

The Human Immune System



[Video](#)

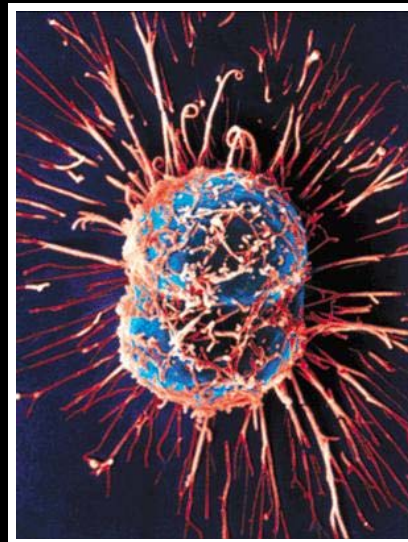
Immune system

- The job of the immune system is to **protect** the body **against pathogens** (foreign particles)
- Types of pathogens include bacteria, virus, and parasites.

Bacteria



Virus



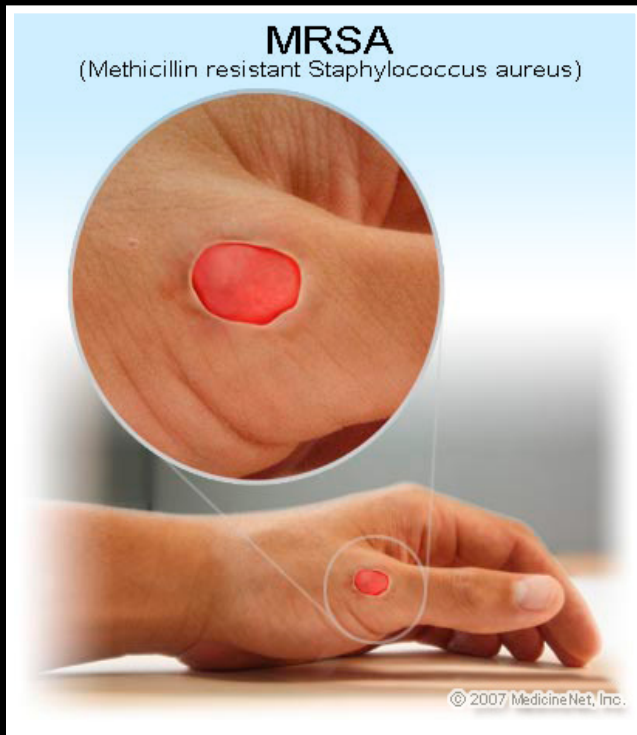
Parasites



Examples of Pathogenic Infections

Pathogen – any **foreign invader** organisms that cause **disease**.

MRSA
(Bacterial)



Oral Herpes
(Viral)



Athlete's Foot
(Fungal)



Why an immune system?

Attack from the outside & inside

- lots of organisms want you for lunch!
- we are a tasty vitamin-packed meal
- cells are packages of proteins, carbohydrates & fats, and cells have no cell wall

Animals must defend themselves against invaders

viruses

HIV, flu, cold, measles, chicken pox, SARS

bacteria

pneumonia, meningitis, tuberculosis

fungi

yeast

protists

amoeba, Lyme disease, malaria

cancer cells

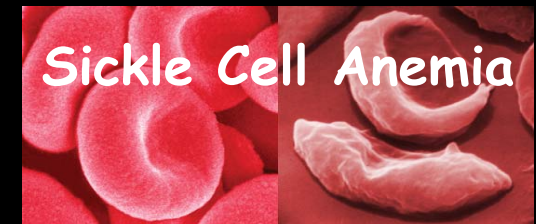
abnormal body cells

What's for lunch?!



Other Causes of Diseases

Inherited disorders

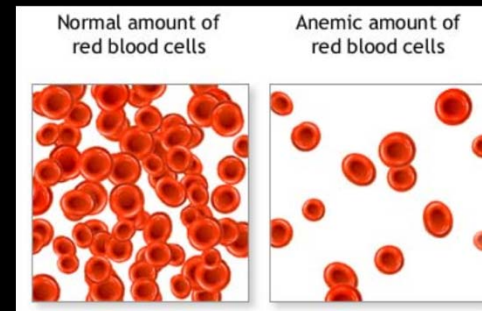


Exposure to toxins



RADIATION POISONING

Poor nutrition
(Goiter, anemia, Scurvy)



Vit. C deficiency



High risk behaviors
(Smoking, tanning, drugs)



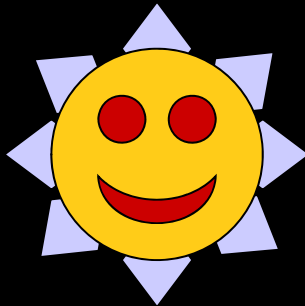
Organ malfunction (Heart Attack, Diabetes)

How are invaders recognized?

- Antigens

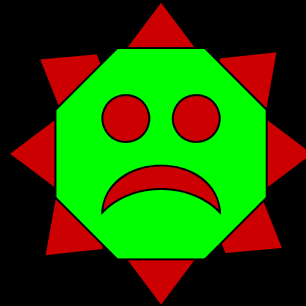
- chemical name tags on the surface of every cell

- “self” vs. “invader”



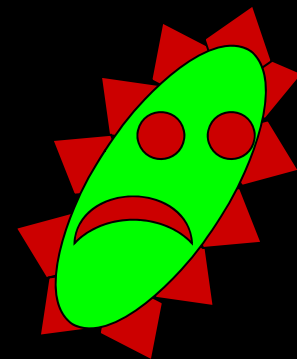
one of your
own cells

antigens say:
“I belong here”



disease-causing
virus

antigens say:
“I am an invader”



disease-causing
bacteria

antigens say:
“I am an invader”

Lines of defense

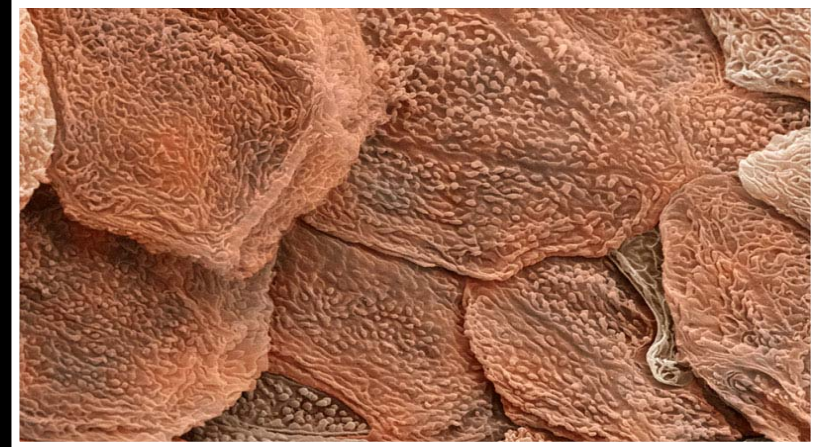
- 1st line: **Barriers**
 - broad, external defense
 - “walls & moats”
 - skin & mucus membranes
- 2nd line: **Non-specific patrol**
 - broad, internal defense
 - “patrolling soldiers”
 - phagocyte (eating) WBCs
- 3rd line: **Immune system**
 - specific, acquired immunity
 - lymphocyte WBCs & antibodies
 - B & T cells



The First Line of Defense (nonspecific)

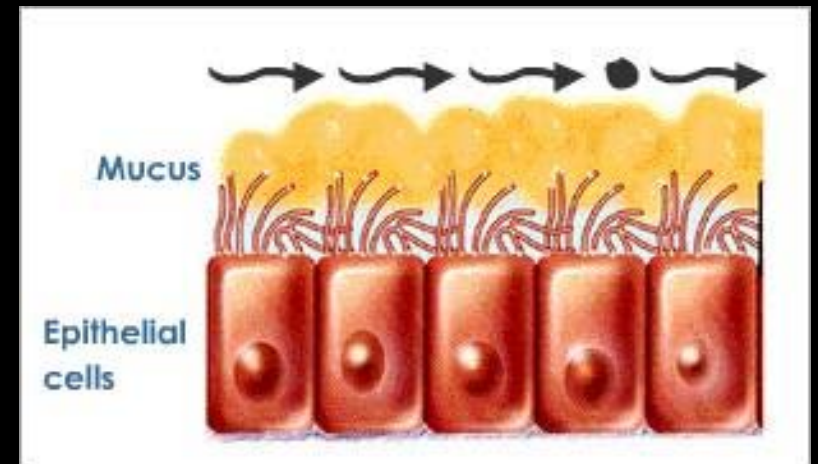
~Skin~

- Skin acts as a **protective covering**, keeping most **pathogens from invading** the body.



~Mucus and Cilia~

- As you breathe in, foreign particles and bacteria bump into **mucus** throughout your respiratory system and get stuck.
- Hair-like structures called **cilia** sweep this mucus into the throat for **coughing** or **swallowing**.



