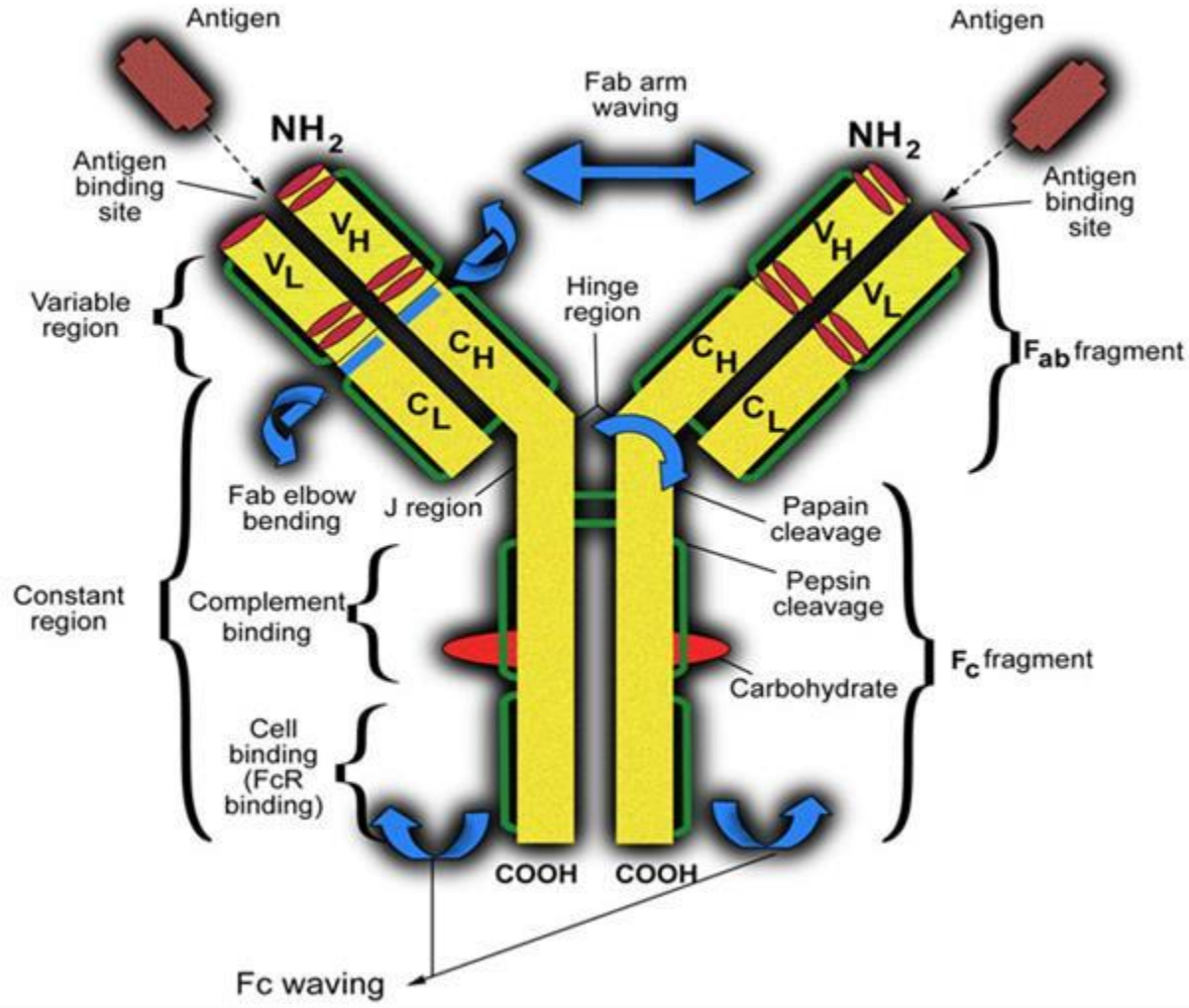
Antibodies

Antibodies : are compact, relatively soluble proteins. They are designed to recognize and bind to a specific antigen. Antibodies are either secreted by plasma cells or attached to the cell membrane of a B cell.

