Haematology Lectures

Reticuloendothelial System (RES) & Spleen

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Objectives

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 spleenectomy.

Lecture content

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

Reticuloendothelial system (RES)

Mononuclear phagocyte system

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

- **Most endothelial cells are not macrophages.**

The reticuloendothelial system (RES)

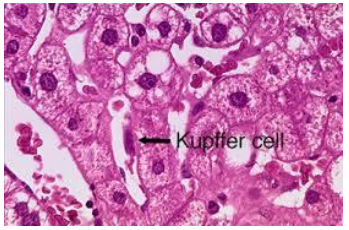
- It is a network of connective tissue fibers inhabited by phagocytic cells such as macrophages ready to attack and ingest microbes.

RES is an essential component of the immune 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.

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.**

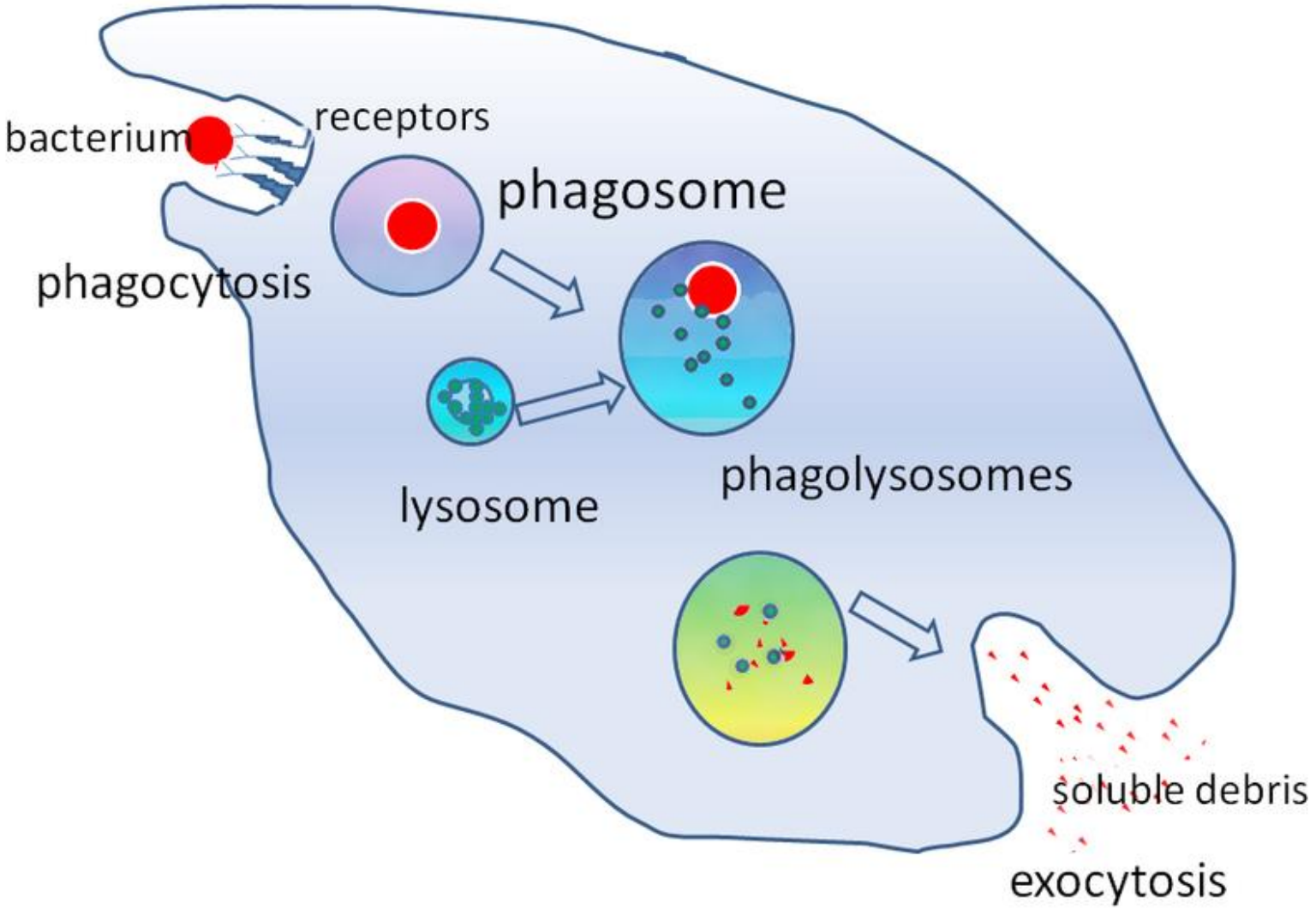
Phagocytosis

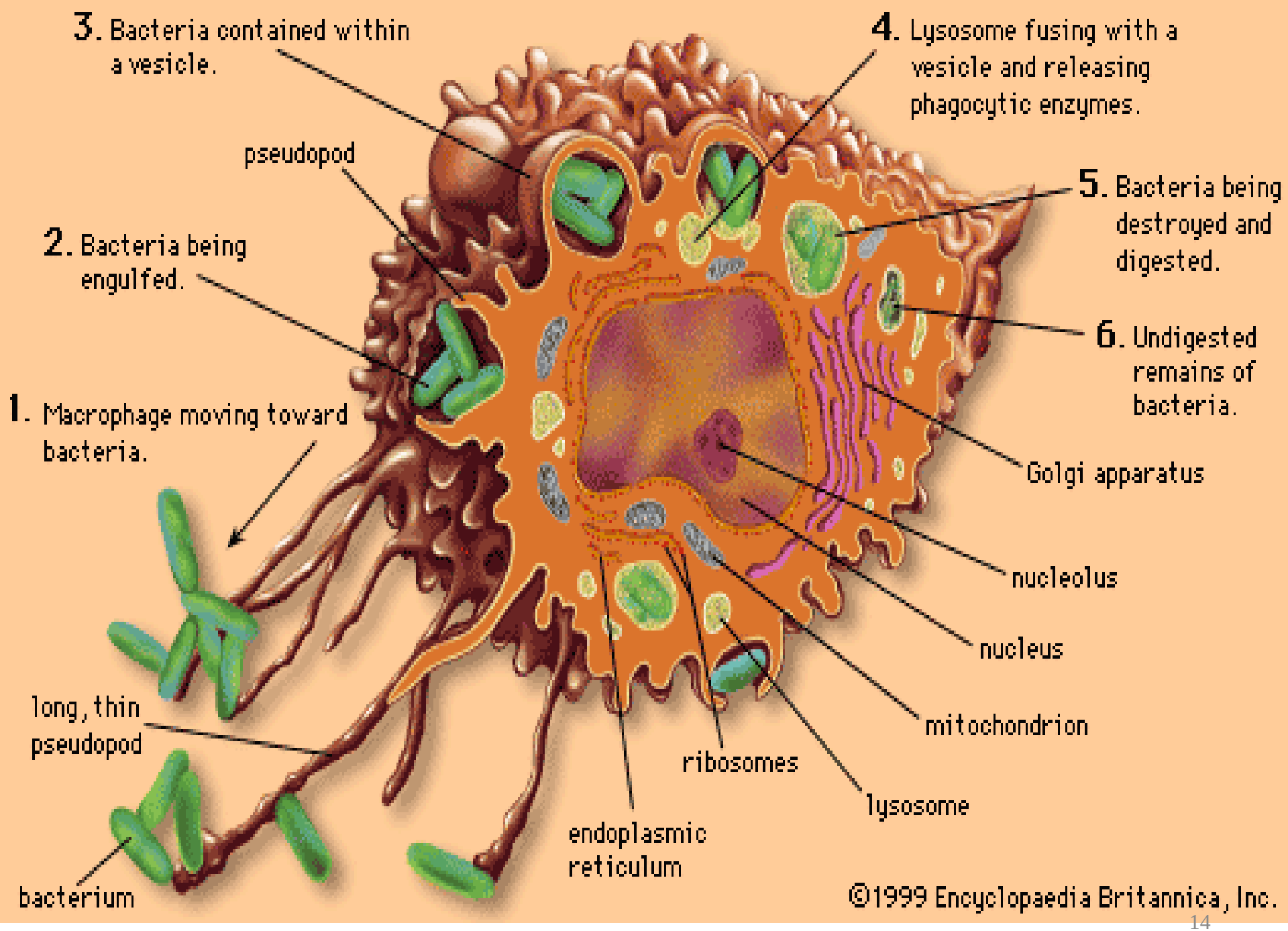
- **Phagocytosis** is part of the natural or innate immune process.

