WALL

- Upper $1/4^{\text{th}}$ is separated from rectum by rectouterine pouch (pouch of Douglas)
- Middle $2/4^{\text{th}}$ is separated from rectum by loose Connective tissue.
- Lower $1/4^{\text{th}}$ is separated from anal canal by perineal body & the muscles attached to it

LATERAL WALLS

- Upper $1/3^{\text{rd}}$ – transverse cervical ligament of pelvic fascia, vaginal veins, ureter getting crossed by uterine artery
- Middle $1/3^{\text{rd}}$ – pubococcygeus part of levator ani.
- Lower $1/3^{\text{rd}}$ – pierces perineal membrane; below it is related to bulb of the vestibule, bulbospongiosus & duct of greater vestibular gland of Bartholin.



ARTERIAL SUPPLY

- Vaginal branch of internal iliac artery (main artery supplying vagina)

In addition,

- UPPER PART - cervicovaginal branch of uterine artery
- LOWER PART - middle rectal & Internal pudental arteries

VENOUS DRAINAGE

Vaginal venous plexus → vaginal veins → internal iliac veins

LYMPHATICS

- UPPER 1/3RD - external iliac nodes.
- MIDDLE 1/3RD - internal iliac nodes.
- LOWER 1/3RD - medial group of superficial inguinal nodes.

NERVE SUPPLY

- UPPER 2/3RD OF VAGINA is insensitive to pain. It is Supplied by:
 1. Sympathetic (L1, L2)
 2. Parasympathetic (S2 – S4)
 3. Nerves are derived from inferior hypogastric & uterovaginal plexuses
- LOWER 1/3RD OF VAGINA is pain sensitive & supplied by the pudendal nerve via inferior rectal and posterior labial branches perineal nerve.

HISTOLOGY

- **MUCOUS MEMBRANE**-lined by non-keratinized Stratified squamous epithelium.
- **LAMINA PROPRIA** – made of loose connective tissue.
- **MUSCLE COAT** – consists of outer longitudinal & inner circular layer.
- **OUTER FIBROUS COAT** – Connective tissue.

CLINICAL ANATOMY

PER-VAGINAL EXAMINATION – To palpate pelvic organs.

VAGINITIS

1. Infection of Vagina.
2. Common in children before puberty and women after menopause.

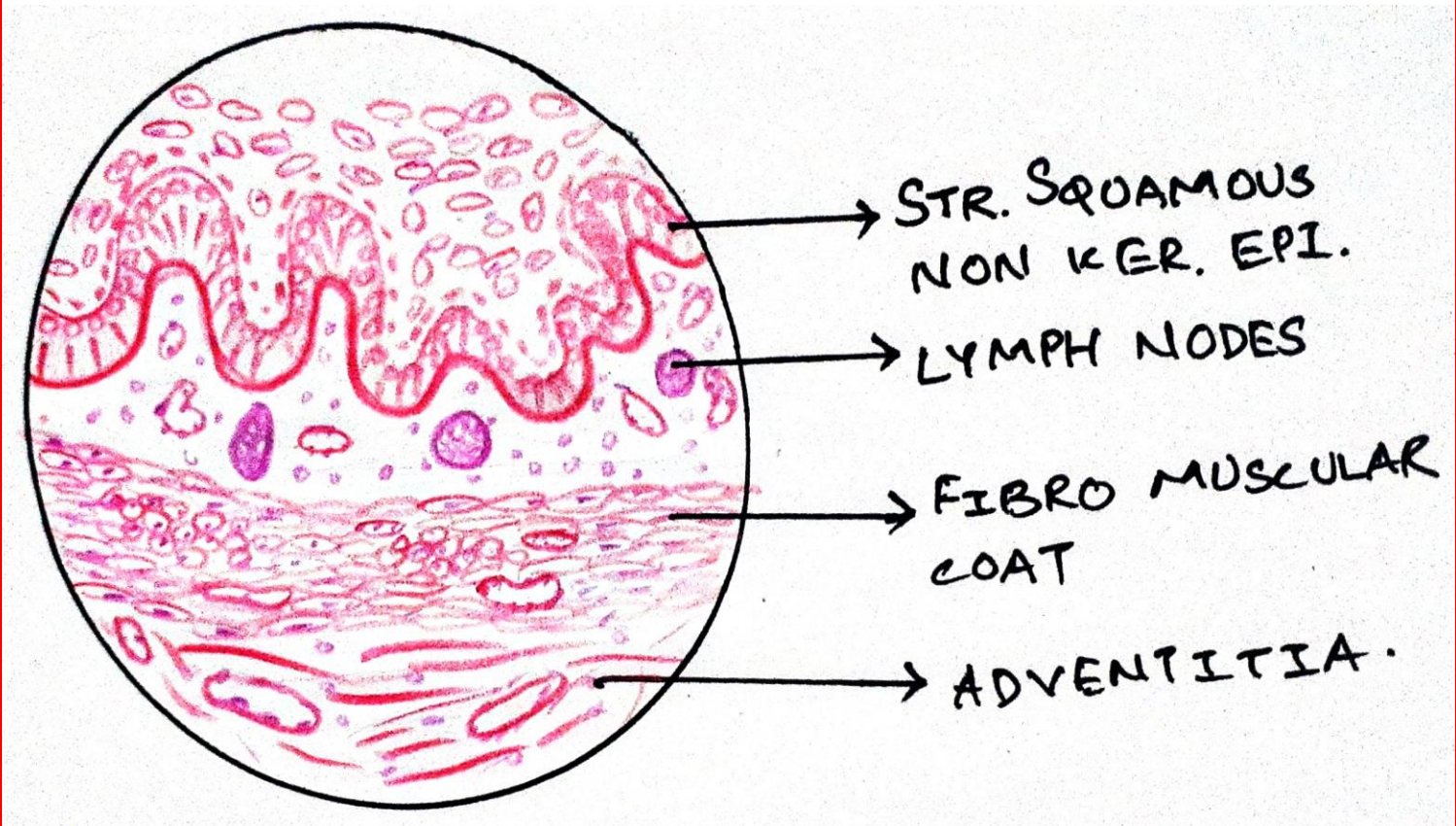
PROLAPSE – prolapsed of anterior Wall drags the bladder (Cystocele) & urethra (urethrocele); posterior wall drags rectum (rectocele).

