Failure to maintain homeostasis an introduction to IMMUNOLOGY

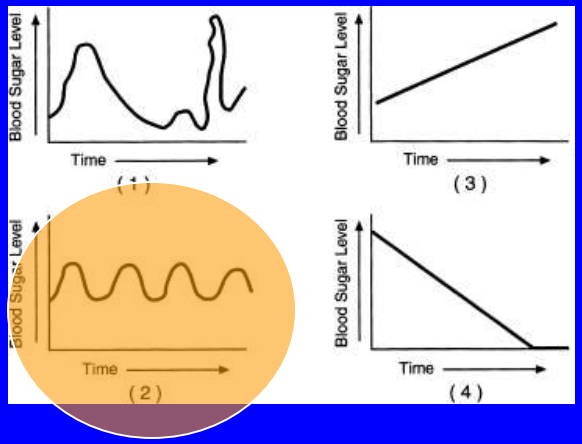
Complex subject

Much still to be learned

Homeostasis

- Refers to a balance
- Dynamic equilibrium = changing but remaining stable

- Which one represents dynamic equilibrium ?



Homeostasis continued

- All organisms must maintain homeostasis
- Examples of homeostasis
  - Paramecium must maintain water balance by pumping water out
  - Humans produce insulin to maintain sugar levels
- Feedback mechanisms help organisms maintain homeostasis.

Failure to maintain homeostasis → disease or death

- Can be caused by:
- Toxic chemicals
- Ex:
- alcohol,
- drugs,
- lead and mercury poisoning…

Genetic disorders can be inherited or from random mutations

- Ex:
- lactose intolerance,
- MS,
- Type 1 diabetes…)

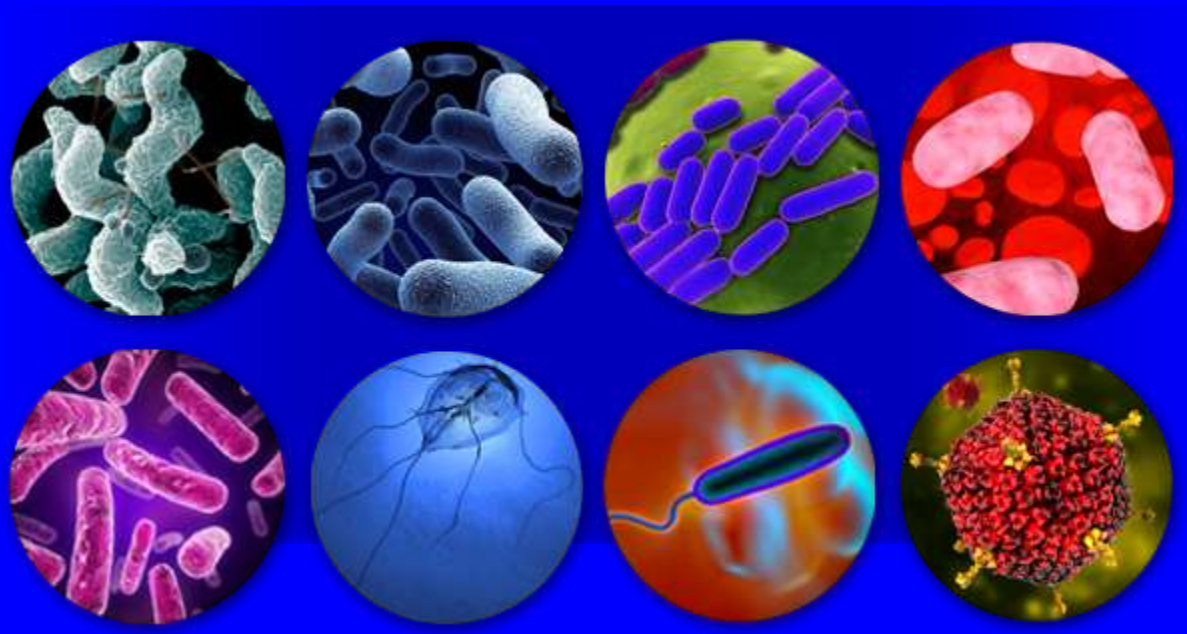
Can be caused by Genetic disorders

Disease caused by malnutrition

- Ex:
- lack of vit C → scurvy,
- lack of vit D → rickets,
- lack of protein → kwashiorkor

Disease causing organisms =

- PATHOGENS



4 types of pathogens

- viruses,
- bacteria,
- protists,
- fungi

1)Viruses

- Small and can't reproduce outside a host cell
- Exception to cell theory (nucleic acids and proteins)
- Cannot be killed with antibiotics

Examples:

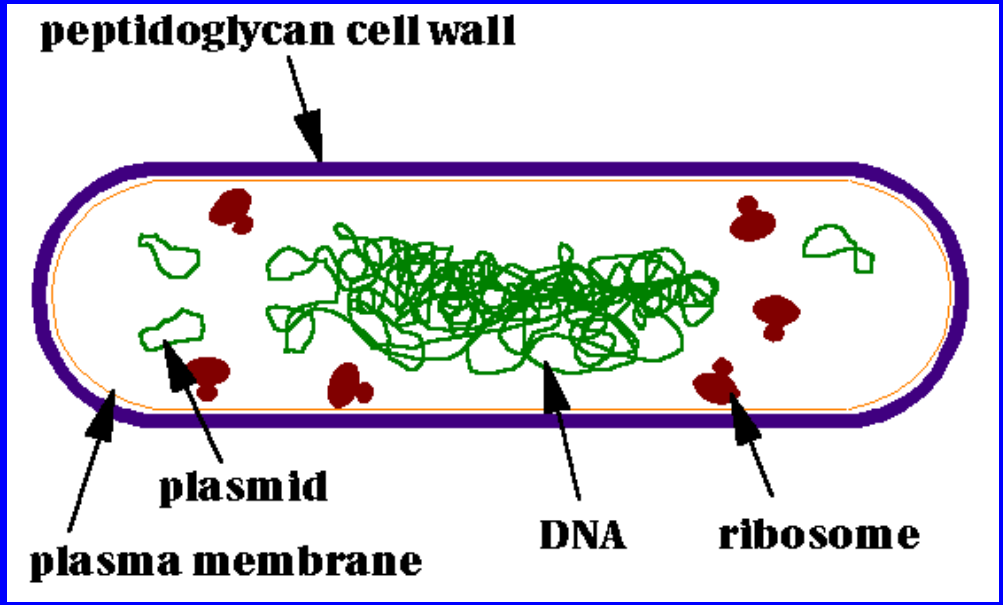
- Common cold
- Flu
- Smallpox
- Herpes
- HIV
- Hepatitis

