### Question No. 1 of 10

**Instructions:** (1) Read the problem statement and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.

**Question #01**

1. The lymphatic system is formed early during human development. Which of the following statements about the development of the lymphatic system is correct?

   - (A) The lymphatic system develops independent of the vascular system.
   - (B) By the 7th week of development, there are lymph sacs that become connected to the venous system.
   - (C) By the 4th week of development, there are lymph sacs that become connected to the venous system.
   - (D) The thymus gland and spleen are formed by the 3rd week of development.
   - (E) The spleen is completely formed from the cells of the third pharyngeal pouch by the 5th week.

**Feedback**

A. Incorrect!
The lymphatic system is derived from the mesoderm, and lymph vessel formation is connected to the formation of the veins in the vascular system.

B. Correct!
By the 7th week of development, there are lymph sacs that become connected to the venous system.

C. Incorrect!
By the 7th week of development, there are lymph sacs that become connected to the venous system.

D. Incorrect!
The thymus gland and spleen are formed by the 8th week of development.

E. Incorrect!
The spleen, along with the thymus gland, is formed by the 8th week of development.

**Solution**

The lymphatic system is derived from the mesoderm during embryogenesis. Lymph vessel formation is connected to and develops with blood vessels. By the 7th week of development, there are lymph sacs that become connected to the venous system. The thymus gland and spleen are formed by the 8th week of development. The thymus gland forms from cells of the third pharyngeal pouch. At birth, the thymus gland takes up the majority of the anterior mediastinal space.

(B) By the 7th week of development, there are lymph sacs that become connected to the venous system.
Question No. 2 of 10

**Instructions:** (1) Read the problem statement and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.

<table>
<thead>
<tr>
<th>Question #02</th>
<th>2. Which of the following statements is not correct about the thymus gland?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(A) The thymus is formed by the 8th week of development.</td>
</tr>
<tr>
<td></td>
<td>(B) B-Cells develop in the thymus gland.</td>
</tr>
<tr>
<td></td>
<td>(C) The thymus gland is made up of two lateral lobes that are contained in a capsule.</td>
</tr>
<tr>
<td></td>
<td>(D) The thymus gland normally undergoes involution.</td>
</tr>
<tr>
<td></td>
<td>(E) Inside the thymus gland, positive and negative selection takes place.</td>
</tr>
</tbody>
</table>

**Feedback**

| A. Incorrect! | The thymus is formed by the 8th week of development. |
| B. Correct!   | B-Cells develop in the bone marrow, and T-Cells develop in the thymus gland. |
| C. Incorrect! | The thymus gland is made up of two lateral lobes that are contained in a capsule. |
| D. Incorrect! | Involution is a normal process of the thymus gland as we age. |
| E. Incorrect! | T-Cells undergo positive and negative selection in the thymus gland. |

**Solution**

The thymus gland is made up of 2 lateral lobes, which are enclosed in a capsule. Each lateral lobe is made up of many smaller lobules. The thymus gland lies posterior to the sternum in the superior mediastinum. The thymus reaches its full size during puberty and then gradually decreases in size as we age, a process known as involution. Inside the thymus, lymphocyte precursors mature into T-Cells. To be released into the circulation, the T-Cells must undergo both positive and negative selection.

**(B) B-Cells develop in the thymus gland.**
### Question No. 3 of 10

**Instructions:** (1) Read the problem statement and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.

**Question #03**

3. The lymphatic system, along with the cardiovascular system, includes capillaries. Which of the following statements about lymph capillaries is correct?

- (A) The lymph capillaries are located near the major arteries of the vascular system.
- (B) Lymph capillaries permit two-way flow of fluid into and out of the lymphatic system.
- (C) Lymph capillaries are larger than blood capillaries and are structured to allow the collection of lymph fluid.
- (D) Lymphatic capillaries are directly connected to efferent lymph node vessels.
- (E) None of the answers is correct.

**Feedback**

- A. Incorrect! The lymph capillaries are closely associated with the tissue (blood) capillaries, at the junction of the arterioles and venules.
- B. Incorrect! Lymphatic capillaries permit one-way flow of fluid, due to their unique valve-like structure.
- C. Correct! Lymph capillaries are larger than blood capillaries and are structured to allow the collection of lymph fluid.
- D. Incorrect! Eventually, the lymphatic capillary becomes the afferent lymphatic vessel at the lymph node.
- E. Incorrect! There is one correct answer above.

**Solution**

The lymph capillaries are closely associated with the tissue (blood) capillaries, at the junction of the arterioles and venules. The lymph capillaries are larger and are structured to allow the collection of lymph fluid. The wall of the lymphatic capillary is made up of endothelial cells. Similar to certain veins, lymphatic capillaries permit one-way flow of fluid, due to their unique structure. Eventually, the lymphatic capillary becomes the afferent lymphatic vessel at the lymph node. The arrows in the image above indicate the flow of fluid into the lymph capillaries.