The First Line of Defense (nonspecific)

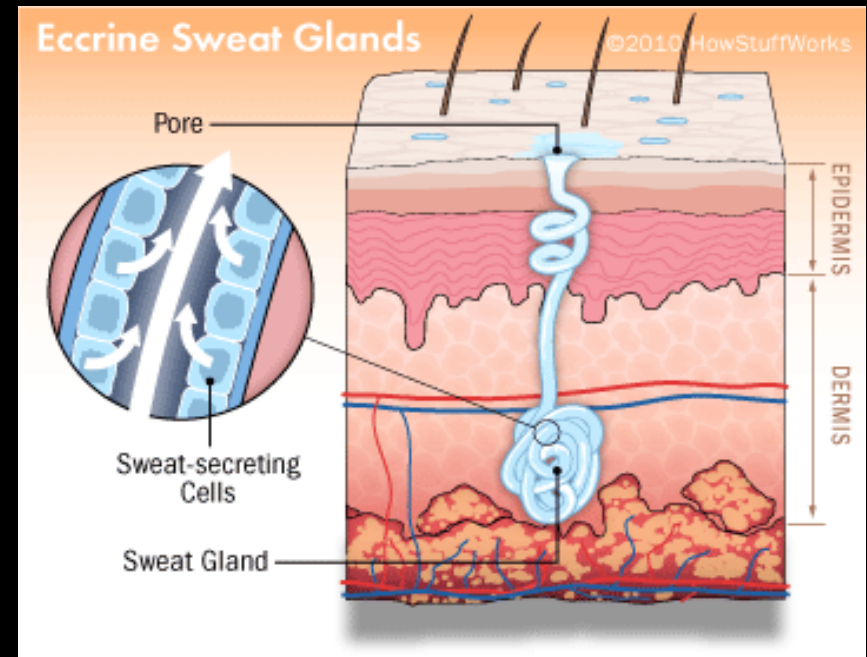
~Sweat and tears~

- Sweat and tear carries many **dangerous microbes** away from the body.



~Oil and sweat glands~

- Oil and sweat glands produce an **acidic environment** that kill many bacteria.



The First Line of Defense (nonspecific)

What's the first thing you do when you cut your finger?

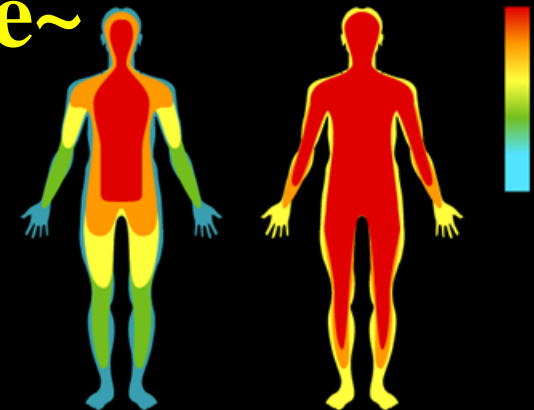
~Saliva~

- Saliva contains many chemicals that **break down bacteria**
- However, thousands of different types of bacteria can survive these chemicals.



~Increase in body temperature~

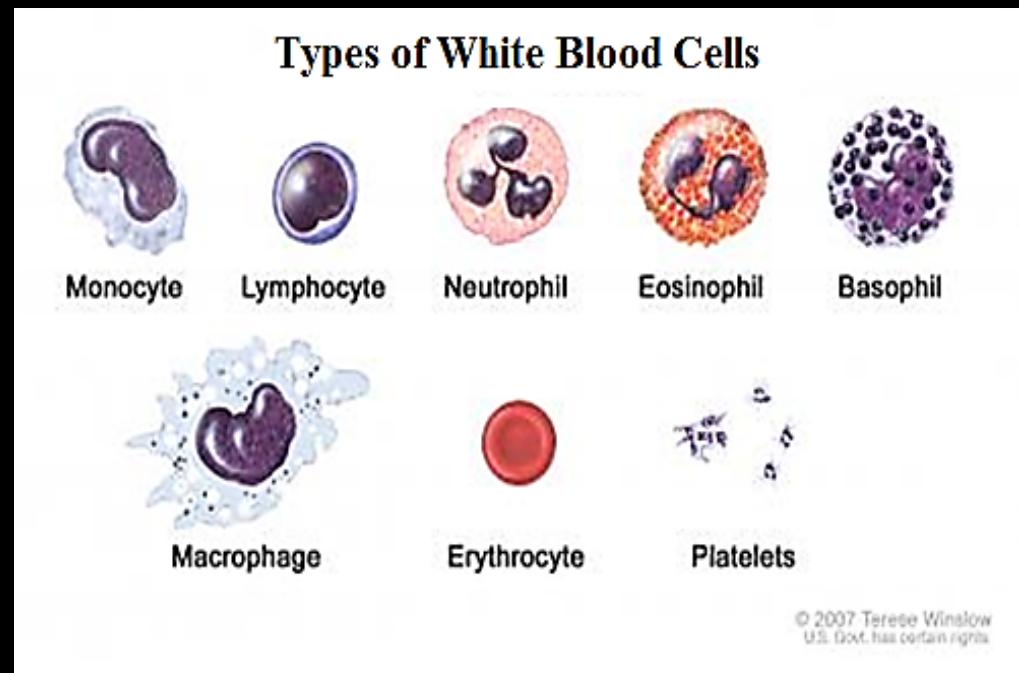
- Increased body temperature may **kill or destroy** some invading pathogens.



The Second Line of Defense (nonspecific)

~White Blood Cells~

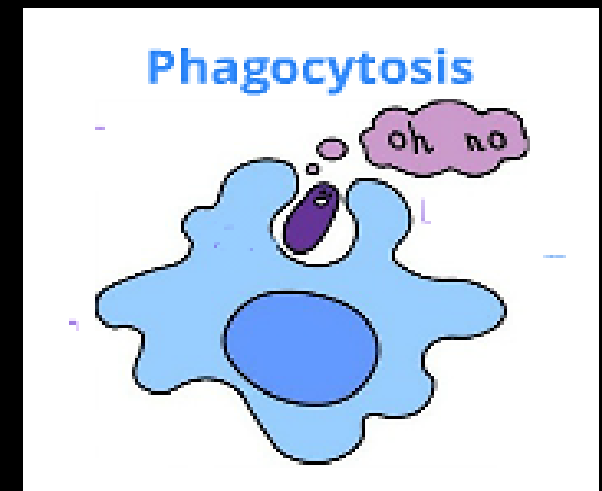
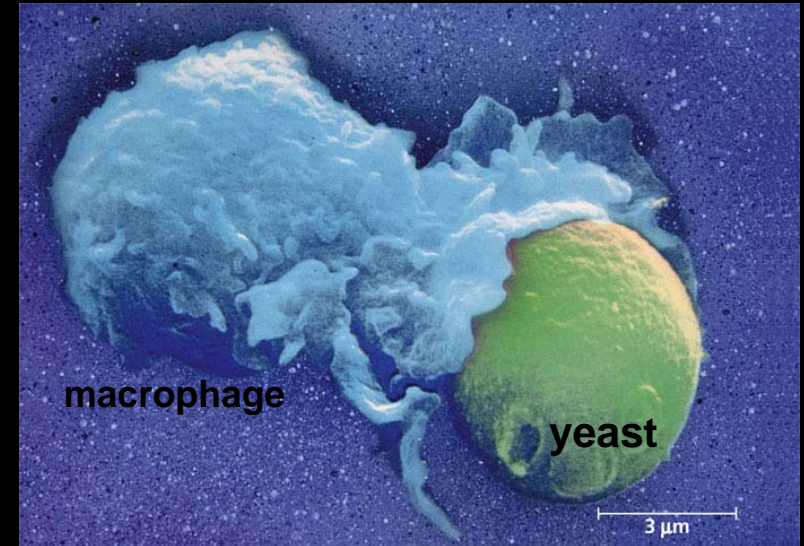
- If invaders actually get **within** the body, then your white blood cells (WBCs) begin their attack
- WBCs normally circulate throughout the blood, but will enter the body's tissues if invaders are detected