- **Macrophages** are a powerful phagocytic cells:

  - Ingest up to 100 bacteria.
  - Ingest larger particles such as old RBC.
  - Get rid of waste products.

Direct anti-inflammatory




3. Bacteria contained within a vesicle.
4. Lysosome fusing with a vesicle and releasing phagocytic enzymes.
pseudopod
5. Bacteria being destroyed and digested.
2. Bacteria being engulfed.
6. Undigested remains of bacteria.
1. Macrophage moving toward bacteria.
Golgi apparatus
nucleolus
nucleus
mitochondrion
long, thin pseudopod
ribosomes
lysosome
endoplasmic reticulum
bacterium
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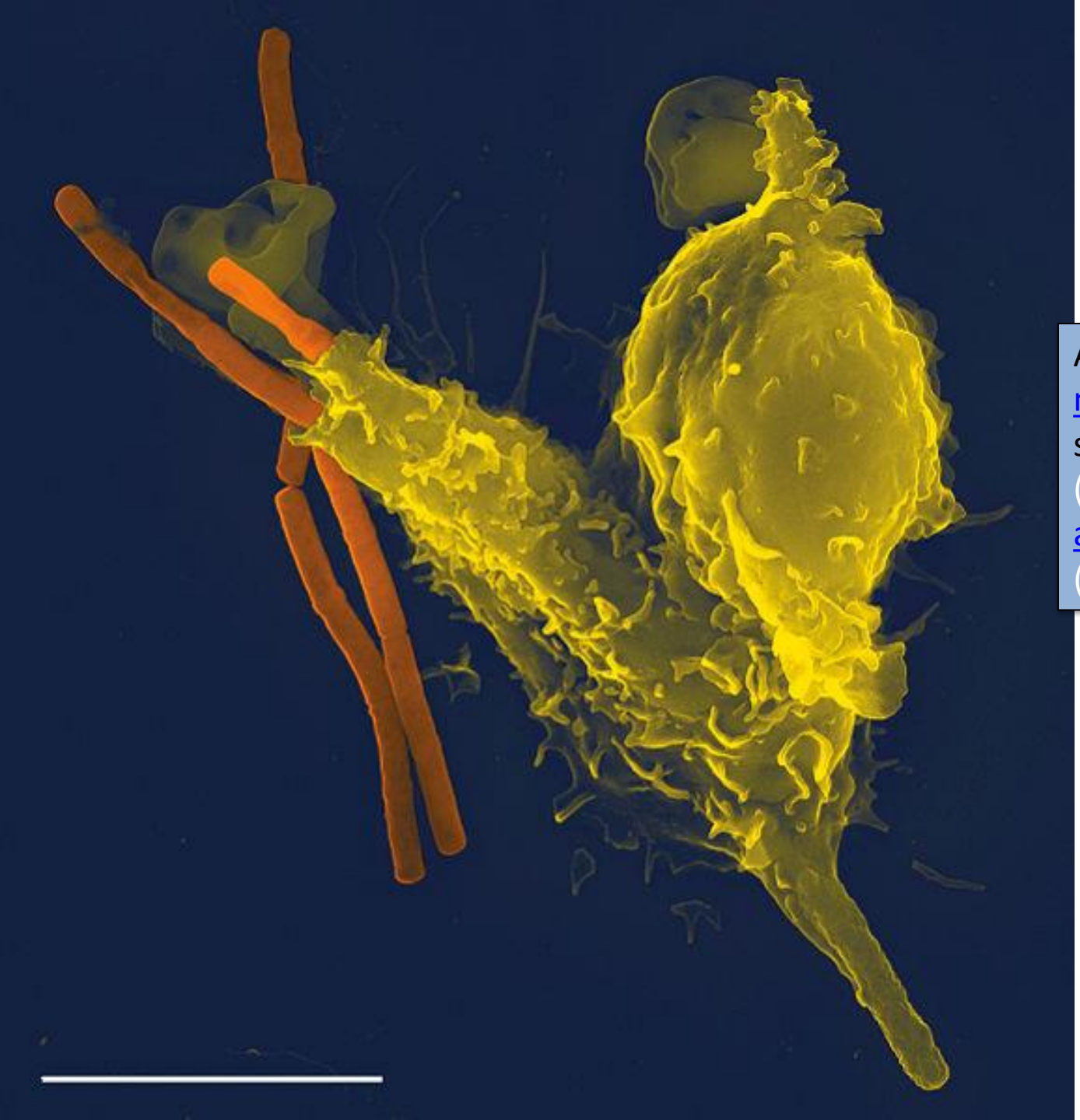
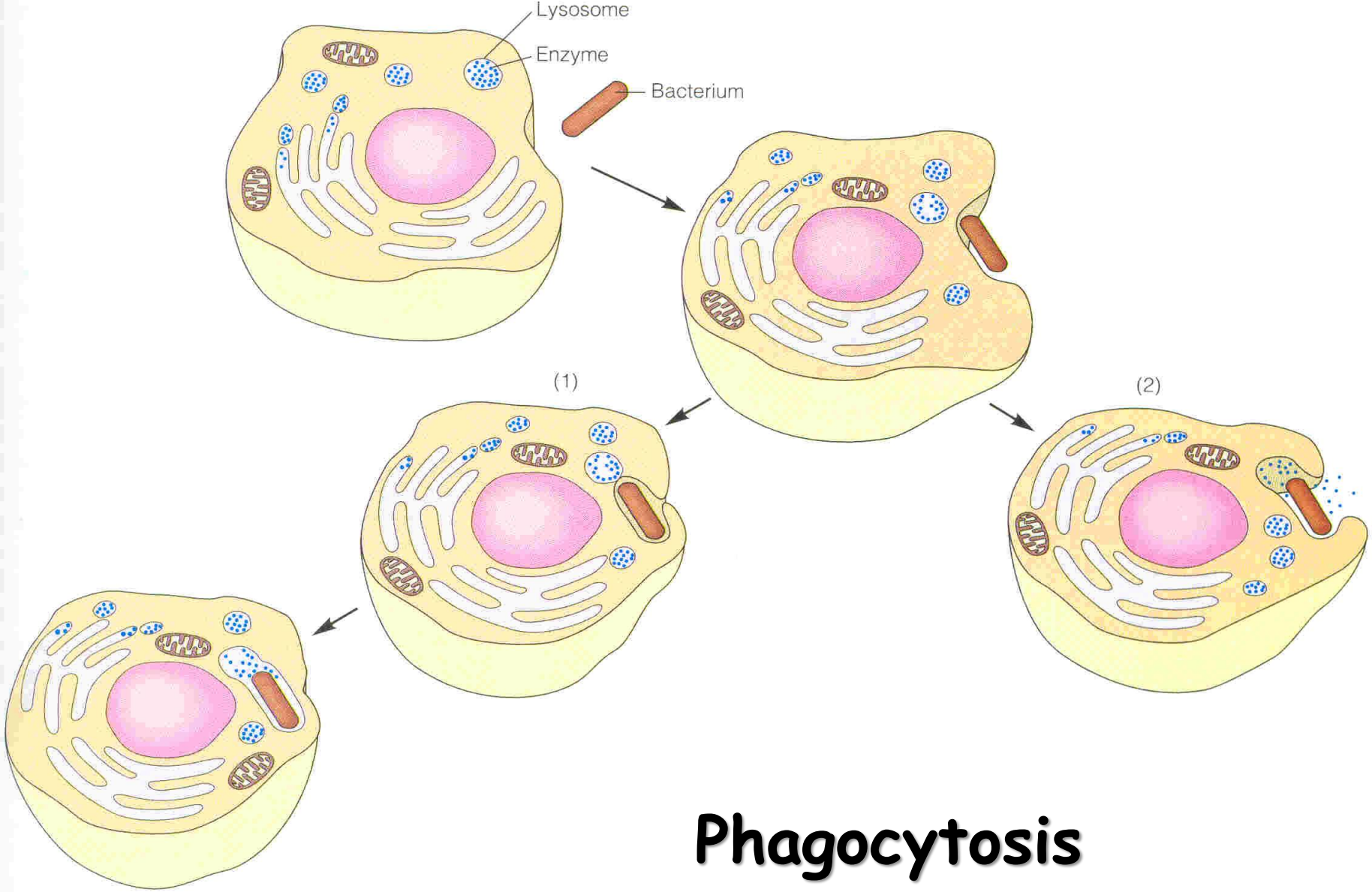


A scanning electron microscope image of a single neutrophil (**yellow**), engulfing anthrax bacteria (**orange**).

