ENTRANCE TEST MCQs (UHS)

1. _____ is a triploblastic organism.
   A. Jelly fish B. Tapeworm C. Sea anemone D. Corals
2. In arthropods, the body cavity is in the form of:
   A. Coelom B. Pseudocoelom C. Haemocoel D. Enteron
3. _____ is a good example of polymorphism.
   A. Hydra B. Obelia C. Star fish D. Equpiectella
4. Name common gut roundworm parasite of human and pig:
   A. Ascaris lumbericoides B. Pheretima posthuma
   C. Lumbricus terrestris D. Hirudo medicinalis
5. _____ is also called liver fluke.
   A. Dugesia B. Fasciola C. Taenia D. Coral
6. Taenia is an endoparasite of human, pig and cattle which belongs to phylum:
   A. Cnidaria B. Annelida C. Aschelminthes D. Platyhelminthes
7. Body of _____ consists of segments called proglottids which contain mainly sex rgans.
   A. Planaria B. Acaris C. Liver fluke D. Tapeworm
8. _____ is a common parasite of the intestine of human and pig which belongs to phylum nematoda.
   A. Taenia solium B. Ascaris lumbricoides C. Schistosoma D. Fasciola hepatica
9. In radial symmetry all body parts are arranged around the central axis. Radial symmetry represents _____ mode of life.
   A. Sessile B. Active C. Streamlined D. Parasitic
10. Pseudocoelomates have a body cavity but it is not true coelom. Which one of the following is included in the group?
    A. Planaria B. Earthworm C. Tapeworm D. Ascaris
11. Chitin, a chemical found in exoskeleton of arthropods is also found in cell wall of:
    A. Bacteria B. Cyanobacteria C. Fungi D. Algae
12. Snails are the intermediate hosts in:
    A. Fasciola hepatica B. Schistosoma C. Taenia solium D. Ancylostoma duodenale
13. _____ is an intestinal parasite of man belonging to phylum nematode:
    A. Taenia solium B. Ascaris lumbercoides C. Wuchereria bancrofti D. Schistosoma
14. Following group is the example of acoelomates:
    A. Annelids B. Molluscs C. Ascheminthes D. Platyhelminthes

ANSWERS KEY

1. B	2. C	3. B	4. A	5. B	6. D	7. D	8. B	9. A	10. D	11. C	12. A	13. B	14. D

Chapter 02 BACTERIA AND VIRUSES

Student Learning Outcomes (SLOs)

After studying this chapter, the students will be able to:

- Draw an annotated diagram of a generalized bacterial cell.
- Describe detailed structure and chemical composition of bacterial cell wall and other coverings.
- Justify the endospore formation in bacteria to withstand unfavourable conditions.
- Explain motility in bacteria.
- Describe with diagram structure of bacterial flagellum.
- Describe bacteria as recyclers of nature.
- Outline the ecological and economic importance of bacteria.
- Explain the use of bacteria in research and technology.
- Define the term normal flora.
- Describe the benefits of the bacterial flora of humans.
- Describe the structure of a model bacteriophage, and HIV.

- We know that over the years many schemes have been proposed for classifying organisms into kingdoms.

Reason of Recommendation of Robert H. Whittaker's Classification in Biology:

- We have studied in chapter 1, the five kingdom classification system, proposed by **Robert H. Whittaker**, is recommended in biology. This system classified the organisms in a comprehensive way that reflects evolutionary history of organisms.
- According to this classification system, all prokaryotes are included in a separate kingdom i.e., **the kingdom Monera.**

Recalling

- Robert H. Whittaker proposed the five-kingdoms of life i.e., Monera, Protista, Fungi, Plantae, and Animalia. The first one includes prokaryotes and the other four include eukaryotes.

Flaws in Five Kingdom System:

- In the last decade, molecular studies have **highlighted serious flaws** in the five kingdom classification system.
- We have also studied in **chapter 1**, most biologists favour replacing it with a new system, called **three-domain system**, which is more aligned with the data gained from **molecular studies**.
- We know that bacteria are the **prokaryotes** classified in the domain of **their own**, i.e., the domain Bacteria.
- In this chapter we will study detailed **structure of bacterial cell.** We will also study the **importance of bacteria.**

STRUCTURE OF BACTERIA

- **Diverse Group + Lack Membranous Organelles:** Bacteria are a **diverse group** and all of them have **unicellular prokaryotic organization,** which lack membrane bounded **organelles,** including a well-defined **nucleus.** They have the simplest cellular organization.

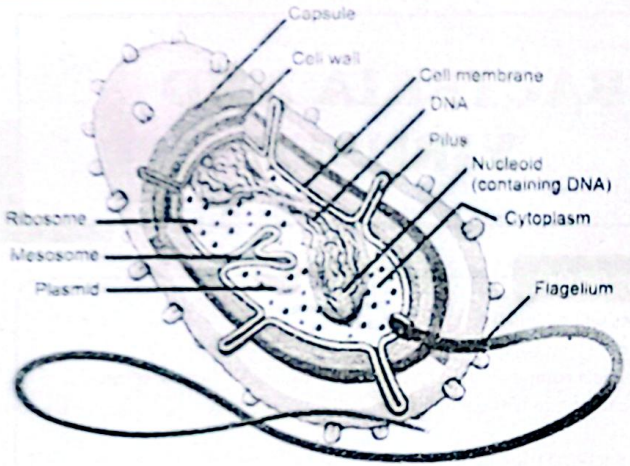

Figure: Structure of a generalized bacterium

Check Understanding!

1. Which feature best explains the higher resistance of Gram-negative bacteria to antibiotics?
A) Presence of thick peptidoglycan
B) Absence of teichoic acid
C) Outer membrane with lipopolysaccharides
D) Lack of nucleoid

(1) Cell Wall:

- **Rigid in Nature:** It is a rigid wall around the plasma membrane of bacterial cell.
- **Have Peptidoglycan:** The major component of bacterial cell wall is a unique macromolecule, called peptidoglycan or murein. **Peptidoglycan** is composed of **long glycan (polysaccharide) chain,** cross-linked with short peptide **fragments** (Figure). Its amount differs in different bacteria.
- **Have Lipids:** Cell wall also contains lipids, which are **linked** to peptidoglycan.

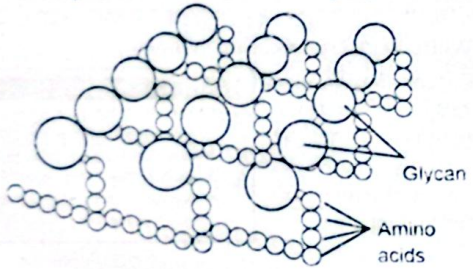

Figure: The molecular model of peptidoglycan

Gram Staining Technique

- Sir Hans Christian Gram devised the technique of Gram's staining. Gram-positive bacteria stain purple because they retain violet dye.
- Gram-negative bacteria do not retain violet dye and so they appear in original colour.

- **Differences in Cell Wall Composition Between Gram Positive & Gram Negative Bacteria:** The composition of cell wall is quite different in **Gram-positive** and **Gram-negative bacteria.**
- **Gram Positive Bacteria: Thick layer of peptidoglycan:** The cell wall of **Gram-positive bacteria** contains thick layer of peptidoglycan and has less lipid content.
- **Gram Negative Bacteria:** The cell wall of **Gram-negative** bacteria has an outer membrane made of lipopolysaccharides and lipoproteins.
- The outer membrane makes **Gram-negative** bacteria resistant to many antibiotics. It contains a protein called porin, which acts like a pore for specific molecules.
- **Thin Layer of Peptidoglycan:** While the cell wall of **Gram-negative** bacteria has a thin layer of peptidoglycan.
- The cell wall of **Gram-negative** bacteria has more **periplasmic** space (space between peptidoglycan layer and cell membrane) than Gram-positive.

