

## CHAPTER 1 WHAT IS MICROBIOLOGY AND WHY DOES IT MATTER?

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### WHY IS THIS IMPORTANT?

- ◆ Microbiology is more relevant than ever in today's world
- ◆ Infectious diseases are a leading health-related issue, especially in societies with an increasing elderly population, and developing countries
- ◆ New infectious diseases continue to emerge and be identified all the time
- ◆ Microbiology impacts every facet of daily life

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### OVERVIEW



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## QUOTE BY LOUIS PASTEUR

- ◆ “C’est les microbes qui auront le dernier mot.”  
(It is the microbes who will have the last word.)

– Louis Pasteur (1822–1895)

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## MICROBIOLOGY & INFECTIOUS DISEASE

- ◆ Today microbiology is mentioned frequently in the news
- ◆ It affects many facets of our daily lives, including:
  - ◆ The air we breathe
  - ◆ The food we eat
  - ◆ The hospitals where we go for treatment of illness and injury
  - ◆ The natural disasters which sometimes occur without warning

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## CASE STUDIES FROM DAILY LIFE

- ◆ The following case studies illustrate how microbiology is part of our everyday lives:
  - ◆ Ivan Goes to Chicago...
  - ◆ It’s for the Birds...
  - ◆ Special Delivery...
  - ◆ Hamburger Havoc...
  - ◆ Did You Wash Your Hands?...
  - ◆ The Hospital Can Be Dangerous...

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**THE RELEVANCE OF MICROBIOLOGY  
TO HEALTH CARE**

- ◆ There has always been disease
- ◆ For generations, little could be done to treat or prevent disease
- ◆ Advances in public health awareness lessened the effects of infection
- ◆ Infectious disease utilizes a large percentage of health care
- ◆ Health care professionals need to understand how pathogens cause disease

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**THE RELEVANCE OF MICROBIOLOGY  
TO HEALTH CARE**

- ◆ The discovery of antibiotics began to prevent serious infection
- ◆ Vaccination and better sanitation practices reduced the incidence of infectious diseases
- ◆ For a time, most infectious diseases were thought to have been conquered

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**THE RELEVANCE OF MICROBIOLOGY  
TO HEALTH CARE**

- ◆ Diseases once thought were conquered are reappearing
  - ◆ Pathogens are showing increasing resistance to antibiotics
  - ◆ New diseases are emerging and organisms that were thought to be harmless have been discovered to cause disease in certain circumstances
  - ◆ Interest in bioterrorism has progressed from fiction to fact
- ◆ A fundamental understanding of microbiology has never been more relevant

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## INFECTIOUS DISEASE

- ◆ Only a tiny fraction of microorganisms cause infections
- ◆ A microorganism that causes an infection is called a pathogen
- ◆ Only a fraction of pathogens affect humans

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## INFECTIOUS DISEASE

- ◆ The potential of a pathogen to cause disease is referred to as pathogenicity
- ◆ The pathogen's fitness to overcome the body's defenses and establish itself is called virulence
- ◆ Many microbes are part of the normal microbial flora of the body
  - ◆ They naturally colonize the skin, mucosal surfaces, and large intestine
  - ◆ Most of the time, these organisms are harmless and often even beneficial

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## INFECTIOUS DISEASE

- ◆ Some of these organisms provide important products and services to the body
- ◆ In certain circumstances, these organisms can become pathogenic
- ◆ When this happens, the organisms are called opportunistic pathogens and typically possess a mild degree of virulence

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## INFECTIOUS DISEASE

- ◆ Some pathogens called primary or obligate pathogens are always associated with disease
- ◆ Some microbes called accidental pathogens can cause disease but are actually not usually found near people
- ◆ Most pathogens can be looked at from the following three perspectives:
  - ◆ Epidemiology
  - ◆ Pathogenesis
  - ◆ Host defense

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## EPIDEMIOLOGY

- ◆ Epidemiology is the study of factors determining the frequency and distribution of disease
- ◆ In epidemiology, pathogens are studied by how well they meet the five requirements of infection:
  - ◆ Entry (Get in)
  - ◆ Establishment (Stay in)
  - ◆ Defeat the host defense
  - ◆ Damage the host
  - ◆ Be transmissible

