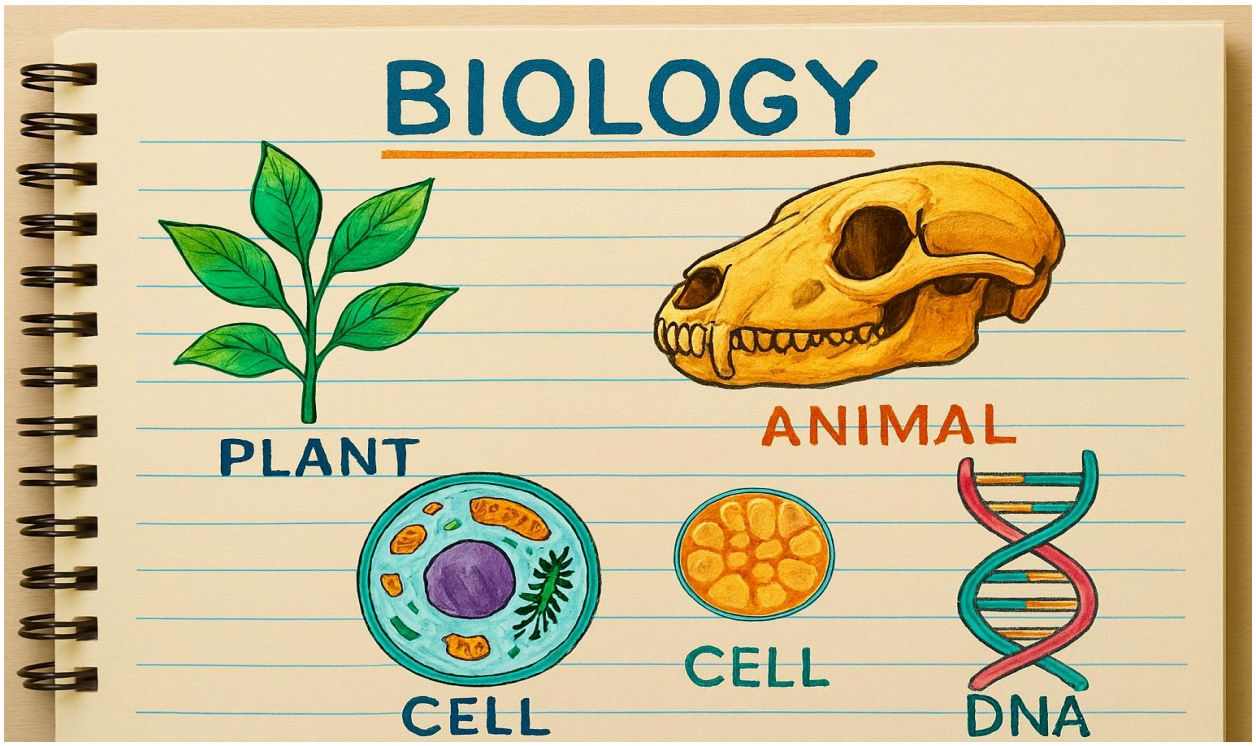


Class: 11th

Subject: Biology

Chapter 2: Bacteria and Viruses

❖ Important Mcqs:

