The Prokaryotes

These notes are to help you check your answers in your Bacteria unit handout package that you received in class.

Textbook reference pages

- Textbook Section 17-2 & 17-3
- pages 360-375

- Prokarytes are wherever there is life and they thrive in habitats that are too cold, too hot, too salty, too acidic, or too alkaline for any eukaryote.
- The vivid reds, oranges, and yellows that paint these rocks are colonies of prokaryotes.

Fig. 27.1

Bacteria and archaea are the two main branches of prokaryote evolution

- Molecular evidence accumulated over the last two decades has lead to the conclusion that there are two major branches of prokaryote evolution, not a single kingdom as in the five-kingdom system.
- These two branches are the bacteria and the archaea.
  - The archaea inhabit extreme environments and differ from bacteria in many key structural, biochemical, and physiological characteristics.

- Current taxonomy recognizes two prokaryotic **domains**: domain Bacteria and domain Archaea.
  - A domain is a taxonomic level above kingdom.
  - The rationale for this decision is that bacteria and archaea diverged so early in life and are so fundamentally different
  - At the same time, they both are structurally organized at the prokaryotic level.

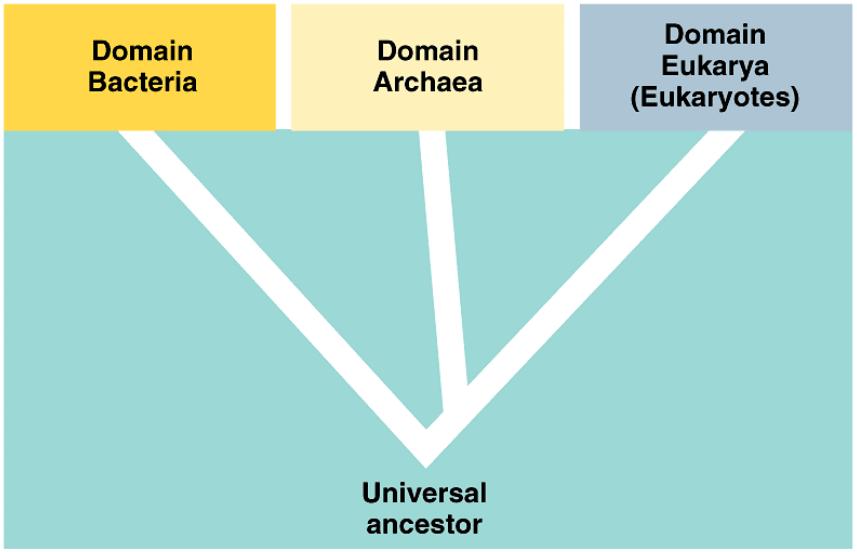


Fig. 27.2

An update on the phylum classification

- Classification is a human construct for organizing information about organisms and it over time as new discoveries are made. In the past Kingdom Monera contained the phylums Archaebacteria and Eubacteria.
- However due to new discoveries in biochemistry, DNA, etc. these phylums have been rearranged and a new level has been created above the Kingdom taxa called Domain.
- Kingdom Monera does not exist now and has been replace by Domain Archaea and Domain Bacteria with Kingdoms underneath these large taxa groups.
- (Domain Eukarya contains the other 4 kingdoms: Protista, Plantae, Fungi, & Animalia)
- However it's still useful to refer to the terms archaebacteria, methanogens, halophiles, thermophiles, eubacteria, cyanobacteria and prochlorobacteria because these terms describe bacteria with similar characteristics.
- (page 4)

Basic structures of bacteria (page 2)

- Refer to diagram on text page 361

- **Nucleoid** – region where bacterial DNA (genetic material) is located
- **Ribosomes** - organelles for making proteins in the cell

Basic structures of bacteria

- **Cell wall** – tough outer thicker layer; gives bacteria their shape
- **Cell membrane** – thin layer just inside the cell wall; regulates substances in and out of the cell
- **Capsule** – layer of slime surrounding the cell wall; allows the bacteria to stick to surfaces and resist host defences

Basic structures of bacteria

- **Flagella** – long whip-like organelle for movement

- Another way for prokaryotes to adhere to one another or to the substratum is by surface appendages called **pili**.
  - Pili can fasten pathogenic bacteria to the mucous membranes of its host.
  - Some pili are specialized for holding two prokaryote cells together long enough to transfer DNA during conjugation.

