
Chapter 7

RESPIRATORY SYSTEM

Outline

Elements of Respiratory System

- Nostrils
- Nasal Cavity
- Larynx
- Trachea
- Bronchi
- Lungs

Relevant Structures

- Thoracic cavity and Mediastinum
- Diaphragm
- Pleura

This is the system by which the body tissues take up oxygen and dispose of carbon dioxide. Delivering oxygen and removing carbon dioxide (the product of cellular respiration) are the two main functions of this system.

ELEMENTS OF RESPIRATORY SYSTEM

The respiratory system consists essentially of the lungs and the passages that conduct air into and out of the lungs. These passages include: the nostrils, nasal cavity, pharynx (see chapter 9), larynx, trachea and bronchi (sing. bronchus).

RELEVANT STRUCTURES

Thoracic cavity and Mediastinum, diaphragm, and pleura.

NOSTRILS

The *external nares* or *nostrils* are the external openings of the respiratory tract. These slit-shaped nostrils are bounded by the medial and lateral *alae* (simply called the *wings*). The wings meet dorsally and ventrally to form *commissures* or *angles*.

NASAL CAVITY

Nostrils lead to the nasal cavity. The nasal cavity is separated from the mouth by the hard and soft palates. It is divided into two halves by the *median nasal septum* and *vomer bone*. All the facial bones except mandible and hyoid, enclose the nasal cavity.

..... (See Figure 7 -1)

BONES

The greater part of each half of the nasal cavity is occupied by the *conchae* (turbinate bones); viz.

- Dorsal concha
- Ventral concha
- Ethmoidal concha (Ethmo-turbinate bone)

The mucus membrane investing this bone is the olfactory epithelium.

MEATUSES

The conchae form many passages throughout the cavity, called **meatuses**.

i. Dorsal Nasal Meatus

It is situated between the roof of the cavity and dorsal concha.

ii. Middle Nasal Meatus

It is situated between the dorsal conchae and ventral conchae.

iii. Ventral Nasal Meatus

It lies between ventral concha and floor of the nasal cavity.

iv. Common Nasal Meatus

It is a narrow passage which is situated between the median nasal septum and concha.

Choanae or Posterior nares: are two elliptical orifices by which the nasal cavity and pharynx communicate. They are in the same plane as the floor of the nasal cavity, and are separated from each other by the vomer bone.

LARYNX

The larynx is a short, but complex valvular apparatus which regulates the volume of air passes through the tract, prevents aspiration of foreign material and, as it contains the **vocal cords**, is the chief organ of voice.

LOCATION

It lies caudal to the ramus of the mandible.

RELATIONS

It is related dorsallyto the pharynx and the origin of the esophagus. Ventrallyit is covered by the skin, fascia, and sterno-hyoid and omo-hyoid muscles. Laterallyit is related to the parotid and mandibular glands.

CARTILAGES OF LARYNX

The skeleton of the larynx consists of a framework of cartilages, which are connected by joints, and ligaments or membranes, and moved by extrinsic and intrinsic muscles. It is lined by mucous membrane.

..... (See Figure 7 – 2)

There are four cartilages in which one is **paired** while the other three are **unpaired**.

TABLE 7 – 1: DESCRIPTION OF LARYNGEAL CARTILAGES

Type	Cartilages	Shape	Location	Features / Parts
Unpaired	Cricoid	Like signet ring	Rostral to first tracheal ring	Dorsal lamina, lateral and ventral arch
	Thyroid	U- shaped	----	Ventral body and two lateral lamina
	Epiglottis	Cordate leaf-like	Above the body of the thyroid.	Base, apex, two surfaces (lingual and laryngeal) and two lateral borders
Paired	Arytenoid	Three sided pyramid	On either side, rostral to lamina of cricoid	A rostral apex and a caudal base

TRACHEA

The **trachea** or **windpipe** is a patent, flexible, cartilaginous and membranous tube for passage of air to and from the lungs. It is kept permanently open by a series of incomplete cartilaginous rings embedded in its wall.

COURSE

The trachea occupies a median position, except near its termination, where it is pushed a little to the right by the arch of the aorta.

LOCATION

The trachea extends caudal to the larynx at the level of 2nd cervical vertebrae to the roots of the lungs opposite to the 5th thoracic vertebrae where it bifurcates into *right* and *left bronchi*.

TABLE 7 – 2: REPRESENTATIVE VALUES FOR TRACHEA

Average Length of Trachea	22-25 cm
Caliber of Trachea	1.5 cm
Total number of Cartilaginous rings	48 – 60

PARTS

The trachea is divided into two parts;

- i. Cervical part
- ii. Thoracic part

i. Cervical Part

In this region, the outline of cartilaginous ring is U-shaped which is roofed up by the *trachialis* muscle.

RELATIONS

In its cervical part, the trachea is related dorsally to the esophagus for a short distance, but chiefly to the longus colli muscles. The sterno-hyoideus muscle lies on the ventral surface.

ii. Thoracic Part

It lies in the cranial and middle mediastinum.

In this region, the cartilaginous rings are bent to form ridge dorsally.

RELATIONS

It is related dorsally to the *longus colli* for a short distance, and beyond this to the esophagus. Ventrally it is related to the anterior vena cava, the brachiocephalic and common carotid trunks, and the cardiac and left recurrent nerves.

BRONCHI

There are three bronchi formed by the bifurcation of trachea.

Right and *left bronchi* are formed by the bifurcation of trachea opposite to the 5th rib.

In addition to right bronchi, 3rd or special, is also supplied to the apical lobe of the right lung.

Special or *3rd bronchus* is aroused from the trachea opposite to the 3rd rib.

DIFFERENCE BETWEEN A BRONCHUS AND TRACHEA

The structure of bronchus is almost similar to that of trachea but the cartilaginous framework consists chiefly of plates instead of rings.

THORACIC CAVITY & MEDIASTINUM

THORACIC CAVITY

It is second in point of size in all the body cavities. In form, it is somewhat like a truncated cone, much compressed laterally in its anterior part, and with the base cut off very obliquely.

BOUNDARIES

The **dorsal wall** is formed by Thoracic vertebrae

The **lateral walls** are formed by Ribs

The **ventral wall** is formed by Sternum

The **posterior wall** is formed by Diaphragm

The **anterior aperture** is occupied by Thoracic inlet

THORACIC INLET

The **thoracic inlet** (anterior aperture or inlet) is small, and of narrow, oval form. It is bounded dorsally by the first thoracic vertebra and laterally by the first pair of ribs. It is occupied by the longus colli muscles, the trachea, esophagus, vessels, nerves, and lymph glands. The **HEIGHT** of thoracic inlet is about 7.5 – 10 cm and its greatest **WIDTH** is about ...5 cm.

MEDIASTINUM

The mediastinum is the median septum of the thorax between the two lungs. It includes the mediastinal pleura.

DIVISION

For descriptive purposes, the mediastinum is divided into three subdivisions; viz.

- i) Anterior mediastinum
- ii) Middle mediastinum
- iii) Posterior mediastinum

DIAPHRAGM

The diaphragm is a broad, unpaired, dome shaped muscle which forms a partition between **thoracic** and **abdominal cavities**. It is the chief muscle of respiration.

DIVISION

The diaphragm consists of two parts; viz.

- i. **Muscular Part:** it is opaque in appearance and extends toward the peripheral region.
- ii. **Tendinous Part:** It is transparent in appearance and located centrally.

ATTACHMENTS

The diaphragm presents; ...

