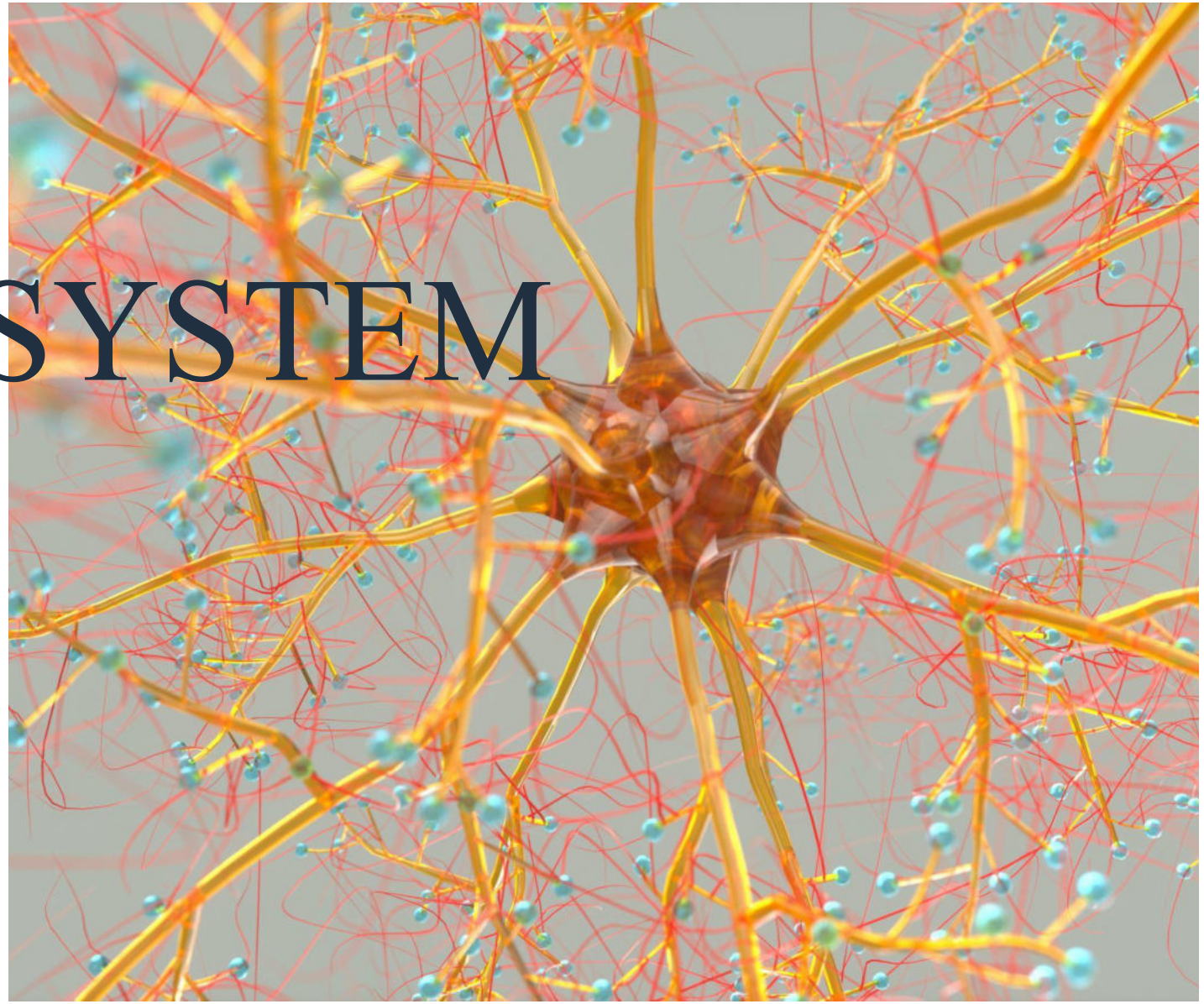
IMMUNE SYSTEM

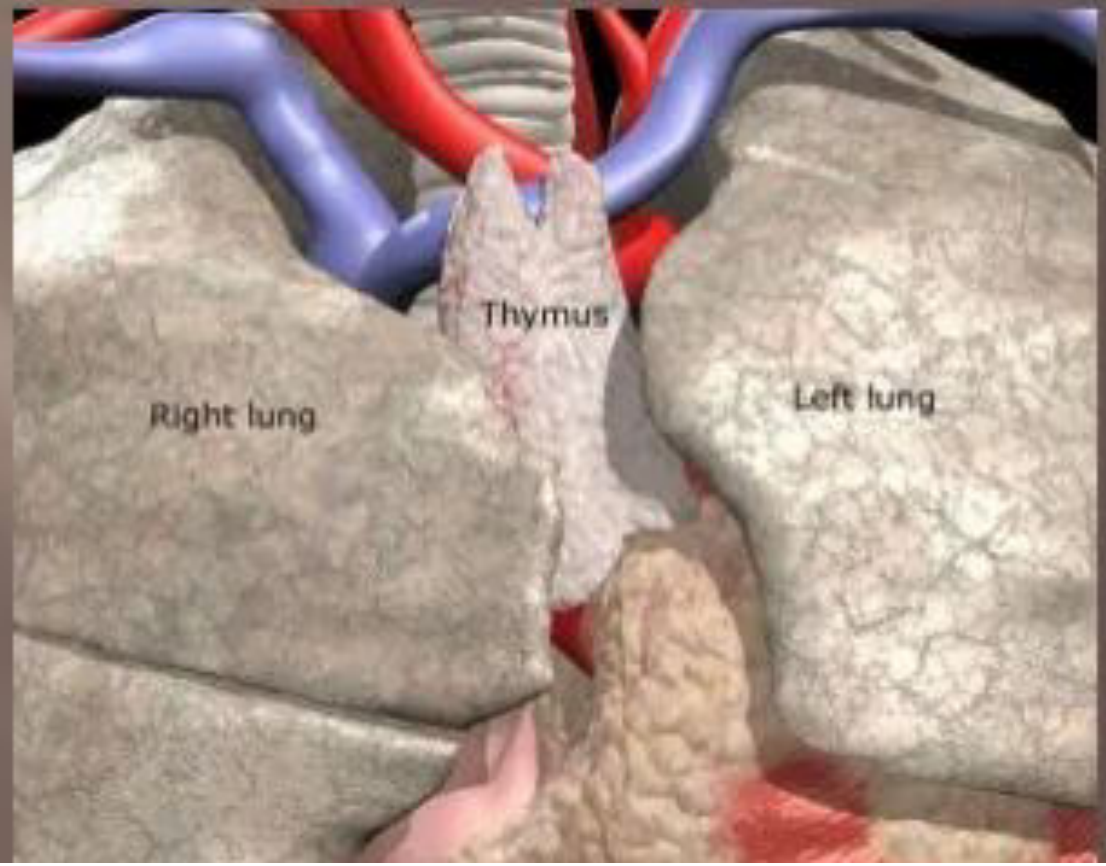


Dr. Kavitha

28th march 2022

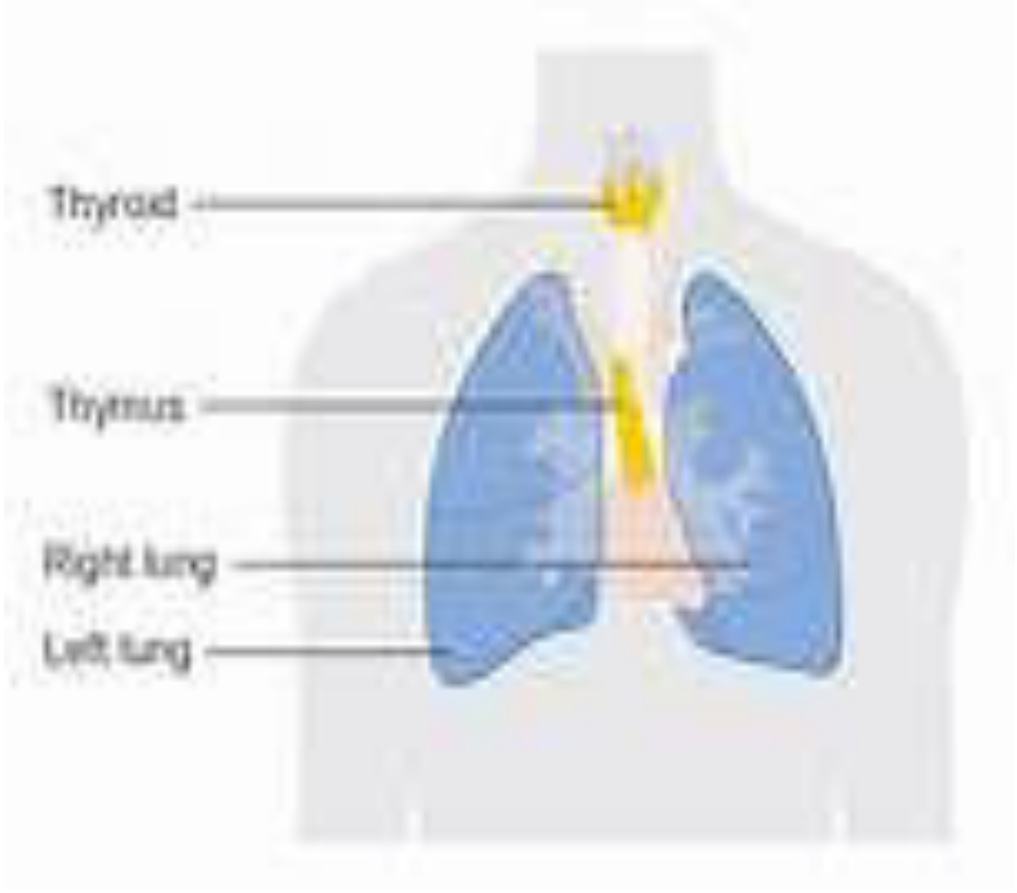
Thymus Gland

The Thymus Gland:
The Heart Of The Immune System

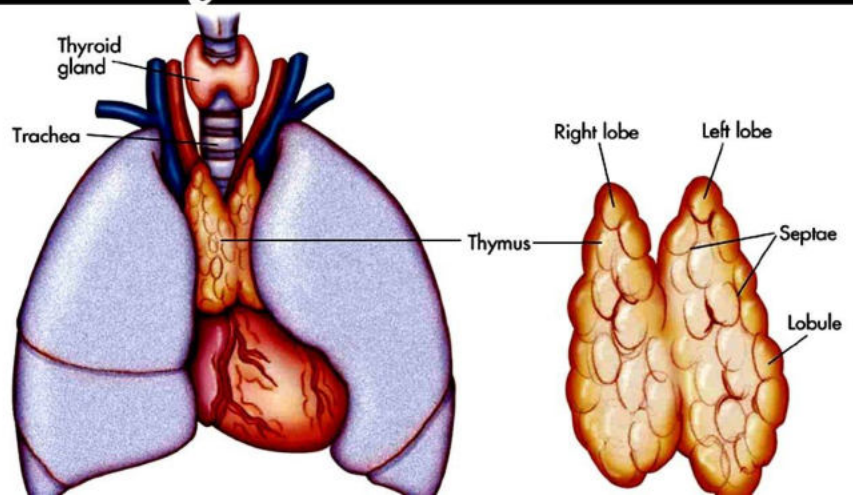


Thymus

- The thymus gland is a very unique organ that is at its largest in children and shrinks away as the body grows older. It is about 2.5 to 5 cms wide, 4 to 6 cms long and 1 cm thick at birth. At its largest instance, (viz. during puberty) the thymus weighs just under 30 grams. After puberty, the thymus slowly starts to shrink and by the age of 75, it is nothing more than fatty tissue. It is a part of the lymphatic system along with the spleen, tonsils and adenoids. It also forms a part of the endocrine system. It is made up of epithelial cells, lymphocytes and fat tissues. This gland is active only until puberty.



Thymus Gland



- The thymus is a specialized primary lymphoid organ of the immune system. Within the thymus, thymus cell lymphocytes or T cells mature. T cells are critical to the adaptive immune system, where the body adapts specifically to foreign invaders. The thymus is …
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Functions ------thymosin

