

ENV H 451/541: Environmental and Occupational Health Microbiology I

Ecology of Environmentally Transmitted Microbiological Hazards

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Course Link

<http://courses.washington.edu/eh451/>

Texts and References:

- Recommended Text: Environmental Microbiology
- Other Reference Books:
 - Manual of Environmental Microbiology, 2nd edition, ASM Press
 - Disinfection, Sterilization and Preservation, 5th edition, LWW
 - Metcalf and Eddy's Wastewater Engineering: Treatment and Reuse, McGraw-Hill
 - Water Quality and Treatment, 5th edition, AWWA
 - Bioaerosols Handbook, Lewis
 - Food Microbiology, Doyle
 - Any Basic Microbiology Text (e.g. Madigan, Martinko and Parker; Prescott, Harley and Klein; etc.)

Texts and References:

- Reference Journals:
 - Journal of Applied Microbiology
 - Letters in Applied Microbiology
 - Journal of Applied and Environmental Microbiology
 - Journal of American Water Works Association
 - Journal of Food Protection
 - International Journal of Food Microbiology
 - Water Science and Technology
 - Water Research
 - Emerging Infectious Disease

Texts and References:

- Websites

- <http://www.cdc.gov/ncidod/index.htm>
- <http://www.epa.gov/nerlcwww/index.html>
- <http://www.swbic.org/outbreak/>
- <http://www.cfsan.fda.gov/~dms/fc01-toc.html>
- <http://www.fas.org/promed/>
- <http://www.foodsafetynetwork.ca/>

Class Participation

- Although class attendance is not expressly required, students will be expected to participate in classroom discussion and in-class group learning activities. Students will not have the opportunity to earn class participation credit for course periods during which they are absent.

Grading Opportunities

For the sake of this class, letter and numerical grades will typically be distributed according to the university grading scale between the following standards:

- A(4.0)= Excellent and exceptional work (typically >90% of available points)
- D (1.0) = Deficient work (typically <66% of available points)
- It is expected that most students will perform at a level of ~3.5 .

Class Rules

- Come to class, please let me know ahead of time if you can not make it.
- Arrive on time
- Turn in assignments on time
- Come to class prepared (keep up with reading)
- Be courteous (No newspapers, audible cell phones, PDAs, beepers)
- Food and drinks are welcome (but keep it quiet)
- Refrain from unnecessary talking
- ASK QUESTIONS
- Try to remain awake (at least no snoring please)
- Let me know how I am doing (if I am moving too fast, not being clear, or otherwise not getting the message across, I need to know.)

Microbes and the Environment

- Microbes are almost everywhere on the planet and the more we look the more places we find them
- Microbes are fundamental and essential to life on earth
- Most microbes in the environment are harmless or beneficial
- A small proportion of microbes are capable of causing disease in humans and/or other hosts
 - Some are “frank” pathogens and almost always have the potential to cause illness
 - Others are “opportunistic” pathogens and only cause illness in compromised hosts or unusual conditions of exposure

TABLE 1.3 Scope of Environmental Microbiology

Subject	Microbial issue
Aeromicrobiology	Collection and detection of pathogens or other microbes in aerosols, microbial movement in aerosols
Agriculture, soil microbiology	Biological control, nitrogen fixation, nutrient cycling
Biogeochemistry	Carbon and mineral cycling, control of acid mine drainage, control of loss of fixed nitrogen
Bioremediation	Degradation of organic contaminants, immobilization or removal of inorganic contaminants found in contaminated soil or water environments
Biotechnology	Detection of pathogens or other microbes in the environment, detection of microbial activity in the environment, genetic engineering
Food quality	Detection of pathogens, elimination of pathogens
Resource production	Production of alcohol, single-cell protein
Resource recovery	Microbially mediated recovery of oil and metals
Wastewater treatment	Degradation of waste, reduction of pathogens
Water quality	Removal of organic and inorganic contaminants, detection of pathogens, elimination of pathogens

Environmental Factors:

- The complex matrix within which organisms live controls most activities
- We will look at those about which there is something to say.
- How do they impact the kinds of organisms and what they do
- We don't know much about effects of multiple factors

Environmental Factors:

- Temperature
- pH
- Salt
- Radiation
- Pressure
- Surfaces
- Reaction to these dictate where they can live