VAGINAL LACERATIONS– Traumatic laceration of Vagina are common and may be caused by forcible Coitus (rape), during childbirth or by accidents

NEOPLASMS – secondary involvement of vagina by cancer cervix is common. Episiotomy is done to increase for the outlet for baby during delivery.

46. HISTOLOGY OF VAGINA

- From within outward, the wall of the vagina consists of 3 layers:
 1. Mucous
 2. Muscular
 3. Serosa



MUCOUS MEMBRANE

- The mucous membrane shows numerous longitudinal folds.
- It consists of:

LAMINA PROPRIA

- Composed of dense, irregular connective tissue.
- Contains plexus of blood vessels, lymphatics, and nerves.
- Contains elastic fibres that extend into muscular layer as interstitial fibres.

EPITHELIUM

- Lined by stratified squamous non -keratinized epithelium.

MUSCLE COAT

- Outer longitudinal and less numerous inner circular layers of smooth muscles.
- Rich in elastic fibres.
- Lower end has striated muscles – Bulbospongiosus muscle – forms sphincter at its external opening.

ADVENTITIA / SEROSA

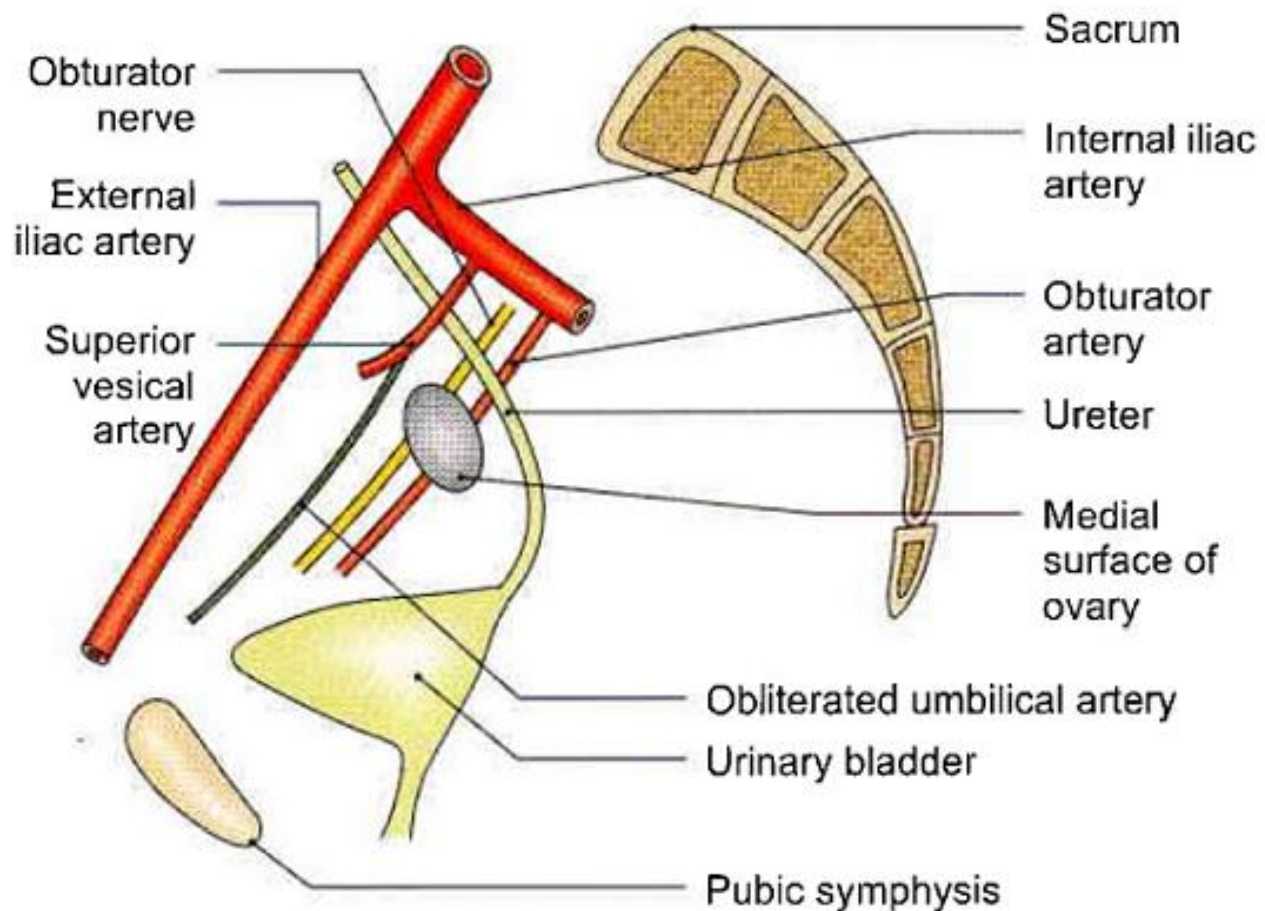
- Fibrous tissue.
- Many elastic fibres.
- Derived from peritoneum.
- Covers only Posterior fornix of Vagina.
- Blood vessels & nerve bundles are abundant.

CLINICAL ASPECTS

- The vaginal fluid is derived from the transudate present in the lamina propria and secretions from cervix.
- Naturally occurring vaginal bacterial flora (Doderlein's bacilli) metabolize the glycogen forming lactic acid and protects the vagina from invasion of pathogenic bacteria.
- Bacterial infection is common before puberty and after menopause as the acidity is low.

