IMMUNOLOGY

DEPARTMENT OF BIOCHEMISTRY

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INTRODUCTION

- IMMUNOLOGY is a study of the immune system and is a very important branch of the medical and biological sciences.
- IMMUNE SYSTEM protects us from infections through various lines of defense.
- Immunity *(immunis* = exempt/free from burden)
- It involves resistance shown and protection offered by the host organisms against the infectious disease.

- The immune system consist of a complex network of cells and molecules and their interactions
- It is specifically designed to eliminate infectious organisms from the body.
- This is possible since the organism is capable of distinguishing the self from non-self ,and eliminate non-self.
- Two types-Innate and Adaptive or Acquired.

ANTIGENS

- Certain components of the cell membrane act as specific antigens.
- They will be different from person to person in their chemical composition and three dimensional structure.
- The immuno-competent cells could recognize the self from non self .
- Any substance which invokes an immunological response in an antigen or immunogen.
- Antibody response will usually be selective against specific spatial configurations on the antigen, which are called antigenic determinant sites, known as epitopes.

IMMUNE RESPONSE

- T- lymphocytes.
- The lymphocytes generated from the bone marrow , passed through and processed by the thymus gland are then called T- lymphocytes.
- They can directly kill the target cells and are the effector cells for the cell-mediated immunity (CMI).
- The T-lymphocytes are found mainly in the paracortical areas of lymph nodes and periarteriolar sheaths in the spleen
- T-cells can identify viruses and microorganisms from the antigens displayed on their surfaces.
- In peripheral blood 80% lymphocytes are T cells and 15% are B cells

TYPES OF T-CELLS

- Inducer T-cell:
- Mediates the development of T-cells in the thymus.
- Cytotoxic T-cells (Tc): Capable of recognizing and killing the infected or abnormal cells.
- Helper T-cells(TH): Initiate immune responses.
- Suppressor T-cells : Mediate the suppression of immune response.
- T – lymphocytes are effector cells for the cell-mediated immunity (CMI)

B-LYMPHOCYTES

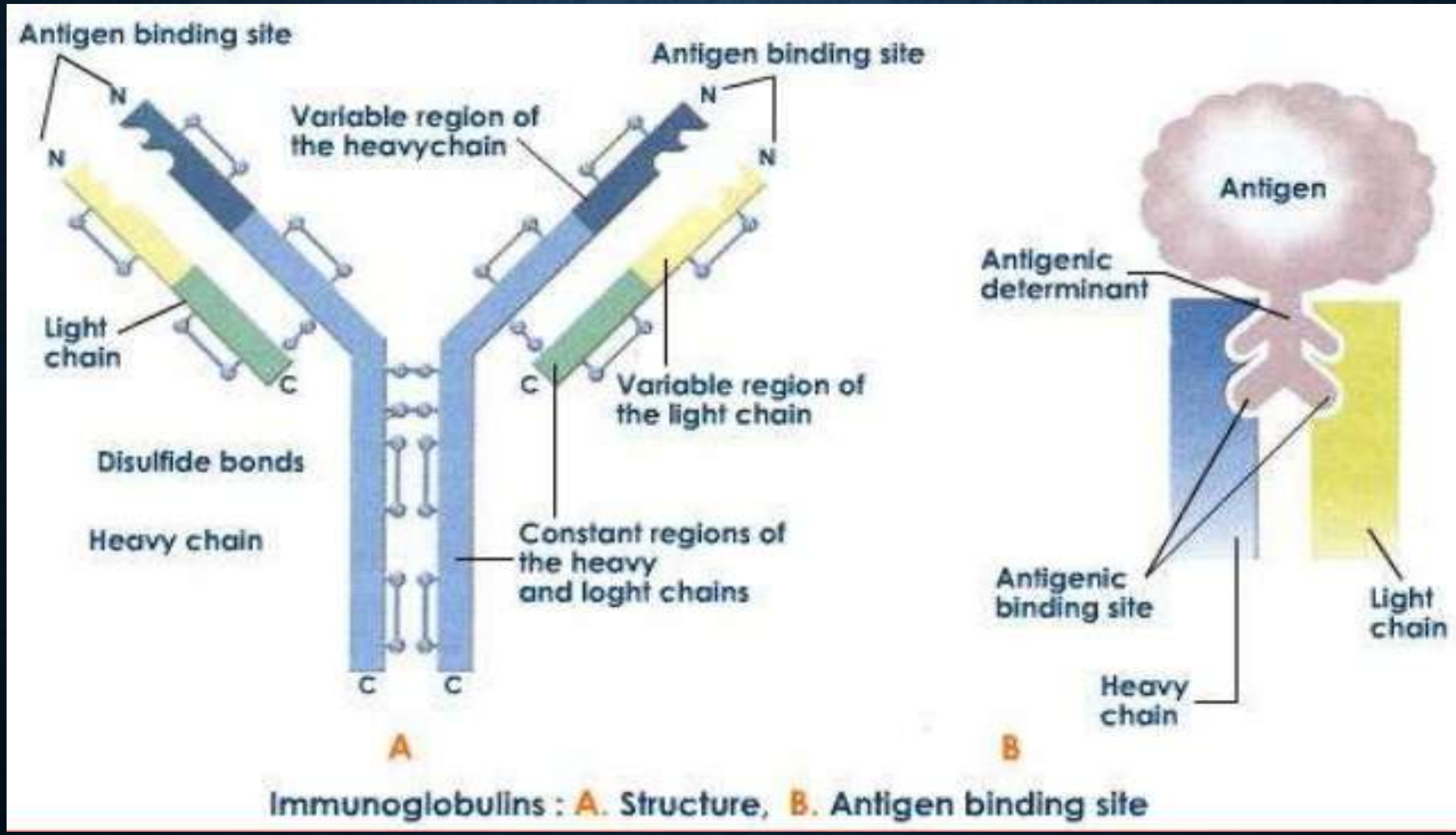
- The site of development and maturation of B-cells occurs in Bursa fabricus in birds, and bone marrow in mammals.
- During the course of immune response , B- cells mature into plasma cells and secrete antibodies (immunoglobulins).
- The B cells govern the humoral immunity
- The B-cells posses the capability to specifically recognize each antigen (i.e. immunoglobulins) against it.
- B – lymphocytes are intimately associated with humoral immunity.