- One of the most important functions of the thymus is to stimulate the production of very specialized cells called T-cells (also called T-lymphocytes). These cells are responsible for directly fending off foreign pathogens such as viruses and bacteria. They also regulate the immune system, helping to prevent autoimmunity, wherein, the body's immune system elicits immune responses on its own healthy cells.
- Thymus also secretes thymosin to stimulate the development of T-cells.
- To stimulate the production of T-Cells, the thymus secretes a hormone called Thymosin. Then, a type of white blood cell called lymphocytes pass through the thymus and gets transformed into T-Cells. Once these T-cells have matured, they migrate to the lymph nodes in the body and consequently aid the immune system. The thymus gland is only active until puberty, however, they produce all the T-cells required by the body well before this period.

Thymus gland -disorders

- The most common disorders caused by the dysfunctioning of thymus gland are- Myasthenia gravis, pure red cell aplasia, and hypogammaglobulinemia.
- Myasthenia gravis is caused due to abnormal enlargement of the thymus. The enlarged thymus produces antibodies that destroy the muscle receptor sites. Thus, the muscles become very weak.
- Pure red aplasia is caused when the patient's own immune cells attack the blood-forming stem cells. This happens when there is a tumour in the thymus.
- Hypogammaglobulinemia occurs when the body does not produce enough antibodies.

categories of immunity

- The human body relies on certain defenses to help keep sickness at bay. The immune system triggers a response that produces cells and proteins to fight off infections.
- There are two categories of immunity at work within the body—innate and acquired.
- **Innate immunity/ non- specific defence mechanisms** is a type of nonspecific protection against pathogens. It responds quickly to a pathogen, but It doesn't have the ability to remember individual threats and mount a specifically targeted defense if they show up again.
- **Acquired immunity/specific defence mechanisms** is the part of immunity that works to identify the difference between individual types of threats.[1] Acquired immunity works more slowly than innate immunity, but it remembers the antigen and responds to it quickly and in a targeted manner if you are exposed again.

definitions

T-cells are a type of white blood cell that originates in the bone marrow and mature in the thymus. They play an important role in defending the body against viruses, protozoa and bacteria

B lymphocyte (B cell) is one of the most important cells of the body. These cells form part of the adaptive immune response by producing antibodies and presenting antigens to T cells. Once activated, they can mature into plasma cells or memory B lymphocytes.

Antibodies (also called immunoglobulins) are specialized proteins that travel through the bloodstream and are found in bodily fluids. They are utilized by the immune system to identify and defend against foreign intruders to the body.