47. OVARIAN FOSSA

- The ovarian fossa is a shallow depression on the lateral pelvic wall, where the ovary lies.
- This ovarian fossa has the following boundaries:
 - **ANTERIORLY**: obliterated umbilical artery
 - **POSTERIORLY**: ureter & internal iliac artery



Medial view of the boundaries of the ovarian fossa as seen in a sagittal section

48. PERINEUM

- Lowest region of the trunk- below pelvic diaphragm
- Includes all structures that include pelvic outlet
- In lithotomy position, perineum is diamond shaped

BOUNDARIES

SUPERFICIAL:

A. ANTERIORLY:

1. Male- Scrotum,
2. Female- Mons pubis

B. POSTERIORLY: Buttocks

C. ON EACH SIDE: Upper medial aspect of thigh

DEEP:

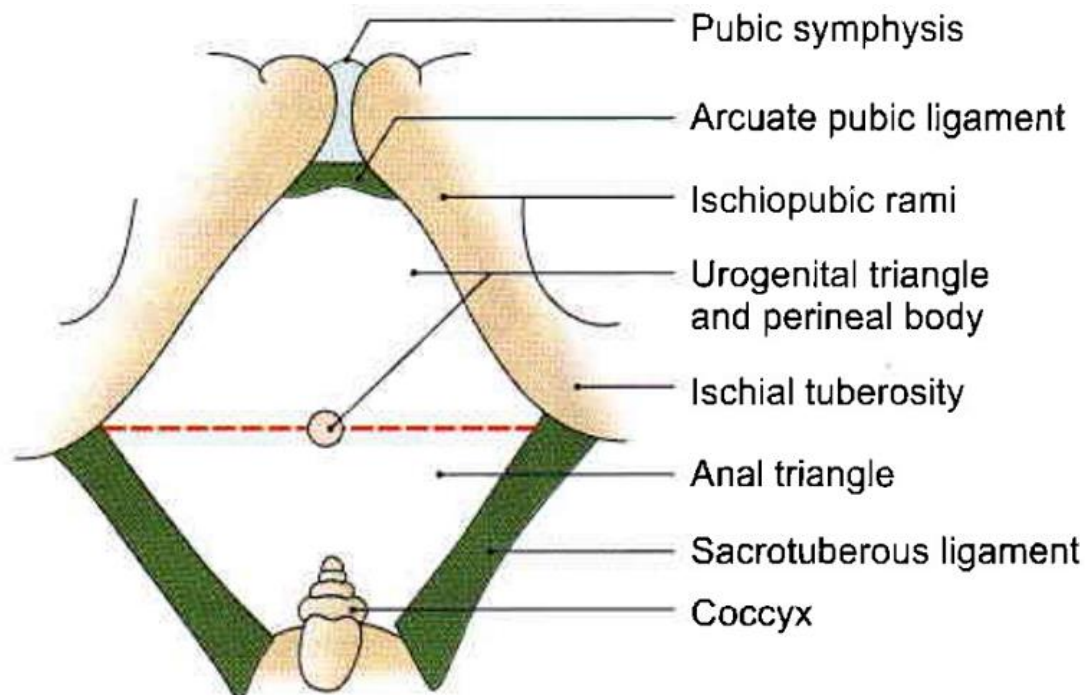
A. ANTERIORLY: Upper part of pubic arch, arcuate pubic ligament

B. POSTERIORLY: Tip of coccyx

C. ANTEROLATERALLY: Conjoint ischiopubic ramus

D. LATERALLY: Ischial tuberosity

E. POSTEROLATERALLY: Sacrotuberous ligament



Boundaries of perineum. Interrupted line shows the division of perineum into urogenital and anal regions

DIVISIONS

- A transverse line joining the anterior parts of ischial tuberosities, & passing anterior to anus, divides the perineum into 2 triangular areas.

ANTERIOR (OR) UROGENITAL REGION:

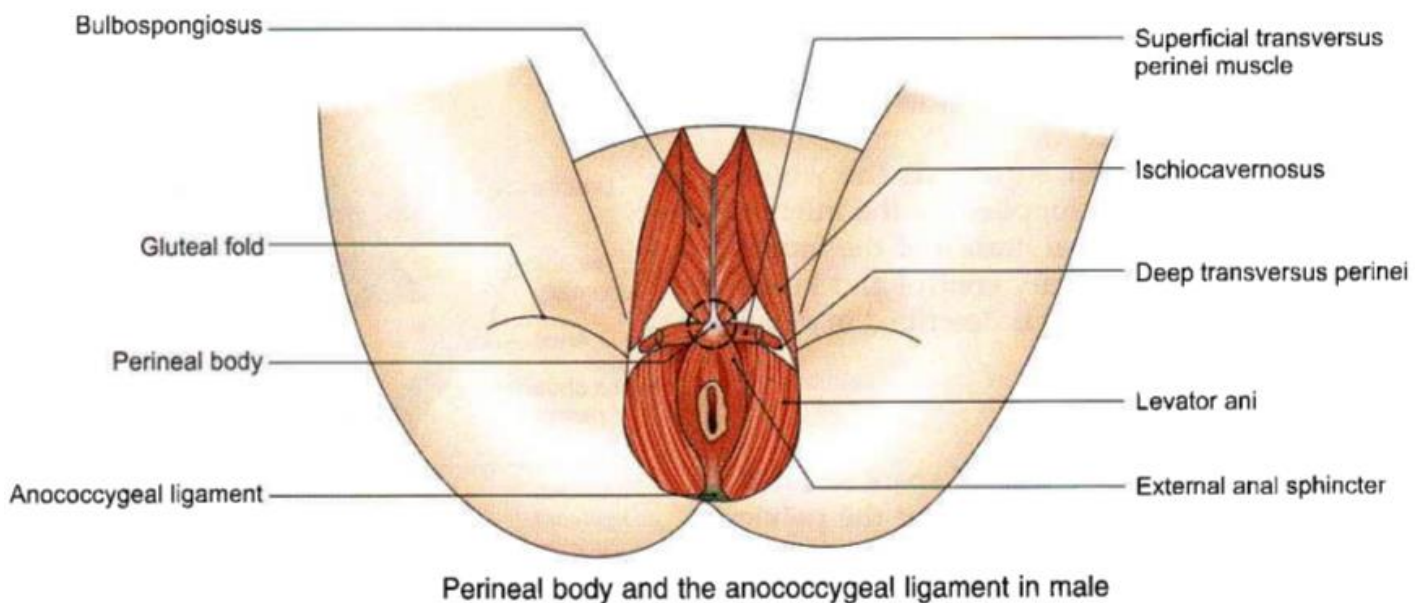
- Contains superficial and deep perineal pouches.
- On the surface, urogenital triangle presents
 1. Male – Penis & scrotum
 2. Female – External genitalia, orifices of urethra & vagina
- **CUTANEOUS INNERVATION-**
 1. Dorsal nerve of penis/clitoris
 2. Ilioinguinal nerve
 3. Genital branch of genitofemoral nerve
 4. Perineal branch of posterior cutaneous nerve of the thigh
 5. Posterior scrotal/ labial nerves
 6. Perineal branch of pudendal nerve

