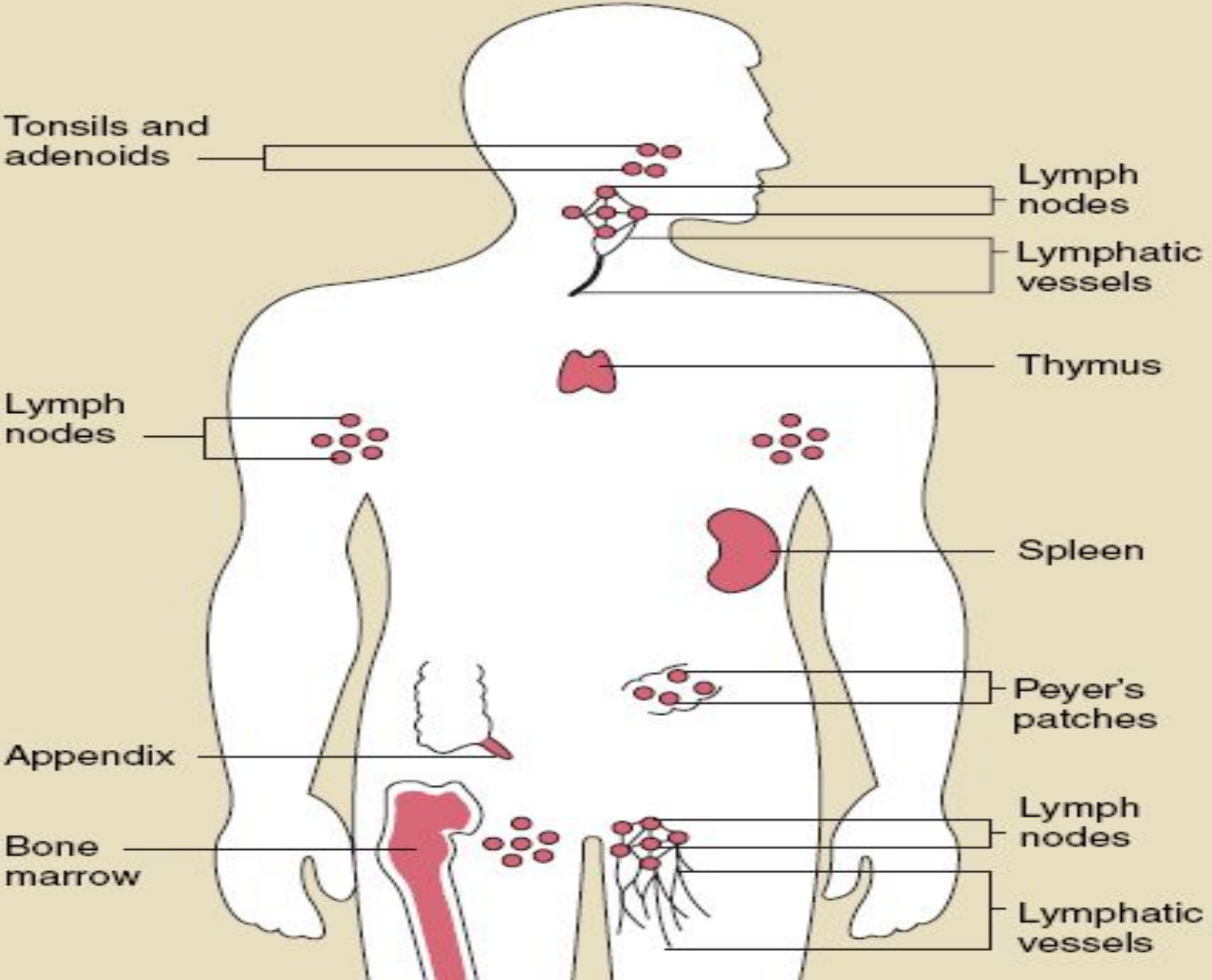
IMMUNE SYSTEM


Tonsils and adenoids
Lymph nodes
Lymphatic vessels
Thymus
Lymph nodes
Spleen
Peyer's patches
Appendix
Lymph nodes
Bone marrow
Lymphatic vessels

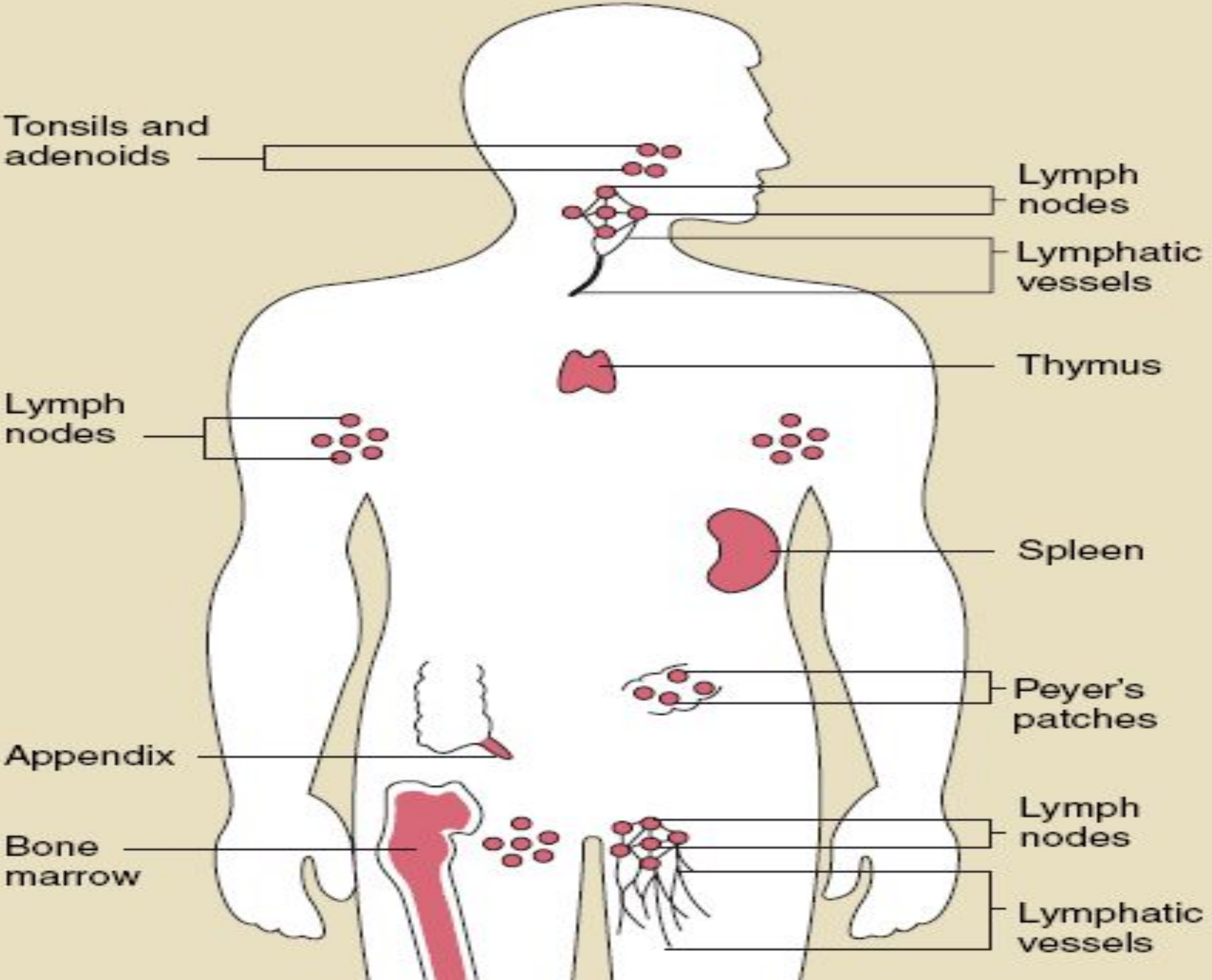
The major organs of the immune system are:

Central:

- Bone marrow
- Thymus

Peripheral:

- Spleen
- Lymph nodes
- Tonsils


Tonsils and adenoids
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Appendix
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Bone marrow
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In central organs

antigen-independent production of uncommitted T lymphocyte (thymus) or B lymphocyte (bone marrow) precursors that later move to peripheral organs and tissues.

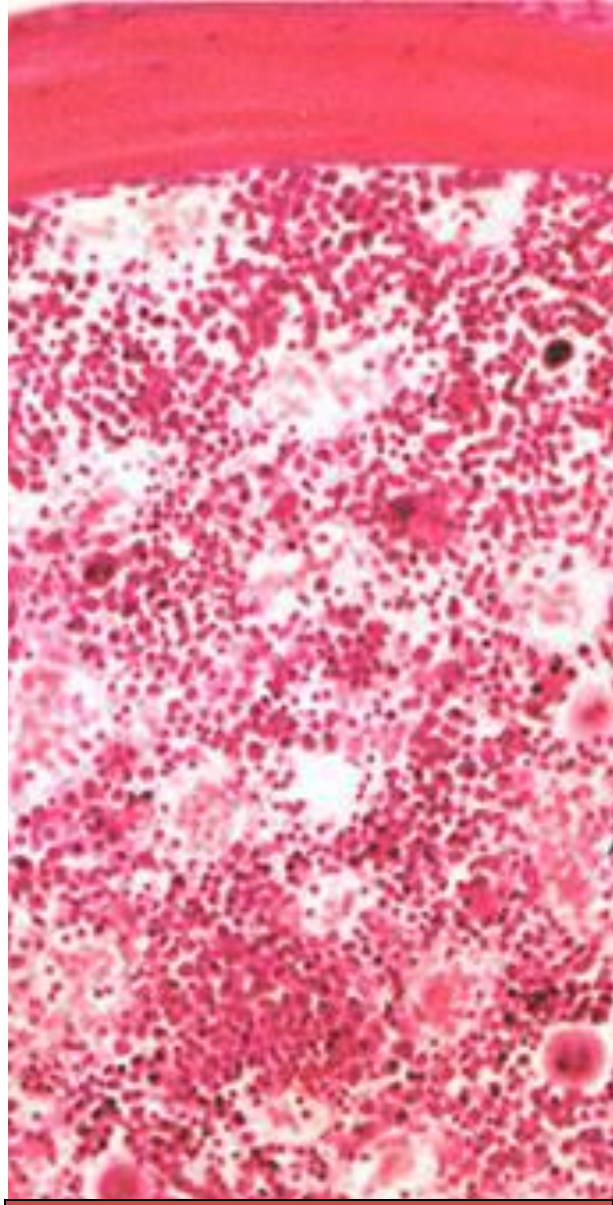
In peripheral organs

lymphocyte production is antigen-dependent and provides committed immunocompetent cells that respond to specific antigens.

Bone Marrow

is a soft tissue occupying the medullary cavity of a long bone

There are 2 main types: red and yellow.



Notice the red marrow and the compact bone

Red bone marrow is blood cell forming tissue and
it is composed of stroma (reticular tissue) and hematopoietic cords.

Red bone marrow is blood cell forming tissue or hematopoietic tissue and
it is composed of stroma and hematopoietic cords.

Stroma consists of

1. reticular connective tissue composed of reticular cells and the reticular fibers.
2. adipocytes (up to 75% of red marrow),
3. macrophages, and
4. adventitial cells

Hematopoietic cords consists of blood cells of all types and at all stages of differentiation

Erythroblastic islands are clusters of developing erythrocytes surrounding macrophages and receiving iron from them.

Sinusoids (capillaries) have openings in their walls through which maturing blood cells and platelets enter the circulation.

