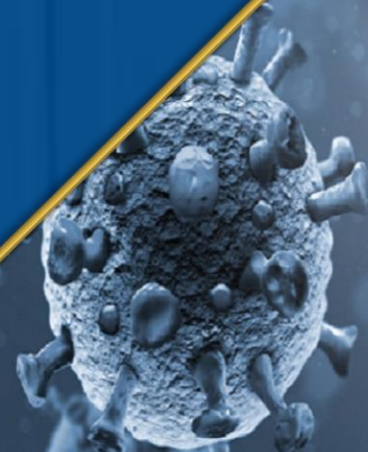


IMMUNOLOGY

Primary Care Paramedicine

Module: 16

Section: 01

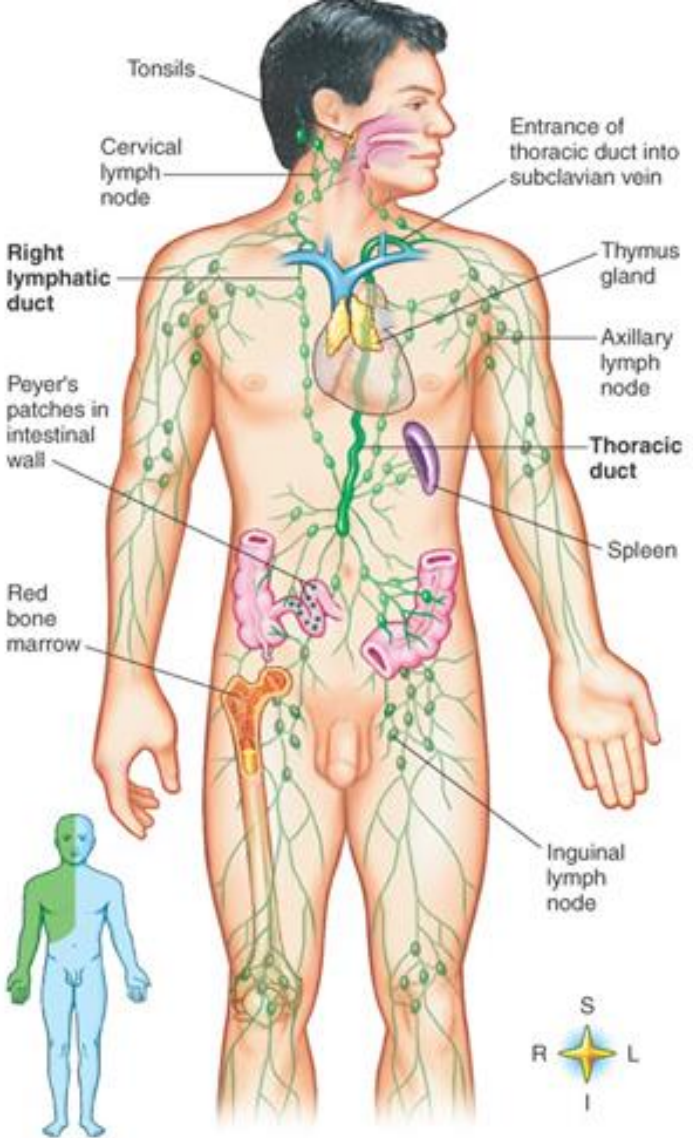
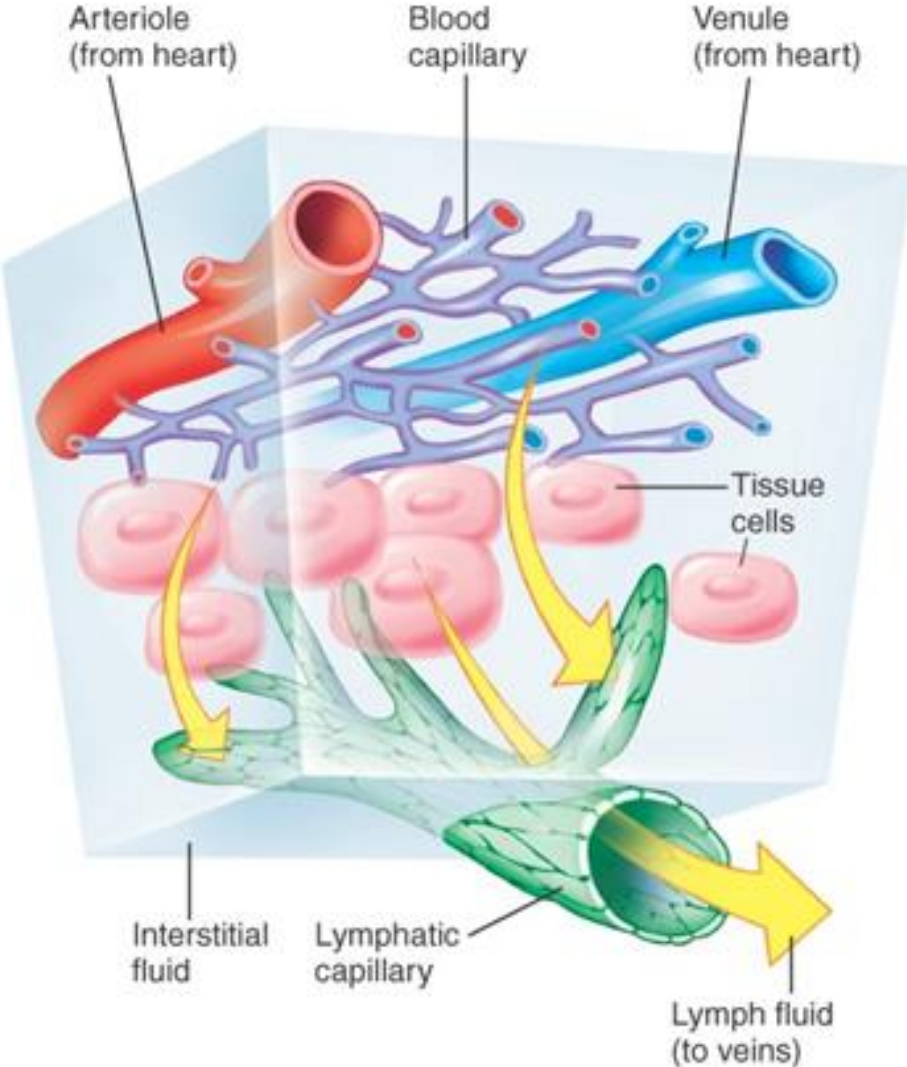