- Antigen is a substances usually protein in nature and sometimes polysaccharide, that generates a specific immune response and induces the formation of a specific antibody or specially sensitized T cells or both.
- MHC- major histocompatibility complex can be defined as a tightly linked cluster of genes whose products play an important role in intercellular recognition and in discrimination between self and non-self. The term ‘histo’ stands for tissue and ‘compatibility’ refers to ‘getting along or agreeable’ The main function of MHC molecules is to bring antigen to the cell surface for recognition by T cells.

Types of Immunity

- Active immunity is the immunity induced in entities by the exposure of antigens. It is mediated by two well-defined mechanisms:

- Cell-mediated Immunity
- Humoral Immunity.
- Both the immune pathways are different in their targets, components and methods of destroying pathogens

- Humoral Immunity
- Humoral immunity is mediated by antibodies. It shows a quick response against pathogens. It is the major defence mechanism against extracellular microbes trying to invade the host systems. The antibodies produced by the B-cells bind to the antigens and neutralize the microbes.
- Cell-Mediated Immunity
- Cell-mediated immunity is facilitated by the T-helper and cytotoxic T-cells. Cytokines secreted by the T- helper cells activate phagocytic cells which phagocytose the pathogens and kill them.

Action of T cells-Cell mediated immunity

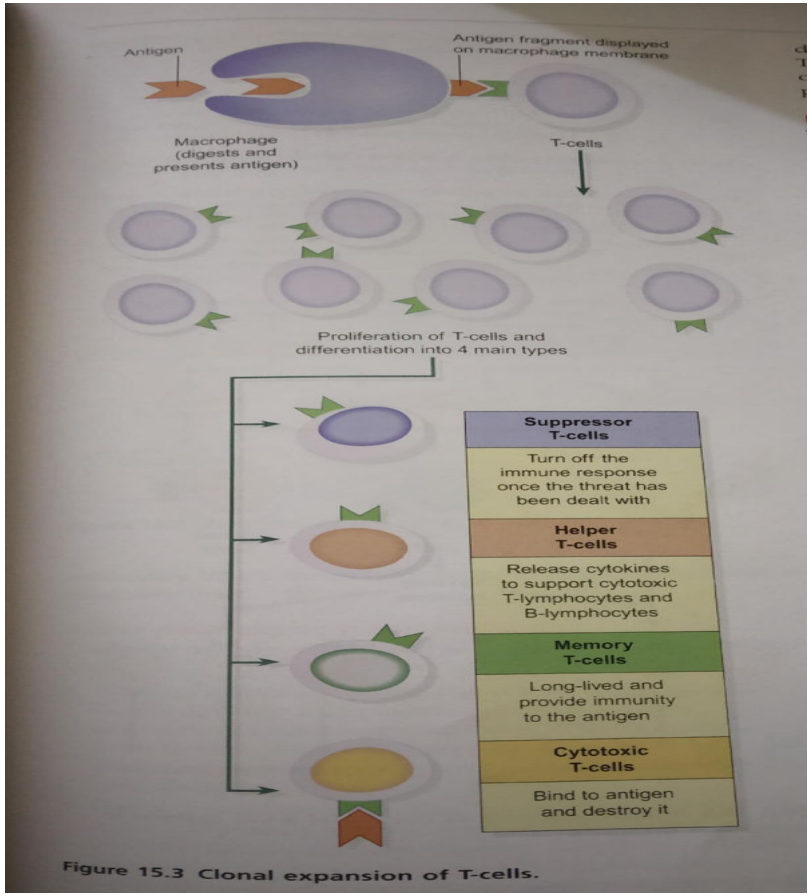
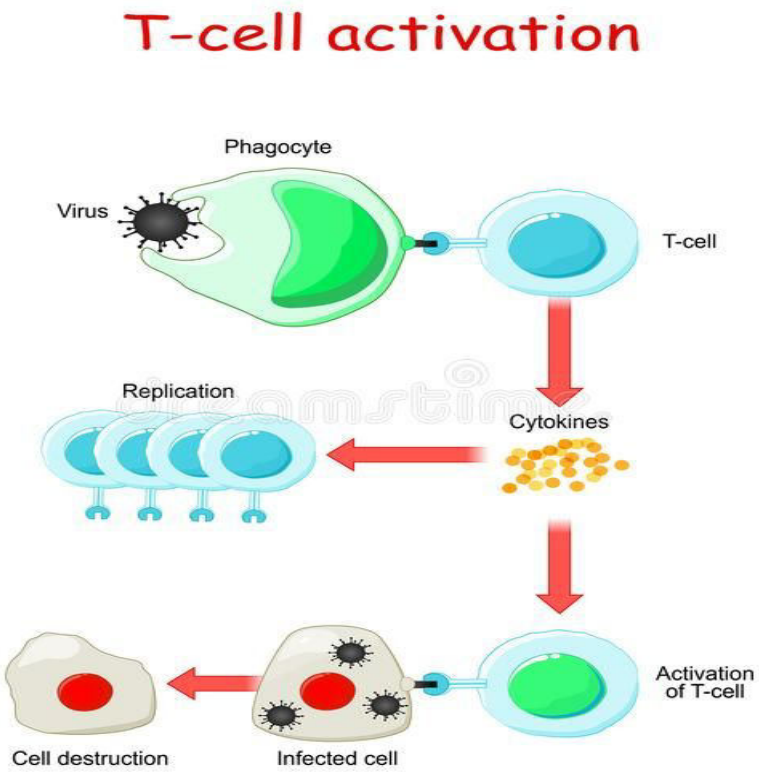


Figure 15.3 Clonal expansion of T-cells.



