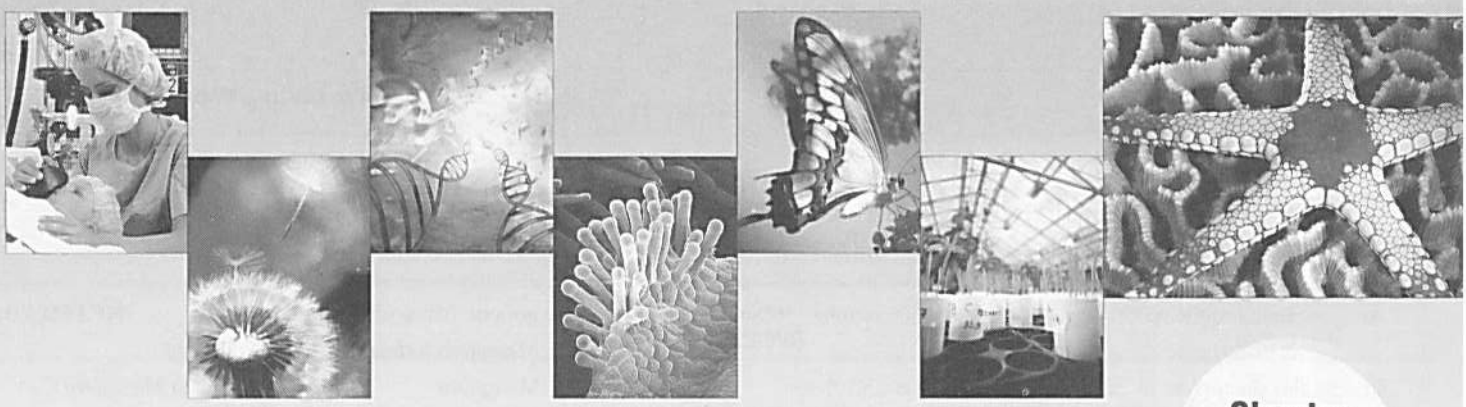


Chapter

1.2

Monera (Prokaryotes)

Characteristics of Monera

Monera (*Monos – single*) includes prokaryotes and shows the following characters :

(1) They are typically unicellular organisms (but one group is mycelial).

(2) The genetic material is naked circular DNA, not enclosed by nuclear envelope.

(3) Ribosomes and simple chromatophores are the only subcellular organelles in the cytoplasm. The ribosomes are 70 S. Mitochondria, plastids, golgi apparatus, lysosomes, endoplasmic reticulum, centrosome, etc., are lacking.

(4) Sap vacuoles do not occur. Instead, gas vacuole may be present.

(5) The predominant mode of nutrition is absorptive but some groups are photosynthetic (holophytic) and chemosynthetic.

(6) The organisms are non-motile or move by beating of simple flagella or by gliding.

(7) Flagella, if present, are composed of many intertwined chains of a protein **flagellin**. They are not enclosed by any membrane and grow at the tip.

(8) Moneran cells are microscopic (1 to few microns in length).

(9) Most organisms bear a rigid cell wall (Peptidoglycan).

(10) Reproduction is primarily asexual by binary fission or budding. Mitotic apparatus is not formed during cell division.

(11) The kingdom Monera includes true bacteria, mycoplasma, rickettsias, actinomycetes (ray fungi) etc. Microbiologists also include blue green algae (*i.e.*, Cyanobacteria) under the group of bacteria because of the presence of prokaryotic cell structure. Studies have established that the members of archaebacteria group are the most primitive and have separated from eubacteria group very early in the process of evolution.

Bacteria

Study of bacteria is called bacteriology. *Linnaeus* placed them under genus vermes. *Nageli* classified bacteria under schizomycetes. Bacteria are unicellular, microscopic and cosmopolitan organisms. The branch of science, which deals with the study of microorganism and their process is called as microbiology. ***Antony Van Leeuwenhoek*** is known as father of bacteriology and father of modern microbiology is ***Robert Koch***.

These are the smallest cell wall having prokaryotic cell. The bacteria constitute a highly specialised group of one celled plants. They differ from animals in having a rigid cell wall and being capable to synthesize vitamins. Bacteria were first seen by a Dutch lens maker, Antony Van Leeuwenhoek (1683) who named them **animalcules**. *Louis Pasteur* (1822-95) made a detailed study of bacteria and proposed *germ theory of disease*. *Ehrenberg* (1829) was the first to use the term **bacterium**. *Robert Koch* (1881) found that some diseases like tuberculosis, cholera in man, and anthrax in cattle is caused by bacteria. *Lister* introduced antiseptic surgery. He used carbolic acid for sterilization of surgical instrument. Pasteurization theory was proposed by *Louis Pasteur*.

(1) **Size :** They are 3 to 5 microns (1μ = 1/1000 *millimetre* or about 1/25,000 *inch*) in length. A few species of bacteria are approximately 15μ in diameter.

❑ Smallest known bacterium is *Dialister pneumonsintes* (0.15–0.3μ).

❑ Largest known bacterium is a recently discovered bacterium *thiomargarita namibiensis* (earlier *Bacillus buschili* in cockroach and *Spirillum volutans* were considered to be the largest bacteria).

(2) **Shape :** The bacteria possess the following forms :

Cocci (Gk. *Kokkos* = Berry) : They are oval or spherical in shape. They are called micrococcus when occur singly as in *Micrococcus*, diplococcus when found in pairs as in *Diplococcus pneumoniae*, tetracoccus in fours, streptococcus when found in chains as in *Streptococcus lactis*, staphylococcus when occurring in grape like clusters as in *Staphylococcus aureus* and *Sarcine*, when found in cubical packets of 8 or 64 as in *Sarcina*.

Bacilli : They are rod–shaped bacteria with or without flagella. They may occur singly (bacillus), in pairs (diplobacillus) or in chain (*streptobacillus*).

Vibrios : These are small and 'comma or kidney' like. They have a flagellum at one end and are motile, vibrio bacteria has curve in its cell *e.g., Vibrio cholerae*.

Spirillum (Spira = Coil) : They are spiral or coiled like a cork-screw. The spirillar forms are usually rigid and bear two or more flagella at one or both the ends *e.g., Spirillum, Spirochaetes* etc.

Filament : The body of bacterium is filamentous like a fungal mycelia. The filaments are very small *e.g., Beggiota, Thiothrix* etc.

Stalked : The body of bacterium possesses a stalk *e.g., Caulobacter*.

Budded : The body of bacterium is swollen at places *e.g., Rhodomicrobium*.

(3) **Flagellation :** Depending upon the presence or absence of flagella, the bacteria are of following types :

Atrichous : When the flagellum is absent it is called atrichous. *e.g., Pasteurella pestis, Lactobacillus*.

Monotrichous : Only one flagellum is found at one end. *e.g., Vibrio cholerae*.

Lophotrichous : When a group of flagella is present at one end *e.g., Spirillum volutans*.

Amphitrichous : When single or group of flagella is present at both the end *e.g., Nitrosomonas*.

Peritrichous : A number of flagella are present all over the body. *e.g., E. coli, Clostridium tetani*.

Staining of bacteria

(1) **Simple staining :** The coloration of bacteria by applying a single solution of stain to a fixed smear is termed simple staining. The cells usually stain uniformly.

(2) **Gram staining :** This technique was introduced by *Hans Christian Gram* in 1884. It is a specific technique which is used to classify bacteria into two groups Gram +ve and Gram –ve. The bacteria are stained with weakly alkaline solution of crystal violet. The stained slide of bacteria is then treated with 0.5 percent iodine solution. This is followed by washing with water or acetone or 95% ethyl alcohol. The bacteria which retain the purple stain are called as Gram +ve. Those which become decolourised are called as Gram –ve. In general the wall of Gram +ve bacteria have simpler nature as compared to Gram –ve bacteria. *E.coli* is a Gram –ve bacterium. Gram negative bacterium can be seen with other stain safranin.

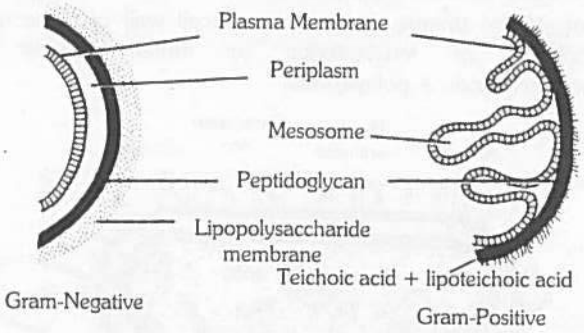


Fig : 1.2-1 Difference between cell walls of Gram-negative and Gram- positive bacteria

Gram positive bacteria : *e.g., Pneumococcus, Streptococcus, Staphylococcus, Bacillus, Clostridium, Mycobacterium, Streptomyces.*

Gram negative bacteria : *e.g., Salmonella, Pseudomonas, Escherichia, Haemophilus, Helicobacter, Vibrio, Rhizobium.*

Table : 1.2-1

Gram + Positive	Gram – Negative
Cell wall thick (250 – 300 Å).	Cell wall thin (100 – 150 Å)
Cell wall homogenous.	Cell wall heterogenous.
Cell wall single layered.	Cell wall 3-layered.
Cell wall more rigid.	Cell wall less rigid
Cell wall made up of mucopeptide (80%).	Cell wall made up of lipoprotein, mucopeptide and lipopolysaccharide.
Teichoic acid (5 – 10%) present.	Teichoic acid absent.
Spore producing forms included.	No spore producing form.
Polar flagellum usually absent.	Polar flagellum usually present.
Contain Mg-ribonucleate.	Mg-ribonucleate absent.
May produce exotoxins.	May produce endotoxins.
Sensitive to penicillin.	Not sensitive to penicillin.
L-lysin present in peptide	Diamino palmilic acid present in peptide.
O-antigen absent	O-antigen present

Structure of bacteria

(1) **Capsule :** In a large number of bacteria, a slimy capsule is present outside the cell wall. It is composed of polysaccharides and the nitrogenous substances (amino acids) are also present in addition. This slime layer becomes thick, called capsule. The bacteria, which form a capsule, are called capsulated or virulent bacteria. The capsule is usually found in parasitic forms *e.g., Bacillus anthracis, Diplococcus pneumoniae, Mycobacterium tuberculosis*.

(2) **Cell wall :** All bacterial cells are covered by a strong, rigid cell wall. Therefore, they are classified under plants. Inner to the capsule cell wall is present. It is made up of polysaccharides, proteins and lipids.

In the cell wall of bacteria there are two important sugar derivatives are found *i.e.*, NAG and NAM (N-acetyl glucosamine and N-acetyl muramic acid) and besides L or D - alanine, D-glutamic acid and diaminopimelic acid are also found.

One of the unique components of cell wall of bacteria is peptidoglycan or mucopeptide or murein (made of mucopolysaccharide + polypeptide).

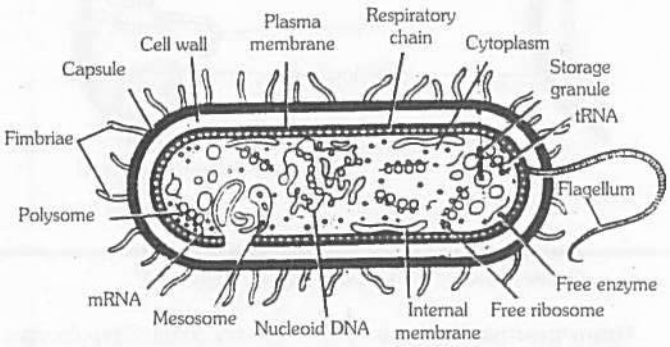


Fig : 1.2-2 Electron microscope structure of a bacterium cell

(3) **Plasma membrane :** Each bacterial cell has plasma membrane situated just internal to the cell wall. It is a thin, elastic and differentially or selectively permeable membrane. It is composed of large amounts of phospholipids, proteins and some amounts of polysaccharides but lacks sterols. It is characterised by possessing respiratory enzymes.

Mesosome : On the plasma membrane generally at mid point, there are present some circular coiled bodies called mesosomes. So mesosomes are simply infoldings of plasma membrane. Mesosomes contain respiratory enzymes like oxidases and dehydrogenases and hence they help in respiration. Hence mesosomes are also known as "mitochondria of bacterial cell" or chondrioides. Mesosomes are more prominent in Gram +ve bacteria.

- It receive DNA during conjugation and DNA replication enzyme.
- Mesosome participate in the formation of septa during cell division.

(4) **Cytoplasm and Cytoplasmic inclusions :** The cytoplasm is a complex aqueous fluid or semifluid ground substance (matrix) consisting of carbohydrates, soluble proteins, enzymes, co-enzymes, vitamins, lipids, mineral salts and nucleic acids. The organic matter is in the colloidal state.

The cytoplasm is granular due to presence of a large number of ribosomes. Ribosomes (70S) in bacteria are found in the form of polyribosome. Membranous organelles such as mitochondria, endoplasmic reticulum, golgi bodies, lysosomes and vacuoles are absent.

Volutin granules : They were first reported in *Spirillum volutans* bacteria. These are also known as metachromatic granules, which are composed of polyphosphate. Volutin serves as a reserve source of phosphate.

Poly-β-hydroxy butyric acid granules (PHB) : These are polymer of lipid like material and chloroform soluble which are often found in aerobic bacteria especially under high carbon low nitrogen culture conditions. Granules can serve as a reserve carbon and energy source.

Glycogen and Sulphur granules : Glycogen are also known as polysaccharide granules. It can be stained brown with iodine. By electron microscopy they appear as dark granules.

(5) **Nucleoid :** It is also known as genophore, naked nucleus, incipient nucleus. There is present nuclear material DNA which is double helical and circular. It is surrounded by some typical protein (polyamine) but not histone proteins.

(6) **Plasmid :** In addition to the normal DNA chromosomes many bacteria (*e.g.*, *E.coli*) have extra chromosomal genetic elements or DNA. These elements are called plasmids. Plasmids are small circular double stranded DNA molecules. The plasmid DNA replicates independently maintains independent identity and may carry some important genes. Plasmid term was given by *Lederberg* (1952). Some plasmids are integrating into the bacterial DNA chromosome called episomes.

Types of plasmid

(i) **F-factor or Fertility factor :** Which is responsible for transfer of genetic material.

(ii) **R-factor or resistance factor :** It provides resistance against drugs.

(iii) **Colicinogenic factor :** Which produces 'Colicines' which kill other bacteria (other than which produce these colicines).

(7) **Flagella :** These are fine, thread-like, protoplasmic appendages which extend through the cell wall and the slime layer of the flagellated bacterial cells. These help in bacteria to swim about in the liquid medium.

The diameter of each subunit is about 40-50Å. These subunits are arranged around a hollow axis. A flagellum is usually 4.5μ long and 120-185Å in diameter. Flagellum is attached to cell membrane by a special terminal hook, which is attached to the basal body called (blepharoplast). A bacterial flagellum can be divided into three parts – (Basal granule, Hook and Filament).

(8) **Pili or Fimbriae :** Besides flagella, some tiny or small hair-like outgrowths are present on bacterial cell surface. These are called pili and are made up of pilin protein. They measure about 0.5–2μm in length and 3–5μm in diameter. These are of 8 types I, II, III, IV, V, VI, VII, and F types. I to F are called sex pili. These are present all most all gram –ve bacteria and few gram +ve bacteria. Fimbriae take part in attachment like holding the bacteria to solid surfaces.

Reproduction in bacteria

Vegetative reproduction

(1) **By budding :** According to *Bisset* and *Hale*, reproduction by budding takes place in *Bigidi bacterium bifidus*.

(2) **By binary fission :** This type of reproduction is most common in all kinds of bacteria. Under favourable conditions bacterial cell expands. Cytoplasm divides into two parts due to constriction and formation of a transverse septum in the centre of the cell. Later on, these two parts separate from each other and give rise to two cells.

Asexual reproduction

(1) **By endospores :** Endospores are formed in all species of the genera *Bacillus* and *Clostridium*. In each cell only one endospore is formed. Endospore is highly resistant to very high and very low temperature.

Endospore is found either in the centre or near the cell wall. Under unfavourable conditions cytoplasm shrinks and gets rounded and around it a hard protective three layer is formed. Each endospore may be either circular, ellipsoidal or semicircular. When favourable conditions come, outer layers rupture and active bacterial cell comes out. So this is a method of perennation (*i.e.*, to tide over unfavourable condition) and some people say it "reproduction without multiplication".

(2) **By conidia :** Some filamentous bacteria *e.g.*, *Streptomyces* reproduce by means of conidia. The conidia are spore like in structure and are formed in chains. Each conidium gives rise to a new bacterium.

(3) **By zoospores :** In rare cases bacterial cell forms some motile spores which give rise to new cells. This process has been rarely seen. *e.g.*, *Rhizobium*.

Sexual reproduction (Genetic recombination)

Sometimes it was believed that sexual reproduction does not take place in bacteria. *Lederberg* and *Tatum* (1946) proved that sexual reproduction takes place in bacteria. On the basis of this discovery they were awarded Nobel Prize.

