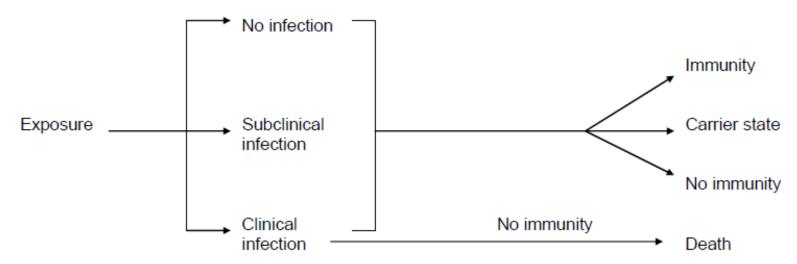
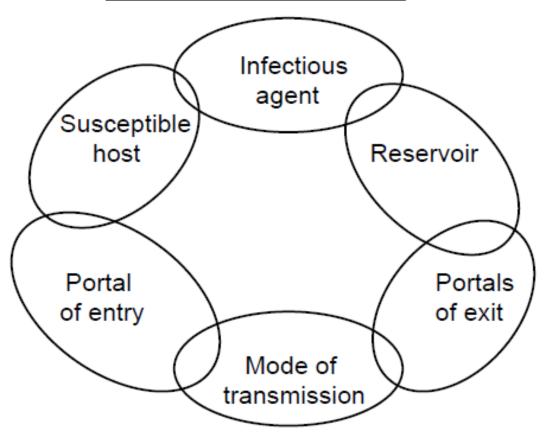
- Disease is a disturbance in the state of health
- Microbes cause disease in the course of stealing space, nutrients, and/or living tissue from their symbiotic hosts (e.g., us)
- To do this, microbes do most of the following:
  - Gain access to the host (contamination)
  - Adhere to the host (adherence)
  - Replicate on the host (colonization)
  - Invade tissues (invasion)
  - Produce toxins or other agents that cause host harm (damage)

#### The different outcomes of an exposure to an infectious agent



Kramer A, et al. Principles of infectious disease epidemiology. In *Modern Infectious Disease Epidemiology*, Kramer A, et al (eds). Springer Science + Business Media, 2010; p 92 (modified from Giesecke 1994)

#### The chain of infection



Kramer A, et al. Principles of infectious disease epidemiology. In *Modern Infectious Disease Epidemiology*, Kramer A, et al (eds). Springer Science + Business Media, 2010; p 91

## BIOLOGIC CHARACTERISTICS OF INFECTIOUS AGENTS

- Infectivity the ability to infect a host
- Pathogenicity the ability to cause disease in the host
- Virulence the ability to cause severe disease in the host
- <u>Immmunogenicity</u> —the ability to induce an immune response in the host

#### **Infectious Disease Terms**

Infectious dose – number of organisms needed to successfully infect Latent period - exposure to infectiousness interval Incubation period – interval from exposure to clinical symptoms Infectious period – interval during which host can transmit infection Reproductive rate – ability of an agent to spread in populations Virulence

Pathogenicity

**Immunogenicity** 

Outbreak - limited spread

Endemic – usually present; steady prevalence

Epidemic – rapid spread

Pandemic – occurring across countries and in multiple populations

## Important Terms

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#### Table 19.1 Terms Used in the Study of Infectious Diseases

Term	Definition
Bacteremia	Bacteria circulating in the bloodstream
Colonization	Establishment and growth of a microorganism on a body surface
Disease	Noticeable impairment of body function
Immunocompromised	A host with weaknesses or defects in the innate or adaptive defenses
Inapparent infection	Infection with no obvious symptoms
Infectious disease	Disease caused by an infecting microorganism or virus
Latent infection	Infection in which the infectious agent is present but not active
Opportunistic pathogens	Organisms that cause disease only when introduced into an unusual location or into an immunocompromised host
Parasite	An organism that benefits at the expense of another organism, the host
Pathogen	Any disease-causing microorganism or virus
Pathogenic	Disease-causing
Primary infection	Infection in a previously healthy person
Secondary infection	An additional infection that occurs as a result of a primary infection and that occurs during or immediately following the primary infection
Septicemia	Acute illness caused by infectious agents or their products circulating in the bloodstream
Systemic infection	Widespread infection through blood or lymph
Toxemia	Toxin circulating in the bloodstream
Viremia	Viruses circulating in the bloodstream
Virulence determinants	Attributes of a microorganism or virus that promote pathogenicity