Tcells –Types

- **Cytotoxic T cells**
- Cytotoxic T lymphocytes kill their target cells primarily by releasing cytotoxic granules into the target cell. These cells recognise their specific antigen (such as fragments of viruses) only when presented on **MHC Class I** molecules present on the surface of all nucleated cells.
- MHC Class I molecules interact with CD8 on the cytotoxic T cells. **Cytotoxic** T cells require several signals from other cells like dendritic cells and T helper cells to be activated.
- Their main function is to kill virally infected cells, but they also kill cells with intracellular bacteria or tumorous cells.
- **T-Helper Lymphocytes**
- T helper cells (Th) have a wide range of effector functions and can differentiate into many different subtypes, such as **Th1, Th2, Th17, TfH** cells and regulatory T cells.
- They become activated when they are presented with peptide antigens on MHC Class II molecules. These are expressed on the surface of APCs. **MHC Class II** molecules interact with CD4 on the T helper cells, which helps identify this cell type.
- CD4+ T cell functions include activating other immune cells, releasing **cytokines,** and helping B cells to produce antibodies. They help to shape, activate and regulate the adaptive immune response.

T cells –types -contd

- **Memory T cells**
- Antigen-specific, long-lived memory T lymphocytes form following an infection. Memory T lymphocytes are important because they can quickly proliferate into large numbers of effector T lymphocyte upon re-exposure to the antigen and have a low threshold for activation.
- They provide the immune system with memory against previously encountered antigens. Memory T lymphocytes may either be CD4+ or CD8+.

Suppressor T cells: these cells act as brakes turning off T and B cells. This limits the powerful and potentially damaging effects of the immune response. Suppressor T cells are thought to help prevent the development of auto-immunity and to protect the foetus during pregnancy.

Functions of tcells

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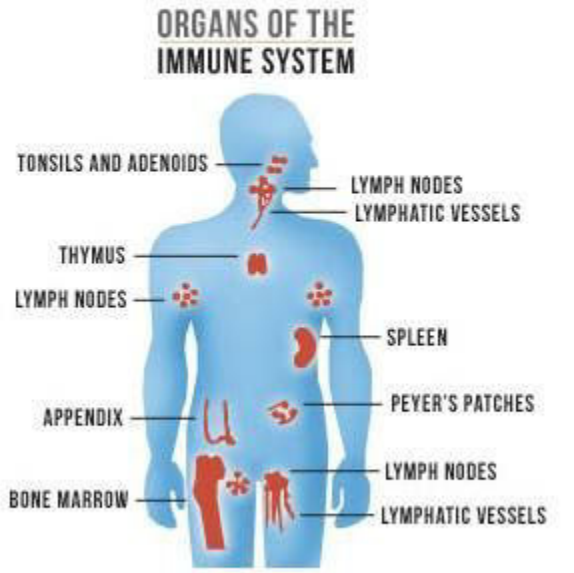
WHAT'S A HELPER T-CELL?

Helper T cells have been called the "generals" of the immune system because they call up troops of B cells, cytotoxic T cells, and other helper cells to go into battle against invading pathogens.



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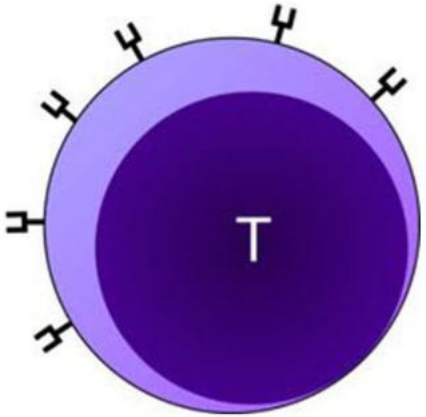
Suppressor T Cells

- Suppressor T cells produce chemicals that "turn off" other immune system cells when an infection has been brought under control.



How it works

- The body needs to be able to recognize what belongs and what doesn't, and antigens are an important part of that process.[1] When the body identifies an antigen, it will initiate an immune response.
- When receptors on white blood cells bind to antigens, this triggers white blood cell multiplication and starts the immune response.

First, the virus is met by a type of cell called B cells. The B cells are responsible for creating antibodies to match the antigen. Remember, each type of antibody matches to only one antigen. After the B cells have created their antibodies, the antibodies stick to the virus, marking it for the next round of attack. T cells are then ordered to attack the antigen that the antibodies have marked for it.
After the antigen has been destroyed, the cleanup crew comes along. A wave of phagocytes, large cells that can consume foreign matter, eats the remains of the infection.

