

Haematology Lectures

# Reticuloendothelial System (RES) & Spleen

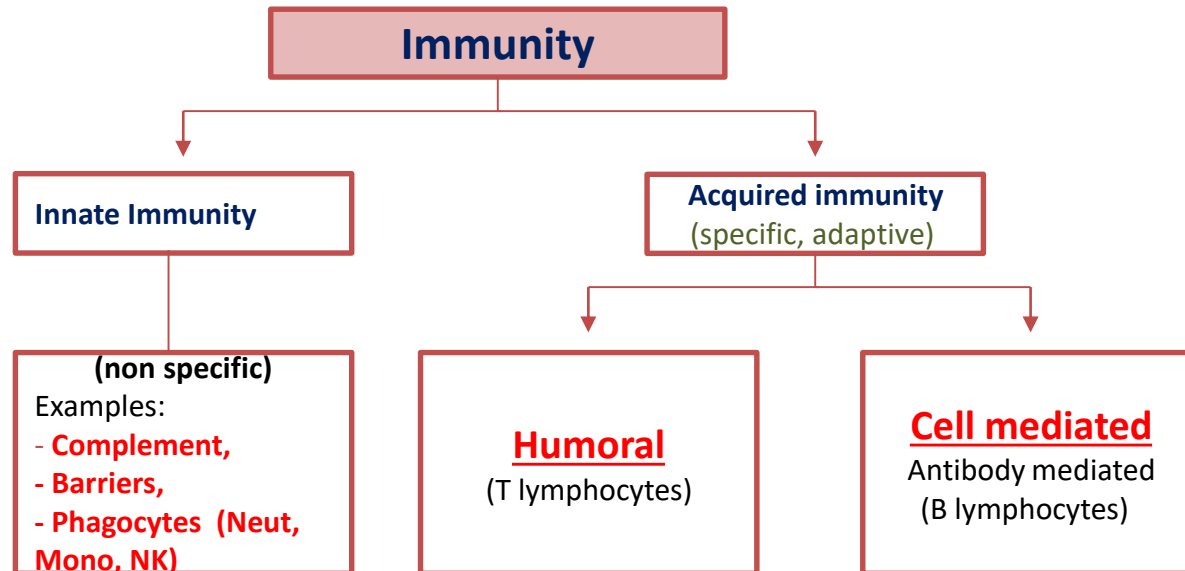
Dr. Nervana Bayoumy

Associate professor  
Physiology department

# Objectives

1. Define the term Reticulo-endothelial system (RES).
2. Describe the **cellular components** of RES.
3. Describe the **functions** of the RES.
4. Define the **structural** function of the **spleen**.
5. Describe the **functions** of the spleen.
6. Understand the basic concept of the indication and risks of **splenectomy**.

# Overview of the immune system



Note: Macrophages are key components of the innate immunity & activate adaptive immunity by transforming into Antigen Presenting Cells.

# Reticuloendothelial system (RES)

## Mononuclear phagocyte system

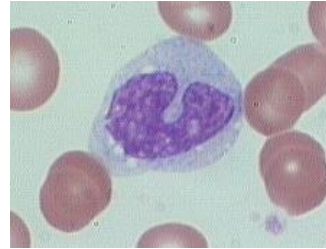
- **Reticuloendothelial system** is an older term for the **mononuclear phagocyte system**.
- **Most endothelial cells are not macrophages.**

# The reticulo-endothelial system (RES)

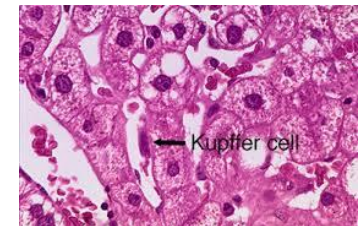
- It is a network of **connective tissue fibers** inhabited by phagocytic cells such as **macrophages** ready to attack and ingest microbes.
- Monocytes transform themselves into macrophages (in tissues) & this system of phagocytes is called as Monocyte-Macrophage Cell System.

