BLOOD PHYSIOLOGY

White Blood Cells (WBC)

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Lecture content

1. Eosinophils and Basophilophils formation, maturation and function.
2. Monocytes and macrophage formation, maturation and function.
3. Reticuloendothelial system component and function.
4. Lymphocytes formation, maturation and Function.
5. Leucocytosis, leucopenia and leukemia

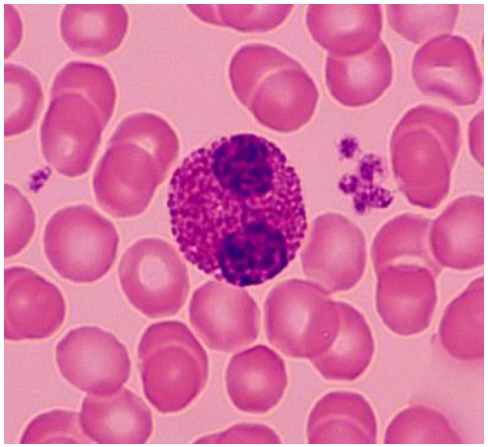
White Blood Cells

EOSINOPHILLS & BASOPHILS

Formation and Maturation of Eosinophils

Formed in Bone Marrow:

1. **Stem cells → Myeloblast→ Promyelocytes →**
2. **Eosinophil myelocytes →**
3. **Eosinophil metamyelocytes →**
4. **polymorphnuclear eosinophil *(*Mature Eosinophil released to blood*)***



Eosinophil Function

- **Phagocytosis**
- **High eosinophil count:**
  - **Parasitic (hook worm, ascaris, bilharzia)**
  - **Allergic (asthma, rhinitis, drug reaction)**
- **Eosinophil attach themselves to parasites and releases substances (hydrolytic anzymes, superoxide*)* to kill it.**

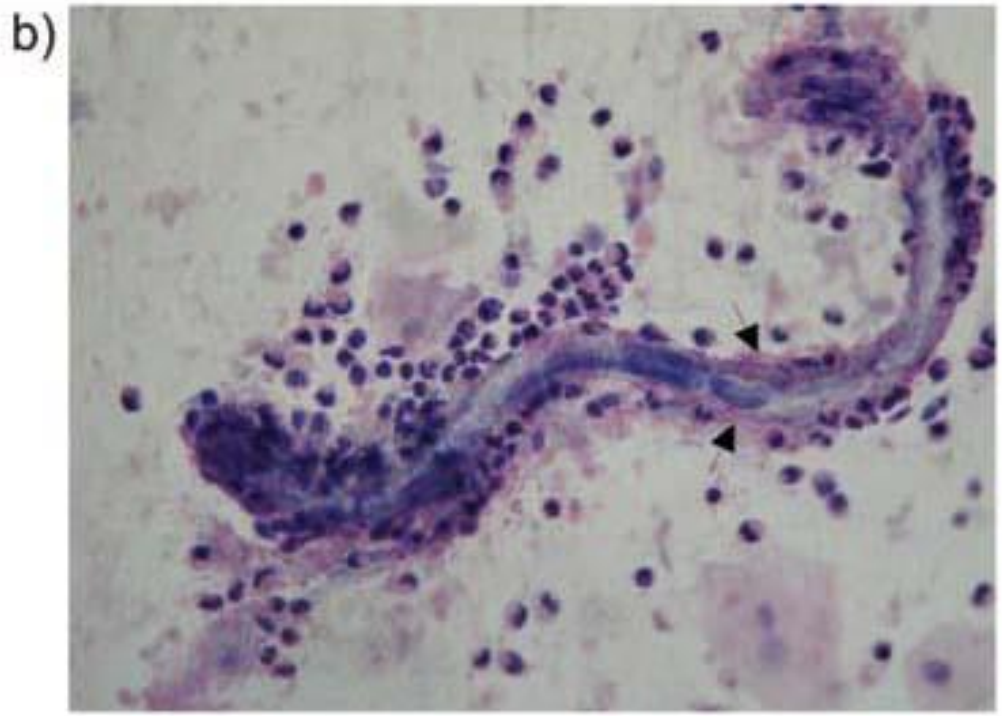
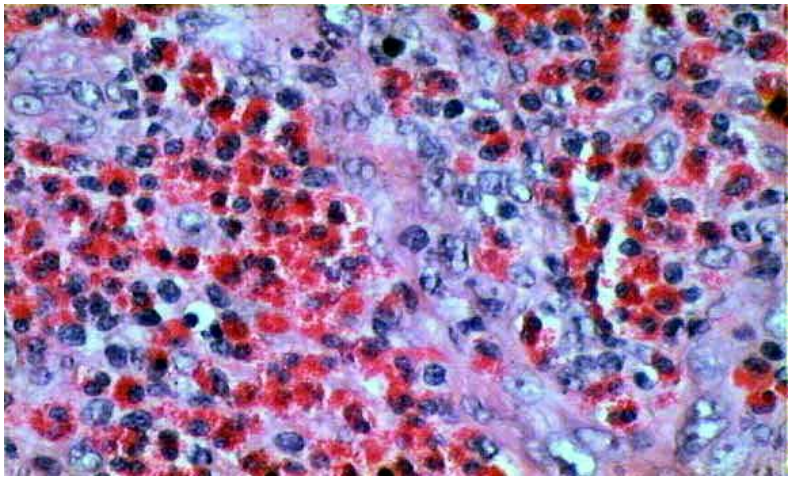


