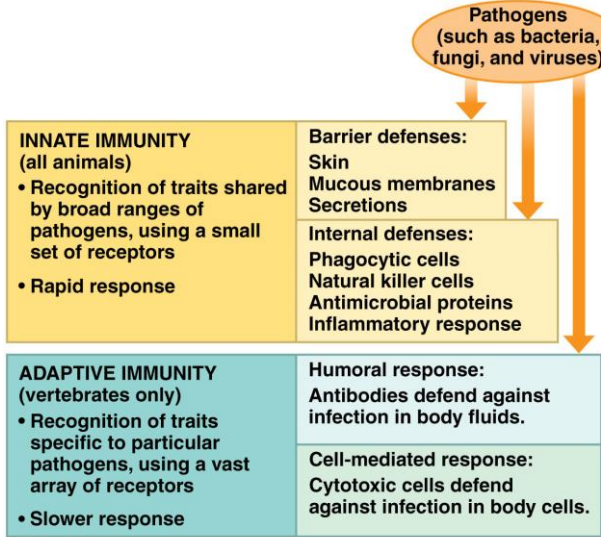


What?...Read?...The Overview?



Name the three general categories of pathogens:

- 1.
- 2.
- 3.

Our immune system is designed to protect us against p_____
Dedicated immune cells in the body fluids and tissues specifically i_____
with and d_____ pathogens.

Concept 43.1 In Innate Immunity, Recognition and Response Rely on Traits Common To Groups Of Pathogens

Innate Immunity in Invertebrates

Innate immunity is found in _____ animals, and in _____ too!
In insects and crustaceans, the _____ is the 1st line of defense
Insect exoskeletons are made of _____, and this barrier is also found in the insect _____.
The enzyme that breaks down bacterial cell walls is named _____.
A method of engulfing foreign cells and particles is termed p_____.

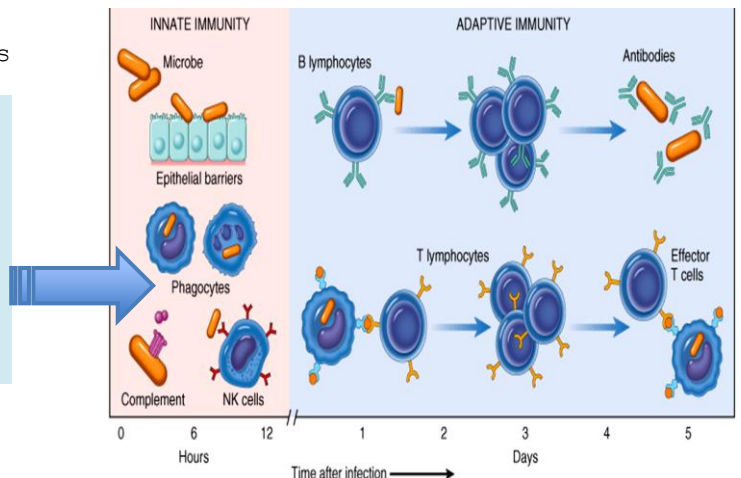
Innate Immunity in Vertebrates

In vertebrates (mammals) the type of tissue utilized to prevent pathogen entry is _____ tissue.
How does mucous entrap microbes and other particles?
The lungs are protected by beating _____ that send mucous in the u_____ direction - toward the epiglottis and esophagus.
Saliva and tears contain _____, a bacterial cell wall-digesting enzyme.
The pH of the stomach is around _____, a _____ (hostile / friendly) environment for bacteria.
Toll-like receptors are good for identifying _____ (groups of pathogens / individual species of pathogens).
Upon phagocytosis, a microbe is entrapped in an organelle called a _____. This organelle then fuses with a _____.
The pathogen is then killed by g_____ and e_____.

Two Main Types of Phagocytic Cells in Mammals

Neutrophils circulate in the _____. They are attracted by signals from _____ (body tissues / pathogens). They destroy the pathogen by _____.

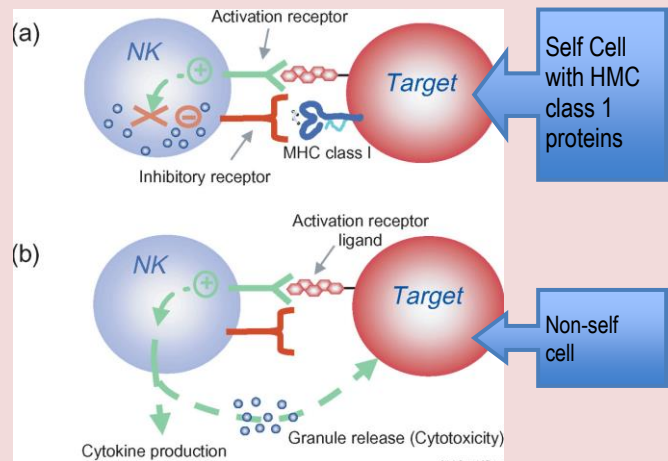
Macrophages are _____ (larger / smaller) than neutrophils. They are found in the bloodstream, in lymphoid organs, in connective tissue matrix, and in organs and tissues (ie. widely distributed and not restricted to the bloodstream).