According to the present view, three types of sexual reproduction are found in bacteria :

(1) **Transformation :** In this process one kind of bacterium is transformed into another kind. It takes place by transferring DNA from capsulated to non-capsulated bacterium. For the first time *Griffith* (1928) reported transformation in mice. Later on, *Avery, McLeod* and *McCarty* (1944) studied transformation in *Diplococcus pneumoniae*.

(2) **Transduction :** In this process DNA of a bacterial cell is transferred into another bacterial cell through bacteriophage – a kind of virus which is parasitic upon bacteria. Bacteriophage consists of DNA. It has been now accepted that DNA of a bacterial cell is transferred through bacteriophage to another bacterium. Transduction was first of all reported by *N.D. Zinder* and *Lederberg* (1952) in bacteria *Salmonella typhimurium*.

(3) **Conjugation :** In this process genetic material from one strain of bacterium which is known as *male* is transferred into another strain of bacterium which is known as *female*. On the experimental basis it is believed that genetic material of male enters into female bacterium in the form of a straight line. *Lederberg* and *Tatum* first of all reported conjugation in bact.0erial strain of *E.coli* called K_{12} (1946). In 1966, *Wollman* and *Jacob* described it in details.

In gram negative bacteria, there are two strains, F^+ (with fertility factor and sex pili) and F^- (without fertility factor and sex pili). These two can come together. Sex pilus of donor cell extrudes a protein that helps it in attaching to the recipient cell. Latter on, sex pilus is converted into conjugation tube between the two. The donor or F^+ can transfer its fertility factor or plasmid to recipient cell or F^- and convert it into donor as well. Sometimes the F^+ plasmid attaches to nucleoid, becomes episome and converts the donor into HFr (high frequency of recombination 1 : 100). There is a transfer of few genes of nucleoid from HFr to F^-. HFr quality can also be transferred occasionally (HFr × F^- = F^- plus a few genes and a few HFr). The transferred segment is called **exogenote** which 'similar' segment of the recipient bacterium is known as **endogenote**. The recipient bacterium is called **merozygote** or **partial zygote**. Some of the donor genes integrate into recipient genome.

In gram positive bacteria sex pili do not develop. Donor cells produce a protein **adhesion** over their surface for bringing recipient cells in contact with them. In *Streptococcus faecalis*, the recipient cells excrete a small peptide (sex hormone) for inducing clumping. Wall dissolves in the region of contact. Transfer of DNA segment occurs from donor to recipient cell.

Respiration in bacteria

With respect to oxygen requirement and mode of cellular respiration, bacteria distinctly belong to two broad categories :

(1) **Aerobic respiration**

Obligate aerobes : These bacteria grow exclusively in presence of molecular oxygen and fail to survive in its absence, *e.g.*, *Bacillus subtilis, Azotobactor, Arthrobactor, Mycobacterium* etc.

Facultative anaerobes : The aerobic bacteria which can also survive in absence of oxygen, *e.g.*, *Aerobacter, Klebsiella, Pseudomonas*, etc.

(2) **Anaerobic respiration**

Obligate anaerobes : These bacteria grow and multiply in the absence of free oxygen. They fail to survive under aerobic conditions, *e.g.*, *Clostridium botulinum*.

Facultative aerobes : The anaerobic bacteria which can also survive in presence of oxygen, *e.g.*, *Chlorobium limicola*.

Mode of nutrition in bacteria

On the basis of mode of nutrition, bacteria are grouped into two broad categories. First is autotrophic and second is heterotrophic bacteria.

Autotrophic bacteria : These bacteria are able to synthesize their own food from inorganic substances, as green plants do. Their carbon is derived from carbon dioxide. These are divided into two categories.

(1) **Photoautotrophic bacteria :** These bacteria are mostly anaerobic bacteria. They use sunlight as source of energy to synthesize food.

They possess a pigment called bacteriochlorophyll which is different from the chlorophyll pigment found in higher plants. This is known as anoxygenic photosynthesis. *e.g.*, **Green sulphur** (*Thiothrix*) and **purple sulphur** (*Chromatium*) bacteria.

Green sulphur bacteria : They are autotrophic. The hydrogen donor is H_2S and the pigment involved in the process is **chlorobium chlorophyll** (Bacterioviridin) *e.g.*, *Chlorobium*.

$$6CO_2 + 12H_2S \xrightarrow[\text{Chlorobium chlorophyll}]{} C_6H_{12}O_6 + 6H_2O + 12S.$$

Purple sulphur bacteria : They are also autotrophic. The hydrogen donor is thiosulphate and the pigment involved in photosynthesis is **bacteriochlorophyll** *e.g.*, *Chromatium*.

$$6CO_2 + 15H_2O + 3Na_2S_2O_3 \xrightarrow[\text{Bacteriochlorophyll}]{} C_6H_{12}O_6 + 6H_2O + 6NaHSO_4.$$

Purple non-sulphur bacteria : They are heterotrophic utilizing succinate or malate or alcohol. *e.g., Rhodospirillum, Rhodopseudomonas.*

$$6CO_2 + 12CH_3CHOHCH_3 \longrightarrow C_6H_{12}O_6 + 12CH_3COCH_3 + 6H_2O .$$

(2) **Chemoautotrophic bacteria :** Some bacteria manufacture organic matter from inorganic raw materials (such as carbon dioxide) and utilize energy liberated by oxidation of inorganic substances present in the external medium such as ammonia, ferrous ion, nitrates, nitrites, molecular hydrogen, etc.

Sulphur bacteria : These bacteria derive energy by oxidizing hydrogen sulphide or molecular sulphur. *Beggiatoa*, a colourless sulphur bacterium oxidises hydrogen sulphide (H_2S) to water and sulphur. The energy released is used up and the sulphur granules are deposited inside or outside the body of bacterial cell.

$$2H_2S + O_2 \longrightarrow 2H_2O + 2S + \text{Energy} .$$

Iron bacteria : They take energy from the oxidation of ferrous salts into ferric salts e.g., *Ferrobacillus, Leptothrix.*

$$\underset{\text{Ferrous carbonate}}{4FeCO_3} + O_2 + 6H_2O \xrightarrow{\text{Leptothrix orchae}} \underset{\text{Ferric Hydroxide}}{4Fe(OH)_3} + 4CO_2 + \text{Energy (81 k.cal)} .$$

Hydrogen bacteria : These bacteria utilize free molecular hydrogen and oxidize to hydrogen into water with the help of either oxygen or oxidize salts *e.g., Hydrogenomonas.*

$$2H_2 + O_2 \rightarrow 2H_2O + \text{Energy (56 kcal)}.$$

Ammonifying bacteria : They oxidise protein and amino acid into NH_3 (ammonia). *e.g., Proteus vulgaris, Bacillus mycoids.*

Nitrifying bacteria : They oxidise ammonia to nitrites and then into nitrates.

$$NH_3 + O_2 \xrightarrow{\text{Nitrosomonas}} NO_2 + H_2O + \text{Energy and}$$

$$2NO_2 + O_2 \xrightarrow{\text{Nitrobacter}} 2NO_3 + \text{Energy} .$$

Denitrifying bacteria : They change nitrogen compound into molecular nitrogen. So that they reduce fertility of soil *e.g., Micrococcus denitrificans, Pseudomonas denitrificans.*

Methane bacteria : The bacterium *Methanomonas* utilizes methane as source of carbon and energy.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O + \text{Energy} .$$

Methane producing bacteria : These are spherical or rod shaped bacteria which produce methane (CH_4) from hydrogen gas and carbon dioxide *e.g., Methanobacterium.*

$$CO_2 + 4H_2 \longrightarrow CH_4 + 2H_2O$$

Methane (swamp gas) is produced under anaerobic conditions and can be used as a "biogas", otherwise it is a pollutant that contributes to the green house effect and global warming.

Carbon bacteria : These bacteria oxidize carbon monoxide into carbon dioxide and use the liberated energy, *e.g., Bacillus oligocarbophilus.*

$$2CO + O_2 \longrightarrow 2CO_2 + \text{Energy} .$$

(3) **Heterotrophic bacteria :** Most of the bacteria can not synthesize their own organic food. They are dependent on external organic materials and require atleast one organic compound as a source of carbon of their growth and energy. Such bacteria are called heterotrophic bacteria. Heterotrophic bacteria are of three types – Parasites, Saprotrophs and Symbionts.

(i) **Parasites :** They obtain their organic food or special organic compounds required for their growth from living cells of plants and animals. Some parasitic bacteria are relatively harmless and nonpathogenic, *i.e.*, do not produce disease in hosts.

Table : 1.2-2 Human diseases

Disease	Casual organism
Paratyphoid	*Salmonella paratyphi*
Gastroenteritis	*Salmonella* sp. and *Escherichia coli*
Dysentery	*Shigella dysenteriae, S. sonnei, S. boydii*
Tularaemia	*Francisella tularensis*
Influenza	*Haemophilus influenzae*

Table : 1.2-3 Plant diseases

Disease	Casual organism
Black chaff of wheat	*Xanthomonas translucens*
Wilt of maize	*Xanthomonas stewartii*
Gummosis of sugarcane	*Xanthomonas asculorum*
Red stripe of sugarcane	*Pseudomonas rubrilineans*
Ring rot of potato	*Corynebacterium*
Canker of tomato	*Corynebacterium michiganense*
Leaf spot of Lady's finger	*Xanthomonas esculenti*
Hairy rot of apple	*Agrobacterium rhizogenes*
Black knot of grapes	*Pseudomonas tumefaciens*

(ii) **Saprotrophic bacteria :** These bacteria obtain their nutritional requirements from dead organic matter (such as animal excreta, corpses, fallen leaves, bread, fruits, vegetables, jams, jellies, etc.). These bacteria breakdown the complex organic matter into simple soluble forms by secreting exogenous digestive enzymes. Then they absorb the simple nutrient molecules and assimilate them. Aerobic break down of organic matter is called decomposition or decay. *e.g., Pseudomonas.*

(iii) **Symbiotic bacteria :** Symbiosis is the phenomenon in which the two organisms live in close association in such a way that both the partners get mutual benefit from this association. For example, a very well known nitrogen fixing bacteria – *Rhizobium* forms a symbiotic association with roots of leguminous plants (soyabean, clover, alfalfa, etc.) and producing root nodules.

Spirochaetes

These are free inhabitants of mud and water, and are chemoheterotrophic unicellular bacteria. These are spiral or helicoid in shape, covered by flexible cell wall and swim actively with flagella present at both pole or ends. Many diseases are caused by them as *Treponema pallidum causes syphilis, Leptospira* causes infectious *jaundice* and *Borrelia* causes relapsing *fever*. Besides some spirochaetes are found in teeth.

Archaebacteria

They are present in rumen (first part of stomach) of cattles. This is simplest and most primitive group of bacteria. The cell wall of these bacteria is made of polysaccharides and proteins (peptidoglycans and muramic acid are absent in cell wall). Archaebacteria are considered to be the *'oldest of living fossils'*. Three main groups of archaebacteria are following.

(1) **Methanogens :** These are strict anaerobic bacteria and mainly occur in muddy areas and also in stomach of cattle, where cellulose is fermented by microbes. These are responsible for

methane gas (CH_4) formation in bio-gas plants, because they have capacity to produce CH_4 from CO_2 or formic acid ($HCOOH$). *e.g., Methanobacterium, Methanobacillus, Methanosarcina* and *Methanococcus*.

(2) **Salt lovers archaebacteria or Halophiles :** These are also anaerobic bacteria, which occur in extreme saline or salty conditions (upto 35% of salt or *NaCl* in culture medium). A purple pigmented membrane containing bacteriorhodopsin is developed in sun-light in these bacteria, which utilizes light energy for metabolic activities (different from photosynthesis). *e.g., Holobacterium* and *Halococcus*.

(3) **Thermoacidophiles :** These are the bacteria which are found in hot sulphur springs (upto 80°C). As against first two groups of archaebacteria, these are aerobic bacteria. These have the capacity to oxidize sulphur to H_2SO_4 at high temperature and high acidity (*i.e., pH* 2.0), hence given the name *Thermoacidophiles, i.e.,* temperature and acid loving.

$$2S + 2H_2O + 3O_2 \rightarrow 2H_2SO_4 + \text{energy}.$$

e.g., Sulfobolus, Thermoplasma, Thermoproteus.

Actinomycetes (Mycobacteria)

It is a group of unicellular branched filamentous bacteria which resemble fungal mycelia. They grow in the form of radiating colonies in cultures and therefore, commonly called **ray fungi**. They are Gram +ve chemo-organotrophic, saprotrophic bacteria. Most species are facultative anaerobic. These are generally present as decomposers in soil. The filaments are aseptate (non-septate) branched and very thin (about 0.2 to 1.2 μm in width). The wall contains mycolic acid. They reproduce asexually by means of conidia, which are produced at tips of filaments. The endospores are not formed. Most of these secrete chemical substances having antimicrobial activities called antibiotics. Some of the most common and effective antibiotics are obtained from the different species of the genus *Streptomyces*.

Table : 1.2-4

(1) **Human disease**	
Tuberculosis	*Mycobacterium tuberculosis*
Leprosy	*Mycobacterium leprae*
Buruli's ulcer	*Mycobacterium ulcerans*
Actinomycosis	*Actinomyces israelii*
Diphtheria	*Corynebacterium diptheriae*
(2) **Animal disease**	
Tuberculosis of cattle	*Mycobacterium bovis*
Lumpy jaw	*Actinomyces bovis*

Rickettsias (H.T. Ricketts 1909)

They are gram negative obligate pleomorphic but walled obligate intracellular parasites which are transmissible from arthropods. They are intermediate between true bacteria and viruses. Rickettsias require exogenous factors for growth. Cell wall is like typical bacterial wall. ATP synthesis is absent but ADP is exchanged with host cell ATP. They have genome and size (0.3-0.5 μm) smaller than true bacteria but have a longer generation time. Internally the cells of rickettsias contain DNA as well as RNA in a ratio of 1 : 3 .5. The cell walls contain muramic acid and are sensitive to lysozyme. Flagella, pili and capsule are absent. Reproduction occurs by binary fission. The natural habitat of rickettsias is in the cells of arthropod gut. They cause typhus group of fevers. Spread by droplet method, lice, ticks, fleas, etc.

Table : 1.2-5 Human diseases

Disease	Causal organism
Typhus fever	*Rickettsia prowazekii.*
Rocky mountain spotted fever	*Rickettsia rickettsii*
Q fever	*Coxiella burnetti*

Chlamydiae

(1) They are also called as PLT virus or basophilic virus or energy parasites (as they are not capable of ATP synthesis).

(2) They are pathogenic only to birds and domestic or wild mammals.

(3) They mainly cause keratoconjunctivitis and trachoma (leading to blindness).

Importance of bacteria

Bacteria are our 'friends and foes' as they have both useful and harmful activities.

Useful activities

(1) **In agriculture or In soil fertility :** Some bacteria increase soil fertility. Nitrogen is essential for all plants. Nitrogen occupies 80% of the atmosphere. The plants take nitrogen in the form of nitrates. In soil, nitrates are formed by three processes :

By nitrogen fixing bacteria : Bacteria are found in soil either free *e.g., Azotobacter* and *Clostridium* or in root nodules of leguminous plants *e.g., Rhizobium leguminosarum*. These bacteria are capable of converting atmospheric free nitrogen into nitrogenous compounds.

Nitrifying bacteria : These bacteria convert nitrogen of ammonia into nitrite (NO_2) *e.g., nitrosomonas* and convert nitrite compounds into nitrates *e.g., nitrobacter*.

Decay of dead plants and animals : Some bacteria attack on dead bodies of plants and animals and convert their complex compounds into simpler substances *e.g., carbon dioxide* (CO_2), water (H_2O), nitrate (NO_3), sulphate (SO_4) etc.

(2) **In dairy :** *Bacterium lactici acidi* and *B. acidi lactici* are found in milk. These bacteria ferment lactose sugar found in milk to form lactic acid by which milk becomes sour.

Lactic acid bacteria bring together droplets of *casein* a protein found in milk and help in the formation of curd.

Pasteurization : Milk is heated at 62.8°C for 30 min or 71.7°C. for 15 sec. only. This reduces the number of bacteria by killing all non spore forming bacteria and thus unboiled milk becomes sour earlier than boiled milk.

(3) **In industries :** From industrial point of view bacteria are most important. Some of the uses of bacteria in industries are as follows :

Vinegar industry : Vinegar is manufactured from sugar solution in the presence of *Acetobacter aceti*.

Fibre retting : By this process fibres of jute, hemp and flax are prepared. In the preparation of flax, hemp and jute the retting of stems of *Linum usitatissimum* (Flax = Hindi Sunn), *Cannabis sativa* (Hemp = Hindi Patson) and *Corchorus capsularis* (Jute) respectively is done.

Tobacco industry : *Bacillus megatherium* is used for its fermentative capacity for developing flavour and taste in tobacco leaves.

Tea industry : By fermentative action of *Mycococcus condisans* curing of tea leaves is done. By this process special taste is developed in the tea leaves.

Tanning of leather : Some bacteria decompose fats which are found in skin of animal with the result that skin and hairs are separated from each other and this leather becomes ready for use.