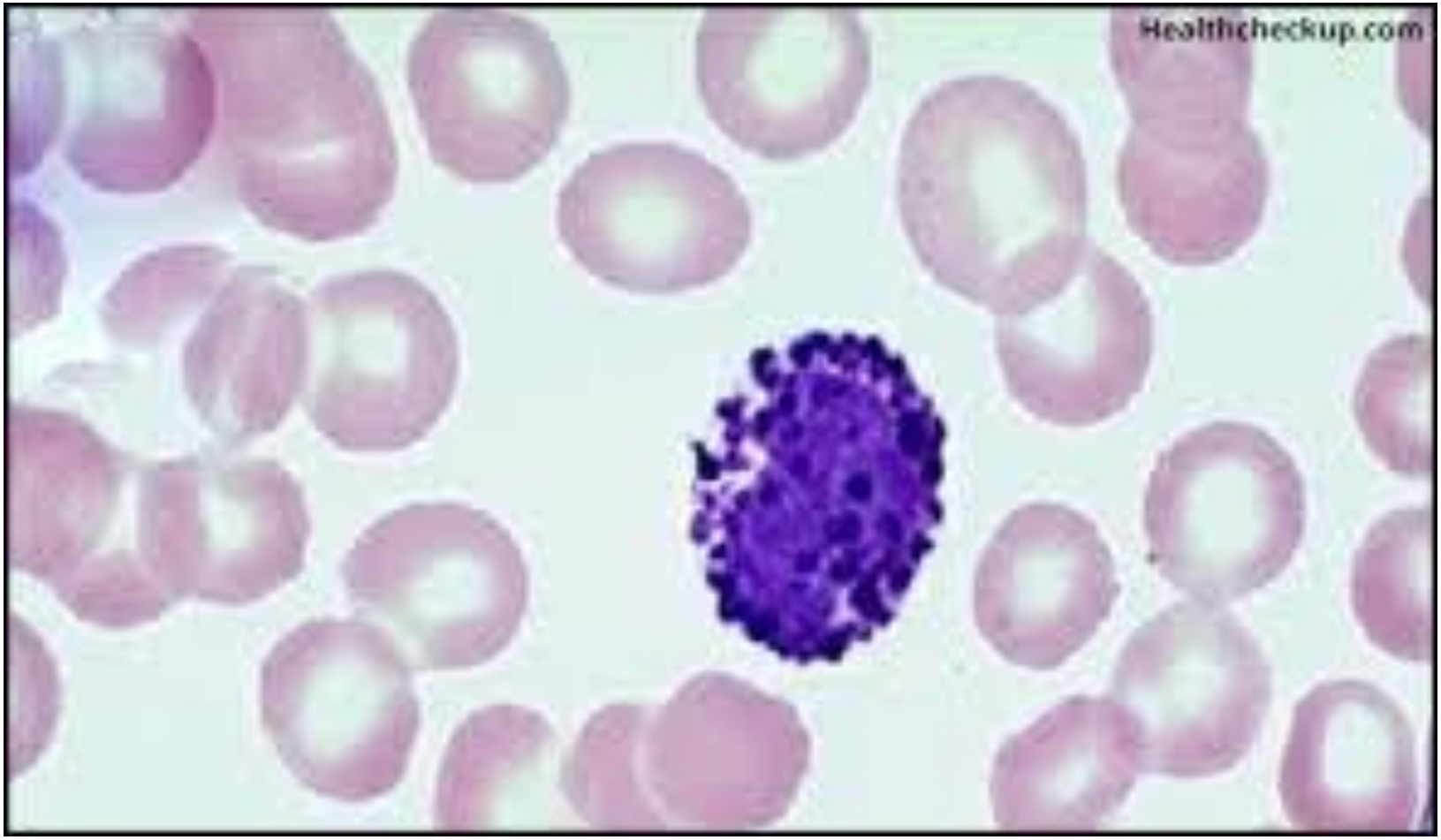
Fig. 1 - *In vivo* eosinophil-mediated cytotoxicity against filariform larvae of *Strongyloides*



Formation and Maturation of Basophils

1. Formed in Bone Marrow
2. Stem cells → Myeloblast→ Promyelocytes →
3. Basophil myelocytes →

   Polymorphnuclear Basophil *(*Mature Basophils released to blood*)*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Basophils

Similar to mast.

cells secret:

- **Heparin to prevent clotting,**
- **Histamine , bradykinin & serotinin contribute to inflammation response**
- **The release of those substances cause local and vascular reactions characteristic of allergic manifestation.**

Mast cell: cell filled with basophil granules, found in connective tissue & releasing histamine & other substances during inflammatory & allergic reactions.