Immunology

LYMPHATIC SYSTEM

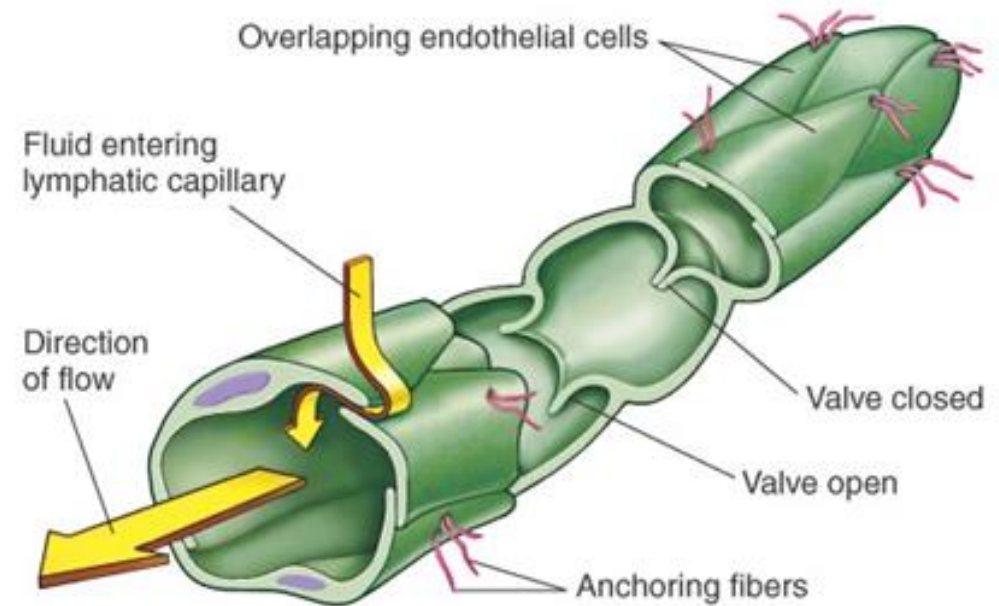
- Maintains fluid balance
- Immunity
- A specialized portion of the circulatory system
- Contains
 - Lymph (moving fluid)
 - Lymphatics (group of vessels)

Lymphatic System



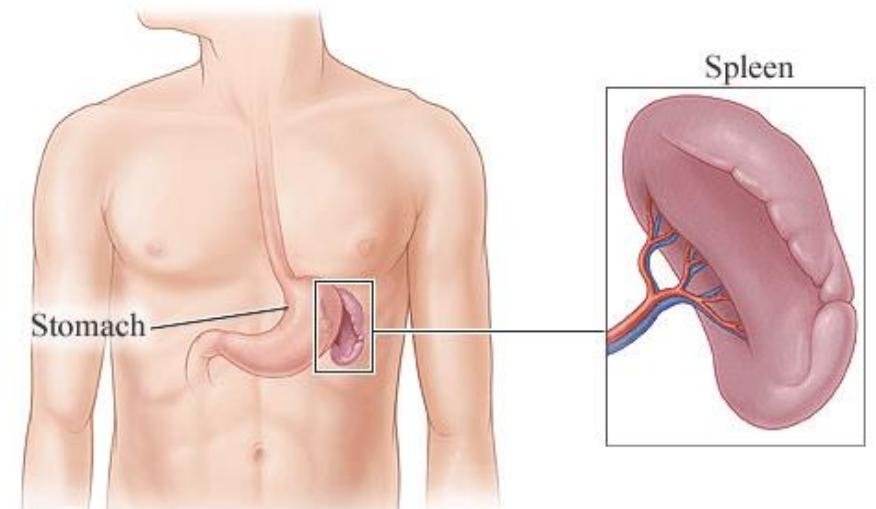
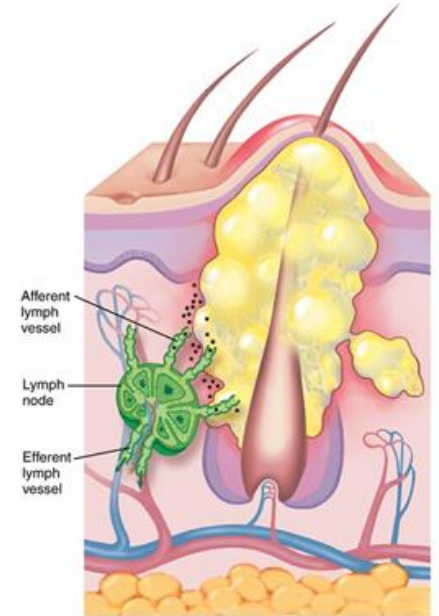
- Lymph
 - Clear, watery fluid
 - Results from fluid exiting circulation (c. 3000 ml daily)
 - Is similar to interstitial fluid (is isotonic to)
 - Usual contains more proteins
 - Most comes from the liver and small intestines (more than ½)

- Lymphatic Vessels
 - Originate as lymphatic capillaries
 - Lie side by side of the blood capillaries
 - Thinner
 - Have more valves
 - Have nodes
 - Continues to merge to form major ducts
 - Right lymphatic duct
 - Upper right quadrant of body
 - Thoracic duct
 - Rest of body