Each antibody has at least two identical antigen-binding sites that bind to identical epitopes. The number of antigen binding sites on an antibody is called the valence of that antibody. For example, most human antibodies have two binding sites; therefore, they are bivalent. Because a bivalent antibody has the simplest molecular structure, it is called a monomer. A typical antibody monomer has four protein chains: two identical light chains and two identical heavy chains. ("Light" and "heavy" refer to the relative molecular masses.) The chains are joined by disulfide links and other bonds to form a Y-shaped molecule. The Y-shaped molecule is flexible and can assume a T shape (notice the hinge region in Figure 17.4a). The antibody's light chain type is not associated with differences in antibody function beyond imparting antigen specificity. In contrast, an antibody's heavy chain composition determines various functional properties such as its interaction with other proteins (Fc receptor binding), complement activation, avidity, and half-life.



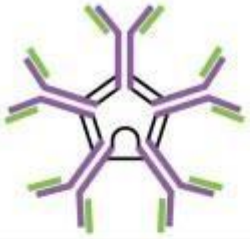
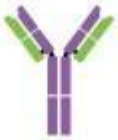
The two sections located at the ends of the Y arms are called **variable (V) regions**. These are the sites that bind to the epitopes .The amino acid sequences and, therefore, the threedimensional structure of these two variable regions are identical on any one antibody. The stem of the antibody monomer and the lower parts of the arms of the Y are called the **constant (C) regions**. They are the same for a particular class of immunoglobulin. There are five major types of C regions, which account for the five major classes of immunoglobulins.

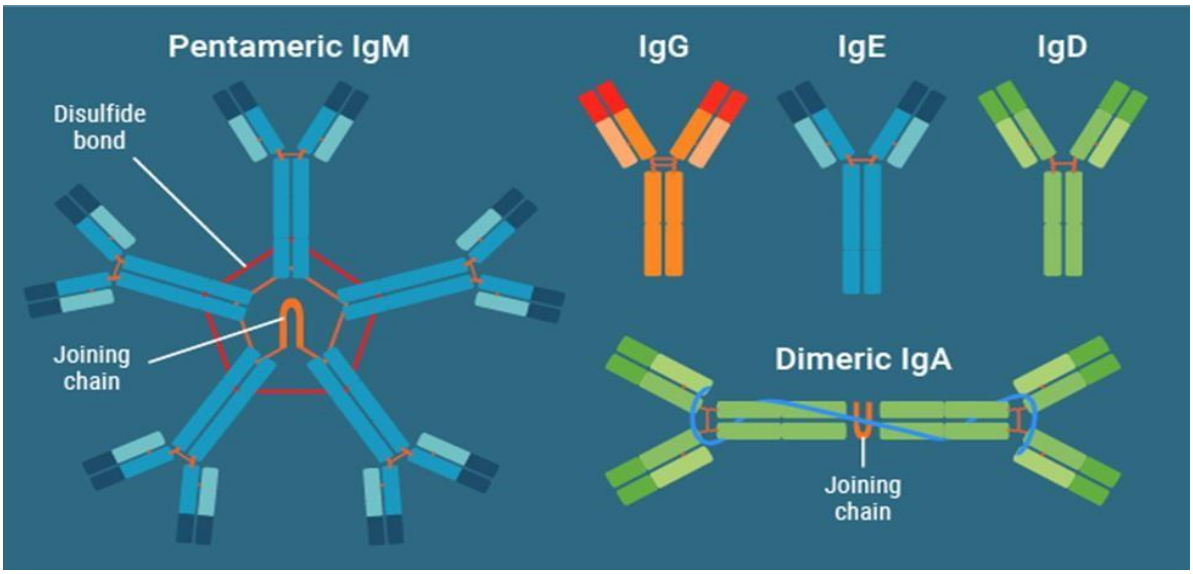
The stem of the Y-shaped antibody monomer is called the Fc region, so named because when antibody structure was first being identified, it was a fragment (F) that crystallized (c) in cold storage.

