CHAPTER 16: NONSPECIFIC DEFENSES OF THE HOST

I. THE FIRST LINE OF DEFENSE

A. Mechanical Barriers (Physical Barriers)
   1.
   2.
   3.
   4.
   5.

B. Chemical Factors
   1.
   2.
   3.
   4.
C. Normal Flora

D. General Health Factors
   1. Nutrition
   2. Age
   3. Activity Level
   4. Mental Outlook

II. THE SECOND LINE OF DEFENSE
A. White Blood Cells – Leukocytes
   1. Granulocytes
      a. Neutrophils – Polys
      b. Basophils/Mast Cells
      c. Eosinophils
   2. Agranulocytes
      a. Monocytes – Macrophages
      b. Lymphocytes – specific immunity
         They differentiate into T cells and B cells
B. Steps In Phagocytosis

1. Chemotaxis

2. Adherence

3. Ingestion and Formation of Phagosome

4. Phagolysosome

5. Digestion

6. Residual Body

7. Discharge of Waste

C. How Microbes Escape Phagocytosis

1. Phagocyte unable to adhere

2. Organism resists digestion

3. Membrane attack complexes produced

4. Organism may inhibit fusion of phagosome and lysosome
D. Inflammation – A Host Response To Tissue Damage

Characterized by four cardinal signs

1. Signs of inflammation
   a.
   b.
   c.
   d.
   e. (Loss of function

2. The inflammatory process
   a.
   b.
   c.
   d.
   e.
E. Complement

a. The classical pathway

By
C5, 6, 7, 8, 9 (Membrane Attack Complex)
b. The alternate pathway

![Diagram of the alternate pathway]

F. Interferon

1. Alpha

2. Beta
G. Fever

H. Natural Killer Cells (NK Cells)
   1. Lymphocytes but neither T-cells nor B-cells
   2. Kill other cells
   3. Produce gamma interferon which activates macrophages
   4. May be stimulated by macrophages

I. Dendritic Cells – Phagocytes found in lymph nodes, spleen and skin

J. Toll-Like Receptors
   1. Proteins in plasma membranes of macrophages and dendritic cells
   2. TLR’s bind to invading microbes
III. THE THIRD LINE OF DEFENSE – SPECIFIC

A. The Specific Immune Response Is Acquired And Different For Each Individual

B. Antibody Mediated Immunity – AMI: Antigens and Antibodies

1. An antigen is:

2. An antigenic determinant is:

3. A hapten is:

4. Antibody structure – proteins and carbohydrates

5. Antibody function
6. The five classes of antibodies:

### IgM Antibodies
- Pentamer
- 5-10% of serum antibodies
- Fix complement
- In blood, lymph, on B cells
- Agglutinates microbes; first Ab produced in response to infection

### IgG Antibodies
- Monomer
- 80% of serum antibodies
- Fix complement
- In blood, lymph, intestine
- Cross placenta
- Enhance phagocytosis; neutralize toxins & viruses; protects fetus & newborn

### IgA Antibodies
- Dimer
- 10-15% of serum antibodies
- In secretions
- Mucosal protection

### IgE Antibodies
- Monomer
- 0.002% of serum antibodies
- On mast cells and basophils, in blood
- Allergic reactions; lysis of parasitic worms

### IgD Antibodies
- Monomer
- 0.2% of serum antibodies
- In blood, lymph, on B cells
- On B cells, initiate immune response
C. The Maturation Of B Cells

D. Clonal Selection And Differentiation Of B Cells
E. Primary And Secondary Antibody Response

1. Primary

2. Secondary
F. **Cell Mediated Immunity – CMI**

1. Maturation of T cells
   a. Differentiation of Lymphocytes to T cells
   b. Maturation in the thymus

2. Activation of T cells
   a. Antigen presenting cells and T cell activation
   b. T-helper activates:
      i. 
      ii. 
      iii. 
3. Subsets of T cells

   a. $T_H$ or T-Helper cells (CD$_4$ T-cells)
      
      Secrete cytokines to activate other cells
      
      $T_H1$ – Activate macrophages, $T_C$-cells and natural killer cells

      $T_H2$ – Associated with allergic reactions or response to parasitic infections

   b. $T_C$ – T-cytotoxic cells (CD$_8$ T-cells)
      
      Kills target cells

   c. $T_R$ – or T regulatory cells (formerly $T_S$ cells)
      