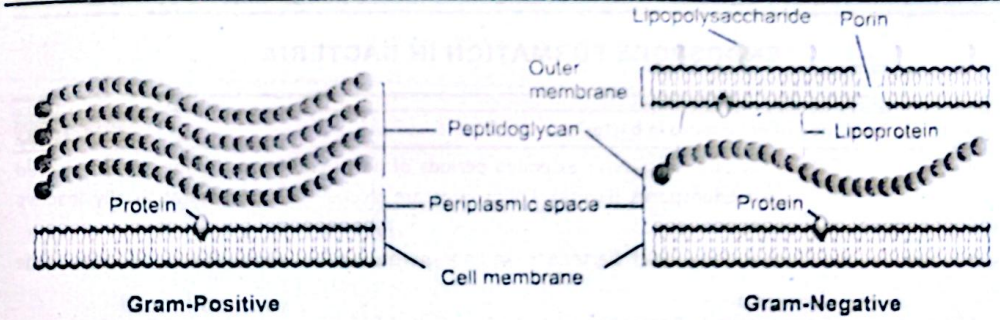

Figure: Cell wall composition of Gram-positive and Gram-negative bacteria

(2) Capsule:

- Some bacteria produce capsule outside their cell walls.
- **Use of Capsule:** It is a gelatinous layer and gives sticky characters to bacterial colonies.

(3) Cell Membrane:

- Cell membrane or plasma membrane is present just **beneath** cell wall.
- It lies at the outermost in bacteria that lack cell wall (e.g., ***Mycoplasmas and Sarcoplasma***).
- **Have No Sterols:** The cell membrane of bacteria does not have sterols (e.g., cholesterol) in its chemical makeup.
- **Form Mesosomes:** At some points, cell membrane invaginates and forms **vesicles, tubules** or **lamellae** in cytoplasm. These structures are known as mesosomes.
- **Uses of Mesosomes:** These are involved in DNA replication and cell division and also serve as respiratory centres.

Check Understanding!

2. How does the structure and organization of the nucleoid reflect the efficiency of bacterial genetic regulation compared to eukaryotes?

(4) Cytoplasm and Genetic Material:

- **Lack membranous Organelles:** Cytoplasm contains dissolved substances and large structures such as nucleoid, ribosomes, and mesosomes. It lacks cytoskeleton and membrane-bounded organelles.
- **Freely Dispersed Ribosomes:** Many ribosomes are freely dispersed in **cytoplasmic** matrix and some are loosely attached to plasma membrane.
- **70S Ribosomes:** Bacterial ribosomes are smaller than eukaryotic ribosomes. Each ribosome sediments at 70S (larger subunit at 50S and smaller subunit at 30S).
- **Nucleoid:** Near the centre of **cytoplasm**, there is an irregular-shaped dense area i.e., nucleoid. It contains DNA.
- **Have DNA + No Histone:** A bacterium possesses a single, circular, double stranded DNA. Bacterial DNA does not have attached histones. It is sometimes called the chromosome of **bacterium**.
- **Plasmids:** Some bacteria have circular, double-stranded extra chromosomal DNA molecules, called plasmids. They are **self-replicating** and can replicate before or after division.
- **Use of Plasmids:** They contain genes that enable bacteria for resistance against unfavourable conditions (e.g., antibiotics).

Importance of Plasmids

- Plasmids also serve as important vectors, in genetic engineering.
- They are used to carry selected genes to bacteria for cloning or for the synthesis of specific proteins.

ENDOSPORE FORMATION IN BACTERIA

Q. State the formation of endospore in bacteria. (Exercise L.Q.)

- **Endospore:** Many bacteria can survive extended periods of harsh conditions by forming specialized "resting" cells, called **endospores** (Figure). Endospores are thick-walled and **metabolically** inactive (dormant) form of **spore**.
- **Sporulation:** The process by which bacteria make endospores, is called sporulation. It happens in the following way:

➢ **Mechanism of Sporulation In Bacteria:**

- **DNA Replicates:** When a bacterium faces unfavourable conditions, it replicates its DNA.
- **Formation of Septum:** Cell membrane makes a septum to isolate the new DNA and a small portion of cytoplasm.
- Cell membrane again grows around the new DNA, cytoplasm, and septum. In this way, the new DNA is surrounded by two membranes.
- **Cell Loses Water:** The DNA of vegetative cell disintegrates and whole cell begins to dehydrate.
- **Formation of New Layer of Peptidoglycan:** A new peptidoglycan layer forms between the membranes around separated DNA and cytoplasm.
- **Formation of Coat:** A spore coat also forms around it. The structure matures into endospore.
- **Breakage of Vegetative Cell:** The vegetative cell breaks and endospore is released.
- Endospore remains dormant unless favourable conditions return. Under favourable conditions, endospore germinates to give rise to a new vegetative cell.

Check Understanding!

3. What distinguishes sliding movement from other bacterial motility forms like gliding or twitching?
A) Requires flagella
B) Passive spreading powered by growth
C) Driven by ATP hydrolysis
D) Requires pili

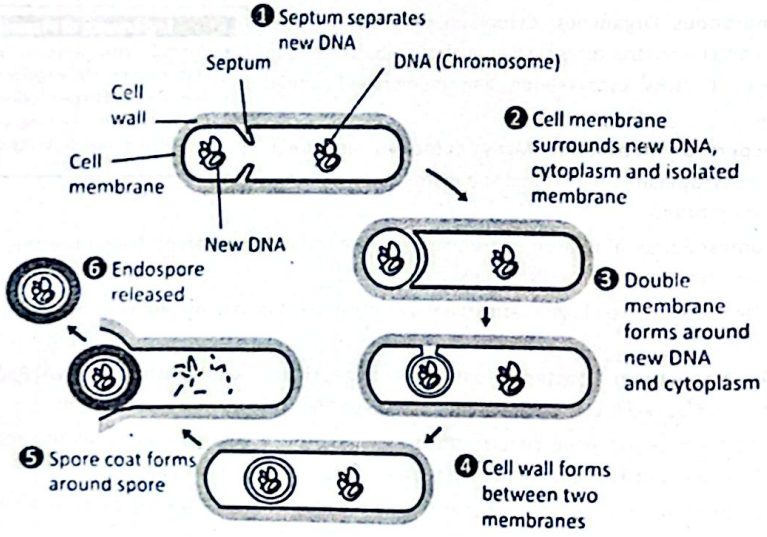

Figure: Process of endospore formation (sporulation) in bacteria

MOTILITY IN BACTERIA

Q. Explain different methods of movement in bacteria. (Exercise L.Q.2)

Bacteria use different motility patterns to navigate and explore natural habitats.

i. **Flagellar Movements:**
   - Most **bacilli and spirilla** bacteria move by means of flagella. They swim by using their flagella.
   - **Swarming:** When a bacterial population moves together by means of flagella, the movement is called **swarming**. Flagellar movement allows **bacteria to travel** in liquid media.
   - Counter clockwise rotation of flagellum pushes the cell forward with the flagellum trailing behind.

ii. **Twitching or crawling:**
   - It is used to move **over surfaces**. It is mediated by pili, which bind to surrounding solid surface and retract. Thus, bacterial cell is pulled forward.

iii. **Gliding:**
   - It is similar to twitching. In gliding, bacteria secrete slimy substance, which help them for smooth gliding over solid surfaces.

iv. **Sliding:**
   - It is due to the **expansion** created by the pushing force of dividing cells.

v. **Brownian movement:**
   - Some bacteria (e.g., *Streptococcus*) that do not have flagella or pili, move due to the random and uncontrolled movements of the particles present in fluid.

vi. **Movement by Axial Filament:**
   - Some bacteria (e.g., *spirochaetes*), have a **modified flagellum.** It is known as axial filament. It is anchored at one end and runs length-wise in periplasmic space (between cell membrane and outer membrane).
   - It consists of **two sets of flagella-like** fibrils anchored at the two poles of cell. It helps spirochaetes for flexing, swimming, creeping and spinning movements.

Check Understanding!

4. How does the structure of the bacterial flagellum facilitate its rotary movement and enable chemotaxis?

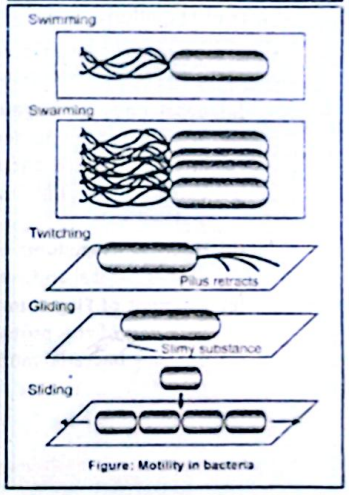

Figure: Motility in bacteria

Figure: Axial filament in a spirochaete

FLAGELLA

- The structures which enable bacteria to move are called Flagella.
- **Secondary Function of Flagella:** The secondary function of flagella is to detect and respond to chemical signals.

