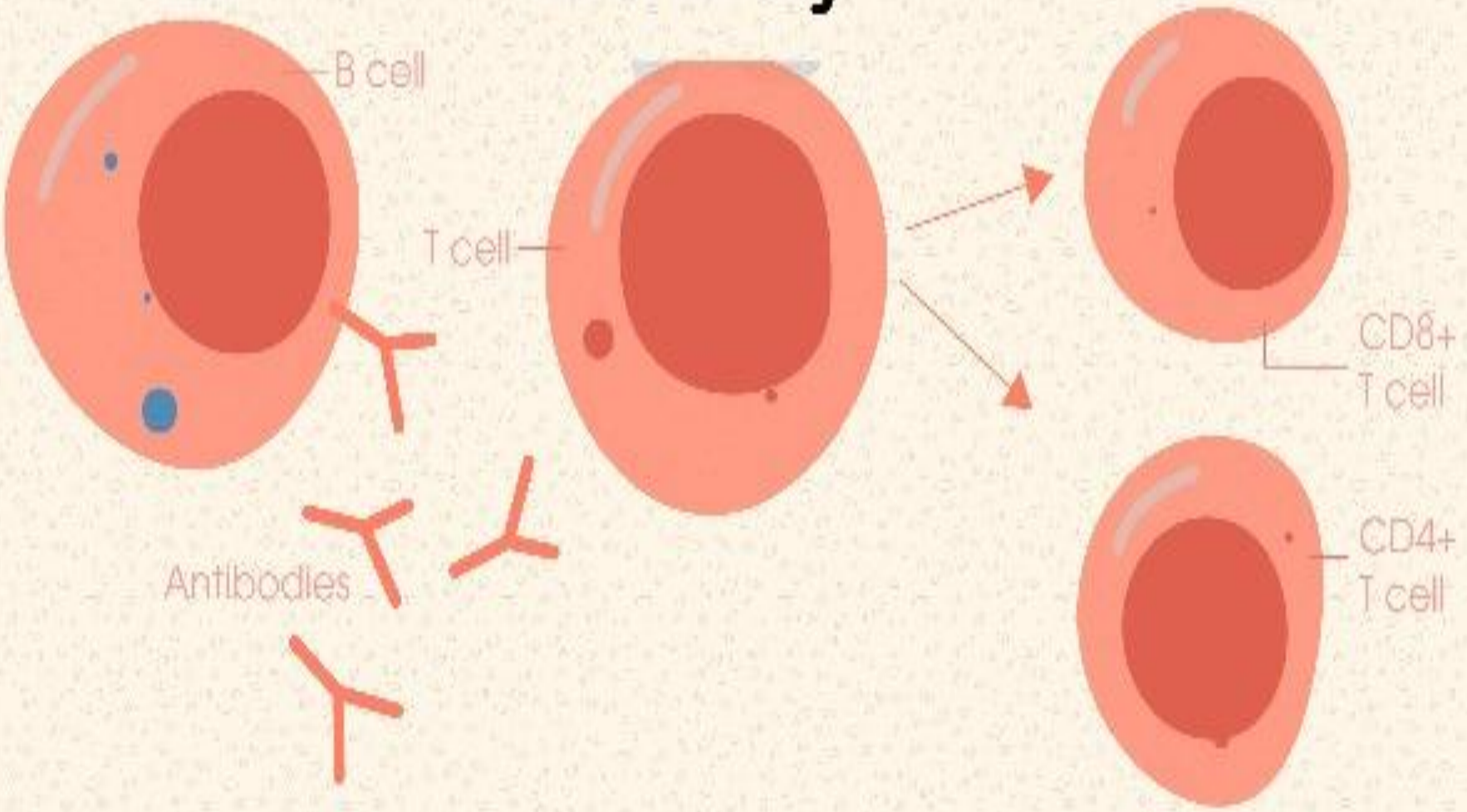
Humoral VS Cellular Immunity



The immune system is a remarkably versatile defense system that has evolved to protect animals from invading antigen, pathogenic microorganisms, foreign chemicals (specially proteins).

Humoral immunity and cell mediated immunity are two types of adaptive immunity.

Adaptive immunity generates an antigen-specific immune response. During adaptive immunity, the antigen is first recognized through receptors of the lymphocytes, and immune cell clones are produced to attack that particular antigen.

Humoral immunity is triggered by B cells while cell mediated immunity is triggered by T cells.

HUMORAL IMMUNITY

The term humoral derived from the latin word "humor" means from the body fluid. This immunity is mediated by macromolecules found in extracellular fluids such as secreted antibodies, complement proteins, and certain antimicrobial peptides

The humoral immunity refers to the interaction of B-Cells with antigens and their subsequent proliferation and differentiation into antibody secreting plasma cells and memory cells for later secondary responses.

Antibodies produced and secreted from activated plasma cells, binds with antigens to make them neutralize and get them eliminated.

This antigen deactivation is achieved by many ways in body

- Interaction of antigen to the antibody neutralizes the charge present on the antigen and gets the antigen precipitated.
- Binding of antibodies to the antigen prevents binding of antigens to the cellular components of host cells.
- Antigen antibody interaction forms clusters, these clusters are more readily destroyed by phagocytic cells.
- Binding with antigens, stimulates complement system that facilitates lysis of antigens.

PROCESS OF DEVELOPMENT OF HUMORAL IMMUNITY:

Humoral immunity is generated and mediated through B-Cells

The antibodies present on immune competent B-cells, can recognize different epitopes. Epitopes are the discrete sites present on antigens and are responsible for binding with antibodies

Appropriate interaction between antigen and B-cells membrane bound antibodies occurs.

This interaction activates B-cells and induce clonal selection of B-cells in which the B-cells divides repeatedly, differentiate and generates a population of activated B-Cells or the effecter cells. This activation takes 4-5 days.

These activated B-cells divide into two types of cells. One is antibody producing plasma cells and second is memory cells.

Antibody secreting cells have no membrane bound antibodies, can secrete one of the five types of antibodies, which have affinity to that antigen, from which the gets activated or stimulated.

Memory cells are smaller in size as compared to plasma cells and carries antibody on their cell surface. Memory cells have longer life span (even for years) and high sensitivity towards antigens.

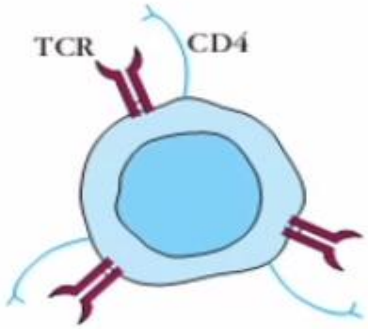
During the secondary exposure (second or more time exposure) of antigen (but the antigen should be the same which activated the B-cells in first response). These memory B-Cells proliferate and rapidly differentiate into plasma cells and produce high affinity antibodies through secondary response.

CELLULAR IMMUNITY (Cell mediated Immune Response)

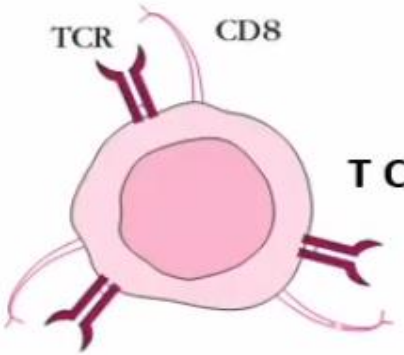
This type of immunity is mediated by T-cells. T-cells are named so because these lymphocytes gets maturation in thymus gland.

This immunity is respond to extra cellular and intracellular antigens in different ways. The mechanism is different from humoral immunity as in humoral immunity antigen directly binds with B-cells, but in Cellular immunity, antigen first binds with Antigen Presenting Cells (APC) and then brought to T-cells.

The two types of T-cells (T-helper and T-cytotoxic) participate in cellular immunity. These T-cells differentiate on the basis of molecules found on their surface. These molecules are CD4 and CD8 type. T-helper (TH) cells represent CD4 molecules, where as most of the Tcytotoxic (Tc) cells represent CD8 molecules.



