

Haematology Block

Physiology Team 431

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Reticuloendothelial System & Spleen

Lecture content:

1. Reticuloendothelial system definition
2. Reticuloendothelial system component
3. Function of RES
4. Direct role in body protection
5. Indirect role in immune reaction
6. Spleen structure and Functions
7. Splenectomy indication and risk

Reticuloendothelial system (RES): Mononuclear phagocyte system:

Reticuloendothelial system is an older term for the mononuclear phagocyte system.

- It is a network of connective tissue fibers populated by phagocytic cells such as macrophages ready to attack and ingest microbes that passed the first line of defense **such as mucus membrane**.
- Is an essential component of the immune system.

Cellular component of RES:

1. Monocytes
2. Macrophage Located in all tissues such as skin (histocytes), liver (kupffer), spleen, bone marrow, lymph nodes, lung
3. Endothelial cells some of endothelial can present antigen (bone marrow, spleen, lymph node)

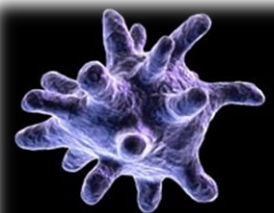
Recently they found that endothelial cells are not only lining the blood vessels they also can present an antigen to the lymphocytes .

Macrophages

- Often remain fixed to their organs. They mostly 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. **(the most important mobile macrophages = Monocytes)**

Types of Macrophages: (same function but different names according to the location)

- 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 histocytes..... in subcutaneous tissues, (fixed macrophages)
 - alveolar cells..... in the lungs



Macrophage

Formation of Macrophages:

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

Transformation of monocytes to macrophages:

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 innate immunity) (RES) is the basic component of immune system, and it also helps the lymphocytes.
2. Indirect immune function: processing and presenting antigen to lymphocytes
3. Breakdown of aging RBC
4. Storage and circulation of iron

Phagocytosis

- Phagocytosis is part of the natural, or innate, immune process.

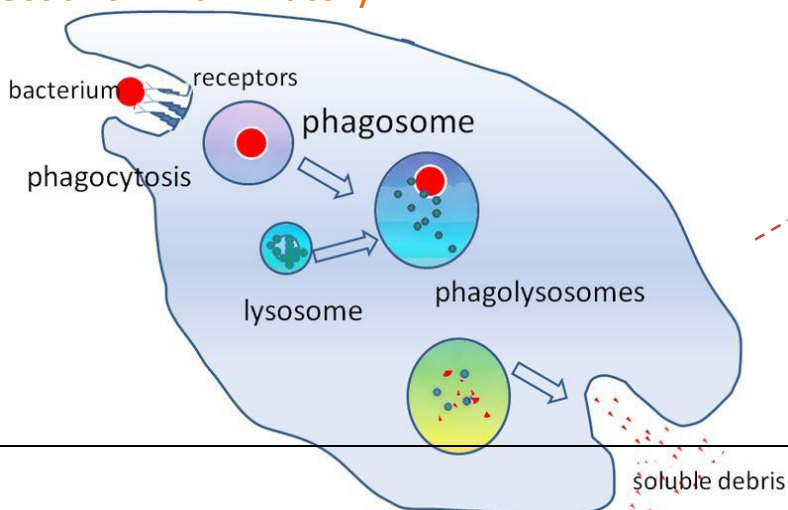
- Macrophages are a powerful phagocytic

cells:

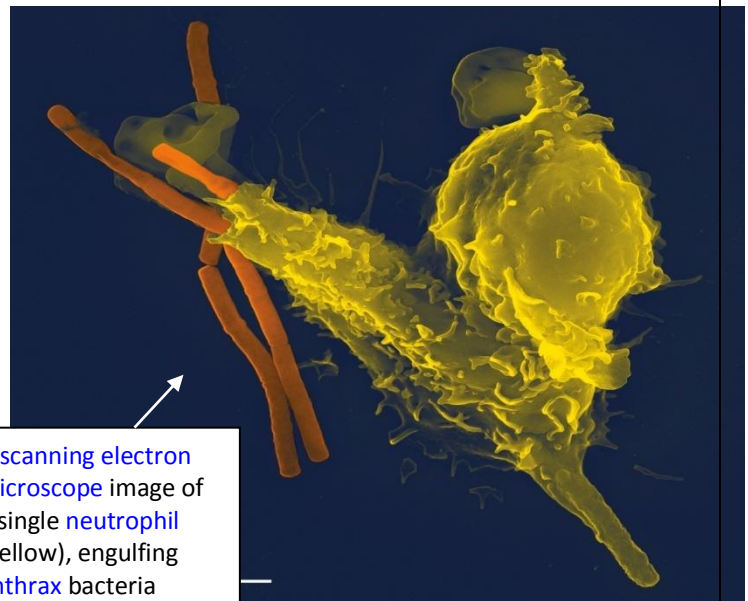
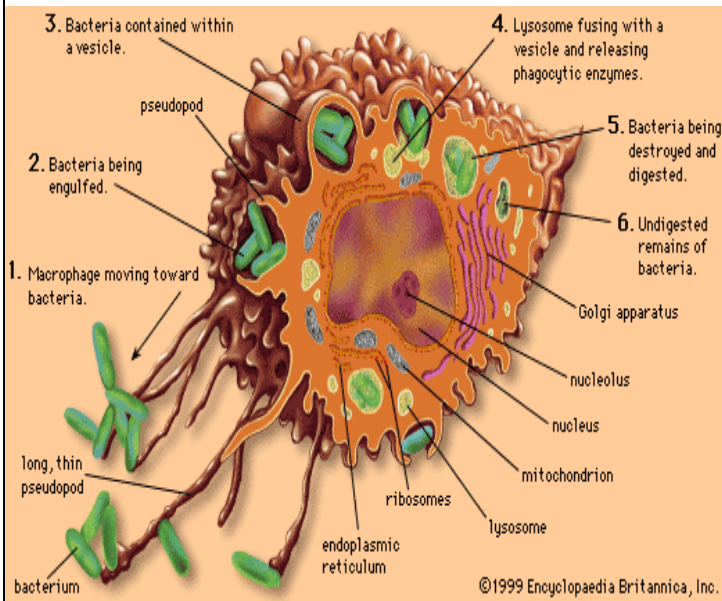
- Ingest up to 100 bacteria (it can ingest large number unlike the neutrophils)
- Ingest larger particles as old RBC
- Get rid of waste and survive (Get rid of the wastes that are produced from the digestion and survive after that)