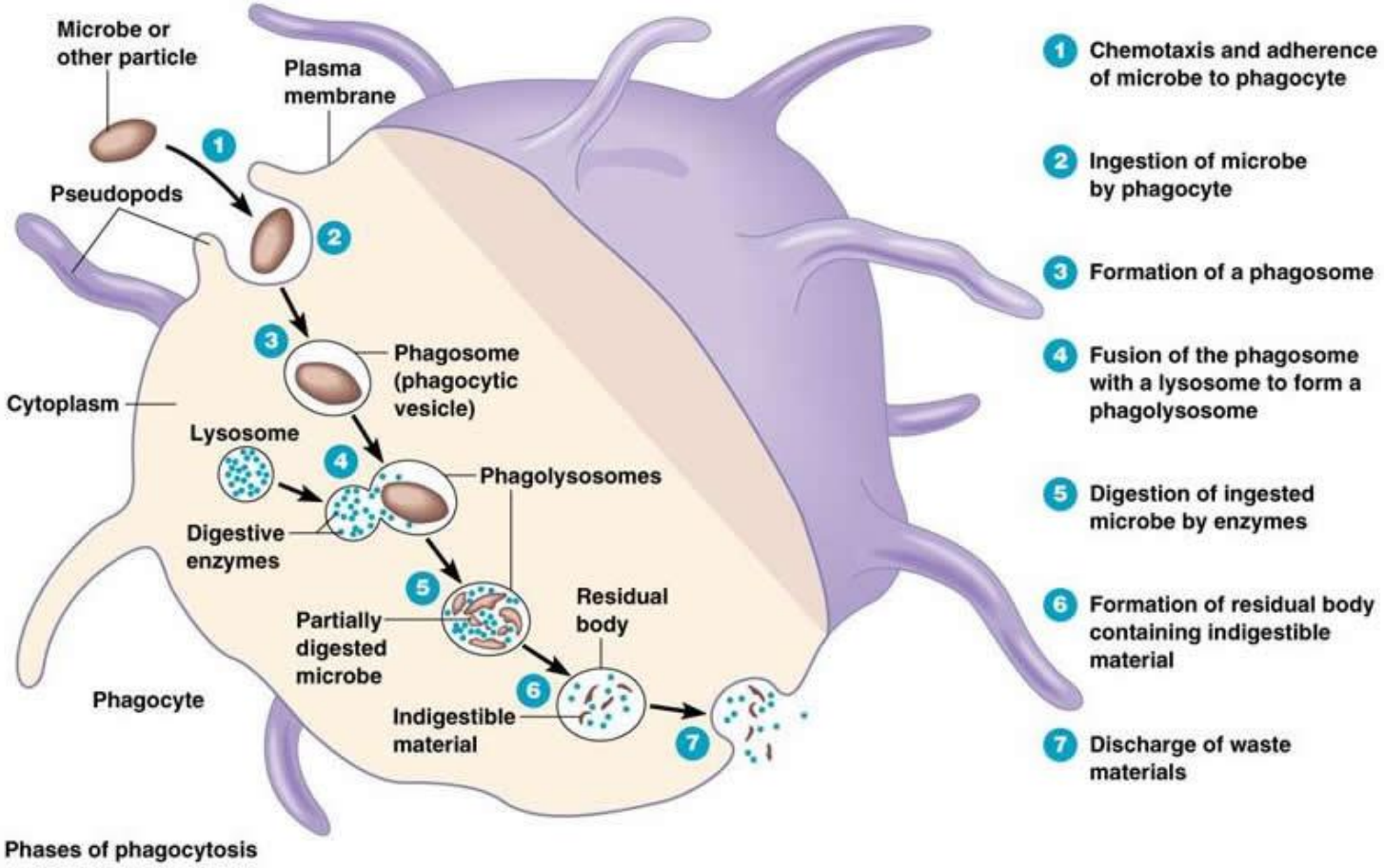


Phagocytosis

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.