- Vertebral attachment Dorsally
- Costal attachment Laterally
- Sternal attachment Ventrally

..... (See Figure 7 – 3)

OPENINGS

The diaphragm, while separating the thoracic and abdominal cavities, gives passage to a number of structures passing in both the directions.

Hiatus

An opening through diaphragm is known as “**hiatus**”. The diaphragm presents three chief openings;

TABLE 7 – 3: OPENINGS OF THE DIAPHRAGM

Name of Hiatus	Structures
Aortic hiatus	Aorta – Vena azygous – Cisterna chili
Esophageal hiatus	Esophagus - Vagus nerve
Caval hiatus	Caudal vena cava

RELATIONS (Major Structures)

Lungs – ribs – sternum – vertebrae – reticulum – liver – spleen – esophagus – large blood vessels i.e. aorta, caudal vena cava etc.

BLOOD SUPPLY

Two **phrenic arteries**, which are variable in origin; may come from aorta, celiac artery or intercostal artery, furnishes the diaphragm.

NERVE SUPPLY

The **phrenic nerve**, a motor nerve, innervates the crura of the diaphragm. It is formed by the union of the ventral branches of the fifth, sixth and seventh cervical nerves.

PLEURA

The pleura is a thin serous membrane that lines the thorax.

DISTRIBUTION

With reference to its distribution, pleura has been subdivided into three parts;

1. Parietal Pleura

It is attached to the bony and muscular elements of the thorax by *endothoracic fascia*, a thin connective tissue layer. It is subdivided into three parts;

- a) **Vertebral pleura:** It lines the vertebral region inside the thoracic cavity.
- b) **Costal pleura:** It lines the thoracic wall that comprises ribs and intercostals spaces.
- c) **Sternal pleura:**The pleura that lines the sternum region.
- d) **Diaphragmatic pleura:** The pleura attached to the thoracic surface of the diaphragm.

2. Visceral Pleura

It is also named the *pulmonary pleura*.

It covers the surfaces and fissures of the lung, except at the hilus and along the attachment of the pulmonary ligament where it is continuous with the parietal pleura. It is firmly adherent to the lung and cannot be separated from it.

3. Mediastinal Pleura

It covers the blood vessels, the esophagus, the lymph nodes, etc. in the mediastinal space. It lines the corresponding surface of the mediastinum and named respectively as follows;

- a) **Cranial mediastinal pleura**
- b) **Middle mediastinal pleura**
- c) **Caudal mediastinal pleura**

PLICA VANAE CAVA

It is a distinct fold of pleura in which the caudal vena cava and phrenic nerve are enclosed.

LUNGS

The **lungs** are a pair of respiratory organs occupying major portion of the thoracic cavity and leave a little space for the heart.

CHARACTERISTICS

- They are accurately adapted to the walls of the cavity.
- The lungs are covered by *pulmonary pleura*.
- The right is almost twice as large as the left lung.
- Their consistency is more dense and leathery to the touch.
- They are duller in color and lobulation is distinct but lobes are small.

SHAPE AND WEIGHT

Each lung is conical, with the base resting on against the cranial side of the diaphragm and the apex in or close to the thoracic inlet. The adult lungs weigh about **350 grams to 1 kg**.

ATTACHMENTS

The lungs are free to move in pleural sacs but attached only by its **root** and by **pulmonary ligament**.

ROOT OF THE LUNG

It is formed by the structures which either enter or come out of the lung at the hilus.

Contents

The root of the lung is made up of the following structures:

1. Principal bronchus
2. One pulmonary artery
3. Varying number of pulmonary veins.

4. Bronchial arteries
5. Bronchial veins
6. Pulmonary plexus of nerves
7. Lymphatics of the lung
8. Bronchopulmonary lymph nodes
9. Areolar tissue

PULMONARY LIGAMENT

The parietal pleura surrounding the root of the lung extends downward beyond the root as a fold called the *pulmonary ligament*. The fold contains a thin layer loose areolar tissue with a few lymphatics.

MORPHOLOGY

Normal Lung	Foetal Lung
Normally pink in color	Pale grey in color
Soft, Spongy, Highly elastic	No such characteristics
Crepitates when pressed	Not crepitated
Floats in water	Sink in water

TABLE 7 – 4: COMPARISON ON MORPHOLOGY OF NORMAL AND FETAL LUNG.

DESCRIPTION

Each lung presents for description: apex (cranially), base (directed caudally) and;

Two Surfaces

- i) Medial or visceral
- ii) Costal

Three Borders

- i) Dorsal
- ii) Ventral
- iii) Basal

THE SURFACES

1. Costal Surface

It presents costal impressions principally.

..... (See Figure 7 – 4)

2. Visceral Surface

It presents hilus of the lung, grooves (for aorta, esophagus, vena azygous, anterior vena cava, posterior vena cava), impressions (of diaphragm, cardia), etc.

..... (See Figure 7 – 5)

BLOOD SUPPLY

The *pulmonary artery* carries venous blood to the lungs and returned to heart by pulmonary veins.

The nutritional arteries of lungs are *bronchial* and *esophageal branches* arise from the thoracic aorta.

Right Lung

The right lung presents four distinct lobes formed by interlobar fissure.

APICAL LOBE

It is as much larger as reach up to the left median plane.

It is partially subdivided into two parts_ **cranial** and **caudal**.

It is especially supplied with **3rd** or **special bronchus** aroused by the trachea.

CARDIAC LOBE

It is elongated, three sided lobe which is separated from apical and diaphragmatic lobe by interlobar fissure.

DIAPHRAGMATIC LOBE

It is the largest lobe of the lung and positioned caudally.

ACCESSORY LOBE

It is pyramidal in shape and its apex is directed towards the hilus of the lung.

The left lung has no accessory lobe. The groove for posterior vena cava can be seen on the visceral surface by lifting this lobe upward.

Left Lung

The left lung is subdivided into two lobes by means of interlobar fissure.

APICAL LOBE

It is divided into two parts; viz.

- i. Cranially directed _ **apical part**.
- ii. Large three-sided ventrally directed _ **cardiac part**.

DIAPHRAGMATIC LOBE

It is the largest lobe of the lung which is positioned caudally.

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Chapter 8

BLOOD VASCULAR SYSTEM

Outline

- **Introduction to**
 - **Angiology**
 - **Blood vascular system**
 - **Division of Blood vessels**
 - **Portal System**
 - **Lymphatic system**
- **Pericardium**
- **Heart**
 - **Right atrium**
 - **Right ventricle**
 - **Left atrium**
 - **Left ventricle**
- **Introduction to Major Blood Vessels**
- **Systemic Arteries**
 - **Arteries cranial to heart**
 - **Branches of thoracic aorta**
 - **Branches of abdominal aorta**
 - **Arteries of the thoracic limb**
 - **Arteries of the pelvic limb**

ANGIOLOGY

Angiology is the description of the organs of circulation of the blood and lymph ---- the heart and the vessels.

BLOOD VASCULAR SYSTEM

It consists of;

1. Arteries:

Which convey blood from heart to the tissues.

2. Capillaries:

These are microscopic tubes in the tissue, which permit of the necessary interchange between the blood and the tissues.

3. Veins:

Which convey the blood back to the heart.

DIVISION OF BLOOD VESSELS

The blood vessels are divided into the pulmonary and the systemic.

PULMONARY ARTERY

The **pulmonary artery** conveys the blood from the right ventricle of the heart to the lungs, where it is arterialized, and is returned by the pulmonary veins to the left atrium of the heart.

