ailed information on nursing books, visit our website www.ejaypee.com, for detailed information on nursing books, visit our website www.ejaypee.com

Nursing Q-Bank Series

For BSc Nursing Students

Applied Microbiology, Infection Control & Safety

As per the Revised INC Syllabus



HIGHLIGHTS

- Various University Examination Question Papers
- Learning Pearls
- Applied Questions
- Case-based Questions

Monika Dean
Abha Narwal
Rachna Khanna
Nandani Kumari

Semester-III

JAYPEE

CONTENTS

PART I: APPLIED MICROBIOLOGY

Unit 1: Introduction 3

Unit 2: General Characteristics of Microbes 9

Unit 3: Pathogenic Organisms 67

Unit 4: Immunity 123

PART II: INFECTION CONTROL AND SAFETY

Unit 1: Hospital Acquired Infections 171

Unit 2: Isolation Precautions and Use of Personal Protective Equipment 189

Unit 3: Hand Hygiene 205

Unit 4: Disinfection and Sterilization 213

Unit 5: Specimen Collection 239

Unit 6: Biomedical Waste Management 273

Unit 7: Antibiotic Stewardship 291

Unit 8: Patient Safety Indicators 315

Unit 9: International Patient Safety Goals 353

Unit 10: Safety Protocols 383

Unit 11: Employee Safety Indicators 413

Learning Pearls 431

University Examination Question Papers 437

1. Atal Bihari Vajpayee Medical University, Uttar Pradesh, 2025 — 437
   Atal Bihari Vajpayee Medical University, Uttar Pradesh, 2024 — 440
   Atal Bihari Vajpayee Medical University, Uttar Pradesh, 2023 — 443
2. Bharti Vidya Peeth, 2023 — 446
3. Baba Farid University of Health Sciences, 2024 — 450
4. Indraprastha University (IP), New Delhi, 2024 — 455
5. Kerala University of Health Sciences (KUHS), 2024 — 458
   Kerala University of Health Sciences (KUHS), 2023 — 461

6. SGT University, 2022–2023 464
7. University of Health Sciences, Rohtak (PGIMS), 2025 467
University of Health Sciences, Rohtak (PGIMS), 2024 470
University of Health Sciences, Rohtak (PGIMS), 2023 473

Case-based MCQs 477

Multiple Choice Questions 483

Image-based Questions 491

UNIT 3: PATHOGENIC ORGANISMS

Note: *In this Unit we have covered following questions. These questions are taken after detailed analysis from the questions bank of various universities.*

LONG QUESTIONS

Sl. No.	Question	Marks
Q1.	Discuss the classification of cocci and bacilli based on Gram staining. Outline the sources, portals of entry, modes of transmission, and diseases caused by each type.	10
Q2.	Define viruses and explain their general structure and classify them.	2 + 8 = 10
Q3.	Define fungi. Classify fungi.	2 + 8 = 10
Q4.	Define parasites. Classify parasites.	2 + 8 = 10

SHORT QUESTIONS

Sl. No.	Question	Marks
Q1.	Difference between Gram-positive and Gram-negative bacteria.	5
Q2.	Difference between cocci and bacilli.	5
Q3.	Difference between bacteria and virus.	5
Q4.	Morphological features of virus.	5
Q5.	Replication of virus.	5
Q6.	Rodents.	5
Q7.	Vectors.	5
Q8.	What are the main differences between vectors and reservoirs in the context of disease transmission?	5
Q9.	*Staphylococcus.*	5
Q10.	*Streptococcus.*	5
Q11.	*Neisseria.*	5
Q12.	*Corynebacterium.*	5
Q13.	*Bacillus anthracis.*	5
Q14.	*Enterobacteriaceae.*	5
Q15.	*Escherichia.*	5
Q16.	*Klebsiella.*	5
Q17.	*Salmonella.*	5
Q18.	*Treponema pallidum.*	5
Q19.	*Clostridium.*	5
Q20.	*Yersinia.*	5
Q21.	*Helicobacter pylori.*	5
Q22.	Coronavirus.	5
Q23.	Herpes virus.	5

JAYPEE BROTHERS

Sl. No.	Question	Marks
Q24.	Varicella-Zoster virus.	5
Q25.	Hepatitis virus.	5
Q26.	HIV.	5
Q27.	Poliovirus.	5
Q28.	*Entamoeba histolytica*.	5

VERY SHORT QUESTIONS

Sl. No.	Question	Marks
Q1.	What is the main difference between Gram-positive and Gram-negative cocci?	2
Q2.	Give two examples of Gram-positive cocci and their associated diseases.	2
Q3.	Explain the difference between Gram-positive and Gram-negative bacilli.	2
Q4.	Name two Gram-negative bacilli and the diseases they cause.	2
Q5.	What are viruses, and how do they differ from living cells?	2
Q6.	Describe the basic structure of a virus.	2
Q7.	What is the process of viral replication?	2
Q8.	How do viruses enter a host cell?	2
Q9.	What are superficial mycoses, and how do they differ from deep mycoses?	2
Q10.	Give an example of a superficial mycosis and its cause.	2
Q11.	What is the main difference between superficial and deep mycoses?	2
Q12.	What are deep mycoses, and which fungal organisms commonly cause them?	2
Q13.	Define a parasite and give an example of a parasitic infection.	2
Q14.	What are the key differences between protozoan and helminth parasites?	2
Q15.	Explain the life cycle of a protozoan parasite.	2
Q16.	What are helminths and give an example of a disease caused by helminths?	2
Q17.	What role do rodents play in the transmission of infectious diseases?	2
Q18.	How do mosquitoes act as vectors for diseases like malaria?	2
Q19.	What is the significance of fleas as disease vectors?	2
Q20.	Describe the portal of entry for pathogens transmitted by ticks.	2
Q21.	What is the role of sandflies in the transmission of Leishmaniasis?	2
Q22.	How do rodents serve as reservoirs for certain infections?	2

MULTIPLE CHOICE QUESTIONS

JAYPEE BROTHERS

UNIT 3

PATHOGENIC ORGANISMS

LONG QUESTIONS

Q1 Discuss the classification of cocci and bacilli based on Gram staining. Outline the sources, portals of entry, modes of transmission, and diseases caused by each type.

