VIRUS

Figure 19.1

CUỘC SỐNG VAY MƯỢN

- “Virus” = “chất độc”

Do: gây nên nhiều chứng bệnh khác nhau và lan truyền

- “Virus” không sống, chỉ tồn tại ở 1 dạng trung gian giữa các “dạng sống” và các “chất hóa học”

Do: không thể sinh sản, chuyển hóa nếu ko có tế bào ký chủ

Cấu trúc của virus

- Viruses are not cells
- A **virus** is a very small infectious particle consisting of nucleic acid enclosed in a protein coat and, in some cases, a membranous envelope

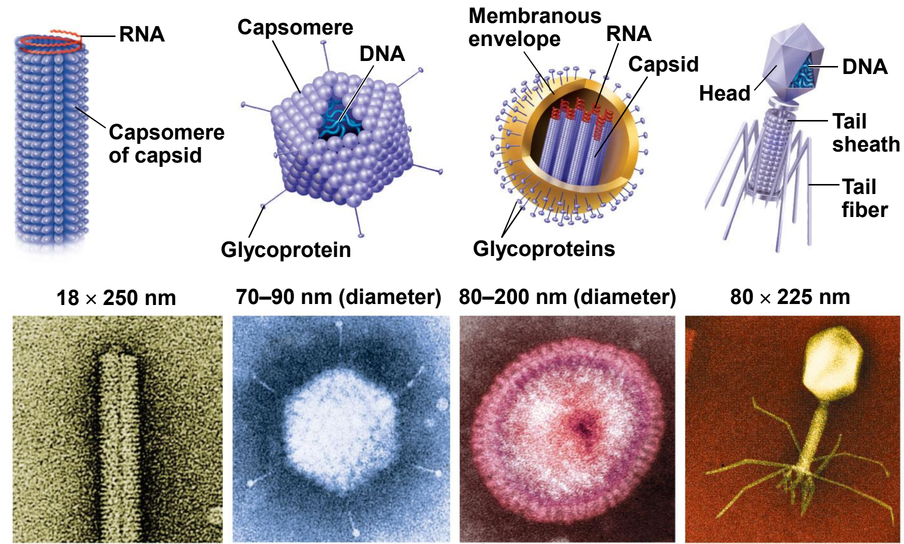
Viral Genomes

- Viral genomes may consist of either
  - Double- or single-stranded DNA, or
  - Double- or single-stranded RNA
- Depending on its type of nucleic acid, a virus is called a DNA virus or an RNA virus

Capsids and Envelopes

- A **capsid** is the protein shell that encloses the viral genome
- Capsids are built from protein subunits called *capsomeres*
- A capsid can have various structures
- Some viruses have membranous envelopes that help them infect hosts
- These **viral envelopes** surround the capsids of influenza viruses and many other viruses found in animals
- Viral envelopes, which are derived from the host cell’s membrane, contain a combination of viral and host cell molecules

Figure 19.3



Tobacco mosaic virus: có 1 vỏ trụ xoắn với hình dạng tổng thể như 1 chiếc que cứng

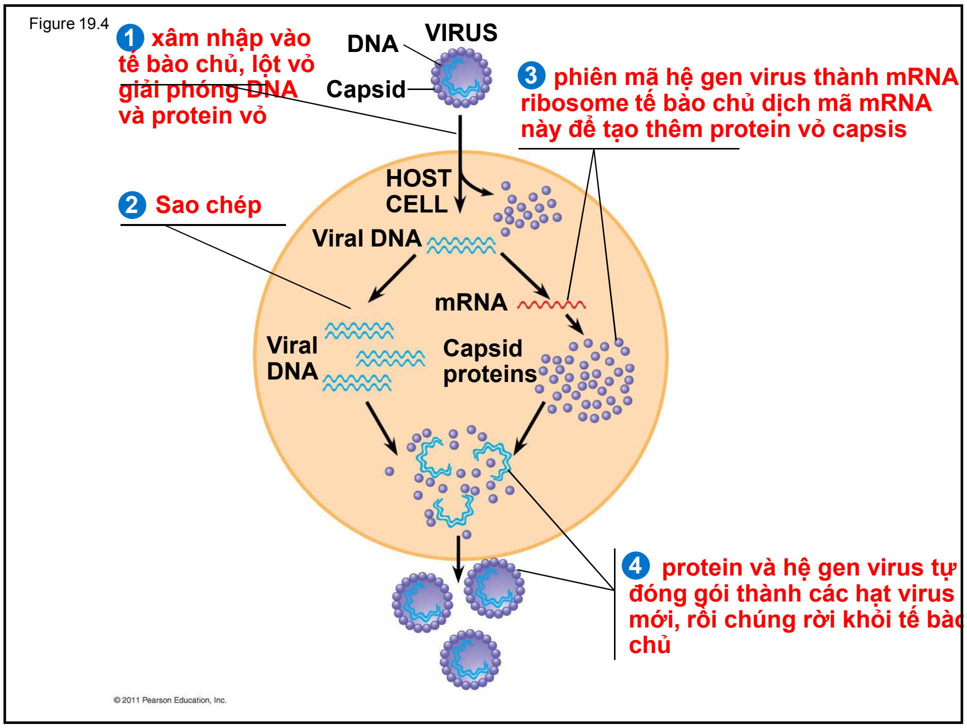
Adenoviruses Có 1 lớp vỏ capsid hình khối 20 mặt tam giác với các gai glycoprotein nhô ra từ mỗi đỉnh góc