IMMUNOGLOBULINS

- Immunoglobulins , a specialized group of proteins .
- Associated with gamma- globulin fraction (on electrophoresis) of plasma proteins.
- Some immunoglobulins ,separate along with β and α globulins.
- So gamma globulin and immunoglobulin are not synonymous.
- Immunoglobulin is a functional term while gamma-globulin is a physical term.

STRUCTURE OF IMMUNOGLOBULINS

- All the immunoglobulin (Ig)molecules basically consist of 2 identical heavy (H) chains (mol. wt. 53,000 to 75,000 each) and 2 identical light (L) chains (mol . wt. 23,000 each)
- Held together by disulfide linkages and non covalent interactions.
- Immunoglobulin is a Y- shaped tetramer {H2L2}
- Each heavy chain contains approximately 450 amino acids.
- Each light chain contains approximately 212 amino acids.
- The heavy chains of Ig are linked to carbohydrates hence Ig s are glycoproteins.



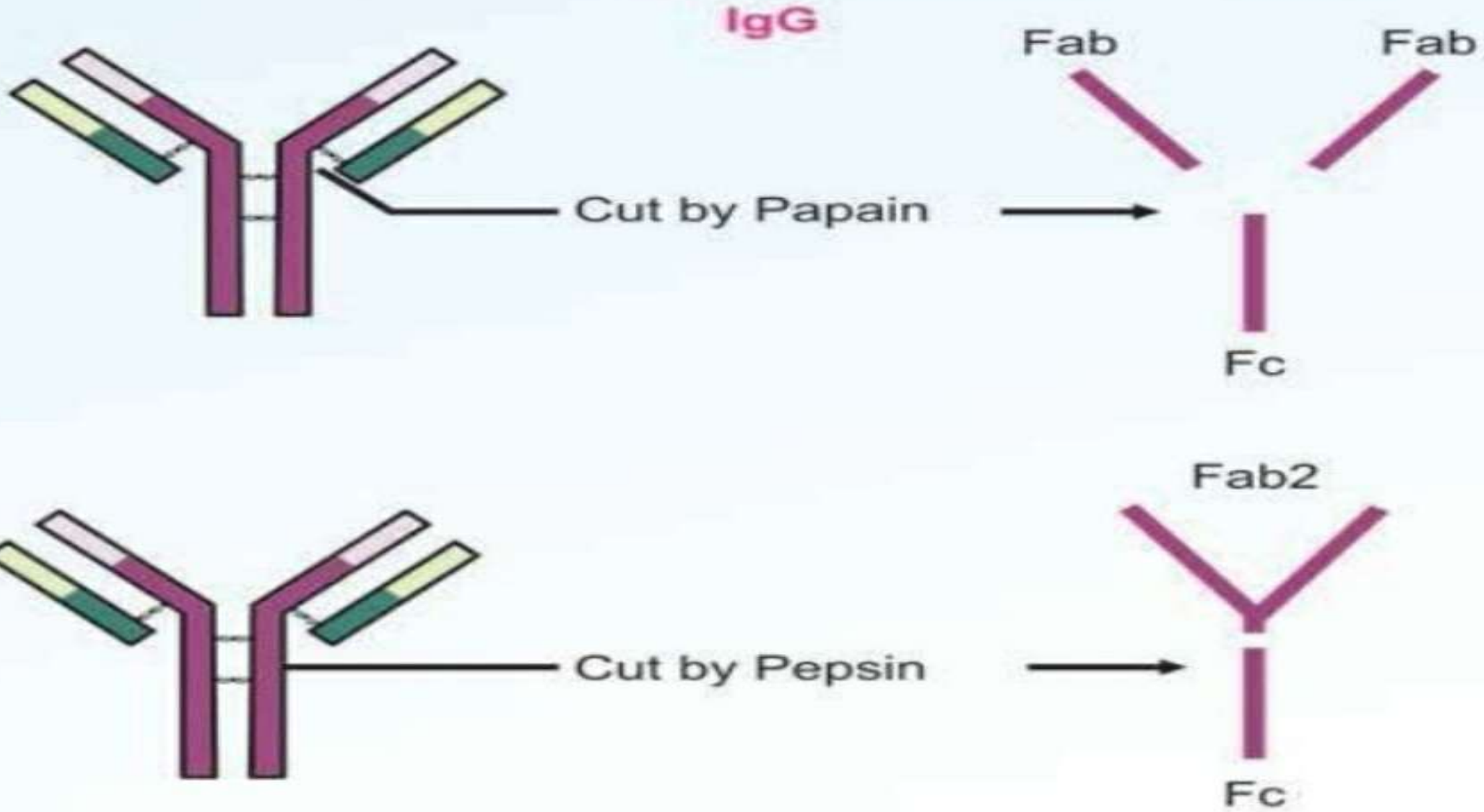
Immunoglobulins : A. Structure, B. Antigen binding site