2) Bacteria

- Moneran Kingdom, prokaryotes (no nucleus)
- Smaller than animal cells bigger than viruses,
- intracellular or extracellular,
- can secrete toxins
- Antibiotics kill bacteria

Examples:

- E. coli
- TB
- Plague
- Salmonella
- Strep. Throat
- Staph infection

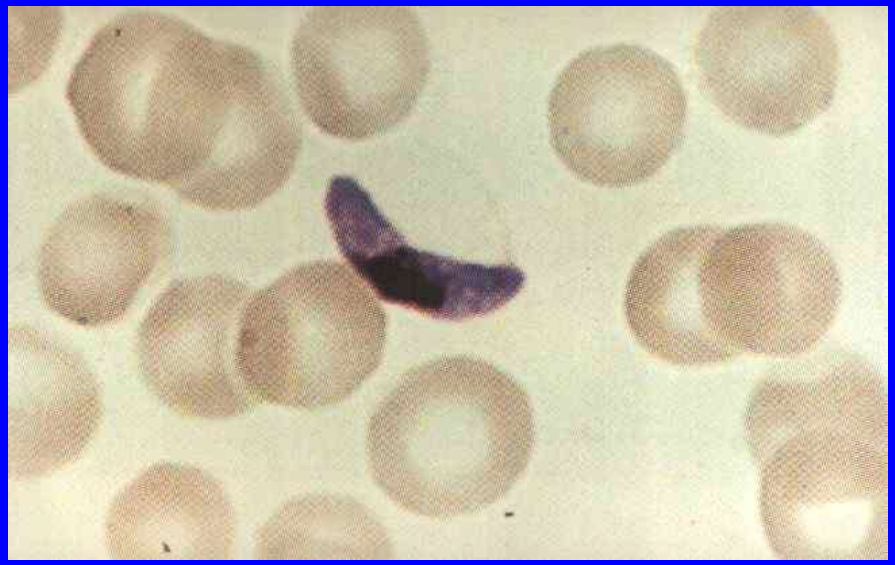


3) Protozoa

- Single celled
- Eukaryotic (nucleus)

  - Examples:
  - Toxoplasma gondii
  - Malaria (caused by a protist carried by a mosquito)
  - Giardia “Beaver fever”

Plasmodium falciparum → malaria



http://www2.mf.uni-lj.si/~mil/praz2/praz2-e.htm

4) Fungi

- Mushrooms, molds, and yeasts
- heterotrophic →toxins

Examples:

- Ring-worm
- Yeast infections or thrush
- Athlete's foot

www.crutchfieldderma tology.com

Job of the immune system

- Help maintain homeostasis
- Repair damaged tissues
- Detect and Destroy pathogens

Immunity is warfare

- Pathogens = Enemies:
  - spies, saboteurs, terrorists, storm troops, missiles, bombs
- Immune system has Defense weapons:
  - CIA/FBI, guns, mines, missiles, planes, ships

- Immune system, unlike organ systems, is not always perfectly successful

Trudeau Institute

Migration Kinetics and Final Destination of Type 1 and Type 2 CD8 Effector Cells Predict Protection against Pulmonary Virus Infection

By Adelheid Cerwenka, Tammy M. Morgan, Allen G. Harmsen, and Richard W. Dutton

From the Trudeau Institute, Saranac Lake, New York 12983

Summary

The requirements for CD8 T cells to provide protection against a localized virus infection in models of adoptive immunotherapy are not well defined. Here we investigated the protective value of defined in vitro–generated hemagglutinin (HA) peptide-specific primary CD8 T cell effectors from the clone 4 T cell receptor transgenic mice, secreting type 1 or type 2 cytokines, against pulmonary infection with whole influenza virus. Cytotoxic T lymphocytes producing type 1 and type 2 cytokine (Tc1 and Tc2) populations were equally cytolytic, but Tc1 effectors and not Tc2 effectors reduced the pulmonary virus titer early during infection. Host recovery mediated by Tc1 effectors was found to be independent of interferon γ production. Tc2 effectors entered the lung with delayed kinetics as compared with Tc1 effectors, and after lung entry Tc2 effector cells did not localize near the infected airway epithelium as did Tc1 effectors but were found within clusters of inflammatory cells distant from the epithelium. We also show that the expression of several chemokine receptors was selectively regulated in the Tc1 and Tc2 subsets. Thus, the protective value of a CD8 cell population against pulmonary influenza virus infection is strongly correlated with its ability to exert its effector potential at the site of virus infection.