      Suppress activity of other T cells
      
      They modify inflammation and regulate the response of the immune system to organ rejection and to autoimmune disease

4. Apoptosis
TYPES OF ACQUIRED IMMUNITY

ACQUIRED IMMUNITY

NATURALLY ACQUIRED     ARTIFICIALLY ACQUIRED

ACTIVE                  PASSIVE                  ACTIVE                  PASSIVE
Antigens enter the body naturally; body produces antibodies and specialized lymphocytes
Antibodies pass from mother to fetus via placenta or to infant in her milk
Antigens are introduced in vaccines; body produces antibodies and specialized lymphocytes
Preformed antibodies in immune serum introduced into body by injection

Examples

_________________ _________________ _________________ _________________
_________________ _________________ _________________ _________________

A. Active means ___________________________________________________________

B. Passive means __________________________________________________________
CHAPTER 18 – ENHANCEMENT OF ACQUIRED IMMUNITY – VACCINES

I. DEFINITION

Vaccination is the process of stimulating protective adaptive immune responses against microbes by exposure to nonpathogenic forms or components of the microbes.

II. PURPOSE

III. TYPES OF VACCINES:

<table>
<thead>
<tr>
<th>Type of Vaccine</th>
<th>Examples</th>
<th>Form of Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Killed microbe</td>
<td></td>
<td>Antibodies</td>
</tr>
<tr>
<td>Whole Agent – Bacteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Killed Microbe</td>
<td></td>
<td>Antibodies</td>
</tr>
<tr>
<td>Whole Agent – Virus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live, attenuated</td>
<td></td>
<td>B and T-cells</td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
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<td>Live, attenuated</td>
<td></td>
<td>B and T-cells</td>
</tr>
<tr>
<td>Whole Agent – Virus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subunit Antigen</td>
<td></td>
<td>Antibodies</td>
</tr>
<tr>
<td>Pneumococcus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prevnar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumovax</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toxoid</td>
<td></td>
<td>Antibodies</td>
</tr>
<tr>
<td>Tetanus, Diphtheria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conjugated</td>
<td></td>
<td>Th cell dependent Antibody response</td>
</tr>
<tr>
<td>Recombinant</td>
<td></td>
<td>Antibodies</td>
</tr>
</tbody>
</table>
### TABLE 18.1  Principal Vaccines Used in the United States to Prevent Bacterial Diseases in Humans

<table>
<thead>
<tr>
<th>Disease</th>
<th>Vaccine</th>
<th>Recommendation</th>
<th>Booster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diphtheria</td>
<td>Purified diphtheria toxoid</td>
<td>See Table 18.3</td>
<td>Every 10 years for adults</td>
</tr>
<tr>
<td>Meningococcal meningitis</td>
<td>Purified polysaccharide from Neisseria meningitidis</td>
<td>For people with substantial risk of infection</td>
<td>Need not established</td>
</tr>
<tr>
<td>Pertussis (whooping cough)</td>
<td>Killed whole or acellular fragments of Bordetella pertussis</td>
<td>Children prior to school age; see Table 18.3</td>
<td>For high-risk adults</td>
</tr>
<tr>
<td>Pneumococcal pneumonia</td>
<td>Purified polysaccharide from Streptococcus pneumonia</td>
<td>For adults with certain chronic diseases; people over 65; children 2–23 months</td>
<td></td>
</tr>
<tr>
<td>Tetanus</td>
<td>Purified tetanus toxoid</td>
<td>See Table 18.3</td>
<td>Every 10 years for adults</td>
</tr>
<tr>
<td>Haemophilus influenza type b meningitis</td>
<td>Polysaccharide from Haemophilus influenza type b conjugated with protein to enhance effectiveness</td>
<td>Children prior to school age; see Table 18.3</td>
<td>None recommended</td>
</tr>
</tbody>
</table>

