HEMATOPOITIC SYSTEM
THYMUS & BONE MARROW

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Lymphatic System

- Not a primary tissue type but a variety of connective tissue.
- **Consists of:**

  - lymph
  - network of vessels
  - lymph nodes and nodules, MALT
  - tonsils
  - spleen
  - thymus gland
  - bone marrow

CELLS OF LYMPHATIC SYSTEM

Chief cells are lymphocytes-

- B lymphocytes
- T lymphocytes
- Natural killer cells
- Supporting cells-
  - interact with lymphocyte
  - Present antigens to Lymphocytes

- OTHER TYPE OF WBC'S

  -monocyte

  -macrophages

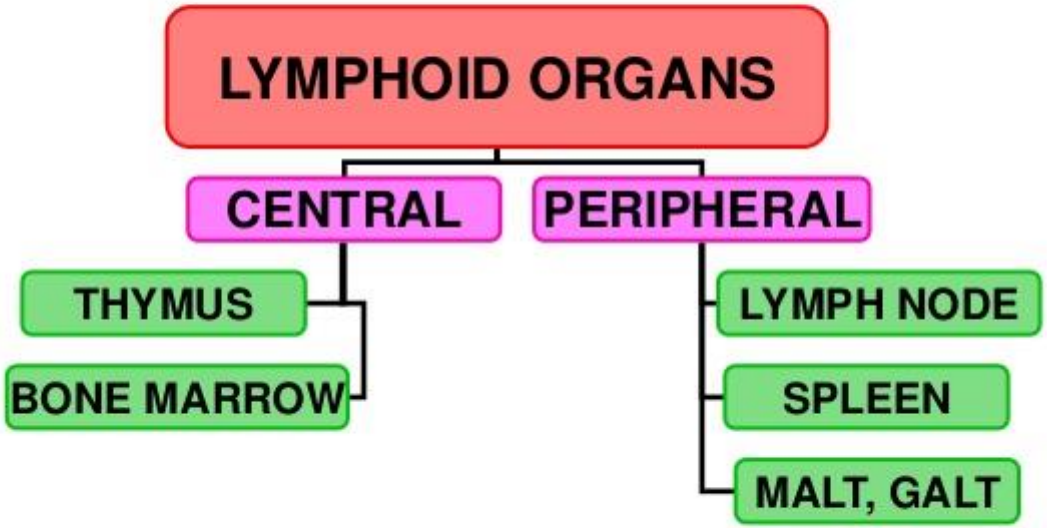
  -neutrophils

  -eosinophil

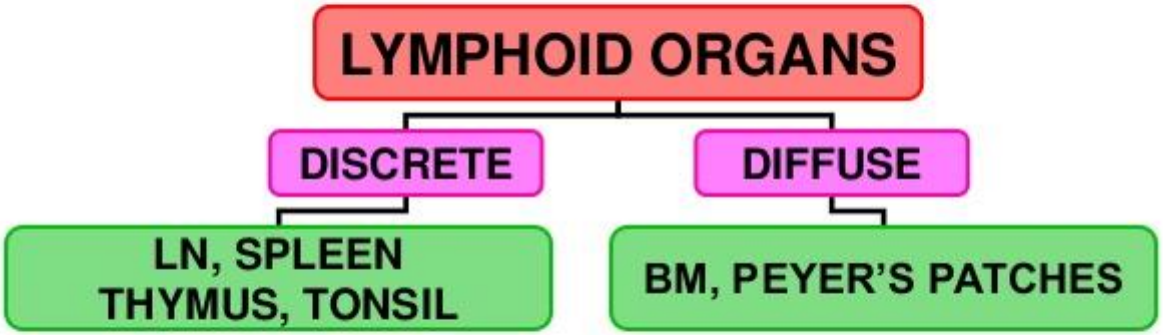
  -basophils

CLASSIFICATION

I. FUNCTIONAL



II. MORPHOLOGICAL

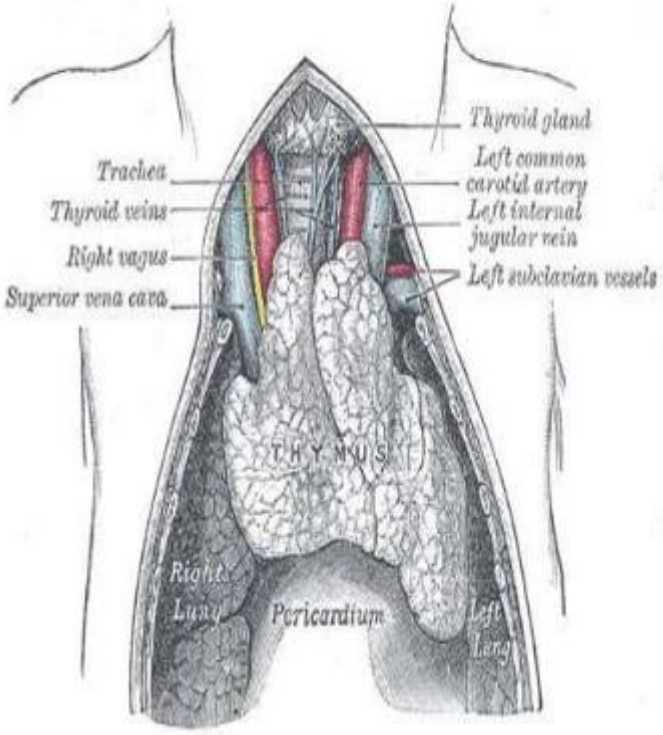


FUNCTIONS

- protects body against foreign material - The site of clonal production of immunocompetent lymphocytes and macrophages in the specific immune response.
- assists in circulation of body fluids between cells and bloodstream - Maintains pressure & volume of extracellular fluid by returning excess water to the circulation.
- transports dietary fats