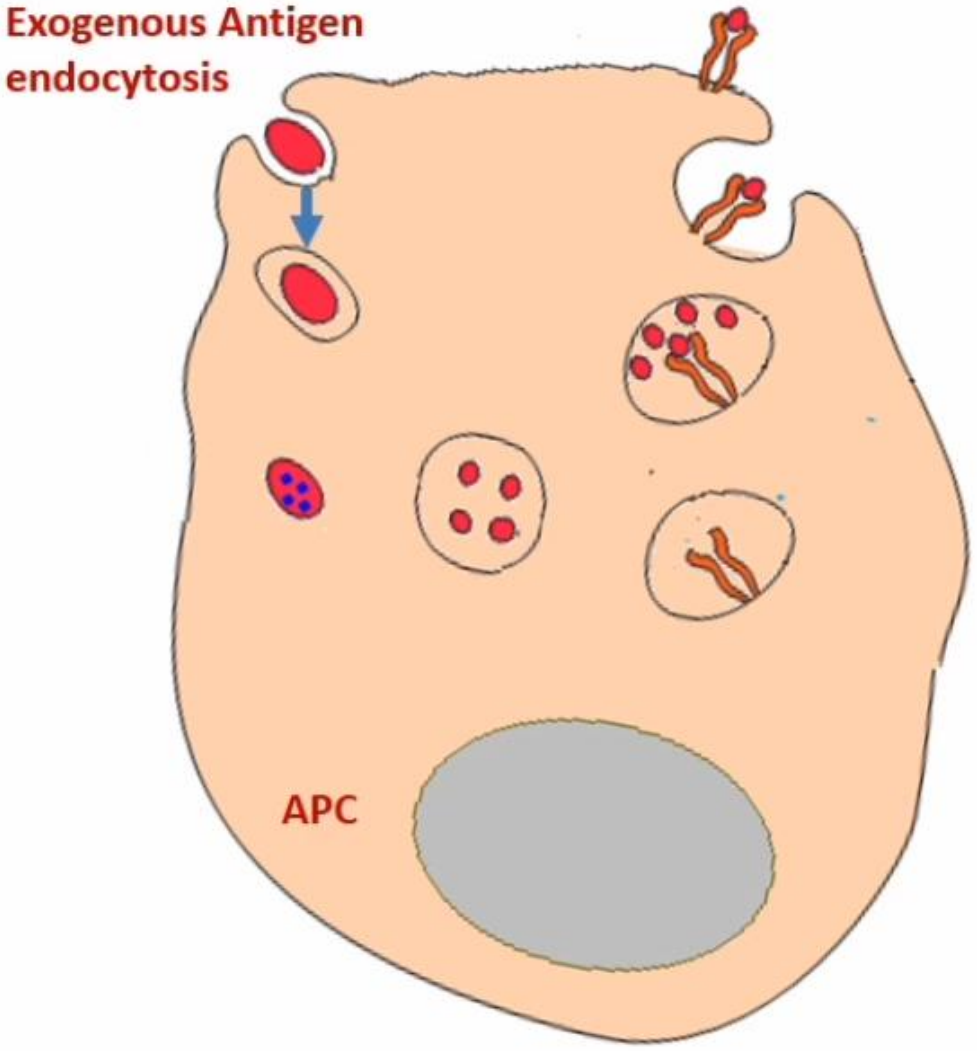
T Helper Cell



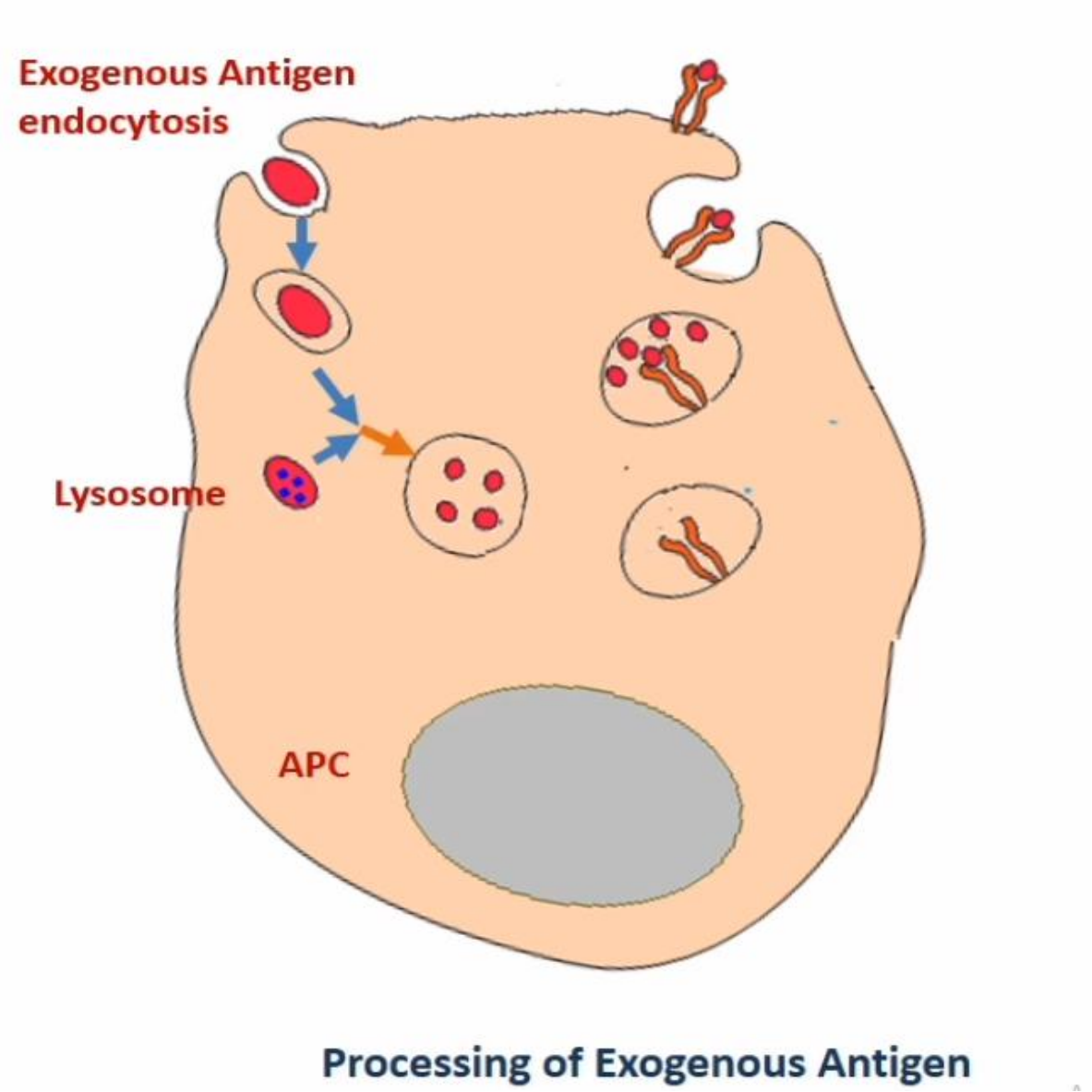
T Cytotoxic Cell

Extra cellular or exogenous antigens (which are found outside of the cell) internalize first through APCs via endocytosis.

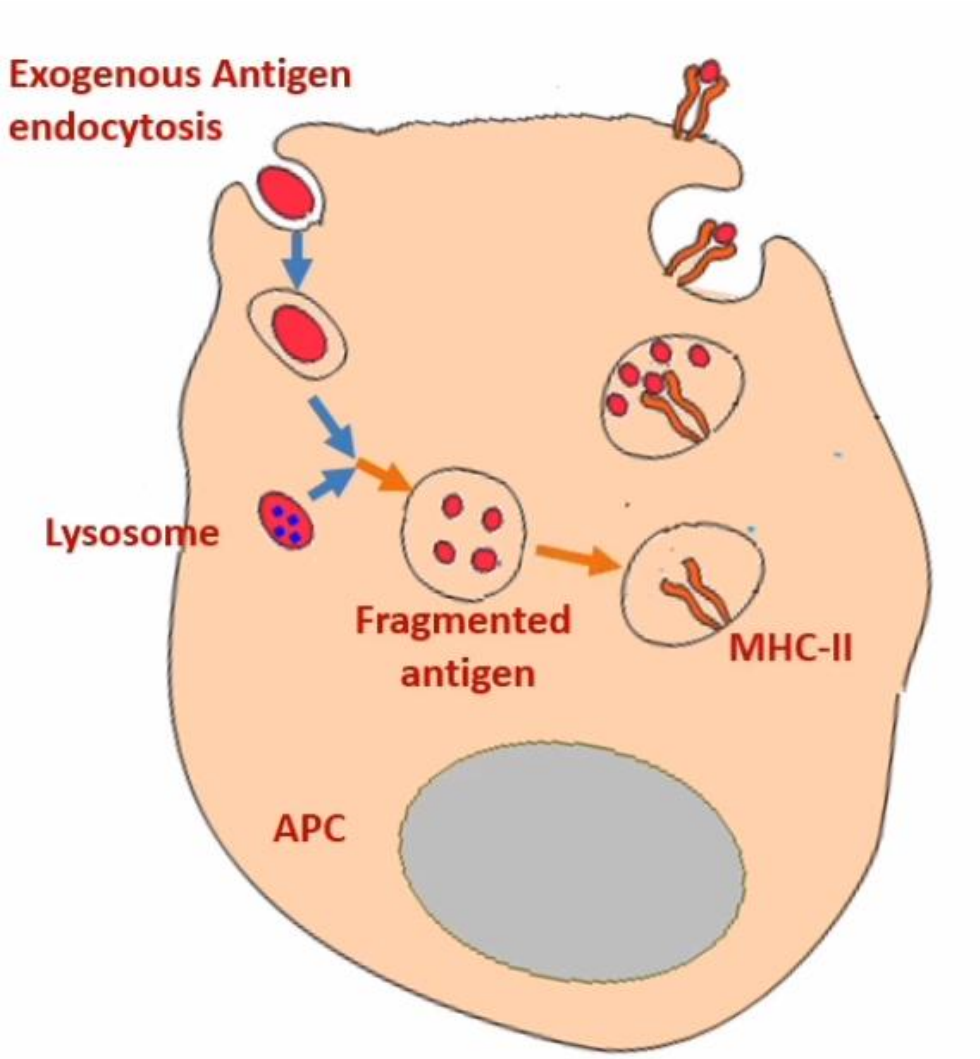
These internalize antigens exposed to lysosomes. Due to lytic activity enzymes, these antigens get fragmented. These fragments then attached with Class II - Major Histocompatibility Complex (MHC) molecules (MHC-II).After binding with MHC-II, these bind antigen fragments again comes to the surface of APCs.