Key words: CD8 • subset • migration • influenza virus • protection

Immunology Vocabulary

- Infection = when an organism gets exposed to a pathogen

- Disease = failure to maintain homeostasis

- Immunity = the ability to prevent a pathogen from causing disease

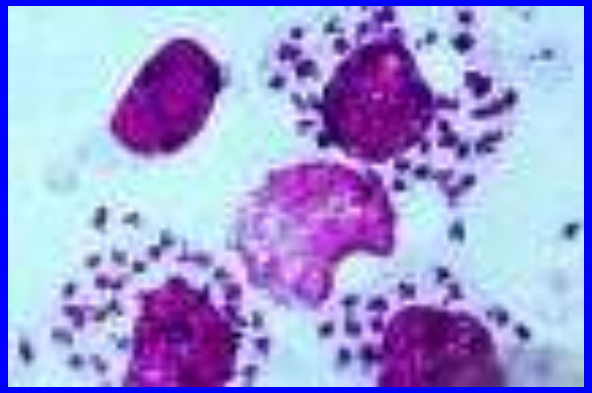
2 Types of Immunity

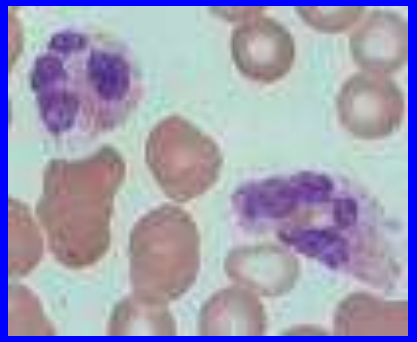
1) Natural (innate) immunity = nonspecific natural defenses that block any pathogen.

–Ex: skin and mucous act as barriers,

–Ex: some white blood cells

(neutrophils and macrophage kill nonspecifically





www.brown.edu/.../Leishmaniasis/immune.html

2 Types of Immunity

2) Acquired (adaptive) immunity = specific

2 ways to get it

–A) get infected → get sick → get better → produce antibodies and memory

–B) get vaccinated → produce antibodies and memory

Review

1. Define pathogen
2. Difference between prokaryote and eukaryote
3. Difference between virus and bacteria
4. List 2 viral diseases
5. List 2 bacterial diseases
6. When you get exposed to a pathogen you have been _____

Flu video notes

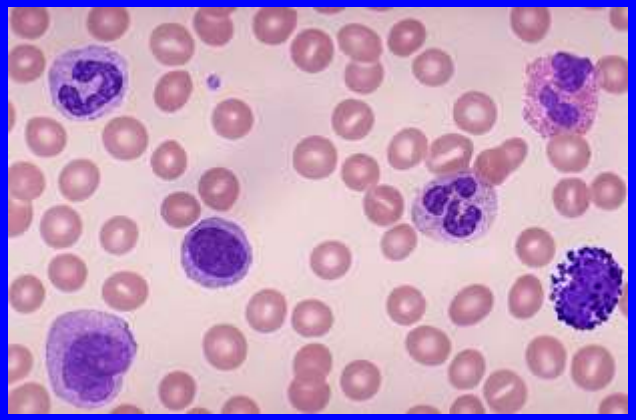
- What do you know about the flu?

- While watching the video describe what happens during a flu infection.

The Flu

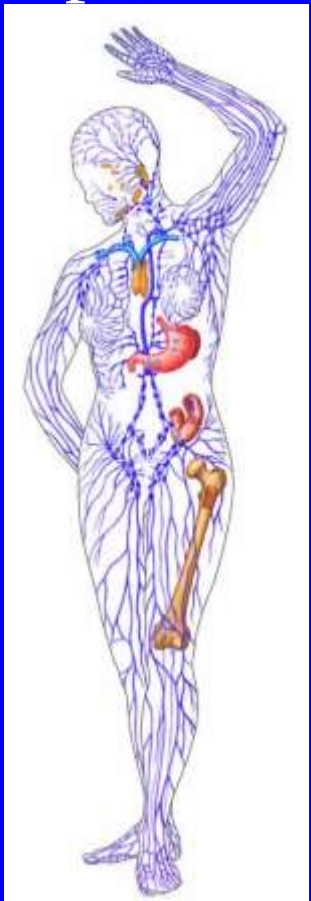
Blood (4 parts)

1. Plasma = liquid part carries dissolved minerals, nutrients, and chem. messengers
2. White blood cells = fight disease
   - (lymphocytes, macrophages, neutrophils)
3. Red blood cells (no nucleus, contain hemoglobin, carry O_2
4. Platelets = blood clotting factors

