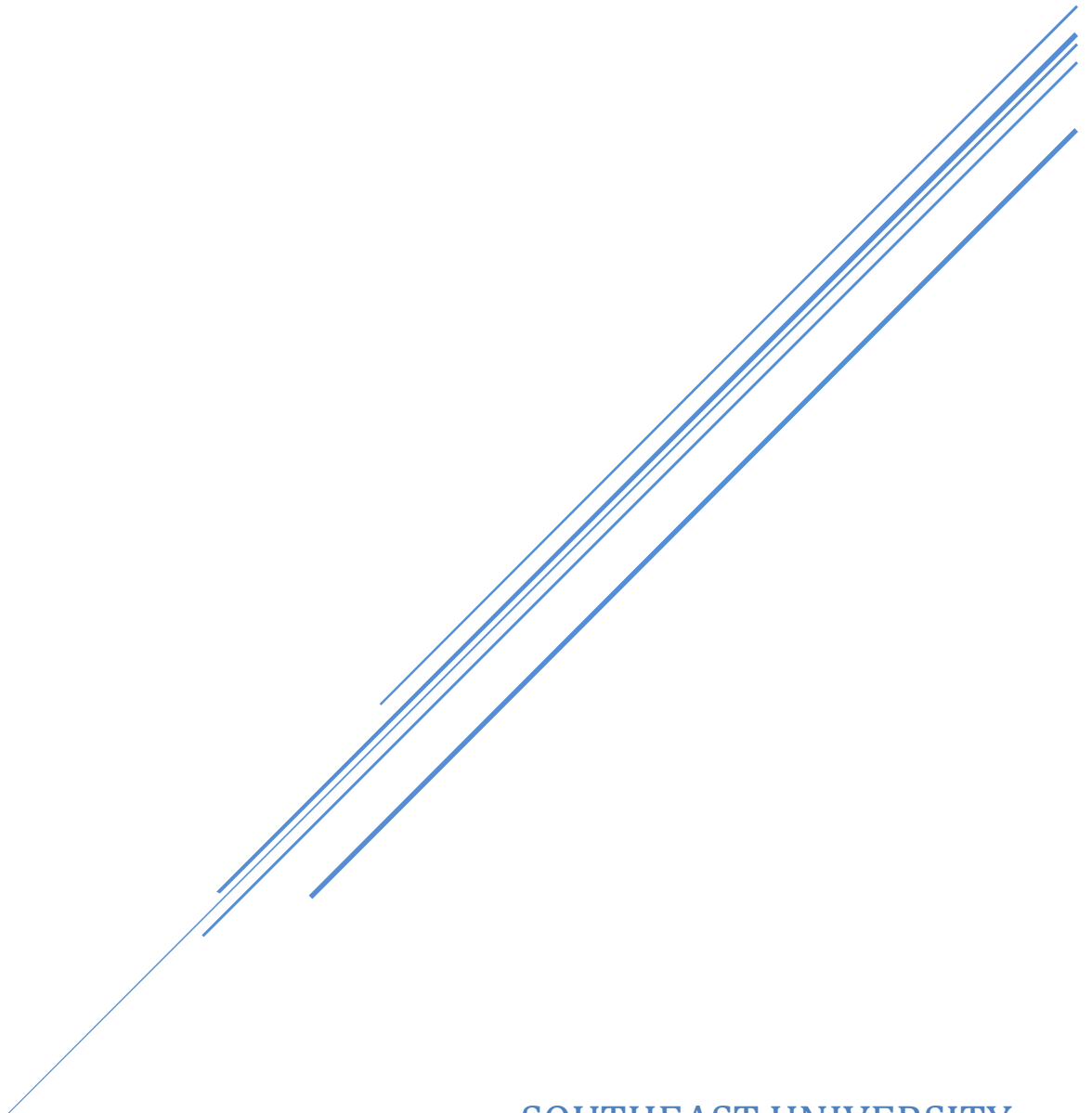


# ANTIBODY (IMMUNOGLOBULIN)

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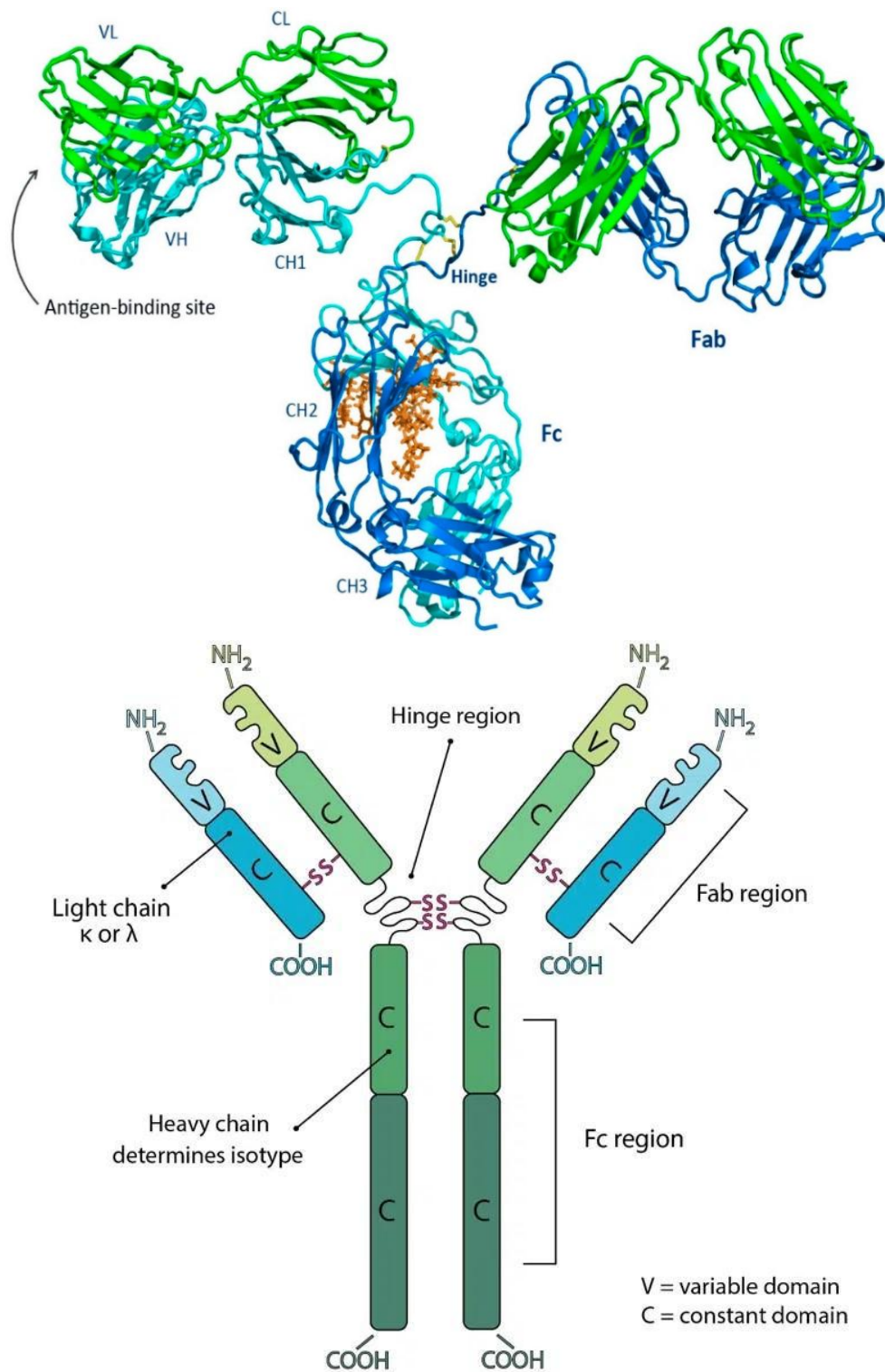
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PHYSICAL PHARMACY-2

Antibodies, also known as immunoglobulins (Ig), are specialized proteins that play a critical role in the immune system. They are produced by B cells in response to the presence of antigens, which are foreign molecules such as pathogens, toxins, or other harmful substances. Antibodies are essential for identifying and neutralizing these threats, making them indispensable for maintaining the body's health and immunity.

## Structure of Antibodies

Antibodies are Y-shaped molecules composed of four polypeptide chains: two identical heavy (H) chains and two identical light (L) chains. These chains are held together by disulfide bonds, creating a quaternary structure. Each chain is a series of domains somewhat similar sequences of about 110 amino acids each. Light chains consist of one variable domain  $V_L$  and one constant domain  $C_L$ , while heavy chains contain one variable domain  $V_H$  and three to four constant domains  $C_{H1}$ ,  $C_{H2}$ ,  $C_{H3}$ . Each antibody has the following structural components:

- 1. Variable (V) Region:** The variable domains can also be referred to as the  $F_V$  region. It is located at the tips of the Y-shaped structure. It contains hypervariable regions known as complementarity-determining regions (CDRs) that directly interact with the antigen.
- 2. Constant (C) Region:** It is found in the stem and lower parts of the arms of the Y-shaped structure. It determines the antibody's class and effector functions.
- 3. Fab (Fragment Antigen-Binding) Region:** Structurally, an antibody is also partitioned into two antigen-binding fragments (Fab). Fab fragment is a region of an antibody that binds to antigens. It is composed of one constant and one variable domain of each of the heavy and the light chain.
- 4. Fc (Fragment Crystallizable) Region:** The Fc region (the trunk of the Y shape) is composed of constant domains from the heavy chains. Its role is in modulating immune cell activity; it is where effector molecules bind to, triggering various effects after the antibody Fab region binds to an antigen. Effector cells (such as macrophages or natural killer cells) bind via their Fc receptor (FcR) to the Fc region of an antibody.