Ans: Gram staining is a differential staining technique developed by Hans Christian Gram, used to classify bacteria into two major groups based on the composition of their cell walls: Gram-positive and Gram-negative. This classification is significant for identifying microorganisms and determining appropriate treatments **(Table 3.1)**. The sources, portals of entry, modes of transmission, and diseases are described in **Table 3.2.**

Table 3.1: Classification of cocci and bacilli based on gram staining.

Feature	Gram-positive cocci	Gram-negative cocci	Gram-positive bacilli	Gram-negative bacilli
Staining color	Purple (retains crystal violet)	Pink/Red (takes up safranin)	Purple (retains crystal violet)	Pink/Red (takes up safranin)
Cell wall composition	Thick peptidoglycan layer; teichoic acids present	Thin peptidoglycan; outer membrane with LPS	Thick peptidoglycan layer; may form spores	Thin peptidoglycan; outer membrane with LPS
Examples	*Staphylococcus aureus* (skin infections)	*Neisseria gonorrhoeae* (gonorrhea)	*Bacillus anthracis* (anthrax)	*Escherichia coli* (UTIs, diarrhea)
	Streptococcus pyogenes (pharyngitis)	*Neisseria meningitidis* (meningitis)	*Clostridium tetani* (tetanus)	*Salmonella typhi* (typhoid fever)
	Enterococcus faecalis (UTIs)		*Corynebacterium diphtheriae* (diphtheria)	*Pseudomonas aeruginosa* (wound infections)
Key characteristics	Retains crystal violet due to thick cell wall	Outer membrane with LPS blocks crystal violet	Often spore-forming in adverse conditions	Resistant to antibiotics due to outer membrane
Clinical relevance	Common in respiratory, skin, and bloodstream infections	Causes meningitis and sexually transmitted infections	Includes spore-forming pathogens causing severe diseases	Associated with GI and systemic infections

JAYPEE BROTHERS

Table 3.2: Outline of sources, portals of entry, modes of transmission, and diseases for cocci and bacilli.

Bacterial type	Sources	Portals of entry	Modes of transmission	Diseases caused
Gram-positive cocci				
Staphylococcus aureus	Skin, nasal passages, contaminated surfaces	Skin (wounds), respiratory tract, bloodstream	Direct contact, fomites, respiratory droplets	Skin infections, pneumonia, septicemia
Streptococcus pyogenes	Throat, respiratory secretions	Respiratory tract, skin	Respiratory droplets, direct contact	Pharyngitis, scarlet fever, rheumatic fever
Enterococcus faecalis	Gastrointestinal tract, hospital environments	Urinary tract, bloodstream	Direct contact, healthcare-associated infections	UTIs, endocarditis
Gram-negative cocci				
Neisseria gonorrhoeae	Infected genital secretions	Genital mucosa	Sexual contact	Gonorrhea
Neisseria meningitidis	Nasopharyngeal carriers, respiratory secretions	Respiratory tract	Respiratory droplets, close contact	Meningitis, septicemia
Gram-positive bacilli				
Bacillus anthracis	Soil, infected animals, animal products	Skin, respiratory tract, gastrointestinal tract	Contact with spores, inhalation, ingestion	Anthrax (cutaneous, inhalation, gastrointestinal)
Clostridium tetani	Soil, contaminated wounds	Puncture wounds	Direct entry of spores through wounds	Tetanus
Corynebacterium diphtheriae	Respiratory secretions, infected individuals	Respiratory tract, open wounds	Respiratory droplets, direct contact	Diphtheria
Gram-negative bacilli				
Escherichia coli	Contaminated food/water, human and animal feces	Gastrointestinal tract, urinary tract	Ingestion, direct contact, healthcare-associated infections	UTIs, diarrhea, sepsis
Salmonella typhi	Contaminated water, infected individuals	Gastrointestinal tract	Fecal-oral route	Typhoid fever
Pseudomonas aeruginosa	Water, soil, healthcare environments	Wounds, respiratory tract, urinary tract	Healthcare-associated infections, contact	Wound infections, pneumonia, sepsis

JAYPEE BROTHERS

Q2 Define viruses and explain their general structure and classify them.

Ans:

Definition of Viruses

Viruses are microscopic infectious agents that can infect living organisms, including humans, animals, plants, and even bacteria. Unlike other microorganisms, viruses are acellular and cannot carry out metabolic processes independently. They require a host cell to replicate and propagate, making them obligate intracellular parasites.

General Structure of Virus

Refer Q. No. 4, Short Questions of Unit II.

Classification of Virus

Refer Q. No. 5, Short Questions of Unit II.

Q3 Define fungi. Classify fungi.

Ans:

Definition of Fungi

Fungi are a diverse group of eukaryotic organisms that include microorganisms such as yeasts, molds, and mushrooms. They are characterized by the following features:

- **Nonphotosynthetic:** Fungi lack chlorophyll and obtain nutrients through absorption.
- **Heterotrophic:** They rely on organic matter, living as saprophytes (decomposers), parasites, or in mutualistic relationships.
- **Cell structure:** Their cells have a true nucleus and organelles, with cell walls made of chitin.
- **Reproduction:** They reproduce through spores, which may be formed sexually or asexually.

Classification of Fungi

Refer Q. No. 5, Short Questions of Unit II.

Q4 Define parasites. Classify parasites.

Ans:

Definition of Parasites

Parasites are organisms that live on or inside a host organism and derive nutrients or shelter at the host's expense, often causing harm. They can infect humans, animals, or plants and may lead to various diseases.

Characteristics of Parasites

1. **Dependency on host:** Parasites cannot survive, grow, or reproduce without a host.
2. **Nutritional advantage:** They feed on the host's resources, leading to weakness or disease in the host.
3. **Types:**
   i. *Ectoparasites:* Live on the external surface of the host (e.g., lice, ticks).
   ii. *Endoparasites*: Live inside the host's body (e.g., *Plasmodium*, which causes malaria).

JAYPEE BROTHERS

4. **Complex life cycles:** Many parasites have life cycles involving multiple stages and often more than one host.

Classification of Parasites (Fig. 3.1)

Parasites are organisms that live on or within a host and derive nutrients from the host, often causing harm. Parasites can be broadly classified into **protozoa** and **helminths**.

1. Protozoa (Single-celled Organisms)

Protozoa are unicellular, eukaryotic organisms that can live as free-living or parasitic organisms. Protozoan parasites are classified based on their mode of movement, structure, and life cycle.