Bone marrow functions

1. Hematopoiesis.
2. Bone marrow helps destroy old red blood cells.
3. Recirculation of the blood and immunocompetent cells.
4. Depot of the blood
5. Immune protection (defence)

Yellow Bone Marrow

- Adipocytes, macrophages, undifferentiated mesenchyme, reticular cells
- Serves as storage area for nutrients (fat) and reserve hematopoietic tissue

Thymus

Functions:

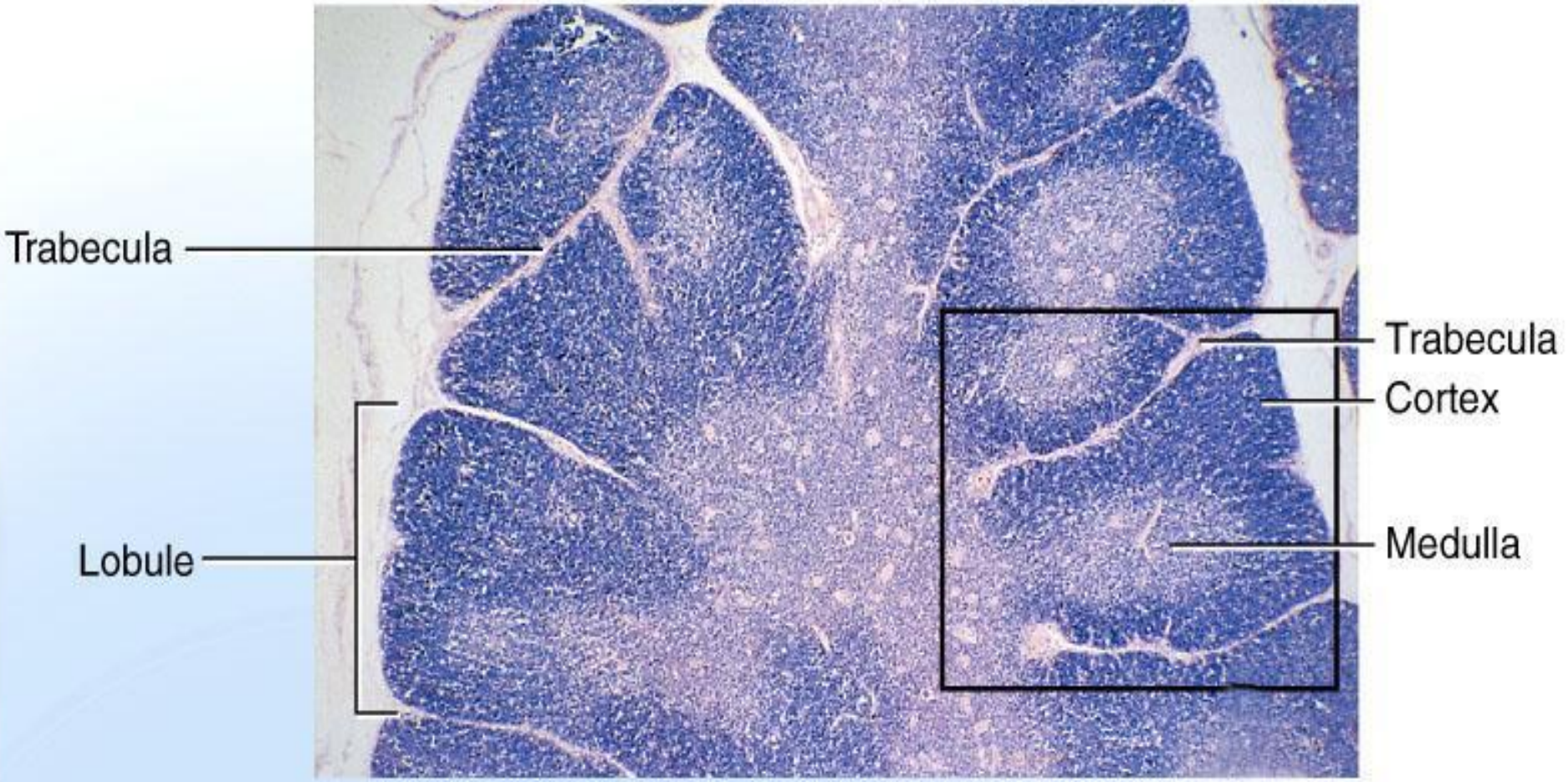
1. Production of T- lymphocyte.
2. Production of hormone - **thymosin**

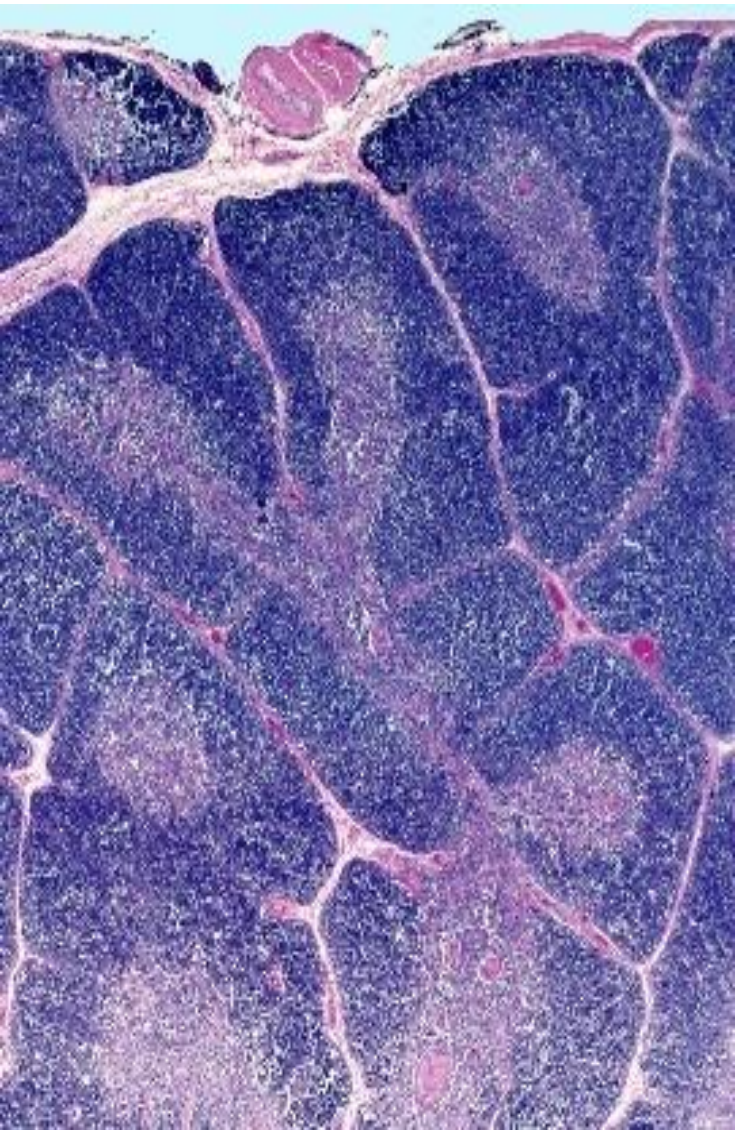
Consists of **epithelial** reticular cells (Stroma) and lymphocytes

A thin capsule send septa (trabecula) dividing Thymus into incomplete lobules.