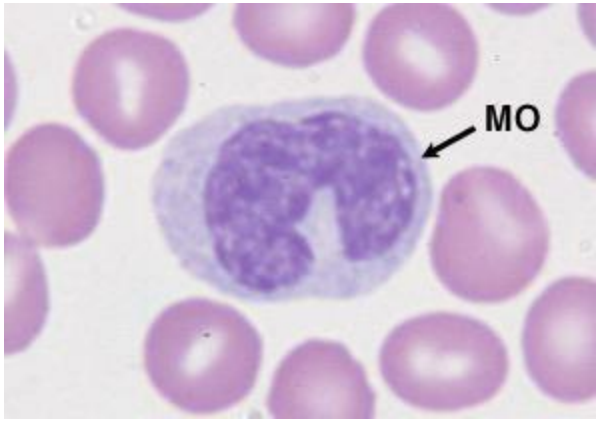
White Blood Cells

MONOCYTES & MACROPHAGES

Monocytes and Macrophages

Formed in Bone Marrow

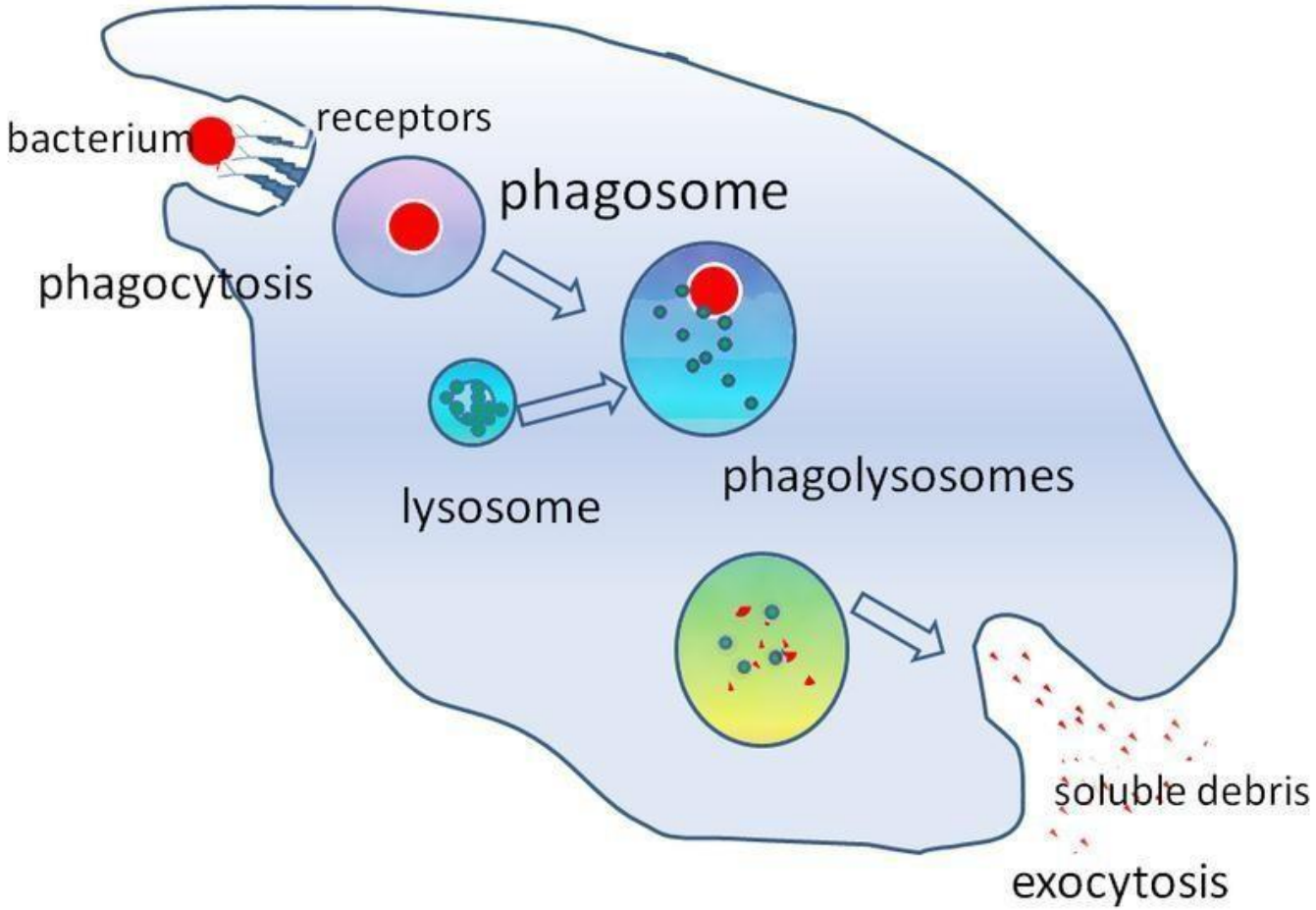
1. **Stem cell → monoblast → promonocyte → mature monocytes released into blood.**
2. **Stay for 10-20 hours in circulation.**
3. **Then leave blood to tissues transforming into larger cells macrophage.**
4. **Macrophage life span is long upto few months.**