# Cellular components of RES

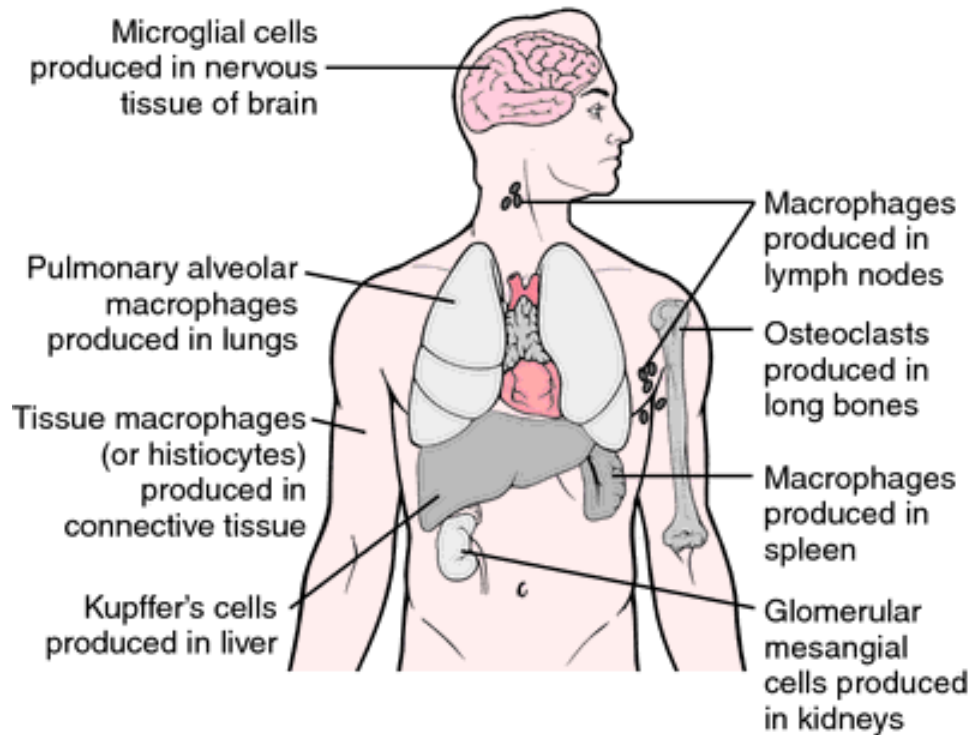
1. **Monocytes.**



2. **Macrophage** Located in all tissues such as skin (**histiocytes**), liver (**kupffer**), spleen, bone marrow, lymph nodes, lung.



3. **Endothelial cells:** bone marrow, spleen, lymph node.



## **Reticuloendothelial System - Monocyte/Macrophage System**

### **3 COMPONENTS:**

- Monocytes in Blood.
- Mobile & Fixed Macrophages in Tissue.
- Specialized Endothelial cells in bone marrow, spleen and lymph nodes.

# Macrophages

- Often remain fixed to their organs. They **filter** and **destroy** objects which are foreign to the body, such as **bacteria**, **viruses**.
- Some macrophages are mobile, and they can group together to become **one big phagocytic cell** in order to ingest larger foreign particles.



# Types of Macrophages

- Macrophage differ depending on the organs in which they reside.
  - **Kupffer cells** .....in the **liver**.
  - **Microglia**.....in the **brain**.
  - **Reticular cells** .....in the **lymph nodes, bone marrow, spleen**.
  - **Tissue histiocytes (fixed macrophages)** .....in **subcutaneous tissues**.
  - **Alveolar cells**.....in the **lungs**.

# Formation of Macrophages

1. Begin by **Stem cell** in **Bone Marrow**:
  - monoblast maturing to **promonocyte** and **mature monocytes** released into blood.
2. Stay for **10-20 hours** in circulation.
3. Then leave blood to tissues transforming into larger cells **macrophage**.
4. Macrophage life span is longer up to few months in tissues.