(4) **In medicines :** Some of the antibiotics are manufactured by bacterial actions *e.g.*, *Bacillus brevis* – antibiotic thyrothricin and *B. subtilis* – antibiotic subtelin. Vitamin B_2 is manufactured by fermentative action of *Clostridium acetobutylicum*.

Antibiotics : These are the chemical substances produces by living microorganisms capable of inhibiting or destroying other microbes. These are the products of secondary and minor metabolic pathways, mostly secreted extracellularly by the microorganisms. These are used in controlling various infectious diseases.

Table : 1.2-6

Antibiotic	Obtained from
Streptomycin	*Streptomyces griseus*
Actidine	*S. griseus*
Chloromycetin	*S. venezuelae*
Tetracycline	*S. aureofaciens*
Terramycin	*S. rimosus*
Erythromycin	*S. erythraeus*
Neomycin	*S. fradiae*
Amphomycin	*S. carus*
Trichomycin	*S. hachijoensis*
Viomycin	*S. floridae*
Bacitracin	*Bacillus subtilis*
Gramicidin	*B. brevis*
Tyrothricin	*B. brevis*
Polymyxin	*Bacillus polymyxa*

(5) **Role of bacteria in petroleum pollution :** Petroleum pollution in water bodies is checked upto some extent by *Pseudomonas*.

Genetically engineered strain of *Pseudomonas putida* (superbug) was developed by Dr. Ananda Mohan Chakraborty which biodegrade spilled oil. These superbugs were allowed by USA government in 1990 for removal of oil from water.

Harmful activities

(1) **Cotton spoilage :** It is done by bacteria called *Spirochaete cytophage*.

(2) **Food poisoning :** Some saprotrophic bacteria cause decay of our food, *i.e.*, they alter their normal form and induce unpleasant aroma, taste and appearance. Some bacteria produce powerful toxins in food to cause "**food poisoning**". Consumption of such food may cause serious illness or even death.

Botulism : It is caused by *Clostridium botulinum*. The main symptoms are vomiting followed by paralysis and death.

(3) **Spoilage of food :** Some examples of bacterial food spoilage are :

Greening on meat surface is caused by *Lactobacillus* and *Leuconostoc*. Souring of milk is caused by *Lactobacillus* and *Streptococcus*. Explosion of curd (gas production) is caused by *Clostridium* and *Coliform* bacteria. Ropiness (*i.e.*, slimy milk) is caused by *Klebsiella* and *Enterobacter* sp.

(4) **Pollution of water :** There are reports of epidemics of cholera, typhoid, jaundice and other infectious diseases, which were caused by polluted water. Many pathogenic bacteria such as, *Vibrio cholerae*, *Salmonella typhi*, *Leptospira cetero-haemorrhagiae*, etc. pollute water and make it unfit for drinking. These are eliminated by chlorination.

(5) **Deterioration of textiles :** Some bacteria (*e.g.*, *Cytophaga*, *Vibrio* and *Cellulomonas*) damage cellulose of textiles.

(6) **Abortion :** Bacteria like *Salmonella* induce abortion in goats, horses, sheep etc.

(7) **Biological warfare :** Some bacteria which cause diseases like anthrax, black-leg, tuberculosis etc, are employed as secret war agents.

(8) **Denitrification :** Denitrification bacteria like *Bacillus licheniformis*, *Pseudomonas aeruginosa* convert nitrates and nitrites into free nitrogen, thus responsible for the process of denitrification. Thus soil is depleted of essential nutrient like usable form of nitrogen.

(9) **Putrefaction :** It is the spoilage of protein in the absence of O_2 by the putrefying bacteria *e.g.*, *Proteus*, *Mycoides*.

(10) **Retting of fibres :** It is the hydrolysis of pectic substances that bind the cells together. *e.g.*, *Clostridium sp.*, *Pseudomonas fluorescence*.

Mycoplasma

Mycoplasmas were discovered by ***E. Nocard*** and ***E. R Roux*** (1898). They were first isolated from bovine sheep suffering from pleuropneumonia. They are often designated as pleuropneumonia–like organisms (PPLO). These organisms were later put under the generic name mycoplasma by *Nowak* (1929). In 1966 international committee of nomenclature of bacteria, placed mycoplasmas under the class *mollicutes*, which consists of two genera Mycoplasma and Acholeplasma.

Structure : These are the simplest and smallest unicellular non-motile known aerobic prokaryotes without cell wall. So that they can change their shape therefore called Jockers of microbiological park. Their size varies from 0.1 – 0.15 μm. Due to the absence of the cell wall, these organisms are highly elastic and readily change their shape; hence the mycoplasmas are irregular and quite variable in shape. That is called pleomorphism. Mycoplasma cells are covered with three layered plasma membrane.

Unit membrane is made up of lipoprotein. The genetic material is a single, linear, double–stranded molecule of DNA, without a nuclear envelope. Unlike other prokaryotes, it is coiled throughout the cytoplasm. The cytoplasm contains the ribosomes which are 70S. It also contains RNA, proteins, lipids and many kinds of enzymes used in biosynthetic reactions. Mycoplasmas are gram-negative.

Physiology and reproduction : Mycoplasma are usually non–motile. They are sensitive to tetracycline and resistant to penicillin. These are destroyed usually by treatment of heat at 50° C for 6 hours mycoplasma are osmotically inactive. Mycoplasmas are heterotrophic in their mode of nutrition. Some of them are saprotrophs, but most of them are parasitic on plants and animals including man. They reproduce by budding or binary fission. Fragmentation specially in filamentous forms. Besides this, Mycoplasma reproduces by elementary cell bodies also. It is also called bleb particle. It is a kind of vegetative reproduction.

Importance of Mycoplasma

(1) **Diseases in human beings :** *Mycoplamsa hominis* causes pleuropneumonia, inflammation of genitals and endocarditis, *etc. Mycoplasma pneumoniae* causes primary a typical pneumonia (PAP), haemorrhagic laryngitis, *etc. Mycoplasma fermentatus* and *M. hominis* cause infertility in man, otitis media (inflamation of middle ear).

(2) **Diseases in animals :** *Mycoplasma mycoides* causes pneumonia in cattle. *Mycoplasma bovigenitalum,* causes inflammation of genitals in animals. *Mycoplamsa agalactia* causes agalactia of sheep and goat.

(3) **Diseases in plants :** Common mycoplasmal diseases of plants are: Bunchy top of papaya, witches' broom of legumes, yellow dwarf of tobacco, stripe disease of sugarcane, little leaf of brinjal, clover phylloidy, big bud of tomato etc.

Cyanobacteria

The new name of cyanobacteria has been given to myxophyceae or cyanophyceae. Cyanobacteria form a group of ancient Gram negative, photosynthetic prokaryotes. Many botanists prefer to call them blue-green algae. They have survived successfully for about 3 billion years. They may cause water blooms.

Cyanobacteria are predominantly fresh water forms, a few are marine. They impart unpleasant taste and smell to the water. One species of cyanobacteria containing red pigment (*Trichodesmium erythraeum*) flourishes in red sea and is responsible for the red colour of its water.

Characteristics of Cyanobacteria

(1) They have prokaryotic type of cells.

(2) Cells do not have any organised nucleus. The nucleolus is absent and the nucleoid is not to be bounded by a nuclear membrane. The type of nucleus called **incipient nucleus**.

(3) The photosynthetic pigments present in the cell are – chlorophyll *a*, *β* carotene, myxoxanthophyll, myxoxanthin, C-phycocyanin and C-phycoerythrin. The C-phycocyanin is blue and C-phycoerythrin is red in colour. If C-phycocyanin is more as compared to C-phycoerythrin, it gives characteristic blue- green colour to the algae.

(4) The photosynthetic pigment are present in lamellae, called thylakoids.

(5) The presence of chlorophyll–a, cyanobacteria synthesis their own food from carbon dioxide and water in the presence of sunlight. Certain cyanobacteria fix atmospheric nitrogen in the presence of oxygen.

(6) In cyanobacteria food is stored as cyanophycean starch or *α*–granules.

(7) Some members possesses simple unbranched filament with heterocyst like *Nostoc, Anabaena, Aulosira, Cylindrospermum* etc.

(8) Some members possesses simple unbranched filamentous forms without heterocysts and akinetes, *e.g., Arthospira, Oscillatoria, Spirulina, Phormidium, Lyngbya, Symploca, Microcoleus, Schizothrix* etc.

(9) Cyanobacteria reproduce asexually by fission and fragmentation. Unicellular forms multiply by binary fission. Sexual reproduction is totally absent.

(10) Cell wall is composed of a gelatinous sheath which is made up of three layers of microfibrils in which cellulose is not present.

(11) Cells contain organelles like cyanophycean granules, gas vacuoles, polyhedral bodies, ribosomes, polyglucoside bodies, polyphosphate bodies etc.

(12) Cyanobacteria are economically important because of having immense capability of fixing atmospheric nitrogen in the soil. An enzyme nitrogenase present in the heterocyst is responsible for the fixation of free nitrogen. Application of heterocysts blue–green algae as biofertilizer enhances the production in paddy field crops. *e.g., Anabaena, Nostoc, Cylindrospermum, Scytonema* etc.

Economic importance of Cyanobacteria

Cyanobacteria have both beneficial and harmful effects in human affairs.

Useful activities

(1) Growth of cyanobacteria in hard water is most probably responsible for the deposit of limestones.

(2) Since they grow, photosynthesis, multiply and ultimately die, thus adding organic matter to the soil and increasing its fertility.

(3) Whereas some cyanobacteria act to breakdown rock, the species that live in hot springs actually build rocks. This they accomplish by depositing salts of calcium and silica within the gelatinous sheath of the algal cell wall.

(4) Balls of *Nostoc commune* are collected, boiled and consumed as food by the Chinese and South Americans. The prepared food is called 'Yoyucho'.

(5) Some cyanobacteria, such as *Anabaena, Lyngbya* etc. help in conservation of soil, thus checking soil erosion.

(6) Few species of *Anabaena* and *Aulosira* are inoculated in ponds to check the development of mosquito larvae.

(7) *Spirulina* is cultivated in tanks to obtain protein rich animal food as well protein rich health food.

Harmful activities

(1) Their most harmful effect is undoubtedly the formation of blooms in bodies of water.

(2) They choke the intake of water supply systems and give the water a disagreeable odour giving a fishy taste to drinking water.

(3) Many cyanobacteria produce toxins. They are directly or indirectly harmful for human. *e.g., Nostoc, Anabaena, Microcystes* etc.

Nostoc

Habitat : *Nostoc* is found in aquatic and terrestrial habitat. The alga forms a jelly like mass in which numerous filaments are embedded. When young, they are more or less spherical, solid and microscopic in size. With advance in age, the colony grows and becomes macroscopic. In species like *N. amplissimum* it attains the diameter of 30*cm* or almost equals to the size of hen's egg in *N. punctiforme*. A number of species of *Nostoc* on soil. They often swell up and glisten after rains and therefore called fallen stars.

Morphology : The plant is filamentous and trichome are unbranched and appear moniliform..

All the cells of the trichome are similar in structure but at intervals are found slightly larger rounded, light yellowish, thick walled cells called as *heterocysts*. Trichome mostly breaks near heterocyst and forms hormogonia and thus they help in its multiplication.

Each cell trichome in *Nostoc* has primitive nucleus and chromoplasm and very much resembles in all details to a cyanophycean cell. Vacuoles and definite chromatophores are absent. The cell wall is differentiated into two layers. Outside the cell wall there is a mucilaginous sheath. Due to confluence of various mucilaginous sheaths of filaments, a mucilaginous colony is formed. The cell is *prokaryotic*.

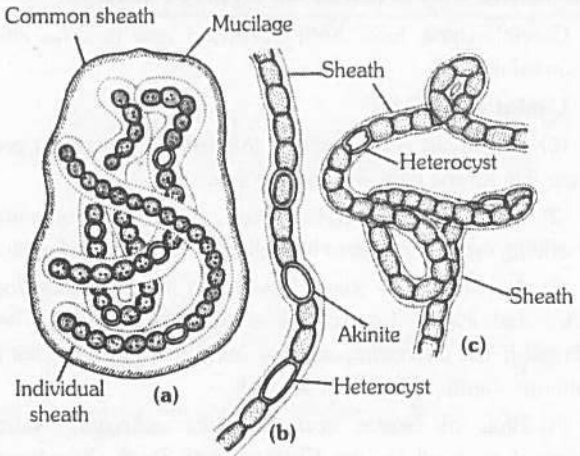


Fig : 1.2-3 Nostoc

Reproduction in Nostoc

There is no sexual reproduction in *Nostoc* but it reproduces asexually by following methods

(1) **Hormogonia :** The filaments break at number of places into smaller pieces called as hormogonia by death and decay of an ordinary cell. They slip out of the mucilage sheath and grow into new plant. Frequently trichomes break near heterocysts.

(2) **Resting spores or akinetes :** Under certain conditions some of the vegetative cells enlarge and accumulate food material and develop thick walls. These are called akinetes and may be arranged on either side of the heterocysts or in between two heterocysts. In mature akinete the outer wall may be 2–3 layered and its protoplasm becomes highly granular. The akinetes germinate after a period of rest and the contents are liberated out through a pore. The protoplast by further division forms the filament.

(3) **Heterocysts :** In exceptional case like *N. commune* the heterocyst may become functional and on germination produces a new colony.

(4) **Endospores :** *Nostoc microscopium* and *Nostoc commune* produce endospore.

Economic importance

(1) Many species of *Nostoc* fix atmospheric nitrogen and thus increases soil fertility.

(2) Reclamation of alkaline usar soils can be done by employing some species of *Nostoc*.

(3) *N. commune* is consumed as vegetable in China and Japan.

Tips & Tricks

- Pasteurization : Kills all non endospore forming bacteria.
- Insulin is the first hormone which obtained from genetically engineered bacteria.
- Free living N_2 fixing bacteria – *Azotobacter* and *Polymyxa*.
- *Clostridium butyticum* has been used in the synthesis of vitamin B.
- Commensals : Those microorganism which are living in large intestine of human and that feed on undigested food without harming the host are termed as commensals.
- External DNA enters in bacteria through mesosomes.
- In bacteria flagella may be present, PS-II absent, photosynthesis is a nonoxygenic.
- Flagella of *Salmonella* bacteria contain H-antigens.
- Chemically *E.coli* has about 70% H_2O, 15% proteins, 6% RNA, 1% DNA. 2% Lipid, 3% carbohydrates, etc.
- Hay bacteria is *Bacillus subtilis*.
- Deodorants have salts of *Zn* and *Al* which kill bacteria causing odour.
- Alternation of generations is absent in bacteria due to absence of meiosis and syngamy.

