Name ______________________

Bozeman—"The Immune System" Video Questions

Homework: Tuesday 3/29 (due Wednesday 3/30)—only page 1 of this packet!!!

1. What are the 3 levels of defense? What are they analogous to in a castle?

Level of defense	Castle Part	Immune System…how does this protect you?
Non-specific	Castle Wall	**Skin**-barrier, low pH, anti-viral chemicals & helpful bacteria
		Inflammation- Macrophage-
Specific		Antibodies-

Finish filling this in!

2. How does specific immune response make it hard for the same pathogen (invader) to attack you twice?

(√= 0:15)

3. Where will you find the stuff that makes up "humoral response" in your body?

4. What's the main job of the B lymphocytes?

5. What is your body attacking when a "cell-mediated response" happens in your body?

(Time √= 8:38 to 10:27)

6. Summary time… pull out helpful information from the portion of the video labeled "A Battle on Two Fronts". FOCUS on big ideas, don't get overwhelmed by the details!

End video notes and/or watching at 10:27

Wed. 3/30 HW (due Th. 3/31)

The Action of Phagocytes

Human cells that ingest microbes and digest them by the process of **phagocytosis** are called **phagocytes**. All are types of white blood cells. During many kinds of infections, especially bacterial infections, the total number of white blood cells increases by two to four times the normal number. The ratio of various white blood cell types changes during the course of an infection.

How a Phagocyte Destroys Microbes

1 Detection
Phagocyte detects microbes by the chemicals they give off and sticks the microbes to its surface.

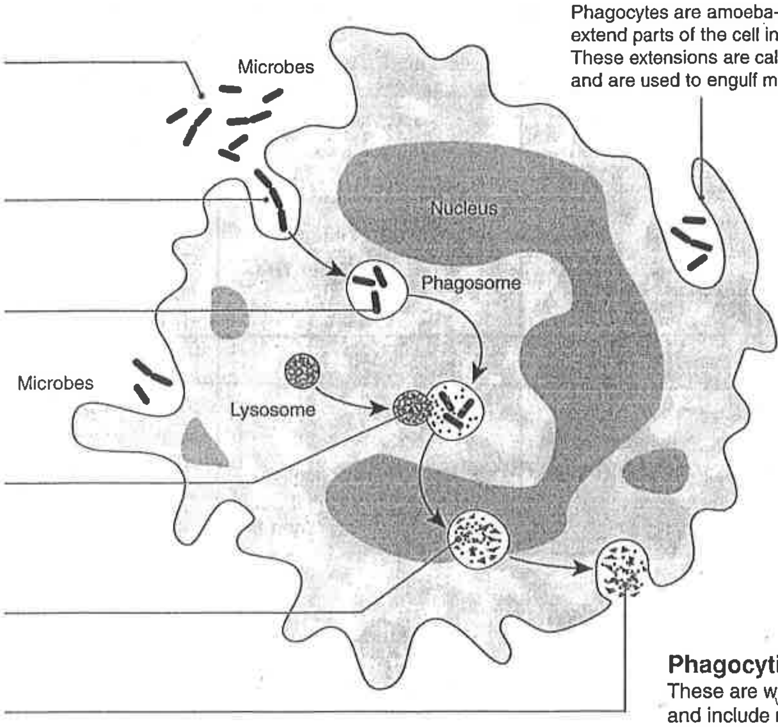
2 Ingestion
The microbe is engulfed by the phagocyte wrapping pseudopodia around it to form a vesicle.

3 Phagosome forms
A phagosome (phagocytic vesicle) is formed, which encloses the microbes in a membrane.

4 Fusion with lysosome
Phagosome fuses with a lysosome (which contains powerful enzymes that can digest the microbe).

5 Digestion
The microbes are broken down by enzymes into their chemical constituents.

6 Discharge
Indigestible material is discharged from the phagocyte cell.

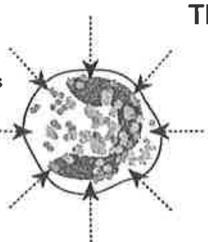


Phagocytes are amoeba-like cells that can extend parts of the cell in different directions. These extensions are called **pseudopodia**, and are used to engulf microbes.

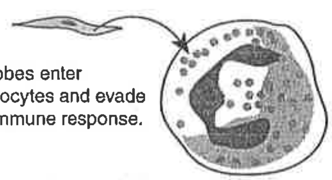
Phagocytic cell
These are white blood cells and include **neutrophils** and **eosinophils**.