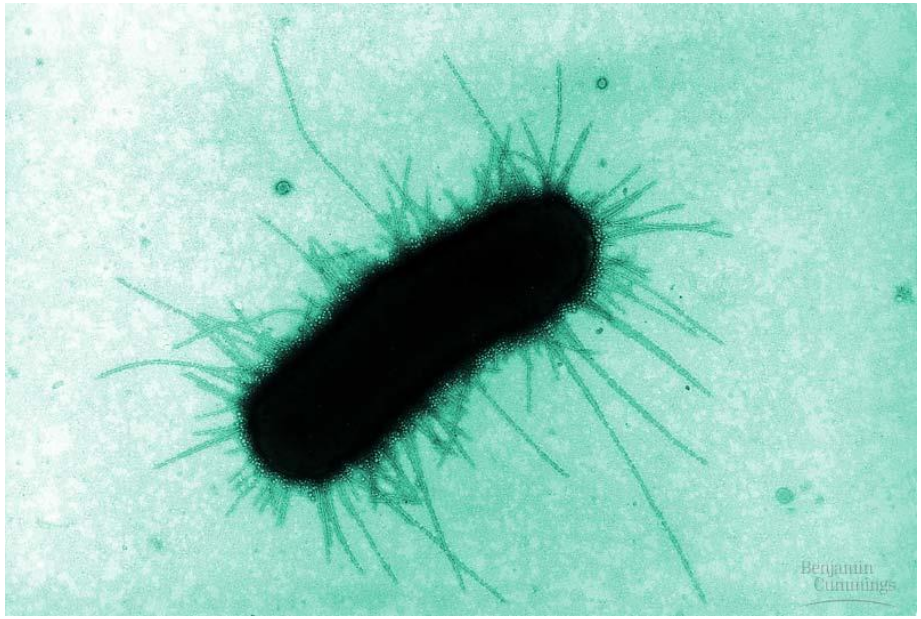


Fig. 27.6

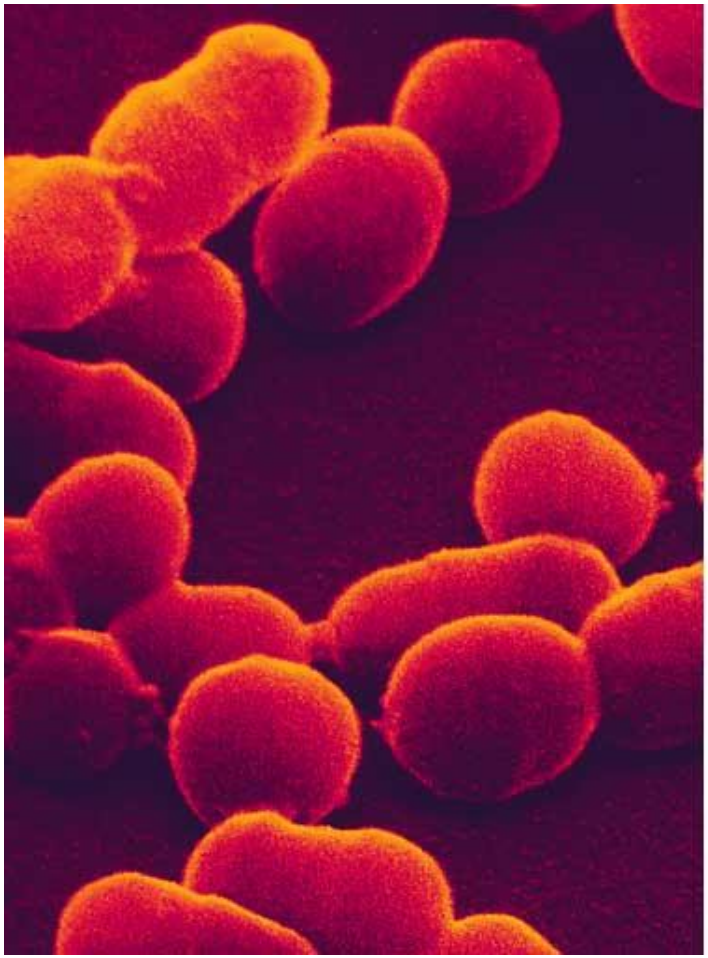
Identifying Monerans

(page 1)

- Monerans can be identified by

1. Cell shape
2. Cell arrangement
3. Cell wall
4. Motility or how bacteria move

Bacteria Cell Shapes



Cell Shape and Arrangement

- Coccus / cocci – spherical shaped;