# Transformation of monocytes to macrophage

Characterized by **an increase in:**

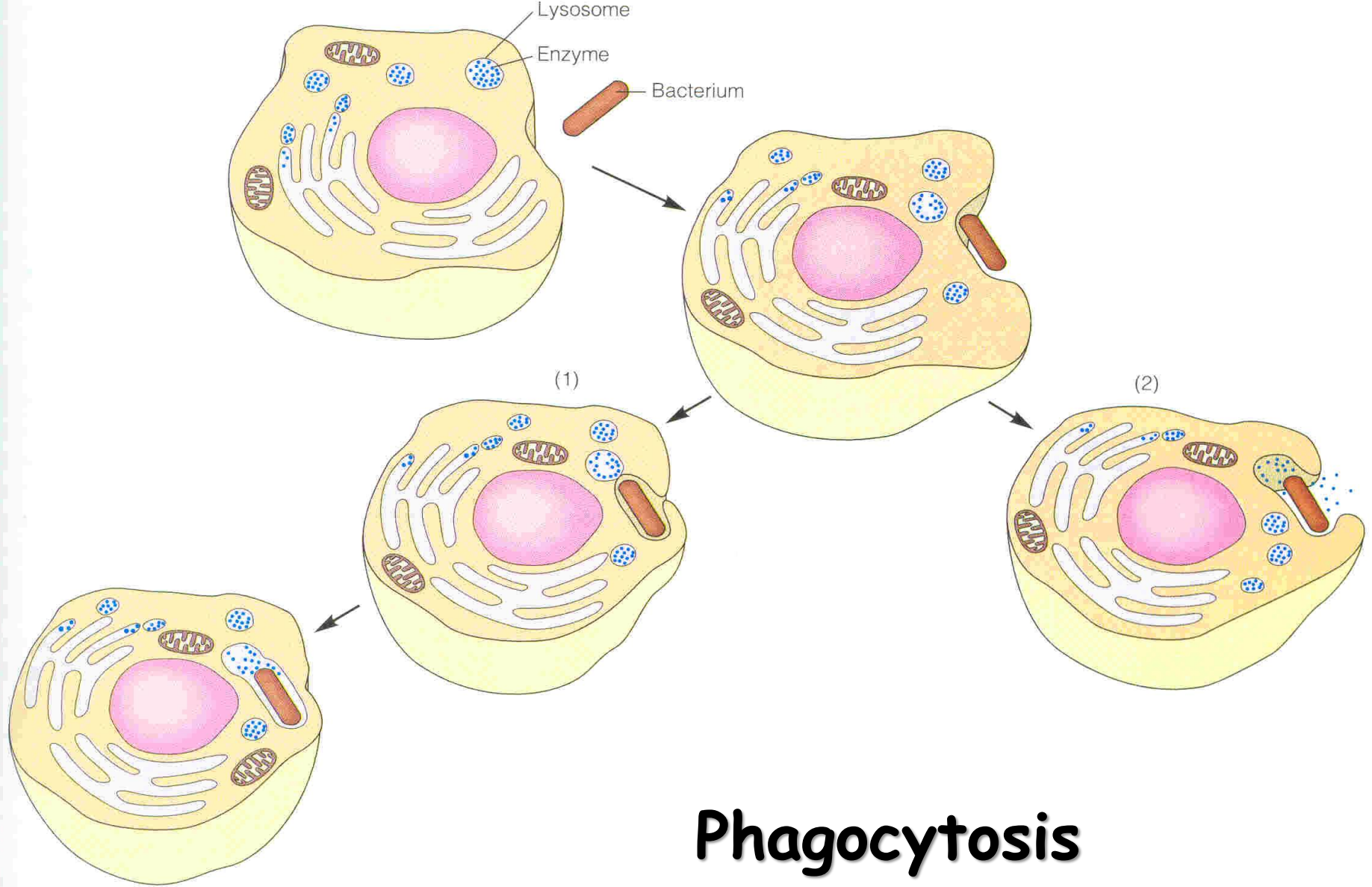
- Cell size.
- Number and complexity of intracellular organelles **Golgi, mitochondria, lysosomes.**
- Intracellular **digestive enzymes.**

# General Functions of RES

1. **Phagocytosis**: Bacterial, dead cells, foreign particles (**direct**).
2. **Immune function**: processing antigen and antibodies production (**indirect**).
3. **Breakdown** of aging RBC.
4. Storage and circulation of **iron**.