POSTERIOR PERINEUM (OR) ANAL TRIANGLE:

- Contains the termination of anal canal in the median plane and Ischioanal fossa on each side.
- **CUTANEOUS INNERVATION-**
 1. Inferior rectal nerve (S2, S3, S4)
 2. Perineal branch of S4 nerve.

49. PERINEAL BODY

- Wedge-shaped mass of fibromuscular tissue
- Situated in median plane, about 1.25 cm in front of anal margin & close to bulb of penis/posterior wall of vestibule of vagina.
- 10 muscles of perineum converge and interlace in perineal body:
 - A. 2 superficial transverse perineal muscles
 - B. 2 deep transverse perineal muscles
 - C. 2 bulbospongiosus muscles
 - D. 2 levator ani muscles
 - E. 1 sphincter ani externus
 - F. 1 longitudinal muscle coat of anal canal
- Important for maintaining integrity of pelvic diaphragm and providing support to pelvic organs.



CLINICAL CORRELATION

DAMAGE OF PERINEAL BODY:

- May be during difficult childbirth or cut inadvertently during episiotomy.
- This may result in prolapse of
 - A. Uterus
 - B. Bladder
 - C. Rectum

EPISIOTOMY:

- Incision given in the perineum to enlarge the vaginal orifice to facilitate childbirth.

MEDIAN EPISIOTOMY:

- Incision begins at the frenulum of labia minora. Proceeds backwards in the midline up to the external anal sphincter.
- Cuts through the skin, vaginal wall, perineal body, superficial transverse perinei muscle.
- Inadvertently, may cut external anal sphincter.

MEDIOLATERAL EPISIOTOMY:

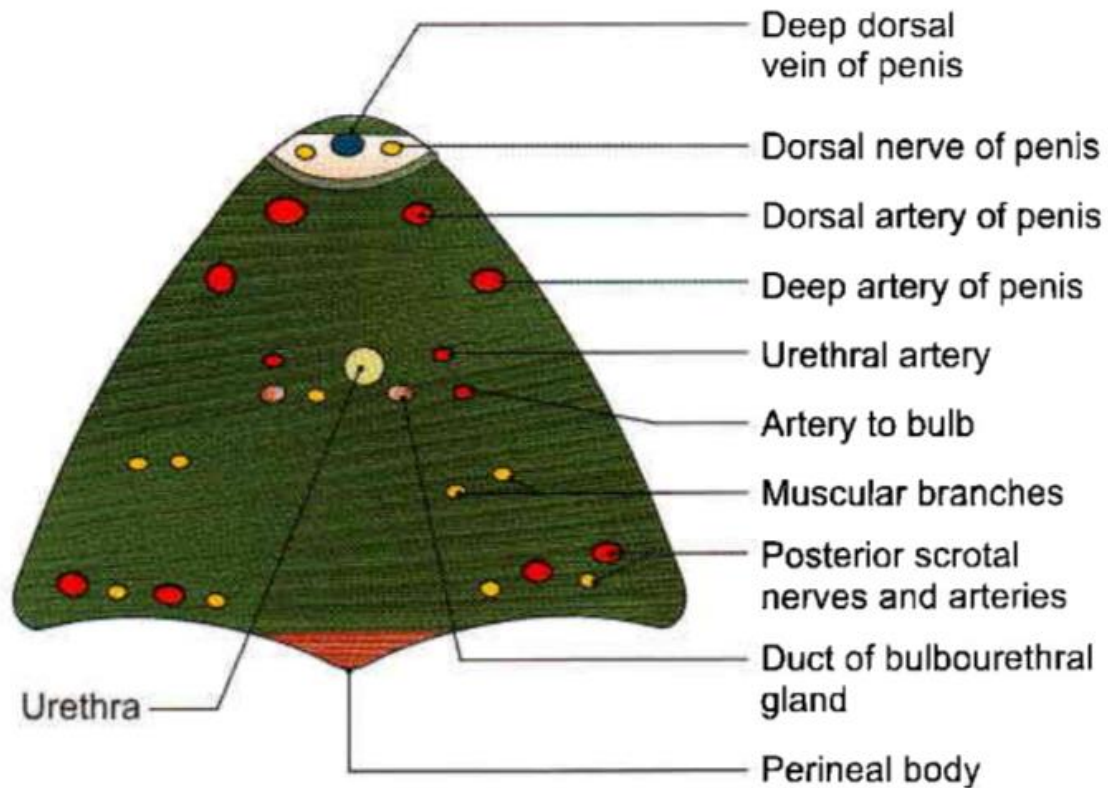
- Incision begins at the labia minor.
- Proceeds laterally at an angle of 45 degrees.
- Cuts through skin, vaginal wall, bulbospongiosus muscle.