CONSTANT AND VARIABLE REGIONS

- Each chain (L & H) OF Ig s has two regions (domains).
- Constant & Variable.
- The amino terminal half of the light chain is the variable region (V L) while the carboxy terminal half is the constant region (C L).
- Heavy chain app one-quarter of the amino terminal region is variable (V H) while the remaining three quarters is constant (C H1,CH2,CH3).
- The amino acid sequence (with its tertiary structure) of variable regions for the specific binding of immunoglobulin (antibody) with antigen.

Fab AND Fc PORTIONS

- Papain (proteolytic enzyme from papaya cleaves the Ig.
- Two Fab (fraction antibody) portions & one Fc (fraction crystallizable) portion are produced.
- The antigen binding part of the Ab is in the Fab fragment.
- The cleavage takes place in the hinge region where Ig molecules can have mobility in 3 dimensional space, so as to adjust for tight grip on the Ag.
- Carbohydrate groups of the Ig molecule are also situated in the hinge region.
- The area capable of the complement binding lies in the Fc portion.
- Pepsin cleaves Ig at another site so as to yield F(ab)2,where 2 Fab portions are combined together.
- Fab part can combine with Ag very weakly , but combination with F(ab)2 is stronger


IgG
Fab
Fab
Cut by Papain
Fc
Fab2
Cut by Pepsin
Fc

Classes of Immunoglobulins

- Immunoglobulin-G (IgG) is made up of heavy chain γ (gamma)
- IgM has μ (mu) heavy chain
- IgA has α (alpha) heavy chain
- IgD contains δ (delta)
- IgE heavy chain is called ε (epsilon).

- The light chains are two types either *K* (Kappa) or (lambda) in all the classes.
- An Ig (of any class) contains 2*K* or 2 Light chains & never a mixture.
- E g: Ig G may consist of either gamma2 kappa2 or gamma 2 kappa 2
- In human beings ,60% light chains are of *K* variety and 40% are of lambda type.

IMMUNOGLOBULIN G

- Ig G contains 2 heavy chains & 2 light chains .
- Heavy chains being of gamma type.
- Ig G is the most abundant (75-80%) class of immunoglobulins.
- Ig G is composed of a single Y – shaped unit (monomer).
- It can pass from vascular compartment to intestinal space.
- It can cross- placental barrier & protects the new born child from infections.
- Ig G is the only immunoglobulin that can cross the placenta and transfer the mother’s immunity to the developing fetus.
- IgG triggers foreign cell destruction mediated by complement system.

IMMUNOGLOBULIN A

- Ig A usually are dimers (total 4 heavy chains and 4 light chains).
- The J chain connects the dimers.
- They are the secondary antibodies seen in secretions of gastrointestinal tract , nasopharyngeal tract , urogenital tract, tears , saliva , sweat , milk etc
- Ig A is the most predominant antibody in the colostrum , the initial secretion from the mother’s breast after a baby is born .
- The Ig A molecule bind with bacterial antigens present on the body (outer epithelial) surfaces & remove them .
- Ig A prevents the foreign substances from entering the body cells.

