

# Chapter 6 – Capillaries, Lymphatic System, and Immunity

## *Objectives*

Given the synopsis in this chapter, competence in each objective will be demonstrated by responding to multiple choices or matching questions, completing fill-in questions, or writing short answers, at the level of 75% or greater proficiency for each student.

- A. To describe the capillary epithelium and explain its role in capillary diffusion and exchange.
- B. To explain the role of the lymphatic vessels in returning fluid to the blood vessels.
- C. To explain the role of the lymphatic system and immune cells in establishing immunity.

## Microcirculation

The microcirculation is the site of fluid and nutrient exchange between blood (vascular space) and interstitial space, and between cells (intracellular space) and interstitial space, as shown in Figures 6.1. The microcirculation contains both blood capillaries and lymphatic capillaries, as shown in Figure 6.2

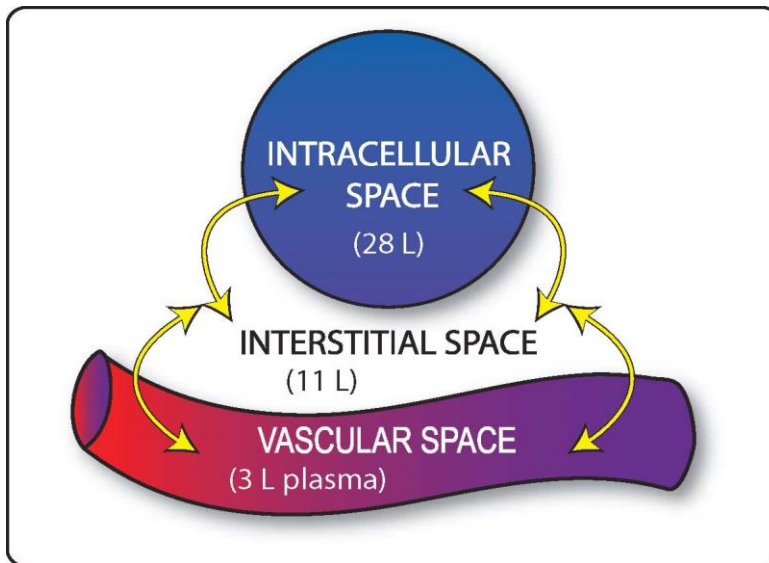


Figure 6.1 © 2007 David G. Ward, Ph.D.

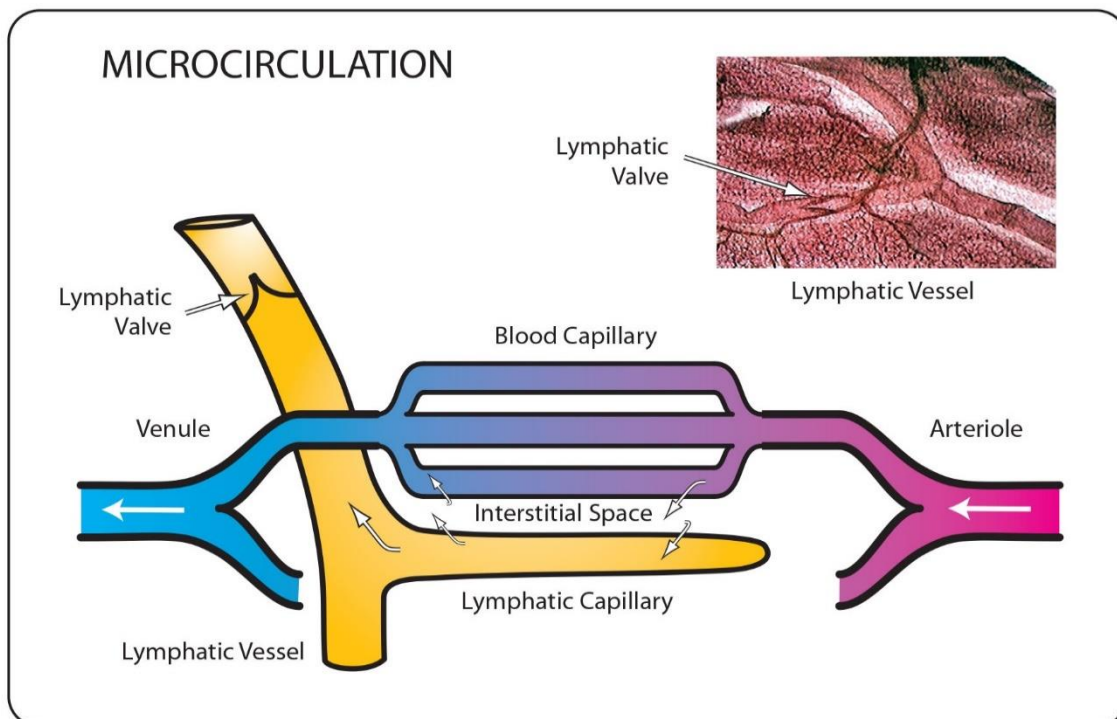


Figure 6.2 © 2007 David G. Ward, Ph.D.