50. PERINEAL MEMBRANE

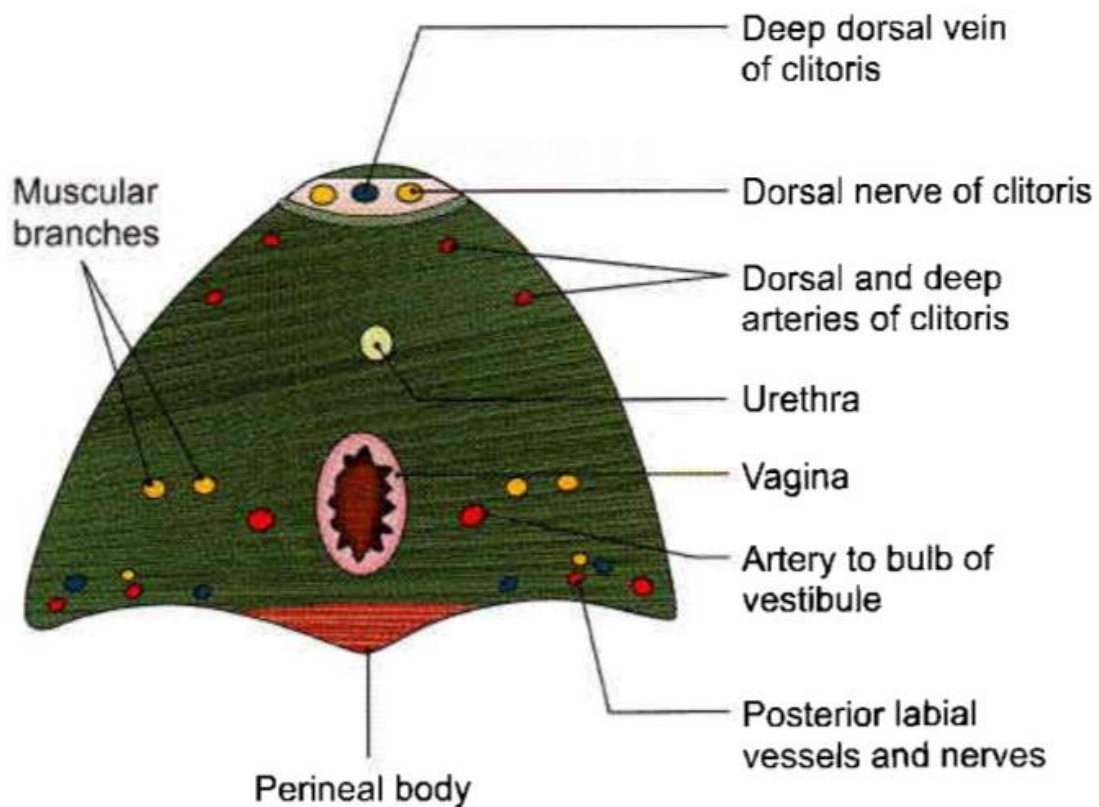
- Strong triangular membrane that stretches across urogenital triangle between the ischiopubic rami at sides.
- Intervenes between superior perineal pouch below & deep perineal pouch above.
- **LATERALLY** attached to periosteum of ischiopubic rami.
- **APEX** is attached to arcuate pubic ligament.
- **POSTERIOR BORDER** is fused to deep parts of perineal body & is continuous with the fascia over deep transverse perinei.

STRUCTURES PIERCING THE PERINEAL MEMBRANE

MALE	FEMALE
1. Urethra	1. Urethra & Vagina (behind urethra)
2. Duct of bulbourethral gland	2.
3. Artery to the bulb of penis	3. Artery to bulb of vestibule
4. Dorsal artery & dorsal nerves of penis	4. Dorsal vessels & nerves of clitoris
5. Deep artery of penis, urethral artery	5. Deep artery of clitoris
6. Posterior scrotal vessels & nerves, anterior to transverse perinei	6. Posterior labial vessels & nerves, anterior to transverse perinei
7. Muscular branches of perineal nerve to superficial perineal muscles	7. Muscular branches of perineal nerve to superficial perineal muscles



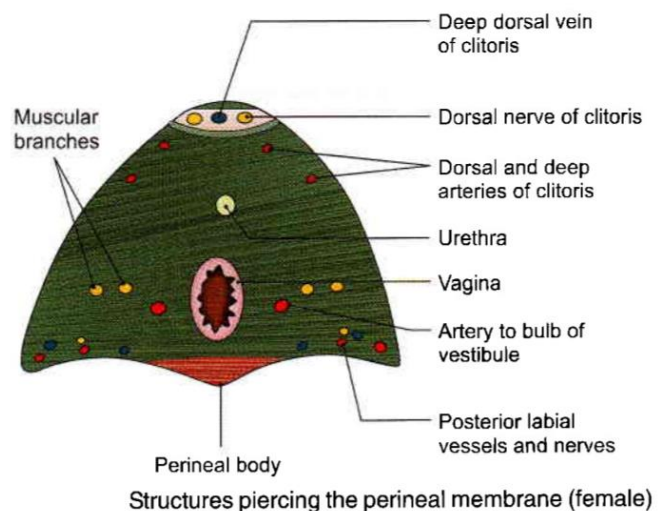
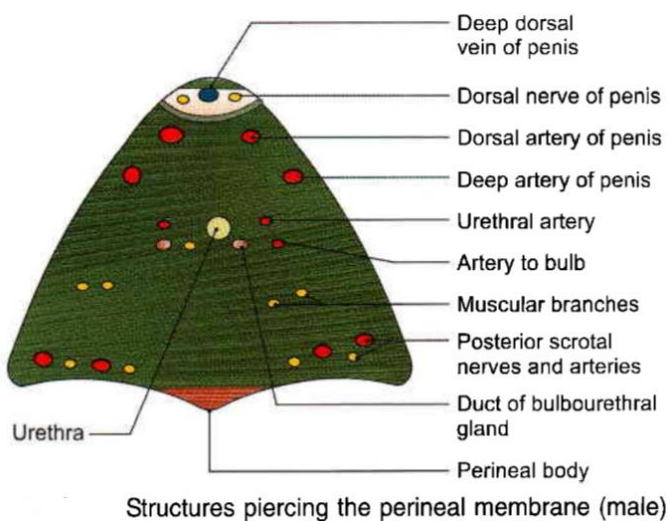
Structures piercing the perineal membrane (male)