Neutrophils digest small amount of bacteria and die that's why it have shorter life span and with infections it will be shorter.

Direct anti Inflammatory :



Bacteria > phagosome > inside the phagosome will be killed by lysosomes or oxygen free radicals > exocytosis of soluble debris .



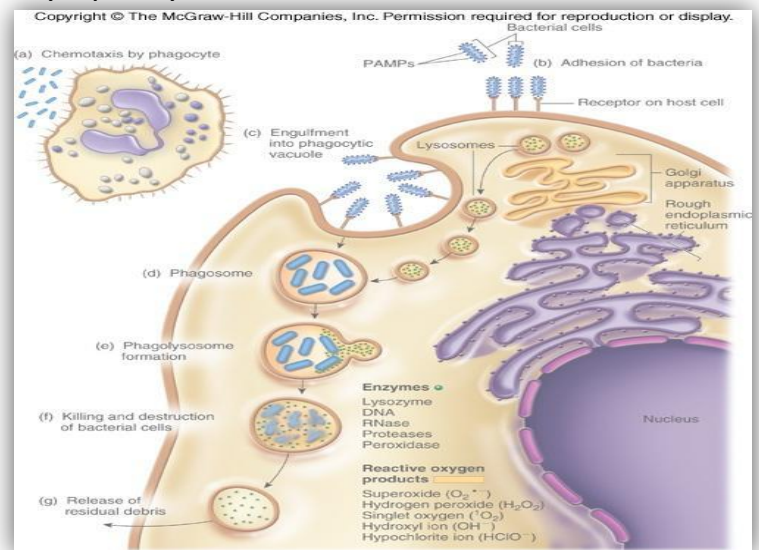
A scanning electron microscope image of a single neutrophil (yellow), engulfing anthrax bacteria (orange).

Indirect Immune function Of RES (antigen presenting)

- Indirectly immunity

– Ingest foreign body process it and present it to lymphocytes.

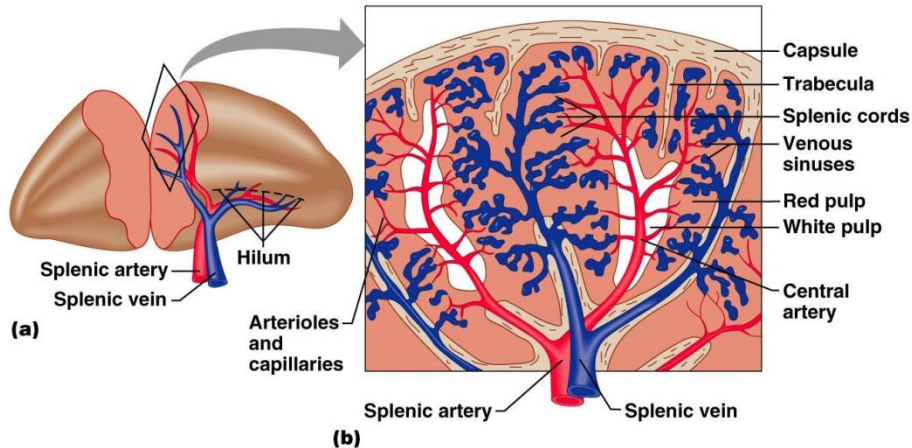
How does it present it ?
MHC2



Lymphoid Organs:

1. **Thymus:** high rate of growth and activity until puberty, then begins to shrink; **site of T-cell maturation.** (the thymus is the main site responsible for T-cells maturation, so if the thymus is absent the T-cells are absent and this is a fatal condition)
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:



