M.Sc ZOOLOGY
SEMESTER 3
PAPER CC 10
HUMORAL IMMUNITY: 2

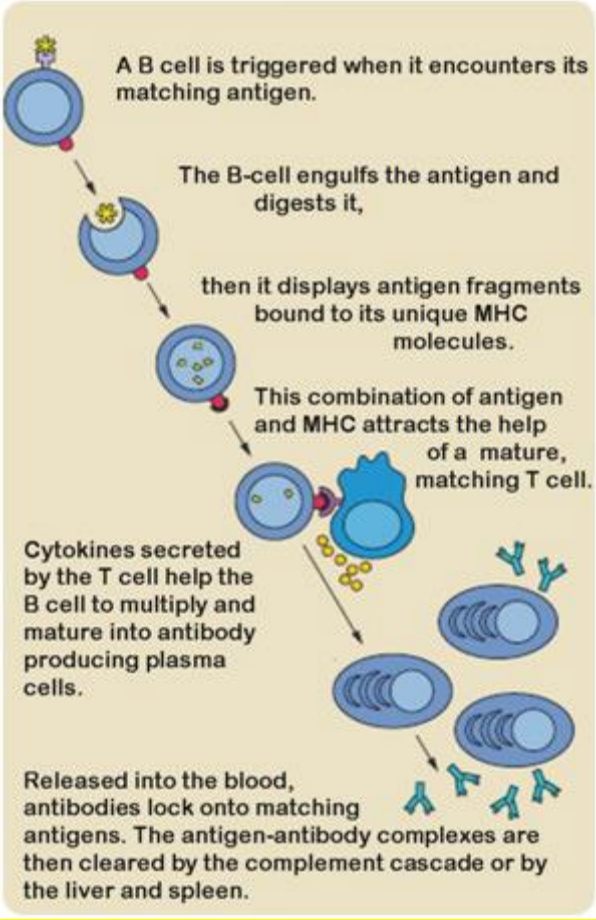
Dr.Anjali Gupta
Associate professor
Department of zoology
H.D.Jain College
ARA

Humoral Immune Response

There are actually two types of immune responses: humoral and cell-mediated. The **humoral immune response** involves mainly **B cells** and takes place in blood and lymph.

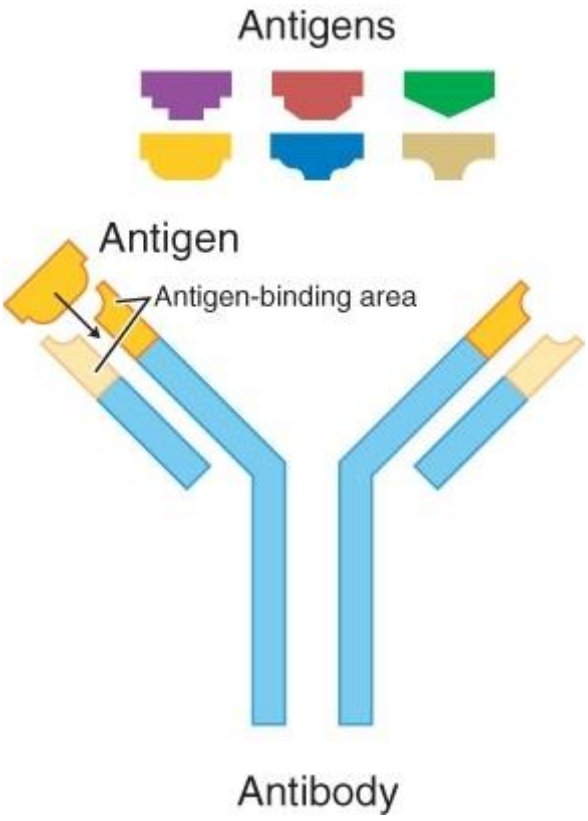
B cell Activation

B cells must be activated by an antigen before they can fight pathogens. This happens in the sequence of events shown in **Figure** below. First, a B cell encounters its matching antigen and engulfs it. The B cell then displays fragments of the antigen on its surface. This attracts a **helper T cell**. The helper T cell binds to the B cell at the antigen site and releases **cytokines** that "tell" or signal the B cell to develop into a **plasma cell**.



Plasma Cells and Antibody Production

Plasma cells are activated B cells that secrete antibodies. **Antibodies** are large, Y-shaped proteins that recognize and bind to antigens. Plasma cells are like antibody factories, producing many copies of a single type of antibody. The antibodies travel throughout the body in blood and lymph. Each antibody binds to just one kind of antigen. When it does, it forms an **antigen-antibody complex** (see **Figure** below). The complex flags the antigen-bearing cell for destruction by **phagocytosis**.



Memory Cells

Most plasma cells live for just a few days, but some of them live much longer. They may even survive for the lifetime of the individual. Long-living plasma cells are called **memory cells.** They retain a "memory" of a specific pathogen long after an infection is over. They help launch a rapid response against the pathogen if it invades the body again in the future..