Structures piercing the perineal membrane (female)

51. STRUCTURES PIERCING THE PERINEAL MEMBRANE

MALE	FEMALE
Urethra	Urethra & Vagina (behind urethra)
Duct of the bulbourethral gland	-
Artery to the bulb of penis	Artery to bulb of vestibule
Dorsal artery & dorsal nerves of penis	Dorsal vessels & nerves of clitoris
Deep artery of penis, urethral artery	Deep artery of clitoris
Posterior scrotal vessels & nerves, anterior to transverse perinea	Posterior labial vessels & nerves, anterior to transverse perinei
Muscular branches of perineal nerve to superficial perineal muscles	Muscular branches of perineal nerve to superficial perineal muscles



52. UROGENITAL DIAPHRAGM

- Triangular muscle sheet formed by sphincter urethrae and deep transverse perineal muscles.
- On the deeper aspect it is covered by a thin layer of endopelvic fascia called superior fascia of urogenital diaphragm.
- On the superficial aspect, it is covered by perineal membrane called inferior fascia of the urogenital diaphragm.
- Occupies the urogenital triangle with its apex behind the pubic symphysis and its sides attached to ischiopubic rami.
- Pierced by urethra in males and by urethra & vagina in females.
- Contains bulbourethral glands within it in males.

53. SUPERFICIAL PERINEAL POUCH

- It is the superficial space of the urogenital region situated superficial to the perineal membrane.

BOUNDARIES

- SUPERFICIAL**: Colle's' fascia
- DEEP**: Perineal membrane
- ON EACH SIDE**: Ischiopubic rami
- POSTERIORLY**: Closed by fusion of perineal membrane with Colle's' fascia
- ANTERIORLY**:
 - MALES**- Open & continuous with the spaces of the scrotum, penis, & anterior abdominal wall
 - FEMALES**- Open & continuous with the spaces of the clitoris & anterior abdominal wall

CONTENTS

MALE	FEMALE
Root of penis	➤ Body of clitoris, urethral orifice, vaginal orifice ➤ Two bulbs of vestibule are there, one on each side of these 2 orifices. ➤ These unite & get attached to glans clitoridis.

MUSCLES

MALE	FEMALE
Ischiocavernosus covering corpora cavernosa of penis	Ischiocavernosus covering the corpora cavernosa of clitoris
Bulbospongiosus covering corpus spongiosum – both united by a median raphe	Bulbospongiosus covering bulb of vestibule – both remain separated to give passage to urethra & vagina
Superficial transversus perinei	Superficial transversus perinei

NERVES

MALE	FEMALE
3 sets of branches from perineal nerve A. Posterior scrotal nerve B. Branch to bulb of penis C. Muscular branches	3 sets of branches from perineal nerve A. Posterior labial nerve B. Branch to bulb of vestibule C. Muscular branches
Long perineal nerve from posterior cutaneous nerve of thigh	Long perineal nerve from posterior cutaneous nerve of thigh

VESSELS

MALES	FEMALES
<u>BRANCHES OF PERINEAL ARTERY</u> 1. Posterior scrotal 2. Transverse perineal	<u>BRANCHES OF PERINEAL ARTERY</u> 1. Posterior labial 2. Transverse perineal

BRANCHES FROM ARTERY OF PENIS

1. Artery to bulb of penis
2. Urethral artery
3. Deep artery of penis
4. Dorsal artery of penis

BRANCHES FROM ARTERY OF CLITORIS

1. Artery to bulb of vestibule
2. Urethral artery
3. Deep artery of clitoris
4. Dorsal artery of clitoris

GLANDS AND DUCTS

MALE	FEMALE
Ducts of bulbourethral glands	Greater vestibular glands & their ducts

54. DEEP PERINEAL POUCH

- This is the thin space of the urogenital region situated deep to the perineal membrane
- Contributes to pelvic floor

BOUNDARIES –

- **SUPERFICIAL**: Perineal membrane
- **DEEP**: Open above
- **ON EACH SIDE**: Ischiopubic rami
- **ANTERIORLY**: Gap between perineal membrane & inferior pubic ligament

CONTENTS –

CONTENTS	MALE	FEMALE
TUBES	Part of urethra	Parts of urethra & vagina
MUSCLES	a) Sphincter urethrae or distal urethral sphincter within the wall of urethra b) Deep transversus perinei – mainly skeletal muscle	a) Sphincter urethrae within wall of urethra b) Deep transversus perinea – mainly smooth muscle c) Compressor urethrae d) Sphincter urethrovaginalis
NERVES ON EACH SIDE	a) Dorsal nerve of penis b) Muscular branches from perineal nerve	Dorsal nerve of clitoris Muscular branches from perineal nerve
VESSELS	a) Artery of penis b) Stems of origin of 4 branches: ▪ Artery to bulb of penis ▪ Urethral artery ▪ Deep artery of penis ▪ Dorsal artery of penis	a) Artery of clitoris b) Stems of origin of 4 branches: ▪ Artery to bulb of vestibule ▪ Urethral artery ▪ Deep artery of clitoris ▪ Dorsal artery of clitoris
GLANDS	Bulbourethral glands	No glands

55. ISCHIORECTAL / ISCHIOANAL FOSSA

- Wedge shaped space situated one on each side of anal canal, below pelvic diaphragm
- Base directed downwards towards surface
- Apex directed upwards

BOUNDARIES

BASE: formed by skin of perineum

APEX:

- Formed by line → obturator fascia meets anal fascia (inferior fascia of pelvic diaphragm)
- Line corresponds to origin of levator ani from lateral pelvic wall

ANTERIORLY:

- Posterior border of perineal membrane

POSTERIORLY:

- Lower border of gluteus maximus
- Sarcotuberous ligament

LATERAL WALL:

- Vertical
- formed by Obturator internus with obturator fascia
- Medial surface of ischial tuberosity below attachment of obturator fascia

MEDIAL WALL:

- Levator ani with anal fascia in upper part
- External anal sphincter with fascia covering it in lower part.