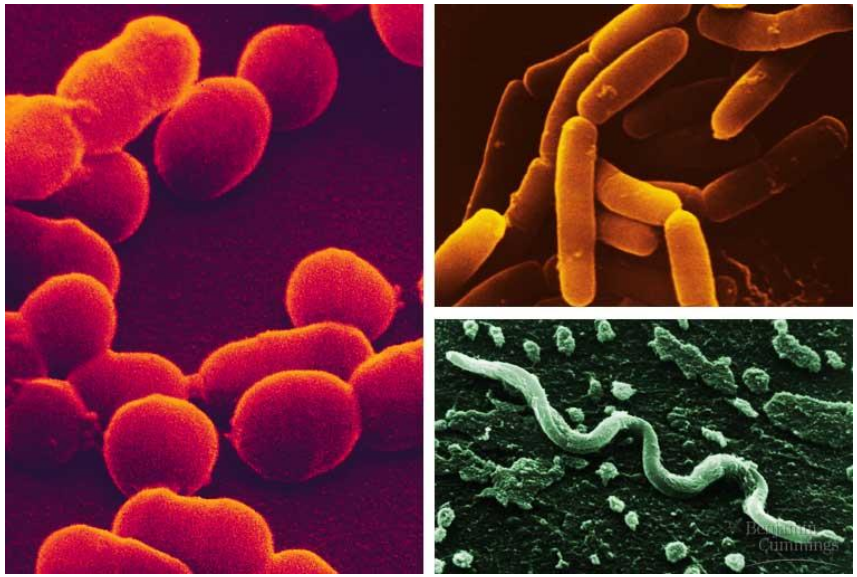
  Example: pneumonia

- Bacillus / bacilli – rod shaped

  Example: tuberculosis

- Spirillum / spirilla – spiral or coil shaped

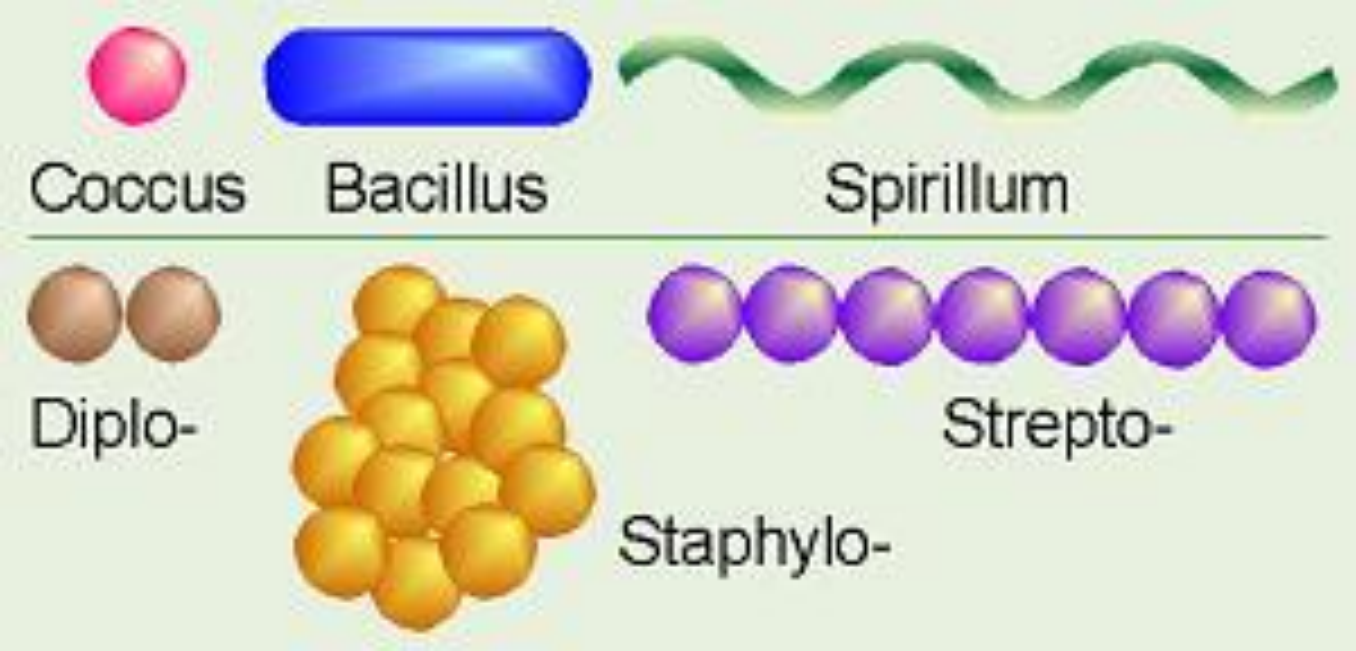
  Example: Syphilis



Cell Shape

Shape	Description	Drawing	Eample
Coccus (singular) / cocci (plural)	spherical shaped		Pneumonia Meningitis
Bacillus / bacilli	rod shaped		Tuberculosis Tetanus
Spirillum / spirilla	spiral or coil shaped		Syphilis

Cell Shape and Arrangement



Cell arrangement

(page 3)

- Single cell
- Diplo – pairs
- Strepto - chains
- Staphylo – clusters

- What do the following names might mean?
- Streptococcus
- Lactobacillus

Cell Wall

Gram-positive

Stain: **Crystal Violet**

Color: **purple**

Cell wall type: thick layer of carbohydrates and **proteins** outside the cell membrane

Gram-negative

Stain: **safranin**

Color: **red / pink**

Cell wall type: a second layer of carbohydrates and **lipids (fats)** molecules

- The **Gram stain** is a valuable tool for identifying specific bacteria, based on differences in their cell walls.
- **Gram-positive** bacteria have simpler cell walls, with large amounts of peptidoglycans.