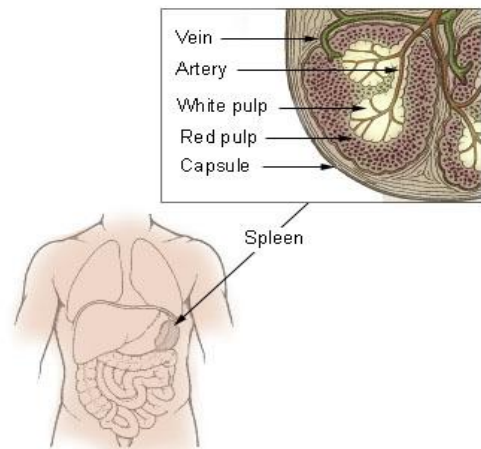
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- Is soft purple gray in color located in the left upper quadrant of the abdomen.
- It is a highly vascular lymphoid organ. (very highly vascular) (in case of car accident the most important thing to worry about is spleen, because internal bleeding might happen which could lead to death)
- It play an important roles in red blood cells integrity (Unhealthy RBC will be removed by spleen)
- It holds a reserve of blood in case of hemorrhagic shock. (The spleen will contract and release blood into the circulation)
- It is one of the centers of activity of the RES and its absence leads to a predisposition toward certain infections
- It play an important roles in immune system.
- Despite its importance, there were no specific tests for splenic function

Structural Function of Spleen

- White pulp: Thick sleeves of lymphoid tissue, 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) (RBC formation in fetal life) . (extramedullary hemopoiesis in adult life when the bone marrow cannot form RBC)
2. Spleen is a main site for destruction of old and abnormal RBCs e.g.spherocytosis

3. Blood is filtered through the spleen.
4. Reservoir of thrombocytes and immature erythrocytes (spleen is a big reservoir for the platelets) (platelets originate in the bone marrow and then go to spleen to be reserved before get released into the blood circulation, so in case of splenectomy platelet count may rise to abnormally high levels (thrombocytosis), leading to an increased risk of potentially fatal clot formation)
5. Recycle 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. Reservoir of lymphocytes in white pulp
3. Destruction and processing of antigens
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:

5. Site of B cell maturation into plasma cells, which synthesizes antibodies in its white pulp and initiation of humoral response
6. Removes antibody-coated bacteria (**opsonization**) along with antibody-coated blood cells.

The process by which bacteria are altered by opsonins so as to become more readily and more efficiently engulfed by phagocytes. (medical dictionary)

7. It contains in its blood reserve half of the body's monocytes within the red pulp, upon moving to injured tissue (such as the heart), turn into dendritic cells and macrophages while promoting **tissue healing**.

Splenectomy:

• Indication:

1. Hypersplenism: enlargement of the spleen (splenomegaly) with defects in the blood cells Count. (**Hypersplenism leads to Low RBC count, low thrombocytes**)
2. primary spleen cancers
3. hereditary spherocytosis (HS) and elliptocytosis (**because the spleen will destroy RBCs which will cause or worsen the anemia**)
4. Idiopathic thrombocytopenic purpura (ITP) (**Subcutaneous hemorrhage leading to bruises, if the cause is low platelets count it is called idiopathic**) (**removing the spleen will prevent the destruction of platelets so it will be higher**)

Spherocytosis is an auto-hemolytic anemia (a disease of the blood) characterized by the production of red blood cells (RBCs), or erythrocytes, that are sphere-shaped.

elliptocytosis predisposes to haemolytic anaemia where red blood cells are elliptical rather than the typical biconcave disc shape.

5. Trauma. (ex: accident>rapture of spleen>splenectomy)
(trauma count 90% of cases)
6. Hodgkin's disease. Hodgkin disease is a type of lymphoma.
Lymphoma is cancer of lymph tissue found in the lymph nodes,
spleen, liver, and bone marrow (splenectomy to exclude splenic
involvement)
7. Autoimmune hemolytic disorders. (the majority will be destroyed
in the spleen so removing it will decrease the destruction)
8. Thalassemia (As the RBCs contain abnormal hemoglobin the
spleen will destroy the majority , so removing the spleen will
decrease the destruction of the RBCs)

Risks of Splenectomy:

- Overwhelming bacterial infection or post splenectomy sepsis.
- Patient prone to malaria
- Excessive bleeding after the operation
- Post operative thrombosis

Objectives

At the end of this lecture the student is expected to be able to:

1. Define the term Reticuloendothelial 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

Question:

1)What does the white pulp of the spleen contain ?

- A)venous sinuses
- B)vitamin A
- C)lymphocytes

2)The site of T-lymphocyte maturation

- A)spleen
- B)thymus
- c)liver

3)The function of the RES:

- A)direct immune system
- B)Indirect immune system
- C)A&B are correct

4)Splenectomy indication

- A)Thrombocytopenia
- B)Thrombocytosis
- C)Erithrocytes

(1=c, 2=B, 3=C, 4=a)