The primary organs allow certain white blood cells – lymphocytes – to form and mature. Both T and B cells are produced in the red bone marrow. B cells mature here; T cells move through the lymph to the thymus gland and mature there. We will learn more about these immune cells later on.

Secondary lymphoid organs are where lymphocytes are activated. Tertiary lymphoid organs are anomalies and will not be further discussed in this article

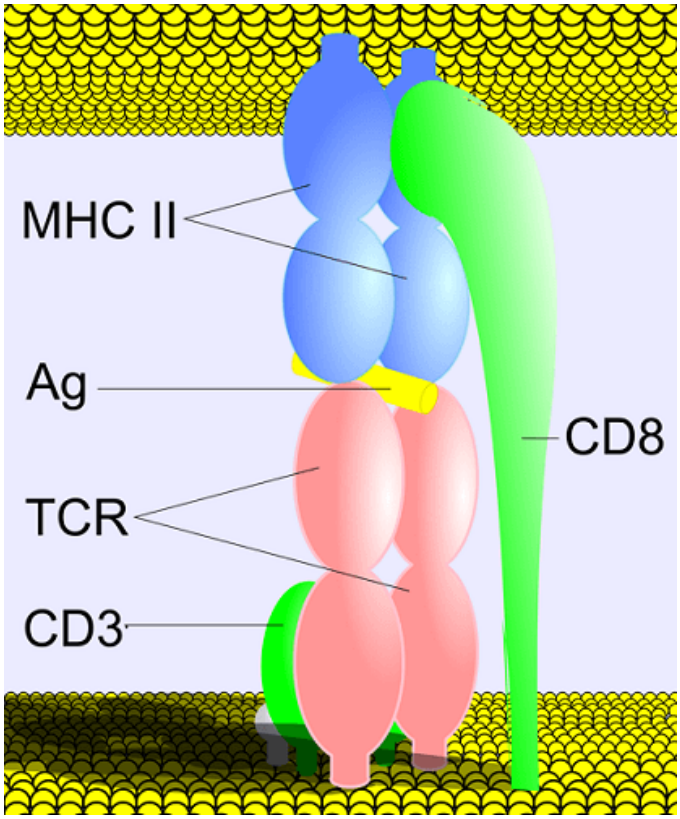
Antigen-Presenting Cells

An antigen-presenting cell is part of the cell-mediated immune response. This is not the same as the humoral immune response and their differences will be discussed further on.

However, recent research has shown that these two processes are intricately linked. While cytotoxic T cells (lymphocytes) can destroy infected cells (cell-mediated), helper T cells activate antibodies. In addition, suppressor T cells slow down or stop the immune response when necessary or if the danger has passed.

An antigen-presenting cell (APC) eats pathogens via phagocytosis. When broken down, the antigens of the pathogen are also reduced into smaller pieces. These fragments are bound to major histocompatibility complex class II (MHC II) molecules inside the cell and moved to the surface of the APC membrane. These are presented to helper T cells.

MHC class I molecules tell a helper T cell that the antigens are non-pathogenic and so avoid an immune response. Unfortunately, many cancerous cells are marked by the immune system as harmless using this mechanism.



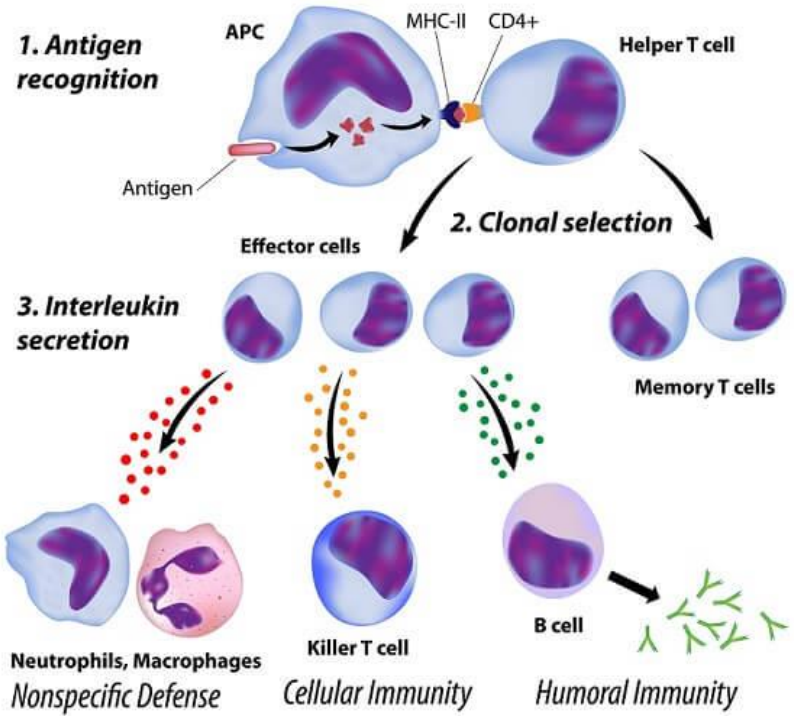
The above image shows how different immune complexes interact. CD refers to cluster of differentiation – in this case two numbered signalling chains on the T helper cell membrane that associate both with the same cell's receptor (TCR) and with the MHC II protein of the presenting cell. The yellow rod marked as Ag is the bound antigen.