IMMUNOGLOBULINS M

- Ig M is the largest immunoglobulin composed of 5 Y –shaped units
- IgM is a pentamer .
- Five subunits ,each having 4 peptide chains (total 10 heavy chain &10 lightchans) are joined together by a J - chain polypeptide .
- It can combine with 5 antigenic sites due to its pentameric structure.
- Due to its large size . Ig M cannot traverse blood vessels, restricted to the blood stream.
- Ig M is the first antibody to be produced response to an antigen & is the most effective against invading microorganisms.

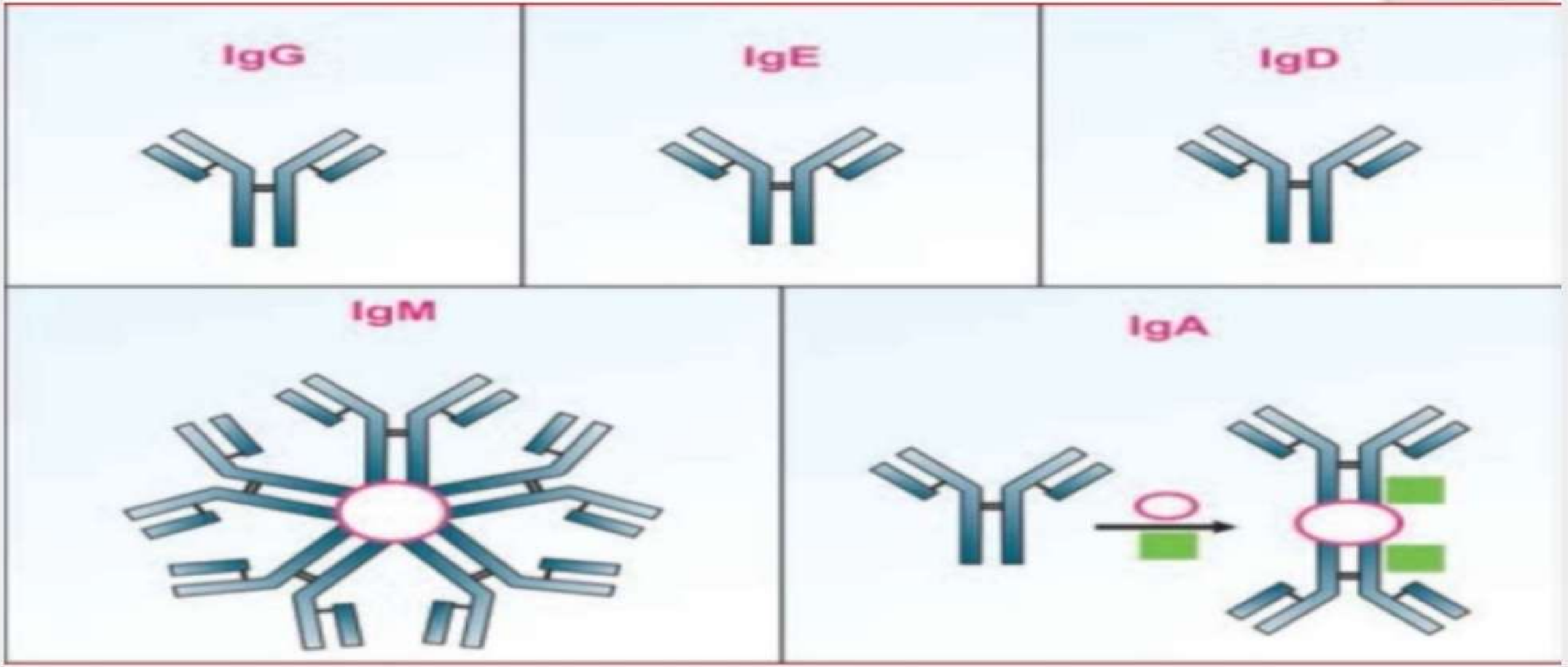
IMMUNOGLOBULIN D

- Ig D is composed of a single Y – shaped unit & is present in a low concentration in the circulation.
- Ig D molecules are present on the surface of B cells.
- Ig D may function as B – cell receptor.

IMMUNOGLOBULIN E

- Ig E is a single Y –shaped monomer.
- It is normally present in minute concentration in blood.
- Ig E levels are elevated in allergic conditions as it is associated with the body’s allergic response.
- Ig E molecules tightly bind with mast cells which release histamine & cause allergy.

- IgG, IgE and IgD have one basic unit each.
- Ig M has 5 basic units and IgA has 2 basic units.
  Red circles represent J pieces.
- Green squares are secretory pieces



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