Textbook of
Microbiology
for GNM Nursing Students

(As per new syllabus of INC for GNM)

3rd Edition

What's **New** in this Edition?

- A thoroughly revised and updated edition
- **200+** Figures, Flowcharts and Tables
- **100+** Subjective and Objective Questions
- Text enriched with Recent Updates
- Nursing Implications covered exclusively
- Includes important clinical images of Bacterial, Fungal, Viral diseases, etc.

Edited by
Indarjit Walia
Anju Dhir

Mrinalini Bakshi

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Nursing Knowledge Tree
An Initiative by CBS Nursing Division

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CBSPD

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4819/XI Prahlad Street, 24 Ansari Road, Daryaganj, New Delhi 110 002, India.

Ph: +91-11-23289259, 23266861, 23266867 Website: www.cbspd.com

Fax: 011-23243014

e-mail: delhi@cbspd.com; cbspubs@airtelmail.in.

Corporate Office: 204 FIE, Industrial Area, Patparganj, Delhi 110 092

Ph: +91-11-4934 4934 Fax: 4934 4935

e-mail: feedback@cbspd.com; bhupesharora@cbspd.com

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CBS Nursing Knowledge Tree

Extends its Tribute to

Florence Nightingale

For glorifying the role of women as nurses,
For holding the title of " The Lady with the Lamp,"
For working tirelessly for humanity–
Florence Nightingale will always be remembered for her selfless and memorable services to the human race.

Florence Nightingale
(May 1820 – August 1910)

Preface to the Third Edition

Nurses play a vital role in preventive medicine and healthcare, often putting their own health at risk to care for others. This makes it essential for them to study microbiology. Understanding microbiology helps nurses provide better care to patients and educate communities about health. It's not just about passing exams; it's about giving nurses the knowledge they need to protect lives and be the true heroes in healthcare.

The third edition of this book has been revised and developed as per the latest syllabus of Indian Nursing Council (INC) for General Nursing and Midwifery (GNM) students to help them understand the subject in most concise yet comprehensive manner. The content is presented in a way so that all the important and practical aspects of microbiology from nursing perspective are enhanced.

The book has been updated as per the recent advancement in the relevant field of nursing. The text is supported by boxes, like "Terms to Learn" (containing the meanings of important terms in the respective chapters) and "Also Know" (containing additional important information related to the topic under discussion).

The "Summary" has been added with each chapter so that students can have last-minute revision of important concepts.

Every chapter ends with a "Student Assignment" section that contains Long Answer Qs, Short Answer Qs and Multiple Choice Qs along with their correct answers to help the students assess their understanding of the chapter. The present edition contains plenty of MCQs which have been extracted from previous year examination papers.

Color Plates have been added for common bacterial, viral, fungal disease, etc. to portray real pictures of the diseases. This book has been developed sincerely with an aim of simplifying the subject for the readers and it is hoped that it suffices the needs of the GNM students.

Mrinalini Bakshi

Preface to the First Edition

Microbes are the most abundant form of life and affect almost every aspect of our lives. Nurses are an integral part of Preventive Medicine and Healthcare. It becomes imperative for them to study microbiology as they are involved in personal, hospital and community hygiene as well.

This book has been developed as per the latest syllabus of Indian Nursing Council (INC) for General Nursing and Midwifery (GNM) students to aid them in the general understanding of the subject in the most concise, yet comprehensive manner. The contents have been arranged in a way so that all the important and practical aspects of microbiology from nursing perspective could be well dealt in simple and easy-to-understand language. The book comes in a colorful layout to make the reading interesting. Relevant diagrams, images and tables have been added to illustrate the text in a lucid and vivid manner. The text includes boxes like Terms to Learn (that contains the meanings of important terminology) and Also Know (that contains additional important information to read). Every chapter ends with Assess Yourself section that contains multiple choice questions along with their correct answers for helping the students to assess their understanding after finishing the chapter. Color Plates have been added for common bacterial, viral and fungal diseases.

This book has been developed sincerely with an aim of simplifying the subject for the readers and it is hoped that it suffices the needs of the GNM students. Although utmost care has been taken while developing the book, some inadvertent errors would have crept in. I will be extremely grateful to receive the feedbacks for improvement as "There is no end to the journey toward perfection". I sincerely hope that you would experience the same pleasure in reading this book as I experienced while developing it.

Mrinalini Bakshi

Acknowledgments

"Feeling gratitude and not expressing it is like wrapping a present and not giving it."

—William Arthur Ward

The completion of this book is not the effort of one person. It is the fruit of efforts and beliefs of many who have influenced me and made me capable to accomplish this task.

To begin with, I would like to express my gratitude to the pillars of my life, my mother, **Mrs Nalini Bakshi**, my father, **Mr Brijender Kumar Bakshi** and brother, **Vikram**. You are a family to live for and die for. You people are the constant stream of strength for me and I am glad that I have been nurtured with the selfless love you all have offered. I consider myself God's favorite to be blessed with a family like you.

I am grateful to the Almighty for giving me this opportunity to be mentored and sculpted in the hands of **Dr Ramakant Jagpal**, who has been an inspiration in my struggles and who infused the "never-say-die" attitude in me. This is the beginning of my ***Guru Dakshina*** to you. I fall short of words to thank **Dr Manish Jagpal** and **Dr Amar Jagpal**, for believing in me and making me explore the various dimensions of my capabilities. You are the reason I never gave up and always strived to explore and learn more.

I am thankful to **Dr Indarjit Walia**, a humble figure, for guiding me through the making of this book and accepting the responsibility of editing this compendium. It was her support and vision that gave this book its present outlook.

I am again thankful to **Dr Anju Dhir** for editing third edition of this book. She has updated this edition thoroughly and helped me to present it in this form.

I am extremely thankful to **Dr Sakshi Arora Hans**, who is the reason why I developed this interest. You have no idea how much instrumental you have been in shaping my career and today if I am able to develop this book, it is because of you. I thank you for inspiring me to learn and develop my skills further.

I cannot thank enough the person who has faced the worst of my outbursts but never failed to believe in me, my husband, **Himanshu**. Thank you for standing by me in the worst of my times and going beyond limits to keep me focused and motivated for accomplishing things.

This book would never have been a reality without the belief and support of two most important people, **Mr Satish Kumar Jain** (Chairman) and **Mr Varun Jain** (Managing Director), M/s CBS Publishers and Distributors Pvt Ltd. I am thankful to them for their immense encouragement and guidance in the publication of this book. One more person who has acted like the backbone to this book is **Mr Bhupesh Aarora** [Sr. Vice President – Publishing and Marketing (Health Sciences Division)], without him this book wouldn't have been what it is today.