Processing of Exogenous Antigen



Processing of Exogenous Antigen



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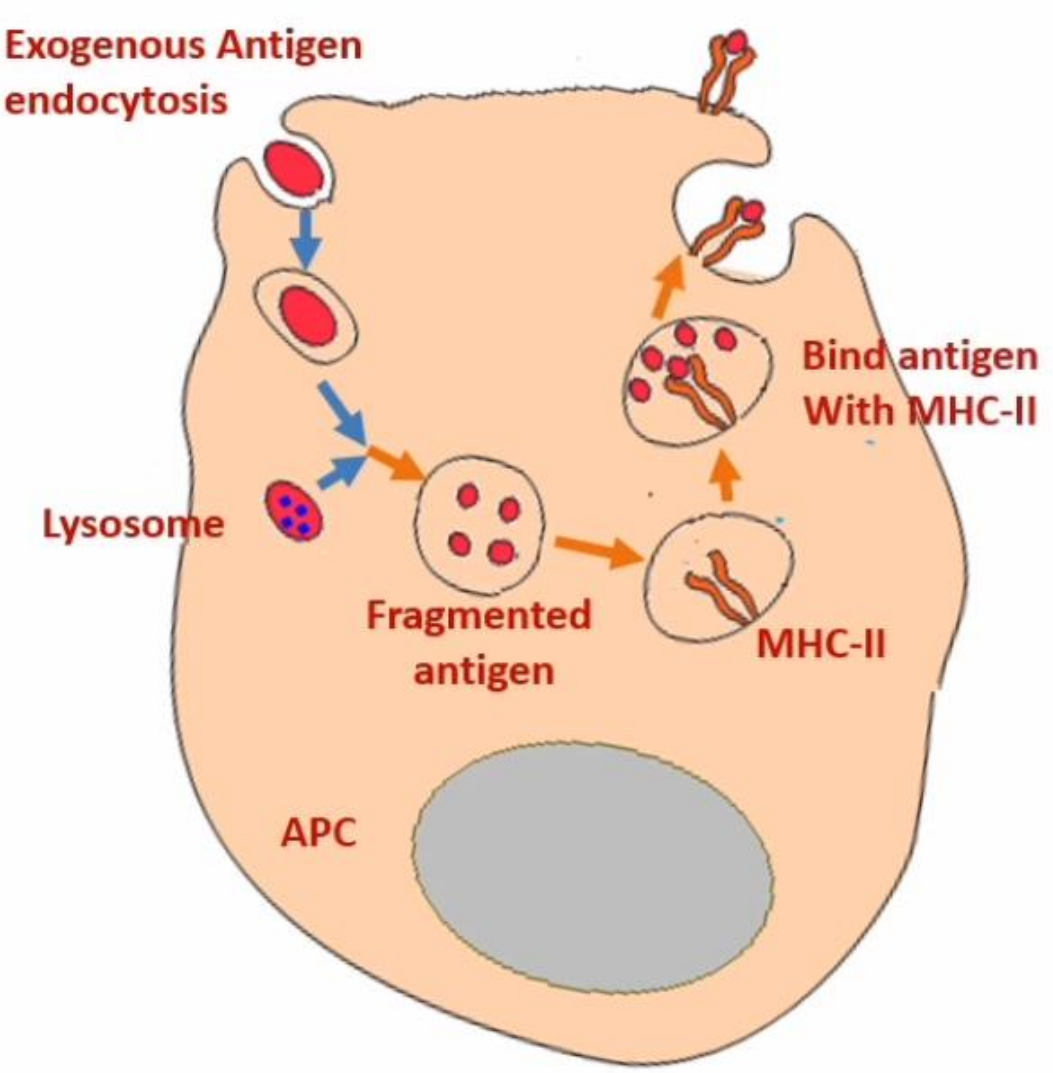
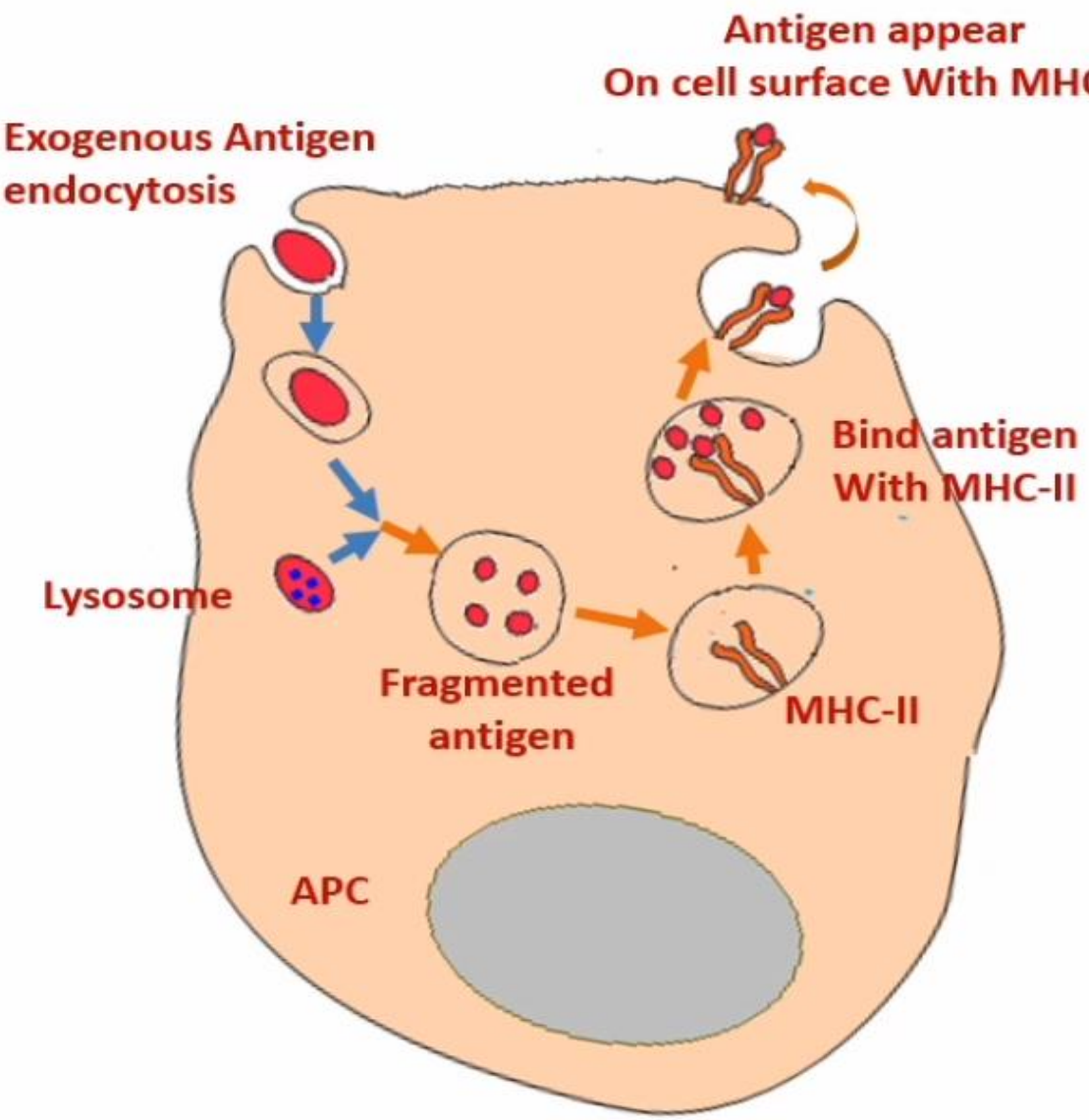