# Phagocytosis

- **Phagocytosis** is part of the natural or innate immune process.
  
- **Macrophages** are a powerful phagocytic cells:
  - Ingest **up to 100** bacteria.
  - Ingest **larger particles** such as old RBC.
  - Get rid of **waste products**.

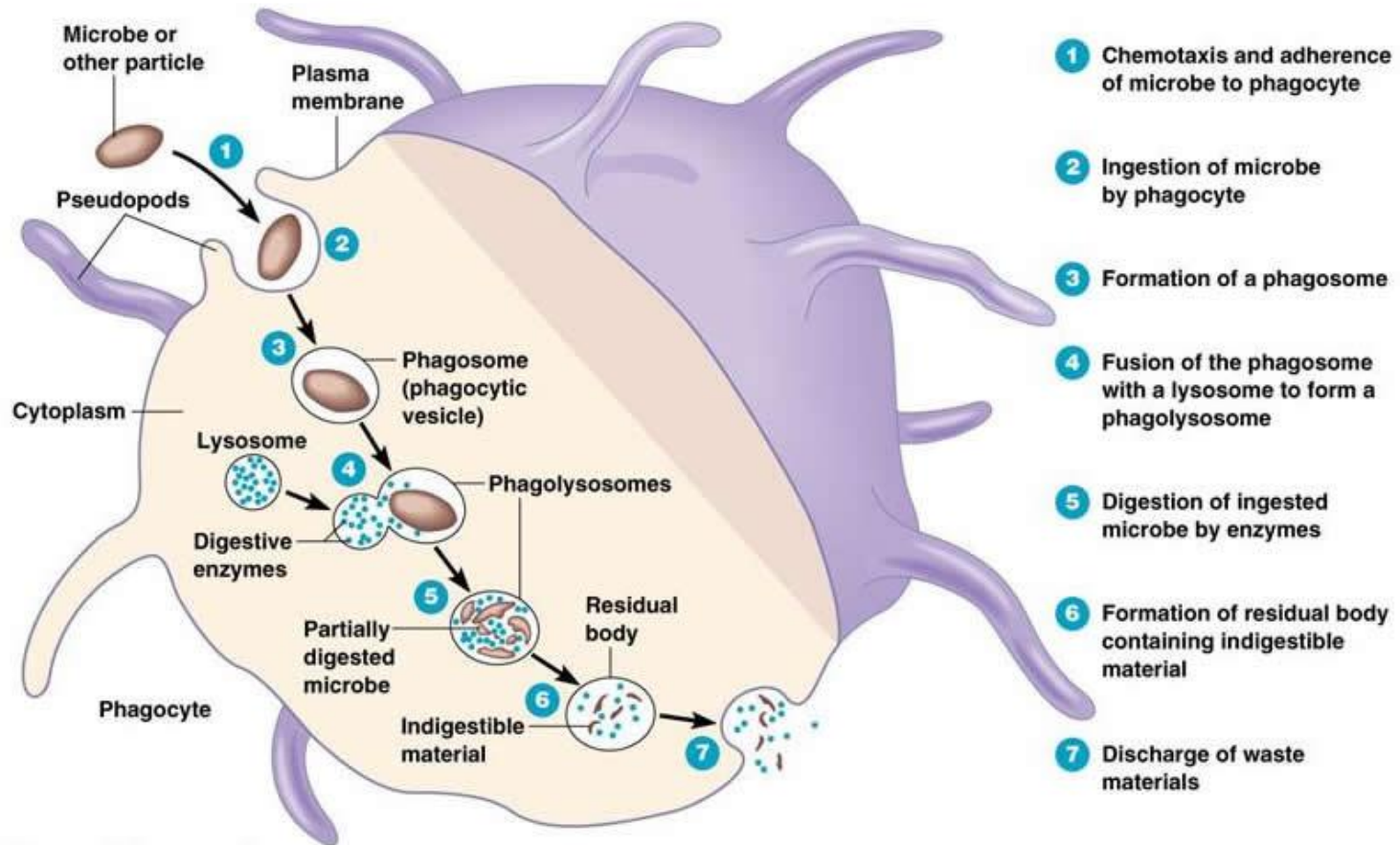


# Phagocytosis

**Figure 15.2**

Phagocytosis by a neutrophil or macrophage. A phagocytic cell extends its pseudopods around the object to be engulfed (such as a bacterium). (Blue dots represent lysosomal enzymes.) (1) If the