SYSTEMIC ARTERIES

The **systemic arteries** convey the blood from the left ventricle all over the body, whence it is returned by the vena cavae (sing. vena cava) to the right atrium.

PORTAL SYSTEM

The term **portal system** is often applied to the portal vein and its tributaries which come from the stomach, intestine, pancreas and spleen.

The vein enters the liver, where it branches like an artery, so that the blood in this subsidiary system passes through a second set of capillaries (in the liver) before being conveyed to the heart by the hepatic veins and the posterior vena cava.

LYMPHATIC SYSTEM

The lymphatic system is subsidiary to the venous part of the circulatory system, from which it arises in embryo. It consists of the lymph vessels and glands.

LYMPH VESSELS

- These contain a colorless fluid, the lymph, in which are numerous lymphocytes.
- They resemble the veins in structure but have thinner walls and are provided with more numerous valves.
- The vessels have a characteristic beaded appearance when distended.
- Nearly all of the lymph is ultimately carried into the venous system by two trunks, the *thoracic duct* and the *right lymphatic duct*.

LYMPH GLANDS

- Also known as **Lymph nodes**.
- Lymph glands are intercalated in the course of the lymph vessels.
- They vary widely in size, some being microscopic, others several inches in length.
- In form they may be globular, ovoid and flattened, elongated or irregular.

UNIT OF LYMPH GLAND

The lymph nodule or follicle is the unit of structure of the lymph gland.

LYMPH NODULES

- Also known as **Lymph follicles**.
- They are minute masses of lymphoid tissue which occur in certain mucous membranes.
- They may be solitary, or aggregated into masses or patches.
- The lymph nodule is the unit of structure of the lymph gland.

PERICARDIUM

The **pericardium** (*Peri-* means “around”) is a fibro-serous sac which encloses the heart and the roots of the great vessels. It is situated in the middle mediastinum.

FORMATION

The pericardium is composed of two types of layers; viz.

Fibrous Layer

It is outermost, relatively thin, but strong and inelastic.

Serous Layer

It is a serous sac, surrounded by fibrous layer; it may be regarded as having two parts:

- i) **PARIETAL PART:** It lines the fibrous layer, to which it is closely attached.
- ii) **VISCERAL PART:** It covers the heart, and parts of the great vessels.

Visceral part of serous pericardium is also termed as the *Epicardium*.

These two layers are continuous with each other at the roots of the great vessels i.e. ascending aorta, pulmonary trunk, vena cavae, and pulmonary veins.

PERICARDIAL SPACE

It is the space between the two serous layers of the pericardium. This space contains pericardial fluid called the *pericardial liquor*. Pericardial fluid prevents friction between the heart and the pericardium when the heart beats.

RELEVANT TERMS

EPICARDIUM: It is the visceral part of serous layer of pericardium that lines the heart muscles.

ENDOCARDIUM: .It lines the cavities of the heart i.e. atria and ventricles of the heart inside.

MYOCARDIUM:This term is applied peculiarly for the striped muscles of the heart.

PERICARDIAL LIQUOR:It is present in between the parietal and visceral layers.

HEART

The heart is a conical hollow muscular organ situated in the middle mediastinum. It is enclosed within the pericardium. It pumps blood to various parts of the body to meet their nutritive requirements.

NOMENCLATURE

The **Greek name** for the heart is *cardia* from which we have the adjective **cardia**.

The **Latin name** for the heart is *cor* from which we have the adjective **coronary**.

SURFACE MARKING

The heart is positioned from 2nd to 5th Rib, 2 inch above costo-chondral junction.

WEIGHT

The heart of a normal healthy animal (i.e. goat) weighs about **85 – 113 grams**.

DISCRIPTION

The heart presents; (See Figure 8 – 1)

Two Parts

i) Apex(faces ventrally, conical in appearance)

ii) Base (from where vessels originate)

Two Surfaces

i) Auricular(facing left thoracic wall)

ii) Atrial (facing right thoracic wall)

Two Borders

i) Cranial(convex and elongated)

ii) Caudal (Straight and short).

Four Chambers

i) Right atriumii) Right ventricleiii) Left atriumiv) Left ventricle

LIGAMENTS OF THE HEART

There are two ligaments of the heart;

i) Sterno-pericardial Ligament

This ligament attaches the apex of the heart with the sternum by the help of pericardium.

ii) Ligamentum Arteriosum

This ligament is present between the descending aorta and pulmonary artery.

BLOOD SUPPLY

The heart receives a large blood supply through the two *coronary arteries*, which arise by aorta.

The blood is returned by the *coronary veins* which open into the right atrium via coronary sinus.

OUTLOOK OF HEART

Heart outlook presents following structures;

Coronary Groove

Also called *atrioventricular groove*.

It is a circular groove indicated the division between atria and ventricle.

Coronary Fat

It lies on the coronary groove.

Longitudinal Grooves

Also termed the *interventricular grooves*.

It corresponds to the septum of the ventricles. There are two longitudinal grooves; viz.

- i) Right longitudinal groove
- ii) Left longitudinal groove.

CHAMBERS OF THE HEART

Right Atrium

The **right atrium** is the right upper chamber of the heart. It receives venous blood (deoxygenated blood) from the whole body; pump it to the right ventricle through the right atrioventricular or tricuspid opening.

PARTS

It consists of two parts;

- 1) **Sinus venosus**: It is a cavity into which all the venous blood is drained.
- 2) **Auricle**:It is a blind pouch or conical diverticulum that faces most cranially.

OPENINGS

There are five chief openings in case of right atrium; viz.

- i) Opening of Anterior vena cava.
- ii) Opening of Posterior vena cava.
- iii) Opening of Vena azygos
- iv) Coronary sinus (The venous blood of heart is drained through it.)
- v) Right atrio-ventricular orifice(opening).

GROSS FEATURES

PECTINATE MUSCLES: The whole cavity of auricle is crossed by transverse muscular ridges. The muscles are interconnected to form a reticular network.

CRISTA TERMINALIS: It is a crest formed by the termination of *pectinate* muscles.

CRISTA SUPRAVENTRICULARIS: It is plane, & smooth surface just above the atrio-ventricular orifice.

INTERVENOUS TUBERCLE: It is a ridge projects just in front of opening of posterior vena cava.

FOSSA OVALE: It is a diverticulum in septal wall; remnant of *foramen ovale* in fetus.

Right Ventricle

The right ventricle receives blood from the right atrium and pumps it to the lungs via. **pulmonary artery**. It forms cranial border of the heart but does not reach the apex.

OPENINGS

There are two openings in the right ventricle;

1. Right Atrio-ventricular Opening

It is a single opening for the blood to pass from right atrium to the right ventricle.

It is guarded by

TRICUSPID VALVE (MAINTAINS THE UNIDIRECTIONAL FLOW OF THE BLOOD)

It has three large cusps, **Semilunar Cusps**; attached to the **Papillary Muscles**, by mean of thread like structures called **Cordea Tendinea**.

2. Pulmonary Orifice(Opening)

It is guarded by

PULMONARY VALVE

GROSS FEATURES

CONUS ARTERIOSUM: It is a dome-shaped structure formed by right ventricle at the cranial border of the heart.

TRABECULAE CARNAE: It is the rough wall of ventricle which bears muscular ridges and bands.