Ordinary Thinking

Objective Questions

Structure, shape and nutrition of bacteria

1. Which of the following statement is correct **[DUMET 2010]**
(a) All bacteria are heterotrophic
(b) Bacteria are either heterotrophic or chemoautotrophic
(c) Bacteria can also be photoautotrophic
(d) Bacteria are either photoautotrophic or chemoautotrophic

2. Bacteria were first discovered by **[NCERT; CBSE PMT 1995; AFMC 1997; Kerala PMT 2000]**
(a) Robert Koch (b) L. Pasteur
(c) Robert Hooke (d) A.V. Leeuwenhoek

3. On the basis of r-RNA genes bacteria are divided into **[Odisha JEE 2008]**
(a) *Gram+ve* and *Gram-ve*
(b) Bacteria and archaebacteria
(c) Actinomycetes and mycoplasma
(d) Cyanobacteria and mycolasma

4. In *Escherichia coli* **[CBSE PMT 1993]**
(a) An organised nucleus is present
(b) One chromosome is present
(c) One DNA molecule is present
(d) One RNA molecule is present

5. Which of the following fixes CO_2 in carbohydrates
(a) *Bacillus* (b) *Rhizobium*
(c) *Nitrobacter* (d) *Rhodospirillium*

6. Bacteria are considered as plants, because **[CPMT 1994; BHU 2005]**
(a) These have a rigid cell wall
(b) They have a green colour
(c) They can reproduce
(d) They are present everywhere

7. Membrane-bound organelles are absent in **[CBSE PMT (Pre.) 2010]**
(a) *Plasmodium* (b) *Saccharomyces*
(c) *Streptococcus* (d) *Chlamydomonas*

8. How many organisms in the list given below are autotrophs *Lactobacillus, Nostoc, Chara, Nitrosomonas, Nitrobacter, Streptomyces, Sacharomyces, Trypanosoma, Porphyra, Wolfia* **[NCERT; CBSE PMT (Mains) 2012]**
(a) Four (b) Five
(c) Six (d) Three

9. Gram *–ve* and *+ve* bacteria have cell membrane made up of **[RPMT 1997]**
(a) Proteins and lipids (b) Cellulose
(c) Fats (d) Chitin

10. Some hyperthermophilic organisms that grow in highly acidic (*pH2*) habitats belong to the two groups **[CBSE PMT (Pre.) 2010]**
(a) Liverworts and yeasts
(b) Eubacteria and archaea
(c) Cyanobacteria and diatoms
(d) Protists and mosses

11. The chief component of bacterial cell wall is
(a) Cellulose and chitin
(b) Cellulose and pectin
(c) Amino acids and polysaccharides
(d) Cellulose and carbohydrates

12. Bacteria whose cell has only a curve/comma is **[NCERT; EAMCET 1995]**
(a) *Vibrio* (b) *Cocci*
(c) *Spirilli* (d) *Bacilli*

13. The main difference between Gram positive and Gram negative bacteria lies in the composition of **[NCERT; CBSE PMT 2001; Odisha JEE 2009; WB JEE 2011]**
(a) Cilia (b) Cell wall
(c) Nucleolus (d) Cytoplasm

14. Muramic acid is present in the cell wall of **[Pb. PMT 1999; BHU 2000; KCET 2001; CPMT 2009]**
(a) Bacteria/Blue green algae (b) Green algae
(c) Yeast (d) *Rhizopus*

15. The shape of the cocci bacteria is **[AMU (Med.) 2012]**
(a) Rod shaped (b) Spherical
(c) Comma shaped (d) Spiral

16. Match the following pairs correctly and choose the right combination

Column-I	Column-II
A. *Escherichia coli*	1. 'nif' gene
B. *Rhizobium melilotae*	2. Digests hydrocarbon of crude oil
C. *Bacillus thurigiensis*	3. Production of human insulin
D. *Pseudomonas putida*	4. Biological control of fungal disease
	5. Bio-decomposed insectiside

[Kerala PMT 2005]
(a) A = 3, B = 1, C = 5, D = 4
(b) A = 1, B = 2, C = 3, D = 4
(c) A = 2, B = 1, C = 3, D = 4
(d) A = 4, B = 3, C = 1, D = 2
(e) A = 3, B = 1, C = 5, D = 2

17. Helically coiled shaped bacteria are called **[Odisha JEE 2008]**
(a) Spirilla (b) Cocci
(c) Bacilli (d) Vibrio

18. Which of the following is a genetic vector **[BVP 2001]**
(a) Phage (b) Plasmid
(c) Mosquito (d) None of these

19. Bacteria bearing flagella all over the body are called **[CPMT 1999; BHU 2000; MP PMT 2001; MHCET 2003]**
(a) Peritrichous (b) Atrichous
(c) Monotrichous (d) Cephalotrichous

20. The habitat of *E. coli* is **[NCERT; RPMT 1995; EAMCET 1995; CBSE PMT 1998; Odisha JEE 2008]**
(a) Water (b) Colon (Intestine)
(c) Soil (d) Organic food

21. Bacterial ribosomes are called
(a) Autosomes (b) Dictyosomes
(c) Centrosomes (d) Polyribosomes

22. Choose the wrong statements regarding bacterial cell
A. Glycocalyx is the outer most envelope in bacteria
B. The glycocalyx could be a loose sheath called capsule
C. The glycocalyx may be thick and tough called slime layer
D. A special structure formed by the plasma membrane is called mesosome
E. Small bristle like fibres sprouting out of the cell are called fimbriae **[Kerala PMT 2012]**
(a) A and C are wrong (b) A and B are wrong
(c) B and C are wrong (d) A and D are wrong
(e) C and D are wrong

23. Which one of the following organisms is not an example of eukaryotic cells **[CBSE PMT (Pre.) 2011]**
(a) *Amoeba proteus* (b) *Paramecium caudatum*
(c) *Escherichia coli* (d) *Euglena viridis*

24. Which of the following statement is correct **[CPMT 2005]**
(a) *E.coli* gram –ve bacterium while *Rhizobium japonicum* is gram +ve bacterium
(b) Both *E.coli* and *Rhizobium japonicum* are gram +ve
(c) Both *E.coli* and *Rhizobium japonicum* are gram –ve
(d) *E.coli* is gram +ve, *Rhizobium japonicum* is gram –ve

25. Which of the following compounds are decomposed during putrefaction
(a) Proteins (b) Fats
(c) Carbohydrates (d) None

26. In the light of recent classification of living organisms into three domains of life (bacteria, archaea and eukarya), which one of the following statements is true about archaea **[CBSE PMT 2008]**
(a) Archaea completely differ from both prokaryotes and eukaryotes
(b) Archaea completely differ from prokaryotes
(c) Archaea resemble eukarya in all respects
(d) Archaea have some novel features that are absent in other prokaryotes and eukaryotes

27. Bacteria obtaining energy from oxidation of inorganic substances are called **[MP PMT 1999]**
(a) Chemolithotrophs (b) Photolithotrophs
(c) Photo organotrophs (d) Chemo organotrophs

28. Bacterial ribosomes are present
(a) In cytoplasm (b) On endoplasmic reticulum
(c) On nuclear membrane (d) On cell wall

29. Mesosome in a bacterial cell is **[MP PMT 1995, 97, 98; CBSE PMT 1997; MHCET 2001; BHU 2003; AIEEE Pharmacy 2004; Manipal 2005]**
(a) Plasmid
(b) Connection between two cells
(c) Plasma membrane infolded for respiration
(d) None of these

30. Colourless, unicellular, cell wall bound, spherical or rod-shaped micro-organism and lacking organized nucleus is called **[CPMT 2004]**
(a) Mycoplasma (b) Virus
(c) Bacteria (d) Cyanobacteria

31. Bacterial flagella is made up of **[AIIMS 2004]**
(a) Protein (b) Amines
(c) Lipids (d) Carbohydrates

32. Which one of the following is not a characteristic of gram positive bacteria **[Kerala PMT 2008]**
(a) Cell wall is smooth
(b) Mesosomes are distinctively prominent
(c) Basal body of flagellum contains 2 rings
(d) Outer membrane is present
(e) Murein content of cell wall is 70 – 80%

33. Bacterial flagella do not show *ATP*ase activity and 9 + 2 organization. These are chemically **[AFMC 2006]**
(a) Flagellin (b) Pilin
(c) Tubulin (d) Bacterin

34. Plasmids are extra chromosomal genetic material of **[KCET 2001; MP PMT 2002; CPMT 2009; Odisha JEE 2011; PET (Pharmacy) 2013]**
(a) Bacteria (b) Virus
(c) Algae (d) Amoeba

35. Which of the following amino acid is present only in bacteria and BGA **[MP PMT 2007]**
(a) Glutamic acid (b) Diaminopimetic acid
(c) Glycine (d) Tyrosine

36. Shorter generation time of *E.coli* compared to eukaryotes may be explained on the basis of **[WB JEE 2008]**
(a) Shape
(b) large surface: volume ratio
(c) Presence of cell wall
(d) Absence of organelles

37. Teichoic acid is found in **[J & K CET 2008; CPMT 2009; AFMC 2012]**
(a) Gram (+ve) bacteria (b) Gram (-ve) bacteria
(c) Cyanobacteria (d) Mycoplasma

38. N-acetyl muramic acid is found as **[WB JEE 2012]**
(a) Cell wall component of plant
(b) Cell wall component of Gram positive bacteria
(c) Cell wall component of fungi
(d) Viral coat material

39. The nitrifying bacteria are **[MP PMT 1994]**
(a) Autotrophic (b) Saprophytic
(c) Parasitic (d) Chemosynthetic

40. Branched chain lipids occur in the cell membranes of
(a) *Archaebacteria* (b) *Mycoplasma*
(c) *Actinomycetes* (d) *Streptomyces*

41. Smallest bacteria is **[CPMT 2002]**
(a) *Spirillium* (b) *Bacillus*
(c) *Dialister* (d) None of these

42. A mutant micro-organism unable to synthesize a compound required for its growth but able to grow if the compound is provided, is known as **[MP PMT 2001]**
(a) Auxotroph (b) Prototroph
(c) Autotroph (d) None of these

43. Which one of the following organisms may respire in the absence of oxygen **[MP PMT 2002]**
(a) *Azotobacter* (b) *Clostridium*
(c) *Rhizobium* (d) *Lactobacillus*

44. A bacterium is capable of withstanding extreme heat, dryness and toxic chemicals. This indicates that it is probabaly able to from **[KCET 2009]**
(a) A thick peptidoglycan wall
(b) Endospores
(c) Endotoxins
(d) Endogenous buds

45. First organism which was evolved on the earth **[CBSE PMT 2001]**
(a) Saprotrophs (b) Chemohetrotrophs
(c) Photoautotrophs (d) Chemoautotrophs

46. Antony Van Leeuwenhoek was first discovered bacteria. He belongs to which country **[MP PMT 2002]**
(a) France (b) Swedan
(c) Holland (d) United Kingdom

47. Bacteria are included in which of the following kingdoms **[AFMC 2001]**
(a) Protista (b) Plantae
(c) Monera (d) Animalia

48. *Salmonella* sp. is **[MP PMT 2002]**
(a) Monotrichous (b) Lophotrichous
(c) Amphitrichous (d) Peritrichous

49. Who classified bacteria under Schizomycetes **[MP PMT 2000]**
(a) Nageli (b) Linnaeus
(c) Leeuwenhoek (d) Sadashivan

50. The correct sequence of stages of growth curve for bacteria is **[Pb. PMT 1999; CBSE PMT 1999]**
(a) Decline, lag, log phase
(b) Lag, log, stationary phase
(c) Stationary, lag, log, decline phase
(d) Lag, log, stationary, decline phase

51. Genophore term was coined by Hans Ris for **[MP PMT 2007]**
(a) Genetic material of virus
(b) Stack on which spore originated
(c) Bacterial chromosome
(d) Fungal chromosome

52. The DNA of *E.coli* is **[CBSE PMT 1997, 98]**
(a) Single stranded and linear
(b) Single stranded and circular
(c) Double stranded and linear
(d) Double stranded and circular

53. In prokaryotes the Glycocalyx when it is thick is called **[KCET 2015]**
(a) Capsule (b) Slime layer
(c) Cell wall (d) Mesosome

54. When a bacterium is provided with flagella arising from two opposite ends, it is called **[KCET 1998; CPMT 2001, 10; MP PMT 2012]**
(a) Monotrichous (b) Lophotrichous
(c) Amphitrichous (d) Polytrichous

55. The structure that help some bacteria to attach to rocks and /or host tissues are **[AIPMT 2015]**
(a) Fimbriae (b) Mesosomes
(c) Holdfast (d) Rhizoids

56. What is a genophore **[WB JEE 2011]**
(a) DNA in prokaryotes
(b) DNA and RNA in prokaryotes
(c) DNA and protein in prokaryotes
(d) RNA in prokaryotes

57. An example of iron bacteria is **[MP PMT 1999]**
(a) *Beggiatoa* (b) *Geobacillus*
(c) Ferrobacillus (d) None of these

58. Bacteria are made up of **[Bihar MDAT 1995]**
(a) Nucleic acid (b) Only proteins
(c) Nucleic acid and proteins (d) Nucleosides
(e) None of these

59. Genes for antibiotic resistance are located in **[BHU 1995; MP PMT 1995, 98]**

Or

Bacterial resistance to antibiotics is a genetic trait, it is normally carried by the **[WB JEE 2016]**
(a) Chromosome (b) Nucleus
(c) Cell wall (d) Plasmid

60. The cells of bacterium *Staphylococcus* remain arranged in the form of **[MP PMT 1995, 98; BVP 2002]**
(a) Plate (b) Cube
(c) Irregular cluster (d) Chain

61. 'Peptidoglycan' is a characteristic constituent of the cell wall of **[BHU 1994, 2008; MP PMT 1997; AIIMS 1999; Kerala PMT 2006, 07]**
(a) Eubacteria and unicellular eukaryotes
(b) Bacteria and cyanobacteria
(c) Archaebacteria and eukaryotes
(d) All members of 'monera' and 'protista'

62. Bacteria and other monerans do not possess **[CPMT 2000]**
(a) Ribosomes (b) Mitochondria
(c) Nucleoid (d) Plasma membrane

63. Mucopeptide in cell wall is more in **[MP PMT 1999]**
(a) Gram-positive bacteria (b) Gram-negative bacteria
(c) Cyanobacteria (d) Bacteriophage

64. Identify the bacterium that appears violet after Gram staining **[WB JEE 2012]**
(a) *Salmonella enterica*
(b) *Escherichia coli*
(c) *Mycobacterium tuberculosis*
(d) *Rhizobium meliloti*

65. Many bacteria bear minute hairy structures on their cell wall, these are called **[AFMC 1996]**
(a) Hairs (b) Flagella
(c) Pili (d) Cilia

66. Which of the following is not correct statement about the plasmids **[Odisha JEE 2011]**
(a) It is the extra chromosomal DNA in bacteria
(b) It is not a integral part but inert genetic material
(c) Host chromosome can be integrated with the plasmid
(d) Transfer of plasmid can be done from cell to cell without killing the host

67. Infoldings of the plasma membrane of gram positive bacteria, gives rise to
(a) Clathrin (b) Chondritin
(c) Chondrioides (d) Chromatin

68. Bacteria with tuft of flagella at one pole is known as **[Odisha JEE 2012]**
(a) Amphitrichous (b) Peritrichous
(c) Atrichous (d) Lophotrichous

69. Circular DNA molecule occurs in **[NCERT; Pb. PMT 1994; MP PMT 1995, 98; CBSE PMT 1996; AIEEE Pharmacy 2003]**
(a) Viruses
(b) Bacteria, chloroplasts and mitochondria
(c) Bacteria and chloroplasts only
(d) Bacteria only

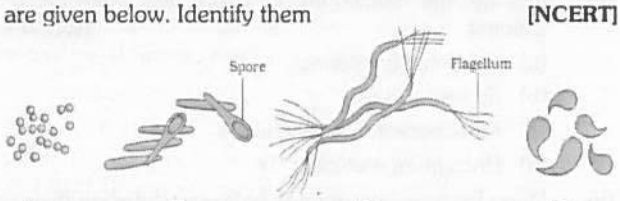
70. Extension of plasma membrane in prokaryotes is **[DPMT 2007]**
(a) ER (b) Mesosome
(c) Ribosome (d) None of these

71. Bacterial cells can be stained with **[MP PMT 1999]**
(a) Mercuric chloride (b) Crystal violet
(c) Crystal violet and iodine (d) Safranin

72. The term 'glycocalyx' is used for **[NEET (Karnataka) 2013]**
(a) A layer present between cell wall and membrane of bacteria
(b) Cell wall of bacteria
(c) Bacterial cell glyco-engineered to possess N-glycosylated proteins
(d) A layer surrounding the cell wall of bacteria

73. Why is a capsule advantageous to a bacterium **[NEET (Karnataka) 2013]**
(a) It protects the bacterium from desiccation
(b) It provides means of locomotion
(c) It allows bacterium to "hide" from host's immune system
(d) It allows the bacterium to attach to the surface

74. According to the shapes the names of the different bacteria are given below. Identify them **[NCERT]**



A B C D
(a) A - *Spirilla*, B – *Vibrio*, C – *Cocci*, D - *Bacilli*
(b) A - *Spirilla*, B – *Bacilli*, C – *Cocci*, D - *Vibrio*
(c) A - *Bacilli*, B – *Cocci*, C – *Spirilla*, D - *Vibrio*
(d) A - *Cocci*, B – *Bacilli*, C – *Spirilla*, D – *Vibrio*

75. Archaebacteria differ from eubacteria in **[CBSE PMT 2014]**
(a) Cell shape (b) Mode of reproduction
(c) Cell membrane structure (d) Mode of nutrition

76. Which structures perform the function of mitochondria in bacteria **[CBSE PMT 2014]**
(a) Cell wall (b) Mesosomes
(c) Nucleoid (d) Ribosomes

77. Which one of the following matching pairs is WRONG **[WB JEE 2016]**
(a) Bacterial cell wall – cellulose
(b) Bacterial ribosome – 16s rRNA
(c) Bacterial flagella – protein
(d) Bacterial glycocalyx – cellulose

78. Methanogens belong to **[NEET (Phase-II) 2016]**
(a) Slime moulds (b) Eubacteria
(c) Archaebacteria (d) Dinoflagellates

79. Which of the following are found in extreme saline conditions **[NEET 2017]**
(a) Archaebacteria (b) Eubacteria
(c) Cyanobacteria (d) Mycobacteria

80. Which of the following components provides sticky character to the bacterial cell **[NEET 2017]**
(a) Cell wall (b) Nuclear membrane
(c) Plasma membrane (d) Glycocalyx

Life cycle/Reproduction in bacteria

1. Bacterial cell divides in every minute it takes one hour to fill up a cup. How much time will be taken to fill half the cup
(a) 59 minutes (b) 30 minutes
(c) 60 minutes (d) 29 minutes

2. Under the optimum condition of temperature and nutrition most of the bacteria divide at the interval
(a) 24 hours (b) 20 minutes
(c) 60 minutes (d) 5 minutes

3. Transformation experiments using *Pneumococcus* bacteria led to the hypothesis that **[CBSE PMT 1993, 99]**
(a) DNA is the genetic material
(b) Bacteria have sexual reproduction
(c) Chromosomes are made up of DNA
(d) RNA is the transfer link

4. The process in which viruses are involved in sexual reproduction of bacteria is called **[MP PMT 1996, 2011; CPMT 1999, 2001; BHU 2000, 01, 08; JIPMER 2001; Haryana PMT 2005]**