- Function of vessels
 - Permit particulate matter (which cannot be absorbed into capillary) to be removed from interstitial space
- Movement of fluid
 - Is uphill
 - Usually attributed to muscular movement

- Lymph nodes
 - Have several lymph vessels entering into this “cellular hub”
 - One vessel leaving
 - Function
 - Defense
 - Filtration
 - Phagocytosis
 - Hematopoiesis
 - Site of maturation of some cells
- Spleen
 - Large lymphoid organ
 - Monitors blood for infection
 - Filters out old erythrocytes and platelets



- A system that uses many mechanisms to ensure the integrity and survival of the internal environment.
- Two major categories:
 - Non-specific “innate” immunity
 - Ancient general defense system against common pattern elements found in pathogens
 - Able to attack the threat as soon as it is present
 - No memory
 - Specific “adaptive” immunity
 - Recognizes specific pathogens and remembers them
 - Slow to recognize targets and overcome the threat (especially first time exposure)

- The work of the system is completed by cells or substances created by cells
- Primary Type:

Non-specific Immunity

- Neutrophils
- Monocytes
- Macrophages
- Natural Killer (NK) Cells

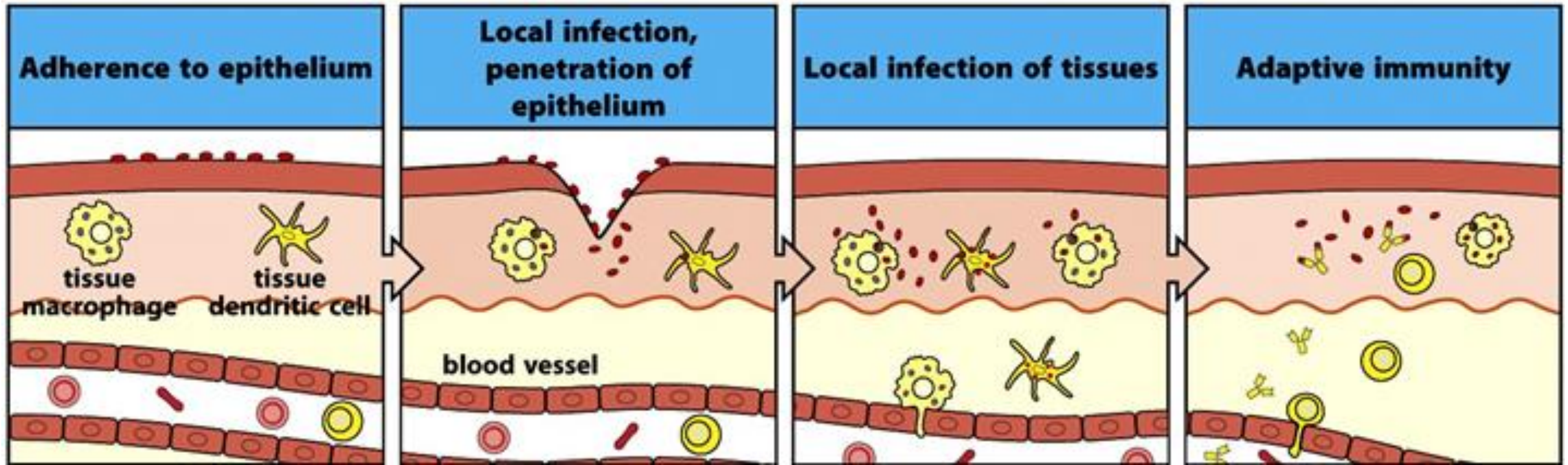
Specific Immunity

- Lymphocytes
 - T-Cells
 - B-Cells

- Species resistance
 - Genetic characteristics to protect the body from certain pathogens
- Mechanical and chemical barriers
 - Skin and mucosa
 - A continuous wall that separates the internal environment from the external environment
 - Secretions
 - Sebum, mucus and enzymes chemically inhibit the activity of pathogens
- Inflammation
 - Isolates pathogens and stimulates the speedy arrival of large numbers of immune cells

- Phagocytosis
 - Neutrophils
 - Granular leukocytes that are usually the first phagocytic cell to arrive due to the inflammatory response
 - Macrophages
 - Monocytes that have enlarged to become phagocytic cells (may be called by other names when found in specific tissues)
 - Dendritic Cells
 - Important bridge between innate and adaptive immune responses
 - Phagocytose pathogens in the tissues and carry them to lymph nodes for identification by T cells
- Natural Killer (NK) Cells
 - A group of lymphocytes that kill different types of cancer cells and virus infected cells

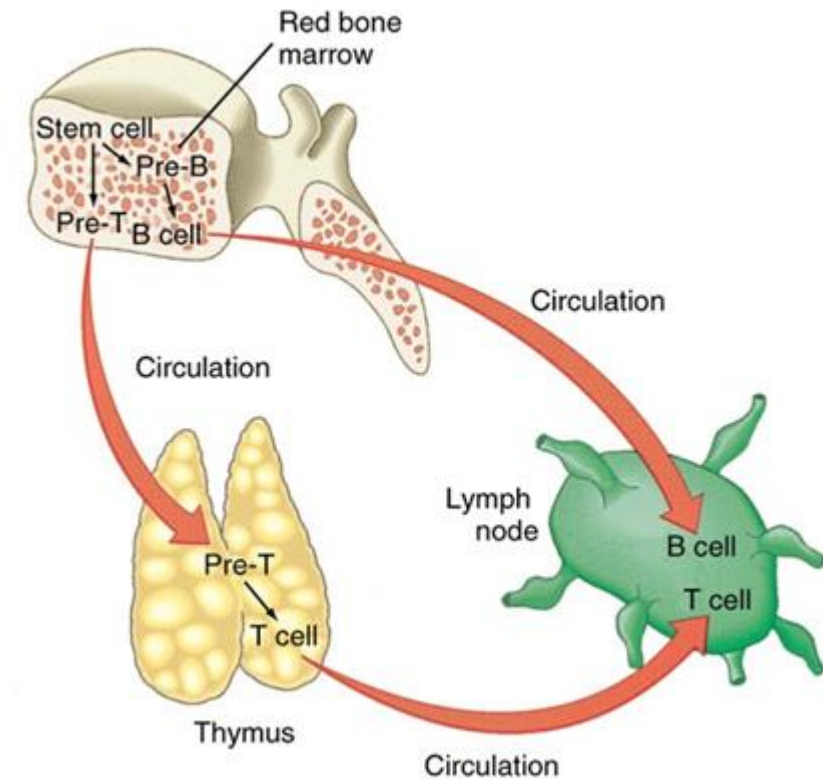
- Interferon
 - Protein produced by cells after they become infected by a virus which inhibits further spread of the viral infection
- Complement
 - Plasma proteins that produce a cascade of chemical reactions that cause lysis of foreign cells



