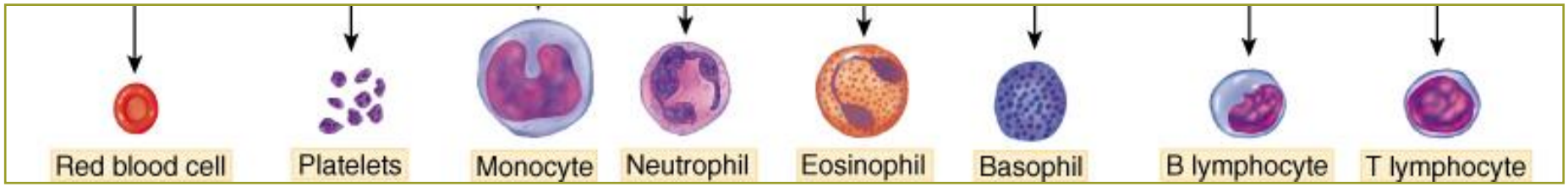
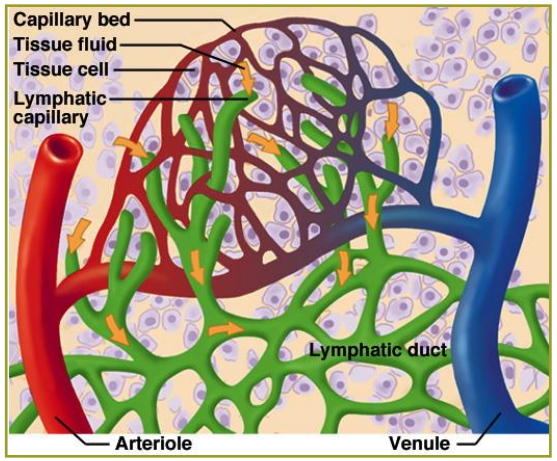
Animal Anatomy and Physiology 1

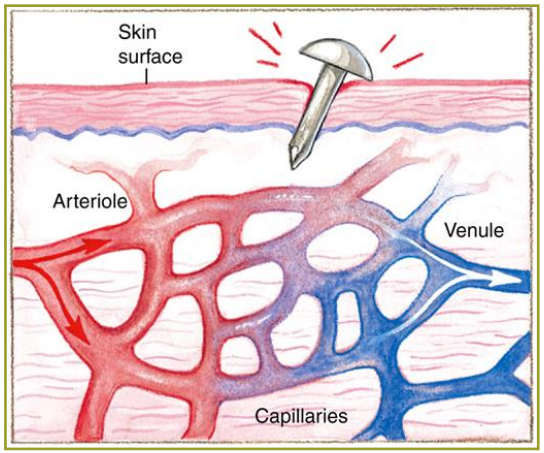
Webinar Chapter 9

Blood, Lymph, and Immunity



Blood, Lymph, and Immunity
Chapter 9





Pages 220-246

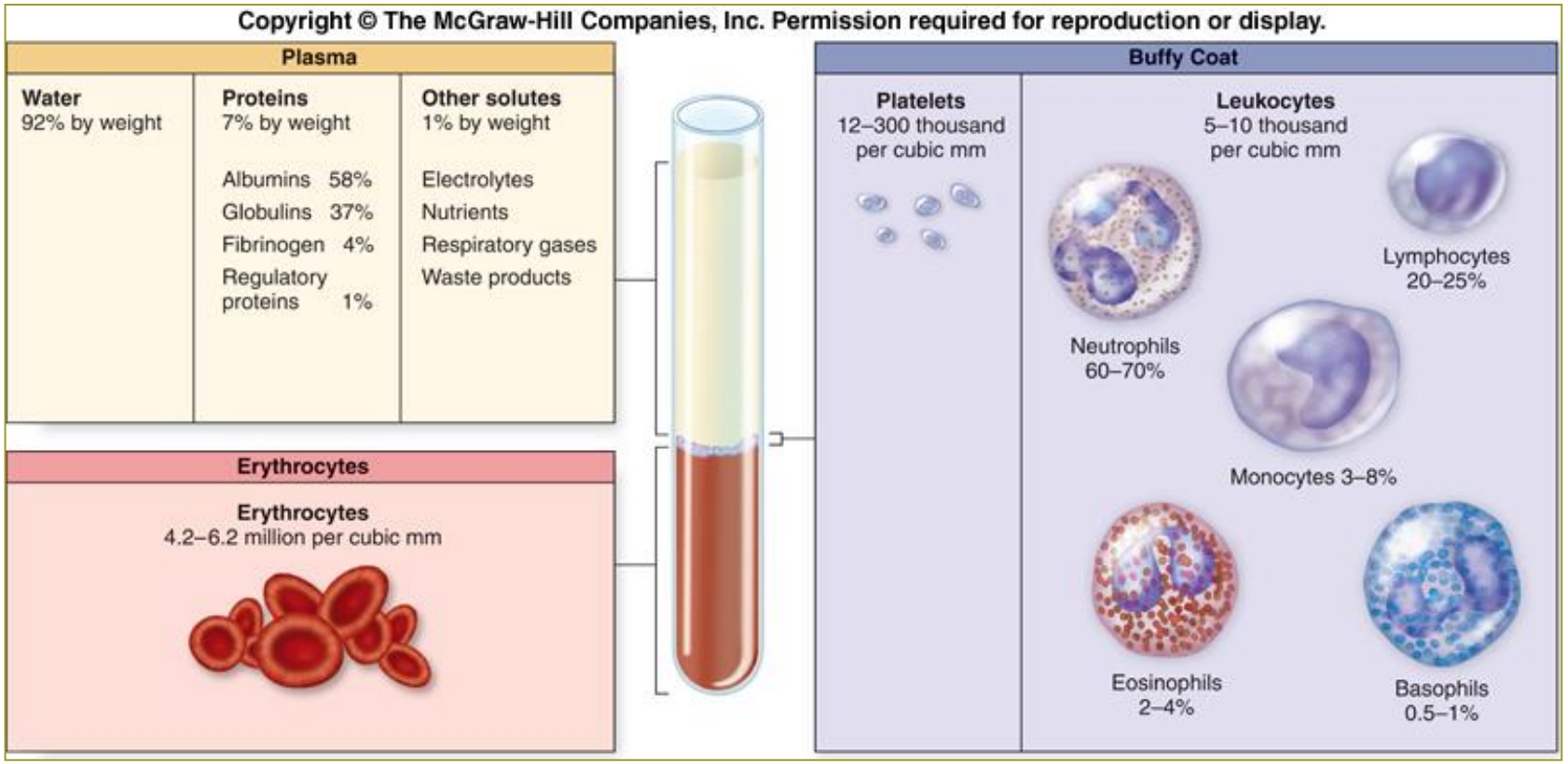
Textbook Learning Objectives

Chapter 9 – Page 220

- List and describe the functions of blood
- Describe the composition of blood plasma
- Describe the characteristics of mature erythrocytes
- Describe the structure of the hemoglobin molecule and explain the fate of hemoglobin following intravascular and extravascular hemolysis
- Give the origin of thrombocytes and describe their characteristics and functions
- List the types of leukocytes and describe the functions of each
- Describe the formation of lymph fluid and its circulation through the lymphatic system
- List the functions of the lymphatic system
- Describe the structure and functions of the lymph nodes, spleen, thymus, tonsils, and GALT
- List the functions of the immune system
- Differentiate between specific and nonspecific immune reactions
- Differentiate between cell-mediated and humoral immunity
- List the components involved in cell-mediated immunity and explain the role of each
- List and describe the classes of immunoglobulins
- Differentiate between active and passive immunity

Topic

List and describe the functions and composition of blood



Functions of Blood

Blood is a connective tissue

- Transportation
  - Oxygen, nutrients ,waste products, hormones
- Regulation
  - Body temperature, tissue fluid content, blood pH
- Defense System
  - White blood cell phagocytosis, platelets, clotting factors

Blood – Molecule Transportation System

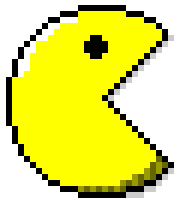
- Oxygen (O_2), carbon dioxide (CO_2)
- Nutrients
- Waste products
- Hormones
- Antibodies
- WBC's
- Platelets

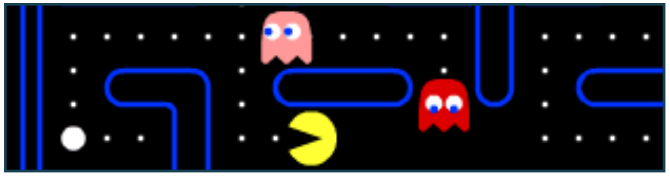
Blood – Regulation

- Body temperature
- Body fluid **volume** homeostasis
  - Salt water aquarium homeostasis
  - Hemoconcentration
  - Hemodilution
- Blood **pH** – What is normal? Why?
  - Salt water aquarium homeostasis

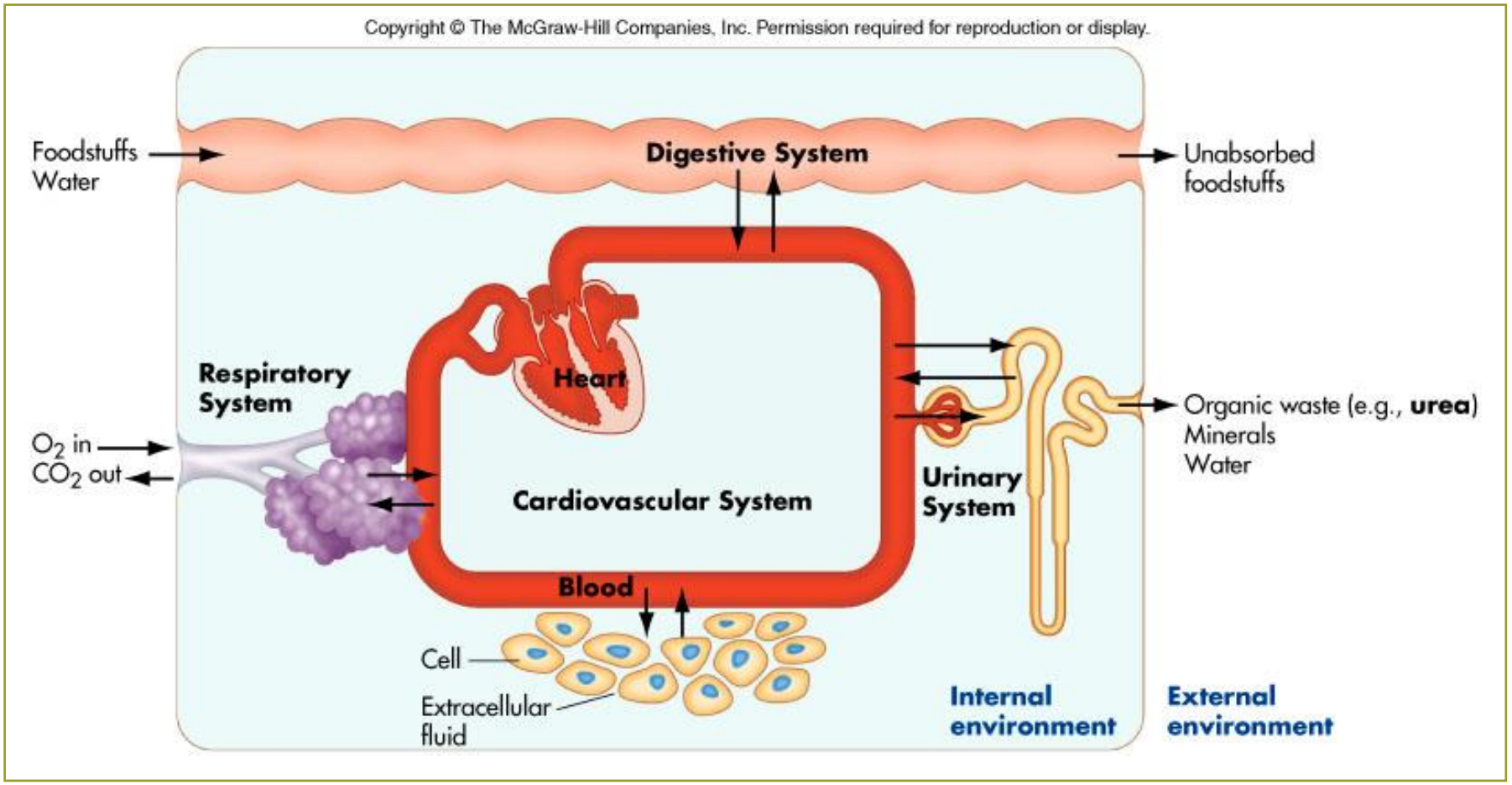
Blood – Defense

- Leukocytes (white blood cells)
  - Phagocytosis
    - Neutrophils & macrophages engulf bacteria
  - Antibody production
    - B-lymphocytes (plasma cells) make antibodies against specific viruses
  - Killer T-lymphocytes
- Platelets & clotting factors
  - Clot blood when blood vessel wall is damaged



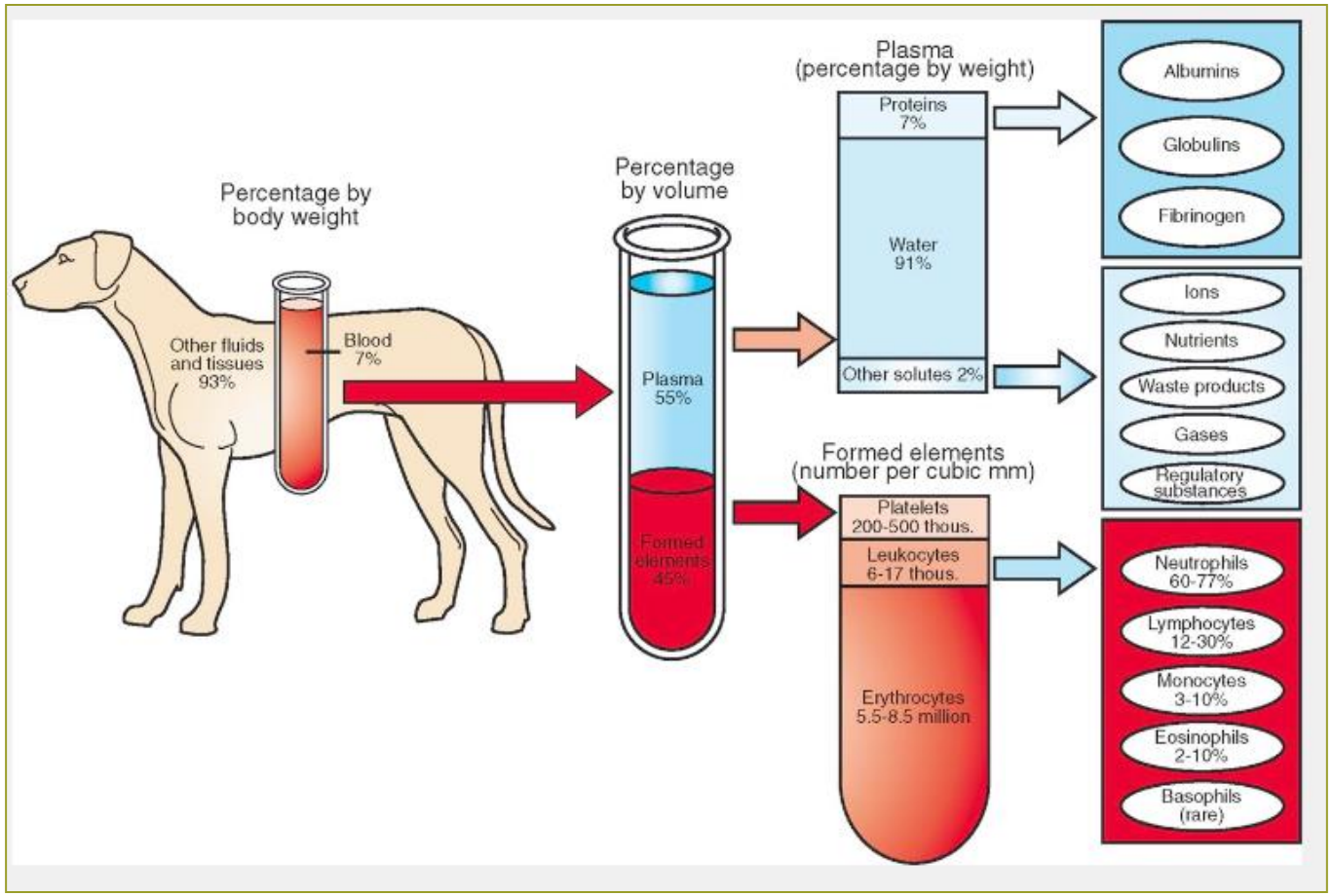


Internal Medicine



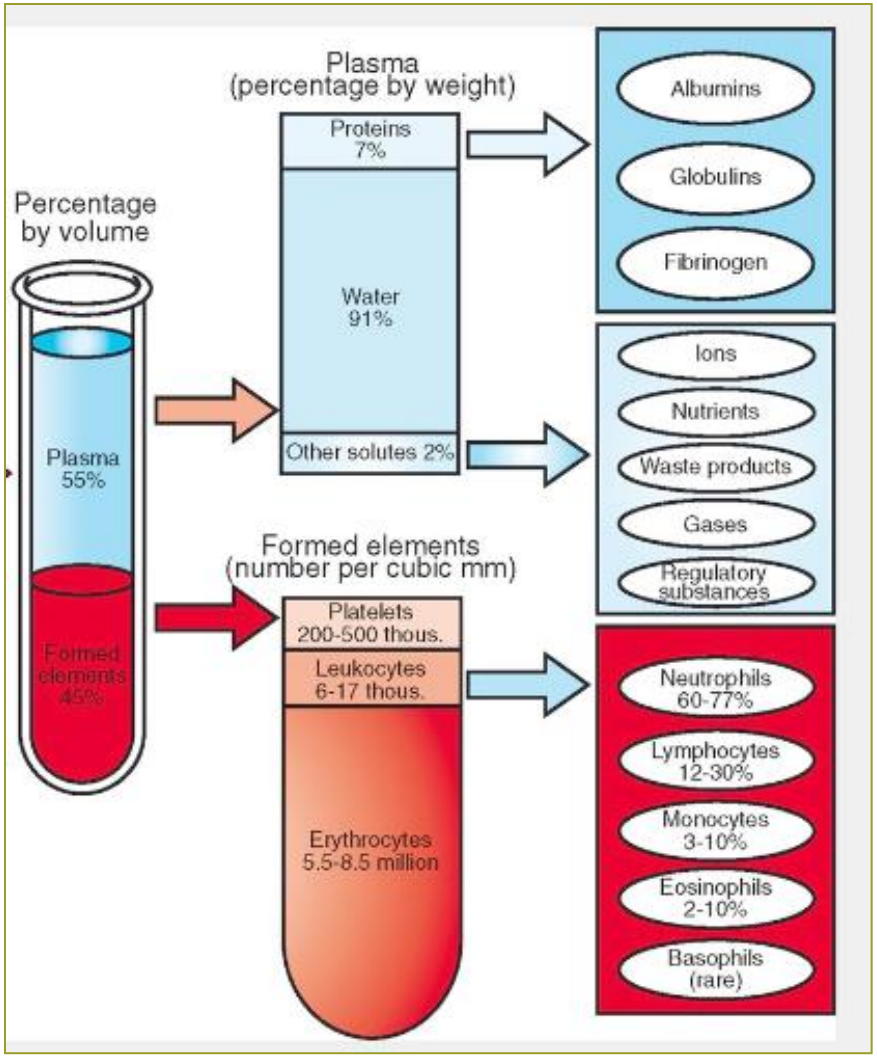
Composition of Blood

Figure 9-1, Page 222



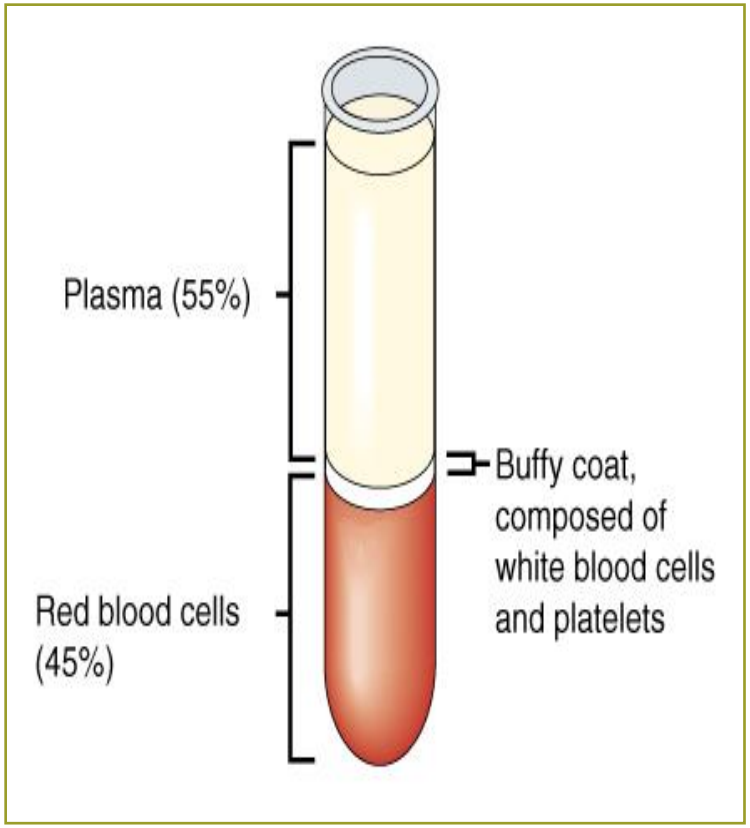
Blood = Plasma + Cells

- Liquid portion: Plasma
- Cellular portion:
  - Red blood cells (**erythrocytes**)
  - White blood cells (**leukocytes**)
  - Platelets (**thrombocytes**)



Blood Plasma

- 0ver 90% water
- 7% plasma proteins
  - created in liver
  - confined to bloodstream
  - Albumin
  - Globulins (immunoglobulins)
    - form antigen-antibody complexes
  - **Fibrinogen**
    - for clotting
- 2% other substances
  - electrolytes, nutrients, hormones, gases, waste products



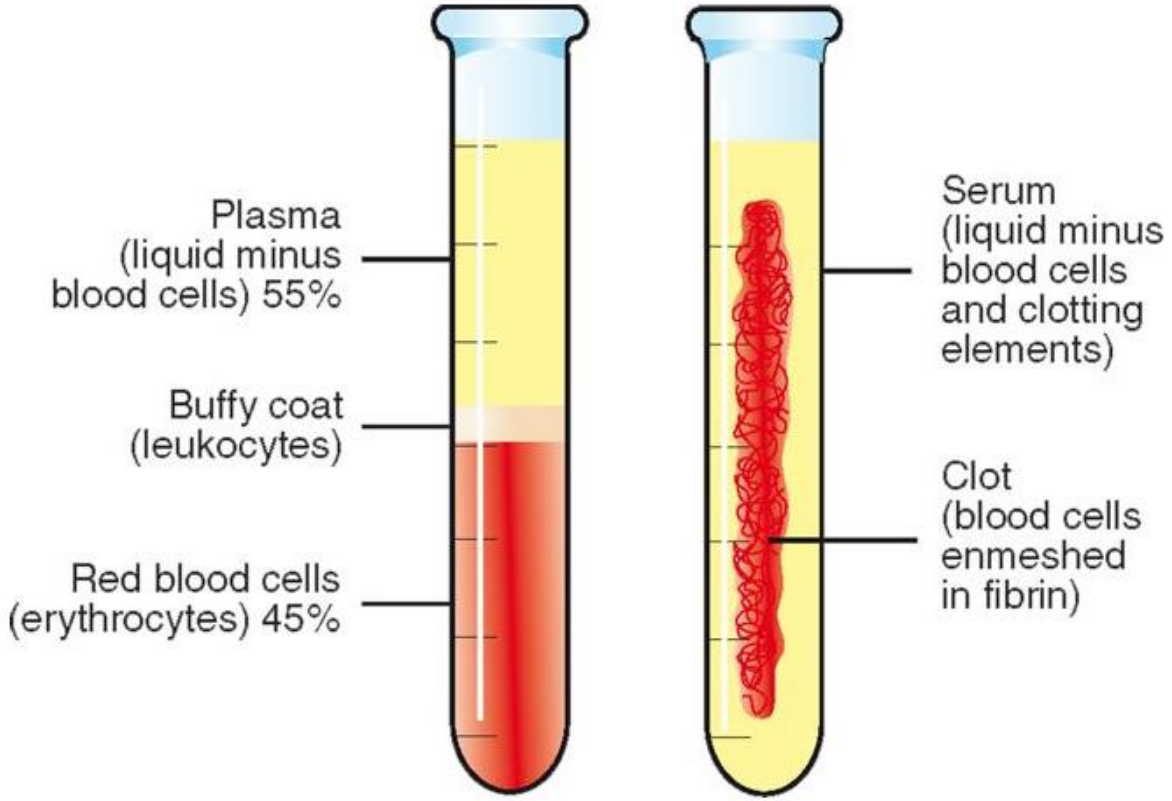
Plasma versus Serum

- Both liquids appear identical to the naked eye
- **Serum** – the liquid part of blood AFTER coagulation
- **Fibrinogen** is not found in serum
  - Plasma protein
  - Assists in the blood clotting process
  - Leaves plasma to help clot blood

Plasma versus Serum

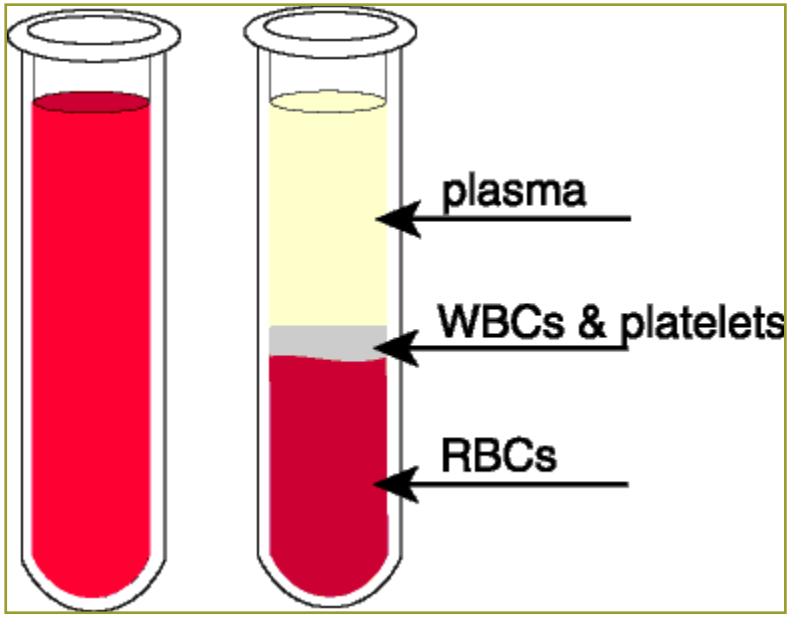
Clinical Application – Page 223 – KNOW THIS! ☺

Difference between blood plasma and blood serum. Plasma is whole blood minus cells; serum is whole blood minus the cells and clotting elements. Plasma is prepared by centrifuging anticoagulated blood; serum is prepared by allowing blood to clot.

