

Unit 2: Bacteria and Viruses

Short Questions

SHORT QUESTION ANSWERS (EXERCISE)

Q1. Write about the structural components of a bacterial cell wall and their arrangement.

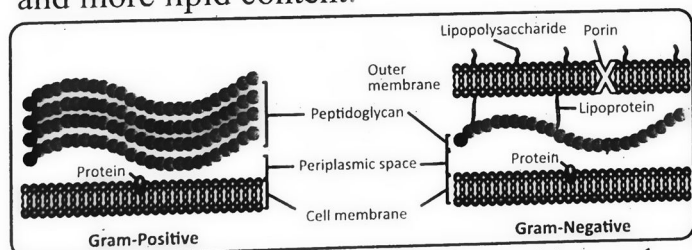
Ans. Bacterial cell wall

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

Q2. Write the composition of the peptidoglycan layer in bacterial cell walls.

Ans. Peptidoglycan layer of Bacterial cell wall

The composition of cell wall is quite different in **Gram-positive** and **Gram-negative bacteria**. The cell wall of Gram-positive bacteria contains **thick layer** of peptidoglycan and has less lipid content. While the cell wall of **Gram-negative** bacteria has a **thin layer** of peptidoglycan and more lipid content.



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

Q3. What are mesosomes? What are their functions?

Ans. Mesosomes

In bacteria at some points, cell membrane invaginates and forms **vesicles**, tubules or lamellae in cytoplasm. These structures are known as **mesosomes**. These are involved in **DNA replication**, **cell division** and also serve as **respiratory centres**.

Q4. How can plasmids be used in genetic engineering?

Ans. Plasmids in genetic engineering

Plasmids 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**. Scientists also insert human genes in bacteria and produce **therapeutic proteins** e.g., insulin, growth hormones or antibodies.

Q5. Define sporulation.

Ans. Sporulation

The process by which bacteria make endospores, is called **sporulation**. **Endospore** remains **dormant** unless favourable conditions return. Under **favourable** conditions, endospore germinates to give rise to a **new vegetative cell**.

Q6. What is the function of the bacterial capsule?

Ans. Function of capsule

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

It provides protection from phagocytosis, prevent desiccation and adherence to surfaces.

Q7. Write the role of pili in bacterial cells. How do they differ from flagella?

Ans. Role of pili

Some bacteria have pili (singular; pilus). These are **non-helical, filamentous** appendages and are smaller and **thinner** than flagella.

- Pili are used for attachment of bacteria to various surfaces.
- They are also involved in the **mating process** (conjugation) between cells to exchange genetic material. Flagella enable bacteria to move to detect and to respond to chemical signals.

Q8. What are plasmids, and how do they contribute to enabling bacteria to resistance against unfavorable conditions?

Ans. Plasmids

Some bacteria have circular, **double-stranded extra chromosomal DNA molecules**, called plasmids. They are **self-replicating** and can replicate before or after division. They contain genes that enable bacteria for resistance against **unfavourable** conditions (e.g., antibiotics).

Q9. Write about the role of endospores in bacterial survival.

Ans. Role of Endospores

Many bacteria can survive extended periods of harsh conditions by forming specialized **“resting”** cells, called **endospores**. Endospores are **thick-walled** and metabolically **inactive** (dormant). The process by which bacteria make endospores, is called **sporulation**. Endospore remains dormant unless favourable conditions return. Under favourable conditions, endospore germinates to give rise to a new vegetative cell.

Q10. What is the significance of lipopolysaccharides and lipoproteins in Gram-negative bacteria?

Ans. Significance

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.

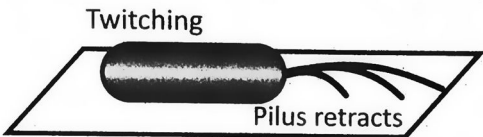
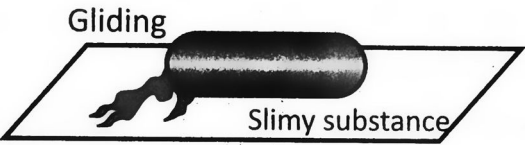
Q11. How do spirochetes achieve motility?

Ans. Motility in Spirochete

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.

Q12. Differentiate between twitching and gliding movements in bacterial motility.

Ans.

Twitching	Gliding
- It is a type of movement in bacteria, that enable them to move over surfaces. - It is mediated by pili, which bind to surrounding solid surface and retract. Thus, bacterial cell is pulled forward. 	- It is similar to twitching. - In gliding, bacteria secrete slimy substance, which help them for smooth gliding over solid surfaces. 