- Attack specific agents the body recognizes as “non-self”
- Adapts to pathogens and has a memory for future exposures
- Controlled by lymphocytes (a class of WBC)
- Lymphocytes are produced throughout life in the red bone marrow from the hematopoietic stem cells
- Develop into two major classes
 - B lymphocytes (B Cells)
 - Produce antibodies (antibody-mediated immunity)
 - T lymphocytes (T Cells)
 - Kill infected human cells or activate other cells to kill pathogens (cell-mediated immunity)

Antibody-Mediated Immunity

- Inactive B Cells
 - Produced in the yolk sac, then the red marrow or the fetal liver
 - Circulated to the lymph nodes and spleen
- Activate B Cells
 - When an inactive B cell encounters a specific antigen
 - This binding triggers a series of mitotic divisions producing clones of B cells
 - The clones can differentiate into plasma cells and secrete antibodies
 - Others remain in the lymphatic system as memory cells and will become plasma cells if introduced to the antigen at another time



Antibody-Mediated Immunity

- Antigen
 - A substance that introduced to the body that induces the formation of antibodies
 - Usually proteins located in the membranes of microorganisms or the outer coats of viruses
- Antigenic Determinants
 - Various shaped, small regions on the surface of the antigen molecule (epitope)
 - Each kind of antigen has specific and uniquely shaped epitopes