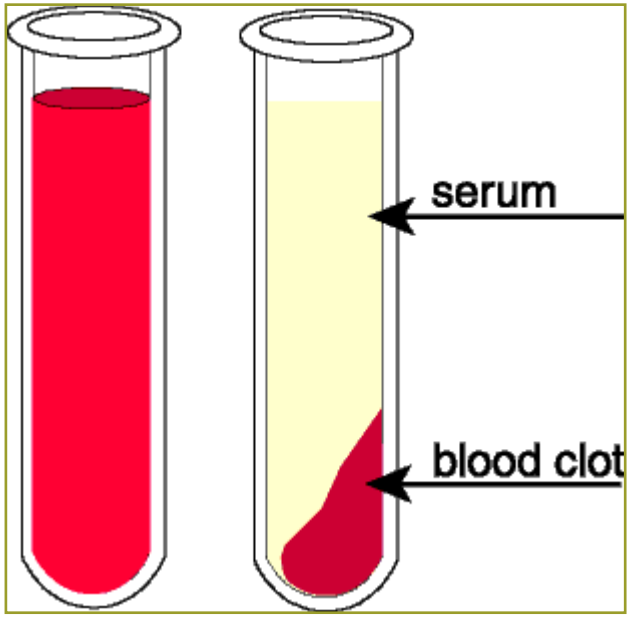


Plasma versus Serum

- Blood to which an **anticoagulant** has been added will not clot



Whole Blood

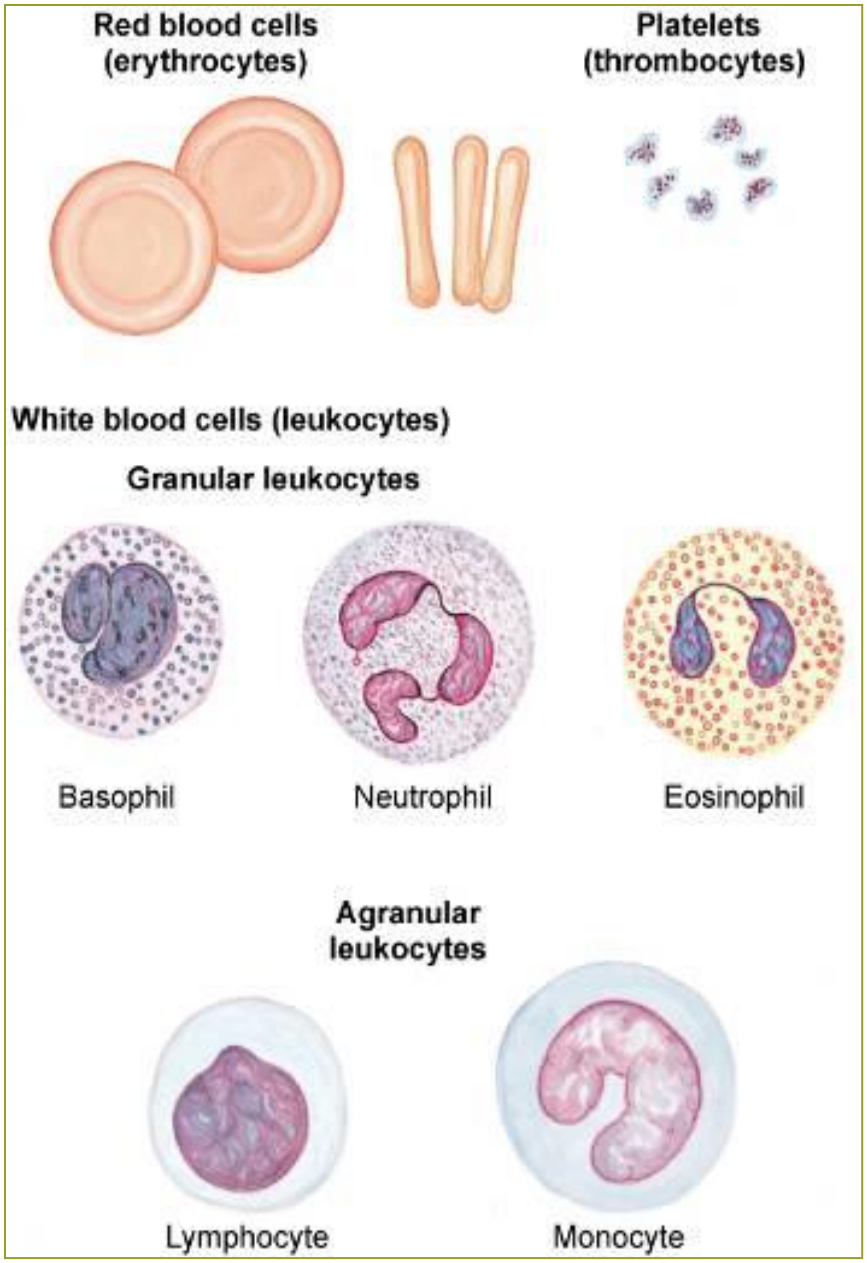


Clotted Blood

Cellular Components

Figure 9-2, Page 224

- Erythro**cytes** – carry oxygen
- Thrombo**cytes** – help prevent leaks from damaged blood vessels
- Leuko**cytes**
  - Granulocytic or agranulocytic



Hematopoiesis

- Production and maturing of ALL blood cells
- Occurs primarily in red bone marrow
- Fetal hematopoiesis occurs in the liver and spleen
- Neonatal hematopoiesis occurs in red bone marrow

Bone Marrow Produces

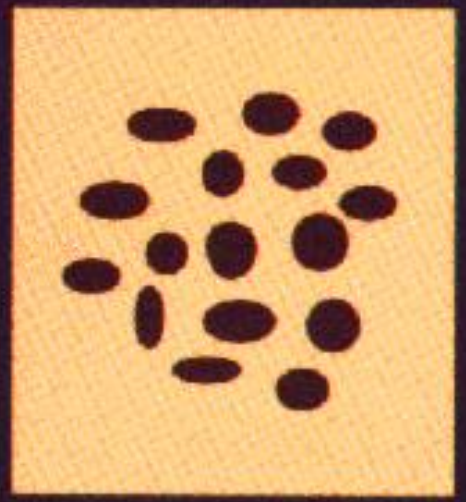
White Blood Cells

Fight Infection

Red Blood Cells

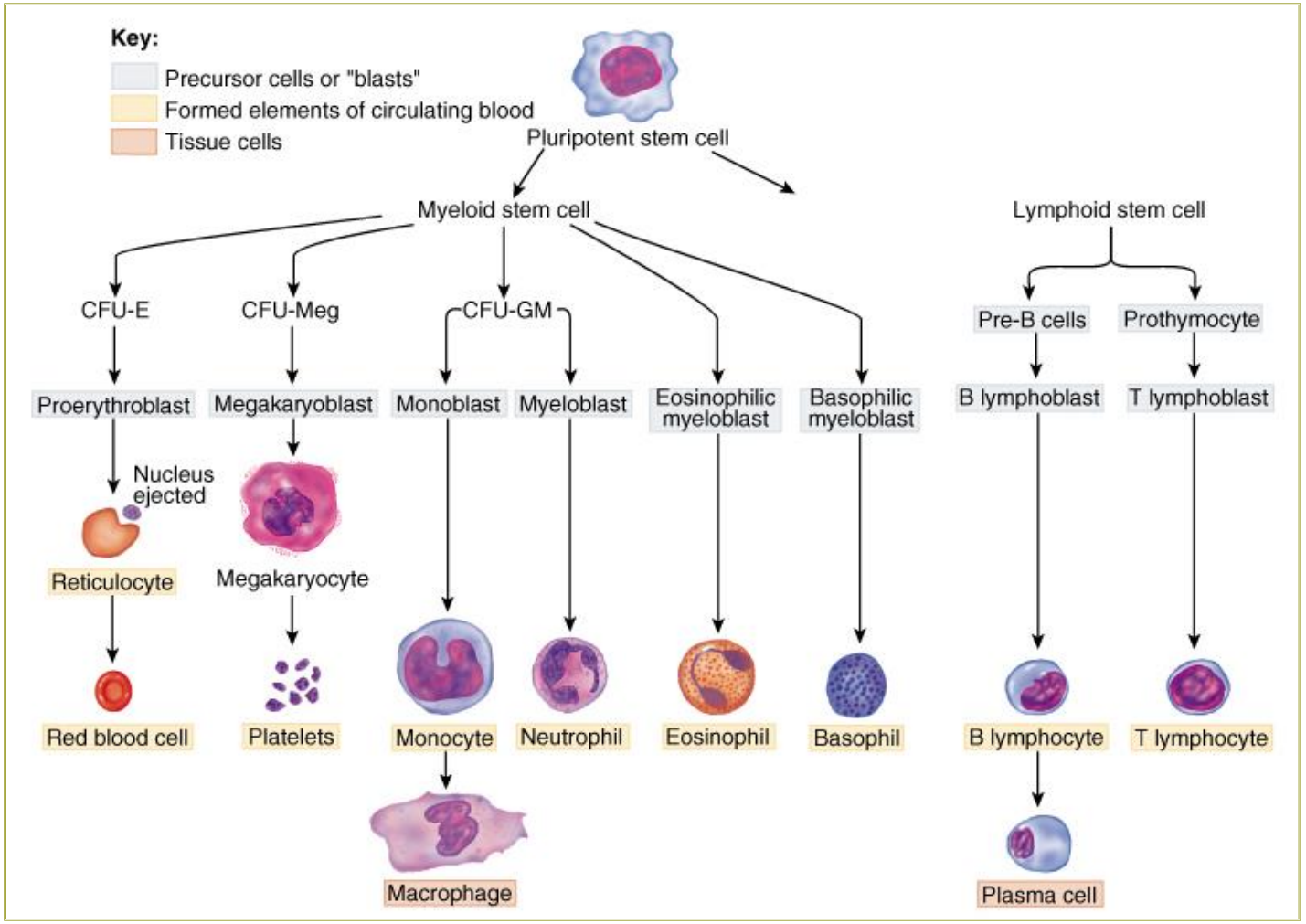
Carry Oxygen

Platelets



Control Clotting

Hematopoiesis – Blood Cell Formation



Erythropoiesis

- **Production of red blood cells**
  - **Erythropoietin**: hormone released from cells in kidney in response to hypoxia
    - Triggers stem cell to divide and differentiate
  - Multiple maturation steps

Blood Volume in Animals

Clinical Application – Page 225– KNOW THIS! ☺

CLINICAL APPLICATION

Blood Volume

Here's the question. How do you know if you can draw 200 ml of blood from an animal without causing serious problems? Our limit will be 25% of the total blood volume, which is more blood than you would routinely draw from an animal, since an animal that loses 25% of its total blood volume has about a 50:50 chance of survival, but let us examine a worst case scenario.

First, you need to know how much blood an animal has. The total blood volume for any animal can be estimated using the animal's lean body weight. *Lean* is the operative word here. A 13.5 kg (30-pound) house cat is not lean. So if you want to figure the total blood volume on this cat, think of it as a 3.5- to 4.5-kg (8- to 12-pound) cat. As a broad rule of thumb, figure 50 to 100 ml (average 75) of blood/kg lean body weight. High-strung animals tend to have more volume because they are always active—pacing, bouncing, running—so they need more oxygen in their muscles.

Using these guidelines, a 454-kg (1000-pound) horse will have a total blood volume of about 34,000 ml or 34 liters (454 kg × 75 ml of blood/kg = 34,050 total blood volume). Taking 200 ml of blood from this horse would result in a blood loss of 0.5% of the total blood volume (200 ml divided by 34,000 ml and multiplied by 100 to get a percentage). Not a problem.

Now let's consider a 16-kg (35-pound) dog with a total blood volume of 1193 ml. Drawing 200 ml from this dog would result in a blood loss of 16%. This is still not a problem, but we're getting closer to trouble.

A Pint's a Pound the World Around

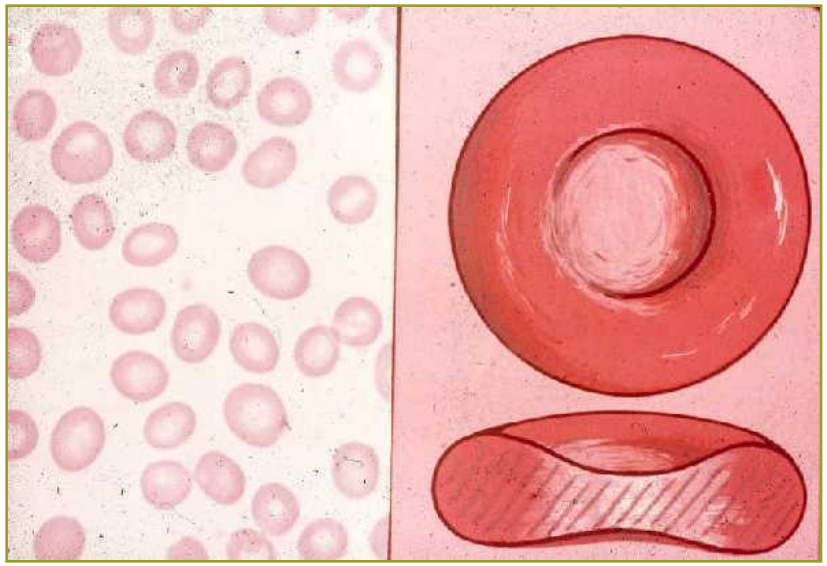
Test Yourself – GREAT Reviews for You All Over the Book! ☺

TEST YOURSELF

1. What are the main functions of blood?
2. What is one of the most common causes of hemoconcentration, and how can it affect blood cell counts in peripheral blood?
3. What is the most abundant component of plasma?
4. What are the three main categories of cellular blood components?
5. What is the difference between red bone marrow and yellow bone marrow?
6. What is the difference between plasma and serum?
7. How does one cell population, the pluripotent stem cells, give rise to all the different blood cells?
8. What is the total blood volume of a 675-pound (lean body weight) animal? How about a 3-pound animal?

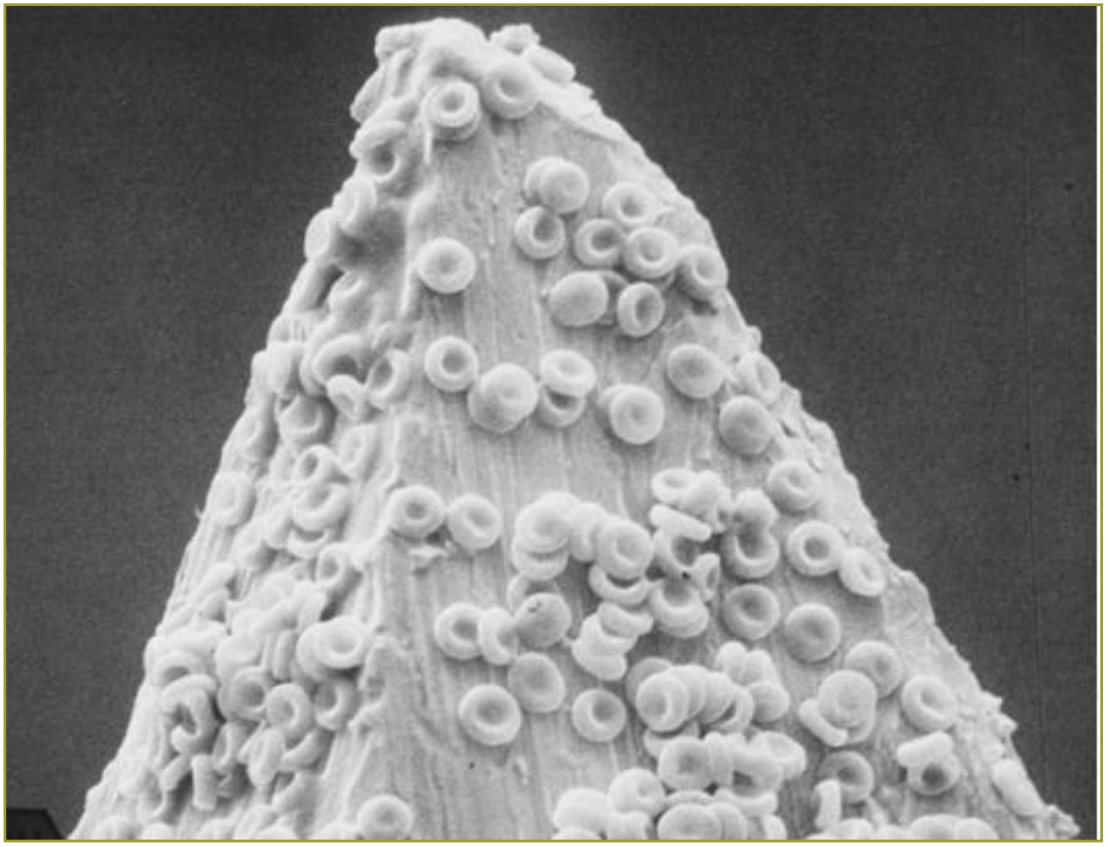
Mammal Erythrocyte Morphology

- Most common of blood cells on a blood smear
- **Biconcave disc**
- **No nuclei in mammal RBC's**
- Nuclei present normally in bird and reptile blood
- Normal canine RBC's have a central pallor (lightness) to them



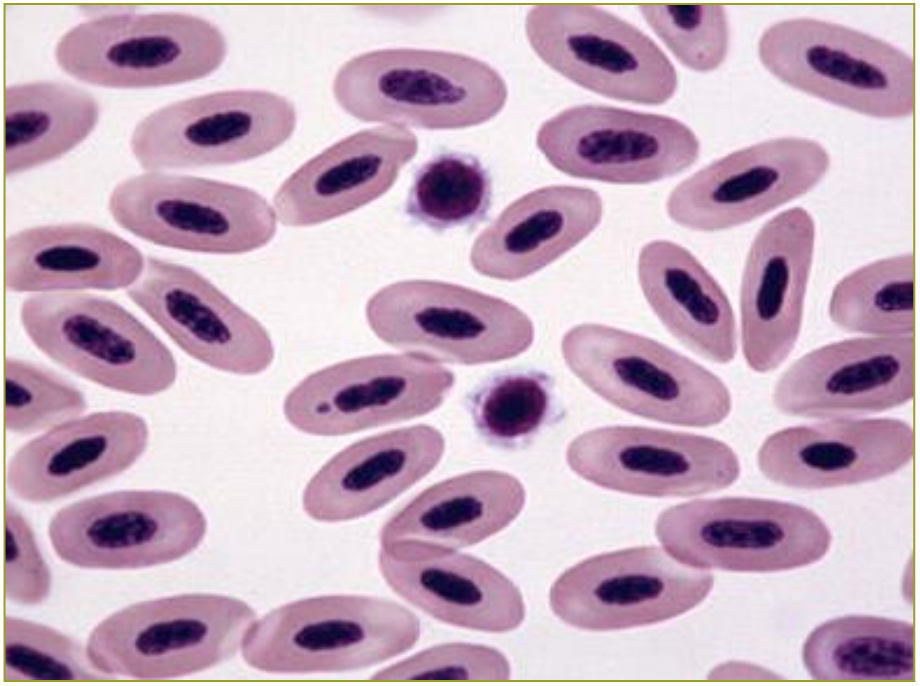
How Small Are They? ☺

- They are soooooooooooo small……

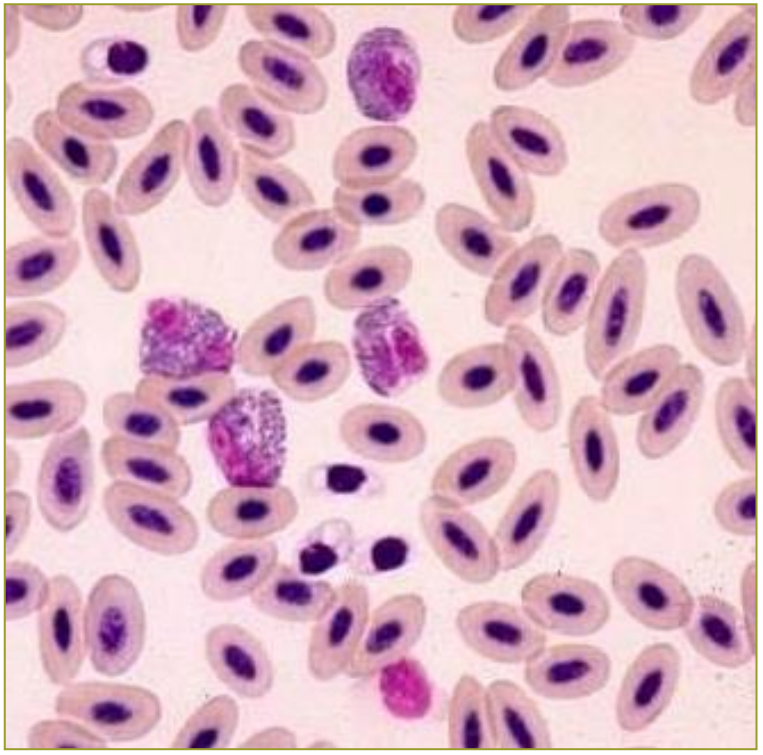


Bird and Reptile RBC's

Bird RBC's



Reptile RBC's



Hemoglobin

- Molecule inside RBC's that carries oxygen
- Oxygenated blood – bright red
- Deoxygenated blood – dark red

Red Blood Cell Life Span

- Varies with the species
  - Dogs ~ 120 days (4 months?)
  - Cats ~ 68 days
  - Horse and sheep ~ 150 days
  - Cow ~ 160 days
  - Mice ~ 20-30 days
- “Recycled” by macrophages from the spleen

Anemia

- Results in decreased O_2 carrying capacity of the blood
- Caused by:
  - Low number of circulating mature red blood cells (blood loss, increased RBC destruction, decreased RBC production)
  - Insufficient hemoglobin production (e.g., iron deficiency)

Polycythemia

- Increase in number of RBCs
- Causes:
  - Hemoconcentration due to fluid loss and dehydration (e.g., vomiting, diarrhea)
  - High altitudes

Carbon Dioxide Transport in the Blood

- CO_2 diffuses into red blood cells and is transformed into carbonic acid
- Ionizes into hydrogen ions and bicarbonate ions

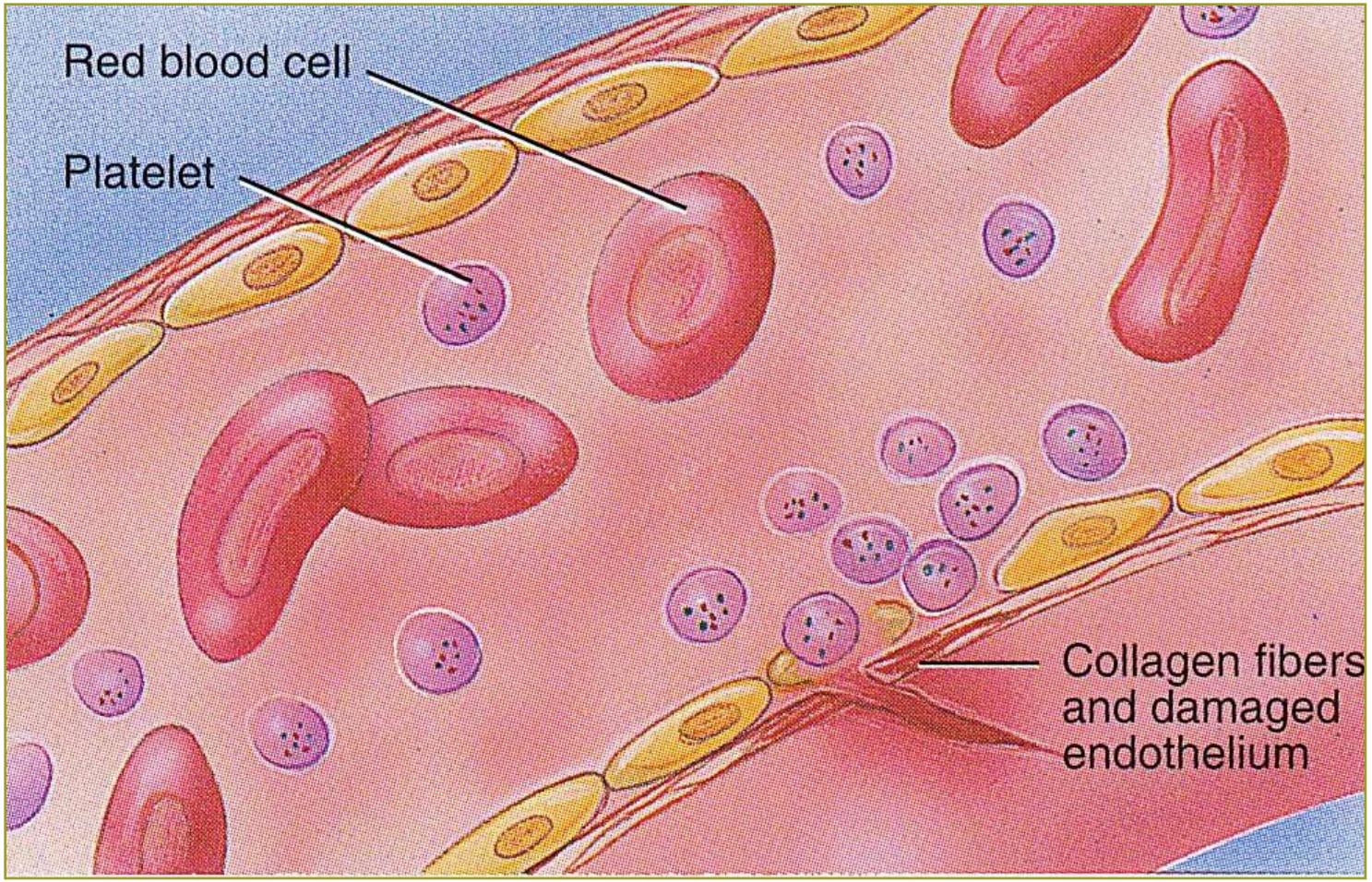
  $H_2O + CO_2 = H_2CO_3 = H^+ + HCO3^-$

  - Deoxyhemoglobin accepts the hydrogen ion
  - Bicarbonate diffuses back into the plasma

Platelets (Thrombocytes)

- Cellular fragments of bone marrow megakaryocytes
- Thrombopoiesis - production and maturation of platelets in the bone marrow

Blood Clotting



Platelet Functions

- Maintain vascular integrity
  - Release endothelial growth factor into blood vessel endothelial cells
- Formation of platelet plug
  - Attracted to exposed connective tissue of damaged blood vessel
  - Adhere to exposed connective tissue and each other
- Stabilize the hemostatic plug
  - Fibrin strands form a netlike mesh around and through the platelets.

White Blood Cells (Leukocytes)

Functions

Presence or Absence of Granules

Nuclear Shape

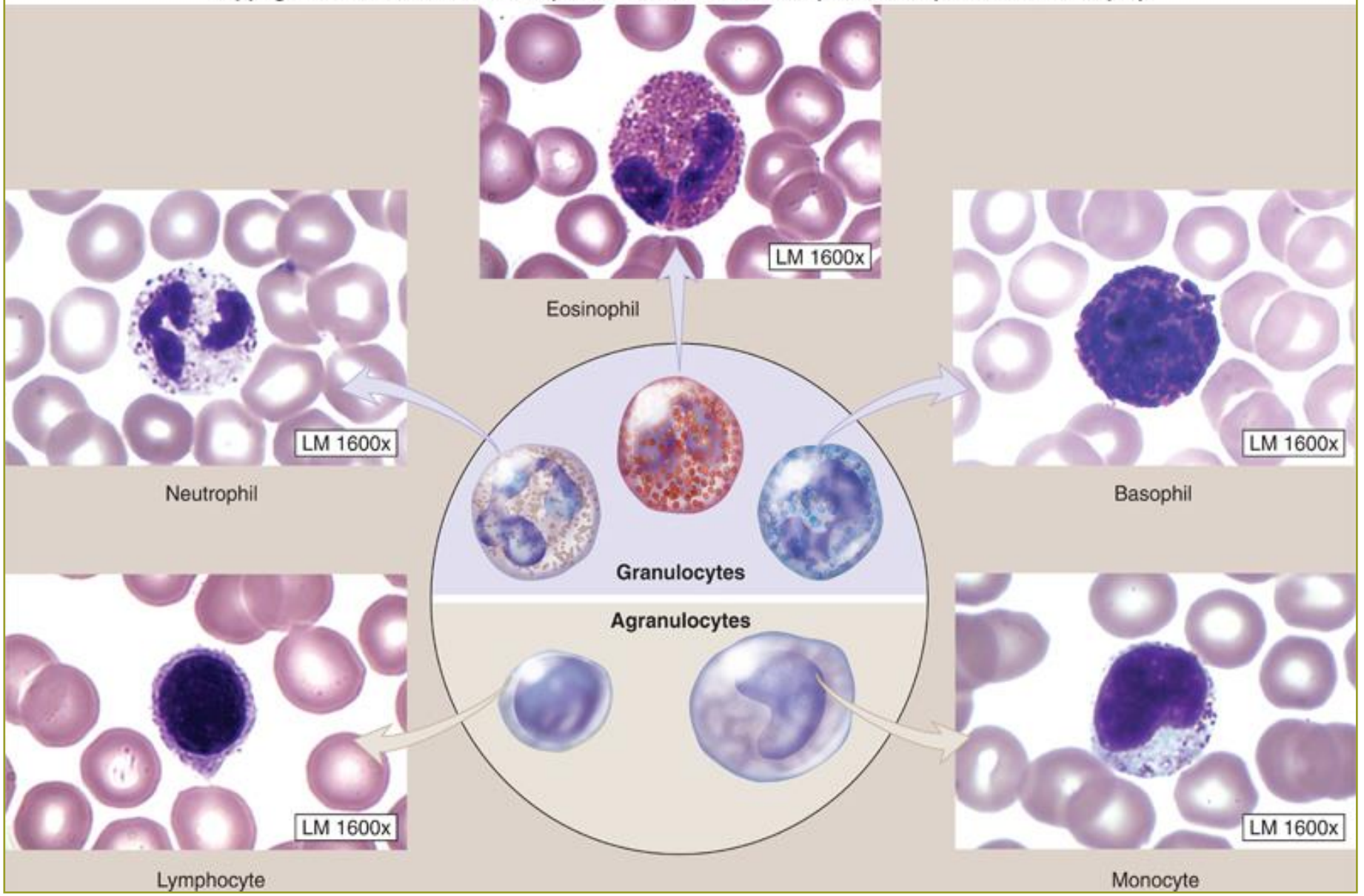
Leukopoiesis

- Production and maturation of all WBC's
- Occurs in red bone marrow
  - Some lymphocytes develop further outside bone marrow
- **Same pluripotent stem cell that produces red blood cells and megakaryocytes**
- Each type of WBC has its own stimulus for production

White Blood Cells

Table 9-2, Page 231

Name	Cytoplasmic Granules	Nuclear Shape	Function	Site of Action
Neutrophil	Don't stain (usually invisible)	Polymorphonuclear	Phagocytosis	Body tissues
Eosinophil	Stain red	Polymorphonuclear	Allergic reactions, anaphylaxis, phagocytosis	Body tissues
Basophil	Stain blue	Polymorphonuclear	Initiation of immune and allergic reactions	Body tissues
Monocyte (macrophage)	None	Pleomorphic	Phagocytosis and process antigens	Body tissues or blood
B cell (lymphocyte)	None	Mononuclear	Antibody production and humoral immunity	Lymphoid tissue
T cell (lymphocyte)	None	Mononuclear	Cytokine production and cell-mediated immunity	Lymphoid tissue and other body tissues



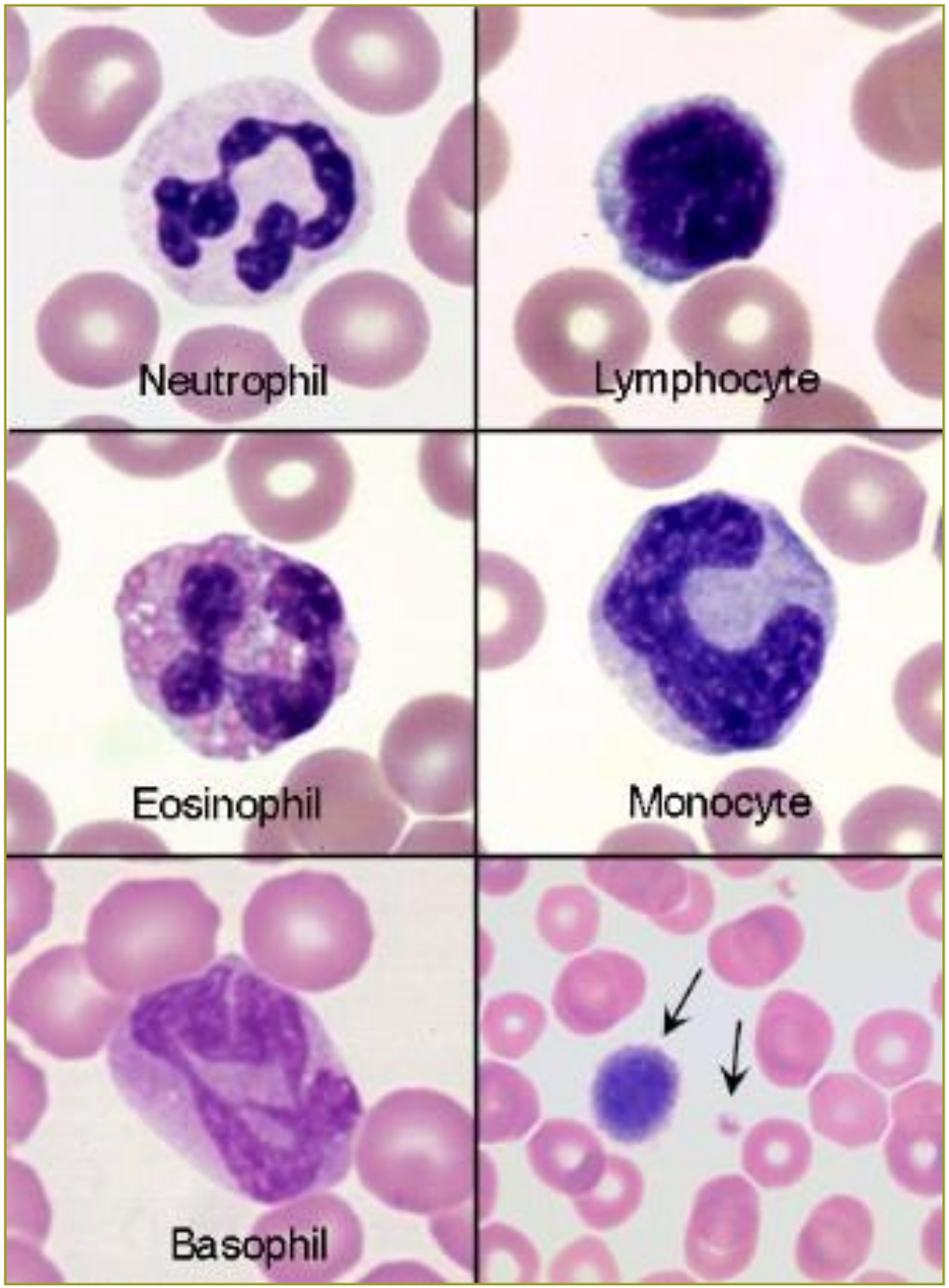
Granulocytes

- **Granulopoiesis** – production and maturation of the **granulocytes** **(neutrophils, eosinophils, and basophils)** in the bone marrow
- The "**phil**" cells! ☺
- Specific cytoplasmic granules produced during maturation
  - Granules contain different substances depending on the cell's function