### TABLE 18.2  Principal Vaccines Used in the United States to Prevent Viral Diseases in Humans

<table>
<thead>
<tr>
<th>Disease</th>
<th>Vaccine</th>
<th>Recommendation</th>
<th>Booster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influenza</td>
<td>Injected vaccine, inactivated virus (nasally administered vaccine with attenuated virus available soon)</td>
<td>For chronically ill people, especially with respiratory diseases, or for healthy people over 65</td>
<td>Annual</td>
</tr>
<tr>
<td>Measles</td>
<td>Attenuated virus</td>
<td>For infants age 15 months</td>
<td>See Table 18.3</td>
</tr>
<tr>
<td>Mumps</td>
<td>Attenuated virus</td>
<td>For infants age 15 months</td>
<td>(Duration of immunity not known)</td>
</tr>
<tr>
<td>Rubella</td>
<td>Attenuated virus</td>
<td>For infants age 15 months; for females of childbearing age who are not pregnant</td>
<td>(Duration of immunity not known)</td>
</tr>
<tr>
<td>Chickenpox</td>
<td>Attenuated virus</td>
<td>For infants age 12 months</td>
<td>(Duration of immunity not known)</td>
</tr>
<tr>
<td>Poliomyelitis</td>
<td>Attenuated or killed virus (enhanced potency type)</td>
<td>For children, see Table 18.3; for adults, as risk to exposure warrants</td>
<td>(Duration of immunity not known)</td>
</tr>
<tr>
<td>Rabies</td>
<td>Killed virus</td>
<td>For field biologists in contact with wildlife in endemic areas; for veterinarians; for people exposed to rabies virus by bites</td>
<td>Every 2 years</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>Antigenic fragments of virus</td>
<td>For children, see Table 18.3; for adults, especially health care workers, homosexual males, injecting drug users, heterosexual people with multiple partners, and household contacts of hepatitis B carriers</td>
<td>Duration of protection at least 7 years; need for boosters uncertain</td>
</tr>
<tr>
<td>Hepatitis A</td>
<td>Inactivated virus</td>
<td>Mostly for travel to endemic areas and protecting contacts during outbreaks</td>
<td>Duration of protection estimated at about 10 years</td>
</tr>
</tbody>
</table>

P:\scilije\Immune System 16
Incredible edible vaccines

Scientists at the Boyce Thompson Institute in Ithaca, N.Y. are using an experimental process called transgenic implantation to create an edible vaccine. They are doing this by creating genetically engineered bananas that carry proteins from disease-causing organisms. One disease that such a vaccine might protect against is the often fatal diarrhea caused by the cholera bacterium. Here is how the process works:

Cutting and pasting
A strand of the cholera DNA is spliced into a ring of DNA from a benign E. coli bacterium. With the help of an electric pulse, the ring is inserted into an E. coli cell. The cell multiplies, creating millions of copies of the DNA.

The modified DNA is spliced again, this time into the DNA ring of a single-celled organism called Agrobacterium, which naturally infects bananas and other plants. When the Agrobacterium attacks a banana cell, the bacterial DNA is introduced into the plant cell and causes it to create proteins like those found in the original cholera bacterium.

Divide and conquer
Now the banana cell is cloned — it divides into many cells, with each new “daughter cell” inheriting the modified DNA and grows into a complete banana plant. When bananas from this plant are eaten, the “cholera” proteins cause the body to respond as if it were being invaded by the cholera bacterium. The immune system reacts, providing immunity to the original disease.

Why a banana?
According to the World Health Organization, each year 8 million to 10 million children die from infectious diseases that could be prevented with vaccines. Researchers hope that vaccines “packaged” in bananas may be made more readily available to those who need them. Bananas are a common food staple in many countries, do not need to be refrigerated, and are usually eaten raw. Medicinal bananas might even sport a different colored peel, thanks to engineered pigmentation genes.
CHAPTER 19 – HYPERSENSITIVITY AND IMMUNE DEFICIENCIES

A. Definition

B. Type I – Antibody Mediated: May have anaphylactic shock and circulatory collapse in less than 30 minutes. Antibody produced Class IgE.
   1. Allergies to food
   2. Asthma, hives, hay fever
   3. Allergies to insect stings
   4. Allergy to latex

C. Type IV (Delayed-Cell Mediated)
   1. Initial exposure = Sensitization
      No symptoms – takes 7-10 days
   2. Second exposure – reaction apparent after a day or two
      Requires time for T-cells and macrophages to migrate to foreign antigen
   3. Examples
      a. Contact Dermatitis
      b. Poison Ivy/Poison Oak
      c. Tuberculin Skin Test
D. Immune Deficiencies

1. Lack of IgA

2. Lack of IgG and IgM

3. Lazy leukocytes

4. Lack of thymus

5. Lack of leukocyte differentiation