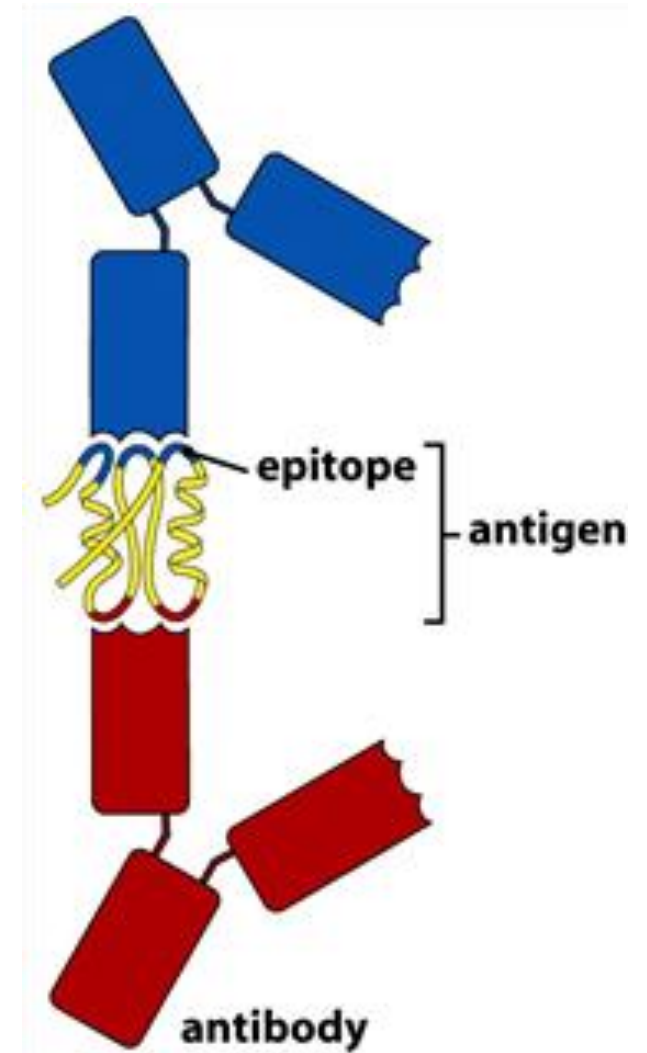
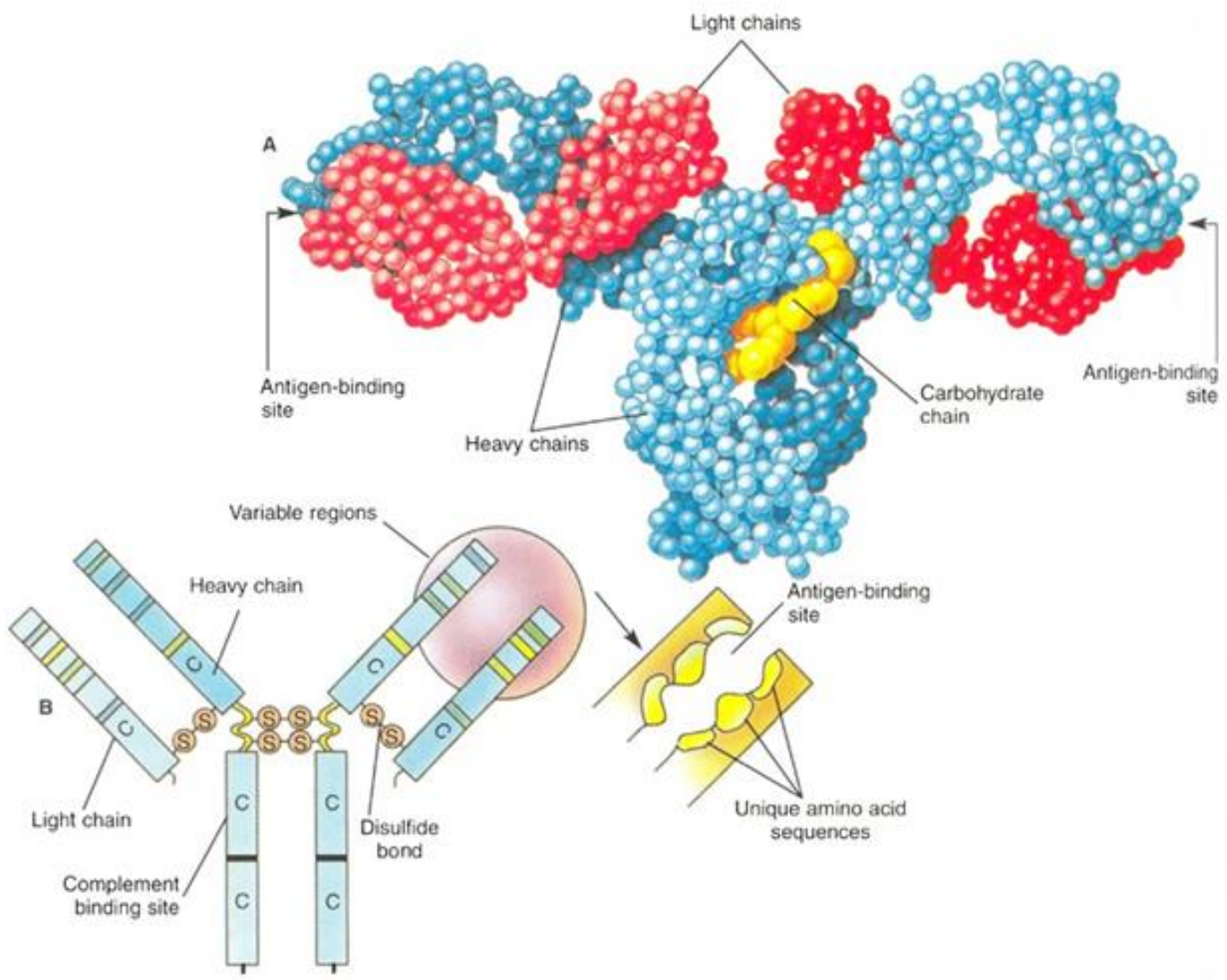
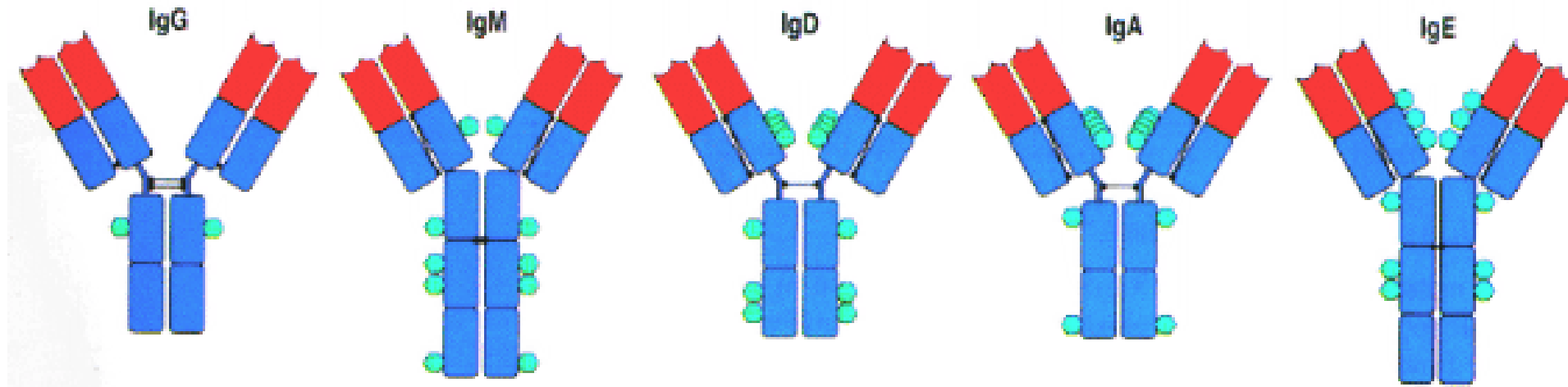


Figure 1-15 Immunobiology, 7ed. (© Garland Science 2008)

- Antibodies
 - Plasma proteins (Immunoglobulins) secreted by B cells
- Combining sites
 - Two small concave regions on the surface of the antibody
 - Like epitopes, have specific and unique shapes
 - Shaped to allow the epitope of the antigen fit into it and thereby bind to form a antigen-antibody complex
- Clone
 - The genetic descendant of a cell
- Complement
 - A group of proteins that work together to destroy foreign cells, can be activated by antibodies