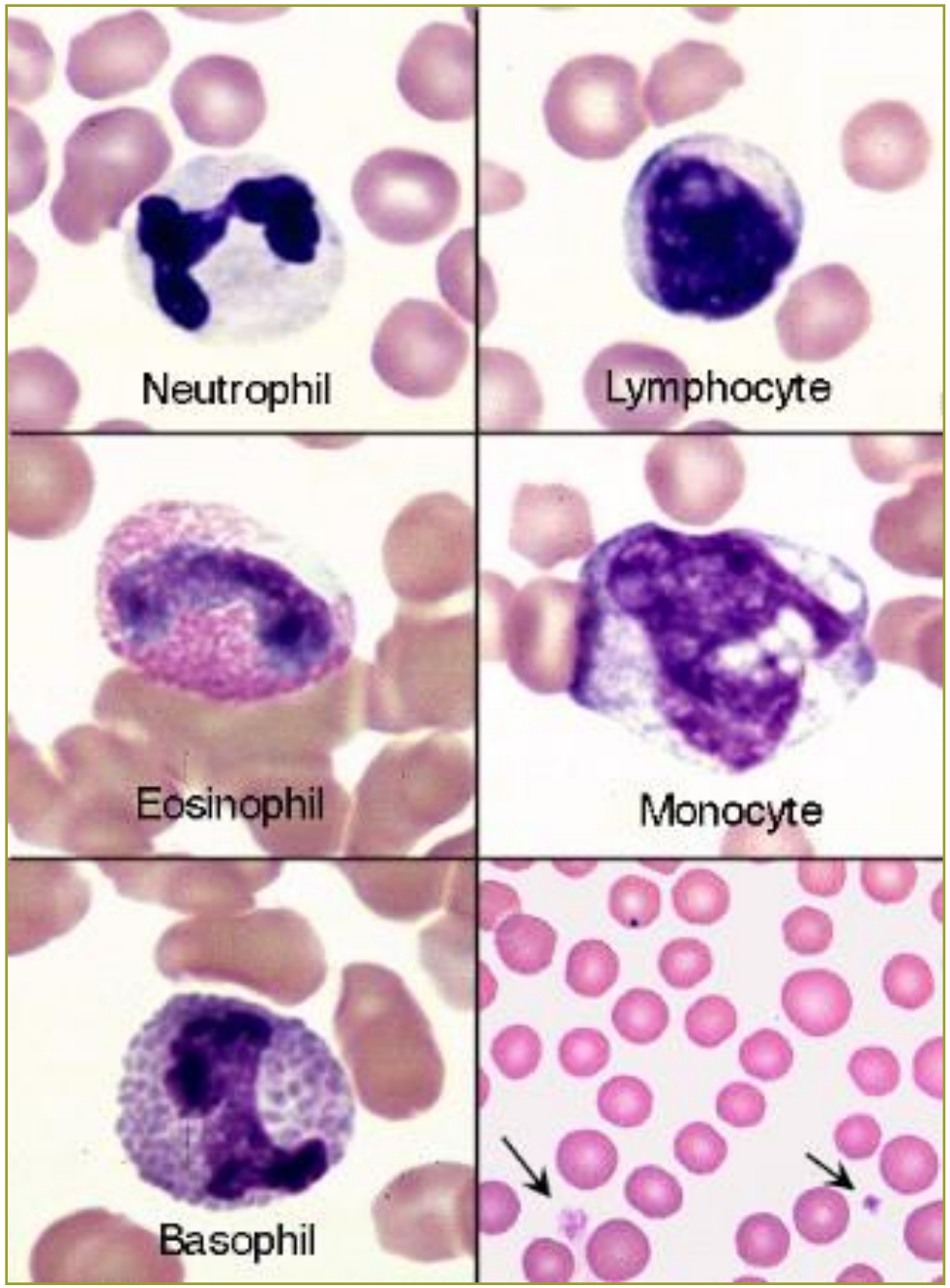
Agranulocytes

- Lymphocytes
- Monocytes
- The "cyte" cells! ☺
- No granules in the cytoplasm

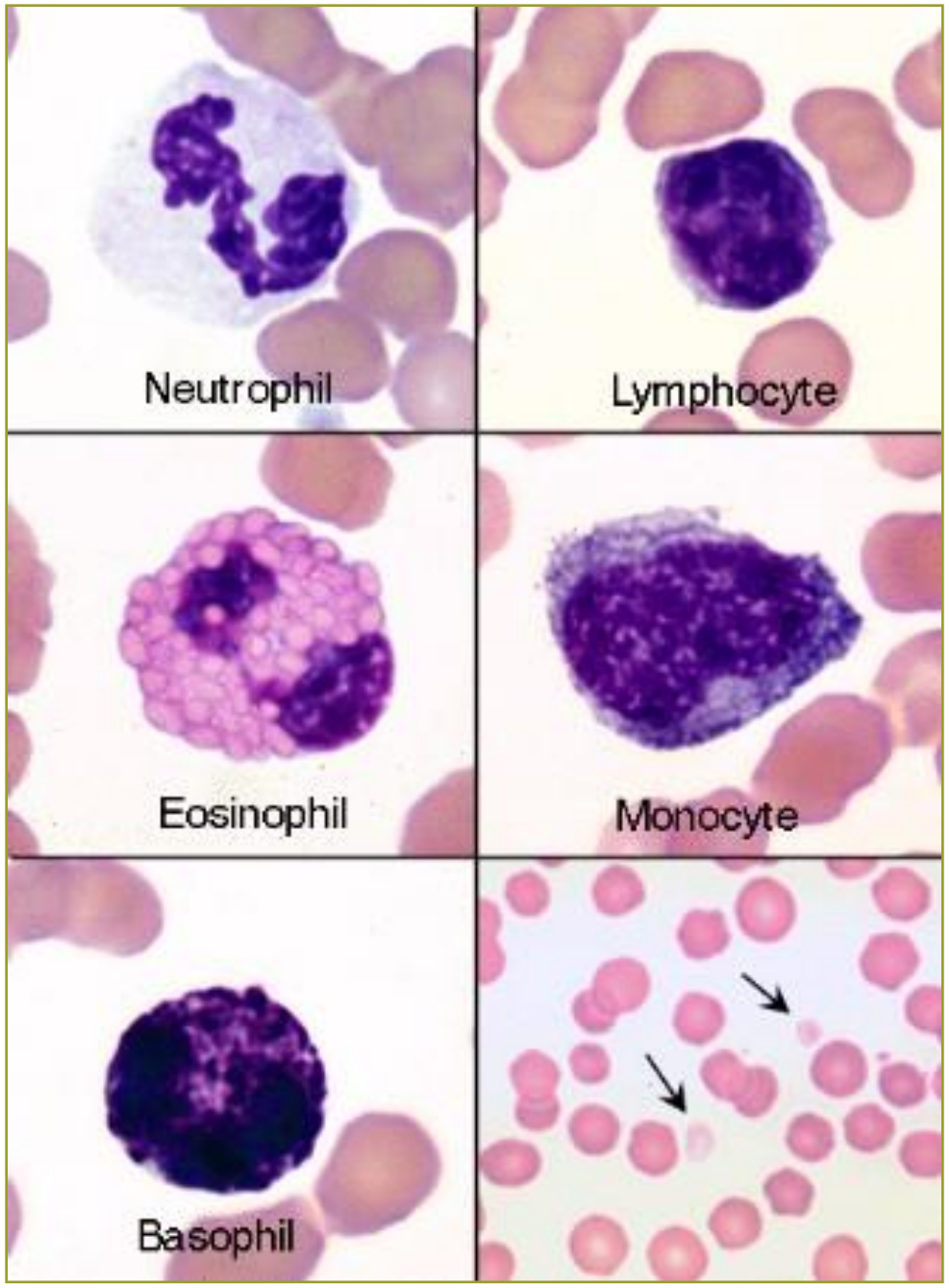
Canine Leukocytes



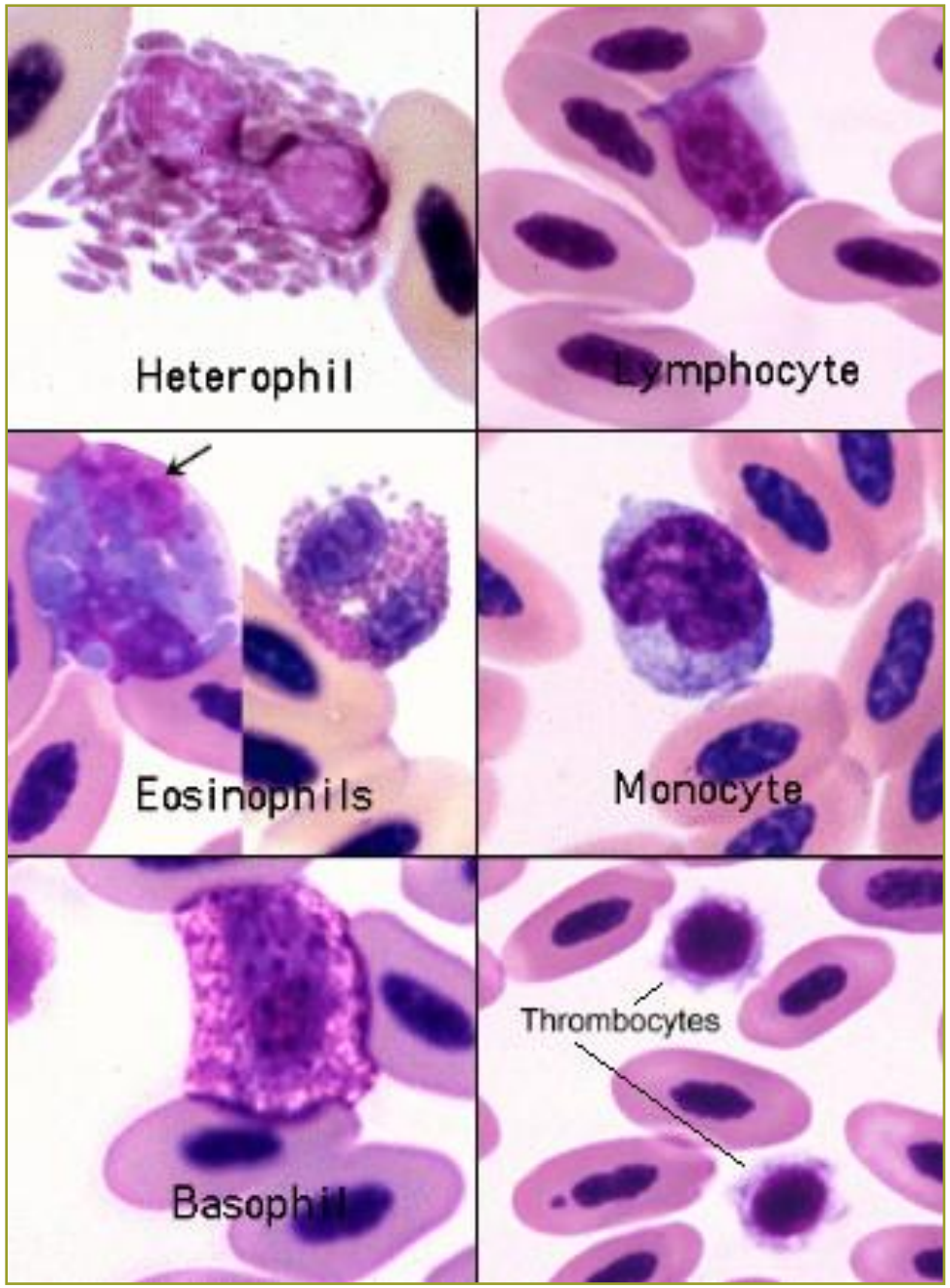
Feline Leukocytes



Equine Leukocytes

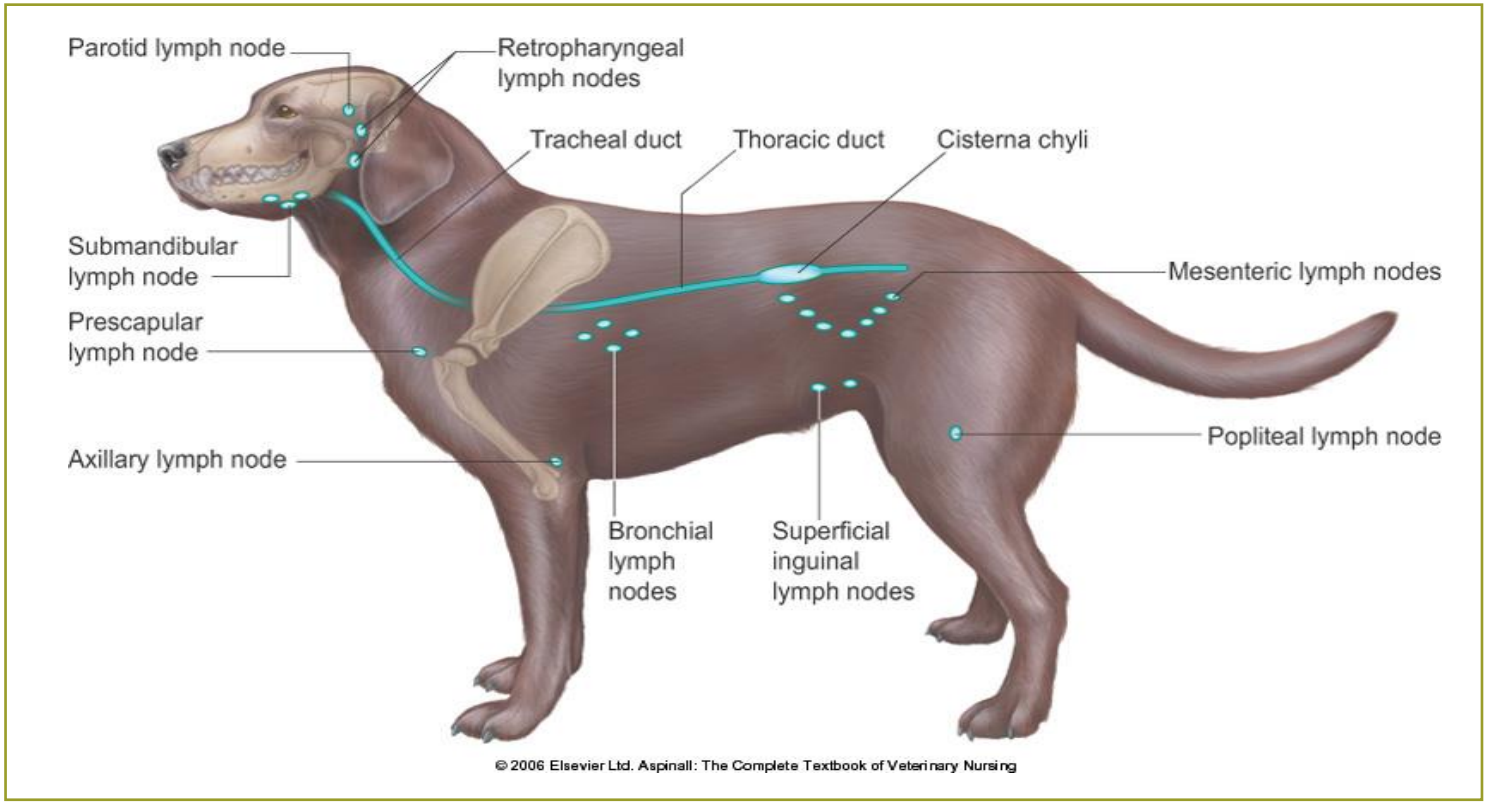


Avian Leukocytes



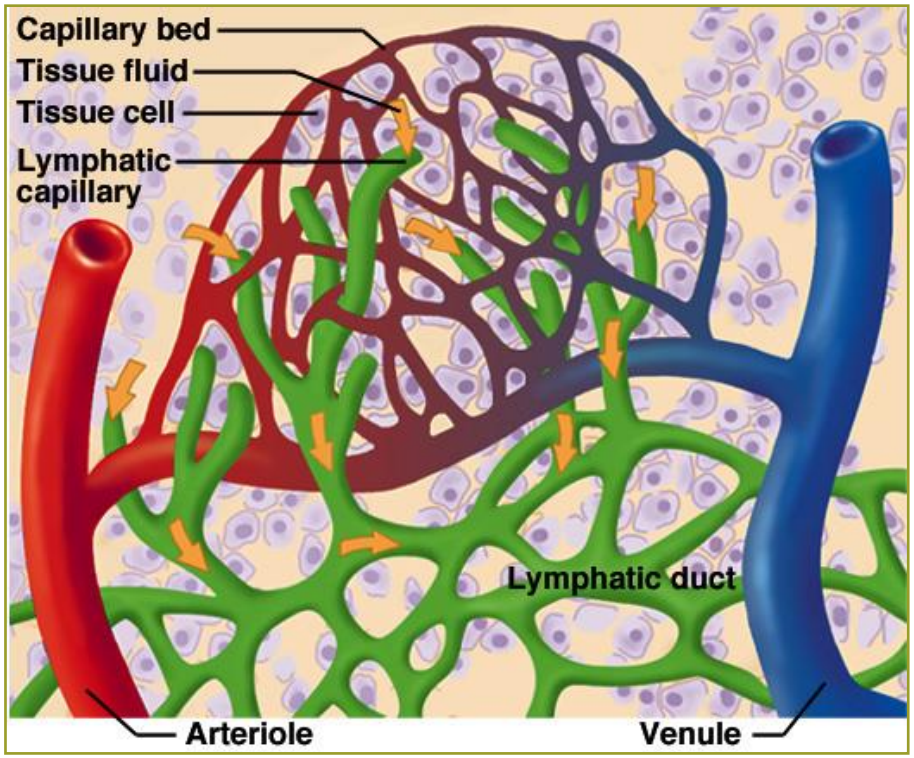
Topic 17

Define and list the functions of the lymphatic system



Lymphatic System – What Is It?

- A "**water filtration system**" for interstitial fluid **(ECF)**
- Series of **vessels**
  - Carries excess fluid to blood vessels near heart
- 3 components
  - Lymph
  - Lymph vessels (ducts)
  - Lymph tissue



Lymphatic System

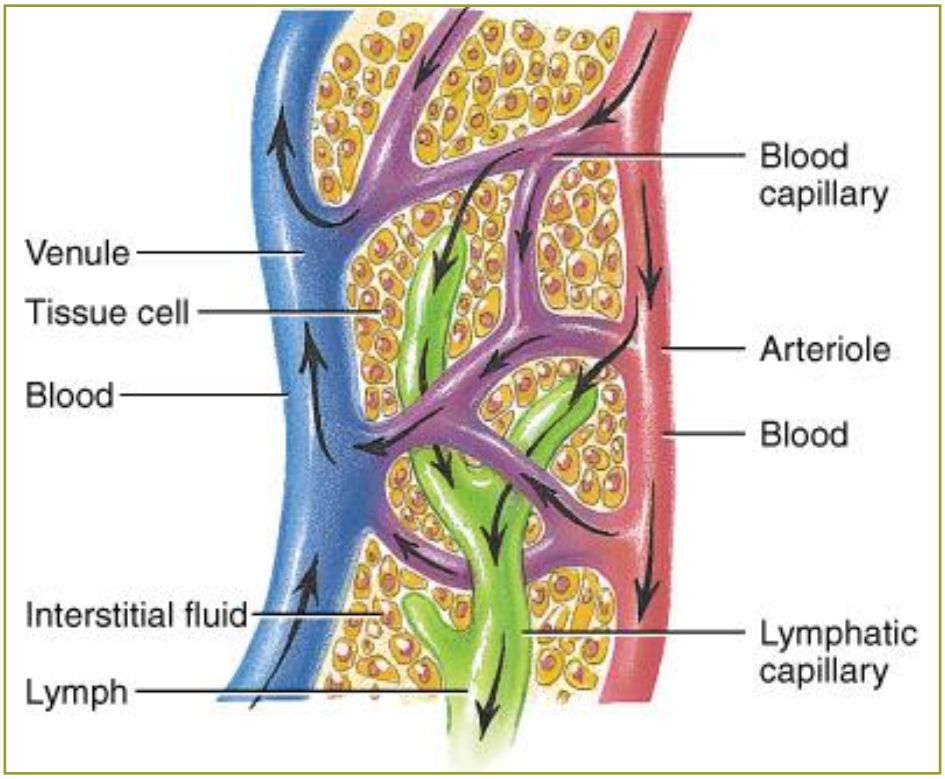
- Series of **vessels/ducts**
- Carry excess interstitial tissue fluid (ECF) to blood vessels near the heart where fluid is put back into the bloodstream
  - **Walking Salt Water Aquariums (Secret of Life!)**
  - **Recycle Resources (Secret of Life!)**
- Also **includes lymph tissue** scattered throughout the body (lymph nodes, spleen, thymus, tonsils)

Lymphatic System Functions

- Removal of excess tissue fluid
- Waste material transport
  - Interstitial fluid (ECF) contains some of the waste materials from the tissue cells
- Filtration of lymph
  - Removal of microorganisms, cellular debris, and other foreign matter
- Protein transport

Topic 18

Describe the formation of lymph fluid and its circulation through the lymphatic system



Lymph – What Is It?

- This liquid consists of:
  - Blood cells – mostly lymphocytes
  - Nutrients (proteins, fats, etc.)
  - Hormones
- Some T cells circulate from blood to interstitial fluid to lymph and back to blood
- B cells are found primarily in lymph tissues and rarely recirculate

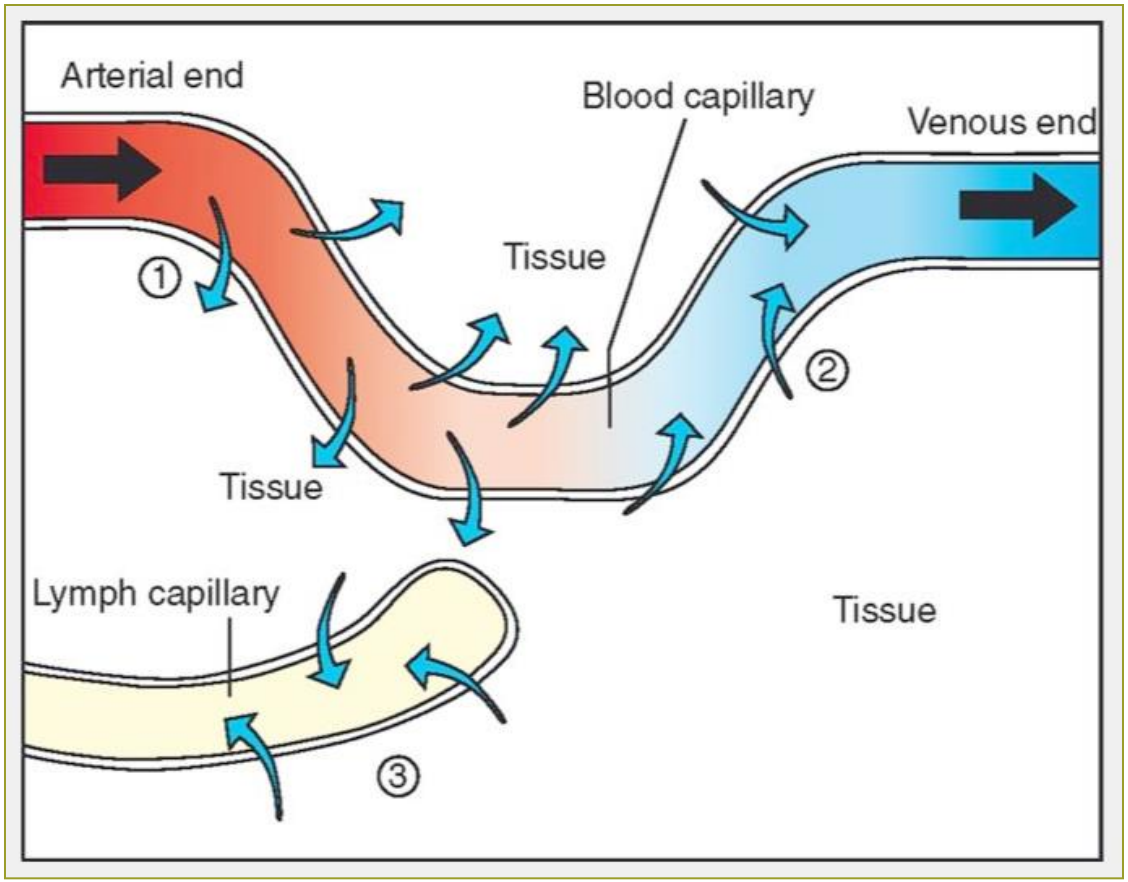
Lymph Characteristics

- **Transparent or translucent liquid** containing varying numbers of cells, primarily **lymphocytes**
- More water, sugar, and electrolytes than plasma
- Fewer of the larger proteins found in plasma
- **Chyle** – Lymph from the digestive system
  - **Chylomicrons** cause lymph to appear white or pale yellow and cloudy

Lymph Formation

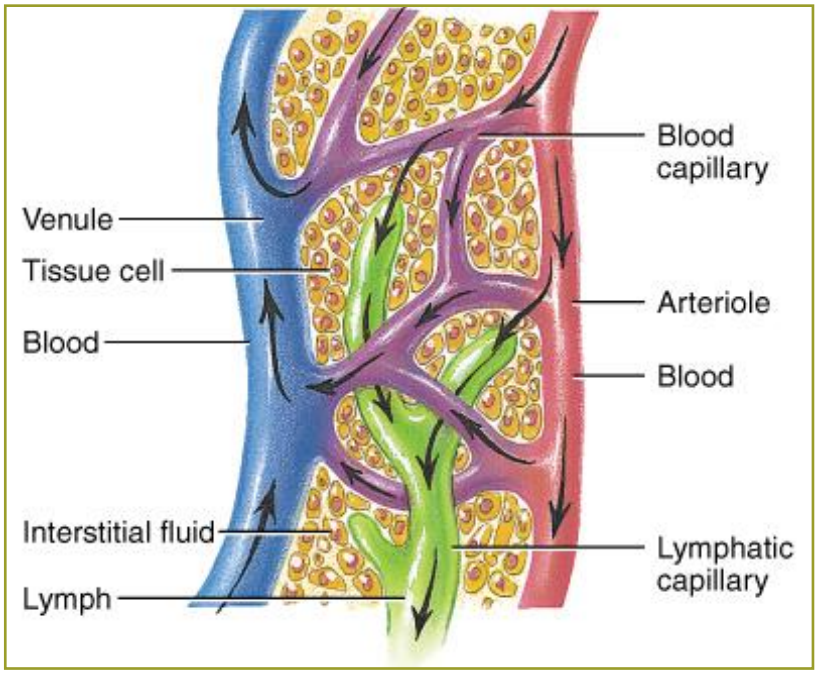
Figure 9-8, Page 239

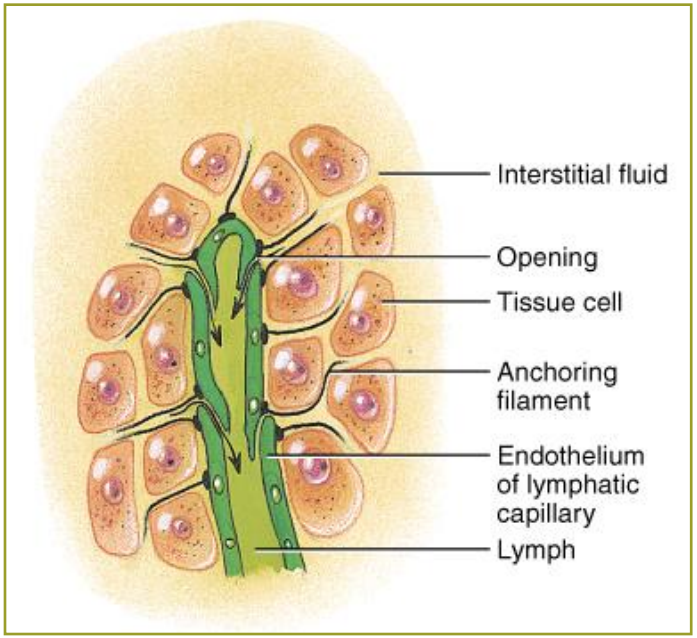
Figure 9-8 **Formation of lymph. 1**, Blood pressure forces plasma out into tissues. **2**, Osmotic pressure draws some of tissue fluid back into capillary, but not all of it. **3**, Blind-ended lymph capillary picks up excess tissue fluid and carries it off into progressively larger lymph vessels that eventually return it to bloodstream.