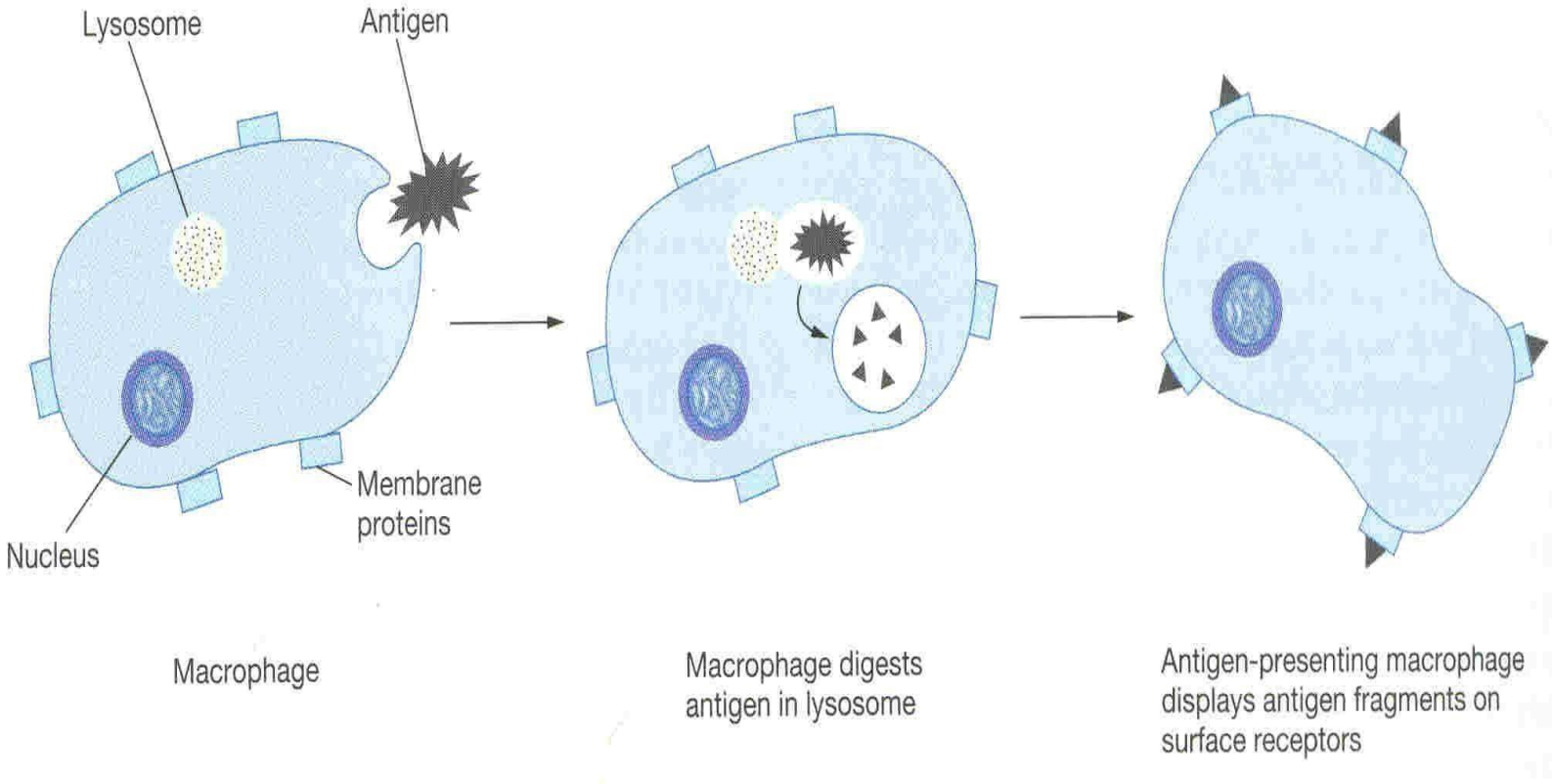
Function of Monocytes and Macrophages

- **Macrophages are a powerful phagocytic cells; first line of defense.**
  - **Ingest up to 100 bacteria,**
    Ingest larger particles as: old RBC
    Get rid of waste (scanvenger)
- **Functions: anti-inflamatory**
  - **Directly: phygocytosis of bacteria, dead cells.**
  - **Indirectly cooperating with lymphocytes by recognizing foreign body (take in foreign body process it and present it to lymphocytes)**