Immunoglobulin Classes :The simplest and most abundant immunoglobulins are monomers, but they can also assume some different sizes and arrangements. The five classes of Igs are designated IgG, IgM, IgA, IgD, and IgE. Each class has a different role in the immune response. The structures of IgG, IgD, and IgE molecules are Y-shaped monomers. Molecules of IgA and

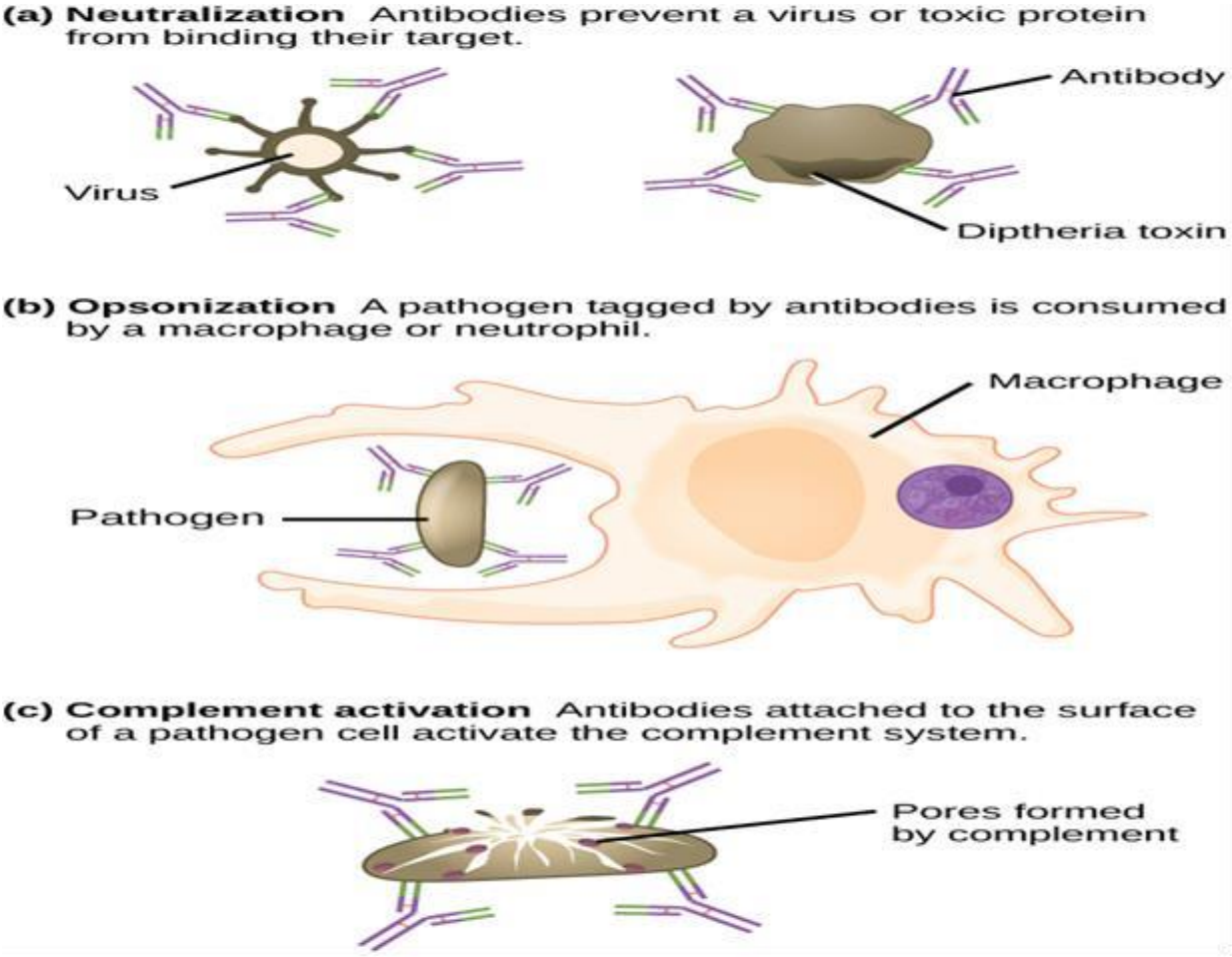
IgM are aggregates of two or five monomers, respectively, that are joined together. IgM is the main antibody isotype present during a primary immune response. The IgG antibody isotype predominates during secondary immune responses and is the most common circulating antibody in the immune system.

