Lymphatic System and Body Defenses
Chapter 14

Lymphatic System

Lymphatic System works quietly and makes possible the continued operation of Circulatory System. It brings back about 3-4L/day of fluids, blood cells, plasma proteins to venous system. It is also vital for the 100% working of body defense.

Circulatory system is a 2-way system – heart to body tissues and from body tissues to heart. On the other hand, lymphatic system operates only from tissues to heart. It is 1-way system. Lymphatic system originates in peripheral tissues as lymph capillaries and vessels and ends at venous connections.

Lymphatic System

Lymphatic system consists of
- Lymphatic capillaries, lymphatic vessels and lymphatic ducts
- Lymphoid tissues – tonsils, and appendix
- Lymphoid organs – Spleen, thymus and lymph nodes
- Lymph – blood plasma with lower % of proteins and white blood cells

Lymphatic Vessels

Peripheral tissues → Lymphatic capillaries → lymphatic vessels → lymphatic duct → opens into subclavian vein. Kidney shaped Lymph nodes are present, periodically associated with lymphatic collecting vessels and trunks. Lymphatic vessels usually have more valves and branch more frequently than veins. Like veins all 3 tunics are present in lymphatic vessels but are thinner. Flap-like mini-valves are present in lymphatic capillaries and help to collect tissue fluid. Lacteals are special lymphatic capillaries present in finger like Villi of intestinal wall. These lacteals collect milky white lymph, called Chyle, rich in fat products.

Lymphatic ducts

Lymphatic Ducts include 2 large ducts in thoracic region.
- Right Lymphatic duct – collects lymph from right arm, right side of head, neck and thorax.
- Thoracic Duct – collects lymph from rest of the body. It arises inferiorly as an extended sac – Cisterna Chyli, in front of 1st and 2nd lumbar vertebrae. Right thoracic duct is not present in all humans. When absent, the lymphatic trunks directly open into veins of the neck.

Lymphoid Cells

Lymphoid Cells – all lymph cells arise in bone marrow but get mature in different ways. B-cells mature in bone marrow and T-cells mature in thymus gland.

B-Cells produce immunoglobulin proteins called Antibodies. Helper T-cells stimulate B-cells to transform into Plasma Cells that produce antibodies on a massive scale.

T-Cells are of basic 3 types. 1. Cytotoxic cells 2. Helper T-cells 3. Memory Cells

Lymphoid Tissues

Lymphoid Tissue is mainly a kind of loose Reticular Connective Tissue. It provides site for storage and proliferation of lymphocytes. These include tonsils and intestinal nodules.

Tonsils are several swellings of mucosa. These include Pharyngeal, Palatine, and Lingual Tonsils.

Pharyngeal tonsils lie close to opening of auditory tubes and prevent infection spreading to middle ear.

Palatine tonsils lie on palate and lingual tonsils lie on posterior part of tongue.

Lymph Nodes

Lymph Nodes are the principal lymphoid organs. Outer Cortex forms lymphocytes and inner Medulla has cords and reticular fibers. Macrophages are associated with reticular fibers and destroy microorganisms and debris. Each lymph node receives many afferent lymphatic vessels and passes lymph into lesser number of efferent lymphatic vessels.
Thymus

Thymus is associated to superior side of heart and major blood vessels. It is a bilobed organ. It is best developed at the time of birth. It degenerates in middle age. It secretes thymosin hormones for differentiation of T-cells.

Spleen

Spleen is fixed to lateral side of stomach. It also lies next to pancreas and left kidney. It stores white blood cells. Macrophages eliminate worn out RBC in spleen.

Recap 1 Lymphatic System

1. Lymphatic system begins as a peripheral network of lymphatic vessels and ends at connections to -------  --------.
2. Lymphatic ducts bring ----L of tissue fluid back to veins.
3. Lymphatic tissues are -------and ----------    ----------------.
4. Lymphatic organs are ----------,--------- and -------   ----------.
5. ------ is a lymphatic organ attached to lateral side of stomach and ---- lies in chest superior to heart.

Immunity

Lymphatic System plays major role in body defense system. Body defense has 2 major divisions – Innate defenses and Acquired Defenses.

Immune response defends against Antigens – bacteria, viruses, cancer cells, mismatching RBC or other molecules declared Non-self or foreign by body immune system.

Immunity means resistance to disease. Body achieves immunity by non-specific and specific responses against invaders.  Non-specific Response is against all invaders and consists of Physical barriers, phagocytes, interferons, complement system and inflammatory response. Specific Response is against particular antigen and involves antibody formation.

Non-specific defenses

Physical Barriers: An intact skin, mucus membranes and their secretions prevent entry of microbes into body. It includes tears in eyes, sweat on skin, saliva in mouth, and acid in stomach and urine. Nasal hair and cilia in respiratory tract also are part of this defense.

Phagocytes like macrophages, neutrophils, Monocytes and eosinophils eat bacteria and viruses by phagocytosis.


Non-specific defenses

Immunological Surveillance is done by macrophages and natural killer cells. They kill virus infected cells and cancerous cells.

Complement system – a combination of at least 20 proteins, when activated fix pore complexes in the membranes of Antigens and kill them due to loss of fluids.

Inflammatory response draws WBC’s to the site of injury, causes swelling and redness. Mast cells of connective tissue and Basophils in blood release histamine to start inflammatory response.

Immunity

Innate Immunity – Immunity by birth due to genes; no previous exposure required and antibody formation is not involved.

Acquired Immunity – is acquired after birth and requires exposure to pathogens or vaccination. It has 2 basic types, Active and Passive Immunity.

Active Immunity

Active Immunity is achieved by making Antibodies inside the body due to infection or vaccination. Antibodies are immunoglobulin proteins of Y-shape. Antibodies attach to antigen on surface of microbes or cells. This marks them to be killed by phagocytes.

Passive Immunity Passive Immunity is achieved by giving antibodies made in another organism of same
or different species. This is done if the patient’s immune system is weak or cannot make antibodies fast enough to defend against the attack. For example a newly born baby has a weak immune system and mother’s milk passes its antibodies to the baby to defend against certain diseases.

### Recap 2 Immunity

1. B-cells originate and mature in ------   ----------.
2. T-cells originate in --- and mature in ----. (mature in = differentiate)
3. Inflammation is brought by ---- cells of blood and ---- cells of connective tissues.
4. AIDS virus attack ------cells of immune system and compromise it.
5. In----immunity body makes its own antibodies after birth and in -----immunity antibodies are made in another body.

<table>
<thead>
<tr>
<th>B – Cells</th>
<th>T – Cells</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mature inside</strong></td>
<td>maturing inside</td>
</tr>
<tr>
<td>Bone marrow</td>
<td>Thymus gland</td>
</tr>
<tr>
<td><strong>Responsible for</strong></td>
<td>humoral (body fluids) immunity</td>
</tr>
<tr>
<td>Humoral</td>
<td>Cellular immunity</td>
</tr>
<tr>
<td><strong>Act by making</strong></td>
<td>antibodies</td>
</tr>
<tr>
<td>Antibodies</td>
<td>Cytotoxic cells and enzymes</td>
</tr>
<tr>
<td><strong>Other types</strong></td>
<td>Change to Plasma cells to produce huge number of antibodies</td>
</tr>
</tbody>
</table>

**AIDS and role of Memory Cells**

AIDS Virus attacks Helper T-cells and destroys the immune system. Then many opportunistic diseases like Pneumonia attack and kill the person.

Memory T-cells live for long periods and alert the immune system when an invader enters the body after 1st infection or vaccination.