#### MODES OF TRANSMISSION

- Direct
  - Droplet
  - Aerosol
  - Skin to skin
- Indirect
  - Fomites (clothes, blankets, door handles etc)
  - Vectors (e.g. mosquitoes)
  - Food and water
  - Intermediate hosts (e.g. snails)

#### Measures of Disease Occurrence

Measure Description

Prevalence Number or proportion of persons with a specific disease at a specific time point in

the population

Incidence Number or proportion of persons developing a specific disease during a time

period

Morbidity Ambiguously used: prevalence or incidence

Mortality Number or proportion of persons dying during a time period

Fatality rate Proportion of persons dying from a specific disease among all persons with the

disease

Attack rate Proportion of cases developing the disease among all persons who were

exposed to the disease

Mikolajczyk R. Methods and concepts of epidemiology. In *Modern Infectious Disease Epidemiology*, Kramer A, et al (eds). Springer Science + Business Media, 2010; p 193

## CLINICAL RESPONSES TO INFECTION BY AN AGENT

- Inapparent infection no clinical symptoms generated
- Carrier state usually no clinical symptoms but host can transmit infection for long periods
- Clinical symptoms
  - Mild disease
  - Severe disease
  - Residual impairment
  - death

# CLASSIFICATION OF INFECTIOUS AGENTS (1 of 2)

- <u>Bacteria</u> survive on appropriate media, stain gram-positive or -negative
- <u>Viruses</u> obbligate intracellular parasites which only replicate intracellularly (DNA, RNA)
- <u>Fungi</u> non-motile filamentous, branching strands of connected cells
- Metazoa multicellular animals (e.g.parasites) with complicated life cycles often involving several hosts

# CLASSIFICATION OF INFECTIOUS AGENTS (2 of 2)

- <u>Protozoa</u> single cell organisms with a welldefined nucleus
- Rickettsia very small bacteria spread by ticks
- Prions unique proteins lacking genetic molecules
- <u>Chlamydia</u> bacteria lacking cell walls

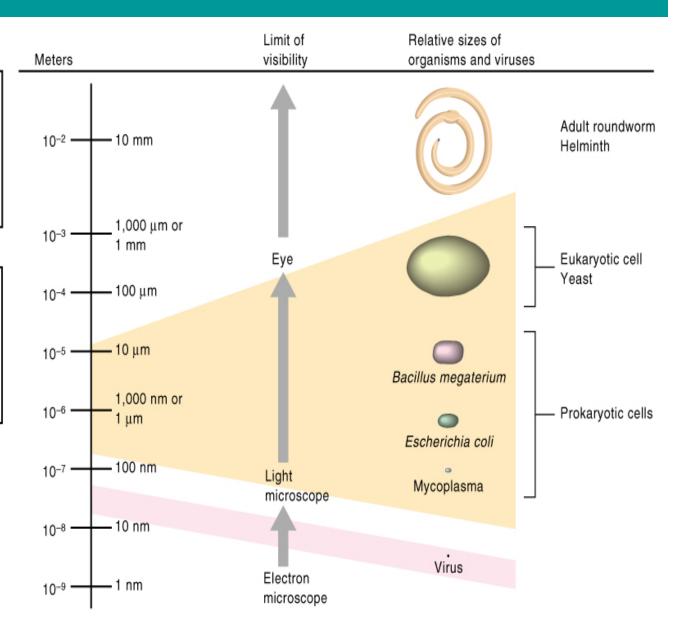
## Size Comparison of Microbes

The basic unit of length is the meter (m), and all other units are fractions of a meter.

nanometer (nm) =  $10^{-9}$  meter = .000000001 meter micrometer ( $\mu$ m) =  $10^{-6}$  meter = .000001 meter millimeter (mm) =  $10^{-3}$  meter = .001 meter 1 meter = 39.4 inches