Natural Killer Cells

Natural Killer Cells are _____ (specific / non-specific) cells that detect an abnormal array of surface proteins on virus-infected or cancerous self-cells and respond by secreting chemicals that are toxic (lethal) to the infected cells. They _____ (are / are not) phagocytes.

Please Note: Your textbook identifies NK cells as a form of **lymphocyte** on page 935. This is a new categorization based upon their lineage. However, they are non-specific (innate) in their protective actions.

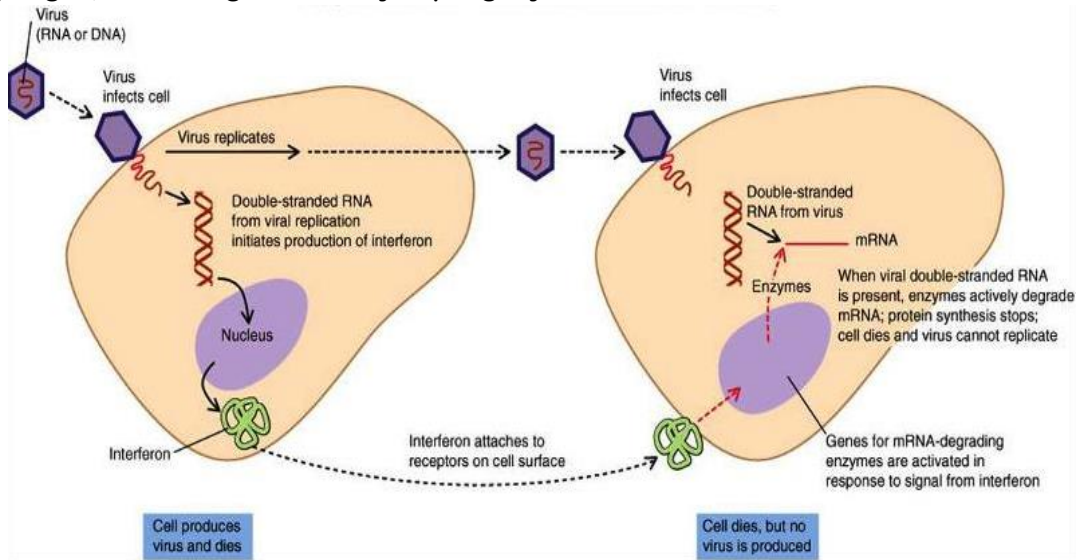


The Lymphatic System

Many of the body's innate defenses are found in the _____ system. The fluid transported within the lymphatic system is called _____. The vessels that carry this fluid are called lymph vessels. Most lymph vessels lead to l_____ n_____ where pathogens are detected by non-specific phagocytic cells. A special cell called a _____ cell lives outside of the lymph nodes but, upon detection of nonself cells, can migrate to the lymph nodes and initiate an adaptive (specific) response.

Antimicrobial Peptides and Proteins

Interferon's - proteins that are produced by infected cells to induce nearby uninfected cells to produce anti-viral proteins. This limits the spread of viruses. Other interferons activate macrophages, enhancing their ability to phagocytize.

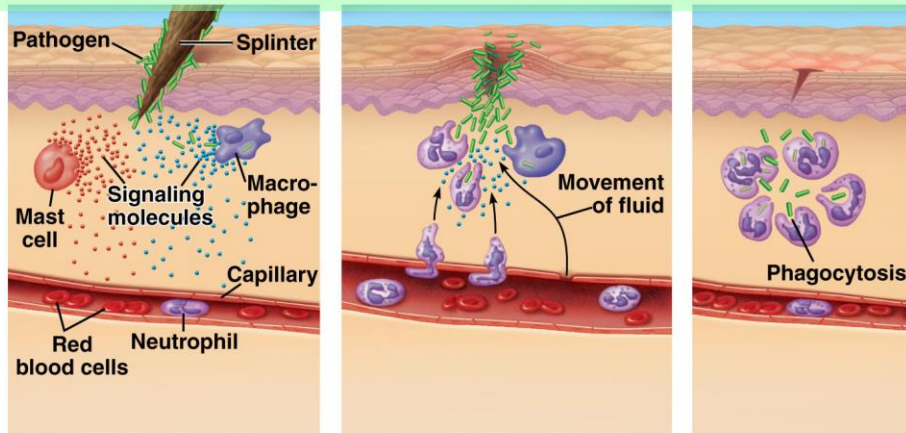


Complement and The Complement System

The term "complement" refers to a group of perhaps _____ (#) proteins that are found in _____. When these proteins are circulated, they are _____ (active / inactive). Exposure to the surface of an invading microbe, they are activated. Activation results in a _____ (Ada / Cascade) of reactions that lead to the bursting (AKA _____) of the invading cells.

