

**FARM MICROBIOLOGY 2008**  
**PART 6: MICROBIAL DISEASES**  
**of Humans, Animals and Plants**

**I. Basic terms.**

- A. Infection.** Organisms are growing in the host, causing an “infectious disease.”
- B. Infestation.** This is where we have an invasion of higher organisms that we can actually see with the naked eye. (These range from roundworms to rats and beyond. Larger types would more likely be **carriers** of disease organisms.)
- C. Intoxication.** The ingestion of illness-producing toxins produced by micro-organisms. The most common examples would be bacteria growing in a food and producing a toxin which, when ingested with the food, causes illness. Infectious organisms can also produce specific toxins at the infection site; these are called toxico-infections.

**II. Concepts of host-parasite relationships in infectious diseases.**

- A. Parasite.** Simply an organism that grows in or on a host. Not necessarily a pathogen.
- B. Host.** An organism (generally a higher organism than the parasite) that harbors a parasite.
- C. Pathogenicity.** Ability of a pathogen to do harm to a host.
- D. Virulence.** What diversity of hosts are affected by the pathogen. May also refer to the degree of damage done by a pathogen.
- E. Contagious disease.** Disease spread from one individual to another by various direct or indirect means.
- F. Epidemic.** Widespread disease traceable to a common source.
- G. Endemic.** Disease that appears to always be associated with a particular locality.
- H. Host's natural resistance.** Natural ability of a host to resist being harmed by a parasite. Can be due to the natural integrity of the host. Can also be due to being helped by such things as the normal flora.
- I. Host immunity.** Ability of a host to resist infection.

**III. The spread of pathogens and its prevention.**

- A. Methods by which pathogens get around.**
  - 1. Direct contact with individuals with active disease or in the carrier state.
  - 2. Direct contact with fecal contamination.
  - 3. Food.
  - 4. Water.
  - 5. Soil.

6. Fomites (objects such as clothing, toys, bedding, tools, implements, etc.).
7. Air.
8. Insects.
9. Mites and ticks.

**B. Preventing the spread of pathogens.**

1. Control of insects, mites, ticks and protection against them.
2. Treatment of sewage.
3. Adequate treatment of hosts. Chemotherapy, antibiotics, immune serum, etc.
4. Control of human carriers.
5. Sanitation/sterilization of foods, water, infected materials. (This can include disinfection, irradiation, pasteurization or other applicable heat treatment.)
6. Slaughter and disposal of infected animals.
7. Quarantine of infected animals and plants.
8. Destruction of infected plants.
9. Breeding resistant varieties/strains.
10. Ventilation and air purification.

**IV. Host defenses against pathogenic microorganisms.**

**A. Natural (constitutive) defense.**

1. **Skin and mucous membranes.** Effective anatomical defenses when intact.
2. **Microbicidal substances.** Lysozyme, for example, is found in serum, saliva, sweat and tears; it lyses bacterial cells by degrading the peptidoglycan in the cell wall.
3. **Normal flora.** Indigenous microorganisms that compete for space with invaders. Can produce substances which act against other organisms (acid, for example).
4. **Inflammation.** Tissue response to infection or injury: redness, swelling, heat, pain – some of which may be directly attributed to the invader. Overall effect of inflammation is to get the body's defence mechanisms to the scene where they can work efficiently. Higher temperature and slightly lower pH effected during inflammation can enhance defence mechanisms.
5. **Phagocytosis.** Ingesting organisms whole. This is accomplished by specialized cells which act much like some protozoa do

**B. Immune (inducible) defense = acquired immunity.** (Directed specifically against an invading pathogen.)

**1. Two types of acquired immunity.**

- a. **Active.** This is due to formation of antibodies in the animal in response to antigens on the invading organism or its products.
- b. **Passive.** This is acquiring antibodies from another individual (human or animal) or from tissue culture (monoclonal antibodies).

## 2. Antigenes and antibodies.

**a. Definition of antigen.** Anything which causes a body to produce antibodies in an effort to neutralize it. These can include certain polysaccharides and proteins on the surface and flagella of bacteria and also toxins produced by microorganisms. Certain components of pollen and food can also be "antigenic."

**b. Definition of antibody.** What an animal produces to counteract a specific antigen. It is a protein present in serum or other body fluid. Antibodies can block the colonization of pathogens and neutralize toxins and viruses and act in various other ways to control an infection.