Lymph

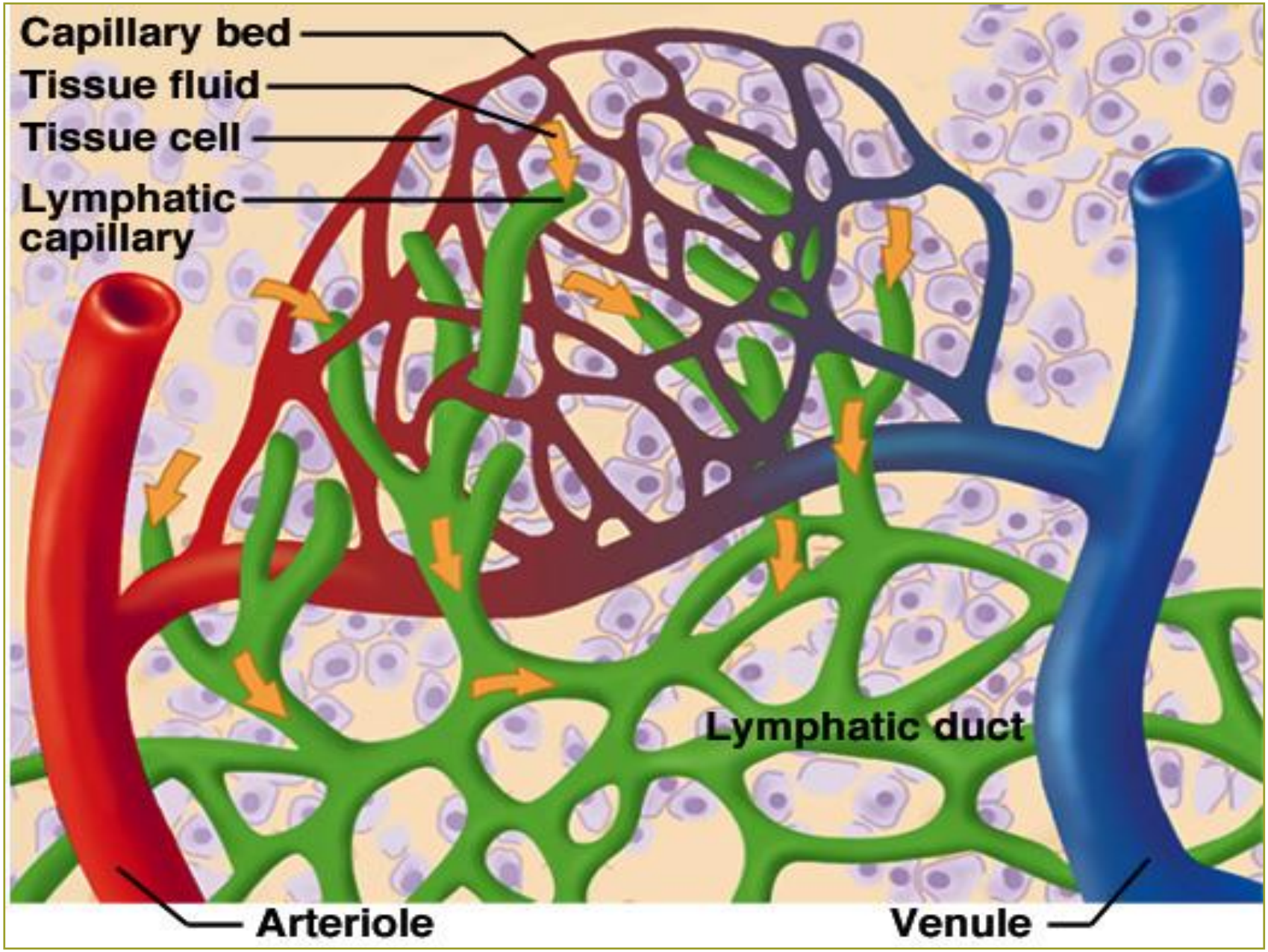
- Excess tissue fluid picked up by blind-ended **lymph capillaries**
- **Fluid is actually plasma** from blood capillaries
  - Nutrients
  - O_2, CO_2
  - Waste molecules





Lymph Circulation

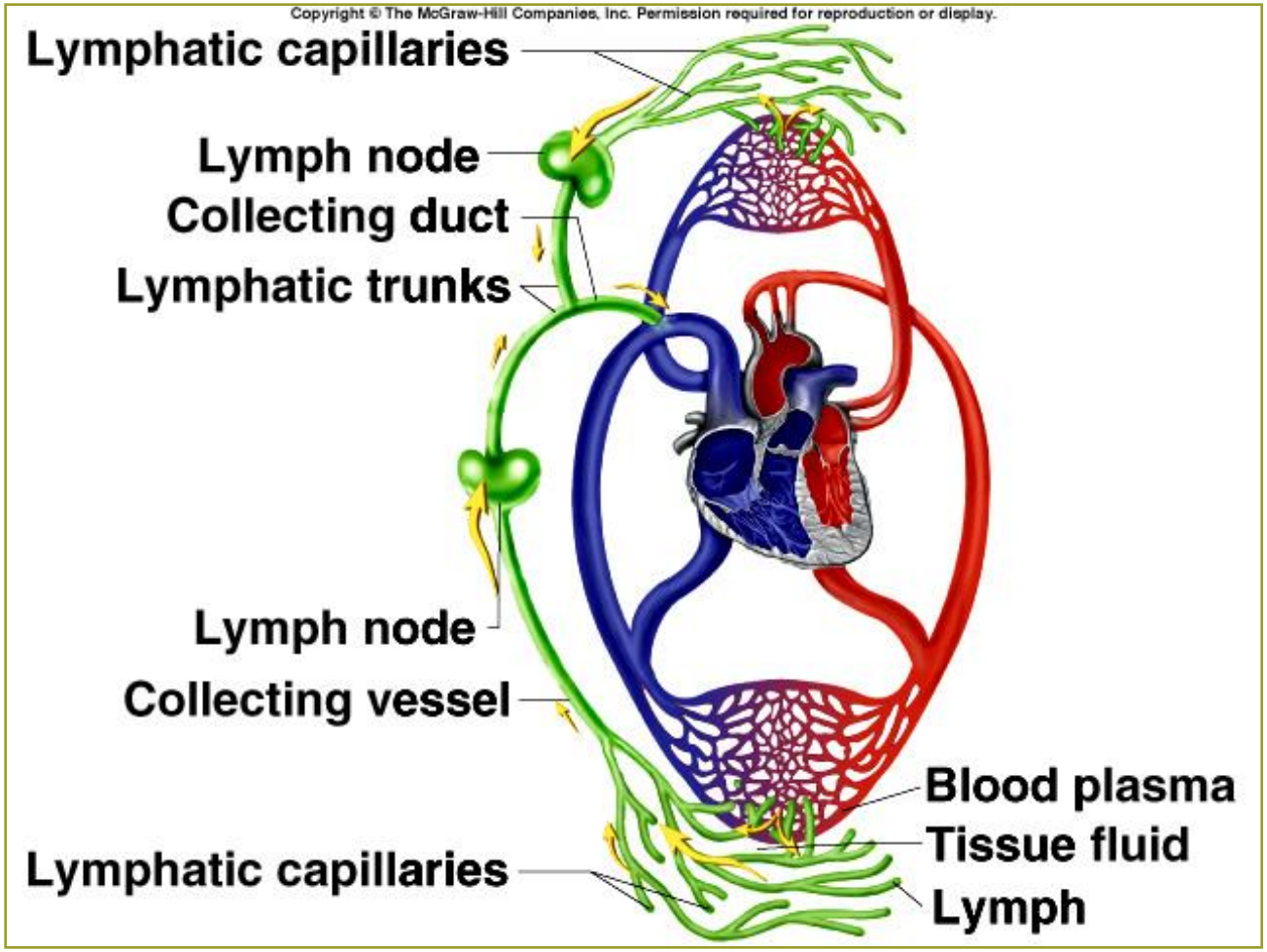
- **Lymph capillaries** join together to form larger and **larger lymph vessels**
- Many contain **one-way valves** that prevent lymph from flowing backwards
- Body movements propel lymph **toward the heart**


Capillary bed
Tissue fluid
Tissue cell
Lymphatic capillary
Lymphatic duct
Arteriole
Venule

Lymph Circulation

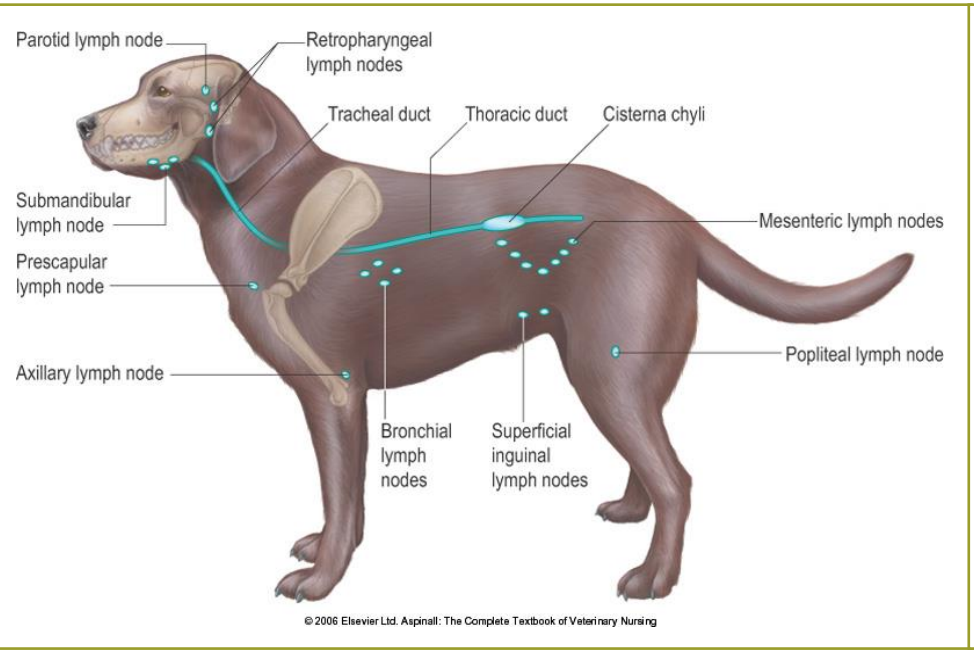
- Lymph vessels eventually join to form the thoracic duct that empties lymph into the vena cava just before it enters the heart
  - Lymph now called "chyle"
- Lymph vessels pass through at least one lymph node and pick up lymphocytes
- Any microorganisms in the lymph are removed by macrophages found in the lymph nodes

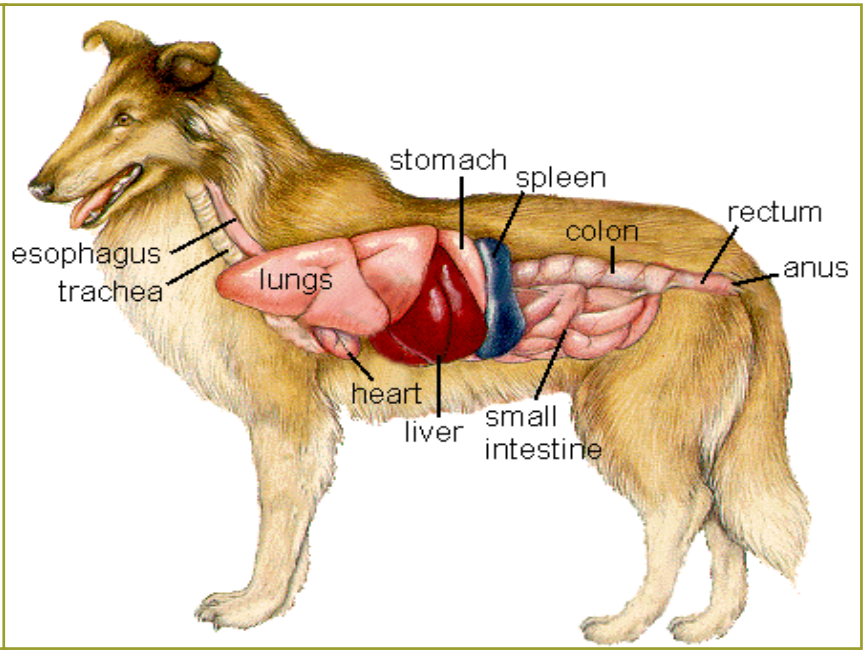
So What Does This Look Like? Trace a Drop of Lymph…….



Topic 19

Describe the structure and functions of the lymph nodes, spleen, thymus, tonsils

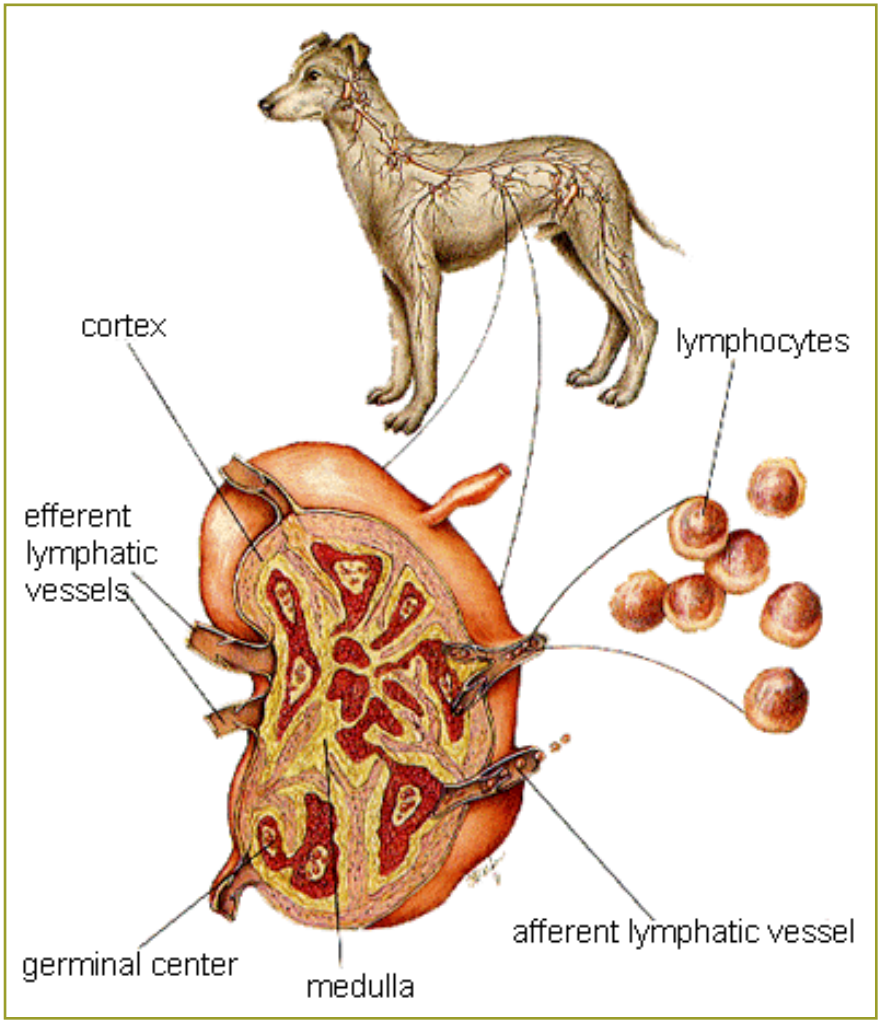




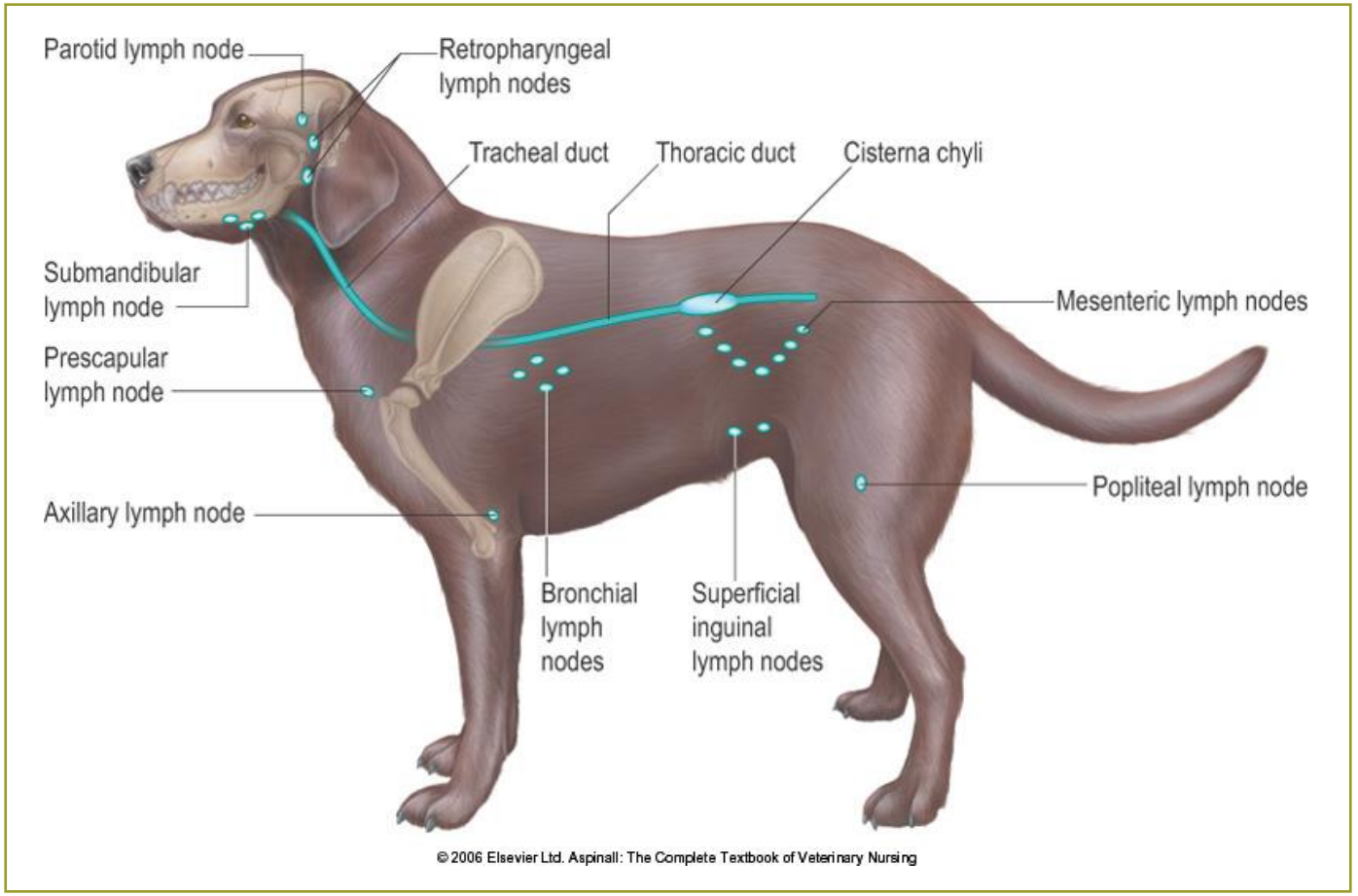
Lymph Nodes

Figure 9-9, Page 240

- Small kidney-shaped structures at various points along lymph vessels
- Lymph **filtration**
  - Cellular debris (cancer cells?)
  - Microorganisms
- Antibody production **(lymphocytes)**

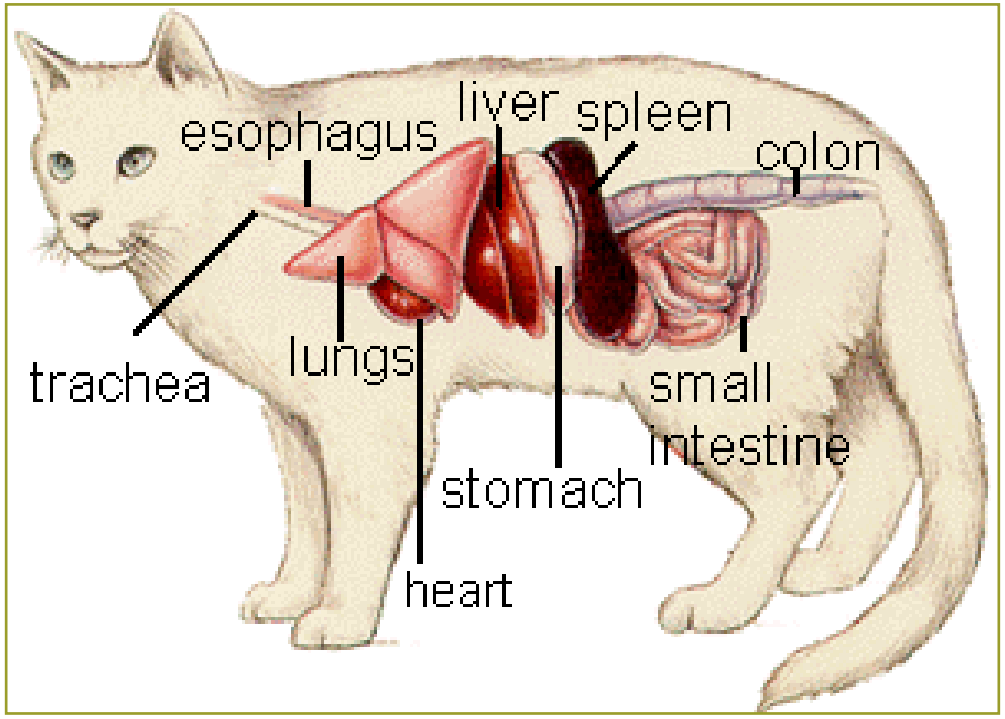


Lymph Nodes in the Dog



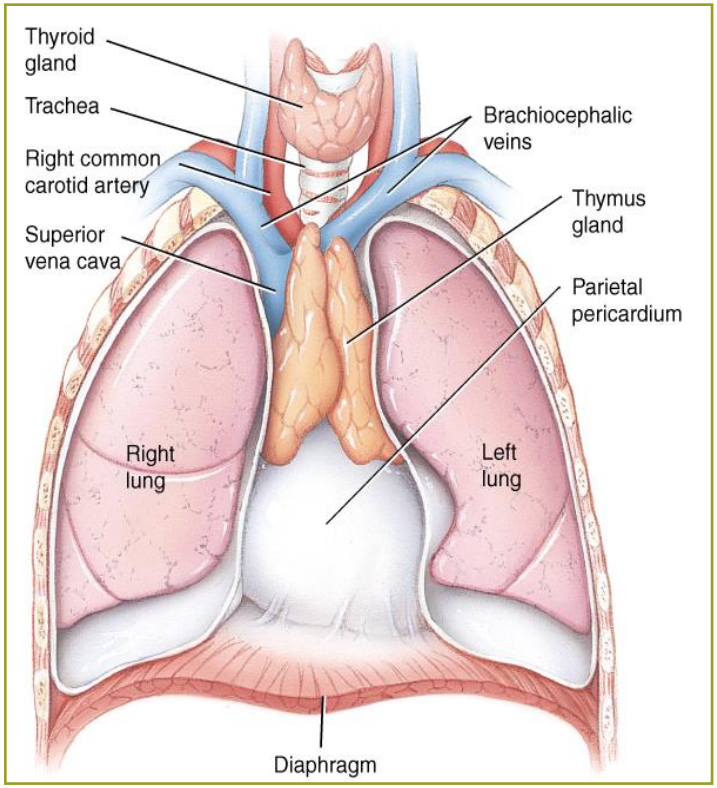
Spleen

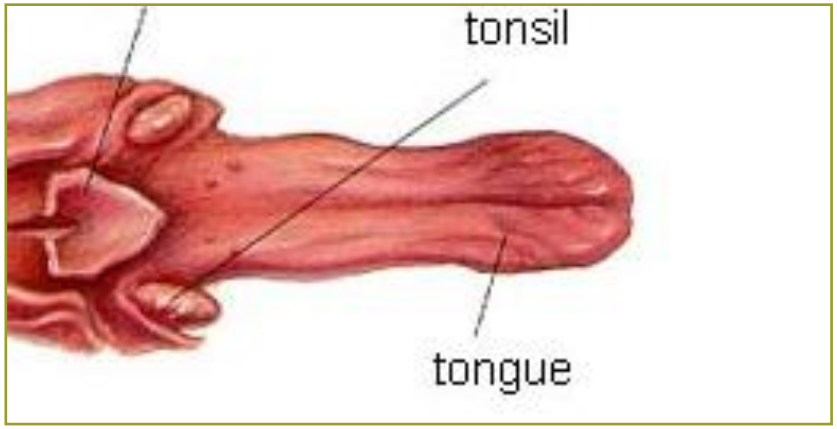
- Largest lymphoid organ
- **Storage of blood**
- **Lymphocyte cloning**
- Removal of old RBC's **(Secret of Life!)**

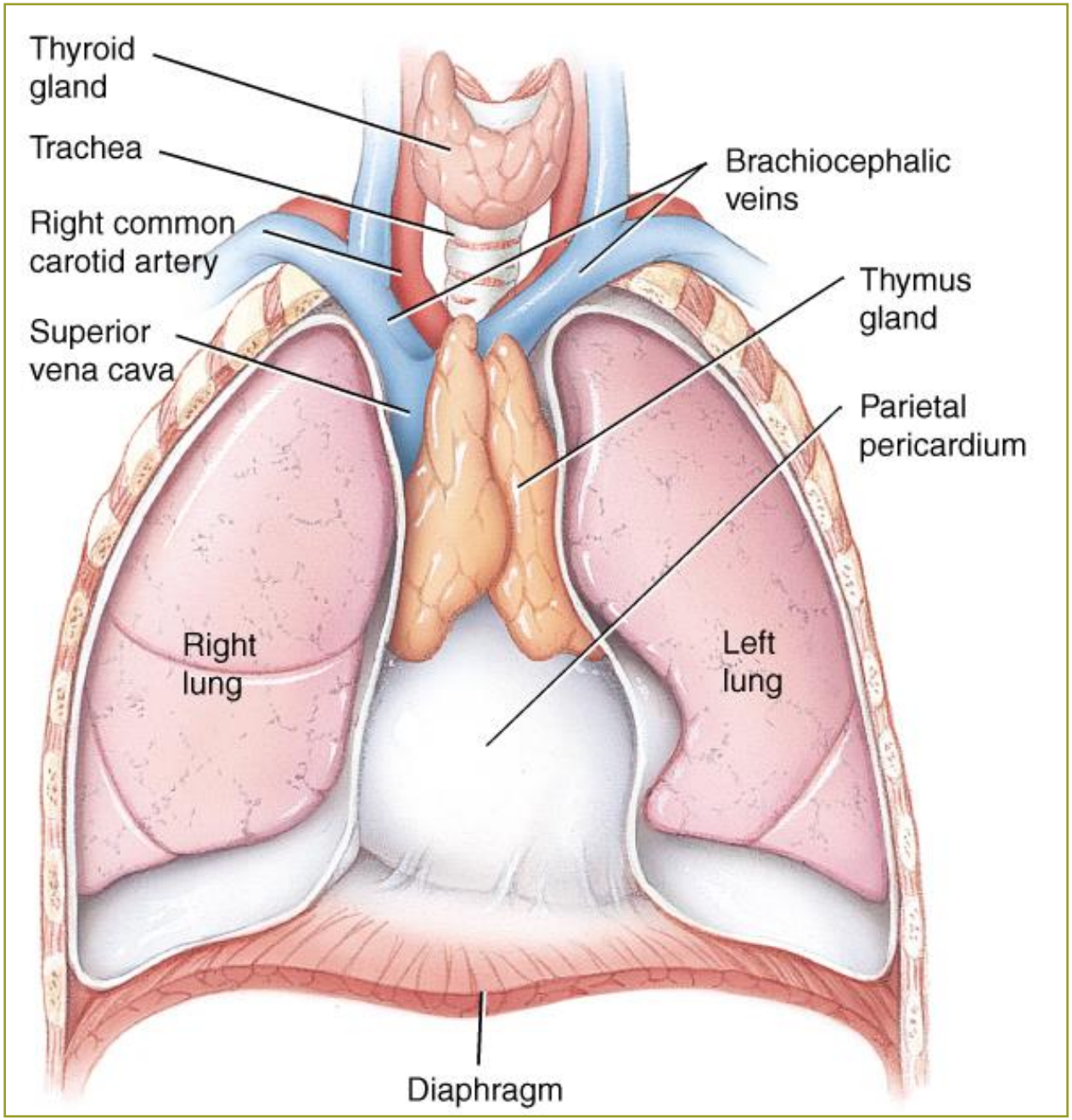


Thymus, Tonsils

- Thymus
  - Lymphoid organ in young animals
  - Ventral thorax near trachea
  - **T-cells** mature here
  - Atrophies with age
- Tonsils
  - Nodules of lymphoid tissue
  - Found close to mucosa, at beginning of lymph drainage
  - **Palatine tonsils**

