



making sauerkraut  
tanning leather  
forming silage

### *Structure of Bacteria*

(see page 240)

#### prokaryotic cell

instead of nucleus - nuclear material clumped in the middle of the cell forms a single, circular DNA molecule

All bacteria except one group have a cell wall (protects the cell and helps to maintain a water balance with the environment)

For additional protection, some are equipped with a slime layer

Others are protected by a tough layer called a capsule (made of a gummy substance)

protects the cell from drying out during temporary dry periods and prevents certain substances from entering the cell

Colony of bacteria often produces a thick capsule called a sheath gives it a moist, shiny appearance and a slimy feel

Read page 240

### *Basic bacterial shape*

Three basic shapes of bacterial cells:

(use the shapes to classify the organism)

1. **Coccus** (plural Cocci) - spherical-shaped bacteria usually grow in clusters
2. **Bacillus** (plural Bacilli) - rod-shaped bacteria
3. **Spirillum** (plural Spirilla) - spiral-shaped bacteria

Pathogens - a disease-causing microorganism

#### Common Pathogenic Cocci:

*Staphylococcus aureus* - causes food poisonings and a variety of skin disorders

*Streptococcus pneumoniae* - the chief microbe responsible for bacterial pneumonia

*Streptococcus pyogenes* - causes scarlet fever and strep throat

staphylo - means "a bunch of grapes" in Greek

(Staphylococci generally occur in clumps resembling bunches)



bacterium

in spite of the small size of individual bacterial cells,  
colonies of bacteria can often be seen as tiny colored  
patches on certain materials

### *Bacterial Movement*

Two common methods of bacterial movement:

1. flagella
2. **brownian movement** - vibrations as water molecules bump into them.

all bacteria are small enough to be easily carried along with  
even the slightest current

### *Bacterial Growth*

Read page 241

Read pages 244-245

Conditions for bacterial growth:

1. moisture
2. temperature
3. pH
4. nutrition
5. darkness

### *Bacterial Reproduction*

#### **Asexual:**

**Binary fission** - one cell splits into two cells (daughter cells)

Reaction to unfavorable conditions: (like heat, cold, dryness)  
many bacteria become dormant to protect themselves

1. Endospore - the resting, or dormant stage of certain bacteria which is resistant to harsh environmental conditions.
  - a. allow bacteria to survive extremely long periods of

- unfavorable conditions
  - b. difficult to kill
  - c. most pathogenic bacteria are not able to form these:  
good thing because certain types of diseases would  
be extremely difficult to control
  - d. not a method of reproduction - a method of  
continuing the species
2. Reduce metabolism - activities decrease

## Sexual:

never results in offspring (doesn't increase # of bacteria)  
two forms: conjugation & transformation

1. **Conjugation** - a temporary union of two organisms or cells for the exchange of nuclear material  
In conjugation (genetic transfer), a conjugation tube forms from the "male" to the bacterium lacking the F factor, the "female."  
Replicated F factors pass from male to female, the donor bacterium giving the traits to the receiver bacterium. (Has made the femal bacterium into the male bacterium.)  
Example - *Escherichia coli* (E. coli)
2. **Transformation** - living cells absorb the DNA of other bacteria  
(DNA from one bacterium is absorbed into another bacterium)  
Example - *Streptococcus pneumoniae*

### *Bacterial Nutrition*

I. **Autotrophs** - able to produce their own food

A. **Photosynthetic**

bacterial photosynthesis

plant photosynthesis

bacteriochlorophyll -  
purple, red, brown

chlorophyll a - green

obtain hydrogen from  
hydrogen sulfide

obtain hydrogen from  
water

oxygen is usually not a  
product

oxygen is a product

- B. **Chemosynthetic**  
produces food by using iron, sulfur, and nitrogen compounds instead of chlorophyll and sunlight
- II. **Heterotrophs** - unable to make their own food  
Most bacteria are heterotrophic.  
Most bacteria are saprophytes.
- A. **Parasitic** - feeding on a living host
  - B. **Saprophytic** - feeding on dead organic matter

### *Bacterial Respiration*

Three types:

1. **Obligate aerobes** - bacteria that require atmospheric oxygen for respiration  
Example: diphtheria, TB, and cholera
2. **Obligate anaerobes** - cannot grow in the presence of atmospheric oxygen  
Example: tetanus and botulism  
Anaerobic bacteria obtain their oxygen from the foods they eat. As these bacteria digest food, they may produce toxins as waste products. Botulism, a very dangerous type of food poisoning, is produced by anaerobic bacteria. Tetanus, sometimes referred to as lockjaw, is another disease which is caused by anaerobic bacteria. The bacteria enter the body through a deep puncture wound and become active deep in the flesh where no oxygen is present.
3. **Facultative anaerobes** - grow best as aerobes but may grow as anaerobes  
Examples: *E. coli*, those that cause typhoid and scarlet fever