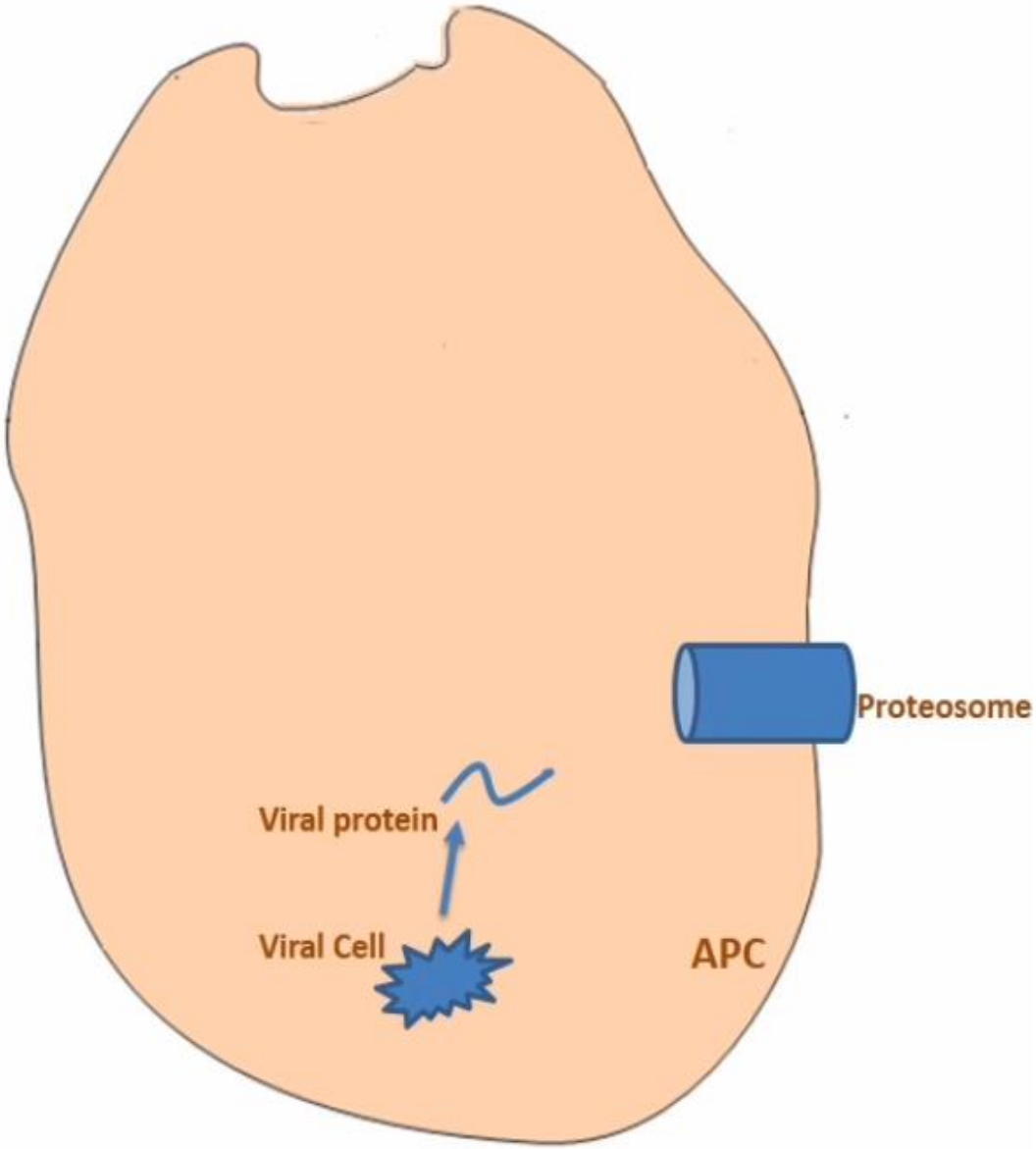
Processing of Exogenous Antigen



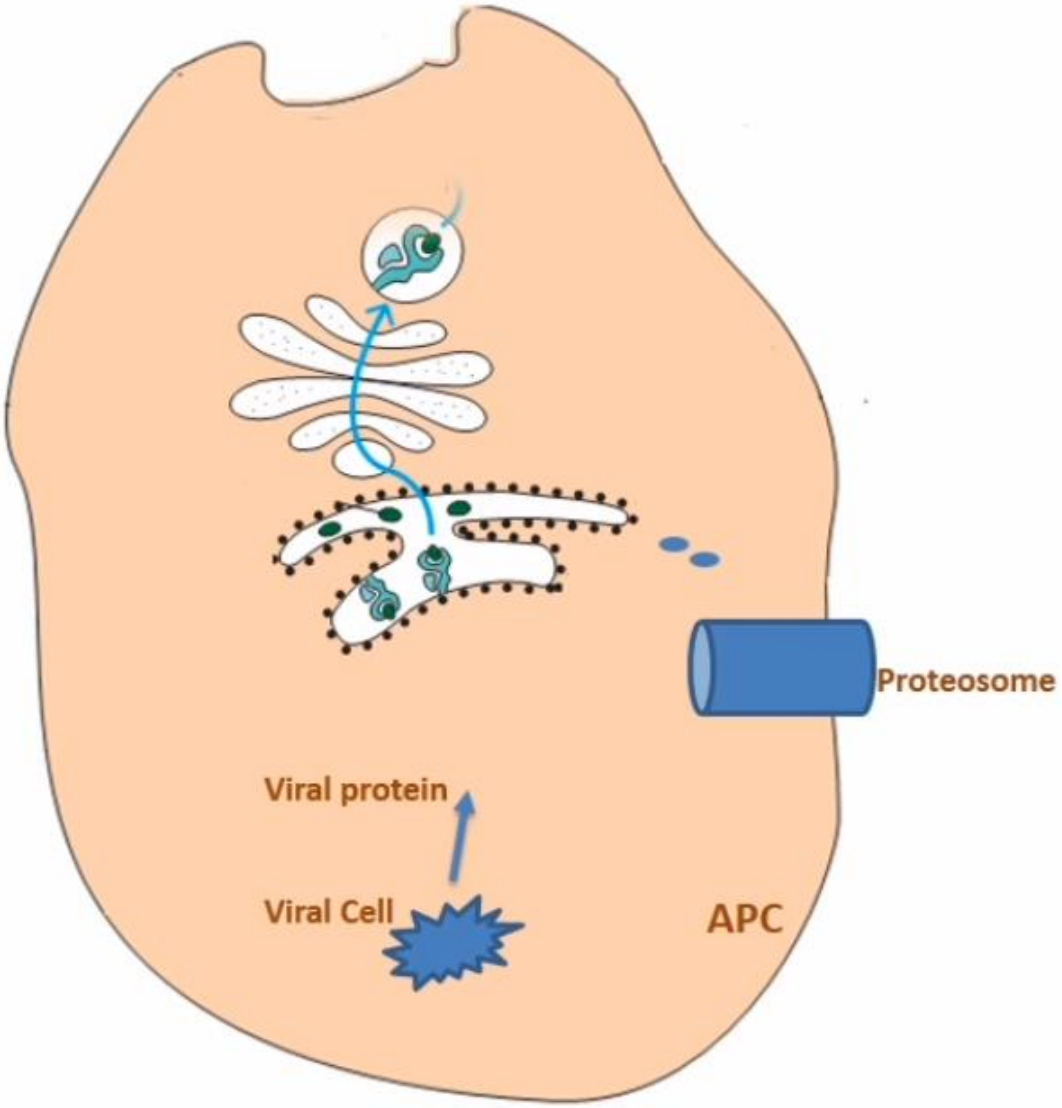
Processing of Exogenous Antigen

Endogenous antigens get fragmented through proteosomes, and the fragmented antigen binds with MHC-I molecules and this assembly again comes to the surface of APCs.