I sincerely thank the entire CBS team for bringing out the book with utmost care and attractive presentation. I would like to thank Ms Nitasha Arora (Assistant General Manager Publishing – Medical and Nursing), Ms Daljeet Kaur (Assistant Publishing Manager) and Dr Anju Dhir (Sr. Product Manager and Medical Development Editor) for their publishing support. I would also extend my thanks to Ms Surbhi Gupta (Sr. English Editor), Mr Ashutosh Pathak (Sr. Proofreader cum Team Coordinator) and all the production team members for devoting laborious hours in designing and typesetting the book.

From the Publisher's Desk

Dear Reader,

Nursing Education has a rich history, often characterized by traditional teaching techniques that have evolved over time. Primarily, teaching took place within classroom settings. Lectures, textbooks, and clinical rotations were the core teaching tools; and students majorly relied on textbooks by local or foreign publishers for quality education. However, today, technology has completely transformed the field of nursing education, making it an integral part of the curriculum. It has evolved to include a range of technological tools that enhance the learning experience and better prepare students for clinical practice.

As publishers, we've been contributing to the field of Medical Science, Nursing and Allied Sciences and earned the trust of many. By supporting **Indian authors**, coupled with **nursing webinars and conferences**, we have paved an easier path for aspiring nurses, empowering them to excel in national and state level exams. With this, we're not only enhancing the quality of patient care but also enabling future nurses to adapt to new challenges and innovations in the rapidly evolving world of healthcare. Following the ideology of **Bringing learning to people instead of people going for learning**, so far, we've been doing our part by:

- Developing quality content by qualified and well-versed authors
- Building a strong community of faculty and students
- Introducing a smart approach with Digital/Hybrid Books, and
- Offering simulation Nursing Procedures, etc.

Innovative teaching methodologies, such as modern-age Phygital Books, have sparked the interest of the Next-Gen students in pursuing advanced education. The enhancement of educational standards through **Omnipresent Knowledge Sharing Platforms** has further facilitated learning, bridging the gap between doctors and nurses.

At Nursing Next Live, a sister concern of CBS Publishers and Distributors, we have long recognized the immense potential within the nursing field. Our journey in innovating nursing education has allowed us to make substantial and meaningful contributions. With the vision of strengthening learning at every stage, we have introduced several plans that cater to the specific needs of the students, including but not limited to **Plan UG** for undergraduates, **Plan MSc** for postgraduate aspirants, **Plan FDP** for upskilling faculties, **SDL** for integrated learning and **Plan NP** for bridging the gap between theoretical and practical learning. Additionally, we have successfully completed seven series of our **Target High** Book in a very short period, setting a milestone in the education industry. We have been able to achieve all this just with the sole vision of laying the foundation of diversified knowledge for all. With the rise of a new generation of educated, tech-savvy individuals, we anticipate even more remarkable advancements in the coming years.

We take immense pride in our achievements and eagerly look forward to the future, brimming with new opportunities for innovation, growth and collaborations with experienced minds such as yourself who can contribute to our mission as Authors, Reviewers and/or Faculties. Together, let's foster a generation of nurses who are confident, competent, and prepared to succeed in a technology-driven healthcare system.

Mr Bhupesh Aarora
(Sr Vice President – Publishing and Marketing)
bhupeshaarora@cbspd.com| +91 95553 53330

Special Features of the Book

LEARNING OBJECTIVES

After the completion of the chapter, the readers will be able to:

- Describe evolution of microbiology
- Understand role of microbiology in nursing

Learning Objectives given in the beginning of each chapter help readers understand the purpose of the chapter.

CHAPTER OUTLINE

- Introduction
- Microorganisms
- History of Microbiology
- Role of Microbiology in Nursing

Chapter Outline gives a glimpse of the content covered in the chapter.

KEY TERMS

Bacteriology: Study of disease causing bacteria
Fermentation: Process that breaks down sugars into alcohol and organic acids
Heat-labile bacteria: Bacteria that can be killed by exposing them to heat
Heat-resistant bacteria: Bacteria that cannot be killed by continuous boiling of the broth
Helminthology: Study of helminths
Mycology: Study of disease causing fungi
Nematology: Study of nematodes
Parasitology: Study of parasites
Protozoology: Study of disease causing protozoans
Virology: Study of infectious viruses

Important **Key Terms** used in the chapter are presented to familiarize the readers with the important terminologies.

Additional information related to the concepts are provided in the **Also Know** boxes.

Also Know

Exceptions to Koch's postulates
Treponema pallidum, *Mycobacterium leprae*, many viruses and Rickettsiae are unable to grow on artificial media.

Studded with 100+ fully **Colored Figures and Images** for easy grasp of the relevant topic.

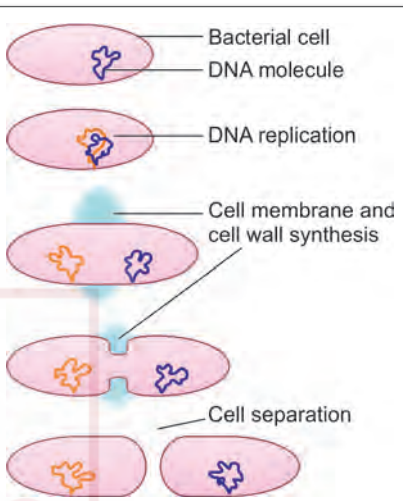

Figure 3.8: Binary fission in bacteria

TABLE 3.2: FUNCTIONS OF PILI

Bacterial species where observed	Function
Escherichia coli (For sex pilus)	Stabilizes bacteria during transfer of DNA during conjugation
Escherichia coli (common pili or fimbriae)	Surface adherence to epithelial cells of the gastrointestinal tract
Neisseria gonorrhoeae	Surface adherence to epithelial cells of the urogenital tract
Streptococcus pyogenes (fimbriae plus the M-protein)	Adherence, resistance to phagocytosis; antigenic variability
Pseudomonas aeruginosa	Surface adherence

Numerous **Tables** are used to clarify the concept and make the reading enjoyable and informative.

Important takeaway points of respective chapters have been highlighted under **Summary** boxes.

SUMMARY

- Microbiology stands for the study of those living organisms that are not visible to the naked eye.
- Antonie van Leeuwenhoek is considered to be the 'Father of Microbiology'.
- Robert Koch introduced many laboratory techniques which are used nowadays such as culture and staining.

STUDENT ASSIGNMENT

LONG ANSWER QUESTIONS

1. Discuss the Koch's postulates.
2. Explain the role of microbiology for nurses.

SHORT ANSWER QUESTIONS

1. Write short notes on:
   a Louis Pasteur
   b. Leeuwenhoek

MULTIPLE CHOICE QUESTIONS

1. **Identify correct statement regarding Robert Koch.**
   a. He is known as father of bacteriology
   b. The causative organism of cholera, *Vibrio cholera* was identified by him
   c. He discovered hypersensitivity phenomenon
   d. All of the above
2. **Father of antiseptic surgery is:**
   a. Louis Pasteur
   b. Robert Koch
   c. Antonie van Leeuwenhoek
   d. Joseph Lister
3. **Which among the following is a contribution by Louis Pasteur in the field of microbiology?**
   a. Techniques of Pasteurization
   b. Process of fermentation
   c. Rabies, cholera and anthrax vaccine
   d. All of the above

Student Assignment in the form of exercises in each and every chapter will facilitate structured learning and revision of the material provided in the respective chapters.