(C) Lymph capillaries are larger than blood capillaries and are structured to allow the collection of lymph fluid.
**Question No. 4 of 10**

**Instructions:** (1) Read the problem statement and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.

<table>
<thead>
<tr>
<th>Question #04</th>
<th>4. Lymph vessels have a unique structure and location. Which of the following statements about lymph vessels is correct?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(A) The valve of a lymphatic capillary is made up of endothelial cell overlap.</td>
</tr>
<tr>
<td></td>
<td>(B) All lymphatic vessels are the size of blood capillaries.</td>
</tr>
<tr>
<td></td>
<td>(C) The deep lymphatic vessels accompany the superficial veins and arteries of the body.</td>
</tr>
<tr>
<td></td>
<td>(D) The right lymphatic duct collects blood from the entire upper body.</td>
</tr>
<tr>
<td></td>
<td>(E) The thoracic duct delivers lymph fluid into the aorta.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feedback</th>
<th>A. Correct! The valve of a lymphatic capillary is made up of endothelial cell overlap.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B. Incorrect! The lymphatic vessels range in size from the lymph capillaries to the large diameter collecting vessels that are known as lymphatic ducts.</td>
</tr>
<tr>
<td></td>
<td>C. Incorrect! The deep lymphatic vessels accompany the deep arteries and veins of the body.</td>
</tr>
<tr>
<td></td>
<td>D. Incorrect! On the right side of the body, the right lymphatic duct collects lymph from the side of the body above the level of the diaphragm.</td>
</tr>
<tr>
<td></td>
<td>E. Incorrect! The thoracic duct delivers the lymph into the venous system at the junction of the left subclavian vein and the left internal jugular vein.</td>
</tr>
</tbody>
</table>

| Solution     | The lymphatic vessels range in size from the lymph capillaries to the large diameter collecting vessels that are known as lymphatic ducts. The lymphatic capillaries are larger than blood capillaries; they have thinner walls and do not have a continuous basal lamina. The valve of the lymphatic capillary is made up by the endothelial cell overlap at one end of the vessel. There are certain regions of the body that contain numerous lymphatic capillaries, such as: in the connective tissue deep to the dermis, mucosa layer of the digestive tract, and in the small intestine. The lymphatic vessels of the body are divided into the superficial lymphatics and the deep lymphatics. The superficial lymphatic vessels follow the path of the superficial veins and are located deep to the dermis, the lining of the digestive, respiratory, urinary and reproductive tracts. The deep lymphatic vessels accompany the deep arteries and veins of the body. In the thoracic region of the body, the lymphatics form large ducts. On the right side of the body, the right lymphatic duct collects lymph from the side of the body above the level of the diaphragm. This vessel delivers the lymph into the venous system at or near the junction, between the right internal jugular vein and the right subclavian vein. On the left side of the body, the thoracic duct collects lymph from the left side of the body and the right side of the body below the diaphragm. The thoracic duct delivers the lymph into the venous system at the junction of the left subclavian vein and the left internal jugular vein. |

(A) The valve of a lymphatic capillary is made up of endothelial cell overlap.
Question No. 5 of 10

Instructions: (1) Read the problem statement and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.

5. A 47-year-old man is diagnosed with a disorder in which the B-Cells in his body cannot produce antibodies. Based on this information, which of the following statements would be correct?

(A) Plasma cell function would be expected to be normal in this patient.
(B) All immunity in this individual would be non-functional, rendering him a severely combined immunodeficient person.
(C) Faulty immunoglobin (Ig) gene rearrangement could be the cause of this patient's disorder.
(D) Natural killer cell function in this patient would also be abnormal, as these cells are derived directly from B-Cells.
(E) The positive and negative selection processes that B-Cells normally undergo would be abnormal in this patient.

Feedback

A. Incorrect!
Plasma cells normally produce antibodies in response to antigen; therefore, these cells would not function normally in this patient.

B. Incorrect!
Cell-mediated immunity through T-Cell function would be expected to be normal in this patient.

C. Correct!
Faulty immunoglobin (Ig) gene rearrangement could be the cause of this patient’s disorder, as this could lead to faulty immunoglobulin (antibody) production.

D. Incorrect!
Natural Killer (NK) cells are formed by the same lymphoid stem cells that give rise to T-Cells and B-Cells.

E. Incorrect!
T-Cells undergo positive and negative selection in the thymus.

Solution

Each B-cell produces a single species of antibody, each with a unique antigen-binding site. When a naïve or memory B-cell is activated by antigen with the aid of a helper T-cell, it proliferates and differentiates into an antibody-secreting effector cell. Such cells make and secrete large amounts of soluble antibody, which has the same unique antigen-binding site as the cell-surface antibody that served earlier as the antigen receptor.