Influenza viruses Có lớp áo ngoài dc "khảm" với gai glycoprotein Hệ gene chứa 8 phân tử RNA khác nhau, mỗi phân tử dc bọc trong 1 vỏ trụ xoắn

Bacteriophage T4 Có 1 lớp vỏ capsid phức tạp gồm 1 đầu hình khối 20 mặt và 1 bộ máy đuôi

Virus chỉ sinh sản trong tế bào chủ

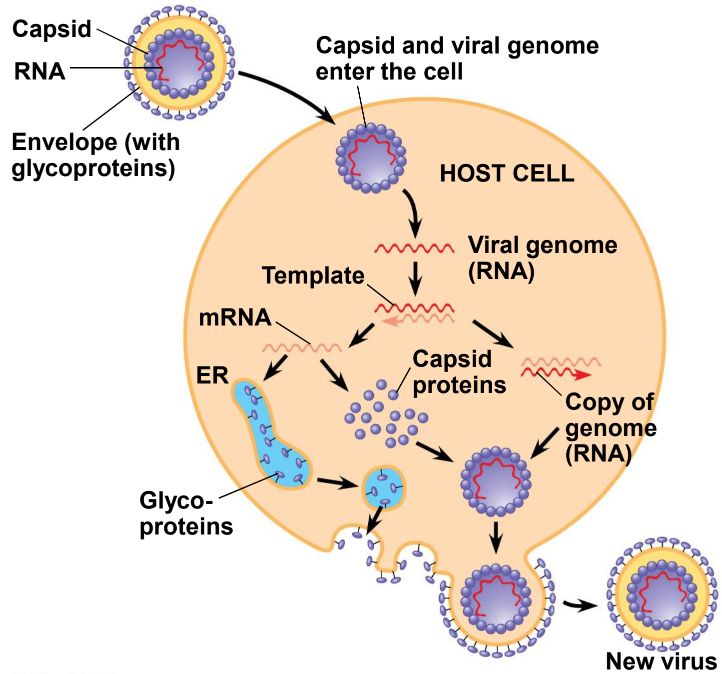
- Virus là những dạng sống ký sinh nội bào bắt buộc, chỉ có thể sinh sản trong tế bào ký chủ do thiếu các enzyme chuyển hóa và bộ máy sản xuất protein (ribosome)
- Mỗi loại virus chỉ có thể lây nhiễm 1 số hạn chế các loại tế bào chủ (**phổ vật chủ)**



Replicative Cycles of Animal Viruses

- There are two key variables used to classify viruses that infect animals
  - DNA or RNA?
  - Single-stranded or double-stranded?

Figure 19.7



RNA as Viral Genetic Material

- The broadest variety of RNA genomes is found in viruses that infect animals
- **Retroviruses** use **reverse transcriptase** to copy their RNA genome into DNA
- **HIV (human immunodeficiency virus)** is the retrovirus that causes **AIDS (acquired immunodeficiency syndrome)**