Syllabus

MICROBIOLOGY

Placement: GNM First Year

Course Description

This course is designed to help students gain knowledge and understanding of the characteristics and activities of microorganisms, how they react under different conditions and how they cause different disorders and diseases. Knowledge of these principles will enable students to understand and adopt practices associated with preventive and promotive health care.

General Objectives

Upon completion of the course, the students shall be able to:

1. Describe the classifications and characteristics of microorganisms
2. List the common disease producing microorganisms
3. Explain the activities of microorganisms in relation to the environment and the human body
4. Enumerate the basic principles of control and destruction of microorganisms
5. Apply the principles of microbiology in nursing practice.

Total: 30 Hours

Unit	Learning Objectives	Content	Hours	Teaching Learning Activities	Assessment Methods
I	Describe evolution of microbiology and its relevance in nursing.	**Introduction** • History of bacteriology and microbiology • Scope of microbiology in nursing	3	Lecture cum discussions	• Objective type • Short answers
II	• Classify the different types of microorganism. • Describe the normal flora and the common diseases caused by pathogens. • Explain the methods to study microbes.	**Microorganisms** • Classification, characteristics, (structure, size, method and rate of reproduction) • Normal flora of the body • Pathogenesis and common diseases • Methods for study of microbes, culture and isolation of microbes	8	• Lecture cum discussions • Explain using slides, films, videos, exhibits, models • Staining and fixation of slides	• Short answers • Objective type • Essay type

Contd...

Unit	Learning Objectives	Content	Hours	Teaching Learning Activities	Assessment Methods
III	• Describe the sources of infection and growth of microbes. • Explain the transmission of infection and the principles in collecting specimens.	**Infection and its Transmission** • Sources and types of infection, nosocomial infection • Factors affecting growth of microbes • Cycle of transmission of infection portals of entry, exit, modes of transfer • Reaction of body to infection, mechanism of resistance • Collection of specimens	4	• Lecture demonstrations • Specimens • Explain using charts	• Short answers • Objective type • Essay type
IV	Describe various types of immunity, hypersensitivity autoimmunity and immunizing agents.	**Immunity** • Types of immunity—innate and acquired • Immunization schedule, Immunoprophylaxis (vaccines, sera, etc.) • Hypersensitivity and autoimmunity • Principles and uses of serological tests	5	• Lecture cum discussions • Demonstration on exhibits	• Short answers • Objective type • Essay type
V	Describe the various methods of control and destruction of microbes.	**Control and Destruction of Microbes** • Principles and methods of microbial control ▪ Sterilization ▪ Disinfection ▪ Chemotherapy and antibiotics ▪ Pasteurization • Medical and surgical asepsis • Biosafety and waste management	5	• Lecture, demonstration on videos • Visit to the CSSD	• Short answers • Objective type • Essay type
VI	• Demonstrate skill in handling and care of microscopes. • Identify common microbes under the microscope.	**Practical Microbiology** • Microscope—Parts, uses, handling and care of microscope • Observation of staining procedure, preparation and examination of slides and smears • Identification of common microbes under the microscope for morphology of different microbes	5	• Lecture, demonstrations • Specimens • Slides	

Contents

6

Common Bacterial Diseases

LEARNING OBJECTIVES

After the completion of the chapter, the readers will be able to:

- Know about the difference between pathogenic and nonpathogenic bacteria.
- Discuss common bacterial diseases.

CHAPTER OUTLINE

- Introduction
- Pathogenic and Nonpathogenic Microbes
- *Staphylococcus*
- *Streptococcus*
- *Neisseria*
- *Corynebacterium diphtheriae*
- *Chlamydiae trachomatis*
- *Bacillus anthracis*
- *Clostridium tetani*
- *Vibrio cholerae*
- *Yersinia pestis*
- *Escherichia coli*
- *Klebsiella*
- *Salmonella typhi*
- *Shigella*
- *Mycobacterium*
- Common Bacterial Diseases

KEY TERMS

Bacteriology: Science of study of bacteria
Commensal: Two different species of bacteria living in close association, such that one species benefits without harming the other.
Meningitis: Inflammation of meninges which are protective membranes covering the brain and spinal cord.

INTRODUCTION

The science of study of bacteria is called bacteriology. Bacteria are the primary source of infections and diseases in human beings. Bacteria live in every climate and location on earth. Some are airborne, while others live in water or soil. A bacterial infection is a proliferation of a harmful strain of bacteria on or inside the body. Bacteria can infect any area of the body. Bacteria may also be classified as Gram-positive or Gram-negative based on the Gram staining. Gram-positive bacteria have a thick cell wall, while Gram-negative bacteria do not. Gram staining, bacterial culture with antibiotic sensitivity determination and other tests are used to identify bacterial strains and help determine the appropriate course of treatment. Let's discuss the most common disease causing bacteria.

PATHOGENIC AND NONPATHOGENIC MICROBES

Pathogenic organism: A pathogenic organism is an organism which is capable of causing diseases in a host.

Nonpathogenic: Organisms which do not cause diseases are called nonpathogenic.

The differences between pathogenic and nonpathogenic microorganisms are given in Table 6.1.

TABLE 6.1: DIFFERENCES BETWEEN PATHOGENIC AND NONPATHOGENIC BACTERIA

Pathogenic bacteria	Nonpathogenic bacteria
Bacteria that can cause diseases	Bacteria that do not cause disease, harm or death to another organism
Parasites	Commensals
Harmful	May be useful
Virulence genes are present in the genome	Do not possess virulence genes
Adhere to the cells of the tissues in order to escape from the fluid flows inside the body	Do not adhere to the tissue
Invades the cells of the body	Live outside the body cells
Resist phagocytosis by using a slick capsule, leucocidins, and other antiphagocytic mechanisms	Subjected to phagocytosis
Produce toxins that can alter the metabolism of the host cells	Do not produce toxins
Produce their colonies within the tissues	Do not produce colonies

STAPHYLOCOCCUS

These are Gram-positive cocci. They are spherical in shape and measure 1 μm in diameter. They are arranged in grape-like clusters (Figure 6.1). Approximately, 20 species from 33 known species of *Staphylococcus* are known to cause infections in humans. The other *Staphylococcus* that is harmless commensal living in the nostrils and mouth and on skin is *S. albus*. These are nonsporing, nonmotile and noncapsulated.