The Inflammatory Response

The inflammatory response is part of a vertebrate's _____ (specific / nonspecific) response to pathogen invasion. The classical signs of acute inflammation are p_____, h_____, r_____, and s_____. Inflammation is a stereotyped response, and therefore it is considered as a mechanism of _____ (innate / adaptive) immunity. One of the most important signaling molecules used during the inflammatory response is h_____. This substance is stored in the v_____ of m_____ cells (which are connective tissue cells). Histamine causes blood vessels to _____ (dilate / constrict) and _____ (increases / decreases) blood vessel permeability. Histamine causes activated macrophages and neutrophils to discharge _____, signaling molecules that enhance the immune response. Cytokines _____ local blood flow. As a result, local temperature _____. Swelling occurs because of the leakage from blood vessels. Increased blood flow brings more c_____ (plasma proteins) and other antimicrobial peptides. As the immune system - pathogen war rages on, _____ (discharged cellular waste, corpses of leukocytes, dead pathogens) accumulates.



Fever

Fever is an elevated temperature set point in the h_____. This temperature set point increase results from the secretion of p_____ (in your notes) from phagocytic cells called m_____. Your textbook cites an elevation in the rate of _____ as the prime benefit resulting from elevated body temperature. Your textbook notes that it also speeds up _____ and accelerates _____.

Septic Shock

Septic shock is an dangerously large i_____ r_____. This condition is typified by high _____, low _____, and poor _____. How dangerous is septic shock? Up to _____ (fraction) of instances are fatal.

Concept 43.2 - In Adaptive Immunity, Receptors Provide Pathogen-Specific Recognition

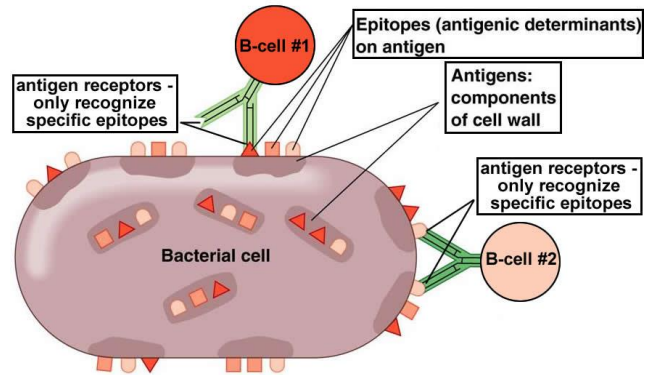
The only animal group to possess adaptive immunity in addition to innate immunity is the _____. The adaptive response involves only 2 forms of leukocytes: _____ and _____. Both of these cells are l_____. Cells that arise from red bone marrow and then migrate to the thymus are _____ cells. Cells that remain in the red bone marrow and mature there are _____ cells. The textbook identifies a 3rd form of lymphocyte that remains in the blood and becomes an agent of innate immunity, the _____ cells.

Antigens

An antigen is any substance that elicits a response from ___ or ___ cells. The binding protein on the surface of a B or T cell that recognizes an antigen and binds to it is called an _____. An antigen receptor can bind to only one type of _____. Actually, it only binds to one part of an antigen on the surface of a pathogen. The cells of the immune system produce _____ (how many?) different types of antigen receptors. However, all of the antigen receptors made by a SINGLE B or T cell are _____. When activation of the adaptive response occurs, ONLY cells with this specific antigen receptor are activated. Each B and T cell has about _____ (how many?) antigen receptors on the surface of the cell.

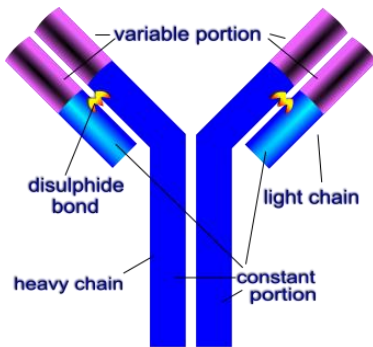
Antigens are usually _____ (self / nonself) molecules. These molecules are typically _____ (large / small). The molecules are usually either p_____ or p_____.

The small, accessible portion of the antigen that binds to the antigen receptor is called the _____. Each B or T cell is sensitive to a particular epitope.