- Blood capillaries are the site for exchange of oxygen and nutrients, and carbon dioxide and metabolic byproducts, between the blood and the cells of the body
- Lymphatic capillaries recover plasma lost from the blood capillaries and return the fluid to the systemic venous circulation

### Capillary epithelium and permeability

Blood capillaries consist of only endothelium (simple squamous epithelium.) The structure of the endothelium of blood capillaries is shown in Figure 6.3. The plasma membrane of the endothelial cells have many openings, especially small water filled channels, and large fused vesicle channels. In addition there are often intercellular clefts between the endothelial cells. Lymphatic capillaries have very large intercellular clefts.

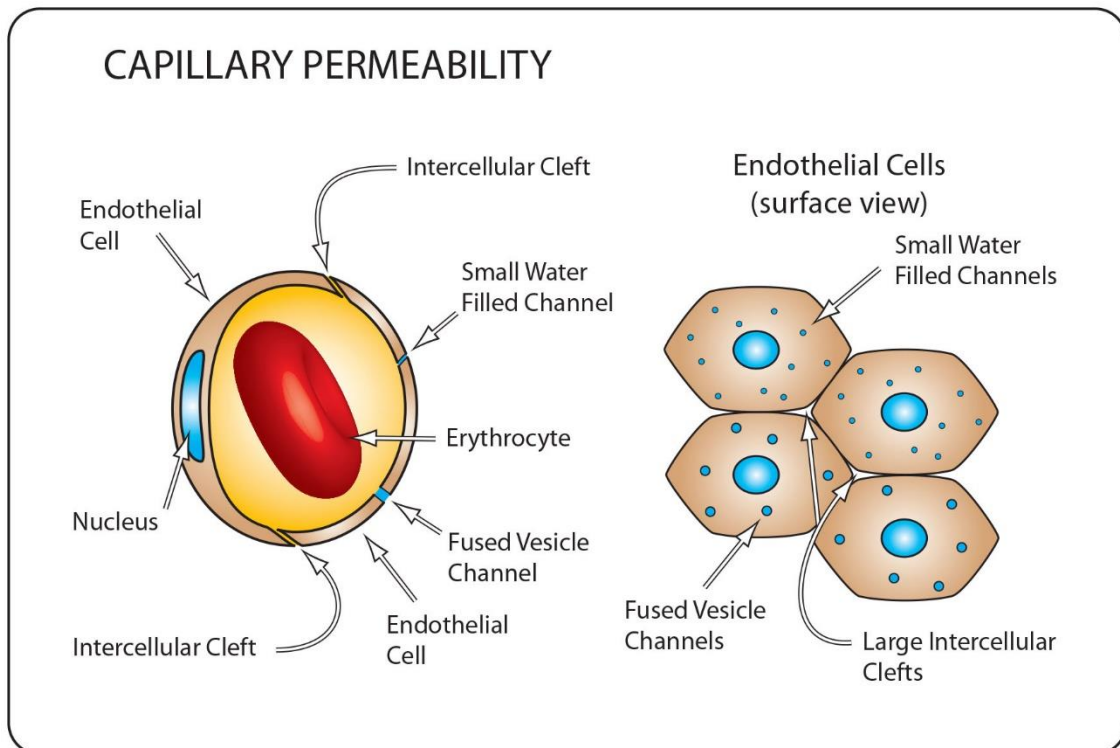


Figure 6.3 © 2007 David G. Ward, Ph.D.

Movement of substances through the capillary wall is by way of diffusion, vesicle transport (endocytosis, exocytosis), bulk flow, and in some cases mediated transport (usually by co-transporters or pumps).

### Capillary diffusion

In most tissues of the body, pressure and concentration gradients are the driving force moving substances from the blood into the interstitial space or from the interstitial space into the blood. Different mechanisms are found in the brain.

### Role of Lymphatic capillaries and vessels in fluid recovery

Fluid that leaks out of the blood capillaries is collected by the lymphatic capillaries. As shown in Figure 6.4, the lymphatic vessels are connected to numerous lymph nodes. Lymph nodes play a major role in cleaning the interstitial fluid. Ultimately, the lymphatic fluid is returned to the blood. Lymph going through the right lymphatic duct is returned to the right subclavian vein. Lymph going through the thoracic duct is returned to the left subclavian vein.