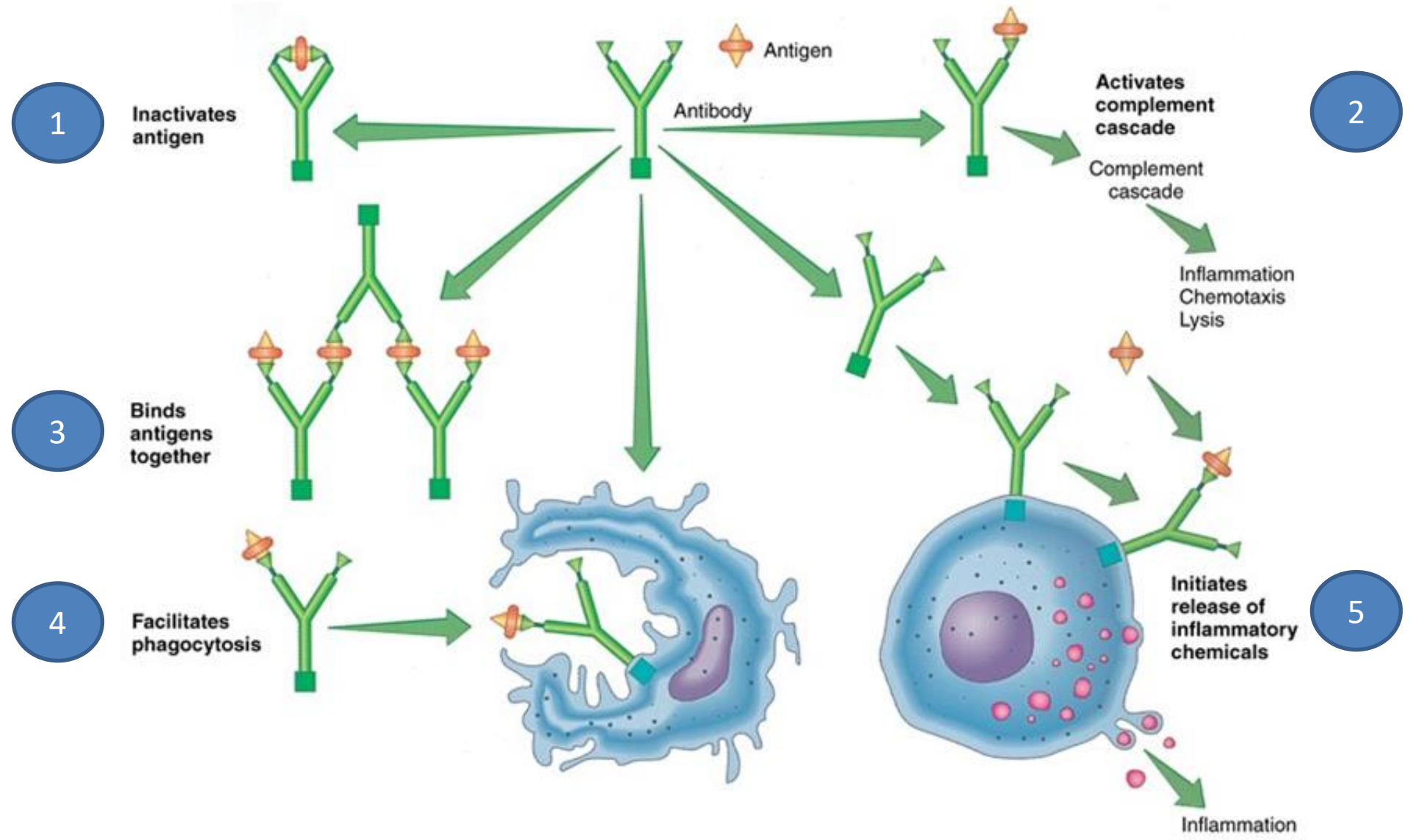
- Proteins of the Immunoglobulin family
- Large molecules composed of long chains of amino acids (polypeptides)
- Consists of four polypeptide chains
 - 2 Heavy
 - Twice as long and heavy
 - Has one variable and three constant regions
 - 2 Light
 - Has one variable and one constant region
- Formed to give a Y shape appearance
- Disulfide bonds join the 2 heavy chains to each other and their adjacent light chain
- Antigen-binding sites are located at the top of the variable regions
- Complement binding sites found in the constant regions

