In the name of GOD

Lymphatic System

For Medicine Students

By

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Lymphatic system

Introduction
Lymphatic Drainage Of Body
Embryology Of Lymphatic Duct
Lymph Nodes
Embryology Of Lymph Nodes
Thymus
Spleen
Tonsils

Introduction

- **Antigens**
- **Antibodies**
- **Classes of Antibodies**
- **Actions of Antibodies**
- **Cytokines**
- **Cells of the Immune System**
- **Lymphocytes**
- **Major Histocompatibility Complex (MHC) & Antigen Presentation**
- **Antigen-Presenting Cells (APCs)**
- **Types of Immune Responses**
- **Lymphoid system……**

The immune system:

Natural immune system
Acquired immune system

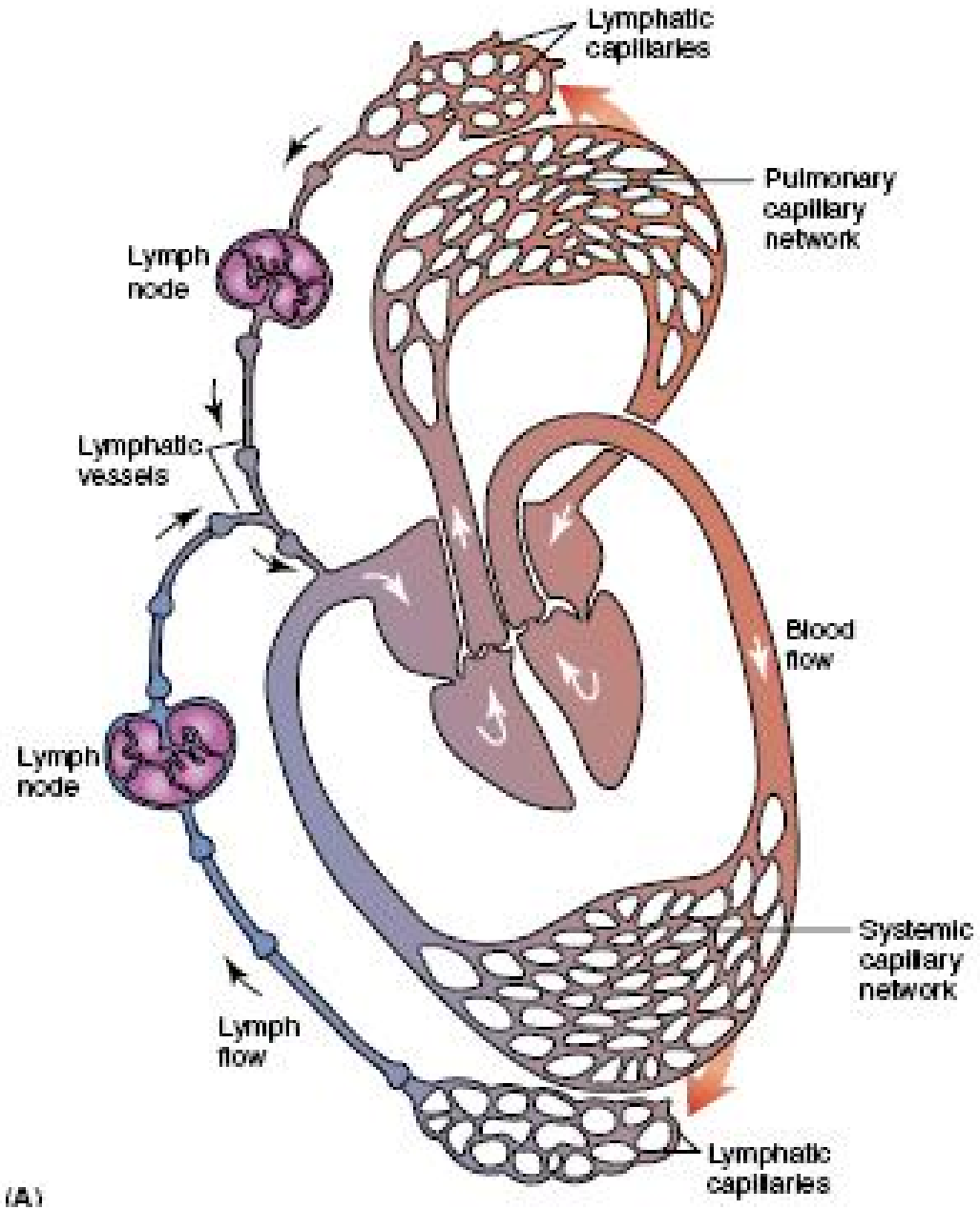
Cells:

Phagocyte
Lymphocyte
Antigen presenting cells

In order to immune system perfectly do these functions:
The Lymphoid tissue + Lymphoid organs = Lymphatic system:
Lymph
Lymphatic capillary & vessels
The Lymphoid tissue:
nodules / diffuse (**peyer's patch**)
Lymphoid organs:
Thymus / lymph nodes / spleen / **tonsils**

INTRODUCTION

The lymphatic system is intimately associated with the blood and the cardiovascular system. Both systems transport vital fluids throughout the body and both have a system of vessels that transport these fluids. The lymphatic system transports a fluid called lymph through special vessels called lymph capillaries and lymphatics. This lymph eventually gets returned to the blood from where it originated. In addition to fluid control, our lymphatic system is essential to helping us control and destroy a large number of microorganisms that can invade our bodies and cause disease and even death. The lymphatic system consists of lymph, lymph vessels, lymph nodes, and four organs. The organs are the tonsils, the spleen, the thymus gland, and Peyer's patches. Figure 15-1 shows the vessels and organs of the lymphatic system.


Lymphatic capillaries
Pulmonary capillary network
Lymph node
Lymphatic vessels
Blood flow
Lymph node
Systemic capillary network
Lymph flow
Lymphatic capillaries
(A)

Lymph

The primary function of this system is to drain from tissue spaces, protein-containing fluid that escapes from the blood capillaries. Other functions are to transport fats from the digestive tract to the blood, to produce lymphocytes, and to develop immunities.

In our bodies where blood capillaries are close to the cells of tissues, the blood pressure in the cardiovascular system forces some of the plasma of blood through the single-celled capillary walls. When this plasma moves out of the capillaries and into the spaces between tissue cells it gets another name and is called **interstitial** (in-ter-**STISH**-al) **fluid**. Most, but not all, of this fluid gets reabsorbed into the capillary by differences in osmotic pressure. However, some does not, and this interstitial fluid must be drained from the tissue spaces to prevent swelling or **edema** (eh-**DEE**-mah) from occurring. It is the role of the lymphatic capillaries to drain this fluid. Once the interstitial fluid enters a lymphatic capillary, it gets a third name and is now called **lymph** (**LIMF**).

In the villi of the small intestine, there are special lymphatic vessels called **lacteals** (**LACK**-teelz) whose role is to absorb fats and transport them from the digestive tract to the blood. Fats from the intestine travel through the lymphatic system, which delivers them to the blood, when the lymph rejoins the blood at the right and left subclavian veins. Lymph in the lacteals looks milky because of the fat content and is called **chyle** (**KYLE**).

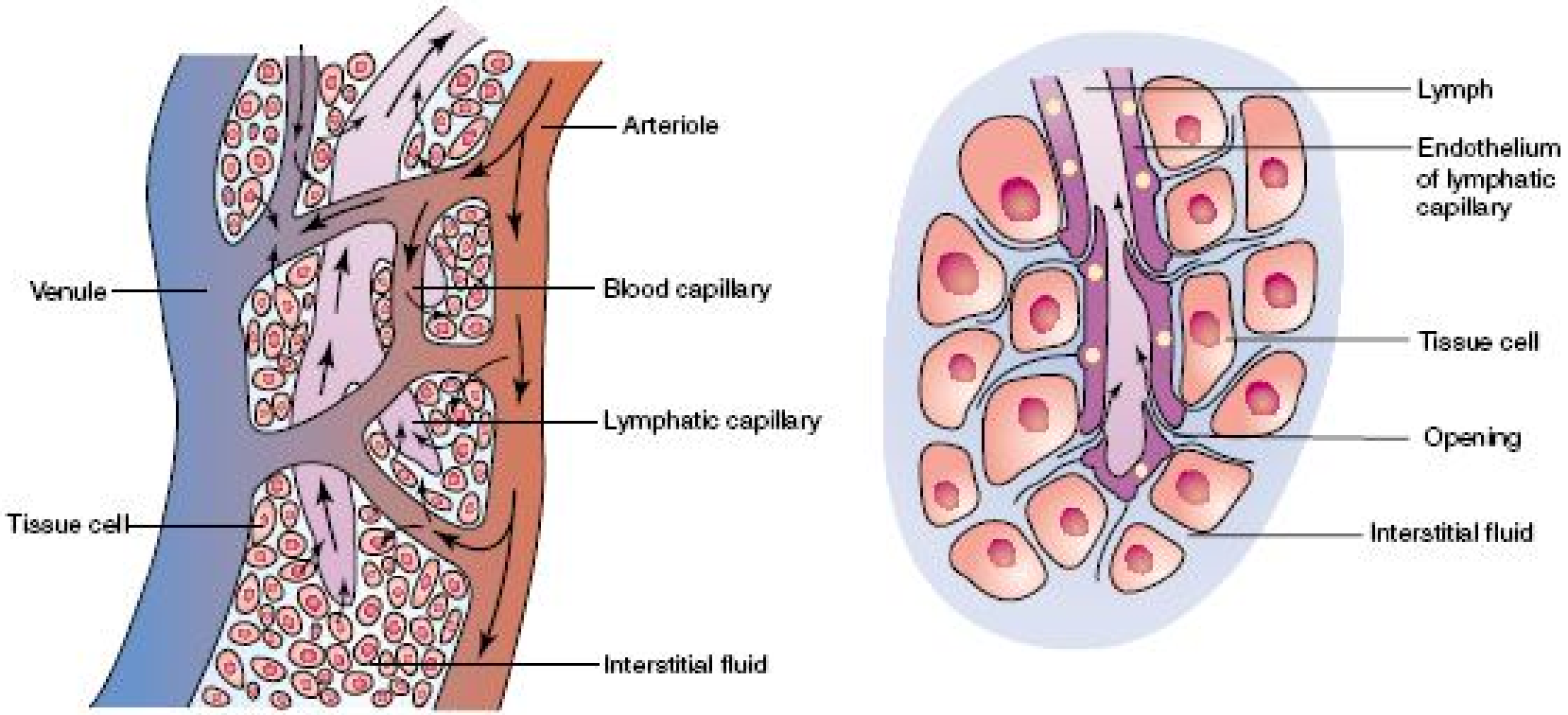
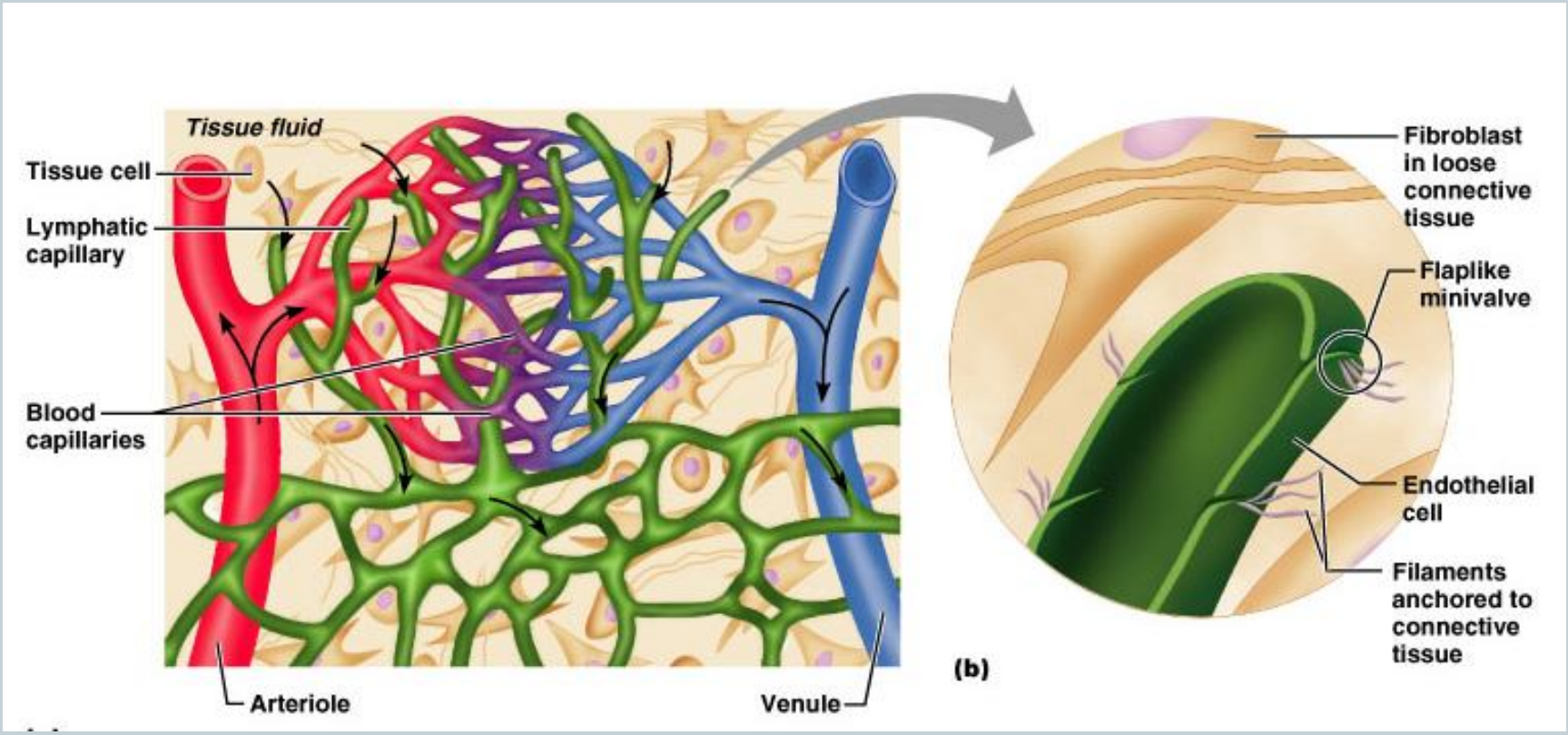


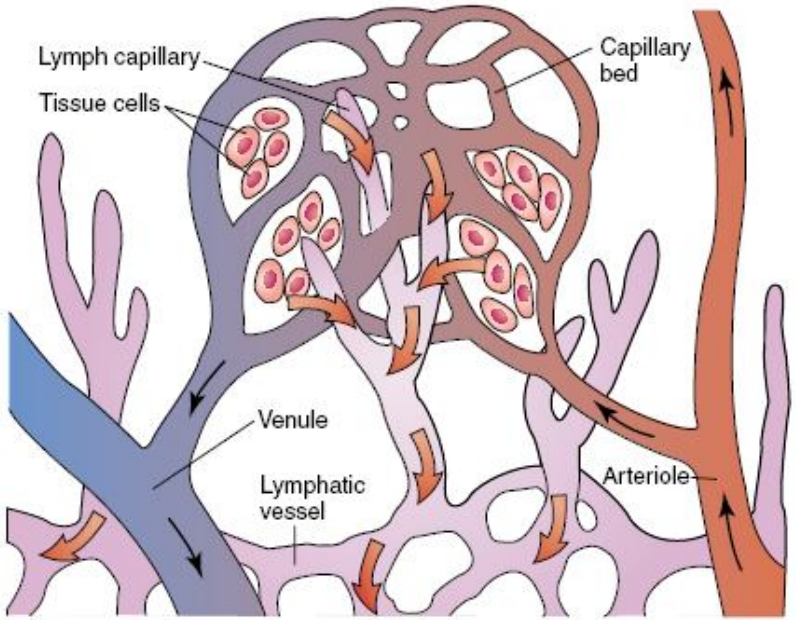
FIGURE 15-3. (A) The relationship between lymph capillaries and tissue cells and blood vessels. (B) Detail of a lymphatic capillary and tissue cells.

Lymphatic capillaries

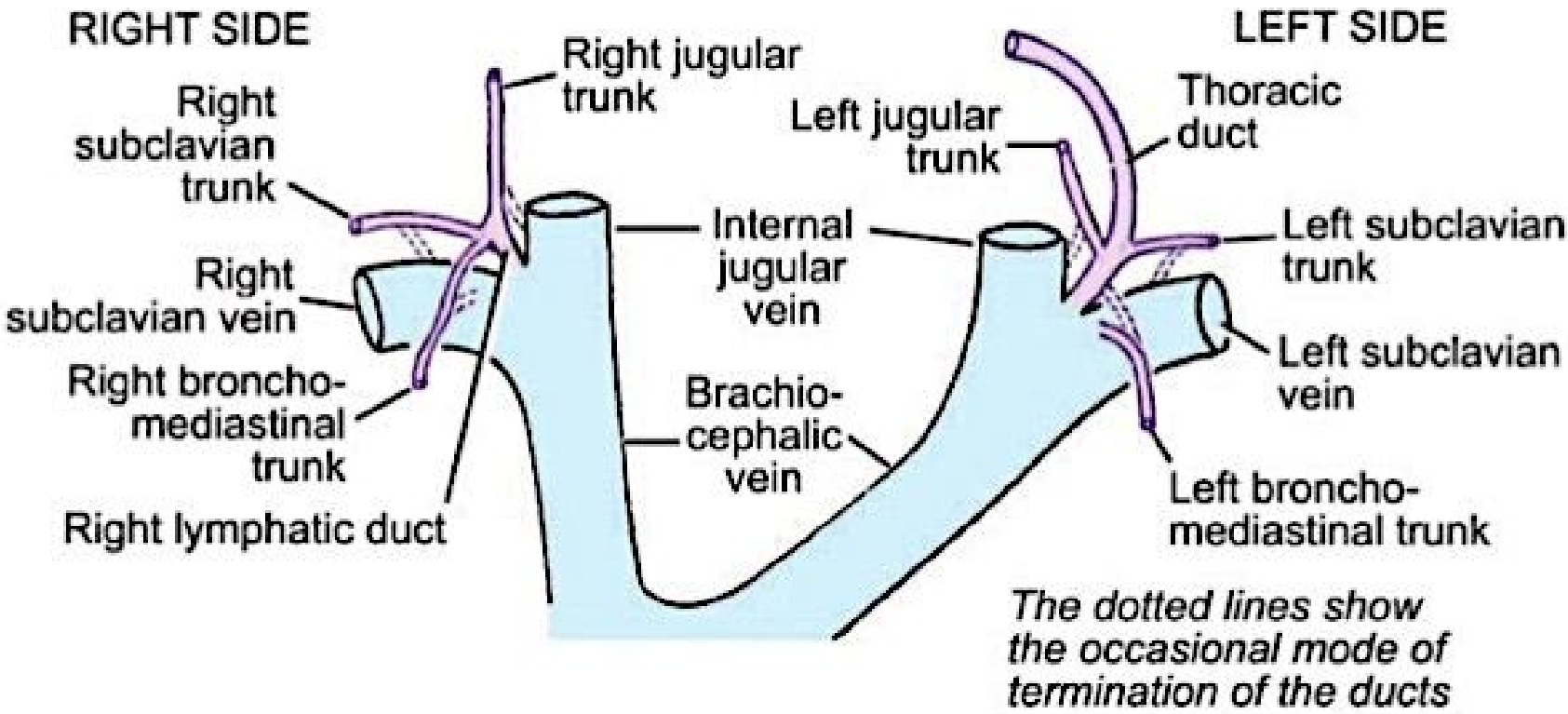


Lymphatic Vessels

Lymphatic vessels originate as blind-end tubes that begin in spaces between cells in most parts of the body. The tubes, which are closed at one end, occur singly or in extensive plexuses and are called **lymph capillaries** (Figures 15-2 and 15-3). These vessels are not found in the central nervous system, red bone marrow, vascular tissue, and portions of the spleen. Lymph capillaries are much larger and more permeable than blood capillaries. Lymph capillaries will eventually unite to form larger and larger lymph vessels called **lymphatics** (**LIM**-fat-iks). Lymphatics resemble veins in structure but have thinner walls and more valves. The large number of valves helps to ensure that the lymph will not backflow but go in one direction only. Along lymphatics there are lymph nodes found at various intervals.



Lymphatics of the skin travel in loose subcutaneous connective tissue and generally follow the routes of veins. Lymphatics of the viscera generally follow the routes of arteries and form plexuses around the arteries. Eventually, all the lymphatics of the body converge into one of two main channels: either the **thoracic duct** (the main collecting channel) or the **right lymphatic duct**.

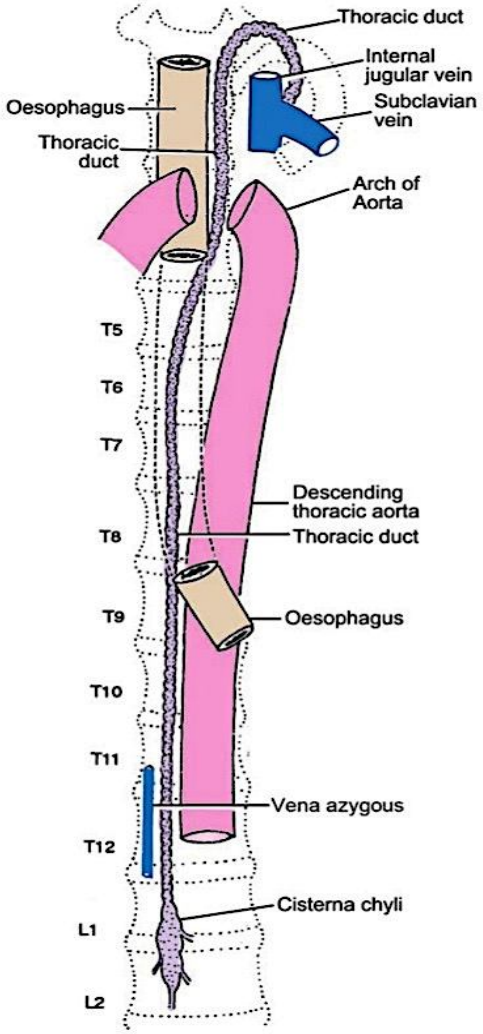


22.7: Scheme to show the main lymphatic ducts

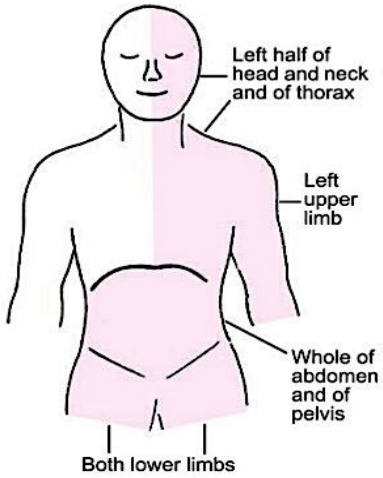
The thoracic duct :

In the lower thoracic cavity in the midline with:

- the thoracic aorta on the left
- the azygos vein on the right
- the esophagus anteriorly



22.5: Course and relations of the thoracic duct as seen from the front



22.6: Scheme to show the area of the body draining through the thoracic duct

Thoracic duct

At T5:
passes to the left and to the left of the esophagus

In the superior mediastinum and the root of the neck:
left of the Esophagus

Arching laterally:
posterior to the carotid sheath

Turns inferiorly:
in front of the thyrocervical trunk
the phrenic nerve
the vertebral artery.

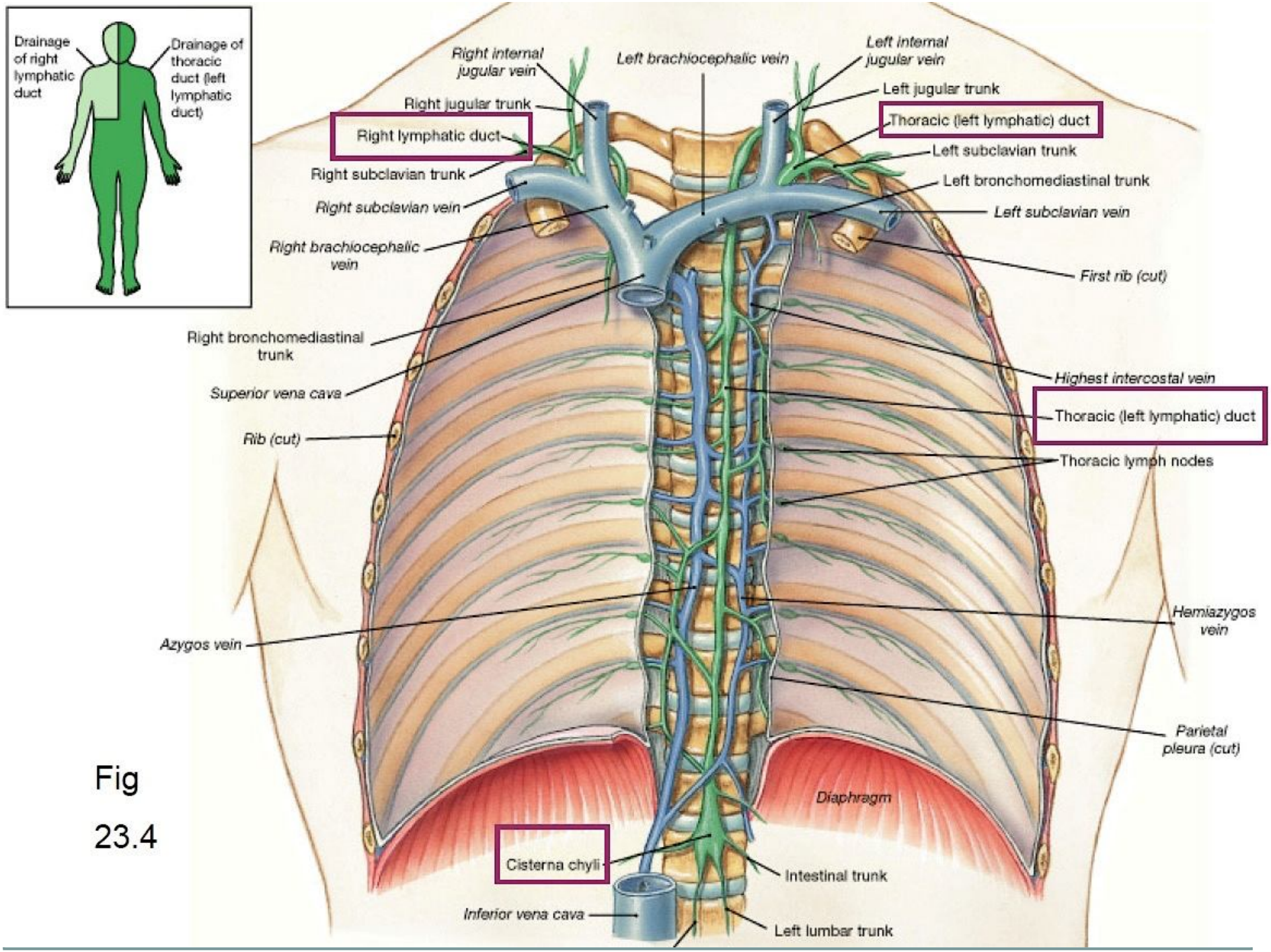

Drainage of right lymphatic duct
Drainage of thoracic duct (left lymphatic duct)
Right internal jugular vein
Left brachiocephalic vein
Left internal jugular vein
Right jugular trunk
Left jugular trunk
Right lymphatic duct
Thoracic (left lymphatic) duct
Right subclavian trunk
Left subclavian trunk
Left bronchomediastinal trunk
Right subclavian vein
Left subclavian vein
Right brachiocephalic vein
First rib (cut)
Right bronchomediastinal trunk
Highest intercostal vein
Superior vena cava
Thoracic (left lymphatic) duct
Rib (cut)
Thoracic lymph nodes
Hemiazygos vein
Azygos vein
Parietal pleura (cut)
Diaphragm
Cisterna chyli
Intestinal trunk
Inferior vena cava
Left lumbar trunk

Fig 23.4

The thoracic duct terminates in the *junction between the left internal jugular and the left subclavian veins*

Near its junction with the venous system it is joined by:

- the left jugular trunk:
The left side of the head and neck

- the left subclavian trunk:
the left upper limb

- the left bronchomediastinal trunk:
left half of the thoracic structures

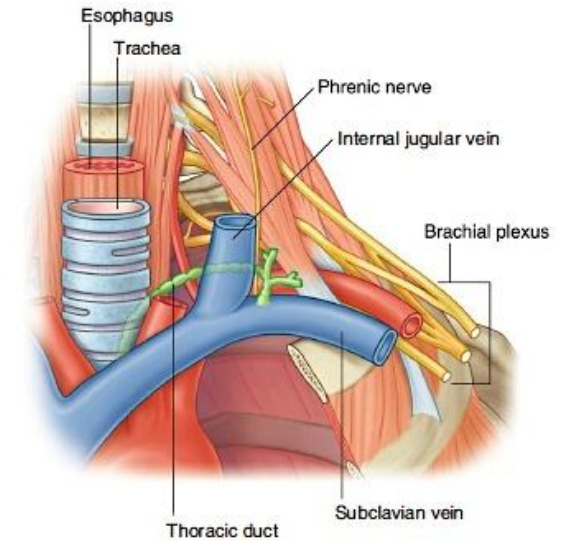
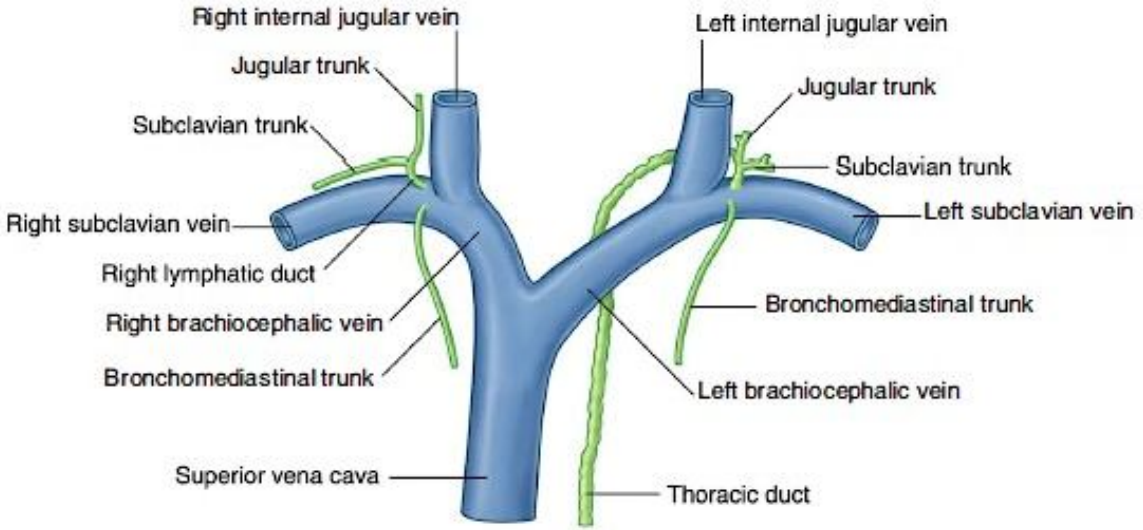


Fig. 8.191 Thoracic duct in the root of the neck.



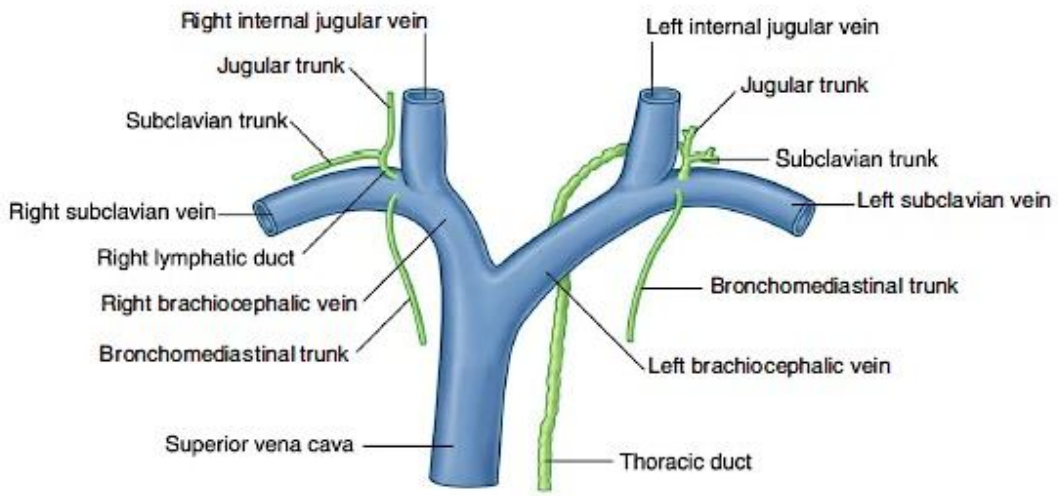
lymphatic trunks on the right side of the body terminates in the *junction between the right internal jugular and right subclavian veins*

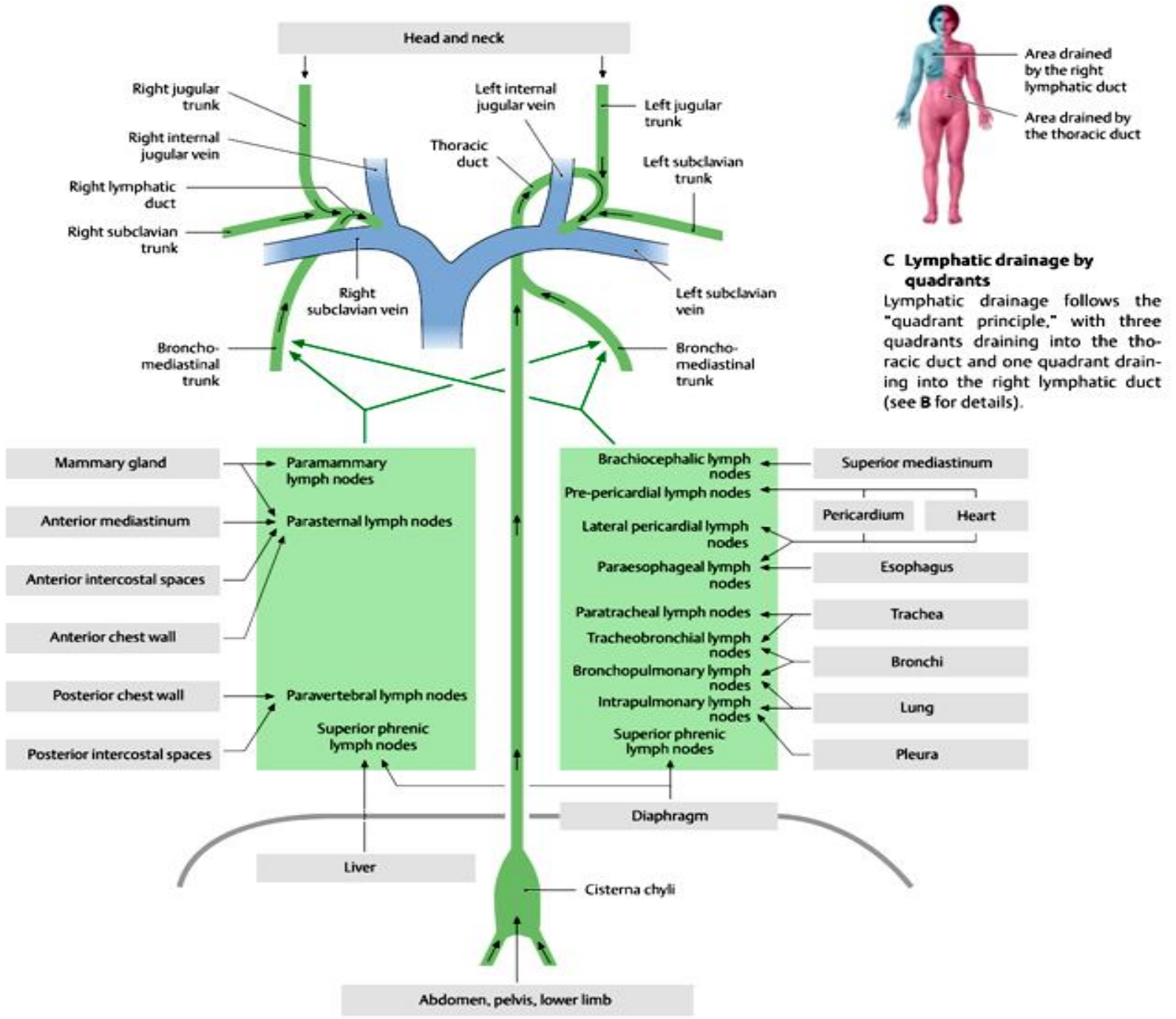
Near its junction with the venous system it is joined by:

• *the right jugular trunk:*
the head and neck

• *the right subclavian trunk:*
the right upperLimb

• *the right bronchomediastinal trunk:*
the structures in the right half of
the thoracic cavity and the right upper intercostal spaces





C Lymphatic drainage by quadrants

Lymphatic drainage follows the "quadrant principle," with three quadrants draining into the thoracic duct and one quadrant draining into the right lymphatic duct (see **B** for details).

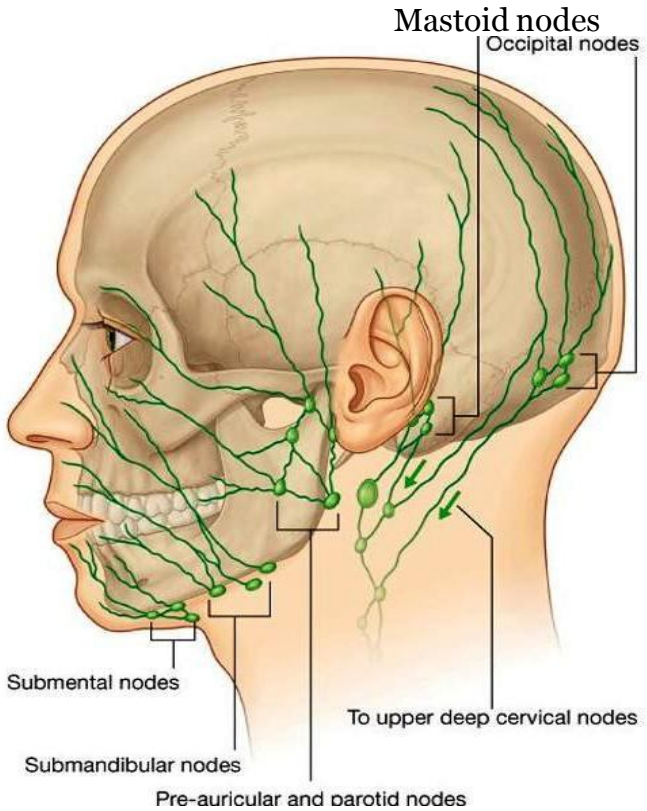
Lymphatic drainage of the scalp

The lymphatics in the occipital= drain to occipital nodes

Lymphatics from the upper part of the scalp drain in two directions:

• Posterior to the vertex :
Mastoid nodes (retro-auricular/posterior auricular nodes)
upper deep cervical nodes.