The Interaction of Microbes and Phagocytes

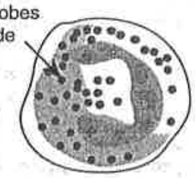
Some microbes kill phagocytes.



Microbes enter phagocytes and evade the immune response.



Dormant microbes may hide inside phagocytes.



Some microbes kill phagocytes
Some microbes produce toxins that can actually kill phagocytes, e.g. toxin-producing staphylococci and the dental plaque-forming bacteria *Actinobacillus*.

Microbes evade immune system
Some microbes can evade the immune system by entering phagocytes. The microbes prevent fusion of the lysosome with the phagosome and multiply inside the phagocyte, almost filling it. Examples include *Chlamydia*, *Mycobacterium tuberculosis*, *Shigella*, and malarial parasites.

Dormant microbes hide inside
Some microbes can remain dormant inside the phagocyte for months or years at a time. Examples include the microbes that cause brucellosis and tularemia.

1. Identify the white blood cells capable of phagocytosis: ______________________________

____

2. Describe how a blood sample from a patient may be used to determine whether they have a microbial infection (without looking for the microbes themselves):

____

____

3. Explain how some microbes are able to overcome phagocytic cells and use them to their advantage:

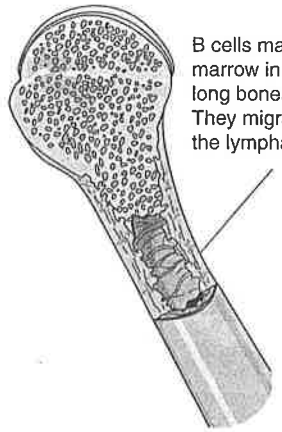
____

Thurs. 3/31 HW (due Fri. 4/1):

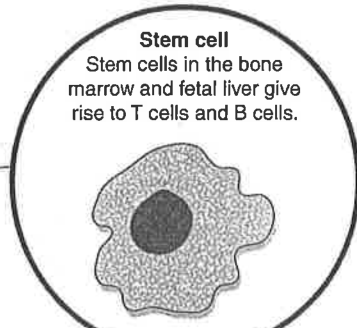
The Immune System

The efficient internal defense provided by the immune system is based on its ability to respond specifically against a foreign substance and its ability to hold a memory of this response. There are two main components of the immune system: the humoral and the cell-mediated responses. They work separately and together to protect us from disease. The **humoral immune response** is associated with the serum (non-cellular part of the blood) and involves the action of **antibodies** secreted by B cell lymphocytes. Antibodies are found in extracellular fluids including lymph, plasma, and mucus secretions. The humoral response protects the body against circulating viruses, and bacteria and their toxins. The **cell-mediated immune response** is associated with the production of specialized lymphocytes called **T cells.** It is most effective against bacteria and viruses located within host cells, as well as against parasitic protozoa, fungi, and worms. This system is also an important defense against cancer, and is responsible for the rejection of transplanted tissue. Both B and T cells develop from stem cells located in the liver of fetuses and the bone marrow of adults. T cells complete their development in the thymus, whilst the B cells mature in the bone marrow.

Lymphocytes and their Functions

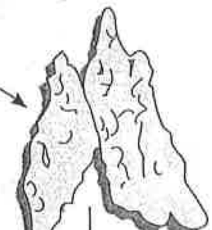


B cells mature in the bone marrow in the shaft of the long bones (e.g. the femur). They migrate from here to the lymphatic organs.

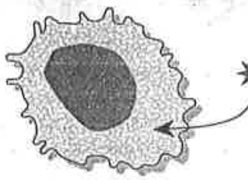


Stem cell
Stem cells in the bone marrow and fetal liver give rise to T cells and B cells.

Thymus gland
The thymus gland is located above the heart on the wind pipe. It is large in infants but regresses with age. Immature T cells move to the thymus to mature before migrating to other lymphatic organs.

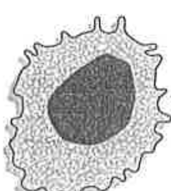


B cell



B cells recognize and bind antigens. Each B cell recognizes one specific antigen. Helper T cells recognize specific antigens on B cell surfaces and induce their maturation and proliferation. A mature B cell may carry as many as 100,000 antigenic receptors embedded in its surface membrane. B cells defend against bacteria and viruses outside the cell and toxins produced by bacteria (free antigens).