S. aureus expresses many potential virulence factors:

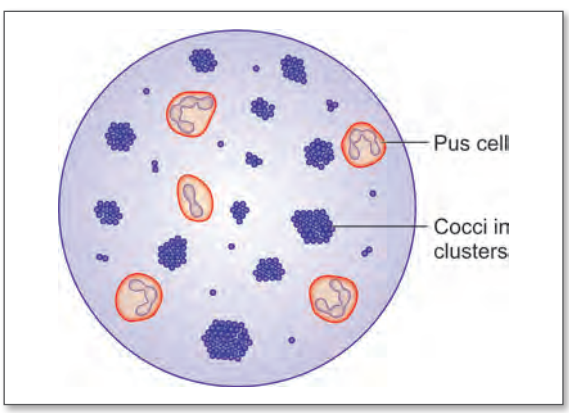

Figure 6.1: Staphylococci and pus cells

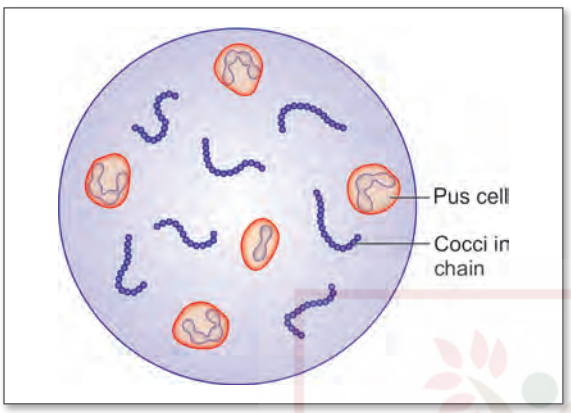

Figure 6.2: Streptococci in Gram-stained smear of pus

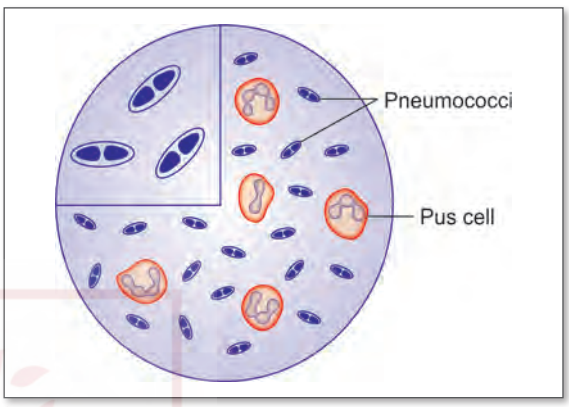

Figure 6.3: *Streptococcus pneumoniae* in pus. Inset: enlarged view

- Surface proteins that promote colonization of host tissues.
- Factors that probably inhibit phagocytosis (capsule, immunoglobulin binding protein A)
- Toxins that damage host tissues and cause disease symptoms.

STREPTOCOCCUS

Streptococci are Gram-positive, nonmotile, nonspore-forming, catalase-negative cocci that occur in pairs or chains (Figure 6.2). Older cultures may lose their Gram-positive character. Most streptococci are facultative anaerobes, and some are obligate (strict) anaerobes. Most require enriched media (blood agar). Group A streptococci have a hyaluronic acid capsule. They are aerobes but most of the species are facultative anaerobes. It requires nutrients to grow therefore, the organism grows well in an enriched medium having blood or serum as a source of extra nourishment.

Streptococcus Pneumoniae

Streptococcus pneumoniae or pneumococci are lancet-shaped, catalase-negative, capsule-forming, α-hemolytic cocci or diplococci. Autolysis is enhanced by adding bile salts (Figure 6.3). *S. pneumoniae* is a normal member of the respiratory tract flora; invasion results in pneumonia. The best defined virulence factor is the polysaccharide capsule, which protects the bacterium against phagocytosis.

NEISSERIA

The genus *Neisseria* contains two important human pathogens, *N. gonorrhoeae* and *N. meningitidis*. *N. gonorrhoeae* causes gonorrhea, and *N. meningitidis* is the cause of meningococcal meningitis. *N. gonorrhoeae* is often referred to as the "gonococcus", while *N. meningitidis* is known as the "meningococcus". *N. gonorrhoeae* is a Gram-negative coccus, 0.6–1.0 μm in diameter, usually seen in pairs with adjacent flattened sides. The organism is frequently found intracellularly in polymorphonuclear leukocytes (neutrophils) of the gonorrhea pustular exudate. *N. meningitidis* is a fastidious, encapsulated, aerobic Gram-negative diplococcus (Figure 6.4).

CORYNEBACTERIUM DIPHTHERIAE

Corynebacterium diphtheriae is a nonmotile, noncapsulated, club-shaped, Gram-positive bacillus (Figure 6.5). *C. diphtheriae* spreads by droplets, secretions, or direct contact. It causes diphtheria in humans when toxin is produced with the help of a particular bacteriophage – β phage, which provides it with toxin producing gene. This is known as phage conversion. When the bacteria are cured of phage, toxigenicity is lost.

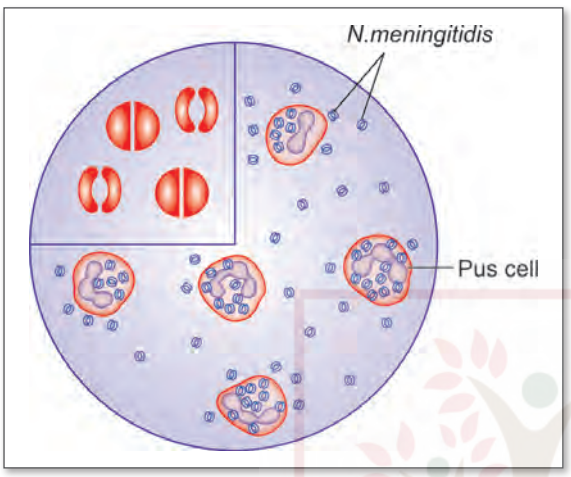

Figure 6.4: *Neisseria meningitidis* in cerebrospinal fluid. Inset: Enlarged view showing adjacent sides flattened or concave and long axes parallel

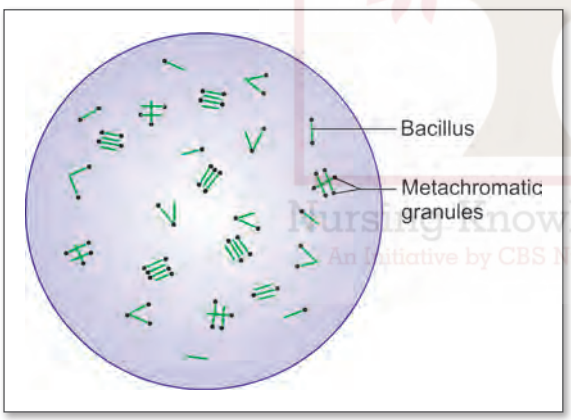

Figure 6.5: *Corynebacterium diphtheriae* showing metachromatic granules and Chinese letter arrangement

CHLAMYDIA TRACHOMATIS

Chlamydiae are small Gram-negative obligate intracellular microorganisms that preferentially infect squamocolumnar epithelial cells (Figure 6.6). They include the genera *Chlamydia* (of which the type species is *Chlamydia trachomatis*) and *Chlamydophila* (e.g., *Chlamydophila pneumoniae* and *Chlamydophila psittaci*). They lack peptidoglycan in cell wall and cannot produce ATP on their own, so they use host's energy – energy parasites.