➢ **Types of Bacteria on the Basis of Flagella:**

i. **Atrichous:** The bacteria which **do not** possess flagella are called atrichous.

ii. **Monotrichous:** The bacteria with **single polar** flagellum are called monotrichous.

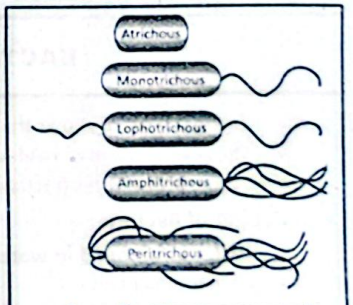

Figure: The different arrangements of bacterial flagella

iii. **Lophotrichous:** The bacteria with a **tuft of** flagella at one pole are called lophotrichous.
iv. **Amphitrichous:** The bacteria with **flagella** at each of two poles are called amphitrichous.
v. **Peritrichous:** The bacteria with **flagella** surrounding the whole cell are called peritrichous (Figure).

Q.3 Explain the structure of bacterium flagellum. [Exercise L.Q. 3]

Structure of Flagellum:

- The flagellum of bacteria is entirely different in structure from the flagellum of eukaryotes.
- They are not built on **9 + 2 pattern** of microtubules, but are composed of flagellin protein.

Parts of Flagellum:

- The bacterial flagellum consists of:
  (a) Basal body (b) Hook (c) Filament

(a) Basal Body of Flagellum: The basal body is present just beneath cell membrane. It consists of rotating rings (one pair in Gram-positive bacteria and two pairs in Gram-negative bacteria). The rings anchor the **flagellum** in cell membrane and cell wall.

(b) Hook of Flagellum: The hook is a curved structure that connects basal body with the filament.

(c) Filament of Flagellum: The filament of a bacterial flagellum is a long, helical structure composed primarily of the protein flagellum. It extends from the cell surface and functions as a propeller, enabling bacterial motility by rotating like a corkscrew.

Pili

- Some bacteria have pili (singular, pilus). These are non-helical filamentous appendages and are smaller and thinner than flagella.
- **Uses of Pili:** Pili are used for attachment of bacteria to various surfaces. They are also involved in the mating process (conjugation) between cells.

Check Understanding!

5. Which type of bacteria has flagella all over its body?
A) Monotrichous B) Atrichous
C) Peritrichous D) Amphitrichous

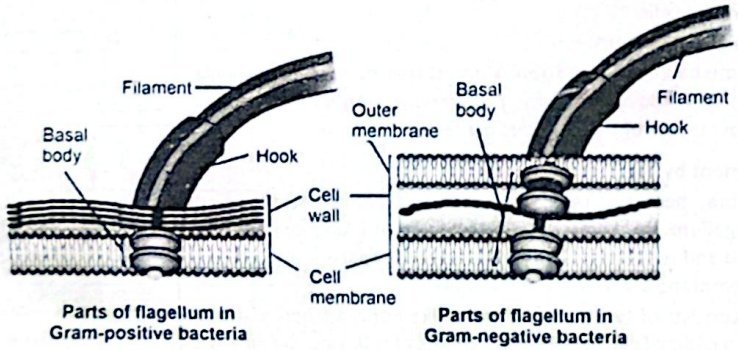

Figure : The structure of bacterial flagella

BACTERIA; ECOLOGY AND DIVERSITY

- *The fossil record shows that* **prokaryotes** *i.e., archaea and bacteria were abundant* **3.5 billion years ago.**
- *They evolved and remained all alone on Earth for the next* **2 billion years.**
- *Today, prokaryotes (archaea and bacteria) are found wherever there is life.*

Habitat of Bacteria:

- *Bacteria are found in* **water, air, soil,** *food and in the bodies of animals and plants.*
- *They out number all eukaryotes. They can survive in* **extreme** *habitats.*

Do You Know

- Perhaps most interesting of all is the recent discovery that the bulk of our modern petroleum deposits were formed by masses of decayed cyanobacteria.

Diversity in Bacteria and Their Ecology:

- **Margulis and Schwartz** proposed a useful classification system for all prokaryotes. They classified them into 16 phyla.

Check Understanding!

6. Why is Mycoplasma considered unique among bacteria?

Important Groups of Domain of Bacteria:

The following discussion deals with the important groups of the **Domain Bacteria** (Figure).

(i) Omnibacteria:

- These are **rigid,** rod-shaped, heterotrophic, Gram-negative bacteria.
- **Pathogenic:** Many important pathogens are included in this group.
- Most of these bacteria **have flagella.** They do not produce spores.
- **Aerobic:** They are usually **aerobic.** *Escherichia coli* is an example of such bacteria. This group also includes vibrios.

(ii) Cyanobacteria:

- **Photosynthetic:** These are photosynthetic bacteria. They played most important role in the history of the Earth for increasing **free oxygen** in atmosphere.
- They contain **chlorophyll-a** and accessory pigments like carotenoids, and blue and red phycobilins.
- **Fix Nitrogen:** Many cyanobacteria fix atmospheric nitrogen in their special cells called **heterocysts.**
- They are common in soil in the form of mats. Cyanobacteria containing lichens are found on rock surfaces.
- The mats on the sediments in the sea are **dominated** by cyanobacteria.

Bloom of Cyanobacteria

- Colourful blooms may occur in polluted water as a result of the rampant growth of cyanobacteria.
- The colours of such blooms result from the photosynthetic pigments of cyanobacteria.

(iii) Mycoplasmas and Spiroplasmas:

- **Lack Cell Walls + Resistant Against Antibiotics:** These groups **differ from all other** bacteria in that they lack cell walls. As they lack cell walls, they are resistant to penicillin and other antibiotics that work by inhibiting cell wall growth.
- **Cause Diseases:** Some mycoplasmas cause diseases in mammals e.g., certain types of pneumonia in humans.
- **Plant Diseases:** Spiroplasmas cause significant plant diseases e.g., the lethal yellowing disease of coconuts.

(iv) Spirochaetes:

- These are long spirilla with **Gram-negative** cell walls.
- They may have 2 to more than **100 flagella.**
- Treponema are important **spirochaetes.**
- They cause **syphilis** (a fatal sexually transmitted disease).

(v) Pseudomonads:

- These are straight or curved **Gram-negative** rods with one or many flagella at one end.
- They are found in soil and water.
- They can easily break down organic compounds.
- **Autotrophic + Parasitic:** Some of them are autotrophic but many are plant pathogens. Some of them play role in denitrification. *Pseudomonas aeruginosa* occurs in soil, water and raw vegetables. Although it is usually harmless, it can form serious infections in weak people.

(vi) Actinomycetes:

- These have filamentous growth forms.
- They produce spores that are resistant to unfavourable conditions.

Figure: Major groups of bacteria

- Some actinomycetes are nitrogen fixers and are found in the root nodules of many flowering plants.
- **Cause Diseases:** Some actinomycetes are responsible for dental plaque, in which the enamel of teeth is destroyed. A member of this group i.e., *Mycobacterium leprae* causes leprosy.
- **Cause T.B.:** Another member i.e., *Mycobacterium tuberculosisis* the cause of tuberculosis.
- **Source of Antibiotics:** Many antibiotics e.g., tetracycline, chloramphenicol, erythromycin, and neomycin were derived originally from actinomycetes.

(vii) Nitrogen-Fixing Aerobic Bacteria:

- This group includes economically important bacteria.
- They are Gram negative and most are flagellated.
- Azotobacteris a member of this group.
- It is found in soil and water and converts atmospheric nitrogen into nitrates.

- About 150 new antibiotics from actinomycetes are being discovered each year.

(viii) Chemosynthetic Bacteria:

- These bacteria derive energy from the oxidation of inorganic compounds of nitrogen, **sulphur and iron**.
- They use this energy for the synthesis of their food.
- **Examples:** Nitrosomonas and Nitrobacter are included in this group.

Check Understanding!

7. Which type of bacteria is responsible for producing natural antibiotics?

A) Cyanobacteria B) Actinomycetes
C) Spirochetes D) Mycoplasma

- **Involve in N_2 Cycle:** They oxidize nitrogen compounds (NH_3) to gain energy. The NH_3 is in turn converted to nitrite and nitrate. Thus, they play vital role in **nitrogen cycle**.