MODERATE BANDS: These extend from septum to the opposite wall. The other name of Moderate band is “trabeculae septomarginalis”

Left Atrium

The left atrium receives oxygenated blood from the lungs through pulmonary veins, and pumps it to the left ventricle through the left atrioventricular or bicuspid or mitral orifice.

Note: In comparison to the Gross Features of both the atria, Anatomy parameters are quite similar.

OPENINGS

The left atrium has two types of openings:

1. Openings of Pulmonary Veins

About 6 -7 pulmonary veins get openings into the left atrium.

Through these openings, oxygenated blood is pour into this chamber.

2. Left Atrio-ventricular Orifice(Opening)

This opening is situated between the both chambers of the left part of the heart.

Left Ventricle

The left ventricle receives oxygenated blood from the left atrium and pumps it to the main blood vessel i.e. aorta. • It reaches up to the apex of the heart, therefore it is regularly conical than the right ventricle. • The wall of the left ventricle is much thicker as compared to that of the right ventricle.

OPENINGS

There are two openings in the left ventricle;

1. Left Atrio-ventricular Orifice

It is guarded by

BICUSPID VALVE (formerly called “Mitral valve”)

It has two broad, large, and thicker cusps, called **Semilunar Cusps**, attached to the **Papillary Muscles** by means of thread like structures known as **Cordae Tendinea**.

2. Aortic Orifice/Opening

It is guarded by.....

AORTIC VALVE:

It is composed of three semilunar cusps like that of pulmonary valve.

GROSS FEATURES

TRABECULAE CARNAE: The rough wall of ventricle which bears muscular ridges and bands.

MODERATE BANDS: These extend from septum to the opposite wall. They prevent overdistension.

VENTRICULAR SEPTUM: It is the partition which separates the cavities of the both ventricles.

INTRODUCTION TO MAJOR BLOOD VESSELS

AORTA

It is a large, unpaired vessel that emerges from left ventricle, medial to the pulmonary trunk. It starts at the base of the left ventricle.

ANTERIOR VENA CAVA

It returns the blood to the heart from the head, neck, thoracic limbs, and the greater part of the thoracic wall.

POSTERIOR VENA CAVA

It returns almost all of the blood from the abdomen, pelvis, and pelvic limbs. These vessels carry blood for/from the muscles of the heart.

THE OPENINGS OF BOTH VANA CAVA ARE VALVELESS.

SYSTEMIC ARTERIES

The systemic arteries convey the blood from left ventricle to all over the body.

DESCRIPTION

The systemic arteries may describe in the following ways; easier to understand.

1. Arteries cranial to the heart
2. Branches of Thoracic Aorta
3. Branches of Abdominal Aorta
4. Arteries of the Thoracic Limb
5. Major arteries of the Pelvic Limb

1. Arteries Cranial to Heart

..... (See Figure 8 – 2)

Name of Arteries	Origin	Tributaries	Area of Distribution
Coronary	Ascending aorta	Right and left coronary	Heart muscles
Brachiocephalic Trunk	Aortic arch	Bicarotid trunk, Right subclavian artery	----
Left Subclavian	Aortic arch	<ul style="list-style-type: none"> • Dorsal (costo-cervical) • Deep cervical • Vertebral • External thoracic • Inferior cervical • Axillary • Internal thoracic 	----
Right Subclavian	Brachiocephalic trunk	Same branches as that of left subclavian artery	----
Dorsal Cervical or Costo-cervical	Subclavian artery	Various branches	Intercostal muscles and Muscles of base of neck & dorsal thoracic vert.
Deep Cervical	Subclavian artery	Mediastinal branch	Base of neck & adjacent scapular region.
Vertebral	Subclavian	Muscular and spinal	Cervical muscles &

	artery	branches	spinal cord.
External Thoracic	Subclavian artery	-----	Pectoral muscles
Inferior Cervical	Subclavian artery	Ascending and descending branches	Muscles of neck and breast.
Axillary	Subclavian artery	-----	Muscles of thoracic limb
Internal Thoracic	Subclavian artery	-----	Muscles of sternum e.g. <i>transverses thoracic</i> etc

2. Branches of Thoracic Aorta

Name of Arteries	Origin	Area of Distribution
Bronchial	Thoracic aorta	Pulmonary tissues i.e. lung
Esophageal	Thoracic aorta	Esophagus
Intercostal • First 5 pairs • last 8 pairs	Thoracic aorta Dorsal cervical artery Thoracic aorta	Intercostals muscles
Phrenic	Variable in origin. May arise from aorta, coeliac or left ruminal Artery.	Crura of the diaphragm

3. Branches of Abdominal Aorta

Name of Arteries	Origin	Tributaries	Area of Distribution
COELIAC • Hepatic • Right Ruminal • Left Ruminal • Omaso-abomasal • Splenic	Abdominal aorta Celiac artery Celiac artery Celiac artery Celiac artery Celiac artery	---- ---- Pancreatic branch, dorsal & ventral coronary Reticular branch Dorsal and ventral branch ----	---- Hepatic tissues (liver) Both surfaces of the rumen Left face of the rumen Omasum and abomasum Spleen
Anterior Mesenteric	Abdominal aorta	----	Anterior part of small intestine
Renal (paired)	Abdominal aorta	----	Right & left kidneys
Spermatic (in male)	Abdominal aorta	----	Testis and epididymis
Uterovarian (in female)	Abdominal aorta	Uterine and ovarian branches	Ovaries, horn & body of

			uterus
Lumber (5-6 pairs)	Abdominal aorta	Dorsal and ventral branches	Interspinous & intertransverse spaces of lumbar vertebrae
Posterior Mesenteric	Abdominal aorta	----	Terminal part of rectum and colon
External Iliac (paired)	Abdominal aorta	Circumflex iliac A. - Continued as femoral artery	----
Internal Iliac (paired)	Abdominal aorta	Middle uterine and umbilical arteries	Perianal region
Middle Sacral	Abdominal aorta	Continued as middle coccygeal A.	Tail region & Coccygeus muscles.

4. Branches of the Thoracic Limb

Name of Arteries	Area of Distribution (Muscles and other structures)
Subscapular	Deep pectoral, Brachio-cephalicus (Muscles)
Subscapular	Subscapularis, Teres major, Triceps brachii (Muscles)
• Thoraco-dorsal	Latissimus dorsi (Muscle)
• Circumflex Arteries of Scapula	Supraspinatus, Infraspinatus, Teres minor (Muscles)
• Posterior Circumflex Artery of humerus.	Joint capsule, Muscles, and Skin of shoulder
Ant. Circumflex Artery of humerus	Deep pectoral, Coracobrachialis (Muscles)
Deep Brachial	Triceps brachii, Tensor fascia antibrachii (Muscles)
Muscular Branches	Teres major, Deep pectoral, Coracobrachialis, Biceps brachii
Ulnar	Muscles of lateral side of carpus
Nutrient Artery of humerus	Enters the nutrient foramen of humerus
Anterior Radial	Biceps brachii, Brachialis, Extensors M. of carpus and digits.
Median	<ul style="list-style-type: none"> • Direct continuation of brachial artery. • It ramifies/supplies the carpus, metacarpus region. • Also again gives off digital arteries.