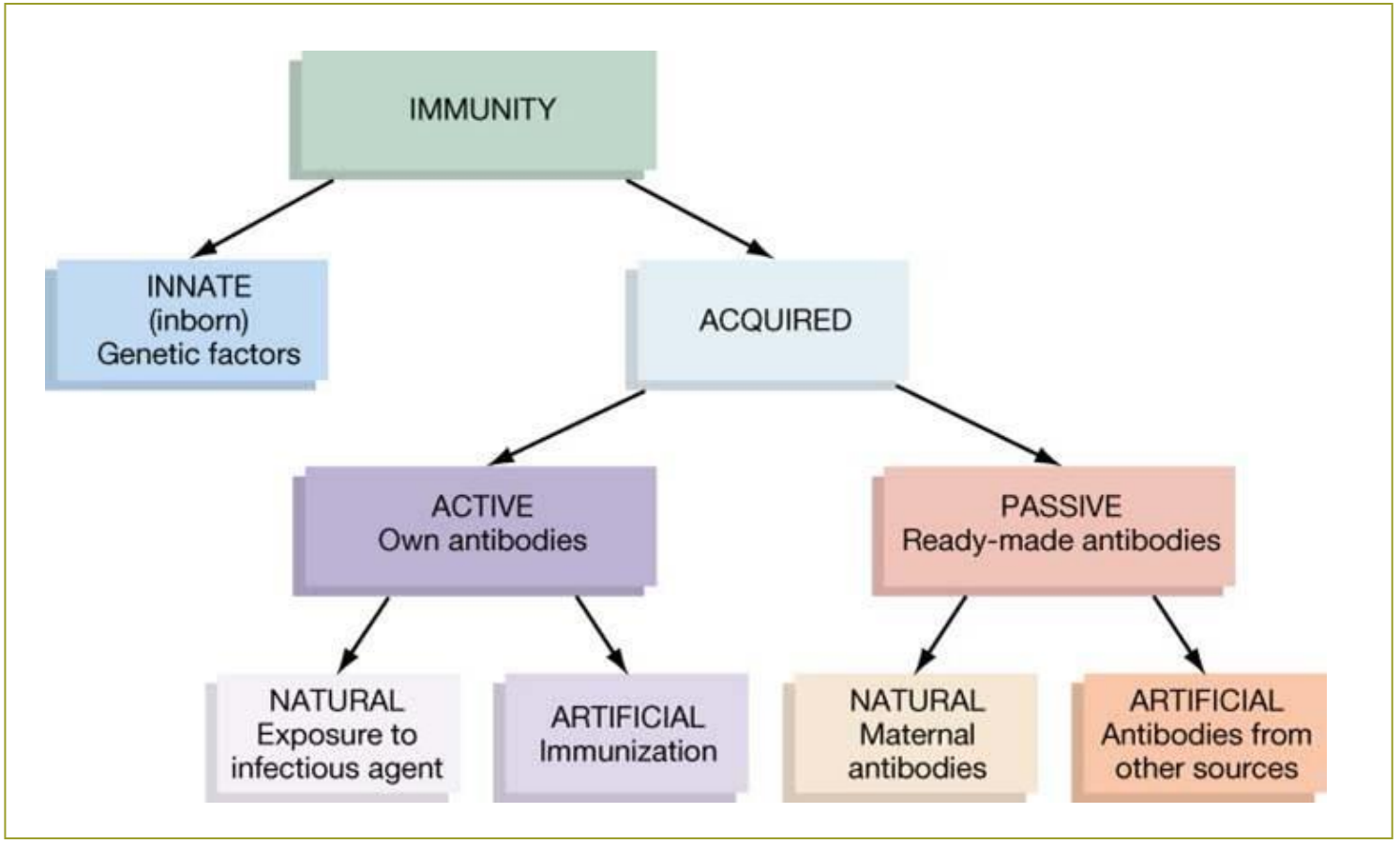





Thyroid gland
Trachea
Right common carotid artery
Superior vena cava
Brachiocephalic veins
Thymus gland
Parietal pericardium
Right lung
Left lung
Diaphragm

Topic 20

Define and list functions of the immune system



Immune System Definitions

- Immunology
- Immune system – protects animal body from infection by pathogens or antigens
- Immunity – immune reaction that helps fight pathogens & antigens
- Immunization – animal develops **specific immunity** to a particular pathogen or antigen
  - Natural or artificial

“Invader” Definitions

- **Pathogens** – disease-causing organisms
  - Viruses
  - Bacteria
  - Parasites, Fungi?
- **Antigens** – foreign proteins
  - From pathogens
  - From anything protein
  - From “self” (Autoimmune diseases)

Immune System Functions

- Protect animal from **pathogens**
- Recognize **antigens** that threaten health of animal
- Deals with
  - Infectious disease control and prevention
  - Cancer
  - Allergies

Types of Immunity

Innate Immunity

Non-innate (Acquired) Immunity

Body Lines of Defense

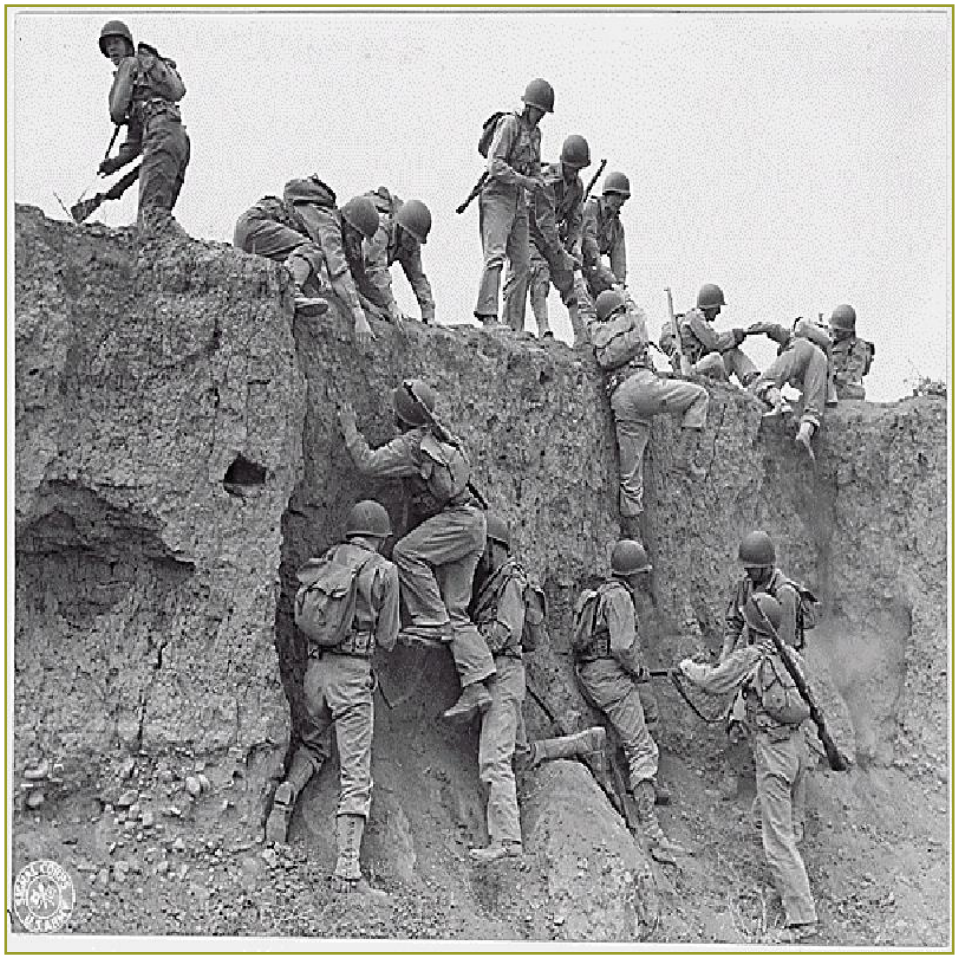
First Line of Defense (Innate – Barriers)

Second Line of Defense (Innate – Phagocytes)

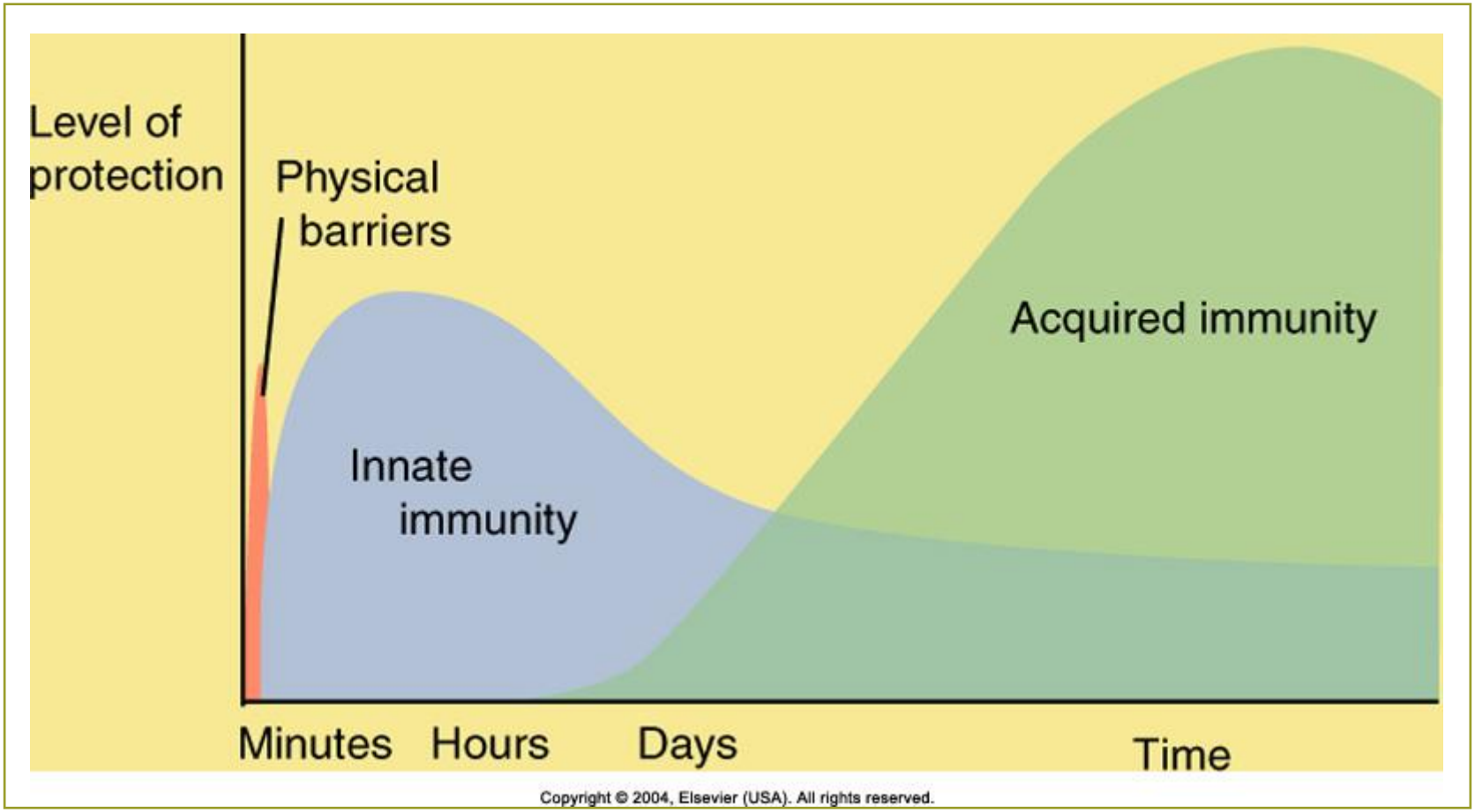
Third Line of Defense (Acquired – Specific Immune Response)

Lines of Defense in Animal's Body

- 1st line of defense – skin & mucosa, etc.
- 2nd line of defense – neutrophils & macrophages (**inflammatory** response)
- 3rd line of defense – lymphocytes (**immune** response)

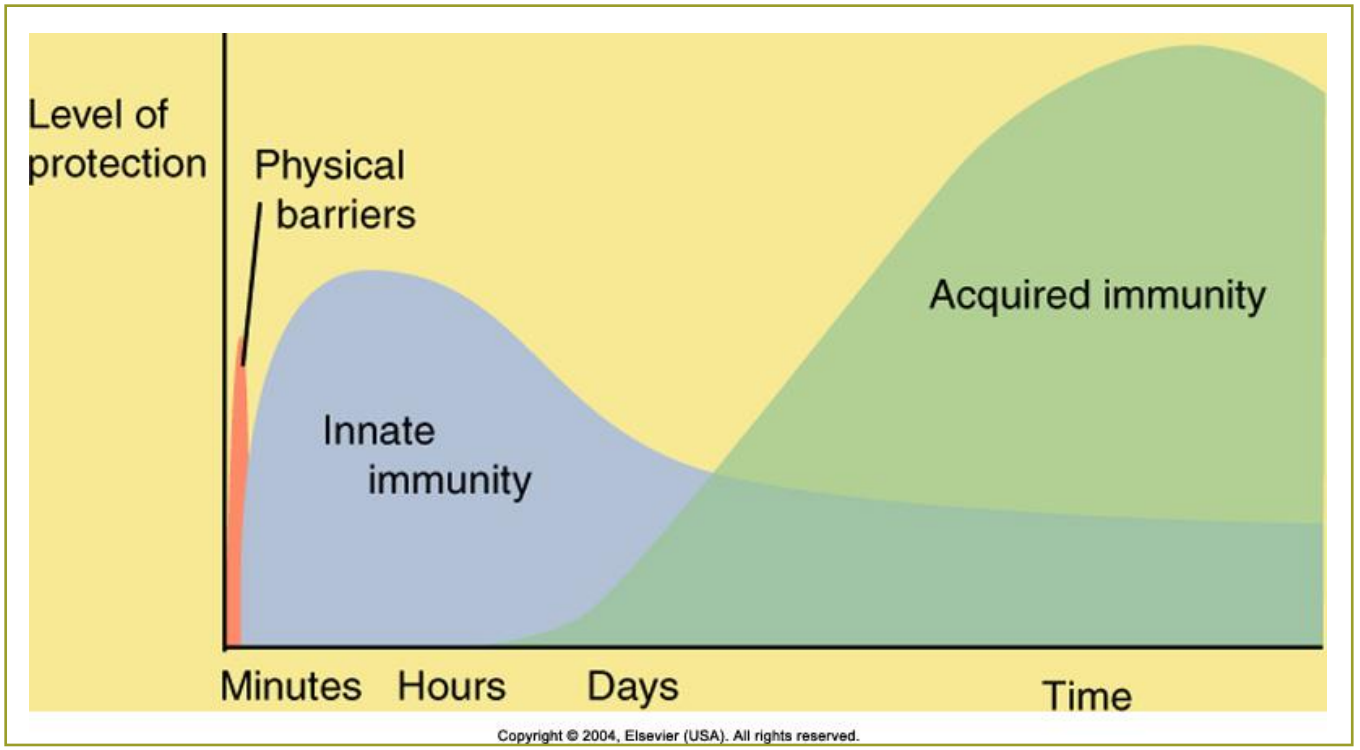


3 Lines of Defense



Topic 21

Compare specific and nonspecific immune reactions



Nonspecific Immunity – Innate

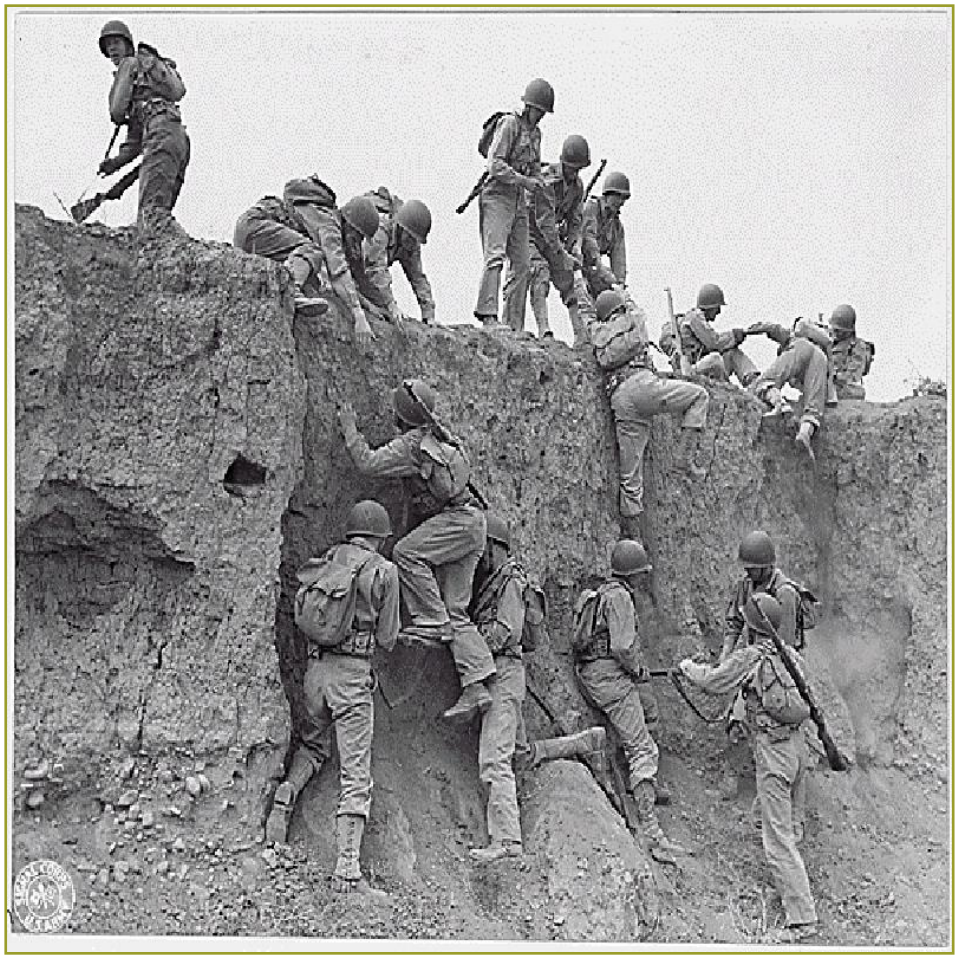
- First Line of Defense
  - Mechanical barriers – skin and mucous membranes
  - Chemical barriers (e.g., hydrochloric acid in the gastric mucosa)
- Second Line of Defense
  - Inflammatory response – tissue damage provokes release of chemical mediators (e.g., histamine) Phagocytosis by neutrophils, monocytes and tissue macrophages

Specific Immunity – Acquired

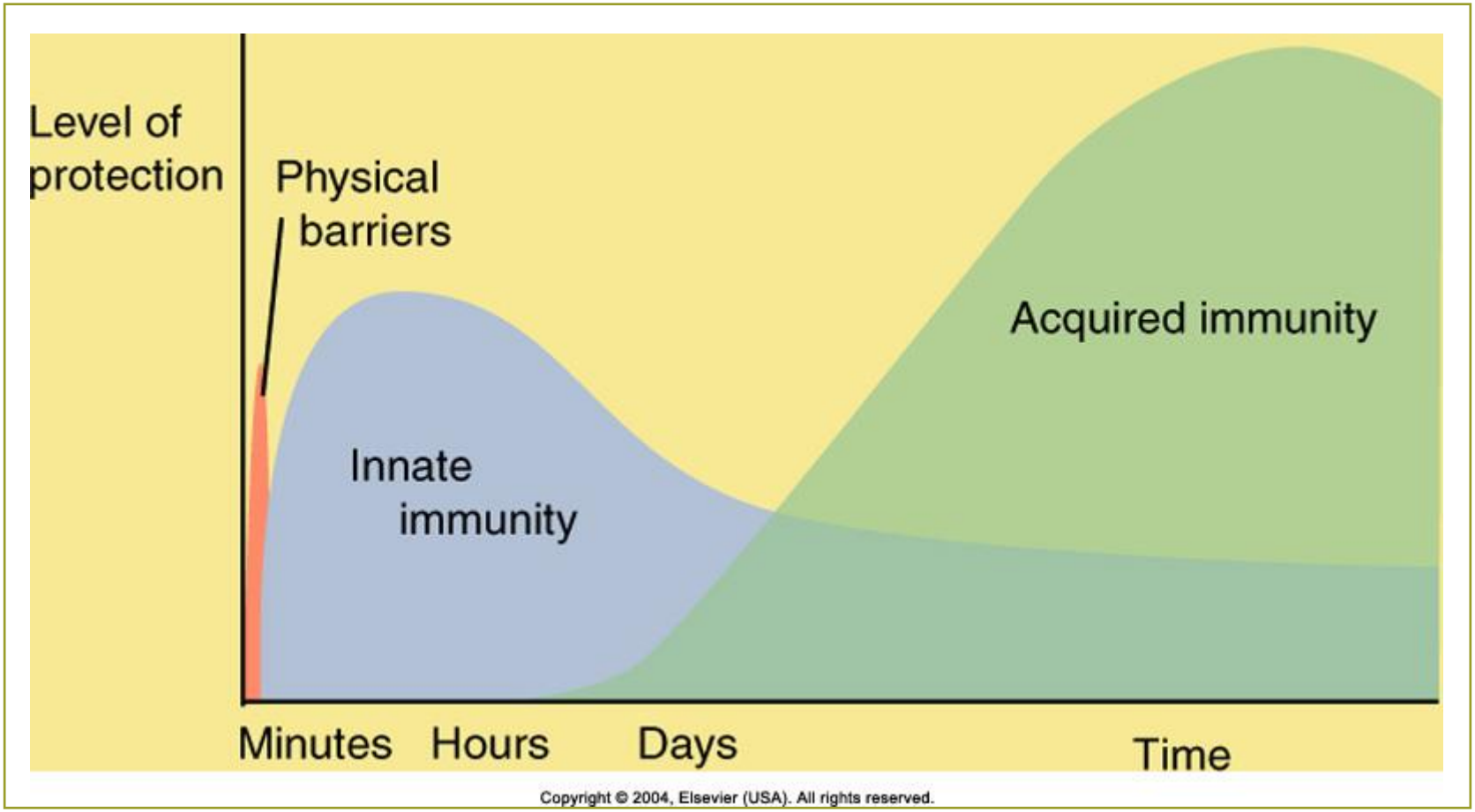
- Third Line of Defense
  - B lymphocytes that produce antibodies or direct other cells to attack the antigen
  - T lymphocytes that attack more directly

Lines of Defense in Animal's Body

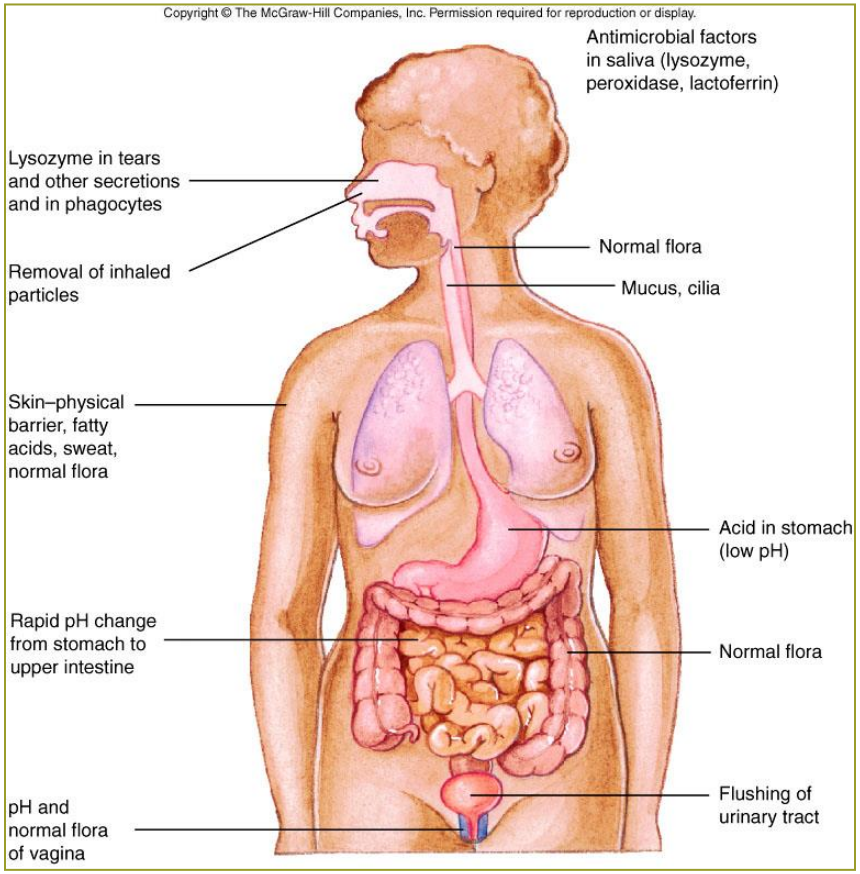
- 1st line of defense – skin & mucosa, etc.
- 2nd line of defense – neutrophils & macrophages (**inflammatory** response)
- 3rd line of defense – lymphocytes (**immune** response)



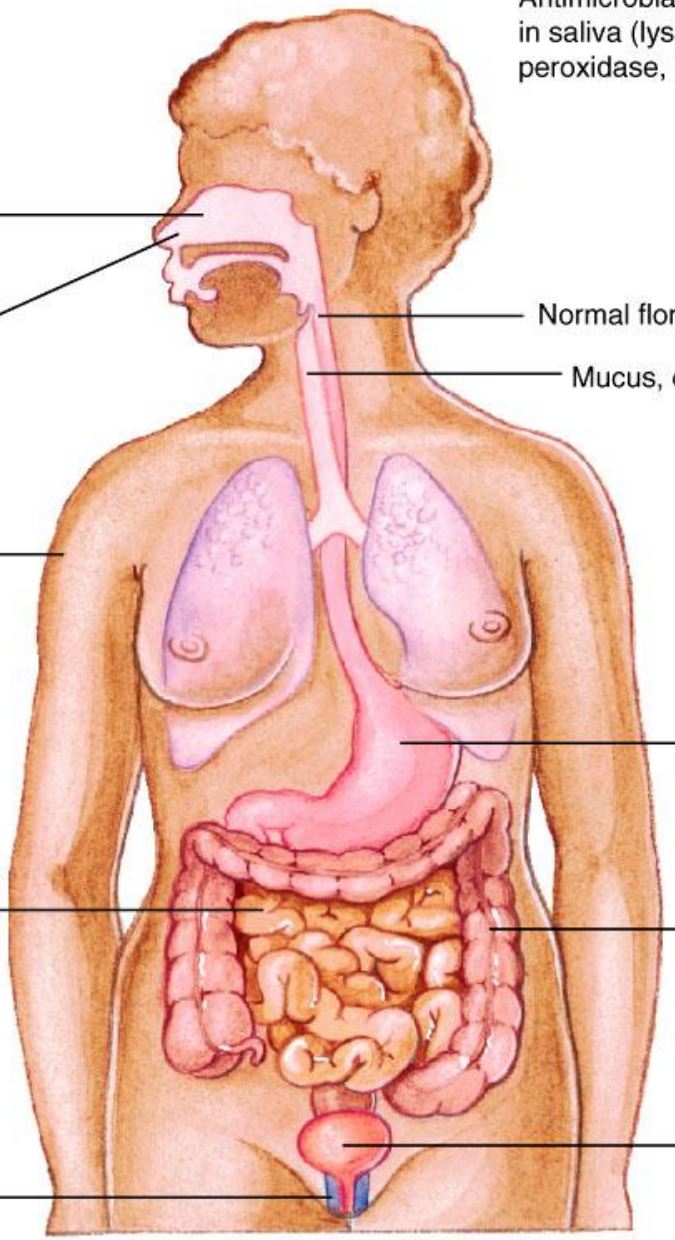
3 Lines of Defense

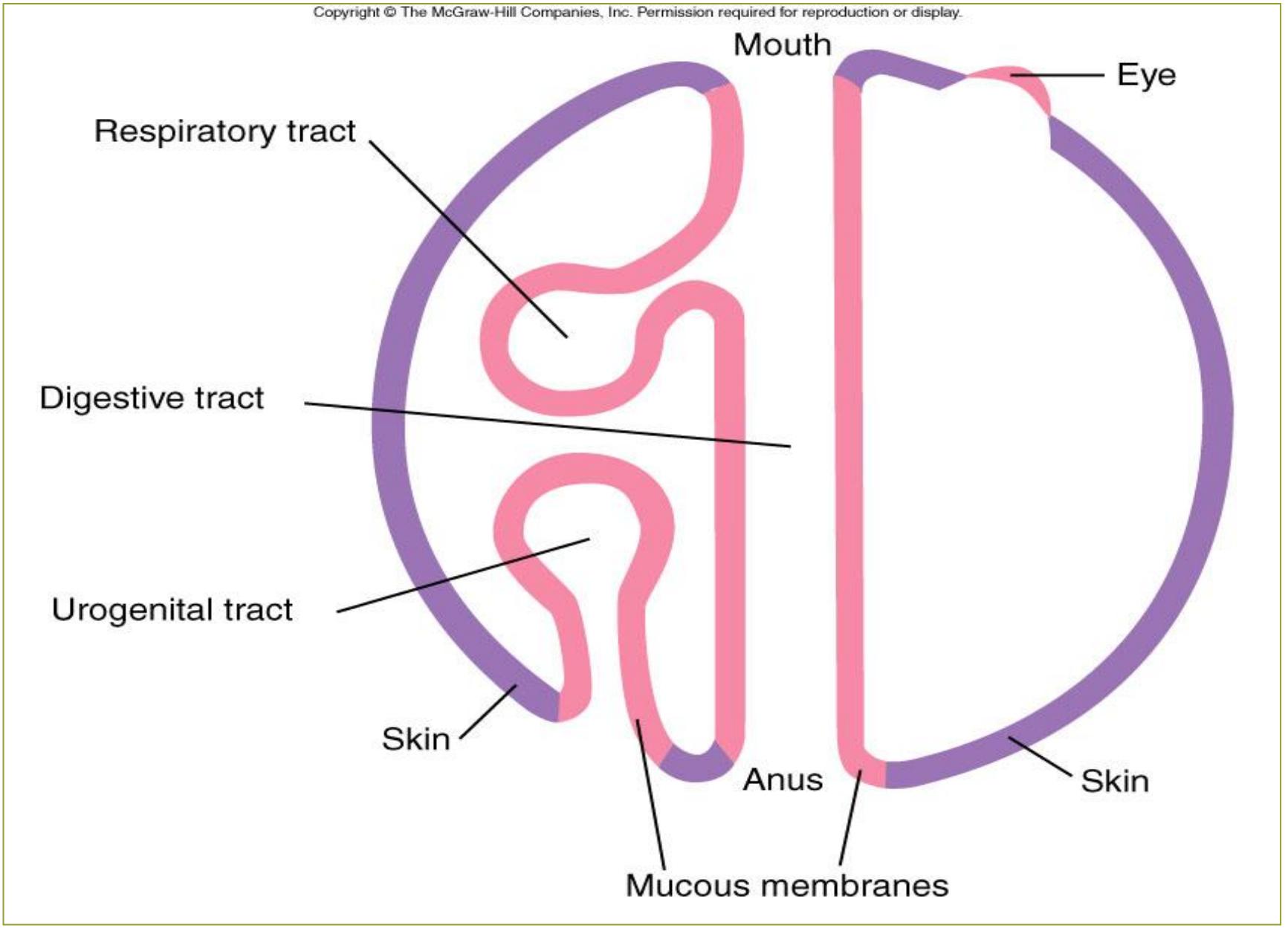


1st Line of Defense – Physical Barriers



- **Skin** is most visible barrier
- Covers majority of surfaces in obvious contact with environment
- **Mucous membranes** barrier that lines digestive tract, respiratory tract and genitourinary tract
  - Mucous protest these surfaces from infections