### *Controlling Bacteria*

**pathogen** - an organism which causes disease

two basic ways of controlling bacteria in our food:  
(see page 245)

1. Destroy all the bacteria present and seal the food in a container - canning

2. Place the foods in an environment that will not permit bacteria to grow or at least not grow as rapidly - refrigeration, freezing, dehydration, salt-curing, chemical preservatives, radiation

Louis Pasteur - first devised the process of pasteurization

Read pages 245-246

Three other smaller groups of organisms in the phylum Schizomycophyta:

1. **Mycoplasmas** - a bacteriallike organism that lacks a cell wall  
found in human mouth, nasal passages, and urinary tract  
can cause atypical pneumonia, arthritis, and infections of the urinary tract
2. **Rickettsias** - an obligate parasite; between bacteria and viruses in size. intracellular parasites (live inside cells)  
found by Dr. Howard T. Ricketts  
causes Rocky Mountain Spotted Fever and Typhus fever  
Insect (human body lice, fleas) or ticks transmit most rickettsial diseases  
Through the years rickettsial diseases have claimed the most human lives
3. **Spirochetes** - a group of spiral-shaped bacteriallike organisms  
normally inhabit the mouths, intestines, and reproductive organs of humans and animals  
cause: yaws, infectious jaundice, syphilis, and relapsing fever

Phylum Cyanophyta  
The Blue-green algae

cellular structure: procaryotic, have a cell wall, produce slimy sheath  
movement: float and some slide along  
reproduction: fission, some form spores  
                  none are known to reproduce sexually  
cellular organization: few are unicellular  
                          most colonial (form **filaments** - long,  
                          thin strands of similar cells)  
color: all contain chlorophyll a  
          many contain a blue pigment (phycocyanin) - appear bluish  
          green

Read page 249

## 9B - Viruses

Read or review **Jenner vaccination** account p.250  
Dr. Edward Jenner                   smallpox; cowpox  
Mrs. Phipps son James first vaccination May 14,1796

Jenner was not the first person to propose this method of developing immunity, but he was the first "scientist" to actually experiment with it.

His methods were not popular; cartoons showed people with cows growing out of them at the places they were vaccinated.

**Immunity**- the ability to resist infection or to overcome the effects of infection.

**Vaccination**- (not a cure for a disease) a method of developing an immunity by exposing a person to either a weakened form of the disease or a similar disease.

1892 **Dimitri Iwanowski** (Russian biologist) worked with tobacco mosaic- a disease which causes light green patches on tobacco leaves and stunts leaf growth.  
He assumed that the fluid containing (TMV- tobacco mosaic virus) contained a poison from a bacterium. The term "virus" (is the Latin word for poison) was given to denote this "poison".

Middle 1930's **Dr. Wendell Stanley**, working at the Rockerfeller Institute, isolated the actual virus substance (TMV)  
1946 awarded the Nobel Prize in Chemistry for it.

Viral diseases are probably the most common of all diseases. Most of us contract at least one viral infection each year - the flu, an intestinal "bug", or a cold.

### What is a **virus**?

A protein particle that shows some characteristics of a living thing but only when it is inside a living cell. When outside a host cell, viruses assume a crystalline structure.

### Structure of virus?

Consist of a nucleic acid molecule enclosed in a protein (a strand of DNA or RNA and a protein coat). *Essentially viruses are chromosomes*. An active virus may be comparable to a much simplified cell nucleus.

A viral disease results when a virus enters a host cell and forces the individual cell to start producing copies of a virus molecule. When it has produced all the virus molecules it can, the cell bursts open and scatters the new virus into the surrounding environment.

Of course this usually results in the death of the host cell and the infection of many other near-by cells.

This is known as the **Lytic cycle**: (see pp. 252-253)

- 1) The virus attaches itself to the cell.
- 2) The DNA (or RNA) of the virus enters the cell.
- 3) The DNA (or RNA) begins to transcribe and replicate.
- 4) The cell begins to manufacture virus proteins.
- 5) Virus particles form within the cell.
- 6) The cell bursts, releasing the newly-formed virus particles.

A virus is not able to affect every cell. (Example TMV does not affect humans)

**Virulence**- the ability of a virus to affect cells.

If the virus does not affect a certain cell: non-virulent  
(Ex. TMV nonvirulent to human cells)

Not all viruses begin to destroy the cell immediately after entering it.