Figure 19.8

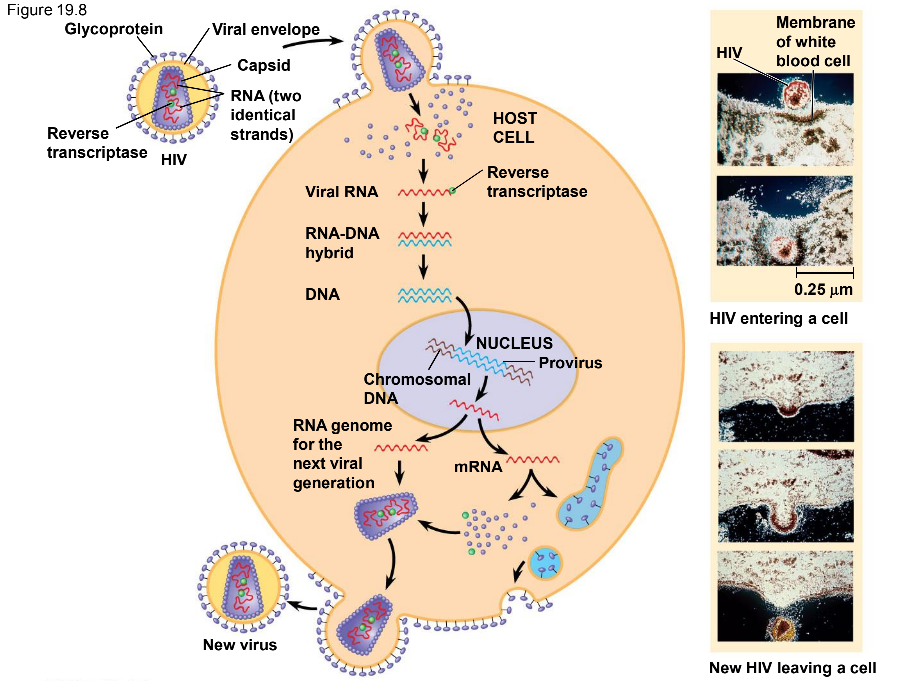
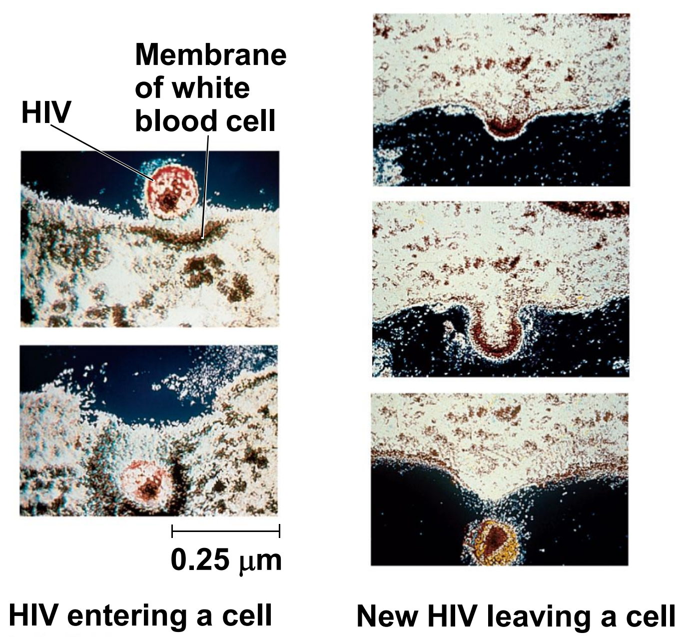


Figure 19.8b



- The viral DNA that is integrated into the host genome is called a **provirus**
- Unlike a prophage, a provirus remains a permanent resident of the host cell
- The host's RNA polymerase transcribes the proviral DNA into RNA molecules
- The RNA molecules function both as mRNA for synthesis of viral proteins and as genomes for new virus particles released from the cell

PLAY Animation: HIV Reproductive Cycle

Concept 19.3: Viruses, viroids, and prions are formidable pathogens in animals and plants

- Diseases caused by viral infections affect humans, agricultural crops, and livestock worldwide
- Smaller, less complex entities called viroids and prions also cause disease in plants and animals, respectively

Viral Diseases in Animals

- Viruses may damage or kill cells by causing the release of hydrolytic enzymes from lysosomes
- Some viruses cause infected cells to produce toxins that lead to disease symptoms
- Others have molecular components such as envelope proteins that are toxic

- **Vaccines** are harmless derivatives of pathogenic microbes that stimulate the immune system to mount defenses against the harmful pathogen
- Vaccines can prevent certain viral illnesses
- Viral infections cannot be treated by antibiotics
- Antiviral drugs can help to treat, though not cure, viral infections