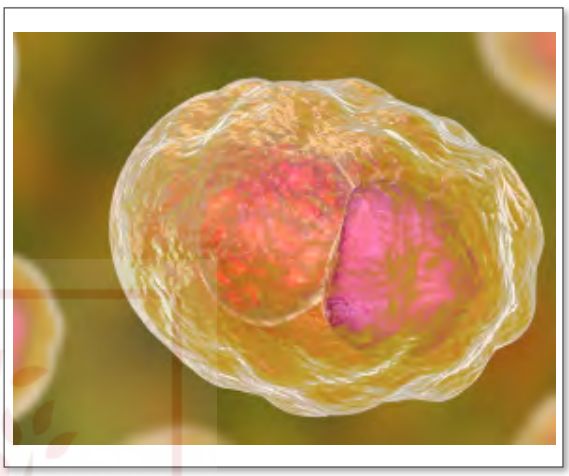

Figure 6.6: *Chlamydia trachomatis* inside the cell

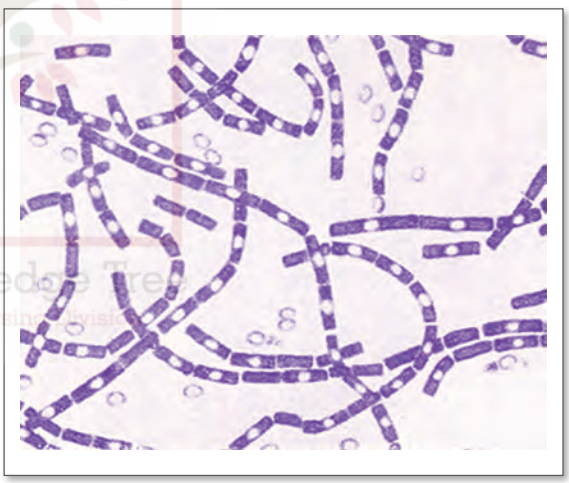

Figure 6.7: *Bacillus anthracis* showing cells arranged as bamboo stick

BACILLUS ANTHRACIS

These are Gram-positive spore bearing rods. They are nonmotile and arranged in chains which is surrounded by capsule. They appear as bamboo sticks under microscope (Figure 6.7). The spores can survive in soil for very long period of time. They are aerobes and facultative anaerobes. On nutrient agar, colonies appear as greyish white, round and irregularly raised. Under low power microscope, the edges of colonies appear as tangled mass of hairy curls—called medusa head.

Figure 6.8: *Clostridium tetani* showing drumstick appearance

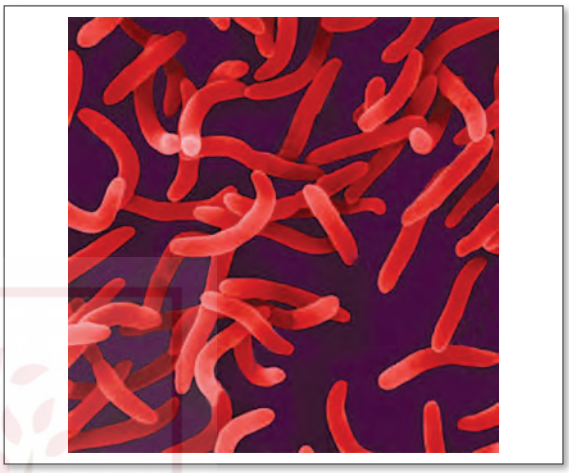

Figure 6.9: *Vibrio cholerae* showing comma shaped bacilli

CLOSTRIDIUM TETANI

Clostridium is the genus of rod-shaped, usually Gram-positive bacteria, members of which are found in soil, water, and the intestinal tracts of humans and other animals. Most species grow only in the complete absence of oxygen. Dormant cells are highly resistant to heat, desiccation, and toxic chemicals and detergents. It is Gram-positive in young cultures, but becomes Gram-negative upon sporulation. *Clostridium tetani* shows drumstick appearance when stained (Figure 6.8).

VIBRIO CHOLERAE

Vibrio cholerae is a "comma"-shaped Gram-negative bacteria with a single, polar flagellum for movement. There are numerous strains of *V. cholerae*, some of which are pathogenic and some of which are not. They live in mutual association with marine life. *Vibrio cholerae* is one of the important members of this genus, which causes cholera in humans. They are aerobes and facultative anaerobes. It does not require enriched media to grow (not fastidious) and it grows at an optimum temperature of 37°C. It produces moist, translucent and round colonies when inoculated on nutrient agar with bluish tinge in transmitted light. *Vibrio cholerae* showing comma shaped bacteria is shown in Figure 6.9.

YERSINIA PESTIS

Yersinia pestis is a zoonotic pathogen that is most commonly transmitted through fleas that feed on infected rodents. *Y. pestis* is a Gram-negative, non-motile, non-spore-forming coccobacillus that is also a facultative anaerobe. They are generally arranged singly in short chains or in small groups.

ESCHERICHIA COLI

Escherichia coli bacteria normally live in the intestines of people and animals. Most *E. coli* are harmless and actually are an important part of a healthy human intestinal tract. It is Gram-negative bacillus. The organism is noncapsulated and 1–3 × 0.4–0.7 μm in size. Most of the strains are motile due to peritrichous flagella. Fimbriae and capsules are present on majority of the strains. However, some *E. coli* are pathogenic; they can cause illness, either diarrhea or illness outside of the intestinal tract. The types of *E. coli* that can cause diarrhea can be transmitted through contaminated water or food, or through contact with animals or persons.

E. coli consists of a diverse group of bacteria. Pathogenic *E. coli* strains are categorized into pathotypes. Six pathotypes are associated with diarrhea and collectively are referred to as diarrheagenic *E. coli*.

KLEBSIELLA

Klebsiella bacteria are normally found in the human intestines (where they do not cause disease). They are also found in human stool (feces). *Klebsiella* is a type of Gram-negative, facultative anaerobic, nonmotile bacteria that can cause different types of healthcare-associated infections, including pneumonia, blood-stream infections, wound or surgical site infections and meningitis.

SALMONELLA TYPHI

These are Gram-negative, noncapsulated, non-sporing bacilli, which are 2–4 μm × 0.6 μm in size. Most of the strains are motile with the help of peritrichous flagella except *S. pullorum* and *S. gallinarum*.

These are aerobes and facultative anaerobes that grow at a temperature of 37°C and pH 6–8. On ordinary media like nutrient agar, colonies are moist, greyish-white, convex, translucent and circular.

S. typhi is the causative agent of typhoid fever or enteric fever. *S. paratyphi* causes disease of less severity. The bacteria enter the body with contaminated water or food. Incubation period is 10–14 days. The bacteria attach themselves to the microvilli and invades the small intestine.

