Chapter 24 – The Body’s Defenses against Pathogens

State Standards
Standard 10.a. –

Standard 10.b. –

Standard 10.c. –

Standard 10.d. –

Standard 10.e. –

Pathogens
Pathogens are

• They are usually microorganisms
  - Viruses – cold, influenza, HIV, SARS
  - Bacteria – E. coli, stomach ulcers, strep throat, MRSA
  - Fungi – ringworm, yeast infections
  - Protozoa – malaria
  - Parasites – trichinosis, round worm, tapeworm
  - Protein – BSA Mad Cow disease

• Bacteria and viruses are everywhere in nature, but

Pathogenic Bacteria
• Some bacteria damage the body’s cells and tissues by breaking down the cells for food.
• Other bacteria release toxins (poisons) that travel throughout the body interfering with the normal activity of the host.
Pathogenic Viruses

• Viruses can attack and destroy certain cells in the body, causing symptoms of the disease.
• Other viruses cause infected cells to change patterns of cell/tissue growth and development.

Everyday steps to protect your health

• **Cover your nose and mouth with a tissue when you cough or sneeze.** Throw tissue in the trash after you use it.
• **Wash your hands often with soap and water.** Alcohol based hand cleaners are also effective.
• **Avoid touching your eyes, nose or mouth.** Germs spread this way.
• **Try to avoid close contact with sick people.**
• **Cook food thoroughly.**

Preventing Infections

• **Sterilization** (medical, tattoo, piercing equipment)
• **Disinfectants/Antiseptics** (bleach, “Lysol” type cleaners)
  - Useful in decontaminating surfaces with which the body may come into contact
• **Food processing** (canning and packaging hygenically)

Treating Bacterial Infections - Antibiotics

Antibiotics

• **Chemicals that inhibit (slow/stop) the growth of bacteria**
• **Function by**
  - - slowing the growth rate of the population giving the body’s defenses time to fight the bacteria
• **Effective in treating bacterial infections only**
• **Ex: penicillin interferes with the growth of bacterial cell walls**
Also work by
• Destroying bacterial cell walls (lysozyme)

• Inhibiting the bacteria from synthesizing DNA, RNA, or proteins (erythromycin, streptomycin, tetracycline)

• Why doesn’t penicillin affect your cells?
• Why doesn’t penicillin affect a virus infection?

Antibiotic Resistance
• When a strain of bacteria is exposed to an antibiotic
  - the bacteria that are susceptible to the antibiotic die.

Complication: Antibiotics also kill beneficial bacteria (that live on and in you) that normally keep the harmful strains in check.

The Body’s Defenses
Nonspecific defenses against infection
• The body’s first lines of defense against pathogens are nonspecific
  - They do not

Nonspecific Defenses – 1st line of defense
Skin
• Outer layer is a barrier of dead cells that most bacteria and viruses can’t penetrate.
• Acids in sweat and oils

• Sweat contains lysozyme that attacks cell walls of bacteria. (Found in saliva and tears, too)

Digestive system
Stomach acid kills most bacteria swallowed in food
Respiratory system

- Hairs in nostrils
- Mucus in respiratory tubes trap microorganisms
- Cilia sweep

Nonspecific defenses – 2nd line of defense – internal defenses

Internal defenses

- When an invader penetrates the body’s external barriers, a set of nonspecific internal defenses that depend mostly on white blood cells acts as a second line of defense.

2nd line of nonspecific defenses - WBC
Types of white blood cells (WBC)

- Macrophages – large cells that move in the interstitial fluid and “eat” any bacteria and virus-infected cell they come in contact with
- Neutrophils and monocytes –
- Natural killer cells – attack cancer cells and infected body cells

**Chemical Warfare**

1. **Interferons**
   Virus infects cell & then the infected cell produces and releases interferon molecules to warn neighboring cells of viral infection
   Interferon binds to healthy cell,

   - What do you think happens when virus tries to infect this cell?

2. **Complement Proteins**
   - Found in blood in inactive form.
   - Activated by
     - Make microbes easier to engulf by macrophages.
     - Or cut lethal holes in membranes of microbes.

**Inflammatory response – nonspecific response to injury**
Can be local… like getting a splinter
- Or
- Widespread due to severe tissue damage or infection
- Increase in the number of white blood cells
- Cells release Pyrogens (“firemakers”), chemicals that tell your brain’s thermostat to turn up the temperature.
- Causing a fever!
- Will this reduce viral replication or bacterial growth?