White Blood Cells

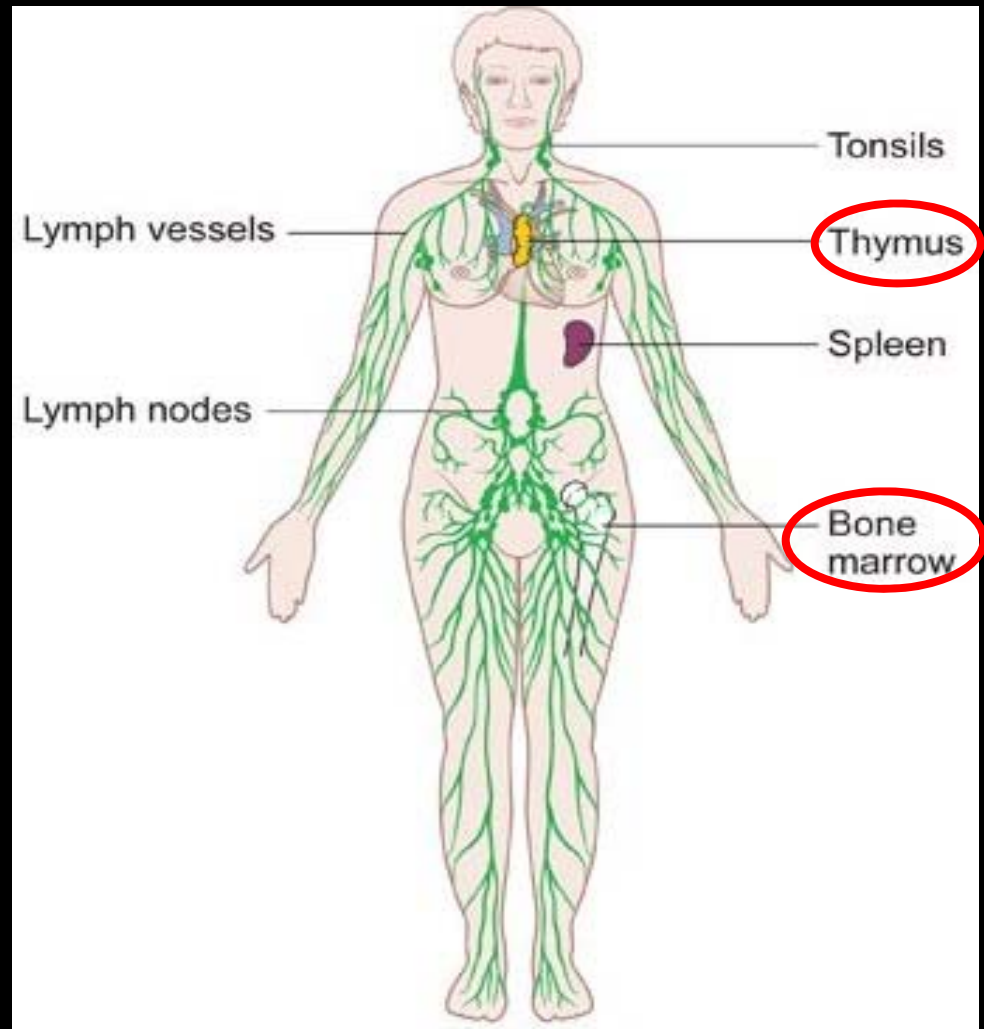
~Phagocytes~

- Type of White Blood Cell (WBC) that consume pathogens through a process called phagocytosis.
- Once engulfed, the phagocyte breaks the foreign particles apart in organelles called lysosomes.



The Lymphatic System - Lymphocytes

- Produces & houses WBC
- Filter's lymph (plasma leaked from capillaries)
- **T cells**
 - "Soldier" cells that **directly combat** the pathogens.
- **B cells**
 - Produces **antibodies** against specific **pathogens**.



Production of white blood cells & traps "foreign" invaders

Third line of defense

Macrophages - engulf foreign objects

– presents foreign antigen to **T cells**

Helper T cells - binds to the antigen and sends chemical messages to **killer T cells** and **B cells**.

Killer T cells - use **chemicals to destroy** invading cells

B cells - produce **antibodies** (secrete them in the blood or position them on their cell surfaces)

When nonspecific methods are not enough and infection becomes widespread.

Antigen Presentation

dendritic cell



1. A phagocyte "eats" a bacteria.



2. Parts of the bacteria (antigen) goes to the surface of the phagocyte



3. The phagocyte presents the antigen to a helper T cell

activated helper T cell



4. The helper T cell is activated.

helper T cell

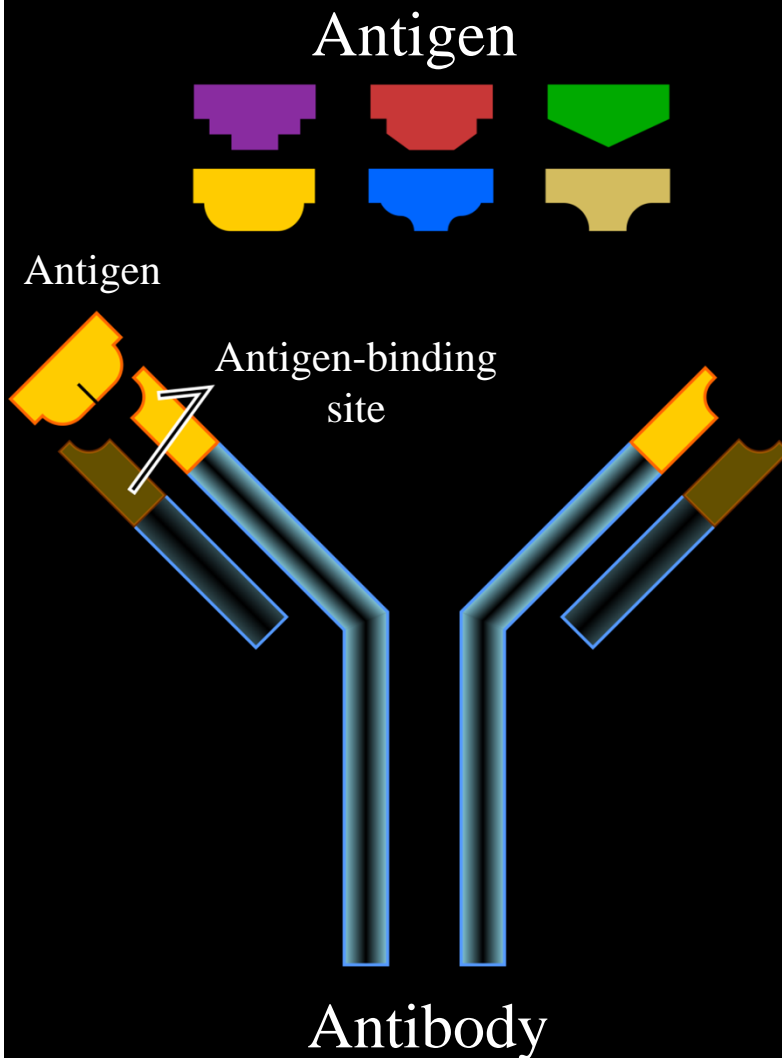
Antibodies

Antibodies are proteins produced by WBC's in response to the presence of a foreign antigen.

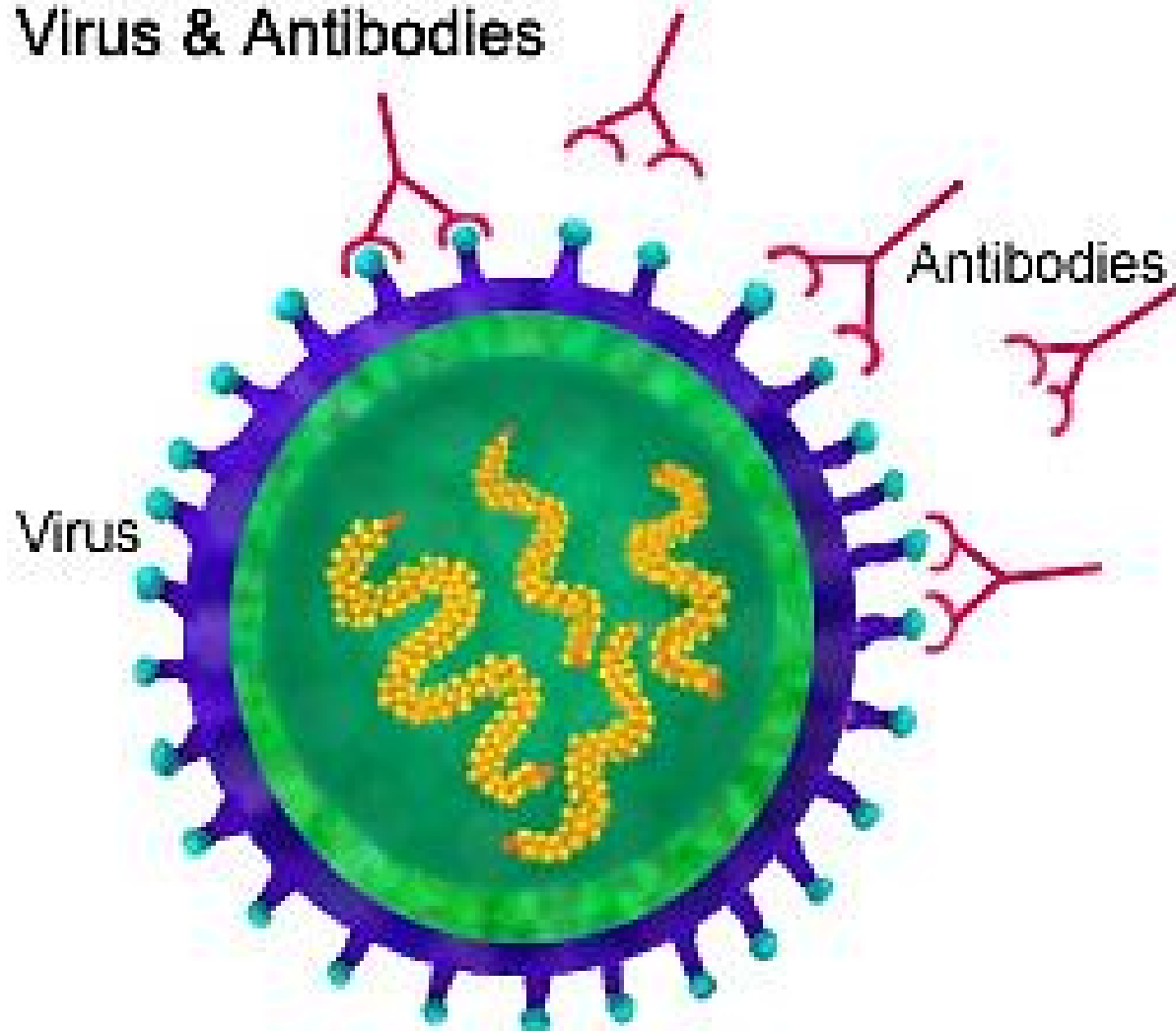
- Mark/label a pathogen for destruction
- are specific, an antibody can only bind to a certain antigen

Antigen

Antigens are proteins on the surface of foreign invading cells.