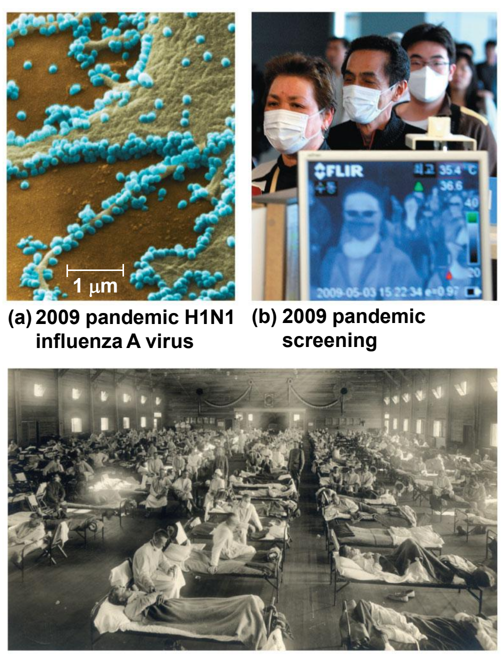
Emerging Viruses

- Emerging viruses are those that suddenly become apparent
- Recently, a general outbreak (**epidemic**) of a flu-like illness appeared in Mexico and the United States, caused by an influenza virus named H1N1
- Flu epidemics are caused by new strains of influenza virus to which people have little immunity

- Viral diseases in a small isolated population can emerge and become global
- New viral diseases can emerge when viruses spread from animals to humans
- Viral strains that jump species can exchange genetic information with other viruses to which humans have no immunity

- These strains can cause **pandemics**, global epidemics
- The 2009 flu pandemic was likely passed to humans from pigs; for this reason it was originally called the “swine flu”

Figure 19.9



(a) 2009 pandemic H1N1 influenza A virus

(b) 2009 pandemic screening

(c) 1918 flu pandemic

Figure 19.9 Influenza in humans.

Viral Diseases in Plants

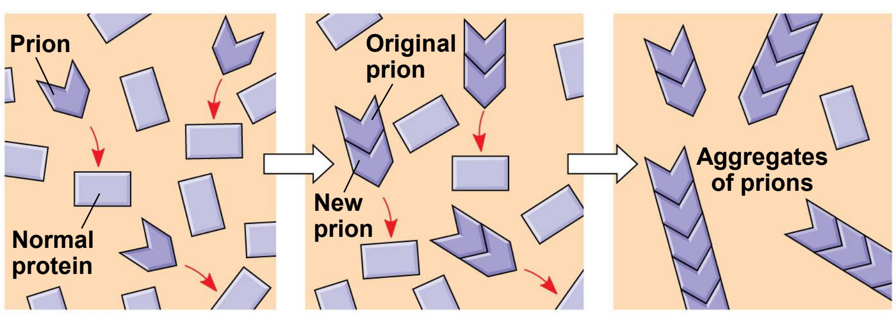
- More than 2,000 types of viral diseases of plants are known and cause spots on leaves and fruits, stunted growth, and damaged flowers or roots
- Most plant viruses have an RNA genome

Figure 19.10

Viroids and Prions: The Simplest Infectious Agents

- **Viroids** are small circular RNA molecules that infect plants and disrupt their growth
- **Prions** are slow-acting, virtually indestructible infectious proteins that cause brain diseases in mammals
- Prions propagate by converting normal proteins into the prion version

Figure 19.11

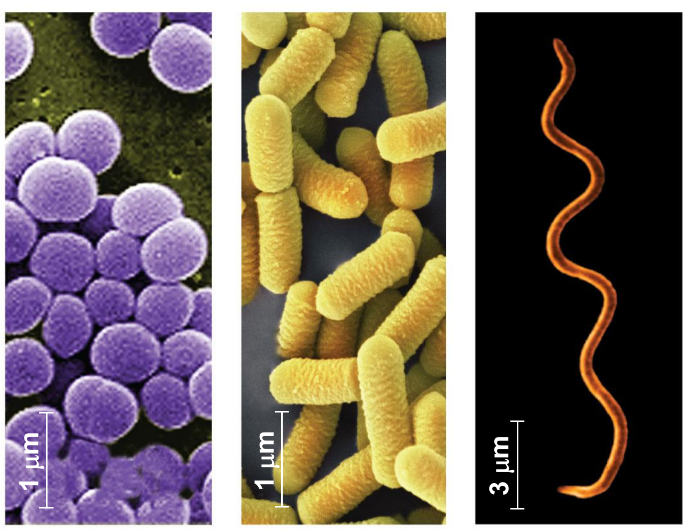


VI KHUẨN

Figure 27.1

- Prokaryotes thrive almost everywhere, including places too acidic, salty, cold, or hot for most other organisms
- Most prokaryotes are microscopic, but what they lack in size they make up for in numbers
- Prokaryotes are divided into two domains: bacteria and archaea