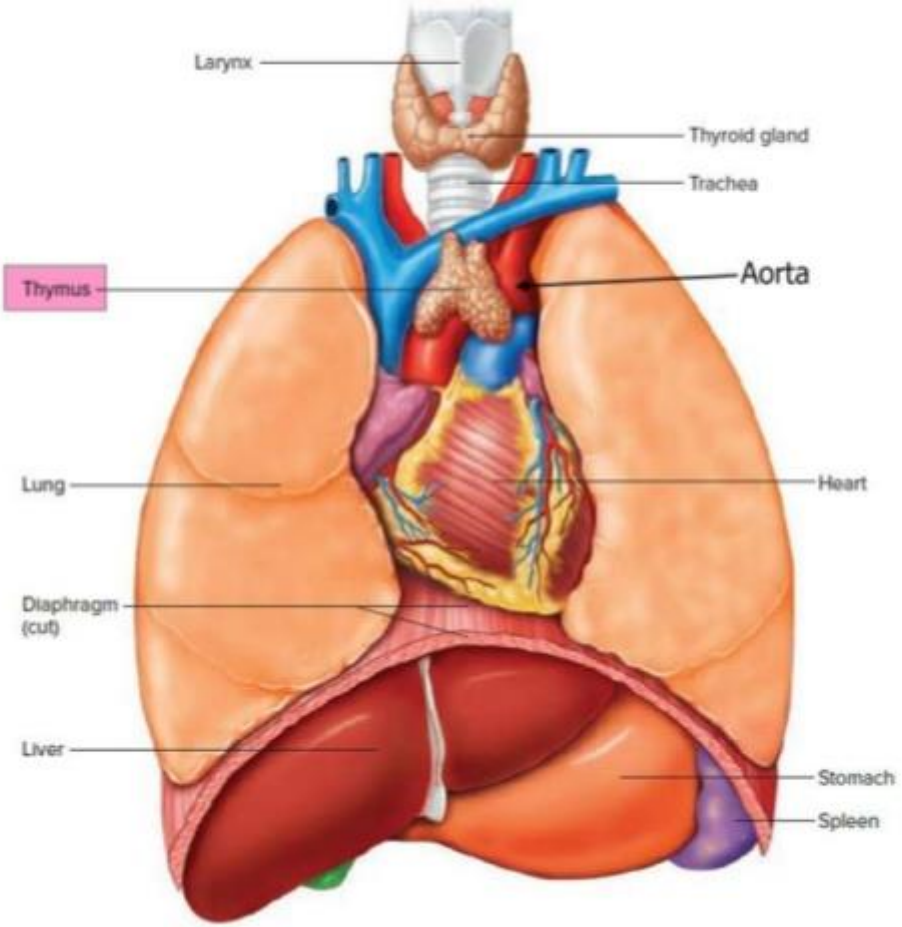
THYMUS

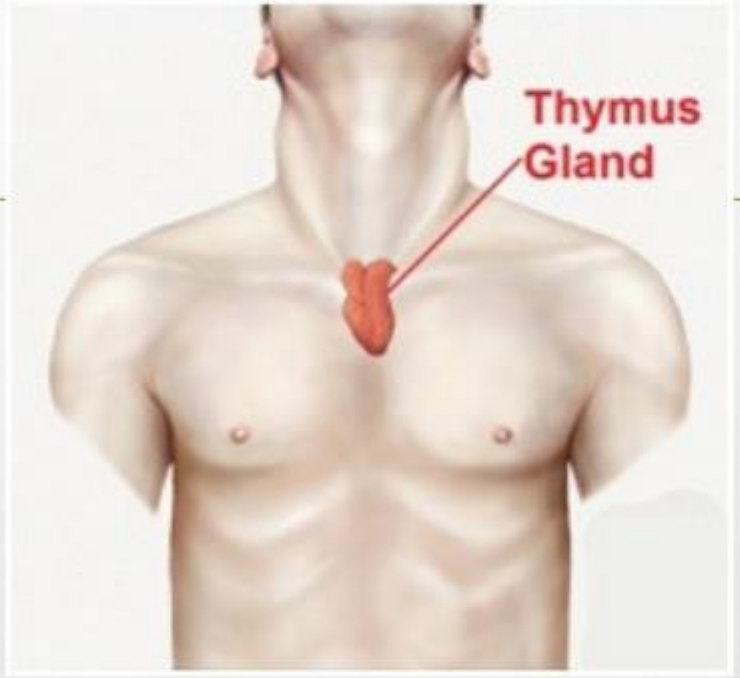
- Introduction
- Gross anatomy
- development
- Histology
  - -Circulation
  - -Relation with immunology
- Functions
- Age changes
- Recent advances