• Anterior to the vertex :
preauricular
parotid nodes



Lymphatic Drainage Of The Face

- **submental nodes:**
inferior and posterior t o the chin,

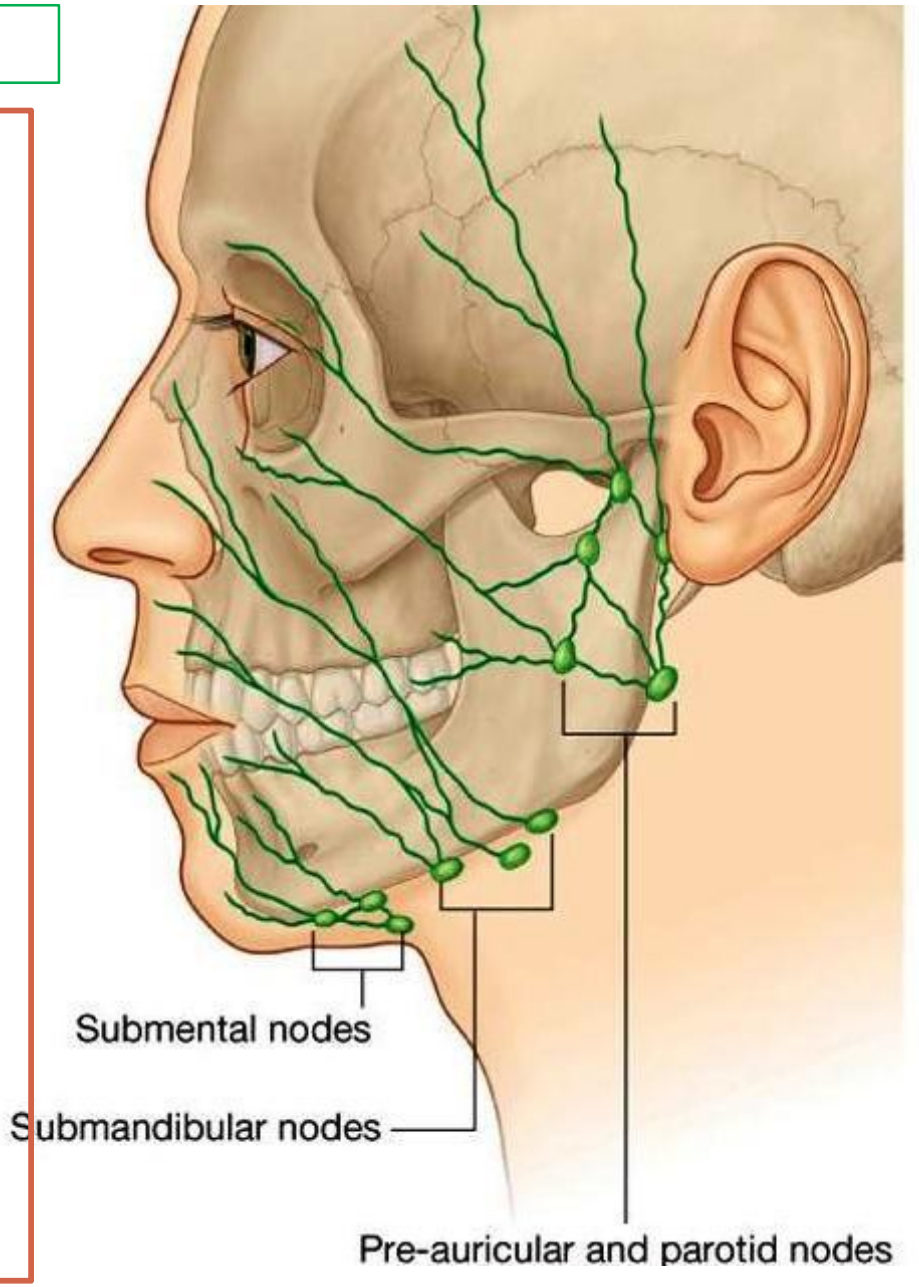
drain lymphatics from
medial part of the lower lip
chin

- **submandibular nodes :**
superficial to the submandibular gland & inferior to the body of the mandible

drain the lymphatics from
medial corner of the Orbit
most of the *external nose*
medial part of the cheek,
upper lip
lateral part of the lower lip

- **pre-auricular and parotid nodes :**
anterior to the ear

drain lymphatics from
most of *the eyelids*
a part of *the external nose*
lateral part of the cheek



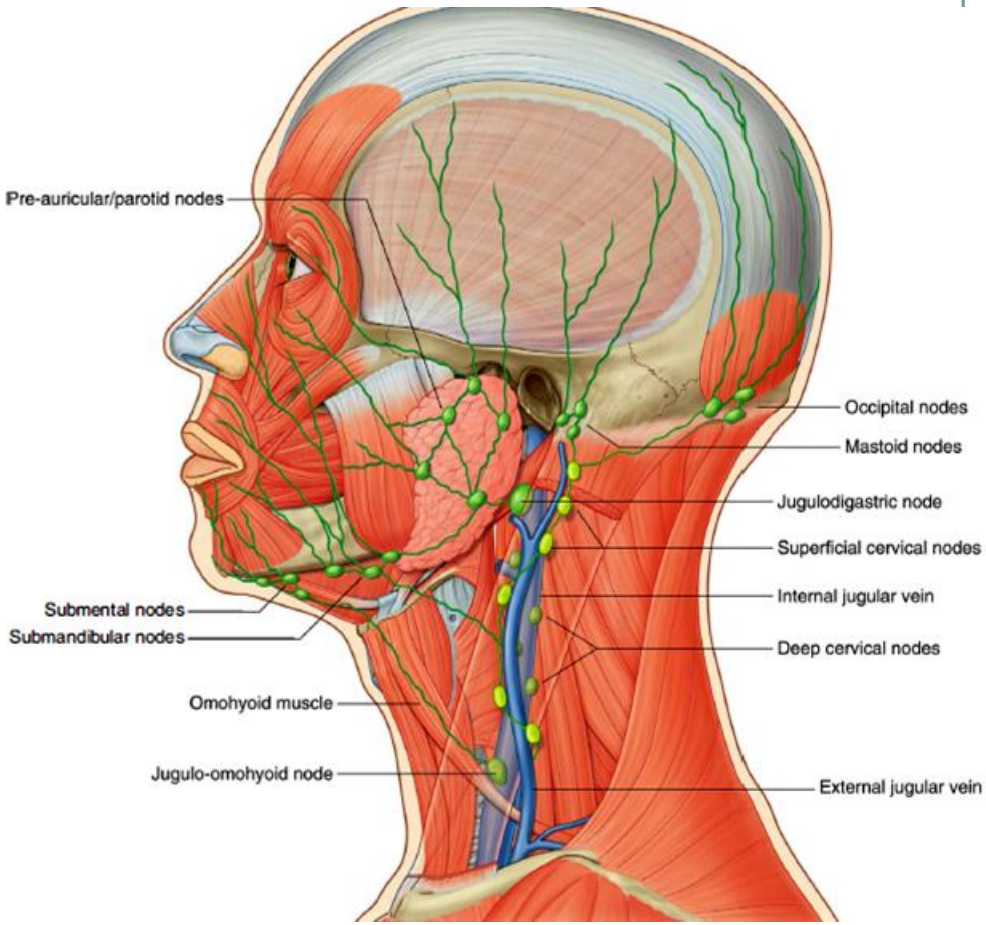
Lymphatics o f the neck

The components of this system include :

Superficial nodes around the head

Superficial cervical nodes along the external jugular vein

Deep cervical nodes forming a chain along the internal jugular vein



Superficial nodes around the head

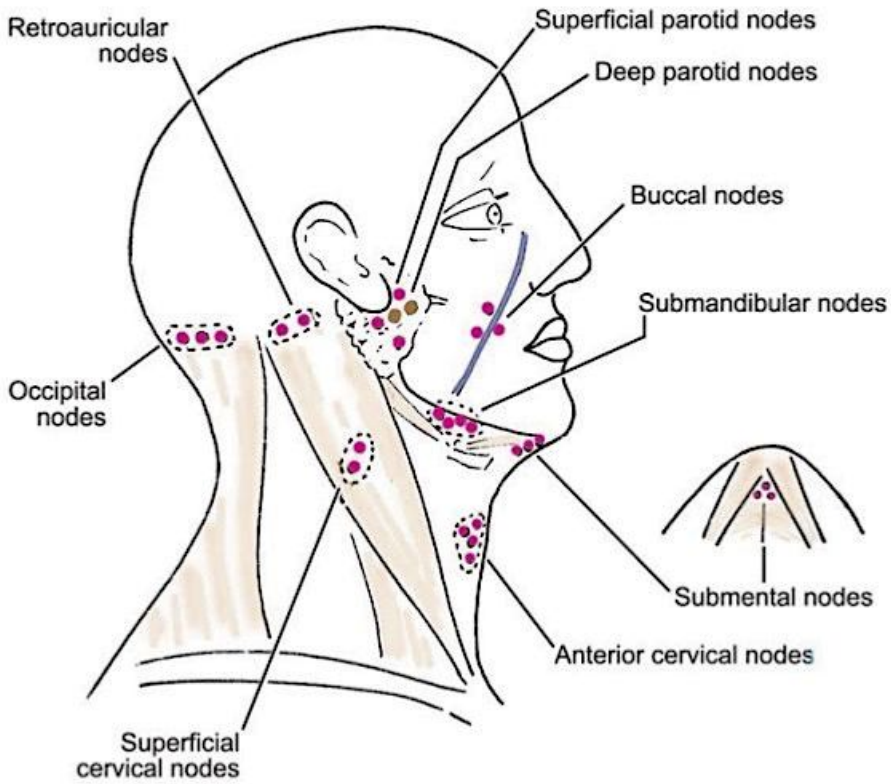
Occipital group *(*associated with the occipital artery *)* = posterior scalp & neck

Retroauricular(mastoid) group *(*associated with the posterior auricular artery) = the posterolateral half of the scalp

Parotid group (superficial / deep) (preauricular) *(*associated with the superficial temporal and trans- verse facial arteries) = anterior surface of the auricle, the anterolateral scalp, the upper half of the face, the eyelids, and the cheeks

Submandibular group *(*associated with the facial artery) = gingivae, the teeth, and the tongue

Submental group = center part of the lower lip, the chin, the floor of the mouth, the tip of the tongue, and the lower incisor teeth



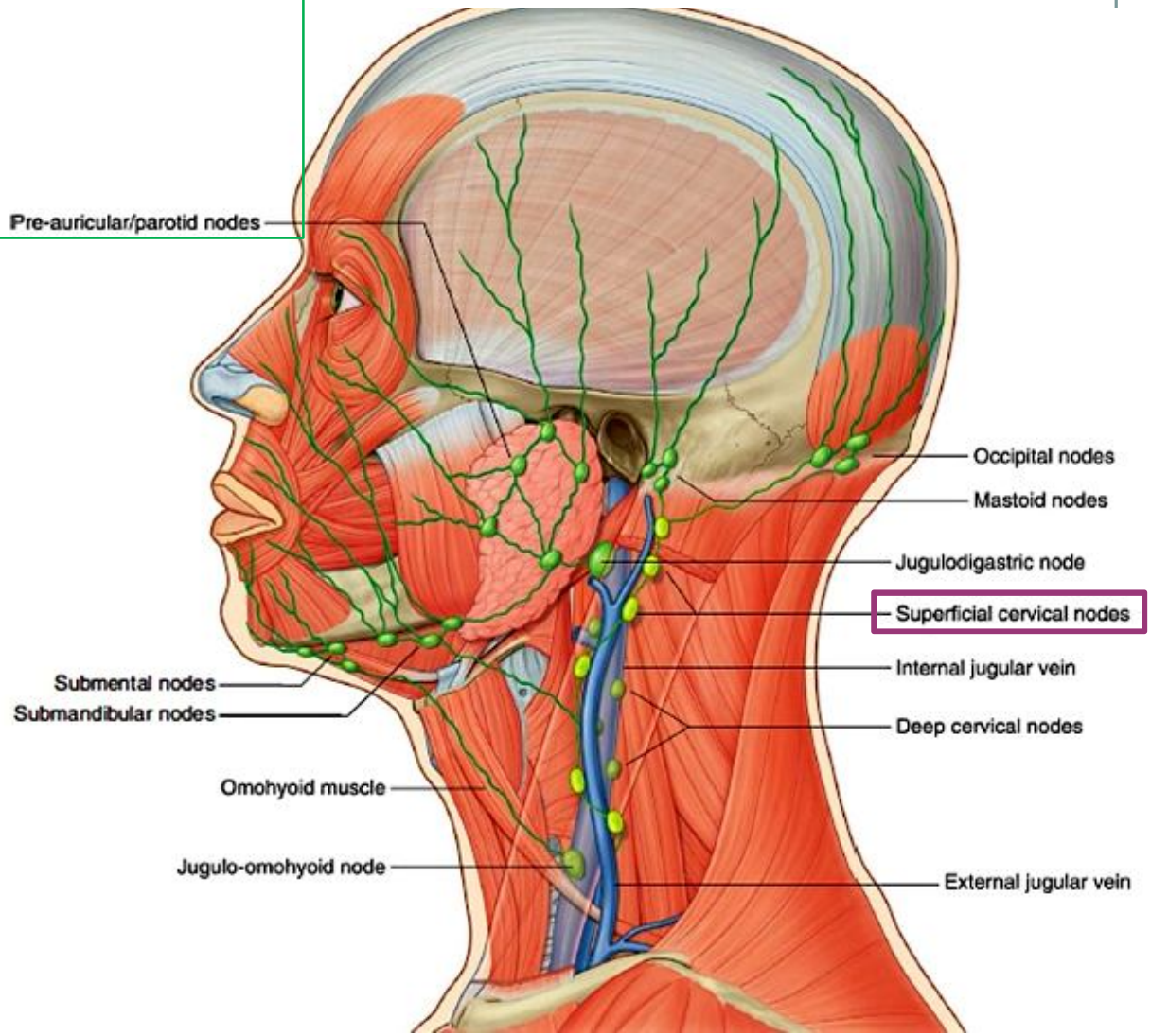
41.22: Lymph nodes draining superficial tissues of the head and neck

Superficial Nodes Around The Head

In the surface of SCM muscle

Afferent:

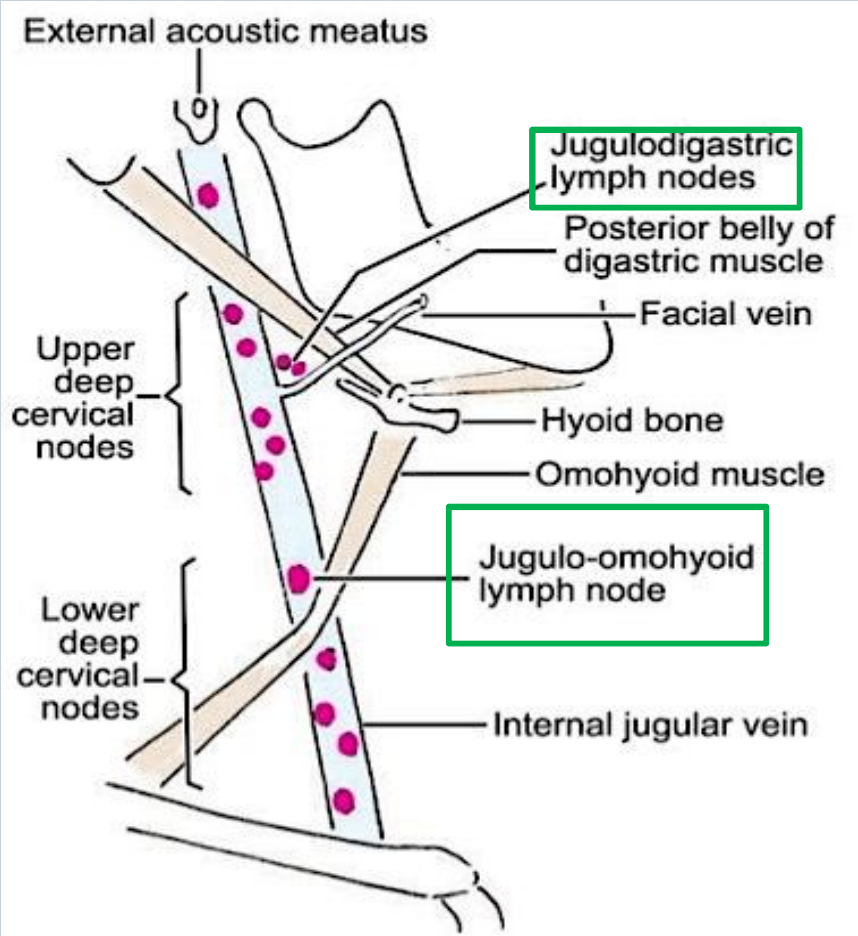
Occipital node
Mastoid node



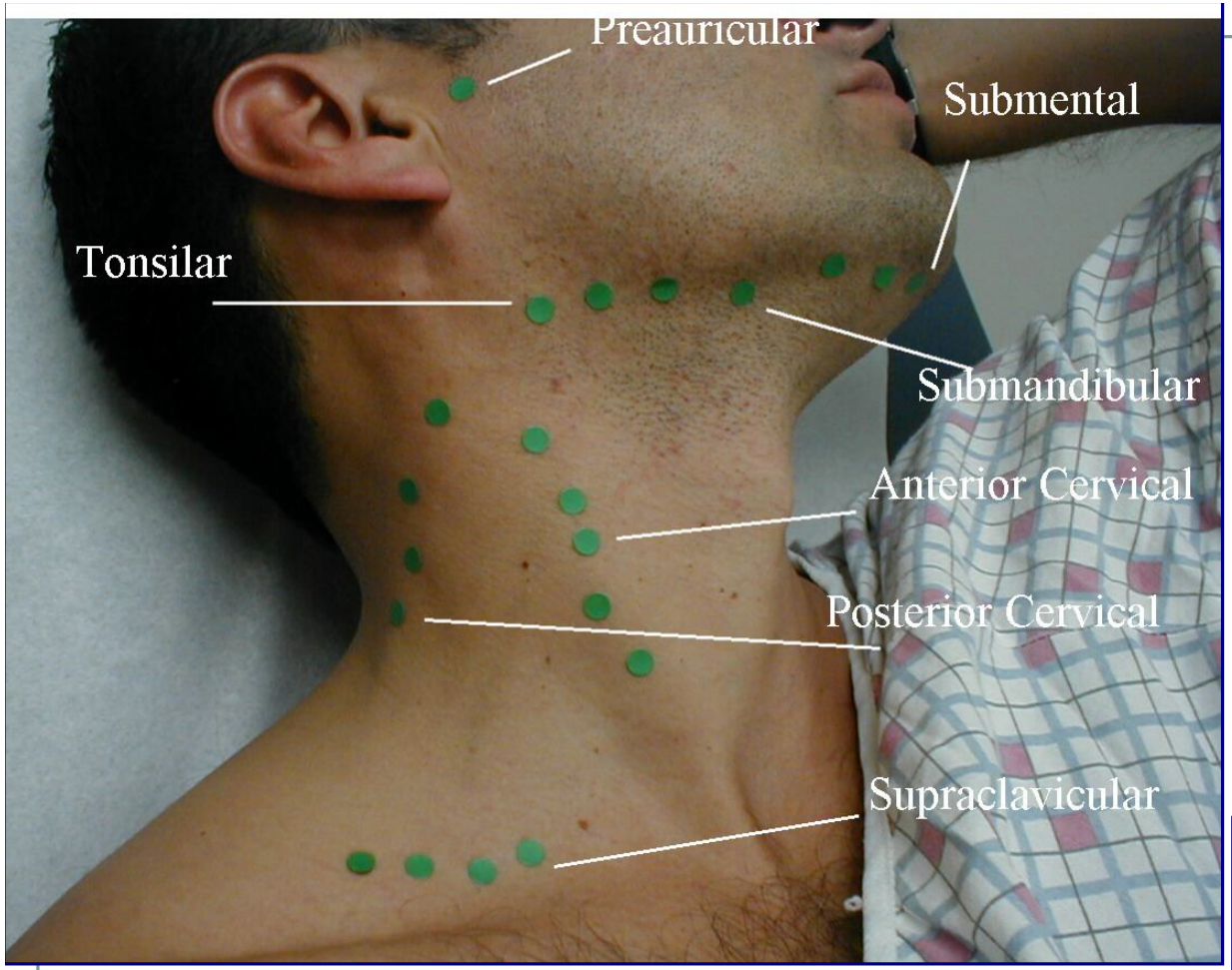
Deep Cervical Nodes

Sup. Group:
Jugulodigastric node
is where the posterior belly of the digastric muscle crosses the internal jugular vein the
Afferent: tonsils and tonsillar region

inf. Group:
jugulo- omohyoid node
inferior to the intermediate tendon of the omohyoid muscle
Afferent: the tongue



41.23: Scheme to show the deep cervical lymph



Surface Locations of Lymph Node Chains in Head and Neck

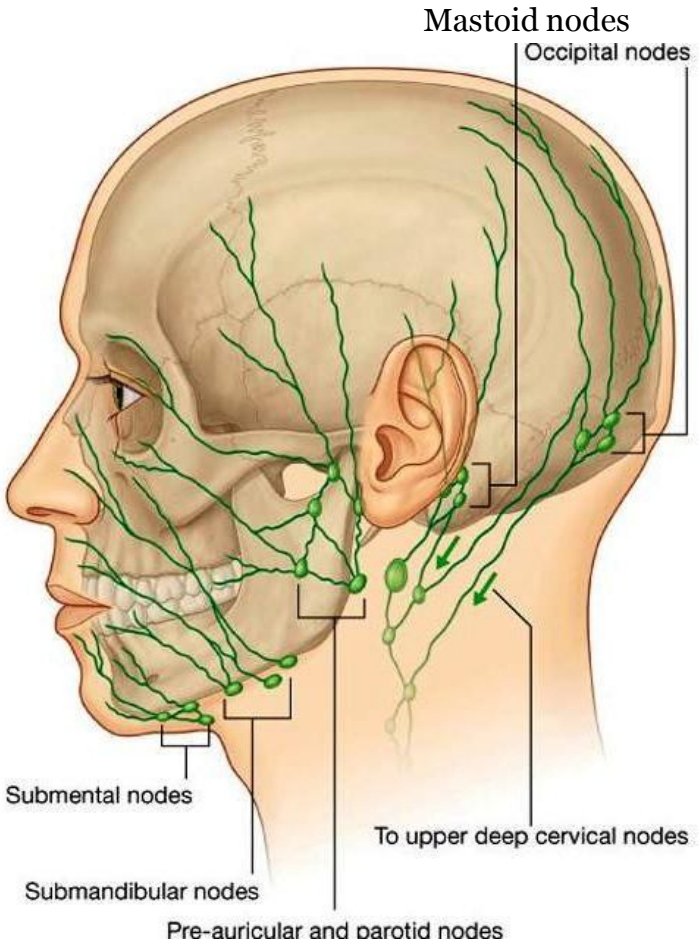
A typical active lymph node,
e.g.
in an infection

Lymphatic drainage o f the auricle

Anteriorly :
Into parotid nodes

Posteriorly:
into mastoid nodes

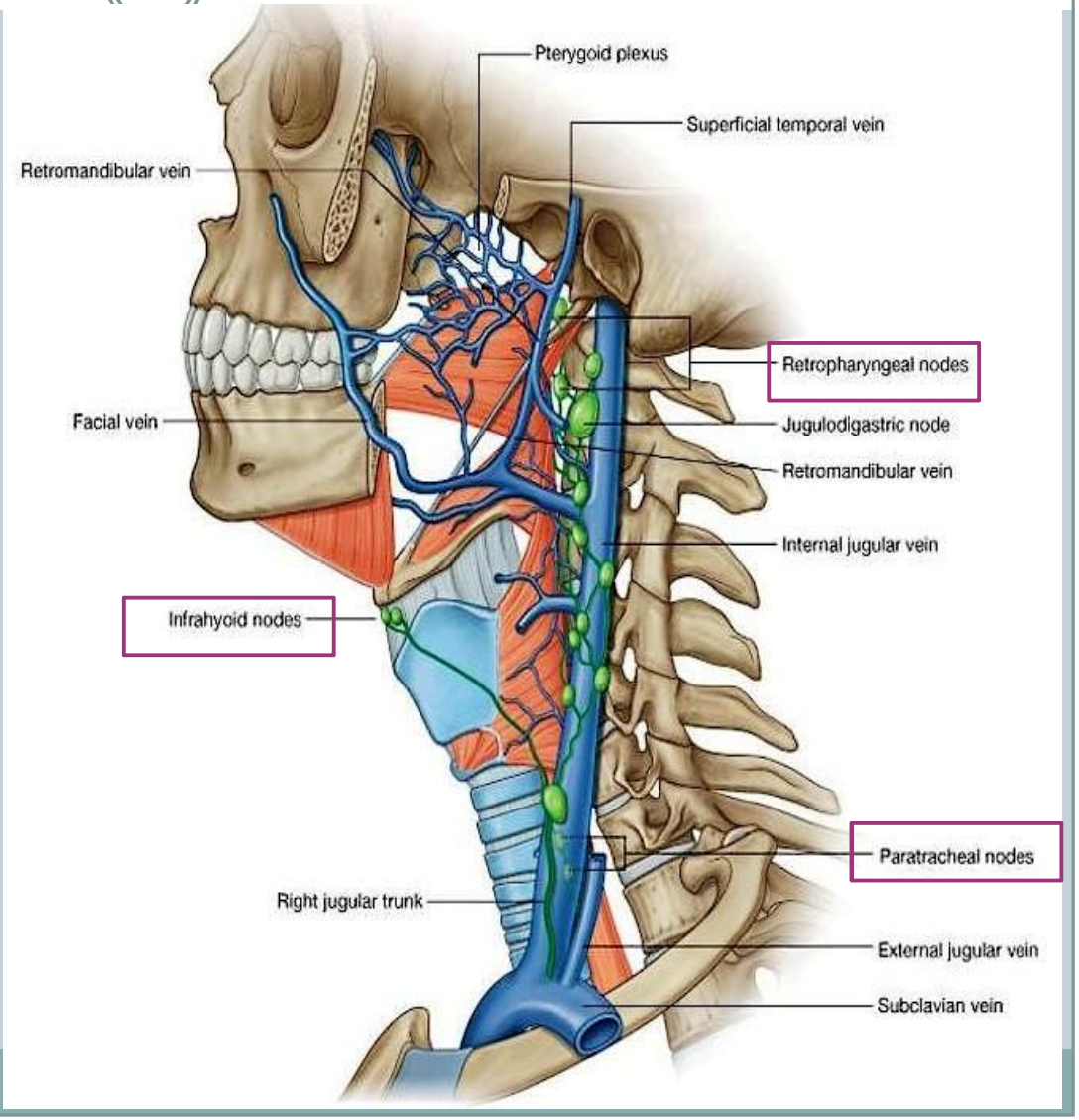
Possibly into the upper deep cervical nodes



Lymphatic Drainage Of The Pharynx

Drain to :

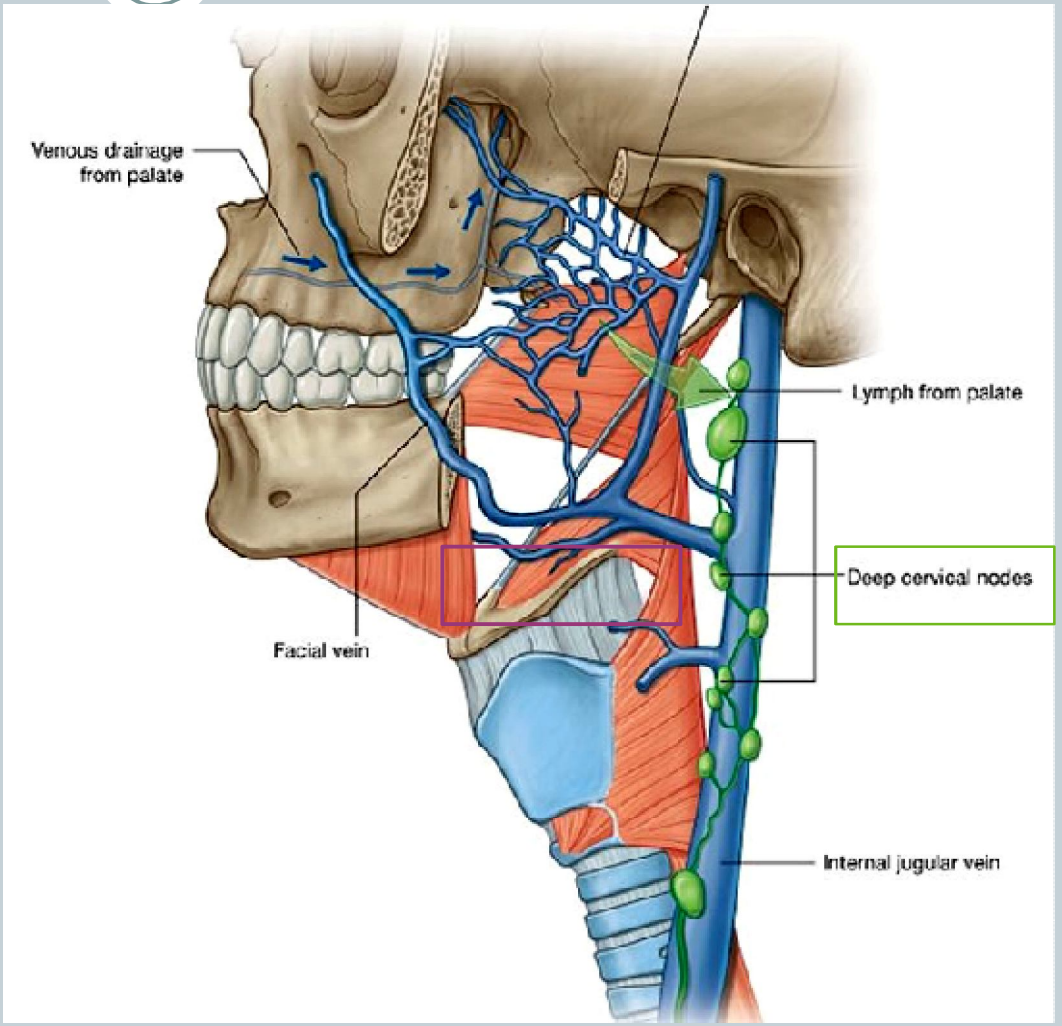
Retropharyngeal node
Paratracheal node
Infrahyoid node



Lymphatic Drainage Of The Palate

The palatine tonsils:

jugulodigastric nodes



Laryngeal lymph nodes

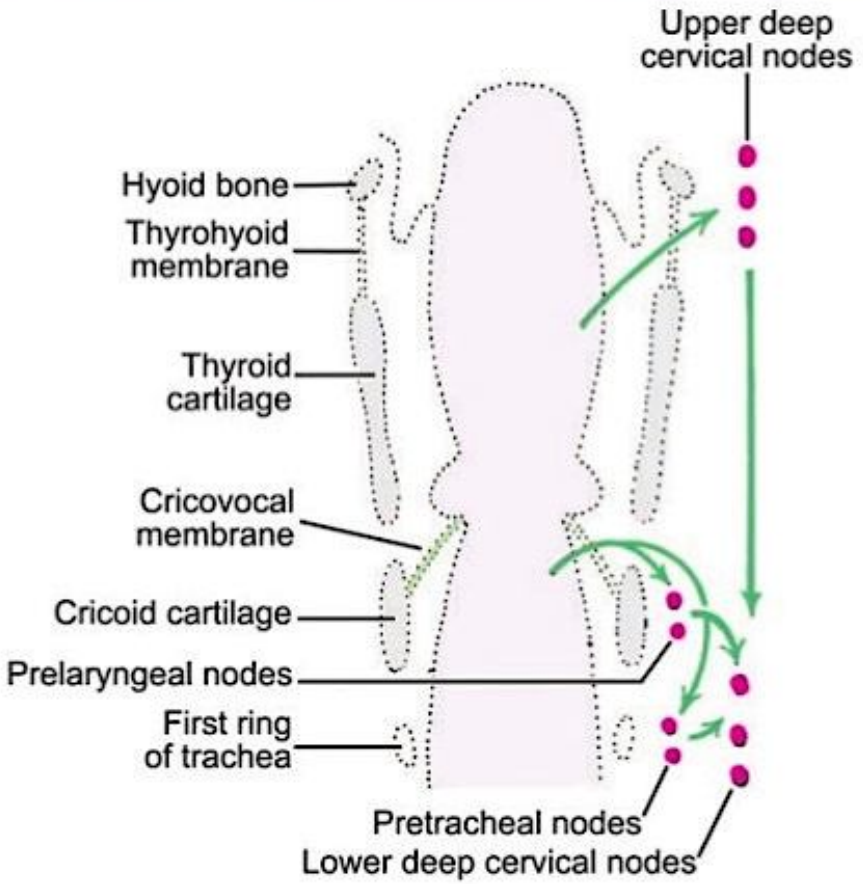
Lymphatics drain regions above and below the vocal folds:

❖ *above the vocal folds =*

a. the superior laryngeal artery
b. deep cervical nodes associated with the bifurcation of the common carotid artery

❖ *below the vocal folds =*

a. deep nodes associ-ated with the inferior thyroid artery
b. nodes asso-ciated with the front of the cricothyroid ligament
c. upper trachea

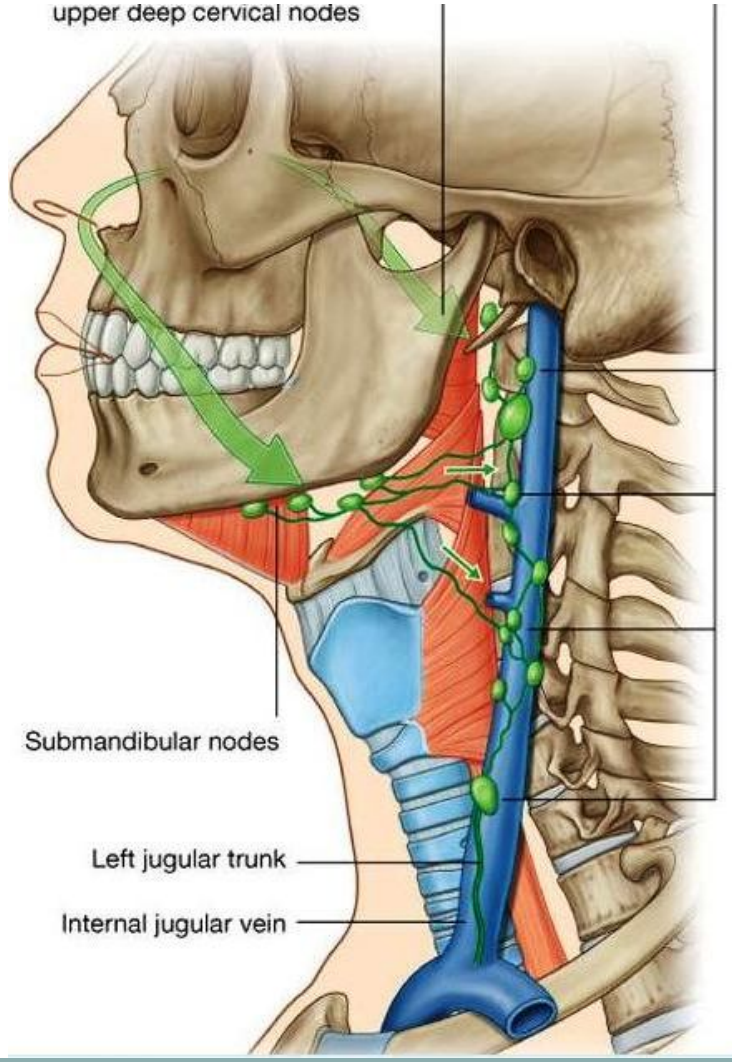


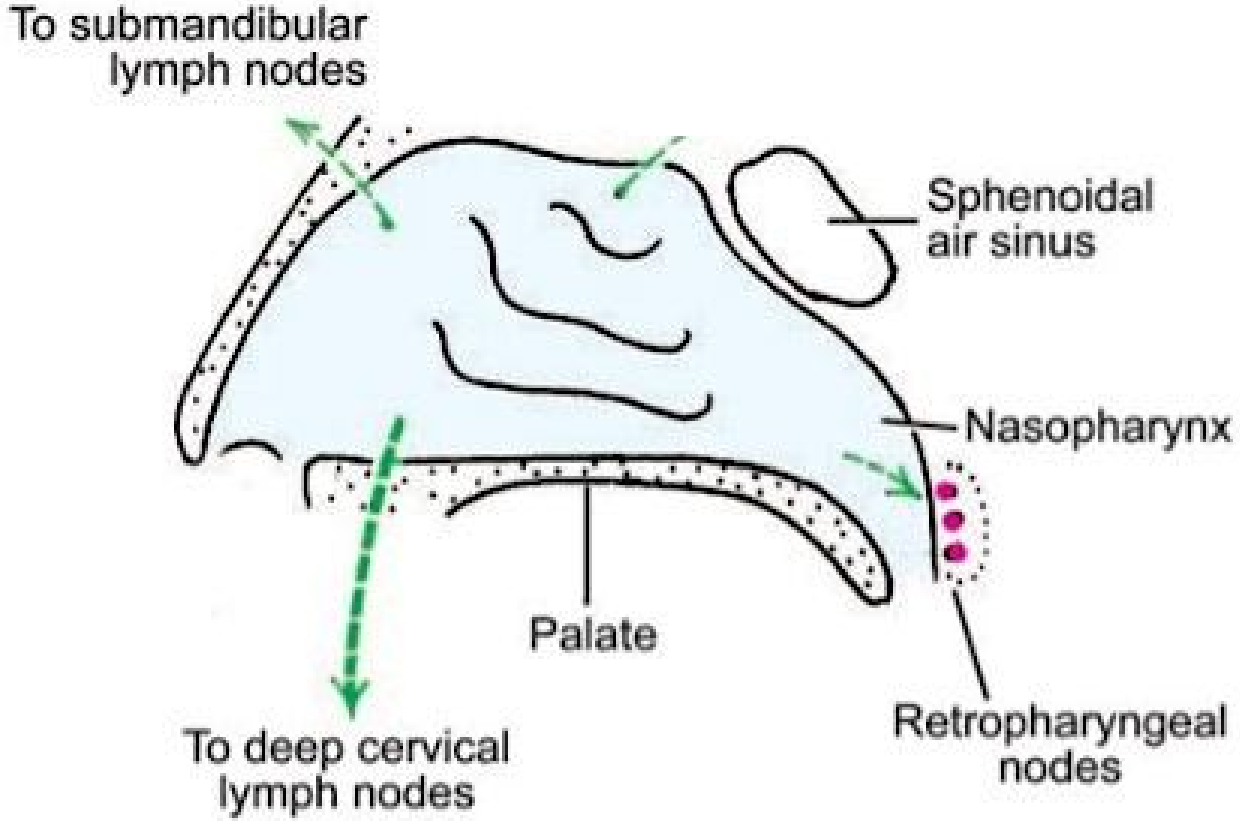
45.20: Scheme to show the lymphatic drainage of the larynx

Lymphatic drainage of the nasal cavities

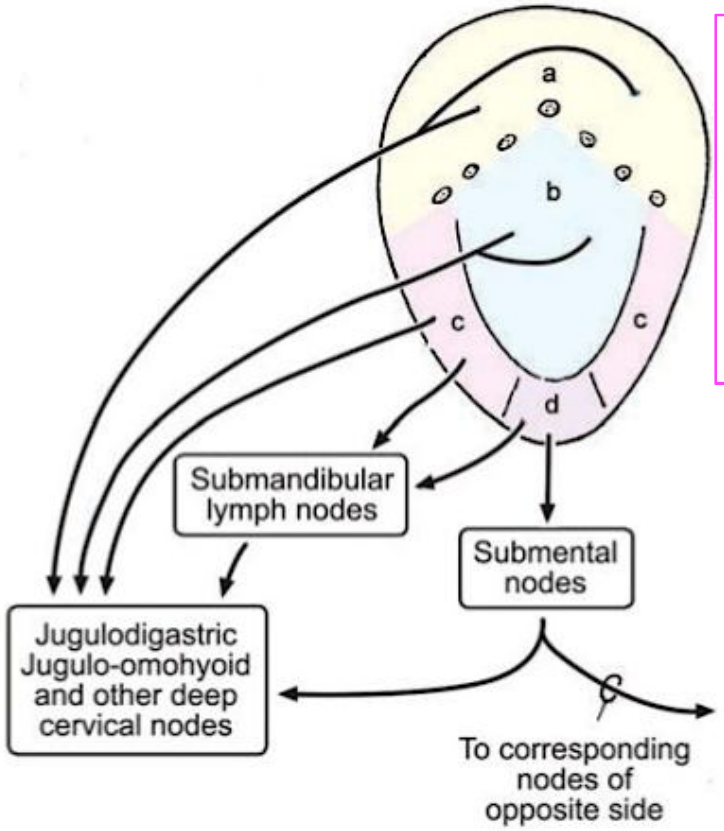
anterior regions of the nasal cavities drains =
forward onto the face /
submandibular nodes

posterior regions of the nasal cavity and the paranasal sinuses drains =
retro- pharyngeal nodes
upper deep cervical nodes