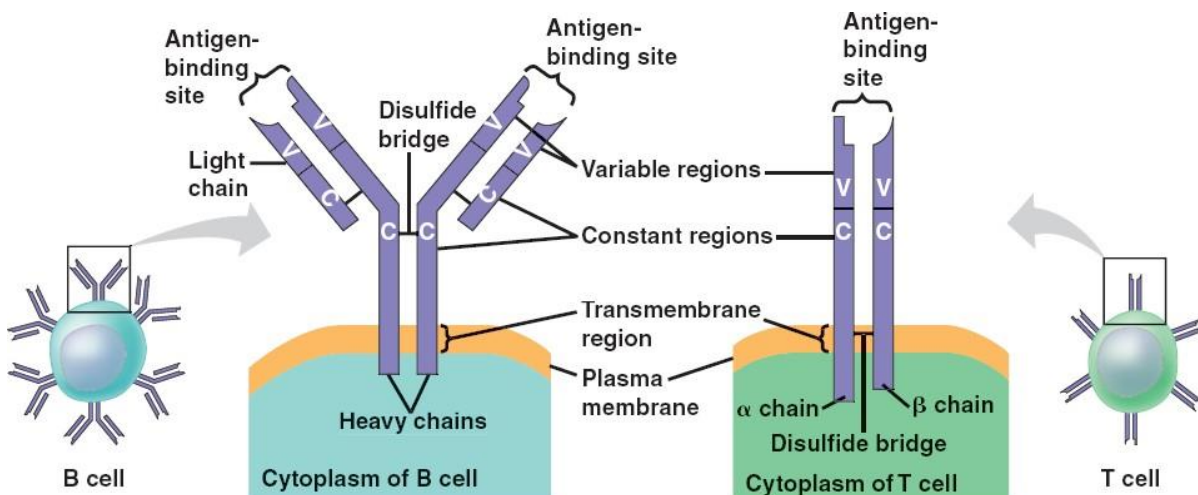


Antigen Recognition by B Cells and Antibodies

The Structure of A B-Cell Antigen Receptor



Each B cell antigen is shaped like the letter _____. It has two identical _____ chains and two identical _____ chains. What holds the heavy and light chains together? _____. The base is anchored to the p_____ m_____ and extends into the _____. The variable region is found at the _____ of the "Y". The tips of the light and heavy chains come together to form an asymmetrical binding site for a specific a_____. Each of the two tips of the "Y" is the same as the other. When a B cell antigen receptor unites with an antigen, it synthesizes antibodies that have _____ (the same / a different) shape as the antigen receptor. It is these antibodies, rather than the B cells themselves, that defend against the antigen-bearing pathogen.



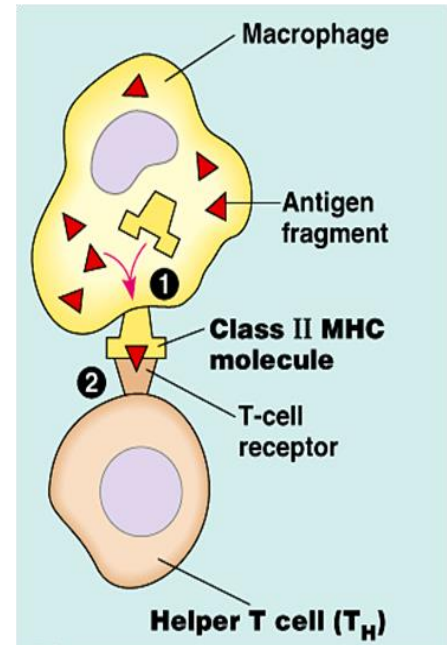
(a) A B cell receptor consists of two identical heavy chains and two identical light chains linked by several disulfide bridges.

(b) A T cell receptor consists of one α chain and one β chain linked by a disulfide bridge.

The Structure of A T-Cell Antigen Receptor

A T-cell antigen receptor looks different than a B-cell antigen receptor. It is not shaped like a "Y"...it is shaped like an ____! It has two polypeptide chains, an ____ chain and a ____ chain. The antigen receptor is anchored in the plasma membrane and extends into the cytoplasm just like a B-cell receptor! Once again, the variable regions are found upon the outer tip of the receptor. Even though, in many ways, the B and T cell receptors LOOK the same, they do not function in the same way. A T cell antigen receptor can bind ONLY to antigens that are d____ (or p____) on the surface of host cells. The host protein that displays the antigen fragment on the cell surface is called a MHC (_____) molecule.

Here's what happens. A pathogen is either infects or is taken in by a host cell (such as a macrophage). The antigens from the absorbed cell are broken into pieces, and the epitopes are combined with MHC proteins and displayed on the surface of the host cell. This is called antigen p____. This advertises the fact that a host cell contains a foreign substance. If the displaying host cell encounters a T cell with the appropriate receptor, the antigen receptor on the T cell combines with both the MHC molecule AND the epitope.



B and T Cell Development

Please read through the textbook and list the four major characteristics of adaptive immunity:

- 1.
- 2.
- 3.
- 4.

To put numbers on the variety of B and T cells synthesized by the immune system:

A person makes more than _____ different B cell antigen receptors.

A person makes more than _____ different T cell antigen receptors.

A Really Broad Examination Of The Way Vertebrates Make Such A Huge Variety Of Antigen Receptors:

Are the light and heavy chains synthesized together or independently? _____

Do gene splicing and recombination occur during antigen receptor synthesis? _____ (Yes / No)

Does mutation occur during antigen receptor synthesis? _____ (Yes / No)

Are there huge numbers of genes that encode for all of these millions and millions of antigen receptors (each a different polypeptide)? _____ (Yes / No)

Why Aren't Host Cells Targeted For Attack By B-cell and T-cells?

Well, first, let's deal with the issue of antigen receptor synthesis. Does a host (like a human) manufacture antigen receptors that correspond to the shapes of the epitopes on the host's own cells? _____ (Yes / No). Are the cells harboring these antigen receptors preserved or destroyed? _____. B and T cells are tested for self-specificity in the bone marrow and thymus when they are very young cells. If there is a match between an antigen receptor and a host cell epitope, the young cell is either destroyed by a _____ (programmed cell death) or rendered non-_____. Your textbook does not go into the details of explaining how this recognition occurs or how the self-recognizing cells are destroyed or inactivated. For that, you should be grateful.