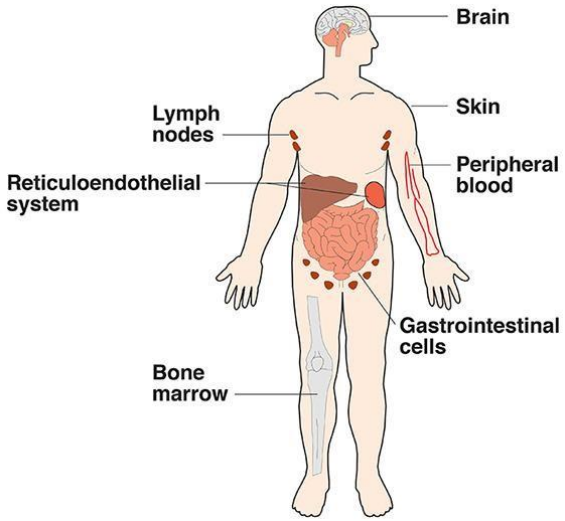
Direct anti Inflammatory



Indirect anti-inflammatory



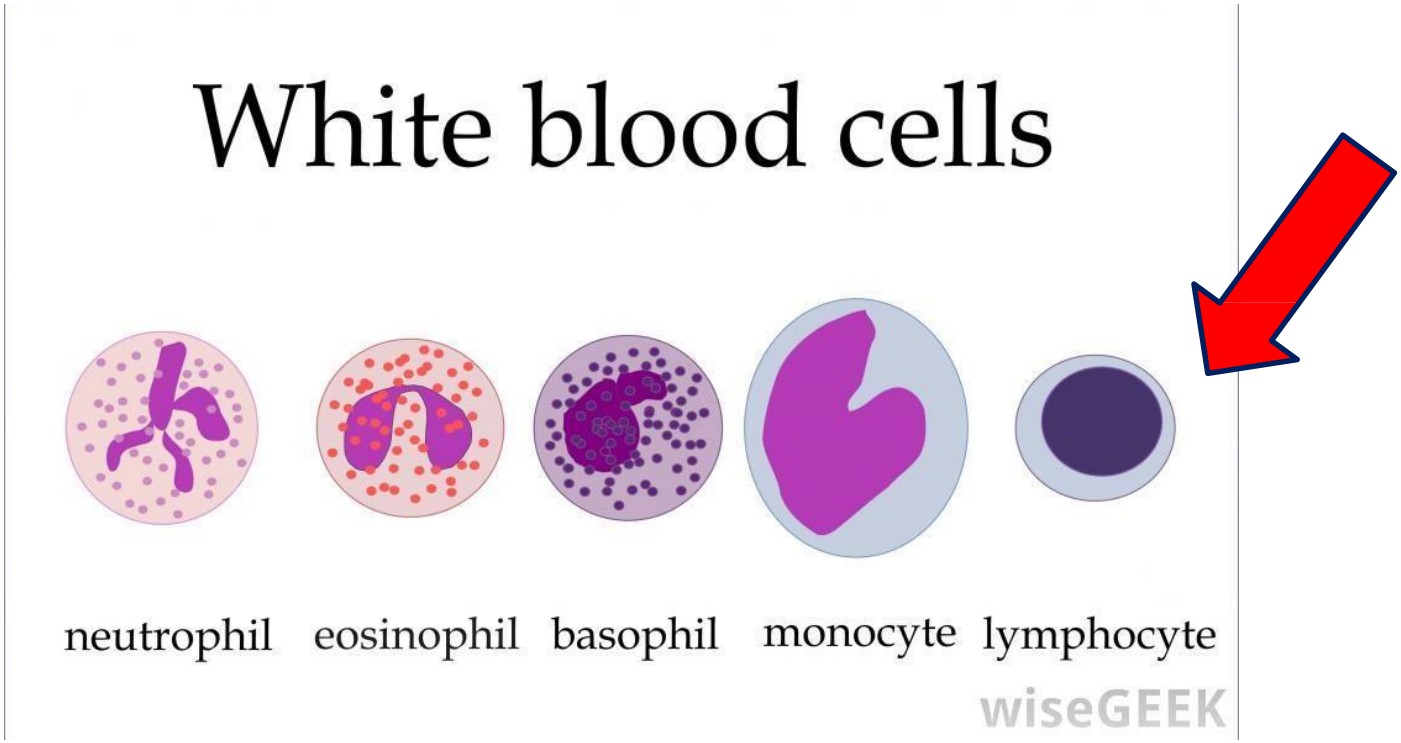
Reticuloendothelial system



- **Consist of:**
  - **Monocytes.**
  - **Macrophage.**
  - **Endothelial cells (bone marrow, spleen, lymph node)**
- **Located in all tissues especially: Skin (histocytes), liver (kupffer), spleen, bone marrow, lymph nodes, lung**

Functions of Reticuloendothelial system

1. **Phagocytosis: Bacterial, dead cells, foreign particles**
2. **Immune function: processing antigen & antibodies production (indirect)**
3. **Breakdown of Hb**
4. **Storage of iron**



White Blood Cells

LYMPHOCYTES

Lymphocytes Formation & Maturation

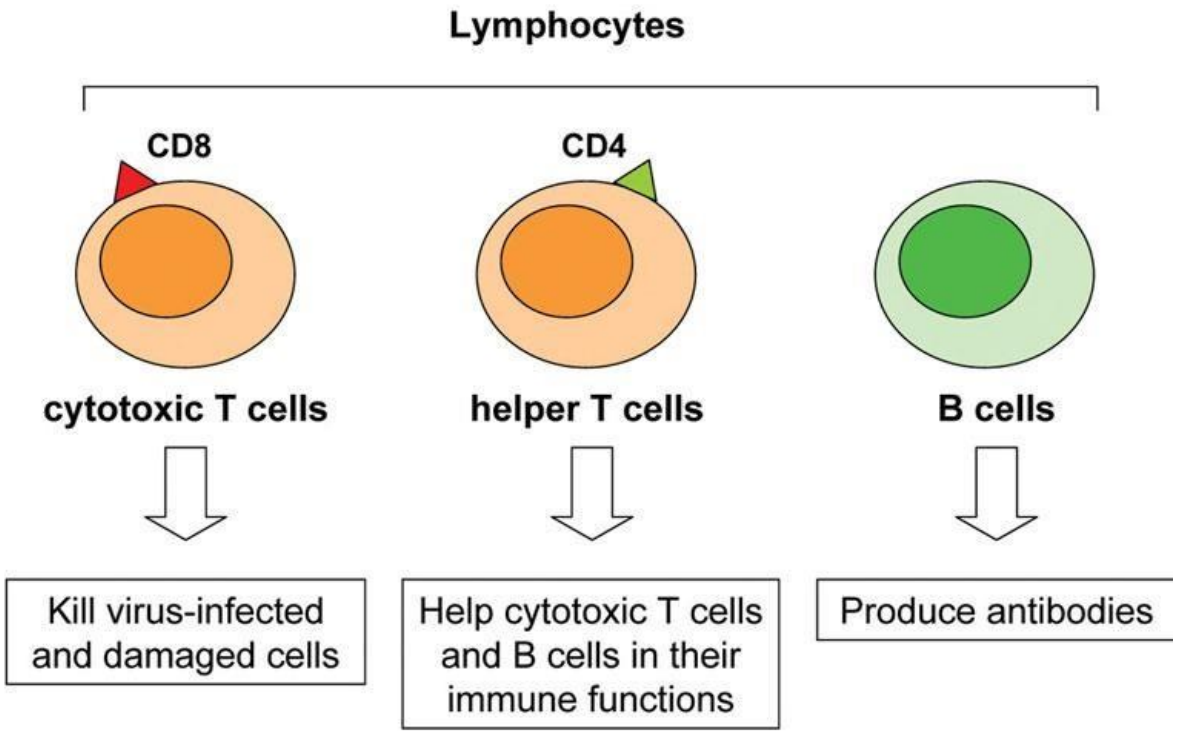
.1 Formed in bone marrow, thymus, lymphoid tissues.