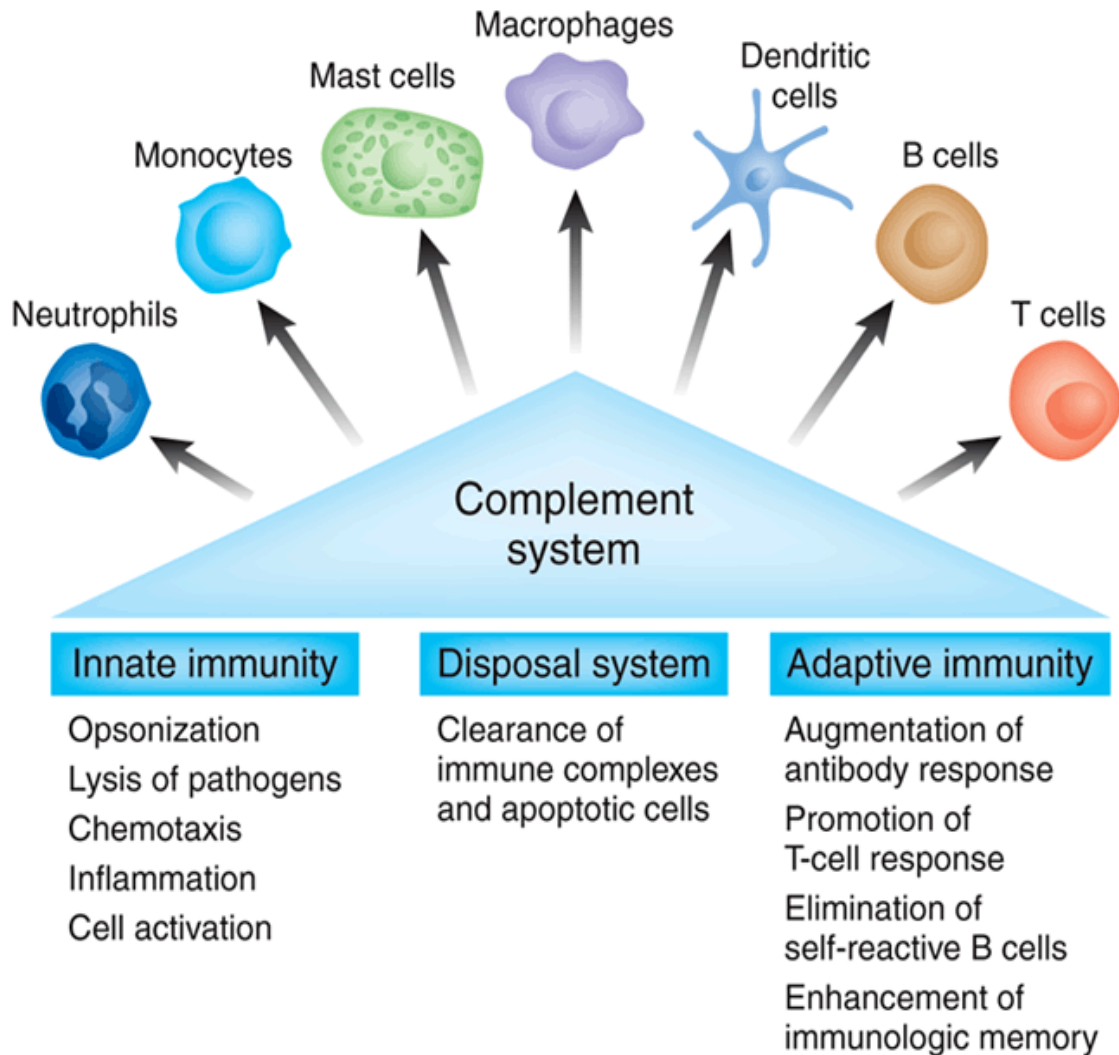




- **IgM**
 - Produced by immature B cells and inserted into plasma membranes
 - Predominate antibody produced after initial contact with an antigen
- **IgG**
 - Most abundant circulating antibody (75%)
 - Predominate in a secondary exposure
 - Cross the placenta barrier to provide natural passive immunity
- **IgA**
 - Found in the mucous membranes, in saliva, tears, and breastmilk
- **IgE**
 - Minor in amount
 - Can produce major effects (allergies)
- **IgD**
 - Found in blood in small amounts (unknown function)

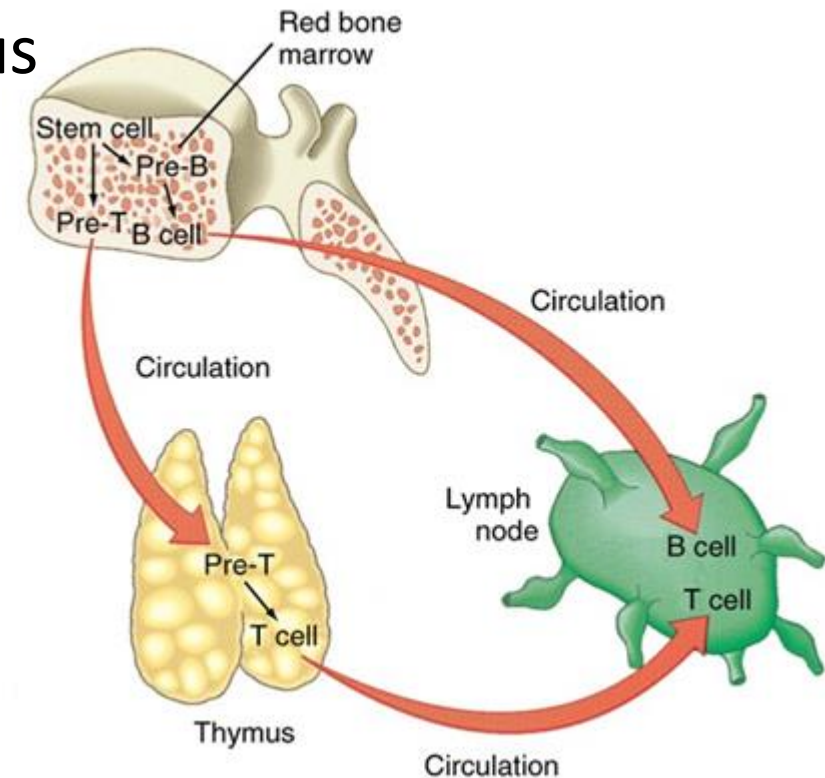
- Function to produce antibody-mediated immunity (humoral immunity)
- Antigen-Antibody reactions
 - Antibodies distinguish self-antigen and nonself-antigens at the binding site
 - This binding causes 5 main outcomes:
 - Transforms toxins into nontoxic substances
 - Exposes the complement-binding sites initiating the complement reaction
 - Agglutinates antigens (clumps) for phagocytic disposal
 - Facilitates phagocytosis (provides a handle for the white blood cells)
 - Initiates release of inflammatory chemicals





- **Complement**
 - Component of blood plasma
 - Are inactive enzymes that are activated in a definitive sequence to catalyze a series of reactions
 - The reactions are produced as proteins react with the complement-binding site
 - Molecules produced by the reactions assemble on the surface of the foreign cell to form a donut-shaped structure
 - Water and ions are diffused into the cell and cause cytolysis
 - Various complement proteins may produce other reactions
 - Vasodilation in the invaded area
 - Attract Neutrophils and enhance phagocytosis