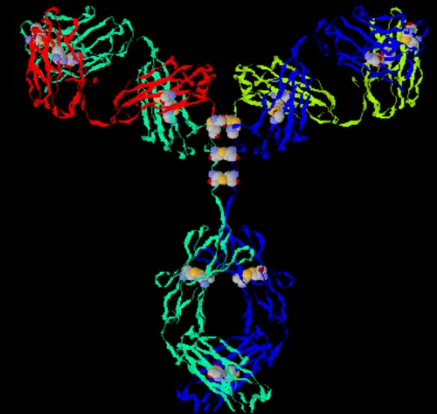
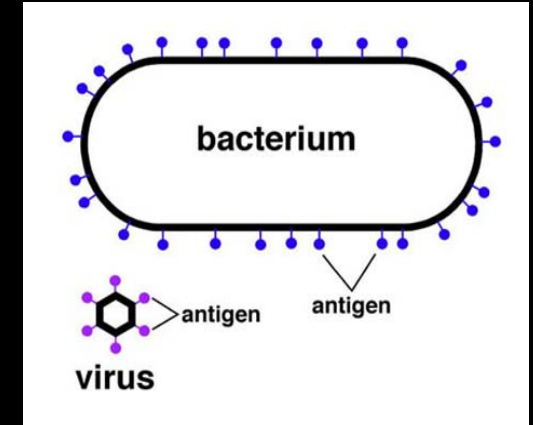
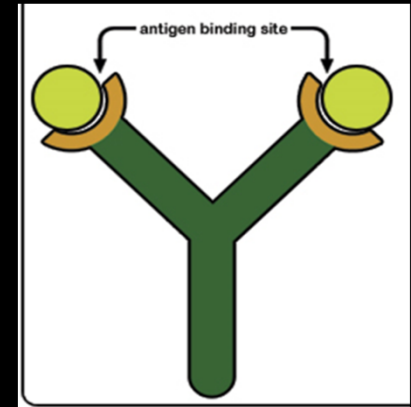


Virus & Antibodies



Antibodies surround the virus and bind to it. This prevents the virus from reproducing or being transported throughout the body.

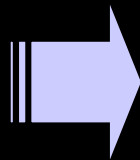
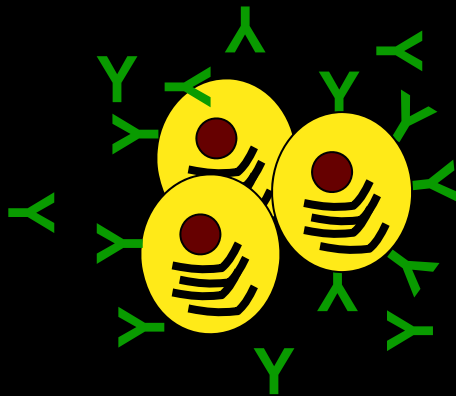
(c) 2006. Duplication not permitted



Antibodies

- Proteins made by B cells that tag invaders in the blood so macrophages can eat them
 - tag says “this is an invader” → gotcha!
 - biological “handcuffs”
 - antibody attaches to antigen of invader