Based on Mode of Movement

i. **Amoeboid Protozoa (Sarcodina)**
   - These protozoa move and feed by forming pseudopodia (false feet), which are temporary projections of the cytoplasm.
   - *Examples*:
     - *Entamoeba histolytica* (causes amoebiasis)
     - *Naegleria fowleri* (causes primary amoebic meningoencephalitis)
     - *Acanthamoeba* species (can cause infections of the eyes and brain)

ii. **Flagellates (Mastigophora)**
   - These protozoa use flagella (whip-like appendages) for movement.
   - *Examples*:
     - *Giardia lamblia* (causes giardiasis)
     - *Trypanosoma brucei* (causes African sleeping sickness)
     - *Leishmania* species (causes leishmaniasis)
     - *Trichomonas vaginalis* (causes trichomoniasis)

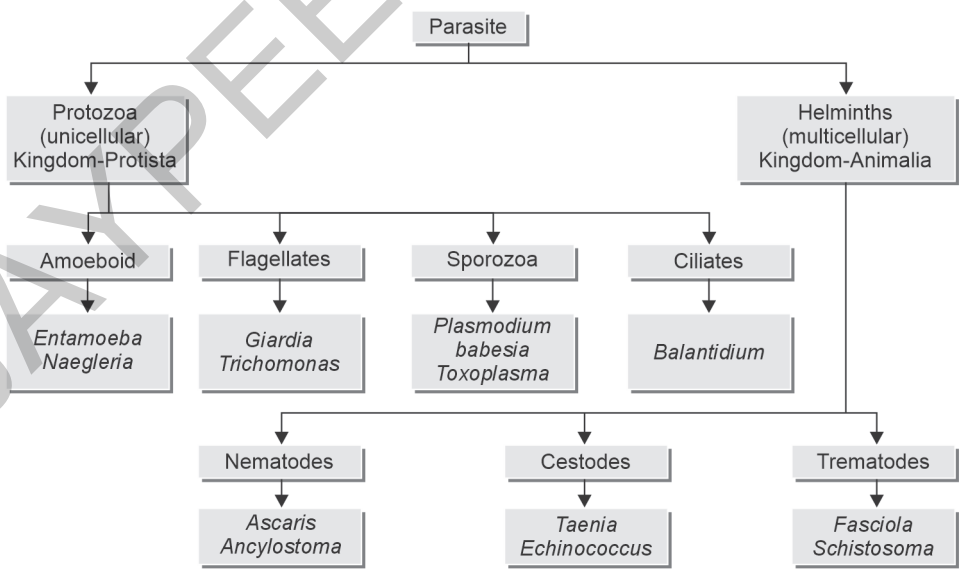

Fig. 3.1: Classification of parasites.

JAYPEE BROTHERS

iii. **Ciliates (Ciliophora)**
- Ciliates move and feed using numerous short hair-like structures called cilia.
- *Examples:*
  - *Balantidium coli* (causes balantidiasis, a dysentery-like condition)

iv. **Sporozoans (Apicomplexa)**
- These protozoa are nonmotile in their adult form and reproduce through a complex life cycle, often involving multiple hosts.
- *Examples*:
  - *Plasmodium* species (causes malaria)
  - *Toxoplasma gondii* (causes toxoplasmosis)
  - *Cryptosporidium* species (causes cryptosporidiosis)
  - *Babesia* species (causes babesiosis)

2. Helminths (Multicellular, Worm-like Organisms)

Helminths are multicellular organisms, often referred to as worms, that are typically larger than protozoa. They are classified into three main types: **nematodes**, **trematodes**, and **cestodes**.

i. Nematodes (Roundworms): Nematodes are cylindrical worms with a complete digestive tract. They can be free-living or parasitic.
Examples:
- *Ascaris lumbricoides* (causes ascariasis)
- *Enterobius vermicularis* (causes pinworm infection)
- *Ancylostoma duodenale* and *Necator americanus* (cause hookworm infection)
- *Trichinella spiralis* (causes trichinosis)
- *Strongyloides stercoralis* (causes strongyloidiasis)
- *Wuchereria bancrofti* (causes lymphatic filariasis)

ii. Trematodes (Flukes): Trematodes are flat, leaf-shaped parasitic worms. They have suckers that allow them to attach to the host's tissues. They typically affect internal organs such as the liver, lungs, or intestines.
Examples:
- *Fasciola hepatica* (causes fascioliasis, liver fluke infection)
- *Schistosoma species* (cause schistosomiasis, affecting the liver, intestines, and urinary tract)
- *Clonorchis sinensis* (causes clonorchiasis, a liver infection)
- *Paragonimus westermani* (causes pulmonary paragonimiasis, affecting the lungs)

iii. Cestodes (Tapeworms): Cestodes are long, flat worms that have segmented bodies. They attach to the intestinal wall of the host via a head-like structure called the scolex, and they absorb nutrients from the host's digestive tract.
- Examples:
  - *Taenia solium* (pork tapeworm, causes taeniasis and cysticercosis)
  - *Taenia saginata* (beef tapeworm, causes taeniasis)
  - *Diphyllobothrium latum* (fish tapeworm, causes diphyllobothriasis)
  - *Echinococcus granulosus* (causes hydatid disease, which affects the liver and lungs)

3. Additional Classification Based on the Type of Host and Transmission

Parasites can also be classified based on their hosts and how they are transmitted:

i. **Monoxenous parasites:** Parasites that complete their entire life cycle in a single host. Example: *Plasmodium* species (malaria parasite) in humans.

JAYPEE BROTHERS

ii. **Heteroxenous parasites:** Parasites that require more than one host to complete their life cycle.
Example: *Schistosoma* species (require an intermediate snail host).
iii. **Endoparasites:** Parasites that live inside the host's body.
Example: *Ascaris lumbricoides* (intestinal roundworm).
iv. **Ectoparasites:** Parasites that live on the outside of the host.
Example: *Pediculus humanus* (head lice).
v. **Obligate parasites:** Parasites that cannot survive without a host.
Example: *Toxoplasma gondii* (causes toxoplasmosis).
vi. **Facultative parasites:** Parasites that can live independently in the environment but will live as a parasite if a suitable host is available.
Example: *Naegleria fowleri* (causes brain infection).