The structures and characteristics of the immunoglobulin classes are summarized in Table

	IgM pentamer	IgG monomer	Secretory IgA dimer	IgE monomer	IgD monomer
					
Heavy chains	μ	γ	α	ε	δ
Number of antigen binding sites	10	2	4	2	2
Molecular weight (Daltons)	900,000	150,000	385,000	200,000	180,000
Percentage of total antibody in serum	6%	80%	13%	0.002%	1%
Crosses placenta	no	yes	no	no	no
Fixes complement	yes	yes	no	no	no
Fc binds to		phagocytes		mast cells and basophils	
Function	Main antibody of primary responses, best at fixing complement; the monomer	Main blood antibody of secondary responses, neutralizes toxins,	Secreted into mucus, tears, saliva, colostrum	Antibody of allergy and antiparasitic	B cell receptor



*ANTIBODY FUNCTIONS

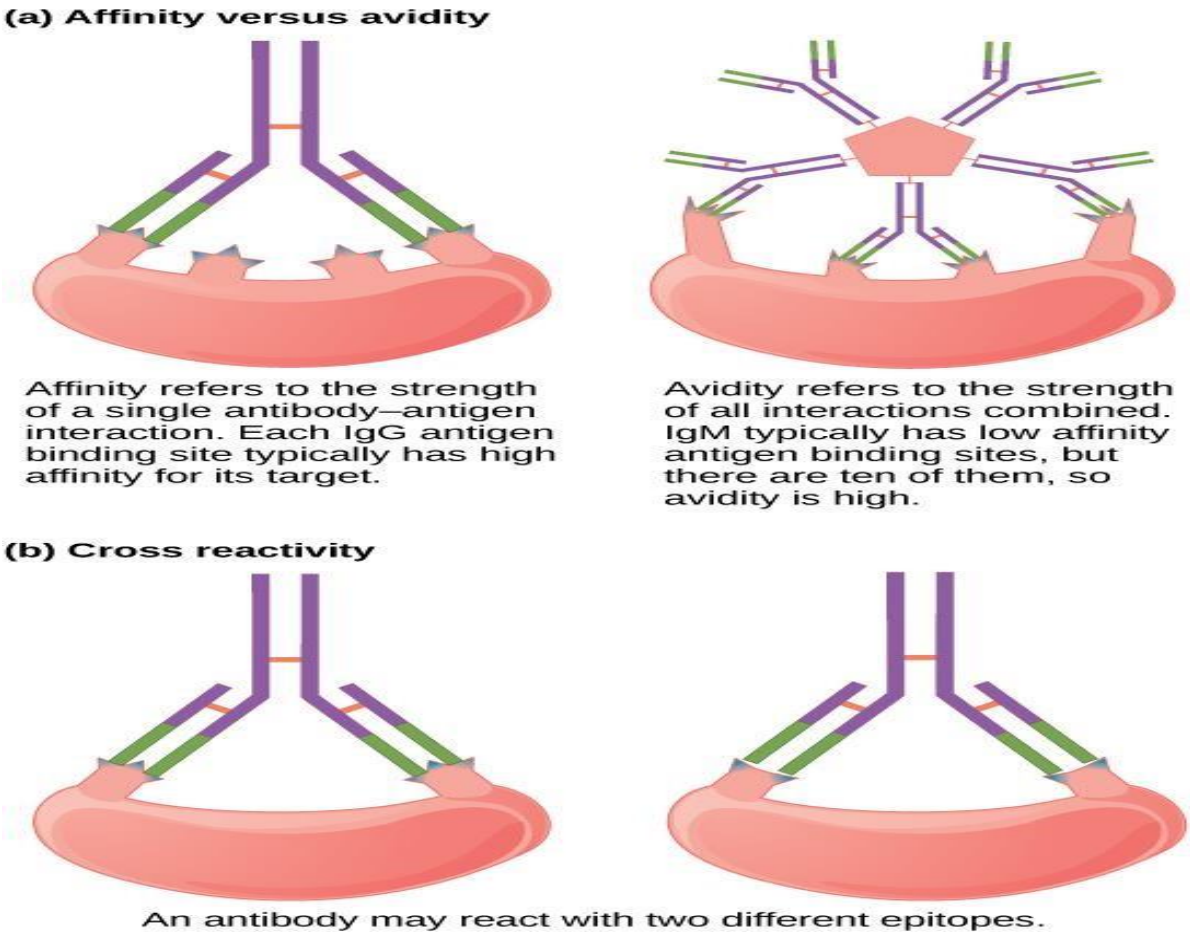


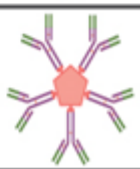
Results of the Antigen–Antibody Interaction

*** Affinity** - Antibody affinity is the strength of the reaction between a single antigenic determinant and a single combining site on the antibody. It is the sum of the attractive and repulsive forces operating between the antigenic determinant and the combining site of the antibody.