B cells
releasing antibodies

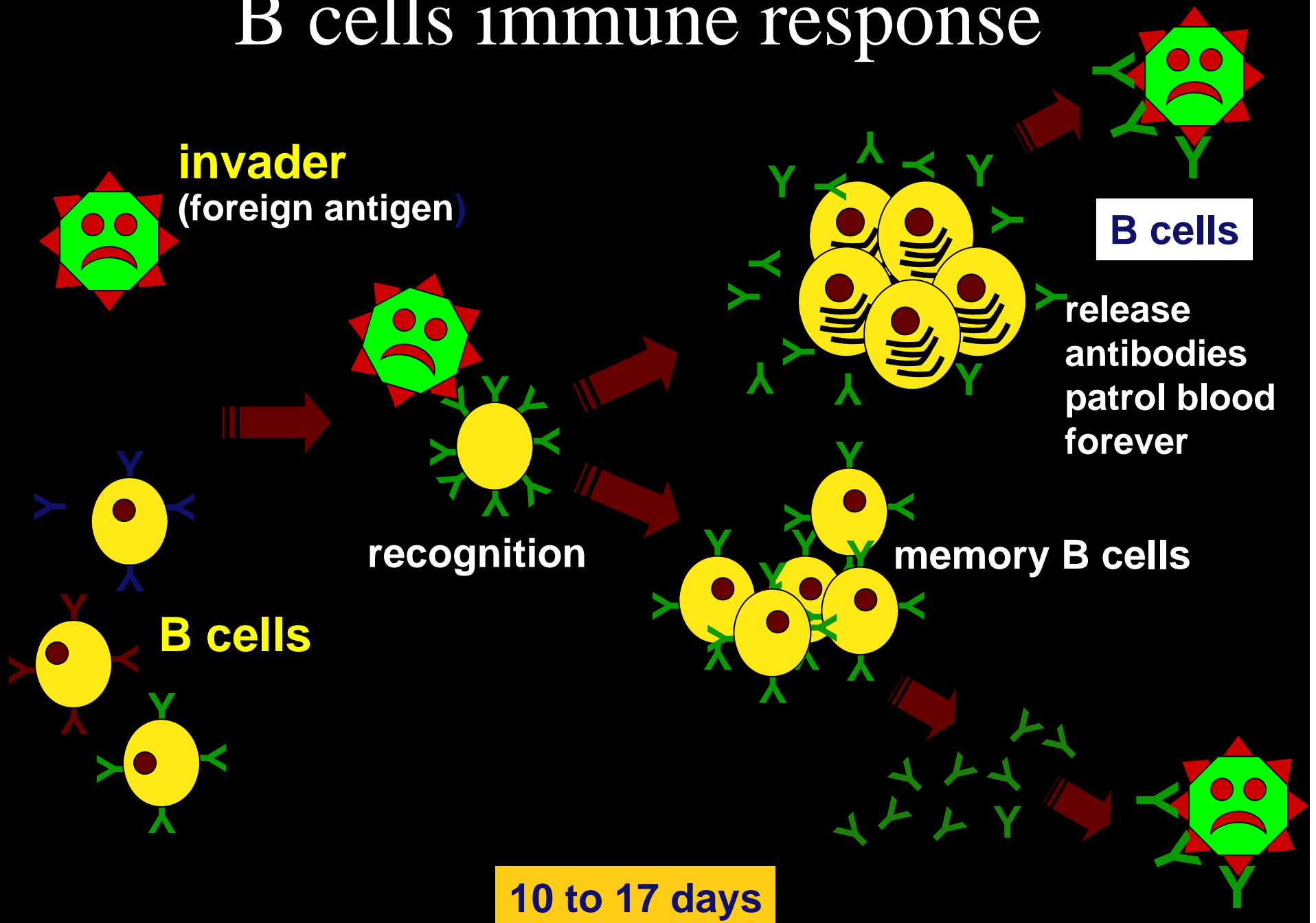


invading germs tagged
with antibodies

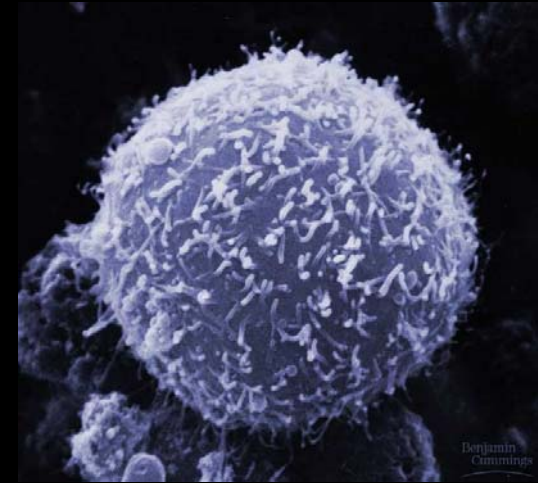


macrophage
eating tagged invaders

B cells immune response

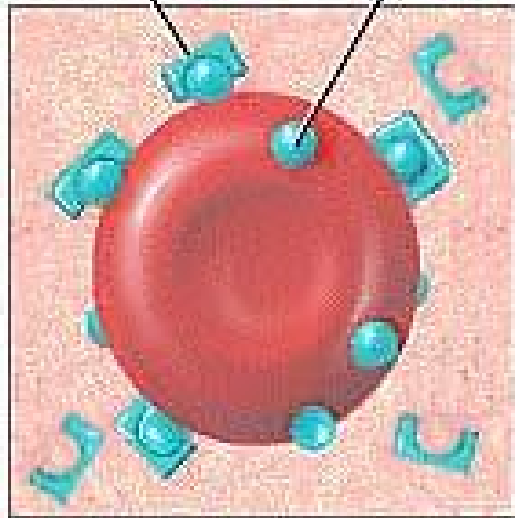


B cells & antibodies



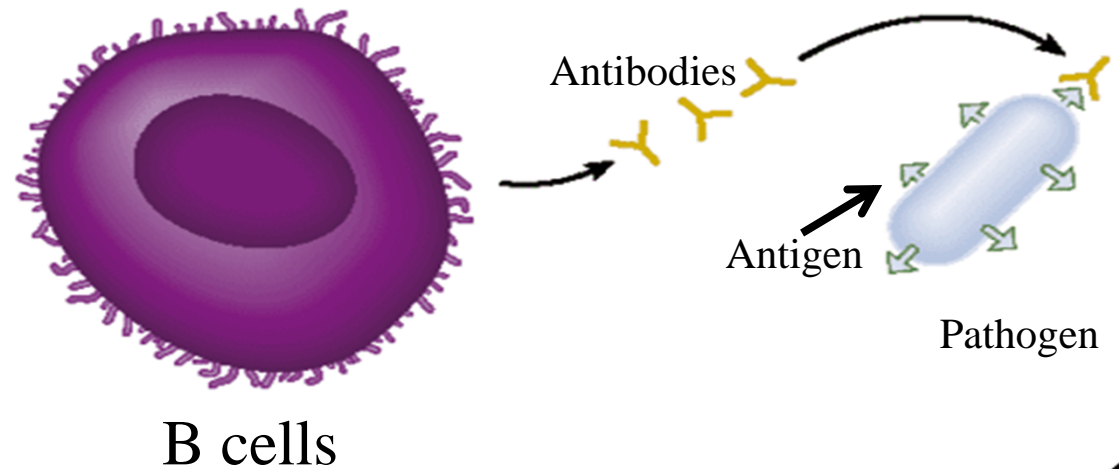
- **B cells**
 - white blood cells that attack invaders in blood
 - mature in Bone marrow
- **Patrolling B cells**
 - make antibodies against invader immediately
- **Memory B cells**
 - remembers invader
 - can make antibodies quickly the next time
 - protects you from getting disease more than once

Antibody
Antigen



Red blood cell

An antibody is a protein produced by the immune system in response to the presence of an antigen



Review

1. Multiple Choice. Whats the job of the immune system
 - A. To help you breathe
 - B. To help move blood through out your body
 - C. To fight diseases
2. Multiple Choice. What is a Pathogen?
 - A. A Microorganism That causes disease
 - B. A Microorganism that fights disease
 - C. A strange looking thing on your skin
3. Multiple Choice. What is the major function of the B-Cells?
 - A. Produce Antibodies
 - B. To kill viruses
 - C. To kill people
4. True or False? The Job of the immune system is to defend against pathogens, viruses and disease.
 - A. True
 - B. False

Lesson 2

Immunity

Active Immunity
Passive Immunity

Are you “immune” to any diseases? Make a list!

Hepatitis B1 HepB

Rotavirus2 RV RV RV2

Diphtheria, Tetanus, Pertussis3 DTaP DTaP DTaP

Haemophilus influenzae type b4 **Hib Hib Hib4**

<http://www.cdc.gov/hi-disease/>

Pneumococcal5 PCV PCV PCV

Inactivated Poliovirus6 IPV IPV

Influenza7

Measles, Mumps, Rubella8

Varicella9 (chicken pox)

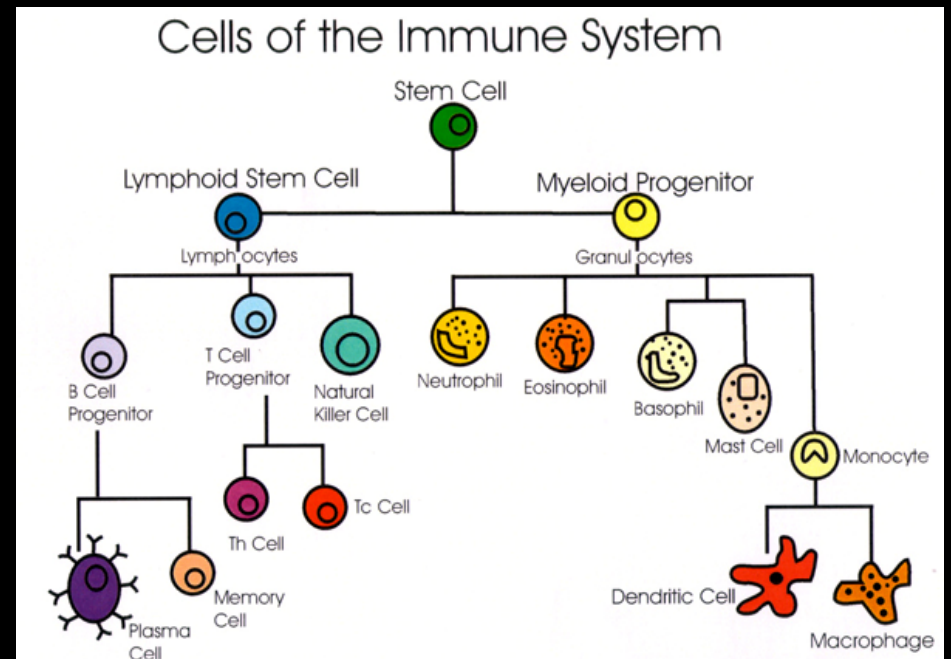
Hepatitis A10

Meningococcal11



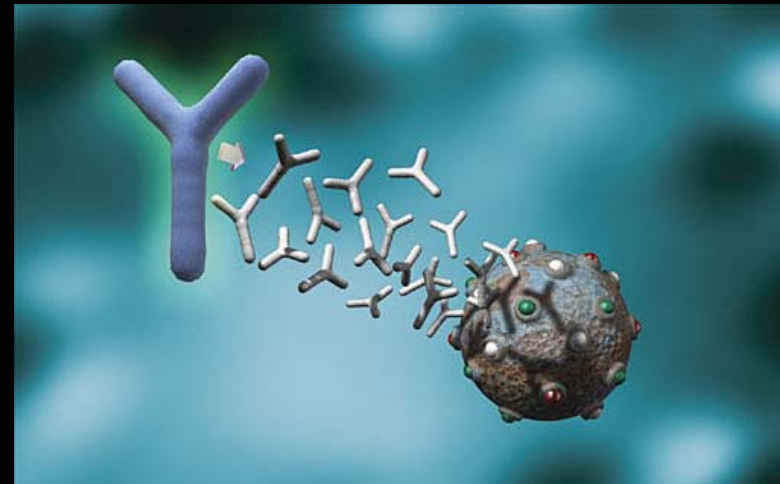
Immunity

- New particles take longer to identify, and a person remains ill until a **new antibody** can be made
- Old particles are quickly recognized, and a person may never become ill from that invader again. This person is now immune.



What is immunity?

- Resistance to a disease causing organism or harmful substance
- Two types
 - Inborn Immunity
 - Acquired Immunity
 - ❖ Passive Immunity
 - ❖ Active Immunity



Inborn Immunity – immunity to certain diseases present at birth.

Acquired Immunity – immunity that is gained during one's lifetime.

How do we develop “immunity”?

Acquired Immunity

1) PASSIVE IMMUNITY

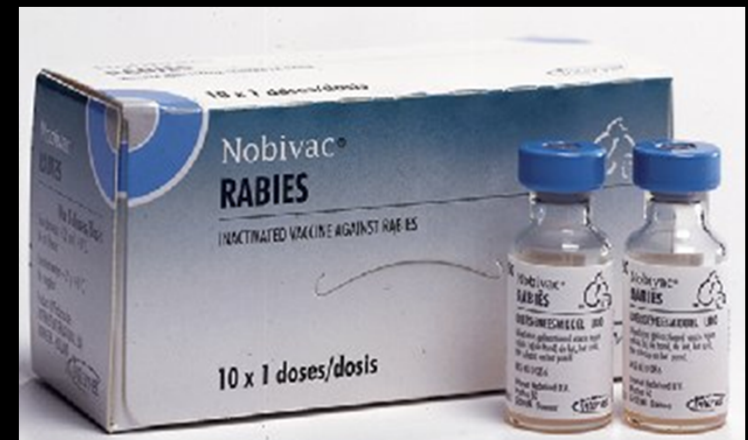
- Antibodies are obtained from an outside source, **NOT made by the body**
- Only temporary (short term)

A. Breast Milk

- Mother’s **antibodies** are passed to the **baby** during breastfeeding

B. Rabies shot

- Injection of **antibodies** by doctor after exposure.