45.8B: Scheme to show the lymphatic drainage of the nasal cavity



39.21: Lymphatic drainage of the tongue

✓ *The pharyngeal part of the tongue =*
jugulodigastric node of the deep cervical chain

✓ *The oral part of the tongue =*
deep cervical nodes
submental and submandibular nodes

The tip of the tongue =
submental nodes
jugula-omohyoid node of the deep cervical chain

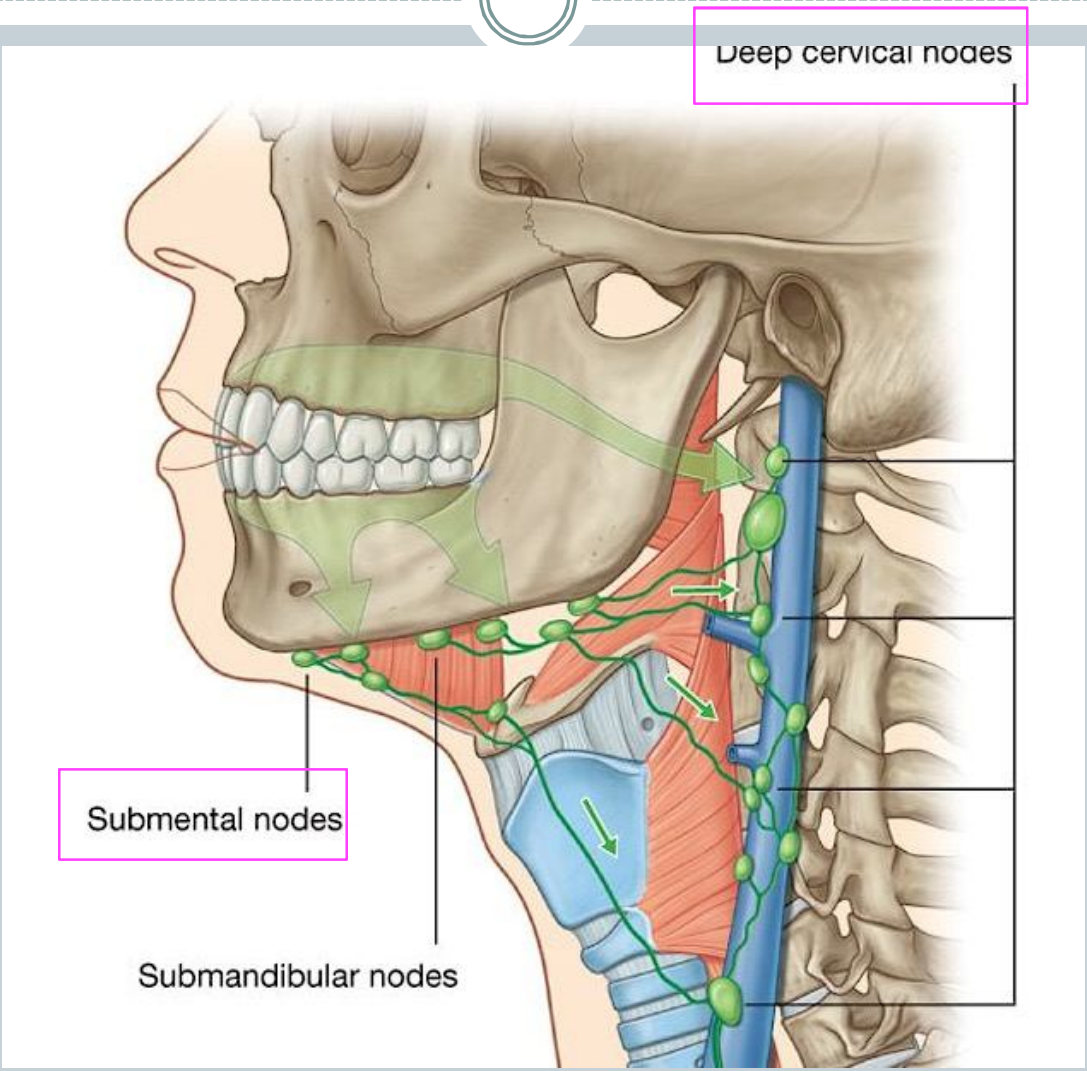
lymphatic vessels from the parotid gland =

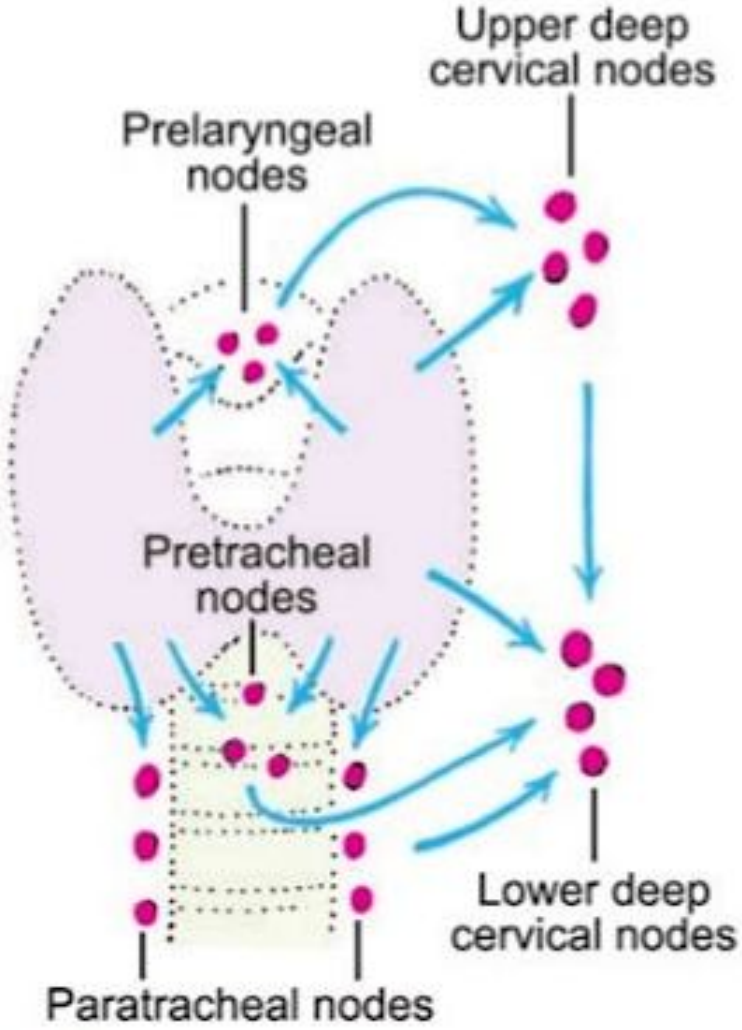
into nodes that are on or in the gland /
then drain into superficial and deep cervical nodes

Lymphatics from the submandibular and sublingual glands =

submandibular nodes /
then into deep cervical nodes(jugula-omohyoid node)

Lymphatic Drainage Of The Teeth And Gums





46.9B: Scheme to show the lymphatic drainage of the thyroid gland

CLINICAL CORRELATION

Enlarged Lymph Nodes

1. Lymph nodes in the head and neck may be enlarged in various diseases. The most important of these are tuberculosis and malignancy.
2. Physical examination of the neck involves systematic palpation of the nodes.
   a. The surgeon stands behind the patient whose neck is slightly flexed (to relax the muscles).
   b. Beginning with the suboccipital region the surgeon palpates:
      i. The occipital nodes
      ii. The retroauricular or mastoid nodes
      iii. The parotid nodes
      iv. The submandibular
      v. Submental nodes
      vi. The anterior cervical nodes
      vii. The deep cervical nodes
      viii. The suprasternal nodes
      ix. The supraclavicular nodes.
3. In block dissection of the neck for removal of enlarged lymph nodes (in tuberculosis or malignancy), the submandibular gland is also removed.
4. A segment of the internal jugular vein may also have to be removed. Removal of the vein on one side is compensated by drainage through the vein of the other side. However, if bilateral removal is required, an interval of a few weeks is given between operations on the two sides to allow collateral venous channels to open up.
5. In block dissection special care is taken not to injure the carotid arteries, the vagus nerve, the spinal accessory nerve, the mandibular branch of the facial nerve and the hypoglosssal nerve.
6. However, sometimes the vagus and hypoglossal nerves may have to be removed.
7. Nerves lying deep to the prevertebral fascia (cervical and brachial plexus and their branches) remain intact. If necessary the sternocleidomastoid muscle is divided for better access.

Tumours of the Neck

1. The lymph nodes in the neck may be involved in carcinoma at various sites.
2. The primary growth may lie in the:
    a. The thyroid
    b. The larynx
    c. The base of the tongue
    d. The laryngopharynx
    e. The paranasal sinuses.
3. Rarely secondaries from carcinoma of the breast, the bronchi the stomach or testis can reach these nodes.
4. Various other tumours may be seen in the neck.
    a. In infancy a swelling of the sternomastoid may be seen and later leads to torticolis.
    b. Tumours may form in remnants of the thyroglossal duct, or in the carotid body.

Other Swellings

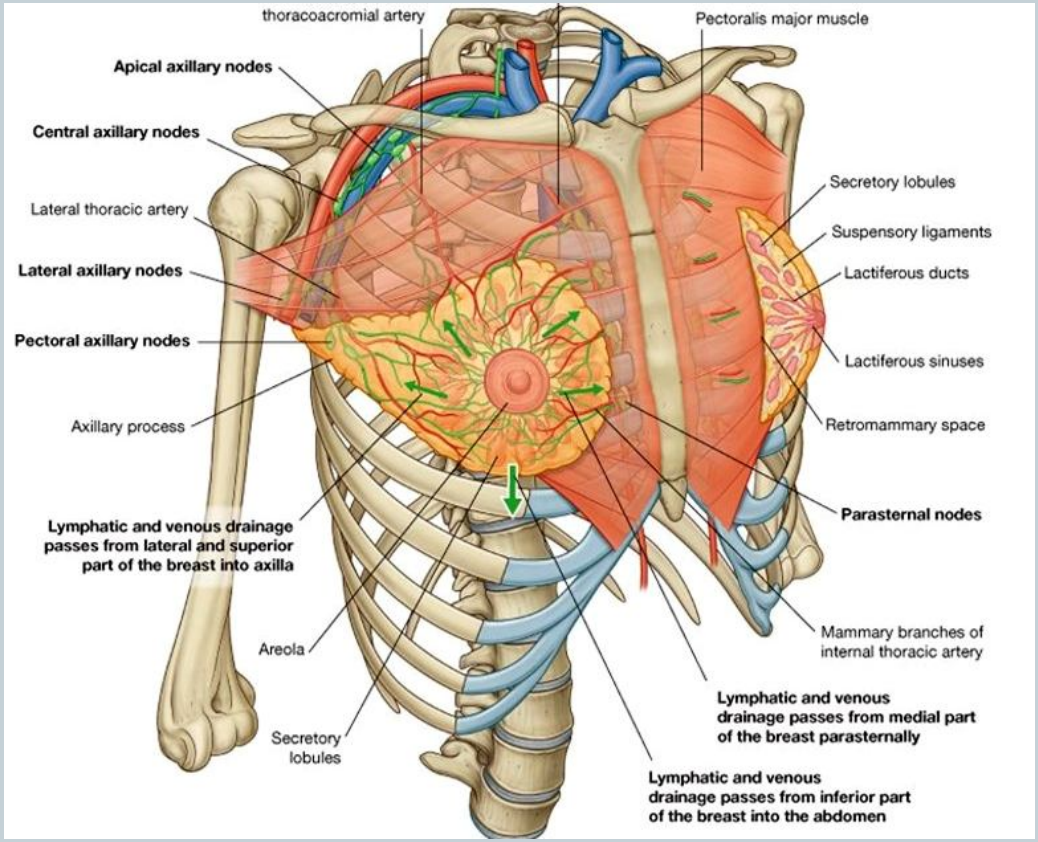
1. Midline swellings may be caused by enlarged submental or suprasternal nodes, thyroglossal cysts, enlargements of thyroid gland, and carcinoma of the larynx.
2. A branchial cyst may form a swelling along the anterior border of the sternocleidomastoid. Rupture of the cyst leads to formation of a branchial fistula. Treatment needs the excision of the tract of the fistula.

Breast

- Approximately 7 5% = laterally and superiorly into axillary nodes / subclavian trunks

- Most o f the remaining = parasternal Nodes / associated with the internal thoracic artery / bronchomediastinal trunks

- Some drainage = intercostal nodes situated near the heads and necks of ribs / thoracic duct or into the bronchomediastinal trunks



C. Lymphatic Drainage of the Breast (See Figure 2-6)

- Is of great importance in view of the frequent development of cancer and subsequent dissemination of cancer cells through the lymphatic stream.
- Removes lymphatic fluid from the lateral quadrants into the axillary nodes and the medial quadrants into the parasternal (internal thoracic) nodes.
- Drains primarily (75%) to the **axillary** nodes, more specifically to the **pectoral (anterior)** nodes (including drainage of the nipple).
- Follows the perforating vessels through the pectoralis major muscle and the thoracic wall to enter the **parasternal (internal thoracic) nodes**, which lie along the internal thoracic artery.
- Also drains to the apical nodes and may connect to lymphatics draining the opposite breast and to lymphatics draining the anterior abdominal wall.

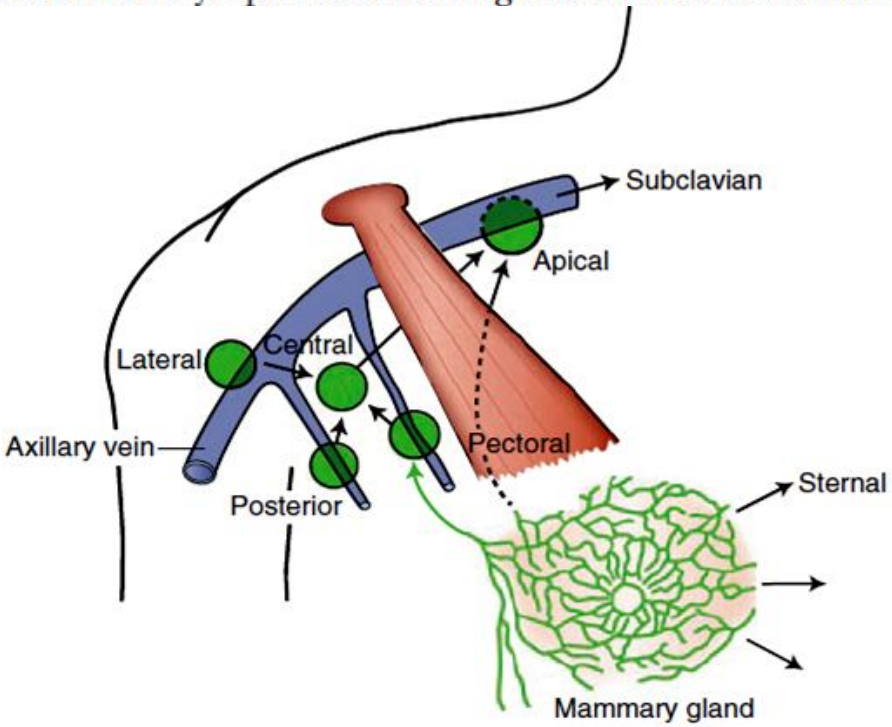


FIGURE 2-6. Lymphatic drainage of the breast and axillary lymph nodes.

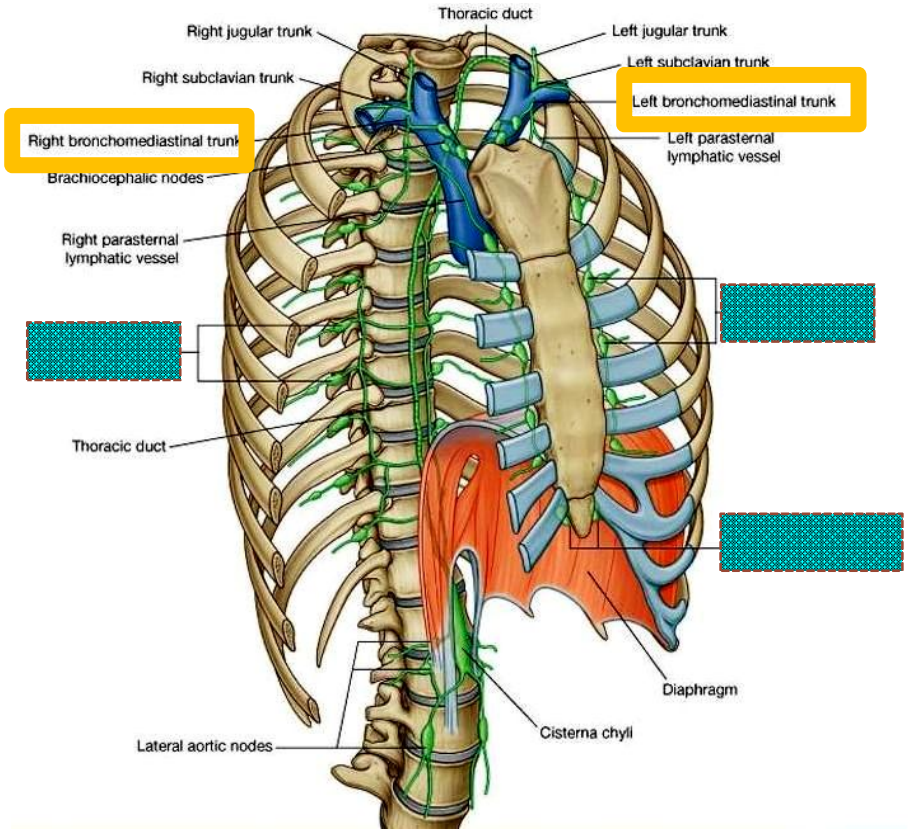
Major lymphatic vessels and nodes of the thoracic wall

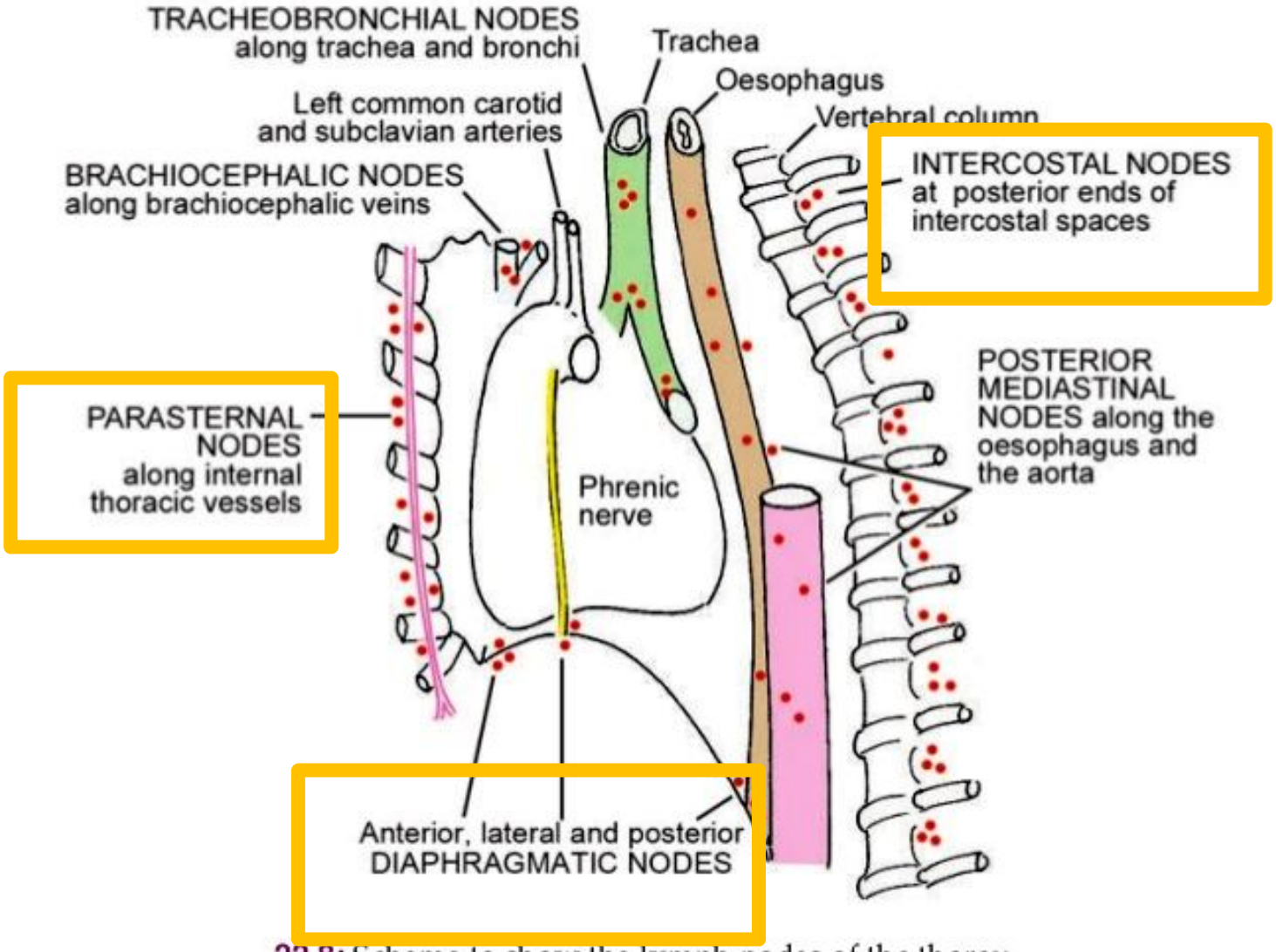
lymph nodes associated with the internal thoracic arteries (parasternal nodes) / bronchomediastinal trunks

- with the heads and necks of ribs (intercostal nodes)

Intercostal nodes *in the upper thorax* also drain into bronchomediastinal trunks, whereas intercostal nodes *in the lower thorax* drain into the thoracic duct.

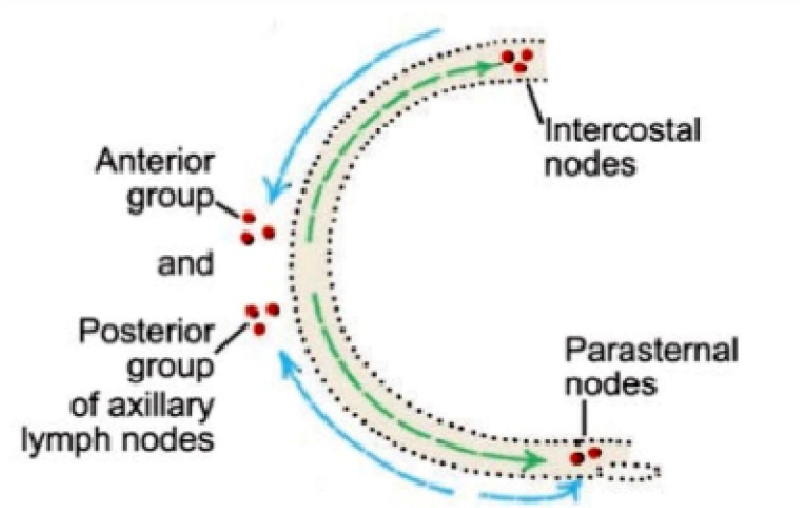
- with the diaphragm (diaphragmatic nodes) / parasternal, prevertebral, juxta-esophageal nodes, brachiocephalic nodes , lateral aortic/lumbar nodes



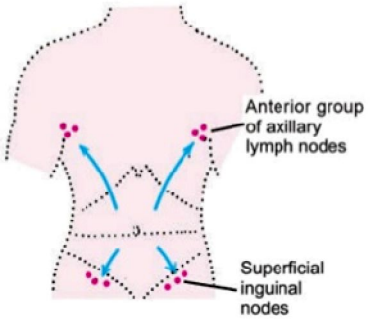


22.8: Scheme to show the lymph nodes of the thorax

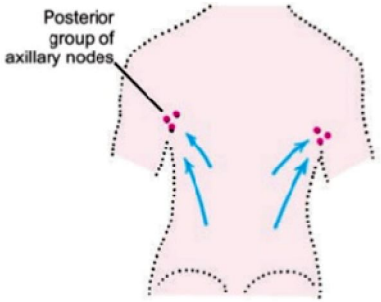
Superficial regions of the thoracic wall drain mainly into *axillary lymph nodes in* the axilla *or parasternal nodes.*



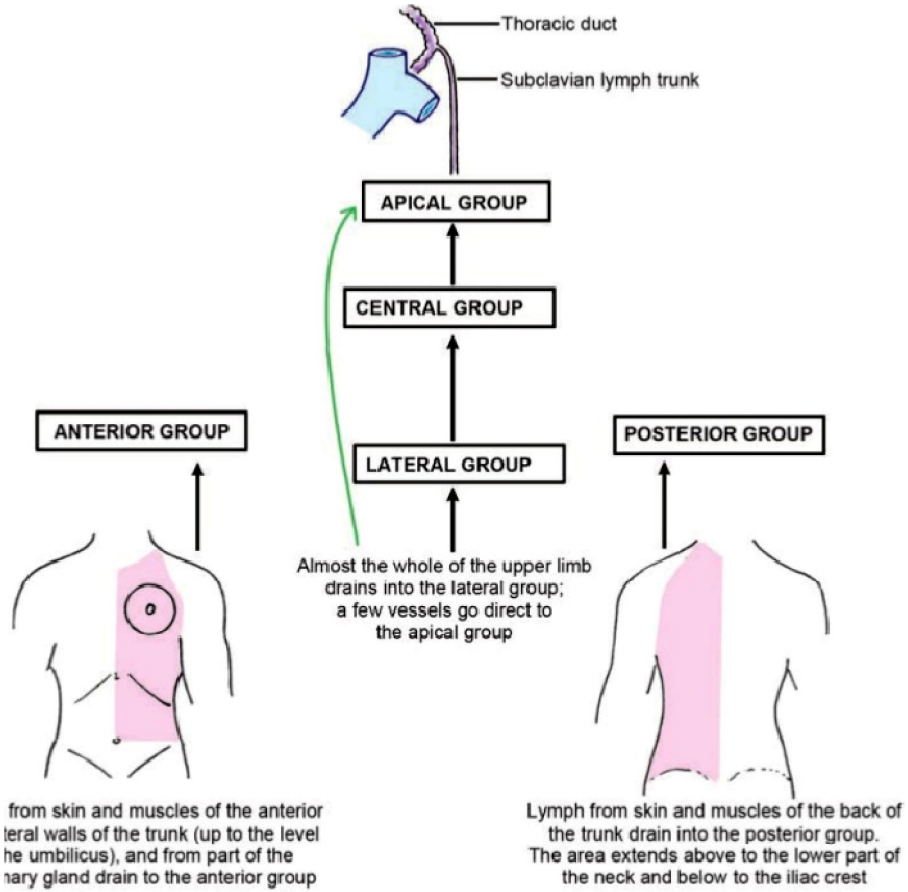
22.10: Scheme to show lymphatic drainage of skin and deeper tissues of thoracic wall



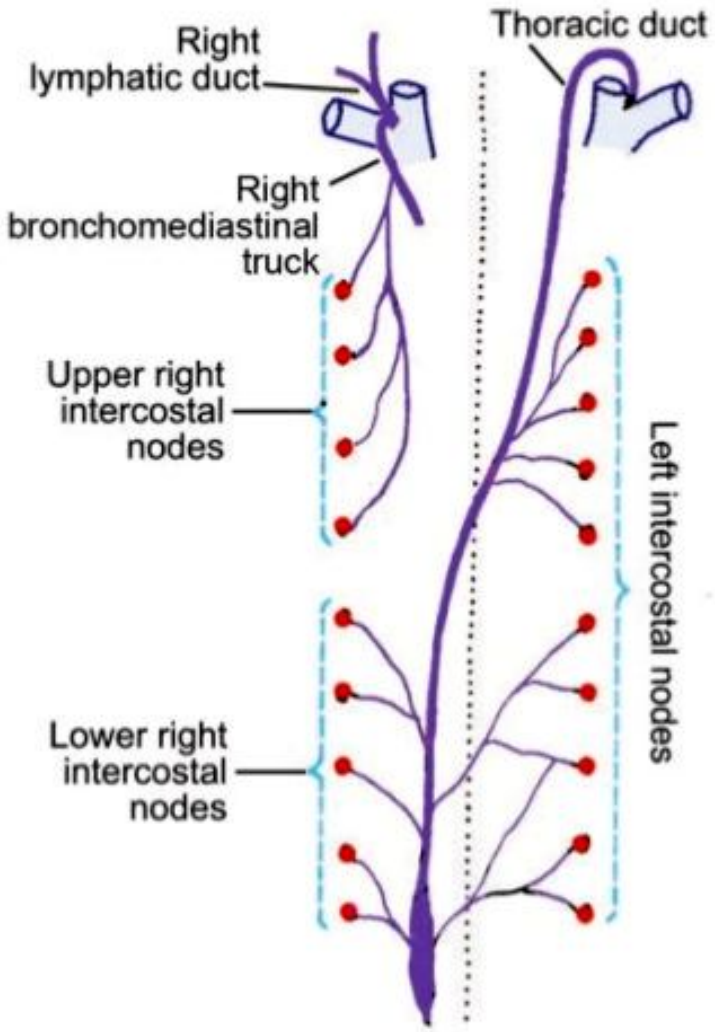
25.28: Lymphatic drainage of anterior aspect of trunk



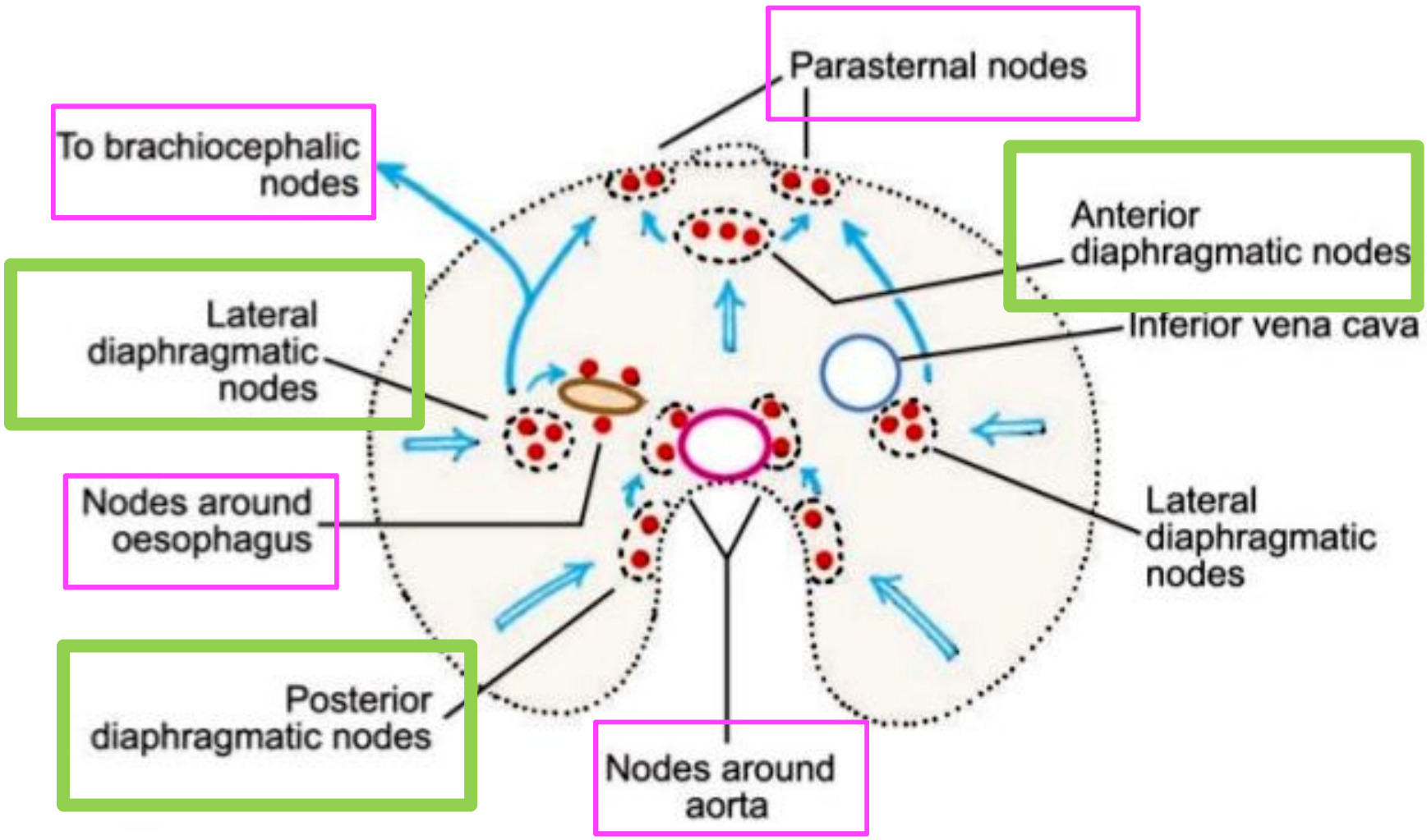
25.29: Posterior aspect of trunk to show its lymphatic drainage.