5. Major Arteries of Pelvic Limb

Name of Arteries	Area of Distribution
FEMORAL	
It is the main arterial trunk of the thigh. It is the direct continuation of external iliac artery.	
Cranial Femoral	
It arises from the femoral artery.	Quadriceps femoris muscles

Caudal Femoral It arises from the femoral artery. Some times it may arise from the popliteal or medial circumflex femoral artery.	Biceps femoris, Vastus lateralis.
Saphenous It is a small vessel which arises from femoral at its middle.	Sartorius and gracilis muscles.
Popliteal It is direct continuation of femoral artery.	Gastrocnemius, superficial digital flexor
Cranial Tibial It is distal continuation of popliteal artery.	Cranial tibial, popliteus, soleus, proneus tertius, Lateral digital extensor.
Caudal Tibial It is smaller terminal branch of the popliteal artery.	Popliteal, superficial digital flexor, soleus, deep digital flexor.
Metatarsal It is the direct continuation of cranial tibial artery.	Metatarsus and digits.

.....
.....

Chapter 9

DIGESTIVE SYSTEM

Outline

Elements of Digestive System

- **Alimentary Canal**
 - **Mouth**
 - **Pharynx**
 - **Esophagus**
 - **Stomach**
 - **Small Intestine**
 - **Large intestine**
- **Accessory Organs**
 - **Tongue**
 - **Teeth**
 - **Salivary Glands**
 - **Liver**
 - **Pancreas**

Relevant Structures

- **Abdominal cavity**
 - **Peritoneum**
 - **Spleen**
-

The digestive system (**digestive tract**) consists of muscular tube lined with mucous membrane that is continuous with the external skin at the mouth and at the anus. Its primary functions are ingestion, mastication, digestion and absorption of food, and elimination of solid wastes.

ELEMENTS OF DIGESTIVE SYSTEM

The apparatus of the digestive system may comprise of two divisions:

1. **Alimentary Canal**
It is a tube that extends from the lips to the anus.
This canal consists of following consecutive segments;
Mouth, Pharynx, Esophagus, Stomach, Small intestine, and Large intestine
2. **Accessory Organs**
Tongue, Teeth, Salivary Glands, Liver, and Pancreas

OTHER RELEVANT STRUCTURES

Abdominal Cavity, Peritoneum, and Spleen

MOUTH

The mouth is the first part of alimentary canal and is used for holding, grinding, and mixing food with saliva but may also be used to manipulate the environment (through grasping of objects) and a defensive and offensive weapon.

PARTS

The mouth consists of two parts;

1. **VESTIBULE:**It is the small space between the teeth and lips.
2. **PROPER ORAL CAVITY:**Teeth and dental pad enclose this cavity.

It is occupied primarily by the tongue. It communicates to the pharynx through *isthmus faucium*.

Lips

These are two musculo-membranous folds which surround the orifice of the mouth. The **upper lip** of small ruminant including goat is deeply grooved with a midline, called *philtrum*.

The lips are densely innervated by sensory fibers, making them very sensitive tactile organs.

The lips of the sheep and goat are soft and flexible and aid in picking up food.

Cheeks

The cheeks form the sides of the mouth. These also present *conical papillae*.

Hard Palate

It is formed by horizontal elements of the incisive (premaxilla), maxilla, and palatine bones.

It is bounded in front and on sides by dental arches and is continuous with soft palate behind.

GROSS FEATURES (See Figure 9 – 1)

MEDIAN LINE/RAPHE: It divides the surface into two equal portions.

PALATINE RIDGES (15-19 in numbers): They cover about two third part of the hard palate.

INCISIVE PAPILLAE: It is present between the dental pad and first ridge of hard palate.

Soft Palate

It is a musculo-membranous curtain which separates the cavity of the mouth from that of pharynx.

Tonsils

The tonsils are *bean shaped* structures which are more or less circumscribed aggregation of lymphatic nodules reside in the *tonsilar sinus*. The tonsilar sinus is present on either side, behind the anterior pillars of the soft palate.

The **PALATINE TONSILS** lie in a pocket on the lateral wall of the pharynx ventral to the soft palate and adjacent to the base of the tongue. They do not project into the pharynx at all.

The **LINGUAL TONSILS** consist of accumulations of lymphatic nodules in the base of the tongue.

The **PHARYNGEAL TONSIL** is an accumulation of lymphoid tissue in the sub-mucosa of the dorsal pharyngeal wall.

TONGUE

The tongue consists of a mass of muscle covered by mucous membrane.

LOCATION

The tongue is situated on the floor of the mouth, between the rami of the mandible.

SHAPE AND COLOR

It is narrower in the middle of the body but width of the apex and root is almost same. The color is variable.

PARTS

The tongue is divided into three parts.

1. **ROOT:**It is attached to the hyoid bone, soft palate and pharynx.
2. **BODY:** It constitutes the main mass of the tongue.
3. **APEX:** It is free, pointed end of the tongue.

The entire tongue is mobile through its muscular attachments to the hyoid apparatus and mandible.

PAPILLARY ARRANGEMENT

The tongue is covered with keratinized stratified squamous epithelium. The surface is characterized by a large number of projections, the *papillae*, that are particularly well-developed on the dorsal surface.

..... (See Figure 9 – 2)

PAPILLA: It is an elevation on the tongue. These are of four kinds; viz.

- i. **Filliform** = thread-like
They are small thread like; soft to touch.
- ii. **Fungiform** = mushroom –like
They are relatively larger and scattered among filliform papillae.
- iii. **Lenticular:**
They are rounded papillae on dorsum linguae (dorsal prominence)
- iv. **Vallate** = cup-shaped
They are on each side of caudal part of prominence of dorsum.
They are almost 14-16 in number.

TASTE BUDS

Taste Buds are the organs of taste. Following three types of papillae are associated with these;

..... i) Fungiformii) Vallateiii) Foliate (absent in case of goat’s tongue).

GROSS FEATURES

DORSUM LINGUAE: It is a dorsal prominence on the dorsal surface of the tongue.

FRENULUM LINGAE: A fold of mucous membrane that is attached to the floor of the mouth.

TRANSVERSE GROOVE: A furrow present on the dorsal surface of the tongue transversely.

GLOSSO-EPIGLOTTIC FOLD: It passes from the root of the tongue to the base of the epiglottis.

TEETH

LOCATION

The teeth are implanted in the alveoli of the bones of the jaws. Teeth are arranged in two *dental arcades*, one associated with the mandible and one, with the incisive and maxillary bones.

PARTS

Basically, a tooth constitutes two parts;

- i) **CROWN:** It is the part of the tooth visible above the mucous membrane of the gum.
- ii) **ROOT:** A tooth is anchored by its root in a socket of a bone, called an alveolus.

COMPOSITION

Teeth are composed of four types of tissues; (from within to outward)

- i) **Pulp** : inner part of tooth that contains nerves, vessels, and loose connective tissue
- ii) **Dentine:** connective tissue surrounding the pulp
- iii) **Enamel** : outer surface located in the crown
- iv) **Cementum:** outer surface located in the root

DESCRIPTION

A tooth presents four surfaces;

1. **Vestibular:** The surface directed towards the lips (i.e. labial surface) and cheeks (i.e. buccal surface).
2. **Lingual:** The surface directed towards the tongue.
3. **Contact:** The surface in contact with adjacent tooth in the same dental pad.
4. **Masticating:** The surface which comes in contact with a tooth or teeth of oppo-site jaw.

SETS OF TEETH

All the domestic animals are *diphyodont*. This means they develop a set of deciduous teeth (also called baby teeth or milk teeth) that fall out and are replaced with permanent teeth.

Thus, there are two sets of teeth based on animals’ growth period.

- i) Deciduous Teeth
- ii) Permanent Teeth

TYPES OF TEETH

The teeth are of four types named as follows;

Incisor = front, cutting tooth.