(C) Faulty immunoglobin (Ig) gene rearrangement could be the cause of this patient’s disorder.
**Question No. 6 of 10**

**Instructions:** (1) Read the problem statement and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.

<table>
<thead>
<tr>
<th>Question #06</th>
<th>6. Which of the following statements about the portion of the lymphatic system labelled in the image is correct?</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A)</td>
<td>The item labelled in the image is the thoracic duct.</td>
</tr>
<tr>
<td>(B)</td>
<td>The organ labelled in the image contains regions known as red pulp and white pulp.</td>
</tr>
<tr>
<td>(C)</td>
<td>The inner portion of this gland is known as the cortex.</td>
</tr>
<tr>
<td>(D)</td>
<td>The thymus gland is labelled in the image.</td>
</tr>
<tr>
<td>(E)</td>
<td>The thymus gland, which is labelled in the image, is made up of 4 major lobes.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feedback</th>
<th>A. Incorrect! The thymus gland is labelled in the image.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B. Incorrect! The thymus gland is divided into 2 major lobes, each of which is made up of many lobules. The spleen contains red and white pulp.</td>
</tr>
<tr>
<td></td>
<td>C. Incorrect! The inner portion of the thymus gland is known as the medulla.</td>
</tr>
<tr>
<td></td>
<td>D. Correct! The thymus gland is labelled in the image.</td>
</tr>
<tr>
<td></td>
<td>E. Incorrect! The thymus gland is made up of 2 lateral lobes, which are enclosed in a capsule. Each lateral lobe is made up of many smaller lobules.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Solution</th>
<th>The thymus gland is made up of 2 lateral lobes, which are enclosed in a capsule. Each lateral lobe is made up of many smaller lobules. The thymus gland lies posterior to the sternum in the superior mediastinum. The thymus reaches its full size during puberty and then gradually decreases in size as we age, a process known as involution. Inside the thymus, lymphocyte precursors mature into T-Cells. To be released into the circulation, the T-Cells must undergo both positive and negative selection.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(D) The thymus gland is labelled in the image.</td>
</tr>
</tbody>
</table>
**Question No. 7 of 10**

**Instructions:** (1) Read the problem statement and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.

---

**Question #07**

7. Interstitial fluid is returned to the cardiovascular system as lymph fluid through the lymphatic system. Which of the following statements about lymph is correct?

(A) Lymph fluid enters a lymph node through the single afferent lymph vessel, attached to each lymph node.

(B) After entering the lymph node, lymph fluid is exposed to reticular fibers, macrophages and dendritic cells.

(C) Just prior to exiting the lymph node, lymph fluid passes through the cortex region.

(D) Lymph fluid does not contain any cells.

(E) Lymph fluid enters the lymph node at the hilum.

---

**Feedback**

A. Incorrect!
There are multiple afferent vessels that deliver lymph into the lymph node.

B. Correct!
The afferent vessels deliver lymph fluid from the tissues and initially into the subcapsular space of the lymph node. Within the subcapsular space of the lymph node are a network of reticular fibers, macrophages and dendritic cells.

C. Incorrect!
Just prior to exiting the lymph node, lymph fluid passes through the medullary cords.

D. Incorrect!
Lymph fluid contains lymphocytes and escaped red blood cells.

E. Incorrect!
The hilum is the region of a lymph node where the lymph fluid exits.

---

**Solution**

Lymph vessels collect lymphatic fluid (along with escaped red blood cells) from the interstitial space. Lymph fluid is made up of: (1) fluid from the intestines containing proteins and fats, (2) a few red blood cells, and (3) many lymphocytes. Lymph fluid can also contain bacteria, which can lead to the activation of the immune system, through presentation to lymphocytes by antigen-presenting cells.

**(B) After entering the lymph node, lymph fluid is exposed to reticular fibers, macrophages and dendritic cells.**
Question No. 8 of 10

Instructions: (1) Read the problem statement and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.

8. Which of the following statements about the tonsil labelled in the image below is correct?

(A) The palatine tonsil is labelled in the image.
(B) The tonsil labelled in the image is one of a pair of tonsils.
(C) The tonsil labelled in the image is a pharyngeal tonsil.
(D) The tonsil labelled in the image is one of four different types of tonsils in the body.
(E) None of the answers are correct.

Feedback

A. Incorrect!
The lingual tonsil, which is located at the base of the tongue, is labelled in the image.

B. Correct!
The lingual tonsils, which are labelled in the image, are a pair of tonsils located at the base of the tongue.