3.16: Scheme to show areas drained by the axillary lymph nodes



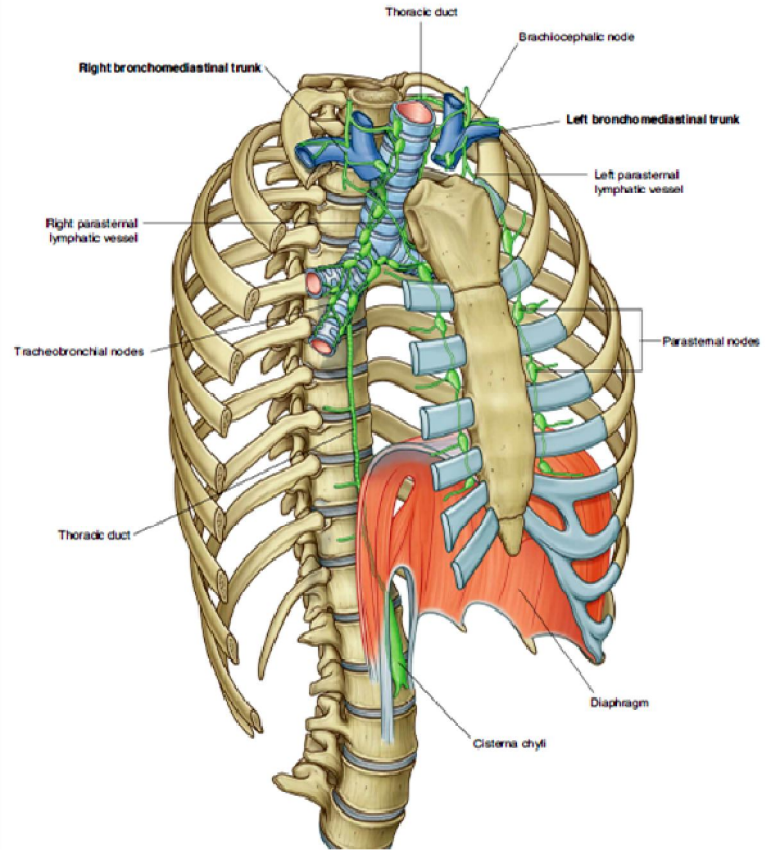
22.11: Scheme to show efferent vessels arising from intercostal lymph nodes

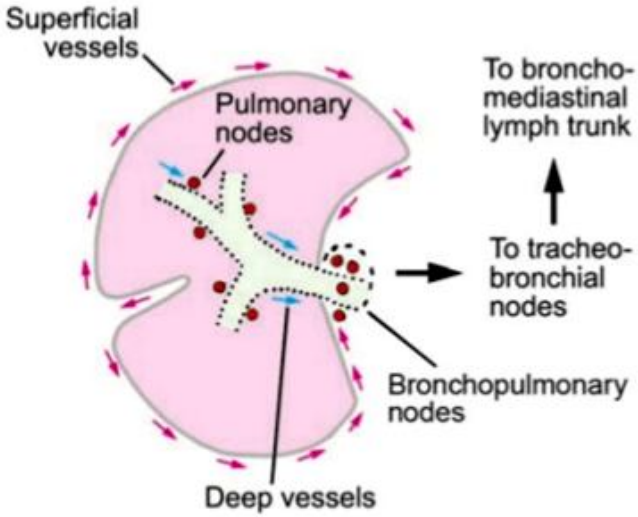


22.12: Scheme to show lymphatic drainage of thoracic surface of diaphragm

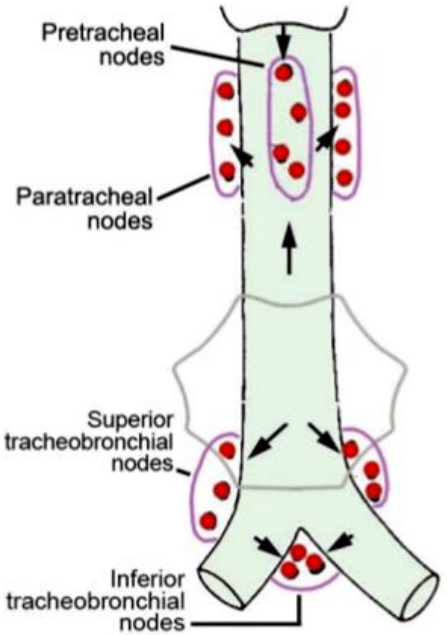
Superficial & deep lymphatics of the lung =

tracheobronchial nodes /
Parasternal nodes and brachiocephalic nodes /
right and left bronchomediastinal trunks /
right lymphatic trunk or thoracic duct





22.13: Lymphatic drainage of the lungs

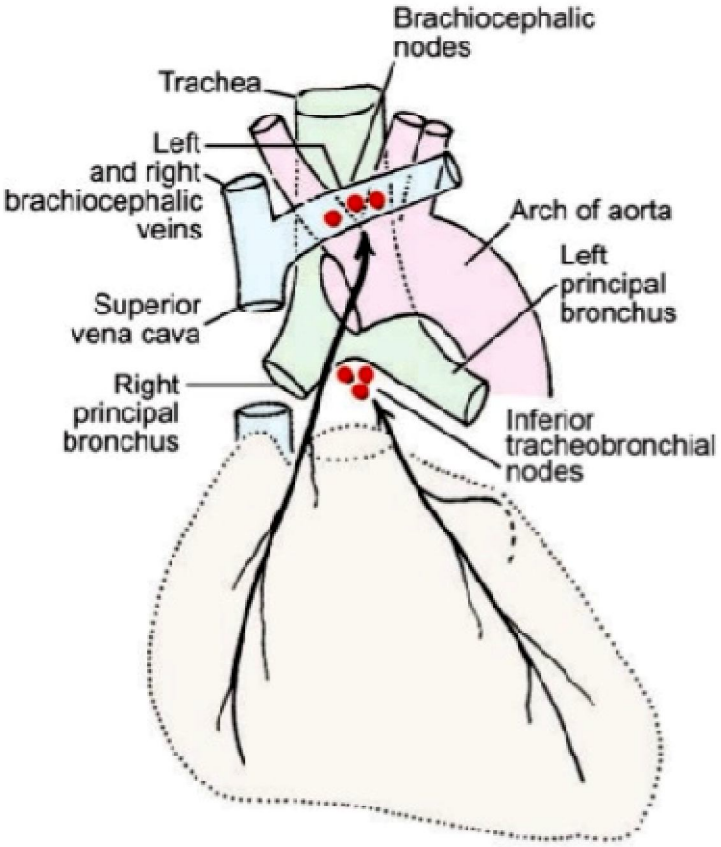


22.16: Lymphatic drainage of trachea

Coronary lymphatics

The lymphatic vessels of the heart follow the coronary arteries and drain mainly into:

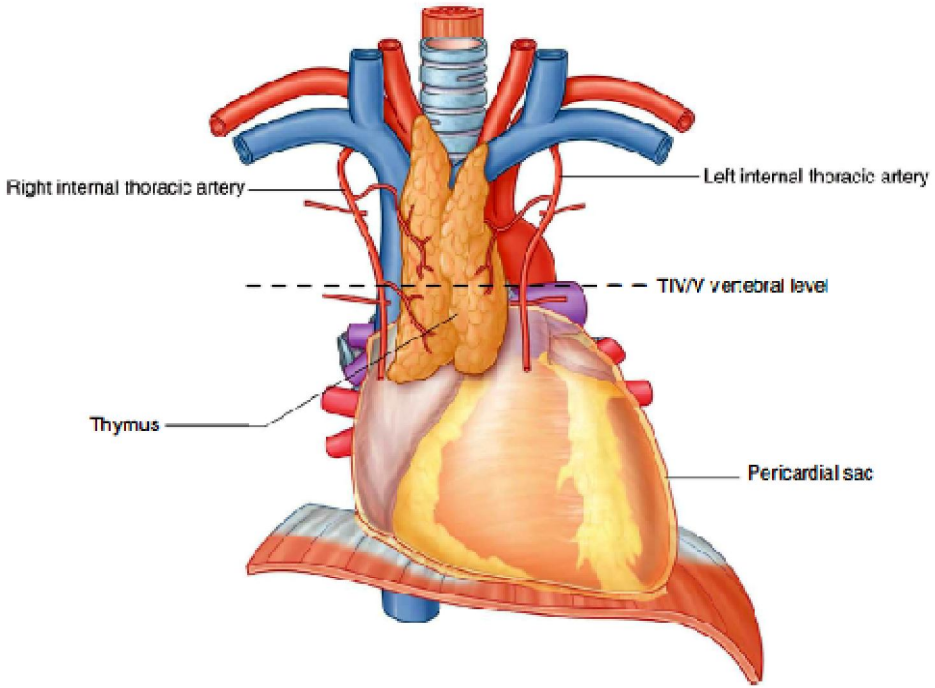
- *brachiocephalic nodes*
- *tracheobronchial nodes*



22.15: Scheme to show the lymphatic drainage of the heart

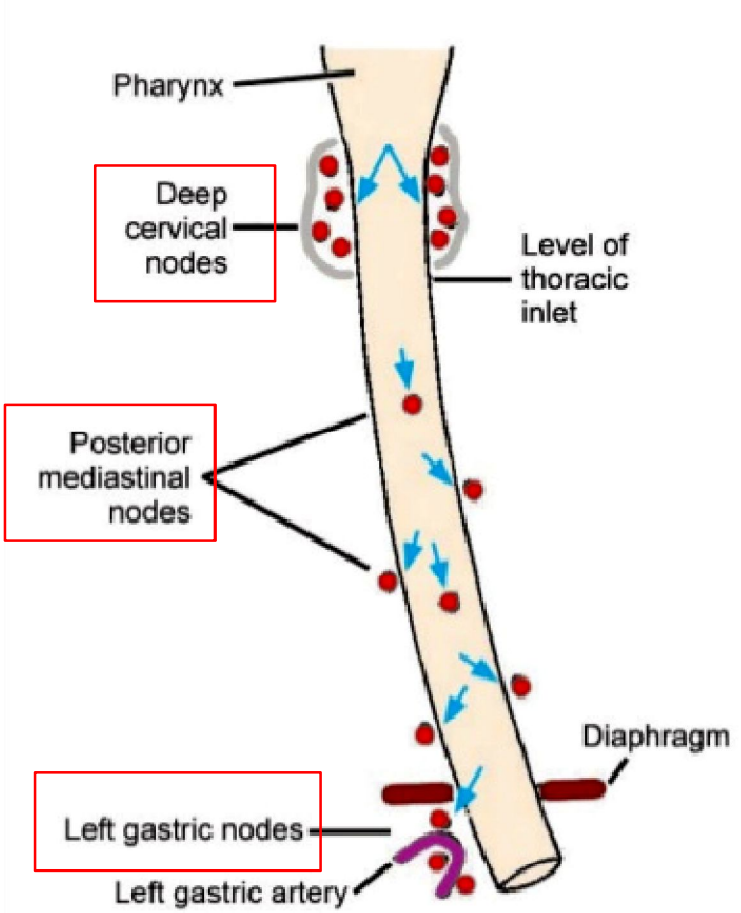
Thymus Lymphatic Drainage

- along the internal thoracic arteries (parasternal)
- at the tracheal bifurcation (tracheobronchial)
- in the root of the neck

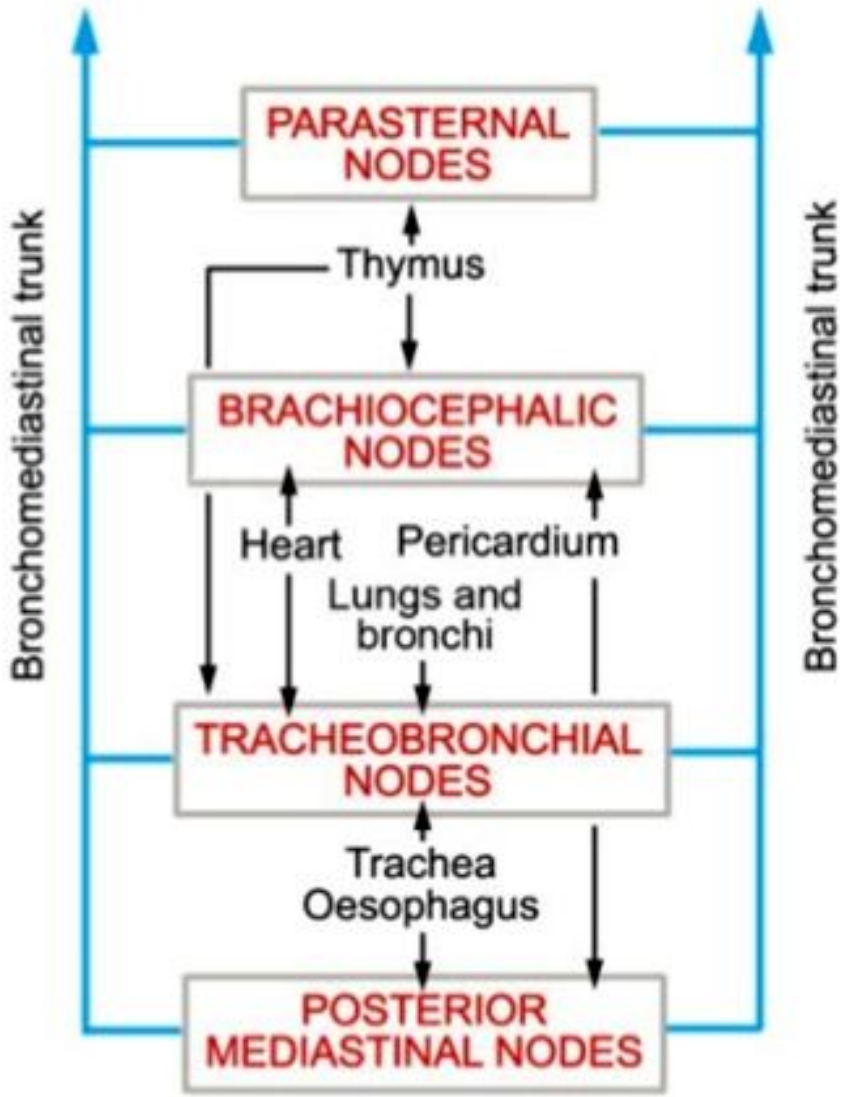


Lymphatic drainage of the esophagus in the posterior Mediastinum :

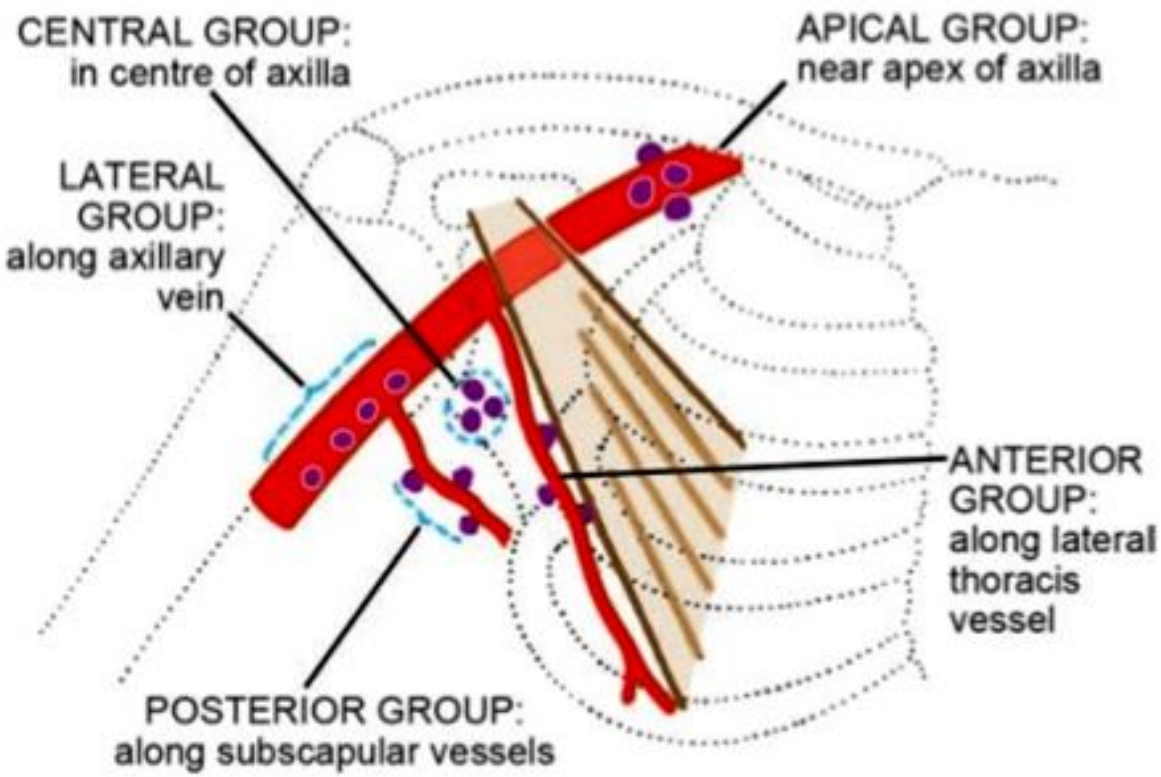
A. returns to posterior mediastinal
B. Left gastric nodes



22.17: Lymphatic drainage of oesophagus



22.14: Scheme to show interconnections of major lymph nodes draining the thoracic viscera



3.17: Axillary lymph nodes seen from the front

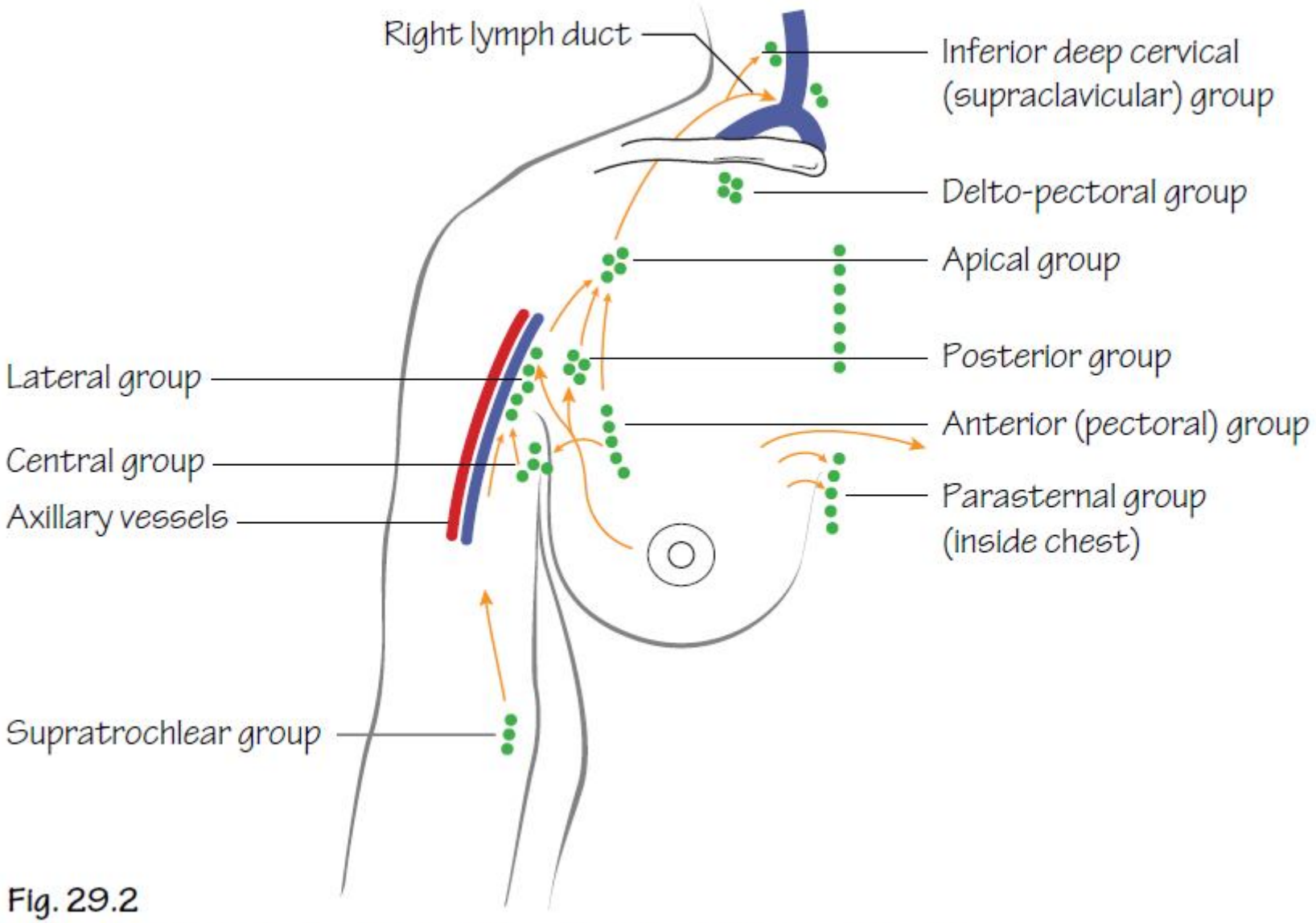


Fig. 29.2
The lymph nodes of the axilla and the lymphatic drainage of the breast

Lymphatic drainage of the anterolateral abdominal wall

- Superficial lymphatics above the umbilicus :

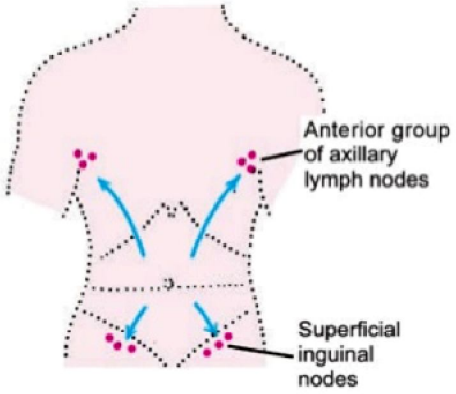
axillary nodes

- Superficial lymphatics below the umbilicus :

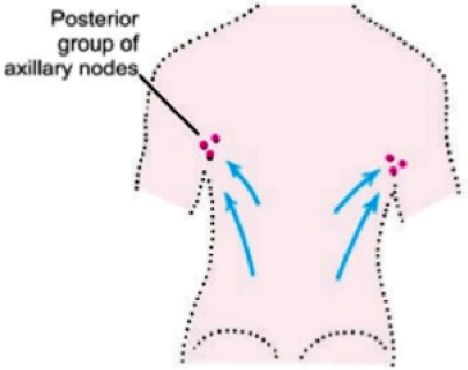
superficial inguinal nodes

- Deep lymphatic drainage follows the deep arteries back:

parasternal nodes along the internal thoracic Artery
lumbar nodes along the abdominal aorta
external iliac nodes along the external iliac artery



25.28: Lymphatic drainage of anterior aspect of trunk



25.29: Posterior aspect of trunk to show its lymphatic drainage.

pre-aortic lymph nodes:

Celiac (enters the cisterna chyli)
superior mesenteric (drains to the celiac nodes)
Inferior mesenteric groups (drains to the superior mesenteric nodes)

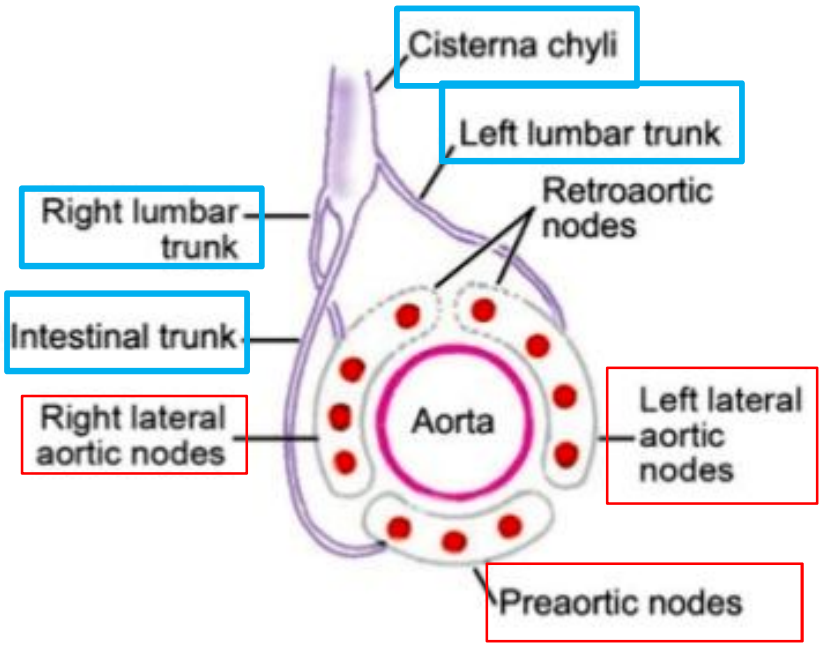
form the intestinal trunk

The lateral aortic or lumbar lymph nodes (para-aortic nodes) : received from

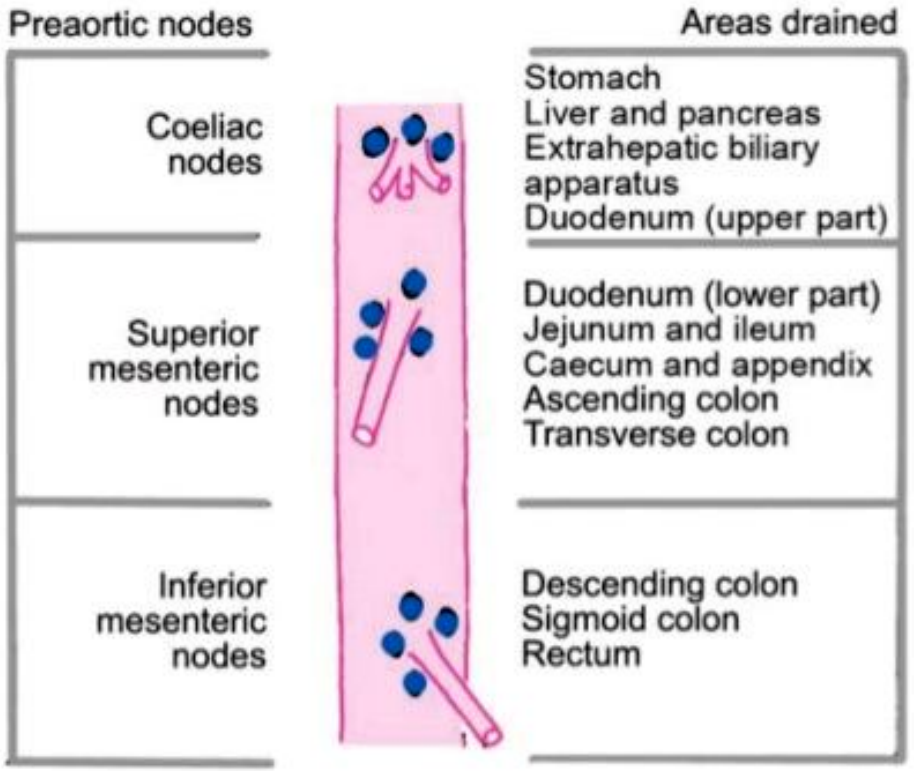
body wall
kidneys
suprarenal glands
testes or ovaries

form the right and left lumbar trunks

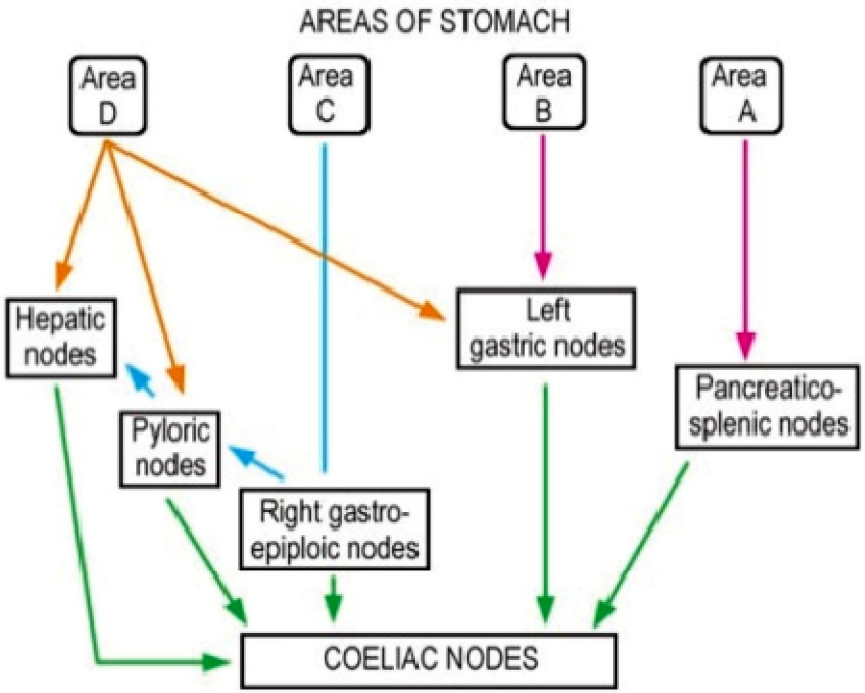
These trunks come together and form a saccular dilation (the cisterna chyli



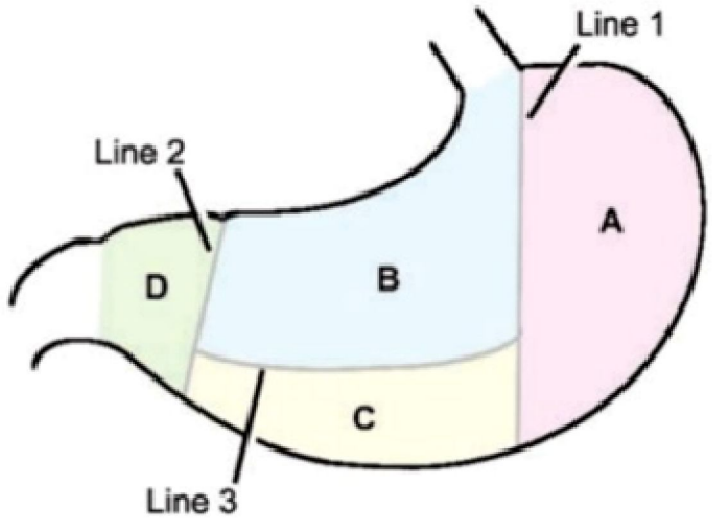
34.1: Scheme to show the terminal lymph nodes of the abdomen



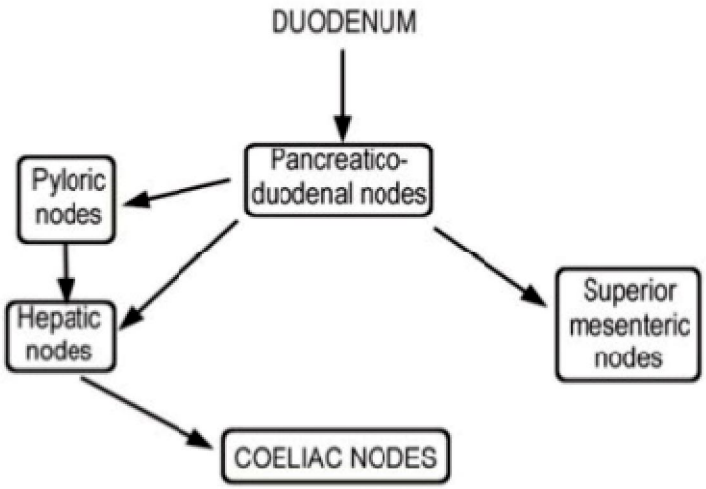
34.2: Subgroups of the preaortic lymph nodes, and areas drained by them



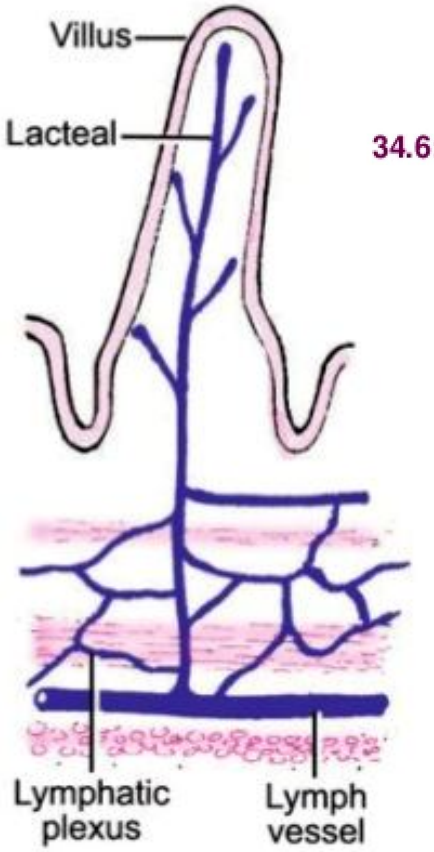
34.5: Scheme to show the lymphatic drainage of the stomach



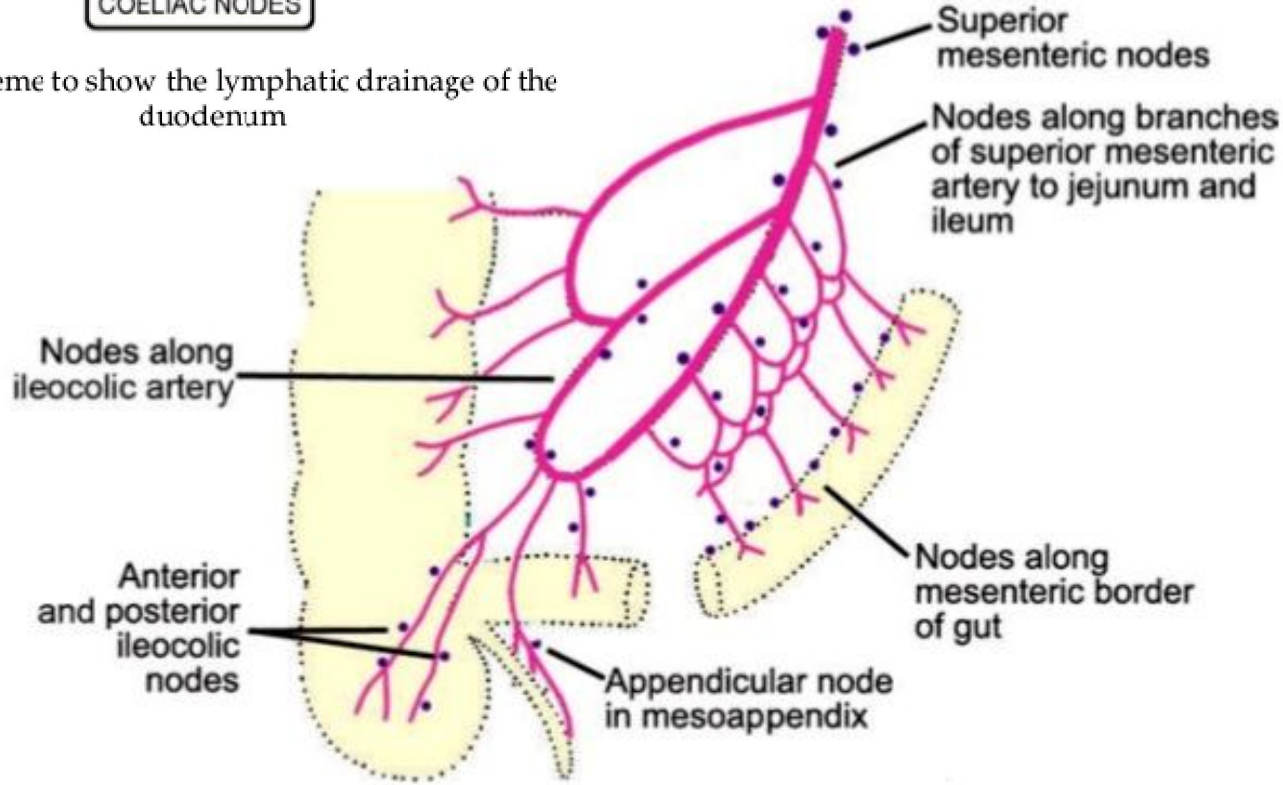
34.4: Areas of stomach having separate lymphatic drainage



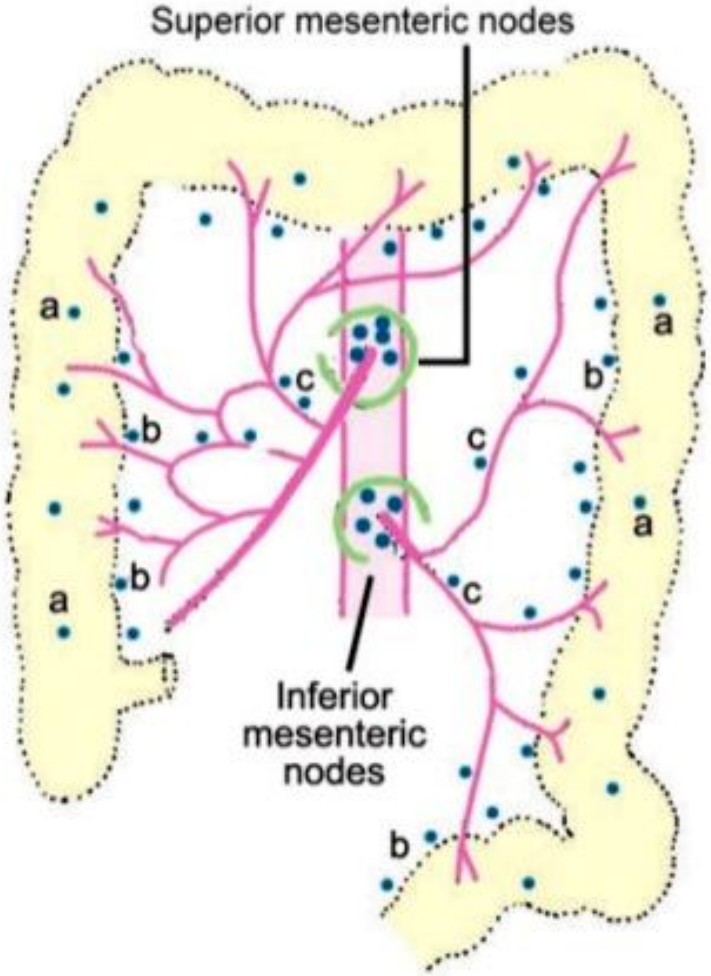
34.6: Scheme to show the lymphatic drainage of the duodenum



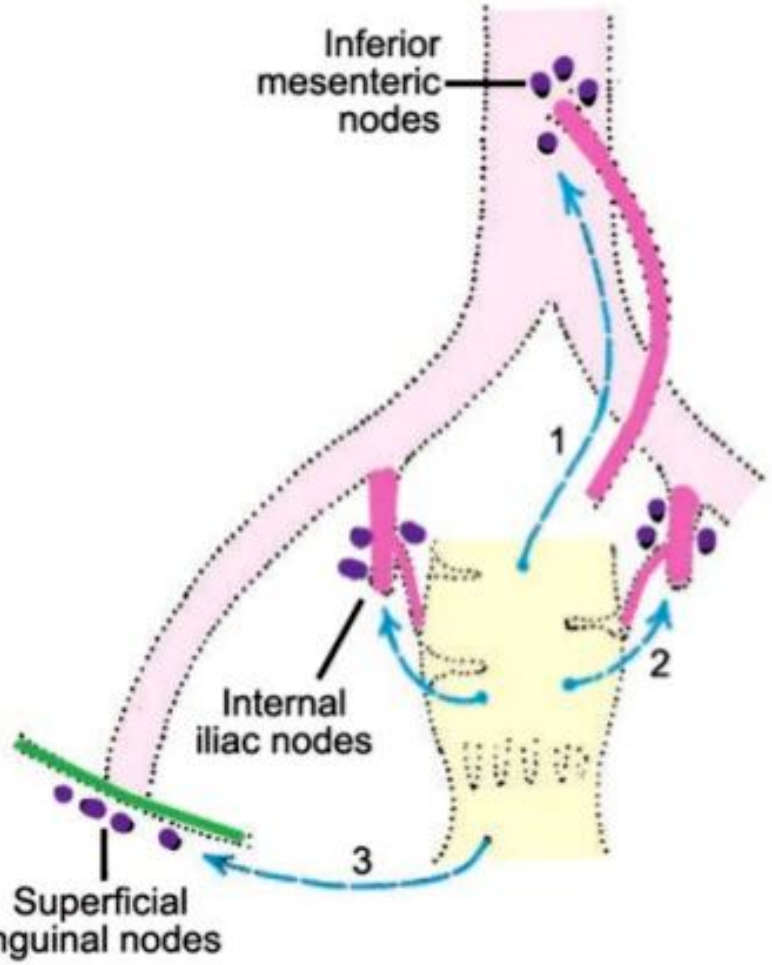
34.7: Scheme to show arrangement of lymph vessels within the gut



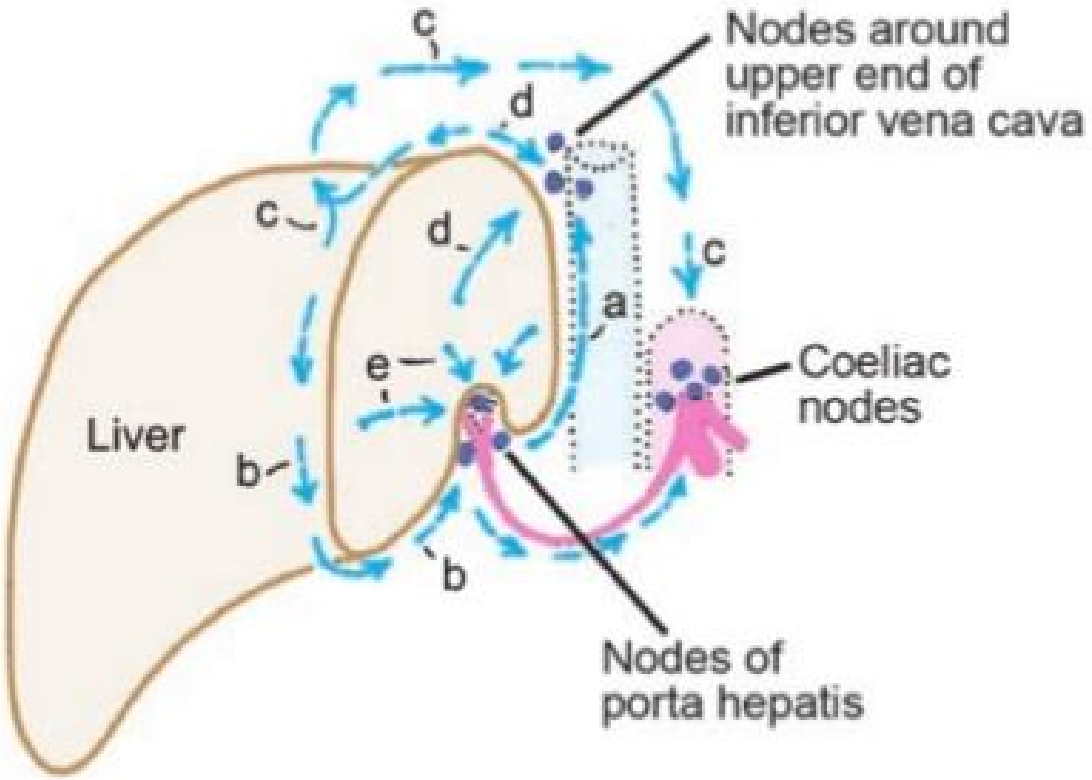
34.8: Lymph nodes draining the jejunum ileum, caecum and appendix



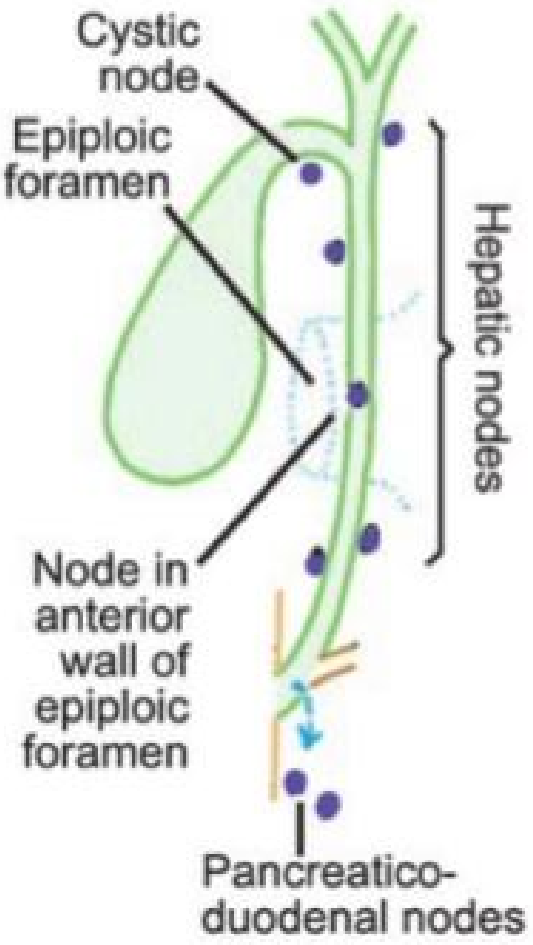
34.9: Lymph nodes draining the colon



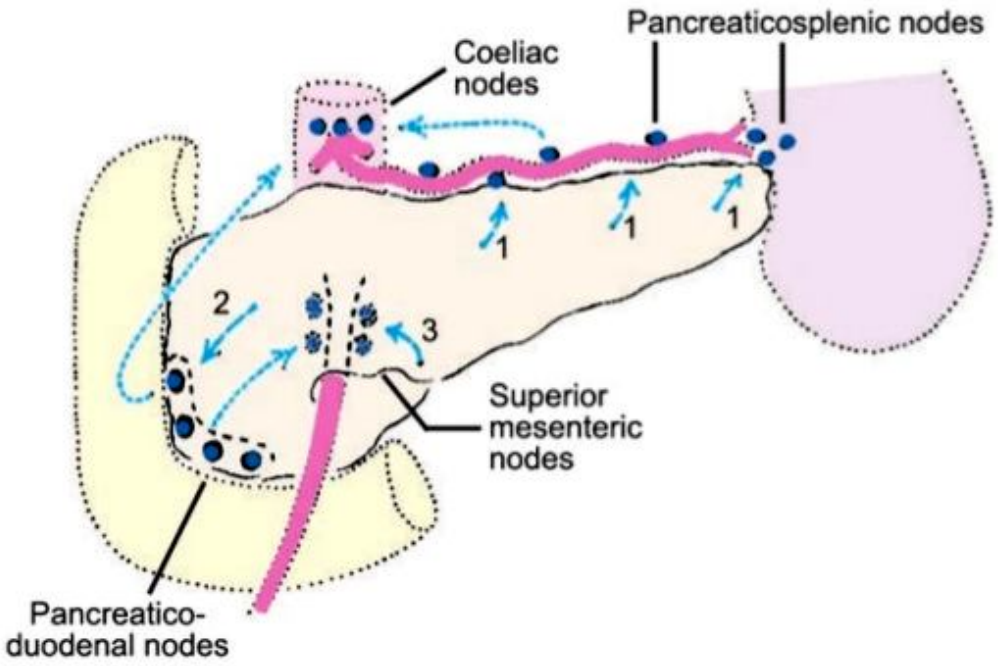
34.10: Scheme to show the lymphatic drainage of the rectum and anal canal