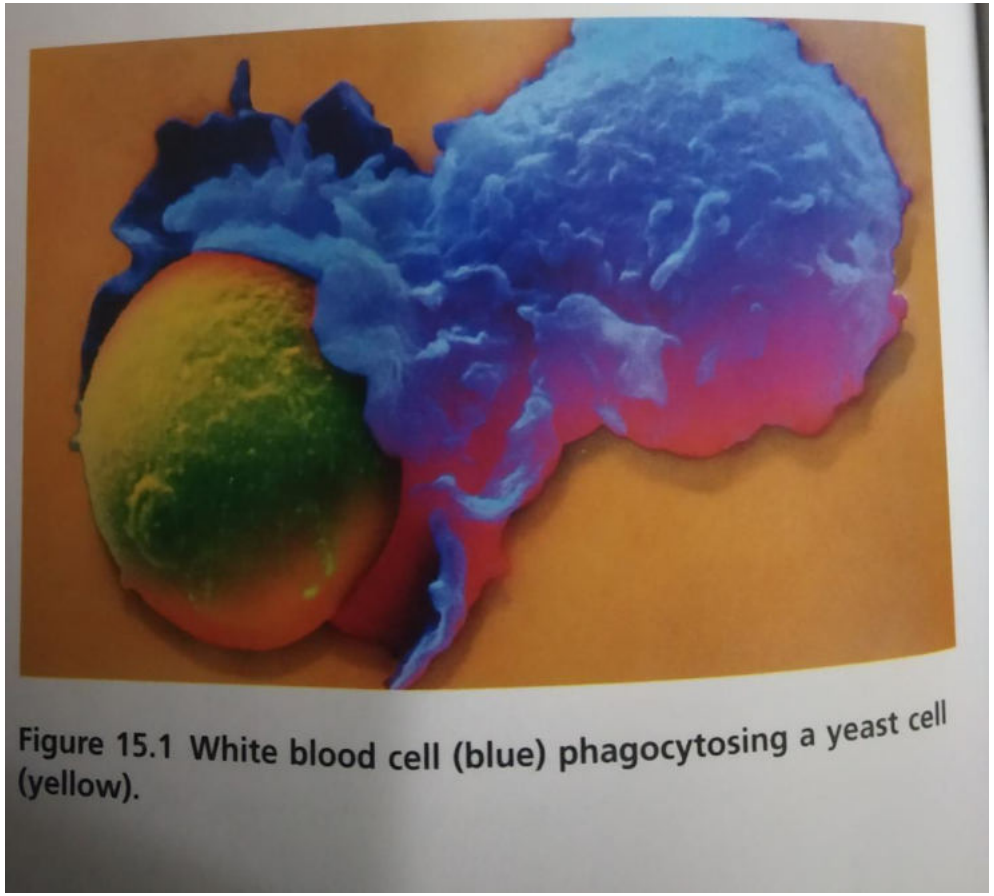


Figure 15.1 White blood cell (blue) phagocytosing a yeast cell (yellow).