1. The five-kingdom classification system was proposed by:

(a) Carl Linnaeus

(b) Charles Darwin

(c) Robert H. Whittaker ✅

(d) Ernst Haeckel

2. In the five-kingdom system, all prokaryotes are placed in:

(a) Protista

(b) Fungi

(c) Monera ✅

(d) Plantae

3. The three-domain system is based mainly on:

(a) Morphology

(b) Molecular studies ✅

(c) Nutrition

(d) Habitat

4. Bacteria belong to which domain?

(a) Archaea

(b) Eukarya

(c) Protista

(d) Bacteria ✅

5. Bacteria are:

(a) Multicellular eukaryotes

(b) Unicellular prokaryotes ✅

(c) Multicellular prokaryotes

(d) Acellular organisms

6. Bacterial cells lack:

(a) Cell membrane

(b) Ribosomes

(c) Membrane-bound organelles ✅

(d) Cytoplasm

7. The main component of bacterial cell wall is:

(a) Cellulose

(b) Chitin

(c) Peptidoglycan ✅

(d) Glycogen

8. Peptidoglycan is also called:

(a) Keratin

(b) Murein ✅

(c) Collagen

(d) Elastin

9. Gram-positive bacteria have:

(a) Thin peptidoglycan layer

(b) Thick peptidoglycan layer ✅

(c) No cell wall

(d) More lipids

10. Gram-negative bacteria possess an outer membrane made of:

(a) Cellulose

(b) Lipopolysaccharides ✅

(c) Chitin

(d) Sterols

11. Porin protein is found in:

(a) Gram-positive bacteria

(b) Gram-negative bacteria ✅

(c) Fungi

(d) Viruses

12. The outer membrane makes Gram-negative bacteria:

(a) Sensitive to antibiotics

(b) Resistant to many antibiotics ✅

(c) Unable to divide

(d) Larger in size

13. Capsule in bacteria is:

(a) Protein layer

(b) Gelatinous outer layer ✅

(c) DNA layer

(d) Lipid bilayer

14. Bacterial cell membrane lacks:

(a) Proteins

(b) Phospholipids

(c) Sterols (cholesterol) ✅

(d) Enzymes

15. Mesosomes are involved in:

(a) Photosynthesis

(b) DNA replication and respiration ✅

(c) Protein synthesis

(d) Excretion

16. Bacterial ribosomes are:

(a) 80S

(b) 60S

(c) 70S ✅

(d) 90S

17. The larger subunit of bacterial ribosome is:

(a) 30S

(b) 40S

(c) 50S ✅

(d) 60S

18. The genetic material in bacteria is present in:

(a) Nucleus

(b) Nucleolus

(c) Nucleoid ✅

(d) Centrosome

19. Bacterial DNA is:

(a) Linear and attached with histones

(b) Circular and without histones ✅

(c) Double nucleus

(d) Single-stranded RNA

20. Extra-chromosomal DNA in bacteria is called:

(a) Chromatin

(b) Plasmid ✅

(c) Mesosome

(d) Capsule

21. Endospores are formed by bacteria to survive:

(a) Favourable conditions

(b) High nutrients

(c) Harsh conditions ✅

(d) Rapid growth

22. Endospores are:

(a) Thin-walled and active

(b) Thick-walled and dormant ✅

(c) Motile structures

(d) Reproductive cells

23. The process of endospore formation is called:

(a) Germination

(b) Binary fission

(c) Sporulation ✅

(d) Conjugation

24. During sporulation, the bacterium first:

(a) Breaks its cell wall

(b) Replicates its DNA ✅

(c) Forms flagella

(d) Releases toxins

25. In endospore formation, the cell membrane forms a:

(a) Capsule

(b) Septum ✅

(c) Plasmid

(d) Ribosome

26. A new peptidoglycan layer forms:

(a) Outside the capsule

(b) Between the two membranes around DNA ✅

(c) Inside ribosomes

(d) In cytoplasm only

27. The vegetative cell breaks to:

(a) Divide

(b) Release endospore ✅

(c) Form plasmid

(d) Absorb nutrients

28. Endospore germinates when:

(a) Conditions are harsh

(b) Temperature decreases

(c) Conditions become favourable ✅

(d) Water is absent

29. Movement of bacteria using flagella in liquid media is called:

(a) Sliding

(b) Swimming ✅

(c) Twitching

(d) Brownian movement

30. Collective movement of bacteria by flagella is called:

(a) Gliding

(b) Swarming ✅

(c) Sliding

(d) Crawling

31. Twitching motility is mediated by:

(a) Flagella

(b) Axial filament

(c) Pili ✅

(d) Capsule

32. Gliding motility involves secretion of:

(a) Enzymes

(b) Slimy substance ✅

(c) DNA

(d) Toxins

33. Sliding movement in bacteria occurs due to:

(a) Flagella rotation

(b) Expansion caused by dividing cells ✅

(c) Pili contraction

(d) Axial filament

34. Brownian movement in bacteria is:

(a) Controlled movement

(b) Due to flagella

(c) Random and uncontrolled movement in fluid ✅

(d) Caused by pili

35. Axial filament is found in:

(a) Bacilli

(b) Cocci

(c) Spirochaetes ✅

(d) Vibrio

36. Bacteria that do not possess flagella are called:

(a) Monotrichous

(b) Amphitrichous

(c) Atrichous ✅

(d) Peritrichous

37. Bacteria having a single polar flagellum are called:

(a) Lophotrichous

(b) Monotrichous ✅

(c) Peritrichous

(d) Atrichous

38. Bacteria with flagella surrounding the whole cell are called:

(a) Amphitrichous

(b) Lophotrichous

(c) Peritrichous ✅

(d) Monotrichous

39. The bacterial flagellum is mainly composed of:

(a) Tubulin

(b) Peptidoglycan

(c) Flagellin protein ✅

(d) Cellulose

40. The basal body of Gram-negative bacteria consists of:

(a) One pair of rings

(b) Two pairs of rings ✅

(c) No rings

(d) Three pairs of rings

41. Prokaryotes were abundant on Earth about:

(a) 1 billion years ago

(b) 2 billion years ago

(c) 3.5 billion years ago ✅

(d) 5 billion years ago

42. Prokaryotes remained alone on Earth for about:

(a) 1 billion years

(b) 2 billion years ✅

(c) 3 billion years

(d) 4 billion years

43. Bacteria are found in:

(a) Water only

(b) Soil only

(c) Bodies of animals only

(d) Water, air, soil and living bodies ✅

44. Omnibacteria are mostly:

(a) Gram-positive cocci

(b) Gram-negative rods ✅

(c) Spiral-shaped bacteria

(d) Wall-less bacteria

45. An example of Omnibacteria is:

(a) Nitrosomonas

(b) Treponema

(c) Escherichia coli ✅

(d) Azotobacter

46. Cyanobacteria are:

(a) Heterotrophic

(b) Photosynthetic bacteria ✅

(c) Parasitic only

(d) Non-pigmented

47. Cyanobacteria fix atmospheric nitrogen in special cells called:

(a) Heterocysts ✅

(b) Plasmids

(c) Mesosomes

(d) Spores

48. Mycoplasmas are resistant to penicillin because they:

(a) Have thick capsules

(b) Lack ribosomes

(c) Lack cell wall ✅

(d) Are Gram-positive

49. Treponema causes:

(a) Tuberculosis

(b) Leprosy

(c) Syphilis ✅

(d) Pneumonia

50. Pseudomonas aeruginosa is commonly found in:

(a) Human blood only

(b) Soil and water ✅

(c) Desert sand only

(d) Marine sediments only

51. Actinomycetes have:

(a) Spherical shape

(b) Filamentous growth form ✅

(c) No DNA

(d) No cell wall

52. Mycobacterium tuberculosis causes:

(a) Leprosy

(b) Pneumonia

(c) Tuberculosis ✅

(d) Cholera

53. Azotobacter belongs to:

(a) Cyanobacteria

(b) Spirochaetes

(c) Nitrogen-fixing aerobic bacteria ✅

(d) Chemosynthetic bacteria

54. Nitrosomonas and Nitrobacter are:

(a) Photosynthetic bacteria

(b) Chemosynthetic bacteria ✅

(c) Spore-forming bacteria

(d) Pathogenic bacteria only

55. Chemosynthetic bacteria obtain energy by:

(a) Photosynthesis

(b) Oxidation of inorganic compounds ✅

(c) Fermentation only

(d) Decomposition of cellulose

56. Bacteria are important for:

(a) Environment only

(b) Humans only

(c) Both environment and other organisms ✅

(d) Plants only

57. Nitrifying bacteria play a key role in:

(a) Carbon cycle

(b) Nitrogen cycle ✅

(c) Water cycle

(d) Oxygen cycle

58. Nitrosomonas and Nitrobacter are:

(a) Denitrifying bacteria

(b) Nitrifying bacteria ✅

(c) Photosynthetic bacteria

(d) Pathogenic bacteria

59. Pseudomonas is involved in:

(a) Nitrogen fixation

(b) Denitrification ✅

(c) Photosynthesis

(d) Fermentation

60. Decomposer bacteria help in:

(a) Producing oxygen only

(b) Breaking down dead organic matter ✅

(c) Causing diseases

(d) Forming spores

61. Cyanobacteria increase free oxygen in atmosphere through:

(a) Respiration

(b) Nitrogen fixation

(c) Photosynthesis ✅

(d) Fermentation

62. Lactobacillus is used in the production of:

(a) Antibiotics only

(b) Plastic

(c) Fermented foods like yogurt ✅

(d) Petroleum

63. The use of bacteria to remove pollutants from environment is called:

(a) Fermentation

(b) Nitrogen fixation

(c) Bioremediation ✅

(d) Denitrification

64. Bacteria used to clean oil spills digest:

(a) Proteins

(b) Hydrocarbons ✅

(c) Vitamins

(d) Minerals

65. Bacillus thuringiensis is used as:

(a) Antibiotic

(b) Fertilizer

(c) Biopesticide ✅

(d) Fungicide

66. Biopesticides are preferred because they are:

(a) Harmful to wildlife

(b) Environmentally friendly ✅

(c) Expensive

(d) Non-degradable

67. Bacteria are widely used in research because they:

(a) Grow slowly

(b) Are difficult to manipulate

(c) Grow quickly and are easy to manipulate ✅

(d) Have complex organs

68. Scientists insert human genes into bacteria to produce:

(a) Toxins

(b) Antibiotics only

(c) Therapeutic proteins like insulin ✅

(d) Spores

69. Commercial preparation of leather involves the use of:

(a) Fungi only

(b) Viruses

(c) Bacteria ✅

(d) Algae

70. The role of bacteria in carbon-hydrogen-oxygen cycle is mainly through:

(a) Photosynthesis

(b) Decomposition ✅

(c) Mutation

(d) Sporulation

71. Normal flora are mostly found on:

(a) Blood

(b) Brain

(c) Skin and mucous membranes ✅

(d) Muscles

72. Internal tissues like blood and brain are normally:

(a) Colonized by bacteria

(b) Free of microorganisms ✅

(c) Full of viruses

(d) Infected

73. The mixture of microorganisms regularly found at a body site is called:

(a) Pathogens

(b) Normal flora ✅

(c) Infection

(d) Vaccine

74. The most numerous microbes in normal flora are:

(a) Fungi

(b) Protists

(c) Bacteria ✅

(d) Viruses

75. Relationship between humans and normal flora is:

(a) Parasitic

(b) Mutualistic ✅

(c) Harmful

(d) Neutral

76. Enteric bacteria produce:

(a) Vitamin C

(b) Vitamin K and B12 ✅

(c) Vitamin A

(d) Vitamin D

77. Normal flora prevent pathogen colonization by:

(a) Producing oxygen

(b) Competing for nutrients and attachment sites ✅

(c) Destroying tissues

(d) Forming spores

78. Normal flora stimulate production of:

(a) Hormones

(b) Enzymes

(c) Cross-reactive antibodies ✅

(d) Toxins

79. Viruses lack:

(a) DNA

(b) RNA

(c) Cellular organization ✅

(d) Capsid

80. Viruses can only be seen under:

(a) Light microscope

(b) Compound microscope

(c) Electron microscope ✅

(d) Simple microscope

81. The genetic material of virus is made of:

(a) Both DNA and RNA together

(b) Either DNA or RNA ✅

(c) Protein only

(d) Lipid only

82. The protein coat of a virus is called:

(a) Envelope

(b) Capsid ✅

(c) Nucleoid

(d) Plasmid

83. Capsid is made up of protein subunits called:

(a) Ribosomes

(b) Capsomeres ✅

(c) Flagellin

(d) Peptidoglycan

84. Core and capsid together form:

(a) Envelope

(b) Nucleocapsid ✅

(c) Genome

(d) Plasmid

85. Herpes virus contains:

(a) 100 capsomeres

(b) 162 capsomeres ✅

(c) 200 capsomeres

(d) 252 capsomeres

86. Adenovirus contains:

(a) 162 capsomeres

(b) 200 capsomeres

(c) 252 capsomeres ✅

(d) 300 capsomeres

87. Viruses with envelope are mainly found in:

(a) Plants only

(b) Animals only ✅

(c) Bacteria only

(d) Fungi only

88. Non-enveloped viruses are called:

(a) Complex viruses

(b) Naked viruses ✅

(c) Retroviruses

(d) Phages

89. Bacterial viruses are called:

(a) Retroviruses

(b) Mycoviruses

(c) Bacteriophages ✅

(d) Adenoviruses

90. T4 phage infects:

(a) Human cells

(b) Plant cells

(c) Escherichia coli ✅

(d) Fungi

91. The tail fibers of bacteriophage help in:

(a) DNA replication

(b) Attachment to bacterial wall ✅

(c) Protein synthesis

(d) Movement

92. HIV belongs to the group of:

(a) Bacteriophages

(b) Retroviruses ✅

(c) Adenoviruses

(d) Poxviruses

93. Retroviruses contain:

(a) DNA only

(b) RNA only

(c) RNA and reverse transcriptase ✅

(d) DNA and RNA

94. The enzyme reverse transcriptase converts:

(a) DNA to RNA

(b) RNA to DNA ✅

(c) Protein to DNA

(d) RNA to protein

95. HIV causes the disease:

(a) Tuberculosis

(b) Syphilis

(c) AIDS ✅

(d) Pneumonia

96. AIDS weakens the:

(a) Digestive system

(b) Nervous system

(c) Immune system ✅

(d) Respiratory system

97. HIV was first identified as the cause of AIDS in:

(a) 1981

(b) 1982

(c) 1984

(d) 1986 ✅

98. HIV envelope contains:

(a) Peptidoglycan

(b) Glycoprotein spikes ✅

(c) Flagella

(d) Ribosomes

99. Viruses are _____ times smaller than most bacteria:

(a) 2–5

(b) 5–10

(c) 10–1000 ✅

(d) 2000

100. HIV is described as a:

(a) Non-host specific virus

(b) Host specific virus ✅

(c) Plant virus

(d) Bacterial virus

📘 Exercise:

SECTION 1: MULTIPLE CHOICE QUESTIONS

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 bacterial structure is responsible for detecting and responding to chemicals?

(a) Capsule

(b) Pili

(c) 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

SECTION 2: SHORT QUESTIONS

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

Answer:

The bacterial cell wall is a rigid layer present outside the plasma membrane. Its main structural component is peptidoglycan (murein).

In Gram-positive bacteria, the cell wall has a thick layer of peptidoglycan and low lipid content.

In Gram-negative bacteria, the cell wall has a thin layer of peptidoglycan and an additional outer membrane made of lipopolysaccharides and lipoproteins. A periplasmic space is present between the cell membrane and peptidoglycan layer, which is more prominent in Gram-negative bacteria.

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

Answer:

Peptidoglycan (murein) is made of long glycan (polysaccharide) chains that are cross-linked by short peptide fragments.

This cross-linking provides strength and rigidity to the bacterial cell wall.

3. What are mesosomes? What are their functions?

Answer:

Mesosomes are infoldings (invaginations) of the bacterial cell membrane that form vesicles, tubules, or lamellae in the cytoplasm.

Their functions include:

- Assisting in DNA replication
- Helping in cell division
- Acting as respiratory centers in bacteria

4. How can plasmids be used in genetic engineering?

Answer:

Plasmids are small, circular, double-stranded extra-chromosomal DNA molecules found in bacteria.

In genetic engineering, plasmids are used as vectors to carry foreign genes into bacterial cells. Scientists insert desired genes (such as the insulin gene) into plasmids. The bacteria then replicate the plasmid and produce the required protein.

5. Define sporulation.

Answer:

Sporulation is the process by which a bacterium forms a thick-walled, dormant structure called an endospore in response to unfavorable environmental conditions.

6. What is the function of the bacterial capsule?

Answer:

The capsule is a gelatinous layer present outside the bacterial cell wall. It protects bacteria from drying and phagocytosis, helps in attachment to surfaces, and gives a sticky character to bacterial colonies.

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

Answer:

Pili help bacteria in attachment to surfaces and are responsible for twitching motility. Some pili also help in conjugation (transfer of genetic material).

They differ from flagella because pili are short and numerous, while flagella are long and few. Flagella help in swimming movement, whereas pili mainly help in attachment and crawling movement.

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

Answer:

Plasmids are small, circular, double-stranded extra-chromosomal DNA molecules found in some bacteria. They carry special genes, such as antibiotic resistance genes, which help bacteria survive in harmful conditions.

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

Answer:

Endospores are thick-walled, dormant structures formed during unfavorable conditions. They help bacteria survive extreme heat, dryness, radiation, and lack of nutrients. When conditions become favorable, they germinate to form new vegetative cells.

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

Answer:

Lipopolysaccharides and lipoproteins are present in the outer membrane of Gram-negative bacteria. They provide extra protection, increase resistance to antibiotics, maintain structural stability, and may act as endotoxins in pathogenic bacteria.