.2 Stem cell (thymus, lymphoid tissue & bone marrow) → lymphoblast → intermediate pyronophilic blast cell → lymphocytes

.3 Life Span Of Lymphocytes ranges from weeks to months according to the type.

LYMPHOCYTES
Types:

1. Thymus dependent (T-lymphocytes)
2. Thymus independent (B-lymphocytes)



T-Lymphocytes (Thymus dependent)

- Formed in bone marrow or lymphoid tissue migrate to thymus for maturation.
- Life spans 100-300 days.
- Circulate between blood, tissues, lymph.
- Types of T-lymphocytes
  - T-helper
  - T-cytotoxic
  - Natural killer

Functions

- Cellular immunity (graft rejection - delayed hypersensitivity.)
- Role in antibody secretion.

Types of T cells (Lymphocytes)

There are various types T cells

- ❖ Cytotoxic T cells (Tc) or Killer Cell(Tk)
- ❖ Helper T cells (Th)
- ▪ Memory T cells sub types
- ▪ Suppressor T Cells sub types

- These are the main types of T-lymphocytes, the remainder few are mainly regulatory.

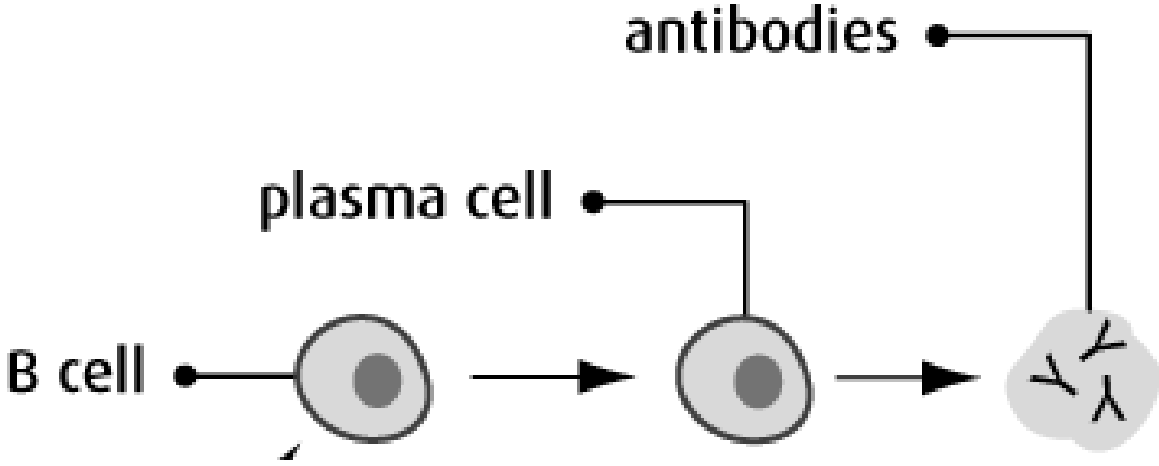
B- Lymphocytes (thymus-independents)