Acquired Immunity

2) ACTIVE IMMUNITY

- Antibodies are PRODUCED by the body
- PERMANENT (long term)



A. Vaccination / Vaccine

- small amount of a dead or weakened pathogen (or its antigens) is injected into the bloodstream
- This stimulates the WBC to produce antibodies & prepares the body for future invasions by that same microbe (immunological memory)



Vaccine

- **Antigens are deliberately** introduced into the immune system to produce immunity
- Because the bacteria has been killed or weakened, minimal symptoms occur
- Have eradicated or severely limited several diseases from the face of the Earth, such as **polio** and **smallpox**



The **flu** is caused by **MANY different kinds of viruses** (which can mutate), it's impossible to vaccinate against all, must get new shot each year to protect against the most common strains present at that time

Think the flu is no big deal?

- Think again...
- In 1918, a particularly deadly strain of flu, called the Spanish Influenza, spread across the globe
- It infected 20% of the human population and killed 5%, which came out to be about 30 - 50 million people



B. Contract & Survive the Disease:

- ex. common cold, chicken pox
- your white blood cells will produce antibodies to fight it off
- usually, you will not get sick from that same pathogen again (Immunological memory)
- Then why do I get a cold more than once?
 - There are MANY strains of viruses that cause the symptoms of “the common cold” and they can mutate

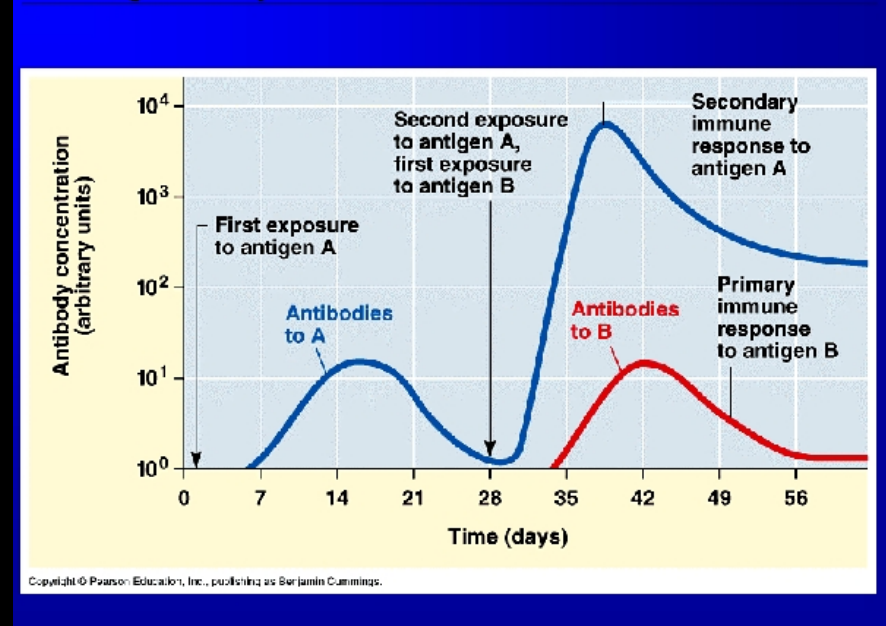


Immunological Memory

Immunological Memory

- Once antibodies have been created, the body always remembers how to make them (memory cells)
- This is why you usually only get the chicken pox virus once

Immunological memory



Review

- 1 The immune system of humans may respond to chemicals on the surface of an invading organism by
 - (1) releasing hormones that break down these chemicals
 - (2) synthesizing antibodies that mark these organisms to be destroyed
 - (3) secreting antibiotics that attach to these organisms
 - (4) altering a DNA sequence in these organisms

2. Vaccinations help prepare the body to fight invasions of a specific pathogen by

(1) inhibiting antigen production

(2) stimulating antibody production

(3) inhibiting white blood cell production

(4) stimulating red blood cell production



3. A vaccine used against an infectious disease may contain

(1) specialized blood cells

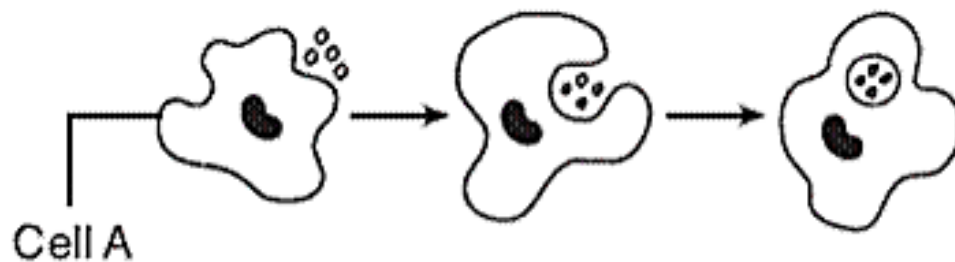
(2) toxic enzymes

(3) a variety of antibiotics

(4) weakened pathogens



4 The diagram below represents an event that occurs in the blood.



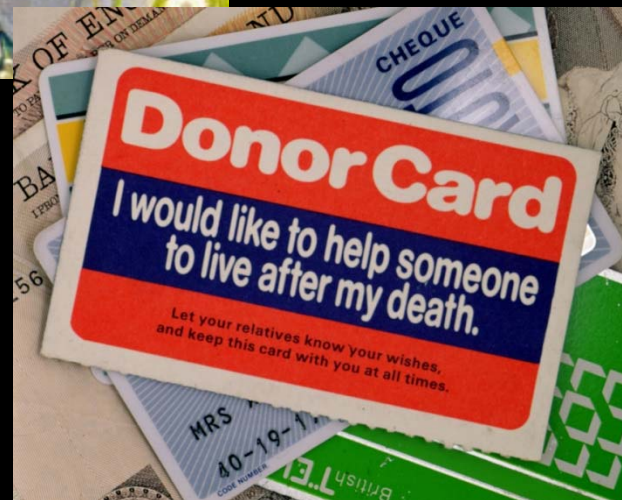
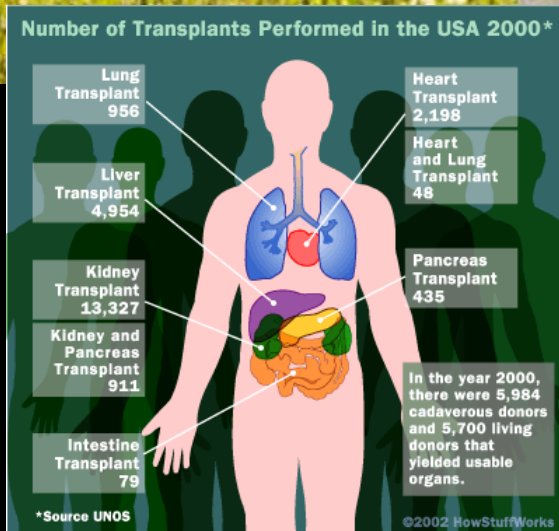
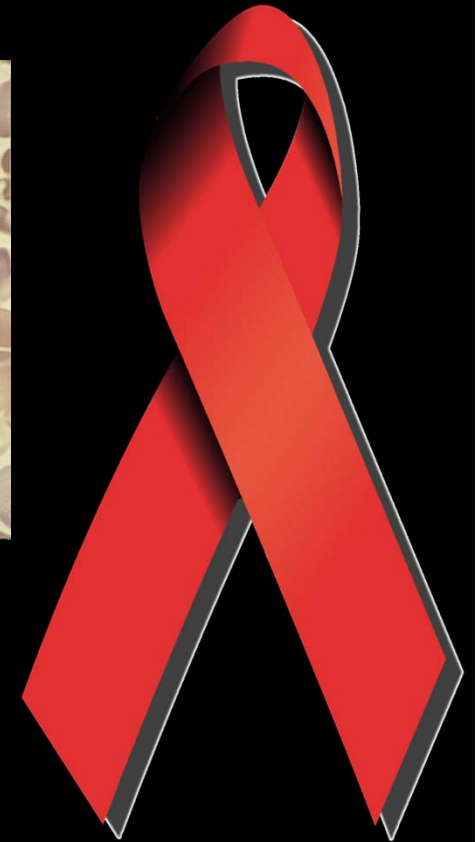
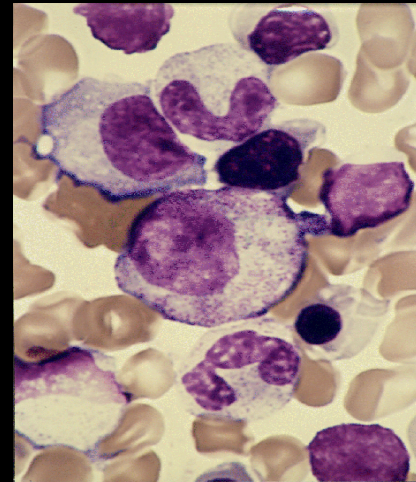
Which statement best describes this event?

- A. Cell *A* is a white blood cell releasing antigens to destroy bacteria.
- B. Cell *A* is a cancer cell produced by the immune system and it is helping to prevent disease.
- C. Cell *A* is a white blood cell engulfing disease causing organisms.
- D. Cell *A* is protecting bacteria so they can reproduce without being destroyed by predators.

5. Scientific studies have indicated that there is a higher percentage of allergies in babies fed formula containing cow's milk than in breast-fed babies. Which statement represents a valid inference made from these studies?