SHORT QUESTIONS

Q1 Difference between Gram-positive and Gram-negative bacteria.

Ans: *See* **Table 3.3.**

Table 3.3: Difference between Gram-positive and Gram-negative bacteria.

Characteristic	Gram-positive bacteria	Gram-negative bacteria
Cell wall structure	Thick peptidoglycan layer, no outer membrane	Thin peptidoglycan layer, outer membrane present
Gram staining result	Stains purple (retains crystal violet stain)	Stains pink (does not retain crystal violet, stains with safranin)
Peptidoglycan layer	Thick, accounts for 60–90% of the cell wall	Thin, accounts for only 10–20% of the cell wall
Outer membrane	Absent	Present
Lipopolysaccharides (LPS)	Lacks lipopolysaccharides	Contains lipopolysaccharides (endotoxins)
Teichoic acids	Present (includes lipoteichoic acid)	Absent
Periplasmic space	Narrow or absent	Present (between inner and outer membranes)
Examples	*Staphylococcus aureus, Streptococcus pneumoniae*	*Escherichia coli, Salmonella, Pseudomonas aeruginosa*
Susceptibility to antibiotics	Generally, more susceptible to penicillin and other beta-lactam antibiotics	Less susceptible to penicillin, more resistant to beta-lactams
Endotoxins	Absent	Present (released when the bacterial cell is destroyed)

Q2 Difference between cocci and bacilli.

Ans: *See* **Table 3.4.**

JAYPEE BROTHERS

Table 3.4: Difference between cocci and bacilli.

Characteristic	Cocci	Bacilli
Shape	Spherical or round-shaped	Rod-shaped or cylindrical
Arrangement	Can be in pairs (diplococci), chains (streptococci), clusters (staphylococci), or tetrads	Typically occur as single cells or in chains or pairs
Size	Smaller in size (0.5 to 1.0 micrometers)	Larger in size (1.0 to 5.0 micrometers)
Examples	*Streptococcus pneumoniae, Staphylococcus aureus, Neisseria gonorrhoeae*	*Escherichia coli, Bacillus anthracis, Clostridium tetani*
Gram staining	Can be either Gram-positive or Gram-negative	Can be either Gram-positive or Gram-negative
Motility	Nonmotile (most are nonmotile, but some can be motile)	Some are motile (through flagella), others are nonmotile
Oxygen requirement	Can be aerobic, anaerobic, or facultative anaerobic	Can be aerobic, anaerobic, or facultative anaerobic
Spore formation	Do not form spores	Some bacilli (e.g., *Bacillus* and *Clostridium*) can form spores
Reproduction	Reproduce by binary fission	Reproduce by binary fission

Q3 Difference between bacteria and virus.

Ans: *See* **Table 3.5.**

Table 3.5: Difference between bacteria and viruses.

Characteristic	Bacteria	Viruses
Nature	Living organisms (single-celled)	Nonliving entities (require a host cell to reproduce)
Structure	Composed of cell walls, cell membrane, cytoplasm, and sometimes flagella	Consist of a protein coat (capsid) and genetic material (DNA or RNA)
Size	Larger (0.2 to 2.0 micrometers)	Smaller (20 to 300 nanometers)
Cellular organization	Prokaryotic (lack a nucleus and organelles)	Not cellular; consist only of nucleic acid and a protein coat
Metabolism	Can carry out metabolism independently (e.g., respiration, fermentation)	Cannot perform metabolic processes; rely on host machinery
Reproduction	Reproduce by binary fission (asexual reproduction)	Reproduce only inside host cells (via replication or assembly)
Response to antibiotics	Often susceptible to antibiotics (e.g., penicillin)	Not affected by antibiotics (require antiviral agents)
Genetic material	DNA or RNA, but always in a double-stranded form	Either DNA or RNA, but never both, and can be single-stranded or double-stranded
Living/ nonliving	Living organisms (can live independently)	Nonliving (cannot live or reproduce without a host)
Examples	*Escherichia coli, Staphylococcus aureus, Mycobacterium tuberculosis*	*Influenza virus, HIV, Coronavirus*
Treatment	Treated with antibiotics (for bacterial infections)	Treated with antiviral drugs (for viral infections)
Transmission	Can be spread through air, water, contact, food, etc.	Transmitted via direct contact, droplets, vectors, or bodily fluids

JAYPEE BROTHERS

Q4 Morphological features of virus.

Ans: Viruses exhibit distinct morphological features that are essential for their identification and function. At the core of a virus's structure is the **genetic material**, which can be either DNA or RNA, but never both. This genetic material can exist as **single-stranded** or **double-stranded**, and may be linear or circular, depending on the virus type. The genetic material contains the information necessary for viral replication within a host cell.

The **capsid** is the protein shell that encases and protects the viral genome. It is composed of subunits called **capsomers**, which assemble in a regular, symmetrical pattern. The shape of the capsid can vary, and it is typically classified into three main forms:

1. **Icosahedral:** A symmetrical, 20-sided structure, common in many viruses, including the adenovirus and poliovirus.
2. **Helical:** These viruses have a rod-shaped structure, with the capsid proteins arranged in a spiral around the genetic material. Examples include the influenza virus and rabies virus.
3. **Complex:** These viruses have more elaborate structures, often including additional components like tails or other appendages. An example is the **bacteriophage**, which has a complex structure with a head (icosahedral) and a tail (helical).

Some viruses possess an **envelope**, which is a lipid membrane derived from the host cell's plasma membrane. The envelope surrounds the capsid and contains viral proteins, such as **glycoproteins**, that help the virus recognize and bind to host cells. Enveloped viruses, like the **human immunodeficiency virus (HIV)** and **influenza virus**, are generally more sensitive to environmental factors like heat and detergents, which can destroy the lipid membrane.

Viruses also have varying sizes, typically ranging from **20 to 300 nm** in diameter, much smaller than bacteria, making them invisible under a light microscope. Their small size and simplicity in structure—lacking cellular machinery, organelles, or a metabolism—are among the key features that distinguish viruses from living organisms.

Q5 Replication of virus.