Action of Bcells- humoral immunity

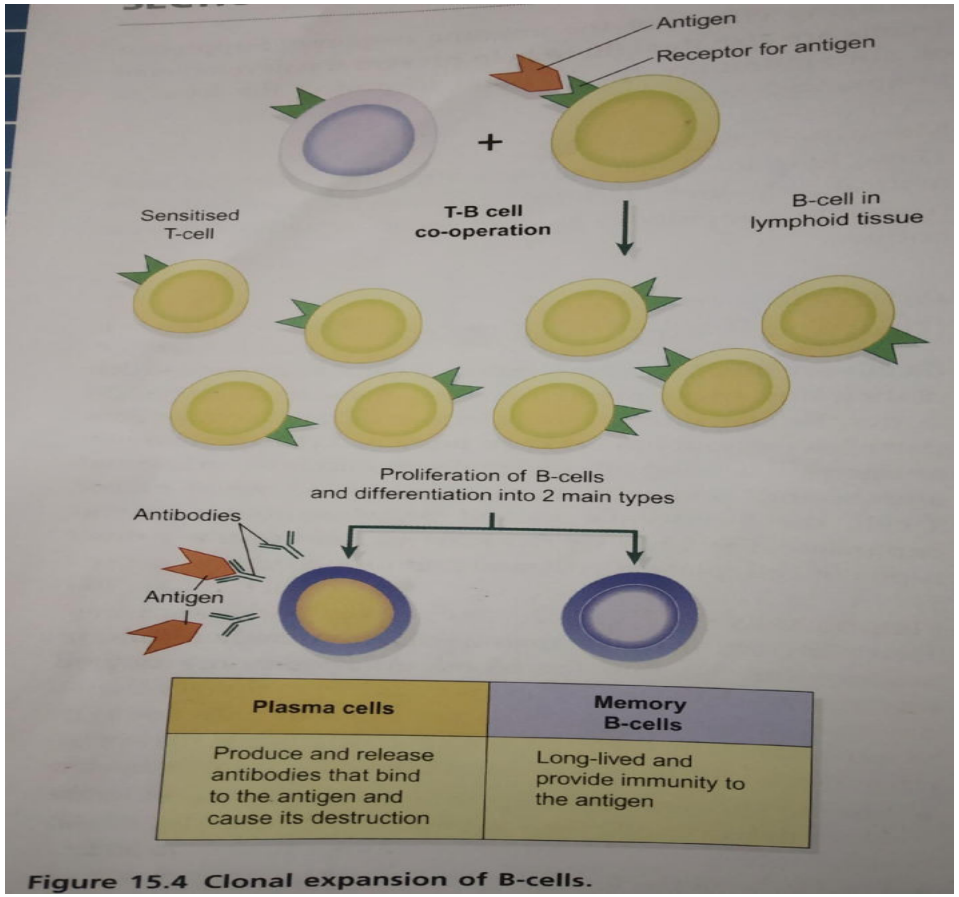
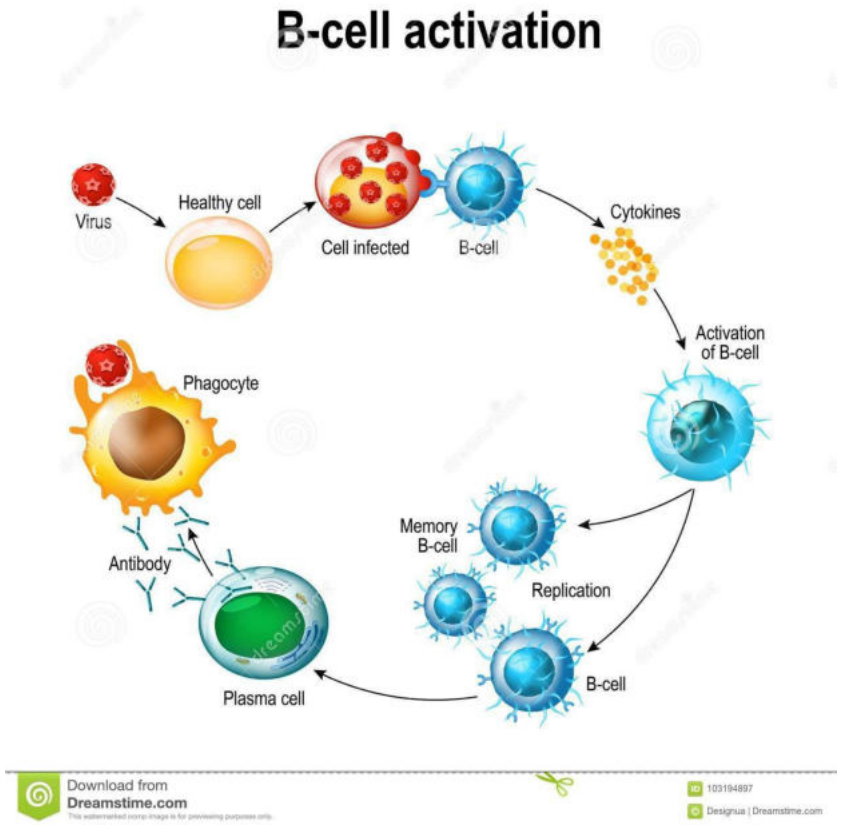


Figure 15.4 Clonal expansion of B-cells.