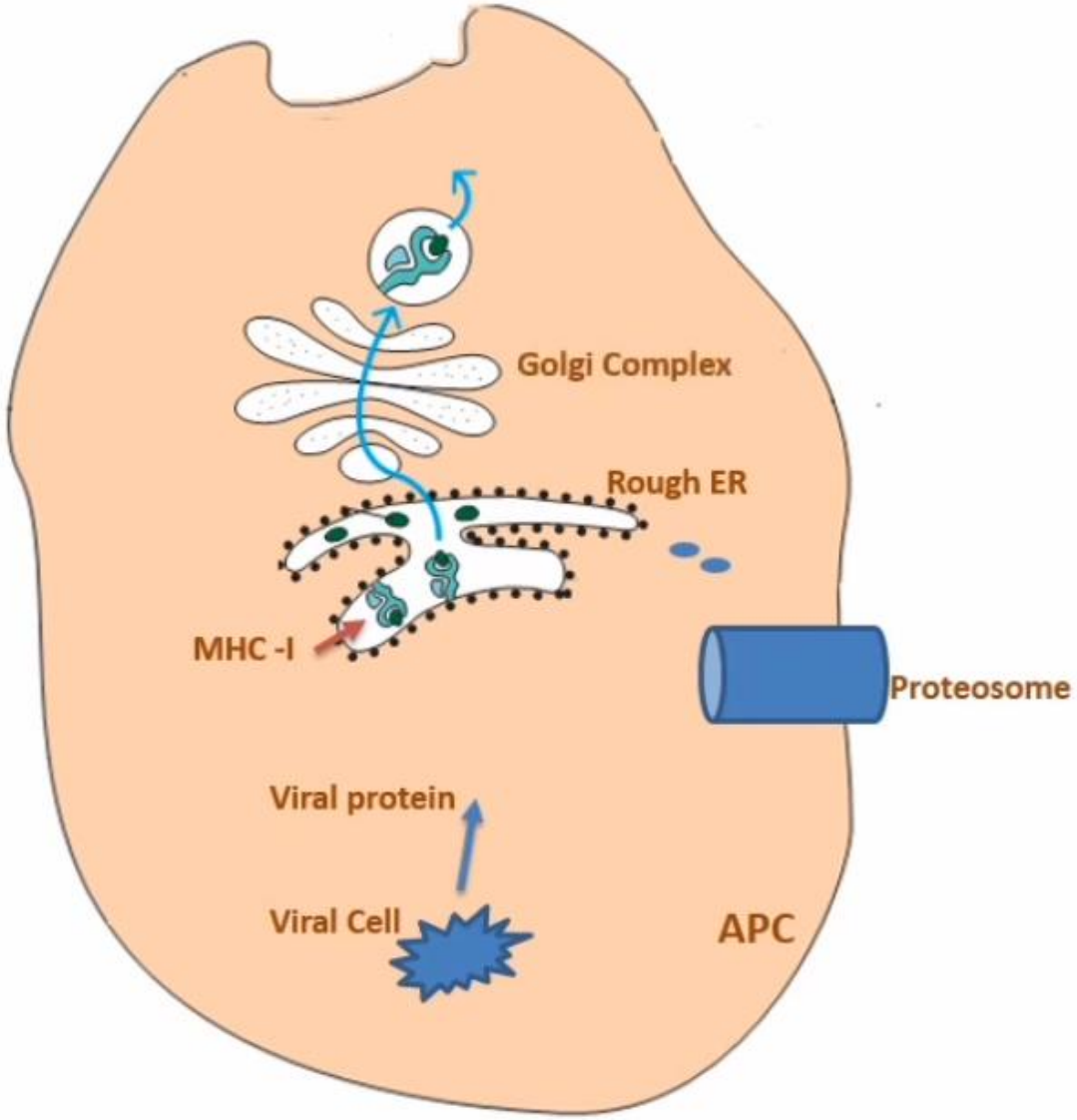
Antigenic fragments attached with MHC-I and MHC –II of APCs are exported to T-cells.