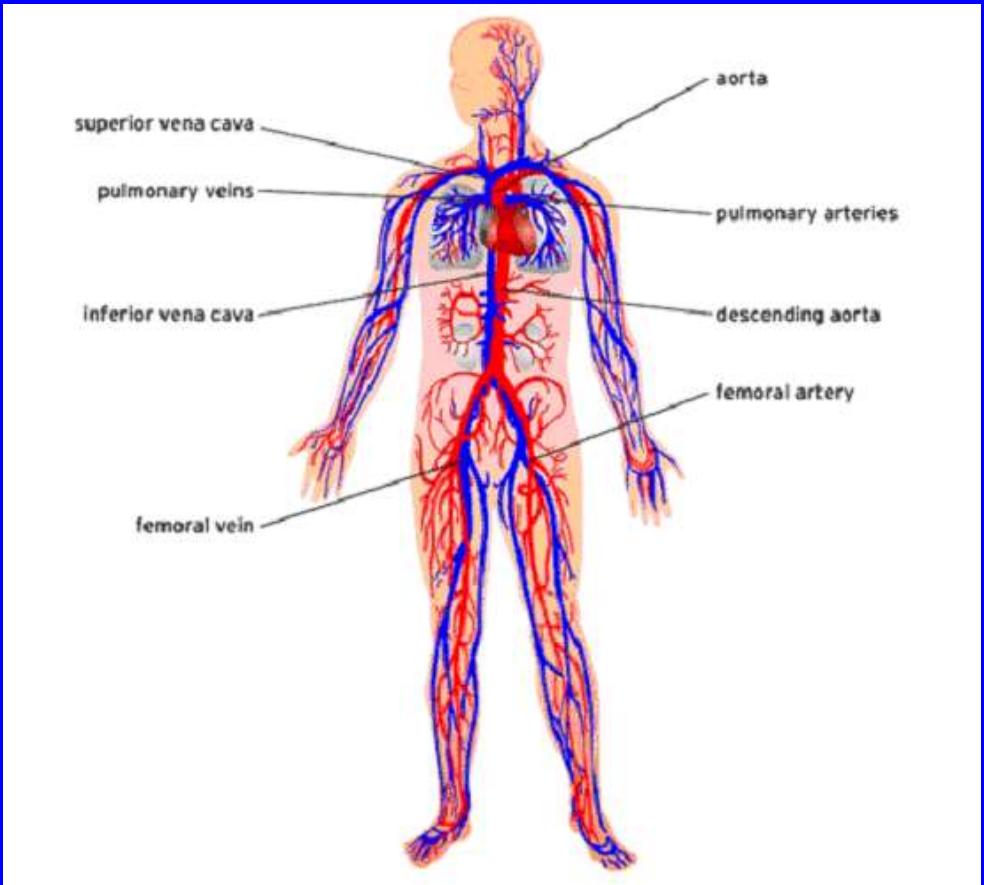


White blood cells circulate in blood and lymph

- Lymphatic system



Circulatory system



Practice regents questions

Immune response to a pathogen:
Initial events

- 1. Infection = Pathogen enters body
  - through a wound or body opening

- 2. Tissue damage caused by trauma or by pathogen leads to inflammation (swelling)

3. Natural (Innate) immunity

a. Neutrophils and macrophages are among first recruited cells.

b. They engulf and destroy

c. In a process called (phagocytosis)

http://dictybase.org/Multimedia/phagocytosis/phagocytosis.htm

4. Acquired immune response (lymphocyte-dependent)

a. Lymphocytes and cells that help lymphocytes kill **specific** targets

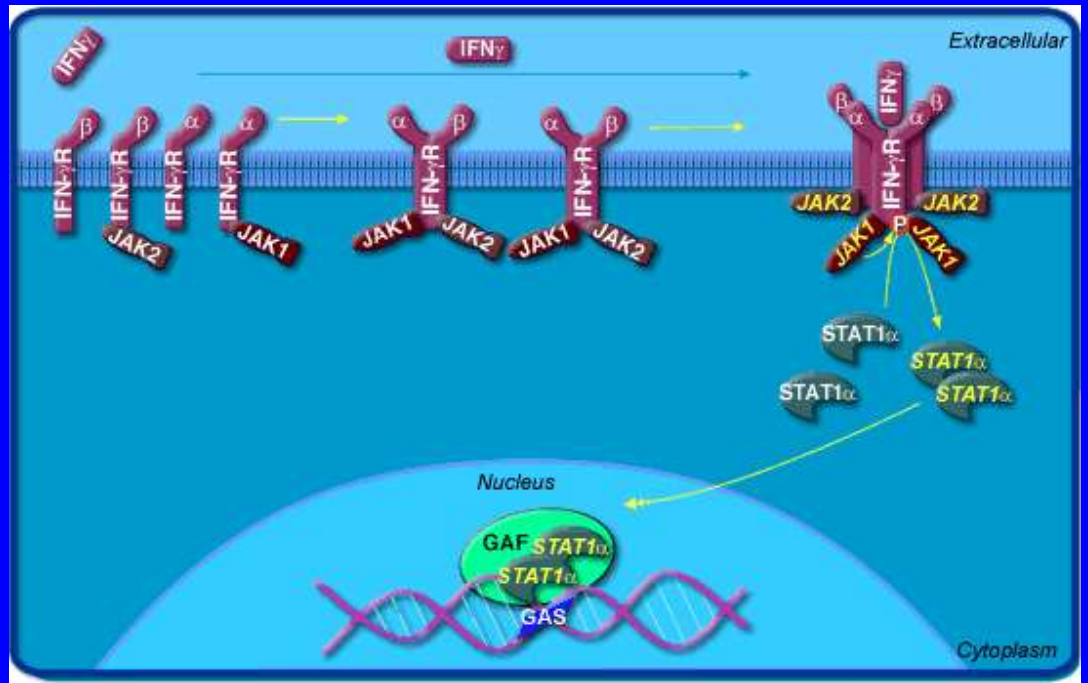
Some kill only infected cells

Some produce antibodies

Some turn into memory cells (remember how to kill specific antigens for next time)

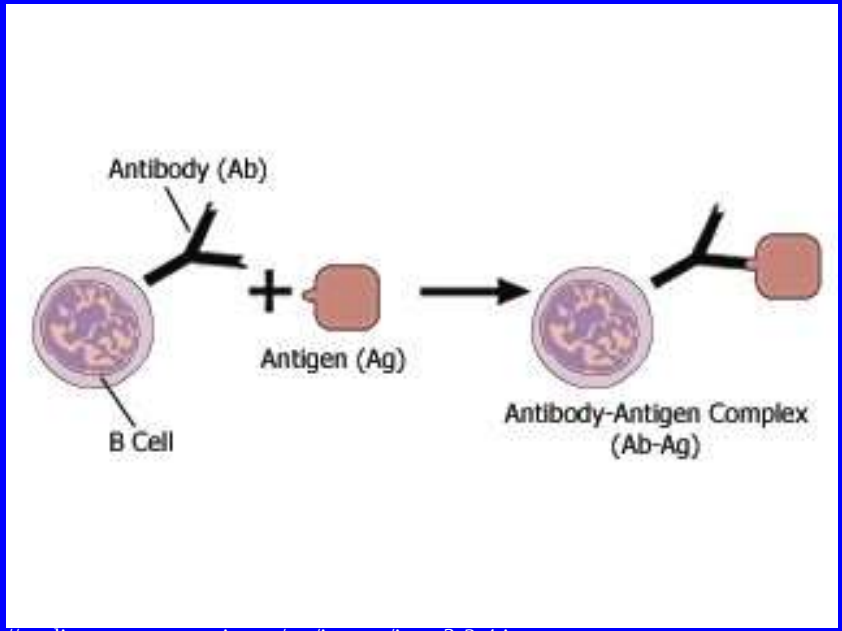
b. White blood cells have receptor molecules → communication