Q13. How do bacteria without flagella can achieve motility?

Ans. Brownian movement

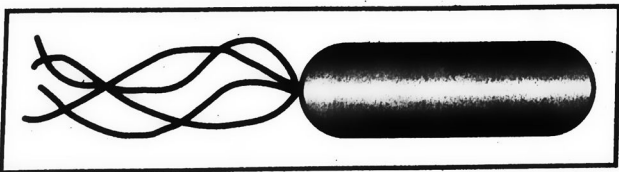
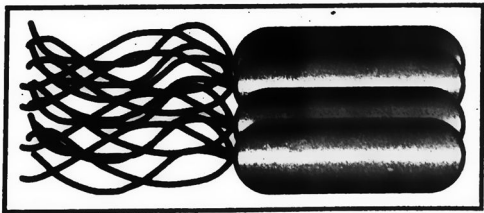
Some bacteria (e.g., Streptococcus) that do not have flagella or pili, move due to the random and uncontrolled movements of the particles present in fluid which is called Brownian movement.

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

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

Q14. What is the difference between swimming motility and swarming motility in bacteria?

Ans.

Swimming Motility	Swarming Motility
Swimming refers to the movement of individual bacteria in liquid environment. They swim by using their flagella, most bacilli and spirilla move by means of flagella. Swimming 	The coordinated movement of a group / population of bacteria is called swarming. Swarming 

SLO BASED SHORT QUESTION ANSWERS

Structure of Bacteria

Q15. Discuss the recent taxonomic status of bacteria.

Ans. Taxonomic status of bacteria

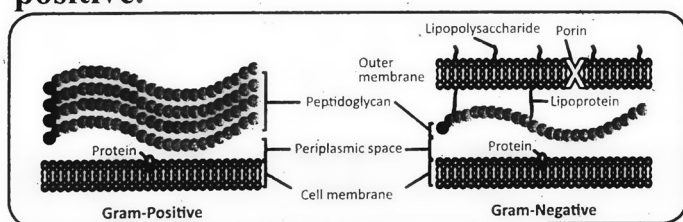
According to five kingdom classification system, proposed by **Robert Whittaker** all prokaryotes are included in a separate kingdom is kingdom **Monera**. But in the last decade, molecular studies have highlighted serious flaws in the **five-kingdom classification system**. Now, most biologists favour replacing it with a new system, called three-domain system, which is more aligned with the data gained from molecular studies. In this new system, bacteria are the prokaryotes classified in the domain of their own, i.e. the domain bacteria.

Q16. What is periplasmic space. How it differs in various bacteria?

Ans. Periplasmic space

The space between peptidoglycan layer and cell membrane of bacteria is called **periplasmic space**.

The cell wall of **Gram-negative bacteria** has more periplasmic space than **Gram positive**.



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

Q17. Why *Mycoplasmas* and *Spiroplasmas* are resistant to penicillin?

Ans. Penicillin is an antibiotic that works by inhibiting cell wall growth in bacteria. There are two genera in bacteria which lack cell wall, they are *Mycoplasmas* and *Spiroplasmas* lack cell walls so their outer membrane is cell

membrane that is why they are resistant to penicillin.

Q18. How the cell membrane and cytoplasm of bacteria is different from eukaryotes?

Ans. Cell membrane of bacteria

The cell membrane of bacteria does not have sterols (i.e. cholesterol) in its chemical makeup while eukaryotic cell membranes possess cholesterol in their lipid bilayer.

Cytoplasm of Bacteria

Bacterial cell lacks cytoskeleton, membrane-bounded organelle and nucleus in their cytoplasm. The only organelle they have is ribosome but these are smaller than eukaryotic ribosomes, while the cytoplasm of eukaryotes contain cytoskeleton, all membrane bounded organelles and nucleus.

Bacteria, Ecology and Diversity

Q19. For how long bacteria and archaea are inhabiting earth? Where are they found on Earth?

Ans. Habitat of Bacteria

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

Q20. Name the major groups of domain bacteria.

Ans. Major groups of bacteria

Followings are the major groups of bacteria:

- (i) Omnibacteria (ii) Cyanobacteria
- (iii) *Mycoplasmas* and *Spiroplasmas*
- (iv) Spirochetes (v) Pseudomonas
- (vi) Actinomycetes
- (vii) Nitrogen fixing bacteria
- (viii) Chemosynthetic bacteria

Q21. Characterize Omnibacteria.**Ans. Characteristics**

These are **rigid, rod-shaped**, heterotrophic, Gram-negative bacteria. Many important **pathogens** are included in this group. Most of these bacteria have **flagella**. They do not produce spores. They are usually **aerobic**. *Escherichia coli* and *vibrios* are examples of such bacteria.