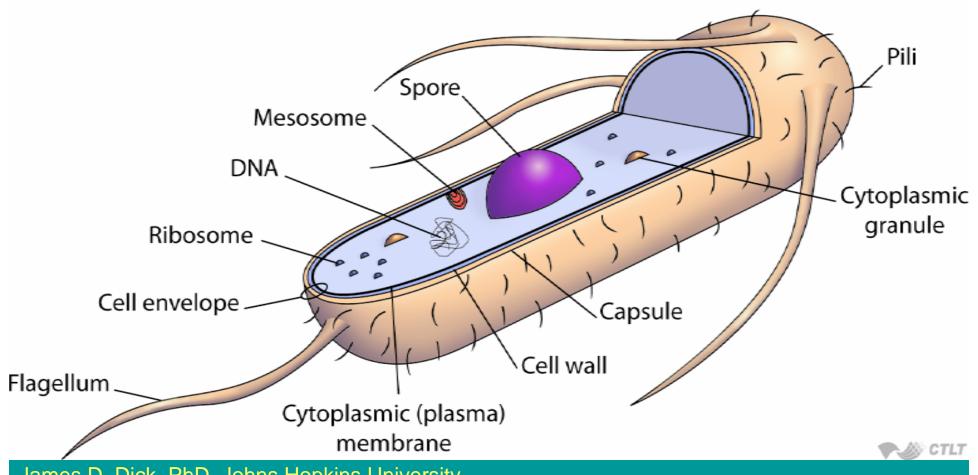
These units of measurement correspond to units in an older but still widely used convention.

1 angstrom (Å) =  $10^{-10}$  meter 1 micron ( $\mu$ ) =  $10^{-6}$  meter



## **Bacterial Cell Structure**

#### **Bacterial Cell Structure**



James D. Dick, PhD, Johns Hopkins University

## Taxonomy of Bacteria

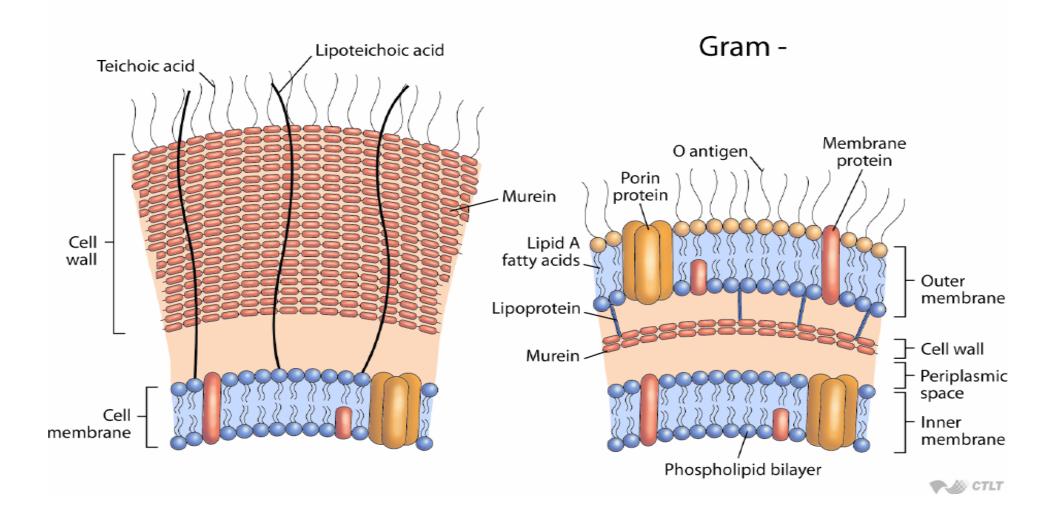
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## Table 10.1Taxonomic Ranks of theBacterium Escherichia coli

Formal Rank	Example
Domain	Bacteria
Phylum	Proteobacteria
Class	Gammaproteobacteria
Order	Enterobacteriales
Family	Enterobacteriaceae
Genus	Escherichia
Species	coli
Strain	O157:H7

- Bacteria are classified by their Gram stain characteristics.
- Gram staining is the application of a crystal violet dye to a culture of bacteria. Bacteria that retain the color of the dye are called Gram positive; bacteria that don't are Gram negative.
  - The Gram stain attaches to peptidoglycan in the bacterial cell wall.
    - In Gram-negative bacteria, the peptidoglycan layer is protected by an outer membrane.

