Blood Physiology

Dr. Rodolfo T. Rafael

- Agglutination
- Hemolysis
- Immunology
Agglutination

- is an antigen-antibody reaction
- Blood
- clumping of red blood cells
- “Blood Typing”

BLOOD TYPING

The ABO Grouping
The Rh Factor
Transfuse Blood

- Anemia
- Hemorrhage

Clumping of RBC will Occur

- A agglutinogen mixes with alpha agglutinins (Anti- A)
- B agglutinogen mixes with beta agglutinins (Anti- B)
Cross Matching

- determination of blood compatibilities for purposes of transfusion
- the donor’s cells are mixed with the recipient serum while the donor’s serum is mixed with the recipient’s cells.
- ideal for transfusion
### The ABO GROUPING

<table>
<thead>
<tr>
<th>Blood Type</th>
<th>Agglutinogen Present (in the red cell)</th>
<th>Agglutinin Present in the Plasma</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A agglutinogen</td>
<td>Beta agglutinin or Anti-B</td>
</tr>
<tr>
<td>B</td>
<td>B agglutinogen</td>
<td>Alpha agglutinin or Anti-A</td>
</tr>
<tr>
<td>O</td>
<td>None</td>
<td>Both alpha and beta or both anti-A and anti-B</td>
</tr>
<tr>
<td>AB</td>
<td>A and B agglutinogen</td>
<td>none</td>
</tr>
</tbody>
</table>

- A person who is blood type A will have red blood cells with an A type protein (antigen) found on its surface.
- In addition, the blood plasma will contain antibodies to the B type protein. This is why B type blood cannot be transfused into A type individuals, the B antibodies of the A plasma will attack and destroy the B red cells, causing dangerous and often fatal blood clotting.
Universal recipients

- AB blood has both proteins, but no antibodies; these individuals can obtain blood from anyone and are called Universal recipients. Unfortunately they can only give blood to another AB type person. Transfusing AB blood into an A type person would result in clotting due to the B type antibodies found in the recipient.
- O blood has neither protein; it can be safely transfused into any individual. It is known as the universal donor.

Blood type in Humans

<table>
<thead>
<tr>
<th>Type</th>
<th>Can give blood to</th>
<th>Can receive blood from</th>
</tr>
</thead>
<tbody>
<tr>
<td>A⁺</td>
<td>A, AB</td>
<td>A, O</td>
</tr>
<tr>
<td>B⁺</td>
<td>B, AB</td>
<td>B, O</td>
</tr>
<tr>
<td>O⁻</td>
<td>A, B, AB, O</td>
<td>O</td>
</tr>
<tr>
<td>AB⁺</td>
<td>AB</td>
<td>A, B, AB, O</td>
</tr>
</tbody>
</table>
Antigens A and B (cells, tissue fluid) except

- cerebrospinal fluid
- testicles
- lens
- chorion frondosum of the plasma
- hair
- compact bone
- cartilage
- epithelial cells of the skin and nails
The RH factor
• antigenic factor independent of the A and B antigens
• Rhesus Monkey
• Rh positive
• Anti-Rh agglutinins
  • are formed only in Rh negative individual who have received several transfusion of Rh positive blood.

Erythroblastosis Fetalis
• 10,000
• 200,000

Error in Blood Transfusion may result in
• agglutination
• destruction of the cell membrane by the circulating antibodies
• renal shut down
Blood Substitutes

- plasma
- 0.9% saline
- dextran
Hemolysis or Laking of the blood

Hemolysis may be caused by:

- hypotonic solution
- chemical substances (acids, alkali, fat solvents, bile salts)
- substances formed in the animal body like hemolysins, bacterial toxins, venoms
Hemolysis

- decrease oxygen carrying capacity of the blood

Red Cell Fragility

- shrink in > osmotic pressure
- spherical < osmotic pressure → hemolysis
- Normal Osmotic Fragility
  - 0.48%
  - 0.33%
- Abnormal Red Cell Fragility
  - hereditary spherocytosis (congenital hemolytic icterus)
  - drugs
  - infection
    - glucose 6-phosphate dehydrogenase
Role of the Spleen

- blood filter
- removes spherocytes and abnormal blood cell
- platelet
- immune system
- Circulation has 2 Components
  - fast
    - nutritive
  - slow
    - filter
- Absence of the spleen
  - bacterial infection
Immunology

Definition

- Immunity constitutes all the physiological mechanism which allow the body to recognize materials as foreign to itself and to neutralize or eliminate them
Function

- Protection against
  - microbes
  - viruses
  - bacteria
  - other unicellular and multicellular organism.
- Elimination of worn out or damage body cell
- Immune surveillance (cancer)
- Involve in the process of aging
- Obstacle to successful transplantation of organ

Classification

- Non-specific Defense Mechanism
- Specific Immune Mechanism
Non-specific defense mechanism

- phagocytes
- lysozymes
- basic polypeptide
- properdin
- interferons

Specific immune mechanism

- humoral immunity (antibodies)
- cell-mediated immunity (sensitized lymphocytes)
**Non-specific defense mechanism**

- do not depend upon previous exposure to the particular foreign substance without having to recognize their specific identities.
- they are particularly important during the initial exposure to a foreign organism before the specific immune response have been activated

**Specific immune response**

- depend upon prior exposure to the specific foreign substances recognition of it upon subsequent exposure and reaction to it.
Some Basic Definitions

- **Antigen**
  - any substance capable of provoking an immune of any type in an immunologically-competent vertebrate. Antigens occurring in nature are substances of high molecular weight and usually are proteins or CHO.