Q22. Briefly describe major characteristics of mycoplasmas and Spiroplasmas. How they differ from other bacteria?**Ans. Characteristics of mycoplasmas and Spiroplasmas**

- These groups differ from all other bacteria in that they **lack cell walls** and that's why they are the smallest bacteria. As they lack cell walls, they are also **resistant to penicillin** and other antibiotics that work by inhibiting cell wall growth.
- Some mycoplasmas cause **diseases** in mammals e.g., certain types of pneumonia in humans.
- Spiroplasmas cause significant plant diseases e.g., the lethal yellowing disease of coconuts.

Q23. Differentiate between cyanobacteria and N₂-fixing bacteria.**Ans.**

Cyanobacteria	N ₂ -Fixing bacteria
• These are photosynthetic bacteria. • They contain chlorophyll-a and accessory pigments like carotenoids, and blue and red phycobilins. • Many cyanobacteria fix atmospheric nitrogen in their special cells called heterocysts. They are common in soil in the form of mats. The mats on the sediments in the sea are dominated by cyanobacteria.	• Nitrogen fixing bacteria are found in soil and water and convert atmospheric nitrogen into nitrates. • This group includes economically important bacteria. • They are Gram-negative and most are flagellated. • <i>Azotobacter</i> is a member of this group.

Q24. Compare spirochetes with pseudomonas.**Ans.**

Spirochaetes	Pseudomonas
• Spirochaetes are long spirilla with Gram-negative cell walls. • They may have 2 to more than 100 flagella. • <i>Treponema</i> are important spirochaetes. • They cause syphilis (a fatal sexually transmitted disease).	• Pseudomonas are straight or curved Gram-negative rods with one or many flagella at one end. • Some of them are autotrophic but many are plant pathogens. Some of them play role in denitrification. • <i>Pseudomonas aeruginosa</i> occurs in soil, water and raw vegetables, it can cause serious infections in people with weak immunity.

Q25. How chemosynthetic bacteria derive energy for survival?

Ans. Energy for survival

Chemosynthetic bacteria derive energy from the **oxidation** of inorganic compounds of **nitrogen, sulphur and iron**.

They use this energy for the **synthesis** of their food. **Nitrosomonas** and **Nitrobacter** are included in this group. 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.

Q26. Name the group of bacteria which are pathogenic and are also decomposers.

Ans. Following are the group of bacteria which are pathogenic as well as decomposers,

- i. Omnibacteria ii. Spirochetes
- iii. Pseudomonas

Q27. Name the group of bacteria which are nitrogen fixers.

Ans. Following are the group of bacteria which are **Nitrogen fixers**

- i. Cyanobacteria ii. Actinomycetes

Q28. Which bacteria are responsible for following diseases?

- (i) Leprosy (ii) Tuberculosis
- (iii) Syphilis
- iv) Lethal yellowing disease of coconuts

Ans.

(i) Leprosy is caused by *Mycobacterium leprae*.

(ii) Tuberculosis is caused by *Mycobacterium tuberculosis*.

(iii) Syphilis is caused by *Treponema pallidum*.

(iv) Lethal Yellowing disease of coconuts is caused by *Spiroplasma*.

Q29. Name the antibiotics derived from actinomycetes.

Ans.

Antibiotics

- Tetracycline
- Chloramphenicol

- Erythromycin

- Neomycin

Q30. Which bacteria play significant roles in the completion of nitrogen-cycle?

Ans.

Nitrifying Bacteria	Denitrifying Bacteria
<i>Nitrosomonas</i>	<i>Pseudomonas</i>
<i>Nitrobacter</i>	
<i>Azotobacter</i>	

Importance of Bacteria

Q31. Some bacteria are titled as “The makers of useful products” justify?

Ans. Makers of useful products

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. In **pharmaceutical** and **agrochemical** industry, bacteria are most important in the production of important chemicals. Some bacteria are used for the **production of antibiotics**. **Commercial preparation** of animals' skin for making leather goods, involves the use of bacteria.

Q32. Describe the role of bacteria as environmental cleaners.

Ans. 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.
- 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.

Q33. Which bacteria are significant in biological pest control? / Justify the role of bacteria as biopesticides?

Ans. 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 environmental friendly and have little or no effect on humans, wildlife, pollinators and most other beneficial insects.

Q34. Which quality of bacteria enables them to be selected for biological research?