RECESSES: Narrow extensions of fossa beyond its boundaries

ANTERIOR RECESS:

- Extends forwards above perineal membrane → reaching up to posterior surface of body of pubis
- closely related to prostate or vagina

POSTERIOR RECESS:

- smaller than anterior
- extends deep to sarcotuberous ligament

HORSESHOE RECESS: connects 2 Ischioanal fossae behind the anal canal.

SPACES AND CANALS**PERIANAL SPACE:**

- Perianal fascia in form of a septum passes laterally from the lower end of longitudinal coat of anal canal
- Extends medially from white line of Hilton to pudendal canal laterally
- Separates a shallow subcutaneous perianal space from deep Ischioanal space
- Perianal space- small & shallow
- Fat- tightly arranged in small loculi formed by complete septa
- Infections- very painful due to tension caused by swelling

ISCHIOANAL SPACE:

- Large and deep
- Fat- loosely arranged in large loculi- formed by incomplete delicate septa
- Infections- least painful because swelling can occur without tension
- Lunate fascia
 1. Arches over Ischioanal fat
 2. Begins laterally at the pudendal canal & merges medially with the fascia covering the deep part of the external anal sphincter

3. Divides Ischioanal space into:
 - a) Suprasegmental space, above fascia
 - b) Tegmental space, below fascia

PUDENDAL CANAL:

- **FASCIAL CANAL**- in lateral wall of Ischioanal fossa- enclosing pudendal nerve & internal pudendal vessels
- **FASCIA**- fused with
 1. lower part of obturator fascia laterally
 2. lunate fascia above
 3. perianal fascia medially
 4. falciform process of sarcotuberous ligament below.

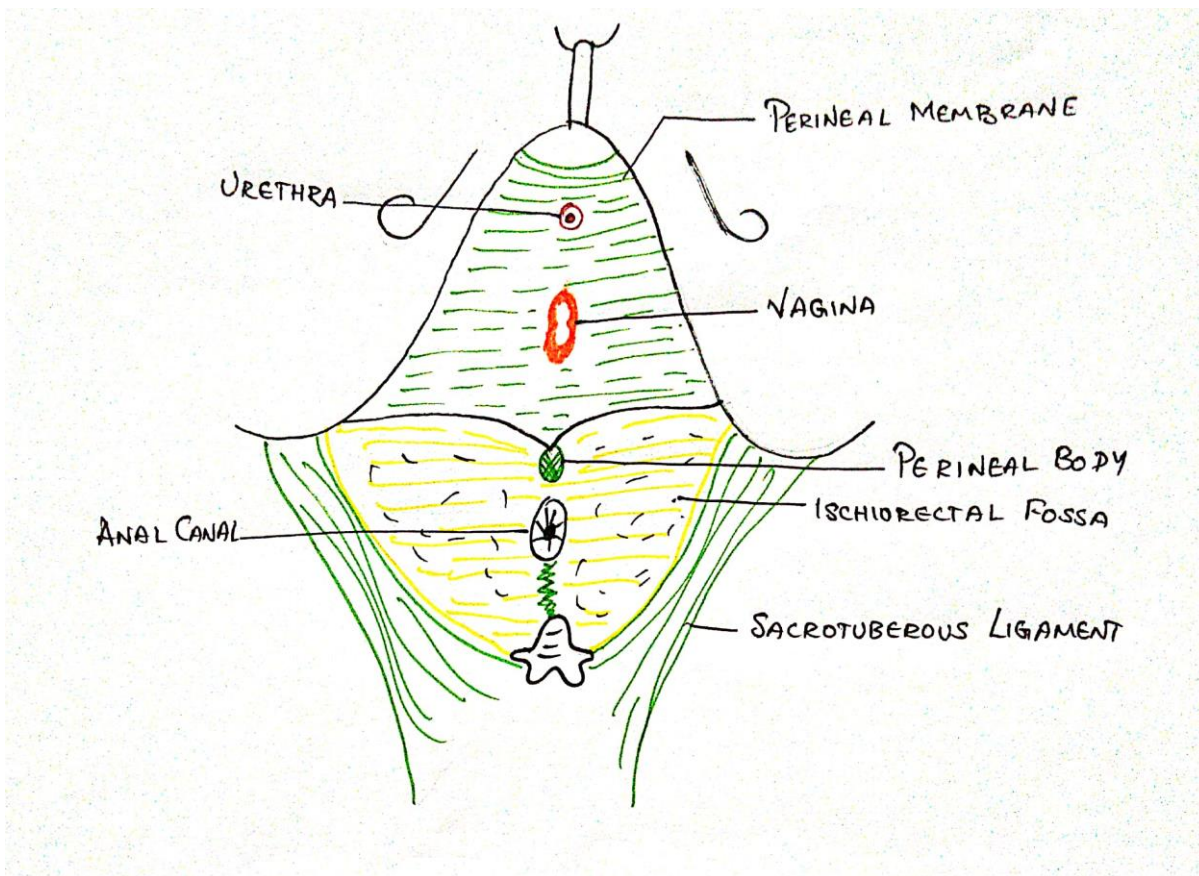
CONTENTS

1. Ischioanal pad of fat
2. Inferior rectal nerve & vessels
3. Pudendal canal with its contents
4. Posterior scrotal (males), Posterior labial (females) nerves and vessels
5. Perineal branch of S4 nerve
6. Perforating cutaneous branches of S2, S3 nerves.