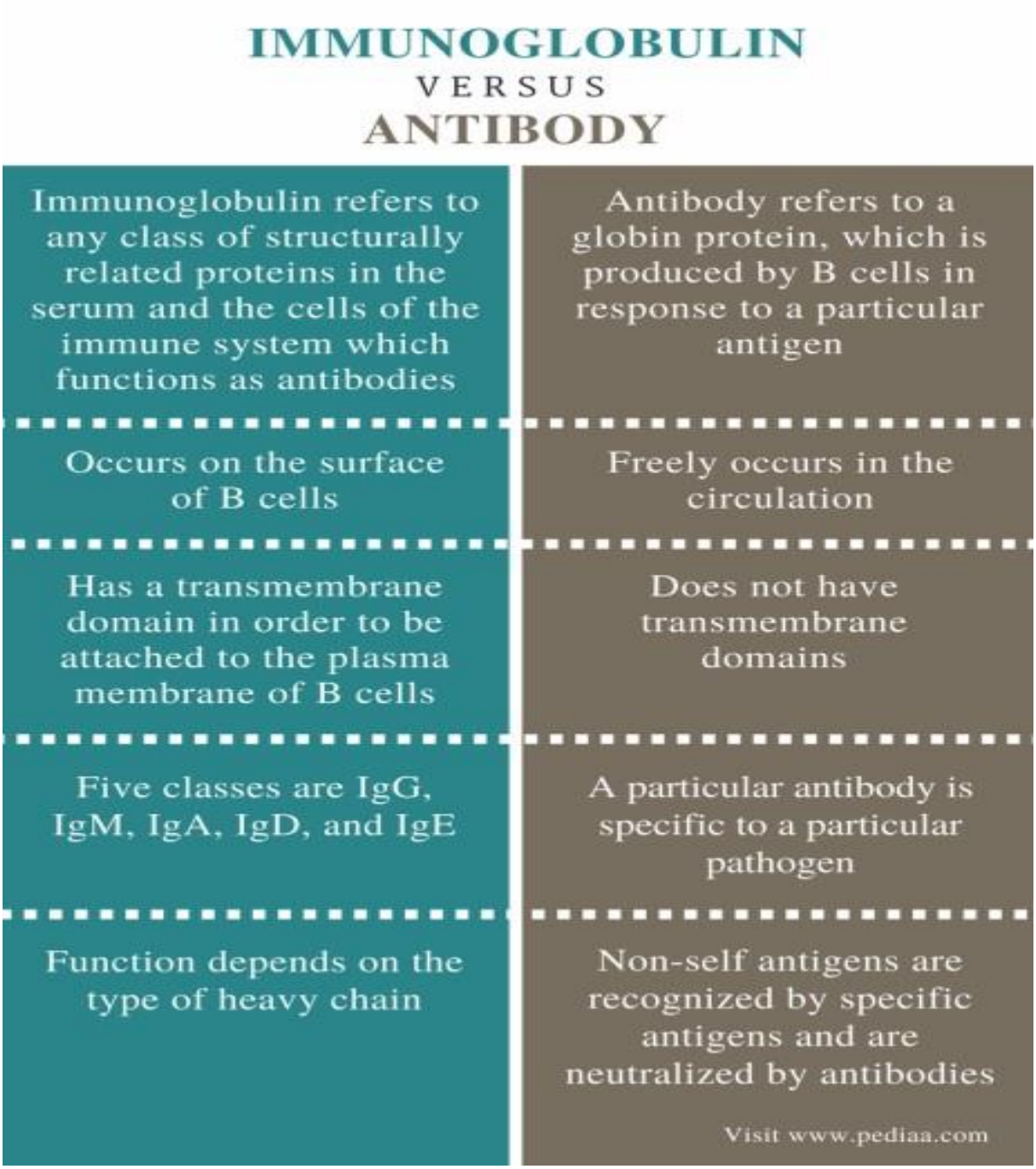
***Avidity** - Avidity is a measure of the overall strength of binding of an antigen with many antigenic determinants and multivalent antibodies. Affinity refers to the strength of binding between a single antigenic determinant and an individual antibody combining site whereas avidity refers to the overall strength of binding between multivalent Ag's and Ab's. Avidity is influenced by both the valence of the antibody and the valence of the antigen.