Ans. Quality of bacteria

Bacteria can grow quickly and scientists can manipulate with them very easily e.g., *Escherichia coli*.

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. Scientists also insert **human genes** in bacteria and produce therapeutic proteins e.g., insulin, growth hormones, or antibodies.

Normal Flora

Q35. Define normal flora. Which organisms make humans normal flora?

Ans. Normal Flora

- 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.

- The normal flora of humans consists of **bacteria, few fungi, protists, and some methanogenic archaea**. Bacteria are the most numerous and obvious microbial components of normal flora.

Q36. Humans and their normal flora are mutualistic comment.

Ans. Benefits of Bacterial Flora of Humans

The associations between humans and their normal flora are **mutualistic**. 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;

- Synthesis of vitamins (**Vit.K, Vit.B₁₂**)
- Prevent colonization by pathogens
- Inhibit or kill pathogens
- Stimulates the production of cross-reactive antibodies

Q37. Describe how normal flora stimulates the production of cross-reactive antibodies?

Ans. Cross reactive antibodies

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.

Q38. Discuss the role of normal flora in synthesis of vitamins and prevention of pathogen entry.

Ans. 1. Synthesis of vitamins: 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. For example, enteric bacteria secrete

Vitamin K and Vitamin B₁₂, and lactic acid bacteria produce certain B-vitamins.

2. 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.

3. **Inhibit or kill pathogens:** The intestinal bacteria produce a variety of substances, which **inhibit** or kill pathogen bacteria.

Virus

Q39. Differentiate between capsid and capsomeres.

Ans. Following are the differences between Capsid and Capsomeres.

Capsid	Capsomeres
- In viruses the core is surrounded by a protein coat, called capsid. - It gives definite shape to virus. - Central core and capsid are collectively called as nucleocapsid.	- Capsid is made up of protein subunits called as capsomeres. - The number and kind of capsomeres is characteristic of a particular virus. Examples i) Herpes virus (causes cold sores, chickenpox etc.) contains 162 capsomeres in its capsid. ii) Adenovirus (causes common cold) contains 252 capsomeres in its capsid.

Q40. What are naked viruses? Brief about general appearance of viruses.

Ans. **Naked viruses**

In some animal viruses, nucleocapsid is covered by another membrane called envelope. It is a lipid-rich membrane and is derived from host cell. Non enveloped viruses are known as **naked-viruses**.

General appearance

There is a great diversity in the general appearance of viruses.

- The animal and plant viruses may be polyhedron (having many sides) or helical.
- The bacterial viruses (bacteriophages) may be **cubical**, **icosahedral** (having 20 faces), **helical**, or **complex** (polyhedral head and rod-shaped tail).

★ Q41. Discuss the role of bacteriophages in genetic engineering.

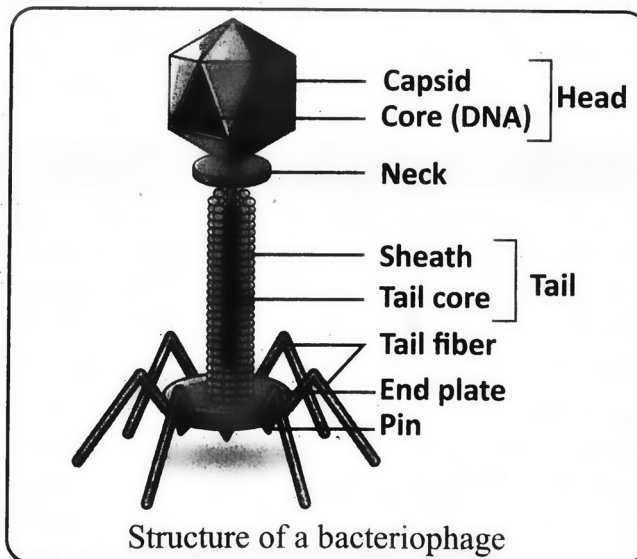
Ans. **Role of bacteriophages**

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**.

Q42. Sketch the structure of T4-phage.

Ans.



Q43. Briefly describe tail of a bacteriophage.

Ans. **Tail of bacteriophage**

The tail of a bacteriophage 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.

Function

They help the phage to attach with bacterial wall. These structures are also made of proteins.

Q44. What do you know about retroviruses?

Ans. Retroviruses

Retroviruses contain RNA and capsids. 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.

Q45. Comment about the entry of HIV into humans.