- Chemical messages are received by receptors
- Receptor binding signals cell to respond
  - Ex: tells cell to divide or make something



c. Some white blood cells → antibodies

- Antibodies are Protein receptors
- Antibodies Bind to antigens
- Antibodies are Very specific because of their shape



http://mediresource.sympatico.ca/ms/images/img_3-2-4.jpg

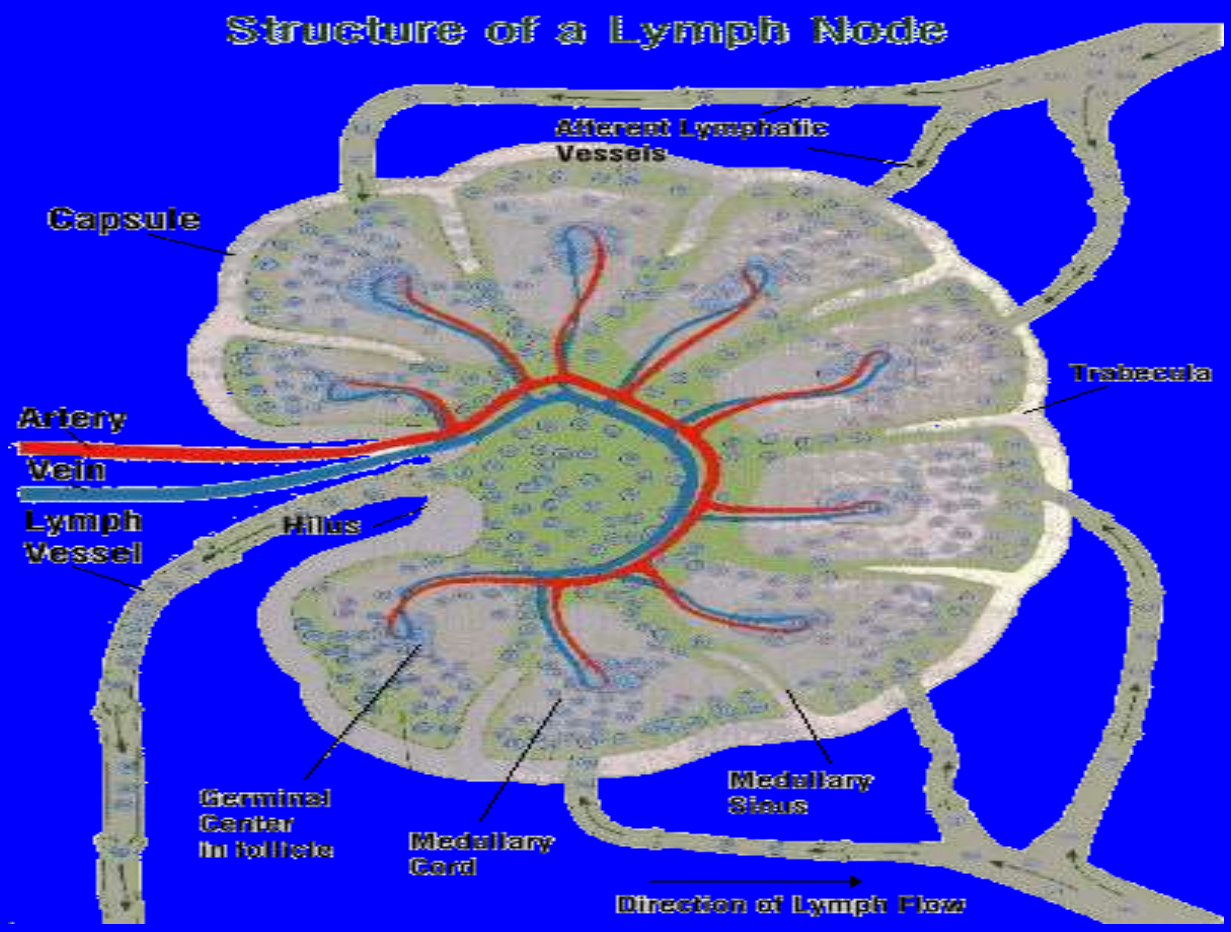
Sepcific immunity involves

- Antigens = parts of pathogens
- can be proteins, carbohydrates or lipids found on pathogens
- Antigens can be used as vaccines

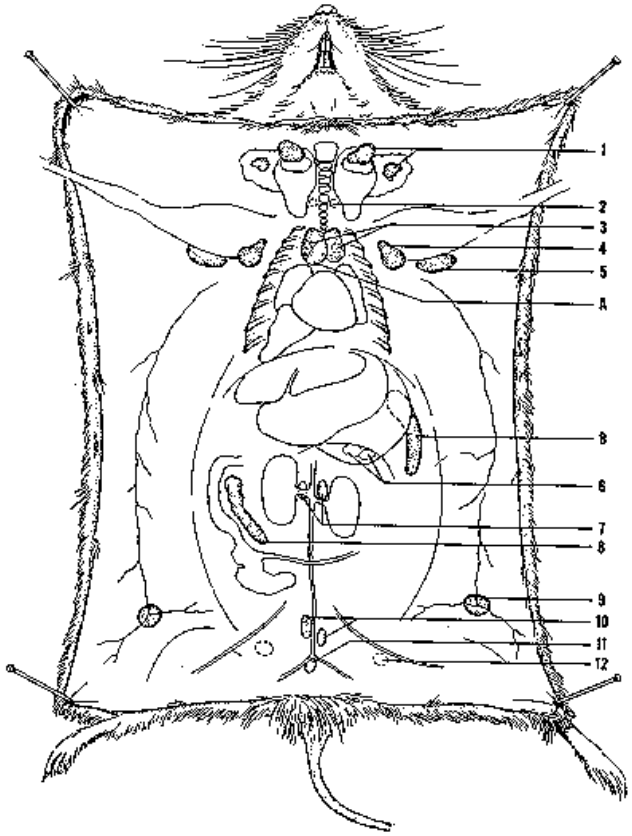
Antibodies = proteins made by white blood cells