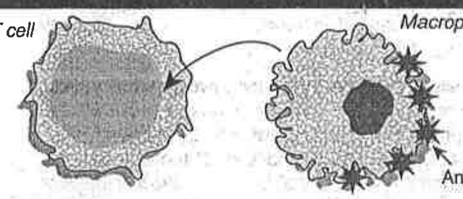
Differentiate into 2 kinds of cells:



Memory cells
Some B cells differentiate into long-lived memory cells (see see Clonal Selection Theory, over page). When these cells encounter the same antigen again (even years or decades later), they rapidly differentiate into antibody-producing plasma cells.

Plasma cells
When stimulated by an antigen (see Clonal Selection Theory, over page), some B cells differentiate into plasma cells, which secrete antibodies into the blood system. The antibodies then inactivate the circulating antigens.

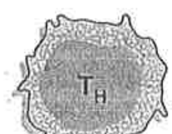
T cell



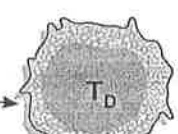
T cells respond only to antigen fragments that have been processed and presented by infected cells or macrophages (phagocytic cells). They defend against:

- Intracellular bacteria and viruses
- Protozoa, fungi, flatworms, and roundworms
- Cancerous cells and transplanted foreign tissue

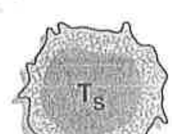
Differentiate into 4 kinds of cells:



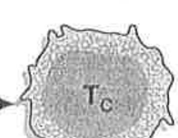
Helper T cell
Activates cytotoxic T cells and other helper T cells. They are necessary for B cell activation.



T cell for delayed hypersensitivity
Protects against pathogens. Causes transplant rejection and inflammation in allergic reactions.



Suppressor T cell
Regulates immune response by turning it off when no more antigen is present.



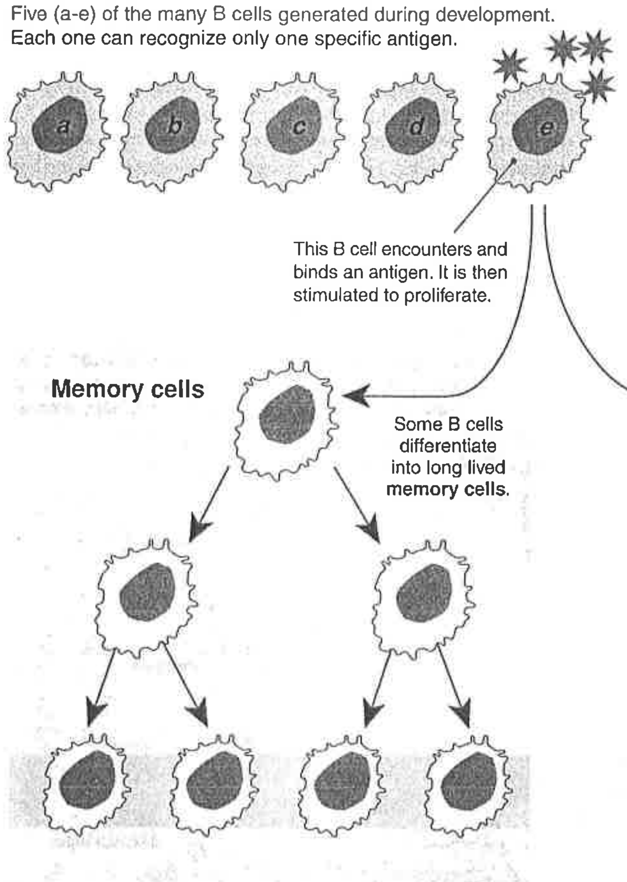
Cytotoxic T cell
Destroys target cells on contact. Recognizes tumor (cancer) or virus infected cells by their surface (antigens and MHC markers).

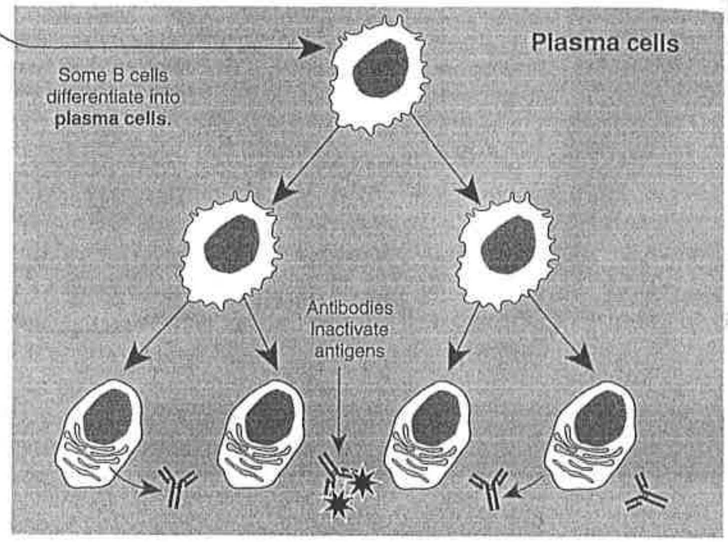
Thurs. 3/31 HW (continued)

