

Overview of the Immune System and the Lymphatic System

Center for Educational Outreach
Baylor College of Medicine

TEM of a white blood cell and two red blood cells.
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Overview of the Immune System

Image Reference

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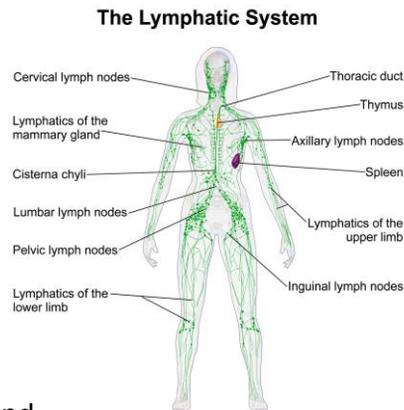
Key Words

immune system, lymphatic system, human, anatomy

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Major Components of the System

- Immune System
 - Network of cells, tissues and organs that protect the body from infection.
- Lymphatic System
 - Network of vessels and tissues composed of lymph, an extracellular fluid, and lymphoid organs, such as lymph nodes.
 - Conduit for transportation and communication between tissues and the blood stream.
 - Immune cells are carried through the lymphatic system.



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Major Components of the System

Lymph is a liquid tissue derived from blood. Fluid and white cells that leak from the capillaries drain into the lymphatic vessels. This material, referred to as lymph, is driven by the distant pressure of blood and movement of skeletal muscles squeezing against the lymphatic vessels. The lymphatic vessels eventually converge and empty into the thoracic duct, where the lymph reenters the cardiovascular system.

Unlike red blood cells, leukocytes (white blood cells) are complete, with nuclei and other internal structures. Although leukocytes are greatly outnumbered by red blood cells, they are able to respond quickly to disease and invading foreign organisms. There are various types of leukocytes, each with a particular role in the body's defense system. Leukocytes distinguish between self and non-self invaders by recognizing proteins on the cell surface, also known as antigens.

References

1. Clark, Joe O.E. (1999). *A Visual Guide to the Human Body*. London: Barnes and Noble, Inc.
2. Raven, P.H. (2005). *Biology, 7th Edition*. New York, NY: McGraw-Hill.

Image Reference

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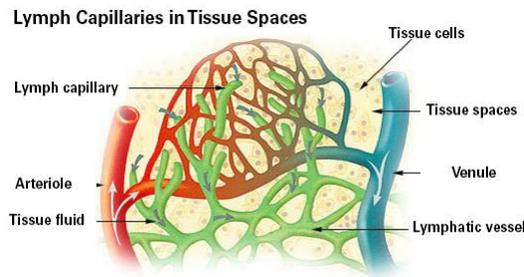
http://commons.wikimedia.org/wiki/File:Blausen_0623_LymphaticSystem_Female.png

Key Words

immune system, lymphatic system, lymph, leukocyte, human

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Lymphatic Capillaries and Vessels



- Lymphatic capillaries and vessels drain excess tissue fluid back into venous circulation.
- Lymph flows away from the tissues, toward the lymph nodes.



Illustration courtesy of the National Cancer Institute, NIH.

Lymphatic Capillaries and Vessels

The lymphatic system is an open circulatory system that returns excess interstitial fluid back to the cardiovascular system. Excess fluid in the tissues drains into blind-ended lymph capillaries with highly permeable walls. This fluid, now called lymph, passes into progressively larger lymphatic vessels that have one-way valves. The lymph eventually enters two major lymphatic vessels which drain into veins on each side of the neck.

References

1. Clark, Joe O.E. (1999). *A Visual Guide to the Human Body*. London: Barnes and Noble, Inc.
2. Raven, P.H. (2005). *Biology, 7th Edition*. New York, NY: McGraw-Hill.

Image Reference

SEER Training Modules: Components of the Lymphatic System. Illustration courtesy of the National Cancer Institute, NIH.
<http://training.seer.cancer.gov/anatomy/lymphatic/components/>

Key Words

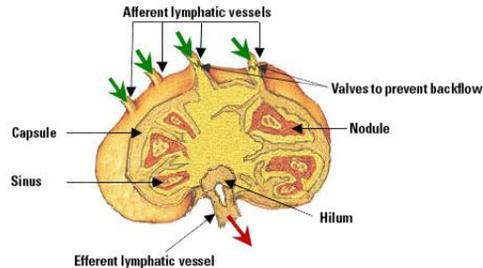
immune system, lymphatic system, lymphatic capillaries, lymph

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Lymph Nodes

- Distributed widely throughout the body and linked by lymphatic vessels.
- Important for filtering foreign particles from the body and fighting infection.
- Become swollen during an infection because of increased production of white blood cells.

Lymph Node Structure



Lymph Nodes

Lymph nodes are small nodules of lymphatic tissue found dotted around the lymphatic system. They are especially dense in the neck, armpits and groin. White blood cells congregate at lymph nodes and scavenge the blood, picking up debris and left-over intruders. During an infection the production of white cells at the lymph nodes increases dramatically, and white blood cells are released into the bloodstream.

References

1. Clark, Joe O.E. (1999). *A Visual Guide to the Human Body*. London: Barnes and Noble, Inc.
2. Raven, P.H. (2005). *Biology, 7th Edition*. New York, NY: McGraw-Hill.