Canine = long, pointed bonelike tooth for grasping and tearing.

Premolar = cheek tooth that grinds food.

Molar = caudal cheek tooth that grinds food.

DENTAL FORMULA

Dental formula represents the type and number of each tooth type found in that species.

Deciduous Teeth Formula	Permanent Teeth Formula
2 (Di 0/4 Dc 0/0 Dp 3/3) = 20	2 (I 0/4 C 0/0 Pm 3/3 M 3/3) = 32
Di = Incisors (of deciduous teeth)	I = Incisors of permanent teeth
Dc = Canine of deciduous teeth	C = Canines (of permanent teeth)
Dp = Premolars (of deciduous teeth)	Pm = Premolars of permanent teeth
	M = Molars (of permanent teeth)

SALIVARY GLANDS

SALIVA

The secretion of all the salivary glands is, collectively, called the **saliva**. It is the first secretion encountered by food in its progress through the alimentary tract.

The salivary glands empty their secretions through ducts that lead into various parts of the mouth at the gums. Saliva contains the starch-splitting amylase enzyme, **ptyalin**.

TYPES OF GLANDS

The salivary glands are basically, classified into two categories;

1. Chief Salivary Glands

- i) Parotid gland
- ii) Mandibular gland
- iii) Sublingual gland

2. Minor Salivary Gland

- i) Labial gland
- ii) Buccal gland
- iii) Lingual gland
- iv) Palatine gland

Parotid Gland

It is located ventral to the ear in relation to the caudal border of the mandible.

Mandibular Gland

It is usually located ventral to the parotid gland.

Sublingual Gland

It is located deep to the mucous membrane along the ventral side of the lateral surface of the tongue near the floor of the mouth.

NATURE OF SECRETIONS

The salivary glands are classified as serous, mucous or mixed. Serous glands secrete a watery fluid, as compared with mucous glands, which secrete mucus, a viscous material that acts as a protective covering for the surface of mucous membrane. A mixed gland produces both mucous and serous fluids.

The **parotid salivary gland** secretes primarily a serous saliva.

The **mandibular and sublingual glands** are classified as mixed glands.

Most of the **minor salivary glands** have a mucous secretion.

PHARYNX

The pharynx is a musculo-membranous sac which forms common passage for both the respiratory and digestive systems.

DIVISION

The pharynx is divided into three parts;

1. Oropharynx

Its dorsal and ventral boundaries are the soft palate and root of the tongue respectively.

2. Nasopharynx

It extends from the posterior nares to the junction of palatopharyngeal arches.

3. Laryngopharynx

It is situated dorsal to the larynx.

OPENINGS

The cavity of the pharynx presents seven openings as following:

- i) One opening ofOral cavity
- ii) Two openings of Nasal cavity
- iii) Two openings of Eustachian tubes
- iv) One opening ofLarynx (Aditus larynges)
- v) One opening ofEsophagus (Aditus oesophagi)

ESOPHAGUS

SYNONYM

The esophagus is also called *gullet*.

DEFINITION

The esophagus is a collapsible, musculo-membranous tube which extends from the pharynx to the stomach.

COURSE

From the pharynx, the esophagus passes dorsal to the trachea and usually inclines somewhat to the left in the neck in the mid-cervical region. It again passes dorsal to the trachea when it enters the thorax and continues caudally between the trachea and the aorta through the mediastinum to pass through the diaphragm at the esophageal hiatus.

Within the abdominal cavity, the esophagus joins the stomach.

DIVISION

The esophagus consists of two parts;

- i) Cervical Part
- ii) Thoracic part

BLOOD AND NERVE SUPPLY

The *esophageal artery*, from the thoracic aorta, furnishes the most of the part of esophagus. Esophageal muscles, both striated and smooth, are innervated by the *vagus nerve*.

STOMACH

SYNONYMS

The stomach is also called the *gaster* or *venter* from which we have the adjective *gastric* applied to structures related to the organ.

REPRESENTATIVE VALUES FOR ESOPHAGUS

DEFINITIONS

The stomach is the large dilatation of the alimentary canal just behind the diaphragm.

Total Length of the esophagus	45 cm
Diameter at the pharynx (where it starts)	1.8 cm
Diameter at cardia of stomach(when it ends)	2.5 cm

It is a muscular bag forming the widest and most distensible part of the digestive tube.

It intervenes between the esophagus and the small intestine.

Ruminants regurgitate and remasticate their food.

CHARACTERISTICS

It occupies nearly 3/4 of the abdominal cavity.

It covers almost all the left half of abdominal cavity except a small space.

The capacity of the stomach is about 15 to 18 liters (4 gallons).

COMPARTMENTS

The stomach of the ruminants e.g. Goat consists of four compartments; ... (See Figure 9 – 3)

- i) First Compartment..... **Rumen**
- ii) Second Compartment**Reticulum**
- iii) Third Compartment **Omasum**
- iv) Fourth Compartment**Abomasum**

FORESTOMACH

The first three compartments are collectively called forestomach.

The forestomach, called the *proventriculi* or *esophageal sacculation*, possesses a non-glandular mucous membrane; no secretions are produced.

TRUE STOMACH

The fourth compartment i.e. abomasum is the **true stomach**. It has a glandular mucous membrane, so only this compartment is responsible for gastric secretions.

ALL ABOUT RUMINANT STOMACH

Contribution of Rumen	71 %
Contribution of Reticulum	8 %
Contribution of Omasum	2 %
Contribution of Abomasum	19 %
As a whole Stomach of Goat	100 %

COMPARTMENTS OF STOMACH

RUMEN

Rumen = largest part that serves as a fermentation vat.

The rumen covers most of the left half of the abdominal cavity.

It extends considerably to the left of the median plane ventrally and caudally.

EXTERIOR VIEW

The rumen may be described as having.....

Two Surfaces

- i) Parietal surface
- ii) Visceral surface

Two Curvatures

- i) Dorsal curvature
- ii) Ventral curvature

Two Extremities

- i) Cranial extremity
- ii) Caudal extremity

GROSS FEATURES

The surface of the rumen is marked by the *right* and *left longitudinal grooves* which subdivide the rumen into dorsal and ventral sacs.

On posterior extremity, there are two blind sacs; *dorsal & ventral blind sacs*, separated by the *posterior transverse groove* and marked off from the remainder rumen by *dorsal* and *ventral coronary grooves*.

INTERIOR VIEW

Interiorly, the demarcation of grooves is replaced by the *pillars*.

Besides the pillars, all the surface area is being covered by *tongue-shaped papillae*; which give towel-like appearance.

ESOPHAGEAL GROOVE

It begins at the cardia of the stomach and ends at the reticulo-omasal orifice.

RETICULUM

Reticulum = most cranial portion

The reticulum is the most anterior part of the stomach. It lies mostly on the left of the median plane.

INTERIORLY

The folds presents 5 or 6 sided honey-comb like cells which also have serrated edges.

PATHOLOGICAL ASPECT

The location of the reticulum immediately caudal to the diaphragm places it opposite the heart, with only the muscular diaphragm between, so any foreign objects such as wire or nails that accumulate in the reticulum may be driven into pleural and pericardial spaces by the reticulum's muscular activity (**hardware disease**).

OMASUM

Omasum = third part that squeezes fluid out of the food bolus.

The omasum is the smallest compartment of the stomach. It lies chiefly to the right of median plane; ellipsoidal in form. The capacity of Omasum is about 300 ml.