Table: Characteristics of some Groups of Bacteria

Name of Group	Form	Motility	Nutrition	Ecological role
i. Omnibacteria	R	N, F	H	• Pathogens and decomposers
ii. Cyanobacteria	R, C, M	G, N	P	• Carbon and nitrogen fixers
iii. Mycoplasmas and Spiroplasmas	No wall	N	H	• Pathogens
iv. Spirochaetes	S	F	H	• Decomposers and pathogens
v. Pseudomonads	R	F	H, C	• Decomposers and plant pathogens
vi. Actinomycetes	M, R	N	H	• Pathogens and nitrogen fixers
vii. N-fixing aerobes	R	N, F	H	• Free-living and mutualistic nitrogen fixers
viii. Chemosynthetic	R, C	N, F	C	• Oxidize nitrogen and sulphur compounds, play role in nitrogen cycle

- **Form:** R, rods (bacilli); C, cocci; S, spirilla; M, regular chains or aggregations
- **Motility:** F , flagellated; N , non-motile; G , gliding
- **Nutrition:** H, heterotrophic; C, chemosynthetic; P, photosynthetic

IMPORTANCE OF BACTERIA

Q. Briefly describe the ecological and economic importance of bacteria. (Exercise L.Q.5)

- Bacteria are very important organisms not only for environment but also for all other organisms. They have beneficial as well as **harmful effects on life on Earth.**

➲ Beneficial Bacteria:

Among the great diversity of bacteria, many bacteria are **beneficial** ecologically as well as economically.

(i) Recyclers of Nature:

- Bacteria are involved in almost all biogeochemical cycles in which different essential elements move to and fro between organisms and environment.
- **Nitrifying Bacteria** (Nitrosomonas, Nitrobacter and Azotobacter) and **denitrifying bacteria** (Pseudomona) play significant role in the completion of nitrogen cycle.
- **Decomposer Bacteria** decompose dead organic matter and play key role in carbon-hydrogen-oxygen cycle.
- The activities of photosynthetic bacteria e.g., cyanobacteria play role in the increase of free oxygen in Earth's atmosphere.

(ii) Makers of Useful Products:

- **Making in Wine + Yogurt + Cheese etc.** Many bacteria e.g., Lactobacillus in combination with yeasts and molds, have been used for thousands of years in the preparation of fermented foods such as cheese, pickles, soy sauce, vinegar, wine and yogurt.
- **Use in Industries:** In pharmaceutical and agrochemical industry, bacteria are most important in the production of important chemicals.
- **Antibiotic Production:** Some bacteria are used for the production of antibiotics.
- Commercial preparation of animals' skin for making **leather goods,** involves the use of bacteria.

Check Understanding!

8. How do bacteria contribute to the food industry through fermentation, and what implications does this have for food preservation and flavor?

(iii) Environmental Cleaners:

- Many bacteria can degrade organic compounds very easily. Such bacteria have been used for the removal or degradation of **pollutants** (bioremediation) from environment. For example, bacteria are used to decompose city sewage into harmless products.
- **Digest Hydrocarbons:** Some bacteria can digest the hydrocarbons present in petroleum. These bacteria are used to clean up oil spills.
- Bacteria are also used for the **bioremediation** of industrial toxic wastes.

(iv) Biopesticides:

- Bacteria are used in the place of **pesticides** in biological pest control. This commonly involves Bacillus thuringiensis, a Gram-positive, soil dwelling bacterium.
- These biopesticides are environmentally friendly and have little or no effect on humans, wildlife, pollinators and most other beneficial insects.

Q. Explain the use of bacteria in research and technology. (Exercise L.Q.6)

(v) Research and Technology Tools:

- Bacteria can grow quickly and scientists can manipulate with them very easily. Due to these reasons, bacteria are used in the fields of molecular **biology, genetics** and **biochemistry**.
- Scientists make mutations in bacterial DNA and examine the changes in characteristics. In this way, they determine the function of genes and enzymes in bacteria. This knowledge is then applied to study the same genes and enzymes in more complex organisms.
- **Proteins Synthesis:** Scientists also insert human genes in bacteria and produce **therapeutic proteins** e.g., insulin, growth hormones, or antibodies.

NORMAL FLORA

Q. Define the term normal flora. State the benefits which we get from normal bacterial flora. (Exercise L.Q.7)

- **Definition:** The mixture of organisms regularly found at any anatomical site is referred to as the normal flora.
- In a healthy animal, the internal tissues, e.g., blood, brain, muscle, etc., are normally free of microorganisms. On the other hand, the surface tissues, e.g., skin and mucous membranes, are constantly in contact with environment and are colonized by certain microbial species.

➢ **Components of Normal Flora:**

- The normal flora of humans consists of:
  (a) Bacteria (b) A few fungi (c) Protists (d) Some methanogenic archaea
- Bacteria are the most **numerous** and obvious microbial components of normal flora.

➲ Benefits of Bacterial Flora of Humans:

- **Mutualistic For Human:** The associations between humans and their normal flora are mutualistic.
- **Bacteria Get Protection From Human:** In human body, normal flora gets nutrients, a stable environment and constant temperature, protection, and transport. Similarly, body also gets many benefits from normal bacteria; for example:

Check Understanding!
9. Which of the following is a key benefit of human gut microbiota?
A) They cause common cold.
B) They synthesize vitamin K.
C) They invade red blood cells.
D) They digest proteins into amino acids.

i. Synthesis of Vitamins for Human Body:
- Bacteria in alimentary canal produce vitamins.
- They excrete vitamins which are in **excess** of their needs.
- From alimentary canal, these vitamins are absorbed and distributed in body.
- **Example:** Enteric bacteria secrete **Vitamin K and Vitamin B12**, and lactic acid bacteria produce certain **B-vitamins**.

ii. Prevent Colonization by Pathogens:
- The bacteria of normal flora compete with pathogens for attachment sites and nutrients.
- So, pathogens have less chance of entering body tissues.

iii. Inhibit or Kill Pathogens:
- The intestinal bacteria produce a variety of substances, which inhibit or kill pathogen bacteria.

iv. Stimulates the Production of Cross-reactive Antibodies:
- Since the normal flora behaves as antigens, they induce immunological response.
- Low levels of antibodies produced against the normal flora are known to cross-react with certain pathogens, and thereby prevent infection or invasion.

VIRUS

- We are familiar with the **five kingdoms** of living organisms.
- We also know that there are **some** creatures that do not possess **cellular organization** yet show some characteristics of livings. Viruses are the representatives of such organisms.

➲ Structure of Virus

- **Extremely Smaller in Size:** Viruses are extremely small infectious agents and can only be seen under electron microscope.
- **Average Size Range:** They range in size from **20 nm** (parvovirus) to **250 nm** (pox viruses). They are 10 to 1000 times smaller than most bacteria. That is why, they can pass through the pores of filter paper.
- **Genome:** The central core of a virus is its genome. It is made up of nucleic acid (either DNA or RNA).
- **Capsid:** The core is surrounded by a protein coat, **called capsid**. It gives definite shape to virus.
- **Capsomeres:** Capsid is made up of protein subunits called as **capsomeres.**

- **Herpes virus** (causes cold sores, chickenpox etc.) contains **162** capsomeres in its capsid.
- **Adenovirus** (causes common cold) contains 252 capsomeres in its capsid.

➢ **Importance of Capsomere:**

- The number and kind of capsomeres is characteristic of a particular virus.

- **Nucleocapsid:** Central core and capsid are collectively called as nucleocapsid.
- **Envelop:** In some animal viruses only, nucleocapsid is covered by another membrane called envelope. It is a lipid-rich membrane and is derived from host cell.
- **Naked Virus:** Non enveloped viruses are known as naked-viruses.
- There is a great diversity in the general appearance of viruses (Figure).
- **Shape of Plant + Animal Virus:** The animal and plant viruses may be **polyhedron** (having many sides) or helical.
- **Shape of Bacterial Virus:** The **bacterial viruses (bacteriophages)** may be **cubical, icosahedral** (having 20 faces), helical, or complex (polyhedral head and rod-shaped tail).

Check Understanding!
10. What is the significance of capsomeres in viral structure and infection?