pseudopods fuse to form a complete food vacuole, lysosomal enzymes are restricted to the organelle formed by the lysosome and food vacuole. (2) If the lysosome fuses with the vacuole before fusion of the pseudopods is complete, lysosomal enzymes are released into the infected area of tissue.

# Microbial killing

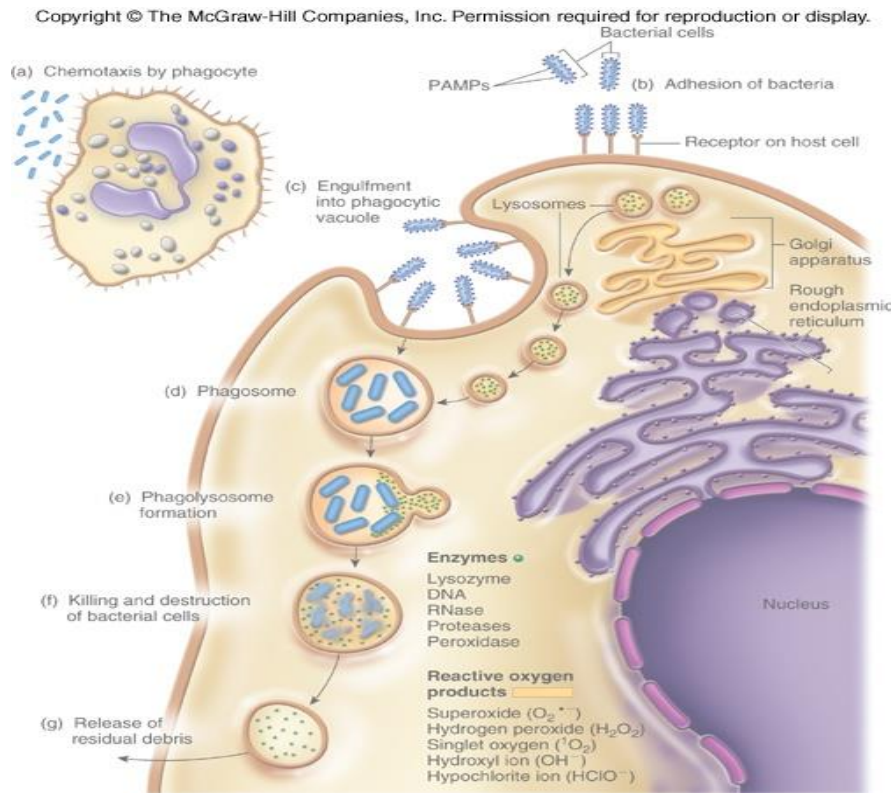


Phases of phagocytosis



# Indirect Immune function Of RES

- **Indirect immune function of RES:**
  - Ingest foreign body, process it and present it to lymphocytes.