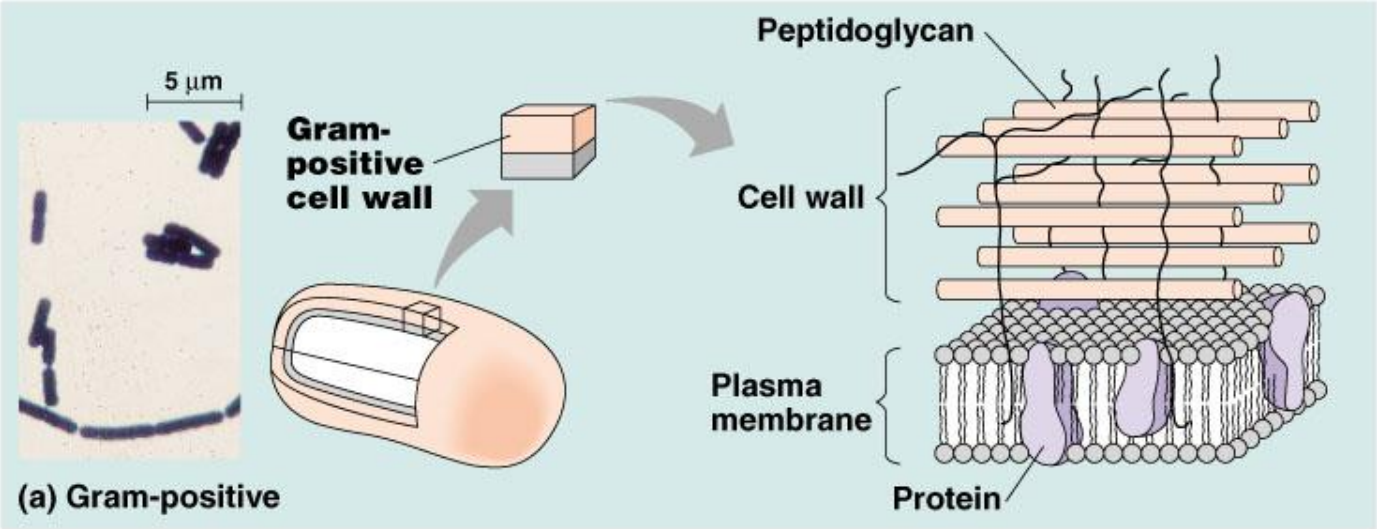


Fig. 27.5a

- **Gram-negative** bacteria have more complex cell walls and less peptidoglycan.
  - An outer membrane on the cell wall contains lipopolysaccharides, carbohydrates bonded to lipids.

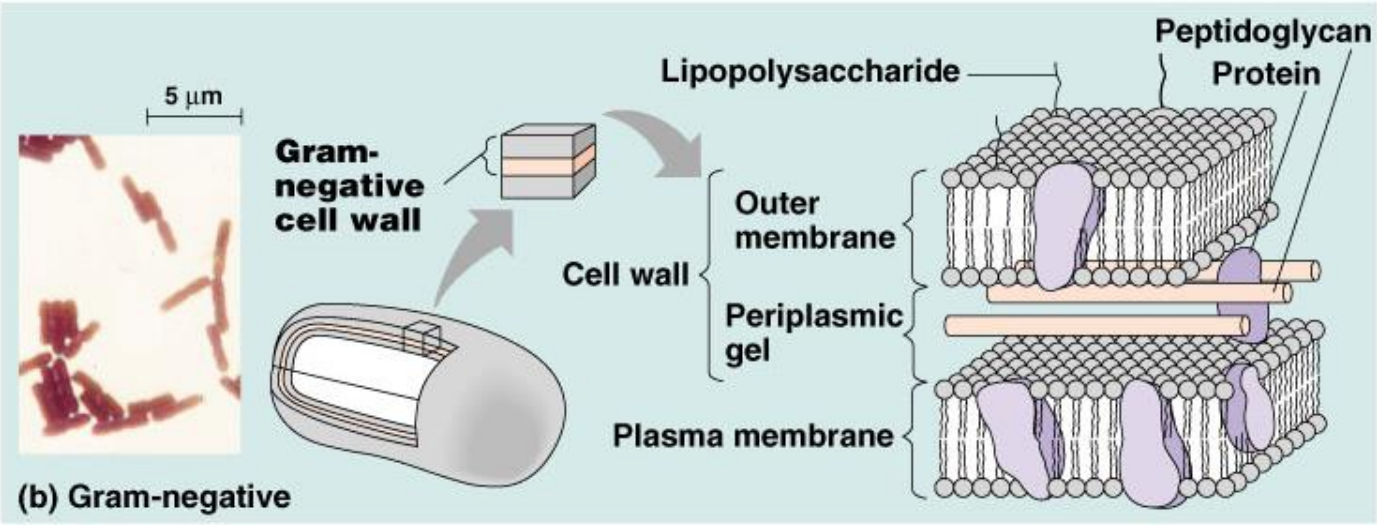


Fig. 27.5b

Obtaining Energy (page 5)

a) phototrophic autotrophs **– capture energy of sunlight and produce their own food; (similar to green plants)**

b) chemotrophic autotrophs – **obtain energy from inorganic molecules such as hydrogen sulfide, nitrites, sulfur, iron**

(refer to textbook page 365)

c) chemotrophic heterotrophs – **obtain energy by taking organic molecules and then breaking them down and absorbing them (includes most bacteria and animals)**

d) phototrophic heterotrophs – **photosynthetic (use sunlight for energy) but also need organic compounds for nutrition**

Study tip: "autotroph" refers to organisms that can make their own food, whereas "heterotroph" refers to organisms that need to consume other organisms (dead or alive) for nutrients; "photo" means light;

Bacterial respiration

- **Respiration** is the process that requires **oxygen** and breaks down food molecules to release energy.