11. How do spirochetes achieve motility?

Answer:

Spirochetes achieve motility by means of a modified flagellum called an axial filament.

The axial filament lies in the periplasmic space between the cell membrane and outer membrane. It helps the bacterium to move by flexing, twisting, swimming, creeping, and spinning movements.

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

Answer:

Twitching movement:

- It is mediated by pili. Pili attach to a solid surface and then retract, pulling the bacterial cell forward.

Gliding movement:

- It does not involve pili. In this movement, bacteria secrete a slimy substance that helps them move smoothly over solid surfaces.

13. How do bacteria without flagella achieve motility?

Answer:

Bacteria without flagella may move by Brownian movement, which is random and uncontrolled movement caused by collisions with particles in the surrounding fluid.

Some may also move by sliding, which occurs due to the pushing force created by dividing cells.

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

Answer:

Swimming motility:

- It is the movement of individual bacteria in liquid media using flagella.

Swarming motility:

- It is the coordinated movement of a bacterial population together over a surface using flagella.

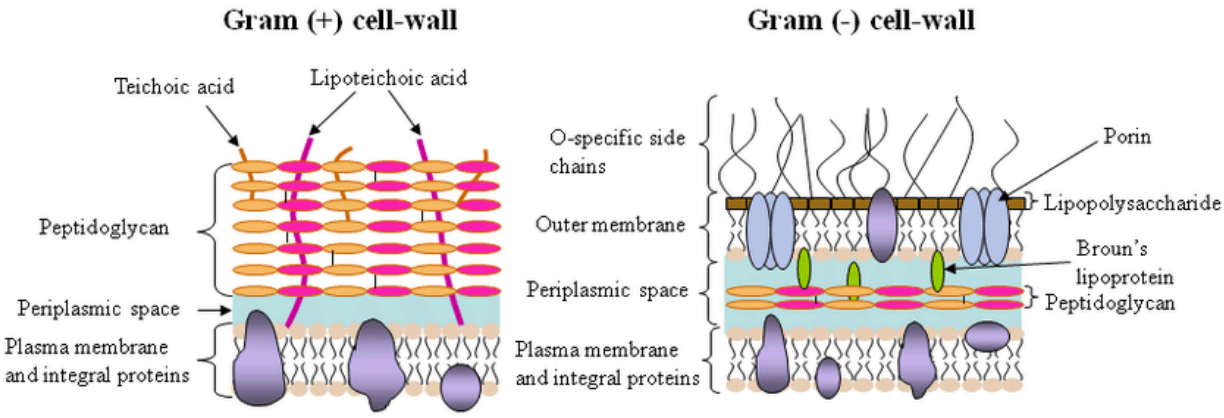
SECTION 3: LONG QUESTIONS

🌟 **Q1: Compare and contrast the cell wall of Gram-positive and Gram-negative bacteria.**

❖ **Answer:**

The bacterial cell wall is a rigid protective layer present outside the plasma membrane. It maintains the shape of the cell, protects it from mechanical damage, and prevents bursting due to osmotic pressure. On the basis of Gram staining and structural differences, bacteria are divided into Gram-positive and Gram-negative types.

🟣 Gram-Positive Bacteria



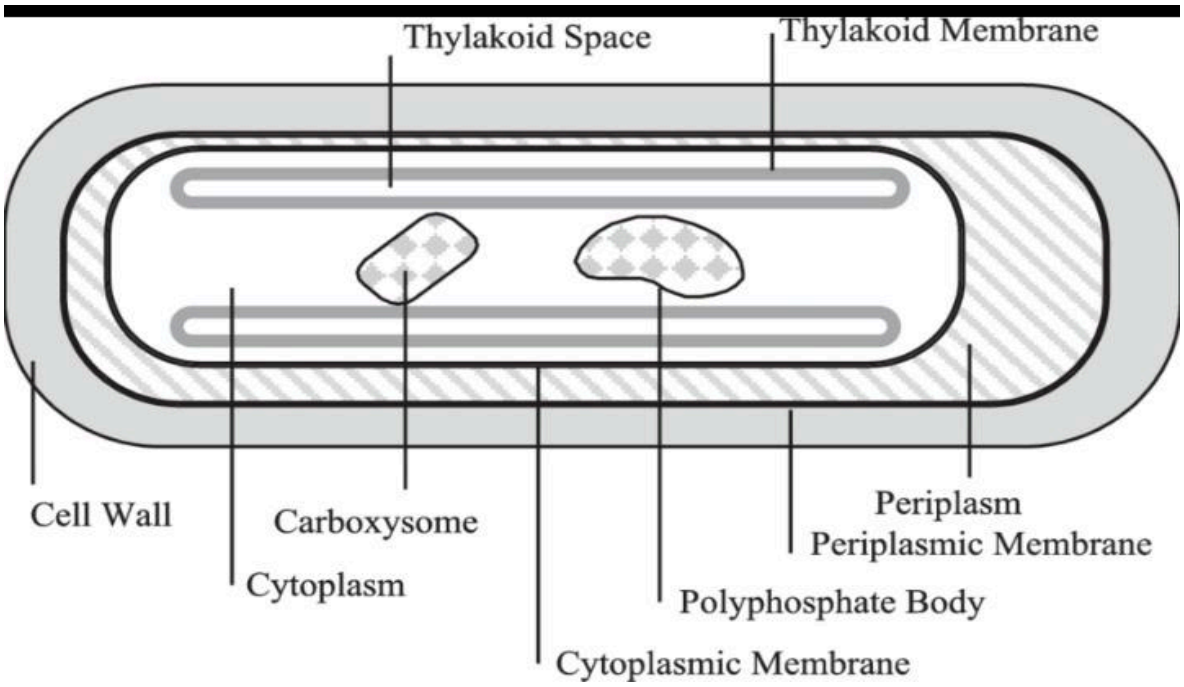
Gram-positive bacteria have a simple but thick cell wall structure.

Their cell wall mainly consists of a very thick peptidoglycan layer (20–80 nm). This thick layer provides rigidity and mechanical strength to the cell. It is made up of long chains of sugars cross-linked by short peptides.

Another important component present only in Gram-positive bacteria is teichoic acid and lipoteichoic acid. These molecules help in maintaining cell wall stability, regulating the movement of ions, and contributing to the antigenic properties of the bacteria.

Gram-positive bacteria do not have an outer membrane. Because of the thick peptidoglycan layer, they retain the crystal violet stain during Gram staining and appear purple under the microscope. They are generally more sensitive to antibiotics such as penicillin and to lysozyme enzyme.

🔵 Gram-Negative Bacteria



Gram-negative bacteria have a more complex cell wall structure.

Their peptidoglycan layer is thin (2–7 nm) and is located in a space called the periplasmic space between the inner plasma membrane and the outer membrane.

The most important feature of Gram-negative bacteria is the presence of an outer membrane. This outer membrane contains lipopolysaccharides (LPS), also known as endotoxins. LPS plays a major role in causing toxic reactions during bacterial infections.

The outer membrane also contains porin proteins, which allow small molecules to pass through.