Pathways of Exposure for Environmentally Transmitted Infectious Diseases

- **Water**
 - **Wastes**
 - **Food**
 - **Fomites**
 - **Vectors**
 - **Air**
 - **Soil**
-
- Many pathogens are potentially transmitted through multiple pathways

- Infectious disease risks from water, poor sanitation and hygiene, food and air are still with us the developed and developing world
- Global Water Supply and Sanitation Assessment 2000
 - 2.4 billion people have inadequate sanitation
 - 1.1 billion people have inadequate/unsafe water
 - 4 billion cases of diarrhea every year
 - 2.2 million deaths from diarrheal disease every year
 - Most illness and death in children <5 years old
 - Less services in rural than in urban areas
 - Urban settlement/slums remain a problem
 - In the developing world wastewater treatment is rare
 - Water losses in large urban systems is typically 40%

TABLE 25.1 Worldwide deaths due to infectious diseases, 1999

Disease	Deaths	Causative agents
Acute respiratory infections ^a	4,000,000	Bacteria, viruses, fungi
Acquired immunodeficiency syndrome (AIDS)	2,700,000	Virus
Diarrheal diseases	2,200,000	Bacteria, viruses
Tuberculosis [*]	1,700,000	Bacteria
Malaria	1,100,000	Protozoa
Measles [*]	875,000	Virus
Tetanus [*]	377,000	Bacterium
Pertussis (whooping cough) [*]	295,000	Bacterium
Meningitis, bacterial [*]	171,000	Bacterium
Syphilis	153,000	Bacterium
Hepatitis (all types) ^{a,b}	124,000	Viruses
Trypanosomiasis (sleeping sickness)	66,000	Protozoan
Leishmaniasis	57,000	Protozoan
Chlamydia	16,000	Bacterium
Intestinal nematode infections	16,000	Parasitic worms
Schistosomiasis	14,000	Parasitic worm
Dengue	13,000	Virus
Other communicable diseases	1,700,000	

Worldwide, there were about 56 million deaths from all causes. About 15.6 million deaths were from infectious diseases, nearly all in developing countries. Data are from the World Health Organization (WHO), Geneva, Switzerland.

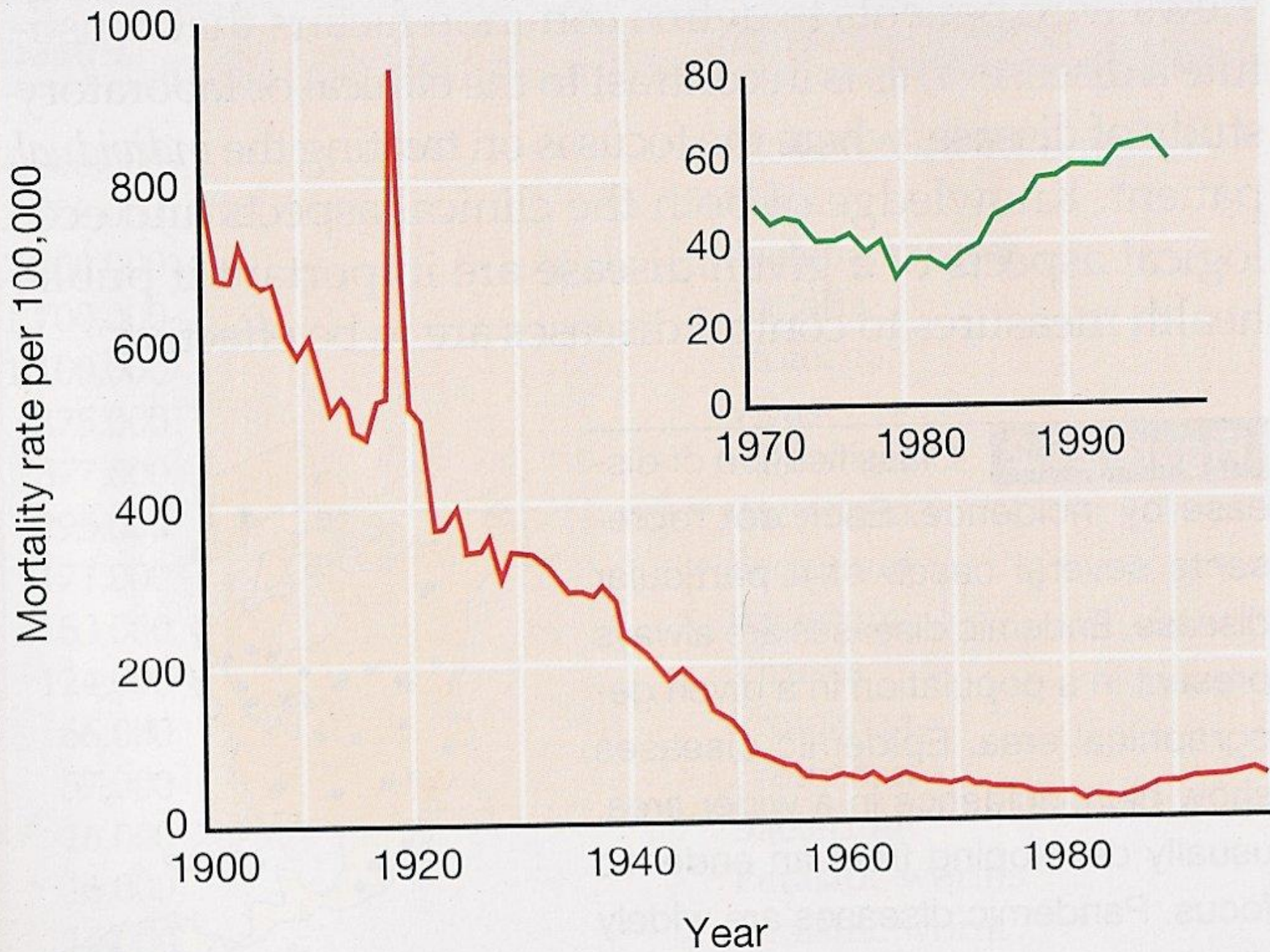
^{*} Diseases for which effective vaccines are available.