SHIGELLA

Shigella is a group of organisms that are *Gram-negative aerobes or facultative anaerobes*. The organism is a non-flagellate, noncapsulated, nonsporing and nonmotile bacillus. It measures about 2–4 μm × 0.6 μm in size.

Shigellosis is an *acute diarrheal disease* caused by *Shigella* and is one of the major health problems in developing countries with poor sanitation. Human beings act as natural reservoirs of this organism. Infection is transmitted through contaminated food or water (feco-oral route of transmission).

MYCOBACTERIUM

The organisms included in Mycobacteria genus are nonmotile, Gram-positive and very slow growing bacilli. These are obligate parasites, opportunistic pathogens or occur as saprophytes. The genus mycobacteria can be divided into three major groups;

- *Mycobacterium tuberculosis*: Causes tuberculosis
- *Mycobacterium leprae*: Causes leprosy
- Nontuberculous mycobacteria.

Refer Table 6.2 For the common bacterial diseases with their characteristics, prevention and treatment.

COMMON BACTERIAL DISEASES

TABLE 6.2: COMMON BACTERIAL DISEASES

Disease and pathogen	Transmission and incubation period	Symptoms	Prevention and treatment
Disease: Actinomycosis **Pathogen:** *Actinomyces*	**Transmission:** Person-to-person via contact of the oral flora **Incubation period:** From several days to several years	Commonly affects jaw. Also affects the brain, lungs or intestines The bacterium is normally present in mouth but it may become pathogenic when a tooth is extracted, causing the slow formation of abscesses and ulcers	**Treatment:** Antibiotics for several months to a year. Surgical drainage or removal of the lesion may be needed **Prevention:** Good oral hygiene and regular dentist visits prevent some forms of actinomycosis
Disease: Anthrax **Pathogen:** *Bacillus anthracis*	**Transmission:** By contact with farm animal hair, hides or excretions	In man, the disease attacks either the lungs, causing pneumonia (wool sorter's disease), or the skin, producing severe ulceration (malignant pustule)	**Treatment:** Administration of large doses of penicillin or tetracycline
Disease: Botulism (and Infant botulism) **Pathogen:** *Clostridium botulinum*	**Transmission:** Through contamination of food (food poisoning) **Incubation period:** **Infants:** 3–30 days **Children and adults:** 12–72 hours	**Infants:** Lethargy, weakness, poor feeding, constipation, poor head control, poor gag and sucking reflex **Children and adults:** Double vision, blurred vision, drooping eyelids, slurred speech, difficulty swallowing, dry mouth and muscle weakness	**Treatment:** Penicillin
Disease: Brucellosis **Pathogen:** *Brucella* genus	**Transmission:** By direct contact or untreated/ contaminated milk of animals	Abdominal pain, back pain, chills, excessive sweating, fatigue, fever, headache, joint pain, loss of appetite, weakness, weight loss	**Treatment:** Antibiotics **Prevention:** Avoid unpasteurized dairy foods. Cook meat thoroughly. Wear gloves. Take safety precautions in high-risk workplaces. Vaccinate domestic animals

Contd...

Disease and pathogen	Transmission and incubation period	Symptoms	Prevention and treatment
Disease: Cellulitis **Pathogen:** Group A *Streptococcus* and *Staphylococcus*	**Transmission:** It may infect after any event that causes a break in the skin, such as: • Surgery • A cut or bite • A new tattoo or piercing • Skin breakdown, such as eczema, psoriasis, or a fungal infection like athlete's foot	At first, the infected area will be warm, red, swollen, and tender. If the infection spreads, one may have a fever, chills, and swollen lymph nodes	**Treatment:** Antibiotics
Disease: Chancroid **Pathogen:** *Haemophilus ducreyi*	**Transmission:** Sexual contact with an infected person **Incubation period:** 1–2 weeks	Chancroid begins with a small bump that becomes an ulcer within a day of its appearance. The ulcer characteristically: • Ranges in size dramatically from 3 to 50 mm (1/8 inch to two inches) across is painful • Has sharply defined, undermined borders • Has irregular or ragged borders • Has a base that is covered with a grey or yellowish-grey material • Has a base that bleeds easily, if traumatized or scraped painful lymphadenopathy occurs in 30–60% of patients	**Treatment:** The CDC recommendation for chancroid is a single oral dose (1 g) of Azithromycin or a single IM dose of Ceftriaxone or oral Erythromycin for 7 days. **Prevention:** Avoid all forms of sexual activity with infected persons
Disease: Chlamydiasis **Pathogen:** *Chlamydia trachomatis*	**Transmission:** By vaginal, anal, or oral sex. It can also be passed from an infected mother to her baby during vaginal childbirth	**In women**: Abnormal vaginal discharge that may have an odor. Bleeding between periods. Painful periods. Abdominal pain with fever. Pain while having sex. Itching or burning in or around the vagina. Pain when urinating. **In men**: Small amounts of clear or cloudy discharge from the tip of the penis. Painful urination. Burning and itching around the opening of the penis. Pain and swelling around the testicles.	**Treatment:** Antibiotics

Contd...

Disease and pathogen	Transmission and incubation period	Symptoms	Prevention and treatment
Disease: Cholera **Pathogen:** *Vibrio cholerae (Vibrio comma)*	**Transmission:** Through contaminated food and water. **Incubation period:** 6 hours to 3 days	Severe diarrhea, irritation of skin around anus, rice water stool; vomiting and muscular cramps, dehydration of the body	Anti- or Bilivaccine
Disease: *Clostridium* infection (food poisoning) **Pathogen:** *Clostridium perfringens*	**Transmission:** Beef, poultry, gravies **Incubation period:** 6–24 hours	Diarrhea and abdominal cramps (not fever or vomiting)	• Thoroughly cook foods to a safe internal temperature • Use a food thermometer • Keep food hot after cooking • Refrigerate perishable foods within two hours (at 40°F or below)
Disease: Diphtheria **Pathogen:** *Corynebacterium diphtheriae*	**Transmission:** Attacks children from 1 to 5 years of age **Incubation period:** 2–4 days	Upper respiratory tract illness having sore throat, an adherent layer on the tonsils, nasal cavity and pharynx. Toxins produce high fever, damage the nervous system and heart	**Prevention:** By active immunization; DT or DPT (bivalent or trivalent) at the age of 3–12 months; 3 doses at the interval of 4–6 weeks.
Disease: Epidemic typhus **Pathogen:** *Rickettsia prowazekii*	**Transmission:** Feeding on a human who carries the bacillus infects the louse. *R. prowazekii* grows in the louse's gut and is excreted in its feces. The disease is then transmitted to an uninfected human who scratches the louse bite (which itches) and rubs the feces into the wound **Incubation period:** 1–2 weeks	Severe headache, a sustained high fever, cough, rash, severe muscle pain, chills, falling blood pressure, stupor, sensitivity to light, delirium and death. A rash begins on the chest about five days after the fever appears, and spreads to the trunk and extremities. A symptom common to all forms of typhus is a fever which may reach 102°F	**Treatment:** Antibiotics Intravenous fluids and oxygen may be needed to stabilize the patient
Disease: Gonorrhea **Pathogen:** *Neisseria gonorrhoeae*	**Transmission:** Through sexual contact (venereal disease)	Burning and pain during micturition. Leads to sterility	**Treatment:** Antibiotics like penicillin G

Contd...