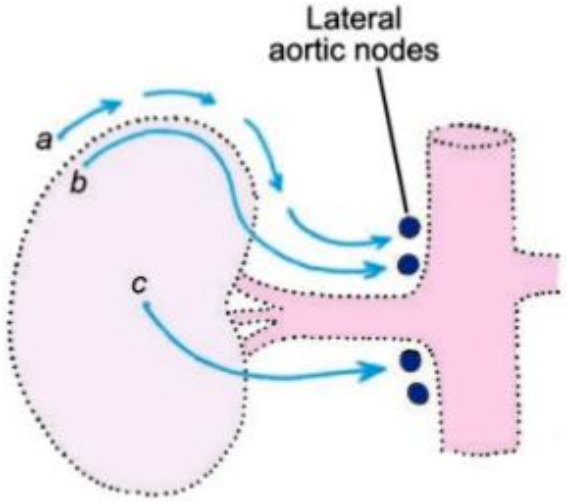
34.11: Lymphatic drainage of the liver



34.12: Lymphatic drainage of gall bladder and bile duct



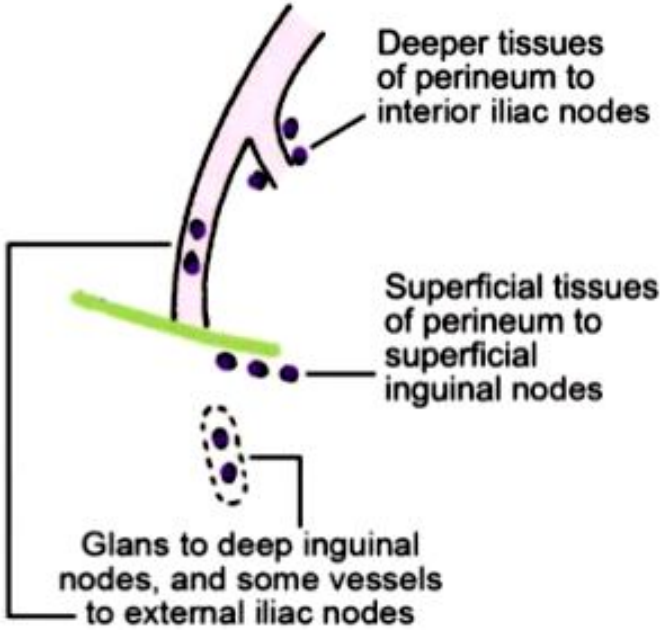
34.13: Lymphatic drainage of the pancreas



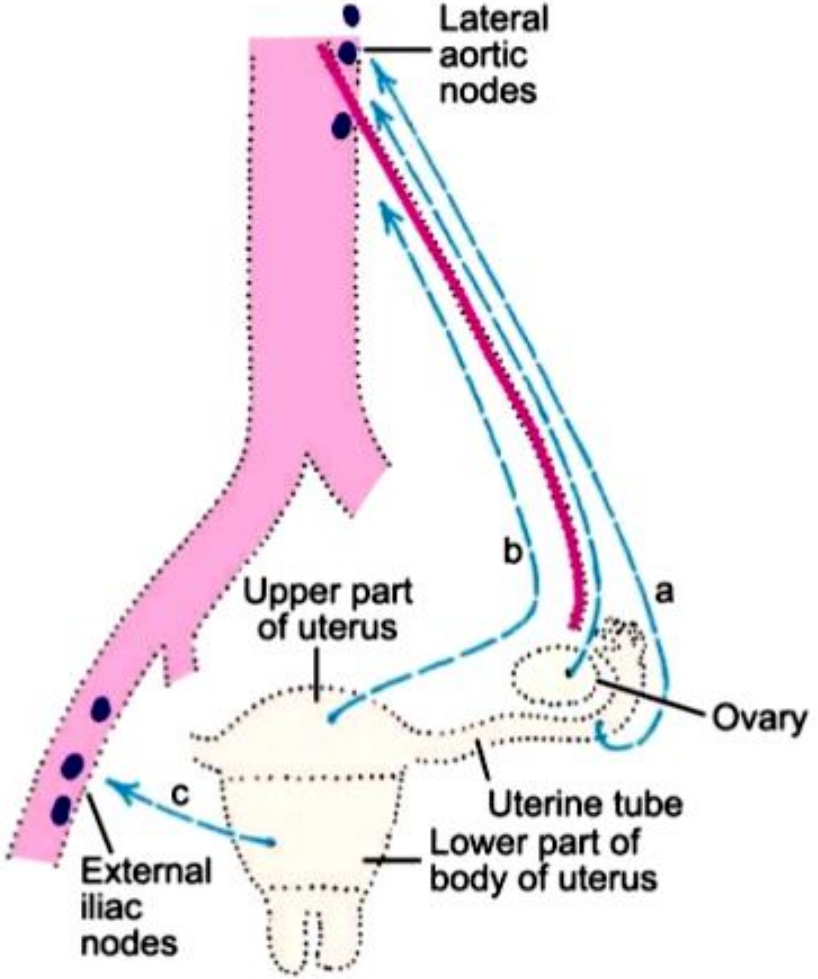
34.14: Lymphatic drainage of the kidney

The lymphatic drainage of each kidney :

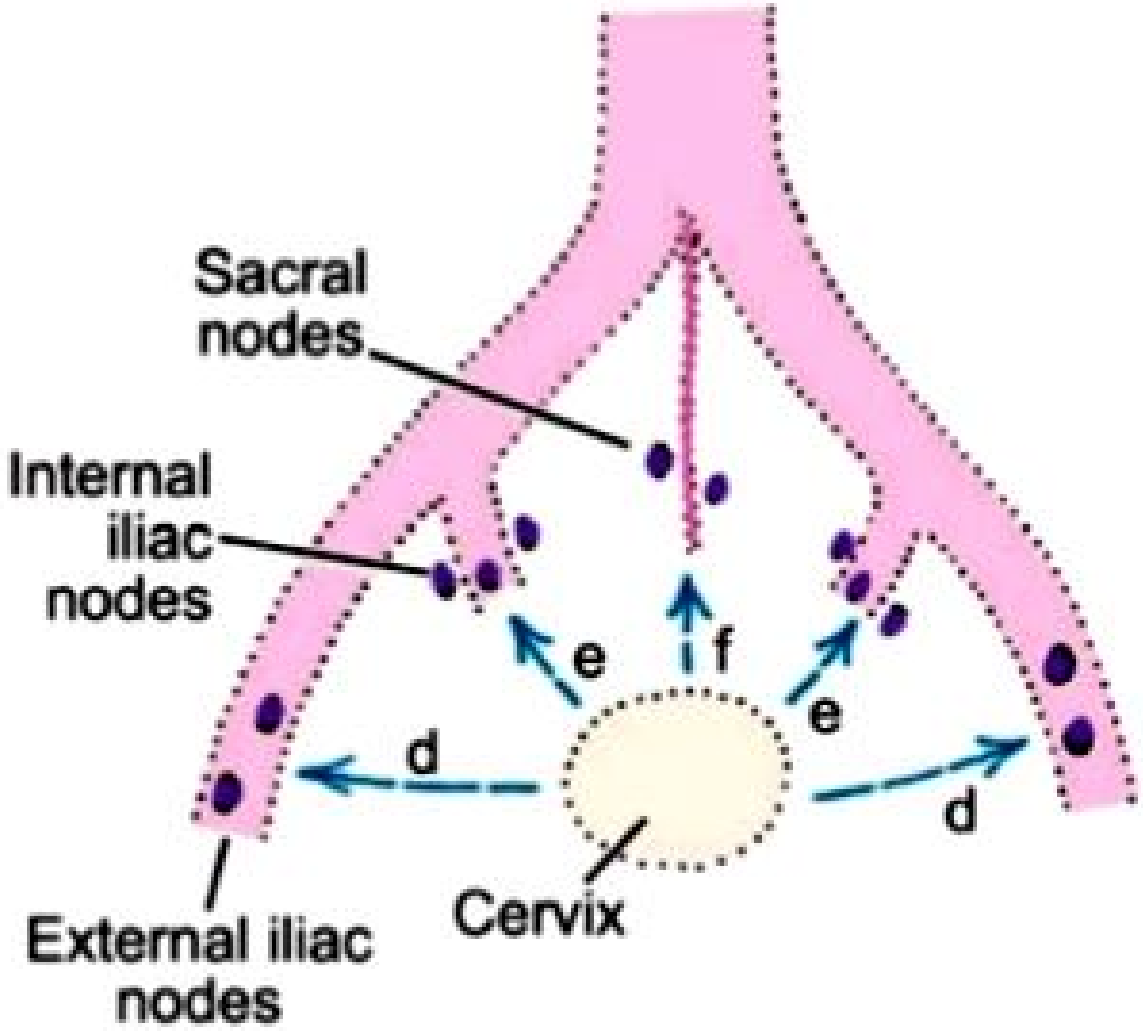
the lateral aortic (lumbar) nodes around the origin of the renal artery



34.15: Lymphatic drainage of the perineum

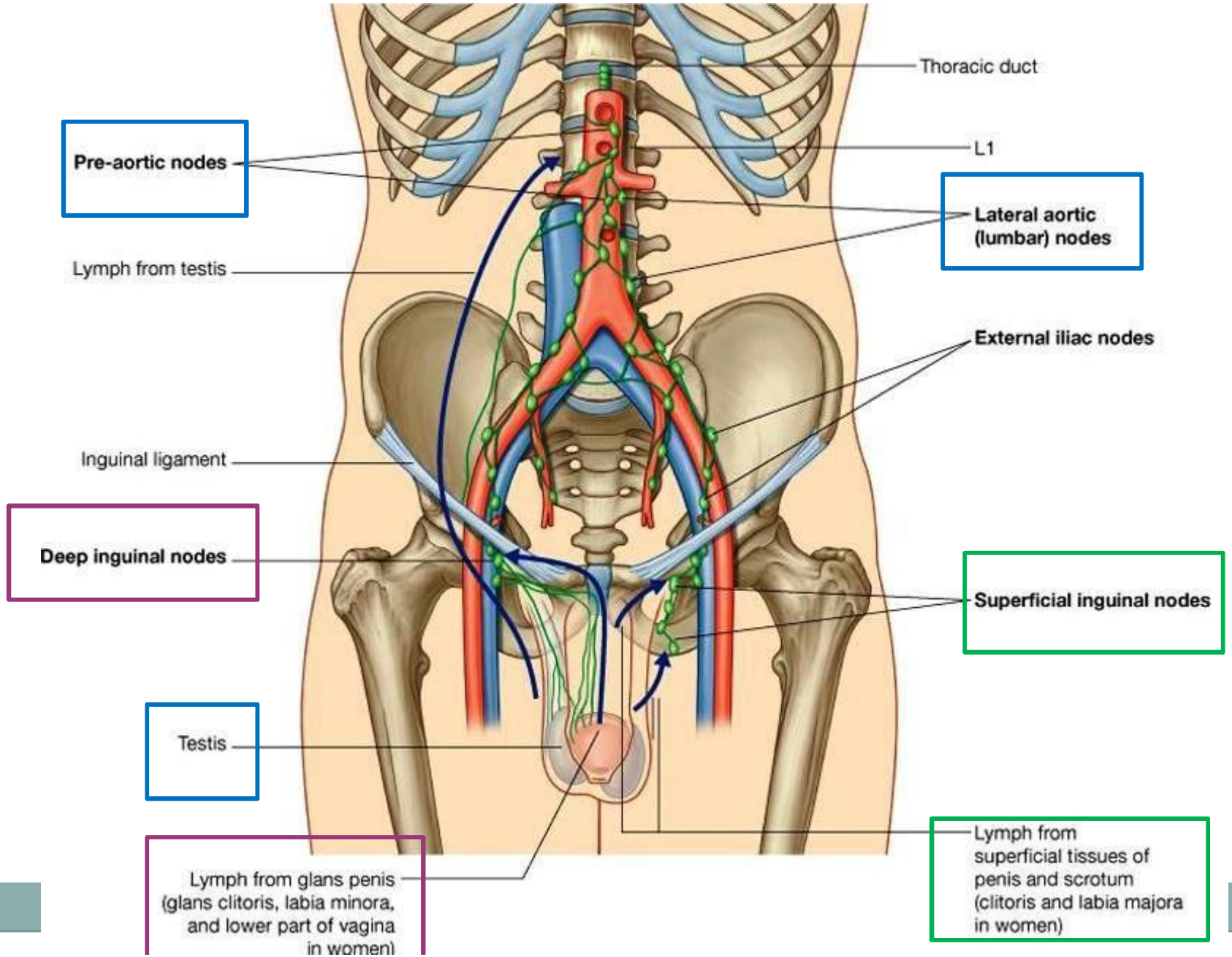


34.16: Scheme to show the lymphatic drainage of the uterus

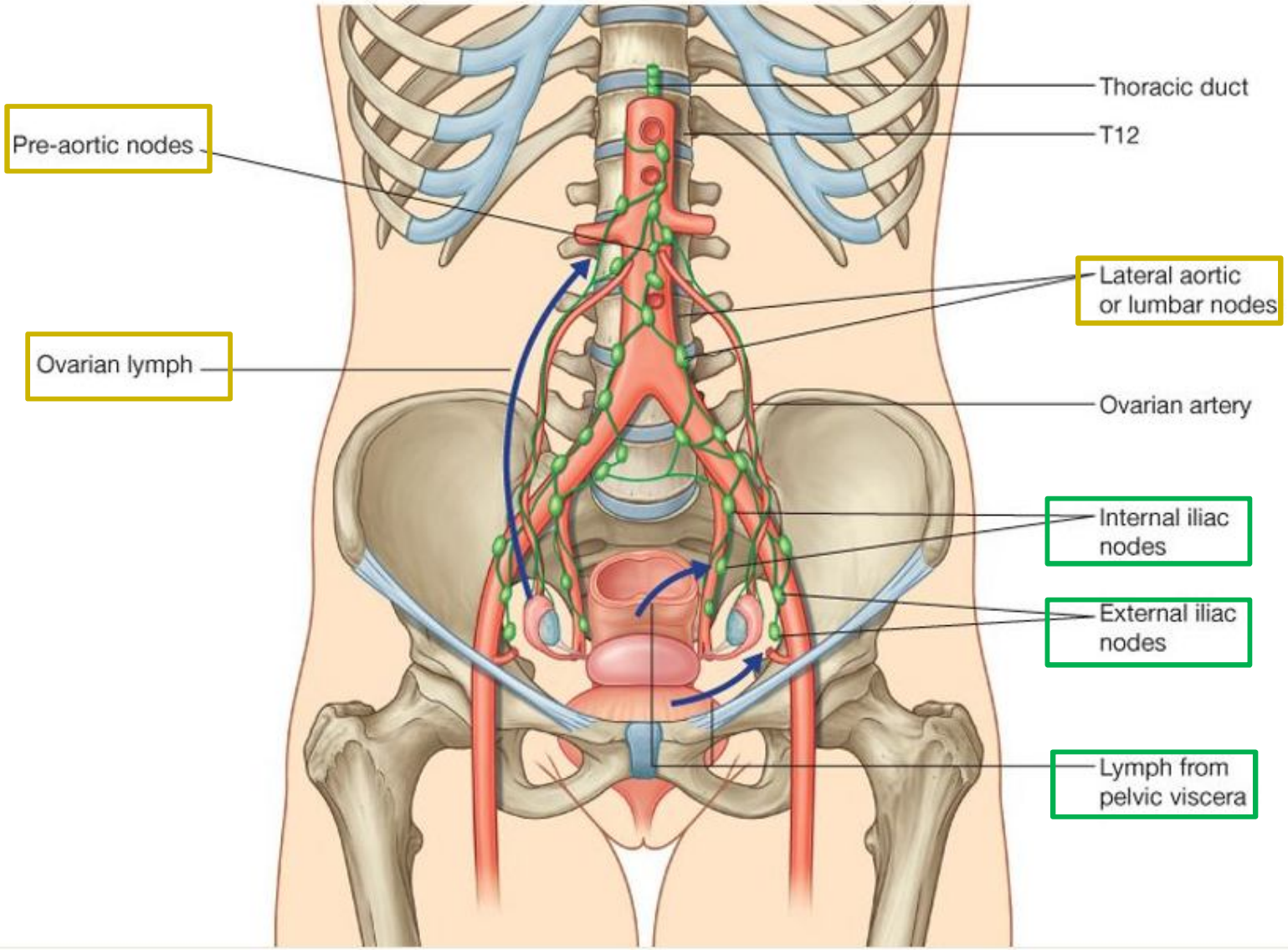


34.17: Scheme to show the lymphatic drainage of the cervix of the uterus

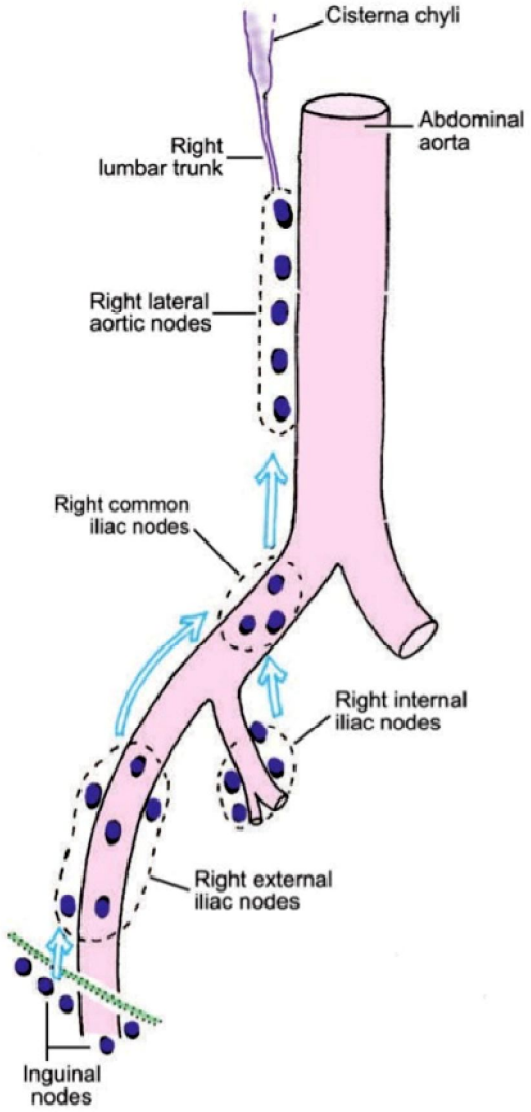
Lymphatic drainage of the perineum



Pelvic lymphatics

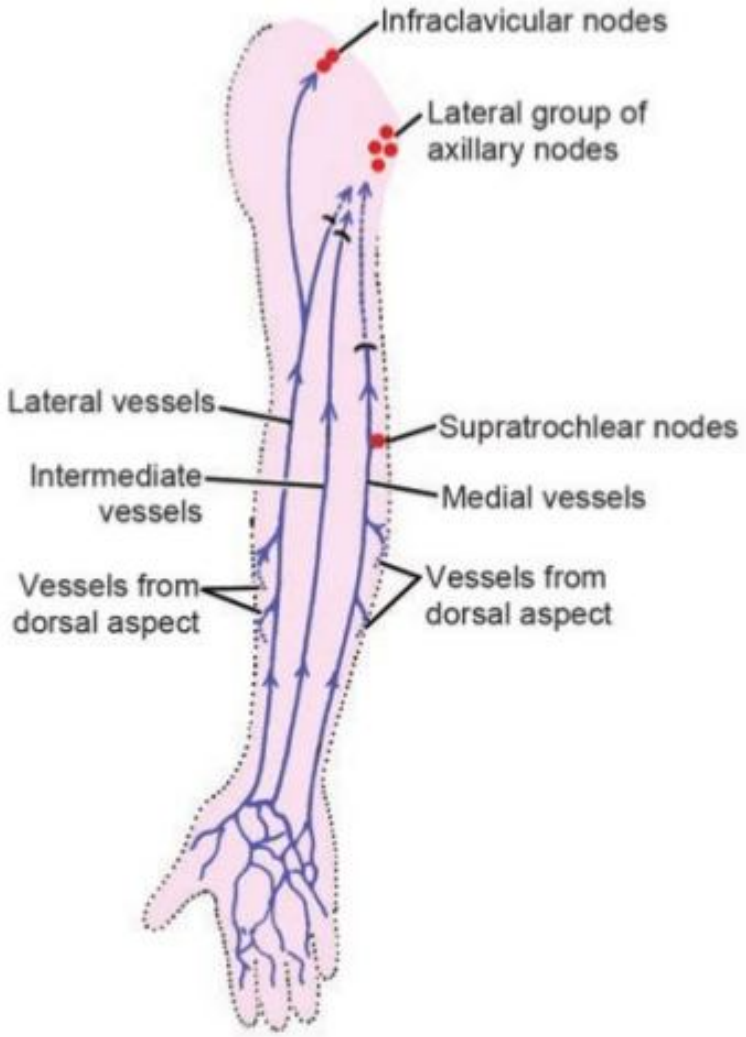


lymphatics associated with the two common iliac arteries and veins



34.3: The lateral aortic lymph nodes

Lymphatic drainage of the upper limb



3.18: Scheme to show the lymphatic drainage of the upper limb

All lymphatics from the upper limb drain into lymph nodes in the axilla axillary nodes receive : the upper back, shoulder, the lower neck, the chest, and the upper anterolateral abdominal wall, approximately 7 5 % of the mammary gland.

The 2 0-30 axillary nodes are generally divided into five groups:

- Humeral (lateral) nodes: posteromedial to the axillary vein / receive most of the lymphatic drainage from the upper limb

- Pectoral (anterior) nodes : inferior margin of the pectoralis minor muscle (lateral thoracic vessels) / receive drainage from the abdominal wall, the chest, and the mammary gland.

- Subscapular (posterior) nodes : on the posterior axillary wall (subscapular vessels)
drain the posterior axillary wall / receive lymphatics from the back, the shoulder, and the neck

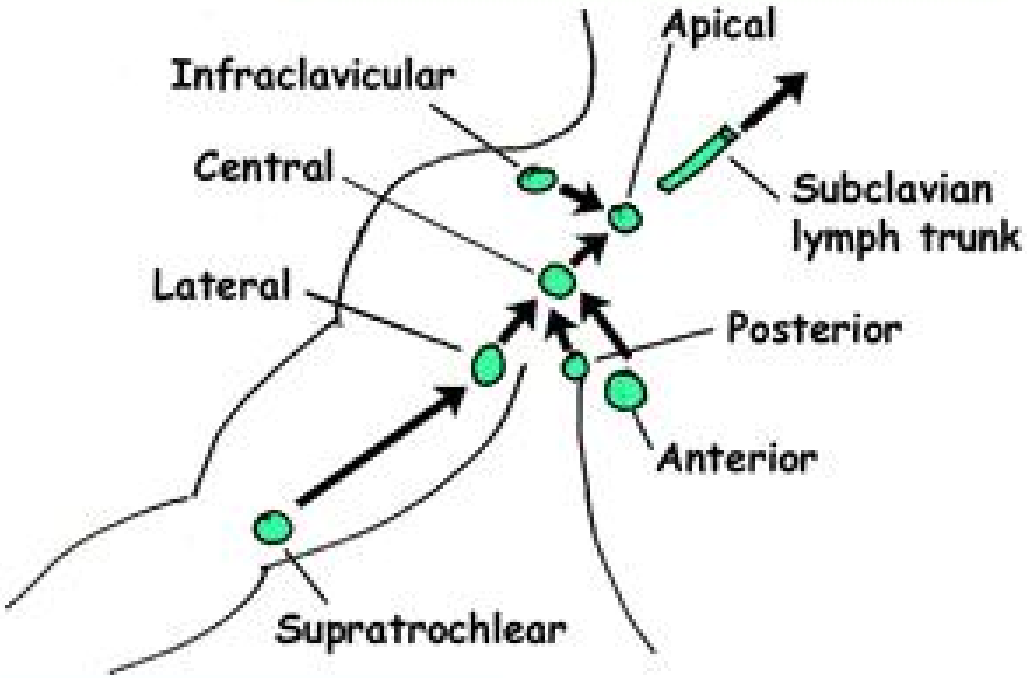
- Central nodes : embedded in axillary fat / receive tributaries from humeral, subscapular, and pectoral groups of nodes

- Apical nodes : most superior group of nodes / drain all other groups of nodes in the Region/lymphatic vessels that accompany the cephalic vein / superior region of the mammary gland.

Efferent vessels from the apical group :

form the subclavian trunk, joins the venous system at the junction between:
On the right, the rt. subclavian vein and the right internal jugular vein in the neck.
On the left, the subclavian trunk usually joins the thoracic duct in the base of the neck.

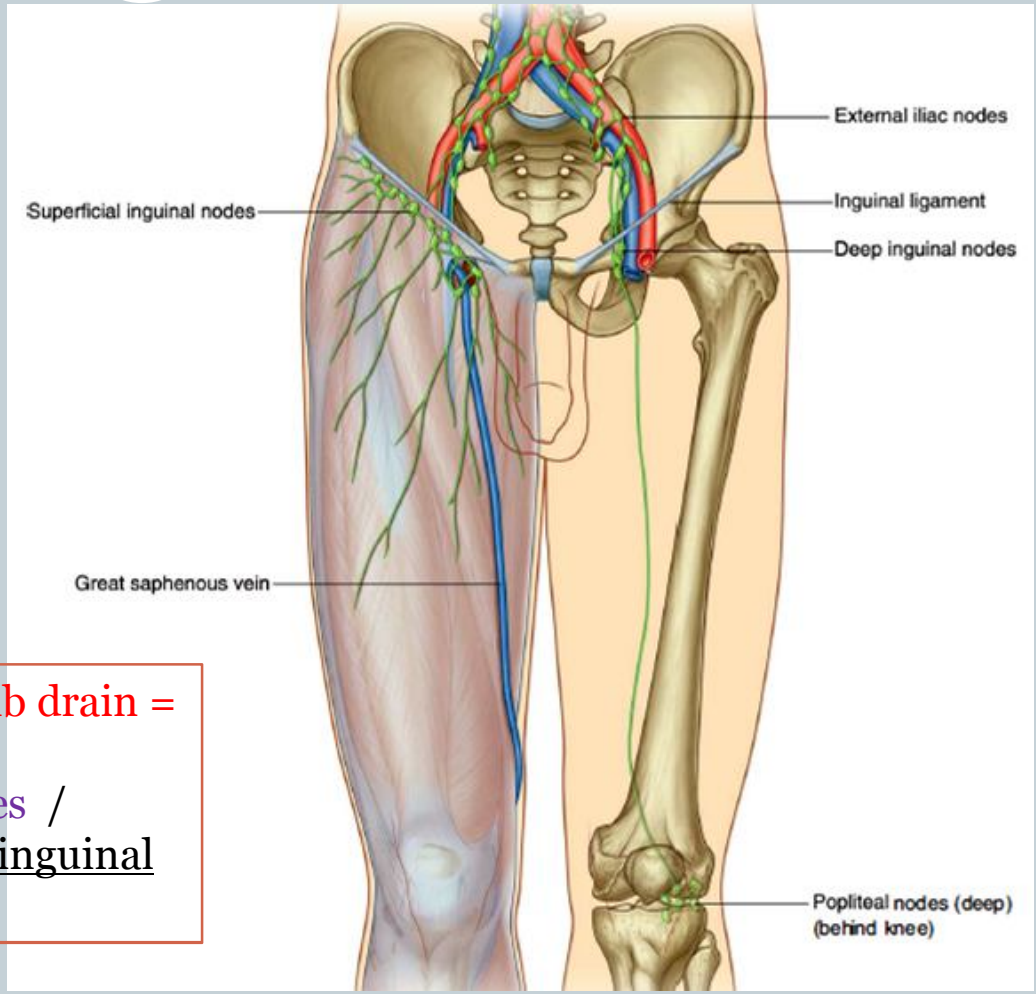
UPPER LIMB LYMPHATICS



Mnemonic for axillary lymph nodes:
A - anterior
P - posterior
I - infraclavicular
C - central
A - apical
L - lateral

For more details & illustrations, please see relevant section in the book - Instant Anatomy, by R H Whitaker & N R Borley. 4th edition. Wiley-Blackwell 2010

Lymphatic drainage of the lower limb



Most lymphatic vessels in the lower limb drain =

into superficial and deep inguinal nodes / located in the fascia just inferior to the inguinal ligament

Superficial inguinal nodes:

- 10 in number
- in the superficial fascia
- parallel the course of the inguinal ligament
- Medially, extend inferiorly along the terminal part of the great saphenous vein
- receive lymph from the gluteal region, lower abdominal wall, perineum, and superficial regions of the lower limb
- Drain into external iliac nodes

Deep inguinal nodes:

- 3 in number
- medial to the femoral vein
- receive lymph from deep lymphatics associated with the femoral vessels , glans penis (or clitoris) in the perineum.
- interconnect with the superficial inguinal nodes
- drain into the external iliac nodes
- passes under the inguinal ligament (femoral canal)

Poplitea l nodes:

- deep nodes posterior to the knee close to the popliteal Vessels
- Receive lymph from superficial vessels accompany the small saphenous vein, deep areas of the leg and foot
- drain into the deep and superficial inguinal nodes

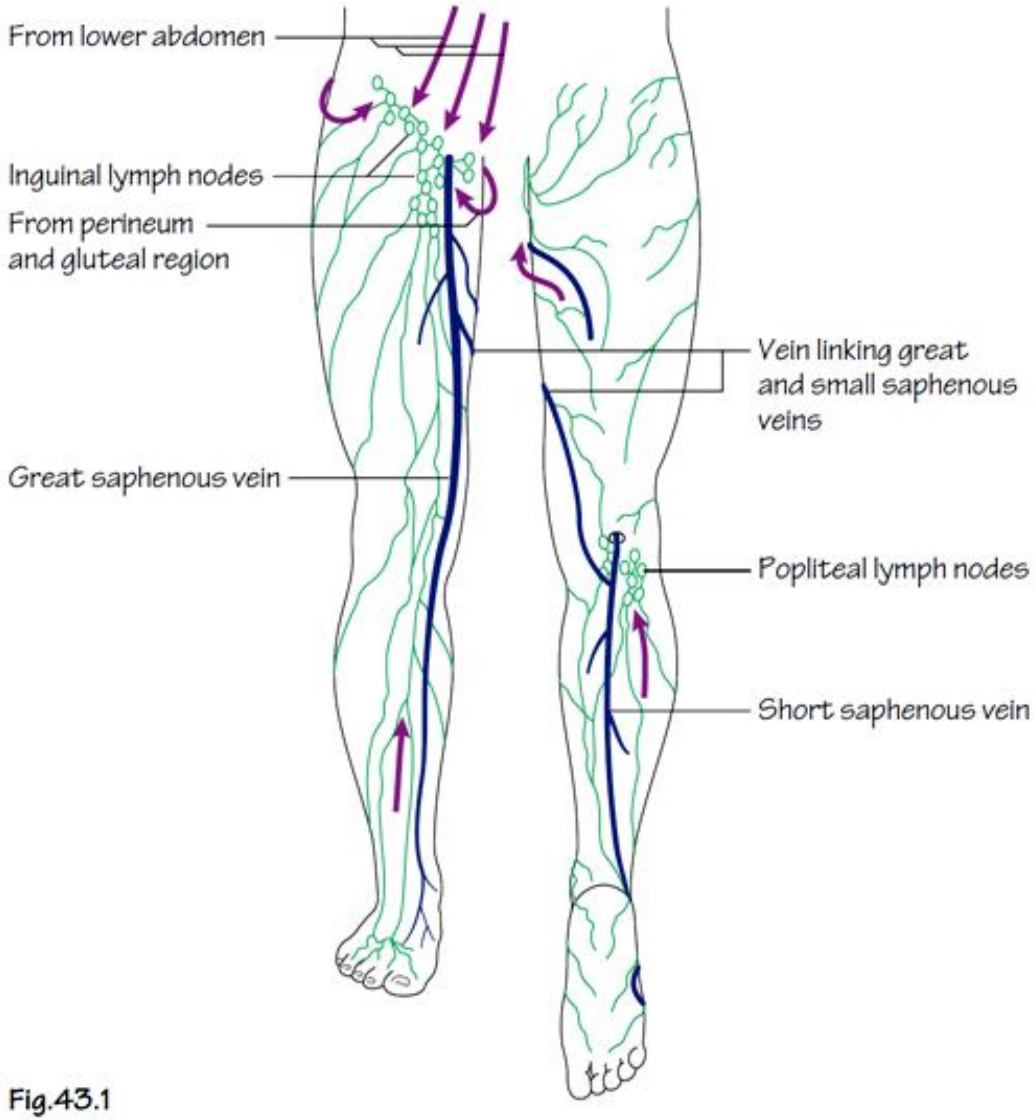


Fig.43.1
The superficial veins and lymphatics of the lower limb. The arrows indicate the direction of lymph flow

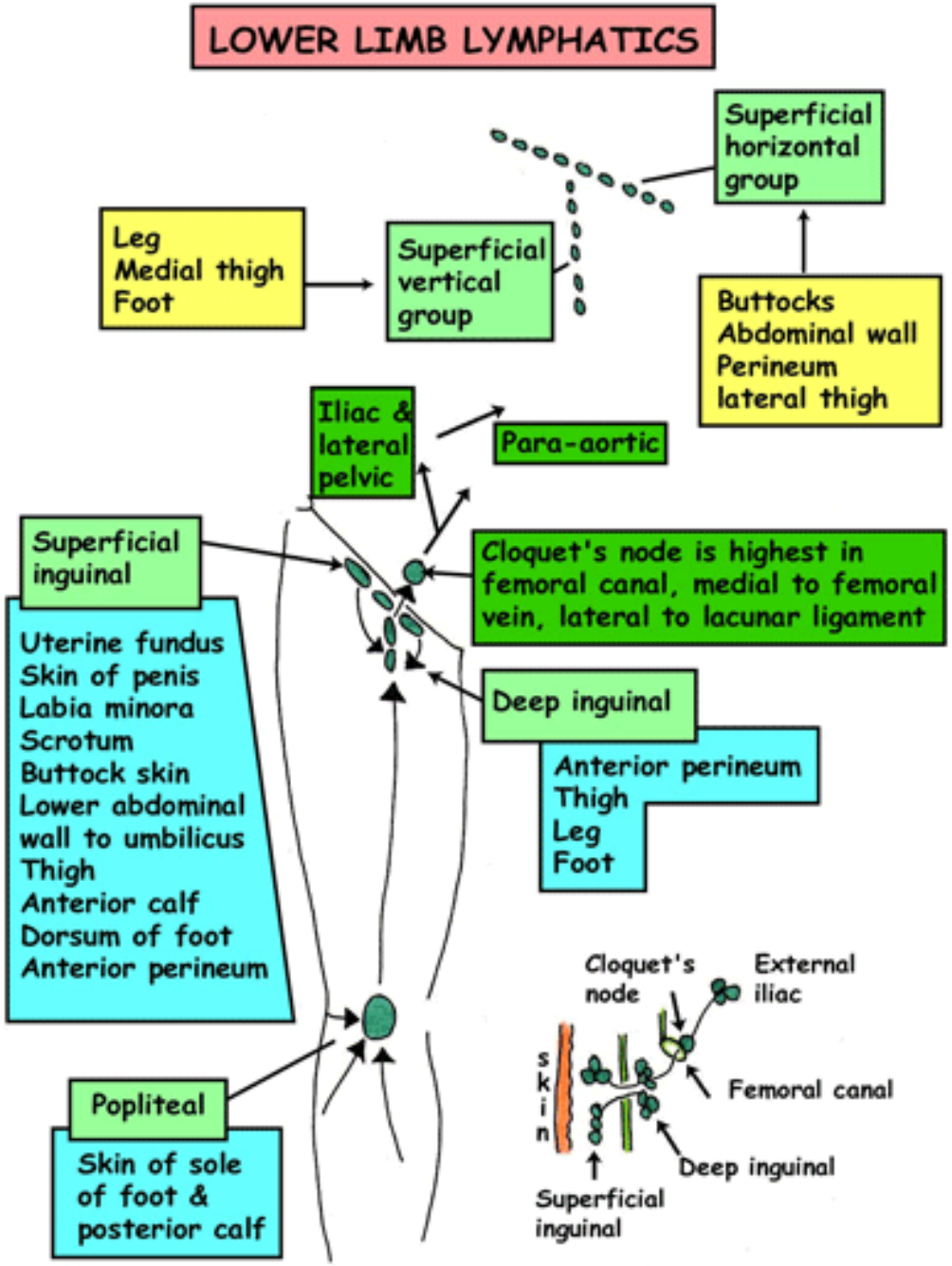
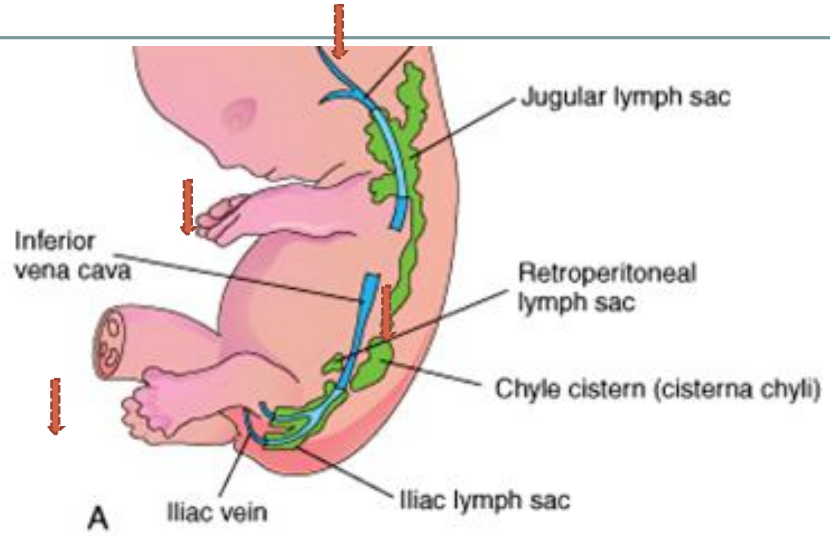