**Latent virus**- enters a cell and may remain inactive for long periods of time.

**Temperate phage** (faj)- a virus which enters a cell and replicates within it but may never destroy the cell. It attaches to the bacterial chromosome.

When a certain stimulus (such as ultraviolet radiation, certain

chemicals, or some unknown agent) is applied, the phage becomes virulent, enters the lytic cycle, and destroys the bacterium. Example: Herpes simplex (see pp. 253-254)

Read Various viruses p.254

Viruses dead or alive?

<u>Dead</u> (outside cells)	<u>Alive</u> (inside cell)
can be isolated in crystal form	metabolism
do not have a cellular structure	growth
do not use food	reproduction
no growth	
no metabolism	
no reproduction	

## 9C - Diseases and Disorders

There was no disease in the original creation.

Diseases and disorders are a part of the curse.

Why does the Lord permit a person to suffer from a disease or a disorder:

Diseases or disorders in a persons life may result in:

Salvation

Patience

Humility before God

Fellowship with God

Trust

Sympathy with, and comfort others who are suffering

"God did not comfort us to make us comfortable,

but to make us comforters."

Punishment for sin

"God is not the author of all events, but He is the master of all events."

God did not cause the disorders or diseases (Remember Job) He allowed it.

God can turn it around and use it for good.

Purpose of everything that happens in our life - conforms us to the image of Christ.

*INFECTIOUS DISEASES*

**Disease** - any condition which interferes with the normal functioning of the body.

Types of diseases

- (1) **INFECTIOUS** - caused by invading microorganisms which destroy living cells.
- (2) **NONINFECTIOUS** - brought about by conditions not involving pathogenic microorganisms. such as: breakdown of the body's tissue, hormonal changes, genetic and developmental problems and poor nutrition.

Invading microorganisms - **Pathogen**,  
 2 important types:  
     bacteria  
     viruses

Other pathogens  
     Mycoplasmas  
     Protozoa  
     Rickettsias  
     Spirochetes  
     Algae  
     Fungi  
     Worms

Where they grow and replace - **host**

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### **Germ theory of Disease**

Approximately 100 years ago **Louis Pasteur**, the famous French scientist, observed that bacteria sometimes ruined wine by turning it to vinegar. This observation led Pasteur to wonder if bacteria might not also have a detrimental effect upon the body.

At that time no one knew what caused diseases, and Pasteur wondered if bacteria might not be a cause. Eventually, he formulated the germ concept of disease.

**germ theory of disease:** every infectious disease is caused by a specific germ. (many diseases are caused and spread by specific pathogens)

It's very difficult to prove this theory.

About the same time that Pasteur was doing his experiments, a German physician named **Robert Koch** (Coke) was experimenting with the bacteria he suspected of causing **anthrax**, a disease which was

a great killer of cattle and sheep. While experimenting with anthrax bacteria, Koch developed the techniques scientists needed in order to study bacteria safely. We honor Koch for his pioneering work by calling him the **first great bacteriologist** (a scientist who studies bacteria).

Koch formulated a procedure for determining if a particular bacterium is the cause of a specific disease.

His procedure has come to be known as **Koch's Postulates:**

- (1) Isolate the suspected pathogen in each diseased animal.
- (2) Grow the pathogen in a pure culture and identify it.
- (3) Inject pathogens from the culture into healthy animals to see if they get the disease.
- (4) Find and identify the same pathogen in these diseased animals.
- (5) Repeat the process using the suspected pathogen obtained in step 4.

Koch proved Pasteur's germ concept of disease. Medical scientists today use Koch's postulates in their own studies of disease and disease pathogens.

Koch is called "the father of **bacteriological techniques**"

Koch received the Nobel Prize in 1905.

#### *The Pathogens of Disease*

**incubation period** - the time between contracting (being exposed to) the disease and the appearance of the first symptoms.

Two ways a pathogen can affect its host:

- (1) **Tissue destruction** - pathogens obtain nutrition from the host's body tissues, causing destruction of these tissues
- (2) **Toxin formation** - bacteria produce poisonous substances which kill cells of the host's body

Two basic types of toxins:

1. **Exotoxins** (soluble toxins) - products secreted by the pathogen that diffuse from the living pathogenic cell into the surrounding tissue.  
(Examples: tetanus, diphtheria, Rheumatic fever bacteria)
2. **Endotoxins** - remain in the pathogen and are released when the pathogen dies.  
(Examples: bacterial dysentery, bubonic plague, cholera, salmonella food poisoning and

typhoid fever)

### *Contagious Diseases*

**contagious disease:** a disease that can spread from one person to another by either direct or indirect means  
(Examples: most childhood diseases - chicken pox, measles, mumps, whooping cough)

Read pp. 259-260

Viruses or bacteria cause most contagious diseases.