Lobules consists of cortex + medulla

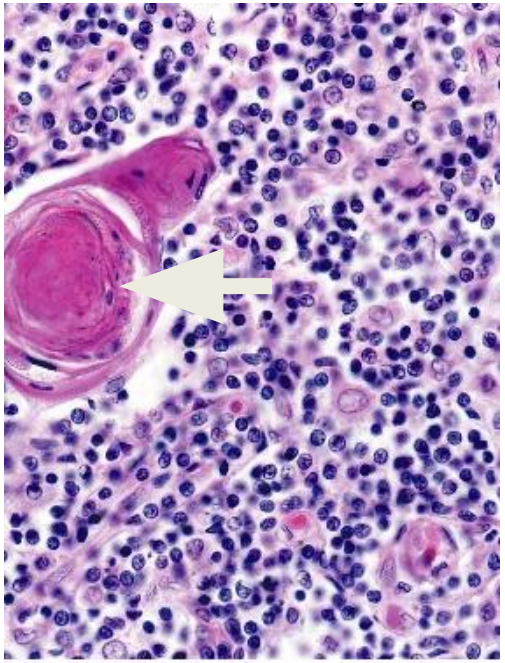
Thymus

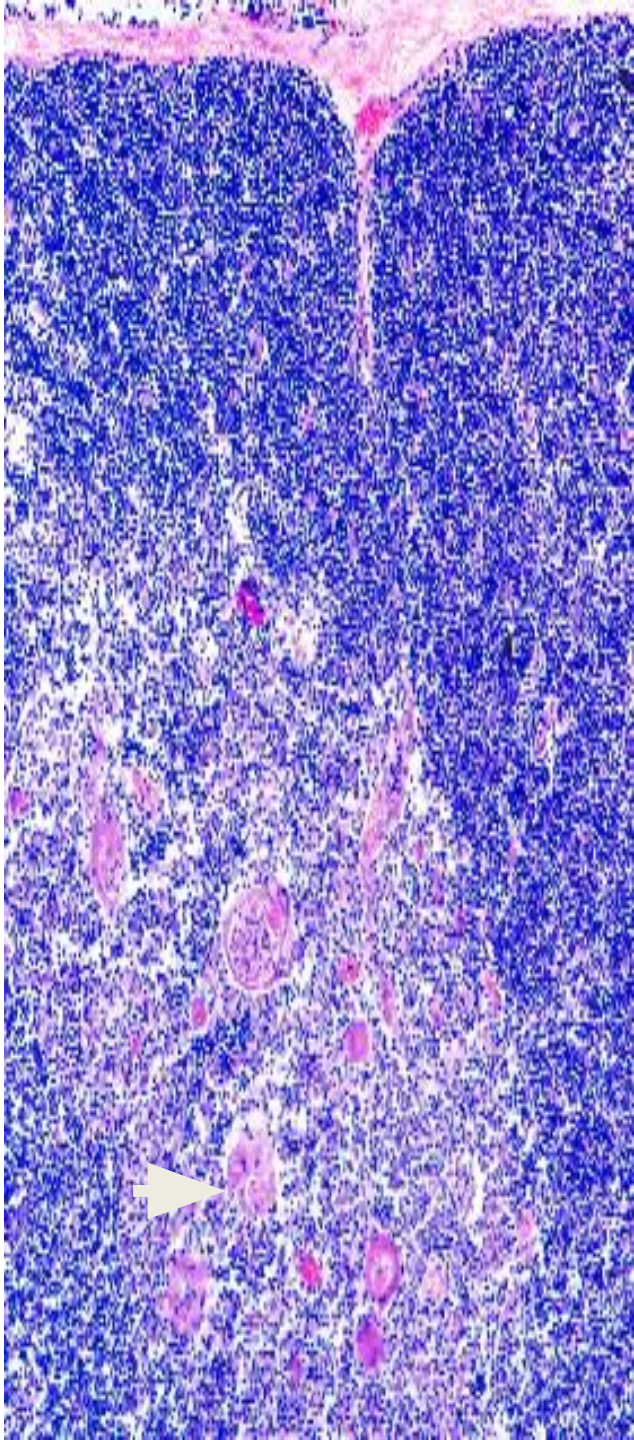




Thymus

- Capsule
- Lobules
- Cortex
- Medulla





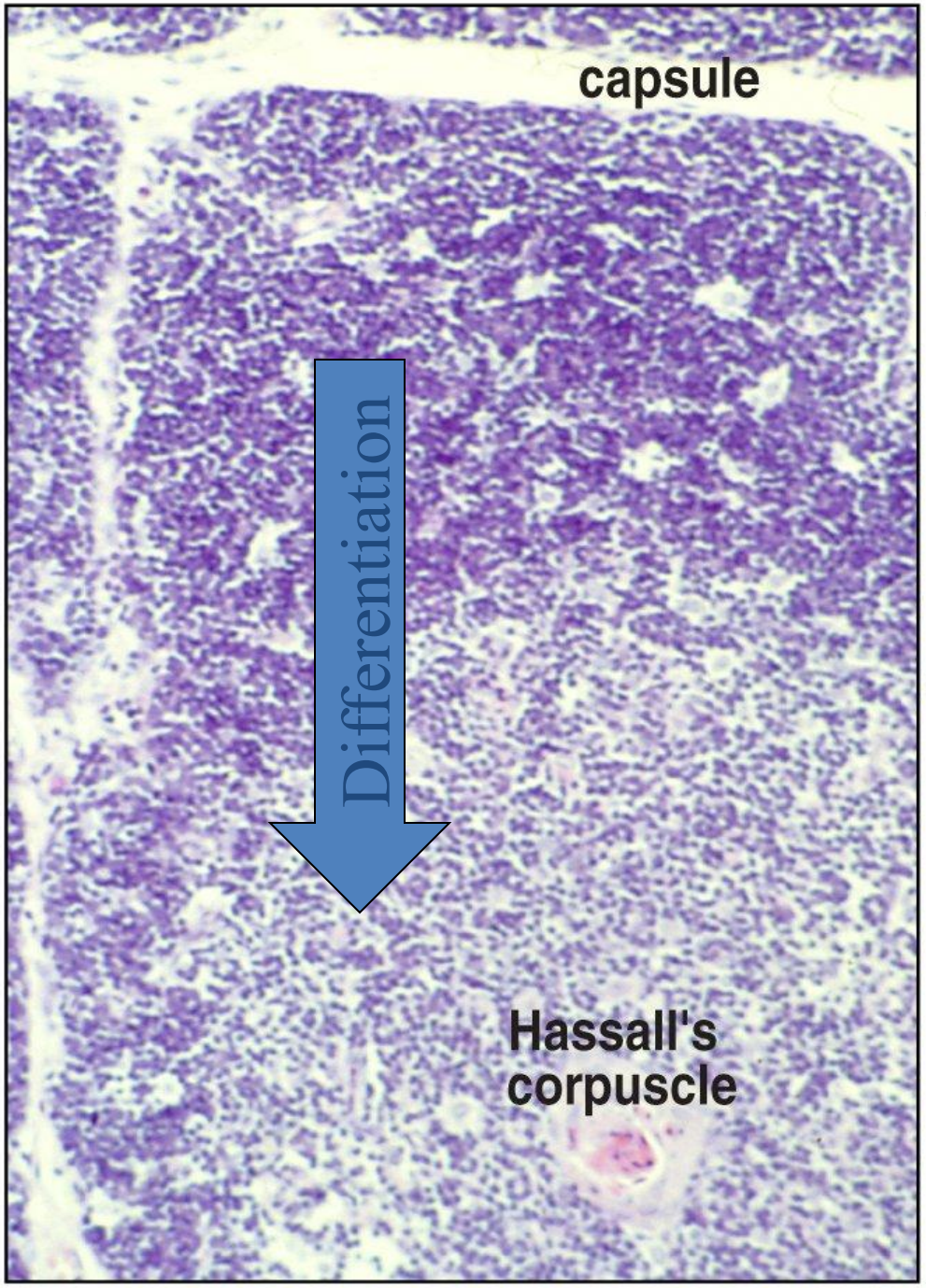
- Hassal's Corpuscles

Cortex--- dark-staining periphery of each lobule. Small lymphocytes predominate

Medulla is the light core of each lobules.

It has more epithelial reticular cells and fewer lymphocytes than in the cortex.

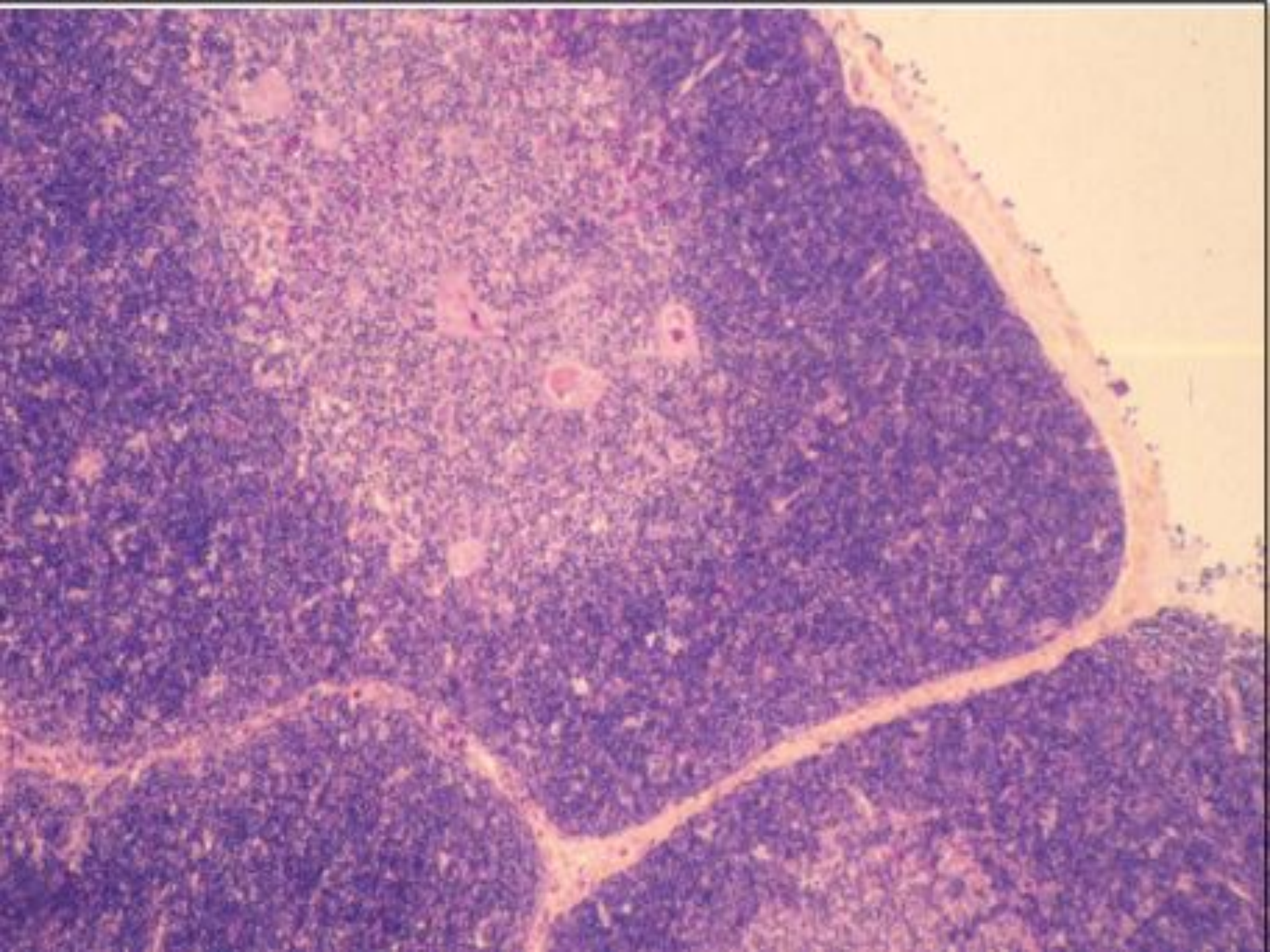
The spheric **Hassall's corpuscles** are composed of concentric layers of flattened epithelial reticular cells.

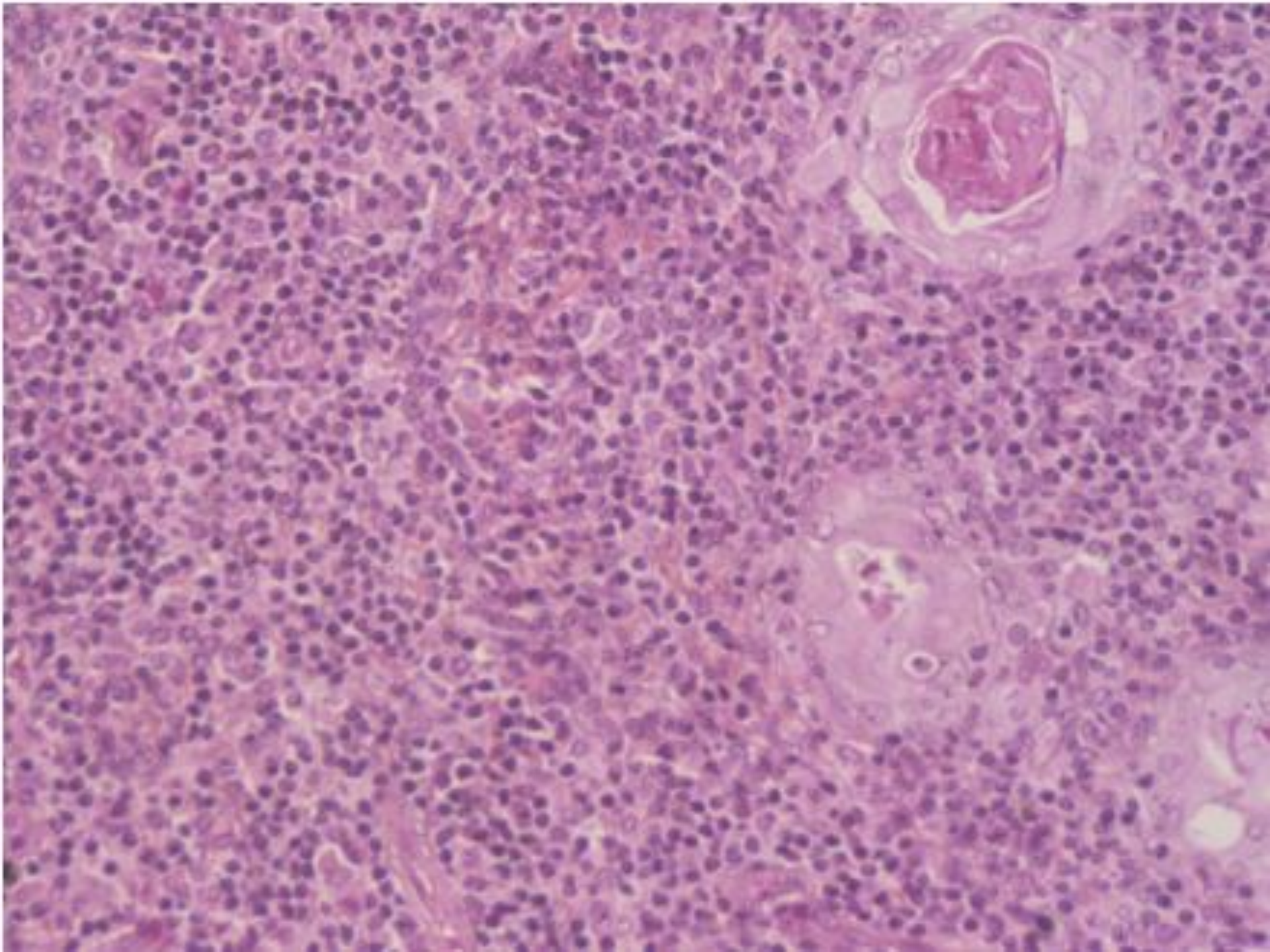


Immature thymocytes are here

More mature thymocytes are here

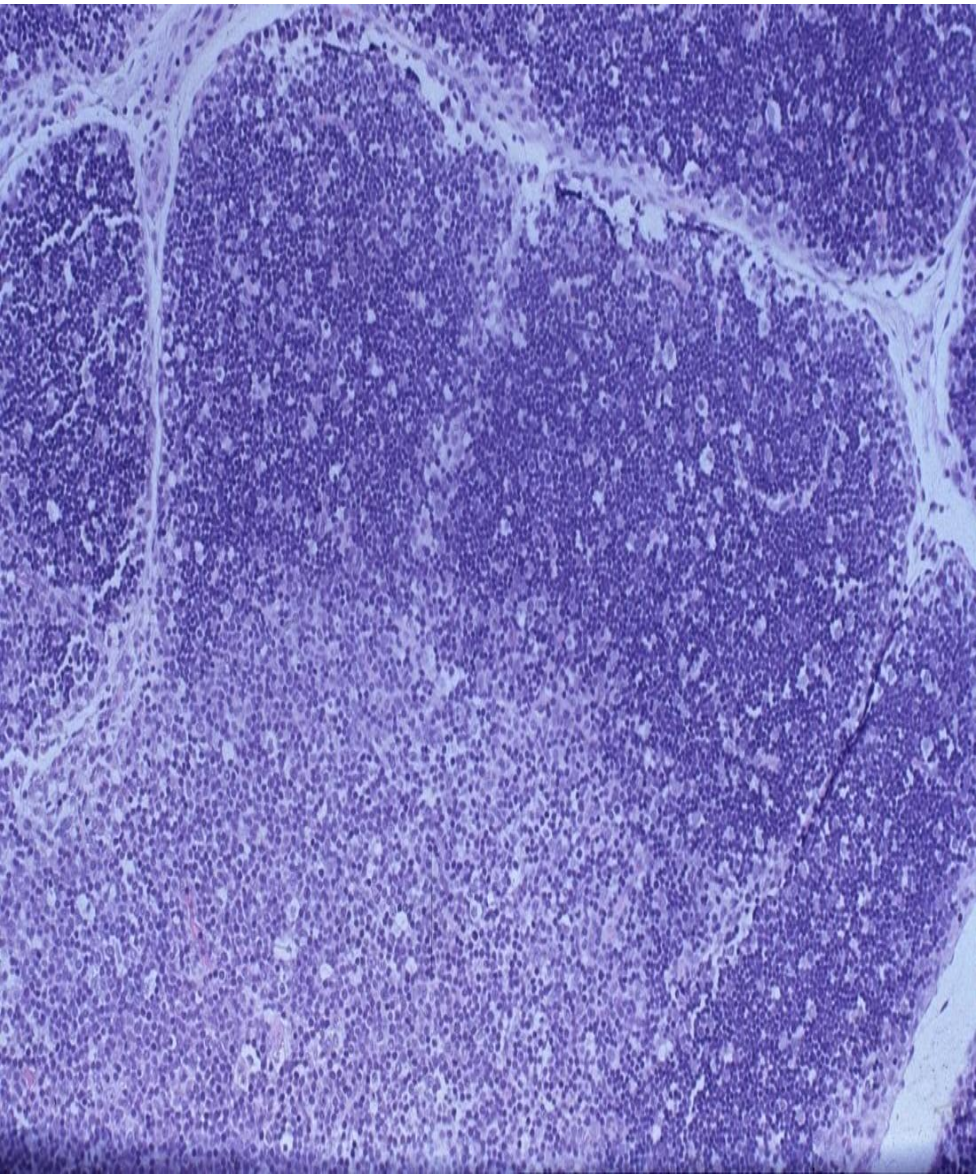
Figure 5-3 part 1 of 2 The Immune System, 2/e (© Garland Science 2005)