Figure 27.2



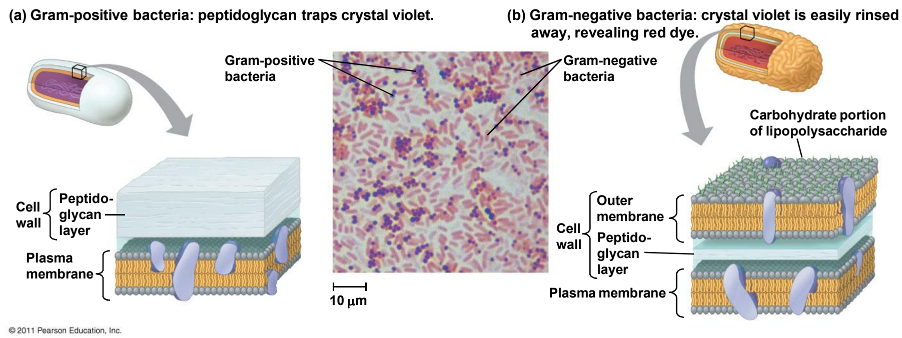
(a) Spherical (b) Rod-shaped (c) Spiral

Cell-Surface Structures

- An important feature of nearly all prokaryotic cells is their cell wall, which maintains cell shape, protects the cell, and prevents it from bursting in a hypotonic environment
- Eukaryote cell walls are made of cellulose or chitin
- Bacterial cell walls contain **peptidoglycan**, a network of sugar polymers cross-linked by polypeptides

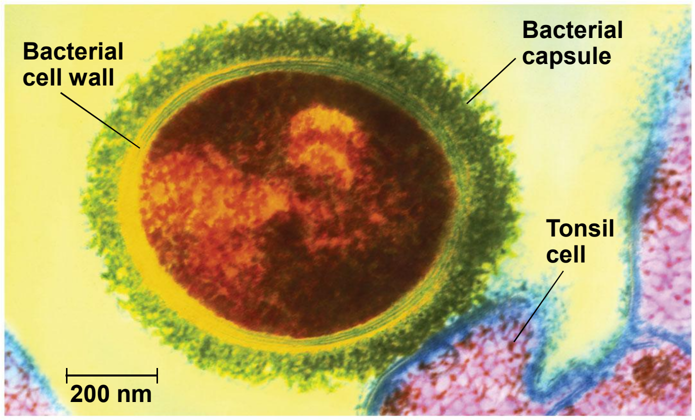
- Archaea contain polysaccharides and proteins but lack peptidoglycan
- Scientists use the **Gram stain** to classify bacteria by cell wall composition
- **Gram-positive** bacteria have simpler walls with a large amount of peptidoglycan
- **Gram-negative** bacteria have less peptidoglycan and an outer membrane that can be toxic

Figure 27.3



- Many antibiotics target peptidoglycan and damage bacterial cell walls
- Gram-negative bacteria are more likely to be antibiotic resistant
- A polysaccharide or protein layer called a **capsule** covers many prokaryotes

Figure 27.4



- Some prokaryotes have **fimbriae**, which allow them to stick to their substrate or other individuals in a colony
- **Pili** (or sex pili) are longer than fimbriae and allow prokaryotes to exchange DNA