C. Incorrect!
The lingual tonsil, which is located at the base of the tongue, is labelled in the image.

D. Incorrect!
The different types of tonsils are: (1) pharyngeal tonsil, (2) palatine tonsils, and (3) lingual tonsils.

E. Incorrect!
Answer B is correct.

Solution

Tonsils are specialized lymphoepithelial tissues located in the oropharynx and nasopharynx. Within the tonsils are lymphocytes that gather and remove microorganisms that enter through the respiratory tract or the gastrointestinal tract. These are the first line of defence against inhaled or ingested microorganisms. The different locations and types for tonsils are: (1) pharyngeal tonsil – also known as an adenoid, this single tonsil is located in the posterior, superior wall of the nasopharynx. Unlike the other tonsils, adenoids have pseudostratified columnar ciliated epithelium, (2) palatine tonsils – are a pair, located at the posterior margin of the oral cavity. At the boundary of the pharynx and the soft palate, and (3) lingual tonsils – are a pair of tonsils that are located at the base of the tongue.

(B) The tonsil labelled in the image is one of a pair of tonsils.
### Question #09

**Question No. 9 of 10**

**Instructions:** (1) Read the problem statement and answer choices carefully, (2) Work the problems on paper as needed, (3) Pick the answer, and (4) Review the core concept tutorial as needed.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Which of the following statements about mucosal-associated lymphoid tissue (MALT) is correct?</td>
<td></td>
</tr>
</tbody>
</table>
| (A) MALT is located only in the lymphatic system. | Incorrect!  
Along the length of the digestive tract, as well as other regions in the body, are lymphoid nodules, known as mucosal-associated lymphoid tissue (MALT). |
| (B) The mucosal-associated lymphoid tissue contains endothelial cells and red blood cells. | Incorrect!  
Mucosal-associated lymphoid tissue is populated with lymphocytes, plasma cells and macrophages. |
| (C) MALT tissue processes and delivers antigens to the cardiovascular system. | Incorrect!  
MALT tissue encounters and processes antigens that pass through the mucosal epithelium; it also plays a role in regulating mucosal immunity. |
| (D) Mucosal-associated lymphoid tissue is populated with lymphocytes, plasma cells and macrophages. | Correct!  
Mucosal-associated lymphoid tissue is populated with lymphocytes, plasma cells and macrophages. |
| (E) None of the answers are correct. | Incorrect!  
Answer D is correct. |

**Feedback**

A. Incorrect!  
Along the length of the digestive tract, as well as other regions in the body, are lymphoid nodules, known as mucosal-associated lymphoid tissue (MALT).

B. Incorrect!  
Mucosal-associated lymphoid tissue is populated with lymphocytes, plasma cells and macrophages.

C. Incorrect!  
MALT tissue encounters and processes antigens that pass through the mucosal epithelium; it also plays a role in regulating mucosal immunity.

D. Correct!  
Mucosal-associated lymphoid tissue is populated with lymphocytes, plasma cells and macrophages.

E. Incorrect!  
Answer D is correct.

**Solution**

Along the length of the digestive tract, as well as other regions in the body, are lymphoid nodules, known as mucosal-associated lymphoid tissue (MALT). MALT tissue includes the following subcategories: gut-associated lymphoid tissues, bronchus-associated lymphoid tissue, and skin-associated lymphoid tissue. These tissues are populated with lymphocytes, plasma cells and macrophages. MALT tissue encounters and processes antigens that pass through the mucosal epithelium; it also plays a role in regulating mucosal immunity.

**D** Mucosal-associated lymphoid tissue is populated with lymphocytes, plasma cells and macrophages.
10. Peyer’s patches are part of the lymphatic system that provides immunity to foreign antigens. Which of the following statements is correct?

(A) Peyer’s patches are located on the surface of the small intestine.
(B) Peyer’s patches are typically found in the lower portion of the small intestine, the ileum.
(C) These structures provide protection for the body, from the spleen where they’re located.
(D) Peyer’s patches process antigens that are gathered from inside the body only, via the lymphatic system.
(E) None of the answers are correct.

A. Incorrect!
Peyer’s patches are typically found in the lower portion of the small intestine, the ileum, and are located in the lamina propria in the mucosa and extend to the submucosa.

B. Correct!
Peyer’s patches are typically found in the lower portion of the small intestine, the ileum.

C. Incorrect!
These structures provide immune protection for the body, from the lower portion of the small intestine.

D. Incorrect!
Peyer’s patches provide immunological defense to the gastrointestinal tract, which encounter many antigens from the outside world.

E. Incorrect!
Answer B is correct.

Peyer’s patches are typically found in the lower portion of the small intestine, the ileum. Histologically, these aggregated lymphoid nodules are oval follicles that are located in the lamina propria in the mucosa and extend to the submucosa. Peyer’s patches provide immunological defense to the gastrointestinal tract, which encounter many antigens from the outside world. Lymphocytes, dendritic cells, and macrophages reside in these specialized nodules and process antigens and provide immunity for the body.

(B) Peyer’s patches are typically found in the lower portion of the small intestine, the ileum.