^a For some acute respiratory agents such as influenza and *Streptococcus pneumoniae* there are effective vaccines; for others, such as colds, there are no vaccines.

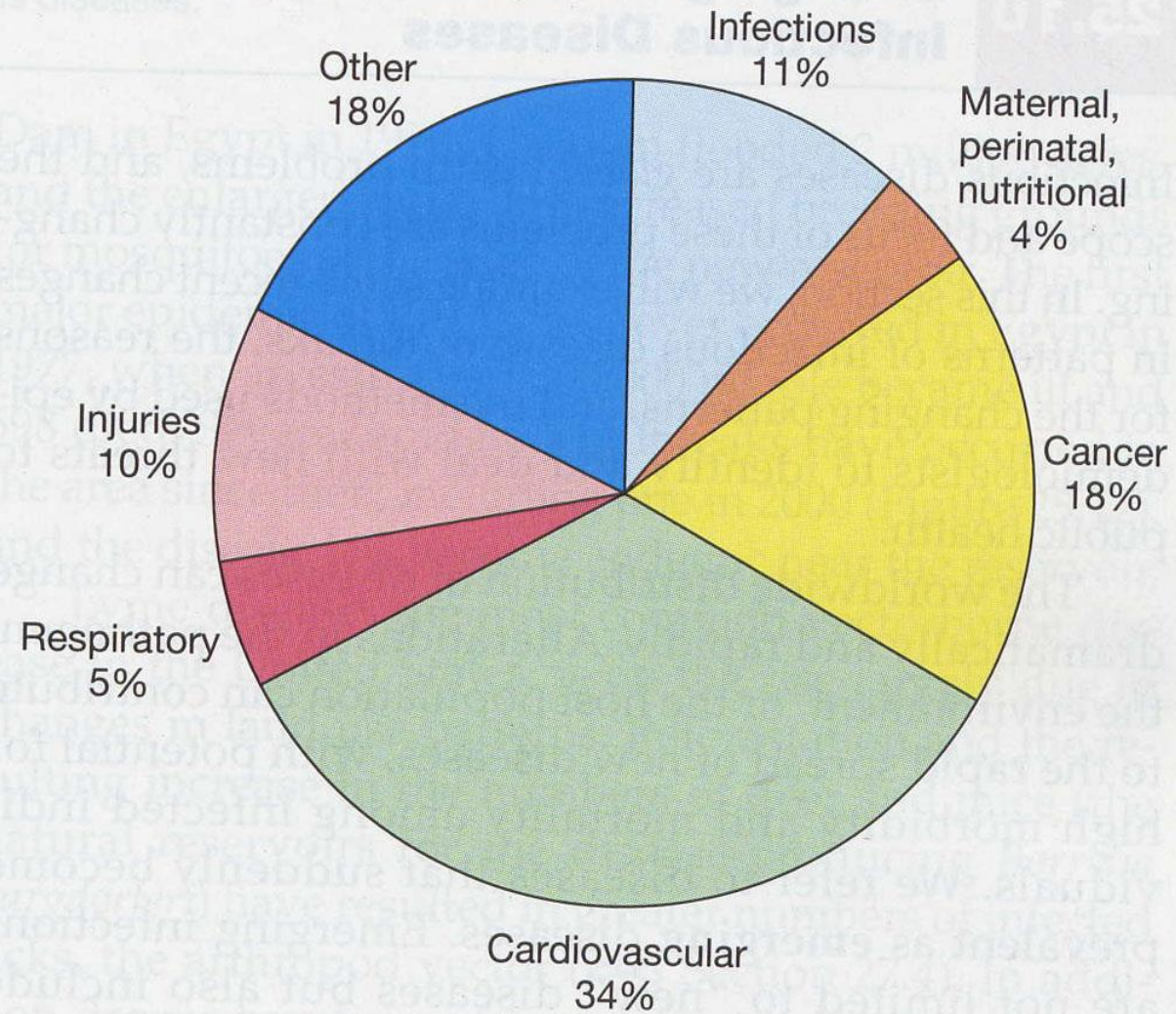
^b Vaccines are available for hepatitis A virus and hepatitis B virus. There are no vaccines for other hepatitis agents.

