

Pathogens and the Immune System “The War Begins”

The Enemy

- immune system responds to antigens (); for us this means a pathogen
- pathogens () try to colonize your body
- bacterial pathogens produce toxins to help them to survive and spread within your body
- these toxins cause the disease symptoms you experience
 - botulism toxin (botox) is a neurotoxin and is one of the deadliest toxins known!
- viral pathogens cause symptoms primarily by destroying or damaging or changing host cells
 - herpes destroys epithelial cells causing blisters
 - HPV causes cells to grow rapidly causing warts ()

Defenses

Nonspecific

- these defenses target all pathogens in general
- skin – physical barrier, low pH, sebum is fungistatic
- stomach acid ()
- lysozyme () found in sweat, tears, saliva, tissue fluids ()
- mucous and cilia – respiratory tract, genitourinary tract
 - mucous traps particles and cilia moves them out of the body or towards destruction
- phagocytes ()
- fever – inhibits bacterial reproduction, enhances immune response
- inflammation – brings immune system to site of injury or infection
 - pain, swelling, heat, redness
- chemical mediators () produced by immune cells – enhance immune response (histamines, prostaglandin's, leukotrienes, interleukins etc.)

Specific

“The Army”

Macrophages – Reconnaissance – find things to eat () take to T-cells

B-cells – Infantry –

T-helper cells – Generals – T-cells stimulate B-cells to make antibodies, stimulate cytotoxic T-cells ()

Killer cells – Assassins – kill cells infected with viruses and cancer cells

Antibodies – immune proteins that bind to pathogens

Mechanisms of Antibody Action

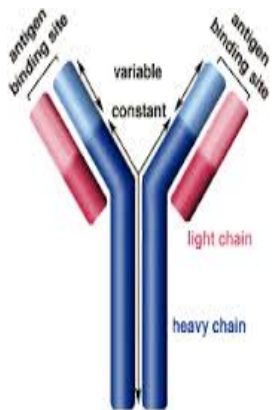
- agglutination – causes pathogens to stick together slowing their spread; easier for phagocytes to eat

- neutralization – toxins neutralized, viruses cannot attach to host cells

- opsonization – stimulates phagocytes to eat pathogens

- precipitation – makes soluble () insoluble ()

- complement activation – these serum proteins assemble to form “tubes” that poke holes thru membranes ()



- a full immune response to a new pathogen including antibody production requires 7-10 days

- if you are immune that means that you can make those antibodies in 1-3 days (you are now resistant to that particular pathogen upon subsequent exposures)

The Outcomes

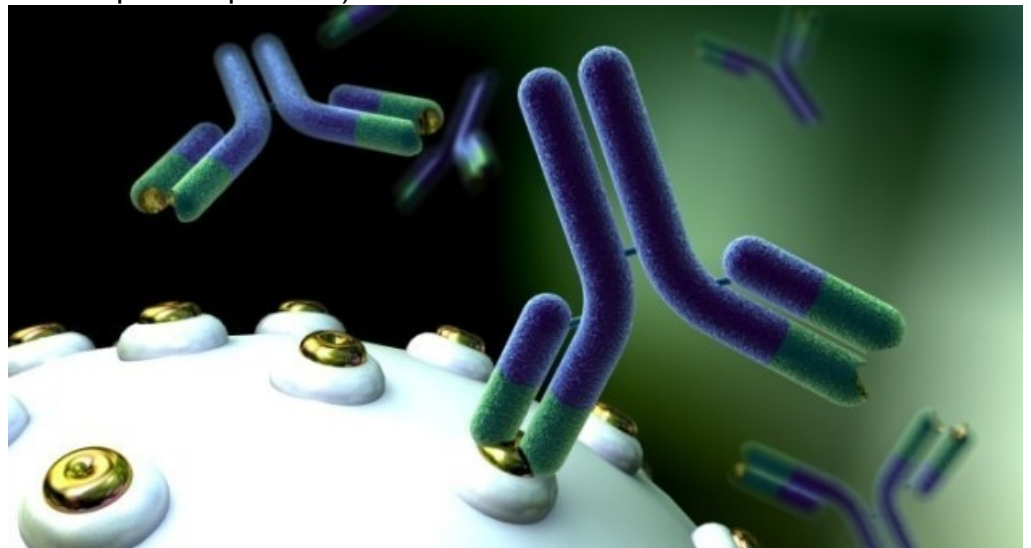
- there are normally two outcomes to an infection

1) the host survives and destroys the pathogen

2) the pathogen survives and destroys the host

Sometimes:

3) certain viruses go dormant and stay inside the host forever ()



- outcomes 1&2 are a “dead end” for most pathogens; the pathogen dies either way

- the pathogen must spread to other hosts in order to survive

- blood and other bodily fluids

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- skin to skin contact

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Vaccination

- process probably begin in India and/or China several centuries ago (earliest documentation was 17th century)
- smallpox scabs were ground into powder and then inhaled up nose
 - technically this is known as “inoculation” not vaccination because the actual pathogen is used () so the inoculation had ~2% death rate
 - vaccination uses a different but related virus or a dead virus to develop immunity (death rate essentially zero!)
- smallpox can kill 20% - 60% of people infected with it ()
- inoculation greatly reduced fatality rate
- **Edward Jenner**
 - as a child he was “inoculated” with smallpox and survived so he was immune
 - milkmaids often got cowpox () but rarely got smallpox
 - Jenner was not the first to suggest or use cowpox for vaccination
 - what Jenner did was analogous to a clinical trial today
 - he experimented with several subjects, documented the results, and published them



Scientific Method

Observations:

Smallpox is more dangerous than variolation () and cowpox less dangerous than variolation.