CLINICAL CORRELATION

- 2 Ischioanal fossae allow distension of rectum & anal canal during passage of feces
- Both perianal & Ischioanal spaces are common sites of abscesses.
 - Sometimes- abscess may burst into anal canal or rectum internally, onto surface of perineum externally

- In this way, Ischioanal type of anorectal fistula (or) fistula in ano may be



produced

- Most common site of internal opening- Floor of one of anal crypts
- If abscess burst externally + healing does not occur ➔ External sinus formed
- Through horseshoe recess, unilateral abscess may become bilateral

ISCHIOANAL FAT

- Acts as cushion-like support to rectum & anal canal,
- Loss of fat- in debilitating diseases- like diarrhea in children ➔ prolapse of rectum
- Occasional gap between tendinous origin of levator ani & obturator fascia ➔ HIATUS OF SCHWALBE.
- Rarely, pelvic organs may herniate through this gap into fossa resulting in Ischioanal hernia.

56. PUDENDAL CANAL / ALCOCK'S CANAL

- Fascial tunnel present in lateral wall of Ischioanal fossa – just above sacrotuberous ligament.
- Transmits
 1. Pudendal nerve
 2. Internal pudendal vessels.
- **EXTENT**: From lesser sciatic notch to posterior border of perineal membrane.
- **FORMATION**: Space between obturator fascia and lunate fascia
- **CONTENTS**:
 - PUDENDAL NERVE:**
 - S2, S3, S4
 - In posterior part of canal, gives off inferior rectal nerve ➡ divides into
 1. larger perineal nerve
 2. smaller dorsal nerve of penis.

INTERNAL PUDENDAL ARTERY:

- Gives off inferior rectal artery in the posterior part of the canal
- In the anterior part – artery divides into
 1. Perineal artery
 2. Artery of penis
- Vein accompanies artery.

57. PUDENDAL NERVE

- Chief nerve of perineum and of external genitalia.
- It is accompanied by internal pudendal vessels.

ORIGIN

1. Arises from sacral plexus in the pelvis
2. Derived from spinal nerves S2, S3, S4

COURSE

Originates in pelvis ➡ Enters gluteal region through greater sciatic notch ➡ Leaves it through lesser sciatic notch ➡ Enters pudendal canal in lateral wall of Ischioanal fossa ➡ Terminates by dividing into branches.

RELATIONS

IN THE PELVIS:

- Descends in front of piriformis- deep to its fascia ➡ Leaves pelvis ➡ Passes through lower part of greater sciatic foramen ➡ between piriformis & coccygeus ➡ medial to internal pudendal vessels ➡ Enters the gluteal region

IN THE GLUTEAL REGION:

- Crosses the apex of sacrospinous ligament ➡ under cover of gluteus maximus ➡ Lies medial to internal pudendal vessels- cross the spine ➡ Leaves gluteal region ➡ accompanying the vessels ➡ Passes through lesser sciatic foramen ➡ Enters Pudendal canal

IN THE PUDENDAL CANAL:

- Neurovascular bundle ➡ lies in lateral wall of Ischioanal fossa.

BRANCHES

- In posterior part of pudendal canal ➔ Gives off inferior rectal nerve ➔ divides into 2 terminal branches:
 1. Perineal nerve
 2. Dorsal nerve of Penis or Clitoris;

INFERIOR RECTAL NERVE:

- Pierces the medial wall of pudendal canal ➔ crosses the Ischioanal fossa from lateral to medial side
- Supplies
 1. external anal sphincter
 2. skin around anus
 3. lining of anal canal below the pectinate line

PERINEAL NERVE:

- Larger terminal branch
- Runs forward- below internal pudendal vessels ➔ terminates by dividing into:
 1. Medial & lateral posterior scrotal (or) labial nerves
 2. Muscular branches to the
 - a) urogenital muscles,
 - b) anterior part of external anal sphincter,
 - c) anterior part of levator ani,
 3. Nerve to bulbospongiosus also gives off nerve to bulb which supplies corpus spongiosum, penis & urethra;

DORSAL NERVE OF PENIS OR CLITORIS:

- Smaller terminal branch

- Runs forward in pudendal canal above internal pudendal vessels ➡ Runs in deep perineal space between these vessels and pubic arch ➡ Passes through the lateral part of the oval gap between apex of the perineal membrane and arcuate pubic ligament ➡ Runs on dorsum of penis or clitoris ➡ Ends in glans penis or glans clitoris
- Supplies skin of body of penis or clitoris and of the glans.

CLINICAL CORRELATION

- Supplies sensory branches to lower part of vagina, through the inferior rectal and posterior labial branches
- In vaginal operations, general anesthesia can be replaced by a pudendal nerve block
- Nerve is infiltrated near the ischial spine by a needle passed through the vaginal wall and then guided by a finger.

58. ANAL FISSURE

- Also called Fissure in ano.
- Caused by rupture of one of the anal valves, usually by the passage of dry, hard stool in a constipated person.
- Each valve is lined by mucus membrane above and skin below
- Involvement of skin ➡ Extremely painful; Associated with marked spasm of anal sphincters.

59. LUMBOSACRAL JOINT

- The lumbosacral joint, also called lumbosacral symphysis, is an articulation between the fifth lumbar (L5) and first sacral (S1) vertebrae.

TYPE	<u>ANTERIOR INTERVERTEBRAL JOINT</u> : symphysis <u>FACET JOINTS</u> : synovial plane joints
ARTICULAR SURFACES	<u>ANTERIOR INTERVERTEBRAL JOINT</u> : Inferior surface of L5 vertebral body, superior surface of S1 vertebral body <u>FACET JOINTS</u> : superior articular processes of the S1, inferior articular processes of L5
LIGAMENTS	Iliolumbar ligament, lateral lumbosacral ligament
INNERVATION	L5 and S1 spinal nerves
BLOOD SUPPLY	Iliolumbar, superior lateral and median sacral arteries
MOVEMENTS	Flexion, extension, lateral flexion