THYMUS GLAND

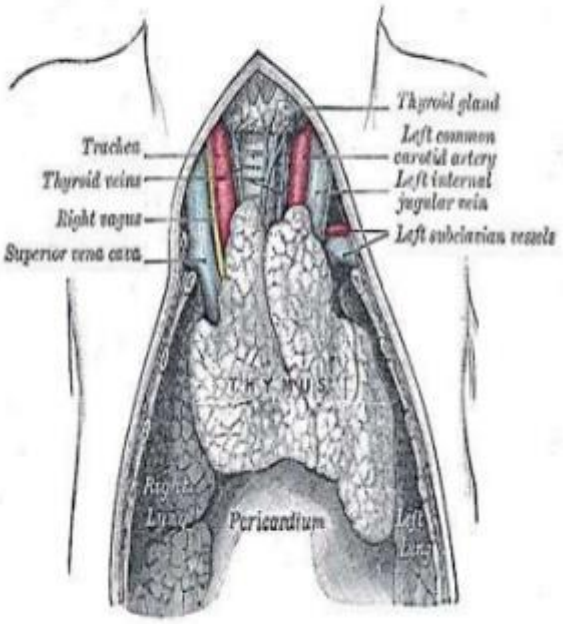
- two-lobed organ
- located in **upper part of chest along trachea**
- inferior to thyroid gland, posterior to sternum
- largest and most active during prenatal period and infancy
- after puberty it decreases in size


Larynx
Thyroid gland
Trachea
Aorta
Thymus
Lung
Heart
Diaphragm
(cut)
Liver
Stomach
Spleen


Thymus
Gland

THYMUS

- Bi-lobed organ
- Located in superior mediasternum ant to heart and great vessels.
- largest and most active during prenatal period and infancy
- after puberty it decreases in size
- Capsule- incomplete septa
- No Afferent lymphatics



THYMUS

- composed of lymphatic tissue
- subdivided into lobules
- immature T cells originating in the bone marrow migrate to thymus via blood
- in thymus, cells develop into mature T cells for release into circulation
- thymic hormones aid in maturation of T cells

RELATIONS

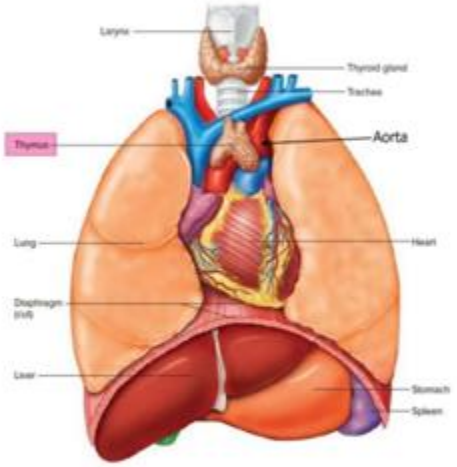
- Largest in the early part of life, particularly around puberty,
- Persists actively into old age
- As age advances **fibrofatty degeneration (**hiding the existence of persistent thymic tissue.
- Greater part of the thymus lies in the **superior** and **anterior mediastinum**;
- Inferior aspect of the thymus reaches the level of the **fourth costal cartilages**

ANTERIOR RELATION…

From superior to inferior…

- Sternohyoid and sternothyroid,
- Cervical fascia,
- Manubrium sterni,
- Internal thoracic vessels,
- Upper three costal cartilages,
- Pleurae lie laterally
- Phrenic nerves are anterolateral and inferior;

(Last 2 structures may be injured during thymectomy)


Larynx
Thyroid gland
Trachea
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Thymus
Lung
Heart
Diaphragm
(cut)
Liver
Stomach
Spleen

POSTERIOR RELATIONS…

- Lies is in contact with the vessels/Viscera of the superior mediastinum…

➢ Left brachiocephalic vein.

➢ Inferior thyroid veins .

➢ Superior part of the thoracic trachea.

➢ Anterior cardiac surface (right atrium and ventricle).