LOWER LIMB LYMPHATICS
Superficial horizontal group
Leg
Medial thigh
Foot
Superficial vertical group
Buttocks
Abdominal wall
Perineum
lateral thigh
Iliac & lateral pelvic
Para-aortic
Superficial inguinal
Cloquet's node is highest in femoral canal, medial to femoral vein, lateral to lacunar ligament
Uterine fundus
Skin of penis
Labia minora
Scrotum
Buttock skin
Lower abdominal wall to umbilicus
Thigh
Anterior calf
Dorsum of foot
Anterior perineum
Deep inguinal
Anterior perineum
Thigh
Leg
Foot
Popliteal
Skin of sole of foot & posterior calf
Cloquet's node
External iliac
skin
Femoral canal
Deep inguinal
Superficial inguinal

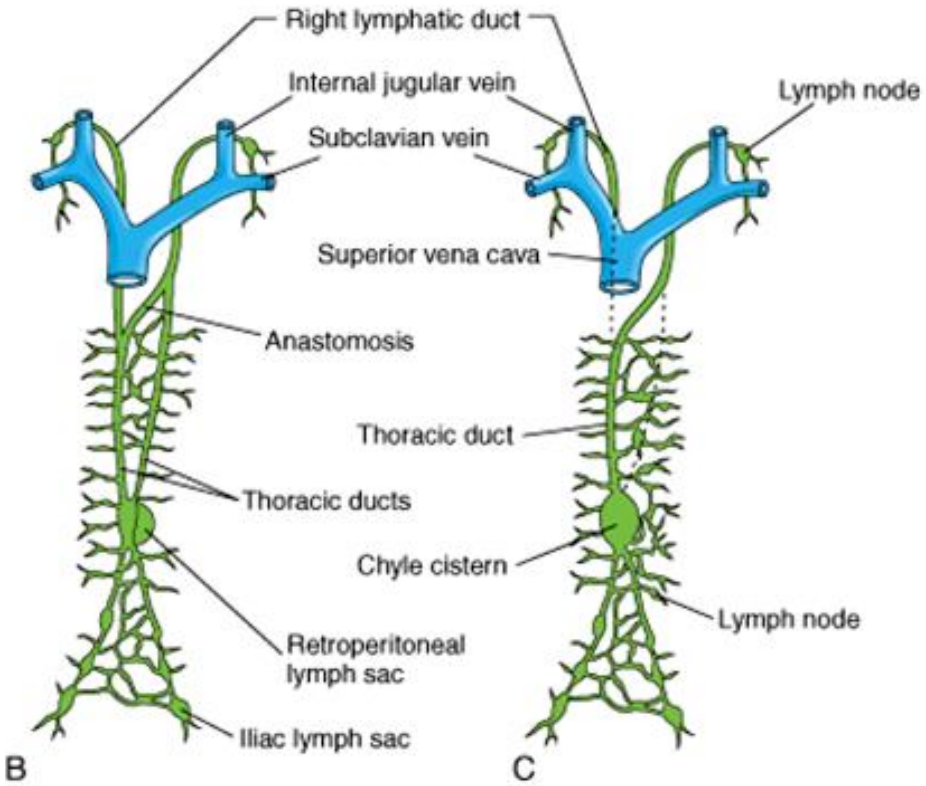
Fig.43.3
Lymphoedema of the lower limb

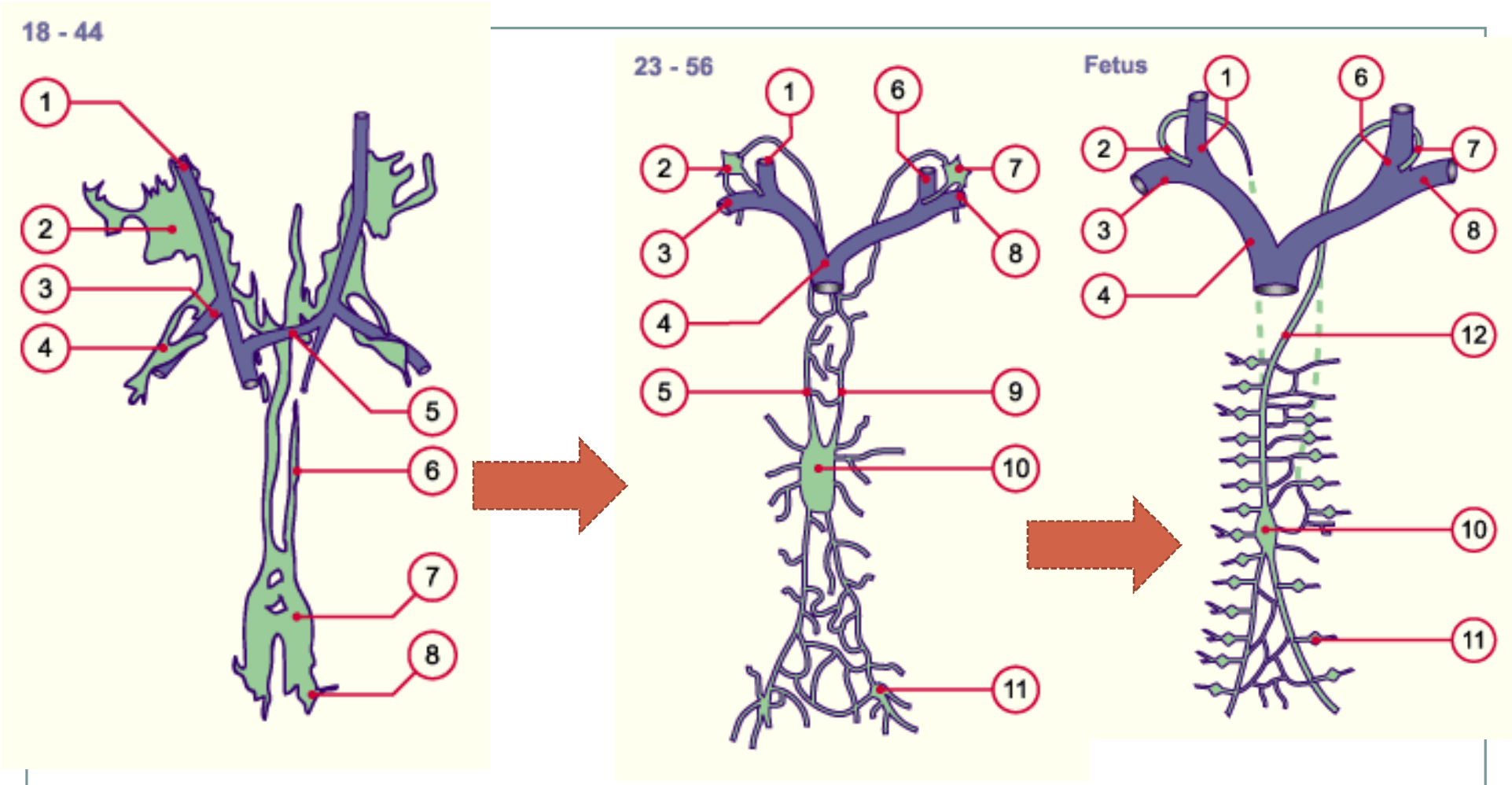
Embryology Of Lymphatic Duct

The **lymphatic system** begins to develop at the end of the ***sixth week***, approximately 2 weeks after the primordia of the cardiovascular system are recognizable.



- ***Two jugular lymph***
- ***Two iliac lymph sacs***
- ***One retroperitoneal lymph sac***
- ***One chyle cistern* (L. *cisterna chyli***





1 Superior cardinal vein (jugular vein)
2 Jugular lymphatic sac
3 Right subclavian vein
4 Axillary lymphatic sac
5 Left brachiocephalic vein
6 Thoracic duct (bilateral)
7 Lumbar lymphatic sac
8 Iliac lymphatic sac

1 Right jugular vein
2 Right jugular and axillary lymph duct
3 Right subclavian vein
4 Superior cava vein
5 Right thoracic duct
6 Left jugular vein
7 Left jugular and axillary lymph duct
8 Left subclavian vein
9 Left thoracic duct
10 Cysterna chyli
11 Inguinal lymph nodes
12 Definitive thoracic duct

CHIEF LYMPH NODES OF ABDOMEN AND PELVIS

1. The entire lymph from the abdomen (and from the lower limbs) ultimately ends in terminal groups of lymph nodes present in relation to the abdominal aorta. These nodes are arranged in three main groups, each having a specific area of drainage.
   a. On either side of the aorta there are the right and left ***lateral aortic*** nodes (34.1). Some outlying members of these groups lying behind the aorta constitute the ***retroaortic nodes***.
   b. In front of the aorta there are the ***preaortic nodes***.
   c. These are divided into the ***coeliac***, the ***superior mesenteric*** and the ***inferior mesenteric*** nodes (34.2) lying around the origins of the corresponding arteries.
2. On each side the efferents from the lateral aortic nodes form the corresponding ***lumbar trunk*** that ends by joining the cisterna chyli (34.1).
3. Efferents from the preaortic nodes form the ***intestinal trunk*** that also ends in the cisterna chyli.
4. The area of drainage of the preaortic nodes is shown in 34.2.
5. The coeliac lymph nodes receive lymph from:
   a. The stomach
   b. Most of the duodenum
   c. The liver
   d. The extrahepatic biliary apparatus
   e. The pancreas
   f. The spleen.
6. The superior mesenteric lymph nodes receive lymph from:
   a. Part of the duodenum, and the whole of
   b. The jejunum
   c. The ileum
   d. The caecum
   e. The appendix
   f. The ascending colon
   g. The transverse colon.

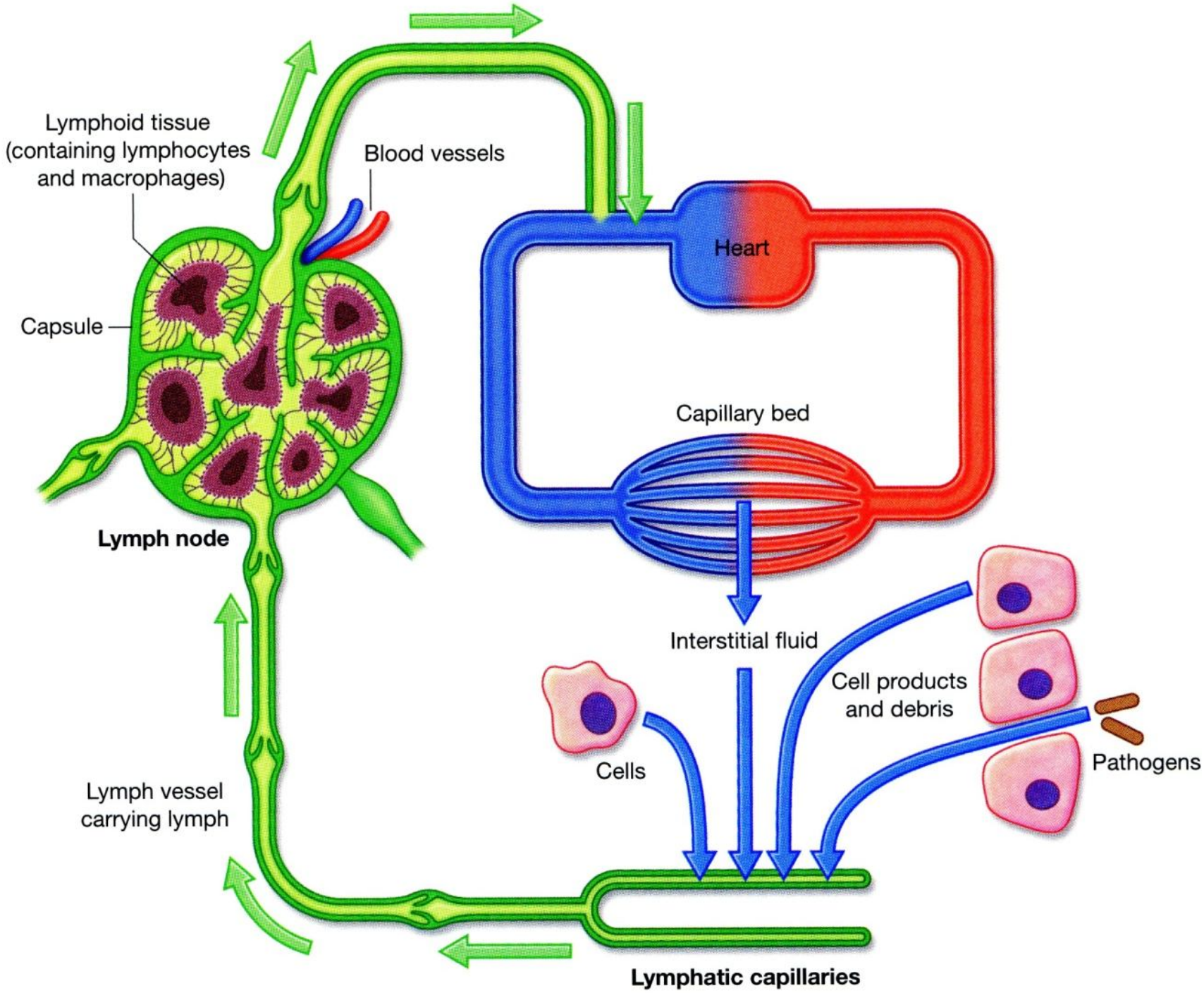
Lymphatic organs

LYMPH NODES
THYMUS
SPLEEN
TONSILS

Lymph Nodes

HISTOLOGY

- Bean – shaped
- Encapsulated (connective tissue)
- 10 mm – 2.5 cm
- Along lymphatic vessels
- 400-450 in number
- Most in Axillary & inguinal region
- Convex surface (afferent lymphatic vessels)
- Concave (hilum) surface (efferent lymphatic vessels + artery + vein + nerve
- Trabeculum
- Valve in lymphatic (unidirectional flow)


Lymphoid tissue
(containing lymphocytes
and macrophages)
Blood vessels
Heart
Capsule
Capillary bed
Lymph node
Interstitial fluid
Cell products
and debris
Cells
Pathogens
Lymph vessel
carrying lymph
Lymphatic capillaries

Cortex :

- Subcapsular sinus
- Cortical sinus (trabecular sinus) =

Fenestrated endothelium / denderetic cells / reticular fiber

- lymphoid nodules = T – helper / B cell / macrophage / denderetic cells

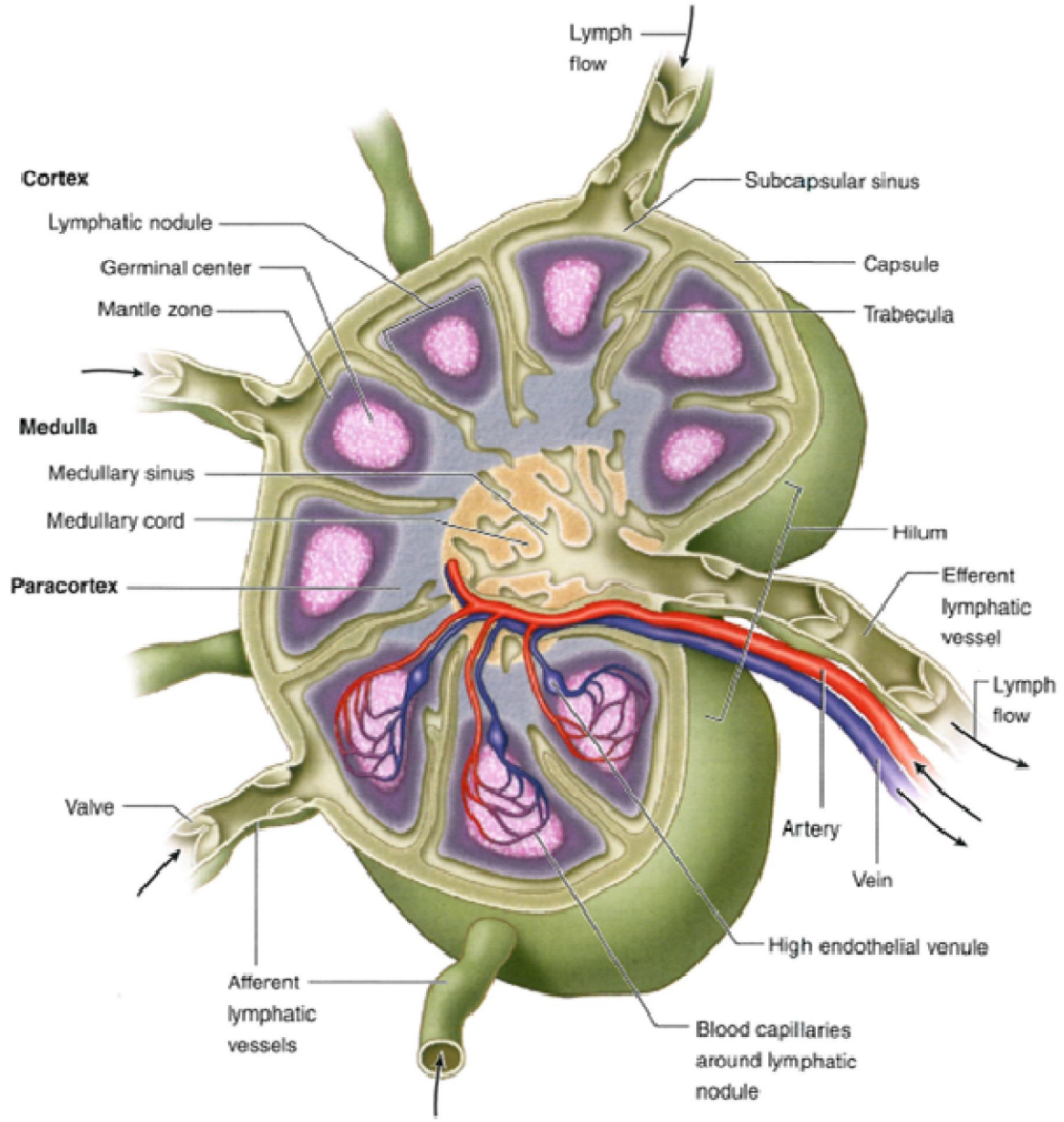
Para cortex:

- No nodules / T cell / post capillary venule (high endothelial venule) :

Entry most (90%) lymphocyte from blood vessels to lymph node /
cuboids endothelial cell + integrin (for diapedesis)

Medulla :

- Medullary cord : T cell / B cell / plasma cell /
- Medullary sinus : form efferent lymphatic / have fenestrated endothelium / reticular cell / macrophage / neutrophil


Lymph flow
Cortex
Subcapsular sinus
Lymphatic nodule
Capsule
Germinal center
Trabecula
Mantle zone
Medulla
Medullary sinus
Medullary cord
Hilum
Paracortex
Efferent lymphatic vessel
Lymph flow
Valve
Artery
Vein
High endothelial venule
Afferent lymphatic vessels
Blood capillaries around lymphatic nodule

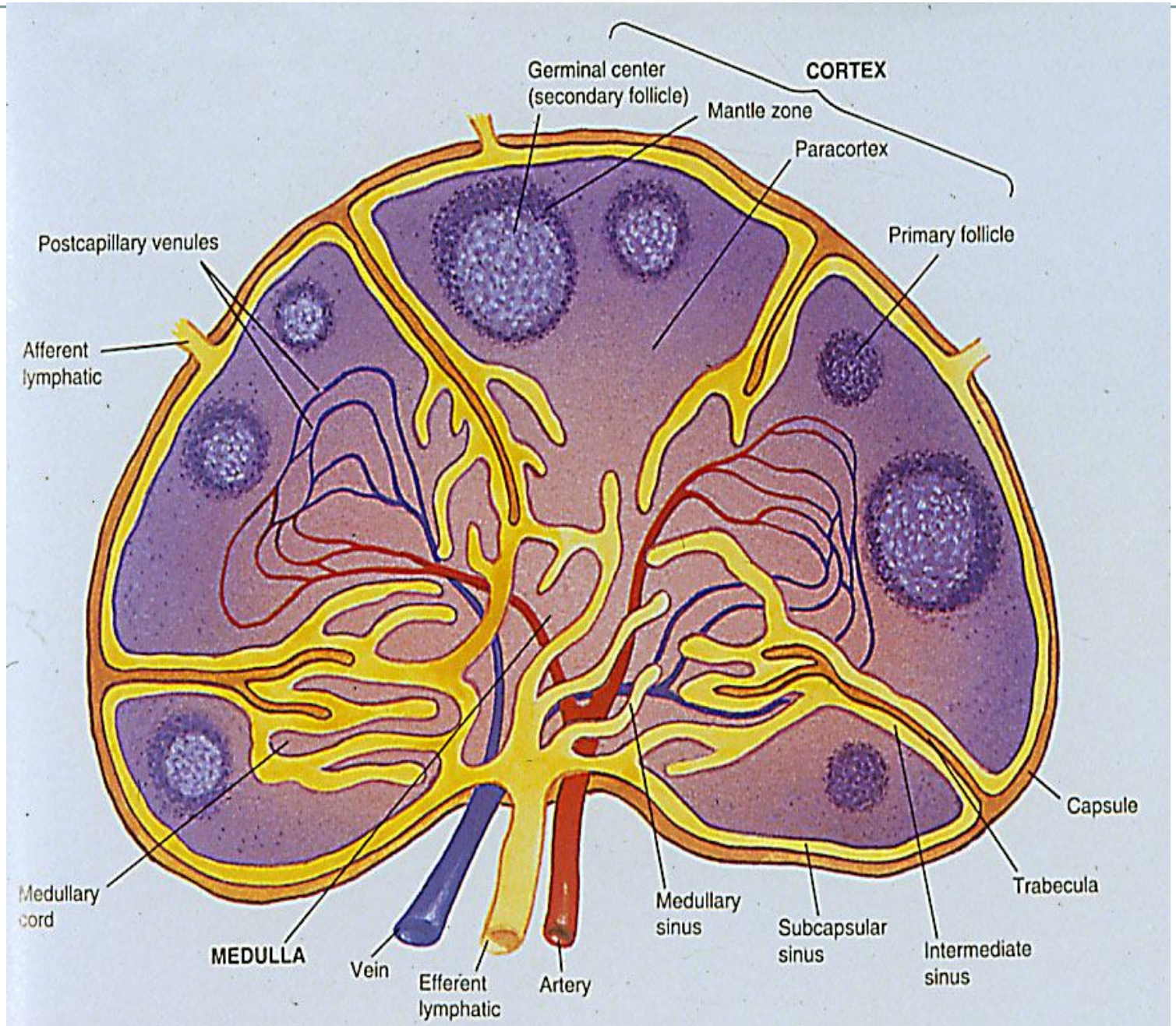
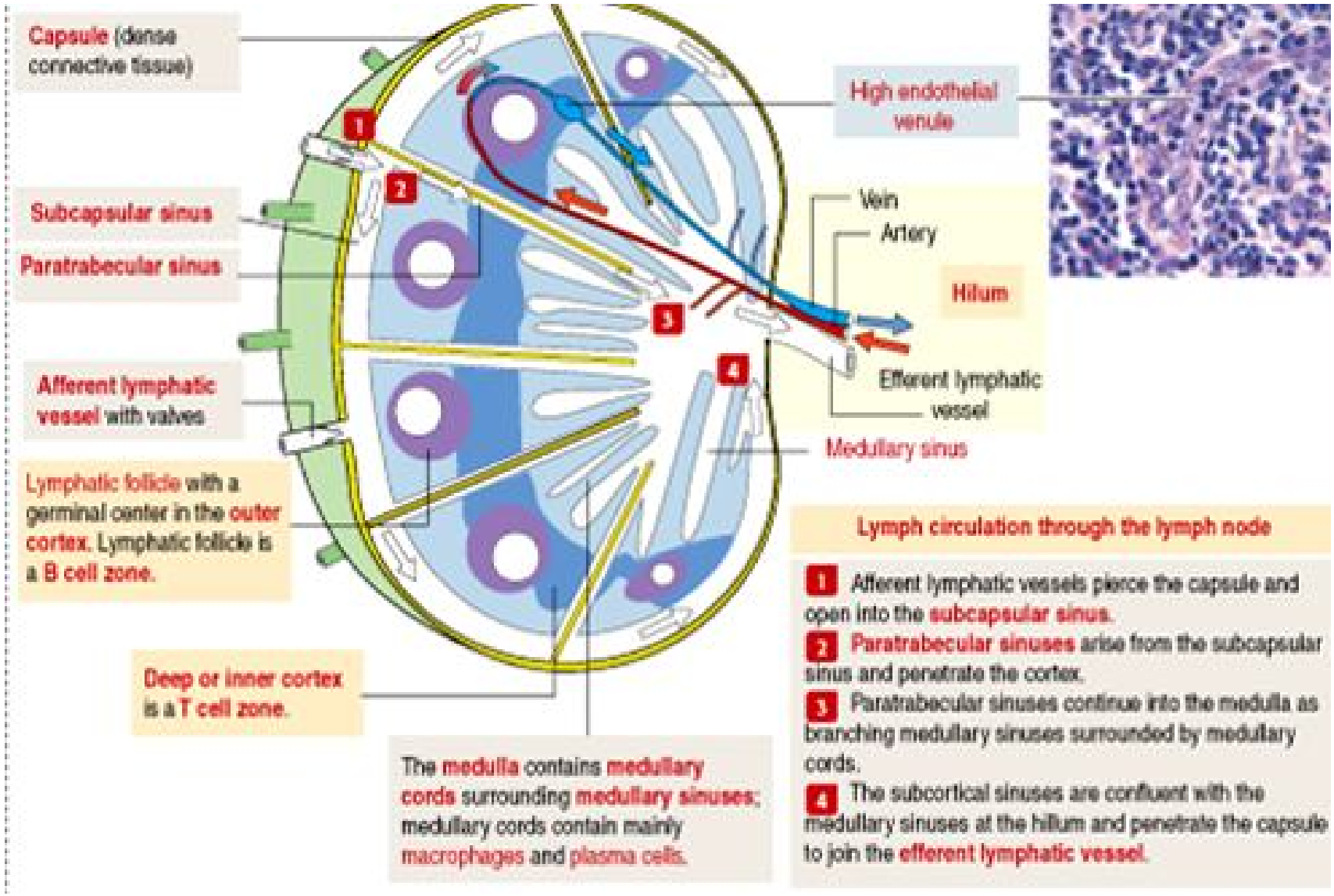


FIGURE *20-12*
Structure of a normal lymph node.

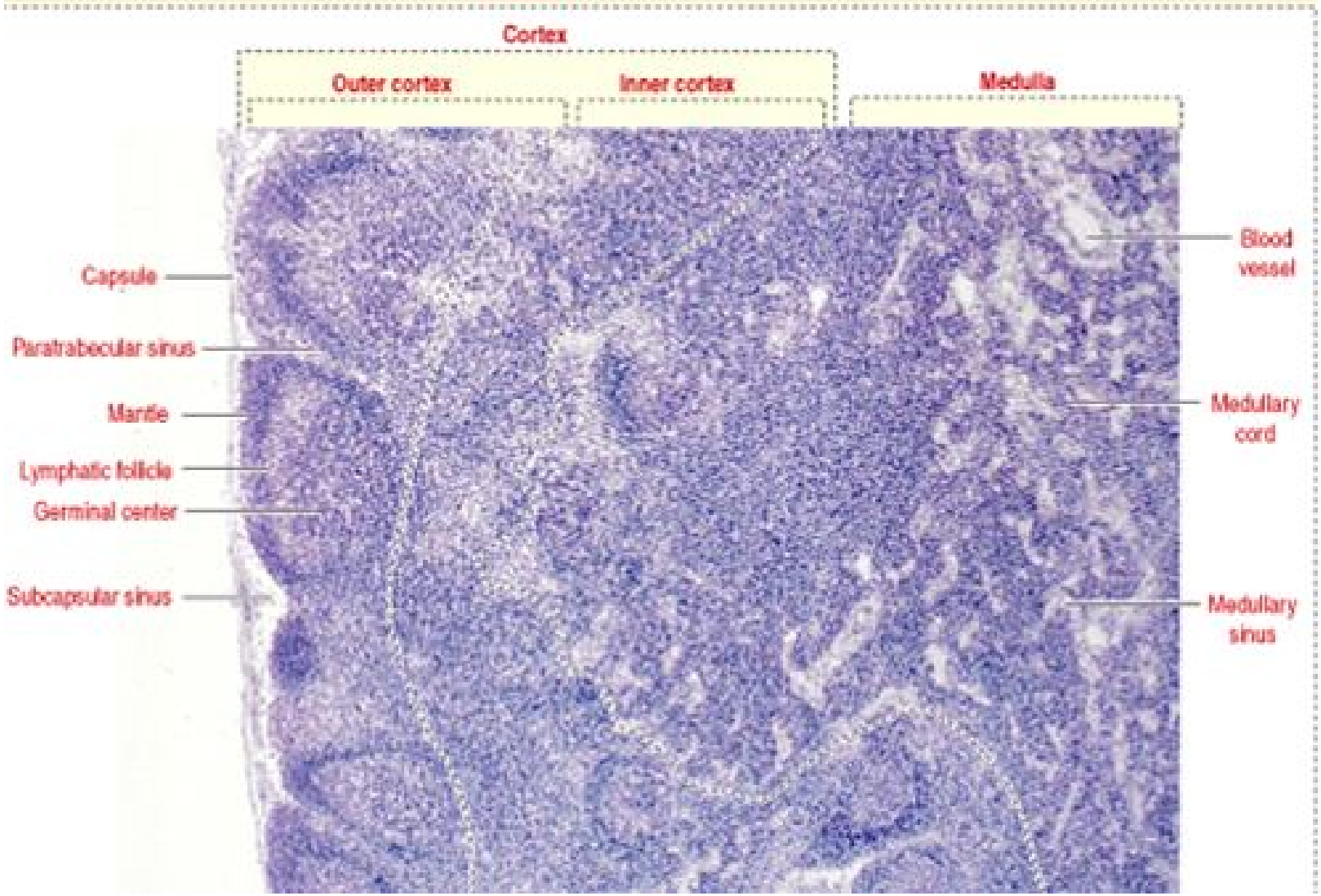
Lymph node



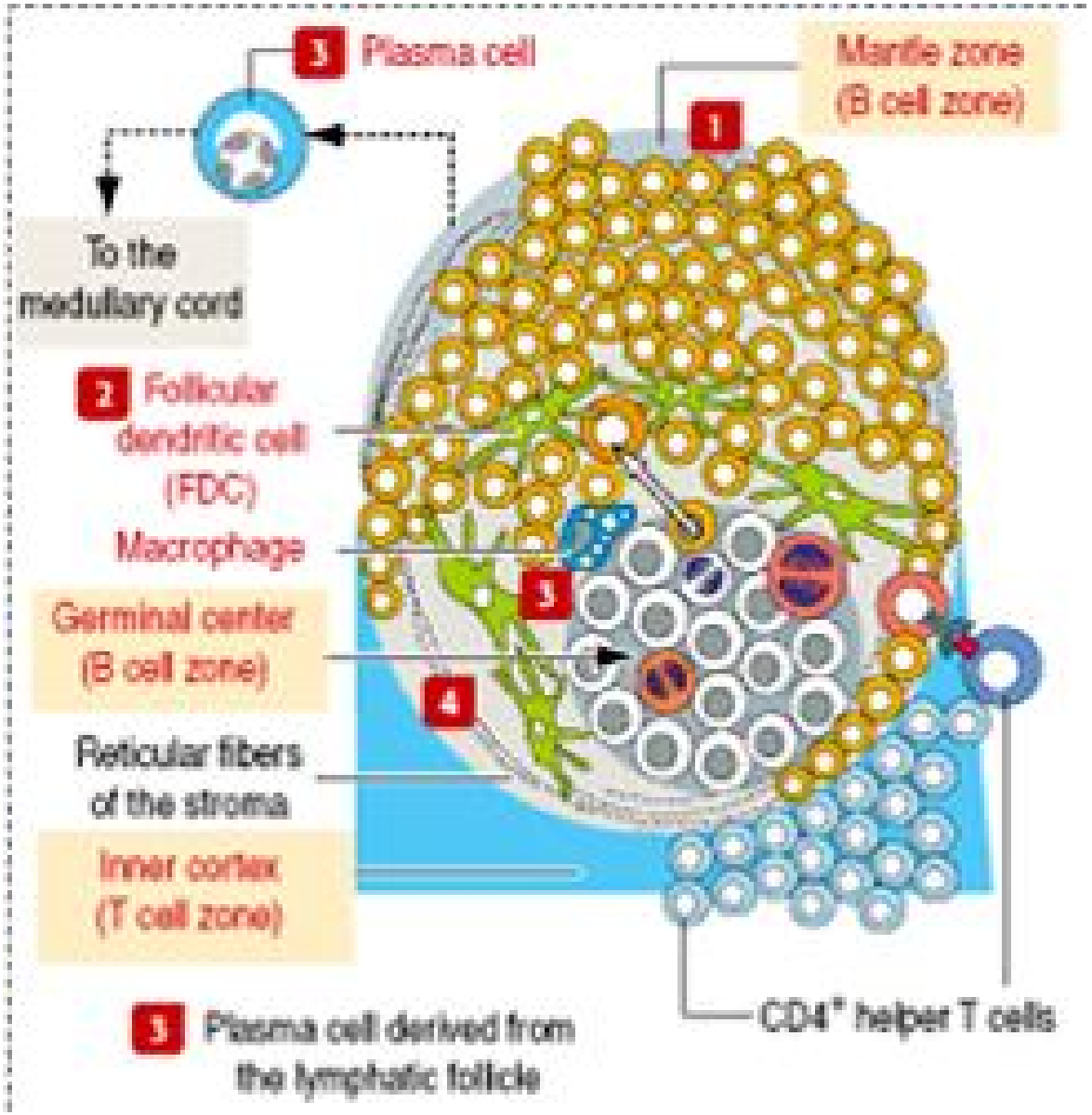
Lymph circulation through the lymph node

1. Afferent lymphatic vessels pierce the capsule and open into the subcapsular sinus.
2. Paratrabecular sinuses arise from the subcapsular sinus and penetrate the cortex.
3. Paratrabecular sinuses continue into the medulla as branching medullary sinuses surrounded by medullary cords.
4. The subcortical sinuses are confluent with the medullary sinuses at the hilum and penetrate the capsule to join the efferent lymphatic vessel.