- **Hapten**
  - any incomplete antigen, e.g., any substance not of itself capable of provoking an immune response but able to serve as a partial antigen when bound to another substance. Haptens are usually of low molecular weight and may be of relatively simple structure.

- **Antibodies**
  - plasma proteins synthesized in (humoral) immune responses which are capable of combining with the provoking antigens.

- **Cellular Specificity**
  - immune cells like antibodies, have a maximal reactivity with the specific antigen and a lessening reactivity with increasingly-related compounds.
• The Immune System
  • This term is used synonymously with the term lymphoid system. Encompasses that system of the body which is responsible for all types of immune responses

• The “T-cell” division
  • defined functionally as the system responsible for the expression of cellular immunity. This division requires the presence of a thymus gland during embryogenesis for its development and maturation.

• The “B-Cell” division
  • defined functionally as the division responsible for the expression of humoral immunity.
  • In birds, the system depends on a hindgut lymphoid organ termed the Bursa of Fabricus for its development and maturation. In mammals, a diffuse system of gut- associated lymphoid tissue and/or bone marrow cells appear to serve as a Bursa- equivalent.
Schematic Ontogeny of the Lymphoid System

- Inducer
- Primordial Bone Marrow
- Lymphoid Stem Cell
- Bursa of Fabricus
- Other Maturational Factor

Thymus

- Mature T-cell
- Mature B-cell

may exert a “Helper” Role in B-cell development

The Immune System

- T-cell Division (cellular)
  - Sensitized Lymphocytes

- B-cell Division (humoral)
  - Antibody Immunoglobulin
Differences Between B-cell and T-cell

- B- cells
  - confer specific immune resistance against bacteria
- T- cells
  - Major carriers of specific immunity against fungi, viruses, parasites and few bacteria which to survive must live inside cells.
  - Destruction of cancer cells
  - Rejection of solid-tissue transplants.

Function of Antibodies

- neutralization of antigens
- antigen-antibody precipitation
- agglutination of bacteria
- lysis of cellular structure
- opsonization
Polypeptide chains and are identical except for a relatively small number of amino acids occupying the first positions in the chains.

These differences constitute the antibody specificity.

Family of proteins known as gamma globulins and are also known as immunoglobulins.

Each immunoglobulin molecule consists of four polypeptide chains—two heavy chains and two light chains.

Each polypeptide chain is intricately folded to form globular regions that are joined together in such a way that the immunoglobulin molecule as a whole is Y-shaped.

Each light chain consists of 214 amino acids.

Heavy chains consist of 446 amino acids, so are about twice as long and weigh about twice as much as light chains.

### Immunoglobulins Characteristics

- **IgG**
  - most abundant
  - can cross the placenta
  - has antibacterial, antiviral antitoxic activities in vivo
- **IgA**
  - second most abundant
  - chief Ig in exocrine secretions
• IgM
  • strong cytolytic and complement-fixing for exceed IgG
  • found predominantly in intravascular pool, larger molecular size does not tend to cross placenta
  • usually the first to appear in immunization
• IgE
  • has homocytotropic property
  • it mediates certain allergic responses
• IgD
  • present in the blood in very small amounts and its function is as yet unknown.

Complement

• a component of blood serum, consist of a set of several proteins.
• They are inactive enzymes that are activated in a definite sequence to catalyze an intricately linked series of reactions.
• The end result of this rapid-fire activity is to produce cytolysis
Properdin

- Like complement, consists of a set of proteins present in blood serum as inactive enzymes.
- When activated it can initiate the complement series in addition to the usual antibody method of activating it.

Interferon

- It is another protein compound that plays a part in producing immunity.
- It is synthesized by body cells under certain conditions, notably after viruses have invaded them.
- Released from the cells that produce it, interferon acts on other body cells to defend them against viruses.
- Recent evidences suggests that interferon retards the growth of cancer cells.
Acquired Immunity

• is that which an individual develops by exposure to a foreign substance or organism or receives from some outside source.
• A person who recovers from plaque, cholera, yellow fever, or various other diseases is usually immune from second attacks of the same disease.

Active Immunity

• is that produce by immunized individuals in response to natural or artificial stimulation of the antibody-producing mechanisms.
• In addition to obvious clinical cases of disease, unrecognized or inapparent infections may also induce immunity.
Passive Immunity

• is that form of immunity produced in an individual either by natural transfer or by injection.
• It is only temporary lasting a few weeks to a few months, whereas active immunity is ordinarily more durable.

Adoptive Immunity

• is an immune state produced by the transfer of antigen sensitive (primed) lymphocytes from an actively immunized donor to a non-immune recipient.
Clinical Correlation

- Autoimmunity
  - Myasthenia Gravis
  - Rheumatic Heart Disease
  - Acute Glomerulonephritis
  - SLE
  - Thyroiditis
- Defects in Development of Immune System
  - Failure of lymphocyte precursors to migrate to thymus, liver, spleen → absence of cellular and humoral immunity
  - Congenital absence of thymus → absence of cellular immunity but humoral immunity is normal
  - Agammaglobulinemia
    - B cells fail to develop
    - Susceptible to bacterial infections.

Thank You!

For not listening….