Hypothesis:

Experimentation/Testing:

If variolation after infection with cowpox fails to produce a smallpox infection, immunity to smallpox has been achieved.

Conclusion:

Immunity to smallpox can be induced much more safely than by variolation.

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- Jenner is often considered the “father of immunology”
 - he received many awards and worldwide recognition but did attempt to profit from it

- he devoted much of his time to the cause of vaccination (medical practice and family life suffered)

Vaccines

- from “vacca” which means cow from cowpox ()

Types

- inactivated vaccines use dead bacteria and viruses
- attenuated vaccines use live weakened bacteria and viruses
- subunit vaccines use pieces () of bacteria and viruses
- DNA vaccines – experimental, designed to make our cells produce pathogen proteins to stimulate the immune system
- toxoid vaccines protect against the toxins produced by a pathogen ()
- vaccines often to not produce lifelong immunity ()

Controversies, Side effects, and Injuries

- vaccine safety and effectiveness have shown in numerous studies

- common side effects include:

- Pain, redness, tenderness or swelling at injection site.
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- Headache.
- Itching at injection site.
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- Dizziness or fainting (most common in adolescents)
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- Mild rash.

- side effects can vary depending on vaccine type

- severe side effects include:

- Allergic reactions
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- Seizures
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- Getting the disease from the vaccine (only possible with live attenuated vaccines)

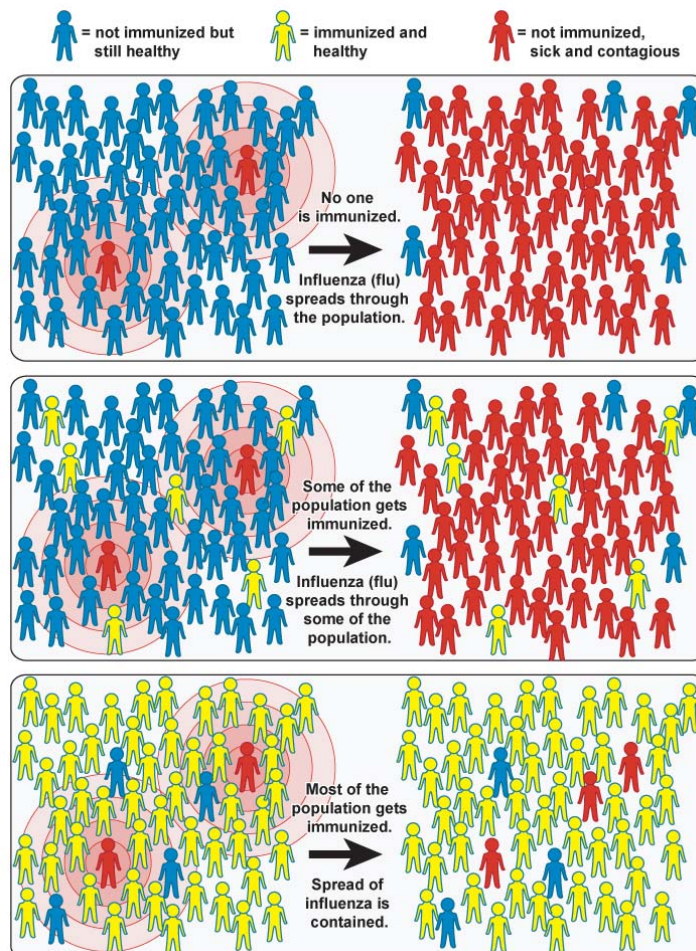
Autism Controversy

- Autism spectrum disorders are characterized by impaired social interactions
- verbal and nonverbal communication are also impaired

- repetitive behaviors are common
- the controversy was created by Dr. Andrew Wakefield, a British surgeon and researcher
- he falsified a research paper in 1998 that claimed a causative relationship between MMR () vaccine and autism
- this paper has been discredited
- multiple studies in many countries have not shown a relationship between childhood vaccines and autism
- because of this fraudulent paper and celebrity anti-vaccine support many parents have chosen not to vaccinate their children
- as a result the incidence of many childhood diseases has significantly increased in recent years

Herd Immunity

- when the majority of a population is immunized, then pathogens cannot spread
- those few individuals who are not immune will be protected