Making Larger Populations Of Activated B and T Cells (Proliferation)

Is there a small or huge number of different types of antigen receptor-bearing cells in the immune system? _____
 Are small or huge populations of cells maintained for each specific TYPE of B or T cell? _____
 Can a population of B or T cells be increased upon exposure to a foreign antigen? _____ (Yes / No)
 This is termed p _____.
 If a B or T cell recognizes a nonself antigen, it undergoes m _____ again and again. The result of this proliferation is a c _____.
 All of the offspring cells are _____ (the same as / different from) the original, activated (by exposure to an antigen) cell.
 The cells that take immediate action against the antigen-bearing cells are called _____ cells.
 The effector cells of B cells are called _____ cells. The effector cells of T cells are _____ cells and _____ cells. What type of cell secretes antibodies? _____ Are there memory T cells? _____ (Yes / No)
 Are there memory B cells? _____ (Yes / No) Are memory cells long-lived or short-lived? _____.

What is clonal selection?

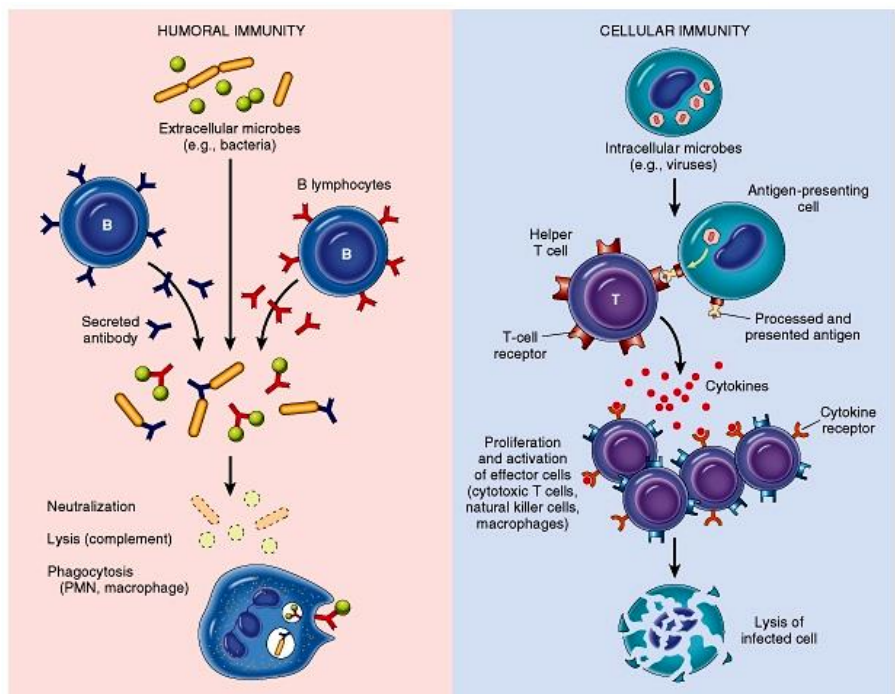
Let's put numbers of the SPEED of the immune response. The primary immune response, upon first exposure to an antigen, takes _____ to _____ days. It takes this long to produce cytotoxic T cells and plasma cells. If an exposure occurs a 2nd time, the response only takes _____ to _____ days, it is of _____ (greater / lesser) magnitude and lasts _____. This is the _____. **This is a hallmark of adaptive (acquired) immunity.**

Do effector cells persist as long as memory cells? _____
 If an antigen is encountered once, CAN it be encountered later in life? _____
 Do B cells and T cells fight infections in the SAME way or in DIFFERENT ways? _____

Concept 43.3 Adaptive Immunity Defends Against Infection Of Body Fluids And Body Cells

If the body's response to pathogen invasion occurs in blood and lymph and involves antibodies from **B-cells**, it is called a _____ response.

If the body's response to pathogen invasion involves cytotoxic and helper **T-cells**, it is called a _____ response.



Helper T-Cells

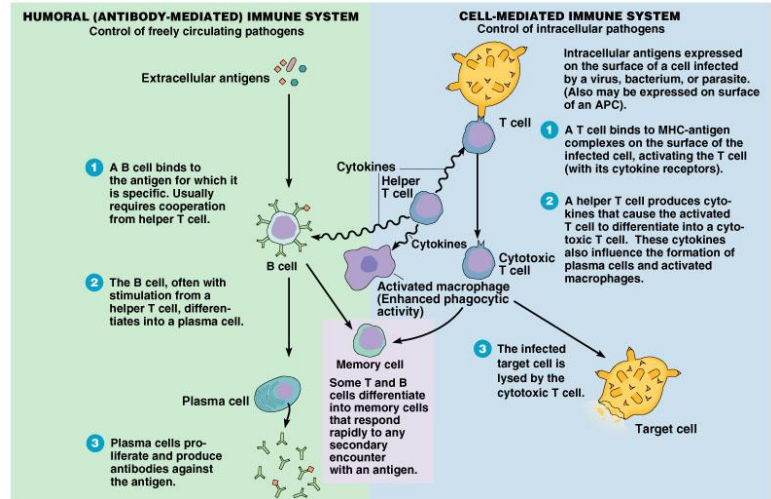
The type of cell that activates BOTH the humoral and cell-mediated responses is the _____. These cells do not carry out the response (ie. they do not "attack" or "produce antibodies".) Rather, they SIGNAL the proliferation of plasma and cytotoxic cells once pathogen entry is detected. Two things must happen for T-cells to initiate the adaptive response: first, a helper T-cell must bind specifically to an invading cell's antigen, and second, this antigen must be displayed on the surface of an _____. There are three categories of antigen-presenting cells: _____.