### c. Vaccination.

**(1) History of "vaccination."** It was long noted that individuals who contracted smallpox rarely got it again. Ancient Chinese would be inoculated with material from smallpox lesions – an extremely risky practice but successful often enough to continue to be practiced. Toward the end of the 18th century, British physician Edward Jenner noted that milkmaids who contracted cowpox rarely got smallpox. After injecting a small boy with material from a cowpox lesion and then exposing him to pus from a smallpox case, Jenner achieved success when the boy did not contract smallpox.

**(2) Active:** A preparation of an antigen or mixture of antigens is injected to cause animal or human to produce antibodies. These antigens are carried on attenuated or avirulent strains of species known to be pathogenic. Other items which can be injected include modified ("detoxified") toxin which is still able to cause the animal or human to produce antibodies against the toxin (i.e., "antitoxin").

**(3) Passive:** Injection of serum which contains one or more antibodies.

### Special Topic: What is a Serotype? (Also known as Serovar.)

- 1. For precise identification and epidemiology.** This is a way in which a bacterium can be identified more precisely than as a species. It could be analogous to classifying humans according to blood type. Important in **epidemiology** in that the finding of the same serotype among persons suffering from a certain disease – as well as in other things such as food products – can help to define the epidemic and to assist in determining the common source of the infection.
- 2. O and H antigens.** An **antigen** is something that – when injected into a human or higher animal – causes the production of a matching **antibody**. Enteric bacteria and many other bacteria have antigens associated with the **cell wall (O antigens)** which are made up of polysaccharides. Each different antigen that has been found is given a certain number. There are also antigens associated with the **flagella (H antigens)** that are made up of amino acids, and each different one is given a certain letter or number.
- 3. Example of a Serotype.** For the following table, the O antigens are in red and the H antigens are in blue. Many serotypes of *Salmonella* have been given convenience names which are often written out like genus and species; e.g., organisms with the antigenic formula shown below are commonly called *Salmonella typhimurium*. However, modern convention tends to follow this form: *Salmonella enterica* ser. Typhimurium.

genus and species	example of serotype designation (the "antigenic formula")
<i>Salmonella enterica</i>	<b>1,4,5,12:i:1,2</b>
<i>Escherichia coli</i>	<b>O157:H7</b>

## V. Human Diseases.

### A. Examples of human diseases caused by bacteria.

disease	causative agent	bacterial characteristics	transmission	symptoms
<i>Staphylococcus aureus</i> food poisoning	<i>Staphylococcus aureus</i>	gram-positive, facultatively anaerobic coccus	food-borne toxin	rapid onset of nausea, vomiting and cramping
Botulism (food poisoning)	<i>Clostridium botulinum</i>	gram-positive, strictly anaerobic, endospore-forming rod	food-borne toxin	
<i>Clostridium perfringens</i> food infection	<i>Clostridium perfringens</i>	gram-positive, strictly anaerobic, endospore-forming rod	food	cramps, diarrhea
<i>Salmonella</i> food infection (gastroenteritis)	many <i>Salmonella</i> serotypes	gram-negative, facultatively anaerobic rod	food	cramps, nausea, vomiting and diarrhea
Typhoid fever	<i>Salmonella</i> serotype Typhi	gram-negative, facultatively anaerobic rod	food	sustained & serious headache and fever; no diarrhea
Shigellosis	<i>Shigella</i>	gram-negative, facultatively anaerobic rod	food	dysentery (bloody diarrhea)
Hemolytic-uremic syndrome	Shiga toxin producing strains of <i>Shigella</i> and <i>E. coli</i>	gram-negative, facultatively anaerobic rod	food	anemia, kidney failure, nervous system injury
Listeriosis	<i>Listeria</i>	gram-positive, facultatively anaerobic rod	food	
Anthrax	<i>Bacillus anthracis</i>	gram-positive, facultatively anaerobic, endospore-forming rod	food, inhalation, thru opening in skin	tissue swelling, hemorrhage, circulatory failure
Lyme disease	<i>Borrelia burgdorferi</i>	gram-negative, microaerophilic spirochete	ticks (mice and deer are among the animal reservoirs)	<b>Stage I:</b> rash, flu-like symptoms with fever & chills, joint pains. <b>Stage II:</b> acute effects on heart and nervous system. <b>Stage III:</b> chronic arthritis and impairment of nervous system.
Legionnaire's disease	<i>Legionella</i>	gram-negative rod	water	flu-like symptoms leading to major complications