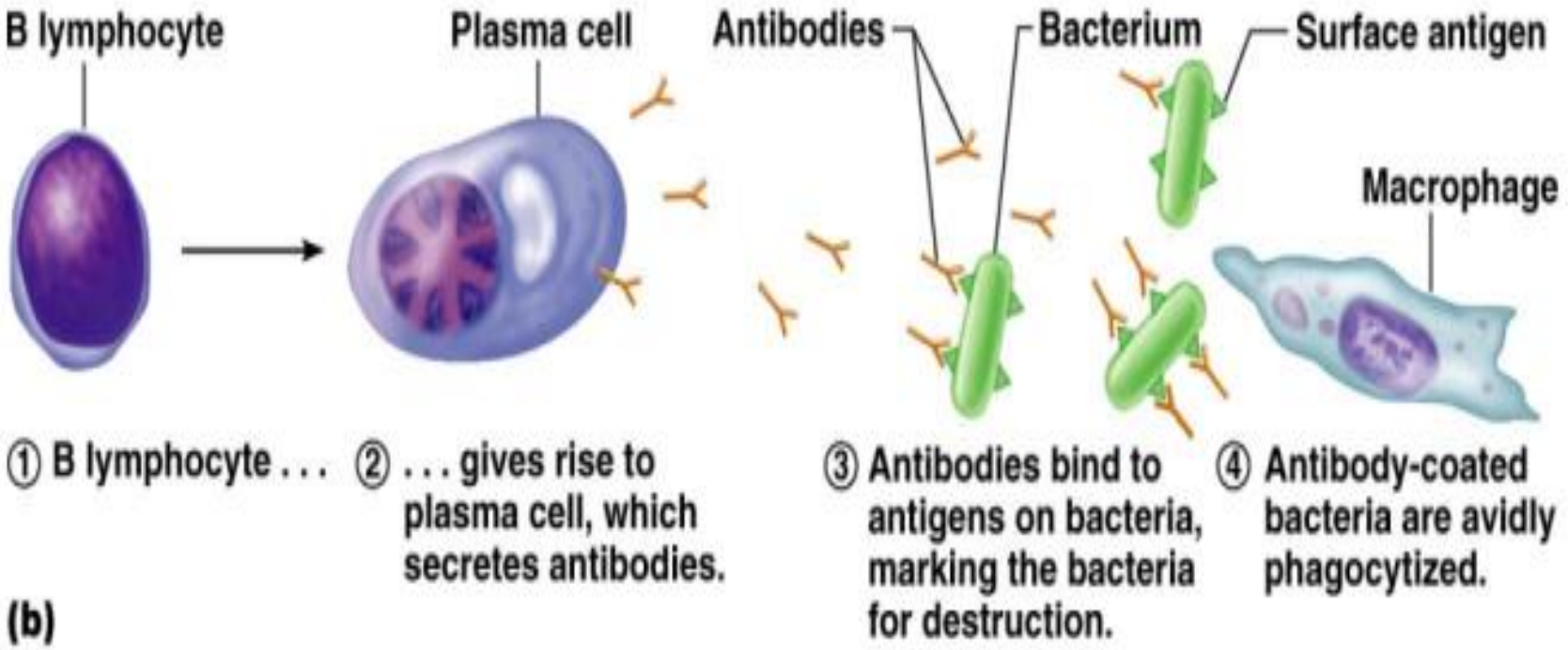
- First discovered in Bird Bursa
- Formed in: Bone marrow, germinal layer of lymph node, red pulp of spleen
- Life span 2-7 days

Stimulated by antigen

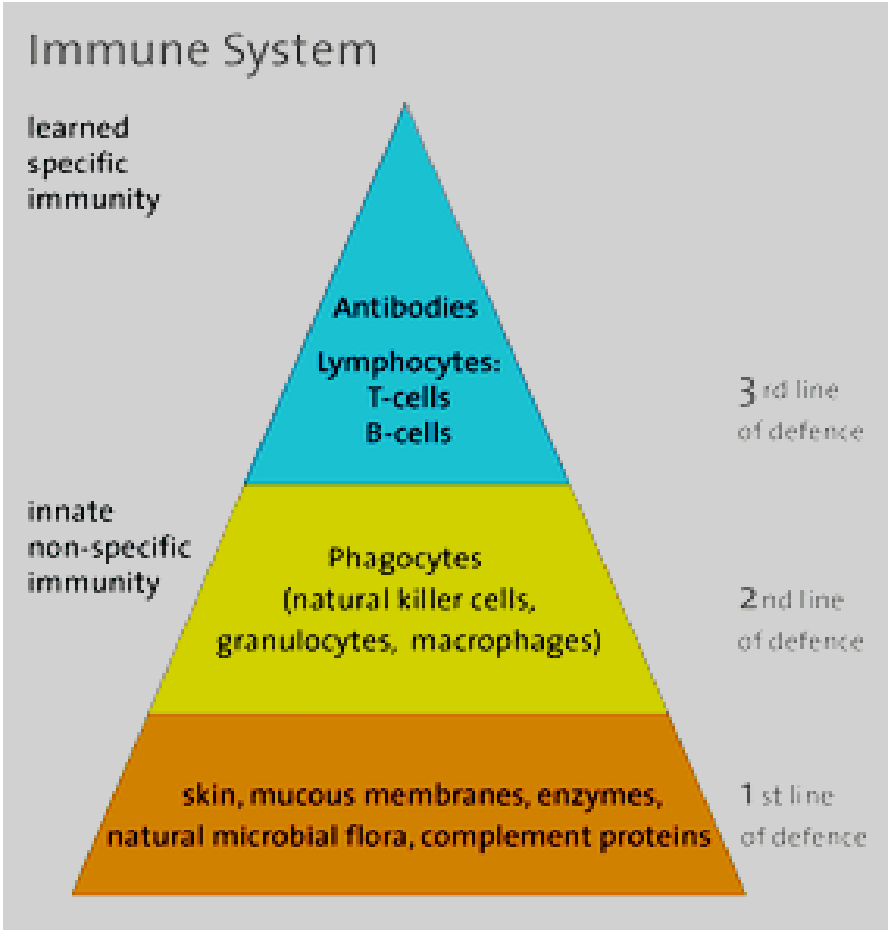
- It transforms into large plasma cell (produce antibody)
- Function: Humoral immunity.