***Specificity** - Specificity refers to the ability of an individual antibody combining site to react with only one antigenic determinant or the ability of a population of antibody molecules to react with only one antigen



Name	Properties	Structure
IgA	Found in mucous, saliva, tears, and breast milk. Protects against pathogens.	
IgD	Part of the B cell receptor. Activates basophils and mast cells.	
IgE	Protects against parasitic worms. Responsible for allergic reactions.	
IgG	Secreted by plasma cells in the blood. Able to cross the placenta into the fetus.	
IgM	May be attached to the surface of a B cell or secreted into the blood. Responsible for early stages of immunity.	

*Immunoglobulin versus Antibody



Humoral Immunity Response Process

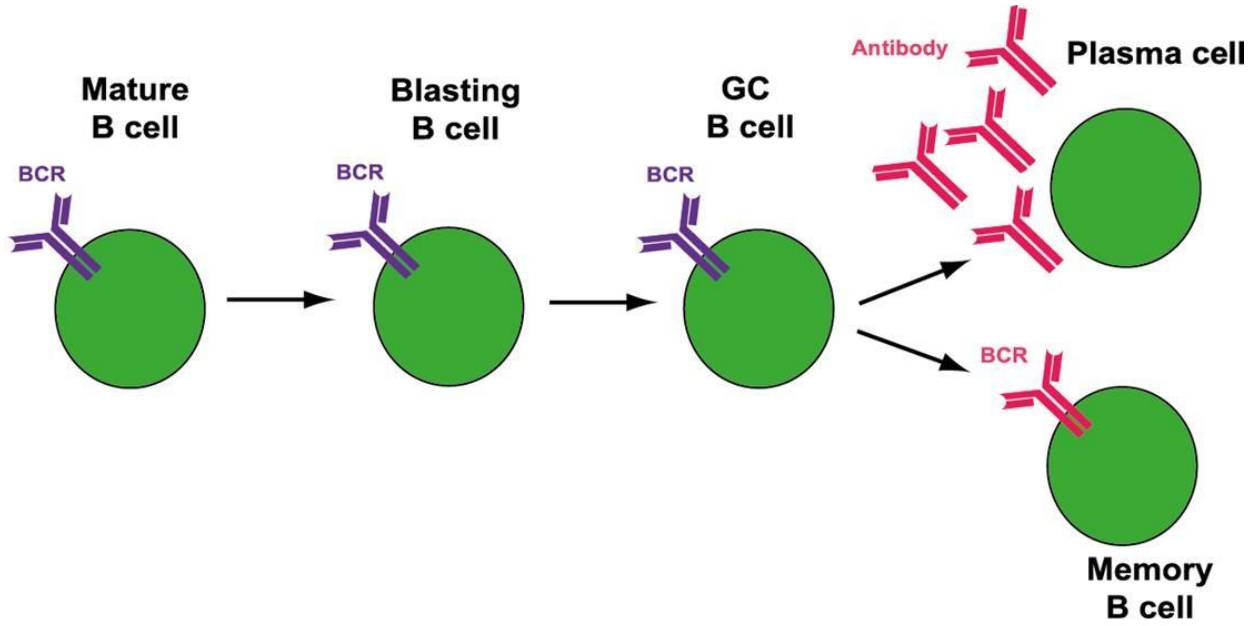
Each B cell carries immunoglobulins on its surface. The majority are IgM and IgD, all of which are specific for recognition of the same epitope (portion of an antigen). Some B cells may have other immunoglobulin families on their surface. For example, B cells in the intestinal mucosa are rich in IgA.

B cells selected to mature can be activated. This allows activated B cells to produce plasma cells that make antibodies as well as memory cells. This process is called clonal expansion, or proliferation.

An antigen that requires a type of T cell called a T helper (TH) cell to activate a B cell is known as a T-dependent antigen.

T-dependent antigens : are mainly proteins of the type found on viruses, bacteria, red blood cells, and haptens with their carrier molecules. For antibodies to be produced in response to a Tdependent antigen, both B and T cells must recognize and interact with different epitopes on a given antigen. This ensures specificity of the attack and also helps prevent an unintentional autoimmune response.

B cells can be activated directly by some antigens, called T-independent antigens, without assistance of T cells.