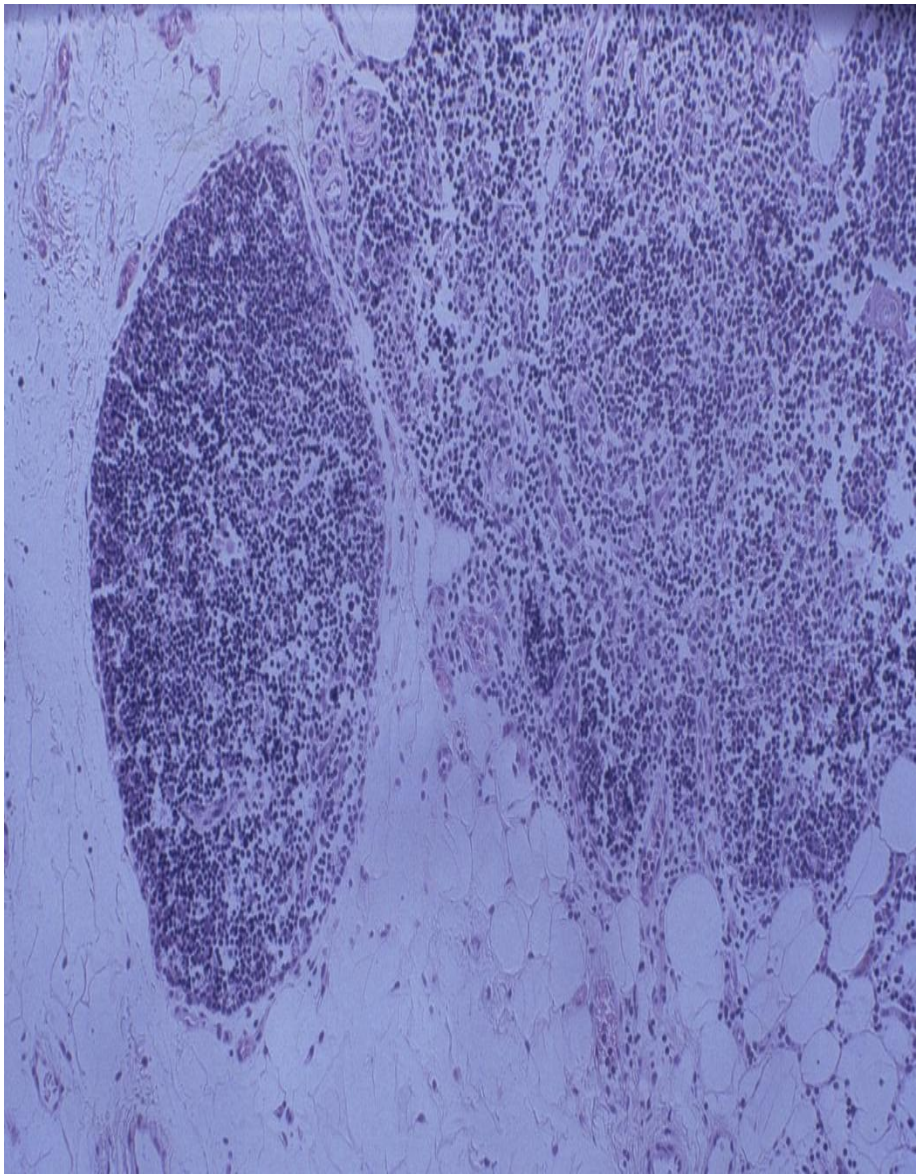


The Human Thymus Involutes With Age:

