Lymphatic System

1. 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.

2. Lymphatic system consists of 2 semi-independent parts 1. Lymphatic vessels 2. Lymphoid tissues and organs. Fig 14.1

3. 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 originate in peripheral tissues as lymph capillaries and vessels and ends at venous connections.

4. Lymphatic capillaries → lymphatic collecting vessels → lymphatic trunks → lymphatic duct → opens into subclavian vein. Kidney shaped Lymph nodes are present, periodically associated with lymphatic collecting vessels and trunks. Fig 14.3. 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.

5. Flap-like mini-valves are present in lymphatic capillaries and help to collect tissue fluid.

6. 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.

7. Lymphatic Ducts include 2 large ducts in thoracic region. 1. Right Thoracic duct – collects lymph from right arm, right side of head, neck and thorax. 2. 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.


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


11. Lymphoid Macrophages are large phagocytes and kill antigens by phagocytosis.

12. Lymphoid Tissue is mainly a kind of loose Reticular Connective Tissue. It provides site for storage and proliferation of lymphocytes. These include tonsils Fig 14.5 and intestinal nodules.
13. Lymph Nodes are the principal lymphoid organs. Fig 14.6. 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.

14. Other lymphoid organs include Thymus – associated to superior side of heart and major blood vessels; Spleen – fixed to lateral side of stomach; Tonsils – are several swellings of mucosa and form a ring around openings of pharynx. These include Palatine, Lingual and Pharyngeal Tonsils. Tonsils are the simplest lymphoid organs. Fig 14.7-8.

**Immunity**

15. Lymphatic System plays major role in body defense system. Body defense has 2 major divisions – Innate defenses and Adaptive Defenses. Fig 14.11 gives an overview of these 2 divisions.

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

17. Immunity means resistance to disease. Body achieves immunity by non-specific and specific responses against invaders. Non-specific action is against all invaders and consists of 2 defense lines 1st and 2nd. Specific Response is against particular antigen and forms 3rd line of defense.

18. 1st line of defense: An intact skin and mucus membranes form 1st line of defense against all invaders. 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. Fig 14.9 depicts summary of non-specific defenses.

19. 2nd defense line is formed by Phagocytes, Natural Killer Cells and proteins like Interferon (effective against viruses) and Complement system.. WBC’s eat bacteria and viruses by phagocytosis. Interferon interferes in multiplication of viruses. 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, Fig 21.6. Inflammatory response draws WBC’s to the site of injury, causes swelling and redness. Fig 21.3. Lymphatic System consists of lymphatic ducts, nodes and capillaries and several other organs like spleen and thymus gland. It helps to return interstitial fluid back to blood and to fight against the infection.

20. **Specific Response** = 3rd line of defense. It produces special proteins effective against a specific invader. It involves making Y-shaped proteins called Antibodies which roam in body fluids like blood to inactivate the invaders. It is called Humoral Immunity. B-cells are responsible for this immunity. T-cells are responsible to defend against invaders inside cells. It is called Cellular Immunity.
21. **Self-Antigens: MHC proteins** – are glycoproteins present on all body cells and are coded by MHC genes. Each individual has unique MHC proteins. This is the cause of transfusion(blood) or graft (organ) rejection.

22. **Acquired Immunity** – has 2 basic types, Active and Passive Immunity. Fig 21.12

23. **Active Immunity** is achieved by making Antibodies inside the body due to infection or vaccination. Antibodies are immunoglobulin proteins of Y-shape. Fig 21.13. 2 Heavy chains form the stem of Y and continue in the stems. 2 Light chains are present only in the limbs of Y, 1 in each limb. Each chain has a constant part and a variable region. There are 5 basic types of gamma globulins = antibodies, G, M, A, D, and E. You can remember by saying G-MADE. IgG is the most common antibody in blood. Table 21.3.

24. **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.

25. **Comparison of B-Cells and T-Cells**:

<table>
<thead>
<tr>
<th>Cell Type</th>
<th>B-Cells</th>
<th>T-Cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mature inside</td>
<td>Bone marrow</td>
<td>Thymus gland</td>
</tr>
<tr>
<td>Responsible for</td>
<td>Humoral (body fluids) immunity</td>
<td>Cellular immunity</td>
</tr>
<tr>
<td>Act by making</td>
<td>Antibodies</td>
<td>Cytotoxic cells and enzymes</td>
</tr>
<tr>
<td>Other types</td>
<td>Change to Plasma cells to produce huge number of antibodies</td>
<td>Helper T-cells and Memory cells</td>
</tr>
</tbody>
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26. AIDS Virus attacks Helper T-cells and destroys the immune system. Then many opportunistic diseases like Pneumonia attack and kill the person.

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