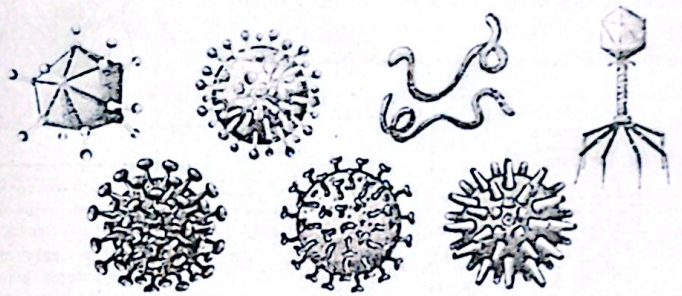

Figure: Diversity in viruses' shapes

Q. Explain the structure of a model bacteriophage and HIV. [Exercise Q.4.]

➢ **Structure of Bacteriophage:**

- **Most Complex:** Bacteriophages are a diverse group of viruses that attack bacteria. They are among the most complex **viruses.**
- The best known phages of ***Escherichia coli*** are T-phages. There are many varieties of T-phages.

➢ **Structure of T4-Phage:**

A T4 phage consists of **(a) Head (b) Tail (Figure)**

(a) Head:
- The head is an **elongated pyramidal** (with two triangles having a common base), **hexagonal** (six sided), prism-shaped structure.
- Its capsid is made of proteins while core contains a long double stranded DNA.

(b) Tail:
- A straight tail is attached with head.
- The tail is also made of **inner core** and outer sheath, both of which are made of different proteins.
- A neck attaches sheath with head and an end plate is present on the other side of sheath. Six tail fibres are attached with end plate.
- They help the phage to attach with bacterial wall.
- These structures are also made of proteins.

- **Bacteriophage & its Uses:** Bacteriophages are used as carriers in genetic engineering.
- The gene of interest is inserted into the DNA of bacteriophage, which carries it to the target bacterial cell.
- When virus incorporates its DNA into bacterial chromosome, the gene of interest also becomes a part of bacterial DNA.
- **Such transgenic bacteria** (transgenic: whose genome has DNA of some other organism) can be grown to get copies of the gene of interest and to get the required protein.

Check Understanding!
11. What is the function of the tail sheath in T4 phage?
A) Replicates DNA
B) Injects viral DNA into host
C) Produces enzymes
D) Synthesizes capsomeres

➢ **Structure of HIV:**

- **Retrovirus:** Human Immunodeficiency Virus (HIV) belongs to the group **called retroviruses.** It is a special group of animal viruses.

- **Have RNA + Capsid:** Retroviruses contain RNA and their capsids. These structures are surrounded by lipid rich envelops.
- **Have Envelope:** The envelope also comprising glycoproteins spikes, which help the virus identify and bind to its target.
- **Shape + Diameter:** They are spherical in form and are about **100 nm** in diameter.
- **Unique Character (Have Reverse Transcriptase Enzyme):** The most distinguishing character of retroviruses is the presence of a **specific enzyme**, reverse transcriptase. This enzyme catalyses the process of reverse transcription in which a single **stranded** RNA is reversely transcribed into a strand of DNA.
- The enzyme then uses DNA strand to complete a double helix of DNA.

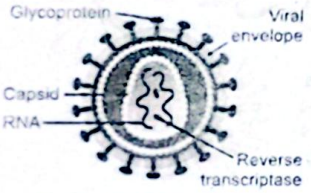

Figure: Structure of HIV

- **Cause AIDS:** HIV is responsible for the disease AIDS (acquired immunodeficiency syndrome).
- AIDS weakens the immune system of patient.
- The disease is fatal because no one can survive without immune system to defend against other viral and bacterial infections.
- **First Reports About AIDS:** The disease was **first reported** in 1981 and the patients were found homosexual. Later on, AIDS was discovered in **non-homosexual** patients too who had received blood or blood products from other AIDS patients.
- **Discovery of AIDS-Virus (HIV):** In 1984, it was discovered that the agent **causing AIDS** was a virus. In 1986, the AIDS causing virus was given the name Human Immunodeficiency Virus (HIV).
- It is a host specific virus. It can multiply in monkeys but do not cause AIDS in them.

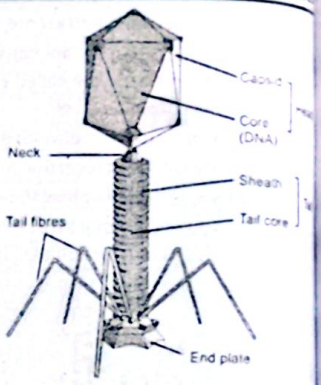

Figure: Structure of a bacteriophage (T4 phage)

- Experts have concluded that HIV originated in the jungles of Africa among wild chimps.
- Evidence suggests that a form of this virus entered human species and became HIV by way of monkey bites or ingesting monkey meat and brains.

Check Understanding!

12. What structural features make HIV highly infectious?

Check Understanding (Solutions)

Sr. #	Option	Explanation
1.	C	• The outer membrane of Gram-negative bacteria contains lipopolysaccharides that act as a barrier to many antibiotics, making them more resistant.
2.	S.Q	• The nucleoid is not membrane-bound and consists of a single circular DNA molecule compacted with proteins. • This arrangement allows rapid transcription and translation as both processes occur simultaneously. • It enables efficient genetic regulation and faster adaptation to environmental changes compared to eukaryotic cells where DNA is separated in the nucleus.
3.	B	• Sliding is a passive movement driven by cell growth and surface interactions without active energy input or motor structures.
4.	S.Q	• The bacterial flagellum is anchored by a basal body functioning as a rotary motor. • Proton motive force drives its rotation, allowing directional movement. • Switching between clockwise and counter clockwise rotation enables chemotaxis.

		• Bacteria move toward or away from chemical gradients by adjusting flagellar rotation.
5.	C	• Peritrichous bacteria have many flagella around the cell, allowing them to move in different directions.
6.	S.Q	• Mycoplasma lacks a cell wall, making it resistant to antibiotics like penicillin. • It has a flexible, pleomorphic shape and survives in osmotically protected environments. • This trait makes it one of the smallest and simplest self-replicating organisms.
7.	B	• Actinomycetes produce antibiotics like streptomycin and erythromycin.
8.	S.Q	• Bacteria like Lactobacillus ferment sugars in dairy and vegetables, producing lactic acid. • This preserves food by lowering pH and enhancing taste (e.g., yogurt, cheese, sauerkraut). • Fermentation also increases shelf life and may improve gut health.
9.	B	• Gut bacteria, especially in the colon, help produce vitamin K which is essential for blood clotting.
10.	S.Q	• Capsomeres are protein subunits that make up the viral capsid. • They protect the viral genetic material from enzymatic degradation. • Some capsomeres aid in host cell recognition and attachment.
11.	B	• The sheath contracts to inject viral DNA into the bacterial cytoplasm.
12.	S.Q	• HIV has glycoproteins (gp120, gp41) for CD4 receptor binding. • Contains two RNA molecules and reverse transcriptase. • The capsid and matrix proteins aid in infectivity and stability.

Exercise

Exercise — MULTIPLE CHOICE QUESTIONS (MCQs) — Section 01

1. **Which of the following component is not found in all kinds of bacteria?**
(a) Ribosomes (b) Cell membrane (c) Nucleoid (d) Capsule
2. **The bacterial chromosome is typically:**
(a) Linear, double-stranded DNA (b) Circular, single-stranded RNA
(c) Circular, double-stranded DNA (d) Linear, single-stranded DNA
3. **In bacterial cells, respiration occurs at:**
(a) Mitochondria (b) Cell membrane (c) Ribosomes (d) Endoplasmic reticulum
4. **Which group of bacteria is known as a good source of antibiotics?**
(a) Omnibacteria (b) Spirochaetes (c) Pseudomonads (d) Actinomycetes
5. **What is the primary function of flagella in bacterial cells?**
(a) DNA replication (b) Cell division (c) Motility (d) Protein synthesis
6. **Which type of motility in bacteria is mediated by pili?**
(a) Brownian movement (b) Gliding motility (c) Twitching motility (d) Swarming motility
7. **Which of the following bacterial structures is responsible for detecting and responding to chemicals?**
(a) Capsule (b) Pili (b) Flagella (d) Ribosomes
8. **Which one of the following are not Nitrifying bacteria?**
(a) Nitrosomonas (b) Nitrobacter (c) Azotobacter (d) Pseudomonas
9. **The enzyme responsible for converting HIV RNA into DNA is:**
(a) RNA polymerase (b) Reverse transcriptase (c) DNA helicase (d) Integrase
10. **The HIV capsid contains:**
(a) Single-stranded DNA and reverse transcriptase (b) Single-stranded RNA and reverse transcriptase
(c) Double-stranded DNA and integrase (d) Double-stranded RNA and RNA polymerase