- A. Milk from cows causes allergic reactions in all infants.
- B. Breast feeding prevents all allergies from occurring.
- C. There is no relationship between drinking cow's milk and having allergies.
- D. Breast milk most likely contains fewer substances that trigger allergies.

Malfunctions and Disorders of the Immune System



Allergic Reactions

- A **hypersensitive response to substances** (allergens) that are not normally harmful

- **Pollen**

- Plant spores

- **Peanuts, shell fish**

- Cat/dog hair or dander

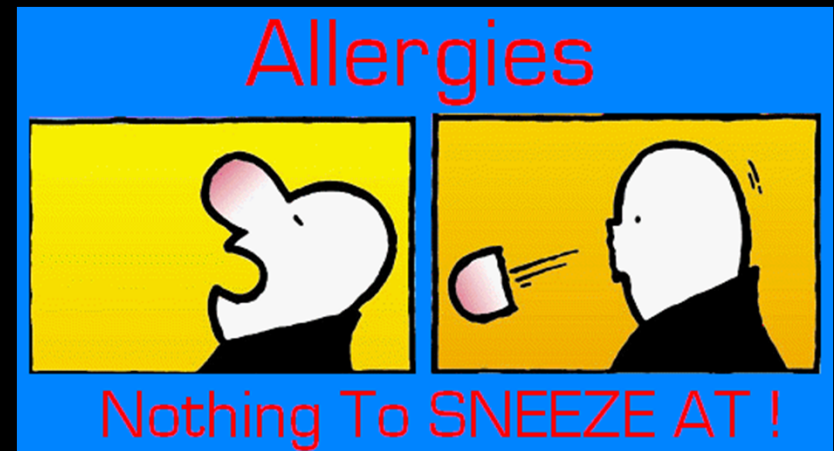


- Antibodies are produced by WBC
 - causes chemical called **histamine** to be produced (leads to itching, swelling, rash)

Allergic Reactions

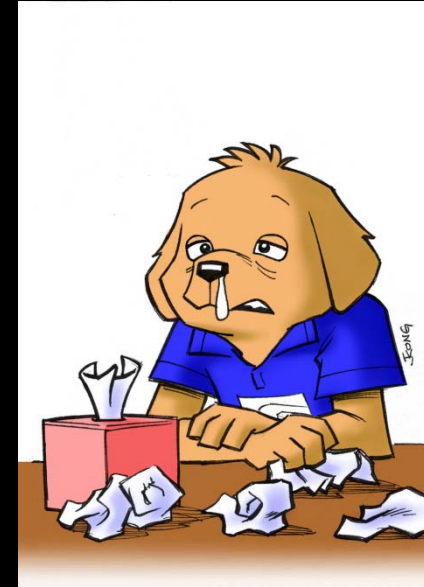
~Allergies~

- Immune system mistakenly recognizes harmless foreign particles as serious threats
- Launches immune response, which causes sneezing, runny nose, and watery eyes
- **Anti-histamines** block effect of histamines and bring relief to allergy sufferers



~The Inflammatory Response~

- Injured body cells release chemicals called **histamines**, which begin inflammatory response
 - Capillaries dilate
 - Pain receptors activate
 - WBCs flock to infected area like sharks to blood



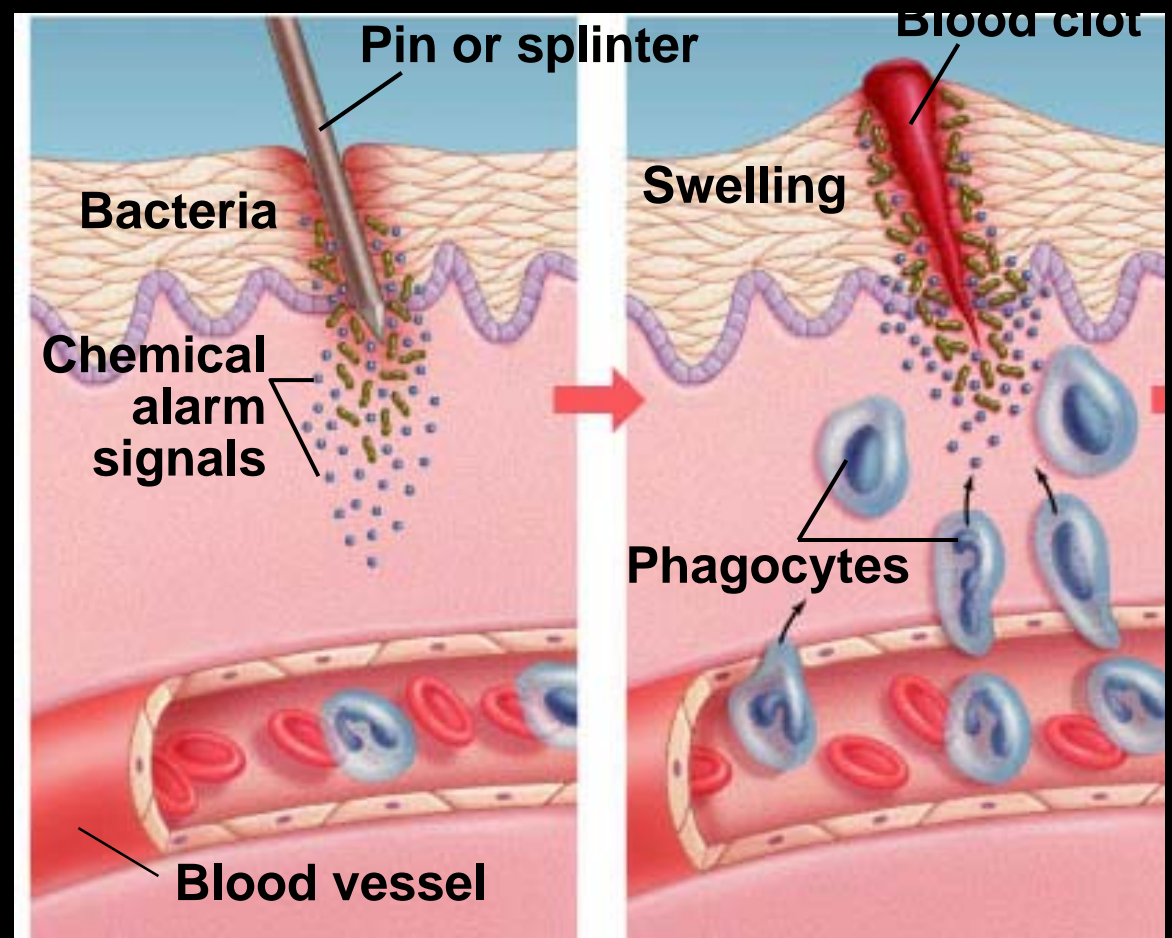
Why do injuries swell?

Inflammation

Injured cells release -

histamines

- increases blood flow
- brings more white blood cells to fight bacteria
- brings more red blood cells & clotting factors to repair



Rejection of Organ Transplant

- Recipient's body **produces antibodies** in response to foreign antigens present in the donor's tissues
- Getting the closest "**match**" reduces risk
- **Immunosuppressant** drugs are usually given to prevent the recipient from rejecting the organ



[Face Transplant Video](#)



AIDS (Acquired Immune Deficiency Syndrome)

- Caused by **HIV** (Human Immunodeficiency Virus) (a Retrovirus)
- Transmitted through **bodily fluids** (blood, semen, vaginal fluids, NOT sweat or saliva)
- Attacks T-Cells, WBC that direct the actions of the immune system
 - Prevents infected person from fighting other diseases like pneumonia or a cold [HIV/AIDS vaccine?](#)
- Reproduces rapidly, undergoes many mutations making it hard to target with drugs

AIDS

~The Modern Plague~

- The HIV virus doesn't kill you – it cripples your immune system
- With your immune system shut down, common diseases that your immune system normally could defeat become life-threatening
- Can show no effects for several months all the way up to 10 years



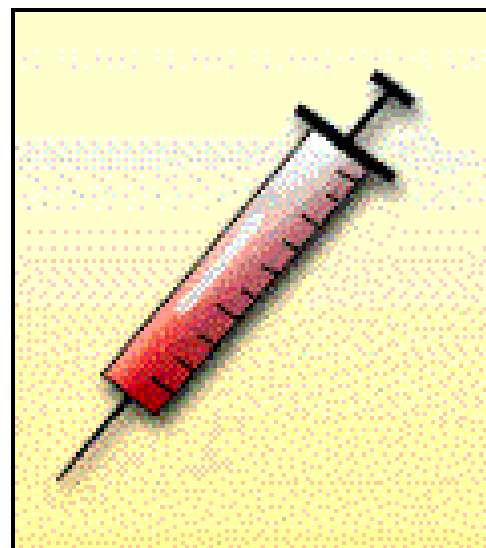


**Unprotected
sexual intercourse
with an infected partner**

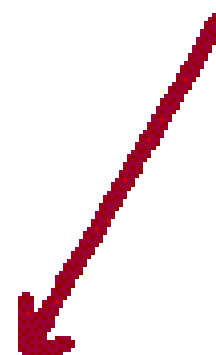
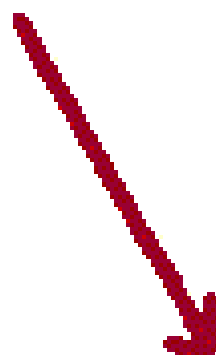


