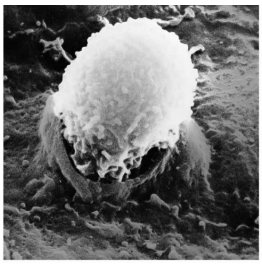
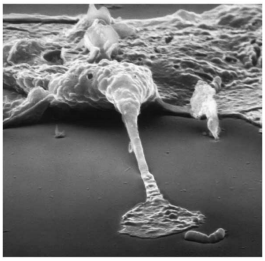
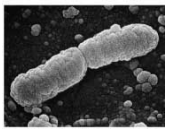
Chapter 36:
Defense Against Diseases: The Immune Response

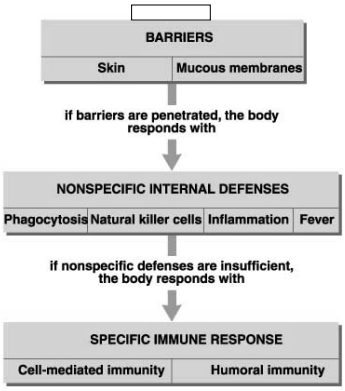




How Does a Body Defend Against Invasion?



Microbes:
Viruses
Bacteria
Fungi
Protists

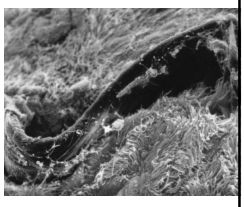


Barriers (1st Line of Defense):

- Prevent microbes from entering body

1) Skin:
   - Inhospitable environment:
     - ❖ Dry, nutrient-free zone
     - ❖ Sweat/oil gland secretions (antibiotics)
     - ❖ Skin sloughed off

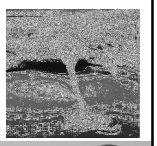
2) Mucous Membranes
(digestive, respiratory, urogenital tracts):
   - Secrete mucus (traps microbes):
     - ❖ Antibacterial enzymes
   - Cilia sweep up mucus (swallowed)



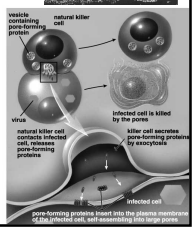
Non-specific Internal Defenses (2nd Line of Defense):

- Attack wide variety of microbes that penetrate barriers

1) Phagocytic Cells (leukocytes):



- Macrophages ("big eaters")
  - ❖ Ingest microbes via phagocytosis
- Natural Killer Cells
  - ❖ Attack virus-infected / cancer cells



Non-specific Internal Defenses (2nd Line of Defense):

- Attack wide variety of microbes that penetrate barriers

2) Inflammation ("to set on fire")
   - Wounded region → **red, swollen and warm:**
     - ❖ Damaged cells 1) release histamine ('leaky vessels')
       2) initiate blood clotting
       3) attract macrophages (Clean area)

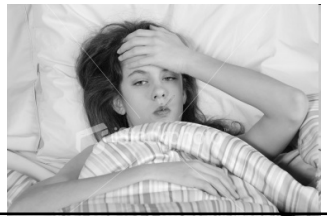
3) Fever (↑ body temperature)
   - Combats large-scale infections (turn up thermostat - hypothalamus)
   - Function: 1) increases macrophage activity
     2) slows bacterial reproduction
     - ❖ Increases macrophage activity

Normal Fever: 98.6 F

Hyperpyrexia: >106 F

❖Medical emergency

Children: Febrile seizures can occur at 102 F or higher

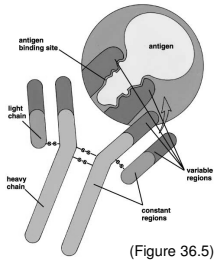


Specific Immune Response (3nd Line of Defense):

- Complex attack against specific target (organism / toxin)
- Immune System: Cells / molecules that work together to combat the microbial invasion
- **Key Players (leukocytes : lymphocytes):**
  - ❖ B cells = Mark / inactivate foreign invaders in blood
  - ❖ T cells = Destroy foreign invaders in cells
  - ❖ Table 36-1 (Overview of cell types…)

Fundamental Steps in Immune Response:

1) Immune system must recognize invader...
   - Antigen: Molecule located on cell surface which triggers an immune response.
   - B cells produce antibodies which recognize antigens

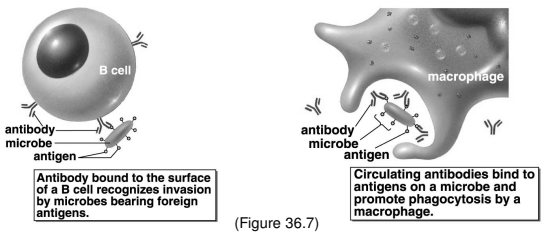


(Figure 36.5)

- Antibody structure:
  - ❖ Y-shaped
  - ❖ 4 chains (2 light; 2 heavy)
    - ➢ Variable / constant regions
- Antigen binding site
  - ❖ High specificity

Fundamental Steps of Immune Response:

1) Immune system must recognize invader...
   - Antigen: Molecule located on cell surface which triggers an immune response.
   - B cells produce antibodies which recognize antigens
     - Antibodies may bind to B cell or may float freely



(Figure 36.7)

Fundamental Steps of Immune Response:

1) Immune system must recognize invader...
   - Antigen: Molecule located on cell surface which triggers an immune response.
   - B cells produce antibodies which recognize antigens
   - T cells produce T-cell Receptors which recognize antigens

Why doesn't our immune system destroy our own cells?