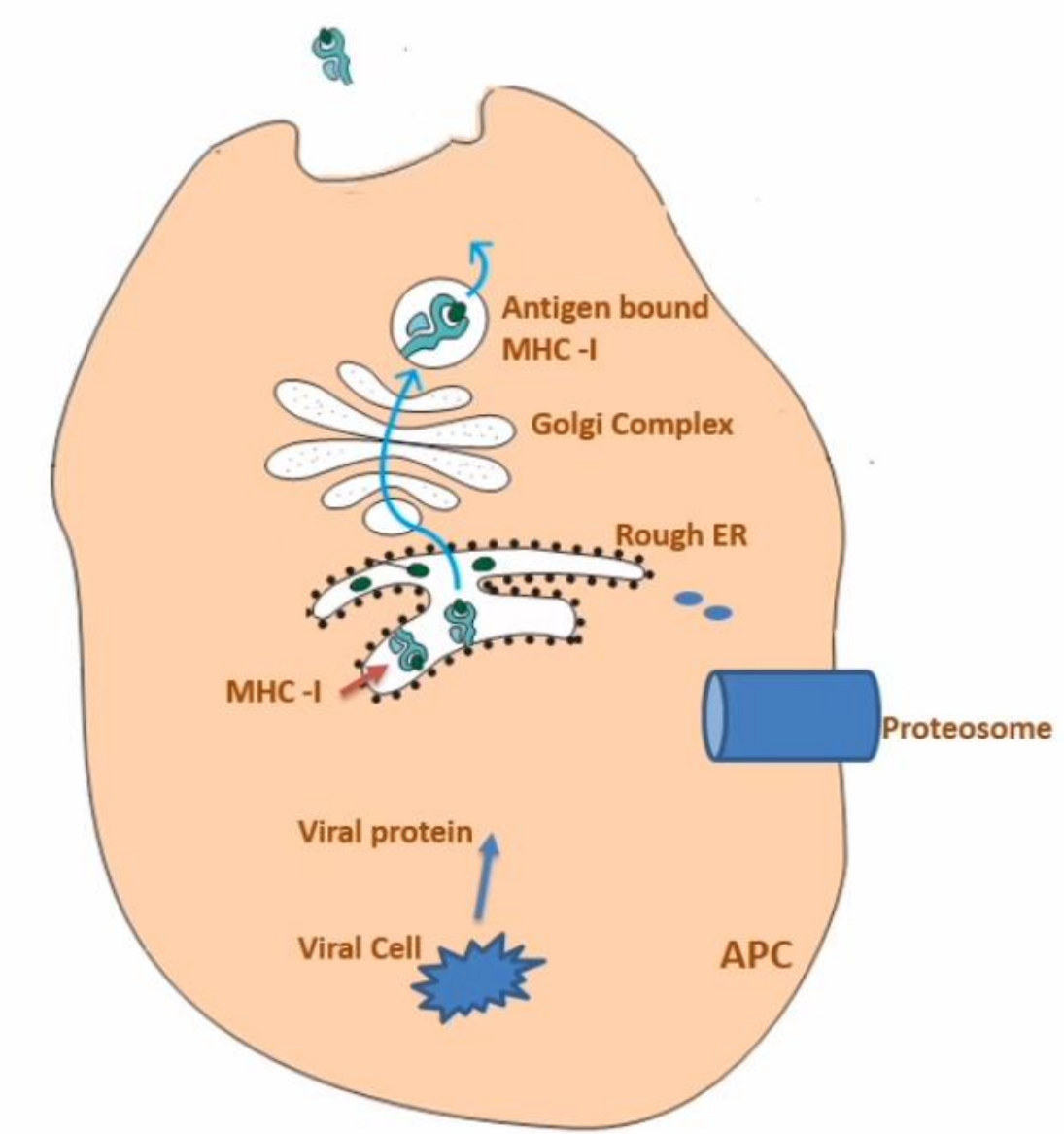
Processing of Endogenous Antigen



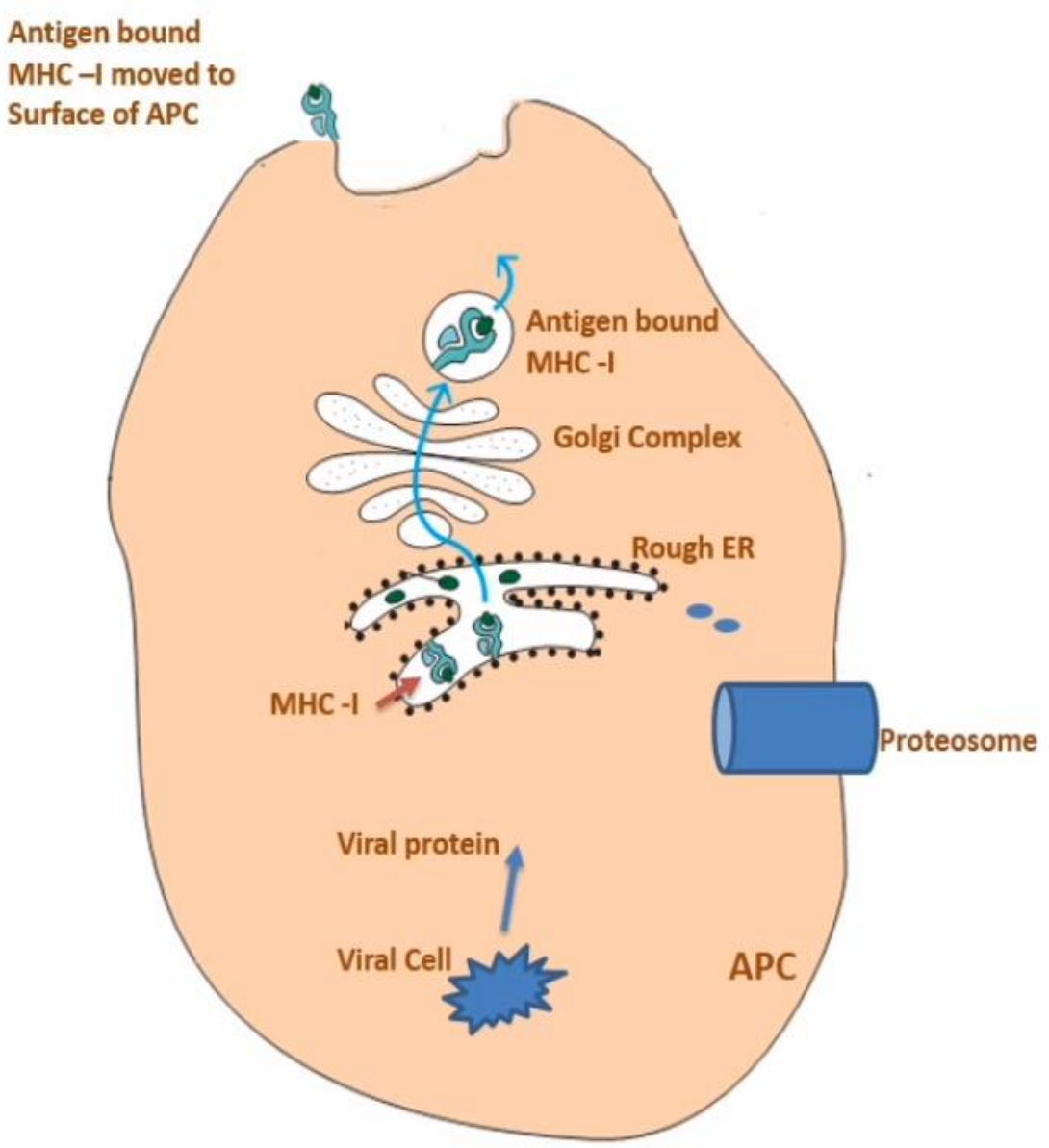
Processing of Endogenous Antigen



Processing of Endogenous Antigen



Processing of Endogenous Antigen



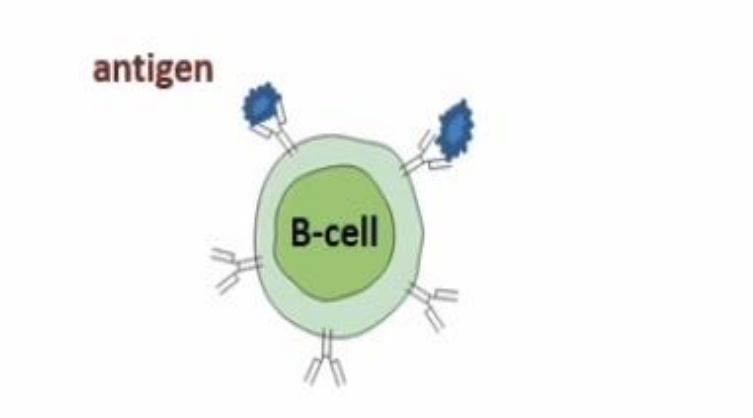
Processing of Endogenous Antigen

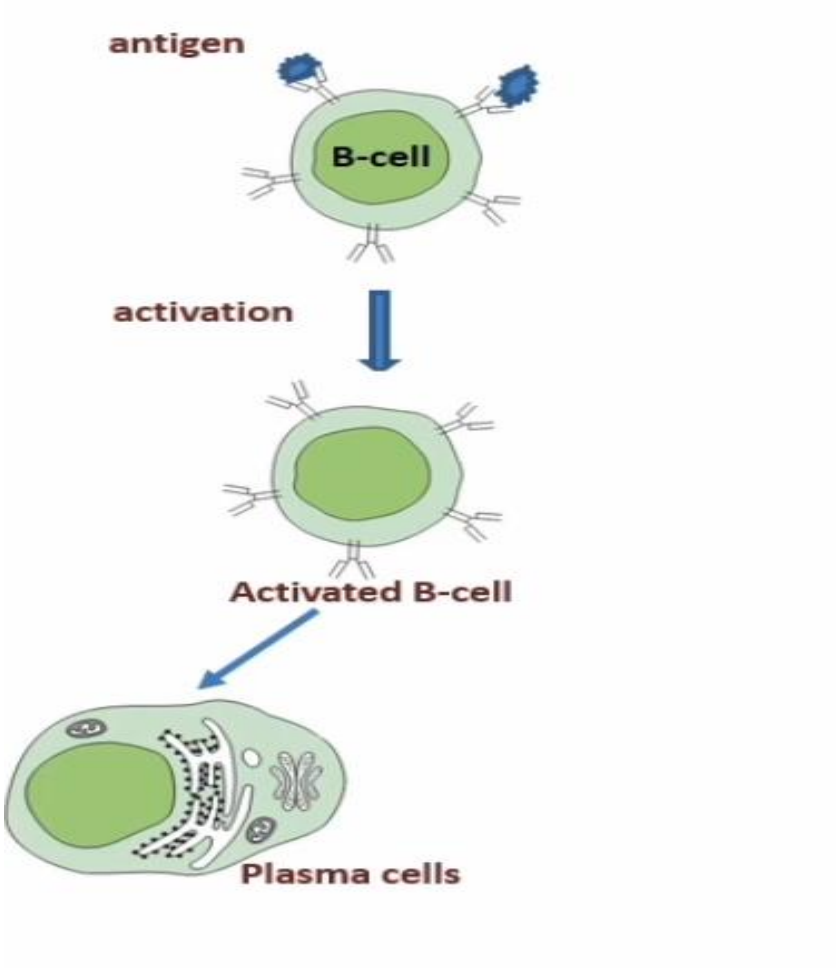
APC with antigen bind MHC-I molecules, takes the antigen to the CD8 molecules of Tc cells. After interaction of Tc cells to antigen bind MHC-I molecule, Tc cells gets activated and generated cytotoxic T lymphocytes (CTL) and mediated self altered cells leading to cell lysis of viruses and bacterial infected cells or the cells having endogenous antigens.

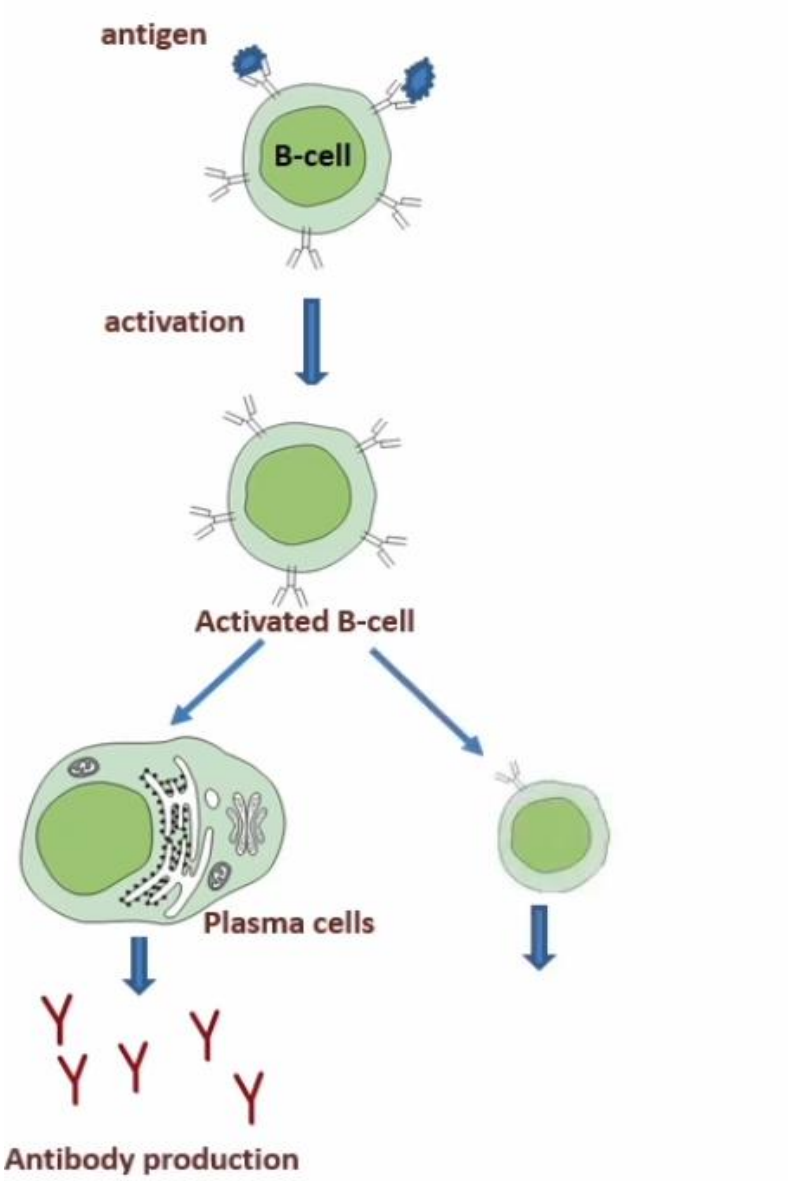
APC with antigen bind MHC-II molecules, takes the antigen to the CD4 molecules of T_H cells. This interaction generates a signal, that together with co-stimulatory signals, leads to secretion of cytokines, including various interleukins (ILs) i.e. IL-2, IL-4, IL-5, IL-6 and interferon gamma (INF-γ).