### B. Additional examples of human diseases.

- Caused by bacteria:** infant botulism (*Clostridium botulinum* causing a food infection), tuberculosis (*Mycobacterium tuberculosis*), bacterial pneumonia (*Klebsiella pneumoniae*, *Streptococcus pneumoniae*), cholera (*Vibrio cholerae*), whooping cough (*Bordetella pertussis*), gonorrhea (*Neisseria gonorrhoeae*), meningitis (*Neisseria meningitidis*), strep throat (*Streptococcus pneumoniae*), gastric ulcers (*Helicobacter pylori*), bubonic/pneumonic plague (*Yersinia pestis*), tetanus (*Clostridium tetani*), diphtheria (*Corynebacterium diphtheriae*), toxic shock syndrome (*Staphylococcus aureus*). Also dental caries, boils, pimples, abscesses.
- Caused by viruses:** common cold, influenza, viral pneumonia, measles, rubella, mumps, chickenpox, smallpox, poliomyelitis, herpes, hepatitis, AIDS, hantavirus pulmonary syndrome.
- Caused by fungi:** blastomycosis, histoplasmosis.
- Caused by protozoa:** malaria, trypanosomiasis (sleeping sickness), amoebic dysentery, giardiasis, cryptosporidiosis.
- Caused by roundworms:** Trichinosis (*Trichinella spiralis*).

## VI. Animal Diseases.

### A. Examples of animal diseases caused by bacteria.

disease	causative agent	bacterial characteristics	transmission	symptoms
Brucellosis, Bang's disease, undulant fever	species of <i>Brucella</i>	gram-negative rod	directly through mucous membranes, skin abrasions, ingestion of infected milk	affects cattle, dogs, goats, pigs, humans, bison, elk, moose, caribou & reindeer; affects mammary glands & uterus in animals; in humans causes recurring fevers and may lead to bone infection
Mastitis	<i>Staphylococcus aureus</i> , <i>Streptococcus agalactiae</i>	gram-positive cocci ( <i>S. aureus</i> = fac. anaerobe; <i>Strep. agalactiae</i> = aerotolerant anaerobe)	direct contact	infection of mammary glands
Tuberculosis (bovine)	<i>Mycobacterium bovis</i>	gram-positive, strictly aerobic, acid-fast rod	ingestion (transmitted to humans in milk)	infection and tissue nodulation in intestinal tract, lymph nodes, bones & joints
Anthrax	<i>Bacillus anthracis</i>	gram-positive, facultatively anaerobic, endospore-forming rod	as for humans (above table)	
<i>Salmonella</i> diseases of poultry	<i>Salmonella</i> serotypes Pullorum and Gallinarum*	gram-positive, facultatively anaerobic, endospore-forming rod	direct contact and transmission thru eggs/into embryos	<b>Pullorum disease:</b> high mortality with white diarrhea in young chicks & poults. <b>Fowl typhoid:</b> high mortality with yellow diarrhea in young and adult poultry.

\* These would be classified as one serotype, but different biochemical reactions and disease symptoms require separation.

### B. Additional examples of animal diseases.

- Caused by bacteria:** Johne's disease, (*Mycobacterium paratuberculosis*), actinomycosis (*Actinomyces israelii*), scours, foot rot.
- Caused by viruses:** foot and mouth disease, hog cholera, Newcastle Disease of poultry, rabies, pseudorabies of swine, canine distemper.
- Caused by prions:** mad cow disease, chronic wasting disease, scrapie of sheep.

### C. Prevention and control of animal diseases.

- Sanitation and confinement.**
- Vaccination.**
- Antibiotics.**
- Quarantine.**

## VII. Plant Diseases.

### A. Examples.

1. **Caused by bacteria:** soft rots (*Erwinia*) and wilts (*Erwinia*, *Pseudomonas*, *Burkholderia*, *Ralstonia*, *Xanthomonas*) of vegetables, galls (*Agrobacterium tumefaciens*), common potato scab (*Streptomyces scabies*).
2. **Caused by viruses and viroids:** mosaic diseases of cucumber, potato and bean; also peach yellows, aster yellows, curly top of sugar beets, potato spindle tuber viroid.
3. **Caused by fungi:** late blight of potato, powdery mildews, corn smut, Dutch elm disease, cereal rusts, white pine blister rust.
4. **Caused by abiotic factors:** nutritional deficiencies, mineral toxicities, toxicity due to pollutants (including pesticides).