When a host (self) cell is infected, they display the antigens of the invader on their cell surface. All body cells have class ____ MHC molecules on their surface, but infected cells have class ____ MHC molecules that combine with the invader's epitope as well. The presentation of the epitope - class II MHC is the signal by which a helper T cell recognizes that the body has been invaded and that it is time to signal the adaptive response.

When a helper T cell recognizes and combines with an infected cell, it releases molecules called _____. For this reason, the contact between the two must be maintained for a somewhat long period of time.

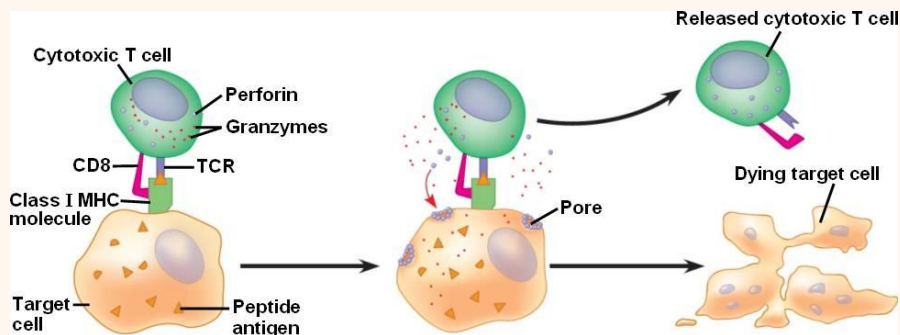
If the antigen-presenting cell is a dendritic cell or a macrophage, the helper T cell proliferates, forming a clone of activated helper T cells.

If the antigen-presenting cell is a B-cell, the helper T cell activates all of the other B-cells of the same type.



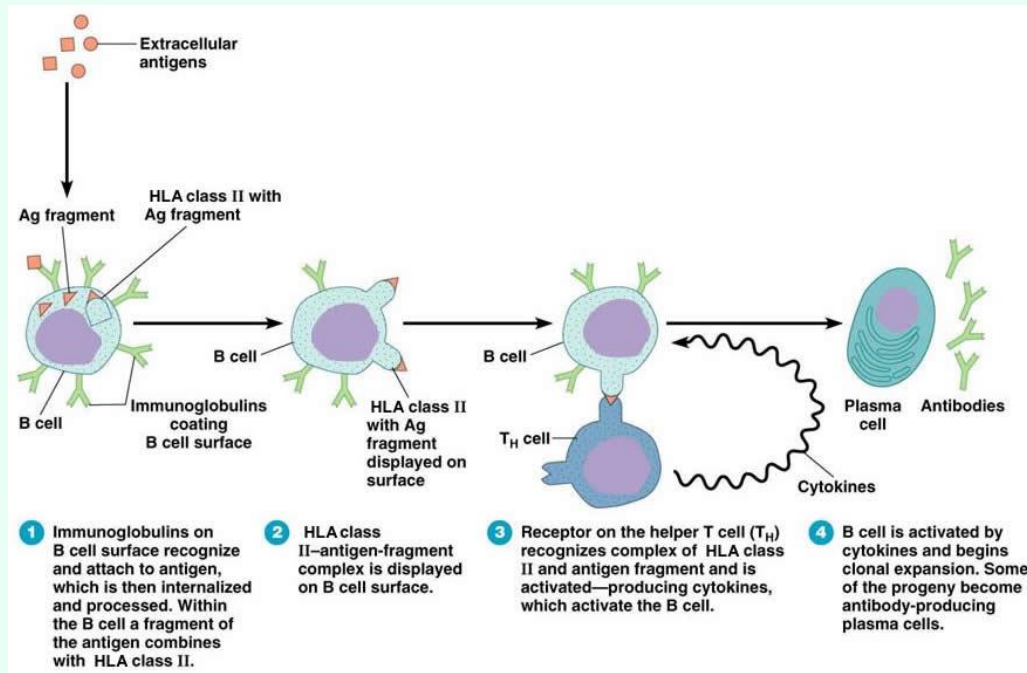
Cytotoxic T Cells

Cytotoxic T Cells are activated by signals from _____ cells. They act by producing t_____g_____p_____ to kill invading cells. Once activated by helper T cells, cytotoxic T cells will ONLY attack cells that display or present a specific antigen. Once activated, cytotoxic T cells can kill _____ (self / nonself) cells that have been invaded by viruses or cancerous cells. Cytotoxic T cells recognize host (self) cells that display an antigen on their class ____ MHC molecules. The two cells (cytotoxic T cell and infected host cell) remain in contact while the T cell is activated. The cytotoxic cell secretes proteins that perforate the infected host cell's _____. Can the cytotoxic cell move on and inactivate another infected host cell? ____ (Yes / No).