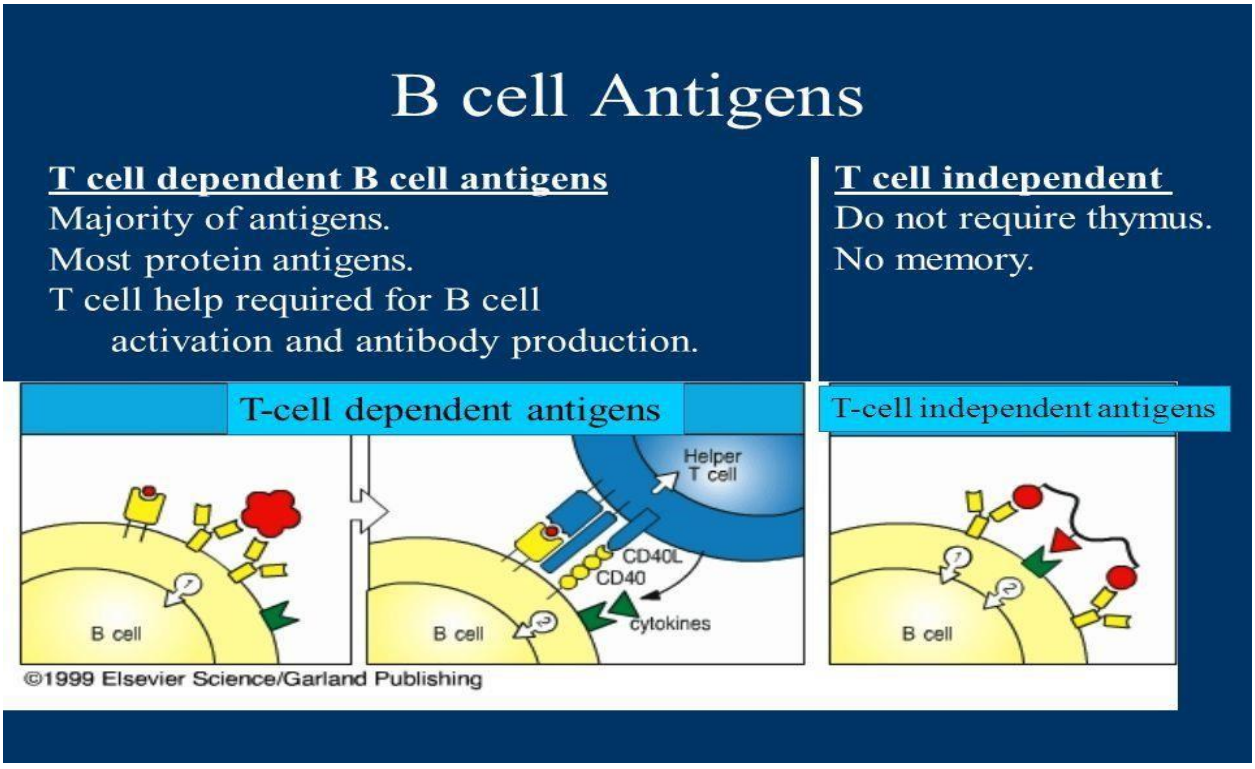


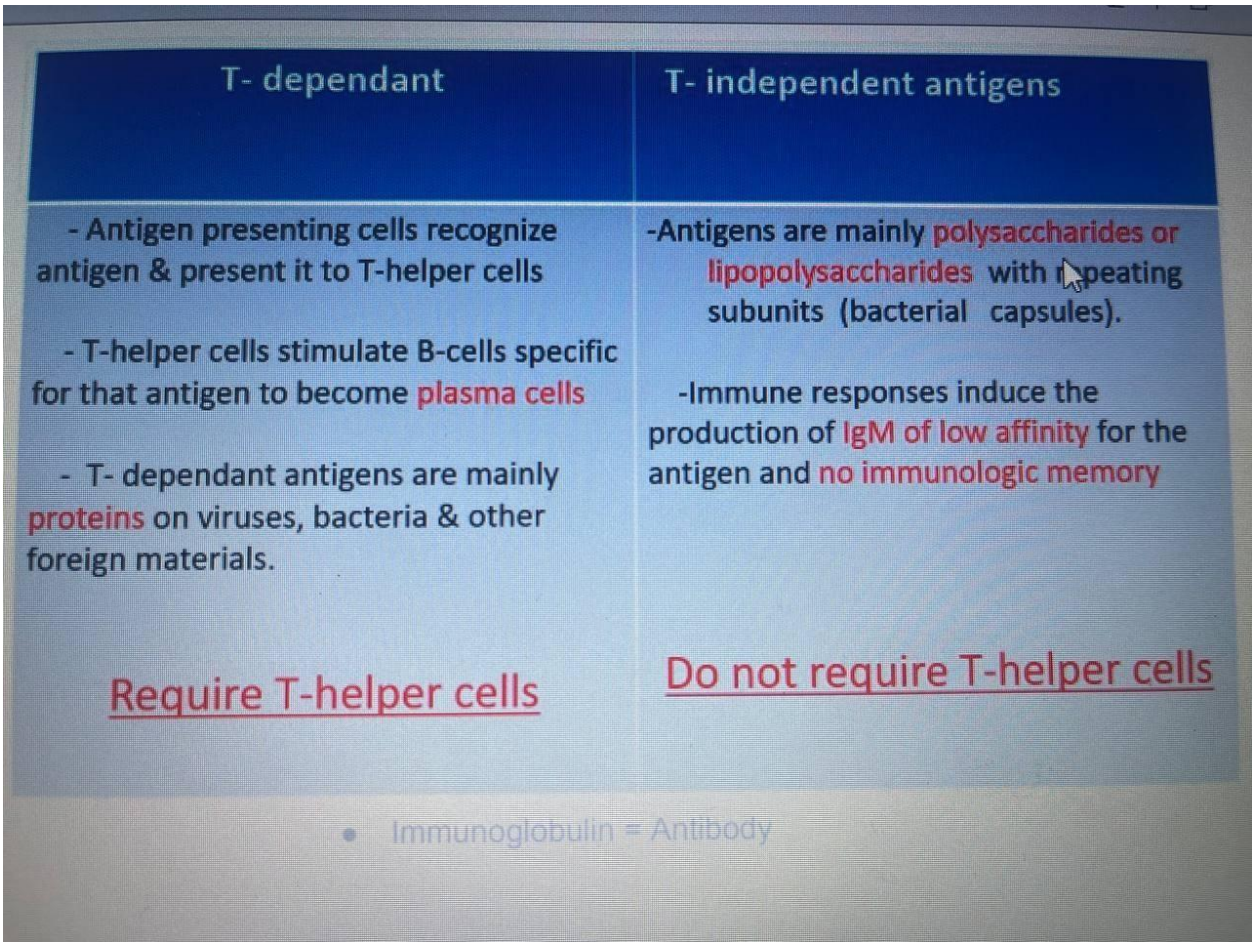
Antigen-Presenting Cell (APC)displays digested antigen fragments on its surface by combining them with its major histocompatibility complex (MHC). The MHC is a collection of glycoproteins embedded in the plasma membrane. Class I MHC are found on all mammalian

nucleated cells. Their presence identifies a cell as "self," preventing the immune system from making antibodies that would be harmful to our own tissues. Class II MHC are found on APCs (B cells, macrophages, and dendritic cells).

Displaying antigen fragments bound to its MHC class II molecules attracts the appropriate T helper cell to the APC cell. The TH cell makes contact with the fragment presented on the APC, and then the T helper cell produces cytokines that activate a B cell, which divides into a large cl Some of the B cell clones differentiate into antibody-producing plasma cells. Others become long-lived memory cells responsible for the enhanced secondary response to an antigen. one of cells.

T-independent antigens : stimulate B cells directly, without the help of T cells. T-independent antigens tend to be molecules consisting of repeating subunits, such as polysaccharides or lipopolysaccharides. Bacterial capsules are a common example of T-independent antigens. The repeating subunits, can bind to multiple B cell receptors, which is probably why this class of antigens doesn't require T cell assistance. However, these antigens tend to provoke a weaker immune response than T-dependent antigens do. The T-independent response is composed primarily of IgM, and no memory cells are generated. The immune system of infants may not be stimulated by T-independent antigens until about age 2.





T- dependant	T- independent antigens
- Antigen presenting cells recognize antigen & present it to T-helper cells - T-helper cells stimulate B-cells specific for that antigen to become plasma cells - T- dependant antigens are mainly proteins on viruses, bacteria & other foreign materials.	-Antigens are mainly polysaccharides or lipopolysaccharides with repeating subunits (bacterial capsules). -Immune responses induce the production of IgM of low affinity for the antigen and no immunologic memory
Require T-helper cells	Do not require T-helper cells