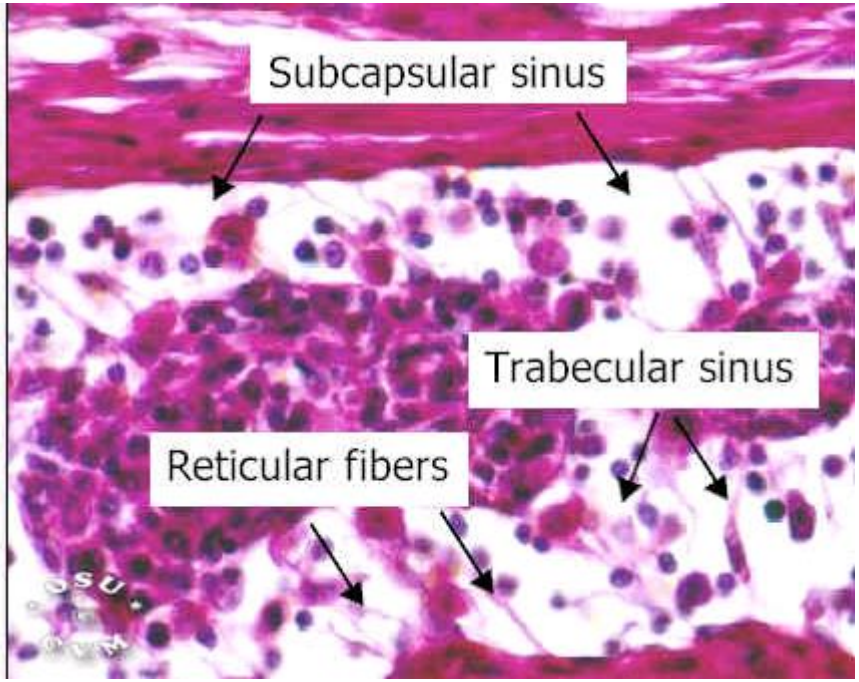
Lymph node

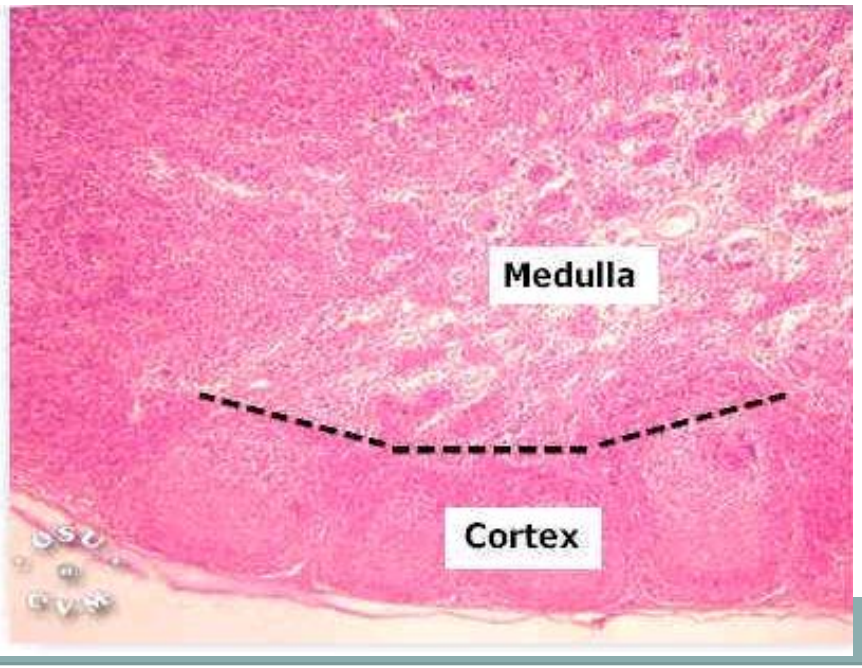

Cortex
Outer cortex
Inner cortex
Medulla
Capsule
Paratrabecular sinus
Mantle
Lymphatic follicle
Germinal center
Subcapsular sinus
Blood vessel
Medullary cord
Medullary sinus

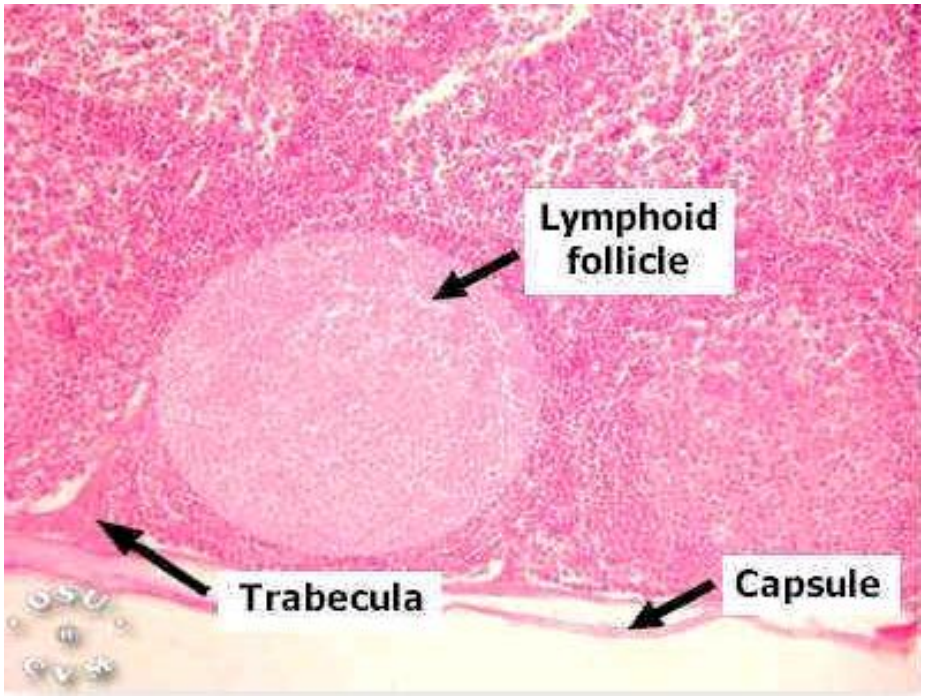
Lymphatic follicle



Micrographs of lymph node of a cat







Development of the Lymph Nodes

except for the superior part of the chyle cistern, the lymph sacs are transformed into groups of lymph nodes during the early fetal period.

mesenchymal cells invade each lymph sac and break up its cavity into a network of lymphatic channels-the primordia of the lymph sinuses.

other mesenchymal cells give rise to the capsule and connective tissue framework of the lymph nodes.

thymus

ANATOMY
EMBRYOLOGY
HISTOLOGY

Anatomy

Thymus

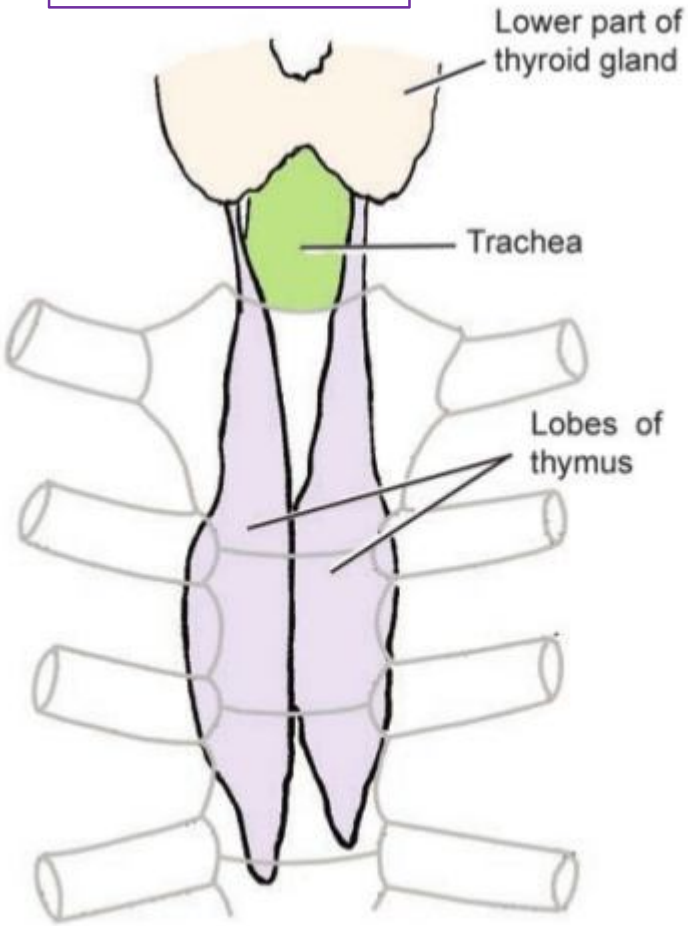
The thymus is the most anterior component of the superior Mediastinum

lying immediately posterior to the manubrium of the sternum

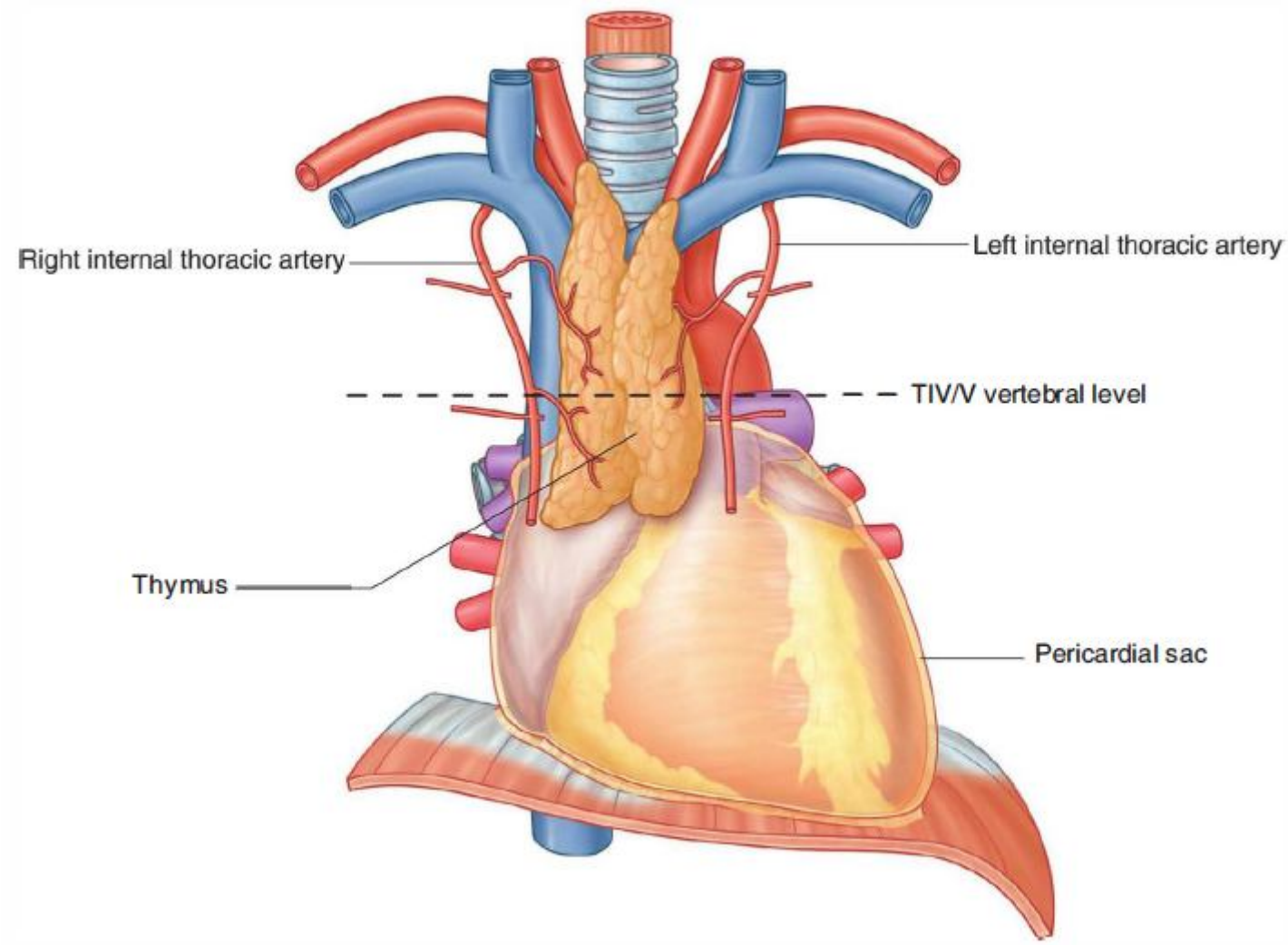
It is an asymmetrical, bilobed structure

The upper extent of the thymus can reach into the neck as high as the thyroid gland;

lower portion typically extends into the anterior mediastinum over the pericardial sac.



22.4: Diagram to show location of the thymus in a person at puberty


Right internal thoracic artery
Left internal thoracic artery
TIV/V vertebral level
Thymus
Pericardial sac

Involved in the early development of the ***immune System***

the thymus is a ***large structure in the child***, begins to ***atrophy after puberty***, and shows considerable size variation in the adult.

In the elderly adult, it is ***barely identifiable as an organ***, consisting mostly of ***fatty tissue*** that is sometimes arranged as two ***lobulated fatty structures***.

Arteries to the thymus consist of small branches originating from the ***internal thoracic arteries .***

Venous drainage is usually into the ***left brachiocephalic vein*** and possibly into the ***internal thoracic veins***.

Lymphatic drainage returns to multiple groups of nodes at one or more of the following locations:

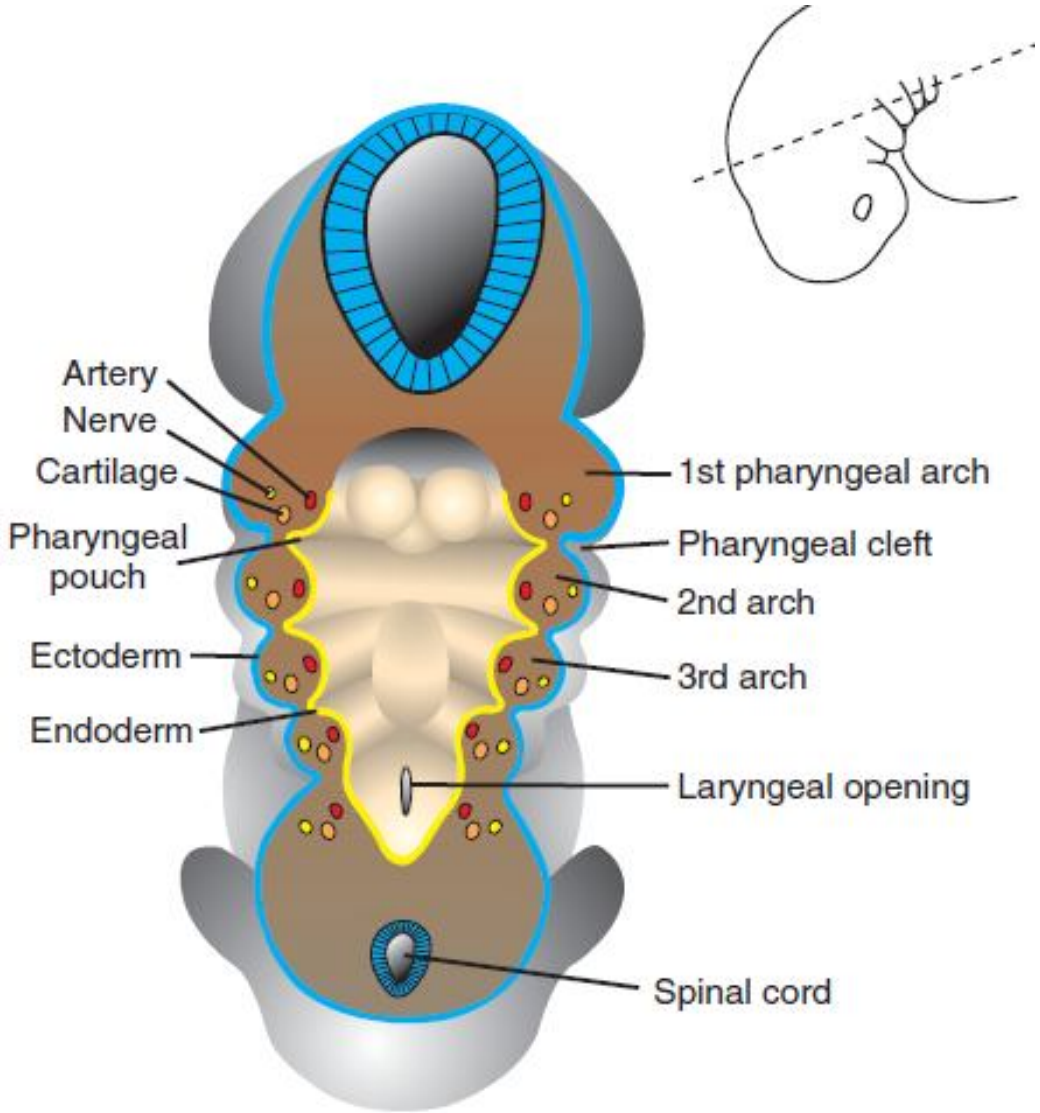
- along the ***internal thoracic arteries (parasternal)***
- at the tracheal bifurcation ***(tracheobronchial)***
- in the ***root of the neck***.

Embryology

Thymus

The thymus **derives from the foregut out of the 3rd and 4th pharyngeal pouches**.

Its stroma arises out of **epithelial cells** of **ectodermal** and also **endodermal origins**.



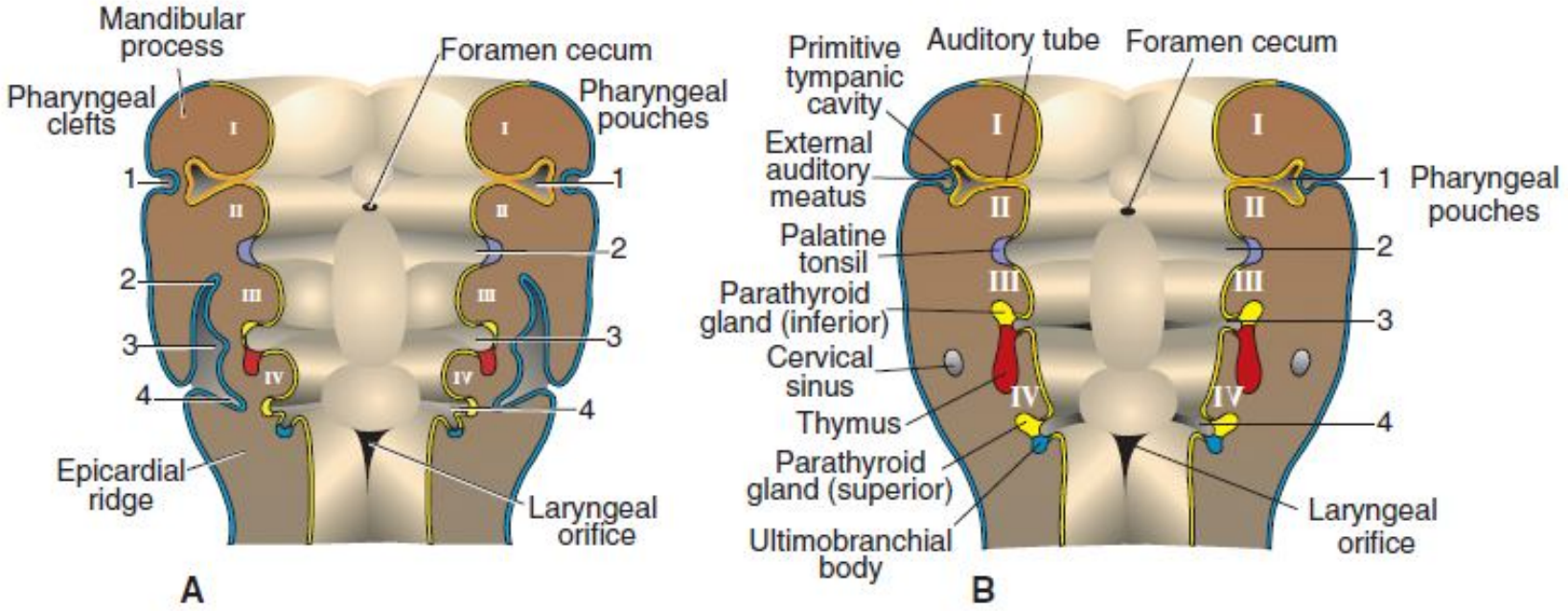


Figure 17.10 **A.** Development of the pharyngeal clefts and pouches. The second arch grows over the third and fourth arches, burying the second, third, and fourth pharyngeal clefts. **B.** Remnants of the second, third, and fourth pharyngeal clefts form the cervical sinus, which is normally obliterated. Note the structures formed by the various pharyngeal pouches.

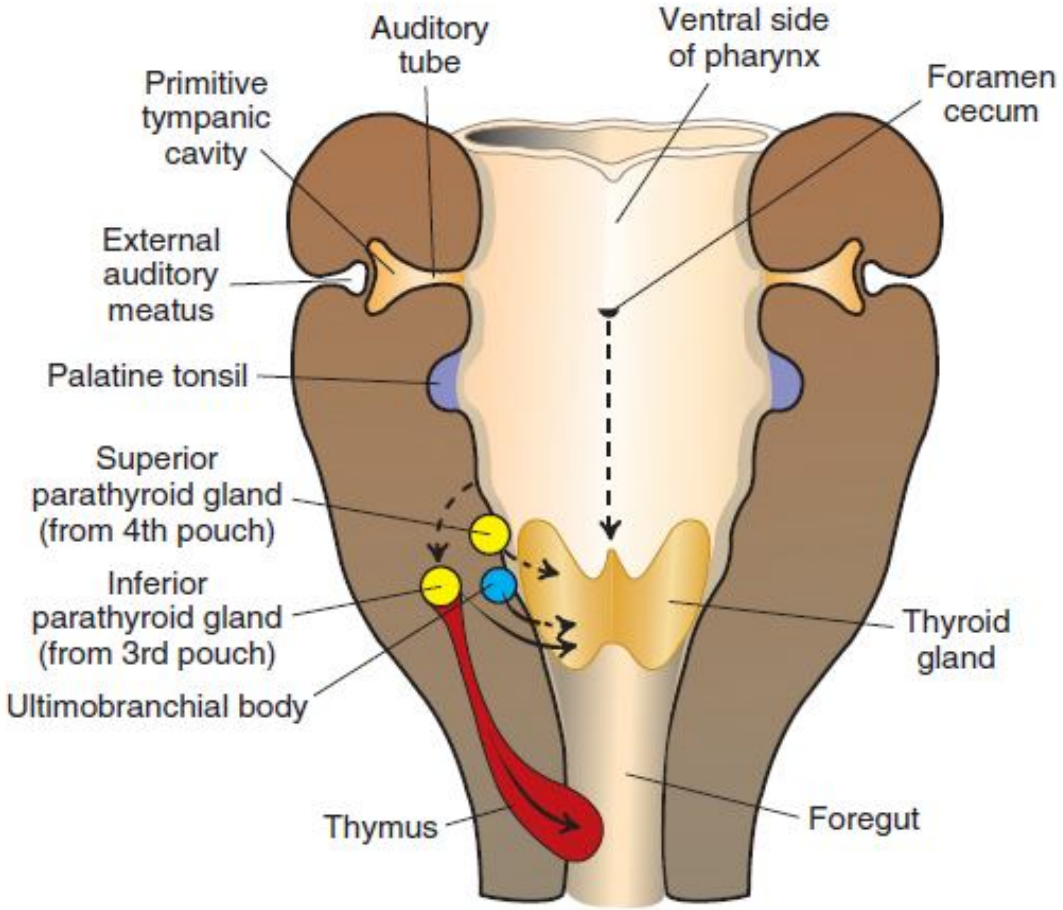
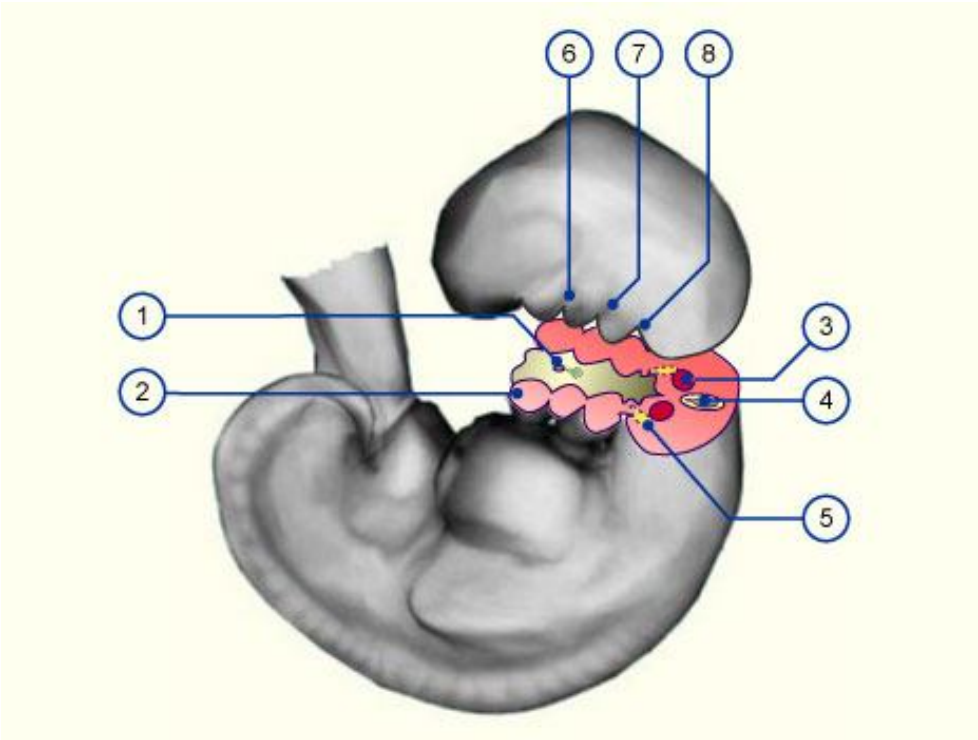
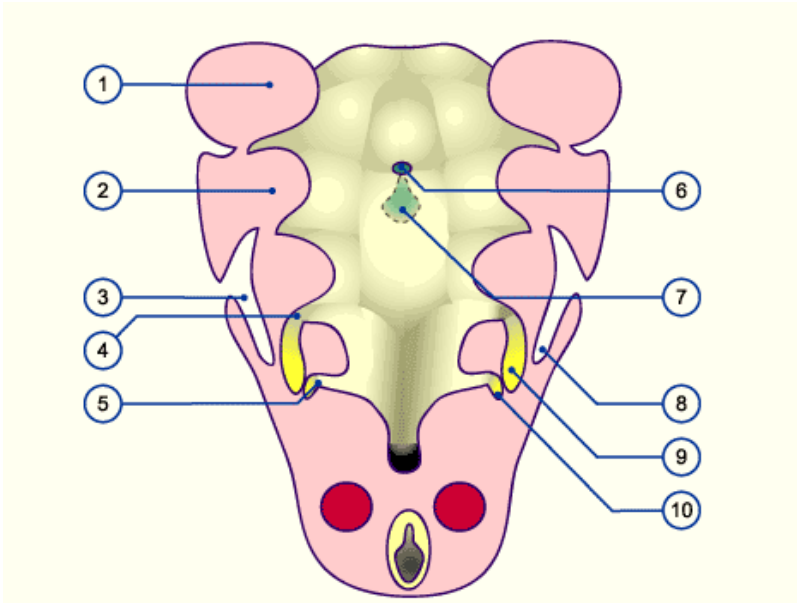


Figure 17.11 Migration of the thymus, parathyroid glands, and ultimobranchial body. The thyroid gland originates in the midline at the level of the foramen cecum and descends to the level of the first tracheal rings.

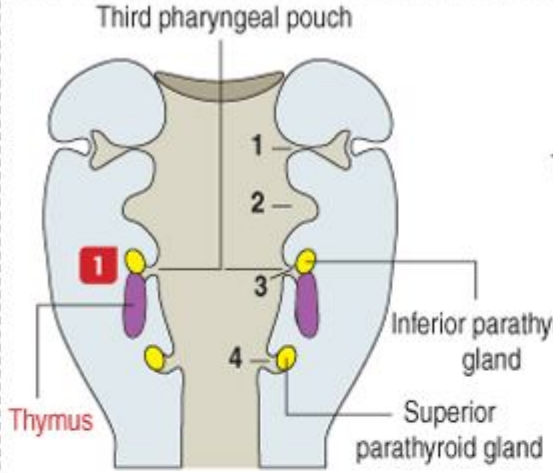


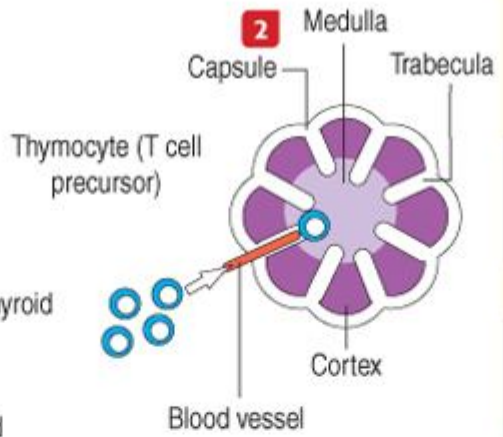
1 Thyroid and foramen cecum
2 1st pharyngeal arch (mandibular arch)
3 Aorta dorsalis (paired)
4 Neural tube
5 Anlage of the thymus
6 1st pharyngeal fold (anlage of the external ear)
7 2nd pharyngeal fold
8 Entrance to the cervical sinus

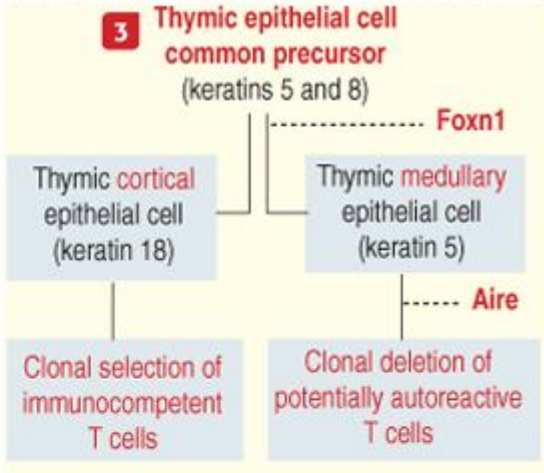


1 Mandibular arch
2 Hyoid arch
3 Entrance to the cervical sinus
4 3rd pharyngeal pouch
5 4th pharyngeal pouch
6 Foramen cecum
7 Thyroid
8 Cervical sinus
9 Thymus (part of the 3rd pharyngeal pouch)
10 Thymus (part of the 4th pharyngeal pouch)

Development of the thymus







1 The thymus rudiments originate from the caudal region of the endodermic **third pharyngeal pouch** on each side, proliferate, migrate to the thorax, and become connected by connective tissue.

Parathyroid gland tissue, developing from the same pouch, migrates with the thymus and becomes the inferior parathyroid glands. The superior parathyroid glands originate from the fourth pharyngeal pouch. The numbers 1 to 4 indicate the pharyngeal pouches.

2 A **capsule** forms from the neural crest mesenchyme. Capsule-derived trabeculae extending into the future corticomedullary region of the thymus divide the thymus into **incomplete lobules**.

By 14 weeks, thymocyte precursors arrive from bone marrow through blood vessels, after interconnected **thymic epithelial cells** form a three-dimensional network and **macrophages** are present. By 17 weeks, the thymus is beginning to produce T cells.

3 Thymic epithelial cells play important functions in clonal selection and clonal deletion of differentiating T cells:

1. A common precursor (keratins 5 and 18) gives rise to thymic cortical (keratin 18) and medullary (keratin 5) epithelial cells.
2. Thymic epithelial cells express two essential transcription factors: **Foxn1** (for forkedhead box N1), and **aire** (for autoimmune regulator). **Foxn1** is essential for the differentiation of thymic epithelial cells. **Aire** promotes the expression of a portfolio of tissue-specific cell proteins by thymic **medullary** epithelial cells, which normally do not express these proteins. These proteins permit the identification and disposal of autoreactive T cells. A mutation of the aire gene in humans causes autoimmune polyendocrinopathy–candidiasis–ectodermal dystrophy (APECED).

Thymus histology

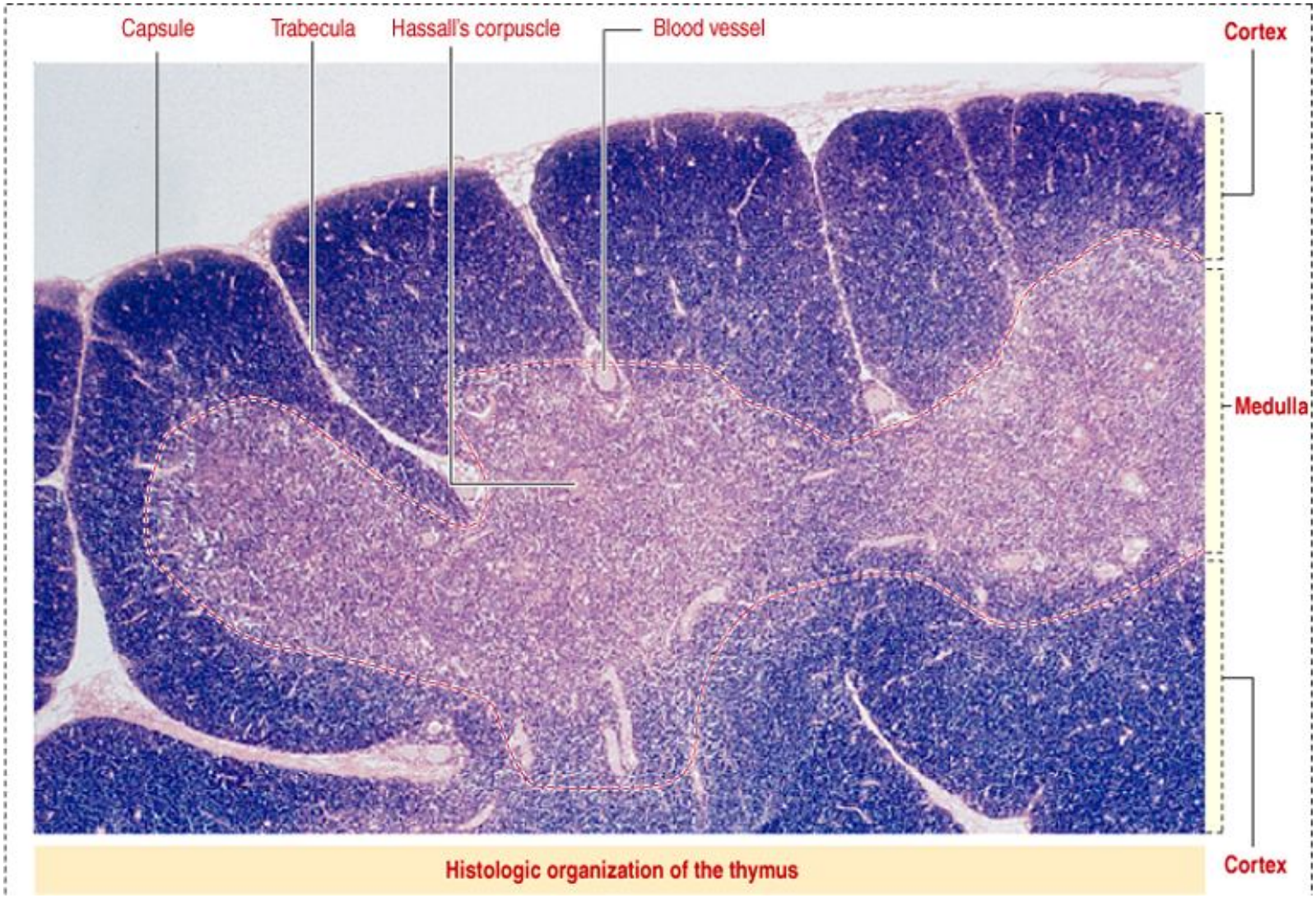
Production of T – cell
Primary lymphatic organ
Main function: central tolerance
Vascular connective tissue capsule
Trabeculae / incomplete lobule
Cortex (basophilic / many T – cell) + medulla

Thymus

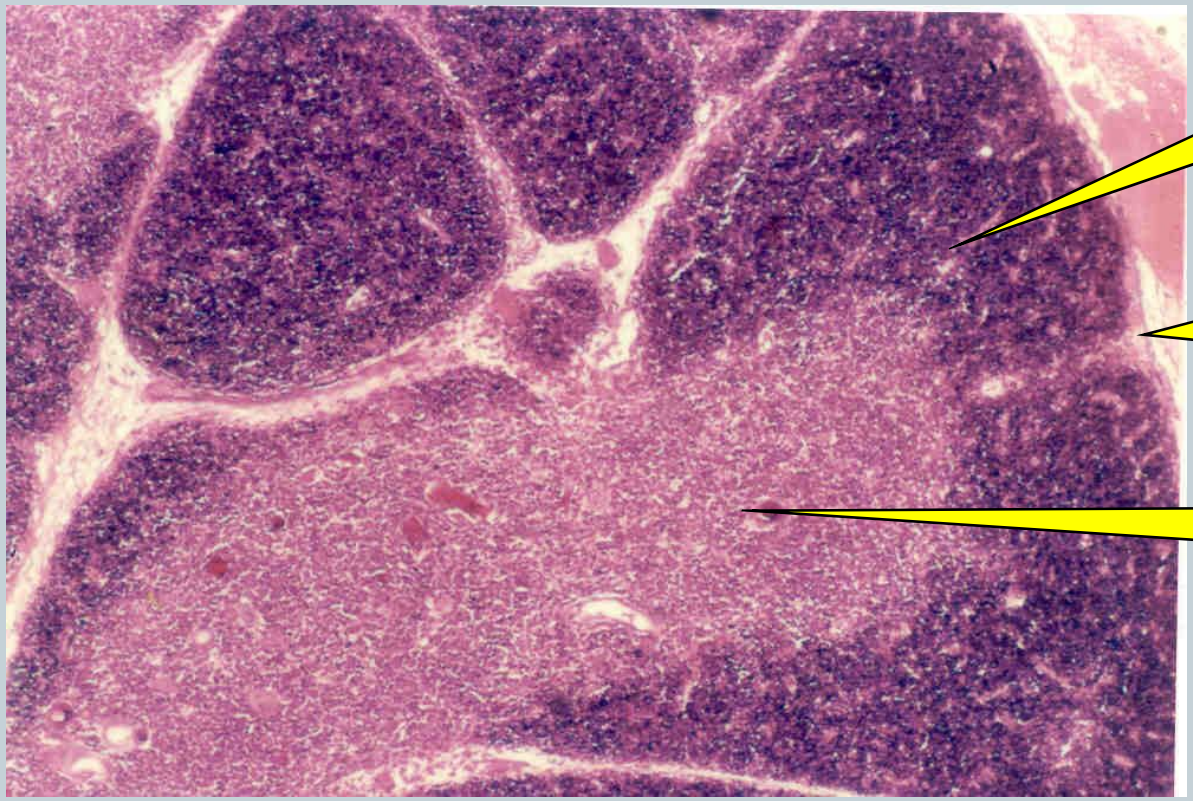
- connective tissue
- interlobular septa

- Thymic lobules Each lobule has a peripheral dark zone(cortex) and a central light zone(medulla).

Thymus Histology

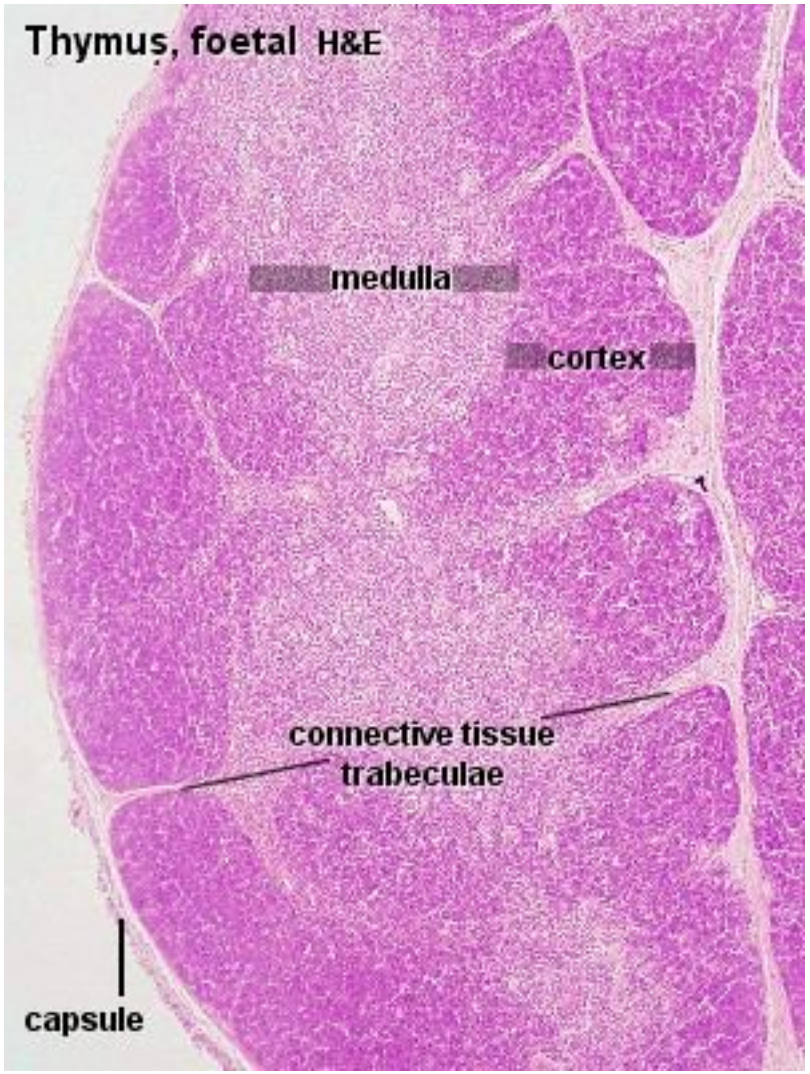


Thymus



Cortex of thymus

Immature T – cell
Macrophage
Thymic epithelial cell (TECs)
(epithelio reticular cell)



Thymic epithelial cell (TECs)

Have 3 types:

1. TEC:

Squamuse cell
Tight & desmosome junction
Separate cortex from capsule + trabeculae + vessels
Form blood – thymus barrier

2. Cytoreticulum:

Satellite form with process
Have tonofilaments in process
Desmosome junction
Like APC
Cytokine secretion / for T – cell maturation

3. plate like cells

Form corticomedullary barrier / between cortex and medulla

Blood – Thymus Barrier

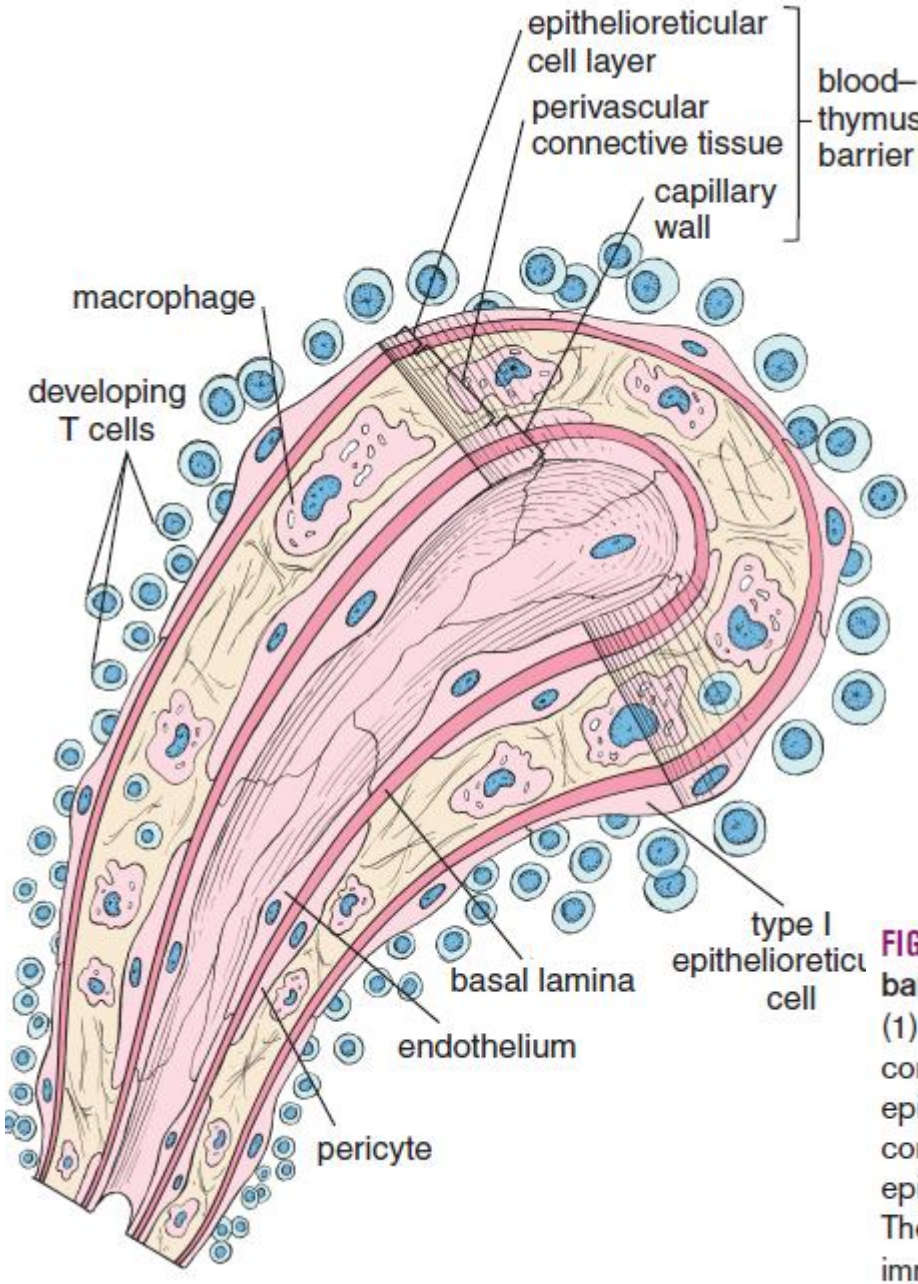
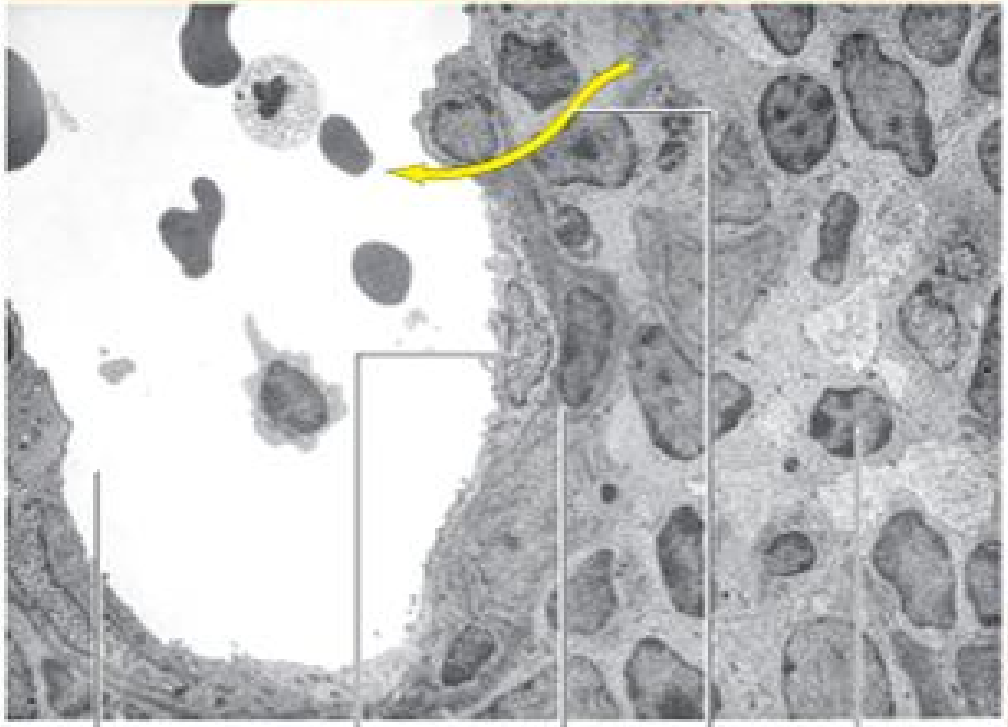


FIGURE 14.27 • Schematic diagram of the blood–thymus barrier. The blood–thymus barrier consists of three major elements: (1) capillary endothelium and its basal lamina, (2) perivascular connective tissue space occupied by macrophages, and (3) type I epithelioreticular cells with their basal lamina. The perivascular connective tissue is enclosed between the basal lamina of the epithelioreticular cells and the endothelial cell basal lamina. These layers provide the necessary protection to the developing immature T cells and separate them from mature immunocompetent lymphocytes circulating in the bloodstream.