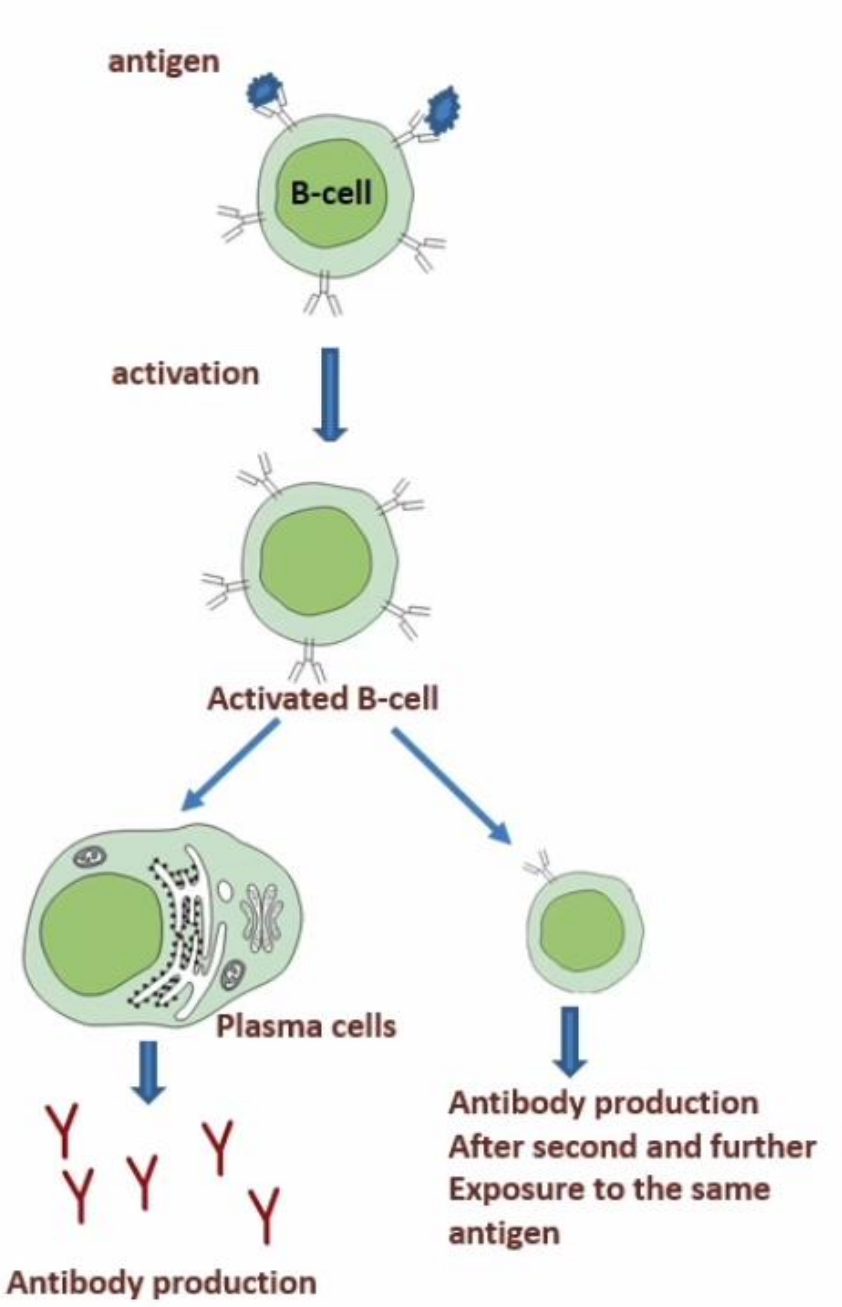
These stimulatory factors serve to stimulate B-cell proliferation and differentiation, and also help to stimulate humoral immune response.

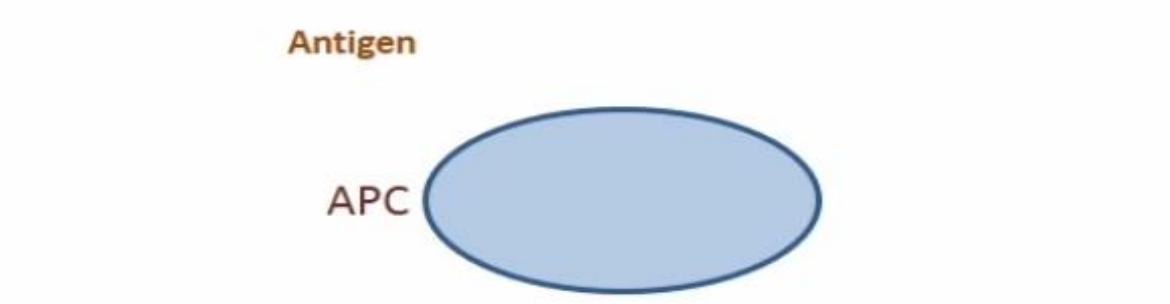
The cytokines secreted by T_H cells also regulate the proliferation and differentiation of non-specific effecter cells (Macrophages and Natural Killer cells), that participate in cell mediated responses. IL-2 and interferon gamma (INF-γ) activate macrophages and Natural Killer (NK) cells, further enhance immune response by their phagocytic activities of antigens and also tumor cells.