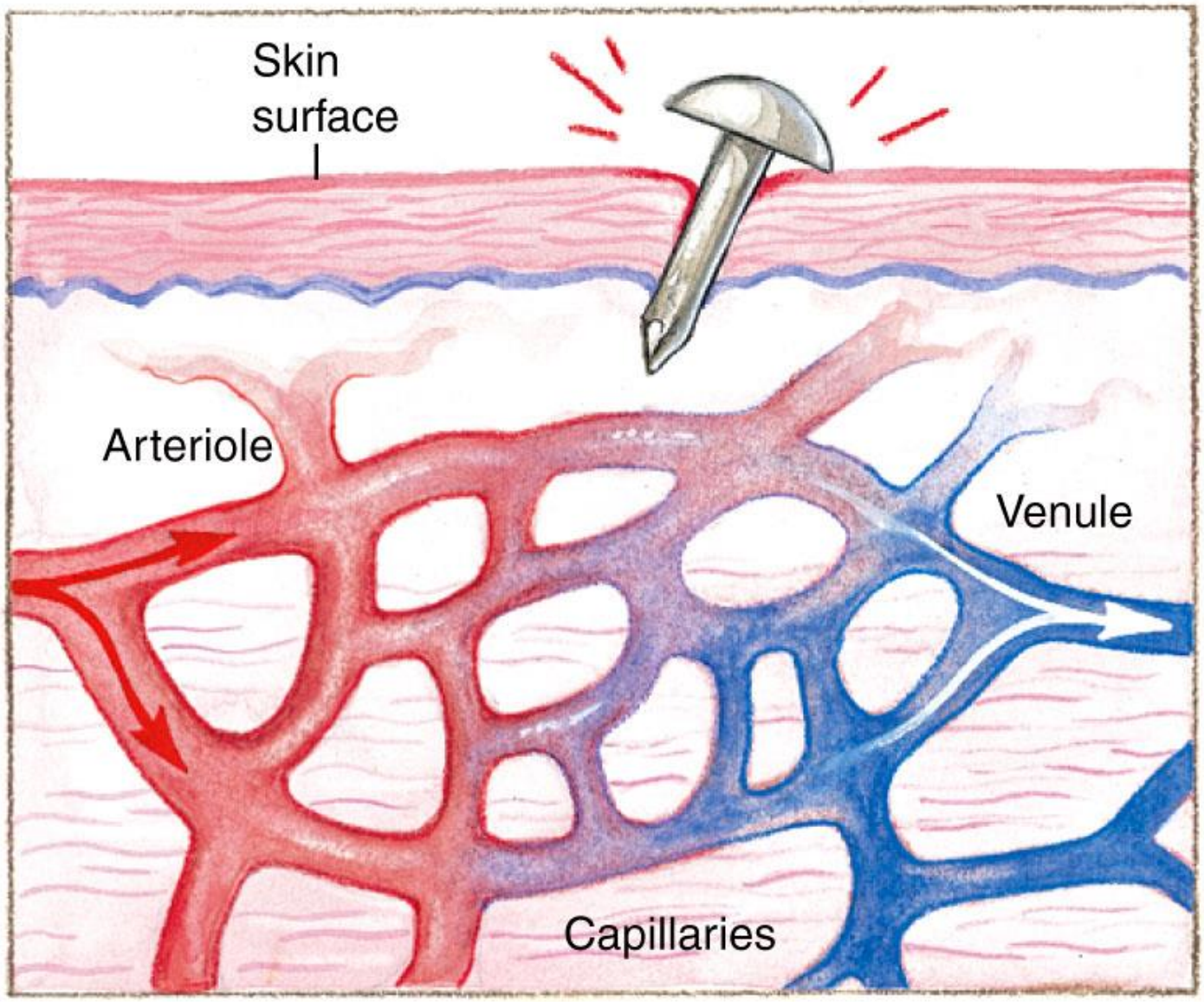




2nd Line of Defense– Phagocytes (Inflammatory Response)

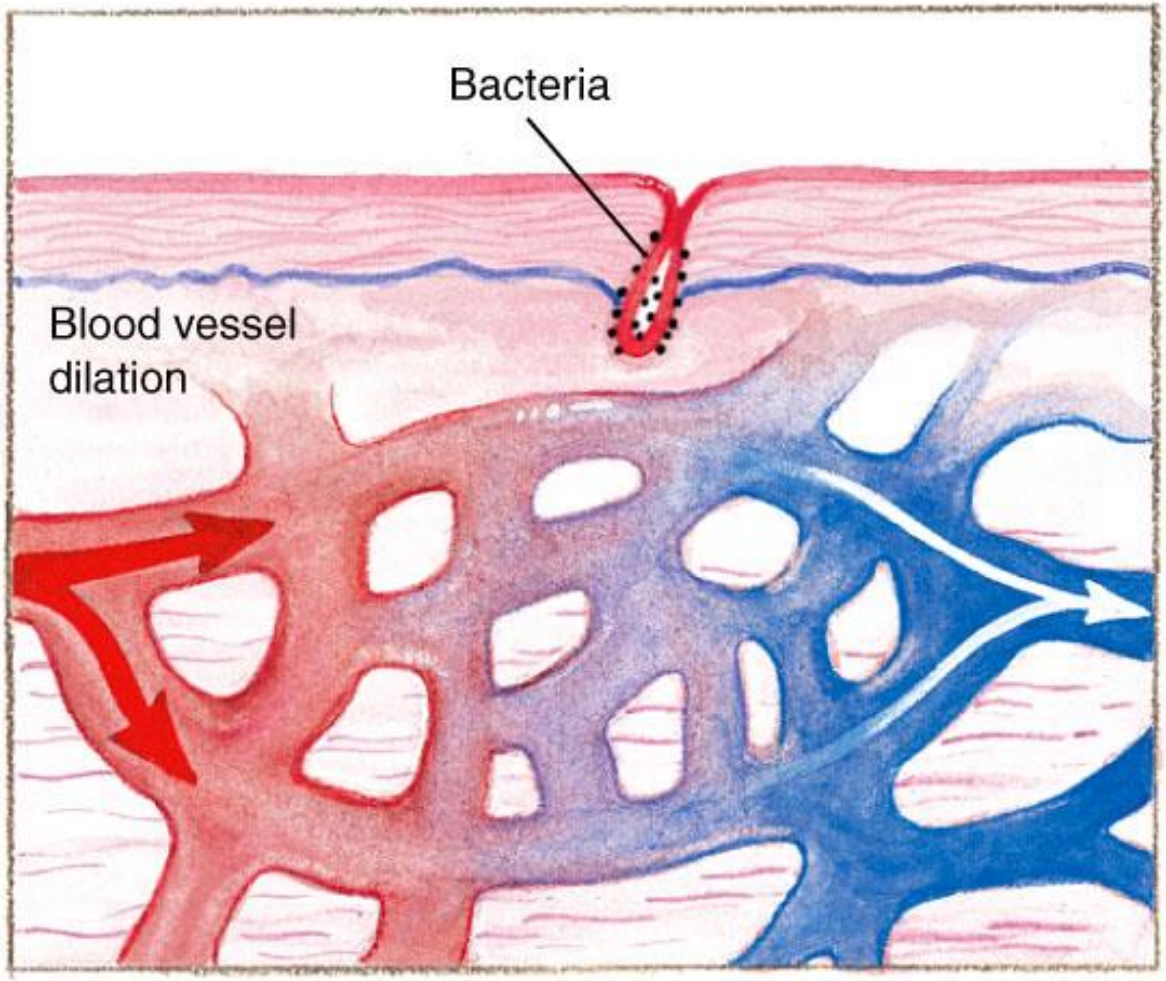
Neutrophils

Macrophages



(a) Normal blood flow in the tissues as injury occurs

- Microbial products
- Microbes
- Tissue damage



(b) Substances released cause dilation of small blood vessels and increased blood flow in the immediate area.

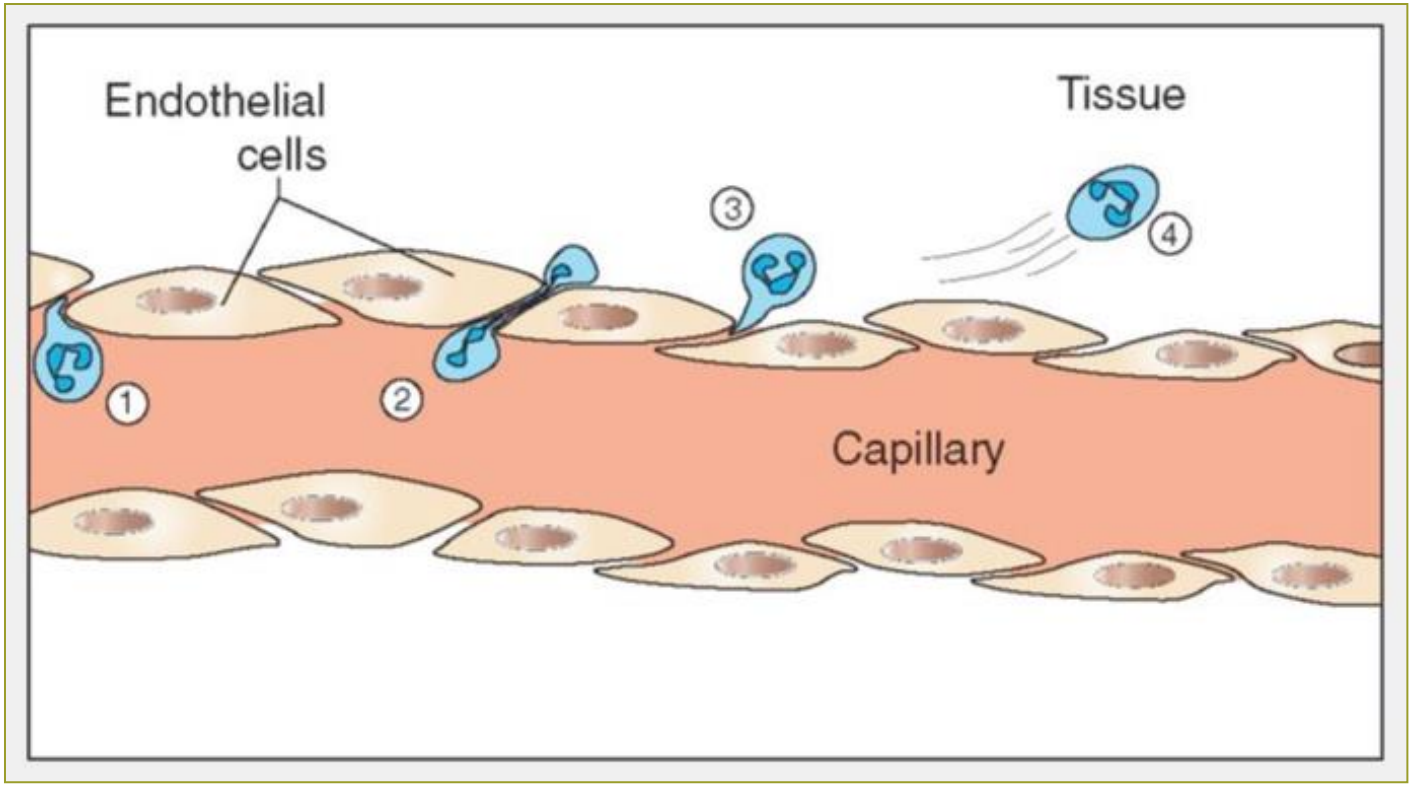
Neutrophil Characteristics

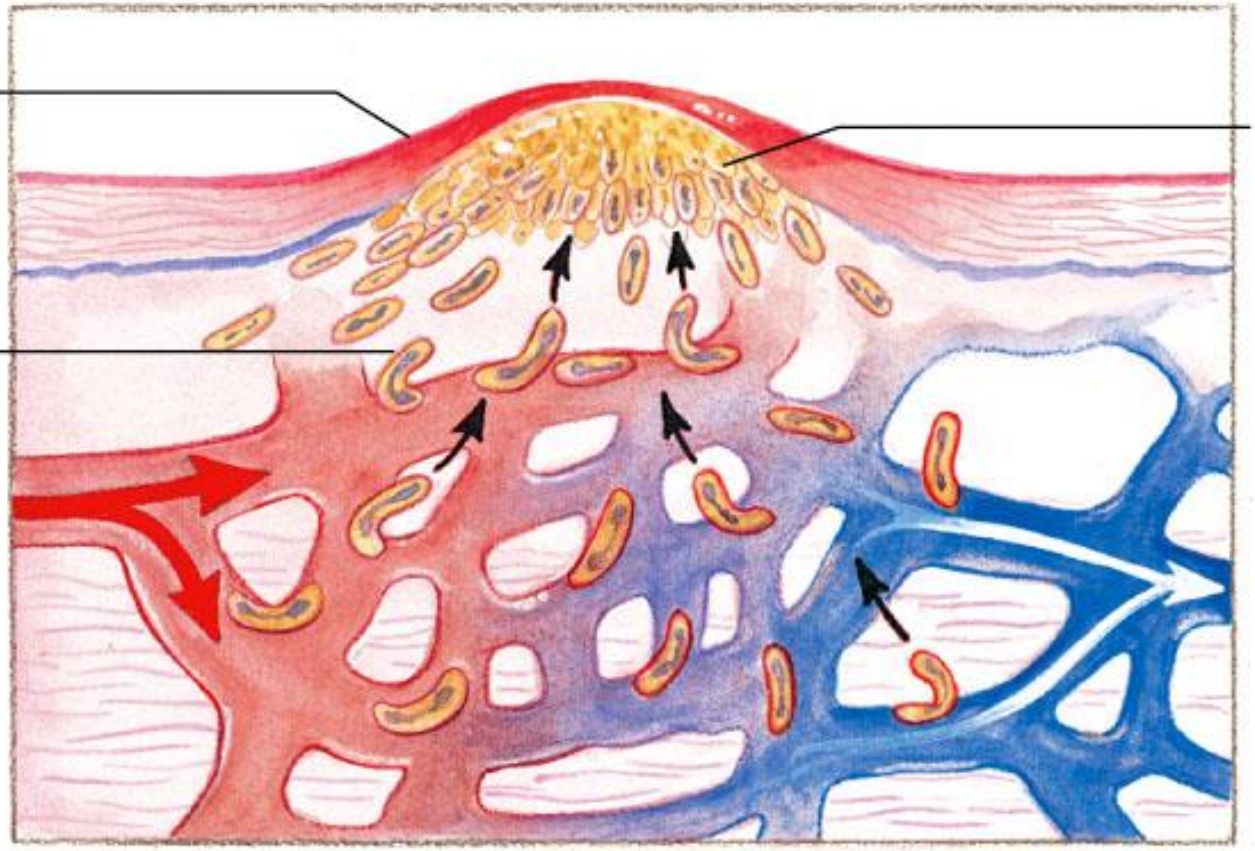
- In peripheral circulation for about 10 hours
- Part of 2nd Line of Defense in animal body
- Diapedesis – process used by neutrophils to go from circulation into tissue spaces
- Chemotaxis – process that attracts neutrophils to inflammatory chemicals at a site of infection

Neutrophil Diapedesis

Figure 9-5, Page 234

Figure 9-5 **Diapedesis. 1**, Neutrophil lying against vessel wall begins to squeeze through the space between endothelial cells by flowing into pseudopod (false foot). **2**, Pseudopod continues to push its way between cells. Rest of the cell cytoplasm flows along with it. **3**, Pseudopod and the rest of the cell emerge on tissue side of blood vessel. **4**, Neutrophil is off in search of foreign invaders to phagocytize.



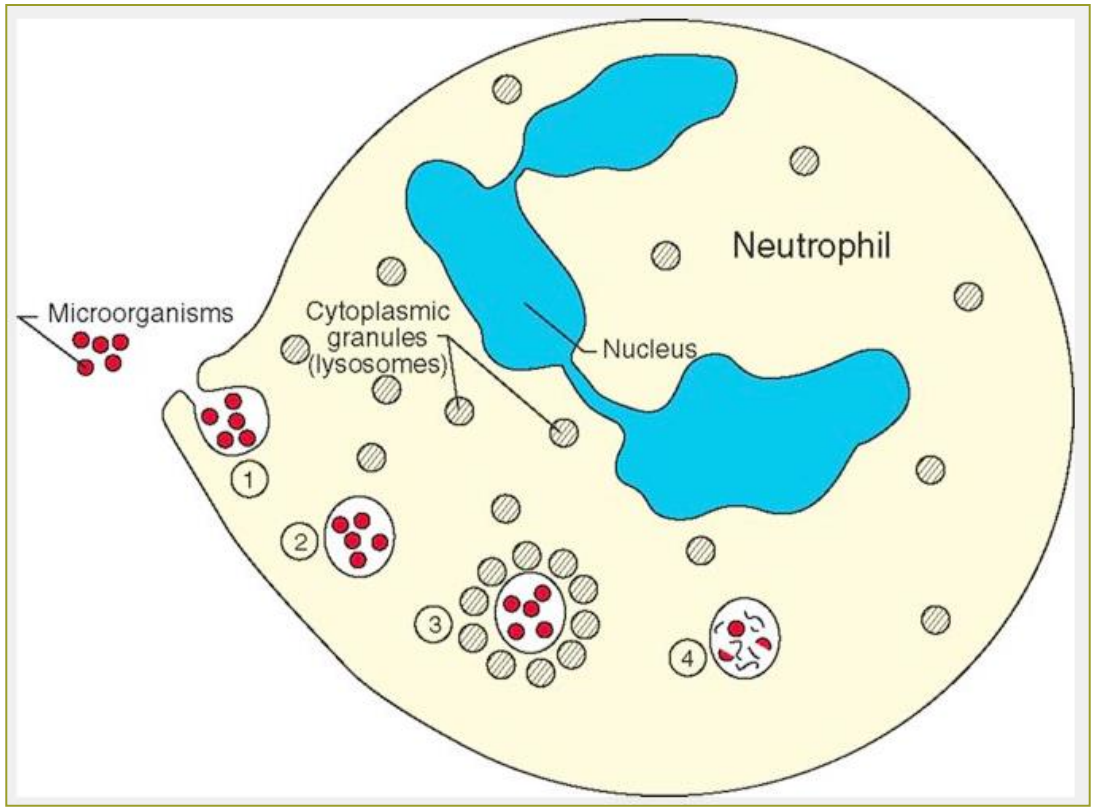


(d) The attraction of phagocytes causes them to move to the site of damage and inflammation. Collections of dead phagocytes and tissue debris make up the pus often found at sites of an active inflammatory response.

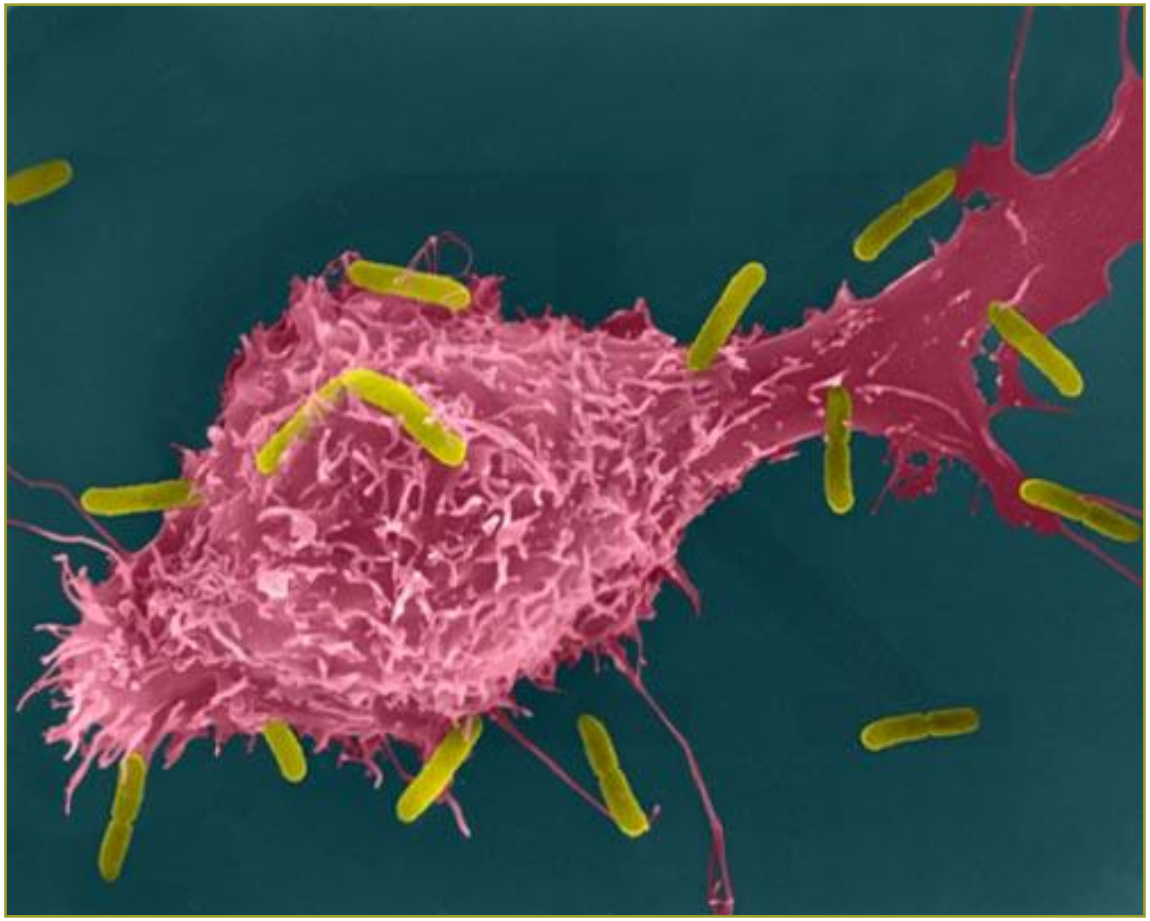
Neutrophil Phagocytosis

Figure 9-6, Page 234

Figure 9-6 **Phagocytosis and destruction of microorganisms. 1**, Neutrophil membrane engulfs microorganisms. **2**, Phagocytic vacuole is formed. **3**, Cytoplasmic granules (lysosomes) line up around phagocytic vacuole and empty their digestive enzymes into vacuole. **4**, Microorganisms are destroyed.



Macrophage Attacking *E.coli*



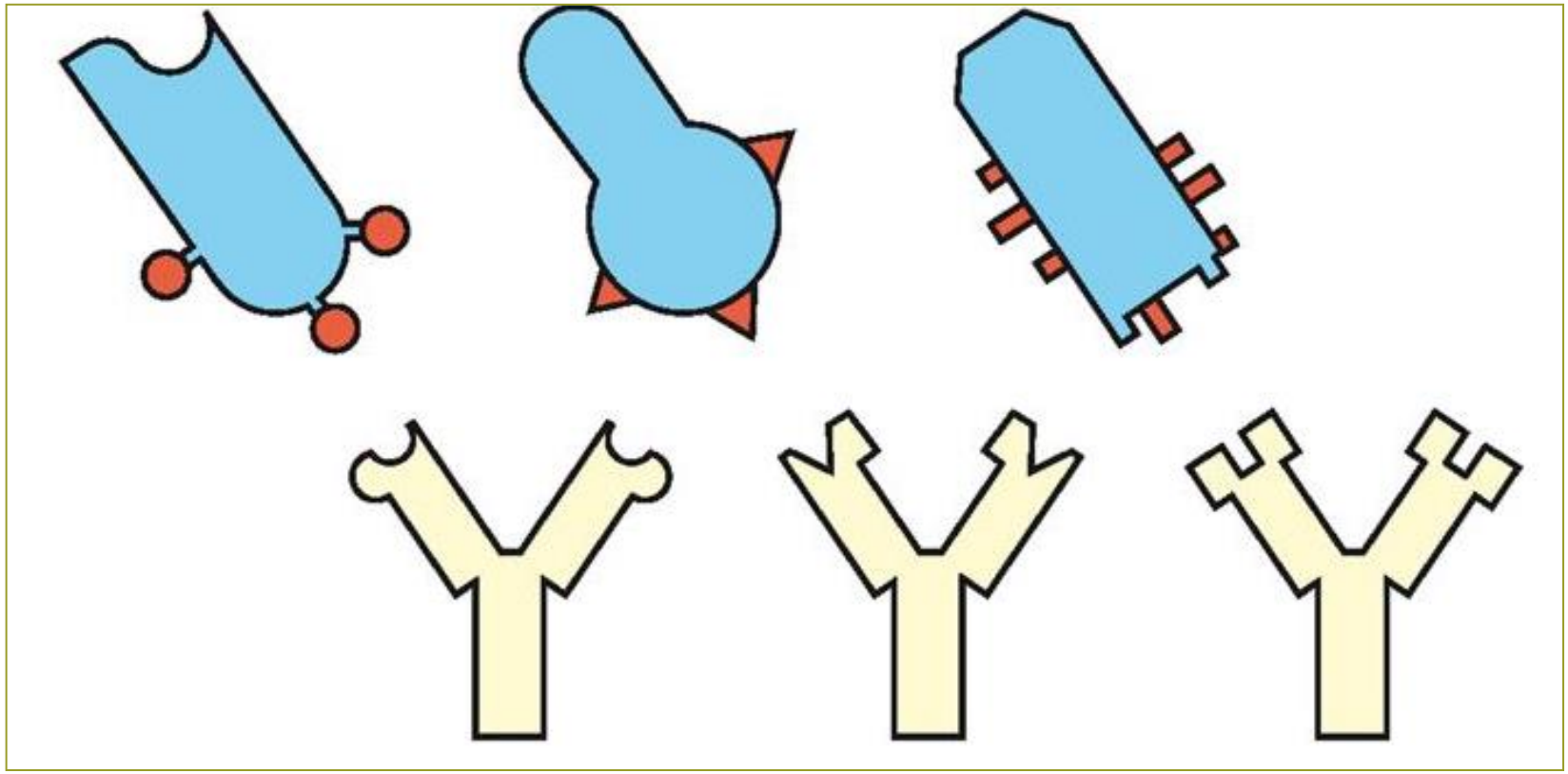
3rd Line of Defense – Lymphocytes Acquired Immunity

B-Lymphocytes

T-Lymphocytes

Topic 22

Compare cell-mediated and humoral (antibody) immunity



3rd Line of Defense – Lymphocytes Acquired Immunity

B-Lymphocytes

T-Lymphocytes

Immune System You Tubes!

http://www.youtube.com/watch?v=4kNsYa20EJU&NR=1
The Immune Response (AWESOME!)

http://www.youtube.com/watch?v=cL9KY_ECzfo&feature=related
Pathogen Recognition

http://www.youtube.com/watch?v=lrYlZJiuf18&NR=1
Antibody Immune Response

http://www.youtube.com/watch?v=1tBOmGoQMbA&feature=related
Cell Mediated Immune (CMI) Response

Lymphocyte Characteristics

- 2 types
  - B-lymphocytes – antibody formation
  - T-lymphocytes – “killer” cells
- Part of **3rd Line of Defense** in animal body
- Memory cells

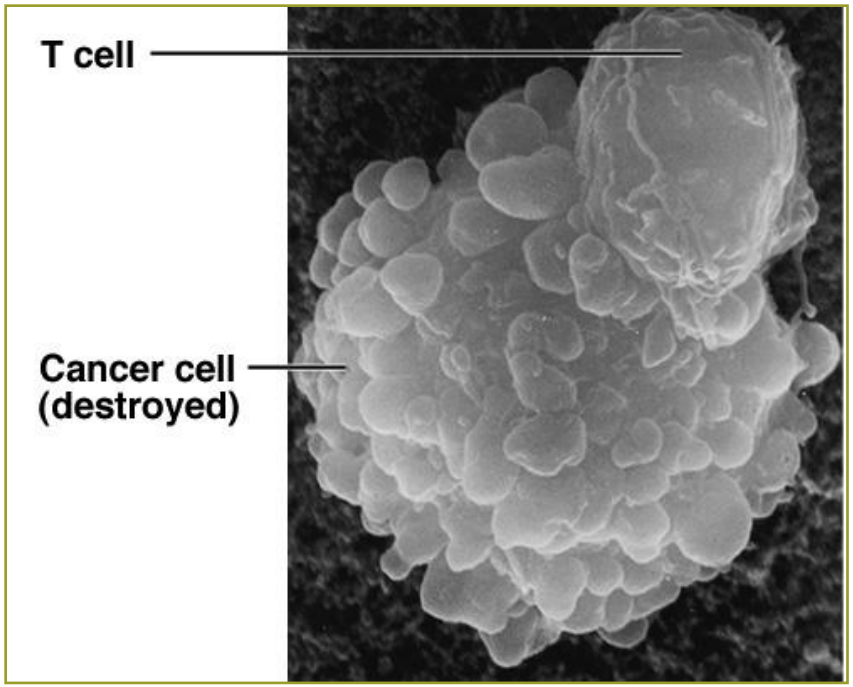
Types of Acquired Immunity

Cell Mediated Immunity (CMI)

Humoral Immunity (Antibodies)

Cell Mediated Immunity (CMI)

- T-lymphocytes
  - Circulate in blood and lymph
  - Attach to antigen or foreign cells
  - Attack and destroy foreign cells and diseased host cells
  - Memory cells
  - Delayed hypersensitivity



Examples of Cell Mediated Immunity

- TB testing
- Allergy testing

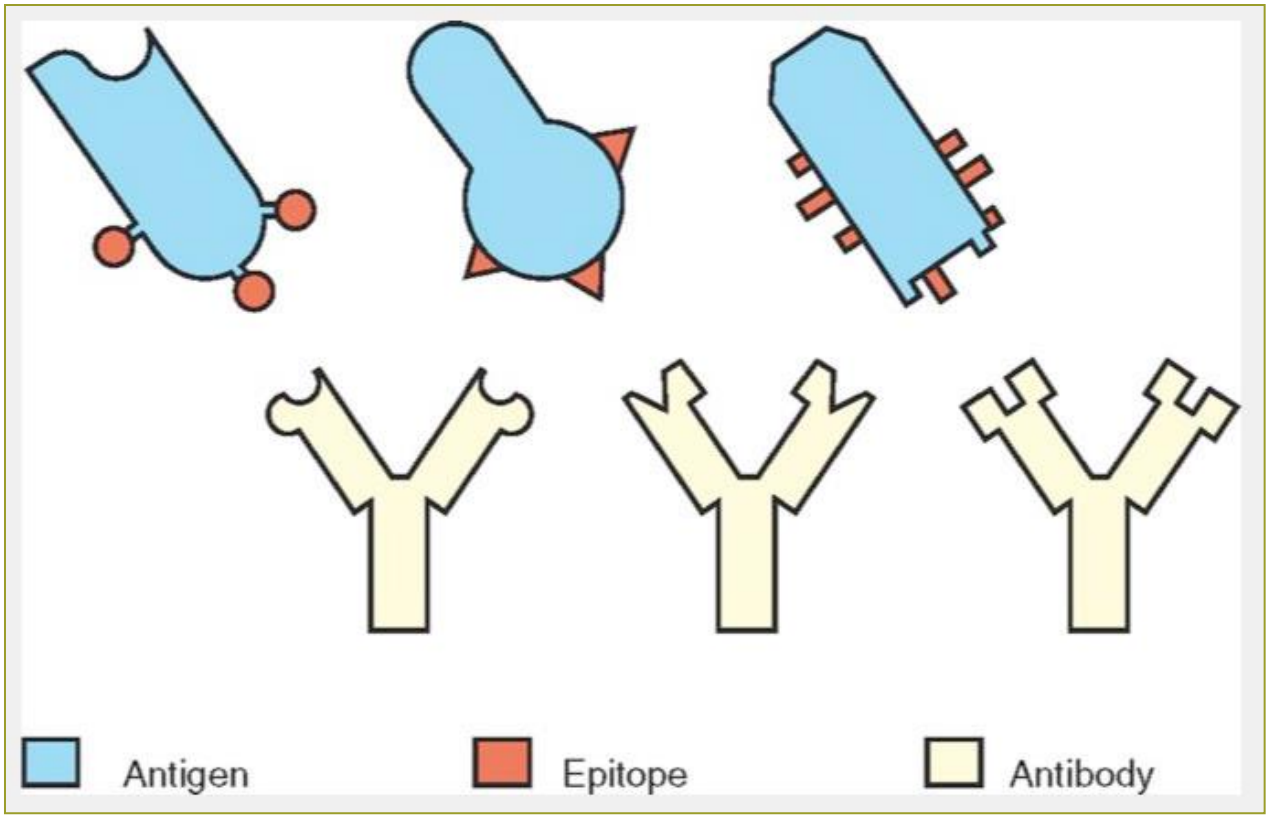
Humoral Immunity (Antibodies)

- B-lymphocytes transform into plasma cells
  - Produce antibodies (immunoglobulins) to specific antigens
  - Stay in lymphocytes, send antibodies into bloodstream
  - Memory cells
- Immediate hypersensitivity

Antigens and Antibodies

Figure 9-7, Page 238

Figure 9-7 **Antigens and antibodies.** Every antigen has a uniquely shaped epitope on its cell membrane that will fit into a combining shape on an antibody.