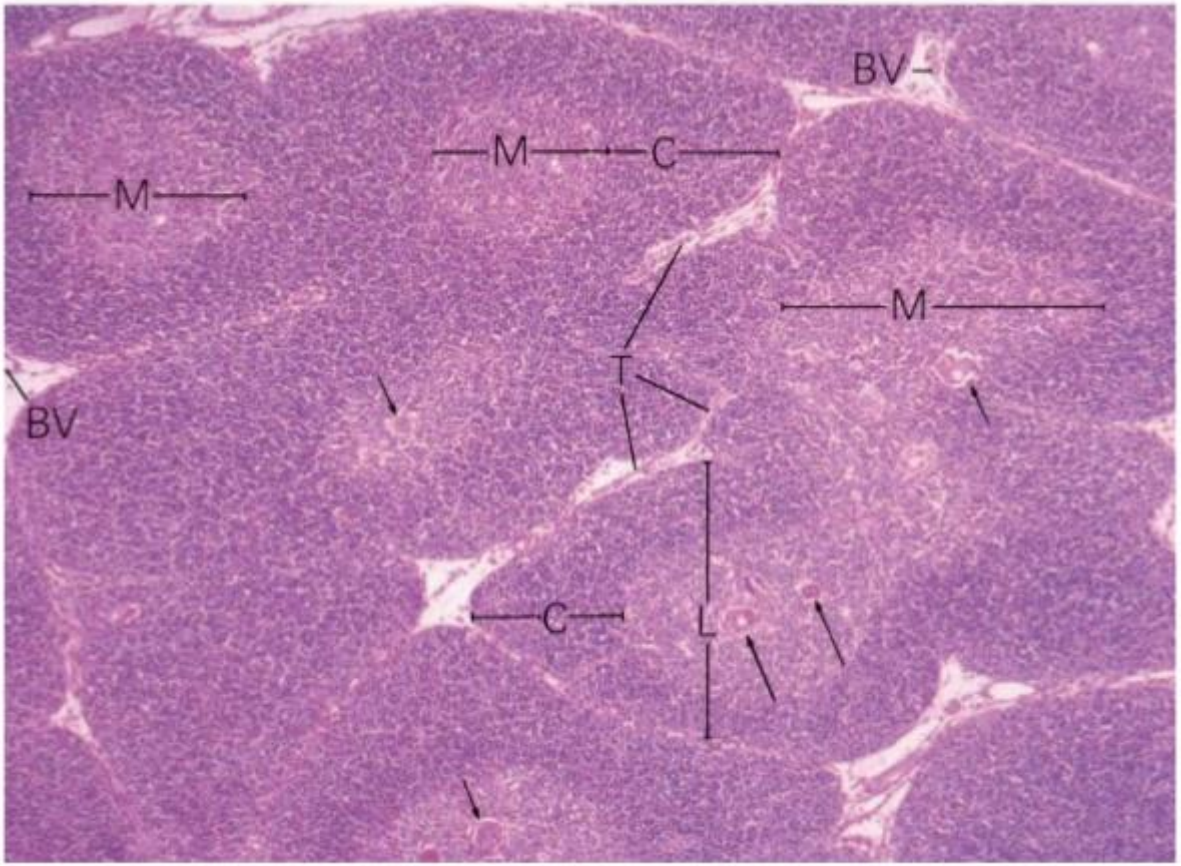
HISTOLOGY…

- Two lobes divided up into many incomplete lobules.
- **CORTEX** - outer, more darkly staining region is the cortex, and this is **highly cellular**.
- **MEDULLA** - inner lighter staining region,less cellular.
- An outer connective tissue capsule and septa divides organ into incomplete lobules.