Or

The transfer of genetic material from one bacterial cell to another through a vector is **[MH CET 2007]**
(a) Transduction (b) Transcription
(c) Transformation (d) Translation

5. Bacteria commonly reproduce vegetatively by **[NCERT; WB JEE 2008]**

Or

Which one of the following processes results in the formation of clone of bacteria **[KCET 2010]**
(a) Binary fission (b) Budding
(c) Conjugation (d) Oidia

6. Some bacteria are not easily killed because of
(a) Chitinous wall (b) Endospore formation
(c) Presence of mesosome (d) High tolerance

7. Identify the correct pair of events when temperate phages infect bacteria
I. No prophages are formed
II. Bacterial cell undergoes many divisions
III. Bacterial cell undergoes immediate lysis
IV. Prophages are formed
The correct pair is **[EAMCET 2009]**
(a) I, II (b) II, III
(c) III, IV (d) II, IV

8. Why the food can be kept for a longer time in cold house than in normal conditions
(a) Insect can not enter
(b) Bacterial multiplication stops
(c) Bacterial multiplication is reduced
(d) There is plasmolysis at low temperature

9. Viral genome incorporated and integrates with bacterial genomes is refer to as **[AFMC 2005]**
(a) Prophages (b) RNA
(c) DNA (d) Both (b) and (c)

10. Sexual reproduction in eubacteria takes place by **[AFMC 2012]**
(a) Conjugation (b) Transduction
(c) Transformation (d) All of these

11. In Griffith's experiment, the conversion of R-type to S-type of *Diplococcus Pneumoniae* when mixed with heat killed S-type is called **[MPPMT 1997, 98, 2000, 09; Kerala PMT 2000, 09; CBSE PMT 2002; DUMET 2010; MHCET 2015]**

Or

The uptake of naked DNA by bacteria is called **[WB JEE 2016]**
(a) Mutation (b) Transduction
(c) Transfection (d) Transformation

12. There is no alternation of generation in *Escherichia coli* because there is no **[CBSE PMT 1994]**
(a) Syngamy (b) Reduction division
(c) Conjugation (d) None of these

13. Penicillin inhibits bacterial multiplication because **[CPMT 1998; Odisha JEE 2008]**
(a) It checks spindle formation
(b) It destroys chromatin
(c) It inhibits cell wall formation
(d) It checks RNA synthesis

14. Pili in bacteria represent **[BHU 2001]**
(a) Extra-chromosomal genetic element
(b) Protoplasmic outgrowths of donor cells
(c) Small flagella
(d) Special bacterial cilia

15. The process of replication in plasmid DNA, other than initiation, is controlled by **[RPMT 1999]**
(a) Plasmid gene (b) Bacterial gene
(c) Cytoplasmic gene (d) Mitochondrial gene

16. The guts of cow and buffalo possess **[AIPMT (Cancelled) 2015]**
(a) *Chlorella* spp. (b) Methanogens
(c) Cyanobacteria (d) *Fucus* spp.

17. Transfer of genetic information from one bacterium to another in the transduction process is through **[CBSE PMT 1998]**
(a) Physical contact between donor and recipient strains
(b) Conjugation between opposite strain bacterium
(c) Bacteriophages released from the donor bacterial strain
(d) Another bacterium having special organ for conjugation

18. Conjugation in bacteria was discovered by **[MP PMT 2000]**

Or

The sexuality in bacteria was established by **[MP PMT 1996]**
(a) Robert Koch (b) Schaudinn and Hoffmann
(c) Lederberg and Tatum (d) Leeuwenhoek

19. Transfer of DNA from one bacteria to another by contact is known as **[Kerala CET 2001]**
(a) Conjugation (b) Transformation
(c) Transduction (d) Transcription

20. Sex factor in bacteria is **[CBSE PMT 1996; BHU 1999]**
(a) F–replicon (b) Chromosomal replicon
(c) RNA (d) Sex pilis

21. Amitosis is shown by **[CPMT 2010]**
(a) Bacteria (b) *Euglena*
(c) *Syllis* (d) *Hydra*

22. Bacteria reproduce sexually by **[MP PMT 2000]**
(a) Endospores (b) Transformation
(c) Conidia (d) Exospores

Economic importance of bacteria

1. Consider the following four statements (1-4) and select the option which includes all the correct ones only
(1) Single cell *Spirulina* can produce large quantities of food-rich in protein, minerals, vitamins etc
(2) Body weight-wise the microorganism *Methylophilus methylotrophus* may be able to produce several times more proteins then the cows per day
(3) Common button mushrooms are a very rich source of vitamin C
(4) A rice variety has been developed which is very rich in calcium

Options **[CBSE PMT (Mains) 2012]**
(a) Statements (3), (4)
(b) Statements (1), (3) and (4)
(c) Statements (2), (3) and (4)
(d) Statements (1), (2)

2. A free living anaerobic bacterium capable of N_2 fixation in soil is **[RPMT 1995; MP PMT 1996, 2006; BHU 1998, 2012; HPMT 2000]**
(a) *Rhizobium* (b) *Azotobacter*
(c) *Streptococcus* (d) *Clostridium*

3. Which of the following is free-living aerobic non-photosynthetic nitrogen fixing bacterium **[CBSE PMT 1997; BHU 2002, 03, 08; J & K CET 2005, 08; DUMET 2009; Odisha JEE 2010; MP PMT 2012]**
(a) *Rhizobium* (b) *Azotobacter*
(c) *Nostoc* (d) *Azospirillum*

4. Which of the following groups of plants are highly useful in increasing soil fertility
(a) Red algae (b) Fungi
(c) Bacteria (d) Bryophytes

5. A prokaryotic autotrophic nitrogen fixing symbiont found in **[NCERT; CBSE PMT (Pre.) 2011]**

Or

Besides paddy fields, cyanobacteria are also found inside vegetative part of **[NEET 2013]**
(a) *Pisum* (b) *Alnus*
(c) *Cycas* (d) *Cicer*

6. Curing of tea leaves is brought about by the activity of **[CBSE PMT 2006]**
(a) Viruses (b) Fungi
(c) Bacteria (d) Mycorrhiza

7. Oxygenic photosynthesis occurs in **[CBSE PMT 2009]**
(a) Chromatium (b) Oscillatoria
(c) Rhodospirillum (d) Chlorobium

8. *Thermococcus*, *Methanococcus* and *Methanobacterium* exemplify **[CBSE PMT 2008]**
(a) Bacteria whose DNA is relaxed or positively supercoiled but which have a cytoskeleton as well as mitochondria
(b) Bacteria that contain a cytoskeleton and ribosomes
(c) Archaebacteria that contain protein homologous to eukaryotic core histones
(d) Archaebacteria that lack any histones resembling those found in eukaryotes but whose DNA is negatively supercoiled

9. The symbiotic nitrogen fixing bacteria present in root nodules of legumes belong to genus **[NCERT; AFMC 1998; CPMT 1998; CBSE PMT 1999; Pb. PMT 1999; BVP 2002; Kerala CET 2003; MP PMT 2003; MHCET 2004; AIEEE Pharmacy 2004; Bihar CECE 2006; DUMET 2009; J & K CET 2010]**
(a) *Xanthomonas* (b) *Pseudomonas*
(c) *Rhizobium* (d) *Acetobacter*

10. Nitrogen fixing bacteria are associated with **[NCERT]**
(a) Leguminosae (b) Cruciferae
(c) Gramineae (d) Malvaceae

11. Which of the following is recently discovered gram positive non-leguminous nitrogen fixing bacterium **[AIEEE Pharmacy 2003]**
(a) *Azospirillum* (b) *Rhizobium*
(c) *Nitrosomonas* (d) *Spirillum*

12. Nitrifying bacteria, *Nitrosomonas* and *Nitrobactor* **[CPMT 2004; Odisha JEE 2010; CBSE PMT (Pre.) 2011]**
(a) Convert (oxidise) ammonia or ammonium compounds into nitrates
(b) Convert nitrate into nitrogen
(c) Convert nitrogen into nitrates
(d) Convert carbon dioxide into carbohydrates

13. Match the items in **column I** with those in **column II** and choose the correct answer

	Column I		Column II
P.	Blue green algae as biofertilizers	i.	Ectomycorrhiza
Q.	Fungi as biofertilizers	ii.	*Thiobacillus sp*
R.	Free living nitrogen fixing bacteria	iii.	*Anabaena sp*
S.	Phosphate solubilizing bacteria	iv.	*Clostridium sp*
		v.	*Azospirillum sp*

[WB JEE 2012]
(a) P–iii, Q-i, R-v, S-ii (b) P-v, Q-i, R-ii, S-iv
(c) P-v, Q-iv, R-i, S-ii (d) P-iv, Q-ii, R-v, S-iii

14. The most abundant prokaryotes helpful to humans in making curd from milk and in production of antibiotics are the ones categorised as **[CBSE PMT (Pre.) 2012]**
(a) Cyanobacteria
(b) Archaebacteria
(c) Chemosynthetic autotrophs
(d) Heterotrophic bacteria

15. During biological nitrogen fixation, inactivation of nitrogenase by oxygen poisoning is prevented by **[AIPMT 2015]**
(a) Xanthophyll (b) Carotene
(c) Cytochrome (d) Leghaemoglobin

16. Free living bacteria that can fix N_2 from soil is **[Odisha JEE 2012]**
(a) *Clostridium* (b) *Azotobacter*
(c) *Beijerinckia* (d) All of these

17. For retting of jute the fermenting microbe used is **[CBSE PMT 2005]**
(a) *Methophilic bacteria* (b) Butyric acid
(c) *Helicobactor pylori* (d) *Streptococcus lactin*

18. Which bacteria is responsible for the reduction of nitrates into nitrogen, (denitrifying Bacteria) in soil **[Odisha JEE 2005; Kerala PMT 2010; AMU (Med.) 2010; MP PMT 2010; J & K CET 2012]**
(a) *Nitrosomonas* (b) *Pseudomonas*
(c) *Rhizobium* (d) *Clostridium*

19. Which of the bacterium is useful in preparing Idli **[BVP 2003]**
(a) *Leuconostoc mesenteroides*
(b) *Clostridium*
(c) Both (a) and (b)
(d) None of the above

20. Which of the folowing is symbiotic nitrogen fixes **[DPMT 2006; CBSE PMT 2009]**

Or

Which of the following can fix nitrogen in non-leguminous plants **[WB JEE 2016]**
(a) *Streptomyces* (b) *Anabaena*
(c) *Frankia* (d) *Rhizobium*

21. Non-symbiotic nitrogen fixation takes place by **[GUJCET 2014]**
(a) *Nostoc, Azotobacter, Clostridium*
(b) *Anabena, Nostoc, Rhizobium*
(c) *Azotobacter, Nitrosomonas, Rhizobium*
(d) *Anabena, Nitrosomonas, Pseudomonas*

22. All of the following statements concerning the actinomycetous filamentous soil bacterium *Frankia* are correct except that *Frankia* **[CBSE PMT 2005]**
(a) Can induce root nodules on many plant species
(b) Cannot fix nitrogen in the free-living state
(c) Cannot fix specialized vesicles in which the nitrogenase is protected from oxygen by a chemical barrier involving triterpene hapanoids
(d) Like *Rhizobium*, it usually infects its host plant through root hair deformation and stimulates cell proliferation in the host's cortex

23. Organisms called Methanogens are most abundant in a **[CBSE PMT (Pre.) 2011]**
(a) Hot spring (b) Sulphur rock
(c) Cattle yard (d) Polluted stream

24. Plasmid are used as carrier because **[CBSE PMT 2000; AIIMS 2007]**
(a) It has antibiotic resistance genes
(b) Its both ends are replication points
(c) It can go between eukaryotic and prokaryotic cells
(d) It is circular DNA which has capacity to bind eukaryote DNA

25. Fermentation is by **[RPMT 1999]**
(a) All micro organism
(b) All fungi
(c) All bacteria
(d) Some fungi and some bacteria

26. Cattle ranches are known to cause acute green house effect. This is due to **[AIIMS 2012]**
(a) Mechanised milking practices
(b) Methanogenic bacteria in rumen
(c) Decomposition of left over fodder
(d) Decomposition of organic remains in faeces

27. Which does not help in N_2 fixation **[RPMT 1999]**
(a) *Anabaena* (b) *Nostoc*
(c) *Oscillatoria* (d) *Rhizobium*

28. Which of the following is non-symbiotic biofertilizer **[CBSE PMT 1998]**
(a) VAM (b) *Azotobacter*
(c) *Anabaena* (d) *Rhizobium*

29. Which bacteria convert ammonium salts into nitrite **[CPMT 1998]**
(a) *Nitrobacter* (b) *Nitrosomonas*
(c) *Azotobacter* (d) None of these

30. Which of the following soil microorganism breaks down plant and animal protein into ammonia **[KCET 1998]**
(a) *Bacillus vulgaris* (b) *Nitrosomonas*
(c) *Pseudomonas* (d) None of the above

31. Which of the following is used to cure off the bitterness of tea leaves **[CPMT 1999; JIPMER 2001]**
(a) *Bacillus subtilis* (b) *B. megatherium*
(c) *B. lactis* (d) *B. mycococcus*

32. One of the useful activities of several bacteria is **[MP PMT 1998]**
(a) Nitrogen fixation
(b) Nitrification
(c) Operation of biogeochemical cycles
(d) All of the above

33. The main role of bacteria in the carbon cycle involves **[CBSE PMT 1998; AIIMS 2000]**
(a) Photosynthesis
(b) Assimilation of nitrogenous compounds
(c) Chemosynthesis
(d) Digestion or breakdown of organic compounds

34. One of the free-living, anaerobic nitrogen-fixer is **[CBSE PMT (Pre.) 2010]**

Or

Which of the following is a photoautotrophic bacterium **[CBSE PMT 2014]**
(a) *Azotobacter* (b) *Beijernickia*
(c) *Rhodospirillum* (d) *Rhizobium*

35. The function of leghaemoglobin in the root nodules of legumes is **[NCERT; CBSE PMT (Pre.) 2011]**
(a) Expression of *nif* gene
(b) Inhibition of nitrogenase activity
(c) Oxygen removal
(d) Nodule differentiation

36. A large number of organic compounds can be decomposed by **[CBSE PMT 1995]**
(a) Chemoorgano (b) *Pseudomonas*
(c) *Acetobacter* (d) Mycoplasma

37. Which one of the following bacteria has potential for nitrogen fixation **[MP PMT 1995; Bihar MDAT 1995]**
(a) *Nitrosomonas* (b) *Nitrobacter*
(c) *Nitrosococcus* (d) *Rhizobium*

38. Certain bacteria living in the soil poor in oxygen convert nitrates into nitrites and then to free nitrogen and such bacteria are termed as **[KCET 2000; CPMT 2003; AFMC 2006]**

Or

The bacteria which convert $NO_3 \rightarrow Free\,N_2$ are called as **[CPMT 1994, 2003; MP PMT 1996; MHCET 2003]**
(a) Nitrogen fixing bacteria (b) Denitrifying bacteria
(c) Ammonifying bacteria (d) Saprophytic bacteria

39. Which of the following is a flowering plant with nodules containing filamentous nitrogen-fixing microorganism **[CBSE PMT 2007]**
(a) *Casuarina equisetifolia* (b) *Crotalaria juncea*
(c) *Cycas revoluta* (d) *Cicer arietinum*

40. Probiotics are **[CBSE PMT 2007; DUMET 2010]**
(a) Safe antibiotics
(b) Cancer inducing microbes
(c) New kind of food allergens
(d) Live microbial food supplement

41. Bacteria which directly convert atmospheric nitrogen into nitrogen compounds are called **[AFMC 1996]**
(a) Denitrifying bacteria (b) Putrefying bacteria
(c) Nitrogen fixing bacteria (d) Nitrifying bacteria

Bacterial diseases

1. The germ theory of disease was putforth by **[MP PMT 1995]**
(a) Koch (b) Pasteur
(c) Rayer (d) Devaine

2. Effective management practice for bacterial leaf blight of rice is **[Odisha JEE 2012]**
(a) Removal of secondary host weed
(b) Use of resistant varieties
(c) Treatment of $ZnSO_4$ and $CaOCl_2$
(d) All of the above

3. In the following table identify the correct matching of the crop, its disease and the corresponding pathogen **[AIIMS 2008]**

	Crop	Disease	Pathogen
(a)	Citrus	Canker	*Pseudomonas rubrilineans*
(b)	Potato	Late blight	*Fusarium udum*
(c)	Brinjal	Root-knot.	*Meloidogyne incognita*
(d)	Pigeon pea	Seed gall	*Phytophthora infestans*

4. Cause of 'Mad Cow' disease of England **[RPMT 1999]**
(a) Virions (b) Mycoplasma
(c) Scrapie Protein (d) Viral protein

5. Which of the following is a bacterial plant disease **[Odisha JEE 2010]**
(a) Tikka disease of groundnut
(b) Downy mildew of grapes
(c) Ring rot of potato
(d) Red rot of sugarcane

6. Mycolic acid is present in cell wall of pathogen causing
(a) Tetanus (b) Cholera
(c) Diphtheria (d) Tuberculosis

7. Tetanolysin is produced by
(a) *Mycobacterium laprae* (b) *Clostridium botulinum*
(c) *Clostridium tetani* (d) None of these

8. Bacterial blight of rice is caused due to **[Odisha JEE 2004; CBSE PMT 2008]**
(a) *Xanthomonas oryzae* (b) *Helminthosporium oryzae*
(c) *Pseudomonas falcatum* (d) *Xanthomonas falcatum*

9. The poisonous substances commonly produced by bacteria are known as **[Kerala CET 2002; AFMC 2003]**
(a) Toxin (Exotoxins) (b) Auxins
(c) Antibiotic (d) Antitoxins

10. Which one of the following pathogen cause canker disease **[MP PMT 2002, 10; Kerala PMT 2007]**
(a) *Meloidogyne incognita* (b) *Anguina tritici*
(c) *Xanthomonas citri* (d) *Pseudomonas rubilineans*
(e) *Phytophthora infestans*

11. The *Bacillus haemophilus* causes
(a) Influenza (b) Pneumonia
(c) A form meningitis (d) Whooping cough

12. Black rot of crucifers is caused by a **[AMU (Med.) 2012]**
(a) Fungus (b) Bacterium
(c) Virus (d) None of these

13. Which of the following is disease causing bacterium in human beings **[MP PMT 2002]**
(a) *Escherichia coli* (b) *Xanthomonas citri*
(c) T.M.V. (d) Pilobolus

14. "Crown gall" is caused by **[BHU 1995; CPMT 1998]**
(a) *Mycobacterium*
(b) *Agrobacterium tumefaciens*
(c) *Erwinia*
(d) *Clostridium*

15. Which is the cause of Anthrax disease **[MP PMT 2002]**
(a) Virus (b) Bacteria
(c) Mycoplasma (d) Algae

16. 'Citrus canker' is caused by a **[NCERT; MP PMT 1997; BVP 2000; AFMC 2008]**
(a) Fungus (b) Bacterium
(c) Virus (d) Nematoda

17. The 2005 noble prize for physiology/medicine was awarded to Barry Marshall and Robin Warren of Australia for their discovery of **[KCET 2011]**
(a) Human papilloma virus causing cervical cancer
(b) Bacterium *Helicobacter pylori* causing peptic ulcer
(c) Prions, a new biological principle of infection
(d) Human immunodeficiency virus

Mycoplasma

1. Which one is the smallest organism capable of autonomous growth and reproduction **[MP PMT 2001; BHU 2012]**
Or
Which among the following are the smallest living cells, known without a definite cell wall, pathogenic to plants as well as animals and can survive without oxygen **[NEET 2017]**
(a) Virus (b) Viroid
(c) Mycoplasma (PPLO) (d) None of the above

2. Little leaf of brinjal is caused by **[Bihar MDAT 1995; MP PMT 2001]**
(a) Virus (b) Mycoplasma
(c) Fungus (d) Algae

3. Which one of the following statements about mycoplasma is wrong **[MP PMT 2002; CBSE PMT 2007]**
(a) They are also called PPLO
(b) They are pleomorphic
(c) They are sensitive to penicillin
(d) They cause diseases in plants

4. What is incorrect for mycoplasma **[RPMT 1997]**
(a) They are osmotically inactive
(b) Show absence of cell wall
(c) Are sensitive to modern antibiotics
(d) Are obligate intracellular parasites

5. Prokaryota includes **[RPMT 1995; CBSE PMT 1996; JIMPER 2002; MP PMT 2004]**
(a) Mycoplasma
(b) *Ulothrix*
(c) Fungi
(d) Mycoplasma and blue-green algae

6. *Penicillin* and *Vancomycin* do not affect the mycoplasma because **[Odisha JEE 2008]**
(a) There is no cell wall (b) There is no nucleus
(c) There is no mitochondria (d) There is no golgi body

7. Which of the following is effective against mycoplasmal diseases
(a) Vancomycin (b) Penicillin
(c) Chloramphenicol (d) All the above

8. Which of the following is called "*Jockers of microbiological park*"
(a) Bacteria (b) Mycoplasma
(c) *Nostoc* (d) None of these

9. The 'Witches broom' of legumes is caused by a **[MP PMT 1994; RPMT 1995; KCET 1999; Pb. PMT 2004]**
(a) Virus (b) Mycoplasma
(c) Bacterium (d) Fungus

10. Elementary cell body in mycoplasma perform the function of **[RPMT 1995; MP PMT 1995, 98]**
(a) Metabolism (b) Excretion
(c) Reproduction (d) Respiration

11. Mycoplasma are not sensitive to **[MP PMT 2000]**
(a) Streptomycin (b) Penicillin
(c) Erythromycin (d) Neomycin

12. Which of the following statement is true for Mycoplasma **[MP PMT 1999; KCET 2015; AIPMT 2015]**
(a) Presence of cell wall (b) Presence of nucleus
(c) Absence of cell wall (d) Definite shape

13. Who recorded pleuropneumonia in cattles
(a) Pasteur (b) Twort
(c) Knoll and Ruska (d) Nocard and Roux

14. "Dodder" can transmit
(a) Mycoplasmal diseases (b) Viral diseases
(c) Both (a) and (b) (d) None of these

15. Which of the species of mycoplasma causes human sterility
(a) *M. hominis* (b) *M. fermentans*
(c) Both (a) and (b) (d) None of these

16. The outermost limiting layer of mycoplasma is made up of **[Odisha JEE 2002]**
(a) Cell wall (b) Cell membrane
(c) Mucilaginous sheath (d) Slime layer

17. The membrane of which one of the following micro-organism is three layered
(a) *Nostoc* (b) *Mycoplasma*
(c) *E. coli* (d) *Rhodospirillum*

18. The disease of cardio-vascular system is caused by
(a) Algae (b) Mycoplasma
(c) Cyanobacteria (d) None of these

19. Tendency of abortion in ladies is caused by **[MP PMT 2007]**
(a) Cyanobacteria (b) Bacteria
(c) Mycoplasma (d) None of these

20. Which disease is caused by mycoplasma
(a) Citrus greening (b) Sandal spike
(c) Grassy shoot of sugarcane (d) All the above

21. Mycoplasma is
(a) Gram positive
(b) Gram negative
(c) Some species are gram positive
(d) None of the above

22. PPLO reproduce (multiply) by
(a) Gametic fusion (b) Binary fission
(c) Akinetes (d) Endospore

23. An organism having cytoplasm DNA and RNA but no cell wall is **[MP PMT 1995, 98; CPMT 2000; BVP 2001; MHCET 2002]**
(a) Cyanobacterium (b) Mycoplasma
(c) Bacterium (d) Virus

24. Mycoplasma is related to
(a) Algae (b) Bacteriophage
(c) Virus (d) L–form bacteria

25. Organisms without any specific shape are **[MP PMT 1997]**
(a) Mycoplasmas (b) Bacteria
(c) Viruses (d) Cyanobacteria

Cyanobacteria / Blue green algae

1. Pigment phycocyanin and phycoerythrin are found in **[Kerala CET 2005, BHU 2008]**
(a) Bacillariophyceae (b) Archaebacteria
(c) Eubacteria (d) Cyanobacteria
(e) Chlorophyceae

2. Incipient nucleus is present in **[BVP 2000]**
(a) Chlorophyceae (b) Rhodophyceae
(c) Myxophyceae (d) Phaeophyceae

3. Which of the following has polar nodule on both the ends
(a) Akinetes (b) Hormogonia
(c) Heterocysts (d) None of these

4. Which of the following shows the absence of chlorophyll '*b*' **[DPMT 2006]**
(a) Green algae (b) Red algae
(c) Blue-green algae (d) Brown algae

5. Which of the following plants is used as biofertiliser **[Kerala CET 2005]**
(a) *Nostoc* (b) *Funaria*
(c) *Volvox* (d) *Rhizopus*

6. The most primitive in the following are **[BHU 2005]**
(a) Cyanobacteria (b) Bryophytes
(c) Gymnosperms (d) Monocots

7. Which of the following statements is right **[KCET 2004]**
(a) Fronds are found in bryophytes
(b) Multiciliate sperms are found in angiosperms
(c) Diatoms produce basidiospores
(d) Heterocysts are found in *Nostoc*

8. Cyanobacteria are **[DPMT 2002; BVP 2004]**
(a) Mosses which attack bacteria
(b) Bacteria which attack cyanophyceae
(c) Autotrophic organism with phycocyanin
(d) None of these

9. Nitrogen fixation by *Nostoc*/Anabaena takes place in **[NCERT; MP PMT 1996; Odisha JEE 2004, 09; AFMC 2009; NEET (Karnataka) 2013]**
(a) Heterocysts (b) Vegetative cells
(c) Akinetes (d) Hormogonia

10. Which of the following may cause water blooms **[NCERT; BVP 2004]**
(a) Bacteria (b) Mycoplasma
(c) Virus (d) Blue-green algae

11. Which of the following is not a blue-green algae **[CPMT 2004]**
(a) *Nostoc* (b) *Anabaena*
(c) Lichen (d) *Aulosiras*

12. The blue-green algae are so called as they have in addition to green pigment chlorophyll, a blue pigment known as **[KCET 1994; MP PMT 1996; Kerala PMT 2003]**
(a) Phycocyanin (b) Chromoplasm
(c) Cyanophycin (d) Phycoerythrin

13. Red sea phenomena due to **[RPMT 2006]**
(a) Red algae
(b) Dinophyceae
(c) Diatoms
(d) Blue-green algae (*Trichodesmium erythrium*)

14. Which of the following movement may be found in blue-green algae
(a) Flagellar (b) Ciliary
(c) Gliding (d) None of the above

15. Which of the following important features are found in blue-green algae **[MP PMT 2006]**
(a) Abundant secretion of pectin
(b) Presence of phycocyanin – C as dominant pigment
(c) No plastids
(d) All the above

16. Which was first photosynthetic organism **[DPMT 2003]**
(a) Green algae (b) Red algae
(c) Cyanobacteria (d) Brown algae

17. Which of the following is a Prokaryote **[MP PMT 2002]**
(a) *Chlorella* (b) *Chlamydomonas*
(c) *Protomyces* (d) *Oscillatoria*

18. What is the photosynthetic product in blue-green algae
(a) Normal starch
(b) Glycogen
(c) Cyanophycean starch resembling glycogen
(d) None of these

19. Which is not a cyanobacterium **[AFMC 2002]**
(a) *Lyngbya* (b) *Plectonema*
(c) *Anabaena* (d) *Sinorhizobium*

20. The characteristic of blue green algae is **[NCERT; CBSE PMT 1999; RPMT 1999, 2002]**
Or
Blue- green algae are called cynobacteria because **[MP PMT 2012]**
(a) DNA without histone
(b) Nuclear membrane absent
(c) 70 S ribosomes
(d) All of the above

21. Cyanobacteria of great nutritive value is **[Kerala CET 2001]**
(a) *Gleocapsa* (b) *Scytonema*
(c) *Stigonema* (d) *Spirulina*

22. Nitrogenase enzyme is found in *Nostoc* in the cell of **[MP PMT 2001]**
(a) Vegetative (b) Heterocyst
(c) Both (a) and (b) (d) None of these

23. *Nostoc* is known to perform **[MP PMT 2001]**
(a) Only photosynthesis
(b) Photosynthesis and nitrogen fixation simultaneously
(c) Only nitrogen fixation
(d) Either photosynthesis or nitrogen fixation at a time

24. Single filament of *Nostoc* without mucilage sheath is known as **[AIIMS 1998]**
(a) Hyphae (b) Colony
(c) Trichome (d) Mycelium

25. In which of the following there is no sexual reproduction **[CBSE PMT 1995, 99; BVP 2001]**
(a) *Ulothrix* (b) *Nostoc*
(c) *Aspergillus* (d) *Volvox*

26. Which of the following algae is symbiotic and nitrogen fixing **[Pb. PMT 1999]**
(a) *Spirogyra* (b) *Cladophora*
(c) *Anabaena* (d) *Oedogonium*

27. Sexual reproduction is absent in **[MP PMT 2000]**
(a) Cyanobacteria (b) Bacteria
(c) Eukaryote (d) All of the above

28. Prokaryotes are characterized by **[Bihar MDAT 1995; CPMT 2009]**
(a) A true nucleus with double layered nuclear membrane is absent
(b) Well developed nucleus with double layered nuclear membrane present
(c) Presence of cell wall made of chitins, mucopolysaccharides and absence of nuclear membrane and cell organelles like mitochondria and chloroplasts
(d) Autotrophic in nature and only DNA is present

29. One of the followings is not the characteristic feature of cyanobacteria **[AMU (Med.) 2010]**
(a) They are multicellular
(b) They form colonies
(c) They form blooms in polluted water bodies
(d) They can fix atmospheric nitrogen

30. The name cyanobacteria refers to **[NCERT; CPMT 2002; CBSE PMT (Pre.) 2012]**
(a) Bacteria (b) Blue–green algae
(c) Yeast (d) Fungi

31. Nuclear membrane is absent in **[CBSE PMT (Pre.) 2012]**
(a) *Penicillium* (b) *Agaricus*
(c) *Volvox* (d) *Nostoc*

33. Which one of the following statements is wrong **[NEET (Phase-I) 2016]**
(a) Cyanobacteria are also called blue-green algae
(b) Golden algae are also called desmids
(c) Eubacteria are also called false bacteria
(d) Phycomycetes are also called algal fungi

34. Which were the organisms who changed earth's surface from reducing to the oxidizing **[BHU 2001]**
(a) Autotrophs (b) Heterotrophs
(c) Photoautotrophs (d) Chemotrophs

35. Cyanobacteria originated about how many years ago **[Pb. PMT 2000]**
(a) 1 billion (b) 2 billion
(c) 3 billion (d) 4 billion

36. Which of the following statements is not true for *Nostoc* **[KCET 2012]**
(a) It is prokaryotic (b) It is autotrophic
(c) It is filamentous (d) It is macroscopic

37. During rainy seasons, the ground becomes slippery due to dense growth of **[BHU 1999]**
(a) Lichens (b) Bacteria
(c) Green algae (d) Cyanobacteria

38. Hormogonia are the vegetatively reproducing structures of **[AIIMS 1999]**
(a) *Ulothrix* (b) *Spirogyra*
(c) *Oscillatoria* (d) *Chlamydomonas*

39. Atmospheric nitrogen-fixation is carried on by **[Pb. PMT 1999; HP PMT 2005]**
(a) *Funaria* (b) *Anabaena*
(c) *Chlamydomonas* (d) Fern gametophyte

40. *Spirulina* is a **[CPMT 2010]**
(a) Blue green algae (b) Fungi
(c) Pteridophyte (d) Bryophyte

41. Cyanophyceae has got
(a) Definite nucleus and plastid
(b) No definite nucleus but plastid
(c) Neither definite nucleus nor plastid
(d) Definite nucleus but no plastid

42. *Nostoc* is a **[MP PMT 1999; MHCET 2007]**
(a) Cyanobacteria (b) Beaded bacterium
(c) Bacteriophage (d) Parasite

43. Unicellular cyanobacteria reproduce asexually by **[MP PMT 1997]**
(a) Conjugation (b) Fragmentation
(c) Binary fission (d) Hormogones

44. Heterocysts are found in certain **[MP PMT 1997; Kerala PMT 2010]**
(a) Viruses (b) Bacteria
(c) Cyanobacteria (d) Mycoplasmas

45. Pigment-containing membranous extensions in some cyanobacteria are **[NEET 2013]**
(a) Chromatophores (b) Heterocysts
(c) Basal bodies (d) Pneumatophores

46. *Nostoc* is characteristic in having **[MP PMT 1998]**
(a) Cellulose cell wall (b) Uniflagellated zoospores
(c) Chlorophyll 'e' (d) Sexual reproduction

Critical Thinking

Objective Questions

1. *Escherichia coli* has the following combination of characters
(a) Rod shaped, 1–3 µm long, gram negative
(b) Rod shaped, 1– 3 µm long, gram positive
(c) Spiral, 1–3 µm long, gram negative
(d) Spiral, 1–3 µm long, gram positive

2. Mycoplasma differs from virus in being sensitive to **[MP PMT 1995]**
(a) Sugar (b) Tetracycline
(c) Protein (d) Amino acid

3. Which one of the following is wrong statement **[CBSE PMT (Pre.) 2012]**
(a) *Anabaena* and *Nostoc* are capable of fixing nitrogen in free living state also
(b) Root nodule forming nitrogen fixers live as aerobes under free living conditions
(c) Phosphorus is a constituent of all membranes , certain nucleic acids and all proteins
(d) *Nitrosomonas* and *Nitrobacter* are chemoautotrophs

4. K_{12} plasmid was studied first in
(a) *E. coli* (b) *Shigella*
(c) *Salmonella* (d) *Eberthella*

5. Lysozyme that is present in perspiration, saliva and tears, destroys **[CBSE PMT 2007]**
(a) Certain fungi
(b) Certain types of bacteria
(c) All viruses
(d) Most virus - infected cells

6. The most throughly studied of the known bacteria-plant interactions is the **[CBSE PMT 2004]**
(a) Nodulation of *Sebania* stems by nitrogen fixing bacteria
(b) Plant growth stimulation by phosphate-solubilising bacteria
(c) Cyanobacterial symbiosis with some aquatic ferns
(d) Gall formation on certain angiosperms by *Agrobacterium*

7. Which one of the following is genetically improved bacteria for pollution control **[CPMT 1998]**
(a) *Pseudomonas* (b) *Rhizobium*
(c) *Nitrobacter* (d) *Nitrosomonas*

8. Otitis media (inflammation of middle ear) is caused by
(a) Virus (b) Bacteria
(c) Bacteriophage (d) Mycoplasma

9. Select the correct combination of the statements (*A-D*) regarding the characteristics of certain organisms
(A) Methanogens are Archaebacteria which produce methane in marshy areas
(B) *Nostoc* is a filamentous blue-green algae which fixes atmospheric nitrogen
(C) Chemosynthetic autotrophic bacteria synthesize cellulose from glucose
(D) Mycoplasma lack a cell and can survive without oxygen
The correct statements are **[CBSE PMT (Mains) 2010]**
(a) (B), (C) (b) (A), (B), (C)
(c) (B), (C), (D) (d) (A), (B), (D)

10. The gram negative bacteria detect and responsed to chemicals in their surroundings by **[Kerala CET 2000; WB JEE 2008]**
(a) Lipopolysaccharide (b) Muramic acid
(c) Porins (d) Volutin granules

11. A few organisms are known to grow and multiply at temperatures of 100 – 105°C. They belong to **[CBSE PMT 1998]**
(a) Thermophilic subaerial fungi
(b) Marine archaebacteria
(c) Thermophilic sulphur bacteria
(d) Hot spring blue-green algae

12. A bacterium divides every 35 minutes. If a culture containing 10^5 *cells / ml* is grown for 175 minutes. What will be the cell concentration / *ml* after 175 minutes **[CBSE PMT 1998; BHU 2004]**

(a) 175×10^5 cells (b) 85×10^5 cells
(c) 35×10^5 cells (d) 32×10^5 cells

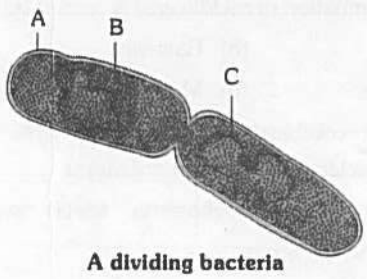
13. Monera possess **[MP PMT 2013]**

(a) Membrane bound nucleoproteins lying free in the cytoplasm
(b) Gene containing nucleoproteins condensed together in compact masses
(c) Nucleoproteins in direct contact with the rest of the cell substance
(d) Only free nucleic acid aggregates

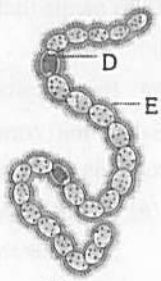
14. Which of the following are likely to be present in deep sea water **[NEET 2013]**

(a) Saprophytic fungi (b) Archaebacteria
(c) Eubacteria (d) Blue-green algae

15. Identify the A, B, C, D and E in the following diagram **[NCERT]**



A dividing bacteria



Nostoc

(a) A – Cell membrane, B – Cell wall, C – DNA, D – Heterocyst, E – Mucilagenous sheath
(b) A – Mucilagenous sheath, B – Cell membrane, C – DNA, D – Heterocyst, E - Cell wall
(c) A – Cell wall, B – Cell membrane, C – DNA, D – Heterocyst, E – Mucilagenous sheath
(d) A – Cell wall, B – Cell membrane, C – Heterocyst, D – DNA, E – Mucilagenous sheath

16. The motile bacteria are able to move by **[CBSE PMT 2014]**

(a) Cilia (b) Pili
(c) Fimbriae (d) Flagella

17. Pick up the wrong statement **[AIPMT 2015]**

(a) Protista have photosynthetic and heterotrophic modes of nutrition
(b) Some fungi are edible
(c) Nuclear membrane is present in monera
(d) Cell wall is absent in animalia

18. Cyanobacteria are classified under **[NCERT]**

(a) Protista (b) Plantae
(c) Monera (d) Algae

19. Conversion of nitrate to ammonia is a/an **[WB JEE 2016]**

(a) Amination process (b) Deamination process
(c) Oxidative process (d) Reductive process

20. Select the mismatch **[NEET (Phase-II) 2016]**

(a) Methanogens-Prokaryotes
(b) Gas vacuoles-Green bacteria
(c) Large central vacuoles-Animal cells
(d) Protists-Eukaryotes

21. Select the wrong statement **[NEET (Phase-II) 2016]**

(a) *Mycoplasma* is a wall-less microorganism
(b) Bacterial cell wall is made up of peptidoglycan
(c) Pili and fimbriae are mainly involved in motility of bacteria cells
(d) Cyanobacteria lack flagellated cells

22. Spliceosomes are not found in cells of **[NEET 2017]**

(a) Plants (b) Fungi
(c) Animals (d) Bacteria

AR Assertion & Reason

Read the assertion and reason carefully to mark the correct option out of the options given below :

(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion
(c) If the assertion is true but the reason is false
(d) If both the assertion and reason are false
(e) If the assertion is false but reason is true

1. Assertion : Bacteria are prokaryotic.
Reason : Bacteria do not possess true nucleus and membrane bound cell organelles. **[AIIMS 1996]**

2. Assertion : Bacteria have three basic shapes, *i.e.*, round, rod, spiral.
Reason : Cocci and Bacilli may form clusters or chain of a definite length. **[AIIMS 2000]**

3. Assertion : Bacterial photosynthesis occurs by utilizing wavelength longer than 700 *nm*.
Reason : Here reaction centre is B-890. **[AIIMS 2002]**

4. Assertion : The nitrogen-fixing bacteria in leguminous plant nodules live as symbionts.
Reason : Leg-haemoglobin synthesized by leguminous plants protect bacteria.

5. Assertion : Bacteria are classified among plants.
Reason : They have cell walls.

6. Assertion : Bacteria do not always move with the help of flagella.
Reason : Flagellated bacteria employs rotary motion of flagellum when it moves.

7. Assertion : Some bacteria have the capacity to retain Gram stain after treatment with acid alcohol.
Reason : They are known as Gram positive as they are attracted towards positive pole under influence of electric current.

8. Assertion : None autotrophic bacteria carry out chemosynthesis.
Reason : Chemosynthetic bacteria trap the small amount of energy released from inorganic compound's oxidation to use in the reactions that synthesize carbohydrates.

9. Assertion : Exotoxins are released by Gram +ve bacteria causing diseases to animals.
Reason : Exotoxins are proteins to whose response WBC of animals react.

10. Assertion : All food chains will come to stand still if bacteria disappear from earth.
Reason : Bacteria are only associated with the soil fertility and hardly any role for food chains.

11. Assertion : Broad spectrum antibiotics are produced by *streptomyces*.
Reason : They can destroy microorganisms by inhibiting DNA replication or protein synthesis.

12. Assertion : Bacterial cell wall is characterised by having mucopolysaccharides.
Reason : Acetyl muramic acid is an example of mucopolysaccharide.

13. Assertion : Root nodules in leguminous plants are inhabited by *Anabaena*.
Reason : Leguminous plants are an example of symbiotic nitrogen fixation.

14. Assertion : *Bacillus butschli* is true bacterium.
Reason : Its cell wall is composed of acetyl muramic acid.

15. Assertion : Plasmids are double-stranded extra chromosomal DNA.
Reason : Plasmids are possessed by eukaryotic cells. **[AIIMS 1997]**

16. Assertion : Pili are motile appendages of bacteria.
Reason : Pili participate in conjugation.

17. Assertion : Cell secretion does not occur in bacteria.
Reason : Golgi complex is absent in bacteria.

18. Assertion : *Agrobacterium tumefaciens* is the causative agent of crown gall disease of dicots .
Reason : *Agrobacterium tumefaciens* causes infection by entering the plant through wounds and injuries. **[KCET 2012]**

Answers

Structure, shape and nutrition of bacteria

1	c	2	d	3	b	4	c	5	d
6	a	7	c	8	c	9	a	10	b
11	c	12	a	13	b	14	a	15	b
16	e	17	a	18	b	19	a	20	b
21	d	22	c	23	c	24	c	25	a
26	d	27	a	28	a	29	c	30	c
31	a	32	d	33	a	34	a	35	b
36	b	37	a	38	b	39	d	40	a
41	c	42	a	43	b	44	b	45	b
46	c	47	c	48	d	49	a	50	d
51	c	52	d	53	a	54	c	55	a
56	b	57	c	58	c	59	d	60	c
61	b	62	b	63	a	64	c	65	c
66	b	67	c	68	d	69	b	70	b
71	c	72	d	73	c	74	d	75	c
76	b	77	a	78	c	79	a	80	d

Life cycle/Reproduction in bacteria

1	a	2	b	3	a	4	a	5	a
6	b	7	d	8	c	9	a	10	d
11	d	12	b	13	c	14	b	15	b
16	b	17	c	18	c	19	a	20	a
21	a	22	b						

Economic importance of bacteria

1	d	2	d	3	b	4	c	5	c
6	c	7	b	8	c	9	c	10	a
11	a	12	a	13	a	14	d	15	d
16	d	17	b	18	b	19	a	20	c
21	a	22	b	23	c	24	a	25	d
26	b	27	c	28	b	29	b	30	a
31	b	32	d	33	d	34	c	35	c
36	a	37	d	38	b	39	a	40	d
41	c								

Bacterial diseases

1	b	2	d	3	c	4	c	5	c
6	d	7	c	8	a	9	a	10	c
11	a	12	b	13	a	14	b	15	b
16	b	17	b						

Mycoplasma

1	c	2	b	3	c	4	d	5	d
6	a	7	c	8	b	9	b	10	c
11	b	12	c	13	d	14	c	15	c
16	b	17	b	18	b	19	c	20	d
21	b	22	b	23	b	24	d	25	a

Cyanobacteria / Blue green algae

1	d	2	c	3	c	4	c	5	a
6	a	7	d	8	c	9	a	10	d
11	c	12	a	13	d	14	c	15	d
16	c	17	d	18	c	19	d	20	d
21	d	22	b	23	b	24	c	25	b
26	c	27	a	28	c	29	a	30	b
31	d	32	c	33	c	34	c	35	d
36	d	37	c	38	b	39	a	40	c
41	a	42	c	43	c	44	a	45	a

Critical Thinking Questions

1	a	2	b	3	c	4	a	5	b
6	d	7	a	8	d	9	d	10	c
11	d	12	d	13	c	14	b	15	c
16	d	17	c	18	c	19	d	20	c
21	c	22	d						

Assertion and Reason

1	a	2	b	3	b	4	a	5	a
6	b	7	c	8	d	9	a	10	c
11	a	12	d	13	a	14	a	15	c
16	e	17	e	18	a				

AS Answers and Solutions

Structure, shape and nutrition of bacteria

5. (d) *Rhodospirillium* is photosynthetic bacteria.

8. (c) *Nostoc*, *Chara*, *Porphyra* and *Wolfia* are *Photoautotrophs* while *Nitrosomonas* and *Nitrobacter* are *chemoautotrophs*.

13. (b) In G^+ (Gram–positive bacteria) cell wall is 200–300 Å thick having mucopeptides 85% and lipids 1–2% while in G^- (Gram-negative bacteria) cell wall is 100–200 Å thick and mucopeptides are 10–12% and lipids 80–90%.

23. (c) *E. coli* is a prokaryotic bacterium.

25. (a) Anaerobic breakdown of proteins is known as putrefaction.

29. (c) In many bacteria (specially gram +ve) the plasma membrane gives rise to infoldings called mesosome. They have respiratory enzymes like succinic dehydrogenase, cytochrome oxidase for respiration.

33. (a) The bacterial flagellum is long, filamentous and protoplasmic appendage that arise in the cell envelope. In the bacterial flagella instead of 9 + 2 arrangement of tubulin there is simply a single filament of globular protein called flagellin.

39. (d) Nitrifying bacteria such as *Nitrosomonas* and *Nitrobacter* manufacturing their organic food utilizing chemical energy in oxidation of some inorganic compound. Hence these bacterias are chemosynthetic.

40. (a) Branched chain lipids of cell membranes of archaebacteria enable them to tolerate high temperature and high acidity.

44. (b) During unfavourable condition highly resistant single spore is formed in the bacterial cell (*e.g.*, Tetanus and anthrax bacteria) which is known as endospore.

52. (d) The bacterium *E. coli* have double stranded circular DNA. Many genetical researches are carried out on *E. coli* for the study of genetic engineering.

55. (a) Fimbriae are more in number, short thin straight bristle like appendages which function as organ of adhesion. Pili are similar to fimbriae but different in function.

59. (d) R-factor is type of plasmid which contains genes for antibiotic resistance.

67. (c) Respiratory enzyme containing infolding of plasma membrane in bacteria called chondrioid.

72. (d) The cell envelope in bacteria consists of a tightly bound three layered structure *i.e.* the glycocalyx followed by the cell wall and then plasma membrane.

75. (c) Cell membrane of archaebacteria possesses branched chain lipids.

76. (b) Mesosomes help in respiration, secretion processes, to increase the surface area of the plasma membrane and enzymatic contact.

77. (a) Bacterial cell wall is made of peptidoglycan.

78. (c) Methanogens, halophiles and thermoacidophiles are archaebacteria.

Life cycle/Reproduction in bacteria

1. (a) The number of bacteria becomes double after each division.

4. (a) In the process of transduction, virus is used as a carrier in the transfer of DNA from one bacterial cell to other.

7. (d) Temperate phages are the avirulent lysogenic phages whose nucleic acids get incorporated in the bacterial DNA (lysogenization). When these phages infect bacteria, the bacterial cell undergoes many divisions and prophages are formed.

9. (a) The phage λ DNA attaches to the specific site of bacterial genome with the help of λ integrase enzyme. The phage DNA in this latent (non virulent) form is called provirus or prophage (integrated viral DNA with the host bacterial DNA).

19. (a) During conjugation two bacteria cell comes together and formed a conjugation tube. By this tube genetic material reach from donor to recipient bacteria.

20. (a) Sex factor or *F*–factor are extra-chromosomal DNA particles which either integrate with main DNA or remain independent from main DNA.

22. (b) It takes place by transferring DNA from capsulated to non-capsulated.

Economic importance of bacteria

1. (d) *Spirulina* is SCP rich in protein, vitamins and minerals and rice variety rich in iron content. 250 gram biomass of *Methylophilus methylotrophus* produce 25 tonn protein/day while cow of 250 *Kg* produces only 200gm protein/day.

2. (d) *Clostridium* is saprophytic, anaerobic N_2 fixing bacteria and have ability to fix atmospheric N_2 into NH_3.

3. (b) *Azotobacter* (aerobic) is a free living N_2, fixing bacteria. This bacteria fix independently atmospheric nitrogen in their body and convert to organic nitrogen compounds. When they die, the organic nitrogen compounds of their body are made available to higher plants through the activities of other bacteria.

4. (c) Bacteria causes N_2 fixation.

5. (c) *Anabaena cycadae* is a BGA found in coralloid roots of *Cycas*.

6. (c) Bacteria causes the curing of tea and coffee by which bitterness is removed and flavour is added.

17. (b) In this process bacteria decompose the pectin of the plant to liberate fibres. The process of fibre preparation is known as retting. This process is carried out by *Clostridium butyrium*.

18. (b) Some bacteria such as *Thiobacillus denitrificans*, *Pseudomonas aoruginosa* and *Micrococcus denitrificans* also occur in the soil which convert the nitrate and ammonia into atmospheric free elemental nitrogen.

20. (c) Actinomycetes are filamentous bacteria, inhabitant of soil. The genus *Frankia* causes nitrogen fixing nodules to form in older tree roots (non-legume plants).

21. (a) Non-symbiotic nitrogen fixation takes place by Blue-green algae (*Nostoc* and *Anabena*) and free living soil bacteria (the aerobic *Azotobacter* species and the anaerobic *Clostridium* species).

23. (c) Methanogens are archaebacteria abundant in cattle yard and paddy fields.

27. (c) They lack heterocyst. That is why, they can not take part in N_2 fixation.

28. (b) Non-symbiotic bacteria are also called free-living nitrogen fixing bacteria *e.g. Azotobacter*. They are agriculturally important.

29. (b) $NH_4 \xrightarrow{Nitrosomonas} NO_2 \xrightarrow{Nitrobacter} NO_3$.

32. (d) Some bacteria can fix atmospheric N_2 like *Azotobacter* and *Clostridium*, some bacteria can change nitrogen of ammonia into nitrate like *Nitrosomonas* and some bacteria help in biogeochemical cycle by breaking of complex organic compound into simple inorganic compound.

33. (d) The main role of bacteria is as a decomposer. The bacteria decompose the complex organic compounds into simple one which are reused in carbon cycle.