**Vertical
transmission**
(from mother
to child)

- in utero
- during delivery
- breastmilk



Injection drug use
(rare: infected
blood/blood products)



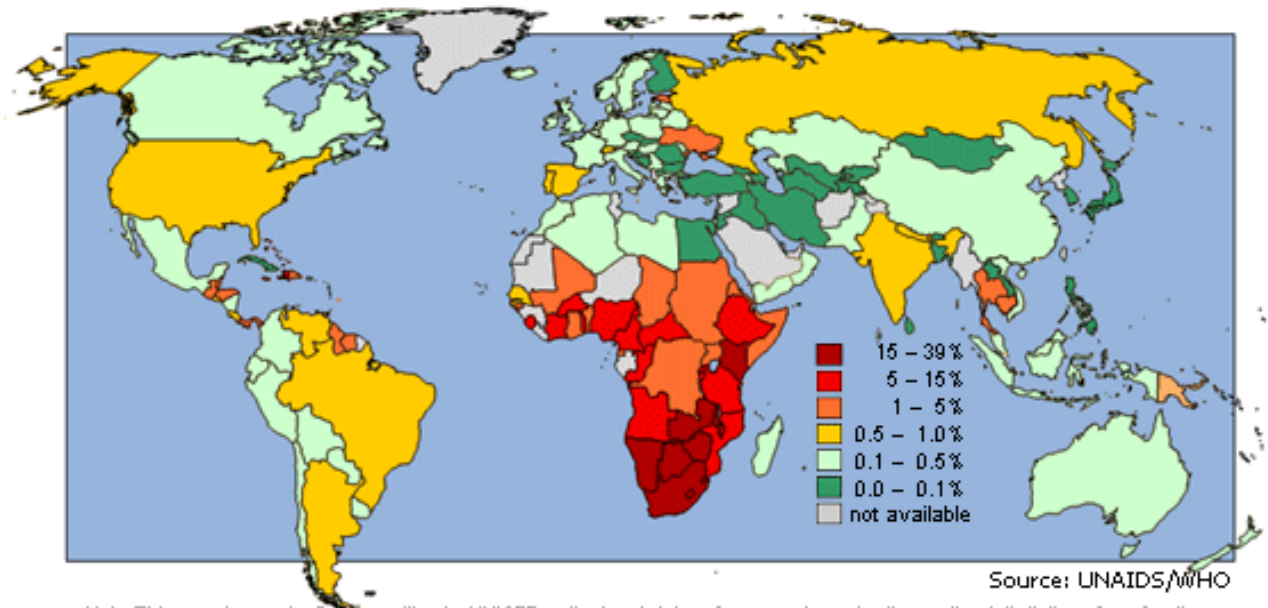
HIV INFECTION

AIDS

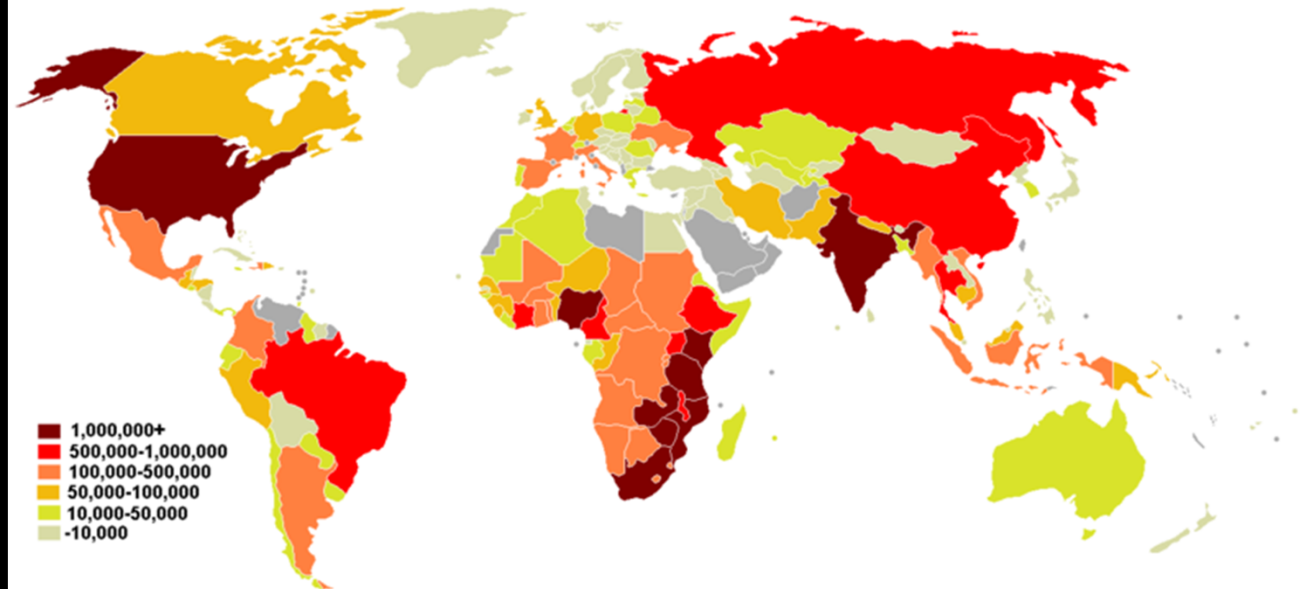
~The Silent Spread~

- Transmitted by sexual contact, blood transfusions, contaminated needles
- As of 2007, it affects an estimated 33.2 million people

HIV prevalence in adults, end 2001

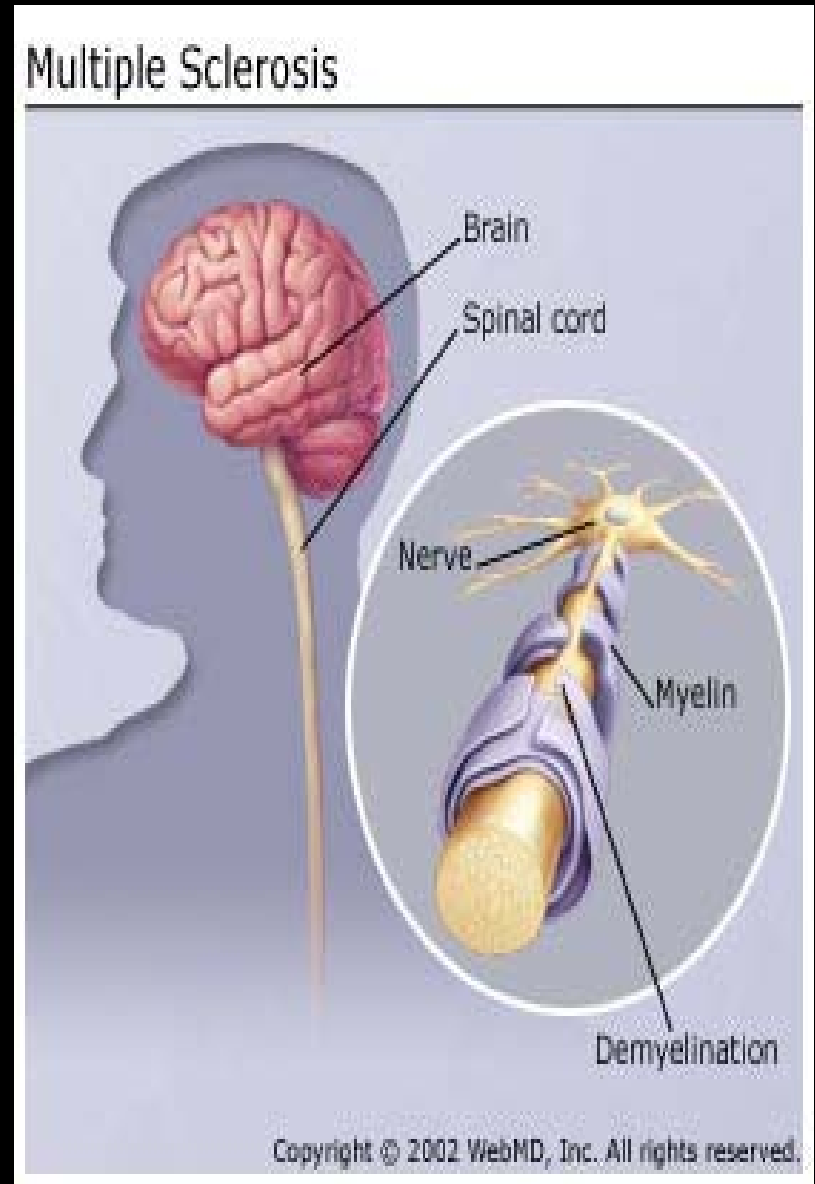


Note: This map does not reflect a position by UNICEF on the legal status of any country or territory or the delimitation of any frontiers.



Autoimmune Diseases

- When the immune system mistakenly attacks the body's **OWN** cells
- Ex. Multiple Sclerosis (MS)
 - Destruction of myelin sheath covering on nerve cells
 - May lead to blindness, loss of motor function



Tissues of The Body Affected By Autoimmune Attack