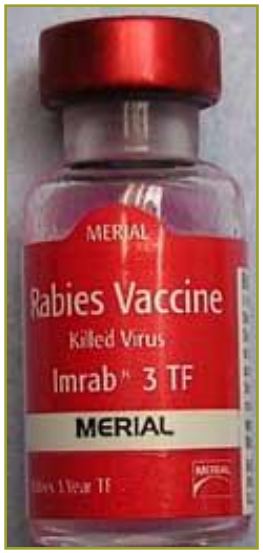


Types of Antibodies Immunoglobulins (Ig)

- IgM - first Ig made during first exposure to an antigen
- IgG - made when animal exposed to an antigen for a long time or when exposed to the antigen for the second time; can cross the placenta
- IgA - can leave blood and enter tissue fluids; plays a role in protecting mucosal surfaces (e.g., intestinal tract and lungs)
- IgE - associated with an allergic response
- IgD - function is unknown

Examples of Humoral Immunity

- Vaccines
- Tetanus Toxoid injections



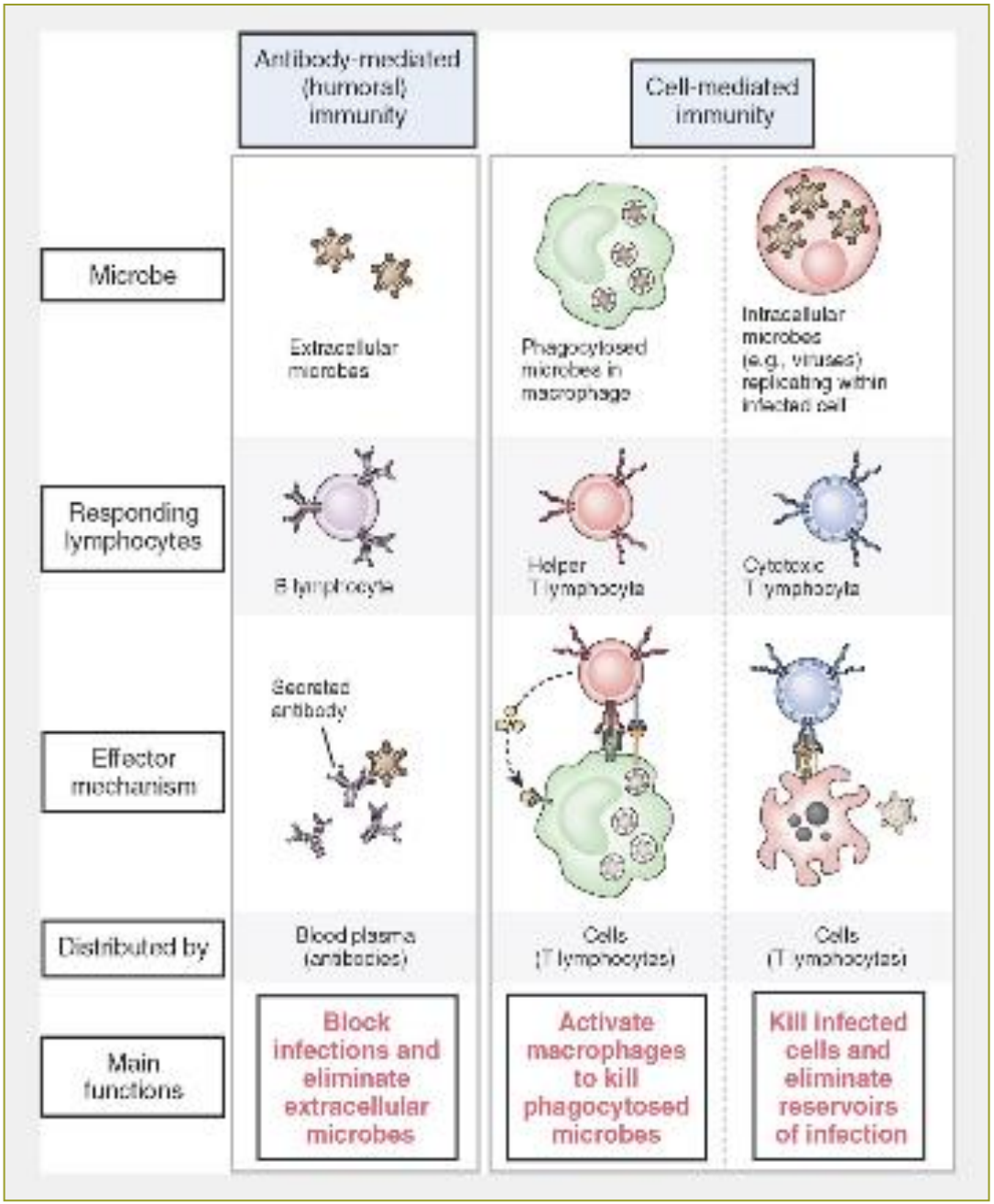
Humoral versus CMI

Table 9-3, Page 243

	Humoral Immune Response	Cell-Mediated Immune Response
Cell type involved	B cell that transforms into a plasma cell after antigenic stimulation	T lymphocyte that transforms into cytotoxic T cell, helper T cell or supressor T cell after antigenic stimulation
Substance produced	Immunoglobulins (antibodies)	Lymphokines
Cellular mobility	B cells and plasma cells stay in the lymphoid tissue. Antibodies are released into plasma.	T cells can enter circulation and travel to the site where an antigen entered the body
Memory cells produced?	Yes	Yes

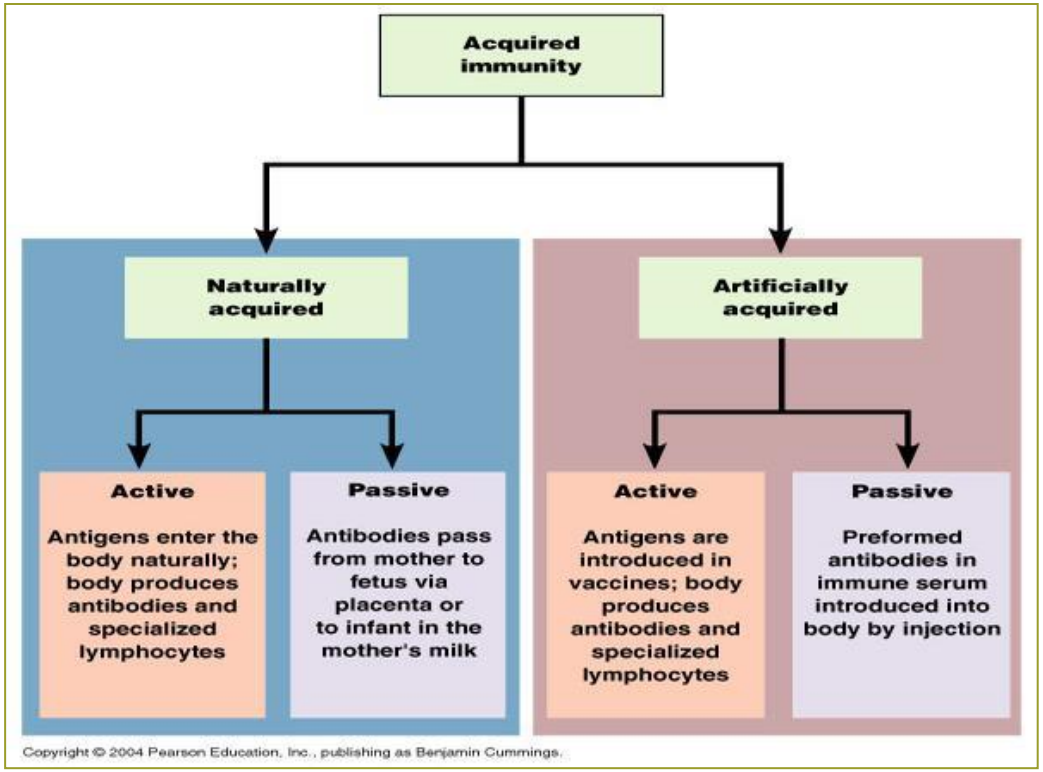
Humoral versus CMI Immunity

Figure 9-12, Page 244



Topic 23

Differentiate between acquired active and passive immunity



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- IgA – can leave blood and enter tissue fluids; plays a role in protecting **mucosal surfaces** (e.g., intestinal tract and lungs)
- IgE – associated with an **allergic response**
- IgD – function is unknown

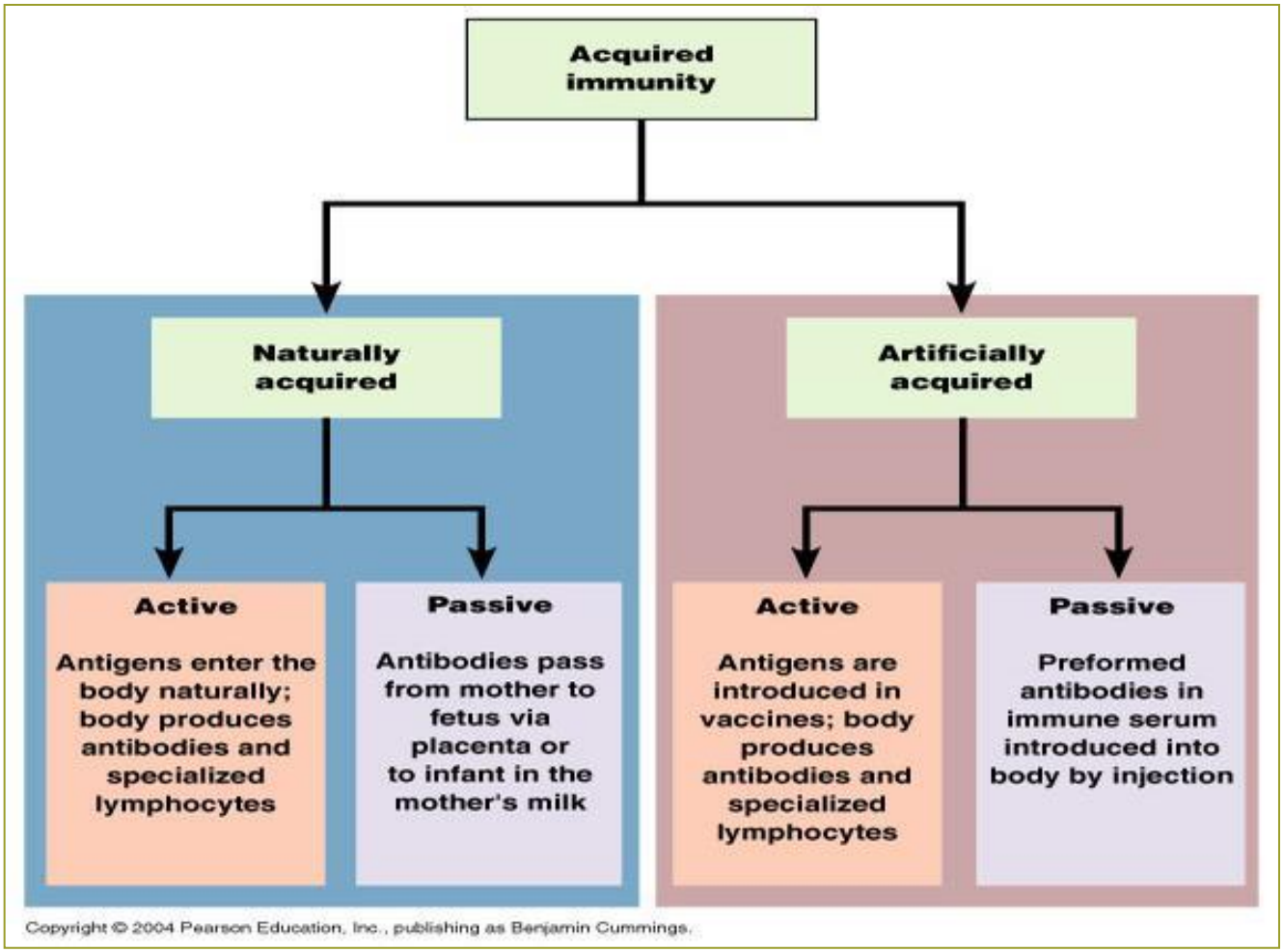
Passive Immunity – Temporary Immunity

- Animal receives preformed antibodies
  - Antibodies produced by a mother that are passed to a fetus transplacentally
  - Ingestion of colostrum (antibody-rich first milk produced)
  - Antibodies produced by another animal and given to a sick animal (e.g., administration of tetanus antitoxin)
- No memory cells produced

Active Immunity – Permanent Immunity

- Exposure to antigen that triggers animal's own immune response
- Memory T or B cells are produced
- Immunization – activate animal's own immune systems
  - Vaccines contain epitope of the antigens
  - Killed or live-but-weakened (attenuated) antigens

The Big Picture of This! ☺



Types of Immunity

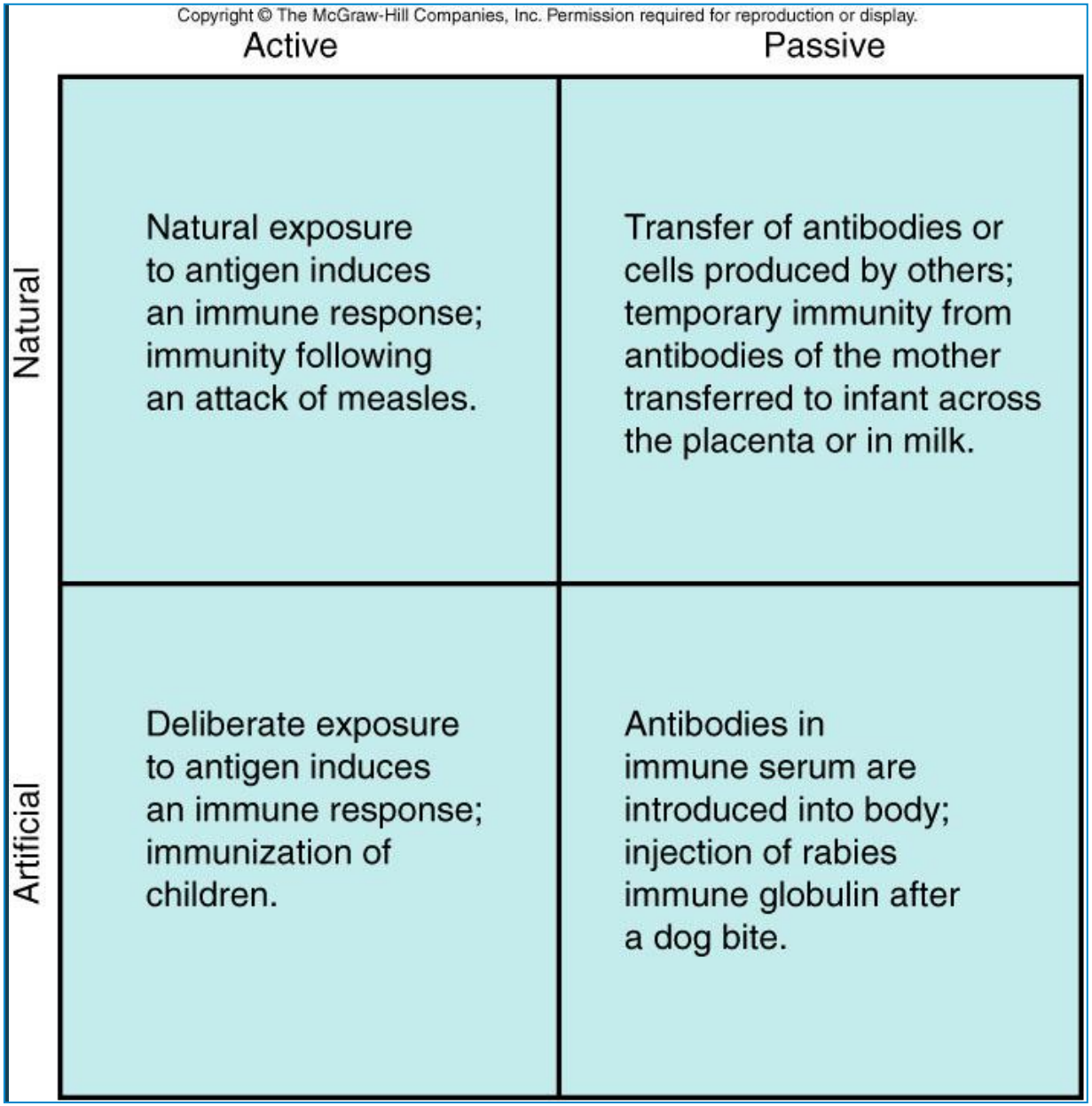
Active (Developed)

Passive (“Borrowed”)

Principles of Immunity

	Active	Passive
Natural	Natural exposure to antigen induces an immune response; immunity following an attack of measles.	Transfer of antibodies or cells produced by others; temporary immunity from antibodies of the mother transferred to infant across the placenta or in milk.
Artificial	Deliberate exposure to antigen induces an immune response; immunization of children.	Antibodies in immune serum are introduced into body; injection of rabies immune globulin after a dog bite.

- **Naturally acquired** immunity is acquisition of adaptive immunity through natural events
- Immunization mimics these events by inducing **artificially acquired immunity**
- Natural or artificial immunity can be divided into
  - Active immunity
  - Passive immunity

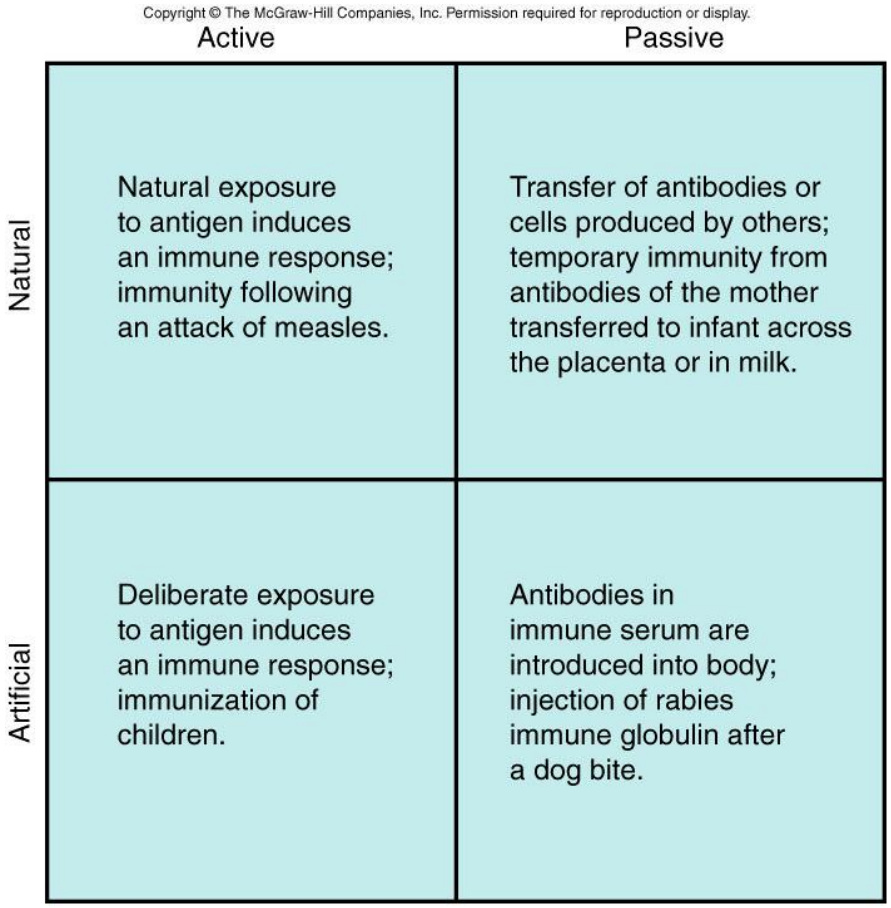


Active Immunity

- Antibodies made by animal
  (Secret of Life!!– Get Tough or Die!!)
- Long-acting
- Memory cells
- Examples
  - Disease itself
  - Vaccines
  - Tetanus toxoid

Active Immunity

- Result from immune response upon exposure to an antigen
- Active immunity can develop **naturally**
  - Following **illness**
- Or **artificially**
  - After **immunization**

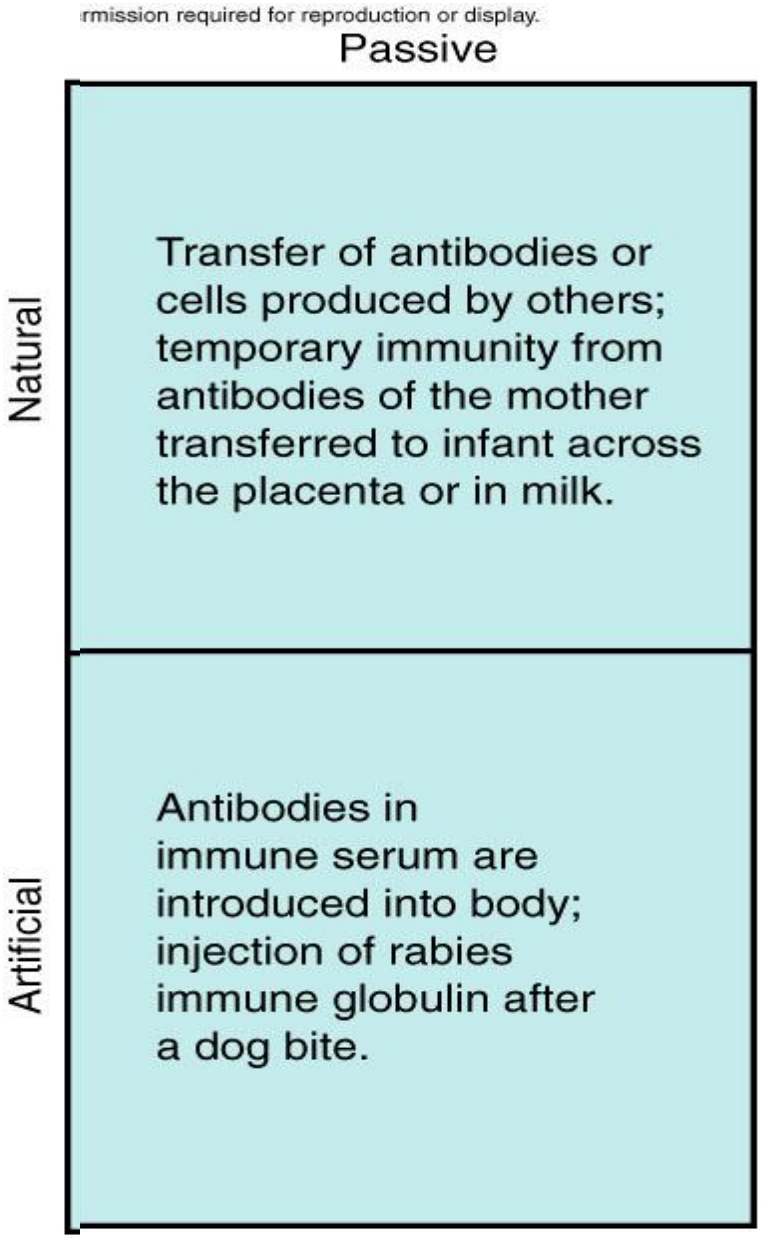


Passive Immunity

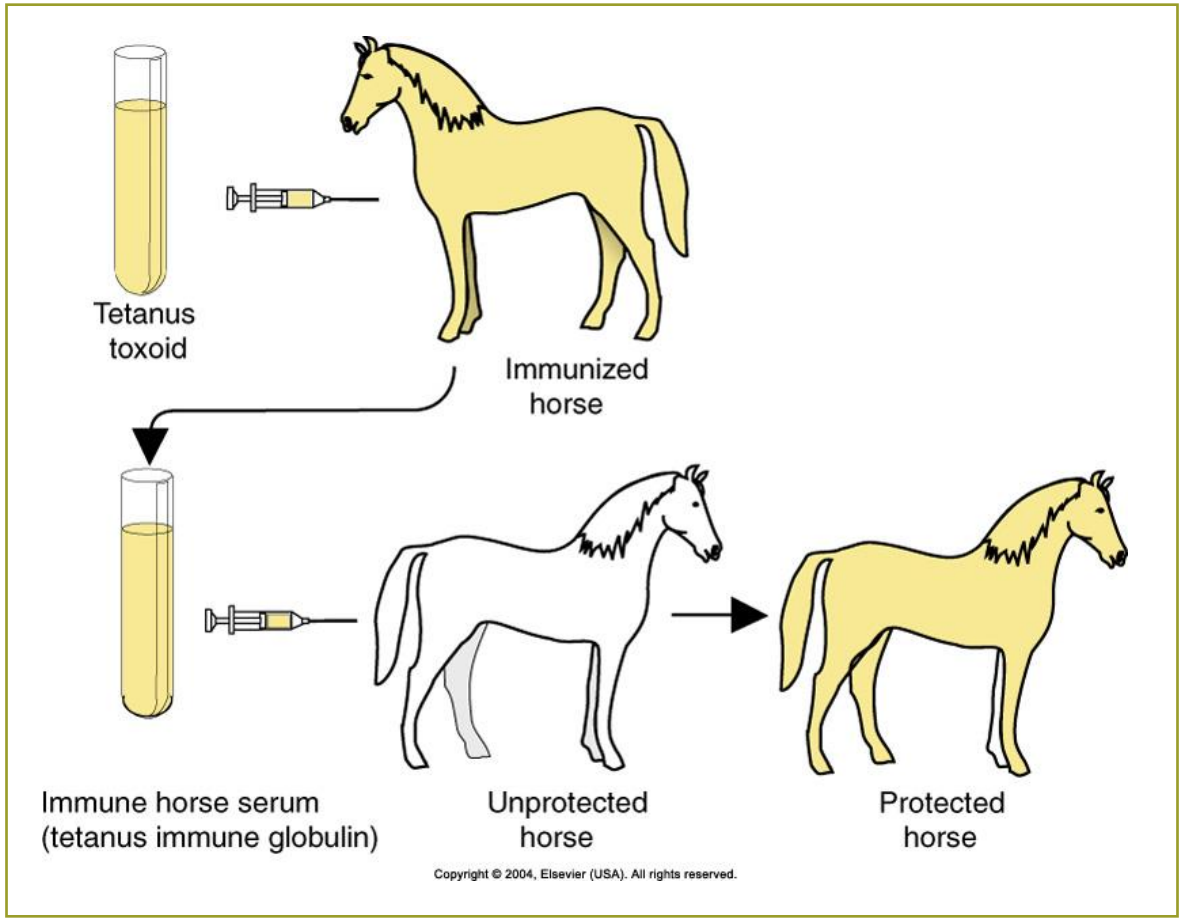
- Antibodies “borrowed” from another source (preformed in another animal)
- **Young** animals
- Short-acting, used up quickly
- No “memory cells”
- Examples
  - Maternal antibodies **(colostrum)**
  - Tetanus antitoxin (TAT)

Passive Immunity

- Occurs **naturally during pregnancy**
- Occurs **naturally** as result of breast feeding (colostrum)
- **Artificial** passive immunity involves transfer of antibodies produced by another person or animal
  - TAT
  - Pasteur Rabies Treatment



Active vs. Passive Immunity



Examples of Artificial Active Immunity

- Vaccines
- Bacterins

Creating Immunity in Animal

- **Biological** – product of a living organism that produces immunity in an animal
  - **Vaccines** – viruses
  - **Bacterins** – bacteria
    - Immunity not as strong
    - Tissue reactions? ("Vaccine reactions"?)