The Lymphatic System
- The lymphatic system is a network of lymphatic vessels and organs
- It returns tissue fluid to the circulatory system
- Lymph nodes can become infected during this war

Lymph nodes are key sites for fighting infection
- They are packed with

Specific defenses – the immune system

The Immune System
- Recognizes and defends against invading microbes and cancer cells
- When detects an antigen increases the number of cells that either
- - Produce defensive proteins, antibodies

Specific Defenses – the immune system

The immune system
- Has
- remembers antigens it has been exposed to
- reacts against the antigens more quickly and more vigorously

Recognizing the Invaders - lymphocytes

**Lymphocytes**
- are white blood cells found most often in the lymphatic system
- produce the immune response
- originate from

- Human body has 2 trillion WBC produced by stem cells in bone marrow
- Two kinds of lymphocytes carry out the immune response
  - **B cells**
  - **T cells**

The Cell mediated immune response
- In the *cell-mediated immune response* T cells fight pathogens that have

**Helper T cells**
- help activate cytotoxic T cells and macrophages
- stimulate B cells

**Cytotoxic T cells**
- Attack body cells
- Cytotoxic T cells are the only T cells that actually kill other cells
- Cytotoxic T cells may attack cancer cells
- The surface molecules of cancer cells are altered by disease

**Humoral immune response**
- B cells secrete specific antibody proteins as a form of defense against given identified antigen*.
*antigen could be from the surface of a cancer cell, virus, bacteria, or other pathogen…

**Antibodies mark antigens for elimination**

**Antibodies**

- Bind to a certain antigen that triggers mechanisms to neutralize or destroy the invaders by
  1. Blocking harmful antigens on microbes
  2. Clumping bacteria or viruses together
  3. Precipitating dissolved antigens
  4. Activating complement proteins

**Immunity**

**Immunity is**

**Passive immunity** –

Antibodies produced by another animal are transferred to you

- Mother to child: before birth + by breast milk
- If bitten by rabid animal, treatment injection of antibodies against rabies

**Active immunity** –

Exposed to a pathogen which triggers the immune response and the development of Memory B cells

- Developing active immunity by…
  - Get sick and survive
- Get vaccinated (weakened form of pathogen)
- More than 20 different vaccines available today

**Immune response has memory**

- In the primary immune response,
  - These cells may give the person lifelong immunity
- Remembers antigens it has been exposed to
- Reacts against the antigens more quickly and more vigorously

**Primary Immune Response**

- Occurs when lymphocytes are first exposed to an antigen
- Antibodies are produced by B cells

- Usually takes several days
  
  **Secondary Immune Response**
  - Occurs when exposed to same antigen again
  - Immune response is

- Memory cells divide quickly producing a large number of lymphocytes that attack the antigen

**Vaccinations**
- Person receives a

  - (Ex: Sabin vaccine used against polio)
  - Causes the primary immune response
  - Produces

- When person exposed to actual antigen, secondary immune response occurs
- Person

**Immunodeficiency diseases**
- Immune components are lacking, and infections recur.
- May arise

  - SCID: Severe combined immunodeficiency (lack T & B cells)
- Or
- Example: AIDS (Acquired immune deficiency syndrome)

**HIV/AIDS**

**Transmission of HIV**

- HIV is not transmitted through

- HIV can ONLY be transmitted through the exchange of
  - blood
  - semen
  - vaginal secretions
  - breast milk

**How HIV replicates in helper T cell**

1. Viral envelope fuses w/ plasma membrane. Virus disassembles
2. HIV’s Reverse transcriptase enzyme copies RNA Genome into DNA
3. Double stranded DNA from new DNA
4. HIV’s DNA inserted into cell’s nuclear DNA (lytic or lysogenic cycle?)
5. Provirus DNA transcribed into RNA
6. Viral RNA translated into viral proteins (capsomeres and enzymes)
7. New HIV viruses assembled
8. New HIV viruses released

*  

- Why are T cells important to your immune system?

**Can AIDS Be Cured?**

- Scientists have no vaccine yet! Why? The high mutation rate of the retrovirus genome is problematic

- The virus can be controlled by expensive multidrug antiviral “cocktails” that fight the virus.

- How can new HIV infections be avoided?

**Preventing HIV Infection**
The only no-risk behavior with respect to HIV and AIDS is

People who share contaminated needles to inject themselves with drugs are at a high risk for contracting HIV.

People who have sex with IV drug abusers are also at high risk.

Rating the risk of transmission
(H) High risk of HIV exposure
(R) Reduced risk of HIV exposure
(N) No HIV exposure

1. Abstinence (NO sexual intercourse of ANY kind)

2. Unprotected sex of ANY kind

3. Sharing needles

4. Getting blood on yourself while helping an injured person

5. Wearing Latex* gloves when helping a person who is bleeding
   *if person has latex allergy, can be substitute with polyurethane

6. Sexual intercourse between two UNINFECTED people who remain monogamous (no other partners) and NEITHER person shares needles.

7. Receiving a blood transfusion in the USA where all blood is tested for HIV.

8. An HIV positive mother breast feeding her baby.

9. Using a NEW LATEX condom or oral barrier during sexual intercourse.

10. Sexual intercourse between two people who remain monogamous (no other partners) AND one person shares needles.