Disease and pathogen	Transmission and incubation period	Symptoms	Prevention and treatment
Disease: Leprosy (Hansen's disease) **Pathogen:** *Mycobacterium leprae*	**Transmission:** By direct contact with infected person **Incubation period:** 1–5 years	Granulomatous disease of the peripheral nerves and mucosa of the upper respiratory tract. Ulcers, nodules, scab deformities of fingers and toes, in particular nerves are being infected	**Treatment:** Lepromin skin test confirms the presence of the disease **Drugs:** Dapsone (DDS; 4, 4' diaminodiphenyl-sulfone) given for several years
Disease: Leptospirosis **Pathogen:** *Leptospira* genus	**Transmission:** Through rodents etc. It is often transmitted by animal urine or water containing animal urine. **Incubation period:** 4–14 day	High fever, severe headache, chills, muscle aches, and vomiting, and may include jaundice, red eyes, abdominal pain, diarrhea, and rash. Initial presentation may resemble pneumonia Biphasic disease with meningitis, liver damage and renal failure	
Disease: Meningitis (Bacterial) **Pathogen:** *Neisseria meningitidis*	**Transmission:** It usually occurs when bacteria enter the bloodstream and migrate to the brain and spinal cord. But it can also occur when bacteria directly invade the meninges, as a result of an ear or sinus infection, or a skull fracture, or rarely, after some surgeries	• Sudden high fever • Severe headache that isn't easily confused with other types of headache • Stiff neck • Vomiting or nausea with headache • Confusion or difficulty concentrating • Seizures • Sleepiness or difficulty waking up • Sensitivity to light • Lack of interest in drinking and eating • Skin rash in some cases, such as in meningococcal meningitis • Signs in newborns • High fever • Constant crying • Excessive sleepiness or irritability • Inactivity or sluggishness • Poor feeding • A bulge in the soft spot on top of a baby's head (fontanel) • Stiffness in a baby's body and neck	**Treatment:** • Intravenous antibiotics • Cortisone medications

Contd...

Disease and pathogen	Transmission and incubation period	Symptoms	Prevention and treatment
Disease: Mycoplasma pneumonia **Pathogen:** *Mycoplasma pneumoniae*	**Transmission:** From person to person	• Persistent fever • Dry cough • Malaise • Fever	**Treatment:** • Antibiotics • Corticosteroids • Immunomodulatory therapy
Disease: Plague **Pathogen:** *Yersinia (Pasteurella) pestis*	**Transmission:** By rats and other rodents. Vector is a flea, *Xenopsylla cheopsis* which feeds on infected rodents and may bite man.	Inflammation of the lymphatics, subcutaneous tissues and viscera; diffused hemorrhage into the skin.	**Treatment:** **Drugs**: Streptomycin, Chloromycin and Kanamycin
Disease: Pneumonia **Pathogen:** *Streptococcus pneumoniae*	**Transmission:** Through contact with infected person **Incubation period:** 1–3 days	Mucus collects in alveoli of the lungs. Restlessness, cough and fever	**Treatment:** Antibiotics like tetracycline or penicillin G
Disease: Scarlet fever (Scarlatina) **Pathogen:** *Streptococcus pyogenes*	**Transmission**: Infection may occur through blood stream or skin and underlying tissues.	Sore throat, fever and a rash over the upper body that may spread to cover almost the entire body.	**Treatment:** Antibiotics
Disease: Shigellosis (Bacillary dysentery) **Pathogen:** *Shigella* genus	**Transmission:** • From one infected person to the next • From stool	Dysentery due to poor hygiene.	**Treatment:** Antibiotic treatment.
Disease: Syphilis **Pathogen:** *Treponema pallidum*	**Transmission:** Through sexual contact. Also caused by kissing and using clothing of infected persons. **Incubation period**: 15–20 days	Affects mucous membrane of genital tract, rectum and mouth	Antibiotics like penicillin G or ampicillin

Contd...

Disease and pathogen	Transmission and incubation period	Symptoms	Prevention and treatment
Disease: Tetanus (Lockjaw) **Pathogen:** *Clostridium tetani* (Gram +ve)	**Transmission:** CNS of man contaminated with dust, soil or water. **Incubation period:** 5–12 years	Toxin, tetanospasmin affects nervous system. Painful stiffness of the neck (lock jaw) and difficulty in swallowing; sensitivity to noise, fever. Prolonged contraction of skeletal muscle fibers	**Prevention:** Anti-tetanus (tetanal immune globulin) injection or vaccination in childhood with tetanus toxoid.
Disease: Trachoma **Pathogen:** *Chlamydia trachomatis*	**Transmission:** By direct contact or using infective cloths of a patient. **Incubation period:** 5–10 days	Inflammation of cornea, redness of eye and discomfort and pain. Probably leading to blindness	Tetracycline and erythromycin as ophthalmic ointments
Disease: Tuberculosis **Pathogen:** *Mycobacterium tuberculosis*	**Transmission:** By contact, i.e., coughing, sneezing, spitting, talking etc. **Incubation period:** 2 weeks	Generally, attacks the lungs but may affect central nervous system, circulatory system, lymphatic system, bones, joints, genitourinary system and skin. Bacteria release toxin-tuberculin, results in fever. Lungs are affected. Weakness and loss of weight.	Streptomycin and para-amino salicylic acid (PAS) or BCG vaccination
Disease: Typhoid fever **Pathogen:** *Salmonella typhi*	**Transmission:** Ingestion of food or water adulterated with feces of an infected person. **Incubation period:** 4 weeks	Continuous fever, headache and lethargy. It is followed by enlargement of spleen, pain in stomach and rose colored rashes on body.	**Drug:** Chloramphenicol; inoculation is given every year.