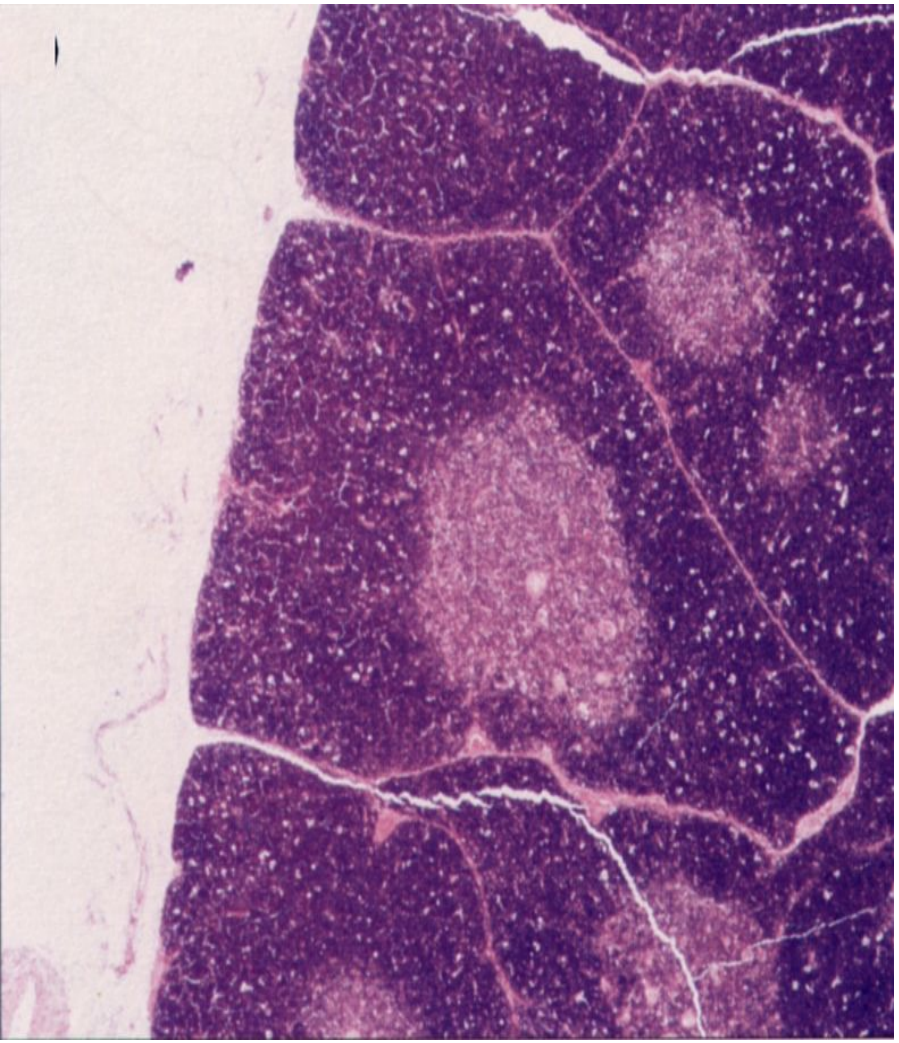
Fetal Thymus

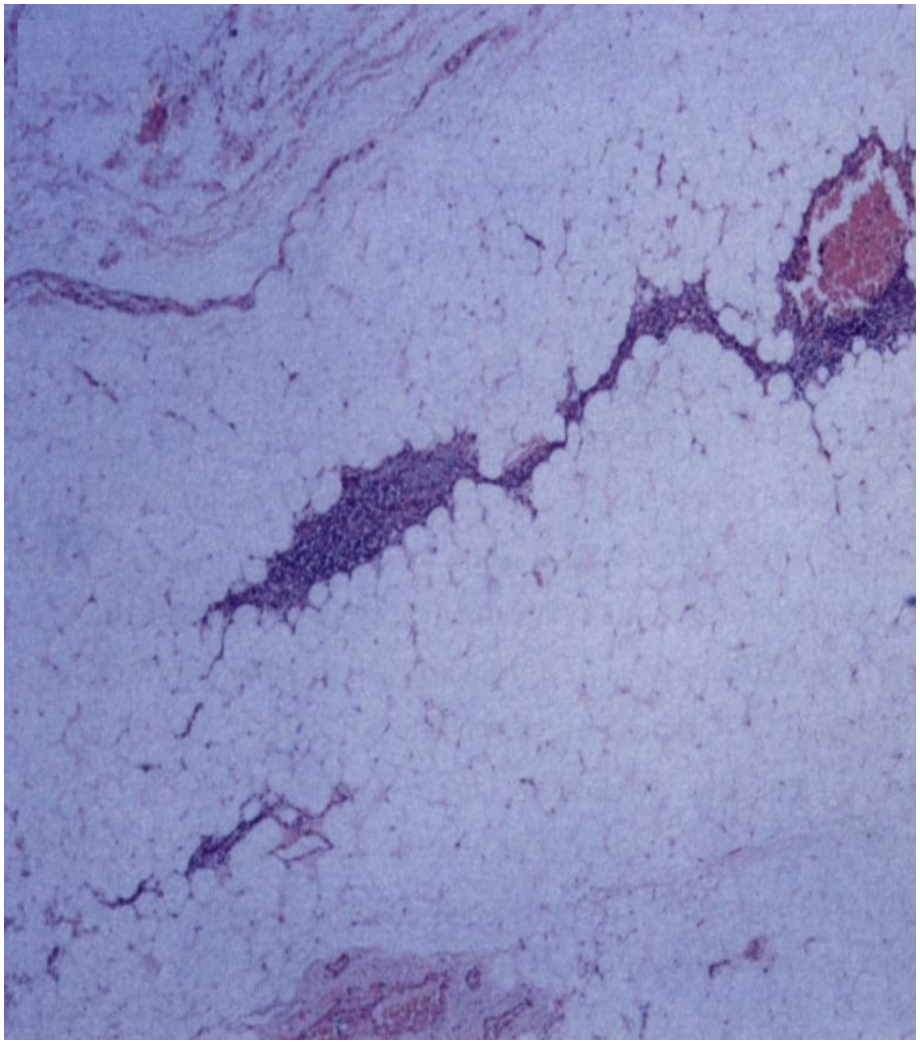


Adult Thymus



INVOLUTION OF THE THYMUS

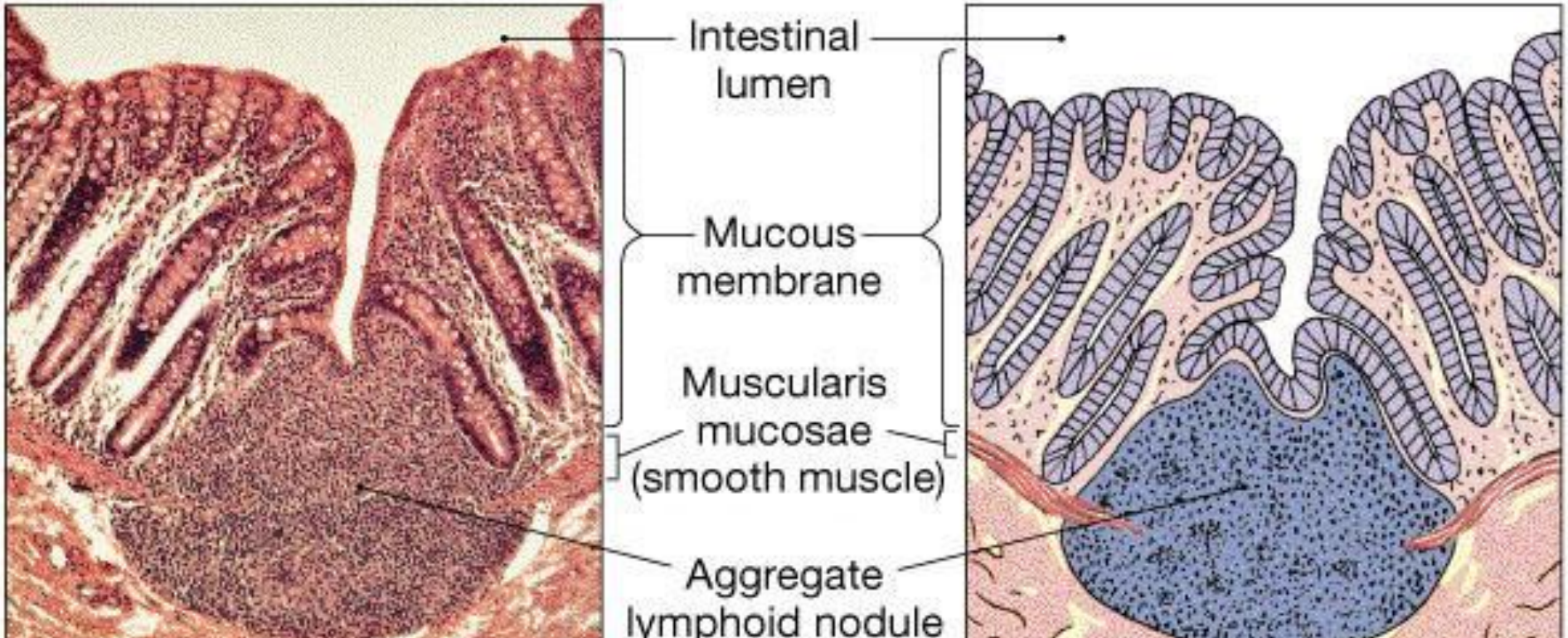




Two types:1. Age dependent 2. Accidental involution due to some exogenous agent, such as chemical or radiation insult or severe chronic infections

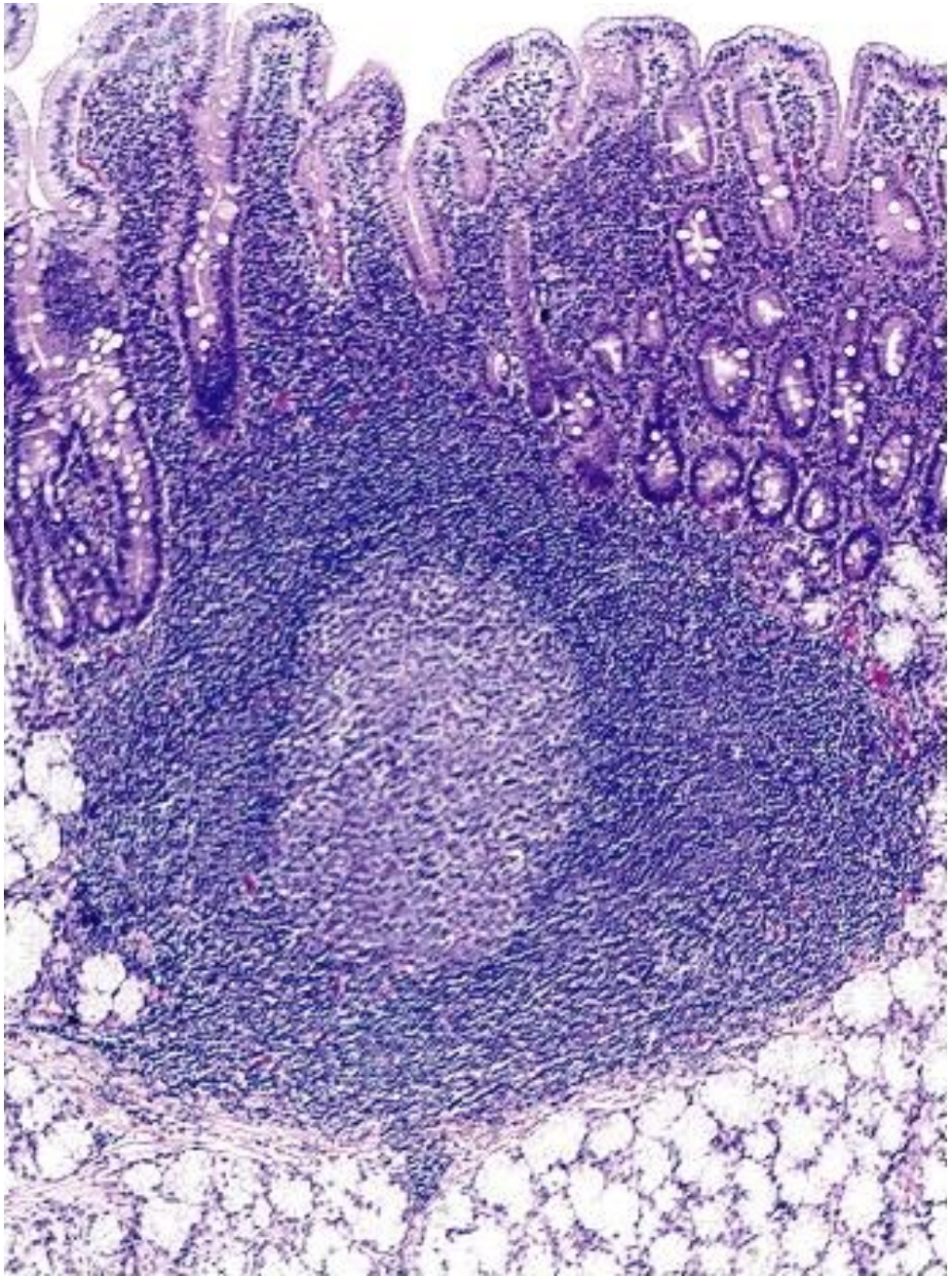
Peripheral part of I. S.

1. Lymphoid (= Lymph, Lymphatic) Nodules (Follicles)



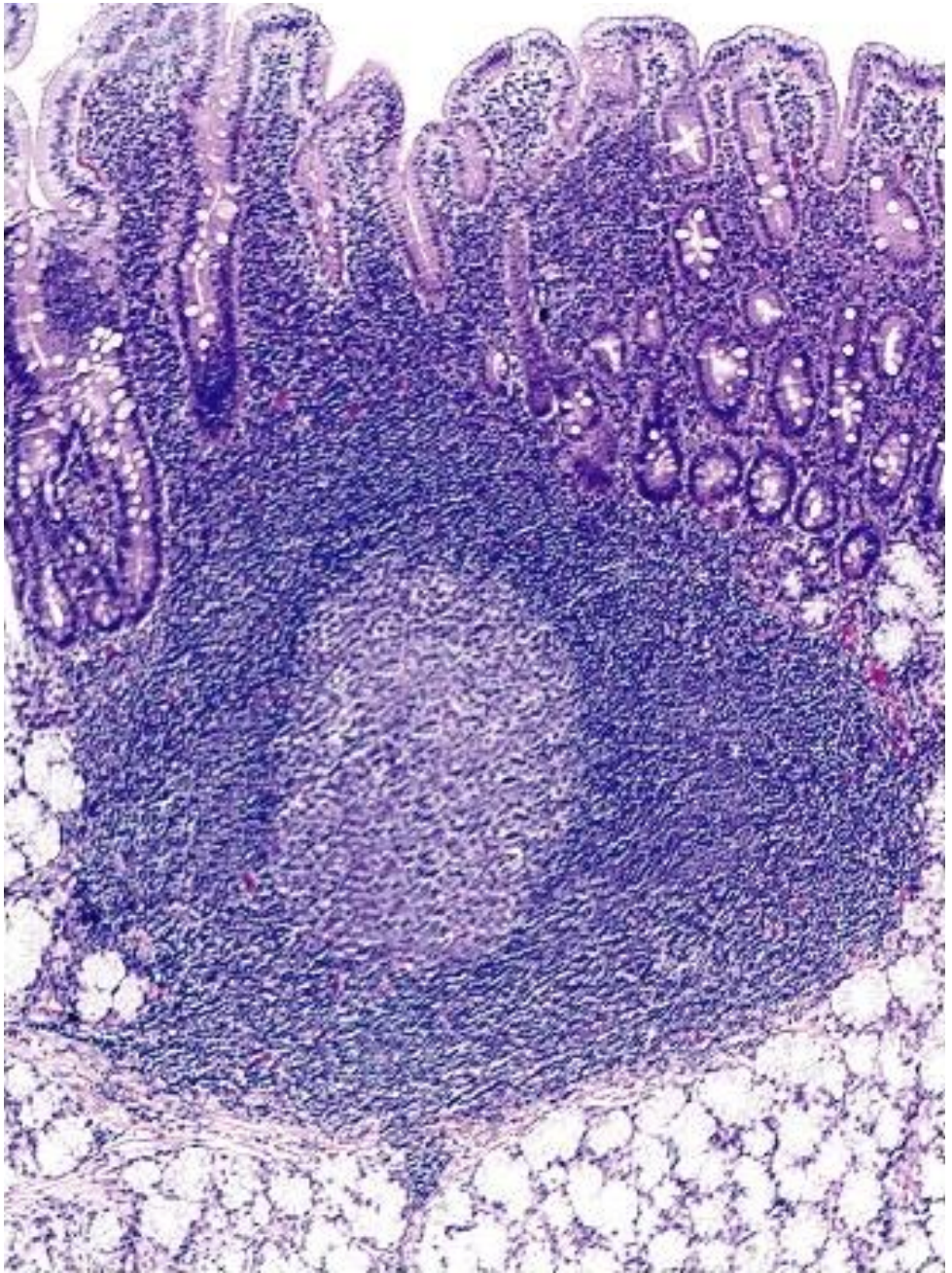
Lymphatic Nodule

- have a dark-staining periphery, or mantle zone, that contains tightly packed small lymphocytes,



Lymphatic Nodule

and a light-staining core, or germinal center, that contains numerous lymphoblasts -lymphocytes stimulated by antigens to enlarge and proliferate.