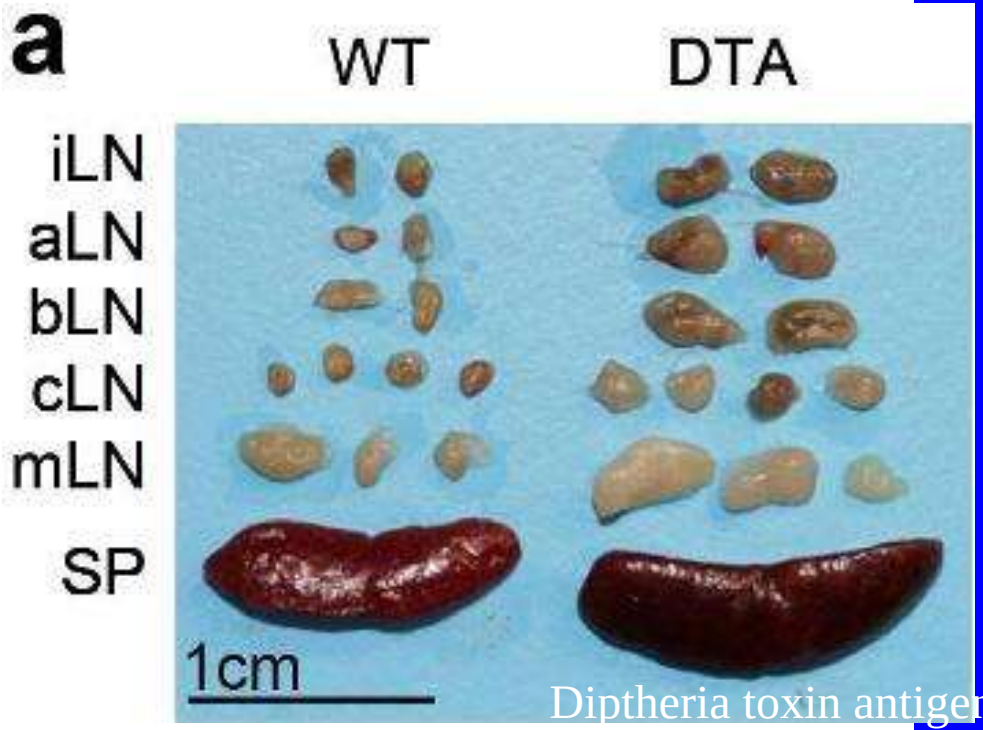
- Antibodies bind to antigens
- Block pathogens from entering cells
- Mark pathogens for destruction

Lymph nodes = places where lymphocytes collect and exchange information



Lots of lymphocytes found in Spleen and Lymph nodes



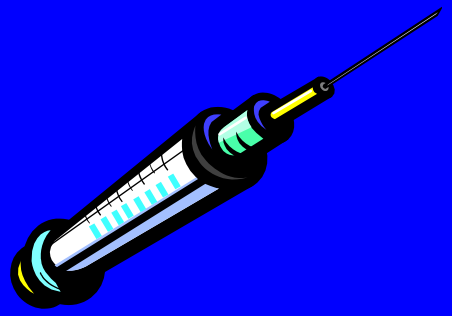


Diptheria toxin antigen

Memory (after the infection is cleared)

- Most lymphocytes die
- Some become memory cells
- Memory cells work faster
- Good memory prevents illness
- 2 ways to get memory
  - Get sick and clear infection
  - Get vaccinated

Vaccines



- Vaccination = trick immune system into thinking a real pathogen is present
  - Vaccines =
  - "weakened" pathogens or antigens →
  - stimulate WBCs →
  - antibodies and memory cells

- Don't cure diseases they prevent them

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Matching Practice

1. Mitochondria
2. Antigen
3. Hemoglobin
4. Homeostasis
5. Protist
6. Prokaryote
7. AIDS
8. Pathogen
9. Macrophages

- HIV
- Antibody
- Dynamic equilibrium
- Energy
- Red blood cells
- Has a nucleus
- Phagocytosis
- Disease organism
- bacteria

More immunology vocabulary

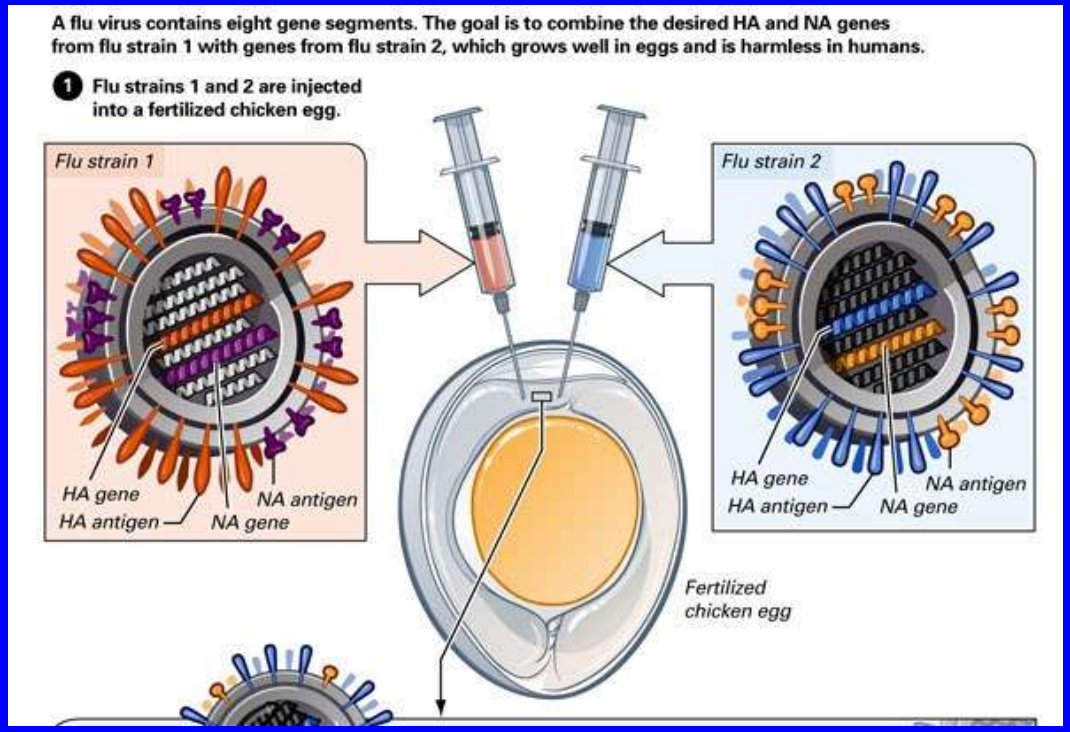
- Virus
  - Exception to cell theory
  - Has to get into a host cell to reproduce
  - Reproduces and mutates rapidly
- Vaccine
  - What are they? Weakened forms of pathogens
  - How they work – stimulate wbc's → antibodies and memory cells
  - Prevent disease (can't cure)