Plasma Cell Development




B lymphocyte
Plasma cell
Antibodies
Bacterium
Surface antigen
Macrophage
① B lymphocyte . . .
② . . . gives rise to plasma cell, which secretes antibodies.
③ Antibodies bind to antigens on bacteria, marking the bacteria for destruction.
④ Antibody-coated bacteria are avidly phagocytized.
(b)

Immune System



Major organs

Primary Lymphoid Organs

- Bone marrow
- Thymus

Secondary (or peripheral) Lymph organs

- tonsils
- adenoids
- spleen
- Lymph nodes
- Lymphatic vessels
- appendix
- peyer's patches

Types of Immunity

Immune system

Innate (non-specific; natural) immunity

1. Second line of defense
2. Is present at birth
3. Persists throughout life
4. Can be mobilized rapidly and act quickly
5. Attacks all antigens fairly equally

Adaptive (specific; acquired) immunity

1. Third line of defense.
2. Antigen specificity. It is activated by thousands of diverse antigens.
3. Responds with the proliferation of cells and the generation of antibodies.
4. Responds slowly, being fully activated about 4 days after the immunologic threat.
5. Exhibits immunologic memory, so that repeated exposure to the same infectious agent results in improved resistance against it.

The Complement System is Part of the 1st Line of Defense

complement system:

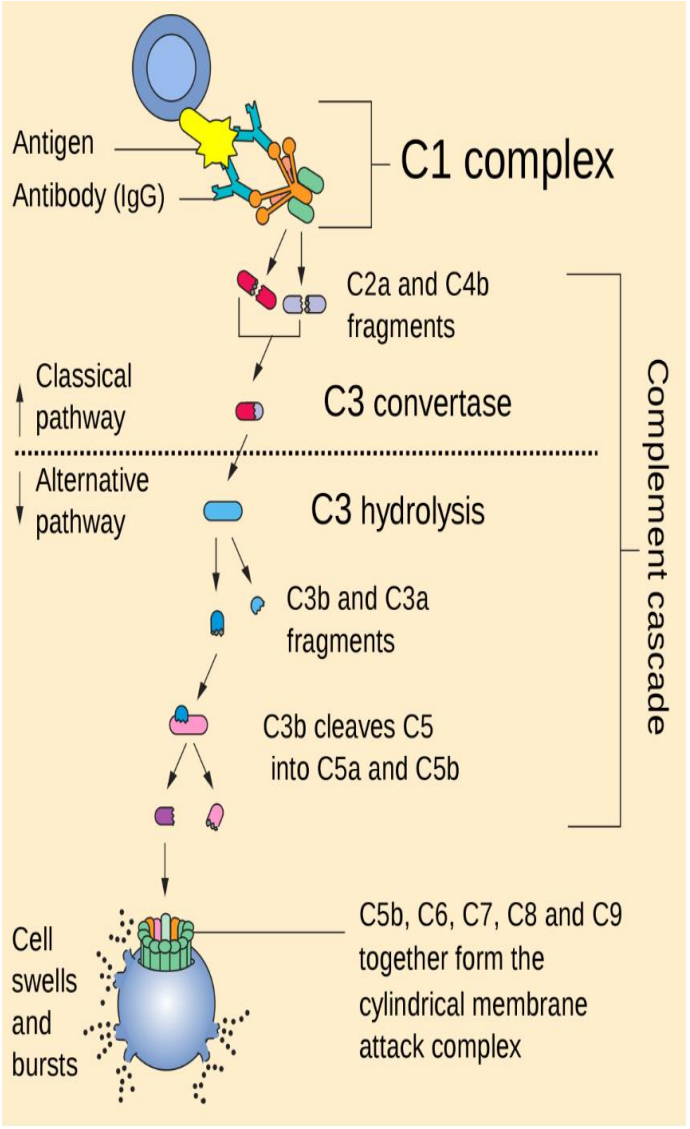
***1*- The first part of the immune system that meets invaders such as bacteria**

2-it <u>is a group of proteins</u>.

3- These proteins flow freely in the blood and can quickly reach the site of an invasion where they can <u>react directly with *antigens (*</u> molecules that the body recognizes as foreign substances).

functions of complement proteins (When activated):

1. **Trigger inflammation.**
2. **Attract eater cells such as macrophages to the area.**
3. **Coat intruders so that eater cells are more likely to devour (swallow and eat) them (a process called as opsonization).**
4. **Kill intruders.**



Leucocytosis

Increased number of WBC

Physiological

–Diurnal ↓ morning ↑ evening

– After physical exercise

–Stress or Adrenaline injection

Pathological:

– Bacterial infection (tonsillitis, Appendicitis)

– Worm infection.

– Allergric reactions.

Leucopenia

Deficiency of the white blood cells:

Causes:

1- malnutrition.

2- typhoid fever.

3- drugs.

4- B_{12} & folic acid↓

5- radiation

Leukaemia

- Cancer of white cells due to chromosomal abnormality caused by chemicals, radiation, and viruses.
- WBC more than $50x10^3$
- Types of leukaemia
  - Myeloblast leukaemia → myeloid cells
  - Lymphoblast leukaemia → lymphocytic cells
- Acute or chronic onset
- Accompanied with anaemia, bleeding

Objectives

At the end of this lecture student should be able to:

١. **Describe Esinophils formation and functions**

٢. **Describe Basophils formation and functions**

3. **Describe Monocytes and macrophage formation and functions.**

4. **Describe Reticuloendothelial componants and functions**

Objectives

At the end of this lecture student should be able to:

5. **Describe lymphocytes formation and maturation.**
6. **Describe the functions of the different types of lymphocytes.**
7. **Recognise leucocytosis and leucopenia.**
8. **Recognize type of leukaemia**