TONSILS

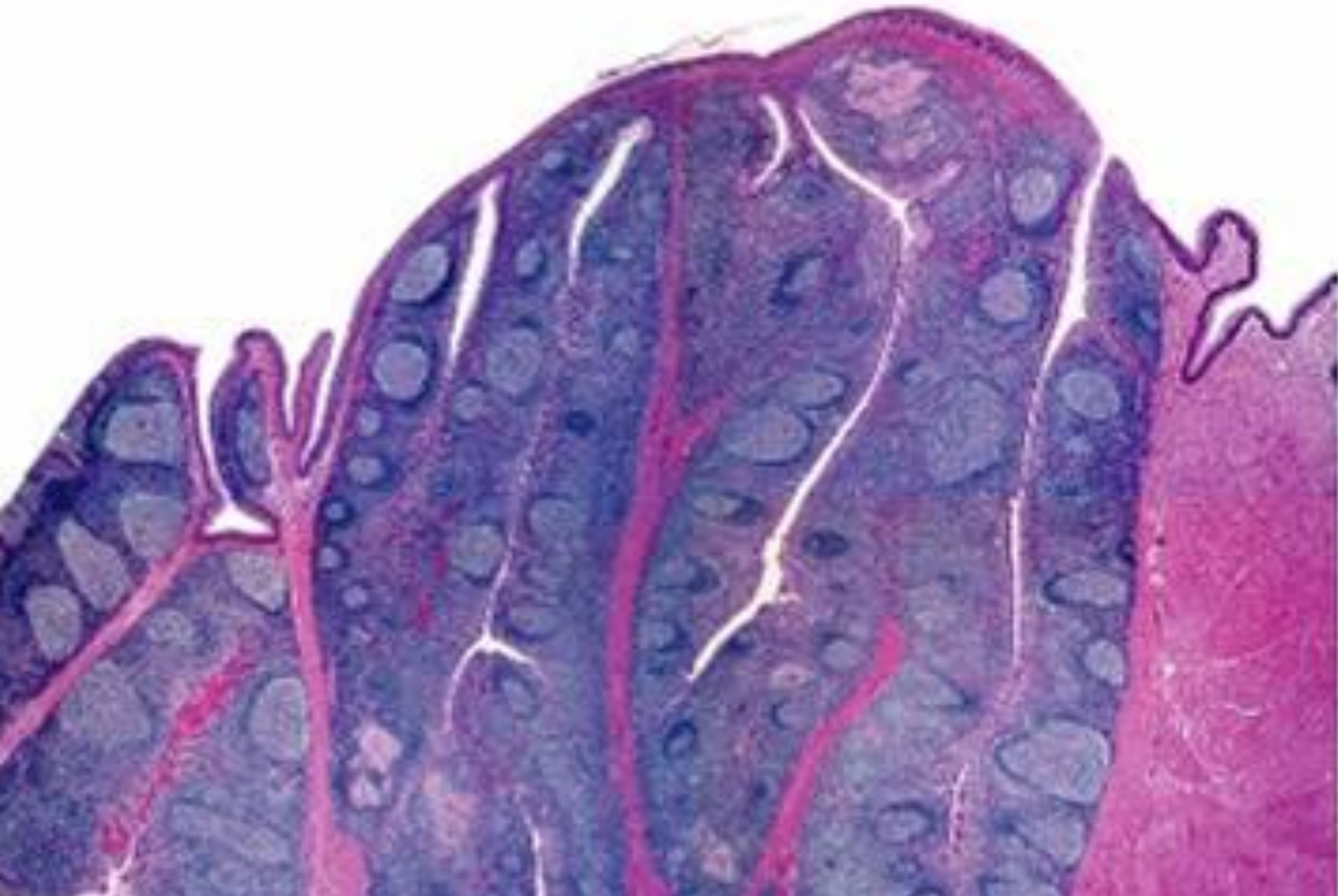
- underlie the epithelial lining of the mouth and pharynx.
- **palatine tonsils (2), pharyngeal tonsil (1), and lingual (1) tonsils, tubarian (2) tonsils** form a ring, they guard the common entrance to the digestive and respiratory tracts.

Most specific structures:

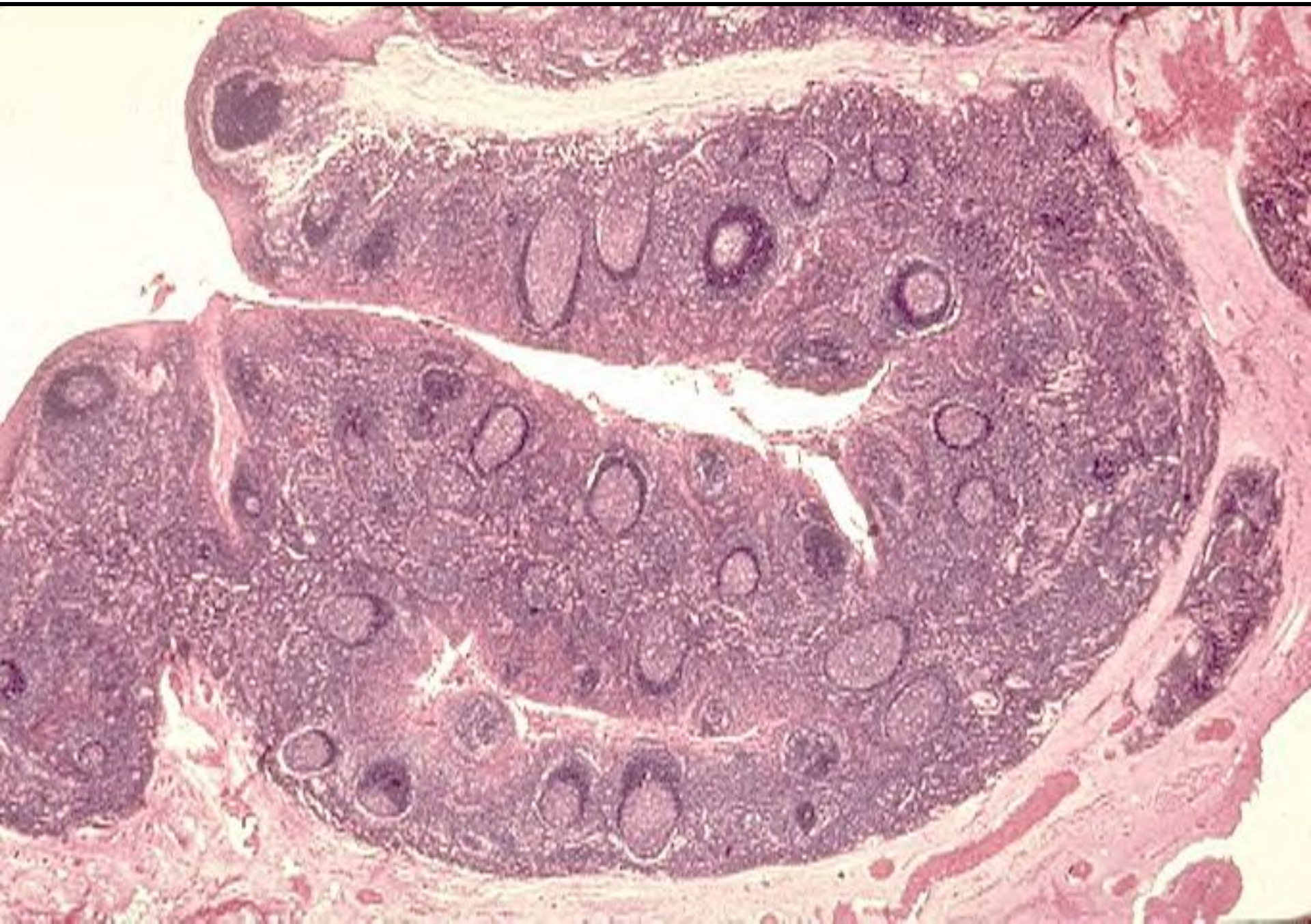
-epithelial linings,

- lymphatic nodules under the epithelium with lymphatic infiltration and crypts.

Tonsils



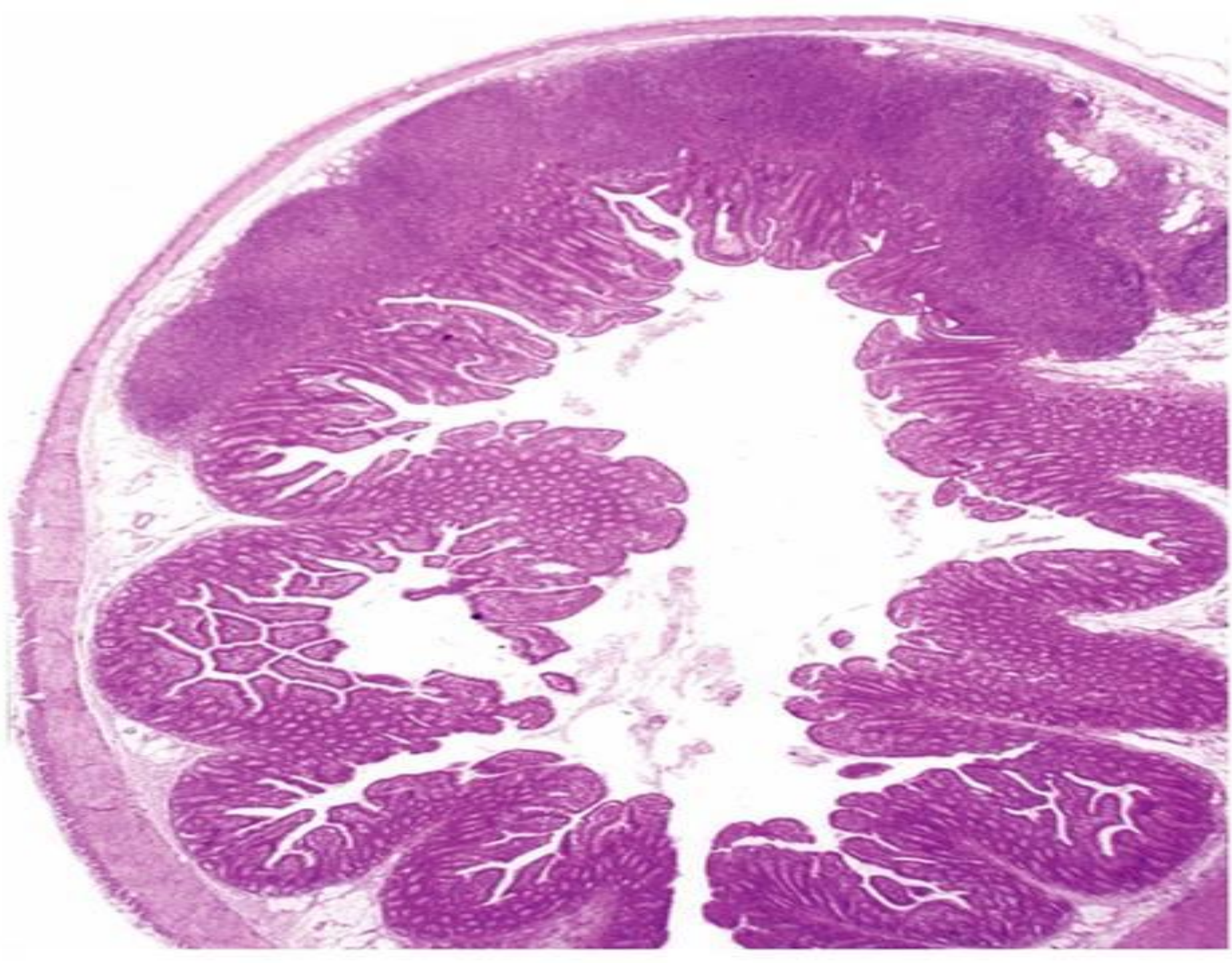
Palatine Tonsil



Peyer's Patches

Smaller aggregates present under mucous membrane:

"Mucosa Associated Lymphoid Tissue" or **MALT (in Digestive sys)**



Lymph Node

- Capsulated
- Afferent lymphatics “subcapsular sinus”
- Hilum – blood vessels, efferent lymphatic
- Cortex and medulla
- Cortex
  - Lymphatic nodules, germinal centres
  - “Paracortex” T-dependent zone
- Medulla
  - Medullary cords and sinusoids