LOCATION

It lies to the right of the ruminoreticulum, just caudal to the liver, and in the goat, normally is not in contact with the abdominal wall.

INTERIORLY

The omasum is filled with muscular laminae, called the *laminae omasi*.

These laminae look like the pages of a book, so omasum is also called the book stomach.

ABOMASUM

Abomasum = fourth part that is the true glandular stomach

The abomasum, true stomach, is an elongated sac which lies chiefly on the abdominal floor.

The abomasum is the first glandular portion of the ruminant digestive system.

LOCATION

Its proximal portion is ventral to the omasum, and its body extends caudally on the right side of the rumen.

EXTERIORLY

The abomasum presents three main parts;

- i) **FUNDUS:** It is an anterior blind portion.
- ii) **BODY:** It is the central part.
- iii) **PYLORUS:** It joins the duodenum

INTERIORLY

The cavity of the abomasum is divided into three chief glandular regions;

- i) **Fundus Gland region:**It presents numerous spiral folds.
- ii) **Pyloric Gland region:** It is much narrower and small.
- iii) **Cardiac Gland region:** It is small confined area adjacent to omasabomasal orifice.

SMALL INTESTINE

The small intestine is the tube which connects the stomach with the large intestine.

ALL ABOUT SMALL INTESTINE

Total length of small intestine	25 meter
Average diameter of small intestine	2-3 cm

DIVISION

The small intestine is clearly divisible into two parts;

- i) **FIXED PART:** It is termed as the duodenum.
- ii) **MESENTERIC PART:** It consists of the jejunum and ileum.

PARTS

The small intestine consists of three parts as described below; (See Figure 9 – 4)

DUODENUM

The duodenum is the shortest, widest and most fixed part of the small intestine.

It is the first part of the small intestine, begins at the pylorus. It forms S-shaped curve distinctly.

It is about 2 to 3 feet (0.6 to 0.9 meters) long.

ATTACHMENT

It is closely attached to the right side of the dorsal body wall by a short mesentery, the *mesoduo-denum*.

OPENING

The bile duct and pancreatic duct joins together and opens at the same point in the duodenum, 25-40 cm away from the pylorus.

JEJUNUM

The jejunum is the longest part of the small intestine.

The jejunum is defined by the marked increase in the length of the supporting mesentery. It forms numerous coils arranged in festoon manner around the mesentery.

ATTACHMENT

The mesentery which attaches the jejunum named the *mesojejunum*.

ILEUM

The ileum is the short and last part of the small intestine that joins the great intestine.

It is distinguished from the jejunum by a fold of mesentery between it and the cecum.

Attachment

The portion of mesentery that is responsible for attachment of this small terminal part is called the *mesoillum*.

LARGE INTESTINE

The large intestine extends from the termination of the ileum to the anus.

ALL ABOUT CAECUM

Avg. length of Caecum	30 cm
Avg. Diameter of Caecum	8 cm
Avg. Capacity of Caecum	1- 1.5liter

PARTS

The large intestine, just like small intestine, is also divided into three parts; (See Figure 9 – 5)

CAECUM

The caecum is a cul-de sac between the small intestine and colon.
It presents three parts;

- i) Base
- ii) Body
- iii) Apex

COLON

The colon can be said to have;

Ascending colon → Proximal loop → spiral loop → Centripetal coils → Central flexure 
Descending colon ← Transverse colon ← Distal loop ← Centrifugal coils ← ← ← ← ← 

ATTACHMENT

This part of large intestine is attached with the lateral body wall by mean of a fold of peritoneum, called the **Mesocolon**.

3. RECTUM

The rectum is the terminal part of the alimentary canal. It extends from the pelvic inlet to the anus.

ATTACHMENT

The attachment of rectum is by mean of **Mesorectum**, a fold of peritoneum around rectum.

ABDOMINAL CAVITY

The abdominal cavity is the largest of the body cavities.
It encloses the peritoneal cavity between its parietal and visceral layers.
It is separated from the thoracic cavity by..... Diaphragm.
It is continuous behind with Pelvic cavity.

FLANK

It is the part of the lateral wall of the abdominal cavity which is formed only of soft organs.

PARALUMBER FOSSA

It is the triangular depression on the upper part of the flank.

PERITONEUM

INTRODUCTION

The peritoneum is a large thin serous membrane which lines the abdominal cavity and pelvic cavity. It is in the form of a closed sac which is invaginated by a number of viscera.

PERITONEAL CAVITY

The peritoneal cavity is the cavity formed by the lining of the peritoneum.

COMPOSITION

The peritoneum is composed of an outer layer of fibrous tissue, which gives strength to the mem-brane and an inner layer of meso-thelial cells which secrete a serous fluid which lubricates the surface, thus allowing free movements of viscera.

LAYERS OF PERITONEUM

As a result, the peritoneum is divided into:

- (i) An outer or parietal layer
- (ii) An inner or visceral layer
- (iii) Folds of peritoneum by which the viscera are

suspended.

Parietal Peritoneum

It lines the inner surface of the abdominal and pelvic walls and the lower surface of the diaphragm. It is loosely attached to the walls by **extraperitoneal** connective tissue and can, therefore, be easily stripped.

Visceral Peritoneum

It lines the outer surface of the viscera, to which it is firmly adherent and can not be stripped. In fact, it forms a part and parcel of the viscera.

Folds of Peritoneum

Many organs within the abdomen are suspended by folds of peritoneum. Such organs are mobile. The degree and direction of mobility are governed by the size and direction of the peritoneal fold. Other organs are fixed and immobile. They rest directly on the dorsal abdominal wall. These organs are said to be *retroperitoneal*.

Peritoneal folds are given various names;

(i) Large peritoneal folds attached to the stomach are called *omenta* singular of which is *omentum* which means "cover".

OMENTUM

It is a fold of peritoneum which passes from the stomach to other viscera.

TYPES OF OMENTA

- i) **GREATER OMENTUM:** It extends from greater curvature of stomach like an apron.
- ii) **LESSER OMENTUM:** It extends from lesser curvature of the stomach.
- iii) **GASTRO-SPLENIC OMENTUM:** ...It extends from the greater curvature to the spleen.

(ii) In general, the name of the fold is made up of the prefix "*mes*" or "*meso*" followed by the name of the organ. For example, the fold suspending the small intestine or *enteron* is called the mesentery; and a fold suspending part of the colon is called mesocolon.

MESENTARY

It is a fold of peritoneum which attaches the intestines to the dorsal wall of the abdomen.

TYPES OF MESENTARY

- Mesoduodnum, Mesojejunum and Mesoilium**..... Attach the small intestine.
- Mesocolon & Mesorectum** Attach the large intestine.

(iii) In many situations, double-layered folds of peritoneum connect organs to the abdominal wall or each other. Such folds are called **LIGAMENTS**.

FUNCTIONS OF PERITONEUM

1. **MOVEMENTS OF VISCERA:** The chief function of the peritoneum is to provide a slippery surface for free movements of abdominal viscera. They permits peristaltic movements of the stomach and intestines.
2. **PROTECTION OF VISCERA:** The peritoneum contains various phagocytic cells which guard against infection. Lymphocytes present in normal peritoneal fluid provide both cellular and humoral immunological defense mechanisms.
3. **ABSORPTION:** The mesothelium acts as a semipermeable membrane across which fluids and small molecules of various solutes can pass. Thus, the peritoneum can absorb fluid effusions from the peritoneal cavity.
4. **HEALING POWER AND ADHESION:** The mesothelial cells of the peritoneum can transfer into fibro-blasts which promote healing of the wounds. They may also form abnormal adhesions causing obstruction in hollow organs.
5. **STORAGE OF FAT:** Peritoneal folds are capable of storing large amounts of fats; particularly in obese individuals.