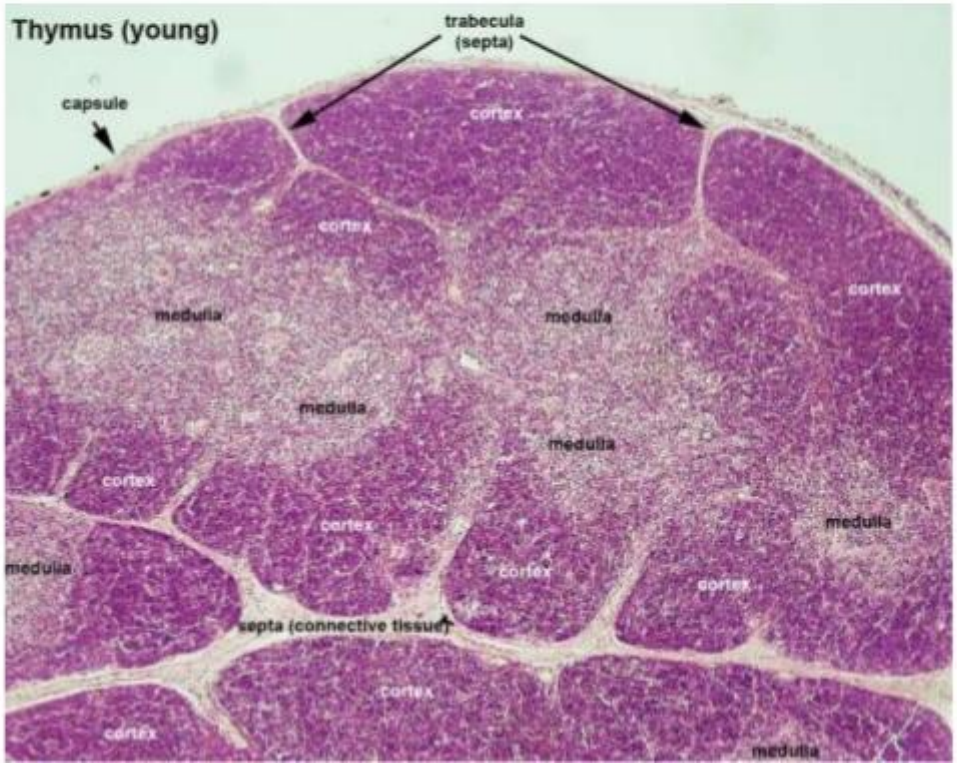
CAPSULE AND TRABECULAE

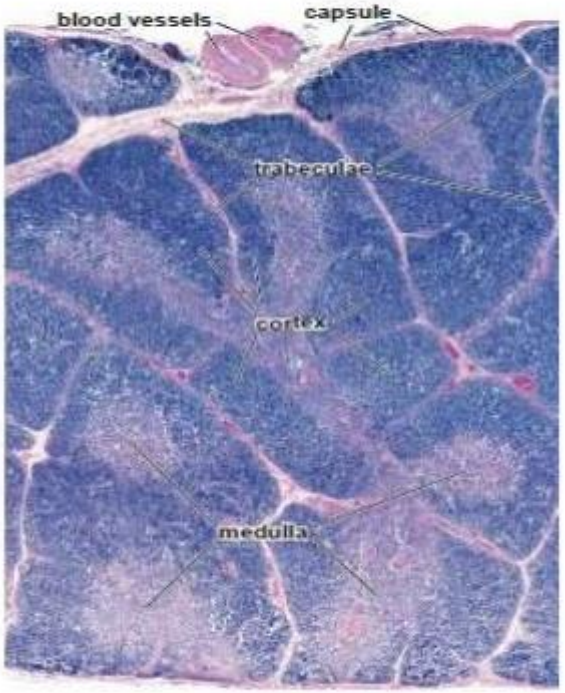
Contain …

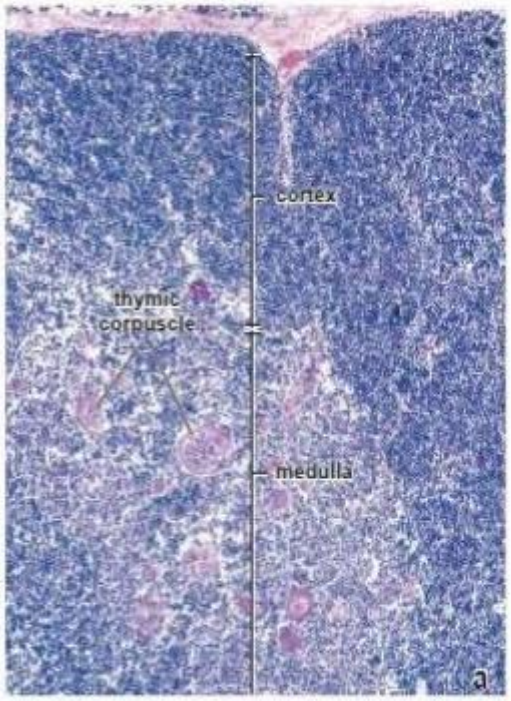
- Blood vessels…
- Efferent (but not afferent) lymphatic vessels
- Nerves.
- Collagen fibers and fibroblasts,
- Variable numbers of plasma cells, granulocytes, lymphocytes, mast cells, adipose cells,and macrophages.


BV
M
M
C
BV
M
C
L

LOW MAGNIFICATION

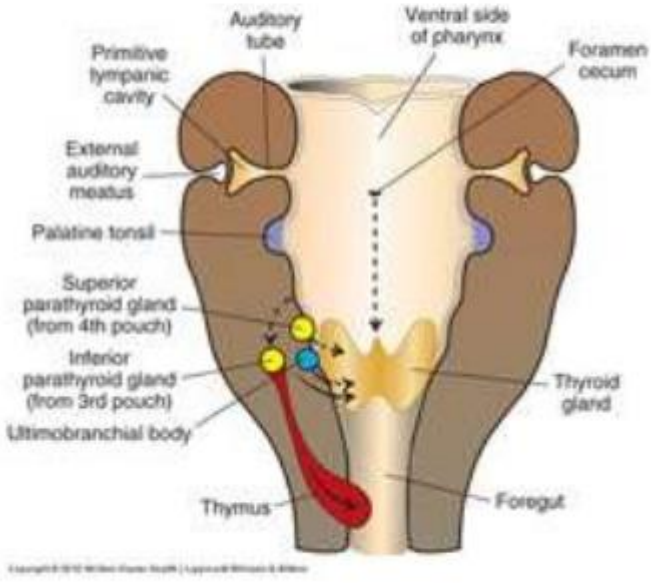



blood vessels
capsule
trabeculae
cortex
medulla


cortex
thymic
corpuscle
medulla
a

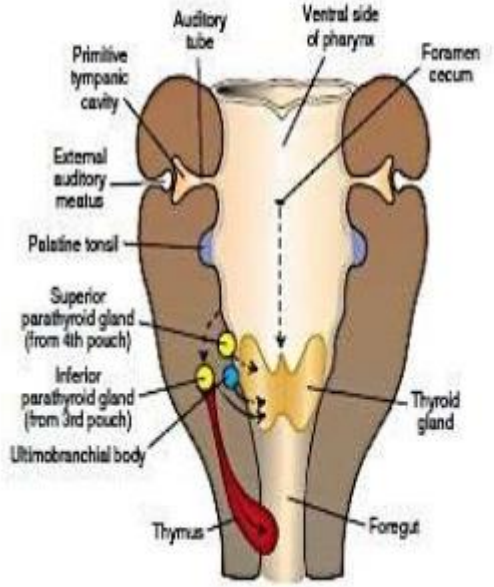
- In some children, the thymus as encircling the **left innominate vein* .**
- Bilateral embryonic origins from the third pharyngeal pouch.
- Superiorly, extensions into the neck are common.