### B. Symptoms of plant diseases caused by bacteria.

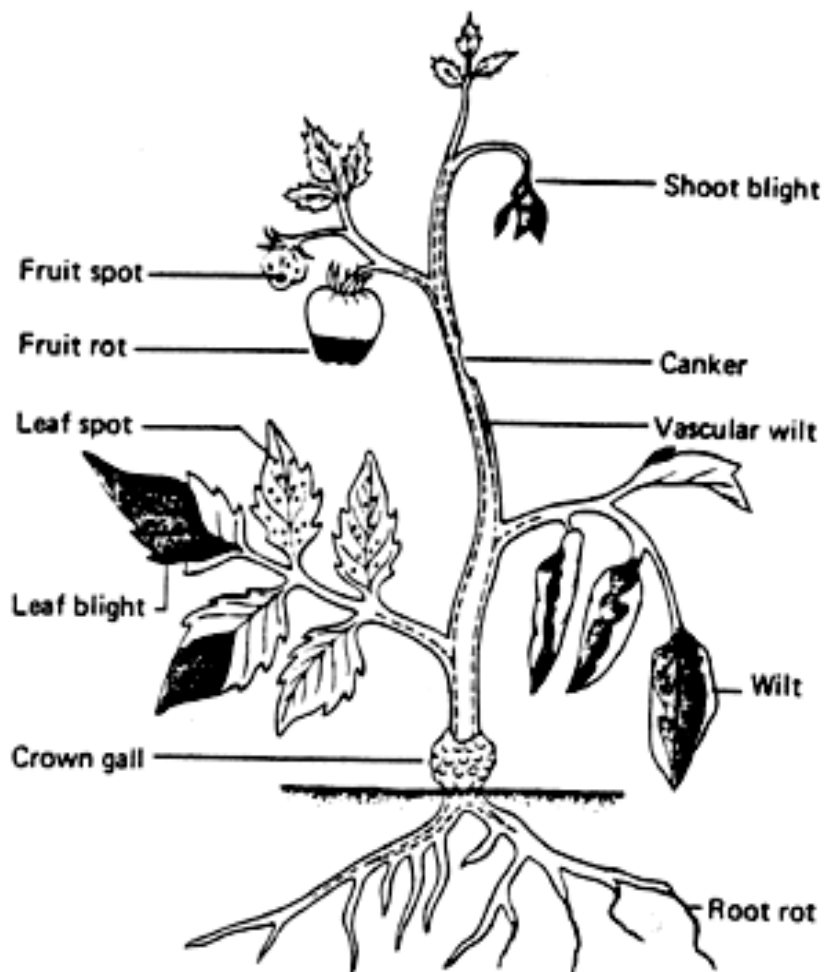
1. **Rots.** Destruction of tissue, usually by enzymatic digestion of the "cement" between cells followed by the subsequent death of the cells. Pectinase, an extracellular enzyme produced by some species of *Erwinia*, destroys pectin.

2. **Wilts.** Invasion of bacteria followed by destruction or blockage of vascular tissue (that which conducts water).

3. **Leaf spots & blights.** Spots of dead cells sometimes surrounded by destruction of chlorophyll (green yields to yellow; photosynthetic capability of plant is decreased).

4. **Cankers & blights of woody tissue.** Destruction of woody tissue and subsequent death of distal portions.

5. **Galls.** Tumor-like proliferation and enlargement of cells, often interfering with water movement.



Generalized Diagram of Plant Diseases.

## **C. Prevention and control.**

### **1. Difficulties:**

- a. Pathogenic organisms often winter in protected places.**
- b. Pathogens can spread rapidly through direct contact, water, wind, etc.**
- c. They can enter damaged plants fast and multiply rapidly.**

### **2. Methods:**

- a. Sanitation.** Use of clean seed: growing plants for seed in uncontaminated areas (can involve different parts of country); hot-water treatments.
- b. Chemical treatment: Fungicides and bactericides.**
- c. Development of resistant varieties.**
- d. Elimination of insect vectors.**
- e. Crop rotation (also remember benefit of increasing soil N).** Alternating different "families" of plants so as to discourage persistence in the soil of organisms that produce diseases in certain crops.