Ans: *See* **Figure 3.2.**

The replication of a virus involves a series of steps where the virus hijacks the cellular machinery of a host cell to reproduce itself. This process varies slightly depending on the type of virus (DNA or RNA, and whether it is a retrovirus), but the general steps are largely similar. Here is an overview of the viral replication cycle:

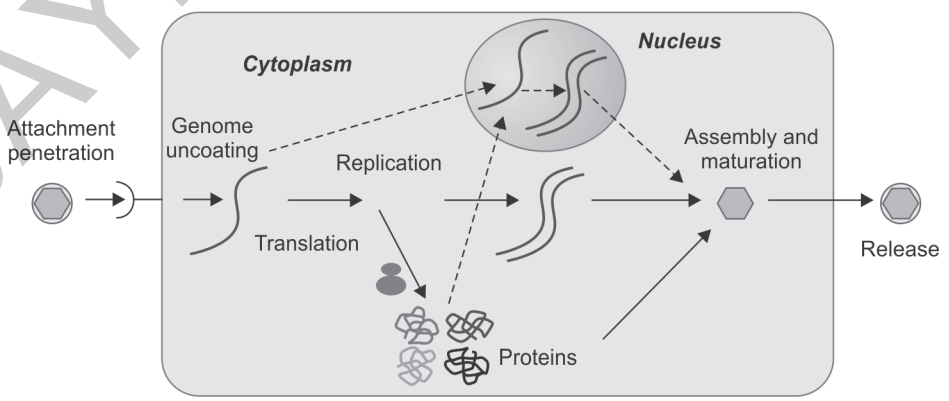

Fig. 3.2: Virus replications.

JAYPEE BROTHERS

1. Attachment (Adsorption)

The virus attaches to specific receptors on the surface of a susceptible host cell. This interaction is highly specific, with viral surface proteins (often glycoproteins in the case of enveloped viruses) recognizing and binding to receptors on the host cell membrane. This is a crucial step because the virus can only infect cells that have the appropriate receptor for the virus.

2. Entry (Penetration)

Once the virus is attached to the host cell, it enters the cell. The mechanism of entry depends on the virus type:

- **Enveloped viruses:** The viral envelope fuses with the host cell membrane, releasing the viral capsid into the cytoplasm.
- **Nonenveloped viruses:** The capsid may undergo conformational changes that allow the virus to be taken up via endocytosis (engulfed by the cell membrane).

3. Uncoating

After entering the host cell, the virus is uncoated, meaning the capsid is removed to release the viral genome (DNA or RNA) into the host cell's cytoplasm or nucleus, depending on the type of virus. This step is essential because the viral genome needs to be exposed in order to replicate and express its genes.

4. Replication and Transcription

The virus now begins to replicate and transcribe its genome using the host cell's machinery:

- **DNA viruses:** Typically, DNA viruses enter the host cell nucleus, where they use the host's enzymes to replicate their genome and transcribe messenger RNA (mRNA). This mRNA is then used to produce viral proteins.
- **RNA viruses:** RNA viruses replicate and transcribe their genome in the cytoplasm. Some RNA viruses (e.g., retroviruses like HIV) carry an enzyme called **reverse transcriptase** to convert their RNA into DNA, which then integrates into the host's genome.

5. Translation (Protein Synthesis)

Viral mRNA is translated by the host cell's ribosomes to produce viral proteins. These proteins include enzymes, structural components of the virus (capsid proteins), and sometimes enzymes necessary for the next steps in replication.

6. Assembly (Maturation)

Newly synthesized viral genomes and viral proteins are assembled into new virus particles (virions) in the cytoplasm or nucleus, depending on the virus. The viral proteins come together to form new capsids, and the viral genome is packaged into these capsids.

7. Budding (Release)

Once assembly is complete, the newly formed virions are released from the host cell to infect new cells. This can occur through:

- **Budding:** For enveloped viruses, the virus acquires its envelope from the host cell membrane during budding. This process allows the virus to exit the cell without immediately killing it, which can enable the virus to infect other cells.

JAYPEE BROTHERS

- **Cell Lysis:** For nonenveloped viruses, the host cell may be destroyed (lysed) as the new virions are released, leading to cell death. This process can damage the tissue and cause symptoms of viral infection.

8. Repeat Cycle

The released viruses go on to infect new cells, repeating the replication cycle. Some viruses may also cause latency, where the virus remains dormant within the host cell for extended periods before becoming active again.

Q6 Rodents.

Ans: Rodents are a group of mammals that belong to the order **Rodentia**, which is the largest order of mammals. Rodents are characterized by their distinctively sharp, chisel-like incisor teeth that grow continuously throughout their lives. These teeth are adapted for gnawing and allow rodents to feed on a wide variety of food sources, particularly plant material.

Key Characteristics of Rodents

- **Teeth structure:** Rodents have four sharp, ever-growing incisors in the upper and lower jaws. These incisors are continuously worn down as they gnaw.
- **Size:** Rodents vary greatly in size, ranging from small species like mice and rats to larger ones like beavers and capybaras.
- **Reproductive rate:** Rodents tend to have high reproductive rates. Many species can reproduce multiple times per year, with some, like mice and rats, having litters of several young at a time.
- **Habitat:** They are adaptable and can live in a variety of environments, including forests, grasslands, urban areas, and even aquatic environments (like beavers).
- **Diet:** Most rodents are herbivores, feeding on seeds, plants, fruits, and roots, though some are omnivores or scavengers.

Rodents and Disease Transmission

Rodents play a significant role in the transmission of diseases to humans, often by acting as **vectors**. Many of these diseases are transmitted either directly (through contact with rodent urine, feces, or saliva) or indirectly (via fleas, ticks, or mites that infest rodents). Some of the most notable diseases associated with rodents include:

- **Plague:** Caused by the bacterium *Yersinia pestis*, which is often spread by fleas that infest rodents, particularly rats. The disease can be transmitted to humans through flea bites or direct contact with infected rodents.
- **Hantavirus:** A virus transmitted through the urine, droppings, or saliva of infected rodents, particularly deer mice. It can lead to severe respiratory illness in humans, such as Hantavirus Pulmonary Syndrome (HPS).
- **Leptospirosis:** Caused by the bacteria *Leptospira*, which can be transmitted through contact with water or soil contaminated by rodent urine.
- **Salmonella:** Rodents can harbor *Salmonella* bacteria, which can be transmitted to humans via contaminated food or surfaces that have come into contact with rodent droppings.
- **Rat-bite fever:** A bacterial infection that can be transmitted through a rat bite or scratch, or through contact with the rodent's urine or feces.