### *How Diseases are Spread*

- (1) **Droplet infections:** travel suspended in water droplets in air, and usually affect the respiratory system. (examples: TB & diphtheria)
- (2) **Contact infections:** result from contact with a sore or lesion or the skin or mucous membrane of an infected person. (examples: impetigo, chicken pox, small pox)
- (3) **Contamination infections:** enter by food or water; often afflict the alimentary canal (examples: cholera, typhoid fever, food poisoning, TB can enter by milk)
- (4) **Wound infections:** enter through wounds in the body (examples: staphylococcus bacteria, tetanus [lockjaw])
- (5) **Vector-carried infections:** carried by insect or other arthropod bites or food contamination (flies, roaches, fleas, ticks, mosquitoes)
- (6) **Immune carriers:** people who spread disease without suffering the symptoms themselves (Typhoid Mary, see page 261) (examples: diphtheria, polio, scarlet fever, typhoid fever)

### *Defense Against Infectious Disease*

The body's three lines of defense against disease:

- I. Structural
- II. Cellular
- III. Chemical

#### I. **Structural Defenses**

##### A. the skin barrier

one of our most effective defenses

physical barrier: bacteria & viruses cannot penetrate the tightly knitted cells of the skin

harmless bacteria (that lives on the skin) protect the body by fighting off harmful bacteria

the acidity of the skin helps to ward off certain harmful bacteria

- B. The mucous membrane barrier (see page 592) equipped with cilia which sweep the pathogens to the throat where they can be expelled by a cough or swallowed and destroyed  
sneezes clear pathogens from the nasal passages
- C. the lysozymes & hydrochloric acid barrier  
stomach's HCl acid kills most of the bacteria which enter by food  
tears and perspiration contain lysozymes - kills bacteria by destroying their cell walls  
tears also wash pathogens from the eyeballs into the tear ducts; tear ducts carry the germs to the nasal passages for disposal
- D. microorganisms of the digestive system  
intestinal floras live in our intestines and interfere with the growth of invading pathogens

## II. **Cellular defenses** - second line of defense

- A. elevated body temperature (fever)  
most bacteria have a very narrow temperature range
- B. the lymphatic system  
the body's cells are surrounded by tissue fluid which originates in the plasma of the blood  
this tissue fluid acts as a battlefield in the fight against invading microorganisms
- C. phagocytic cells (pus)  
two types of phagocytic cells
  1. **fixed** - found in lymph nodes and certain organs (liver)
  2. **free** - white blood cells (leucocytes)

## III. **Chemical defenses** - the third line of defense

Antibodies: protein molecules made by the body and carried by the blood, which are able to combat specific pathogens or their toxins  
Pathogens contain protein materials called antigens which are foreign to the body and these foreign materials stimulate the production of antibodies by our bodies.

Antibodies are produced in the spleen, lymph nodes, and thymus gland.

Antibodies react with antigens to neutralize them.

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### *Immunity*

**immunity** - the ability of the body to resist an infectious disease

#### I. Inborn immunity

## II. Acquired immunity

- A. Active acquired immunity
  - 1. natural - by exposure to the disease
  - 2. artificial - by vaccines, toxoids, etc.
- B. Passive acquired immunity
  - 1. natural - from mother through placenta or milk
  - 2. artificial - from serum

Two types of immunities:

- (1) **inborn:** (present at birth) because of inherited characteristics  
examples - you are immune to many of the diseases that affect fish, birds, and other animals because your body does not provide a suitable environment
- (2) **acquired:** an immunity that results from having survived a disease or being appropriately inoculated
  - a) **active:** when the person manufactures the antibodies himself
  - b) **passive:** developed by being given antibodies from a person or animals

**Active Acquired Immunity**

- 1. Natural: the contract the disease and manufacture antibodies (examples - diphtheria, scarlet fever, measles, mumps)
- 2. Artificial: through the use of vaccines or toxoids
  - vaccine:** a weakened form of a pathogen sometimes produced by exposing the pathogen to x-ray
  - toxoid:** a weakened form of a toxin which has been produced by exposing the toxin to acids or heat