SUMMARY

- Pathogenic organism is an organism which is capable of causing diseases in a host.
- Organisms which do not cause diseases are called nonpathogenic.
- *Staphylococcus albus* is harmless commensal living in nostrils, mouth and on skin.
- Streptococci are Gram-positive, nonmotile, nonspore-forming, catalase-negative cocci that occur in pairs or chains.
- *Streptococcus pneumoniae* or pneumococci are lancet-shaped, catalase-negative, capsule-forming, α-hemolytic cocci or diplococci.
- N. gonorrhoeae causes gonorrhea, and *N. meningitidis* is the cause of meningococcal meningitis.
- *C. diphtheriae* spreads by droplets, secretions, or direct contact. It causes diphtheria.
- Chlamydiae are small Gram-negative obligate intracellular microorganisms that preferentially infect squamocolumnar epithelial cells.
- *Clostridium* is the genus of rod-shaped, usually Gram-positive bacteria.
- *Vibrio cholerae* is a "comma"-shaped Gram-negative bacteria with a single, polar flagellum for movement.
- *Bacillus anthracis* appear as bamboo sticks under microscope.
- *Yersinia pestis* is a zoonotic pathogen that is most commonly transmitted through fleas that feed on infected rodents.
- *S. typhi* is the causative agent of typhoid fever or enteric fever.
- *Escherichia coli* bacteria normally live in the intestines of people and animals.
- Shigellosis is an *acute diarrheal disease* caused by *Shigella*
- *Klebsiella* is a type of Gram-negative, facultative anaerobic, nonmotile bacteria that can cause different types of healthcare-associated infections, including pneumonia, bloodstream infections, wound or surgical site infections and meningitis.

Color Plates of Bacterial Diseases

Color plate 1: Dental caries

Color plate 2: Streptococcal pharyngitis

Color plate 3: Gonorrhea

Color plate 4: Tuberculosis

Color plate 5: Lyme Disease

Color plate 6: Leprosy

STUDENT ASSIGNMENT

LONG ANSWER QUESTIONS

1. What are pathogenic and nonpathogenic bacteria?
2. Write differences between pathogenic and nonpathogenic bacteria.

SHORT ANSWER QUESTION

1. Write short notes on:
   a. Leprosy
   b. Tuberculosis

MULTIPLE CHOICE QUESTIONS

1. Drug of choice to treat leprosy is:
a. Rifampicin
b. Acyclovir
c. Zidovudine
d. Dapsone

2. Food poisoning is caused by:
a. *Clostridium perfringens*
b. *Clostridium botulinum*
c. *Corynebacterium diphtheriae*
d. *Clostridium tetani*

3. The causative agent of tuberculosis (TB) is:
a. *Mycobacterium tuberculosis*
b. *Mycobacterium leprae*
c. *Treponema pallidum*
d. *Borrelia* species

4. The causative agent of plague is:
a. Mosquito
b. *Yersinia pestis*
c. *Mycobacterium tuberculosis*
d. *Mycobacterium leprae*

5. Characteristic feature of *Staphylococcus aureus* is:
a. It is aerobic
b. It produces golden yellow colonies
c. Nonsporing
d. All of the above

6. Which of the following is a Gram-positive cocci?
a. *Streptococcus*
b. *Neisseria*
c. *Escherichia*
d. *Corynebacterium*

7. Who discovered Vibrio cholerae (cholera)?
a. Robert Koch
b. Ronald Ross
c. Filippo Pacini
d. Alexander Flaming

8. Who discovered the Mycobacterium leprae bacilli?
a. Edward Jenner
b. Yersin
c. Loeffler
d. Hansen

9. Presence of pathogenic bacteria in the blood is known as:

a. Toxemia
b. Septicemia
c. Bacteremia
d. All of the above

10. Which of the following microorganisms are the most commonly found normal flora in a healthy human body?

a Bacteria
b Fungi
c Parasites
d Viruses

11. Which of the following microorganism is a part of the normal flora of the skin and is also a common pathogen isolated from skin infections?

a Bacillus anthracis
b E. coli
c. Staphylococcus aureus
d. Candida albicans

ANSWER KEY

1. d **2.** b **3.** a **4.** b **5.** d **6.** a **7.** a, c **8.** d
9. c 10. a 11. c

Textbook of

Microbiology

for GNM Nursing Students

Salient Features

- This textbook has been designed for undergraduate nursing students, especially for the students of GNM Nursing.
- The book is written in simple and easy-to-understand language.
- The point-wise presentation of the text helps students to recall the concepts.
- All the chapters have been thoroughly revised as per the advancement in the field of nursing
- A good number of clinical images have been covered for the better understanding of the concept
- Nursing implications/responsibilities in the clinical settings have been covered in an integrated manner for better practical understanding.

Learning Objectives given in the beginning of each chapter help readers understand the purpose of the chapter.

LEARNING OBJECTIVES

After the completion of the chapter, the readers will be able to:

- Describe evolution of microbiology
- Understand role of microbiology in nursing

Chapter Outline gives a glimpse of the content covered in the chapter.

CHAPTER OUTLINE

- Introduction
- Microorganisms
- History of Microbiology
- Role of Microbiology in Nursing

Important **Key Terms** used in the chapter are presented to familiarize the readers with the important terminologies.

KEY TERMS

Bacteriology: Study of disease causing bacteria
Fermentation: Process that breaks down sugars into alcohol and organic acids
Heat-labile bacteria: Bacteria that can be killed by exposing them to heat

Additional information related to the concepts are provided in the **Also Know** boxes.

Also Know

Exceptions to Koch's postulates
Treponema pallidum, *Mycobacterium leprae*, many viruses and Rickettsiae are unable to grow on artificial media.

Studded with 200+ fully **Colored Figures and Images** for easy grasp of the relevant topic.

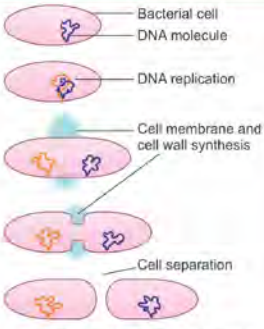

Figure 3.8: Binary fission in bacteria

Numerous **Tables** are used to clarify the concept and make the reading enjoyable and informative.

TABLE 3.2:

Bacterial species where observed	Function
Escherichia coli (For sex pilus)	Stabilizes bacteria during transfer of DNA during conjugation
Escherichia coli (common pili or fimbriae)	Surface adherence to epithelial cells of the gastrointestinal tract

Important takeaway points of respective chapters have been highlighted under **Summary** boxes.

SUMMARY

Microbiology stands for the study of those living organisms that are not visible to the naked eye. Antonie van Leeuwenhoek is considered to be the 'Father of Microbiology'.
Robert Koch introduced many laboratory techniques which are used nowadays such as culture and staining.

Student Assignment in the form of exercises in each and every chapter facilitates structured learning and revision of the material provided in the respective chapters.

STUDENT ASSIGNMENT

LONG ANSWER QUESTIONS

1. Discuss the Koch's postulates.
2. Explain the role of microbiology for nurses.

SHORT ANSWER QUESTIONS

1. Write short notes on:
   a. Louis Pasteur
   b. Leeuwenhoek

MULTIPLE CHOICE QUESTIONS

1. **Identify correct statement regarding Robert Koch.**
   a. He is known as father of bacteriology
   b. The causative organism of cholera, *Vibrio cholera* was identified by him
   c. He discovered hypersensitivity phenomenon
   d. All of the above
2. **Father of antiseptic surgery is:**
   a. Louis Pasteur

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