LYMPH NODES

These are

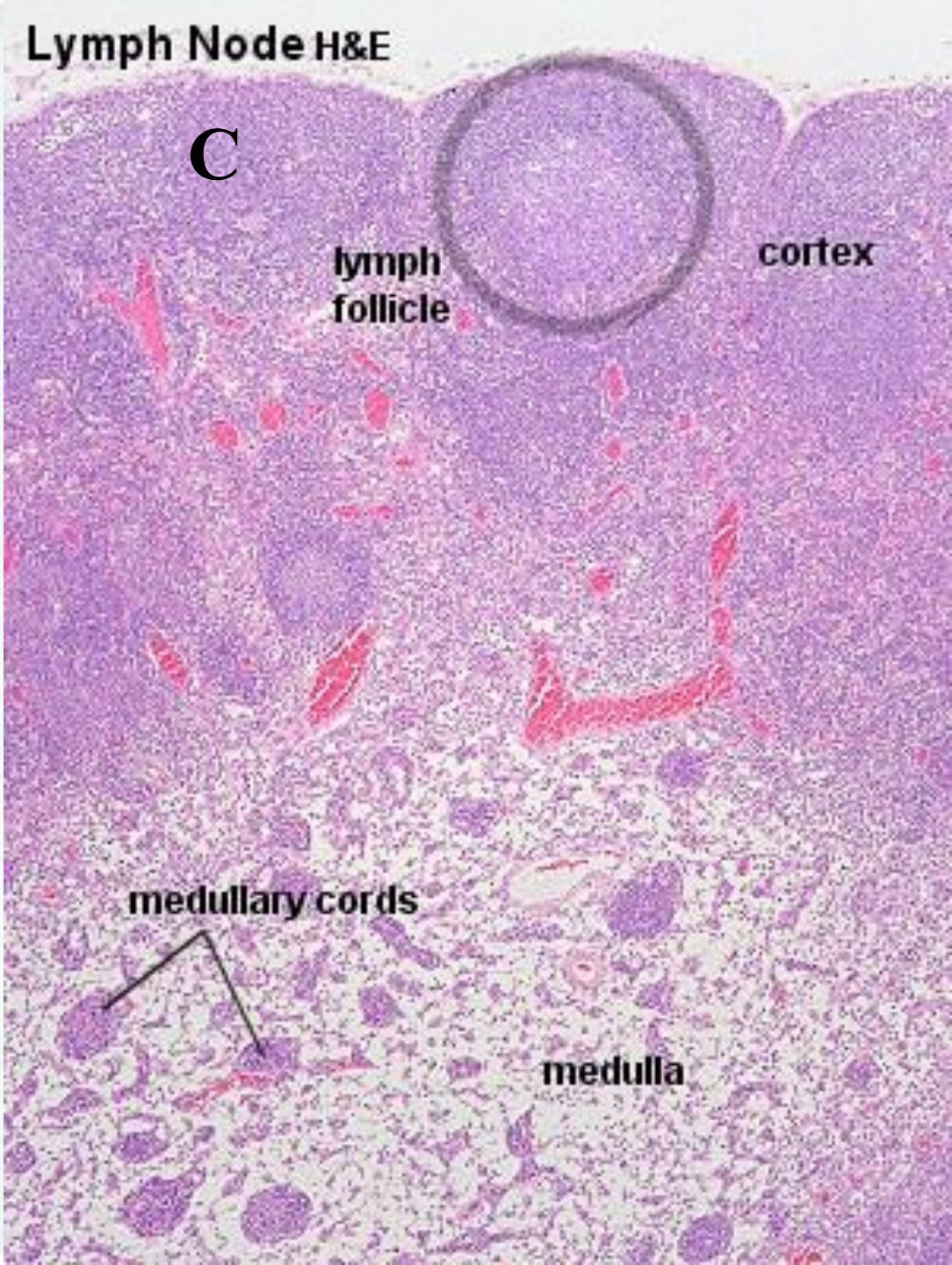
-the *smallest* but *most numerous* encapsulated lymphoid organs.

Lie in groups along lymphatic vessels

Functions:

1. Filtration of lymph
2. Lymphocyte production (lymphopoiesis).
3. Immunoglobulin production.


M


Lymph Node H&E
C
lymph follicle
cortex
medullary cords
medulla

LYMPH NODES

-- Inner space consists of reticular connective tissue and has **3 zones:**

1. cortex, adjacent to the convex surface,

2. - a central **medulla** lying near the depression (hilum) in the concave surface,

and intermediate **paracortical zone**.

. **Cortex** consists of layer of typical lymphoid nodules

2. Paracortical zone.

This is the T-dependent region, It contains mainly T-lymphocytes.

3. Medulla.

is composed of cords of lymphoid tissue (**medullary cords**) separated by **medullary sinuses**.

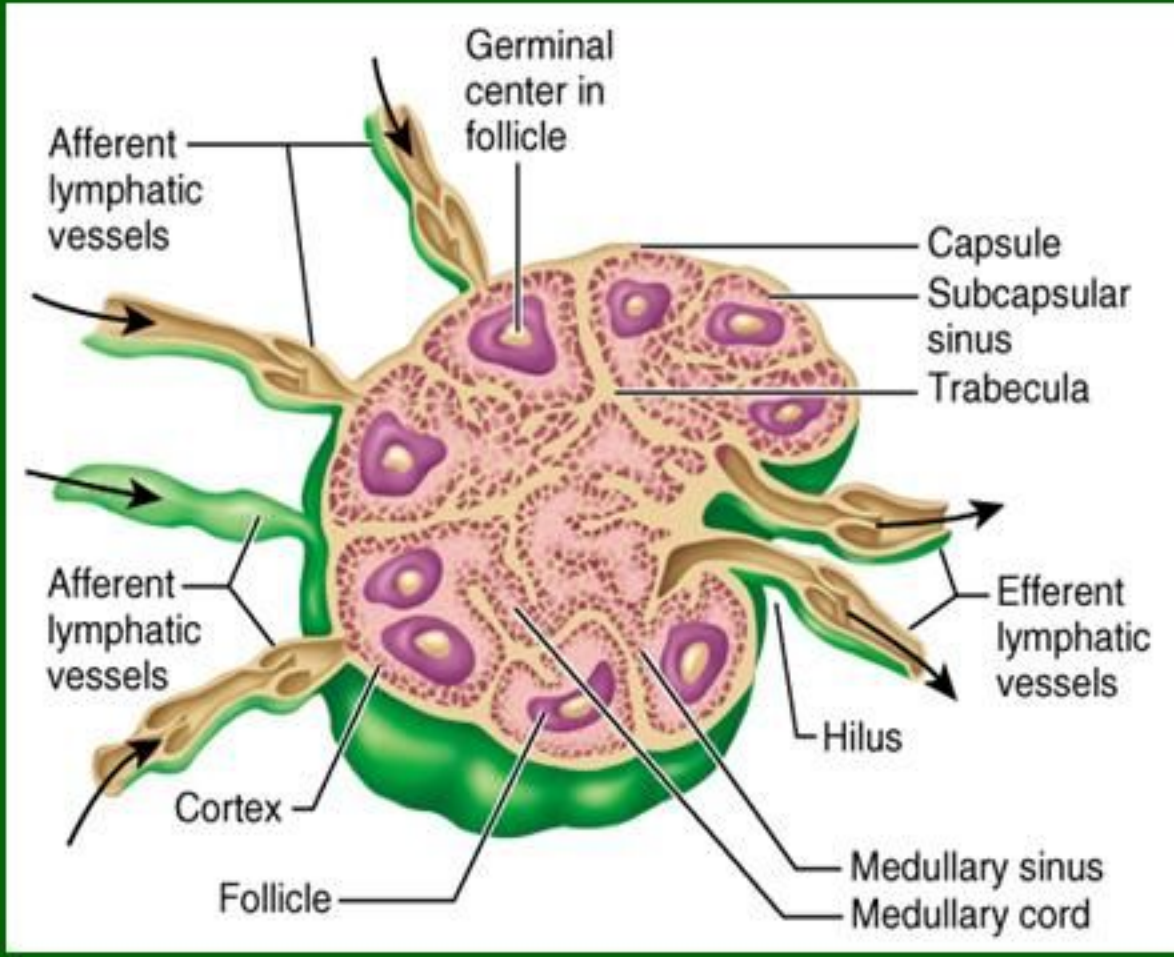
The cords contain many plasma cells that have migrated from the cortex.

Lymphatic vessels inside LN are Sinuses.

Types: subcapsular,
peritrabecular,
medullary

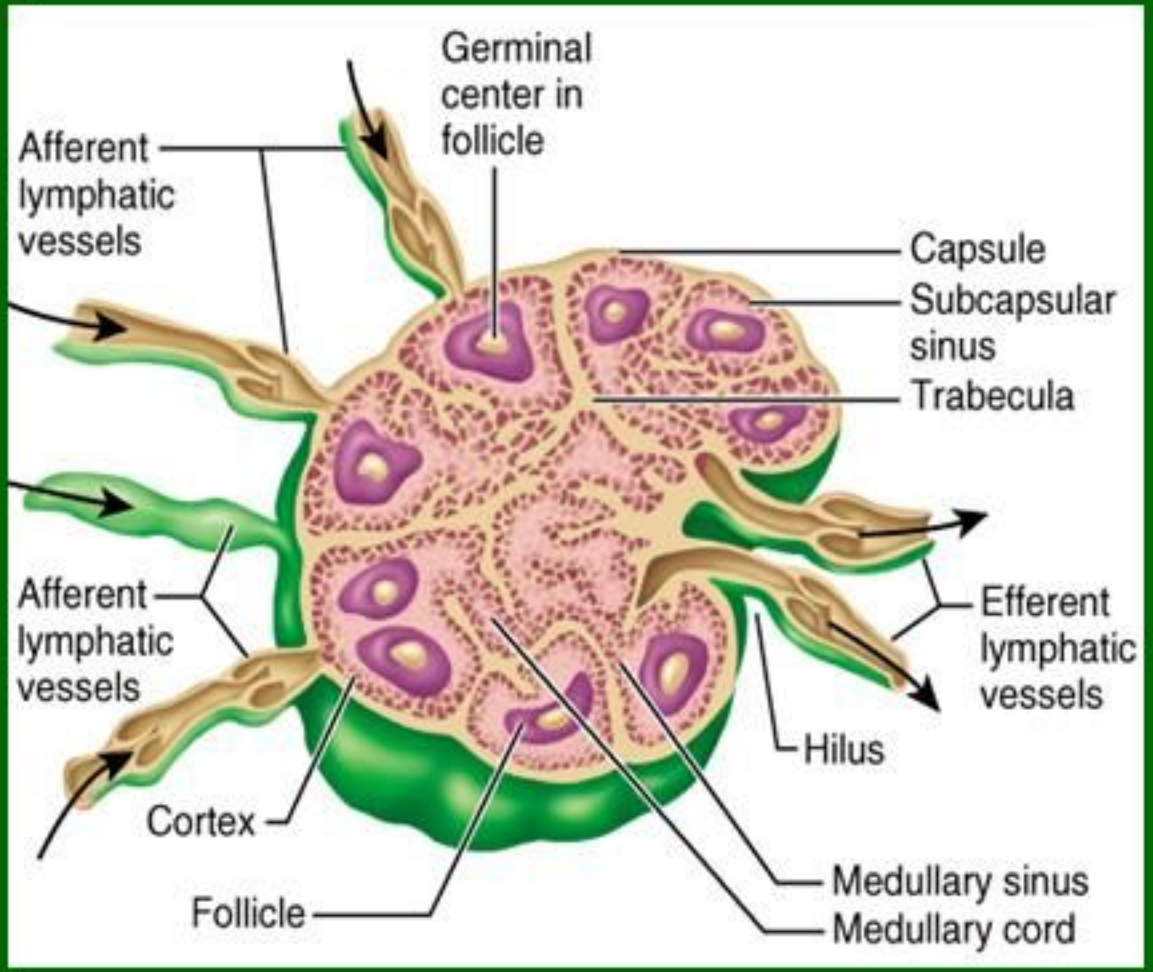
Lymph Node Structure

- Cortex
  - Superficial portion is packed with follicles – containing multiple B lymphocytes
  - Deeper portion contains T lymphocytes
- Medulla
  - Contains medullary cords which are inward extensions of cortical lymphoid tissue
    - *What cells do they contain?*
  - Large lymph capillaries known as medullary sinuses are also present



Lymph Node Function

- Multiple afferent lymphatic vessels enter a lymph at its hilus - the indented region on the concave side
- Lymph percolates thru the node and it is scrutinized by macrophages and lymphocytes ready to mount an immune response
- Lymph leaves via a few efferent lymphatic vessels
- Lymph usually has to pass thru several nodes before it is "clean"



Why is it significant that there are more afferent than efferent lymphatic vessels?

SPLEEN --

-- Is the largest of the lymphoid organs

Functions:

1. Filtration of blood.
2. Lymphocyte production (lymphopoiesis).
3. Destruction of worn red blood cells
4. Extramedullary hematopoiesis (in embryonic period)

Inner space -- Splenic pulp -- is composed of:

1. reticular tissue consisting of reticular cells and reticular fibers,
2. as well as blood vessels -- usual and sinusoid capillaries.

Splenic pulp = White pulp + Red pulp

White pulp

- consists of lymphocytes;
-- surround small arteries;
--- has 2 major components:

1. **Periarterial lymphatic sheaths (PALS)** - W.P. immediately surrounding each small **artery** (called "**central artery**"). *These contain mainly T lymphocytes and constitute the T-dependent regions of the spleen.*
2. **Peripheral white pulp (PWP) --** includes a typical lymphoid nodules (usually with a germinal center). *These contain mainly B lymphocytes and constitute the B-dependent regions of the spleen.*

Red pulp -- collects blood and
makes up most of the spleen
and also has 2 major components:
- the red pulp cords and
-- the splenic sinusoids that lie between them.