During Gram staining, Gram-negative bacteria do not retain crystal violet due to the thin peptidoglycan layer. Instead, they take up the counterstain (safranin) and appear pink or red under the microscope. They are generally more resistant to antibiotics and chemicals because the outer membrane acts as an additional protective barrier.

🔎 Comparison in Explanation Form

Gram-positive bacteria have a thick peptidoglycan layer, teichoic acids, and no outer membrane. In contrast, Gram-negative bacteria have a thin peptidoglycan layer, no teichoic acids, but possess an outer membrane containing lipopolysaccharides.

Gram-positive bacteria stain purple, whereas Gram-negative bacteria stain pink. Gram-negative bacteria are usually more resistant to antibiotics due to their complex cell wall structure.

✦ Summary:

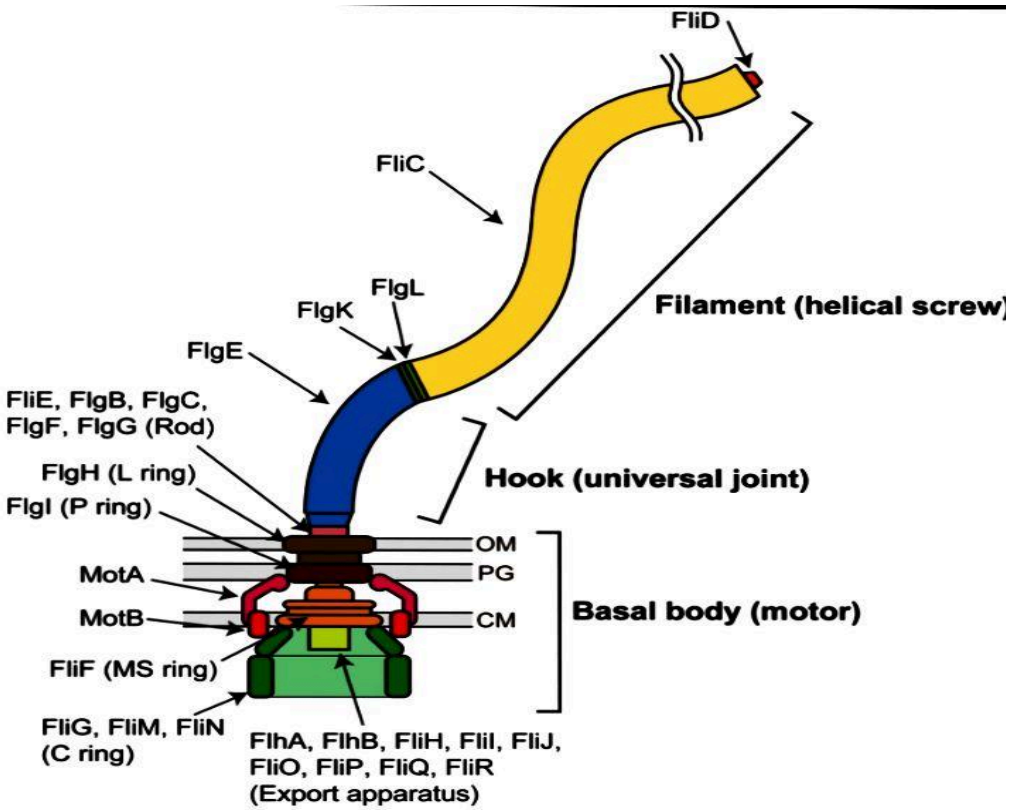
In conclusion, the major difference between Gram-positive and Gram-negative bacteria lies in the thickness of the peptidoglycan layer and the presence of an outer membrane. Gram-positive bacteria have a thick peptidoglycan wall without an outer membrane, while Gram-negative bacteria have a thin peptidoglycan layer with an outer membrane containing LPS. These structural differences affect their staining behavior, pathogenicity, and response to antibiotics.

🌟 Q2: Explain Different Methods of Movement in Bacteria

❖ **Answer:**

Bacteria show different types of movement (motility) that help them reach favorable environments, escape harmful conditions, and find nutrients. Some bacteria are motile, while others are non-motile. The main methods of bacterial movement are explained below.

1. Flagellar Movement (Swimming and Swarming)



The most common type of bacterial movement is by flagella.

Flagella are long, whip-like protein structures attached to the cell surface.

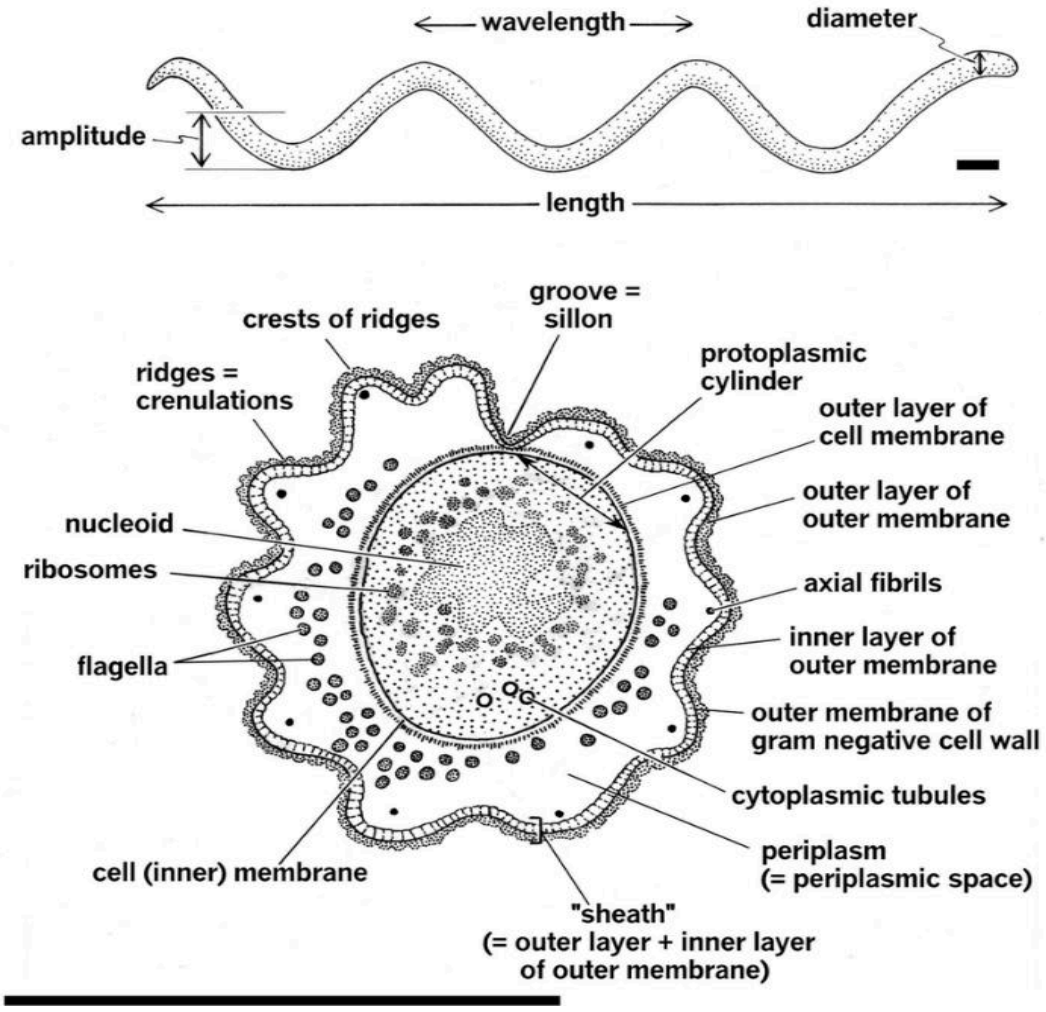
- **Swimming Motility**

- Occurs in liquid media.
- Individual bacteria move independently.
- Caused by rotation of flagella like a propeller.