An antigen is recognized by an area at its tip called the epitope; without the antigen-presenting cell, an immune cell response will not be activated. Once a T helper cell has come into contact with an MHC II signal on the APC surface, it can activate a B cell.

T Cells

T lymphocytes are part of the innate and acquired immune systems. Cytotoxic (killer) T cells directly destroy infected cells. Helper T cells, however, bridge the gap between both systems. When presented (by an APC) with an antigen bound to an MHC Class II molecule, it activates and releases cytokines (primarily interleukins) to attract B cells.

Helper T cells are themselves recognized by MHC II via a CD surface protein. T cells can also differentiate into memory T cells that, upon a second infection involving the same antigen, produce both cytotoxic and helper T cells.

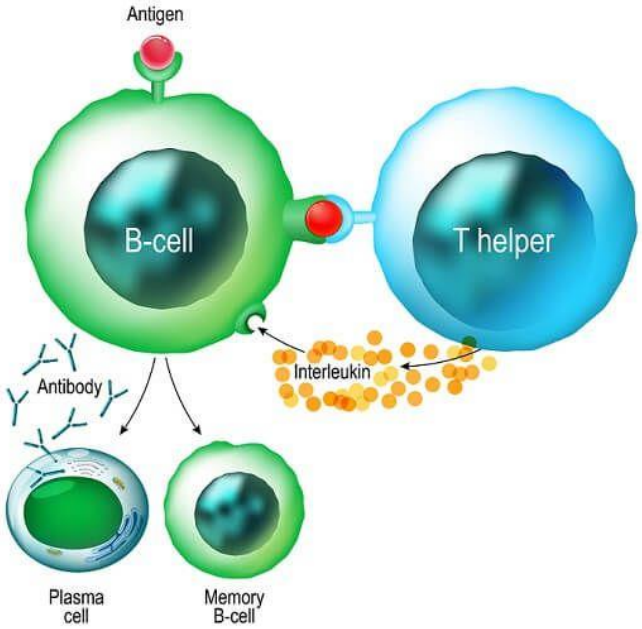


B Cells

B cells have three functions: as antigen-presenting cells (see above), to secrete chemical messaging molecules called cytokines (the colored dots), and to produce antibodies as part of the humoral immune response.

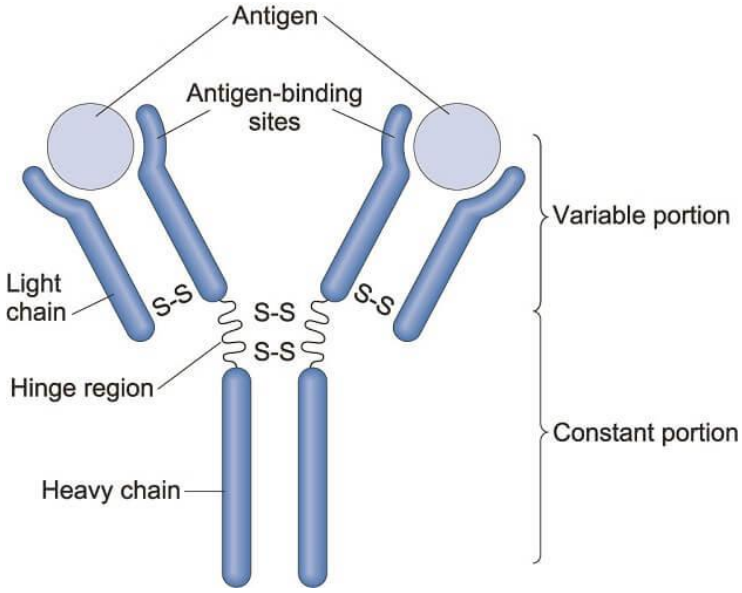
When still in the bone marrow, B cells develop membrane receptors – B-cell receptors or BCRs. These receptors will later recognize the antigens presented by T helper cells. This can only occur after a T helper cell has released cytokines; the cytokines activate the B cell.

Upon activation, a B cell divides. It will either produce two plasma cells or two inactivated memory



Plasma cells or effector B cells produce antibodies at a relatively slow rate. They manufacture one of five types of antibodies and move around the body attracted by cytokines. When they arrive at the source of a cytokine distress signal, they secrete these antibodies.

Memory cells remain inactive and live much longer than plasma cells. A second attack from the same pathogen activates the memory cell; this subsequent attack occurs more rapidly than that of the first pathogen exposure.


Antigen
Antigen-binding sites
Variable portion
Light chain
S-S
S-S
S-S
S-S
Hinge region
Constant portion
Heavy chain