Gram +



Cocci (spherical)







Staphylococcus aureus

Streptococcus pneumoniae

Streptococcus pyogenes

Bacilli (rods)



Bacillus anthracis



Haemophilus influenzae

Curved or spiral



Vibrio cholerae



Borrelia burgdorferi

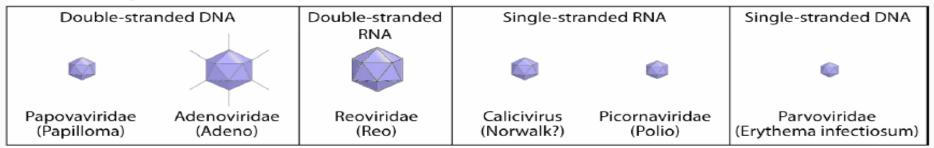
Gram-positive

Gram-negative

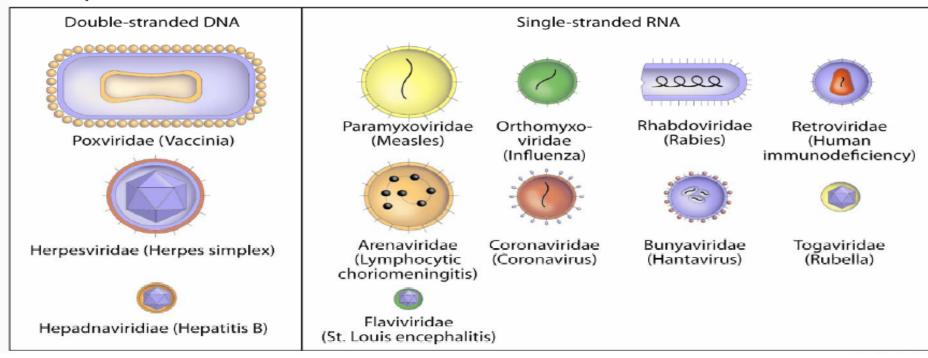
- Viruses are acellular, obligate intracellular organisms.
- The complete infectious virus is termed a virion.
- The virion consists of the specific nucleic acid (DNA or RNA) surrounded by a protein coat (capsid).
  - Some viruses are enveloped which means that they possess a lipoprotein coat that surrounds the capsid and is acquired from infected host cell membrane.
  - Viruses that lack an envelope are "naked."

- Viruses are typically classified by:
  - Genetic material (DNA vs. RNA)
  - Strandedness (single vs. double)
  - Size and shape of the capsid and whether its enveloped or non-enveloped
  - Method of replication

#### Nonenveloped



#### Enveloped



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#### Table 14.1a Classification of RNA Viruses Infecting Vertebrates

Family	Drawing of Virion	Virion Structure	Genome Structure*	Representative Pathogenic Members and Some Diseases They Cause
Picornaviridae (pico, micro; ma, ribonucleic acid)		Naked isometric	1 molecule, ss RNA	Poliovirus; rhinovirus
Caliciviridae (calix, cup)	$\otimes$	Naked isometric	1 molecule, ss RNA	Norwalk virus; many members cause gastroenteritis
Togaviridae (toga, cloak)		Lipid-containing envelope	1 molecule, ss RNA	Many multiply in arthropods and vertebrates; encephalitis in humans
Flaviviridae (flavus, yellow)		Lipid-containing envelope	1 molecule, ss RNA	Yellow fever virus; dengue virus
Coronaviridae (corona, crown)	<b>6</b>	Lipid-containing envelope	1 molecule, ss RNA	Colds and respiratory tract infections
Rhabdoviridae (rhabdos, rod)		Bullet-shaped; lipid-containing envelope	1 molecule, ss RNA	Rabies virus
Filoviridae, (filo, threadlike)	:(\\\\\\\\\):	Long filamentous; sometimes circular; lipid-containing envelope	1 molecule, ss RNA	Marburg virus; ebola virus
Paramyxoviridae, (para, by the side of; myxa, mucus)		Pleomorphic; lipid-containing envelope	1 molecule, ss RNA	Mumps virus; parainfluenza virus

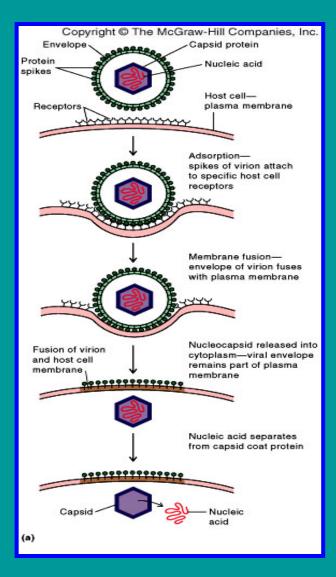
<sup>\*</sup> ss, single-stranded; ds, double-stranded.