🔹 **Swarming Motility**

- Occurs on solid or semi-solid surfaces.
- Movement of a group of bacteria together.
- Requires flagella and surface contact.

2. Axial Filament Movement (Spirochetes)

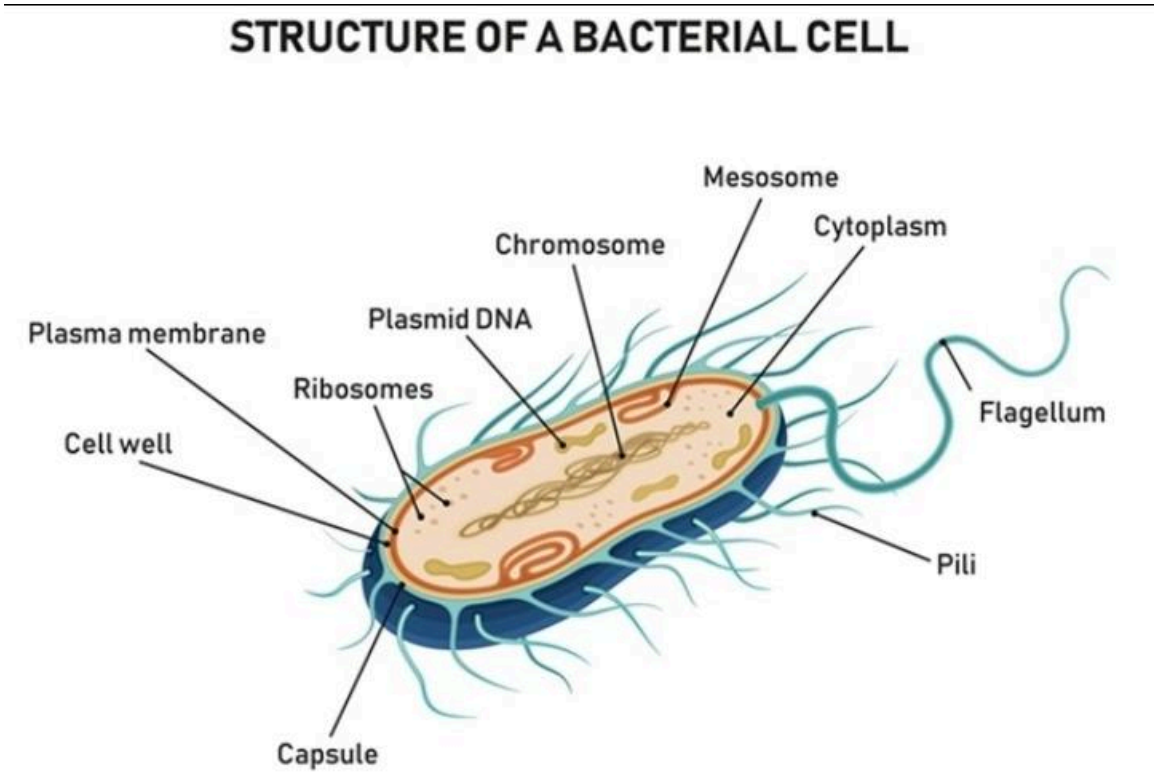


Spirochetes possess special internal flagella called axial filaments (endoflagella).

These lie in the periplasmic space between the cell wall and membrane.

When the axial filament rotates, the entire bacterium moves in a corkscrew or spiral manner, helping it move through viscous environments like mucus.

3. Twitching Motility

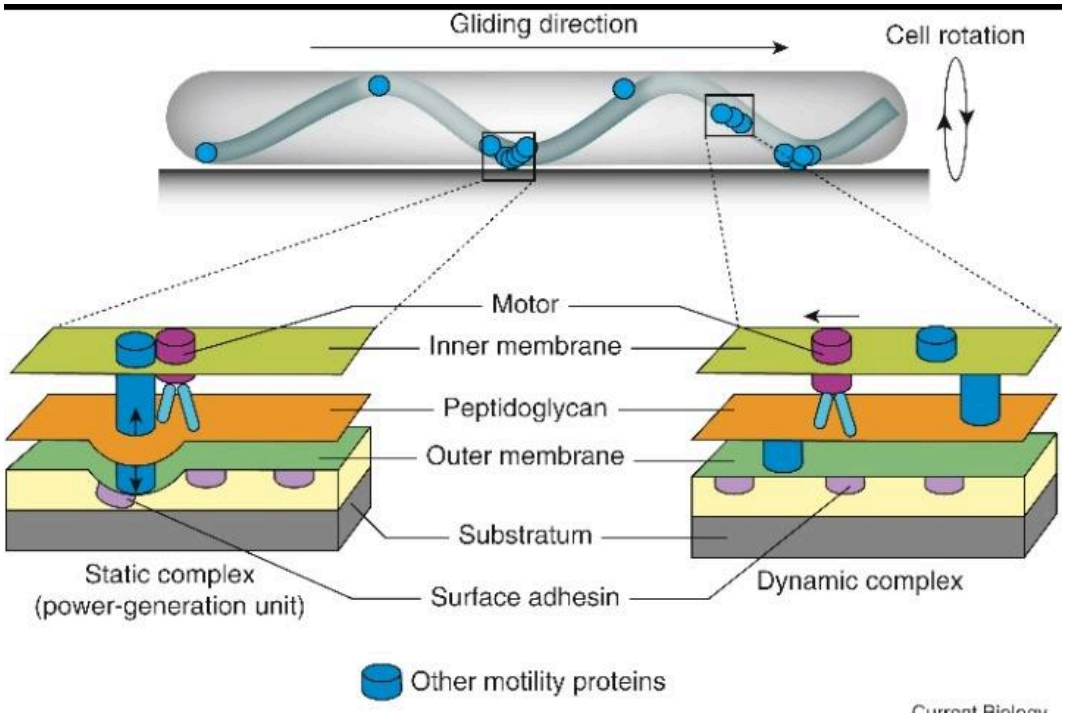


Twitching movement occurs by means of pili (fimbriae).

- Pili attach to a surface.
- Then they retract (shorten), pulling the bacterium forward.

- Movement is jerky or twitch-like.
- Common in bacteria like Pseudomonas.

4. Gliding Motility



Some bacteria move without flagella or pili. This movement is called gliding motility.