In 1955, the Australian **Sir Frank Macfarlane Burnet** proposed the **clonal selection theory** to explain how the immune system is able to respond to the large and unpredictable range of potential antigens in the environment. The diagram below describes **clonal selection** after antigen exposure for B cells. In the same way, a T cell stimulated by a specific antigen will multiply and develop into different types of T cells. Clonal selection and differentiation of lymphocytes provide the basis for **immunological memory**.

Clonal Selection Theory

Millions of B cells form during development. Antigen recognition is randomly generated, so collectively they can recognize many antigens, including those that have never been encountered. Each B cell makes antibodies corresponding to the specific antigenic receptor on its surface. The receptor reacts only to that specific antigen. When a B cell encounters its antigen, it responds by proliferating and producing many clones all with the same kind of antibody. This is called clonal selection because the antigen selects the B cells that will proliferate.





Some B cells differentiate into long lived **memory cells.** These are retained in the lymph nodes to provide future immunity (**immunological memory**). In the event of a second infection, B-memory cells react more quickly and vigorously than the initial B-cell reaction to the first infection.

Plasma cells secrete antibodies specific to the antigen that stimulated their development. Each plasma cell lives for only a few days, but can produce about 2000 antibody molecules per second. Note that during development, any B cells that react to the body's own antigens are selectively destroyed in a process that leads to **self tolerance** (acceptance of the body's own tissues).

1. Describe the general action of the two major divisions in the immune system:

   (a) Humoral immune system: ____________________

   (b) Cell-mediated immune system: ____________________

2. Where do B cells and T cells originate (before maturing)? ____________________

3. (a) Where do B cells mature? ____________ (b) Where do T cells mature? ____________

4. Describe the function of each of the following cells in the immune system response:

   (a) Memory cells: ____________________

   (b) Plasma cells: ____________________

   (c) Helper T cells: ____________________

   (d) Suppressor T cells: ____________________

   (e) Delayed hypersensitivity T cells: ____________________

   (f) Cytotoxic T cells: ____________________

5. Explain the basis of **immunological memory**: ____________________

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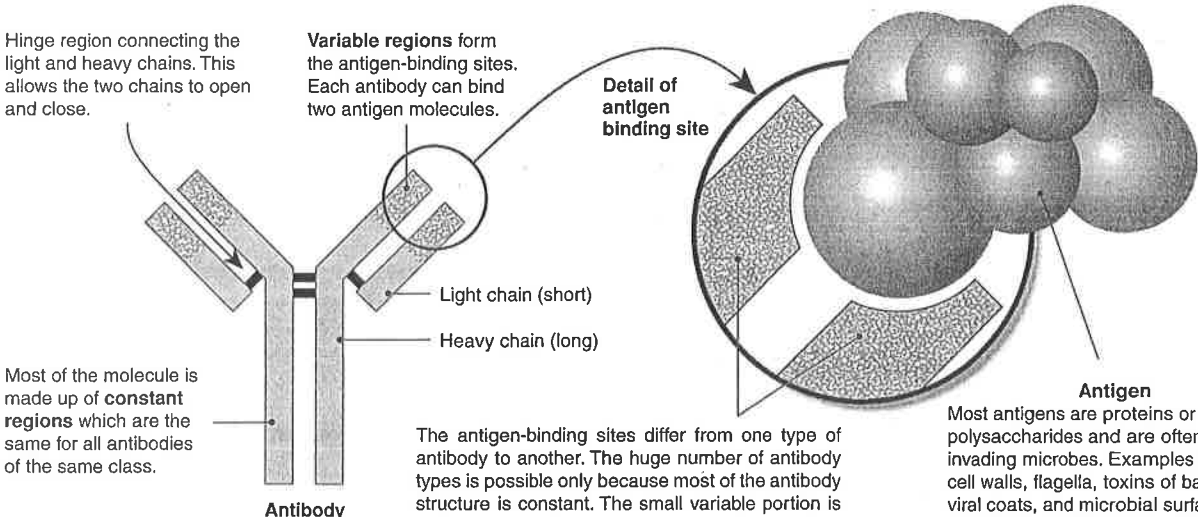
Spring Break HW: Part 2