- **Fermentation** is another process but it is different from respiration in that it **does not require oxygen to carry out energy production**

Bacterial respiration

- **Obligate aerobes:** need constant supply of oxygen

- **Obligate anaerobes**: must live in the absence of oxygen; **will die if oxygen is present**; example: intestinal bacteria

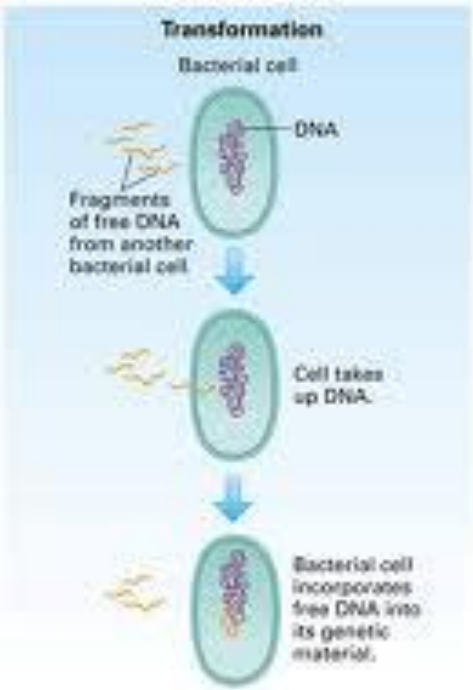
- **Facultative anaerobes**: will use oxygen if present but can also use fermentation in an anaerobic (no oxygen) environment

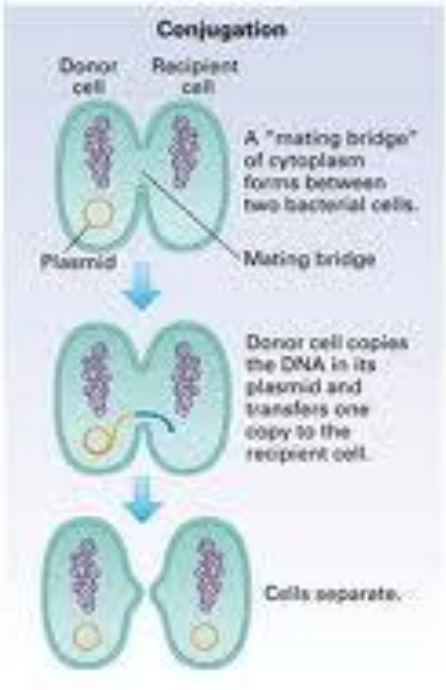
Bacterial Reproduction

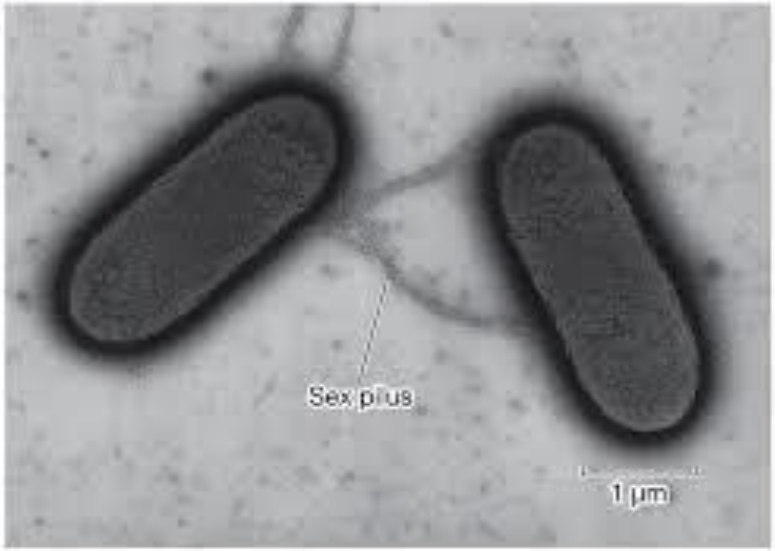
- (page 7)
- Some bacteria can reproduce in just **20** minutes!