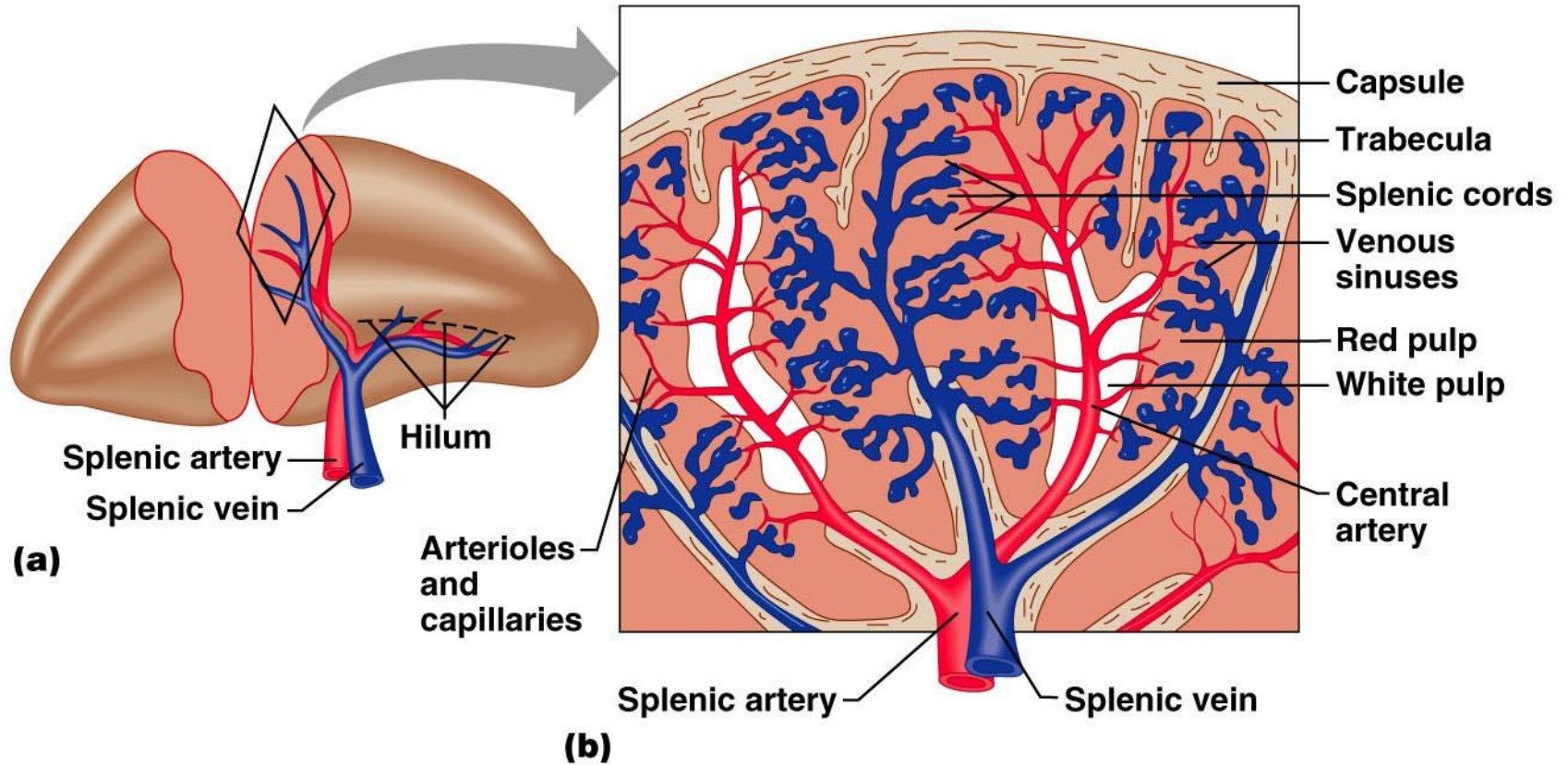
# Lymphoid Organs

1. **Thymus:** high rate of growth and activity until puberty, then begins to shrink; site of T-cell maturation.
2. **Lymph nodes:** small, encapsulated, bean-shaped organs stationed along lymphatic channels and large blood vessels of the thoracic and abdominal cavities.
3. **Spleen:** structurally similar to lymph node, it filters circulating blood to remove worn out RBCs and pathogens.

# Spleen

- Is soft **purple gray** in color located in the **left upper quadrant** of the **abdomen**.
- It is a **highly vascular** lymphoid organ.
- It plays an important roles in: **red blood cells** integrity and has **immune function**.
- It holds a **reserve** of blood in case of **hemorrhagic shock**.
- It is one of the centers of activity of the **RES** and its **absence** leads to a **predisposition** toward certain **infections**.
- Despite its importance, there are **no tests** specific to splenic function.