Global Burden of Infectious Diarrheal Disease

- The burden of infectious diarrhea is higher in developing than in developed countries
 - Developed: 1 illness per person per year
 - Undeveloped: about 5 illnesses per person per year
- The attributable fraction of diarrheal illness for different exposure routes or sources may not be very different in developed versus developing countries:
 - 1/4th contact
 - 1/4 water
 - 1/4 food
 - 1/4 other

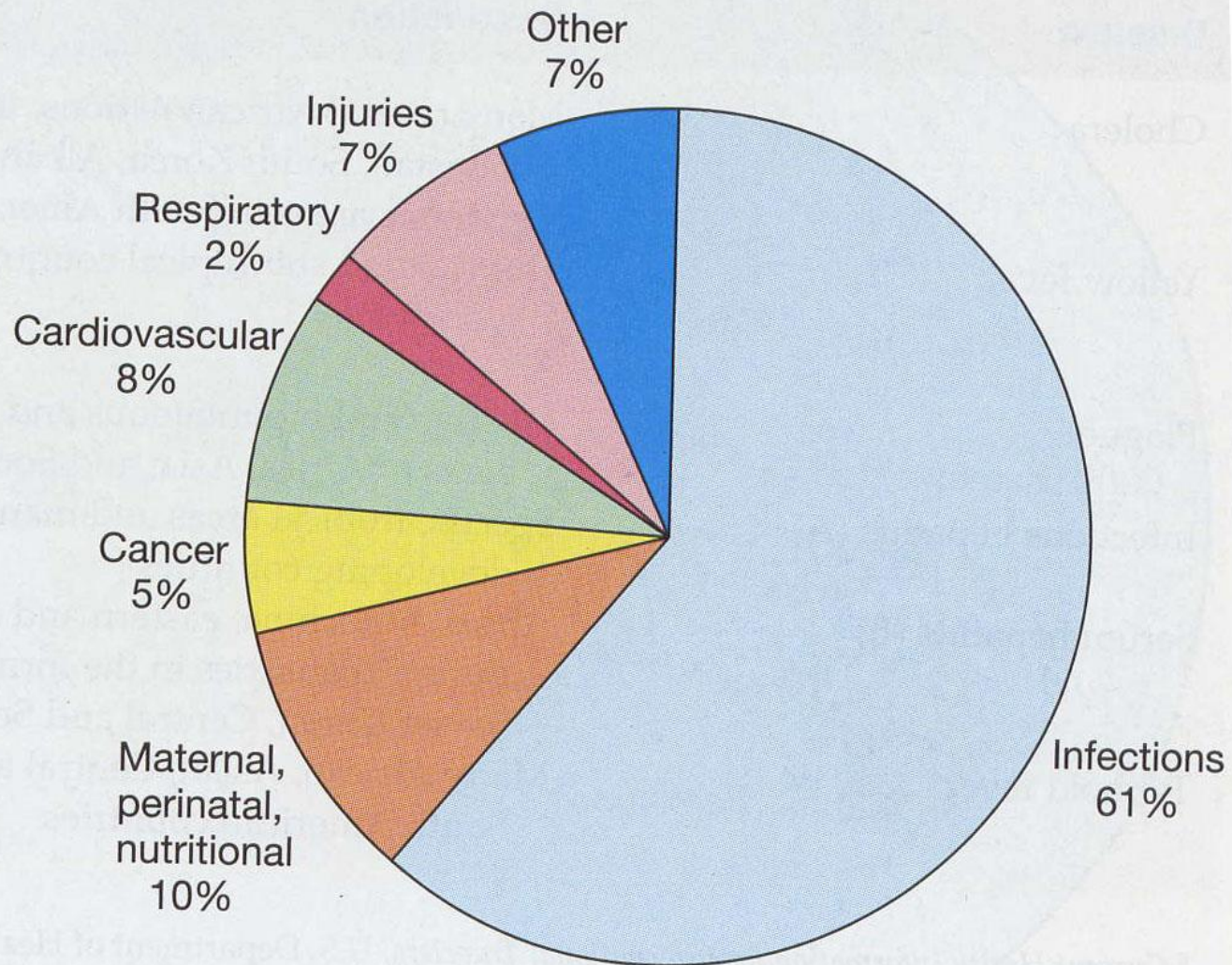


The Americas



(b)

Africa



(a)



Figure 25.12 Recent outbreaks of emerging and reemerging infectious diseases.

Viruses: smallest (0.02-0.3 μm diameter); simplest:
nucleic acid + protein coat (+ lipoprotein envelope)

Bacteria: 0.5-2.0 μm diameter; prokaryotes; cellular;
simple internal organization; binary fission.

Protozoa: most >2 μm - 2 mm; eucaryotic; uni-cellular;
non-photosynthetic; flexible cell membrane; no cell
wall; wide range of sizes and shapes; hardy cysts

Groups: flagellates, amoebae, ciliates, sporozoans
(complex life cycle) and microsporidia.

Helminths (Worms): multicellular animals; some are
parasites; eggs are small enough (25-150 μm) to pose
health risks from human and animal wastes in water.