- Occurs on solid surfaces.
- Bacteria secrete a slimy substance.
- The slime helps them slide smoothly.
- Seen in Myxobacteria and some cyanobacteria.

5. Sliding and Brownian Movement

🔹 Sliding Movement

- Passive movement over surfaces.

- Caused by growth and division pushing cells outward.
- No special structures involved.

🔹 **Brownian Movement**

- Random movement due to collisions with water molecules.
- Not true motility because bacteria do not actively control it.

✦ **Summary:**

Bacteria show various types of movement depending on their structure.

Most bacteria move by flagella, while spirochetes use axial filaments. Some bacteria move by pili (twitching) or by gliding and sliding without flagella. Brownian movement is random and not true motility.

These different methods help bacteria survive, spread, and adapt to different environments.

🌟 **Q3: Explain the structure of bacterium flagellum.**

❖ **Answer:**

The bacterial flagellum is a whip-like appendage that provides motility to bacteria, allowing them to move toward favorable conditions and away from harmful environments. It functions like a rotary motor and is a complex structure with three main components: filament, hook, and basal body.

1. Filament

- The filament is the long, outermost part of the flagellum that extends into the surrounding medium.
- It is composed of the protein flagellin.
- Its main function is to act as a propeller, pushing the bacterium forward when it rotates.
- The filament is flexible and can rotate clockwise or counterclockwise, enabling directional movement.

2. Hook

- The hook is a short, curved segment that connects the filament to the basal body.
- It acts as a flexible joint, transmitting rotation from the basal body to the filament.
- The hook allows the filament to rotate smoothly and efficiently.

3. Basal Body

The basal body is embedded in the cell wall and plasma membrane, anchoring the flagellum.

It serves as the motor, generating rotation using energy from the proton motive force (movement of protons across the membrane).

The basal body consists of several rings:

- Gram-positive bacteria: 2 rings (inner membrane and cell wall)
- Gram-negative bacteria: 4 rings (L-ring in outer membrane, P-ring in peptidoglycan, MS-ring in plasma membrane, and C-ring in cytoplasm)

⚙️ Mechanism of Movement

- The basal body rotates, transmitting motion through the hook to the filament.
- This rotation drives the bacterium through liquid media, allowing swimming.
- Clockwise or counterclockwise rotation enables the bacterium to change direction efficiently.

✦ **Summary:**

The bacterial flagellum is a rotary motor organelle composed of filament, hook, and basal body. The filament acts as a propeller, the hook provides flexibility, and the basal body functions as a motor embedded in the cell envelope. This structure allows bacteria to move efficiently, respond to stimuli, and navigate their environment.

🌟 **Q4: State the formation of endospore in bacteria.**

❖ **Answer:**

Endospores are highly resistant, dormant structures formed by some bacteria to survive harsh environmental conditions such as heat, drought, chemicals, and radiation. The process of forming an endospore is called sporulation.

🔸 **Stepwise Formation of Endospore:**

1. DNA Replication:

The bacterium first replicates its DNA in preparation for spore formation.

2. Septum Formation:

The cell membrane grows inward to form a septum, isolating a portion of cytoplasm along with one copy of the DNA.

3. Membrane Enclosure:

The septum and cytoplasm are surrounded by two membranes, enclosing the DNA.

4. Cytoplasm Disintegration and Dehydration:

The remaining vegetative cytoplasm disintegrates and the developing endospore dehydrates, which increases its resistance.

5. Peptidoglycan Layer Formation:

A peptidoglycan layer is laid down between the two membranes for added strength.

6. Spore Coat Formation:

A thick spore coat forms around the developing endospore, protecting it from extreme conditions.

7. Maturation:

The endospore matures and becomes metabolically inactive, fully resistant to environmental stresses.

8. Release:

The vegetative cell ruptures, releasing the mature endospore into the environment.

9. Germination:

Under favorable conditions, the endospore germinates to form a new vegetative bacterial cell.

✦ **Summary:**

Endospore formation is a survival strategy in bacteria. Through sporulation, bacteria form highly resistant dormant structures by replicating DNA, enclosing it in membranes, dehydrating cytoplasm, forming peptidoglycan layers and spore coats, maturing, and finally releasing the endospore. These endospores germinate when conditions become favorable, ensuring bacterial survival.

🌟 **Q5: Briefly describe the ecological and economic importance of bacteria.**

❖ **Answer:**

Bacteria are among the most abundant and versatile organisms on Earth. They are microscopic prokaryotes, yet their roles in nature and human life are immense and indispensable. Their importance can be divided into ecological significance and economic value.

1. Ecological Importance of Bacteria

Bacteria play key roles in maintaining ecosystem balance. They are crucial for nutrient cycling, environmental cleaning, and maintaining life-supporting conditions on Earth.

A. Recyclers of Nature

- Bacteria are major participants in biogeochemical cycles, such as carbon, nitrogen, and oxygen cycles.
- Decomposer bacteria break down dead plants, animals, and organic matter, releasing nutrients like nitrogen, phosphorus, and carbon back into the soil and water.
- **Nitrogen cycle:**
    - Nitrifying bacteria (Nitrosomonas, Nitrobacter, Azotobacter) convert atmospheric nitrogen into forms usable by plants, like nitrates.
    - Denitrifying bacteria (Pseudomonas) convert nitrates back into nitrogen gas, maintaining atmospheric nitrogen balance.

B. Oxygen Production

- Photosynthetic bacteria, especially cyanobacteria, contribute to the production of oxygen.
- Early cyanobacteria were responsible for increasing free oxygen in the Earth's atmosphere billions of years ago, making life possible for aerobic organisms.

C. Environmental Cleaning (Bioremediation)

- Certain bacteria can degrade harmful pollutants in the environment.
- **Examples include:**
    - **Sewage treatment:** Bacteria decompose organic waste in sewage.
    - **Oil spills:** Hydrocarbon-degrading bacteria break down petroleum, cleaning polluted water.

- **Industrial waste management:** Bacteria degrade toxic compounds in factories, reducing environmental pollution.

2. Economic Importance of Bacteria

Bacteria have been used by humans for centuries in industries, medicine, and agriculture. Their versatility makes them economically valuable.

A. Production of Useful Products

- **Fermented Foods:** Bacteria such as Lactobacillus and Leuconostoc are used in yogurt, cheese, vinegar, pickles, soy sauce, and wine production.
- **Antibiotics:** Actinomycetes bacteria are the source of antibiotics like tetracycline, chloramphenicol, erythromycin, and neomycin.
- **Leather Industry:** Bacteria are used in the processing of animal hides to produce leather.

B. Biopesticides

- Certain bacteria, such as Bacillus thuringiensis, act as biological control agents.
- These bacteria target specific insect pests without harming humans, wildlife, or beneficial insects.
- Biopesticides are eco-friendly alternatives to chemical pesticides.

C. Research and Biotechnology

Bacteria grow rapidly and are easy to manipulate, making them ideal for laboratory studies.