Figure 27.5

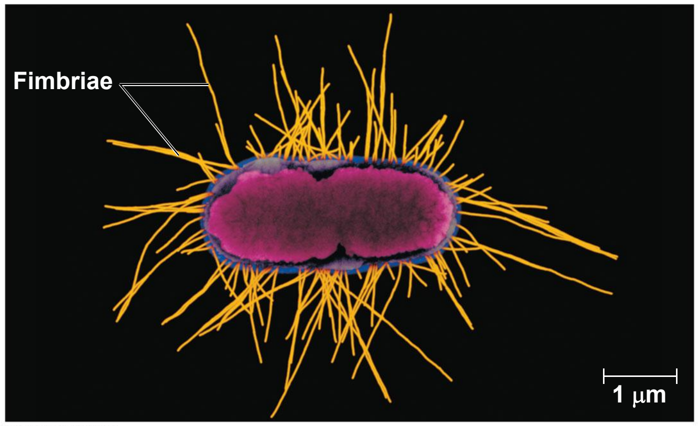


Figure 27.6

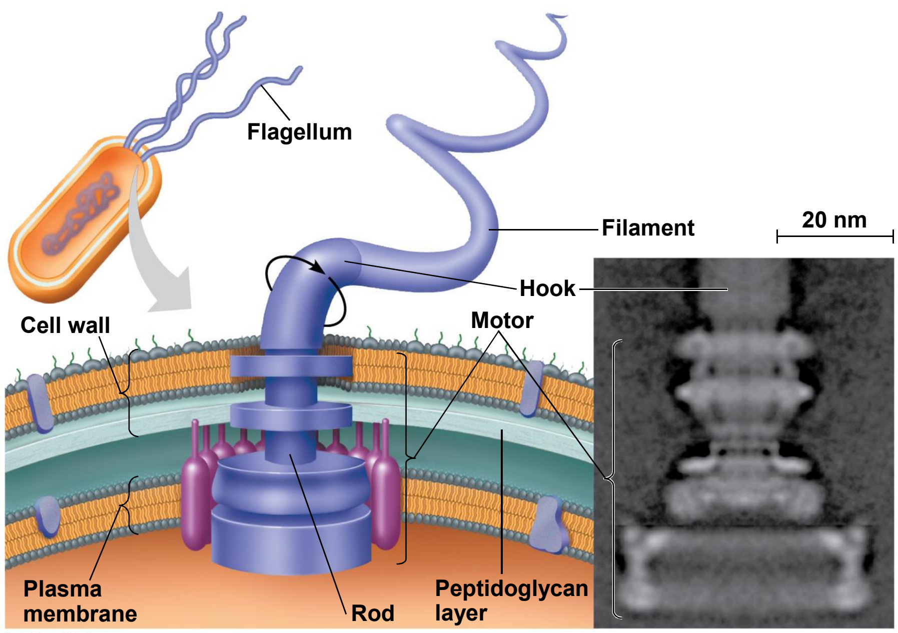


Figure 27.8

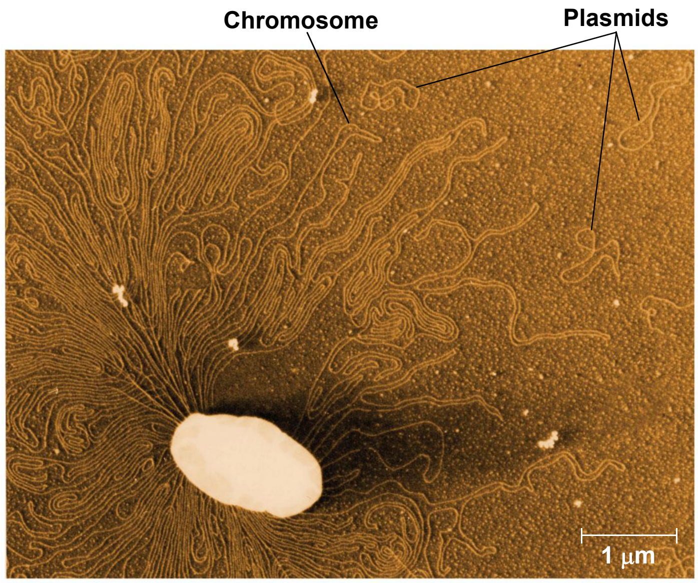
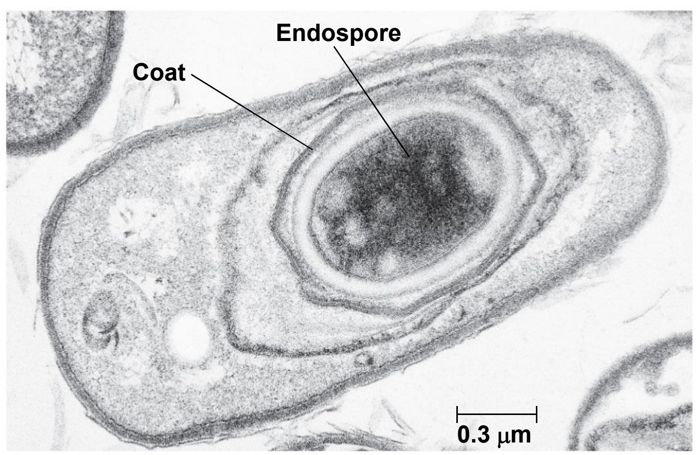


Figure 27.9



- Prokaryotes have considerable genetic variation
- Three factors contribute to this genetic diversity:
  - Rapid reproduction
  - Mutation
  - Genetic recombination

Archaea

- Archaea share certain traits with bacteria and other traits with eukaryotes

Table 27.2

Table 27.2 A Comparison of the Three Domains of Life

CHARACTERISTIC	DOMAIN		
	Bacteria	**Archaea**	**Eukarya**
Nuclear envelope	Absent	Absent	Present
Membrane-enclosed organelles	Absent	Absent	Present
Peptidoglycan in cell wall	Present	Absent	Absent
Membrane lipids	Unbranched hydrocarbons	Some branched hydrocarbons	Unbranched hydrocarbons
RNA polymerase	One kind	Several kinds	Several kinds
Initiator amino acid for protein synthesis	Formyl-methionine	Methionine	Methionine
Introns in genes	Very rare	Present in some genes	Present in many genes
Response to the antibiotics streptomycin and chloramphenicol	Growth inhibited	Growth not inhibited	Growth not inhibited
Histones associated with DNA	Absent	Present in some species	Present
Circular chromosome	Present	Present	Absent
Growth at temperatures > 100°C	No	Some species	No