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## EPIDEMIOLOGY

- ◆ In epidemiology, pathogens are classified by the transmission mechanisms they use. Such as:
  - ◆ Air
  - ◆ Food or water
  - ◆ Insect vectors
  - ◆ Person-to-person contact
- ◆ Pathogens can also be classified according to their geographic distribution
  - ◆ Some are found worldwide, others are restricted to certain geographic areas

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## EPIDEMIOLOGY

- ◆ Providing the best care for infected individuals and protection of others involves a clear understanding of the five requirements for infection
- ◆ Knowing how an organism gains entry and how it spreads are vital to care for infected individuals
  - ◆ It allows for the implementation of strategies to limit spread
  - ◆ It also helps in understanding of the spread of disease

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## EPIDEMIOLOGY

- ◆ Outbreaks are caused by a variety of factors, including the following:
  - ◆ Poor socioeconomic conditions
  - ◆ Ignorance of how infections occur
  - ◆ Poor hygiene
  - ◆ Natural disasters

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## PATHOGENESIS

- ◆ Virulence factors are required for a pathogen to do the following:
  - ◆ Persist in the patient
  - ◆ Cause disease
  - ◆ Escape or defeat host defenses

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## PATHOGENESIS

- ◆ Pathogens employ a variety of methods to accomplish infection.
- ◆ Bacterial pathogens can:
  - ◆ Produce digestive enzymes
  - ◆ Produce toxins
- ◆ Viral pathogens can kill the host cells
- ◆ Sometimes, damage associated with an infection is due to over-active host defenses

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## PATHOGENESIS

- ◆ Symptoms can be associated with particular types of infection:
  - ◆ Coughing – respiratory system
  - ◆ Diarrhea – digestive system
  - ◆ Nervous system dysfunction – central nervous system

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## HOST DEFENSE

- ◆ Infection is a complex and competitive struggle
- ◆ It can be characterized as pathogens versus host defense
- ◆ The outcome of this struggle depends on the success or failure of the host defense
- ◆ Failure of the host defense = infection!

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## HOST DEFENSE

- ◆ There are two basic types of host defense:
  - ◆ Innate immune response:
    - ◆ First line of defense
    - ◆ Nonspecific response
    - ◆ Involves a variety of cellular and chemical factors

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## HOST DEFENSE

- ◆ There are two basic types of host defense:
  - ◆ Adaptive immune response:
    - ◆ Specific response
    - ◆ Involves immune system memory

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## HOST DEFENSE

- ◆ Many pathogens have developed methods to defeat host defenses
  - ◆ Some directly attack host defenses
  - ◆ Some change their looks (a form of camouflage)
  - ◆ Some hide

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## TREATMENT OF INFECTIOUS DISEASES

- ◆ Many potent and successful tools are available to defeat infection. These include:
  - ◆ Antibiotics
  - ◆ Disinfectants and antiseptics
- ◆ Antibiotics are toxic chemicals and therefore must act selectively
  - ◆ They must kill the disease-causing microorganisms but not harm the patient

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## TREATMENT OF INFECTIOUS DISEASES

- ◆ Treatments are easier for bacterial infections than for fungal and viral diseases
- ◆ Fungal cells are similar to human cells. So very few chemicals are selectively toxic
- ◆ Viruses are intracellular parasites so either:
  - ◆ They must be attacked before entry into a host cellor  
The infected host cells must be killed to eliminate the virus

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## TREATMENT OF INFECTIOUS DISEASES

- ◆ The best treatment of disease is prevention
- ◆ Prevention involves public health measures and immunization

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## TREATMENT OF INFECTIOUS DISEASES

- ◆ Public health measures include:
  - ◆ Disinfection of water supplies
  - ◆ Monitoring food supplies
  - ◆ Proper hygiene and sanitation
  - ◆ Proper waste removal and treatment
  - ◆ Insect and pest control

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## TREATMENT OF INFECTIOUS DISEASES

- ◆ Immunization requires that we understand immune mechanisms and that we design vaccines that will successfully stimulate protection
- ◆ Immunization also requires:
  - ◆ Public health control of the immunization of children
  - ◆ Design and development of new vaccines
  - ◆ An ability to ensure the safety of vaccines

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