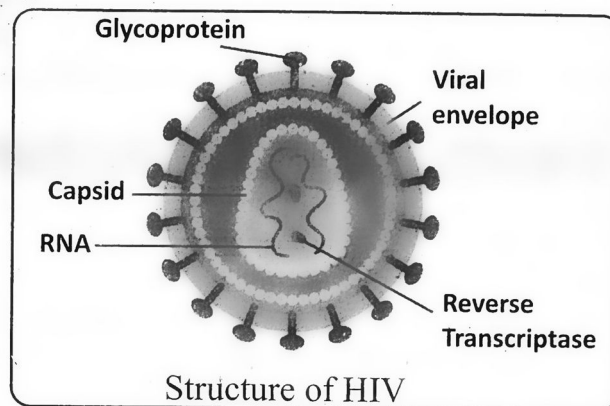
Ans. Entry of HIV

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.

Q46. Sketch the structure of HIV.

Ans.



Q47. Brief about the discovery of AIDS.

Ans. Discovery of 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.

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.

LONG QUESTIONS (EXERCISE)

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

Ans. See Q2. of theory.

Q2. Explain different methods of movement in bacteria.

Ans. See Q5. of theory.

Q3. Explain the structure of bacterium flagellum.

Ans. See Q6. of theory.

Q4. State the formation of endospore in bacteria.

Ans. See Q4. of theory.

Q5. Briefly describe the ecological and economic importance of bacteria.

Ans. See Q8. of theory.

Q6. Explain the use of bacteria in research and technology.

Ans. See Q9. of theory.

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

Ans. See Q10. of theory.

Q8. Explain the structure of a model bacteriophage and HIV.

Ans. See Q12. and Q13. of theory.

INQUISITIVE QUESTIONS

Q1. Why do bacteria have ribosomes even though they do not have membrane bound organelles?

Ans. Ribosomes in bacteria

Bacteria **lack** membrane bounded organelles, because they lack sub-cellular membrane they have only one organelle which is not bounded by any membrane, that is ribosome (the sole organelle of prokaryotes). The prime function of ribosomes is same as in eukaryotes that is protein synthesis. Although they are **smaller** (70s) than **eukaryotic ribosomes** (80s).

Q2. If bacteria do not have mitochondria, how do they generate energy for survival?

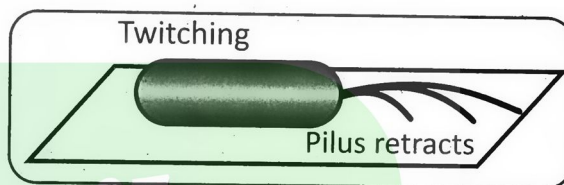
Ans. Generation of energy

Bacteria although **lack** mitochondria, but they still obtain energy through cellular respiration, especially involving **electron transport chain** and **ATP synthase**, which are located in their plasma membranes (eukaryotes have ETC in mitochondrial membrane).

Q3. Why do certain bacteria exhibit twitching motility using pilli instead of flagella?

Ans. Twitching motility

Twitching motility also called **crawling** motility is used by bacteria to move over surfaces. It is provided and mediated by pili, which bind to surrounding solid surface and retract. Thus bacterial cell is pull forward in a crawling or **twitching** fashion.



Q4. Give reasons in favour of statement “Prevention is better than cure” and present your arguments in class.

Ans. Prevention is better than cure

- (i) Preventive actions are helpful in **reducing the risk of spreading** harm and disease to others e.g. isolation in case of contagious diseases like mumps, measles, COVID-19 etc.
- (ii) It helps to **avoid the consequences** which can not be fully reversed e.g. chronic diseases.
- (iii) It **ensures long term well being** like regular screening tests helps in the early detection of lethal diseases like cancer, emphysema, and increases survival chances.
- (iv) **Reduces physical, emotional or financial distress** and is also cheaper than cure, which are now a days very expensive.

Q5. Co-relate the social and cultural values of a country with the prevalence of AIDS.

Ans. Prevalence of AIDS

AIDS is a sexually transmitted disease and have many other modes of transmission (like unscreened blood transfusion, body fluids, infected surgical instruments), and still today it is incurable, and its prevalence is significantly influenced by the social and cultural values of a country, following socio-cultural factors can contribute for AIDS prevalence.

- (i) Lack of education and poor awareness about its contraction.
- (ii) Religious oppositions.
- (iii) Traditional healing (spiritual false) delaying in HIV treatment.
- (iv) Weak health care systems i.e. lack of testing and treatment.
- (v) Polygamy (in case of infected males).
- (vi) Lack of circumcision (as male circumcision reduces female-to-male HIV transmission).
- (vii) High risk group protections (drug user).