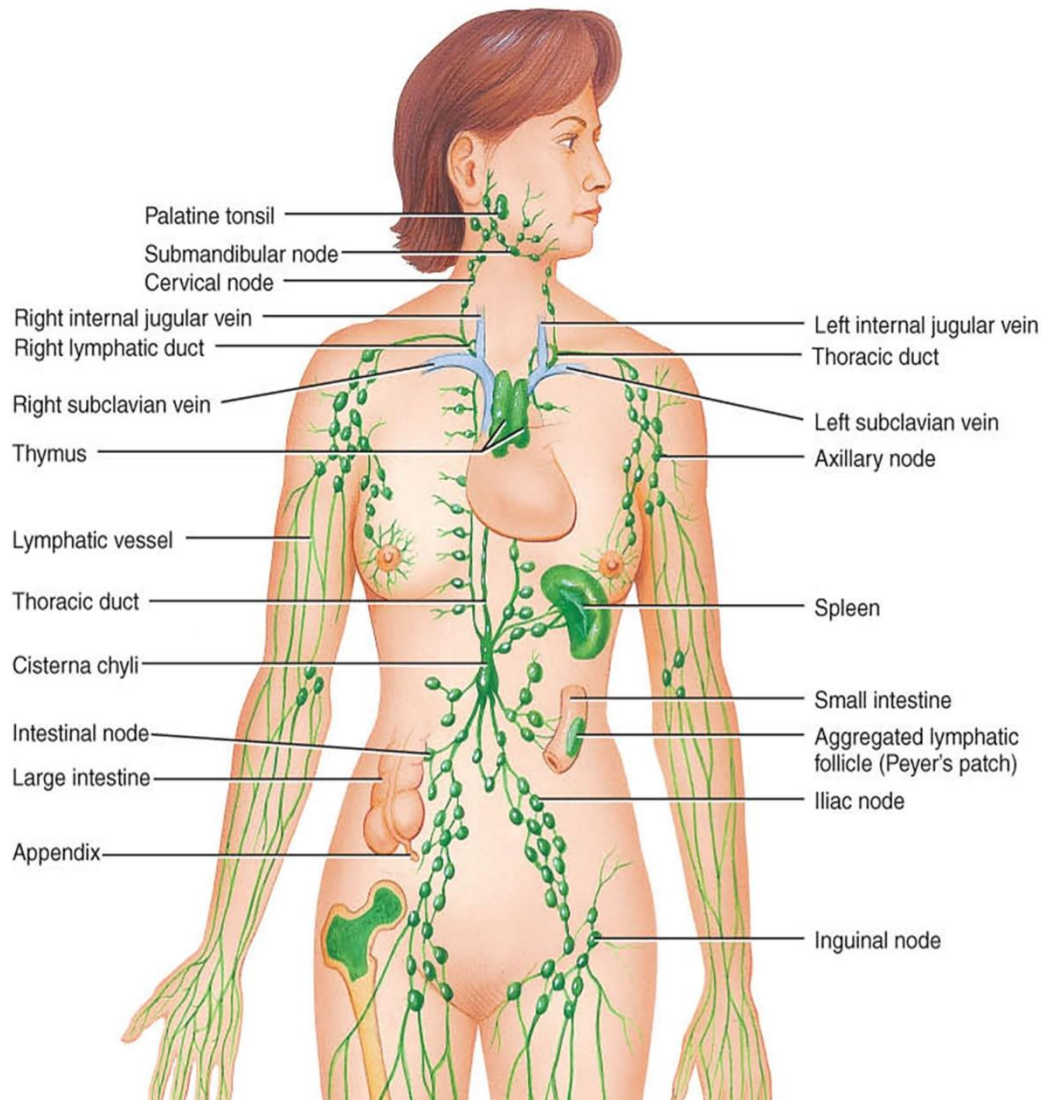


Figure 6.4 © McGraw-Hill

## The Lymphatic System and Immunity

The lymphatic vessels are part of the lymphatic system of the body that protects the body from damage by microbes and pathogens. Common microbes and pathogens include:

- Bacteria – single cell pathogens that are self-replicating
- Viruses – DNA and RNA pathogens that are self-replicating
- Prions – protein pathogens that are self-replicating

### Lymphatic System

The lymphatic system includes:

- Lymphatic Capillaries and Vessels
- Lymph Nodes – enlargements along the lymphatic vessels that contain lymphocytes
- Spleen – a vascular organ that contains lymphocytes and serves as a “lymph node” for the blood
- Thymus – a “gland” near the heart that stores and allows maturation of T-lymphocytes
- Bone marrow – the interior of bone that produces blood cells, including lymphocytes

## The Immune System

As shown in Figure 6.5, the immune system is often divided into two major parts; an innate immune system and an acquired immune system

### Innate Immune System

#### Physical and Chemical Barriers to Entry:

- Intact Skin
- Mucus membranes
- Lysing enzymes in sweat, saliva, and tears

#### Bloodborne phagocytes:

- Neutrophils – engulf pathogens and debris; function similarly to macrophages
- Monocytes (macrophages) – engulf pathogens and hold antigen fragments via MHC proteins
- Eosinophils – engulf and destroy parasites, bacteria, pollen, animal dander
- Basophils – produce histamine, a vasodilator
- Natural Killer Cells – engulf abnormal cells

#### Complement Proteins:

- C-plasma proteins
- Alternate pathway – Work without antibodies to destroy foreign cells
- Classical pathway – Work in combination with antibodies to destroy targeted cells

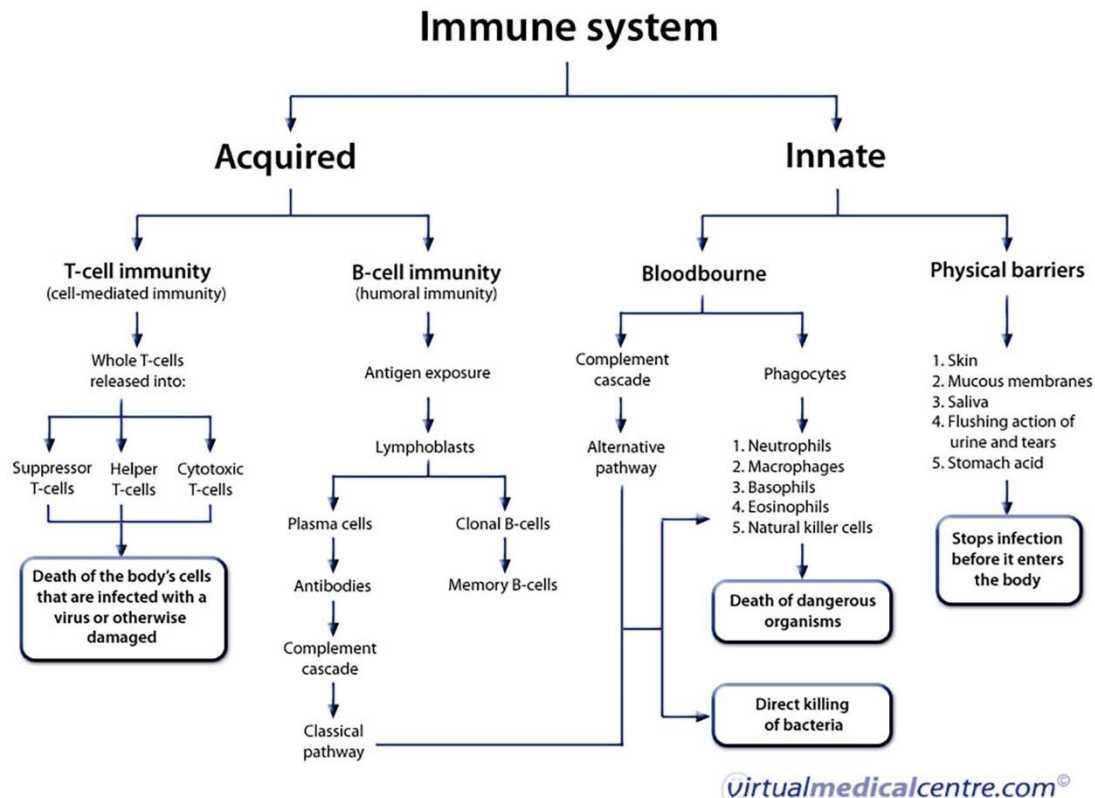


Figure 6.5 © virtualmedicalcentre.com

## Acquired (Adaptive) Immune System

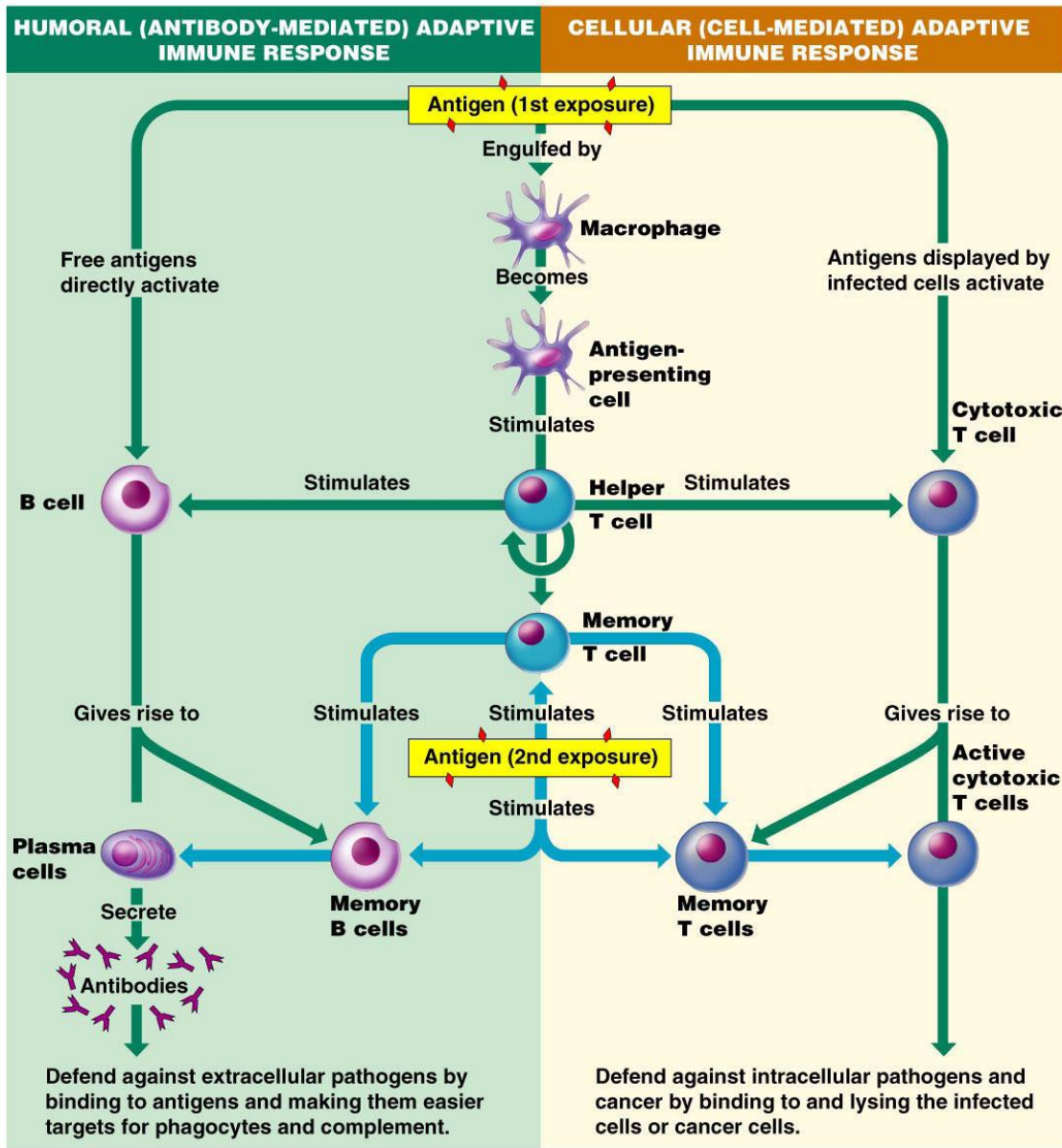
### B-Cells and Antibody Mediated Immunity (humoral immunity) (also see Figure 6.6)

- B-cells have receptors that bind to antigens
- B-cells bound to antigen are sometimes called lymphoblasts
- B-cells duplicate (clone) and become plasma B-cells and memory B-cells
- Helper T-cells can stimulate B-cells to duplicate (clone)
- Plasma B-cells produce and secrete specific antibodies
- Antibody-antigen complexes cause destruction of extracellular pathogens, mainly by attracting phagocytes or stimulating complement proteins.

### T-Cells and Cell mediated immunity (cellular immunity) (also see Figure 6.6)

- T-cells are unable to recognize an antigen unless the antigen is displayed by an infected cell or by an antigen presenting cell
- Antigen presenting cells, such as macrophages, breaks apart the antigen, and via MHC proteins present it to Cytotoxic T-cells directly, or to Helper T-cells
- The Helper T-cells stimulate Cytotoxic T-cells and Memory T-cells.
- Cytotoxic-T-cells cause destruction of intracellular pathogens and cancer by lysing the infected cells or cancer cells.





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