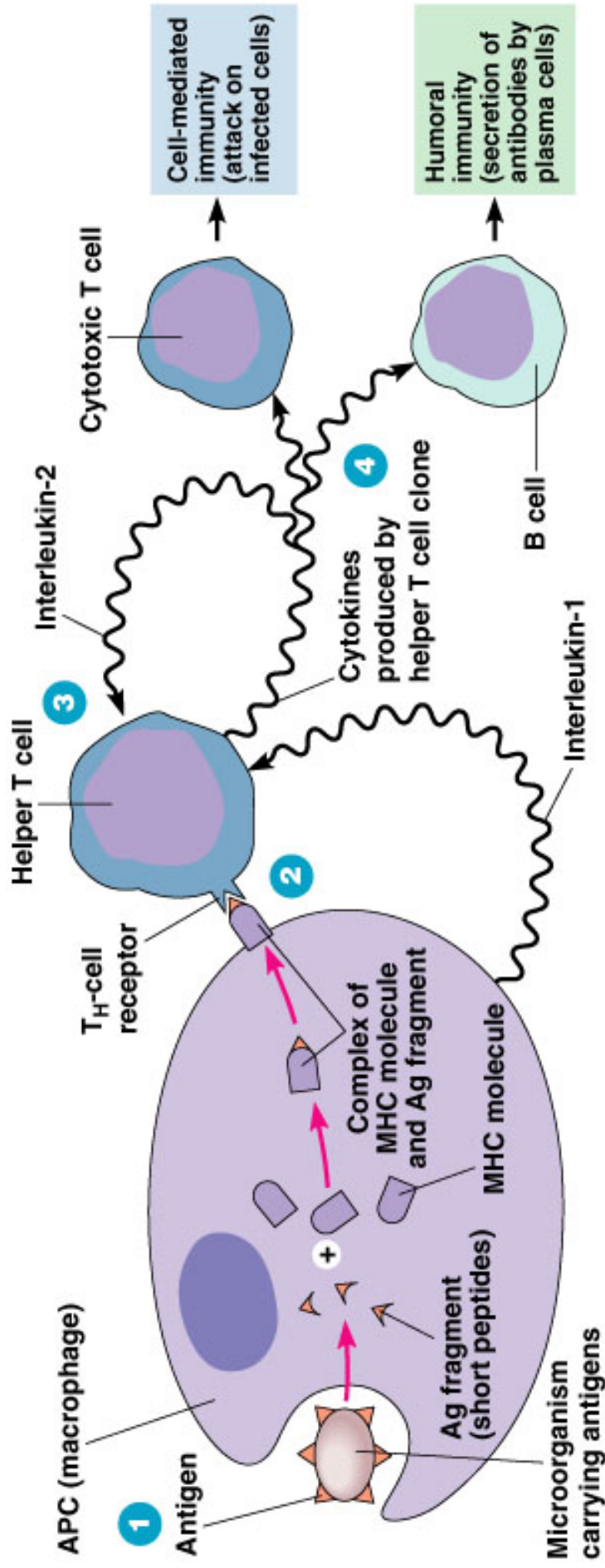


Antiviral Drugs

- antiviral drugs are not antibiotics; antibiotics do not work against viruses
- unlike antibiotics which kill bacteria, antiviral drugs do not “kill” viruses
- these drugs inhibit development and reproduction of viruses
- example targets – interfere with genome replication ()
 - interfere with attachment of virus to host cell (potential to stop infection from occurring)
 - interfere with release of virus from host cell
 - interfere with assembly and maturation of new virus particles
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Study Objectives

1. What does the immune system respond to?
2. How do pathogens (bacterial and viral) make you sick and cause symptoms?
3. Describe the various nonspecific defenses.
4. What is the function of chemical mediators?
5. Describe the parts of the specific defense and what they do.
6. Know the parts of the diagram at the end of this handout. Explain what happens to AIDS patients and the immune system relative to that diagram.
7. Know and describe all 5 mechanisms of antibody action.
8. Describe the 3 possible outcomes of an infection.
9. How can pathogens spread to other hosts?
10. What is the difference between inoculation and vaccination?
11. Describe Edward Jenner’s contribution to vaccination.
12. Using the scientific method, explain how Jenner determined that vaccination with cowpox was safer than inoculating with smallpox.
13. Describe the 5 types of vaccines.
14. List the mild and severe possible side effects of vaccines.
15. What is the controversy associated with vaccines and autism? What happens when parents do not vaccinate their children?
16. Describe herd immunity and how it benefits everyone in a population.
17. Contrast antiviral drugs with antibiotics.
18. What are the common targets for an antiviral drug?



- 1** An antigen-presenting cell (APC) encounters and ingests a microorganism. Antigen fragments (short peptides) from the microorganism combine internally with MHC (self molecules) and the complex of MHC molecules and antigen fragments is presented on the surface of the APC.

- 2** A helper T (T_H) cell receptor binds to the complex, stimulating the APC to secrete interleukin-1.

- 3** This interleukin-1 stimulates the helper T cell to produce interleukin-2, which then stimulates that helper T cell to form a clone of helper T cells.

- 4** The cells of this clone in turn produce cytokines, stimulating cells of both immune systems.

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