LIVER

SYNONYM

The liver is also called the "*hepar*" from which we have the adjective '*hepatic*' applied to many structures connected to this organ.

DEFINITION

The liver is the largest gland of the body, constituting about 1-2 % of total adult body weight. It secretes bile and performs various other metabolic functions.

COLOR AND WEIGHT

The liver is red-brown in color and quite friable. The weight of the liver is about **550 to 700 grams**.

LOCATION

The liver is always located immediately caudal to the diaphragm (in contact with it) and tends to be located on the right side as the reticulo-rumen pushes everything else to the right.

DESCRIPTION

The liver presents two surfaces;

(i) Parietal Surface

It is attached with the diaphragm and with last 2-3 rib.

(ii) Visceral Surface

It is related to the reticulum, omasum, and abomasum, pancreas and esophagus.

The caudate process possesses a deep depression for right kidney.

PARIETAL SURFACE

The parietal surface is also known as *diaphragmatic surface*.

It is convex and is related to the most part of the diaphragm.

IMPRESSIONS

A small part of parietal surface is in contact with the last 2-3 ribs and presents costal impression.

VISCERAL SURFACE

The visceral surface of the liver presents following features; (See Figure 9 – 5)

1. Portal Fissure:

It is well-defined rounded depression, which contains portal vein, hepatic duct hepatic artery and several hepatic lymph glands.

2. Umbilical fissure:

It is deep & partially divides gland into two chief lobes; dorsal & ventral.

IMPRESSIONS

The Organs which are in contact with the liver gives impressions.

More prominent impressions are.....

i) Reticular impression

ii) Omasal impression

iii) Abomasal impression

iv) Renal impression (possess by the right

kidney)

3. Esophageal Notch:

It is represented by a slight impression.

4. Fossa Vena Cava:

When the vessel of posterior vena cava is removed, underlie deep depression is known as fossa vena cava.

Gall Bladder

It is pear-shaped sac that lies partially in contact with the visceral surface of the liver.

It is regarded as the diverticulum of the bile duct; or reservoir for the bile.

CYSTIC DUCT: The neck of the gall bladder is continued by a small duct, called cystic duct.

COMMON BILE DUCT

It is the tube that carries bile and opens into the duodenum 25-40 cm away from pylorus.

Formation

The bile leaves the liver through hepatic ducts, which join the cystic duct from the gallbladder to form the common bile duct.

Cystic duct + Hepatic duct = Common Bile duct

LIGAMENTS OF THE LIVER

The attachment of the liver is governed by six chief ligaments;

1. Coronary Ligament
2. Falciform Ligament
3. Hepatorenal Ligament kidney
4. Round Ligament
5. Right Lateral Ligament
6. Left Lateral Ligament

BLOOD SUPPLY

The liver receives two blood supplies.

1. The **Hepatic artery**, a branch of **coeliac artery** (first branch of abdominal aorta) supplies the liver. It is the nutrient blood artery of liver.
2. The **Portal vein** carries blood from the stomach, intestines and spleen to the liver, while all the venous blood is pour down into the posterior vena cava via hepatic veins.

FUNCTIONS OF LIVER

1. **METABOLISM** of carbohydrates, fats and proteins.
2. **SYNTHESIS** of bile and prothrombin.
3. **EXCRETION** of drugs, toxins, poisons, cholesterol, bile pigments and heavy metals
4. **PROTECTIVE** by conjugation, destruction, phagocytosis, antibody formation and excretion.
5. **STORAGE** of glycogen, iron, fat, vitamin A and D.

SPLEEN

INTRODUCTION

The spleen is, normally called the graveyard of RBCs (Red blood cells).

The spleen is a lymphatic organ which acts as a filter for blood and plays an important role in the immune responses of the body. It is approximately triangular in outline; with the angles round off.

ALL ABOUT SPLEEN

Weight of the spleen	Aprox. 100 grams
Length of the spleen	12 -15 cm
Greatest width of spleen	7.5 -10 cm

SHAPE AND WEIGHT

The spleen is oyster shaped, soft or elastic to the touch and weighs about 56-85 grams.

LOCATION

It lies on the dorsal sac of the rumen just behind the diaphragm.

DESCRIPTION

The spleen may be described as having;

Two Ends

- i) Dorsal end or base
- ii) Ventral end

Two Surfaces

- i) Parietal surface
- ii) Visceral surface

Two Borders

- i) Anterior border
- ii) Posterior border

PARIETAL SURFACE

It is convex and is related to the diaphragm.

It often shows impressions of last three ribs; *costal impressions*.

VISCERAL SURFACE

It is concave and its anterior half is attached to the greater curvature of the rumen.

The visceral surface presents following features;

- i) **HILUS:** It is present close to the antero-basal angle.
- ii) **LINE OF PERITONEAL REFLECTION**

LIGAMENTS

There are two ligaments that attach the spleen with other viscera.

1. **Gastro-splenic Omentum**

It extends from the visceral surface of the spleen to the greater curvature of the rumen.

2. **Suspensory Ligament**

BLOOD SUPPLY

The *splenic artery*; a branch of the celiac artery enters the hilus of the spleen.

The *splenic vein* carries blood to the portal vein.

FUNCTIONS OF SPLEEN

- 1. **PHAGOCYTOSIS:** The spleen is an important component of the reticulo-endothelial system.
- 2. **HAEMOPOIESIS:** It is an important haemopoietic organ during foetal life but lymphopoiesis continues throughout life.
- 3. **IMMUNE RESPONSES:** Under antigenic stimulation, there occurs increased lymphopoiesis for cellular responses and increased formation of plasma cells for the humoral responses.
- 4. **STORAGE OF RBCs:** Red blood cells can be stored in the spleen and released into the circulation when needed.

PANCREAS

The pancreas (*pan* = all; *kreas* = flesh) is a gland that is partly exocrine and partly endocrine. The exocrine part secretes the digestive pancreatic juice and the endocrine part secretes hormones, e.g. insulin. It is soft, reddish brown, loosely lobulated and elongated organ.

SHAPE AND WEIGHT

Roughly the pancreas' shape is like an oak leaf.

The weight of the pancreas is about 50 to 70 grams.

LOCATION

The pancreas lies entirely to the right of the median plane.

It mostly lies on the visceral surface of the liver and attached with the duodenum.

It is deeply notched to the liver to accommodate the portal vein.

LOBES OF PANCREAS

There are two lobes of the pancreas; (See Figure 9 – 6)

- i) A large Right Lobe
- ii) A small Left Lobe.

BLOOD SUPPLY

The arteries of the pancreas, *pancreatic arteries*, come from the branches of the celiac & anterior mesenteric arteries. The *pancreatic veins* carry blood to the portal vein.

FUNCTIONS OF PANCREAS

- 1. **DIGESTIVE:** Pancreatic juice contains many digestive enzymes of which the important ones are as follows; Trypsin Amylase Lipase.
- 2. **ENDOCRINE:** Insulin helps in utilizations of sugar in the cells. Deficiency of insulin results in hyper-glycemia. The disease is called *diabetes mellitus*.
- 3. **PANCREATIC JUICE:** It provides appropriate alkaline medium (pH – 8) for the activity of the pancreatic enzymes.

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