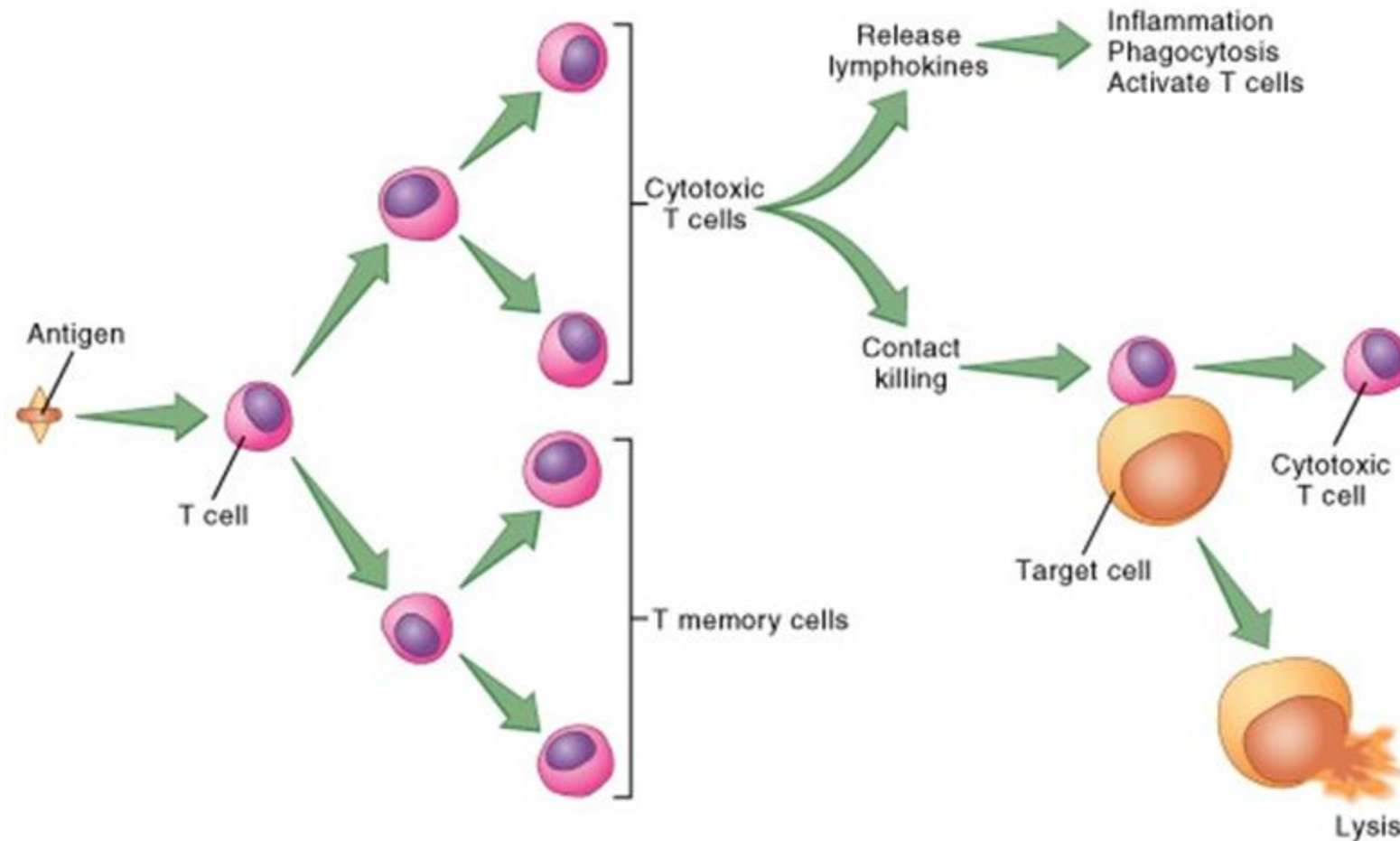
- T cells are lymphocytes that have passed through the thymus gland where they learn to distinguish between self and foreign antigens
- Pre-T cells are released from bone marrow
- Pre-T cells develop into thymocytes in the thymus
- Thymocytes are rapidly reproduced (can divide 3 - 4 times a day)
- Once released into the blood from the thymus they locate in areas of the lymph nodes and spleen (T-dependant zones)
- Now they are T cells



- T cells have antigen receptor sites (T cell receptors) on their membrane
- Dendritic cells phagocytose pathogens in the tissues and present antigens to the T cell receptor on the T cell
- Binding activates (sensitizes) the T cell causing it to divide and produce clone cells (activated T cells)
- These T cells will be either:
 - Cytotoxic T cell
 - Kills infected or cancerous human cells on contact
 - Helper T cell
 - Helps B cells make antibodies and helps innate cells kill pathogens

- T cells do not directly kill bacteria or viruses
 - Killer T cells kill virus infected human cells or cancer cells
 - Helper T cells help macrophages phagocytose bacteria
 - Helper T cells help B cells make antibodies to target bacteria or viruses for disposal

- Killer (cytotoxic) T cells in action:



- Some memory lymphocytes of each type (cytotoxic T cells, helper T cells, and B cells) can be saved for future encounters with the same pathogen
- This provides a memory for both:
 - Cell-mediated immunity
 - Memory Helper T cells
 - Memory Killer T cells
 - Antibody-mediated immunity
 - Memory B cells
- Innate immune cells (neutrophils, macrophages, and dendritic cells) don't have memory
- Immunologic memory is the principle that makes vaccination possible

Inherited Immunity

- Also known as Inborn Immunity

Acquired Immunity

- Natural (Exposure to the causative agent is not deliberate)
 - Active (exposure)
 - Exposure to infection (measles) and produces immunity
 - Passive (exposure)
 - Received from mother through the placenta barrier or through breast milk
- Artificial (Exposure is deliberate)
 - Active (exposure)
 - Vaccinations
 - Passive (exposure)
 - Antibodies that are produced by another immune system (e.g. Anti-venoms are typically horse or sheep antibodies that neutralize the venom toxins)

	Vaccines							
Age:	DTaP/IPV	Hib Haemophilus influenza type b vaccine	MMR	HBV	dTap	VZV	PCV-7	MenC- conjugate
At 2 months	X	X		X			X (@ 2/3 mos)	X (@ 2/3 mos)
At 4 months	X	X		X			X (@ 4/5 mos)	X (@ 4/5 mos)
At 6 months	X	X		X			X (@ 6/7 mos)	X (@ 6/7 mos)
At 12 months			X			X	X (@12-15 mos)	
At 18 months	X	X	and X	or				
At age 4-6 years	X		or X	X 3 doses				
Teenage years				@ 0, 1 & 6 mos	dTap at 14-16 years			
Adult years				at any age	dT every 10 years			