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#### Table 14.2 Classification of DNA Viruses Infecting Vertebrates

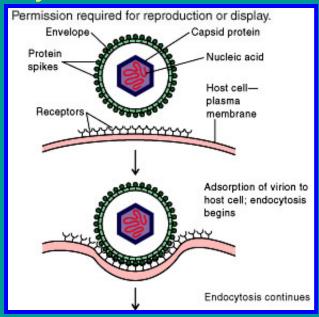
Family	Drawing of Virion	Virion Structure	Genome Structure*	Representative Pathogenic Members and Some Diseases They Cause
Hepadnaviridae (hepa, liver; dna, deoxyribonucleic acid)		Lipid-containing envelope	1 molecule, mainly ds DNA but with a single-stranded gap	Hepatitis B virus
Parvoviridae (parvus, small)	•	Naked	1 molecule, ss DNA	Outbreaks of gastroenteritis following eating of shellfish
Papovaviridae ( <i>pa</i> pilloma, <i>po</i> lyoma, <u>va</u> cuolating agent		Naked	1 molecule, circular ds DNA	Human papillomaviruses associated with genital and oral carcinomas
Adenoviridae ( <i>adenos</i> , gland)	*	Naked	1 molecule, ds DNA	Some cause tumors in animals
Herpesviridae (herpes, creeping)		Enveloped with surface projections	1 molecule, ds DNA	Herpes simplex virus; cytomegalovirus
Poxviridae (poc, pustule)		Enveloped; large brick-shaped	ds DNA; covalently closed ends	Smallpox virus; vaccinia virus
Iridoviridae (irid, rainbow)		Naked	1 molecule, ds DNA	No known human pathogens; only animal pathogens

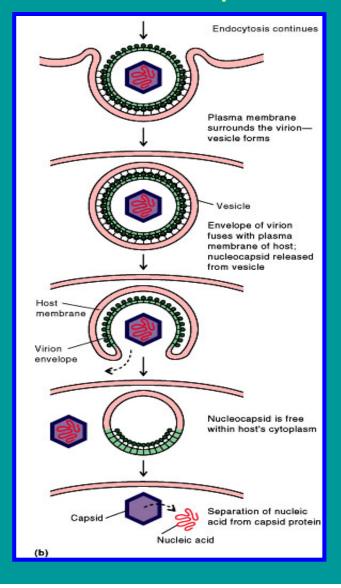
## Viruses Entry into the Host Cell with an Envelope



#### Viruses

#### Entry into the Host Cell with an Envelope





- All fungi are chemoheterotrophs
- Pathogenic fungi have two forms: yeasts (unicellular) and molds (multicellular)
- Some fungi are dimorphic (this is particularly true for the pathogenic fungi)
- Molds grow as filamentous, branching strands of connected cells known as hyphae

#### Types of Parasites:

- Protozoa: Single-celled, microscopic organisms that can perform all necessary functions of metabolism and reproduction. Some protozoa are free-living, while others parasitize other organisms for their nutrients and life cycle.
  - The morphology of protozoa varies widely and includes oval, spherical and elongated cells that can range in size from 5-10 to 1-2 mm.
  - Structurally, the protozoa resemble other eukaryotic cells and possess a cytoplasmic membrane that encloses cytoplasm containing membrane-bound nuclei, mitochondria, 80s ribosomes and a variety of organelles.

- Types of Parasites:
  - Helminths: A large, multicellular organism (worm) that is generally visible to the naked eye in its adult stages.
  - Helminths can be free-living or parasitic.
    - Nematodes: Roundworms
    - Trematodes: Flukes
    - Cestodes: Tapeworms

- Prions are abnormal, transmissible agents that are able to induce abnormal folding of normal cellular prion proteins in the brain, leading to brain damage and the characteristics signs and symptoms of the disease.
- Prion diseases are usually rapidly progressive and always fatal.