Answer: Major Histocompatibility Complex (MHC):

- Unique set of proteins / polysaccharides which identify "self" cells of body
- Act as antigens in other individual's bodies

Fundamental Steps in Immune Response:

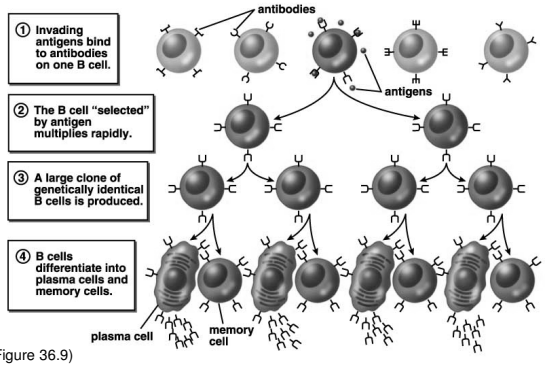
2) Immune system must launch attack...

A) Humoral Immunity (B cells / circulating antibodies):
   - Attacks invaders (bacteria, protists, fungi) prior to cell entry

(1) B cell antibody receptor binds antigen
(2) Activated B cell divides rapidly (clonal selection):

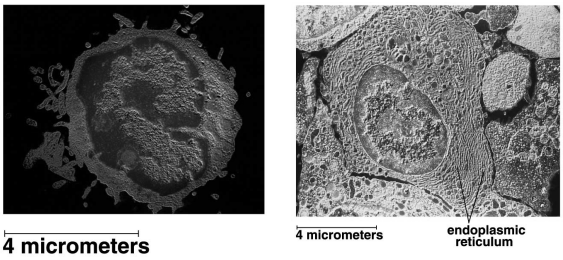
(a) Memory cells (Future immunity)
(b) Plasma cells: ↑ antibodies (released into blood)

Clonal Selection:



(Figure 36.9)

B cell → Plasma cell



(Figure 36.9)

Fundamental Steps in Immune Response:

2) Immune system must launch attack...

A) Humoral Immunity (B cells / circulating antibodies):
- Attacks invaders (bacteria, protists, fungi) prior to cell entry
  - (1) B cell antibody receptor binds antigen
  - (2) Activated B cell divides rapidly (clonal selection):
    - (a) Memory cells (Future immunity)
    - (b) Plasma cells: ↑ antibodies (released into blood)
  - (3) Antibodies destroy invaders:
    - Inactivate invader (binding)
    - Cause invaders to clump together
    - Coat invaders with blood proteins

} ↑ leukocyte activity (phagocytosis)

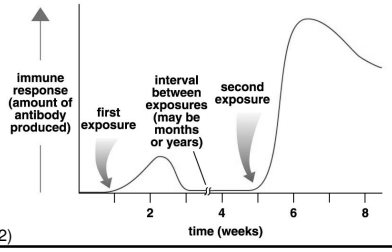
Fundamental Steps in Immune Response:

2) Immune system must launch attack...

B) Cell-mediated Immunity (T cells):
- Attacks invaders (viruses, cancers) after they enter body cells
  - (1) Cytotoxic T cells:
    - Release proteins → disrupt plasma membrane
  - (2) Helper T cells:
    - Stimulate immune cells (via hormones)
      - Destroyed by AIDS virus
  - (3) Suppressor T cells:
    - Activated following infection; shut down B / T cells
  - (4) Memory T cells:
    - Protect body against future invasion

Fundamental Steps in Immune Response:

3) Immune system must remember past victories...
   - Memory cells "remember" specific antigens
     - May survive for years
     - Respond faster and larger to repeat invasion



(Figure 36.12)

Medical Care Augments Immune Response:

1) Antibiotics: Slow down microbial reproduction (not viruses)
   - Problem: Antibiotic resistant strains

2) Vaccinations: Injection of killed microbes to confer immunity
   - Stimulates development of memory cells

Are Vaccine dangerous?

- **Yes, though side effects are uncommon**
  - ❖ **Allergic reactions, hypersensitivity to dead microbes**
  - ❖ **Occasionally some people contract the disease**
    - ❖ **Especially when the vaccine uses live viruses.**
- **1998 paper linked MMR vaccines to autism**
  - **Prompted numerous studies**
  - **Investigative reporting revealed author was paid 400,000 pounds (~$800,000)to find a vaccine link to autism.**
- **Current studies indicate no link from vaccines to autism**

Anti-vaccination movement

- **Since 1998, vaccinations fell 20 – 40% depending on country**
  - ❖ **Measles outbreaks since reduction in vaccines**
    - ➢ **Netherlands (199-2000) 2961 cases**
    - ➢ **UK & Ireland (2000) 300 cases**
    - ➢ **US (2005) 34 cases in Indiana.**
    - ➢ **US (2009) 121 cases in 15 states so far.**

➢ ***Measles was eradicated in the US in 2000.***

Malfunctions of Immune System:

1) Allergies: Adverse reaction to harmless substances
   - B cells recognize substance as antigen (histamine release)
     - ➢ Anaphylactic Shock = can be fatal.
2) Autoimmune Disease: Body mistakes own cells as invaders
   - ➢ Diabetes mellitus (Type I): Destruction of pancreatic cells
   - ➢ Multiple Sclerosis: Destruction of neuron insulation (myelin)
3) Immunodeficiency Disease:
   - ➢ Severe Combined Immune Deficiency (SCID): ("Bubble Boy")
   - ➢ Aquired Immune Deficiency Syndrome (AIDS)
4) Cancer: Unchecked growth of tumor cells
   - Cells evade / overwhelm immune system