Antibodies

Antibodies and antigens play key roles in the response of the immune system. Antigens are foreign molecules that are able to bind to receptors and provoke a specific immune response. Antigens include potentially damaging microbes and their toxins (see below) as well as substances such as pollen grains, blood cell surface molecules, and the surface proteins on transplanted tissues. **Antibodies** (also called immunoglobulins) are proteins that are made in response to antigens. They are secreted into the plasma where they circulate and can recognize, bind to, and help to destroy antigens. There are five classes of **immunoglobulins**. Each plays a different role in the immune response (including destroying protozoan parasites, enhancing phagocytosis, protecting mucous surfaces, and neutralizing toxins and viruses). The human body can produce an estimated 100 million kinds of antibodies, recognizing many different antigens, including those it has never encountered. Each type of antibody is highly specific to only one particular antigen. The ability of the immune system to recognize and ignore the antigenic properties of its own tissues occurs early in development and is called **self-tolerance**. Exceptions occur when the immune system malfunctions and the body attacks its own tissues, causing an **autoimmune disorder**.



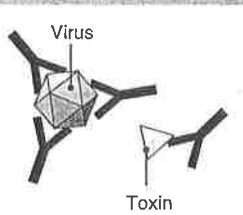
The antigen-binding sites differ from one type of antibody to another. The huge number of antibody types is possible only because most of the antibody structure is constant. The small variable portion is coded by a relatively small number of genes that rearrange randomly to produce an estimated 100 million different combinations.

Antigen
Most antigens are proteins or large polysaccharides and are often parts of invading microbes. Examples include cell walls, flagella, toxins of bacteria, viral coats, and microbial surfaces. The specific site on the antigen that is recognized by the immune system is called the **epitope** or antigenic determinant.

Y Symbolic form of antibody

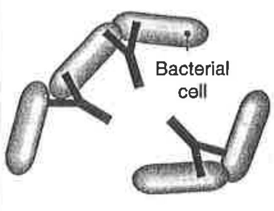
How Antibodies Inactivate Antigens

Neutralization



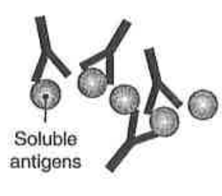
Antibodies bind to viral binding sites and coat bacterial toxins.

Sticking together particulate antigens



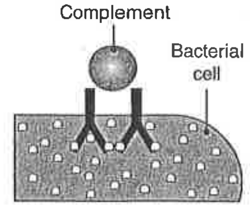
Solid antigens such as bacteria are stuck together in clumps.

Precipitation of soluble antigens



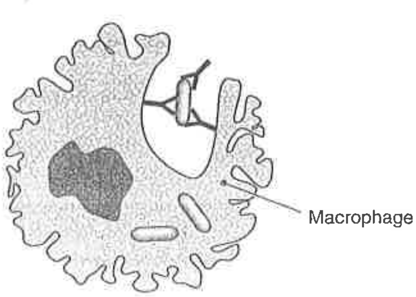
Soluble antigens are stuck together to form precipitates.

Activation of complement

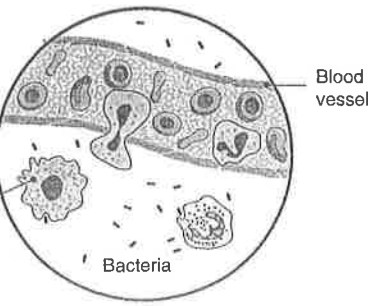


Tags foreign cells for destruction by phagocytes and complement.

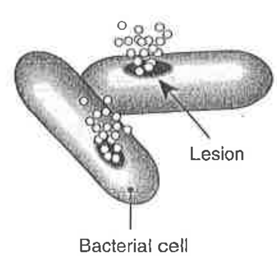
Enhances phagocytosis



Enhances inflammation



Leads to rupture of cell



1. Distinguish between an **antibody** and an **antigen**:

2. Describe the structure of an antibody, identifying the specific features of its structure that contribute to its function:

3. It is necessary for the immune system to clearly distinguish the body's own cells and proteins from foreign ones.

   (a) Why is this the case?

   (b) How does **self tolerance** develop?

   (c) What type of disorder results when this recognition system fails?

   (d) Describe two examples of disorders that are caused in this way, identifying what happens in each case:

Trp- online research this briefly.

4. Discuss the various ways in which antibodies inactivate antigens:

5. Explain how antibody activity enhances or leads to:

   (a) Phagocytosis:

   (b) Inflammation:

   (c) Bacterial cell lysis: