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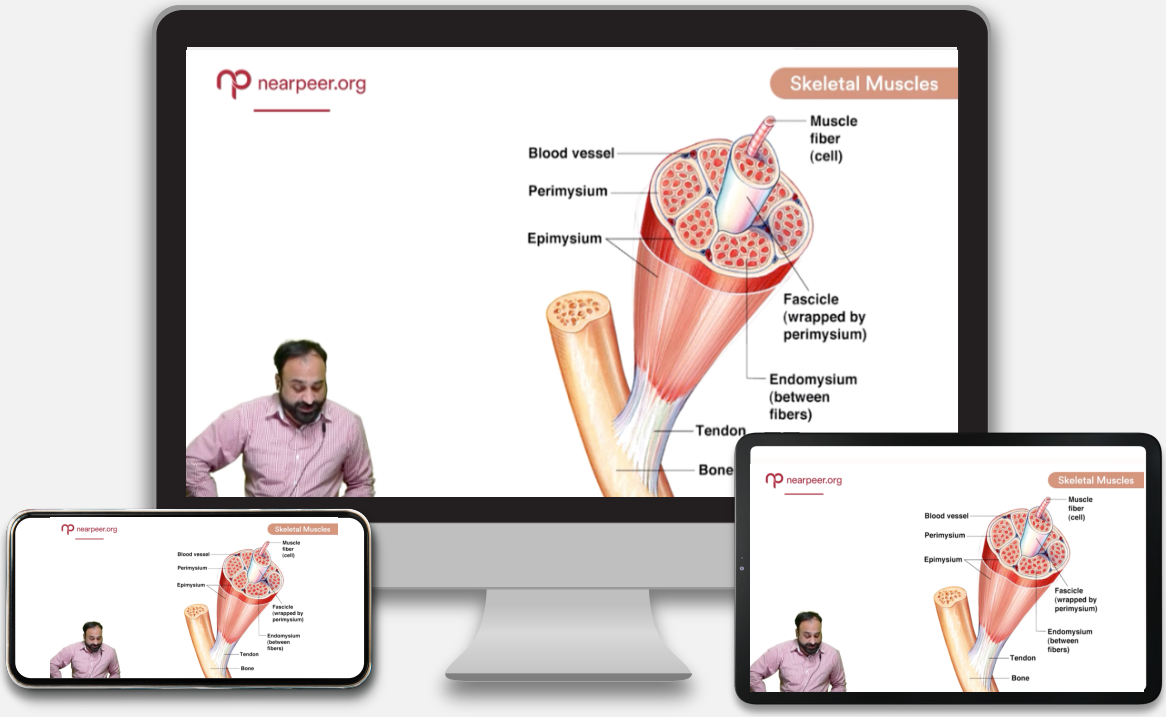
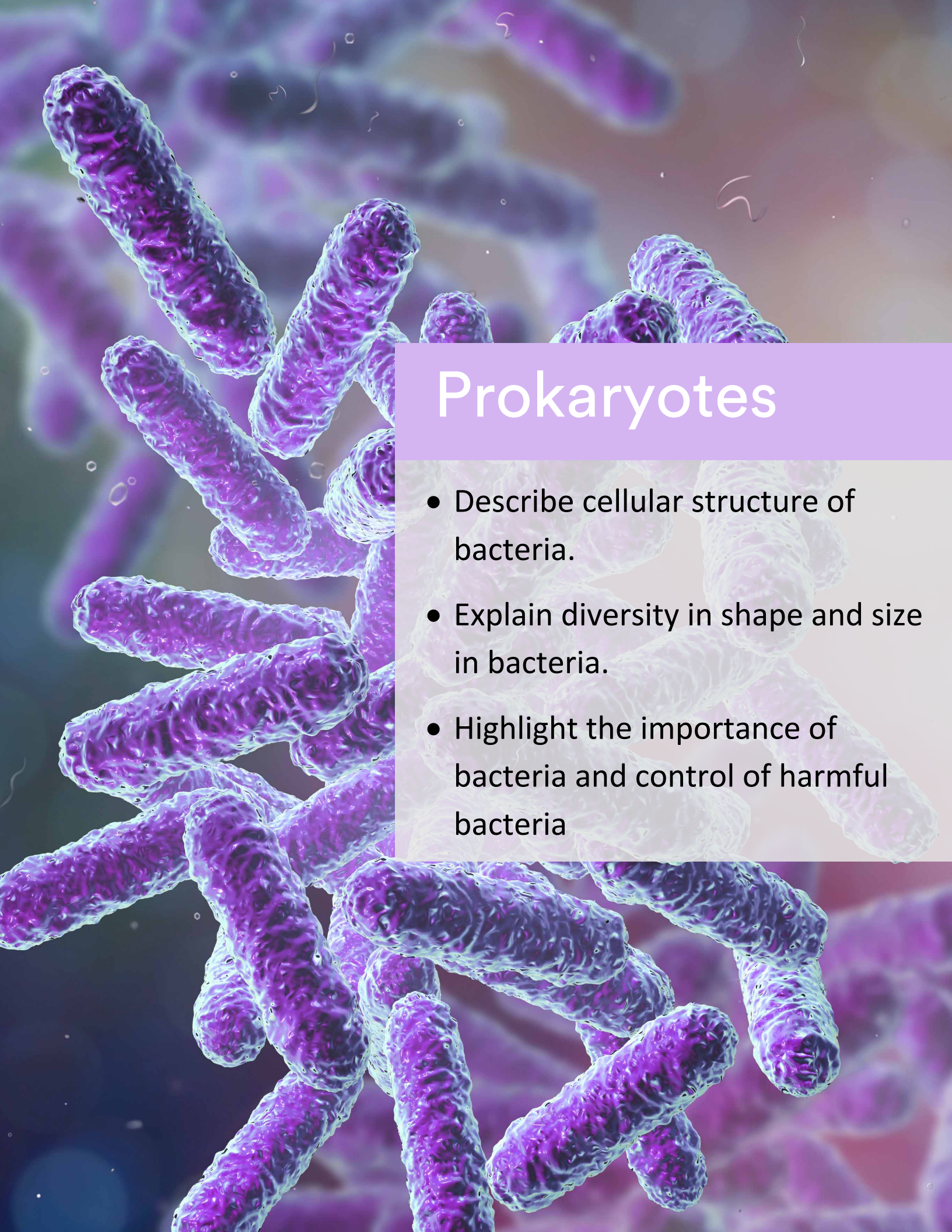




Prokaryotes

- Describe cellular structure of bacteria.
- Explain diversity in shape and size in bacteria.
- Highlight the importance of bacteria and control of harmful bacteria

Prokaryotes

- It consists of organisms with prokaryotic cells.
- In Greek the word Pro means "before" and karyon means nucleus. So prokaryotes are cells that do not have true nucleus structure. It mainly includes bacteria.

Microbiologists place bacteria in two major groups:

1. Eubacteria (In Greek it means "true bacteria")
2. Archaeobacteria (In Greek it means "ancient bacteria"). It is a small division.

Size of Bacteria

- The size is from 0.1 to 600 µm.
- The smallest bacteria are present in the genus Mycoplasma with the size of 100 to 200nm in diameter. It is about the size of the largest viruses (poxviruses).
- Escherichia coli is 1.1 to 1.5 µm wide and 2.0 to 6.0 µm long.
- Some spirochetes may reach 500 µm in length.
- Staphylococci and Streptococci i.e, 0.75 – 1.25µ in diameter.
- A huge bacterium (Epulopiscium fishclsoni) has been discovered in the intestine of the brown surgeonfish (Acanthurus nigrofuscus). Its size is 600 µm by 80 µm (a little smaller than a printed hyphen). It is now clear that a few bacteria are much larger than the average eukaryotic cell.

Shapes of Bacteria

Most of the bacterial species have constant characteristic shapes. However, some are pleomorphic and present in many shapes. On the basis of shapes bacteria can be classified as cocci, bacilli and spirillum.

1. Cocci

The Cocci are spherical or oval bacteria.

These are arranged according to planes of division.

I. Division in One Plane:

If division is in one plane it produces two types of arrangements.

a. Diplococcus Arrangement: When cocci are present in pairs then arrangement is diplococcus (Diplococcus pneumoniae).

b. Streptococcus Arrangement: When cocci are present in long chain of cells then the arrangement is streptococci.

II. Division in Two Planes:

When the division of cell is in two planes it will produce a tetrad arrangement. A tetrad is a square of 4 cocci.

III. Division in Three Planes:

When the division is in three planes it will produce a sarcina arrangement. Sarcina is a cube of 8 cocci.

IV. Division in Random Planes:

When division occurs in random planes it will produce a staphylococcus arrangement. Here the cocci are arranged in irregular grape-like clusters (Staphylococcus aureus).

2. Bacilli

Bacilli are rod-shaped bacteria. They all divide in one plane producing four kinds of arrangements:

I. Bacillus: It is a single cell of bacteria.
II. Streptobacillus: It is a chain of bacilli.
III. Diplobacillus: When rod shaped bacteria occur in pairs then it is called diplobacillus.
IV. Coccobacillus: When rod shaped bacteria are like coccus.

Examples of Rod Shaped Bacteria: Escherichia coli. Bacillus subtilis, Pseudomonas

3. Spiral (Spiral Shaped Bacteria)

These bacteria are spirally coiled.

Spirals can be in one of three forms, a vibrio, a spirillum, or a spirochete.

I. Vibrio: It is curved or comma-shaped rod.
II. Spirillum: It is a thick, rigid spiral.
III. Spirochete: It is a thin, flexible spiral.

Examples of Spiral Shaped Bacteria: Vibrio, Hyphomicrobium

Other Shapes of Bacteria:

Some other shapes of bacteria are trichrome forming, sheathed, stalked, square, star shaped, spindle shaped, lobe shaped and filamentous bacteria.

- All bacteria have cell membrane, cytoplasm, ribosome and chromatin bodies.
- Most of bacteria have a cell wall, which gives shape to the bacterial cell.
- The structures like capsule, slime, flagella, pili, fimbriae and granules are found in some/different bacteria.

Structure of a Bacterial Cell

We will study structure of a bacterial cell under the following headings:

1. Flagella and their Functions

- These are very thin hair like structures that come out through the cell wall. The flagella originate from basal body. It is a structure just beneath the cell membrane in the cytoplasm. Flagella are made up of protein flagellin.
- Classification of bacteria on the basis of presence, attachment and number of flagella
- On the basis of presence, attachment and number of flagella. bacteria are classified as:

I. Atrichous: The bacteria without any flagella are called atrichous.
II. Monotrichous: These have a single polar flagellum.
III. Lophotrichous: These have a tuft of flagella at one pole only.
IV. Amphitrichous: These have tuft of flagella at both poles.

V. Peritrichous: In this condition flagella surrounds the whole cell.

Most of bacteria and spiral shaped bacteria have flagella. Cocci very rarely have flagella.

Functions of Flagella:

I. Motility: Primary function of flagella is to help in motility.
II. Chemotaxis: They also help to detect and move in response to chemical signals (stimulus). It is a type of behaviour called as chemotaxis.

2. Pili and their Functions

I. Definition: These are hollow, non-helical, filamentous appendages.
II. Presence: True pili are only present on gram-negative bacteria.
III. Size: Pili are smaller than flagella.
IV. Chemical Composition: They are made up of special protein called pilin.
V. Functions: Pili are not involved in motility.
Following are their functions:
a. Mating Process (Conjugation):
They are involved in mating process called conjugation.
b. Attachment:
Some pili are used for attachment of bacteria to various surfaces.

3. The Cell Envelope (The Outer Wrapping of Bacteria)

In bacteria the complex of layers external to the cell protoplasm is called as cell envelope. It includes capsule, slime and cell wall.

(i) Capsule: Some bacteria produce capsule. It is tightly bound to the cell.
Capsule is made up of repeating polysaccharide units, or of protein, or of both.
It has a thicker, gummy nature that gives sticky characters to the colony.

(ii) Slime: It is a loose, soluble cover of macromolecules called as slime capsule. It is present some bacteria.
Slime provides greater pathogenicity to bacteria and protects them against phagocytosis

(iii) Cell Wall: Beneath the extracellular substances and external to cytoplasmic membrane is cell wall It is a rigid structure and determines the shape of bacterium.
Cell wall also protect the cells from osmotic lysis.
Cell wall is only absent in mycoplasmas.

Gram Stain Technique on the Basis of Differences in Cell Wall:

Christian Gram developed the technique of gram stain on the basis of differences in the cell wall.
On the basis of this technique bacteria can be divided into two groups:

i. Gram Positive Bacteria: These are the group of bacteria that stained purple. They retain the primary dye due to the formation of CV-I complex in the cell wall.
ii. Gram Negative Bacteria: These bacteria are stained pink because they retain secondary dye in the cell wall.

Comparison of Gram Positive and Gram-Negative Cell Wall:
Difference in staining is due to difference in structure of cell walls of two groups. It is clear from the following table:

Characteristics		Gram Positive		Gram negative	
Number of Major Layers					
(i)	Chemical mark up	(a) (b) (c) (d)	Peptidoglycan (50% of dry weight in some bacterial cells) Techoic acid Lipotechoic acid Lipids (1 – 4 %)	(a) (b) (c) (d)	Lipopolysaccharides Lipoprotein Peptidoglycan 10 % dry weight of some bacterial cells Lipids (11 – 12 %)
(ii)	Overall thickness		20 – 80 nm		8 – 11 nm
(iii)	Outer membrane		No		Yes
(iv)	Periplasmic space		Present in some		Present in all
(v)	Permeability		More permeable		Less permeable

Chemical Composition of Cell Wall:
- The cell walls of most bacteria have a macromolecule called peptidoglycan.
- Its amount varies in different types of bacteria.
- Peptidoglycan is composed of long glycan chains cross-linked with peptide fragments.
- The cell wall also contains sugar molecules, teichoic acid, lipoproteins and lipopolysaccharides. These are linked to peptidoglycan.
- Cell walls of Archaeobacteria are different from Eubacteria. They do not contain peptidoglycan. Their cell walls are composed of proteins, glycoproteins and poly saccharides.
- Cell walls of other bacterial groups: Many bacterial groups have no cell wall structure which is characteristic of gram positive or gram negative bacteria.

- No cell wall in Some Bacteria: Some bacteria have no cell wall (like Mycoplasmas).

4. Cell Membrane

I. Location: Beneath the cell wall is the cell membrane or plasma membrane.

II. Nature: It is thin, delicate, flexible and completely surrounds the cytoplasm. Any damage to results in the death of organism.

III. Chemical Composition: Bacterial membrane differs from eukaryotic membrane because it does not contain sterol (such as cholesterol).

IV. Functions: Cell membrane regulates the transport of proteins, nutrients, sugar and electrons or the metabolites.
It also contains enzymes for respiratory metabolism.

4. Cytoplasmic Matrix

i. Definition: The cytoplasmic matrix is' the substance present between the plasma membrane and the nucleoid.
   a. The plasma membrane and everything present within is known as protoplast.

ii. Properties of Cytoplasmic Matrix: It is a major part of protoplast. It has gel like consistency.
   a. Small molecules can move through it rapidly.
   b. Large separate structures such as chromatin/nuclear body, ribosomes, Mesosomes granules and nucleoid are present in this matrix.
   c. The cytoplasm of prokaryotic cell has no membrane bound organelles and cytoskeleton: (microtubules).

5. Nucleoid

I. Definition: The DNA of bacteria is a single circular and double stranded molecule. It aggregates as an irregular shaped dense material called as nucleoid.
   a. Other names for nucleoid are nuclear body, chromatin body and nuclear region. In bacteria chromosomes and nuclear membrane absent

II. Location: Nucleoid is present near the center of cell.

III. Visible in the Light Microscope: It is visible in the light microscope after staining with Feulgen stain

IV. Size: It is very long molecule of DNA which is tightly folded so as to fit in the cell component. The closed circle chromosome (DNA) of Escherichia coli is about 1.4000 11 m.

V. Haploid Organisms: Because of the presence of a single chromosome, bacteria are haploid organisms.

6. Plasmid

- In addition to the single circular DNA molecule found in all bacteria, some species also contain one or more plasmids.
- A plasmid is a small, self-replicating circle of extra DNA. It possesses only a few genes, which generally give extra survival advantage. They contain drug, heavy metals, disease and insect resistant genes.
- Some give resistance to antibiotics. For example, some staphylococci contain a plasmid which includes a gene for the enzyme penicillinase. This breaks down penicillin, thus making the bacteria resistant to penicillin.
- Other plasmid genes are known which give resistance to disinfectants. cause disease or responsible for the fermentation of milk to cheese by lactic acid bacteria
- In the modem genetic engineering techniques plasmids are important vectors. Genes are inserted in them to get complex chemicals as food, hydrocarbons, with applications in clearing oil spills and producing protein from petroleum.

7. Ribosomes

(i) Location: They are mostly free in the cytoplasm. Sometimes they are loosely attached to the plasma membranes.
(ii) Size: They are smaller (70S) than eukaryotic (80S) ribosome.
(i) Number of Ribosomes: There are thousands of ribosomes in each healthy growing cell.
(iv) Chemical Composition: Ribosomes arc composed of RNA and proteins.
(v) Function: They are protein factories.

8. Mesosomes

(i) Definition: The cell membrane, invaginate into the cytoplasm forming a structure called as Mesosomes.
(ii) Shapes of Mesosomes: Mesosomes are in the form of vesicles, tubules or lamellae.
(iii) Function: Mesosomes are involved in DNA replication. They play a role in cell division.
Some Mesosomes are involved in the export of exo-cellular enzyme.
Respiratory enzymes-are also present on the Mesosomes.

9. Granules and Storage Bodies

(i) Storage: Bacteria live in competitive environment and the nutrients become short. Therefore, the store extra nutrients when possible
(ii) Storage Materials: Storage materials may be glycogen. Sulphur, fat and phosphate. Waste materials are generally exerted in the form of alcohol, lactic acid and acetic acid.

10. Spores

Some bacteria, mainly of the genera Clostridium and Bacillus form endospores (spore produced inside cells). They are thick walled. Long lived and extremely resistant particularly to heat drought and shortwave radiations. Their position in the cell, variable and is of importance in recognition and classification.
Certain Species Bacteria Produce Spores:

(i) Formation / Production: Spores are metabolically dormant bodies and are produced at a later stage of cell growth.

(ii) Types of Spores: Spores are of two types:
  (a) Exospores: These are formed external to the vegetative cells.
  (b) Endospores: These are formed within the vegetative cells.

(iii) Properties / Functions: Spores are resistant to adverse physical environmental conditions. For example, light high temperature, desiccation, pH and chemical agents,
Under favorable conditions they germinate and form vegetative cells.

11. Cysts

(i) Definition: Cysts are dormant, thick-walled, desiccation resistant forms. However, they are not heat resistant.

(ii) Development: They are developed during differentiation of vegetative cells.

(ii) Germination: These can germinate under suitable conditions.

Nutrition of Bacteria

Why Nutrition / Energy Required?
Like other organism's bacteria need nutrition (energy) for their growth, maintenance and reproduction.

Classification of Bacteria on The Basis of Nutrition:

On the basis of nutrition bacteria are of two types which are heterotrophic and autotrophic.

1. Heterotrophic

They cannot synthesize their organic compounds from simple inorganic substances. Most bacteria are heterotrophic. They live either as the saprophytes or as the parasites.

(i) Saprophytic Bacteria: They get their food from dead organic matter. Soil is full of organic compounds in the form of humus.

Humus is the material resulting from the partial decay of plants and animals.

Many bacteria in the soil have every extensive enzyme system that break down the complex substances of humus to simpler compounds.

The bacteria absorb and use these simpler substances as a source of energy.

(ii) Parasitic Bacterial: These are fully dependent on their host for their nutrition.

2. Autotrophic bacterial

They can synthesize organic compounds from inorganic substances. Some kinds of bacteria are autotrophic. These bacteria are divided into two groups:

(i) Photosynthetic Autotrophs:

These bacteria synthesize their food by the process of photosynthesis. The chlorophyll in them is different from that of green plants.

Bacterial chlorophyll is dispersed in the cytoplasm (while in most green plants, the chlorophyll is present in the chloroplasts).

During photosynthesis these bacteria use hydrogen sulphide (H_2S) instead of water as a hydrogen source and release sulphur instead of oxygen.

The overall reaction of photosynthesis in photosynthetic bacteria is:

$$CO_2 + H_2 2S \xrightarrow[\text{Chlrophyll}]{\text{Light}} (CH_2O) + H_2O + 2S$$

Examples:

Green Sulphur bacteria, purple Sulphur bacteria and purple non-Sulphur bacteria are photosynthetic bacteria.

(ii) Chemosynthetic Autotrophs:

These bacteria can, oxidize inorganic compounds like ammonia, nitrate. nitrite, Sulphur or ferrous iron. As a result, the energy is released which is used for their synthetic reactions, Nitrifying bacteria are chemosynthetic.

Respiration in Bacteria

On the basis of mode of respiration bacteria are divided into following groups:

1. Aerobic Bacteria:

These are able to grow in the presence of oxygen. Pseudomonas is an aerobic bacterium.

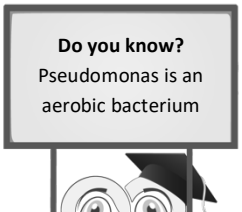
2. Anaerobic Bacteria:

These can grow in the absence of oxygen. Spirochete is anaerobic bacterium.

3. Facultative Bacteria:

These bacteria can grow either in the presence or absence of oxygen. E. coli is a facultative anaerobic bacterium.

4. Microaerophilic:



Some bacteria require a low concentration of oxygen for growth and are known as microaerophilic. Example is Campylobacter.

Growth and Reproduction in Bacteria

Bacterial Growth:

The increase in number of bacterial cells is called as bacterial growth. This increase in number occurs by asexual reproduction.

Asexual Reproduction:

In bacteria asexual reproduction occurs by means of binary fission.

(i) Binary Fission: The division of a prokaryotic cell into two identical daughter cells is called IS binary fission. Following processes occur in binary fission:

- Parent cell enlarges
- Its chromosome duplicates
- Plasma membrane pinches inward at the center of the cell
- When nuclear material has been equally distributed, the cell wall grows inward to separate cell into two.

Repeating the Process:

This sequence is repeated at intervals by each new daughter cell. As a result, the population of cells increases. Once the division is complete, bacteria grow and develop their specific features.

Generation Time:

The time interval until the completion of next division is known as generation time. In the fastest growing bacteria such divisions may occur as often as every 20 minutes.

Bacterial Growth Curve:

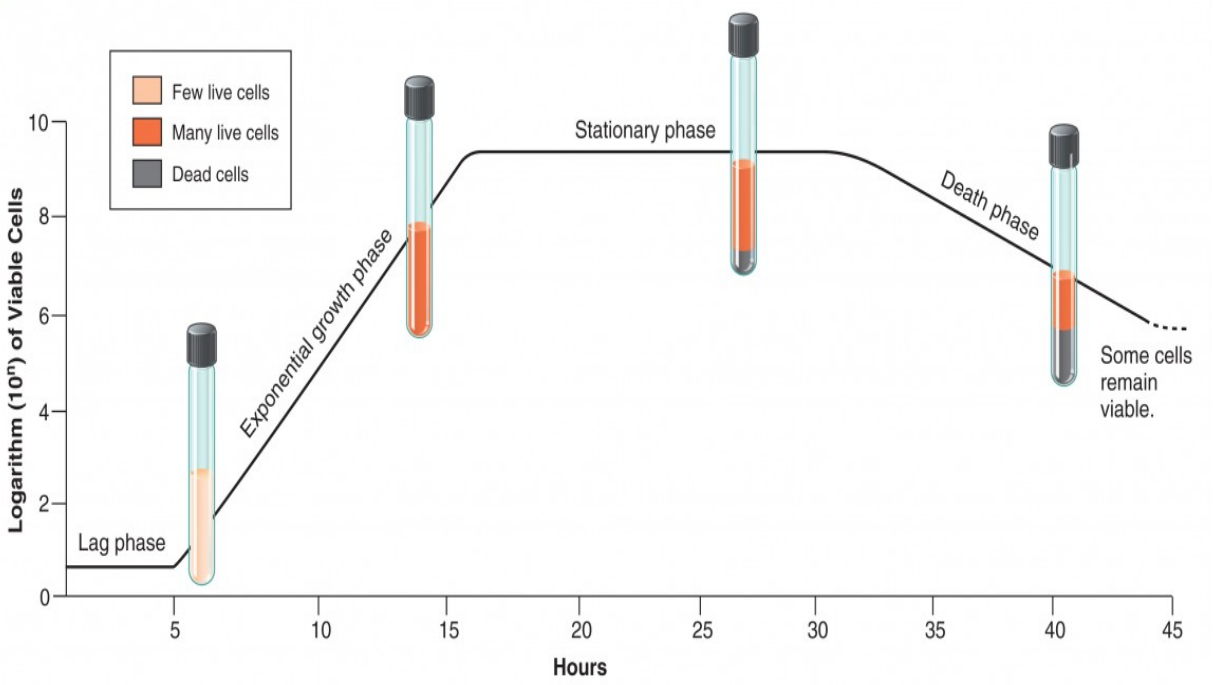
Four different phases are known in bacterial growth curve.

(i) Lag Phase: It is phase of no growth. Bacteria prepare themselves for division.

(ii) Log Phase: It is phase of rapid growth. Bacteria divide at exponential rate.

(iii) Stationary Phase: Bacterial death rate is equal to the bacterial rate of reproduction and multiplication.

(iv) Death/Decline Phase: Bacteria start dying. Death rate is more than reproduction rate.



Total cells in population, live and dead, at each phase.

Sexual Reproduction:

- In 1946 it was discovered that bacteria can take part in a primitive form of sexual reproduction. The usual process of sexual reproduction and mitosis is absent in bacteria.
- Gametes are not involved, but the exchange of genetic material does take place and is called genetic recombination. It is generally by conjugation.
- Conjugation involves transfer of DNA between cells in direct contact. One cell acts as the donor (male) and the other as the recipient (female).
- The ability to serve as a donor is determined by genes in a special type of plasmid called the sex factor, or F factor (F for fertility). This forms the protein of a special type of pilus the F pilus or sex pilus. This enables cells to come into contact. The pilus is hollow and the DNA passes through the pilus from the donor (F^+) to the recipient (F).

Advantages of Sexual Reproduction (Conjugation):

Due to conjugation new genetic combinations are produced. As a result, these bacteria can survive in many different conditions.

Mutualism (or symbiosis) is the name given to any form of close relationship between two living organisms in which both partners benefit.

Examples of bacterial mutualists are Rhizobium, a nitrogen-fixer living in the root nodules of legumes such as pea and clover, and Escherichia coli, which

inhabits the gut of humans and probably contributes vitamins of the Band K groups.

Importance of Bacteria

We will discuss importance of bacteria under following headings:

1. Ecological Importance:

Bacteria are ecologically very important. This is because of the following reasons:

(i) Highly Adaptable:
They are highly adaptable and found almost everywhere.

(ii) Decomposition:
They decompose organic matter. In this way they prevent the accumulation of dead material and metabolic wastes.

(iii) Recycling of Elements:
They play important role in the completion of nitrogen, phosphorus, sulfur and carbon cycles.

2. Economic Importance

Bacteria are economically very important. Their beneficial and harmful effects are as follows:

(i) Beneficial Effects:
- (a) Food Production: They are used in food production.
- (b) Vaccine and Antibiotics: Bacteria are involved in the production of antibiotics and vaccines,
- (c) Drugs: They are used in the formation of many different kinds of drugs.
- (d) Biotechnology: They are used in biotechnology.

(ii) Harmful Effects:
- (a) Spoilage of Food and Vegetables: Bacteria are also responsible for spoilage of food and vegetables.
- (b) Plant Pathogens: Many plant pathogens adversely affect the agriculture.
- (c) Animal/Human Pathogens: Bacteria are very common pathogens of man and other animals. About 200 species of bacteria cause diseases in man.

Control of Bacteria

Microorganisms can be controlled by various methods.

1. Physical Methods

Many physical methods are applied to prevent bacteria. For example, steam, dry heat, gas, filtration and radiation.
The process in which we use physical agents to control bacteria/microorganism is known as sterilization process. Sterilization is destruction of all life forms.

(i) High Temperature Treatment: High temperature is used in microbiological labs for control of microbes. Both heat and moist heat are used.

(a) Moist Heat: Moist heat causes coagulation of proteins and kills the microbes.

(b) Dry Heat: Dry heat causes oxidation of different chemicals of microbe's end kills them.

(ii) Radiations: Certain electromagnetic radiations below 300 nrn can effectively kill the microorganisms Gamma rays are commonly used for sterilization process.

(iii) Membrane Filters: Heat sensitive compounds like antibiotics series, hormones etc., are sterilized by membrane filters.

2. Chemical Methods

Chemical methods for control of bacteria include antiseptics, disinfectants are chemotherapeutic agents.

(i) Antiseptics: These are chemical substances used on living tissues to kill and inhibit the growth microorganism.

(ii) Disinfectants: These chemical agents are used to inhibit the growth of vegetative cells on the nonliving materials.
These include oxidizing and reducing agents. For example, halogens, phenols, hydrogen peroxide, Potassium permanganate, alcohol and formaldehyde etc.

(iii) Chemotherapeutic: Chemotherapeutic agents and antibiotics work with natural defense and stop the growth of bacteria and other microbes. They destroy or inhibit the growth of microorganisms living tissues. These are Sulfonamides, tetracycline, penicillin, etc.
Some other processes that kill / inhibit the microbial population are:

(a) Microbicidal Effect: Microbicidal effect is one that kills the microbes immediately.

(b) Microbistatic: Microbistatic inhibits the reproductive capacities of the cells and maintain the microbial population at constant size.

Mode of Action:

Mode of action, of different physical and chemical agents, of control vary. Damage occurs due to malfunctions in cell wall, cell membranes, cytoplasm, enzymes or nucleic add.

Use and Misuse of Antibiotics

1. Antibiotics: (Greek word Anti, against, and Bios, life)

Antibiotics are the chemotherapeutic chemical substances used in treatment of infectious diseases.

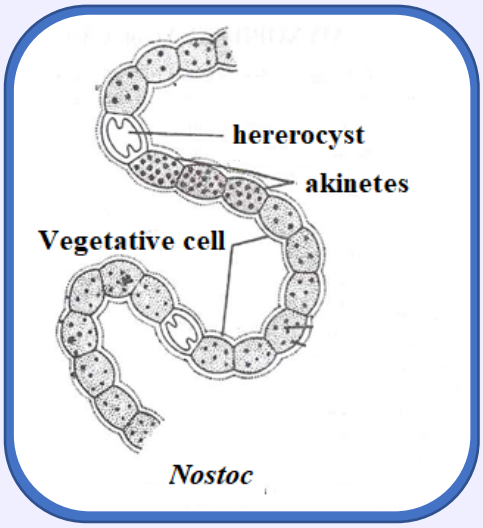
2. Origin: They are synthesized and secreted by bacteria, actinomycetes, fungi and in the laboratory however, their origins are living cells.
3. Selection of Antibiotics: To select the antibiotic, we must know:
   Its mode of action and Possible adverse (side) effects
4. Use of Antibiotics: Use antibiotics as prescribed by the physicians
   Take dose at regular intervals and complete the treatment as advised by the doctor.
5. Adverse Effects of Antibiotics: The misuse of antibiotics results in the following adverse effects:
   (i) Drug Resistance: The great use 01 antibiotics, is followed by the problems of drug resistance in microorganisms. Due to this, resistance against disease treatments is increasing.
   (ii) Interact with Human Metabolism: Misused antibiotics can interact with the human metabolism and may cause death.
   (iii) Allergic Reactions: Misuse of antibiotic like penicillin can cause allergic reactions.
   (iv) Deafness: Streptomycin can affect auditory nerve. The result is deafness.
   Discoloration of Teeth: Tetracycline and its related compounds cause permanent discoloration of the teeth in the young children.

- Microbicidal effect is one that kills the microbes immediately.
- Microbiastic inhibits the reproductive capacities of the cells and maintains the microbial population at constant size.

Additional/Related Readings

1. Kingdom Prokaryote (prokaryotic cells) includes Bacteria and cyanobacteria.
2. Microbiologists place bacteria in two major groups: EUBACTERIA (In Greek it means "true bacteria") and Archaeobacteria (In Greek it means "ancient bacteria".
3. The discovery of small organisms (like bacteria) was linked with the invented in of microscope.
4. Antonie Van Leeuwenhoek was a Dutch Scientist and in 1673 he reported the microbes (such as bacteria and protozoa) for the first time. He called these small creatures as "animalcules".
5. Louis Pasteur developed the vaccines for diseases anthrax, fowl cholera and rabies.
6. Louis Pasteur proved that microorganism could cause disease. He also developed pasteurization process and fermentation.
7. Robert Koch isolated rod-shaped bacteria with squarish ends (bacilli) from the blood or sheep that was died of anthrax.
8. Robert Koch formulated the germ theory of disease which has four postulates.
9. Koch and his colleagues invented many techniques for: inoculation, isolation and media preparation, maintenance of pure cultures and preparation of specimens for microscopic studies.
10. Some bacteria are present in specific environments. For example: hot springs, alkaline/acidic soil, highly saline environments, in highly polluted soils and waters etc.
11. The size of bacteria is from 0.1 to 600 µm.
12. The procedures used to eliminate or reduce infection is called antisepsis
13. The cyanobacteria are the largest and the most diverse group of photosynthetic bacteria previously called blue green algae.
14. Cyanobacteria are true' prokaryotes. They range in diameter from 1-10 urn. They have Gram-negative type cell wall.
15. Cyanobacteria may be unicellular, colonial or filamentous
16. Filaments cyanobacteria consisting of trichomes surrounded by mucilaginous sheath
17. In cyanobacteria flagella are absent. They use gas vesicles to move in the water.
18. A trichome is a chain of cells within the filament. Due to gas vesicles many filamentous species have gliding motility.
19. For photosynthesis the cyanobacteria have chlorophyll a and photosystem II.
20. Bacteria have sulfogenic photosynthesis while cyanobacteria have oxygenic photosynthesis.
21. In Cyanobacteria, Photosynthetic pigments and electron transport chain is in thylakoid membranes linked with particles called phycobilisomes.

22. In Cyanobacteria, CO_2 is assimilated through the Calvin cycle.
23. Phycocyanin pigment (blue) is their predominant phycobilin, Cyanobacteria use phycobilins as accessory pigments.
24. Reserve food material in cyanobacteria is glycogen.
25. Cyanobacteria reproduce by binary fission and fragmentation, Hormogonia, akinetes and heterocysts may also form in it.
26. Cyanobacteria: Formally called blue-green algae, single rod-shaped or spherical prokaryotic cells that occur in clusters or in long filamentous chains and' carry out photosynthesis by means of chlorophyll a, carotenoids, and red and blue pigments.
27. Cyanobacteria have heterocysts, which are helpful in the fixation of atmospheric nitrogen.
28. Super blue green algae is a single celled organism that produces its own food through photosynthesis. It serves as a "complete whole food" which contains 60 proteins with all essential amino acids.
29. Oscillatoria and few other cyanobacteria can be used as pollution indicator.
30. Many species of cyanobacteria form water blooms.
31. Nostoc is common in terrestrial and subaerial environment.
    Note: Gas vesicles are not true membranous organelles in the cyanobacteria.
32. Nostoc forms a jelly like mass in which many filaments are embedded.
33. Trichome breaks near heterocyst to form fragments called hormogonia.
34. In cyanobacteria there is no sexual reproduction. However asexual reproduction is present.
35. Pieces of trichome or filament are Hormogonia.
36. Akinetes are thick walled, enlarged vegetative cells which accumulate food and become resting cells.



37. Binary fission: The division of prokaryotic cells into two identical daughter cells.
38. Chemoautotroph: An organism deriving energy from the oxidation of inorganic compounds
39. Eubacteria: Literally, "true bacteria"; by far the most abundant group of prokaryotes
40. Gram negative bacteria: Bacteria, such as E. coli, whose cell walls are surrounded by a lipid bilayer and hence do not take up iodine dye (crystal violet) during staining.
41. Gram positive bacteria: Bacteria having a peptidoglycan cell wall, which takes up crystal violet dye and hence appears to stain purple under the light microscope.
42. Heterotroph: An organism that obtains energy for cellular processes by taking in food consisting of whole autotrophs or other heterotrophs, their parts, or their waste products
43. Humus: One of four main constituents of soil, humus consists of decomposing organic, materials that release nutrients and prevent soil from compacting.
44. Nitrogen fixation: The conversion in plants of atmosphere N_2 to a usable form, NH^4(ammonium ion)
45. Nucleoid: A dense, unbounded area within a prokaryotic cell that encompasses the eel. single chromosome and serves much like a nucleus.
46. Obligate aerobe: An organism, generally a bacterium, which must have oxygen form metabolic processes.
47. Phycobilin: A pigment in red algae that gives the algae their color and enables them capture green and blue wavelength of light in, deep water.
48. Obligate aerobe: An organism, generally a bacterium, which must have oxygen form metabolic processes.

Assessment 1

1. First phase in the growth curve is:
(a) Lag phase (b) Log phase
(c) Stationary phase (d) Decline phase

2. Which one of the following is the most resistant stage found in bacteria?
(a) Cyst (b) Fission stage
(c) Endospore (d) Capsulated stage

3. In some bacteria, surface appendages to attach one another or to host organisms are:
(a) Flagella (b) Pili
(c) Hapteron (d) Fimbriae

4. In bacteria, the enzymes for oxidation of metabolites are present in:
(a) Pili (b) Oxysomes
(c) Thylakoids (d) Mesosomes

5. Accessory genes of bacteria are present in:
(a) Plasmids (b) Nucleoid
(c) RNA (d) Plasmids and nucleoids

6. Bacterial flagella are made up of:
(a) Flagellin (b) Tubulin
(c) Actin (d) Myoglobin

7. In bacteria, aerobic respiration is supported by:
(a) Cell wall and capsule (b) Cell wall and membrane
(c) Cell membrane and mesosomes (d) Cell wall and mesosome

8. A plasmid integrated into bacterial DNA is called:
(a) Episome (b) Provirus
(c) Prophage (d) Induction

9. In bacteria, cell membrane invaginates into the cytoplasm forming a structure called:
(a) Mesosome (b) Ribosome
(c) Lysosome (d) Glyoxysome

10. If a bacterial cell divides in every 20 minutes, how much time it will take in the formation of bacteria?
(a) 20 minutes (b) 60 minutes
(c) 80 minutes (d) 40 minutes

Assessment 2

1. Which of the following is archaeobacteria?
(a) Methanogenic (b) Pseudomonas
(c) Green sulfur (d) Purple non-sulfur

2. Bacteria differs from viruses in having:
(a) Cytoplasm (b) Protein
(c) DNA (d) Infectious nature

3. An example of respiratory and digestive disease:
(a) Tuberculosis (b) Cholera
(c) Jaundice (d) Dysentery

4. In which activity Robert Koch was not involved:
(a) Preparation of specimen for microscopic examination
(b) Discovery of bacteria that caused anthrax
(c) Development of vaccine for anthrax and cholera
(d) Formulation of germ theory of disease

5. Where are bacteria present?
(a) Oil deposits (b) Highly saline environment like dead sea
(c) Hot springs (d) All of these

6. Some members of genus mycoplasma have size range about:
(a) 100 – 200 nm (b) 1.1 – 1.5 nm
(c) 2.0 – 6.0 nm (d) 0.75 – 1.25 nm

7. The simplest of the oxygen producing photosynthetic organisms are:
(a) Bacteria (b) Cyanobacteria
(c) Algae (d) Fungi

8. Some bacteria that can exist in variety of shapes are called:
(a) Pleomorphic (b) Hetromorphic
(c) Morphovariants (d) Spirobacillus or coccobacillus

9. Cocci bacteria are found in different arrangements, which are based on:
(a) Plane of cell division (b) No. of cells found in a particular arrangement
(c) Shape of the cell (d) Both a and b

10. Which one is the example of cocci bacteria?
(a) Pseudomonas (c) Hyphomicrobium
(b) Escherichia coli (d) None of them

Assessment 3

1. Cocci bacteria are generally:
(a) Peritrichous (b) Lophotrichous
(c) Amphitrichous (d) Atrichous

2. Function of bacterial endospore is:
(a) Reproduction (b) Survival
(c) Protein synthesis (d) Storage

3. A bacterium with tuft of flagella at two poles is:
(a) Atrichous (b) Amphitrichous
(c) Monotrichous (d) Lophotrichous

4. Cells of the trichome break at the point next to heterocyst and each piece is:
(a) Fragment (b) Hormogonium
(c) Segment (d) Peritoneum

5. In gram negative bacteria, lipids are:
(a) 10 (b) 12
(c) 11 (d) 11 – 12

6. The bacterium E.coli is:
(a) Microaerophilic (b) Facultative anaerobic
(c) Aerobic (d) Anaerobic

7. Which one is the phase of rapid growth in bacteria?
(a) Log (b) Lag
(c) Stationary (d) Decline

8. In bacteria, main waste materials are:
(a) Alcohol (b) Acetic acid
(c) Lactic acid (d) Alcohol, lactic acid and acetic acid

9. In bacteria the dormant, thick-walled, non-heat resistant forms and develop during differentiation of vegetative cells which can germinate under suitable condition are:
(a) Exospores (b) Cysts
(c) Endospores (d) Zoospores

10. The process in which we use physical agents to control bacteria/microorganism is known as:
(a) Sterilization (b) Immunization
(c) Vaccination (d) Pasteurization

Assessment 4

1. Bacteria fully dependent on their host:
(a) Parasitic (b) Chemosynthetic
(c) Photosynthetic (d) Heterotrophic

2. Gram positive bacteria contain less of _____ as compared to gram negative.
(a) Peptidoglycan (b) Lipoid materials
(c) Permeability (d) Techoic acid

3. Slime provides greater pathogenicity to bacteria by:
(a) Attaching them at target site
(b) Protecting them from the effect of antibiotics
(c) Protecting them against phagocytosis
(d) All of the above

4. Bacterial cell membrane differs from eukaryotic cell membrane by:
(a) Lacking cholesterol
(b) Containing enzyme for respiratory metabolism
(c) Forming infolding like mesosome
(d) All of the above

5. Rod shaped bacteria are:
(a) Cocci (b) Bacilli
(c) Spirilla (d) Vibrius

6. Which of the following is present in both gram positive and gram negative walls?
(a) An outer membrane (b) Peptidoglycan
(c) Teichoic acid (d) Lipopolysaccharides

7. Asexual reproduction in bacteria occur by:
(a) Conjugation (b) Binary fission
(c) Multiple fission (d) Transformation

8. In bacteria chlorophyll is present in:
(a) Ribosomes (b) Mesosomes
(c) Plasmids (d) Cytoplasm

9. In gram positive bacteria, overall thickness of cell wall is:
(a) 20 – 80 nm (b) 20 – 60 nm
(c) 8 – 11 nm (d) 1 – 4 nm

10. The bacteria which exist in grape like cluster are called:
(a) Staphylococci (b) Coccobacillus
(c) Streptobacillus (d) Pleomorphic

Key

Assessment 1

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

Assessment 2

11. a
12. a
13. a
14. c
15. d
16. a
17. b
18. a
19. b
20. d

Assessment 3

21. d
22. b
23. b
24. b
25. d
26. a
27. a
28. d
29. b
30. a

Assessment 4

31. a
32. a
33. d
34. a
35. b
36. b
37. b
38. d
39. a
40. a