Answer Key with Explanations

Sr.No.	Option		Explanations
1.	(d)	Capsule	• Capsule is an outer covering present in some bacteria, not all, optional, unlike ribosomes, membrane, or nucleoid.
2.	(c)	Circular, double-stranded DNA	• Most bacteria have a single, circular, double-stranded DNA molec as their genetic material.
3.	(b)	Cell membrane	• Bacteria lack mitochondria, so respiratory enzymes are located in infoldings of the cell membrane.
4.	(d)	Actinomycetes	• Actinomycetes, like Streptomyces, produce many antibiotics used medicine.
5.	(c)	Motility	• Flagella help bacteria move toward or away from stimuli through process called chemotaxis.
6.	(c)	Twitching motility	• Pili help in a type of movement called twitching, where the cell jerc forward using pilus extension and retraction.
7.	(b)	Pili	• Pili are involved in sensing the environment and initiating response such as attachment and motility.
8.	(d)	Pseudomonas	• Pseudomonas are denitrifying bacteria; they convert nitrates nitrogen gas, not nitrites to nitrates.
9.	(b)	Reverse transcriptase	• Reverse transcriptase synthesizes DNA from viral RNA, a key step HIV replication.
10.	(b)	Single-stranded RNA and reverse transcriptase	• HIV is a retrovirus with single-stranded RNA and reverse transcriptas inside its capsid to initiate infection.

SHORT ANSWER QUESTIONS

Q.1 Write about the structural components of a bacterial cell wall and their arrangement.

Ans. Structural Components of a Bacterial Cell Wall and Their Arrangement:

- The bacterial cell wall is composed of several layers, including the peptidoglycan layer, outer membra (in Gram-negative bacteria), and teichoic acids (in Gram-positive bacteria).
- The peptidoglycan layer provides structural support and maintains the cell's shape.
- The outer membrane contains lipopolysaccharides and porins, which regulate the passage of molecu
- The arrangement of these components varies between Gram-positive and Gram-negative bacteria.

Q.2 Write the composition of the peptidoglycan layer in bacterial cell walls.

Ans. Composition of the Peptidoglycan Layer:

- The peptidoglycan layer is composed of glycan chains cross-linked by peptide bonds.
- The glycan chains are made up of N-acetylglucosamine and N-acetylmuramic acid.
- The peptide bonds are formed between the amino acids of adjacent glycan chains.
- The peptidoglycan layer provides structural support and maintains the cell's shape.

Q.3 What are mesosomes? What are their functions?

Ans. Mesosomes:

- Mesosomes are **invaginations** of the bacterial cell membrane.
- They are thought to be involved in cellular processes such as DNA replication and cell division.
- Mesosomes may also play a role in the formation of **septa during** cell division.
- However, their exact function is still debated.

Q.4 How can plasmids be used in genetic engineering?

Ans. Use of Plasmid in Genetic Engineering:

- Plasmids are small, **self-replicating** circular DNA molecules that can be used as vectors in genetic engineering.
- They can be engineered to carry **foreign genes**, allowing for the expression of new traits.
- Plasmids can be introduced into bacterial cells through transformation.
- They are commonly used in **biotechnology** applications.

Q.5 Define sporulation.

Ans. Sporulation:

- Sporulation is the process by which certain bacteria, such as Bacillus and Clostridium, form highly resistant spores.
- Spores are formed through a complex process involving the engulfment of the bacterial cell by a septum.
- Spores are highly resistant to heat, desiccation, and other environmental stresses.
- They can remain dormant for extended periods.

Q.6 What is the function of the bacterial capsule?

Ans. Function of the Bacterial Capsule:

- The bacterial capsule is a layer of polysaccharides or proteins that surrounds the cell.
- It provides protection against desiccation, phagocytosis, and other environmental stresses.
- The capsule can also play a role in virulence and adherence to surfaces.
- It is a key virulence factor in many pathogenic bacteria.

Q.7 Write the role of pili in bacterial cells. How do they differ from flagella?

Ans. Role of Pili in Bacterial Cells:

- Pili are hair-like appendages that protrude from the bacterial cell surface.
- They play a role in attachment to surfaces, DNA transfer, and motility.

Differences From Flagella:

- Pili are distinct from flagella, which are involved in **motility.**
- Pili are typically shorter and more **rigid** than flagella.

Q.8 What are plasmids, and how do they contribute to enabling bacteria to resistance against unfavourable conditions?

Ans. Plasmids:

- Plasmids are small, **self-replicating** circular DNA molecules that can carry genes conferring resistance to antibiotics or other stresses.
- They can be transferred between bacterial cells through conjugation.

Antibiotic Resistance Genes:

- Plasmids often carry genes that produce enzymes or proteins capable of breaking down antibiotics or pumping them out of the cell.
- This enables bacteria to survive in environments with high antibiotic concentrations.

Toxin Production:

- Some plasmids encode genes for toxins that damage host tissues or inhibit competing microorganisms, increasing the bacterium's chance of survival under hostile conditions.

Heavy Metal Resistance:

- Plasmids can carry genes that allow bacteria to resist toxic metals like mercury or arsenic by converting them into less harmful forms or actively expelling them from the cell.

Q.9 Write about the role of endospores in bacterial survival.

Ans. Role of Endospores in Bacterial Survival:

- Endospores are highly resistant structures formed by certain bacteria.
- They provide protection against extreme temperatures, desiccation, and other environmental stresses.
- Endospores can remain dormant for extended periods, allowing bacteria to survive in hostile environments.
- They are a key factor in the survival of bacteria such as *Bacillus* and *Clostridium*.

Q.10 What is the significance of lipopolysaccharides and lipoproteins in Gram-negative bacteria?

Ans. Significance of Lipopolysaccharides and Lipoproteins in Gram-negative Bacteria:

- Lipopolysaccharides and lipoproteins are components of the outer membrane of Gram-negative bacteria.
- They play a role in the structural integrity of the outer membrane.
- Lipopolysaccharides can also act as endotoxins, eliciting a strong immune response in hosts.
- They are a key virulence factor in many Gram-negative pathogens.

Q.11 How do spirochetes achieve motility?

Ans. Mobility of Spirochetes Achieve Motility:

- Spirochetes achieve motility through the rotation of their axial filaments.
- Axial filaments are internal flagella that run along the length of the cell.
- The rotation of the axial filaments causes the cell to move in a corkscrew-like motion.
- This unique form of motility allows spirochetes to move through viscous environments.

Q.12 Differentiate between twitching and gliding movements in bacterial motility.

Ans.

Twitching	Gliding
• Relies on "type IV pili", which extend, attach to surfaces, and retract to pull the bacterium forward in a jerky motion. • Short, jerky, and intermittent movements over solid surfaces (e.g., "Pseudomonas aeruginosa").	• Involves "secreted slime", motor proteins, or specialized adhesion complexes that enable smooth, continuous movement along surfaces without flagella or pili. • Smooth, wave-like, and directional movement, often used for spreading colonies or hunting prey (e.g., Myxococcus xanthus or Cytophaga species).

Q.13 How do bacteria without flagella achieve motility?

Ans. Bacterial Motility without Flagella:

- Some bacteria without flagella achieve motility through **gliding or twitching** movements.
- **Gliding Motility:** It involves the movement of the cell along a surface without the use of flagella.
- **Twitching motility:** It involves the use of type IV pili to pull the cell forward.
- **Other mechanisms**, such as the use of appendages or changes in cell shape, can also contribute to motility in bacteria without flagella.

Q.14 What is the difference between swimming motility and swarming motility in bacteria?

Ans.

Swimming Motility	Swarming Motility
• Swimming motility refers to the movement of individual bacterial cells through a liquid environment. • The distinction between swimming and swarming motility lies in the behavior of the cells and the environment in which they are moving.	• Swarming motility, on the other hand, involves the coordinated movement of a group of bacterial cells across a surface. • Swarming motility is often associated with the formation of a complex community or biofilm.