- Some archaea live in extreme environments and are called **extremophiles**
- **Extreme halophiles** live in highly saline environments
- **Extreme thermophiles** thrive in very hot environments

Figure 27.16

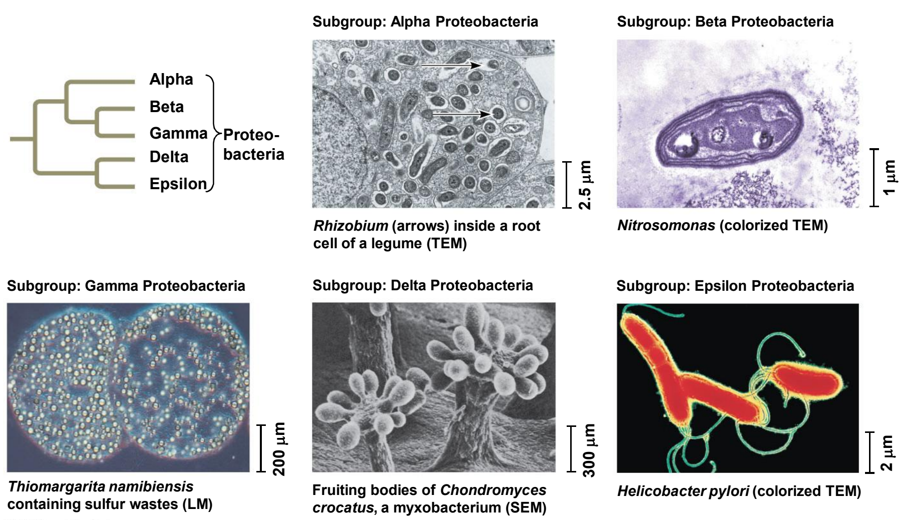
Bacteria

- Bacteria include the vast majority of prokaryotes of which most people are aware
- Diverse nutritional types are scattered among the major groups of bacteria

Proteobacteria

- These gram-negative bacteria include photoautotrophs, chemoautotrophs, and heterotrophs
- Some are anaerobic, and others aerobic

Figure 27.17-a

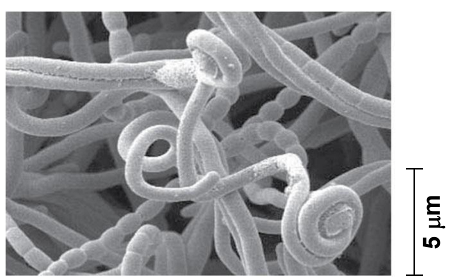


Gram-Positive Bacteria

- Gram-positive bacteria include
  - Actinomycetes, which decompose soil
  - *Bacillus anthracis*, the cause of anthrax
  - *Clostridium botulinum*, the cause of botulism
  - Some *Staphylococcus* and *Streptococcus*, which can be pathogenic
  - Mycoplasms, the smallest known cells

Figure 27.17j

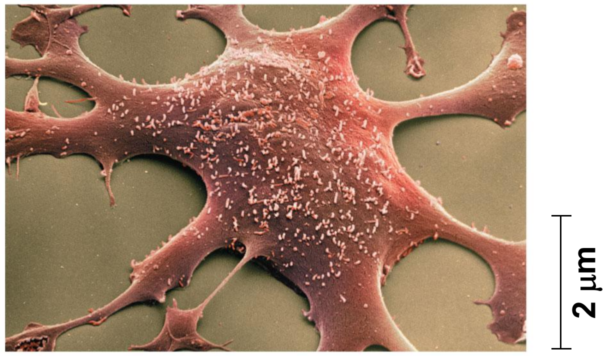
Gram-Positive Bacteria



***Streptomyces*, the source of many antibiotics (SEM)**

Figure 27.17k

Gram-Positive Bacteria



Hundreds of mycoplasmas covering a human fibroblast cell (colorized SEM)

Concept 27.5: Prokaryotes play crucial roles in the biosphere

- Prokaryotes are so important that if they were to disappear the prospects for any other life surviving would be dim

Chemical Recycling

- Prokaryotes play a major role in the recycling of chemical elements between the living and nonliving components of ecosystems
- Chemoheterotrophic prokaryotes function as **decomposers**, breaking down dead organisms and waste products
- Prokaryotes can sometimes increase the availability of nitrogen, phosphorus, and potassium for plant growth