**Fig: Antibody**

## Types of antibodies:

There are five main classes of antibodies, each with unique functions and properties:

### 1. IgG

- Most abundant antibody in blood and extracellular fluid.
- IgG provides long-term protection because it persists for months and years after the presence of the antigen that has triggered their production. IgG protects against bacteria and viruses, neutralises bacterial toxins, triggers complement protein systems, and binds antigens to enhance the effectiveness of phagocytosis.

### 2. IgA

- Found in mucosal areas such as the respiratory and gastrointestinal tracts.
- Protects mucosal surfaces by preventing pathogen attachment.

### 3. IgM

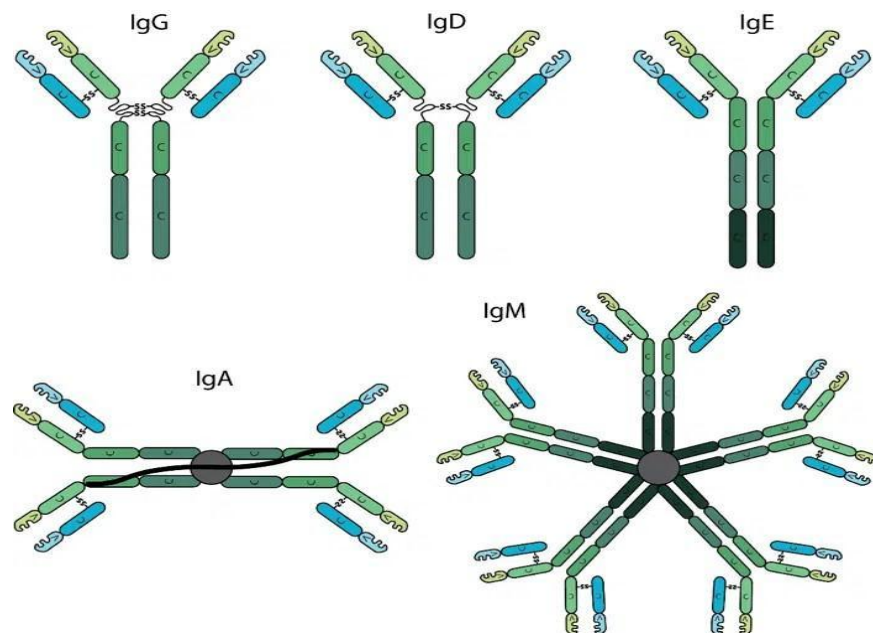
- The first antibody produced in response to an infection.
- Effective in forming antigen-antibody complexes.

### 4. IgE

- Involved in allergic reactions and responses to parasitic infections.
- Binds to allergens and triggers histamine release from mast cells and basophils.

### 5. IgD

- Functions primarily as a receptor on immature B cells.
- Plays a role in initiating B cell activation.



## Function:

**Neutralization:** Antibodies bind to antigens on pathogens or toxins, preventing them from attaching to and infecting host cells.

**Opsonization:** Antibodies coat pathogens, marking them for phagocytosis by immune cells such as macrophages and neutrophils.

**Activation of the Complement System:** The Fc region of antibodies activates the complement system, a group of proteins that assist in destroying pathogens. Complement activation leads to the formation of the membrane attack complex (MAC), causing lysis of the pathogen.

**Agglutination and Immune Complex Formation:** Antibodies cross-link pathogens or antigens, forming clumps (agglutination). These clumps are easier for phagocytes to engulf and remove from circulation.

**Antibody-Dependent Cellular Cytotoxicity (ADCC):** Antibodies bind to infected or abnormal cells and recruit natural killer (NK) cells. NK cells recognize the Fc region and release cytotoxic molecules (e.g., perforin, granzymes) to kill the target cell.

**Mucosal Protection (IgA):** IgA antibodies prevent the attachment of pathogens to epithelial surfaces in mucosal tissues, protecting areas like the respiratory and gastrointestinal tracts.

**Allergic Responses:** IgE binds allergens and triggers mast cells and basophils to release histamine and other inflammatory mediators. This leads to symptoms of allergies and protects against parasitic infections.