EMBRYOLOGY



Development

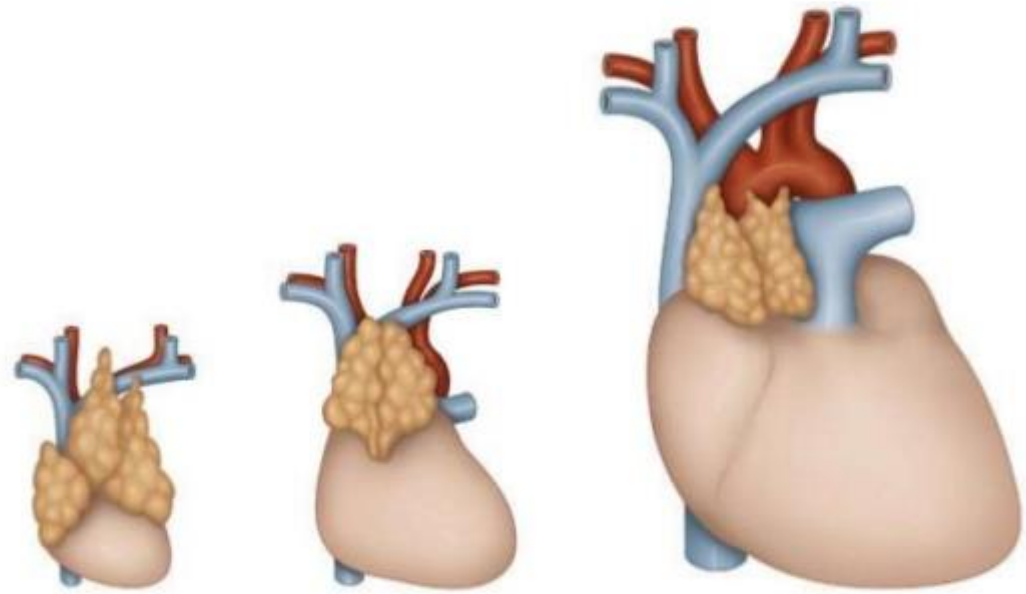
- 3rd Endodermal pouch



Changes of Thymic Structure with Age (involution)

- Largest at birth
- fully functional at 20 weeks of foetal life.
- progressive involution of adipose tissue.
  - Accelerated by adrenal corticosteroids and sex hormones
- In juveniles:
  - isolation of cortical compartments,
  - reduction of cortical and medullary volume, and
  - appearance of more, larger blood vessels,
- until the adult thymus is mainly dominated by fat.

AGE RELATED CHANGES…

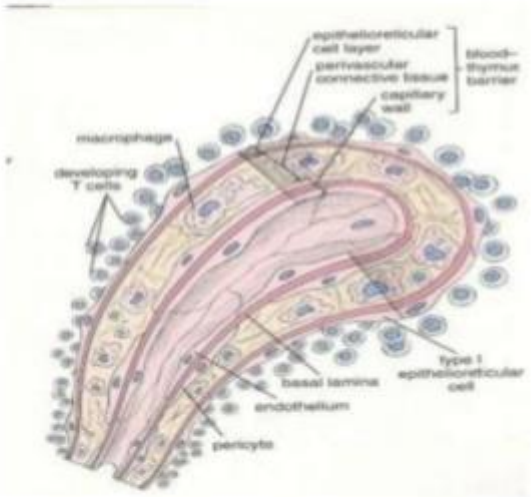


Thymus in a newborn. Thymus in a 2-year-old child. Thymus in an adult

BLOOD THYMUS BARRIER.

- Blood from the inferior thyroid, and internal thoracic arteries enters the thymus.
- **Epithelial cells form a sheath** around the capillaries, to form a barrier to the entry of antigenic material into the spaces between the epithelial cells in the reticular network..
- Efferent lymphatics transport lymph and lymphocytes away from this organ.

