UNIT – 3

Types of Immunity: Humoral Immunity and Cellular Immunity

Humoral Immunity:

- **Main Effectors:** Antibodies (immunoglobulins).
- **Source:** B cells.
- **Function:** Antibodies circulate in the blood and lymph, targeting extracellular pathogens (e.g., bacteria, viruses in the bloodstream).
- **Primary Défense:** Neutralization, opsonization, and activation of the complement system.

Cellular Immunity:

- **Main Effectors:** T cells (e.g., cytotoxic T cells, helper T cells).
- **Source:** T cells.
- **Function:** Targets infected cells and intracellular pathogens, including cancer cells.
- **Primary Defense:** Direct killing of infected cells and regulation of immune responses.

a) Structure of Immunoglobulins

Immunoglobulin Structure:

1. **Basic Unit:** Composed of two heavy chains and two light chains connected by disulfide bonds.
2. **Domains:** Each chain has variable (V) and constant (C) domains.
3. **Antigen-Binding Site:** Located in the variable domains, responsible for antigen recognition.
4. **Classes:** Immunoglobulins are classified into IgG, IgM, IgA, IgD, and IgE based on the type of heavy chain.

b) Structure and Function of MHC

Major Histocompatibility Complex (MHC):

1. **Structure:** MHC molecules are cell surface proteins that present antigens to T cells.
2. **Classes:** MHC class I presents endogenous antigens to cytotoxic T cells, while MHC class II presents exogenous antigens to helper T cells.
3. **Function:** Crucial for antigen recognition by T cells and the initiation of immune responses.

c) Hypersensitivity Reactions, Immune Stimulation, and Immune Suppression

Hypersensitivity Reactions:

1. **Type I (Immediate):** IgE-mediated allergic reactions (e.g., anaphylaxis).
2. **Type II (Cytotoxic):** Antibody-mediated destruction of cells (e.g., autoimmune hemolytic anemia).
3. **Type III (Immune Complex):** Immune complexes deposit in tissues, leading to inflammation (e.g., lupus).
4. **Type IV (Delayed):** Cell-mediated response causing tissue damage (e.g., contact dermatitis).

Immune Stimulation and Suppression:

- **Stimulation:** Enhancing immune responses through vaccines, immunomodulatory drugs.
- **Suppression:** Reducing immune responses in autoimmune diseases, transplant rejection prevention.

d) General Method of the Preparation of Bacterial Vaccines, Toxoids, Viral Vaccines, Antitoxins, Serum-Immune Blood Derivatives, and Other Products Relative to Immunity

1. **Bacterial Vaccines:**
    - **Preparation:** Killed or attenuated bacteria used as vaccines (e.g., inactivated polio vaccine).
    - **Example:** Diphtheria-tetanus-pertussis (DTP) vaccine.
2. **Toxoids:**
    - **Preparation:** Inactivated toxins used as vaccines (e.g., diphtheria and tetanus toxoids).
    - **Example:** Diphtheria toxoid in DTP vaccine.
3. **Viral Vaccines:**
    - **Preparation:** Attenuated or inactivated viruses used as vaccines (e.g., measles-mumps-rubella vaccine).
    - **Example:** Measles vaccine.
4. **Antitoxins:**
    - **Preparation:** Antibodies against bacterial toxins (e.g., diphtheria antitoxin).
    - **Example:** Diphtheria antitoxin.
5. **Serum-Immune Blood Derivatives:**
    - **Preparation:** Blood components containing antibodies (e.g., immune globulin).
    - **Example:** Intravenous immunoglobulin (IVIG).

e) Storage Conditions and Stability of Official Vaccines

- **Storage Conditions:**
    - Most vaccines are stored at 2-8°C (refrigerated).
    - Some vaccines, like live attenuated vaccines, may require freezing.
    - Storage conditions are critical for maintaining vaccine efficacy.
- **Stability:**
    - Vaccines must maintain potency throughout their shelf life.
    - Factors affecting stability include temperature, light exposure, and formulation.
    - Proper cold chain management is crucial to prevent vaccine degradation.

f) Hybridoma Technology - Production, Purification, and Applications

Hybridoma Technology:

1. **Production:**
    - Fusion of antibody-producing B cells and myeloma cells to create hybridoma cells.
    - Hybridomas produce monoclonal antibodies (mAbs) with specificity from the parent B cell.
2. **Purification:**
    - Antibodies are harvested from hybridoma cell culture.
    - Purification methods include chromatography, protein A/G affinity, and precipitation.
3. **Applications:**
    - Diagnostic assays (e.g., ELISA, Western blotting).
    - Therapeutics (e.g., cancer treatment, autoimmune diseases).
    - Research tools in molecular and cellular biology.

g) Blood Products and Plasma Substitutes

Blood Products:

1. **Whole Blood:** Used in emergencies for volume and oxygen-carrying capacity.
2. **Packed Red Blood Cells (PRBCs):** Concentrated red blood cells for anemia treatment.
3. **Platelets:** Used in clotting disorders or for chemotherapy patients.
4. **Fresh Frozen Plasma (FFP):** Contains clotting factors, used for bleeding disorders.

5. **Cryoprecipitate:** Rich in clotting factors, used in hemophilia.

Plasma Substitutes:

- **Colloids (e.g., Albumin, Hetastarch):**
    - Used to increase blood volume in cases of shock or low blood volume.
    - Maintain oncotic pressure.
- **Crystalloids (e.g., Saline, Lactated Ringer's):**
    - Used for fluid replacement and to maintain electrolyte balance.
    - Less expensive but shorter duration of action compared to colloids.

Understanding these aspects of immunity, vaccine preparation, and blood products is crucial for healthcare professionals involved in immunization, blood transfusion, and therapeutic interventions. These technologies and products have significantly advanced medical treatments and interventions.