# Spleen

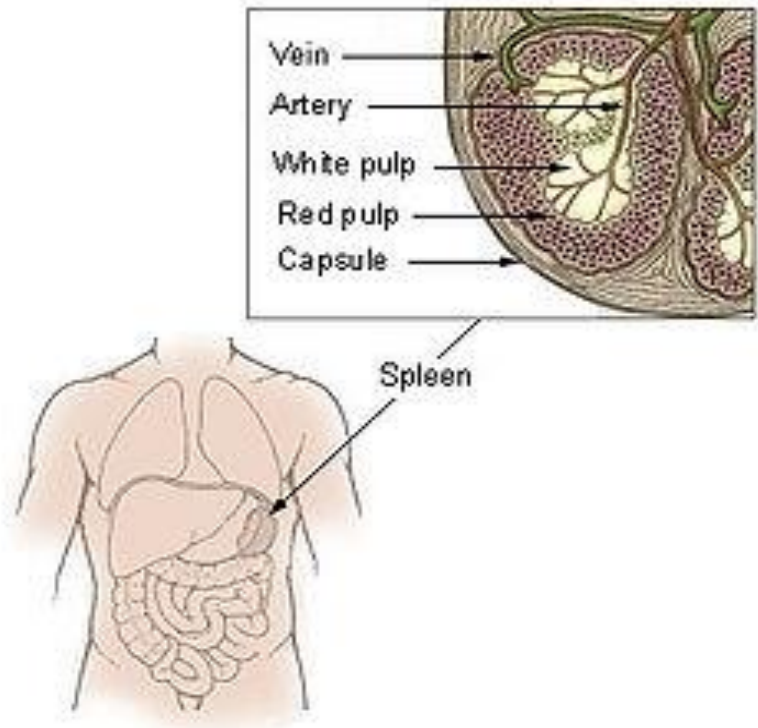


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# Structural Function of Spleen

- White pulp: Thick sleeves of lymphoid tissue, that provides the immune function of the spleen.
- Red pulp: surrounds white pulp, composed of **Venous sinuses** filled with whole blood and Splenic cords of reticular connective tissue rich in **macrophages**.

Spleen



# Functions of Spleen

1. **Haematopoiesis (Hemopoiesis)**: fetal life.
2. Spleen is a main site for **destruction of RBCs** specially old and abnormal e.g. spherocytosis.
3. Blood is **filtered** through the spleen.
4. **Reservoir** of **thrombocytes** and immature erythrocytes.
5. Recycles of **iron**.

# Immune Functions of Spleen

1. Because the organ is directly connected to blood circulation, it responds faster than other lymph nodes to **blood-borne antigens**.
2. **Destruction and processing** of antigens.
3. **Reservoir of lymphocytes** in white pulp.
4. Site for **Phagocytosis** of bacteria and worn-out blood cells (Slow blood flow in the red pulp cords allows foreign particles to be phagocytosed )

# Immune Functions of Spleen *cont.*

5. Site of **B cell maturation** into plasma cells, which synthesize antibodies in its white pulp and initiates **humoral response**.
6. Removes antibody-coated bacteria along with **antibody-coated blood cells**.
7. It contains (in its blood reserve) half of the body **monocytes** within the red pulp, upon moving to injured tissue (such as the heart), turn into **dendritic cells** and **macrophages** that promoting **tissue healing**.

# Splenectomy

## ▣ Indications:

1. **Hypersplenism**: enlargement of the spleen (splenomegaly) with defects in the blood cells count.
2. Primary spleen **cancers**.
3. **Haemolytic anaemias**: Sickle cell anaemia, Thalassaemia, hereditary spherocytosis (HS) and elliptocytosis,
4. Idiopathic thrombocytopenic purpura (**ITP**).
5. Trauma.
6. Hodgkin's disease.
7. Autoimmune hemolytic disorders.



# Risks & Complications of Splenectomy

- Overwhelming **bacterial infection** / post splenectomy **sepsis**.
- Patient prone to **malaria**.
- Inflammation of the **pancreas** and collapse of the **lungs**.
- Excessive post-operative **bleeding** (surgical).
- Post-operative **thrombocytosis** and **thrombosis**.