- Prokaryotes can also “immobilize” or decrease the availability of nutrients

Ecological Interactions

- **Symbiosis** is an ecological relationship in which two species live in close contact: a larger **host** and smaller **symbiont**
- Prokaryotes often form symbiotic relationships with larger organisms

- In **mutualism**, both symbiotic organisms benefit
- In **commensalism**, one organism benefits while neither harming nor helping the other in any significant way
- In **parasitism**, an organism called a **parasite** harms but does not kill its host
- Parasites that cause disease are called **pathogens**

- The ecological communities of hydrothermal vents depend on chemoautotropic bacteria for energy

Concept 27.6: Prokaryotes have both beneficial and harmful impacts on humans

- Some prokaryotes are human pathogens, but others have positive interactions with humans

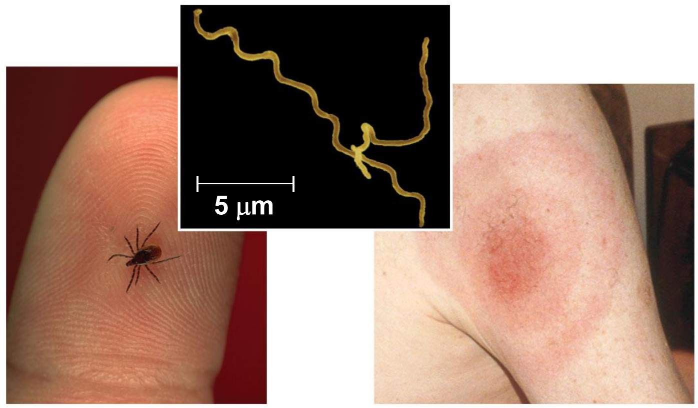
Mutualistic Bacteria

- Human intestines are home to about 500–1,000 species of bacteria
- Many of these are mutalists and break down food that is undigested by our intestines

Pathogenic Bacteria

- Prokaryotes cause about half of all human diseases
  - For example, Lyme disease is caused by a bacterium and carried by ticks

Figure 27.20



- Pathogenic prokaryotes typically cause disease by releasing exotoxins or endotoxins
- **Exotoxins** are secreted and cause disease even if the prokaryotes that produce them are not present
- **Endotoxins** are released only when bacteria die and their cell walls break down

- Horizontal gene transfer can spread genes associated with virulence
- Some pathogenic bacteria are potential weapons of bioterrorism

Prokaryotes in Research and Technology

- Experiments using prokaryotes have led to important advances in DNA technology
  - For example, *E. coli* is used in gene cloning
  - For example, *Agrobacterium tumefaciens* is used to produce transgenic plants
- Bacteria can now be used to make natural plastics

- Prokaryotes are the principal agents in **bioremediation**, the use of organisms to remove pollutants from the environment
- Bacteria can be engineered to produce vitamins, antibiotics, and hormones
- Bacteria are also being engineered to produce ethanol from waste biomass

Figure 27.21

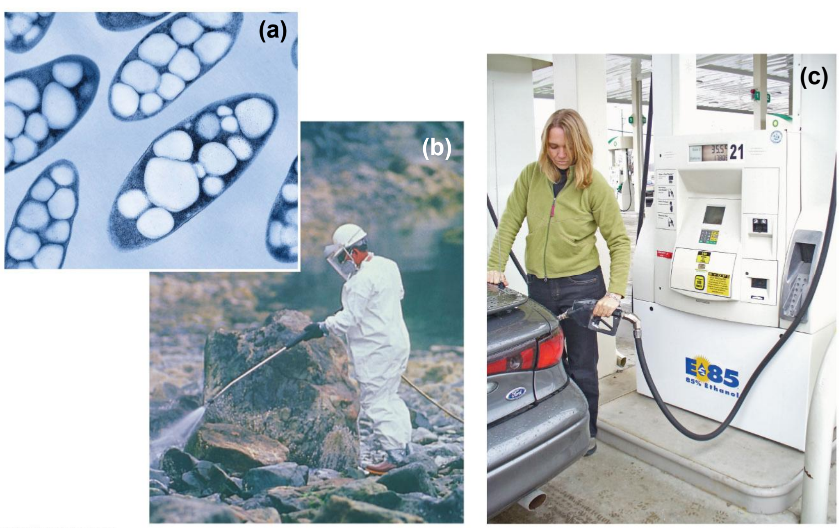


Figure 27.21 Some applications of prokaryotes.