Exercise — LONG ANSWER QUESTIONS — Section 03

Q.1 Compare and contrast the cell wall of Gram-positive and Gram-negative bacteria.

Ans. Gram-Positive vs. Gram-Negative Bacteria:

Similarities in Cell Walls	Differences in Cell Walls
i. **Peptidoglycan Presence:** Both have peptidoglycan as the main structural component of the cell wall. ii. **Protective Function:** In both, the cell wall provides protection against osmotic pressure and mechanical damage. iii. **Shape Maintenance:** The cell walls of both types help maintain the characteristic shape of the bacterium. iv. **Anchoring Site:** Both cell walls serve as sites for anchoring important surface molecules or appendages like pili or flagella.	i. **Peptidoglycan Thickness:** Gram-positive bacteria have a thick peptidoglycan layer. Gram-negative bacteria have a much thinner peptidoglycan layer. ii. **Outer Membrane:** Present only in Gram-negative bacteria, absent in Gram-positive. iii. **Teichoic Acids:** Present in Gram-positive cell walls. Absent in Gram-negative cell walls. iv. **Lipopolysaccharide (LPS):** Found in the outer membrane of Gram-negative bacteria. Absent in Gram-positive bacteria.

Q.2 Explain different methods of movement in bacteria.

Ans. **See Page No. (44,45)**

Q.3 Explain the structure of bacterium flagellum.

Ans. **See Page No. (46)**

Q.4 State the formation of endospore in bacteria.

Ans. **See Page No. (43)**

Q.5 Briefly describe the ecological and economic importance of bacteria.

Ans. **See Page No. (49)**

Q.6 Explain the use of bacteria in research and technology.

Ans. **See Page No. (50)**

Q.7 Define the term normal flora. State the benefits which we get from normal bacterial flora.

Ans. **See Page No. (50)**

Q.8 Explain the structure of a model bacteriophage and HIV.

Ans. **See Page No. (52)**

Exercise — INQUISITIVE ANSWER QUESTIONS

Q.1 Why do bacteria have ribosomes even though they do not have membrane-bound organelles?

Ans. Presence of Ribosomes in Bacteria:

- Although bacteria are prokaryotic and lack membrane-bound organelles like mitochondria or endoplasmic reticulum, they still contain ribosomes because protein synthesis is essential for their survival.

Function and Structure:

- Bacterial ribosomes are 70S in size, smaller than eukaryotic 80S ribosomes, and are not enclosed by membranes.
- They float freely in the cytoplasm and translate mRNA into proteins required for growth, replication, and metabolic functions.

Logical Reason:

- Ribosomes are not membrane-bound and therefore can exist in both prokaryotic and eukaryotic cells.
- Since proteins are vital for all cellular processes, even simple cells like bacteria must have ribosomes.

Conclusion:

- Bacteria possess ribosomes despite lacking other organelles because ribosomes are essential, membranous structures needed to produce proteins necessary for life.

Q.2 If bacteria do not have mitochondria, how do they generate energy for survival?

Ans. Energy Production in Bacteria:

- Although bacteria lack mitochondria, they still produce energy efficiently through cellular respir and fermentation processes that occur in their cytoplasm and cell membrane.

Site of Energy Generation:

- In bacteria, the plasma membrane functions like the inner mitochondrial membrane of eukaryote contains electron transport chains (ETC) and enzymes that help generate ATP through chemiosmos

Reason:

- Bacteria have evolved to carry out aerobic or anaerobic respiration using enzymes embedded in plasma membrane. These mechanisms allow them to produce ATP without mitochondria.

Q.3 Why do certain bacteria exhibit twitching motility using pili instead of flagella?

Ans. Role of Pili in Bacterial Motility:

- Some bacteria use pili—short, hair-like projections—for a special type of movement called twitch motility, which helps them move across surfaces in response to environmental changes.

Reason for Using Pili:

- Pili allow bacteria to attach to surfaces and then pull themselves forward by extending and retract the pili.
- This enables movement in moist environments, especially where flagella may be ineffective.

Environmental Advantage:

- Using pili for motility helps bacteria colonize host tissues, form biofilms, or move toward nutrient solid or semi-solid environments, giving them a survival advantage.

Conclusion:

- Bacteria use pili for motility in certain conditions because they provide surface-based movem enabling them to adapt, survive, and thrive in diverse environments.

Q.4 Give reasons in favour of the statement "Prevention is better than cure" and present your argument the class.

Ans. Why "Preventing Sickness is Better than Curing It":

i. **Saves money:** Vaccines/check-ups cost less than treating serious illnesses.
ii. **Less pain:** Avoid getting sick (e.g., eating healthy stops diabetes).
iii. **Stops spread:** Vaccines protect many people (like stopping flu outbreaks).
iv. **Helps hospitals:** Fewer patients means better care for emergencies.
v. **Find problems early:** Tests catch diseases sooner (like cancer).
vi. **Teaches good habits:** Exercise, clean habits keep you healthy.
vii. **Stronger community:** Healthy people work, study, and help others better.
viii. **Fixes causes:** Prevents problems instead of just treating them later.

Q.5 Correlate the social and cultural values of a country with the prevalence (spread) of AIDS.

Ans. Relation of Social and Cultural Values of a Country with the Prevalence (Spread) of AIDS:

i. **Fear and Shame:** In some cultures, people feel ashamed of AIDS, so they avoid getting tested or treat which spreads the disease.
ii. **Traditions and Habits:** Certain cultural practices, like having many partners or not using protection increase the risk of AIDS.
iii. **Lack of Knowledge:** If people are not taught about AIDS and how it spreads, they may unknow engage in risky behaviors.
iv. **Religious Believes:** Some religions may limit open talks about sex and AIDS, which makes it harder spread awareness and prevention methods.

ADDITIONAL MCQs

Q.1 Which of the following best justifies the recommendation of Robert H. Whittaker's classification in modern biology?

A. It included cellular and acellular organisms together.
B. It grouped organisms based on physical similarities only.
C. It reflected evolutionary relationships using molecular data.
D. It classified organisms to represent evolutionary history.

Q.2 Which feature made the five-kingdom classification less favored in modern taxonomy?

A. It separated plants and fungi clearly.
B. It grouped all prokaryotes under one kingdom.
C. It introduced the concept of domains.
D. It used both molecular and morphological traits.

Q.3 Why is the three-domain system considered superior to the five-kingdom system?

A. It does not rely on molecular data.
B. It merges all prokaryotes into a single group.
C. It includes viruses as a separate domain.
D. It reflects molecular-level differences among prokaryotes.

Q.4 Which of the following is NOT a component of the generalized bacterial cell wall?

A. Peptidoglycan
B. Lipopolysaccharide
C. Cellulose
D. Teichoic acid

Q.5 What is the most logical reason bacteria can endure harsh conditions through endospore formation?

A. They replicate quickly.
B. They reduce their metabolic activity.
C. They increase nutrient uptake.
D. They become genetically modified.

Q.6 What distinguishes bacterial flagellum from that of eukaryotic cells?

A. It is composed of microtubules.
B. It rotates like a propeller.
C. It uses ATP directly.
D. It is involved in DNA replication.

Q.7 Which function best supports the role of bacteria as "recyclers" in nature?

A. Causing diseases in humans
B. Nitrogen fixation and decomposition
C. Producing antibiotics
D. Enhancing photosynthesis in plants

Q.8 Which role of bacteria contributes most to the balance of natural ecosystems?

A. Causing infections
B. Producing toxins
C. Decomposing organic matter
D. Infecting viruses

Q.9 Which feature of bacteria has made them highly useful in genetic engineering?

A. Their slow reproduction
B. Their small size
C. Presence of plasmids
D. Absence of DNA

Q.10 Which of the following is TRUE about the term "normal flora"?

A. It only includes pathogenic bacteria.
B. It refers to bacteria that harm the host.
C. It refers to bacteria beneficial to the host.
D. It refers to algae in the gut.

Q.11 How does the bacterial flora benefit the human digestive system?

A. By causing inflammation
B. By aiding nutrient absorption and vitamin synthe
C. By blocking absorption of nutrients
D. By converting sugar into alcohol

Q.12 Which of the following best differentiates a bacteriophage from HIV?