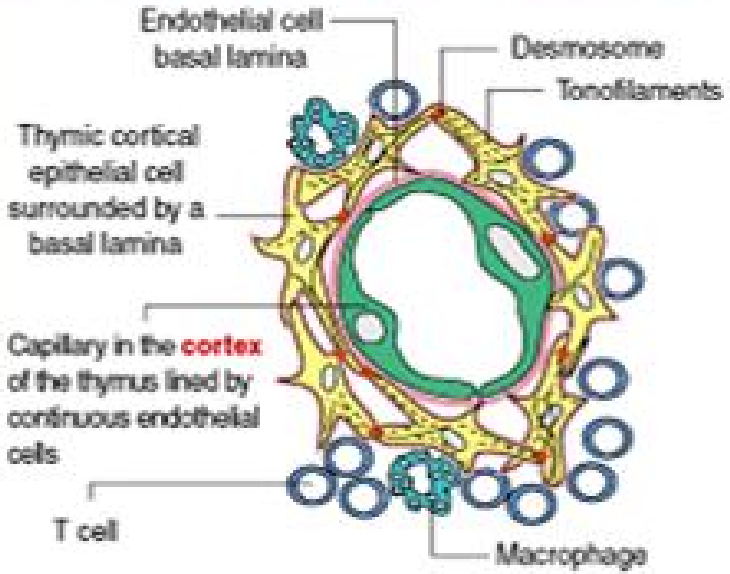
Blood – Thymus Barrier

Postcapillary venule in the corticomedullary junction



Mature T cells—completing their differentiation under the guidance of thymic medullary epithelial cells—migrate across the endothelium into the lumen of a corticomedullary postcapillary venule.

The blood-thymus barrier in the cortex of the thymus



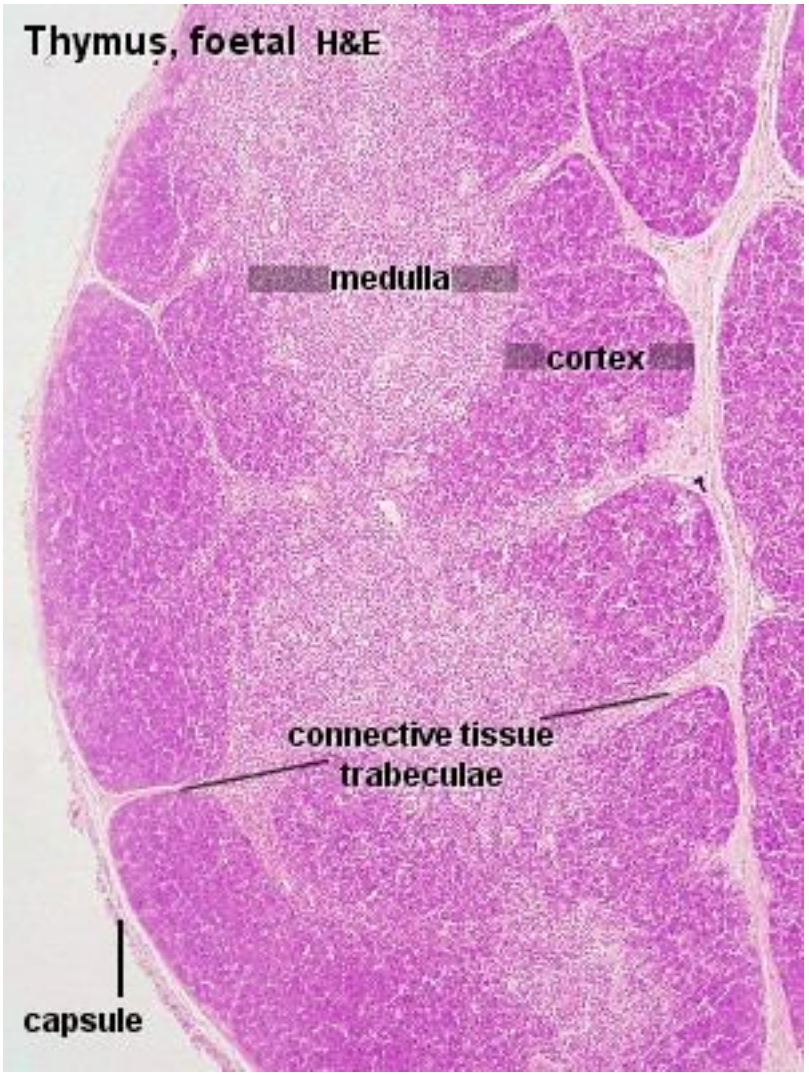
The **blood-thymus barrier** consists of thymic cortical epithelial cells joined by desmosomes, dual basal laminae produced by thymic cortical epithelial cells and endothelial cells, and capillary endothelial cells linked by tight junctions.

Medulla of thymus:

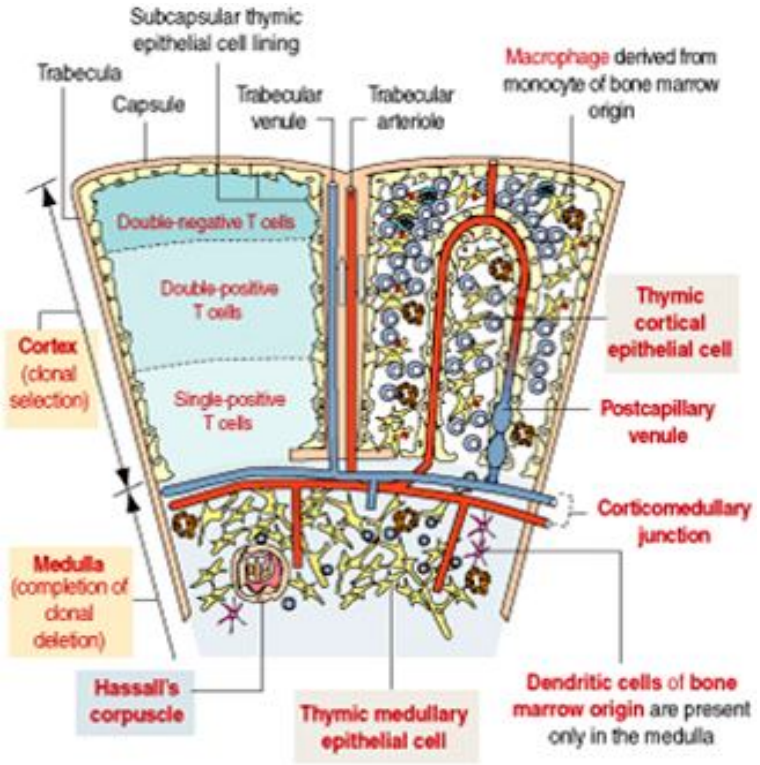
- Low T –cell
- Danderetic cell
- Macrophage
- Hassal corpuscle: (compaction of TEC)

Cytokine secretion for:
Control denderetic cell function &
Development of Regulatory T- cell

- Capillary without TEC



Thymus


Subcapsular thymic epithelial cell lining
Trabecula
Capsule
Trabecular venule
Trabecular arteriole
Macrophage derived from monocyte of bone marrow origin
Double-negative T cells
Double-positive T cells
Single-positive T cells
Cortex (clonal selection)
Thymic cortical epithelial cell
Postcapillary venule
Corticomedullary junction
Medulla (completion of clonal deletion)
Hassall's corpuscle
Thymic medullary epithelial cell
Dendritic cells of bone marrow origin are present only in the medulla

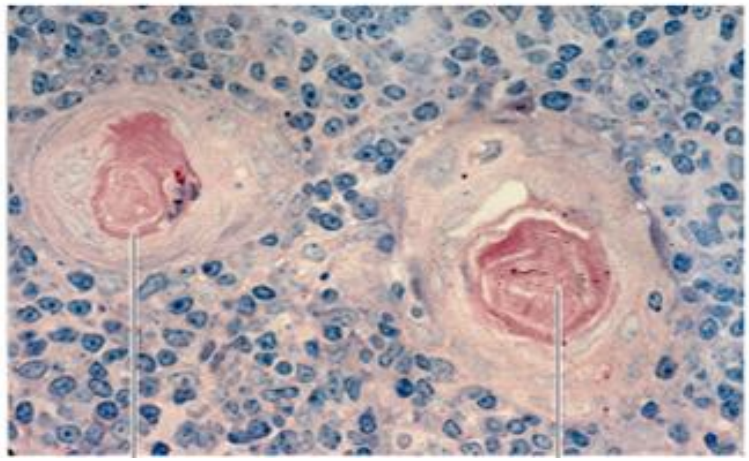
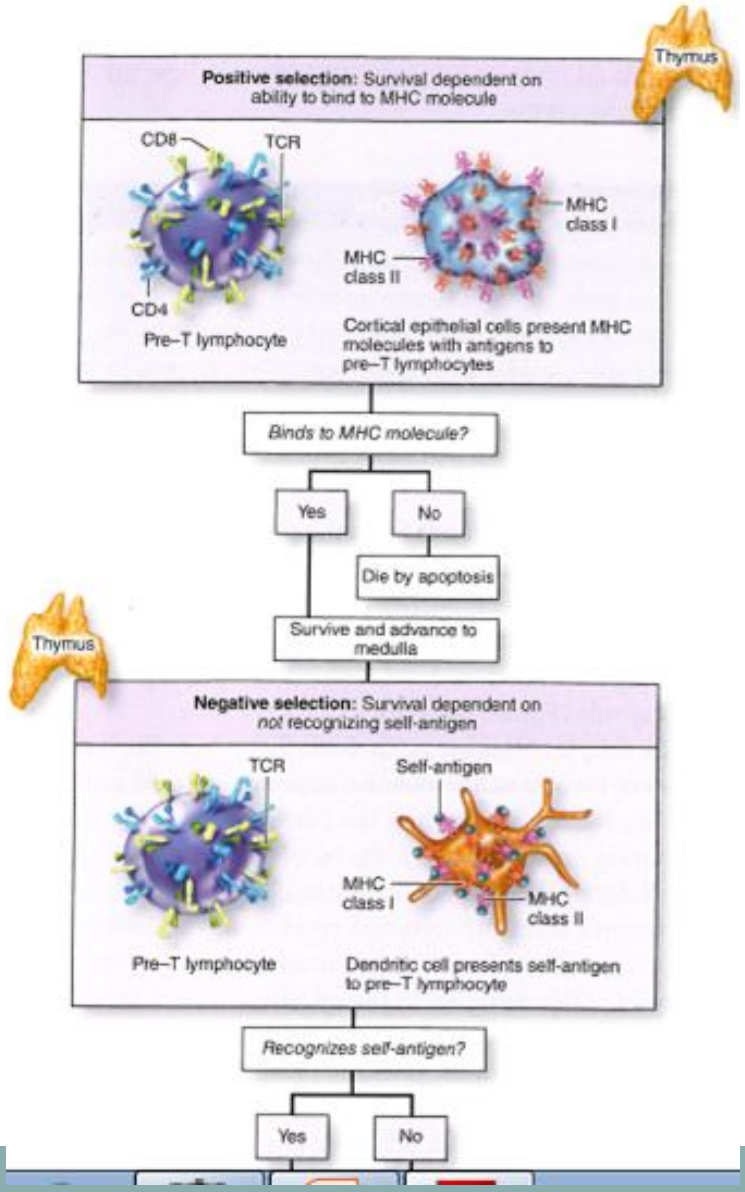
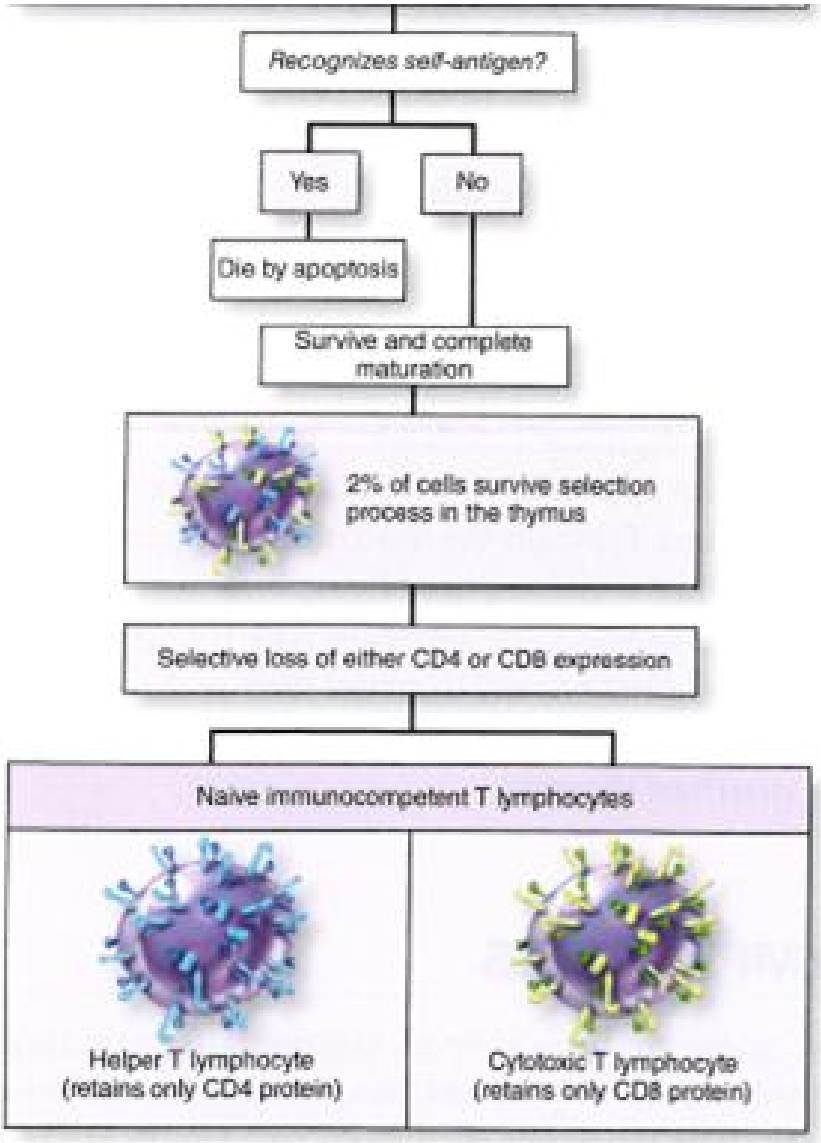
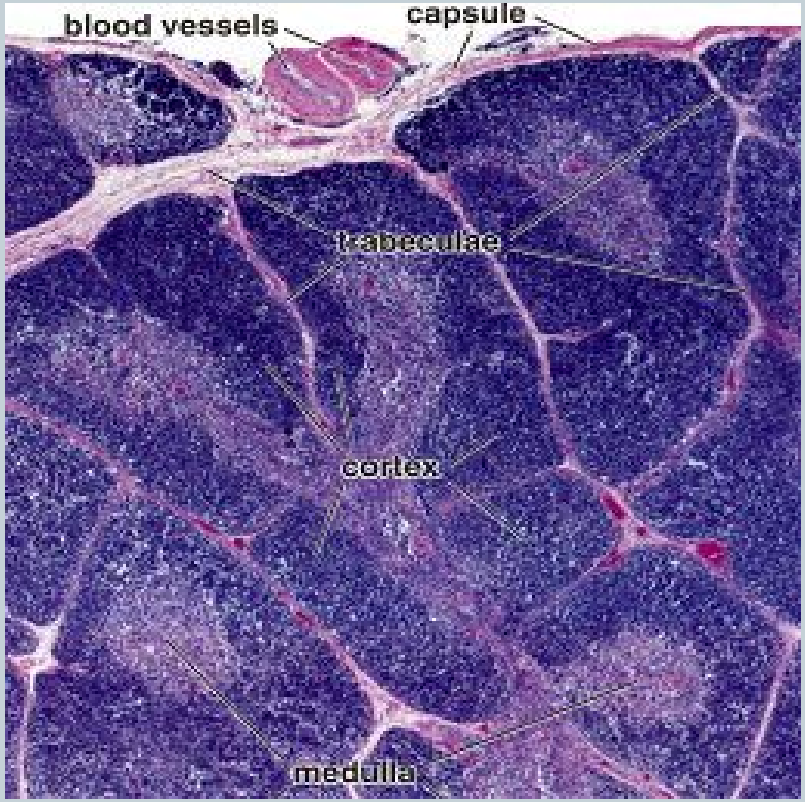


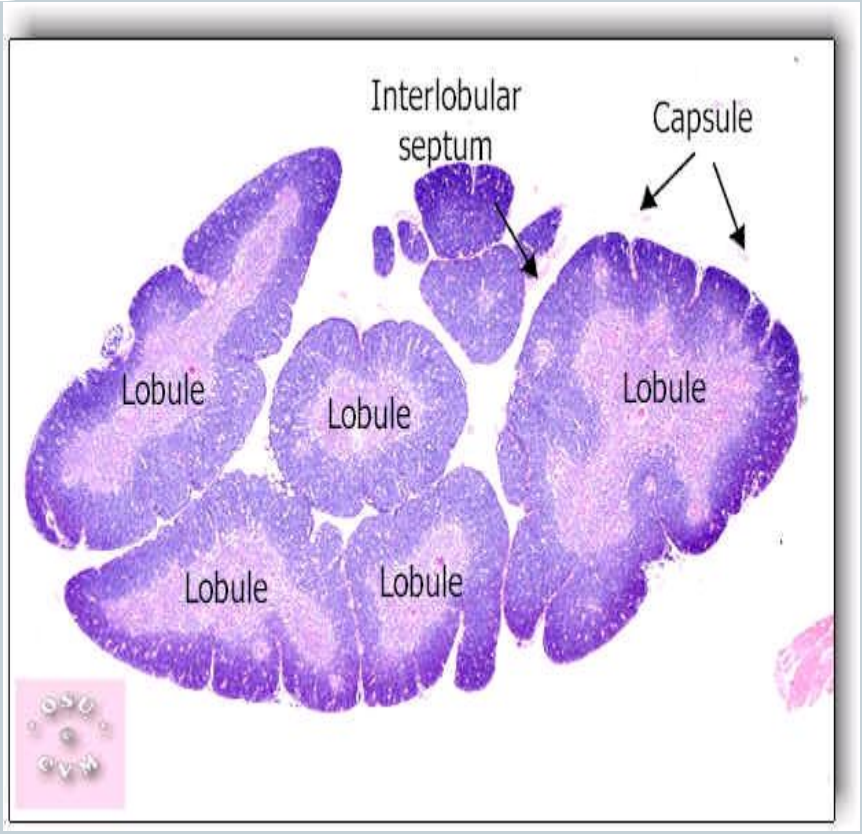
FIGURE **14–11** **Thymic selection of functional but not self-reactive T cells.**



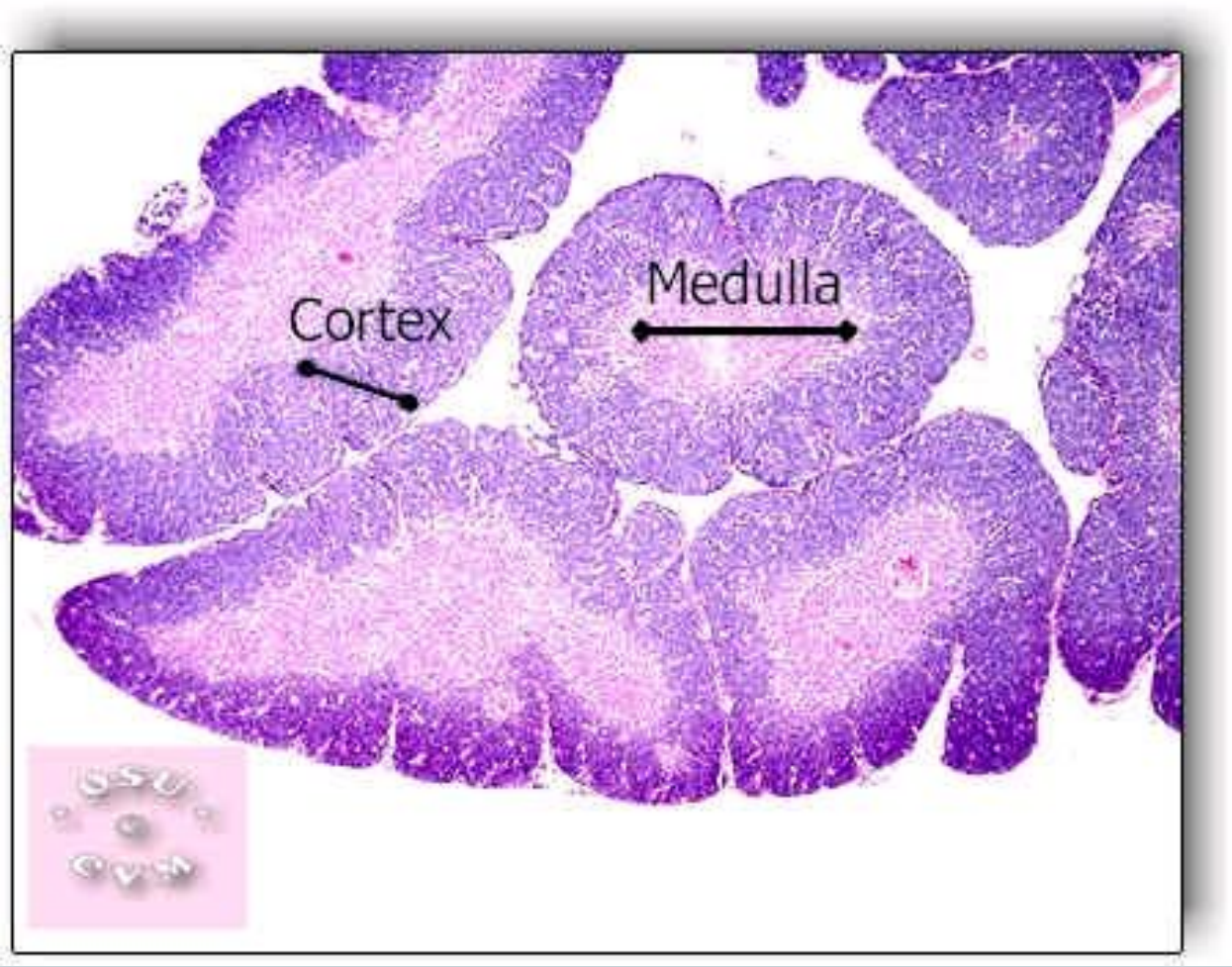


Thymus

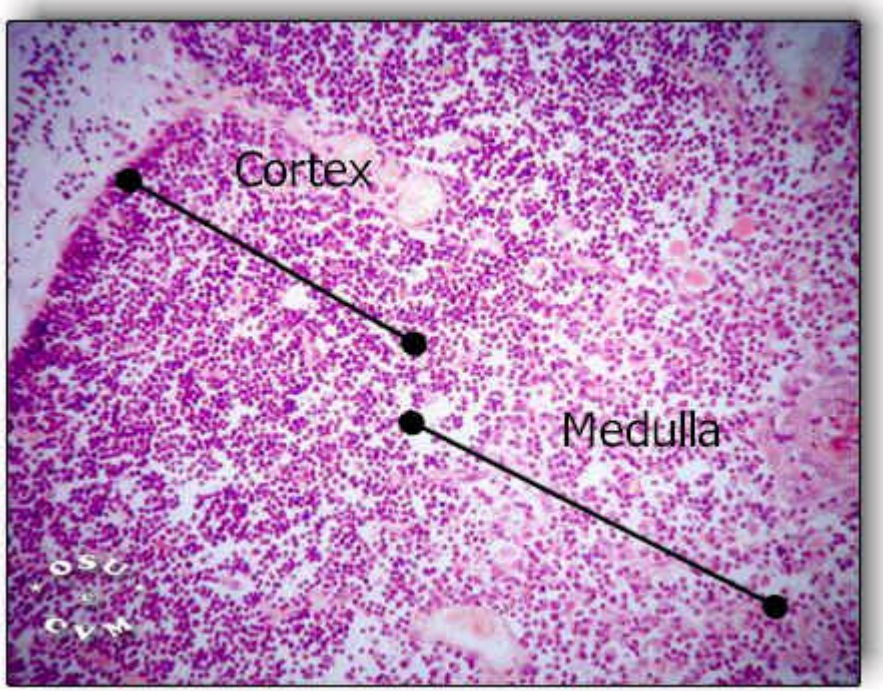

blood vessels
capsule
trabeculae
cortex
medulla

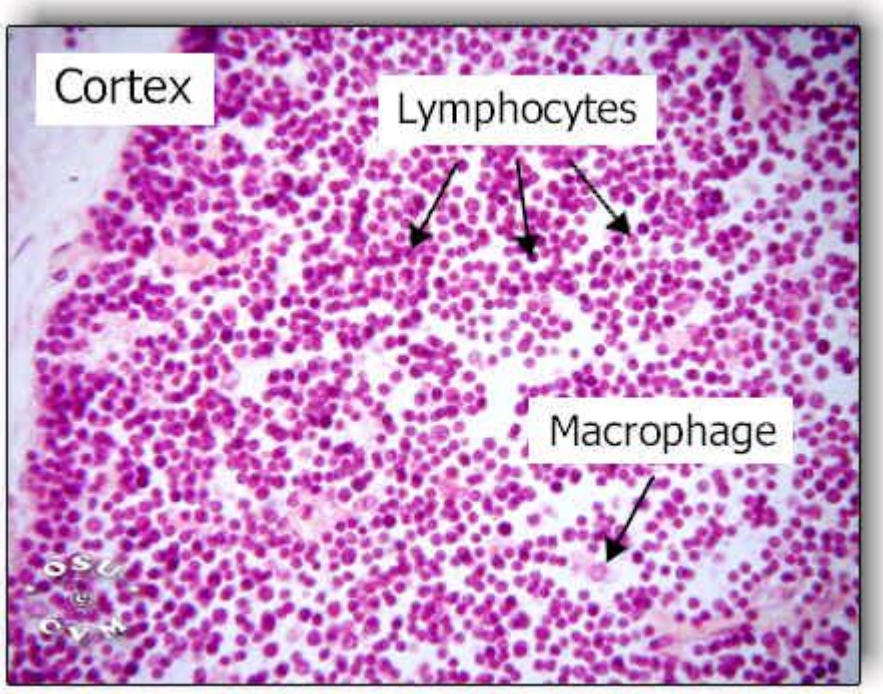

Interlobular septum
Capsule
Lobule
Lobule
Lobule
Lobule
Lobule

Thymus

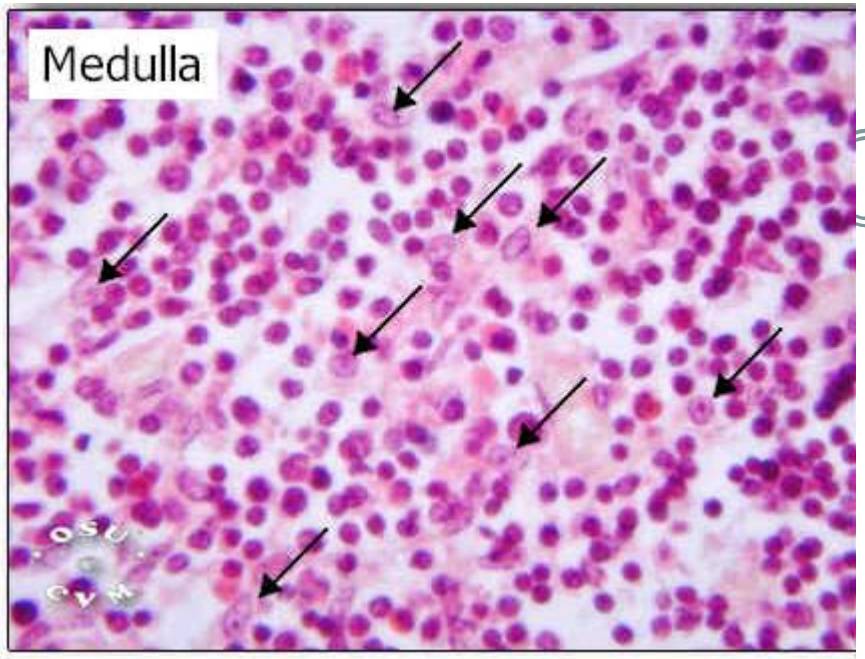


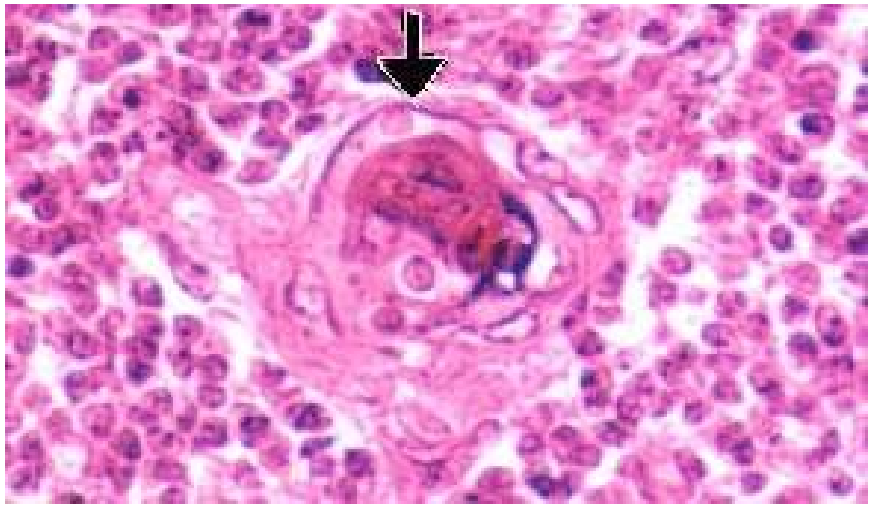
Thymus



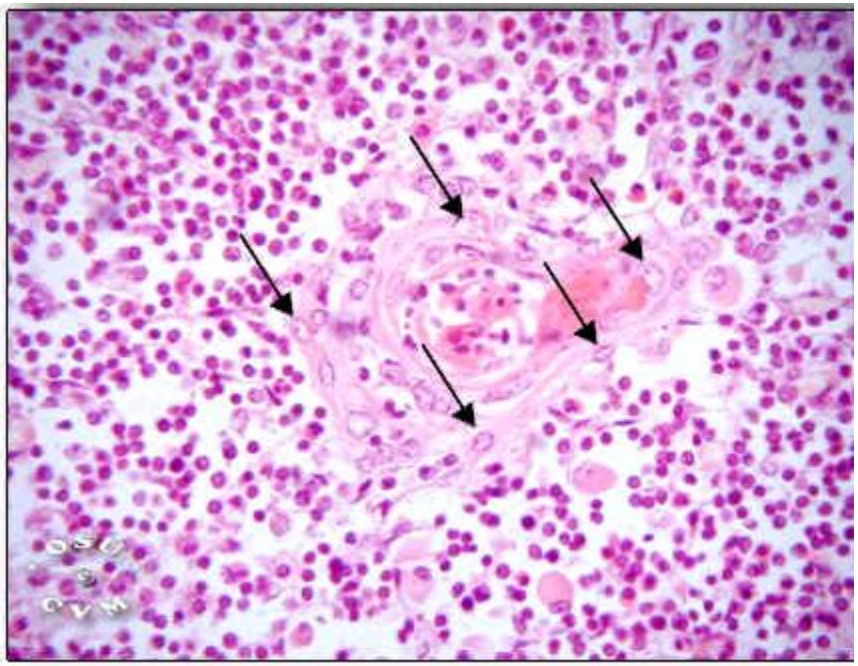


Thymus





Epithelial cells



Hassall's corpuscles

DiGeorge syndrome

- More frequent cleft lip/palate
- Small jaw
- Small upper lip/mouth
- Eyes slanted upward or downward
- Low-set and/or abnormal folding of ears
- Short stature, mild to moderate learning difficulties
- Underdeveloped parathyroid and thymus
- Cardiac malformations

Digilio et al., 2005

Spleen

ANATOMY
EMBRYOLOGY
HISTOLOGY

Anatomy

Spleen

- part of the vascular system
- in the part of the dorsal mesentery
- In the adult, the spleen lies against the **diaphragm**, in the area **of rib IX to rib X.**
- ***in the left upper quadrant***, or left hypochondriac, of the abdomen.

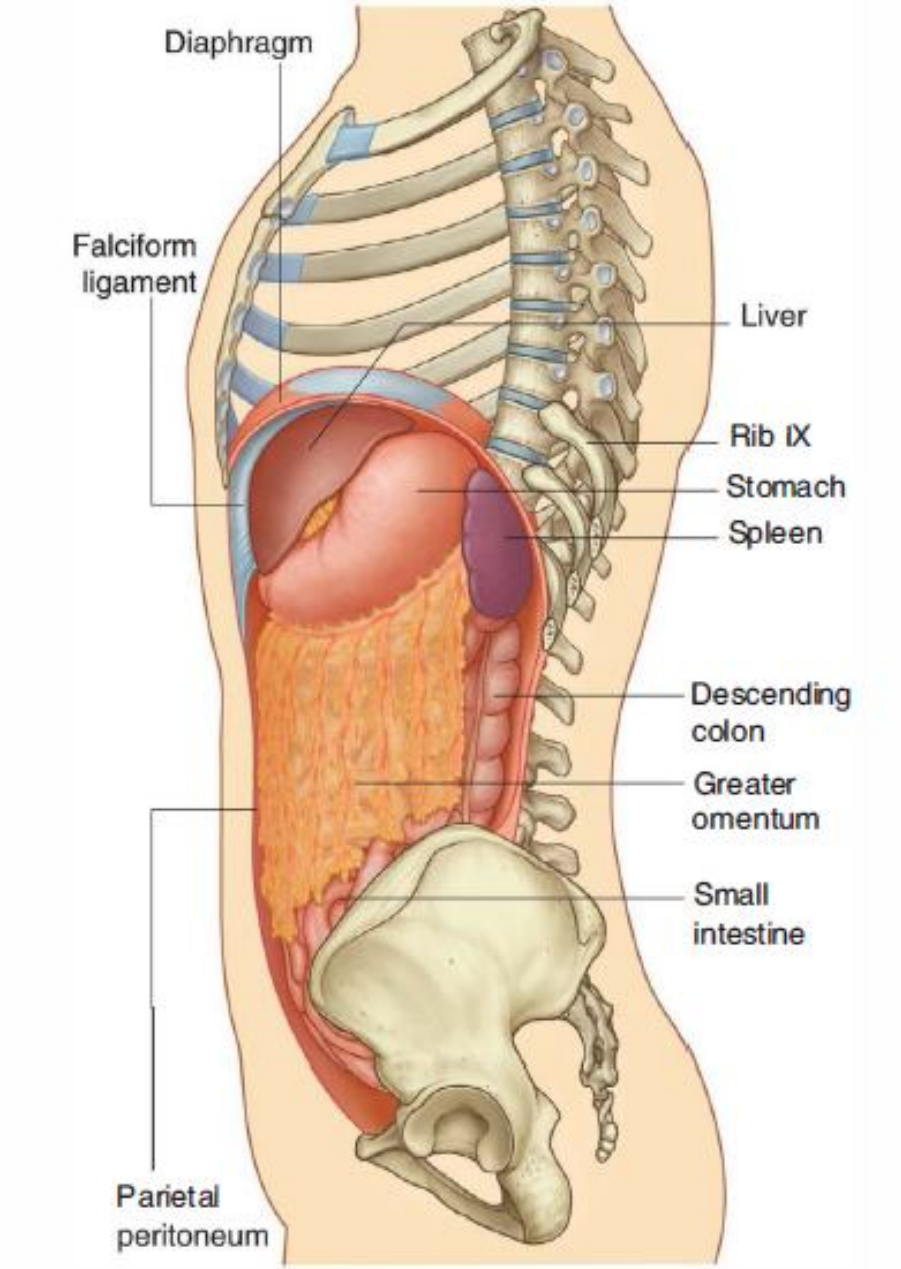


Fig. 4.103 Spleen.