- Binary fission
- Conjugation
- Endospore

Transformation vs conjugation







TE 5e, Figure 12.25 (Part 1)

Scientists have been able to make possible bacteria and hamster cell conjugation by genetically selecting membrane proteins

Importance of Monerans

- Some bacteria live in or with other organisms in a relationship where both benefit. This is known as **symbiosis**

- An example of bacteria and humans would be found in our **colon/large intestine.**
-
- Bacteria also are important in the recycling of nutrients in the environment. They help decompose dead material.
-
- **Saprophytes** are organisms that **use the complex molecules of dead organisms as their energy source of energy and nutrition**
- **Parasites** are organisms that survives by living and feeding inside or on another organism. This harms the host organism.
- Note: you are to read p369-372 on your own and summarize/make your own notes from the textbook readings in a later page with a chart provided for you to fill out.

Bacteria and Disease

- (page 9)
- Food poisoning
- 3 examples:
- *Salmonella*
- *Staphylococci*
- Botulism (from canned food) *Clostridium botulinum*)

- Antibiotics are natural substances produced by micro-organisms that attack and destroy other bacteria
- Example: penicillin

Article: Killing Micro-organisms

1. Antibiotic therapy has some problems:

- Some people are allergic to the antibiotics
- Antibiotics also kill off the beneficial bacteria along with the disease-causing bacteria
- Can prevent natural immunity from developing in our bodies and result in reoccurring dependency on antibiotic therapy
- certain strains of bacteria are showing growing resistance to antibiotics

Article: Killing Micro-organisms

2. Physicians believe that antibiotics should be administered only when absolutely necessary because:

- Fear that resistant strains of bacteria will completely replace present strains and antibiotic therapy will no longer be effective
- Adding antibiotics to livestock feed also increases the development of resistant strains and these bacteria can be easily transferred from animals to humans

Sterilization

- Kill bacteria by exposing them to **heat** or **chemical action**

1) Exposing bacteria to high heat. This usually involves **boiling the item or flaming the equipment**.

2) Chemicals: A **disinfectant** is **a chemical solution that kills bacteria** .

Example: **bleach**

3) **Radiation (used in laboratories)**

Food spoilage prevention

1. Refrigeration
2. Cooking food (boiling, frying, steaming)
3. Canning food
4. Preservatives (sugar, salt , vinegar)

Review Sheet: Bacteria – Typical Monerans

a. Flagella – long, whip like structures used for movement
b. Ribosomes – tiny organelles responsible for making proteins
c. Nucleoid – region where DNA is located
d. Cell wall – tough outer layer; give bacteria shape & protection
e. Cell membrane – thin layer just inside the cell wall; provides structural support
f. Capsule – layer of slime surrounding the cell wall

1. binary fission
2. endospores
3. Lack a nucleus
4. prokaryotic

Self Quiz - Monerans

1. nucleus
2. mitochondria
3. blue-green algae
4. oxygen
5. round, rodlike, spiral
6. flagellum
7. anaerobes
8. binary fission
9. saprophytes
10. mutualism (both species benefit from the relationship)
11. moisture, proper temperature
12. freezing, refrigeration, canning & radiation
13. archaebacteria
14. nitrogen-fixing
15. mutation
16. cyanobacteria
17. Actinomycetes (not on test)
18. Spirochetes (not on test)
19. Chemosynthetic (same as chemotrophic autotrophs)
20. Bacteria (not on test)