BLOOD THYMUS BARRIER

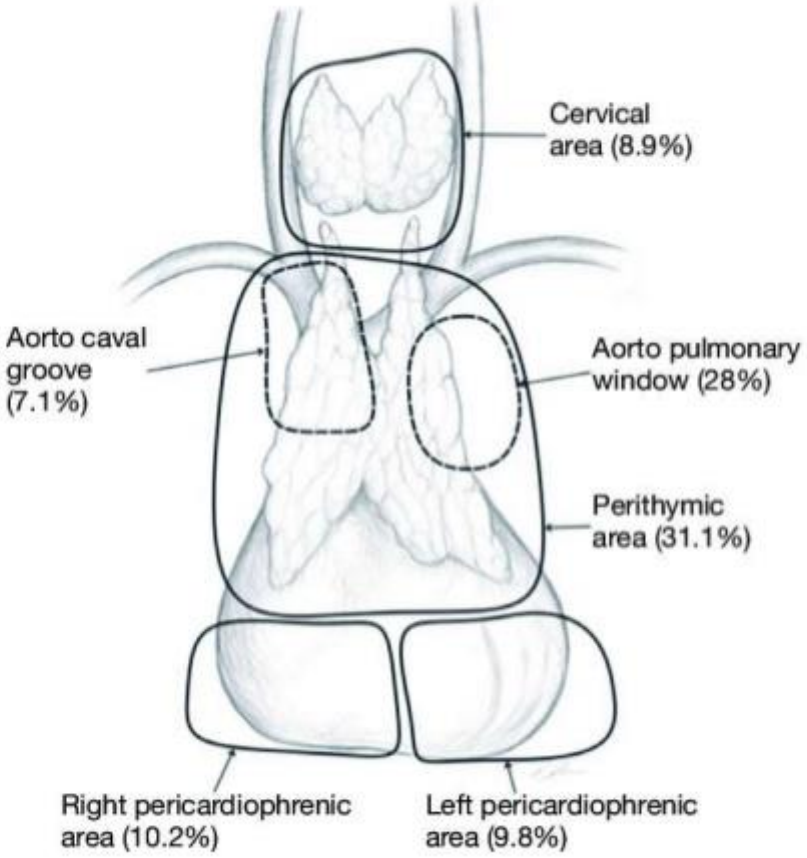


ECTOPIC THYMUS…

Often found…

- Scattered around the gland
- In unusual mediastinal locations.

- Accessory nodules may occur in the neck
- Representing separated portions, detached during embryological descent.
- Sometimes reaching more superiorly than the **thyroid cartilage**.
- **Ectopic intrathyroidal thymi** have been reported in children.


Cervical
area (8.9%)
Aorto caval
groove
(7.1%)
Aorto pulmonary
window (28%)
Perithymic
area (31.1%)
Right pericardiophrenic
area (10.2%)
Left pericardiophrenic
area (9.8%)

VASCULAR SUPPLY…

- **Thymic branches** originating from…
  - ***Internal thoracic,***
  - ***Inferior and***
  - ***Superior thyroid arteries***.
- As no definite hilum exists
- Arterial branches either travel along the interlobar septa before entering the thymus at the junction of the cortex and medulla
- Reach the thymic tissue directly through the capsule.

VENOUS DRAINAGE…

Thymic veins drain to …

- ***Left brachiocephalic v.,***
- ***Internal thoracic v.and***
- ***Inferior thyroid veins***, and occasionally directly into the ***superior vena cava***.

- One or more veins often emerge medially from each lobe of the thymus to form a common trunk opening into the ***left brachiocephalic v****.

LYMPHATIC DRAINAGE…

- *No afferent lymphatics.*
- **Efferent lymphatics** arise from the medulla and corticomedullary junction,
- Drainage through the extravascular spaces, accompany the supplying arteries and veins, d
- Drained in…

➢ *Brachiocephalic,*

➢ *Tracheobronchial*

➢ *Parasternal nodes.*

INNERVATION…

Sympathetic -

- Cervicothoracic (stellate) ganglia or ansa subclavia
- Branches from the **phrenic** and descending cervical nerves (inferior roots of the ansa cervicalis) are distributed mainly to the capsule.

Parasympathetic - Vagi.

- Two lobes are innervated separately through their dorsal, lateral and medial aspects.

INNERVATION…

- During development and before its descent into the thorax , by the **vagi** in the neck.
- After its descent, receives a sympathetic innervation via fibres travel along the vessels;
- **Postganglionic sympathetic terminations -** branch radially and form a plexus with the vagal fibres at the cortico-medullary junction.

FUNCTION…

Organ is important for…

- Development of immunocompetent T-cells,
- Proliferation of clones of of mature T-cells,
- Developing immunological self-tolerance,
- Secretion of hormones for T-cell development. (thymosin, thymulin and thymopoietin)
- Hormones are produced by reticular epithelial cells in the cortex.

Applied

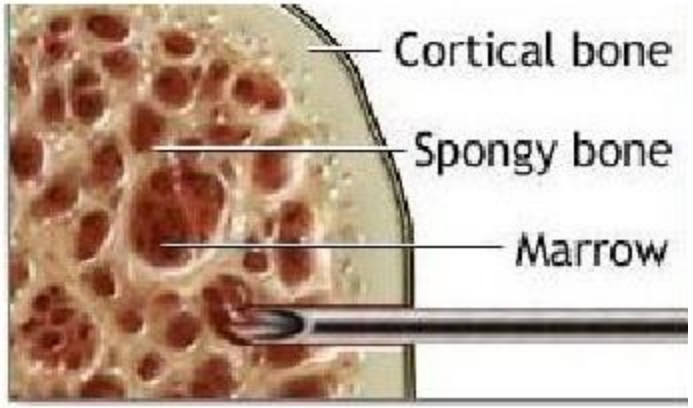
- Myasthenia gravis
- DiGeorge syndrome-absent-thymus & parathyroid ,defect in cardiac outflow tract

BONE MARROW

What is bone marrow

- Bone marrow is a highly cellular, viscus , and highly vascular tissue present within the hollow cavities of hard bone and is specially designed to support the proliferation, differentiation, and maturation of hematopoietic cells

Anatomy..



