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. 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 consists of

3. Lymphatic capillaries, lymphatic vessels and lymphatic ducts

4. Lymphoid tissues – tonsils, vermiform appendix and intestinal lymphoid nodules

5. Lymphoid organs – Spleen, thymus and lymph nodes

6. Lymph – blood plasma with lower % of proteins and white blood cells

7. 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.

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

9. 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.

10. 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.


12. 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.

14. Lymphoid Macrophages are large phagocytes in tissues and kill antigens by phagocytosis. Macrophages may be fixed or free inside tissues. Monocytes escape from blood capillaries and transform into macrophages inside tissues.

15. **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.

16. **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.

17. **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.

18. **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.

19. **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.

**Immunity**

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

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

22. 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.

23. **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. Fig 14.9 depicts summary of non-specific defenses.

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

26. **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.

27. **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.

28. **Specific Response** = is 3rd line of defense. It produces special proteins effective against a specific invader. It involves making Y-shaped proteins called Antigodies 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.

29. **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.

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

31. **Acquired Immunity** – is acquired after birth and requires exposure to pathogens or vaccination. It has 2 basic types, Active and Passive Immunity. Fig 21.12

32. **Active Immunity** is achieved by making Antigodies inside the body due to infection or vaccination. Antigodies 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. Ig G is the most common antibody in blood. Table 21.3.

33. **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.

34. **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>
</tbody>
</table>
### Table: Immune Response Mechanisms

<table>
<thead>
<tr>
<th>Act by making</th>
<th>Antibodies</th>
<th>Cytotoxic cells and enzymes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Other types</strong></td>
<td>Change to Plasma cells to produce huge number of antibodies</td>
<td>Helper T-cells and Memory cells</td>
</tr>
</tbody>
</table>

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

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