Image Reference

SEER Training Modules: Lymph Nodes. Illustration courtesy of the National Cancer Institute, NIH.
<http://training.seer.cancer.gov/anatomy/lymphatic/components/nodes.html>

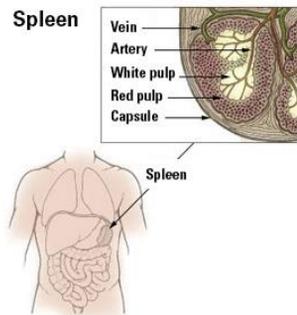
Key words

immune system, lymphatic system, lymph node, leukocyte, human

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Spleen

- Located in the upper left region of the abdomen.
- Can be divided into red and white pulp, both of which have important immunologic functions.
 - Red pulp filters out old red blood cells, antigens and microbes.
 - White pulp contains white blood cells, such as T cells.



Spleen

The spleen acts as a reservoir, holding leukocytes until they are needed to fight a foreign invader, at which point they are released into the blood stream. The red pulp filters old red blood cells and holds a reserve of monocytes and red blood cells, in case the body needs them in an emergency. The white pulp synthesizes antibodies, and can recognize and remove bacteria or other foreign invaders coated in antibodies.

References

1. Clark, Joe O.E. (1999). *A Visual Guide to the Human Body*. London: Barnes and Noble, Inc.
2. Raven, P.H. (2005). *Biology, 7th Edition*. New York, NY: McGraw-Hill.

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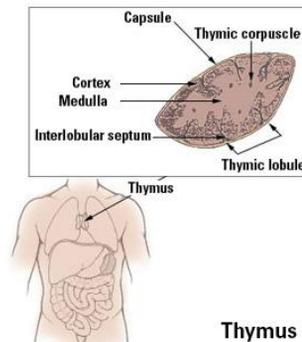
Key Words

immune system, spleen, leukocyte, human

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Thymus

- Bi-lobed organ, located slightly above the heart and in front of the trachea.
- Most active during childhood, it begins to atrophy after puberty, but retains immune system functions.
- Location of T cell maturation (T cells are white blood cells capable of recognizing an invading microbe).



Thymus

T cells originate in the bone marrow and migrate to the thymus, where they reach maturity. T cells are produced early in life, and thymus becomes less active in adulthood. However, the thymus continues to act as an endocrine organ and a stimulant for the immune system.

References

1. Clark, Joe O.E. (1999). *A Visual Guide to the Human Body*. London: Barnes and Noble, Inc.
2. Raven, P.H. (2005). *Biology, 7th Edition*. New York, NY: McGraw-Hill.

Image Reference

SEER Training Modules: Thymus. Illustration courtesy of the National Cancer Institute, NIH.

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Key Words

immune system, thymus, T cell, human

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Leukocytes

- Leukocytes, also known as white blood cells, defend the body from disease and infection.
- The lymphatic system stores cells and other agents used in the immune response.
- Some leukocytes act immediately; others recognize infectious agents previously encountered by the body.



TEM showing a cross-section of a small blood vessel containing numerous red blood cells and a white blood cell. The surrounding cells contain many mitochondria and some rough endoplasmic reticulum.



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Leukocytes

Unlike red blood cells, leukocytes (white blood cells) are complete, with nuclei and other internal structures. There are various types of leukocytes, each with a particular role in the body's defense system. Leukocytes may be called into action to fight off invading bacteria, viruses, fungi or parasites.

References

1. Clark, Joe O.E. (1999). *A Visual Guide to the Human Body*. London: Barnes and Noble, Inc.
2. Raven, P.H. (2005). *Biology, 7th Edition*. New York, NY: McGraw-Hill.

Image Reference

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Key Words

immune system, leukocyte, disease, bacteria, virus, defense

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Functions of the Systems

- Immune System
 - Protects against disease by identifying and killing pathogens.
 - Initiates inflammation to increase blood flow to an infection site and retard bacterial growth.
- Lymphatic System
 - Lymphatic vessels return excess interstitial fluid, called lymph, back to the cardiovascular system.
 - Lymph transports fats, proteins, cellular debris, and white blood cells.
 - Part of the immune response.



Functions of the Systems

Leukocytes are mobile. Some circulate in the blood, while others move in and about tissues, checking for potential threats to the immune system. The release of histamines and prostaglandins in response to an invading pathogen causes inflammation. This increases blood flow, which brings a wave of phagocytic cells to engulf and destroy invading bacteria. A rise in temperature, such as with a fever, causes the liver and spleen to store iron, thereby reducing blood levels of iron, which bacteria require to grow.

The lymphatic system has nutritive and waste-clearing functions, and also serves as a reservoir and major transport system for white blood cells. Lymphatic vessels also enable excess fluid to return to the cardiovascular system via the thoracic duct. Lymph contains proteins, fats and other products of digestion.

References

1. Clark, Joe O.E. (1999). *A Visual Guide to the Human Body*. London: Barnes

and Noble, Inc.

2. Raven, P.H. (2005). *Biology, 7th Edition*. New York, NY: McGraw-Hill.

Key Words

immune system, lymphatic system, protection, histamine, prostaglandins, phagocyte, function

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