JAYPEE BROTHERS

- **Lymphocytic choriomeningitis virus (LCMV):** Transmitted by the common house mouse, this virus can cause flu-like symptoms and, in severe cases, lead to meningitis.

Rodent Control

Due to their role in disease transmission, controlling rodent populations is crucial in public health. Measures to control rodent infestations include:

- **Sealing entry points** into buildings (like cracks or holes).
- **Sanitation:** Proper disposal of food waste and reducing clutter where rodents may hide.
- **Rodent traps** and **poisons** to reduce the population.
- **Rodent-proofing structures** by using materials like wire mesh to block access to food and shelter.

Rodents are crucial to ecosystems, providing food for predators and playing a role in seed dispersal and soil aeration, but they can pose significant health risks when they invade human living spaces. Understanding their behavior and role in disease transmission helps in managing the risks associated with them.

Q7 Vectors.

Ans: Vectors are organisms, often arthropods (such as insects and ticks), that transmit pathogens (bacteria, viruses, or parasites) from one host to another, thus playing a key role in the spread of infectious diseases. Vectors typically do not cause disease themselves but facilitate the transmission of infectious agents.

Types of Vectors

1. **Biological vectors:** These are organisms that not only transmit pathogens but also play a role in the pathogen's life cycle. The pathogen may undergo some developmental stages or multiplication within the vector before being transmitted to the host. Examples include:
   - *Mosquitoes* (e.g., *Anopheles*, *Aedes*, *Culex* mosquitoes) are biological vectors for diseases like malaria, dengue fever, and Zika virus. The malaria parasite, *Plasmodium*, undergoes part of its life cycle in the mosquito.
   - *Ticks* are biological vectors for diseases such as Lyme disease, Rocky Mountain spotted fever, and babesiosis. The pathogens that cause these diseases (e.g., *Borrelia* spp. for Lyme disease) multiply in the tick before being transmitted to humans.
2. **Mechanical vectors:** These vectors simply carry the pathogen on their body (e.g., legs, mouthparts) and pass it on to a new host without the pathogen undergoing any development or multiplication inside the vector. An example of mechanical vectors includes:
   - *Flies*, particularly houseflies, can mechanically transmit bacteria like *Salmonella* and *Shigella* from contaminated food or surfaces to humans.
   - *Cockroaches* are also mechanical vectors for a variety of bacteria and viruses, spreading them via their body and feces.

Common Disease: Causing Vectors and the Diseases They Transmit

- **Mosquitoes**:
  - *Malaria* (caused by *Plasmodium* species)
  - *Dengue fever* (caused by *Dengue virus*)
  - *Zika virus* (caused by *Zika virus*)
  - *West Nile virus* (caused by *West Nile virus*)

JAYBEE BROTHERS

- **Ticks**:
  - *Lyme disease* (caused by *Borrelia burgdorferi*)
  - *Rocky mountain spotted fever* (caused by *Rickettsia rickettsii*)
  - *Babesiosis* (caused by *Babesia* species)
- **Fleas:**
  - *Plague* (caused by *Yersinia pestis*)
  - *Endemic typhus* (caused by *Rickettsia typhi*)
- **Lice:**
  - *Epidemic typhus* (caused by *Rickettsia prowazekii*)
  - *Trench fever* (caused by *Bartonella quintana*)
- **Triatomine bugs (Kissing bugs):**
  - *Chagas disease* (caused by *Trypanosoma cruzi*)
- **Sandflies:**
  - *Leishmaniasis* (caused by *Leishmania* species)

Characteristics of Vectors

- **Invertebrates:** Most vectors are invertebrates (arthropods), such as insects (mosquitoes, flies, fleas) and arachnids (ticks).
- **Feeding habits:** Vectors typically feed on the blood of hosts, which is how they acquire and transmit the pathogens. For example, mosquitoes and ticks feed on the blood of mammals, while flies feed on decaying organic matter.
- **Host specificity:** Some vectors are highly specific to the type of host they will infect, while others can be more generalized. For example, some mosquito species primarily bite humans, while others may feed on birds or amphibians.
- **Ability to travel:** Many vectors, especially mosquitoes and flies, can travel long distances, which aids in the widespread transmission of diseases. For instance, migratory birds can carry mosquitoes across vast areas, contributing to the spread of West Nile virus.

Transmission Cycle

- **Pathogen acquisition:** The vector becomes infected with the pathogen (e.g., when a mosquito feeds on an infected person or animal).
- **Incubation in vector:** The pathogen may undergo development, reproduction, or maturation within the vector.
- **Transmission to new host:** When the vector feeds on a new host, it transmits the pathogen, initiating infection in the new host.
- **Infection of host:** The pathogen enters the host's bloodstream or tissue and causes disease.

Prevention and Control of Vector-borne Diseases

- **Vector control:** Reducing the number of vectors through insecticides, breeding site elimination, and other methods can decrease the transmission of diseases.
  - *Mosquito nets* (in the case of mosquitoes).
  - *Tick repellents* and *proper clothing.*
  - *Insecticides* to kill adult mosquitoes or larvae.
- **Environmental measures:** Removing standing water (for mosquitoes), managing waste (to avoid attracting rodents that are flea hosts), and eliminating shelter for vectors can reduce the risk of vector-borne diseases.

JAYPEE BROTHERS

- **Personal protection:** Using insect repellent, wearing protective clothing, and taking other precautions can help reduce the likelihood of being bitten by disease-transmitting vectors.
- **Vaccination:** For some vector-borne diseases, vaccines have been developed to prevent infection. For example, the **dengue fever vaccine** is available in some regions, and **malaria vaccines** are under development.

Q8 What are the main differences between vectors and reservoirs in the context of disease transmission?

Ans: *See* **Table 3.6**.

Table 3.6: Differences between vectors and reservoirs in the context of disease transmission.