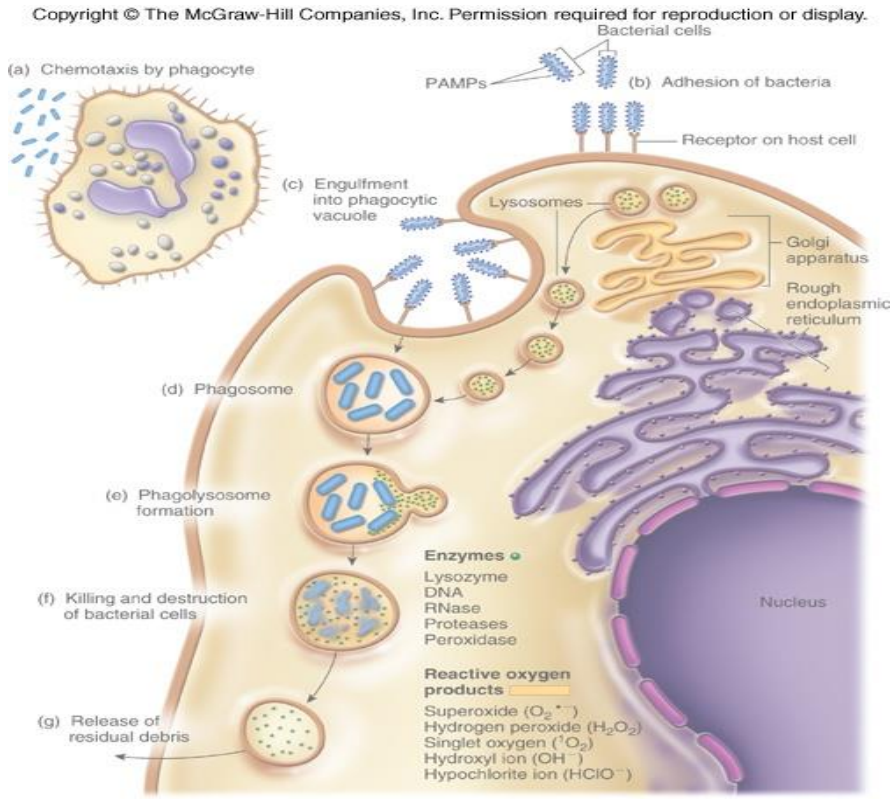
Microbial killing



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.

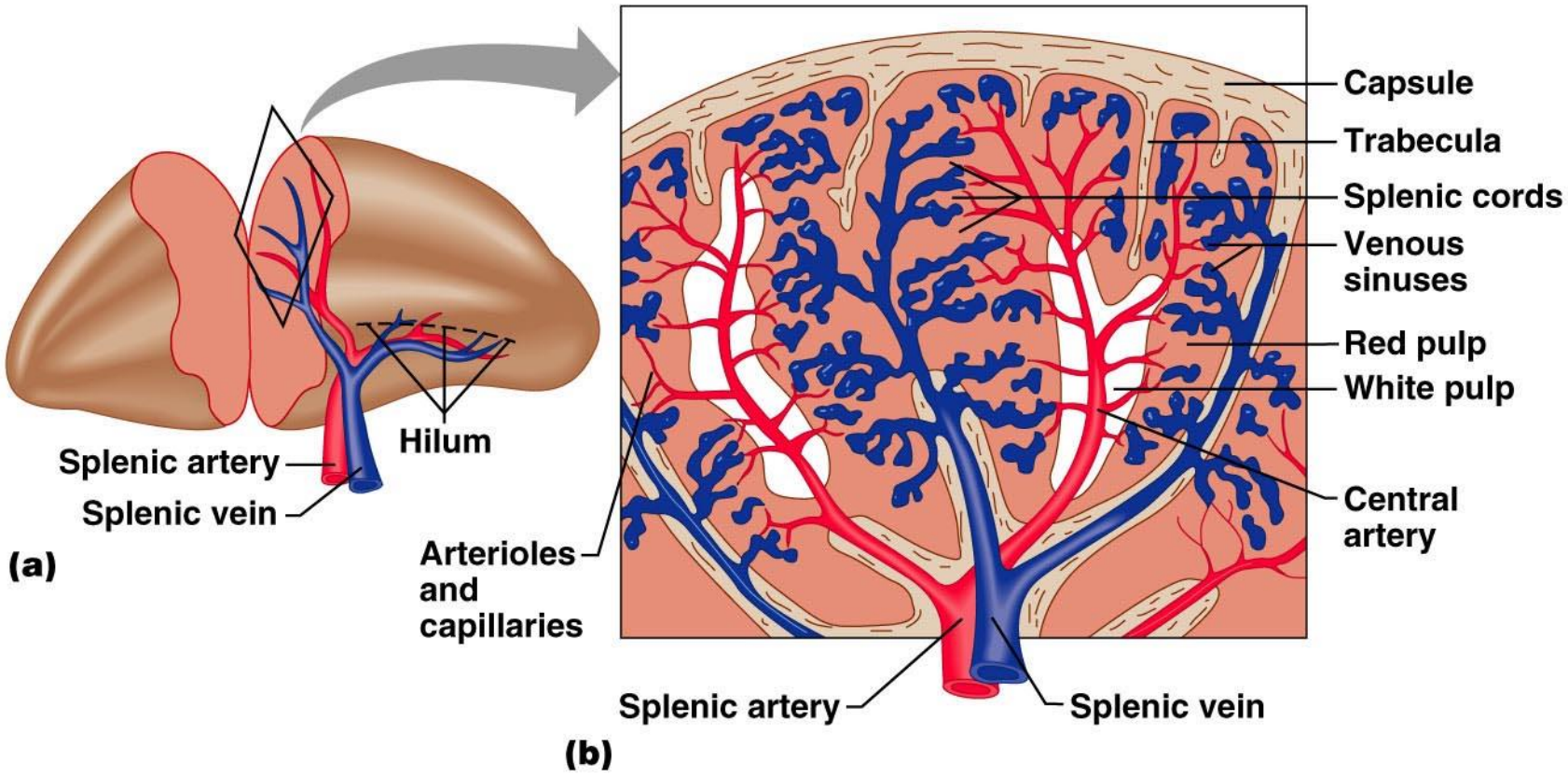
2. Lymph nodes: small, encapsulated, bean-shaped organs stationed along lymphatic channels and large blood vessels of the thoracic and abdominal cavities.