34. (a) Rhodospirillum bacteria is facultative aerobic photo-autotrophic bacteria use non-sulphur aliphatic organic compound as donor of H_2 *e.g.*, Propyl alcohol.

$$6CO_2 + 12CH_3CHOHCH_3 \xrightarrow{Light}$$
$$C_6H_{12}O_6 + 12CH_3COH_3 + 6H_2O$$

35. (c) LHB is O_2 scavanger.

39. (a) *Frankia* is a filamentous N_2-fixing bacteria which is symbiont on the root of *Casuarina equisetifolia*.

Bacterial diseases

1. (b) On the basis of his work Pasteur proposed "germ theory of disease" which was recognised by medical scientists very soon.

6. (d) *Mycobacterium tuberculosis* releases the mycolic acid, it is changed to mycoides involved in causing disease.

7. (c) Tetanolysin is a Neurotoxins.

15. (b) Bacteria *Bacillus anthracis* caused anthrax disease.

Mycoplasma

2. (b) Little leaf of brinjal : In this disease, the leaves of Brinjal remain small in size because mycoplasma inhibits leaf expansion of leaf cells.

4. (d) Mycoplasma can grow out side the host cell. Thus it is clear that mycoplasma are not obligate parasite like viruses.

6. (a) Penicillin and vancomycin inhibits the cell wall synthesis.

10. (c) Elementary bodies are related with asexual reproduction of mycoplasma. When cell of mycoplasma divides into minute bodies, these bodies are called elementary bodies.

11. (b) Because mycoplasma lacks cell wall where as penicillin acts on cell wall.

14. (c) *Cuscuta reflexa* (Dodder) is parasite on angiosperms through which viruses and mycoplasma transmit.

16. (b) Mycoplasma lacks cell wall, therefore the outermost existing layer is cell membrane.

19. (c) *Mycoplasma salivarium* inhibit the food as well as blood to the developing embryo in pregnant female, which cause abortion.

22. (b) Mycoplasma is irregular in shape and divides by simple binary fission.

23. (b) Mycoplasma are cell wall less cells but show multiplication like bacteria, so that they are termed as cell wall less bacteria.

24. (d) Both mycoplasma and L-form bacteria are cell wall less.

25. (a) Due to the absence of cell wall, mycoplasma are highly elastic and readily change the shape, hence the mycoplasmas are irregular and quite variable in shape. This nature is called pleomorphism.

Cyanobacteria / Blue green algae

1. (d) Cynobacteria have a water soluble phycobilin pigments. c-phycocyanin (blue) and c–phycoerythrin (red).

2. (c) Myxophyceae is another name of cyanobacteria which are moneran.

3. (c) Each heterocyst is connected with vegetative cells, on two sides through the prominent pores into the wall. Which later on one occupied by a refractive cynophycean granule called polar nodule.

4. (c) Chlorophyll-*b* is found in eukaryotic photoautotroph.

5. (a) *Nostoc* possess special type of cells called heterocyst for free N_2 fixation that is why *Nostoc* is biofertliser.

9. (a) Heterocysts are airtight anaerobic bodies in which enzyme nitrogenase fixes atmospheric nitrogen.

14. (c) Cilia and flagella absent in blue green algae.

19. (d) *Sinorhizobium* is a bacterium.

20. (d) Blue green algae or cyanobacteria is designated as Prokaryotes.

21. (d) *Spirulina* is a rich source of proteins and vitamin B-complex as well.

23. (b) Because they have photosynthetic lamellae for photosynthesis and heterocyst for N_2-fixation.

26. (c) *Anabaena* is found symbiotically in *Azolla* and help in N_2 fixation.

27. (a) Cyanobacteria is haploid so meiosis and fertilization is absent.

31. (d) Because *Nostoc* is prokaryotes

33. (c) Cyanobacteria appeared in precambrian period around 3.2 billion years ago and were the first to have oxygenic photosynthesis to evolve O_2 in photosynthesis that caused conversion of primitive reducing atmosphere to present day oxidising atmosphere (oxygen revolution).

42. (c) Unicellular forms reproduce asexually by binary fission while filamentous forms are by Hormogones.

43. (c) Some cyanobacteria possess heterocyst like *Nostoc*, *Scytonema* etc. Heterocyst is a site of N_2 fixation.

Critical Thinking Questions

2. (b) Mycoplasma are sensitive to tetracycline and resistant to penicillin, because they lack cell wall.

4. (a) K_{12} plasmid was first studied in *E.coli*, by two American scientist Lederberg and Tatum (1946).

5. (b) Lysozyme is a enzyme which can dissolve the cell wall of bacteria.

7. (a) Genetically modified *Pseudomonas* can decompose organic product like petroleum, oils etc.

9. (d) Chemosynthetic autotrophs oxidize inorganic substances to produce energy and helps cycling of minerals.

10. (c) Porins is a proteins, which is found in the cell of Gram negative bacteria. Which function as channels for the entry and exist of hydrophilic low molecular weight substances.

12. (d) As we know that bacterium divides after every 35 *minutes* through simple mitotic division therefore number of divisions are $\frac{175}{35}=5$

Since one bacterium on division produces two cells so cell concentration after 175 minutes will be

$=10^5\times(2)^5 \quad =32\times10^5$.

16. (d) Motile bacteria have thin filamentous extensions from their cell wall called flagella.

20. (c) Large central vacuole is present in plant cells

21. (c) Motility is performed by flagella only in bacterial cells while fimbriae provide attachment to base and pili form conjugation tube during conjugation

Assertion and Reason

1. (a) Bacterial cell is prokaryotic. It lacks true nucleus, membrane bound organelles and sexual reproduction.

2. (b) Bacteria have different shapes spherical, rod, and spiral are three important type. Cocci may be in cluster or chain form or single and bacilli may be single, in pair in chain.

3. (b) Bacteria utilize the wavelengths longer than 700 nm for photosynthesis and the reaction centre is P-890 the reductant is NADH + H^+. In bacteria donor may be H_2S or malate or succinate.

4. (a) *Rhizobium* form a symbiotic association with roots of leguminous plants producing root nodules. These bacteria reside inside the nodules and reduce atmospheric nitrogen (N_2) to ammonia. The fixed nitrogen is taken up by plant. In return the plant provides nutrients both and protection to bacteria.

5. (a) Plant cells are characterized by the presence of a rigid cell wall on the basis of which they can be differentiated from animal cells. Hence classified among plants.

6. (b) Myxobacteria do not have flagella and move by gliding movement.

7. (c) The cell wall of Gram-negative bacteria contains alcohol-soluble lipid, while the cell wall of Gram-positive bacteria lacks the lipids and therefore resist decolourisation and retain the primary stain, appearing violet. Gram-negative bacteria are decolorized by organic solvents and therefore, take the counter stain, appearing red. Gram +ve bacteria does not attracted towards positive pole under influence of electric current.

8. (d) Chemosynthetic bacteria are without photosynthetic pigments. For the synthesis of their own organic food, (carbohydrates), they obtain carbon from CO_2 of the atmosphere, necessary energy from oxidation of inorganic or organic compounds, such as hydrogen sulphide (H_2S), ferrous compounds (Fe^{2+}), molecular hydrogen (H_2) ammonia (NH_3) and nitrites (NO_2^-).

9. (a) Mostly pathogenic gram +ve bacteria releases exotoxins outside the cell and kills the W.B.C. and causes the disease.

10. (c) The bacteria play an important and dual role by disposing off the dead bodies and wastes of organism and by increasing the fertility of soil.

11. (a) Streptomyces produced broad spectrum of antibiotics by living microorganism capable of inhibiting or destroying other many types of microbes.

12. (d) Chemically bacteria consists of acetylglycosamine, acetyl muramic acid and a peptide chain of four or five amino acids. All these chemicals together form a polymer called peptidoglycan (= murein or mucopeptide). Some other chemical substances deposited on the cell wall are – teichoic acid, protein polysaccharides lipoproteins and lipopolysaccharides.

13. (a) *Anabaena* found symbiotically in the root nodules of many leguminous plants which helps in N_2 fixation.

14. (a) *Bacillus butschli* is the Gram positive bacterium and its cell wall consist of acetyl muramic acid.

15. (c) In addition to bacterial chromosomes many bacteria have accessory rings of DNA called plasmids. Plasmids are absent in eukaryotic chromosome.

16. (e) In some bacteria, nonmotile appendages called pili or fimbriae are also present. They take part in sexual reproduction, *i.e.*, conjugation.

17. (e) Cell secretion occurs even in the prokaryotic cells (bacteria) in relation to the production of a variety of enzyme to the medium. In certain protozoa, vacuoles similar to the contraction expel water into the medium. Golgi complex are found, which by their contraction expel water into the medium. Golgi complex and other membrane found organelle are absent in prokaryotes.

18. (a)

Monera (Prokaryotes)

SET Self Evaluation Test

1. Which of the following represents obligate anaerobes
(a) *Spirogyra* (b) *Pisum sativum*
(c) Onion (d) Methane bacteria

2. *Mycoplasma mycoides* causes which of the following diseases
(a) Bovine pleuropneumonia (b) Inflammation of genitals
(c) Agalactia (d) None of these

3. Food material can be preserved at **[MP PMT 2006]**
(a) High temperature (b) Osmotic pressure
(c) Low temperature (d) All of the above

4. The bacteria which lacks flagella and moves by gliding are included in
(a) Spirochaetes (b) Rickettsia
(c) Myxobacteria (d) Eubacteria

5. Select the correct match

A.	*Nitrosomonas*	-	Nitrite to nitrate
B.	*Thiobacillus*	-	Denitrification
C.	*Nostoc*	-	Free-living nitrogen-fixer
D.	*Azotobacter*	-	Anaerobic nitrogen-fixer

[Kerala PMT 2011]
(a) A and B (b) C and D
(c) B and C (d) B and D
(e) A and C

6. Pasteurization is heating at **[MP PMT 2006 DUMET 2009; CPMT 2009]**
(a) 120°C for 60 minutes (b) 60-70°C for 30 minutes
(c) 70°C for 60 minutes (d) 80°C for 30 minutes

7. Exotoxin is produced by
(a) Gram positive bacteria (b) Gram negative bacteria
(c) Both (a) and (b) (d) None of the above

8. Clover phyllody is caused by **[MP PMT 2011]**
(a) Spirochaetes (b) Protoplasts
(c) Spheroplasts (d) Mycoplasmas

9. The murein found in bacterial cell is **[CPMT 1998]**
(a) Derivative of protein
(b) Derivative of fat
(c) Derivative of organic acids
(d) Derivative of sugars

10. Koch's postulates are not applicable to **[CBSE PMT 1999]**
(a) T. B. (b) Leprosy
(c) Cholera (d) Diphtheria

11. The purple sulphur bacteria use hydrogen sulphide and release sulphur but not oxygen. Which of the following agrees with above observation **[AIEEE Pharmacy 2002]**
(a) The H_2 that reduces CO_2 comes from H_2S that liberates sulphur
(b) Photosynthesis does not require chlorophyll
(c) Photosynthesis consist of a light and a dark reaction
(d) The H_2 which reduces CO_2 in photosynthesis comes from H_2O that releases O_2

12. Why bacteria do not survive in the salt pickle which has high salt contents **[KCET 2000]**
(a) Salt retards the rate of reproduction of bacteria
(b) Bacteria do not get light for photosynthesis
(c) Due to plasmolysis bacteria die
(d) Essential elements for bacterial viability are not present in the pickle

13. For reproduction, 'endospores' are formed in the following genera **[BHU 1994; KCET 1999; Pb. PMT 2000]**
(a) *Bacillus* and *Clostridium*
(b) *Mucor* and *Bacillus*
(c) *Monococcus* and *Clostridium*
(d) *Saccharomyces* and *Clostridium*

14. Match column I with column II and select the correct option given below

	Column I		**Column II**
A.	Aerobic	1.	*Frankia*
B.	Cyanobacteria	2.	*Azospirillum*
C.	*Casuarina*	3.	*Clostridium*
D.	Tropical grasses	4.	*Aulosira*
		5.	*Azotobacter*

[Kerala PMT 2006]
(a) $A-4, B-3, C-2, D-1$
(b) $A-3, B-5, C-4, D-2$
(c) $A-2, B-1, C-3, D-5$
(d) $A-5, B-3, C-4, D-1$
(e) $A-5, B-4, C-1, D-2$

15. Which bacterium causes cotton destruction
(a) *Clostridium botulinum*
(b) *Spirochaeta cytophaga*
(c) *Mycobacterium*
(d) *Vibrio*

16. Bacteroids are **[MP PMT 2010]**
(a) Enlarged non-motile cellular bacteria *Rhizobium leguminosarum* in root nodules of legumes
(b) A bacterial cell infected with viruses
(c) A motile bacterium
(d) *Nitrosomonas* bacteria in soil

17. Activity of nitrogenase in nitrogen fixing micro-organisms can be seen when
(a) Methane is converted to ethane
(b) Ethane is converted to methane
(c) Ethylene is converted to acetylene
(d) Acetylene is converted or reduced to ethylene

18. *Azotobacter* and *Polymyxa* are example of **[CBSE PMT 1996]**

(a) Symbiotic nitrogen fixation
(b) Non-symbiotic nitrogen fixation
(c) Disease causing bacteria
(d) Ammonifying bacteria

19. Match the types of bacteria listed in column I with their activity given in column II. Choose the correct combination of alphabets of the two columns

Column-I (Types of bacterial)		Column-II (Activity)	
A.	*Streptomyces*	p.	Food poisoning
B.	*Rhizobium*	q.	Source of antibiotics
C.	*Nitrosomonas*	r.	Nitrogen fixation
D.	*Acetobacter*	s.	Nitrification
		t.	Vinegar synthesis

[NCERT; KCET 2004]

(a) A = q; B = r; C = p; D = t
(b) A = q; B = r; C = s; D = t
(c) A = s; B = t; C = p; D = r
(d) A = t; B = p; C = r; D = s

20. The bacteria *Pseudomonas* is useful because of its ability to **[AIIMS 2004]**

(a) Transfer genes from one plant to another
(b) Decompose a variety of organic compounds
(c) Fix atmospheric nitrogen in the soil
(d) Produce a wide variety of antibiotics

21. Pullorum disease of poultry is caused by **[KCET 2000]**

(a) *Hemophilus* (b) *Clostridium*
(c) *Salmonella* (d) *Mycobacterium*

22. Which of the following is a seed borne disease **[DPMT 2004]**

(a) Bacterial blight of rice
(b) Kharia of paddy
(c) Whiptail of *Brassica*
(d) All of these

Answers and Solutions

1	d	2	a	3	d	4	c	5	c
6	b	7	a	8	d	9	d	10	b
11	a	12	c	13	a	14	e	15	b
16	a	17	c	18	b	19	b	20	b
21	c	22	a						

3. (d) Food preservation and spoilage of food involve the factors that control the growth of microorganisms. These methods of preservation are used today.

1. **Osmotic pressure**–The addition of salts of a solution resulting in increase of osmotic pressure and can be used to preserve food. The high salt or sugar concentration draw water of any microbial cell out thus prevent their growth.
2. **Low-temperature**–Pathogenic bacteria with a few exception will not grow at low temperature (near about 0°C).
3. **Pasteurization**–It is heating of food at high temperature i.e., the microorganisms eliminated from the food.

4. (c) Cyanobacteria are also called myxobacteria. In which flagella one completely absent but the movement occurs in some genera by special gliding motion. Such movement are connected with the secretion of mucilage.

6. (b) In the classic pasteurization treatment of milk, the milk was exposed to a temperature of about 63°C for 30 minutes. Most milk pasteurization today uses higher temperatures, at least 72°C, but for only 15 seconds.

7. (a) Exotoxin is produced by mostly gram positive bacteria, these are protenaceous and heat labile compound which are excreted by bacteria out side the cell.

9. (d) The mucopeptide or murein is a polymer of two amino sugars namely N-acetylglucosamine (NAG) and N-acetyl muramic acid (NAM).

10. (b) Causing agent of *Mycobacterium laprae* can not be cultured.

11. (a) $6CO_2 + 12H_2S \xrightarrow{\text{Light}} C_6H_{12}O_6 + 12S + 6H_2O$ + energy. Here H_2S is utilized as a source of hydrogen, which reduces CO_2 into glucose. Oxygen is not liberated in bacterial photosynthesis.

12. (c) Salting of pickles, meat, fishes etc. and addition of sugar to jams, jellies, cut fruits etc., prevent their decay by microbes, as the latter get killed due to plasmolysis or due to high concentration of salt or sugar.

13. (a) Endospore formation is more common in rod shaped bacteria or bacillus forms.

15. (b) Some bacteria damage cellulose of textiles. *e.g.*, *Spirochaete cytophage, cellulomonas* etc.

16. (a) Bacteroid : Symbiotic bacteria *Rhizobium leguminosarum* in leguminous plants *e.g.*, gram, pea etc. in their roots nodules produce *Leg haemoglobin*, this whole *Bacteria + Leg haemoglobin* + Polyploide cells of roots is called as bacteroid.

22. (a) Bacterial blight of rice is a seed borne disease which is transmitted to paddy. Seedlings when raised under high humid conditions. This disease is caused by *Xanthomonas oryzae*.

* * *