Aspect	Vector	Reservoir
Definition	Organism that transmits pathogens from one host to another	Organism or environment that harbors and sustains the pathogen
Function	Facilitates the spread of the pathogen to new hosts	Serves as a source and habitat for the pathogen
Examples	Mosquito, tick, flea, lice	Animals (bats, rodents), humans, soil, water
Pathogen's life cycle	Pathogen may undergo part of its life cycle within the vector	Pathogen survives and replicates within the reservoir
Transmission	Actively transmits the pathogen to a new host (e.g., through bites, stings, etc.)	Pathogen persists in the reservoir and may be shed to infect other hosts
Role in disease causation	Does not cause disease directly but is crucial for transmission	Pathogen does not usually cause disease in the reservoir, but the reservoir serves as a continuous source of infection
Transmission mechanism	Pathogen is transferred actively through bites or contact with body parts	Pathogen is shed from the reservoir passively through urine, saliva, feces, etc.
Disease manifestation	The vector itself is not usually affected by the pathogen but may become infected	The pathogen may not cause illness in the reservoir but can cause disease in other hosts

Q9 *Staphylococcus*.

Ans: ***Staphylococcus*** is a genus of bacteria that includes a variety of species, many of which are part of the normal flora of humans and animals but can also cause infections. These bacteria are Gram-positive cocci, meaning they appear purple when stained with the Gram stain and are spherical in shape. *Staphylococcus* species are facultative anaerobes, meaning they can survive in both aerobic and anaerobic environments.

Key Features of *Staphylococcus*

- **Shape:** Spherical (cocci), often appearing in clusters resembling grapes.
- **Gram staining:** Gram-positive.
- **Catalase test:** Positive (they produce the enzyme catalase, which breaks down hydrogen peroxide).
- **Oxidase test:** Negative.
- **Facultative anaerobes:** Can survive with or without oxygen.
- **Nonmotile:** *Staphylococcus* bacteria do not have flagella, so they cannot move by themselves.

JAYPEE BROTHERS

Major Species of *Staphylococcus*

1. Staphylococcus aureus

- The most clinically significant species, associated with a wide range of infections, from minor skin infections to more severe conditions such as **pneumonia**, **sepsis**, **endocarditis**, **osteomyelitis**, and **toxic shock syndrome**.
- Known for producing various virulence factors such as **hemolysins** (which break down red blood cells), **coagulase** (which clots plasma), and **exfoliative toxins** (which cause skin blistering).
- Can be methicillin-resistant (*MRSA*), making infections difficult to treat.

2. Staphylococcus epidermidis

- A part of the normal skin flora, but it is an opportunistic pathogen, especially in immuno-compromised individuals.
- Often associated with infections related to implanted medical devices (e.g., catheters, prosthetic joints).

3. Staphylococcus saprophyticus

Commonly associated with **urinary tract infections**, especially in young sexually active women.

4. Staphylococcus haemolyticus

Part of the normal skin flora but can cause infections in individuals with weakened immune systems.

Virulence Factors

- **Coagulase:** A major virulence factor of *S. aureus*, which promotes clotting and can help the bacteria evade immune detection.
- **Exotoxins:** Several types, including **enterotoxins** (which cause food poisoning) and **toxic shock syndrome toxin** (which causes toxic shock syndrome).
- **Enzymes:** Include **hyaluronidase**, **lipases**, and **nucleases** that help the bacteria spread and degrade host tissues.
- **Protein A:** A surface protein that binds to the Fc region of antibodies, preventing immune cells from recognizing and attacking the bacteria.

Pathogenesis

Staphylococcus species can cause a variety of infections:

- **Skin and soft tissue infections:** *S. aureus* is the most common cause of **boils**, **cellulitis**, and **abscesses**.
- **Respiratory infections:** Includes **pneumonia**, particularly in immunocompromised patients.
- **Bloodstream infections:** Can lead to **bacteremia** or **sepsis**.
- **Bone and joint infections:** *S. aureus* can infect bones and joints, causing **osteomyelitis** and **septic arthritis**.
- **Urinary tract infections:** *S. saprophyticus* is a common cause of UTIs in young women.

JAYPEE BROTHERS

Diagnosis

- **Gram stain:** Shows Gram-positive cocci in clusters.
- **Culture:** Grows on common media like **blood agar**, where it may show golden colonies due to pigment production in *S. aureus*.
- **Coagulase test:** Differentiates *S. aureus* (coagulase-positive) from other staphylococci (coagulase-negative).
- **Antibiotic sensitivity testing:** Important for determining the susceptibility of *S. aureus* to methicillin and other antibiotics, especially for diagnosing methicillin-resistant *Staphylococcus aureus* (MRSA).

Treatment

- **Methicillin-sensitive *Staphylococcus aureus* (MSSA):** Treated with **beta-lactam antibiotics** such as **nafcillin** or **oxacillin**.
- **Methicillin-resistant *Staphylococcus aureus* (MRSA):** Treated with **vancomycin**, **linezolid**, or **clindamycin**, as MRSA is resistant to most beta-lactam antibiotics.
- ***Staphylococcus epidermidis*:** Often resistant to many antibiotics and requires **vancomycin** or **rifampin** in some cases.

Prevention

- **Hand hygiene:** Proper handwashing and hygiene practices are critical, especially in healthcare settings.
- **Wound care:** Proper cleaning and dressing of wounds to prevent infection.
- **Antibiotic stewardship:** To prevent the emergence of resistant strains like MRSA, antibiotics should be used judiciously.

Q 10 *Streptococcus*.

Ans: ***Streptococcus*** is a genus of Gram-positive, spherical (cocci) bacteria that often occur in chains or pairs. These bacteria are facultative anaerobes, meaning they can grow in both the presence or absence of oxygen. Streptococci are commonly found in the human body, where they can be part of the normal flora but also have the potential to cause a variety of infections.

Key Features of *Streptococcus*

- **Shape:** Spherical (cocci), often arranged in chains or pairs.
- **Gram staining:** Gram-positive.
- **Catalase test:** Negative (they do not produce the enzyme catalase).
- **Facultative anaerobes:** Can grow in both aerobic and anaerobic conditions.
- **Nonmotile:** They lack flagella, so they cannot move on their own.

Major Groups of *Streptococcus*

Streptococcus species are classified based on their hemolytic activity (ability to break down red blood cells) and Lancefield grouping (based on cell wall antigens).

