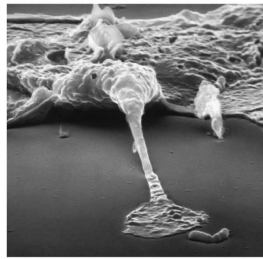
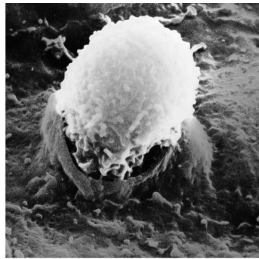
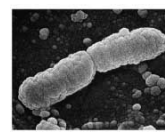


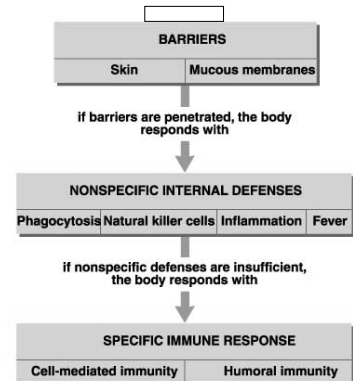
Chapter 36:  
Defense Against Diseases: The Immune Response



How Does a Body Defend Against Invasion?



Microbes:  
Viruses  
Bacteria  
Fungi  
Protists



**Barriers (1st Line of Defense):**

- Prevent microbes from entering body

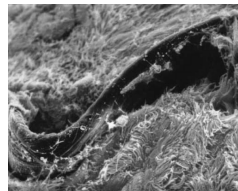
1) Skin:

- 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)

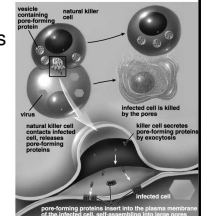
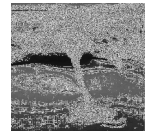


**Non-specific Internal Defenses (2nd Line of Defense):**

- 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**

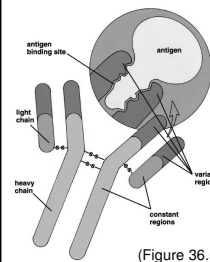


### Specific Immune Response (3rd Line of Defense):

- 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

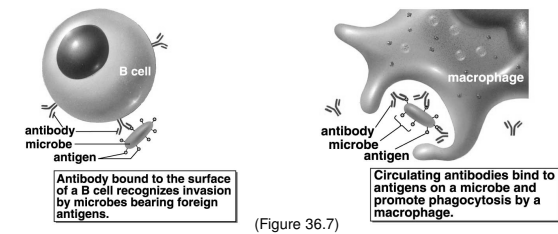


- Antibody structure:
  - ❖ Y-shaped
  - ❖ 4 chains (2 light; 2 heavy)
    - Variable / constant regions
- Antigen binding site
  - ❖ High specificity

(Figure 36.5)

### 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?

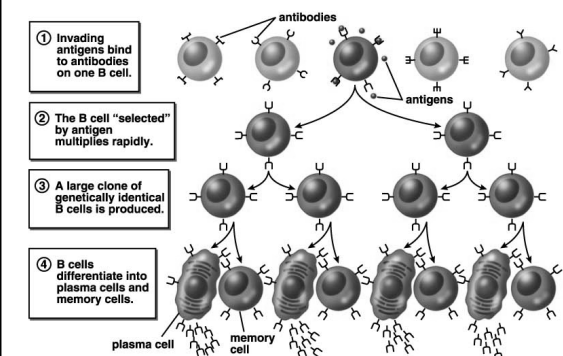
Answer: Major Histocompatibility Complex (MHC):

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

### Fundamental Steps in Immune Response:

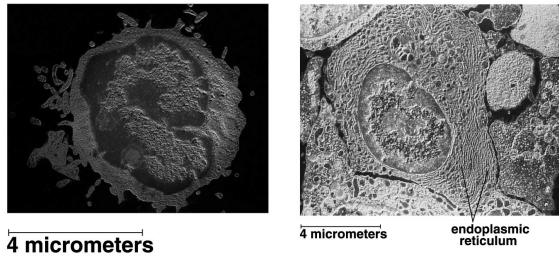
- 2) Immune system must launch attack...
    - A) Humoral Immunity (B cells / circulating antibodies):
      - Attacks invaders (bacteria, protists, fungi) prior to cell entry
- (1) B cell antibody receptor binds antigen
  - (2) Activated B cell divides rapidly (clonal selection):
    - (a) Memory cells (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...

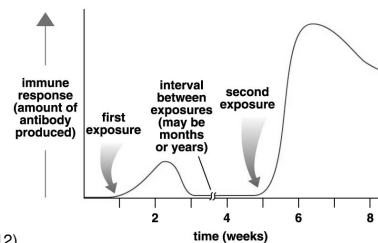
##### B) Cell-mediated Immunity (T cells):

- 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")
  - Acquired Immune Deficiency Syndrome (AIDS)
- 4) Cancer: Unchecked growth of tumor cells
  - Cells evade / overwhelm immune system