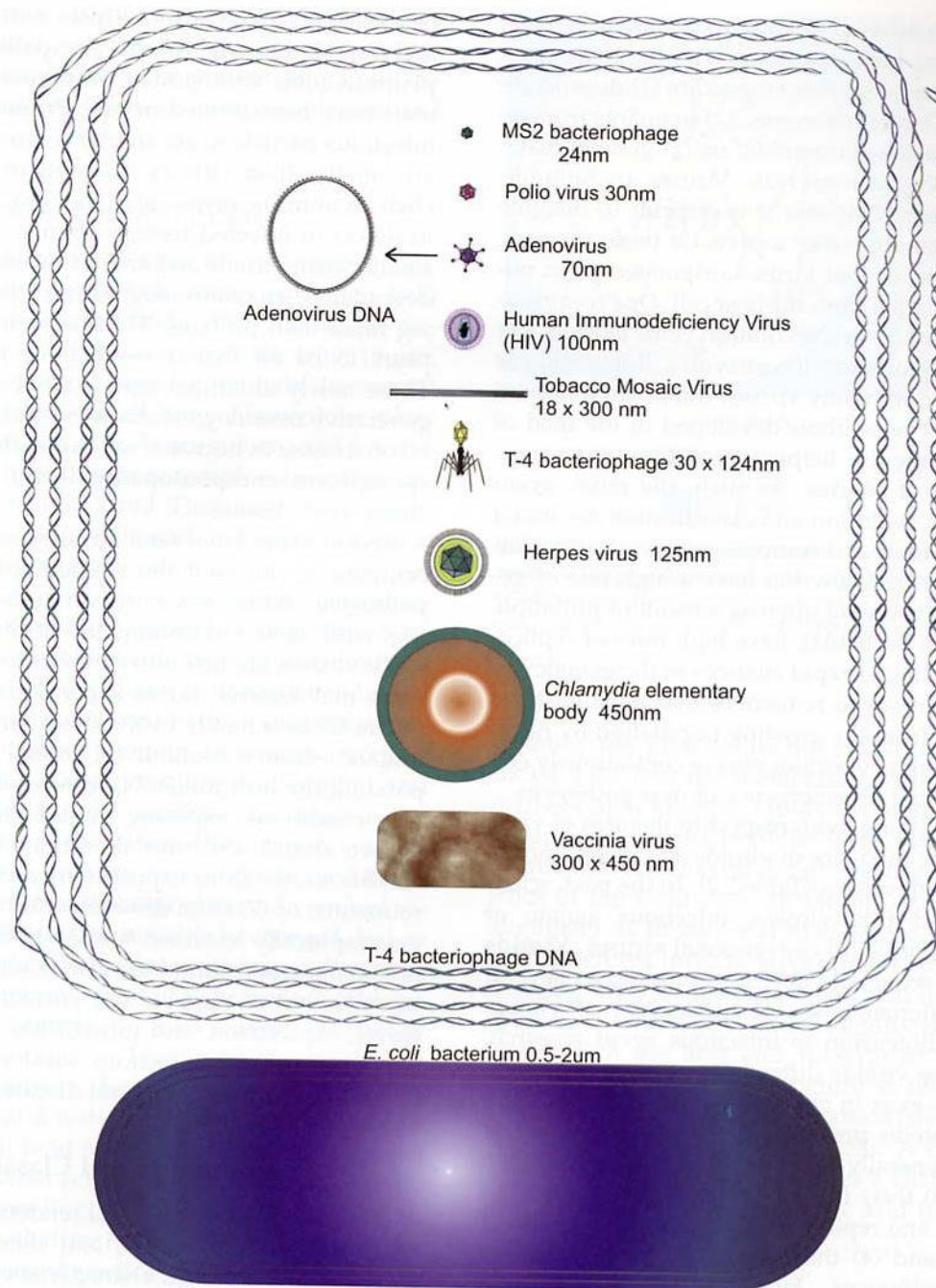


FIGURE 2.2 Comparative sizes of selected bacteria, viruses, and nucleic acids.

THE MICROBIAL WORLD:

SIZES OF MICROBES

•
VIRUS
0.1 μm

BACTERIUM
1 x 2 μm

PROTOZOAN PARASITE
Cryptosporidium Parvum
5 microns

TABLE 19.1 Incubation Time for Common Enteric Pathogens

Agent	Incubation period	Modes of transmission	Duration of illness
Adenovirus	8–10 days	Fecal–oral–respiratory	8 days
<i>Campylobacter jejuni</i>	3–5 days	Food ingestion, direct contact	2–10 days
<i>Cryptosporidium</i>	2–14 days	Food or water ingestion, direct and indirect contact	Weeks, months
<i>Escherichia coli</i>			
ETEC	16–72 hr	Food or water ingestion	3–5 days
EPEC	16–48 hr	Food or water ingestion, direct and indirect contact	5–15 days
EHEC	72–120 hr	Food/ingestion, direct or indirect contact	2–12 days
<i>Giardia lamblia</i>	7–14 days	Food or water ingestion, direct and indirect contact	Weeks–months
Norwalk agent(s)	24–48 hr	Food or water ingestion, direct and indirect contact, aerosol?	1–2 days
Rotavirus	24–72 hr	Director and indirect contact	4–6 days
Hepatitis A	30–60 days	Hepatitis	2–4 weeks
<i>Salmonella</i>	16–72 hr	Food ingestion, direct and indirect contact	2–7 days
<i>Shigella</i>	16–72 hr	Food or water ingestion, direct and indirect contact	2–7 days
<i>Yersinia enterocolitica</i>	3–7 days	Food ingestion, direct contact	1–3 weeks