Vaccines

- https://www.youtube.com/v/mdIVRBIgMxs

Making flu vaccines

1. Predict which strains will thrive each season
2. Inject fertilized chicken eggs with the seasonal strains



3. Incubate → virus reproduce
4. Harvest the egg whites
5. Use detergents to deactivate the virus
6. Test on animals for effectiveness

Experimental Design Review

- Test on animals first → FDA approval
- Describe an experiment to test a new vaccine
  - Title
  - Independent variable
  - Dependent variable
  - Control group
  - Procedures

http://www.reuters.com/article/2008/03/18/us-birdflu-vietnam-vaccine-idUSHAN17707420080318

Flu vaccine experiment

- Title =
- The effect of vaccine on flu immunity in mice
- Independent variable =
- vaccine
- Dependent variable =
- flu immunity
- antibodies to flu
- Control group =
- no vaccine

Procedures

- Set up 2 groups of 50 mice under the same conditions except
  - Control = no vaccine
  - Experimental group = vaccine
- Give all mice the same amount of flu and count # that get sick or look for antibodies to flu

After extensive testing → human trials

HIV

- Virus → AIDS
- Blood to blood contact
  - Sexually transmitted
  - Blood transfusions
  - Dirty needles
- Infects wbc's → weakened immune system

Cancer related terms

- Cancer
  - What? Uncontrolled cell division (mitosis)
  - Causes = UV rays, smoking, toxic chemicals (carcinogens), mutations
- Leukemia
  - Cancer of wbc's
- Mutation
  - Any change in DNA

- Tumor = mass of cells
  - Benign = stays in one place
  - Malignant = breaks off and grows in other places of the body

Organ transplants

- Organ transplants from tissue donors have different antigens
- Immune system might reject foreign antigens
- Recipients take immunosuppressants (drugs that decrease immune response)

Allergies

- Immune response to harmless substances
- ex: peanuts, pets, eggs, milk…

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When WBC's fail to do their job

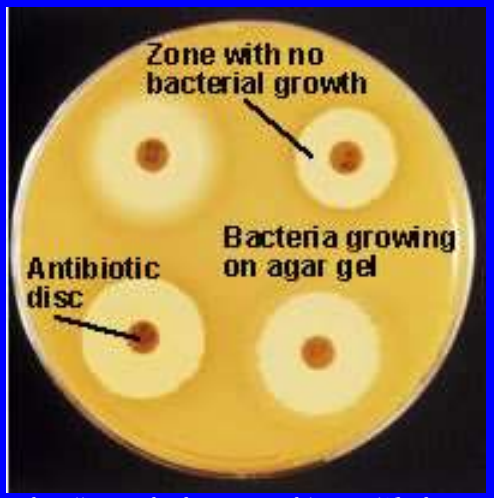
- Failure to maintain homeostasis
- Disease = specific symptoms from specific pathogen

- You can be infected without → disease if you have <u>immunity</u>

http://www.xenu.net/archive/scientology_illustrated/sick.gif

Antibiotics

- Chemicals made by fungi and plants → kill bacteria
- DO NOT KILL VIRUSES!!!!
- Overuse and improper use of antibiotics → selects antibiotic resistant strains of bacteria
- Antibiotic resistance = can't be killed by the antibiotic



http://www.schoolscience.co.uk/content/4/biology/abpi/immune/images/antibiotic_disc.jpg

Sci Fri article and Bill Nye video

Immune system disorders

- Allergies = immune system over-reacts to harmless substances
- Ex:(pollen, cat hair, peanut butter)
- Antihistamines = medicines → decrease symptoms

Immune System Disorders

- Immunodeficiency = immune system cannot function properly
- Ex: HIV = virus that infects white blood cells (T cells) → weakened immune system → get sick more

Immune System Disorders

- Autoimmune disorders = immune system attacks otherwise healthy tissues
- Examples
  - Lupus
  - MS
  - Rheumatoid arthritis
  - ALS (Lou Gherig's disease)

Organ transplants

- Organ transplants are foreign
- White blood cells might attack and reject new organs
- Therefore → take drugs to decrease immune response

Cancer

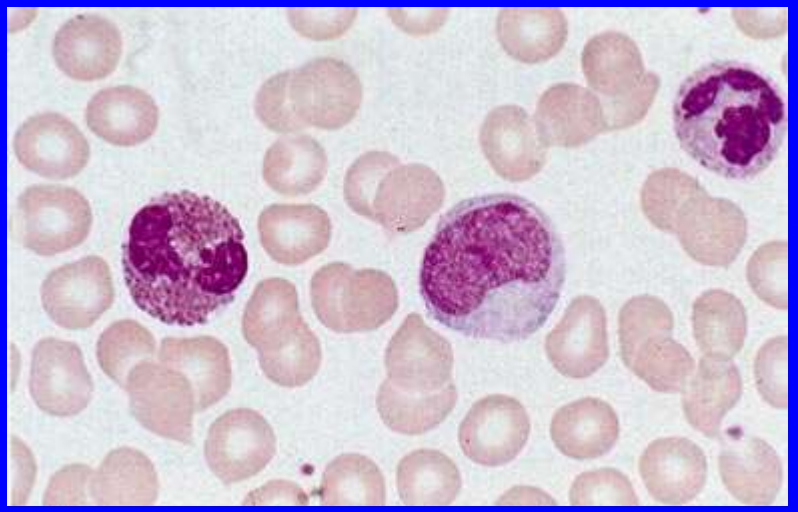
- Uncontrolled cell division
- UV rays from sun, smoking, toxic chemicals… → mutations → uncontrolled cell division
- Mass of cancer cells = tumor
- Benign = stays in one place
- Malignant = travels thru body
- Leukemia = cancer of white blood cells