- **Immunization** – giving of a biological to produce immunity

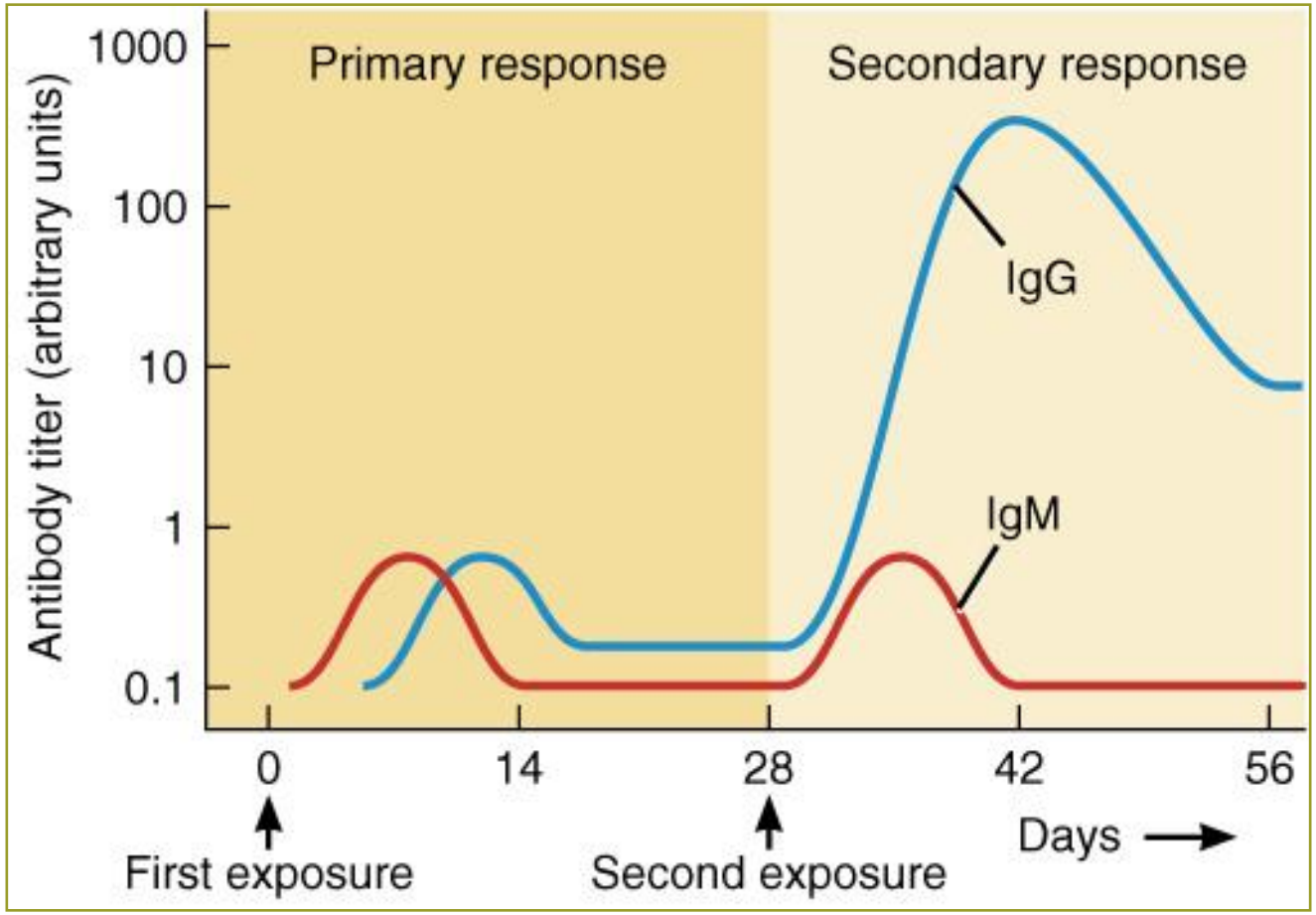
Fundamentals of Immunization

- Vaccine **series** for young animals
- Core “Booster vaccines" & annual health exam
- Give entire vaccine, regardless of animal size
- Expiration dates, refrigeration
- New sterile needle and syringe
- Do not use products in wrong species

2 Types of Antibodies Immunoglobulins (Ig)

- **IgM** – made during first exposure to antigen
  - **Primary response**
  - Slow production
- **IgG** – made during second exposure to antigen
  - Most common immunoglobulin
  - Secondary (“booster”) response
  - Production more rapid than IgM
  - Can cross the **placenta**

Primary & Secondary Response



“Booster Shots”

"A BOOSTER SHOT"...what does that mean? When an animal or human is vaccinated they generally will develop a response to the vaccine by increasing their level of protective defense immunity. This level may be high, low, or none. Usually there is a measurable response indicating some protection. If a **second** vaccine for the same disease is given at a later time...this second vaccine will BOOST the protective levels of immunity that were induced by the first vaccine. So, whether the vaccine is for Rabies or Parvovirus or Feline Leukemia, it might be called a "BOOSTER SHOT" if it is given sometime after an original vaccination.

How Vaccines Work

http://www.thehorse.com/articles/34397/superheroes-in-a-syringe-how-vaccines-work

Superheroes in a Syringe: How Vaccines Work

By Christy Corp-Minamiji, DVM | Aug 25, 2014 | Basic | Topics: Immune System, Vaccinations, Eastern Equine Encephalitis (EEE), Rabies, Western Equine Encephalitis (WEE), Influenza, Potomac Horse Fever

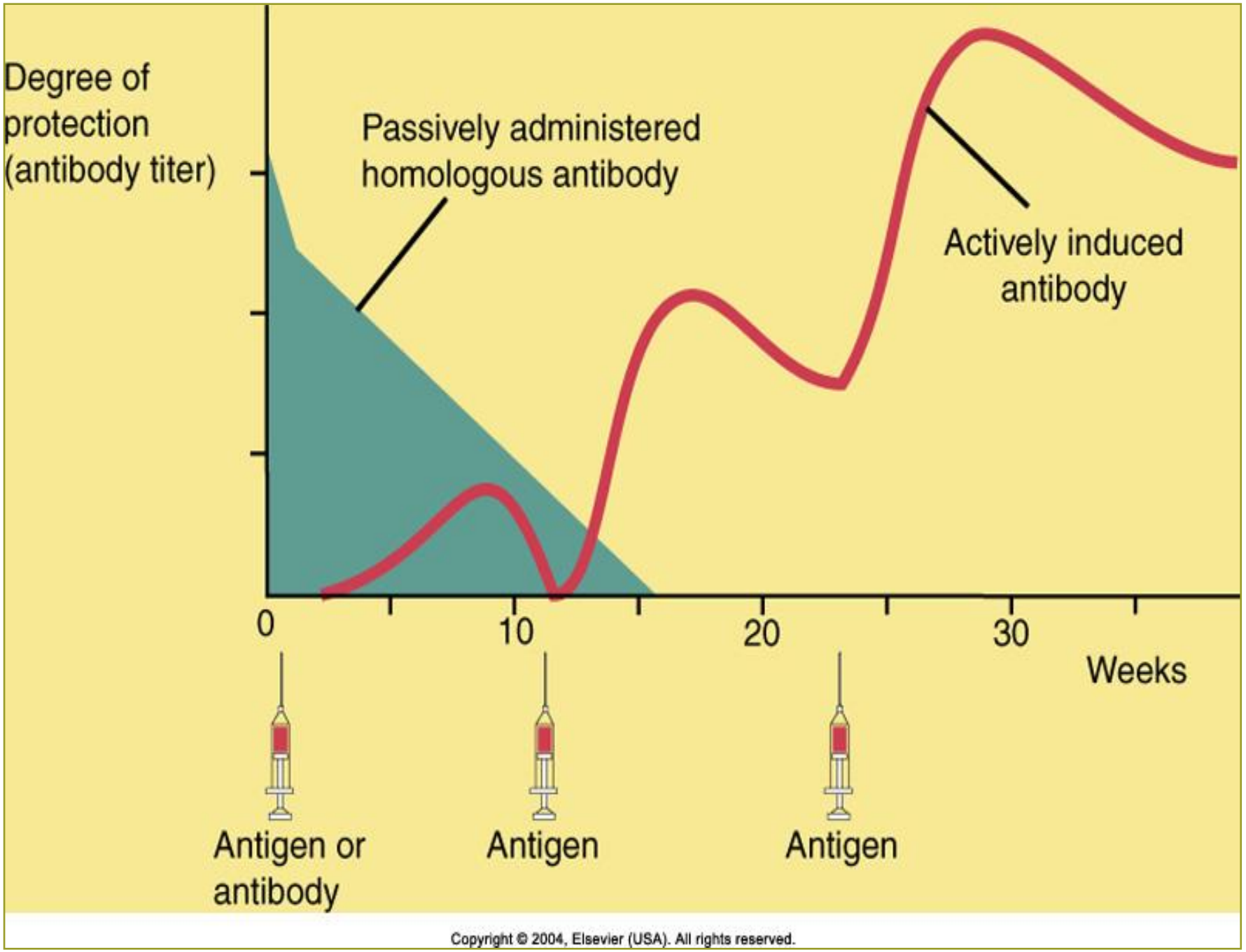
Work with your veterinarian to decide what vaccinations your horse needs, as well as when and how often to vaccinate.

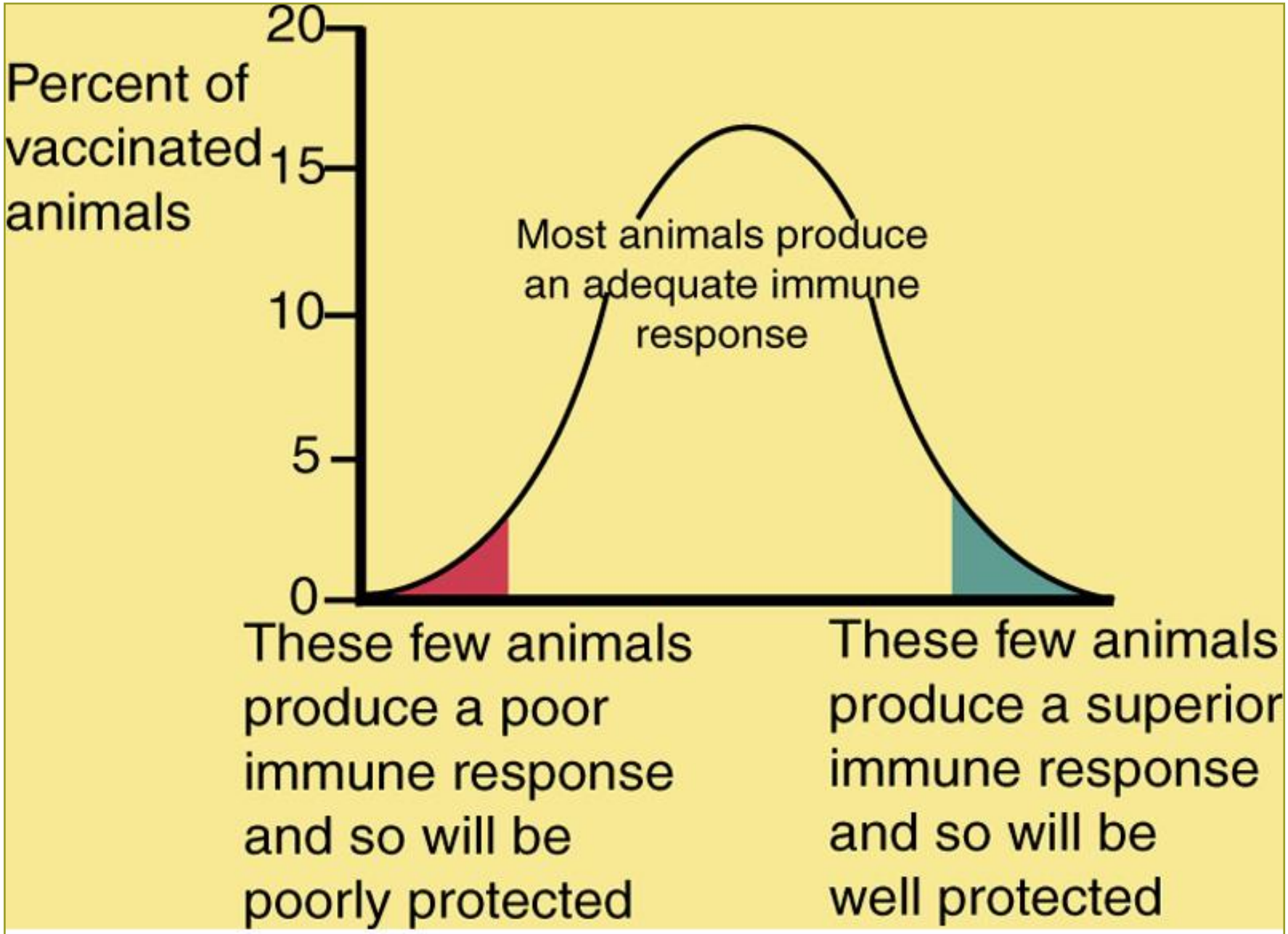
A behind-the-scenes look at how your horse's immune system is best primed for battle.

If you weren't felled by polio, your children missed the measles, your barn dodged a flu outbreak, and you've never seen a horse tormented by tetanus, you probably can thank

Related Content

Equine Influenza





Canine Core Vaccines – AAHA

- Canine distemper
- Canine hepatitis (adeno-virus 2)
  - Cross immunization
- Parvo virus
- Rabies (zoonosis)

AAHA Canine Vaccination Guidelines

https://www.aahanet.org/Library/CanineVaccine.aspx

2011 AAHA Canine Vaccination Guidelines

Published in 2011 (Sep/Oct)

Since the last time the American Animal Hospital Association's (AAHA) *Canine Vaccination Guidelines* were revised in 2006, new vaccines have been licensed, others have been withdrawn, and new information has led to the revision of previous recommendations. The *2011 AAHA Canine Vaccination Guidelines* offer a comprehensive review of canine vaccines currently available in North America, updated recommendations for core versus non-core vaccines, and revised recommendations for shelter-housed dogs.

Developed in a manner consistent with best vaccination practices, the 2011 Guidelines include expert opinions supported by scientific study, published and unpublished documents, and encompass all canine vaccines currently licensed in the U.S. and Canada. The task force that developed the guidelines included experts in immunology, infectious diseases, internal medicine, law, and clinical practice.

To help address common questions heard by members of the task force about canine vaccination issues asked by practicing veterinarians, a Frequently Asked Questions (FAQs) section was added to the Guidelines. Since scientific studies and referred journal publications are not available to support all of the vaccination recommendations included within the FAQ section, some answers are based on unpublished studies, current knowledge of immunology, and the experiences of experts in the field.

Also new to this edition:

- Updated recommendations on serologic testing
- Expanded discussion on vaccine adverse events
- Review of the legal implications associated with administering vaccines in clinical practice
- Full consideration of both U.S. and Canadian canine vaccination regulations

To view the *2011 AAHA Canine Vaccine Guidelines*, please click here.

Core Vaccines – Cats (FVRCP)

- Feline Distemper (Panleukopenia)
- Feline Viral Rhinotracheitis (FVR)
- Feline Calici Virus
- Rabies

AAFP Canine Vaccination Guidelines

http://www.catvets.com/public/PDFs/PracticeGuidelines/VaccinationGLS-summary.pdf

American Association of Feline Practitioners 2006 Feline Vaccination Guidelines. Summary: Vaccination in General Practice

Vaccine	Primary Series-Kittens (≤ 16 weeks)	Primary Series-Adolescent/ Adult (> 16 weeks)	Booster	Comments
Panleukopenia Virus (FPV) /Feline Herpesvirus-1 and Feline Calicivirus (FHV-1/FCV) Injectable: • MLV, non-adjuvanted • Killed, adjuvanted[l] • Killed, non-adjuvanted Intranasal • MLV, non-adjuvanted	Begin as early as 6 weeks of age, then every 3-4 weeks until 16 weeks of age.	2 doses, 3 to 4 weeks apart	A single dose is given 1 year following the last dose of the initial series, then no more frequently than every 3 years.	*Core* • Killed vaccines are preferred for use in pregnant cats (and only if absolutely necessary) and in FeLV and/or FIV infected cats, especially those showing evidence of immunosuppression. • Killed panleukopenia vaccines should be used in kittens less than 4 weeks of age. • All kittens and cats should receive at least one injectable panleukopenia injection.
Rabies[e] Injectable: • Canarypox virus-vectored recombinant (rRabies), non-adjuvanted • 1-year killed, adjuvanted[a] • 3-Year killed, adjuvanted[a]	Administer a single dose as early as 8 or 12 weeks of age depending on the product label. Revaccinate 1 year later.	Administer 2 doses, 12 months apart.	Annual booster is required. Vs. Every 3 years or as required by State or local ordinance for 3-year	*Core* • In States and municipalities where feline rabies vaccination is required, veterinarians must follow applicable statutes. • Booster vaccination with a 1-year rabies vaccine is only appropriate in States and municipalities where permitted by law. • Any rabies vaccine can be used for revaccination, even if the product is not the same brand or type of product previously administered. • No laboratory or epidemiologic data exist to support the annual or biennial administration of 3-year vaccines following the initial series.

What About Rabies?

- **Zoonosis!!!**
- Fatal disease
- Wildlife
  - Bats
  - Skunks
  - Raccoons
- Percentage of dogs & cats vaccinated

Center for Disease Control (CDC)

http://www.cdc.gov/rabies/location/usa/index.html

Rabies in the U.S.

Public Health Importance of Rabies

Over the last 100 years, rabies in the United States has changed dramatically. More than 90% of all animal cases reported annually to CDC now occur in wildlife; before 1960 the majority were in domestic animals. The principal rabies hosts today are wild carnivores and bats.

The number of rabies-related human deaths in the United States has declined from more than 100 annually at the turn of the century to one or two per year in the 1990's. Modern day prophylaxis has proven nearly 100% successful.

In the United States, human fatalities associated with rabies occur in people who fail to seek medical assistance, usually because they were unaware of their exposure.

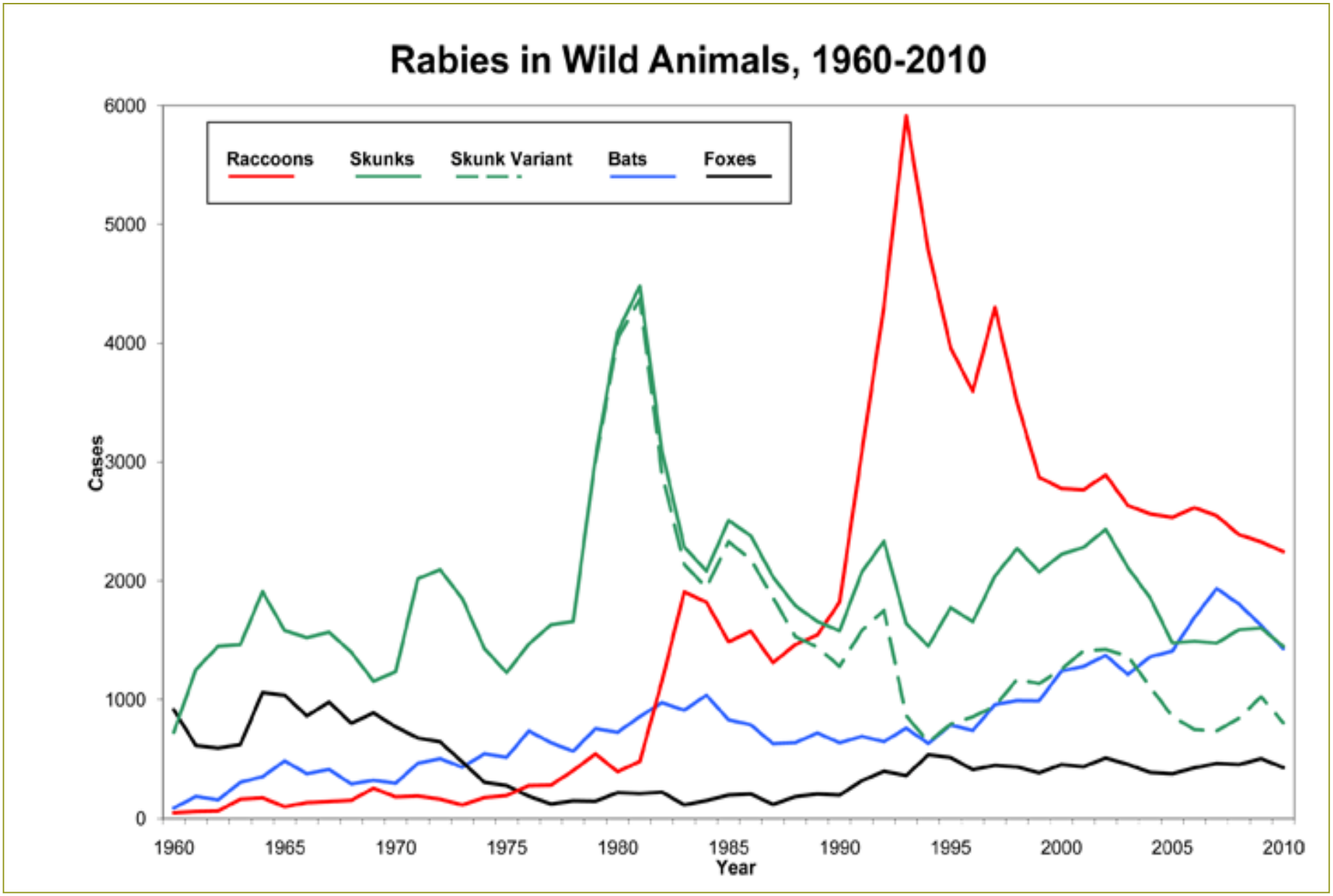
Wild Animals

- **Wild animal surveillance**
- Domestic animal surveillance
- Human rabies surveillance

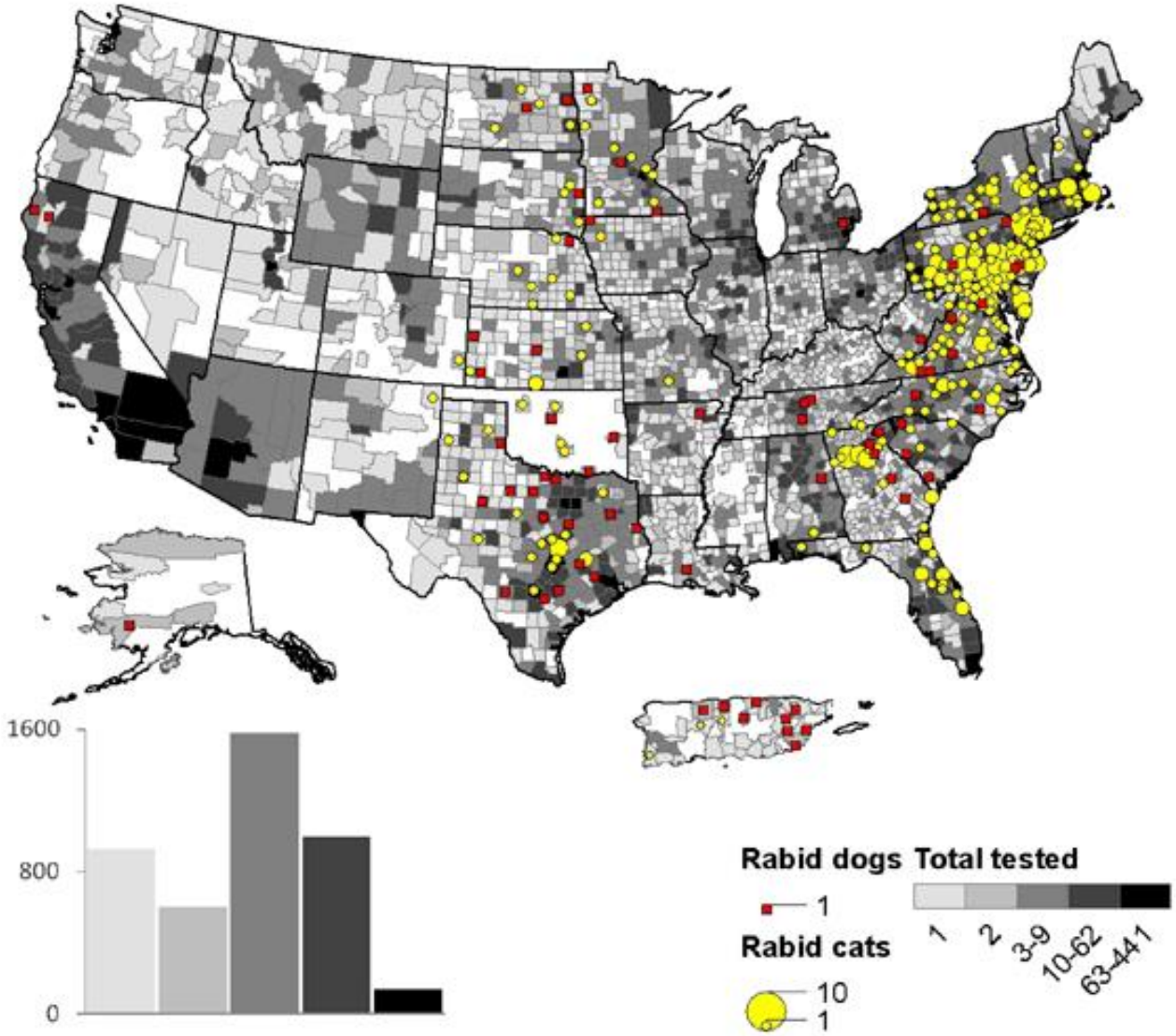
Wild animals accounted for 92% of reported cases of rabies in 2010. Raccoons continued to be the most frequently reported rabid wildlife species (36.5% of all animal cases during 2010), followed by skunks (23.5%), bats (23.2%), foxes (7.0%), and other wild animals, including rodents and lagomorphs (1.8%). Reported cases decreased among all wild animals during 2010.

Outbreaks of rabies infections in terrestrial mammals like raccoons, skunks, foxes, and coyotes are found in broad geographic regions across the United States. Geographic boundaries of currently recognized reservoirs for rabies in terrestrial mammals are shown on the map below:

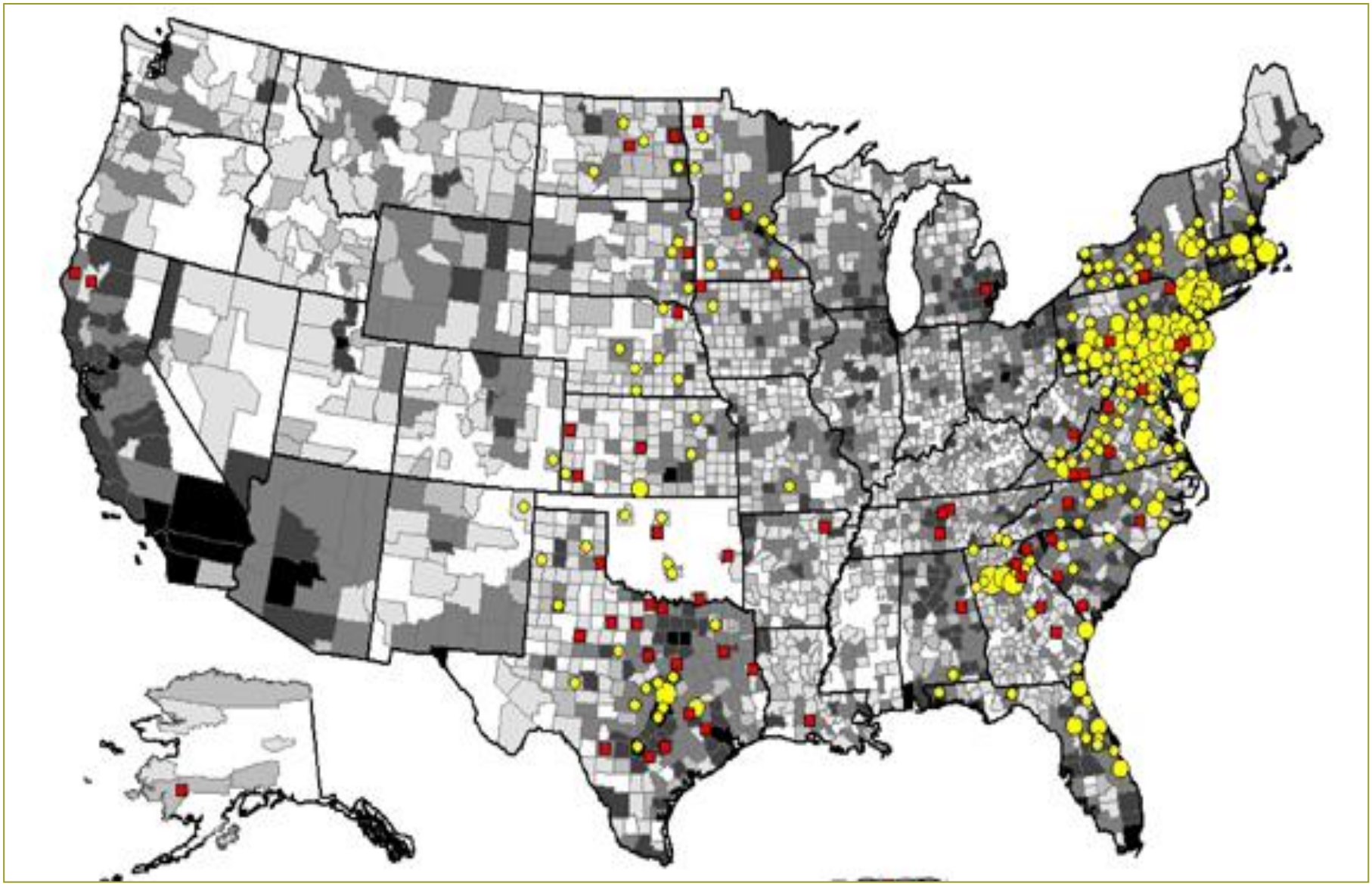

Skunk
Skunk
Skunk
Skunk
Skunk
Raccoon
Fox
Fox
Fox
Mongoose


Rabies in Wild Animals, 1960-2010
Raccoons
Skunks
Skunk Variant
Bats
Foxes
Cases
6000
5000
4000
3000
2000
1000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year

Rabid Cats and Dogs Reported in the United States during 2010



Map of rabid dogs and cats reported in the United States during 2010.




LONG BEACH
ANIMAL CONTROL
B.A.D.-12345

Wellness Plan for Pets

- Nutrition
- Vaccinations
- Parasite control
- Surgical neutering
- Behavior counseling

Test Yourself

KNOW THESE IN EVERY CHAPTER!

Pages 225, 229, 230, 231, 239, 242, 246

Clinical Applications

Pages 222, 223, 225, 226, 227, 228, 229, 230, 232, 232, 233, 235, 235, 235, 241, 242

GREAT Clinical Applications to Review

- Postprandial Lipemia (Page 222)
- Blood Volume (Page 225)
- Blood Glucose & RBC Metabolism (Page 227)
- Jaundice/Icterus (Page 228)
- Venipuncture & Platelets (Page 250)
- Total WBC Count & Differential Count (Page 252)
- Leukemia (Page 252)
- Swollen Lymph Nodes (Page 241)
- Autoimmune Diseases (Page 242)