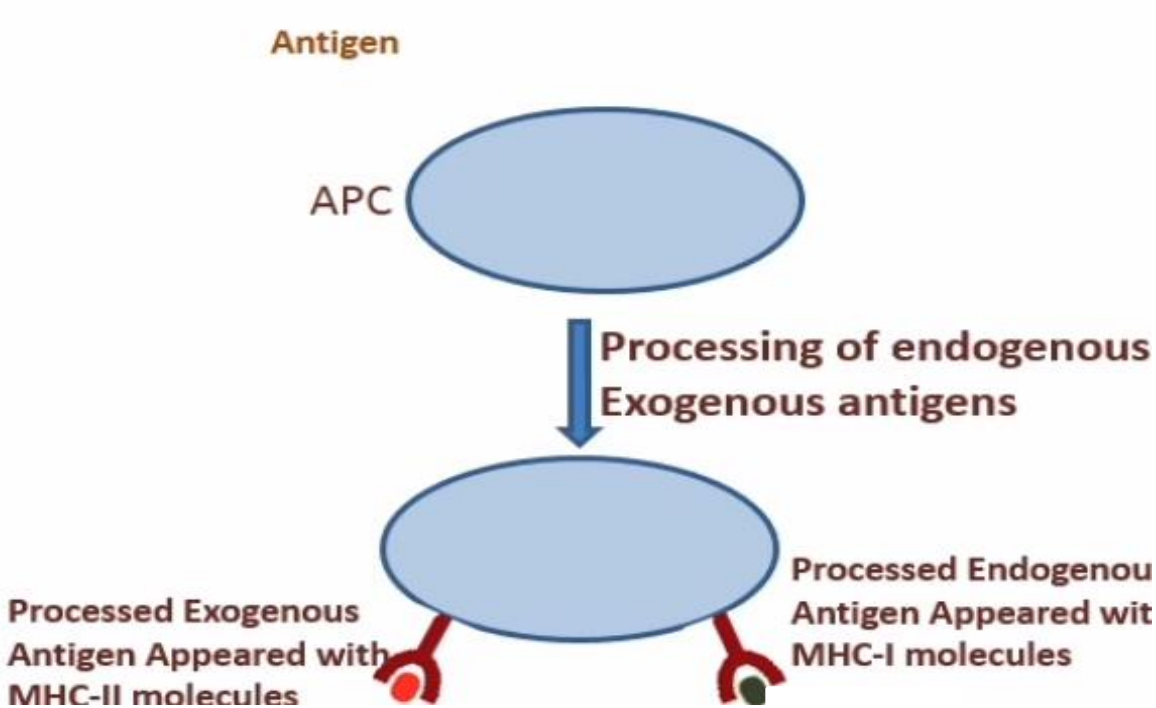

antigen
B-cell

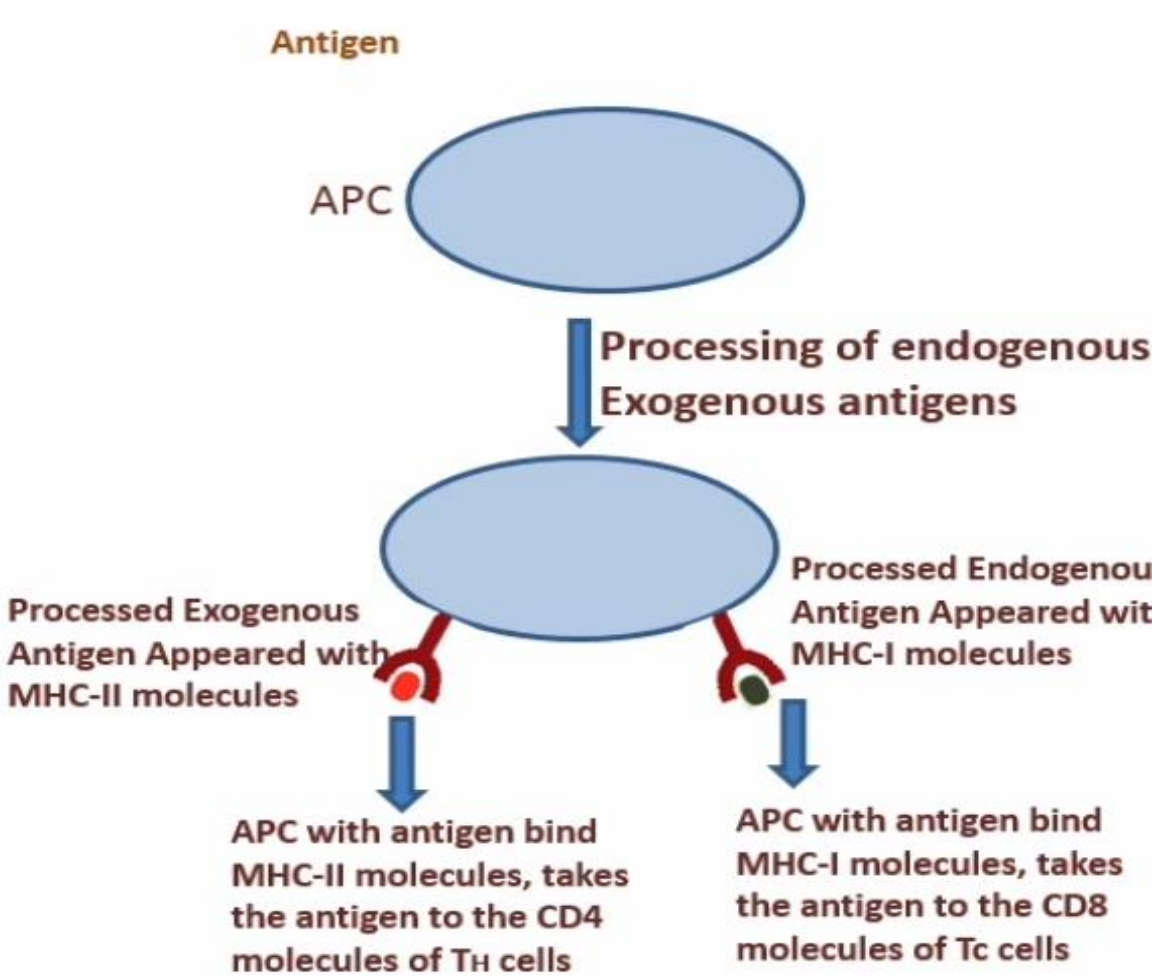

antigen
B-cell
activation
Activated B-cell
Plasma cells

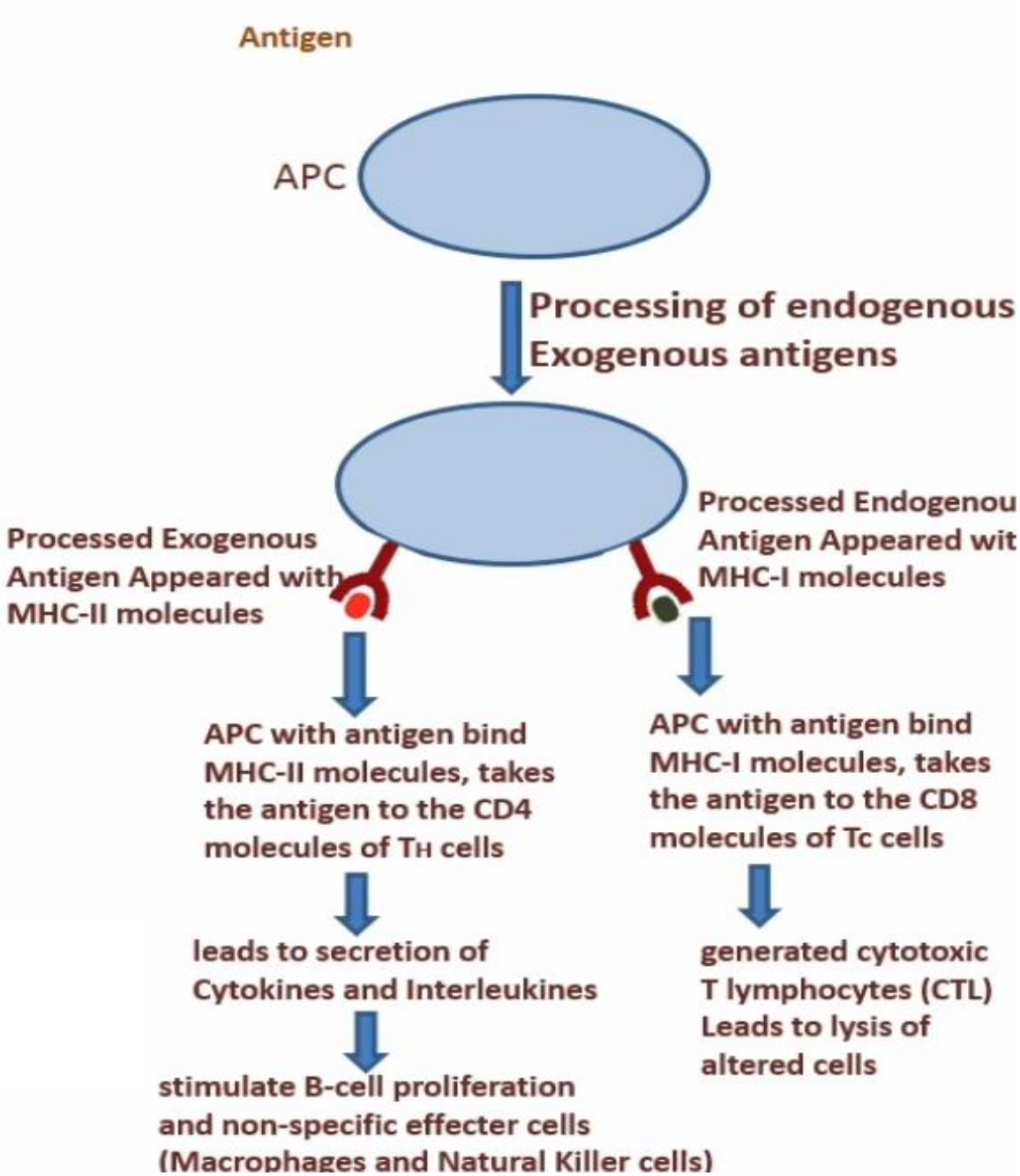

antigen
B-cell
activation
Activated B-cell
Plasma cells
Antibody production


antigen
B-cell
activation
Activated B-cell
Plasma cells
Antibody production
Antibody production
After second and further
Exposure to the same
antigen


Antigen
APC


Antigen
APC
Processing of endogenous
Exogenous antigens
Processed Exogenous
Antigen Appeared with
MHC-II molecules
Processed Endogenou
Antigen Appeared wit
MHC-I molecules


Antigen
APC
Processing of endogenous
Exogenous antigens
Processed Exogenous
Antigen Appeared with
MHC-II molecules
Processed Endogenou
Antigen Appeared wit
MHC-I molecules
APC with antigen bind
MHC-II molecules, takes
the antigen to the CD4
molecules of TH cells
APC with antigen bind
MHC-I molecules, takes
the antigen to the CD8
molecules of Tc cells


Antigen
APC
Processing of endogenous
Exogenous antigens
Processed Exogenous
Antigen Appeared with
MHC-II molecules
Processed Endogenou
Antigen Appeared wit
MHC-I molecules
APC with antigen bind
MHC-II molecules, takes
the antigen to the CD4
molecules of TH cells
APC with antigen bind
MHC-I molecules, takes
the antigen to the CD8
molecules of Tc cells
leads to secretion of
Cytokines and Interleukines
generated cytotoxic
T lymphocytes (CTL)
Leads to lysis of
altered cells
stimulate B-cell proliferation
and non-specific effecter cells
(Macrophages and Natural Killer cells)