1. Hemolysis Classification

- **Alpha-hemolytic streptococci:** Partially break down red blood cells, leading to a greenish discoloration of the surrounding area on blood agar. These include:

JAYPEE BROTHERS

  - *Streptococcus pneumoniae*: A major cause of **pneumonia**, **meningitis**, and **otitis media**.
  - *Streptococcus viridans*: A group of species that are part of the normal flora of the mouth and throat, but can cause **endocarditis**.
- **Beta-hemolytic streptococci:** Completely break down red blood cells, resulting in a clear zone around the bacterial colonies on blood agar. These include:
  - *Group A Streptococcus (GAS): Streptococcus pyogenes*: Known for causing **pharyngitis**, **scarlet fever**, **rheumatic fever**, and **necrotizing fasciitis**.
  - *Group B Streptococcus (GBS): Streptococcus agalactiae*: Often colonizes the genital tract and is a major cause of **neonatal infections**, including **meningitis** and **sepsis**.
- **Gamma-hemolytic streptococci (Nonhemolytic):** Do not break down red blood cells. These include:
  - *Enterococcus species:* Commonly found in the gastrointestinal tract and can cause **urinary tract infections**, **endocarditis**, and **wound infections**.

2. Lancefield Grouping

Streptococci are also classified based on their **Lancefield group**, which is determined by the antigenic differences in their cell wall carbohydrates:

- **Group A:** *Streptococcus pyogenes* (commonly associated with throat infections and skin infections).
- **Group B:** *Streptococcus agalactiae* (commonly associated with neonatal infections).
- **Group C:** Includes *Streptococcus dysgalactiae* and others, which cause infections like **pharyngitis** and **wound infections**.
- **Group D:** Includes ***Enterococcus*** species, typically involved in **urinary tract infections** and **endocarditis**.
- **Group F and G:** Some species that can cause infections, although less commonly.

Virulence Factors

*Streptococcus s*pecies possess a variety of virulence factors that enable them to cause disease:

- **Surface proteins:** Such as **M protein** in *S. pyogenes*, which helps the bacteria evade immune response by inhibiting phagocytosis.
- **Exotoxins:** Including **streptolysins** (toxic to host cells), **pyrogenic exotoxins** (cause fever and shock), and **hyaluronidase** (breaks down tissue).
- **Capsule:** Many species, including *S. pneumoniae*, have a capsule that protects them from being engulfed by immune cells.
- **Adhesins:** Molecules that help the bacteria adhere to host tissues, such as the throat and skin.
- **Enzymes:** *Streptococcus* species produce enzymes like **streptokinase**, which breaks down fibrin and allows the bacteria to spread through tissue.

Pathogenesis

- **Pharyngitis:** *S. pyogenes* is the most common cause of **strep throat**, leading to symptoms like sore throat, fever, and swollen lymph nodes.
- **Scarlet fever:** Caused by *S. pyogenes* producing erythrogenic toxin, leading to a characteristic rash, fever, and red tongue.
- **Rheumatic fever:** A complication of untreated **strep throat**, leading to heart valve damage and arthritis.
- **Necrotizing fasciitis:** A severe, rapidly progressing soft tissue infection caused by *S. pyogenes*.

JAYPEE BROTHERS

for detailed information on nursing books, visit our website www.ejaypee.com, for detailed information on nursing books, visit our website www.ejayp

Nursing Q-Bank Series *For BSc Nursing Students*

Applied Microbiology, Infection Control & Safety

Salient Features

- Covers recent Applied Microbiology, Infection Control & Safety university examination papers.
- Integrates theoretical understanding with practical nursing scenarios.
- Challenges critical thinking skills through varied question formats.
- Includes multiple choice questions (MCQs), short answer, long answer, practice questions.
- Provides clear explanations for each question to reinforce learning.
- Offers questions at different difficulty levels to accommodate student progression.
- Uses visual aids like diagrams and illustrations for better understanding.

Monika Dean MSc(N) (Obstetric and Gynecology), is currently working as Principal, Kailash Institute of Nursing and Paramedical Sciences, Greater Noida, Uttar Pradesh, India. She has done her postgraduation in Obstetrics and Gynecology from Chaudhary Charan Singh University, Meerut, Uttar Pradesh, and graduation from PGI University, Rohtak, Haryana. She has spent around 15 years in the healthcare sector, in teaching as well as in clinical practice. She has published 6 handbooks for auxiliary nurse midwife (ANM) with M/s Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India. She has also conducted an awareness program on COVID-19 for Paramedical Staff from different regions of the country. She is also motivated healthcare professional, public speaker and writer.

Abha Narwal MSc(N) (Community Health Nursing), is currently working as Professor, Shaheed Baba Deep Singh College of Nursing, Fatehabad, Haryana, India. She was born and brought up in Rohtak, Haryana. After completing her schooling in her hometown, she moved to Delhi in 2005 to pursue her BSc in Nursing. After completing her MSc from Bhopal's Barkatullah University, she worked as a Consultant Research Officer with the National Institute of Health and Family Welfare (NIHFW) in New Delhi.

Rachna Khanna MSc(N) (Obstetric and Gynecology), is working as Associate Professor, Kailash Institute of Nursing and Paramedical Sciences, Greater Noida, Uttar Pradesh, India. She has done graduation in Nursing from Guru Nanak College of Nursing, Dhahan Kaleran, Punjab, and postgraduation from Dayanand Medical College and Hospital, Ludhiana, Punjab. She has been teaching Maternal Health Nursing, Child Health Nursing, Nursing Research & Statistics, and Nursing Management and Administration. She has many years of experience in teaching. She has also participated in various national and international conferences and workshops. She has reviewed textbooks of Obstetrics and Gynecology in Nursing.

Nandani Kumari MSc(N) (Medical Surgical Nursing), is Nursing Officer, Vardhman Mahavir Medical College (VMMC) and Safdarjung Hospital, New Delhi, India. She has done her MSc in Surgical Nursing from CCS University and BSc Nursing from Army College of Nursing, Jalandhar, Punjab; Baba Farid University of Health Sciences, Faridkot, Punjab. She has many years of experience in teaching, research, and clinical settings. She is an Ex-Faculty for BSc (Nursing) degree and diploma programs in Metro College of Health Sciences and Research, Greater Noida, Uttar Pradesh. She has published numerous articles in national and international journals and actively participates in various national and international workshops and conferences held by the Indian Nursing Council (INC).

Scan for more nursing titles...

Buy from ejaypee

JAYPEE BROTHERS

ISBN 978-93-6616-353-6

9 789366 163536