- Two types of bone marrow:
  - **Medulla ossium rubra** (*Red Marrow* - consisting mainly of hematopoietic tissue)
  - **Medulla ossium flava** (*Yellow Marrow* - consisting mainly of fat cells)

- On average, bone marrow constitutes 4% of the total body mass of humans
- In adults weighing 65 kg (143 lbs), bone marrow accounts for approximately 2.6 kg (5.7 lbs)
- The hematopoeitic compartment of bone marrow produces approximately 500 billion blood cells per day

Pattern of distribution..

- **At birth**, all bone marrow is red.
- With age, more and more of it is converted to the yellow type; only around half of adult bone marrow is red
- **In Adults** Red marrow is found mainly in the Flat bones and in the epiphyseal ends of long bones such as the femur and humerus
- Yellow marrow is found in the medullary cavity, the hollow interior of the middle portion of long bones

Structure of bone marrow

- Vascular compartment
- Hematopoietic compartment

a) Hematopoietic cells
b) Stromal cells

Stroma

- isn't directly involved in the primary function of hematopoiesis.
- The yellow bone marrow belongs here, and makes the majority of the bone marrow stroma, in addition to stromal cells located in the red bone marrow.
- Still, the stroma is indirectly involved in hematopoiesis, since it provides the *hematopoietic microenvironment* i.e structure suport.
- For instance, they generate colony stimulating factors, affecting hematopoiesis.

Stroma of Bone Marrow

- Cells that constitute the bone marrow stroma are:
  - fibroblasts (reticular connective tissue)
  - macrophages
  - adipocytes
  - osteoblasts
  - osteoclasts
  - endothelial cells, which form the sinusoids.

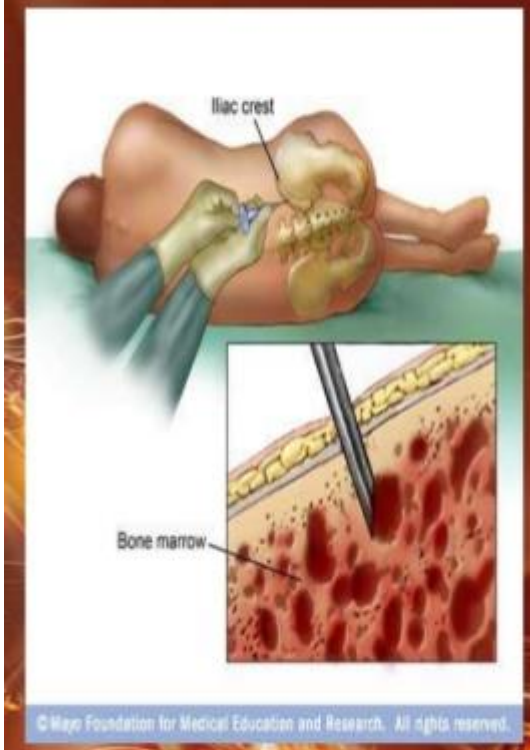
Diseases of the bone marrow

- Aplastic anemia
- Malignancies- multiple myeloma
- Infections- tuberculosis
- various forms of leukemia

BONE MARROW BIOPSY

A bone marrow biopsy is the removal of soft tissue called marrow from inside bone. Bone marrow is found in the hollow part of most bones. It helps form blood cells.

The biopsy is done using a small needle inserted into an age appropriate area (long bone for children, flat bone for adults).



- Procedure of bone marrow biopsy:

a) doctor will give you a sedative medication to make you drowsy and relaxed

b) doctor will clean and numb the biopsy site with an anesthetic.

c) A biopsy needle will be insert into the bone to withdraw a sample of bone marrow.

d) The bone marrow sample will be sent to the laboratory for evaluation.

e) Lastly,doctor will remove the needle and clean and bandage the area.

Bone marrow aspiration

Bone marrow aspiration is the removal of a small amount of this tissue in liquid form for examination.

- carried out principally to permit cytological assessment but also for immunophenotypic, cytogenetic, molecular genetic, and other specialised investigations.

Procedure of bone marrow aspiration

Skin is numbed and needle is inserted into the bone.

Syringe is used to withdraw the liquid bone marrow.

Needle is removed.

Bone marrow aspiration and biopsy diagnose?

A bone marrow aspiration and/or biopsy may be ordered as a diagnostic procedure when

- Aplastic Anemia
- Acute Leukemia
- Myelodysplastic Syndrome
- Chronic Myelogenous Leukemia
- Myelofibrosis and Essential Thrombocythemia
- Multiple Myeloma(our case)
- Severe thrombocytopenia, anemia and neutropenia

Complication in bone marrow biopsy and aspiration

- some patients may have excessive bleeding at the collection site or develop an infection
- persistent or spreading redness or bleeding at the site
- Fever
- Increasing pain.
- Long-lasting discomfort at the biopsy site
- Penetration of the breastbone (sternum) during sternal aspirations, which can cause heart or lung problems
- Complications related to sedation, such as an allergic reaction, nausea or irregular heartbeats


END