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.

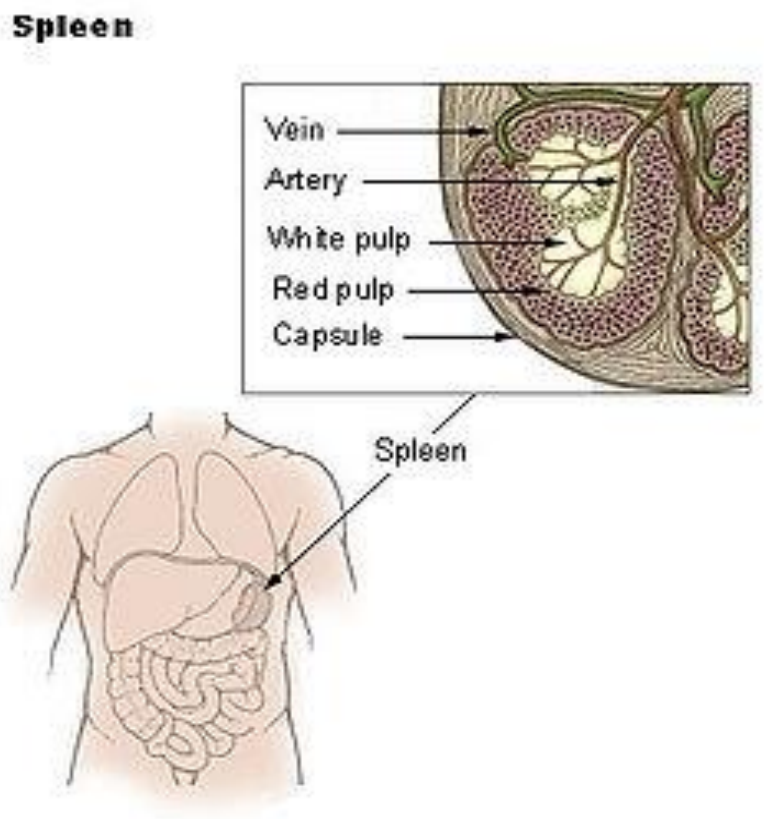
Spleen



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.



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.

Spleenectomy

- **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, Thalassemia,hereditary spherocytosis (HS) and elliptocytosis,
4. Idiopathic thrombocytopenic purpura **(ITP).**
5. Trauma.
6. Hodgkin's disease.
7. Autoimmune hemolytic disorders.

Risks & complications of Spleenectomy

- Overwhelming bacterial infection or 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.

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