B Cells and Antibodies

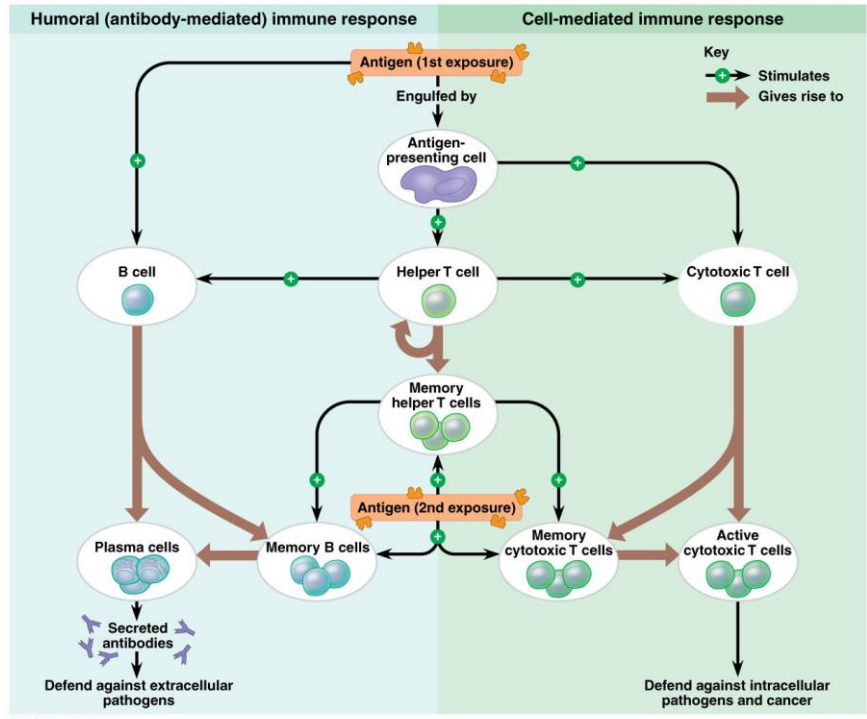
The humoral immune response involves the use of ____ cells, which produce a _____. B cells are activated by cells that contain their specific a _____. B cell activation is aided by cytokines secreted from _____ cells that have encountered the same antigen. Stimulated by both the antigen AND these cytokines, the B cells p _____ and differentiate into p _____ cells, which secrete _____, and _____ cells to pre-arm the organisms against future invasions by the same pathogen. A single activated B cells gives rise to _____ (#) of identical plasma cells. These cells begin secreting a _____. A plasma cell produces _____ antibodies every second of the cell's ____ to ____ day life span. If the invading cell contains multiple epitopes (as most do), several populations of B cells are activated that ALL produce antibodies and clone memory cells.



How Antibodies Function

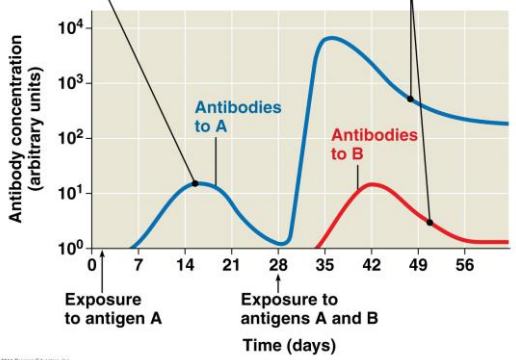
Antibodies _____ (do / do NOT) kill pathogens. Instead, they bind to the a _____ on the surface of the pathogen and mark them for the body to deal with. The "marked" infectious cells will either be inactivated or _____. One way they protect the body is to bind to the antigen so that the antigen-bearing invader cell cannot enter or infect a host cell. This is called _____. Another method of antibody protection involves the union of the antibody with _____ secreted by the infectious cell, thus preventing the toxins from entering the host cell. A third method of antibody utilization results from the union of an antibody with an antigen to target the cells for destruction by macrophages or neutrophils. This is termed _____. A fourth method of antibody utilization results from antibody-antigen unions causing infectious cells to clump together in an aggregate that is immobile and easy for phagocytes to attack. A fifth method of antibody utilization involves creating an antibody-antigen complex that complement recognizes, causing a cascade of protein synthesis that ends in the construction of a membrane attack complex that forms a _____.

Please recall that antibodies are most effective in dealing with infections in body f _____ and b _____. For this reason, the production of antibodies is referred to as the _____ response.



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Primary immune response to antigen A produces antibodies to A.
 Secondary immune response to antigen A produces antibodies to A; primary immune response to antigen B produces antibodies to B.



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Active Immunity or Passive Immunity or Both

- _____ Short lived immunity, no memory cells produced
- _____ Production of plasma cells by B cells after exposure to a foreign antigen
- _____ Passage of immunoglobulin proteins from mother to fetus across the placenta
- _____ Passage of immunoglobulin proteins from mother to fetus in breast milk
- _____ Vaccination can provide immunity artificially
- _____ Vaccines against polio, small pox, measles
- _____ Antivenin given immediately after a snake bite

Fill-ins

- _____ Human pregnancy tests use _____ antibodies to test for human chorionic gonadotropin (HCG) in urine.
- _____ A big concern with a transplant or a transfusion _____ rejection.
- _____ Antibodies for blood type are produced because of a _____ that has an epitope similar to the blood type epitopes.
- _____ A person who has type B blood would produce _____ antibodies but not _____ antibodies since those would attack the self cells.
- _____ The problem with organ transplants are the _____ molecules and the variety of genes for these.
- _____ To lower risks of rejection an organ recipient must _____ the immune response.