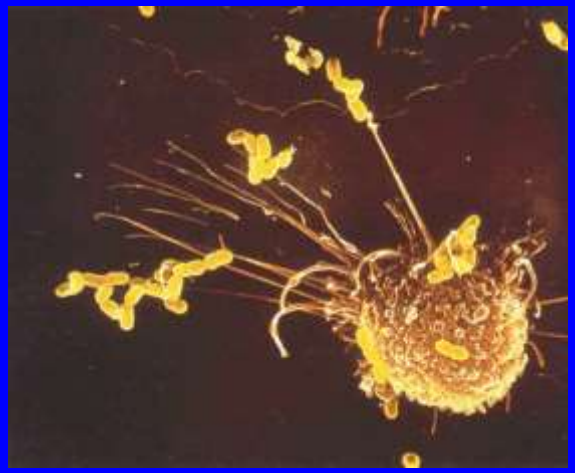
Immunology Vocabulary

- Homeostasis
  - Internal stability
  - Dynamic equilibrium
- 4 parts of blood
  - Plasma (liquid part)
  - White blood cells (fight disease)
  - Red blood cells (carry oxygen)
  - Platelets (clot)

White Blood Cells

- Many different types
- Fight disease
- Engulf pathogens
- Produce antibodies
- Can become memory cells





Electron microscope image
WBC engulfing bacteria

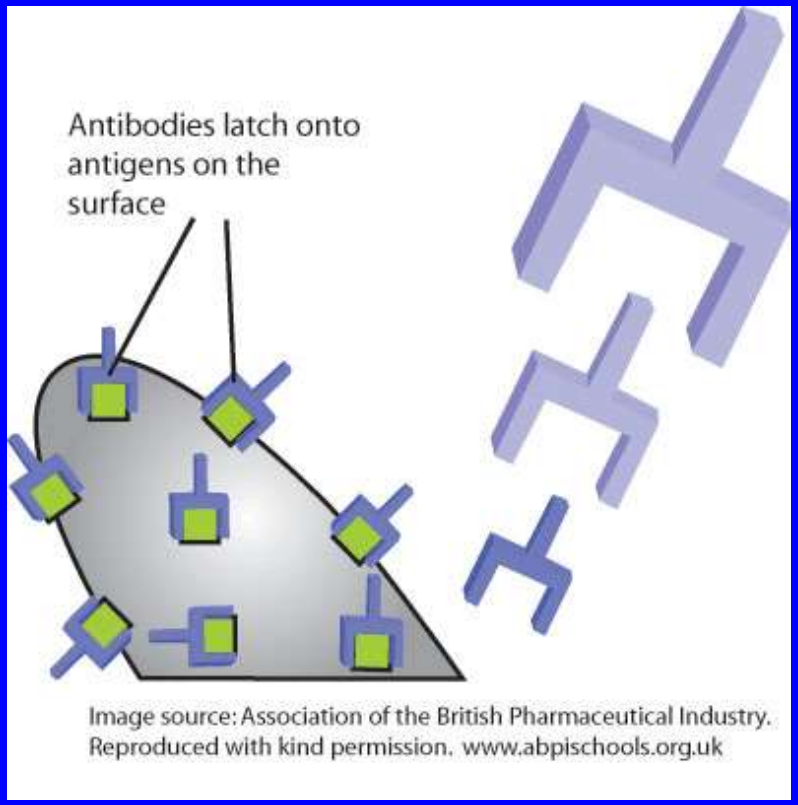
http://library.thinkquest.org/25896/sub_blood/wbc.htm

Words related to white blood cells

- Macrophages
  - Type of WBC
  - Engulf and destroy pathogens
- Phagocytosis
  - Engulf
- Lymphocytes
  - Type of WBC
  - T and B cells → kill specific targets
  - Make antibodies

Antigens and Antibodies

- Antigens
  - Foreign molecules
- Antibodies
  - Proteins
  - Made by wbc's
  - Bind to antigens specifically
  - Mark pathogens for destruction



Killing Pathogens

- Pathogens
  - Disease causing organisms
- Antibiotics
  - Chemicals that kill bacteria
  - Produced by plants and fungi
- Antibiotic resistant bacteria
  - Antibiotics can't kill them
  - Overuse of antibiotics → increase in resistance

Natural Selection Terms

Natural Selection terms

- **Variation =** natural differences in population
  Due to:
  - » Mutations
  - » Sexual reproduction

  NO VARIATION = NO NATURAL SELECTION = NO EVOLUTION

- **Overproduction =**
  - species can reproduce exponentially → too many for the environment

- **Struggle for existence =**
  - organisms compete for limited resources

- **Survival of the fittest** = best adapted to the environment will survive

- **Adaptation** = any characteristic that helps an organism survive

- **Natural selection** = best adapted survive and reproduce

Examples of Evolution

1. Bacteria + antibiotic →
   - only resistant bacteria survive and reproduce

2. Insect pests + pesticides →
   - only pesticide resistant pests survive and reproduce

Plasmids

- Extra pieces of DNA in bacteria → extra traits
  - Ex: extra DNA →antibiotic resistance

Bacterial Conjugation = plasmid transfer

It was on a short-cut through the hospital kitchens that Albert was first approached by a member of the Antibiotic Resistance.

http://www.honeymarkproducts.com/a-solution-to-antibiotic-resistance.aspx

Summary notes

- Genetic diversity = helps a population survive environmental changes
- Diversity → Stability

In a changing environment -

No variations =

No adaptations =

No survival

Practice regents questions