**Passive Acquired Immunity**

- 1. Natural: a mother who has an immunity to a specific disease can supply antibodies to an unborn infant through the placenta, or to a newborn infant by means of her milk
- 2. Artificial: when a person receives antibodies produced in other people or animals
  - serum:** made by removing the blood cells and most dissolved substances from the fluid portion of the blood, leaving specific antibodies

use serum injections to prevent measles, mumps, and hepatitis

also serum is sometimes used as a treatment for a patient who has been exposed to, or actually contracted, a disease such as diphtheria,

tetanus, botulism, or gas gangrene

*Medical Control of Disease  
Chemotherapy*

**chemotherapy:** the use of chemical agents to treat or prevent disease

Although most people think of cancer treatment when they hear the word chemotherapy, most of the drugs used by doctors are chemotherapeutic. (examples: medicine for a cold, aspirin for headache)

They select chemicals that will injure or kill specific pathogens without damaging the host's body.

There may be side effects.

Use chemical agents derived mainly from plants.

two types of chemicals:

1. **bactericidal** - bacteria-killing (antibiotics, penicillin, streptomycin)
2. **bacteriostatic** - prevent multiplication of bacteria (sulfa drugs, salvarsan)

Read pages 266-267

**Paul Ehrlich:** founded chemotherapy and showed that certain dye injections cure certain tropical diseases. Found first treatment for syphilis after 605 unsuccessful tries.

**Gerhard Domagk:** in 1930 discovered the first of the sulfa drugs (1895-1964) He is best known for his work on a group of chemicals that destroys streptococcal bacteria.

**Antibiotics:** chemicals, produced by living organisms, that naturally kill or inhibit the growth of other organisms

Discovered by accident in 1929 by **Alexander Fleming.**

Fleming discovered *Penicillium*.

Read page 267

Antibiotics are substances produced by bacteria, mold, and certain other organisms.

Antibiotics cannot kill viruses.

*Disorders*

**disorder:** any affliction which is not caused by a pathogen

three major types of disorders:

1. **Inherited** disorders: either the direct result of an inherited gene (examples: hemophilia, PKU, sickle-cell anemia) or an inherited tendency for a disorder (example: diabetes mellitus).
2. **Injuries**: disorders caused by physical damage (examples: bruise, minor cut, loss of leg or eye, burn, broken bones, sprains)
3. **Organic disorders**: can have various causes  
deficiency disease - improper nourishment such as lack of vitamin or mineral  
chemical poisoning & radiation sickness - exposure to various environmental factors (examples: strokes, tumors, ulcers, blood clots)

### *Tumors*

**tumors**: an abnormal growth of a cell mass

types of tumors:

1. **benign**: when the growth is slow and localized (examples: moles, warts, certain birthmarks)
2. **malignant**: when the growth is rapid and chaotic (often called cancer)

To diagnose: doctor performs a **biopsy** - removes a sample of the tumor tissue and sends it to a pathologist

**pathologist**: a specialist in diseased tissue

Read pages 268-269

### *Cancer*

Cancer is a condition in which normally dividing cells become uncontrollable and cannot stop reproducing as they should. This results in too numerous, malformed, and nonfunctional cells accumulating in tissue.

**Ways cancer cells differ from normal body cells:**

larger nuclei  
more DNA  
bizarre appearance  
harmful functions  
often an abnormal chromosome number  
often they consume a specific nutrient or produce a toxic chemical

most common type of cancer is lung cancer  
second most common type of cancer is colon cancer

possible causes of cancer:

1. **carcinogens:** cancer-causing chemicals (examples: chemical residue of smoking, saccharin, many insecticides, some food preservatives)
2. **radiation:** excessive exposure to ultraviolet rays in sunlight and x-rays (example: skin cancer)
3. **viruses:** in humans warts are the only tumors known to be produced by viruses
4. **dietary deficiencies:** such as a lack of vitamin B-17

**seven danger signals of cancer:**

1. unusual bleeding or discharge
2. a lump or thickening
3. a sore that does not heal
4. change in bowel or bladder habits
5. persistent hoarseness or cough
6. persistent indigestion or difficulty in swallowing
7. change in wart or mole

cancer treatments (KEY: early detection)

1. **surgery**  
to remove affected part  
leading method  
is successful if all cancer cells are removed
2. **radiation**  
use x-ray or emissions from radioactive isotopes to destroy cancer cells  
can cause tumors and side effects
3. **chemotherapy**
4. **laetrile** (vitamin B-17)

*Aging & Death*

Read pages 270-273

**gerontology:** the science of aging

**clinical death:** the absence of brain waves for 24-48 hours

**EEG (electroencephalogram):** an instrument that measures brain waves