43.4 Disruptions in immune system function can elicit or exacerbate disease.

Disease Matching

Allergies

Autoimmune

Stress/exertion

Immunodeficiency

- _____ Disrupts the endocrine, nervous and immune system homeostasis
- _____ Symptoms include sneezing, runny nose, breathing difficulties
- _____ Severe combined immunodeficiency
- _____ Marathon runners get sick less often during training but more often after the race
- _____ Caused by a loss of self tolerance or the immune system attacking self cells
- _____ The immune system response is absent leading to frequent infections
- _____ The beta cells of the pancreas stop producing insulin (diabetes)
- _____ T cells attack myelin sheath in the central nervous system (multiple sclerosis)
- _____ May cause anaphylactic shock leading to death from being unable to breathe
- _____ Production of antibodies against pollen grains
- _____ A lack of sleep causes you to be more susceptible to things like the common cold
- _____ Symptoms include rashes, fever, kidney dysfunction (lupus)
- _____ Development of immune cells is disrupted
- _____ Mast cells release histamine and inflammatory chemicals

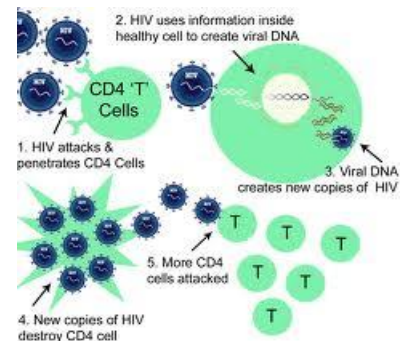
Pathogens have evolved to avoid immune responses just as immune responses have evolved to fight off pathogens. Match the evolutionary adaptations to the descriptions below.

Antigenic Variation

Latency

Attacking the Immune System/HIV

- _____ Change in the epitopes prevent the memory cells from recognizing the pathogen again
- _____ Influenza is an example
- _____ The reason there is a need for booster vaccinations or vaccinations every year
- _____ Virus is able to go dormant for a period of time
- _____ Herpes simplex virus is an example
- _____ Infects helper T cells
- _____ Performs reverse transcriptase and becomes part of the DNA
- _____ Transported by body fluids containing cells with the virus particle



Cancer and Immunity

- _____ When adaptive immunity is inactivated the frequency of cancer _____.
- _____ Viruses are involved in _____ of all human cancers.
- _____ A vaccine has been developed for _____ that leads to cervical cancer
- _____ Cervical cancer kills _____ women annually in the United States.

Innate and Adaptive Immunity

All animals have **innate immunity**. This form of immunity is immediately active upon i _____ and is the same whether or not a p _____ has been encountered. Innate immunity always involves a s _____ or a s _____ found on the outside of an animal. Pathogens can still bypass this outer covering, because animals exchange materials with their environment and there are various openings to the environment, including those associated with the r _____, d _____, and r _____ systems. Located at or close to these openings are c _____ s _____ that trap or kill microbes. The linings to these passageways also provide protection from microbial invasion.

If, however, microbes enter the body, then a completely different set of responses are necessary. Once inside the body, the invader is no longer an outsider. BUT, it is still foreign to the body. The body must have some way of recognizing it as an invader (or a n _____ cell) and killing it. In other words, an immune system must be able to distinguish n _____ cells from s _____ cells. All of the body's self cells can trace their ancestry to the zygote that the animal began life as. None of the nonself cells came from this zygote, so they have a different genealogy and different identifying proteins. Detection of nonself cells is accomplished by m _____ r _____ in which r _____ molecules bind specifically to molecules from foreign cells or self cells containing v _____. This binding of an innate immune receptor to a protein on the surface of a microbe activates the internal defenses of the animal body.

A different (more advanced) form of molecular recognition occurs in vertebrates. This type of recognition results in a _____ i _____. Animals with THIS type of immunity produce a huge number of different types of r _____, each of which can recognize a surface molecule in a particular pathogen. Because of this, adaptive immunity involves a very high level of s _____. The adaptive immune response is also known as the a _____ immune response. The innate response, of course, occurs much more _____ (quickly / slowly). However, the adaptive response is a much more specialized, dedicated response and protection that lasts for a much _____ (longer / shorter) period of time.

Matching - Innate (I) and Adaptive (A) Immunity

- | | |
|--|--|
| _____ Utilized in vertebrates only. | _____ Cytotoxic cells |
| _____ Utilize antibodies | _____ Skin, hair, nails, fur |
| _____ Identification of particular pathogens | _____ Use of a wide range of receptors |
| _____ Phagocytic cells | _____ Mucous membranes |
| _____ Response measured in days or weeks | _____ Use of acids for protection |