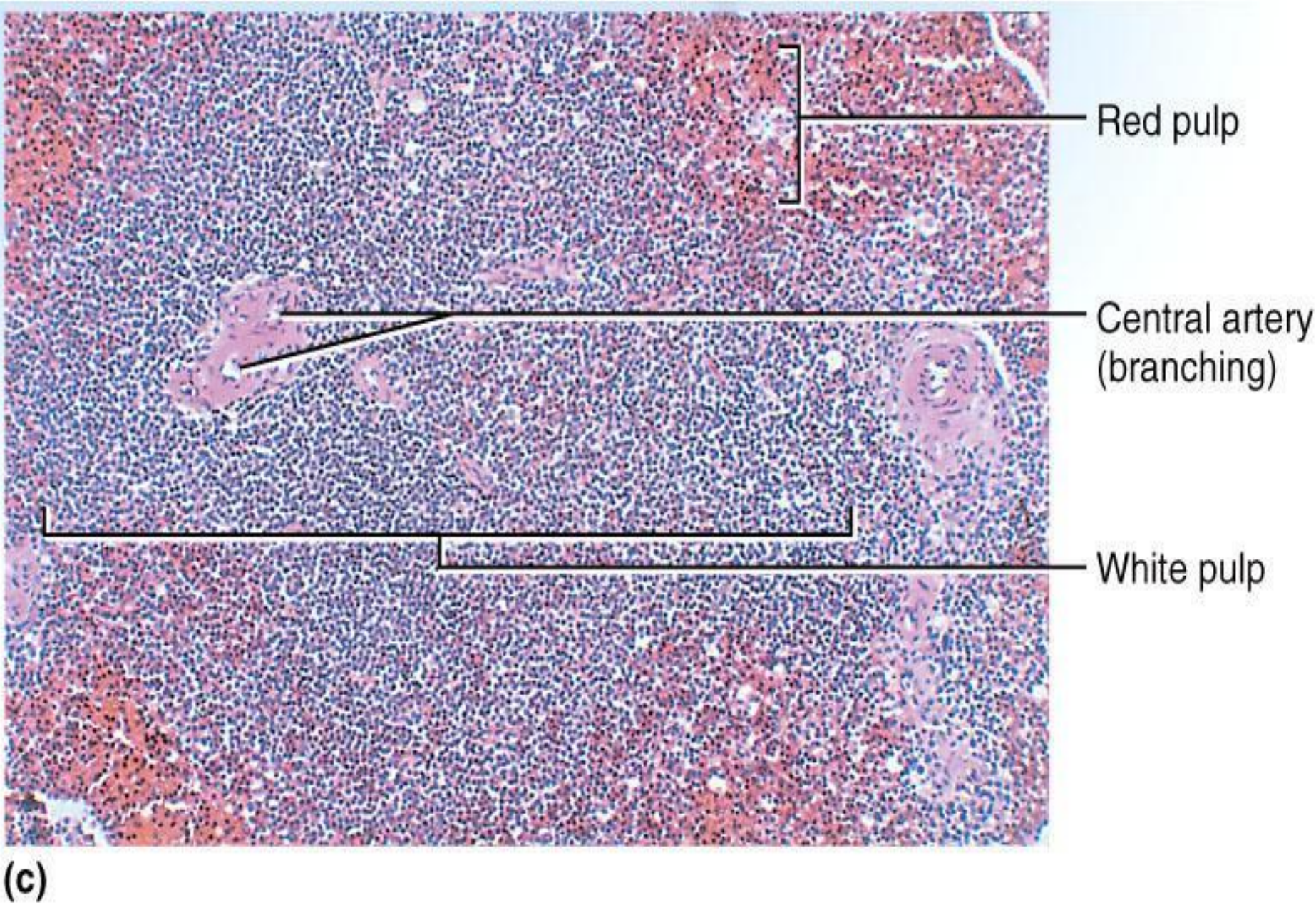
Red pulp -- collects blood and
makes up most of the spleen
and also has 2 major components:
- the red pulp cords and
-- the splenic sinusoids that lie between them.

The **red pulp cords** are irregular sheets of reticular connective tissue.
The cords contain
- reticular cells and fibers (stroma), formed elements of blood,
- dendritic cells, macrophages, plasma cells, and lymphocytes .

Splenic sinusoids differ from common capillaries:
- the lumen is wider and more irregular;
- small spaces between the lining endothelial cells;
--- discontinuous basal lamina.

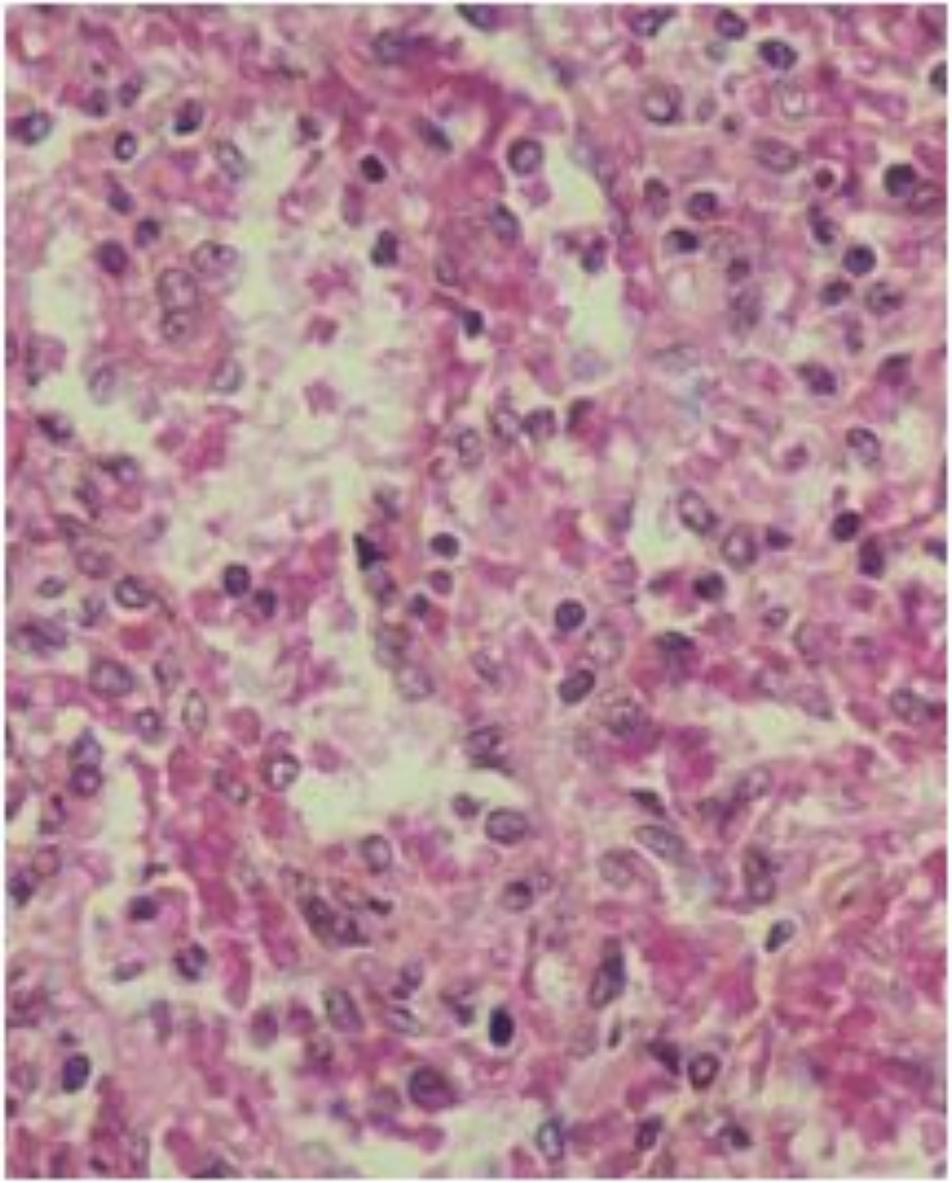
The marginal zone forms a border between the white and red pulp; it consists of **blood sinuses** and loose lymphoid tissue containing few lymphocytes.

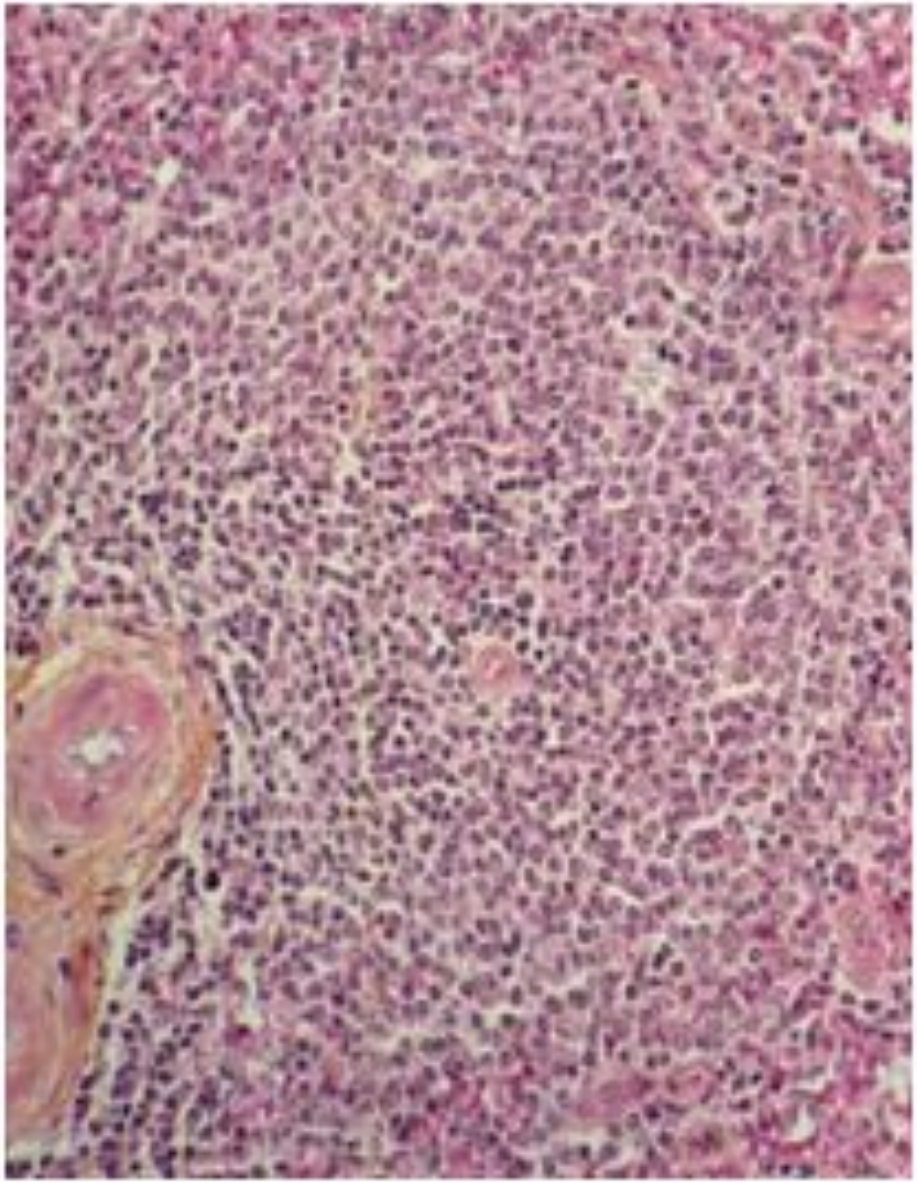
Spleen



Red Pulp

White Pulp





Open and closed theories of splenic circulation.

Blood in the capillaries reaches the sinusoid lumens by two ways.

The **closed theory** holds that the capillary walls are continuous with the walls of the sinusoids and that the capillaries empty directly into the sinusoid lumens.

The **open theory** holds that the capillaries end abruptly in the red pulp cords and that blood reaches the sinusoid lumens passing through openings in the sinusoid walls. For humans, current evidence favors the open theory.

Central arteries and open blood circulation are unique feature for the spleen.