A. Both infect human cells.
B. Bacteriophage has RNA as genetic material.
C. Bacteriophage infects bacteria; HIV infects human T-cells.
D. HIV is a non-infectious virus.

Q.13 Which of the following correctly identifies the domain to which prokaryotic bacteria belong, according to modern classification systems?

A. Kingdom Monera B. Domain Archaea C. Domain Bacteria D. Kingdom Protista

Q.14 The major criticism of the five-kingdom classification system arose due to:

A. Lack of morphological data
B. Inability to classify plants accurately
C. Molecular studies highlighting evolutionary differences
D. Too much dependence on fossil records

ANSWER KEY

1. D	2. B	3. D	4. C	5. B	6. B	7. B	8. C	9. C	10. C	11. B	12. C	13. C	14. C

ADDITIONAL SHORT ANSWER QUESTIONS

Q.1 Why did Whittaker classify organisms into five kingdoms instead of using older systems?

Ans. Classification Whittaker:

- Whittaker classified organisms into five kingdoms to reflect fundamental differences in cell structure, mode of nutrition, and body organization.
- This system provided a more natural and evolutionary-based grouping.

Q.2 What was a major limitation of Whittakers five-kingdom classification?

Ans. Limitation of Whittakers five-kingdom Classification:

- The five-kingdom system grouped all prokaryotes into one kingdom, Monera, without recognizing the major genetic and biochemical differences between Archaea and Bacteria.

Q.3 Why is the three-domain system considered superior to the five-kingdom system?

Ans. Three-domain System Superior than Five-kingdom System:

- The three-domain system, based on molecular data like rRNA sequencing, separates organisms into Bacteria, Archaea, and Eukarya, offering a more accurate representation of evolutionary relationships.

Q.4 How did molecular studies influence modern classification systems?

Ans. Molecular Studies Influence Modern Classification Systems:

- Molecular studies revealed significant genetic differences between groups previously thought to be similar, leading to a shift from morphology-based to gene-based classification systems.

Q.5 How does the structural composition of Gram-positive and Gram-negative bacterial cell walls influence their susceptibility to antibiotics?

Ans. Effect of Bacterial Cell Walls on Susceptibility of antibiotics:

- Gram-positive bacteria have a thick peptidoglycan layer that retains crystal violet stain and is more susceptible to antibiotics like penicillin.
- Gram-negative bacteria have a thin peptidoglycan layer and an outer membrane containing lipopolysaccharides, which provide extra protection and reduce antibiotic entry.

Q.6 Why is the bacterial cell membrane considered functionally equivalent to eukaryotic organelles?

Ans. Bacterial Cell Membrane Equivalent to Eukaryotic Organelles:

- The bacterial cell membrane is involved in vital processes such as respiration, transport, and biosynthesis.
- It contains enzymes and protein complexes that perform functions similar to mitochondria and endoplasmic reticulum in eukaryotic cells.

Q.7 Compare twitching and gliding motility in terms of surface interaction and molecular machinery.

Ans.

- Twitching involves type IV pili that extend, adhere, and retract to pull the cell.
- Gliding uses focal adhesion sites or secreted slime for smooth surface movement.
- Both need surface contact but differ in motility mechanisms and protein complexes.
- Twitching is more abrupt; gliding is continuous and energy-dependent.

Q.8 What is the function of the hook in the bacterial flagellum?

Ans. Function Of The Hook In The Bacterial Flagellum:

- The hook connects the filament to the basal body.
- It acts as a flexible joint, helping to transfer rotation from the motor to the filament.
- This allows the flagellum to move in a curved motion for swimming.

Q.9 How do monotrichous and peritrichous bacteria differ in their movement?

Ans.

- **Monotrichous Bacteria:** Which have one flagellum and usually move in a straight line.
- **Peritrichous Bacteria:** Which have many flagella all around and can tumble and change direction.
- This helps them move better in complex environments.

Q.10 What makes cyanobacteria unique among prokaryotes in terms of their role in ecosystems?

Ans. Uniqueness of Cyanobacteria:

- Cyanobacteria perform oxygenic photosynthesis using chlorophyll-a.
- They contribute significantly to oxygen production and nitrogen fixation.
- They are important primary producers in aquatic ecosystems.

Q.11 How do actinomycetes contribute to both medicine and soil health?

Ans. Importance of Actinomycetes:

- They decompose organic matter, enhancing soil fertility.
- Actinomycetes produce antibiotics like streptomycin.
- Their structure helps them colonize soil and maintain ecological balance.

Q.12 Why are nitrogen-fixing bacteria essential in agriculture?

Ans. Importance of Nitrogen–fixing Bactria in Agriculture:

- They convert atmospheric nitrogen into ammonia.
- These bacteria form symbiotic associations with legumes.
- Their role reduces dependence on chemical fertilizers.

Q.13 What distinguishes chemosynthetic bacteria from photosynthetic bacteria?

Ans. Chemosynthetic Bacteria vs Photosynthetic Bacteria:

- Chemosynthetic bacteria gain energy by oxidizing inorganic compounds.
- They do not require sunlight, unlike photosynthetic organisms.
- Found in extreme habitats like deep-sea hydrothermal vents.

Q.14 Why are certain bacteria considered essential tools in scientific research and biotechnology?

Ans. Bacteria as Essential Tools in Scientific Research and Biotechnology:

- Escherichia coli is used as a model organism for genetic engineering due to its rapid growth and well known genome.
- Bacteria can be engineered to produce insulin, vaccines, and enzymes.
- Their simple structure makes them ideal for controlled lab studies.

Q.15 How does the normal flora of the human body prevent colonization by pathogens?

Ans. Importance of Normal Flora in Human Body:

- Competes with pathogens for nutrients and space.
- Produces antimicrobial substances like bacteriocins.
- Maintains pH and immune system balance, limiting pathogen growth.

Q.16 In what way do intestinal bacteria contribute to vitamin production in humans?

Ans. Importance of Intestinal Bacteria:

- Intestinal flora synthesize vitamins like vitamin K and some B-complex vitamins.
- These are absorbed by the host and essential for metabolic functions.
- Antibiotic use may disrupt this process, leading to deficiencies.

Q.17 How does the head and tail structure of a T4 bacteriophage help in infection?

Ans. Importance of Head and Tail of T4 in Infection:

- The head stores viral DNA.
- The tail attaches to the bacterial surface using tail fibers.
- The contractile sheath injects DNA into the host like a syringe.

SELF-ASSESSMENT Chapter # 02

Total Mark: 30

Q.1 Encircle the correct option. (1 x 6 = 06)

i. **Which of the following component is not found in all kinds of bacteria?**
(a) Ribosomes (b) Cell membrane (c) Nucleoid (d) Capsule

ii. **In bacterial cells, respiration occurs at:**
(a) Mitochondria (b) Cell membrane (c) Ribosomes (d) Endoplasmic reticulum

iii. **What is the primary function of flagella in bacterial cells?**
(a) DNA replication (b) Cell division (c) Motility (d) Protein synthesis

iv. **Which type of motility in bacteria is mediated by pili?**
(a) Brownian movement (b) Gliding motility (c) Twitching motility (d) Swarming motility

v. **Which of the following bacterial structures is responsible for detecting and responding to chemicals?**
(a) Capsule (b) Pili (b) Flagella (d) Ribosomes

vi. **The enzyme responsible for converting HIV RNA into DNA is:**
(a) RNA polymerase (b) Reverse transcriptase (c) DNA helicase (d) Integrase

Q.2 Write short answers of the following questions. (2 x 8 = 16)

i. Write the composition of the peptidoglycan layer in bacterial cell walls.
ii. How can plasmids be used in genetic engineering?
iii. What is the function of the bacterial capsule?
iv. What are plasmids, and how do they contribute to enabling bacteria to resistance against unfavourable conditions?
v. What is the significance of lipopolysaccharides and lipoproteins in Gram-negative bacteria?
vi. Differentiate between twitching and gliding movements in bacterial motility.
vii. How do monotrichous and peritrichous bacteria differ in their movement?
viii. Why are nitrogen-fixing bacteria essential in agriculture?

Q.3 Extensive Questions. (4 x 2 = 8)

(a) Briefly describe the ecological and economic importance of bacteria.
(b) Explain the structure of a model bacteriophage and HIV.