Applications include:

- **Genetic studies:** Scientists manipulate bacterial DNA to study gene functions.
- **Protein production:** Human genes are inserted into bacteria to produce insulin, growth hormones, antibodies, and vaccines.
- **Molecular biology:** Bacteria are used as model organisms to understand biochemical processes applicable to higher organisms.

✦ **Summary:**

Bacteria are ecologically and economically indispensable:

- **Ecological roles:** Recycling nutrients, producing oxygen, decomposing waste, and cleaning pollutants.
- **Economic roles:** Producing fermented foods, antibiotics, biopesticides, leather products, and therapeutic proteins.

Through these activities, bacteria sustain ecosystems, support human industries, and contribute to scientific research, highlighting their immense value to life on Earth.

🌟 **Q6: Explain the use of bacteria in research and technology.**

❖ **Answer:**

Bacteria are extremely important tools in modern research and biotechnology because of their simple structure, rapid growth, and ease of manipulation. They are widely used in molecular biology, genetics, biochemistry, and industrial applications.

1. Advantages of Using Bacteria in Research

- **Rapid Growth:** Bacteria can multiply quickly, allowing scientists to perform experiments over short periods.
- **Simple Structure:** As prokaryotes, they lack complex organelles, making it easier to study fundamental cellular processes.
- **Genetic Manipulation:** Bacterial DNA can be easily altered to study gene functions or produce desired proteins.

2. Applications in Molecular Biology and Genetics

A. Gene Function Studies

- Scientists create mutations in bacterial DNA to observe changes in characteristics.
- This helps in understanding the role of specific genes and their encoded enzymes.
- Findings from bacterial studies can be applied to more complex organisms, including humans.

B. Recombinant DNA Technology

Bacteria can be used to produce human proteins:

- Insulin for diabetes treatment
- Growth hormones
- Antibodies for therapies

Human or other foreign genes are inserted into bacterial plasmids, which then replicate and express the protein.

C. Cloning and Plasmid Studies

- Plasmids are small, circular DNA molecules in bacteria that replicate independently of chromosomal DNA.
- They are used as vectors in genetic engineering to transfer genes from one organism to another.
- This is a key step in producing recombinant proteins or studying gene expression.

3. Industrial and Biotechnological Applications

A. Enzyme Production

- Bacteria are used to produce enzymes for detergents, food processing, and pharmaceuticals.

B. Bioremediation

- Some bacteria are engineered to break down pollutants, making them useful in environmental cleaning.

C. Vaccine Development

- Bacteria are used to produce antigens for vaccines.
- Recombinant bacterial systems help in producing safer and cost-effective vaccines.

4. Why Bacteria Are Preferred in Research

- **Cost-effective:** Easy and cheap to culture in laboratories.
- **Ethically simpler:** No complex ethical restrictions compared to higher organisms.
- **Versatile:** Can express a wide range of proteins and metabolites.

✦ **Summary:**

Bacteria are indispensable tools in research and biotechnology because they are fast-growing, genetically manipulable, and versatile. They are used to study gene function, produce therapeutic proteins, develop vaccines, and perform environmental and industrial applications, making them a cornerstone of modern science and technology.

🌟 Q7: Define the term normal flora. State the benefits which we get from normal bacterial flora.

❖ **Definition:**

Normal flora refers to the microorganisms (mainly bacteria, but also some fungi and protists) that are regularly found on the surface and certain regions of the body of healthy animals and humans.

- Internal tissues such as blood, brain, and muscles are normally free from microorganisms.
- Surface tissues like skin, mouth, and mucous membranes are colonized by these microorganisms.
- These bacteria coexist with the host without causing disease under normal conditions.

Benefits of Normal Bacterial Flora

The relationship between humans and their normal flora is mutualistic – both benefit:

1. Synthesis of Vitamins:

Certain bacteria in the alimentary canal produce vitamins which the body can absorb:

- **Vitamin K** – important for blood clotting (produced by enteric bacteria)
- **Vitamin B12** – necessary for red blood cell formation
- Some lactic acid bacteria also produce other B vitamins.

2. Prevention of Pathogen Colonization:

- Normal flora compete with harmful microbes for attachment sites and nutrients.
- This reduces the chance of pathogenic bacteria entering tissues and causing infections.

3. Inhibition or Killing of Pathogens:

- Intestinal bacteria produce antimicrobial substances that can inhibit or kill harmful microbes.
- This helps maintain a healthy microbial balance.

4. Stimulation of Immune System:

- Normal flora act as antigens, prompting the body to produce low levels of antibodies.
- These antibodies can cross-react with certain pathogens, offering protection against infections.

✦ **Summary:**

Normal flora are the microorganisms naturally found on the body surfaces. They are mutually beneficial, helping the host by:

- Producing vitamins (Vitamin K, B12, etc.)
- Preventing pathogen colonization
- Inhibiting harmful microbes
- Stimulating the immune system

Thus, normal flora are essential for maintaining health and supporting the immune system.

🌟 **Q8: Explain the structure of a model bacteriophage and HIV.**

❖ **Answer:**

Bacteriophages and HIV are both viruses, but they differ significantly in their structure, host specificity, and genetic material. Here's a detailed explanation without using a table.

1. Structure of a Model Bacteriophage

Bacteriophages are viruses that infect bacteria. A commonly studied example is the T4 phage, which infects Escherichia coli.

Head (Capsid):

The head is a protein shell made of subunits called capsomeres. It is typically icosahedral or pyramidal in shape and contains the double-stranded DNA of the virus.

Tail:

The tail is attached to the head via a neck region. It consists of an inner core and an outer sheath. The sheath can contract to inject the viral DNA into the bacterial host.

End Plate and Tail Fibers:

At the end of the tail is the end plate, which anchors six tail fibers. These fibers help the bacteriophage attach specifically to the bacterial cell wall before injecting DNA.

Function:

Bacteriophages use the tail and tail fibers to attach to the bacterial cell and inject their DNA, allowing replication inside the host.

2. Structure of HIV (Human Immunodeficiency Virus)

HIV is a retrovirus that infects human immune cells, especially CD4+ T cells, and causes AIDS.

1. Genetic Material:

HIV contains two copies of single-stranded RNA. It carries an enzyme called reverse transcriptase, which converts RNA into DNA inside the host cell.

2. Capsid:

The RNA is enclosed in a cone-shaped capsid made of protein.

3. Envelope:

Surrounding the capsid is a lipid-rich envelope derived from the host cell membrane. Embedded in the envelope are glycoprotein spikes (gp120 and gp41) that help the virus recognize and attach to target cells.

4. Enzymes:

In addition to reverse transcriptase, HIV contains integrase, which helps integrate the viral DNA into the host genome.

5. Function:

HIV uses its envelope and glycoprotein spikes to enter host cells, reverse transcriptase to convert RNA to DNA, and integrase to incorporate viral DNA into the host genome for replication.

✦ **Summary:**

Bacteriophages are complex viruses with a head-tail structure designed to infect bacteria, deliver DNA, and replicate. HIV, in contrast, is an enveloped retrovirus that infects human immune cells, carries RNA as its genetic material, and relies on reverse transcription and integration into the host genome for replication.

Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

Author: Muhammad Asghar

Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.

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