B cells

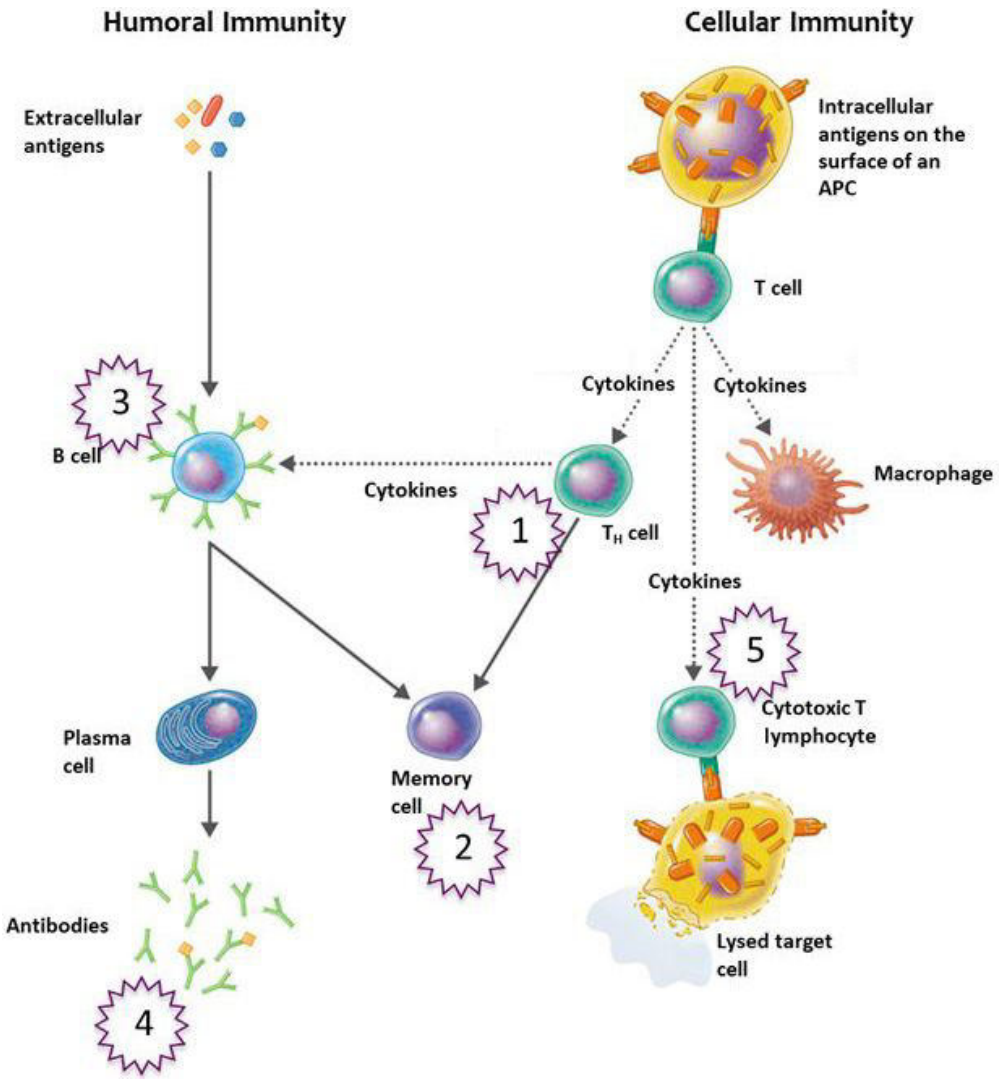
- B and T lymphocytes arise from common lymphoid progenitor cells within the bone marrow. The progenitor cells that are committed to the B cell lineage are selected at random. T cell progenitors migrate to the thymus for maturation whereas B cell progenitors remain in the bone marrow.
- Two selection processes happen during B cell development. Positive selection ensures that only B cells with functional receptors are allowed to develop further. This occurs when the B cell receptor successfully binds its ligand, which induces survival signals. Negative selection happens when B cells respond to self -antigens in the bone marrow and, as a result, undergo receptor editing, anergy or apoptosis. This promotes central tolerance and minimises the risk of autoimmune reactions when the B cells eventually mature and move to the peripheral circulation.
- Once differentiated in the bone marrow, B cells migrate to lymphoid follicles in the spleen. They also migrate to areas where lymphoid activation and defence is likely to be triggered such as in the mucosal linings. This includes the Peyer's patches of the colon, which are a type of mucosa-associated lymphoid tissue (MALT). Other 'MALTs' also exist and are named according to their location or organisation e.g. Bronchial (BALT), Nasal (NALT), Organised-mucosa (O-MALT).

- Types of B Lymphocytes

Plasma Cell

- Once activated, B lymphocytes can differentiate into plasma cells. Plasma cells are large cells with abundant endoplasmic reticulum, which allows them to produce large quantities of antibodies against specific antigens.
- They respond to signals from T cells during infection and continue to produce antibodies until the infection is controlled. Plasma cells are often found in chronic inflammation
- . Memory B Lymphocyte
- Some B lymphocytes will differentiate into memory B cells, which are are long-lived cells that remain within the body and allow a more rapid response to future infections.
- If the host is re-exposed to the same antigen, these cells rapidly proliferate with assistance from T cells. This produces more cells capable of secreting specific antibodies to the pathogen. This often means that the pathogen can be dealt with before the infection takes hold and becomes symptomatic.
- T-independent B Lymphocyte
- B lymphocytes require T cells to produce antibodies. However, a small number can function without T cell help and these are found within sites such as the spleen and peritoneum.
- They are particularly important for dealing with encapsulated bacteria. Encapsulated bacteria have a polysaccharide outer layer as opposed to a protein-based one, which allows them to evade T cells. T-independent B cells can recognise these layers and produce antibodies without T cell help.

Dual nature of cellular and humural immunity



DIFFERENCES

Cell-mediated Immunity	Humoral Immunity
It is mediated by T-cells.	It is mediated by B-cells.
No formation of antibodies.	Formation of antibodies.
Receptors are made used to identify antigens.	Antibodies are made use to identify antigens.
T-cell receptors bind to the T-cell and the T-cells stick to the antigens.	The antibodies produced by B-cells stick to the antigen.
It protects against virus, fungi and other intracellular bacterial pathogens.	It protects against extracellular virus and bacteria.
It can eliminate tumour cells and thus protects against cancer.	It cannot eliminate tumour cells.
Both CD4+ and CD8+ cells participate in cell-mediated immunity.	Only TH cells participate in humoral immunity.
Mediates hypersensitivity type IV.	Mediates hypersensitivity I, II and III.
It shows delayed response.	It is quick in response.

reference

- https://teachmephysiology.com/immune-system/cells-immune-system/t-cells
- https://www.ncbi.nlm.nih.gov/books/NBK10762
- https://www.news-medical.net/health
- Ross and Wilson ‘Anatomy &Physiology in Health and Illness:12 edition 2014