

Chapter 6

PROKARYOTES

Q1. Outline the bacterial ecology and diversity.

Ans: Bacteria are found almost everywhere on environment and show great diversity.

Occurrence of bacteria:

Bacteria occur in the widest range of habitats. Bacteria are found almost everywhere in air, water, soil, food and in the bodies of plants and animals including human beings. In fact, many bacteria species are extremophiles, which are adapted variously to extreme temperature, pressure, pH, salinity and other abiotic factors.

Major groups of bacteria:

Historically, bacteria have been subdivided taxonomically into groups based on their cell wall types (Gram-positive or Gram-negative), presence of endospore, metabolism, growth and nutritional characteristics, physiological characteristics and other criteria.

Cyanobacteria-The Most Prominent Photosynthetic Bacteria:**Introduction:**

Cyanobacteria (Gk. Kyanoa, blue and bacterion, rod) are the most prominent photosynthetic bacteria which are found in any damp place. Majority of them are free living while some are found as epiphytic or symbiotic forms.

Structure and organization:

Cyanobacteria have Gram-negative type of cell wall. The body may be unicellular and solitary or in the form of filaments which may form colonies. In

filamentous forms the cells are arranged in linear row, the trichome which is embedded in mucilage sheath e.g. *Anabaena*, *Nostoc* etc.

Photosynthesis:

Photosynthesis takes place in the extensive system of membrane (thylakoid membranes), which is located in the outer zone of the cytoplasm inner to the cell membrane.

Photosynthetic events:

Like algae and plants, they use carbon dioxide as a source of carbon, water as hydrogen donor, both photosystems (non-cyclic photophosphorylation) to harvest light energy and release oxygen during photosynthesis. They are believed to be responsible for first introducing oxygen into the primitive atmosphere.

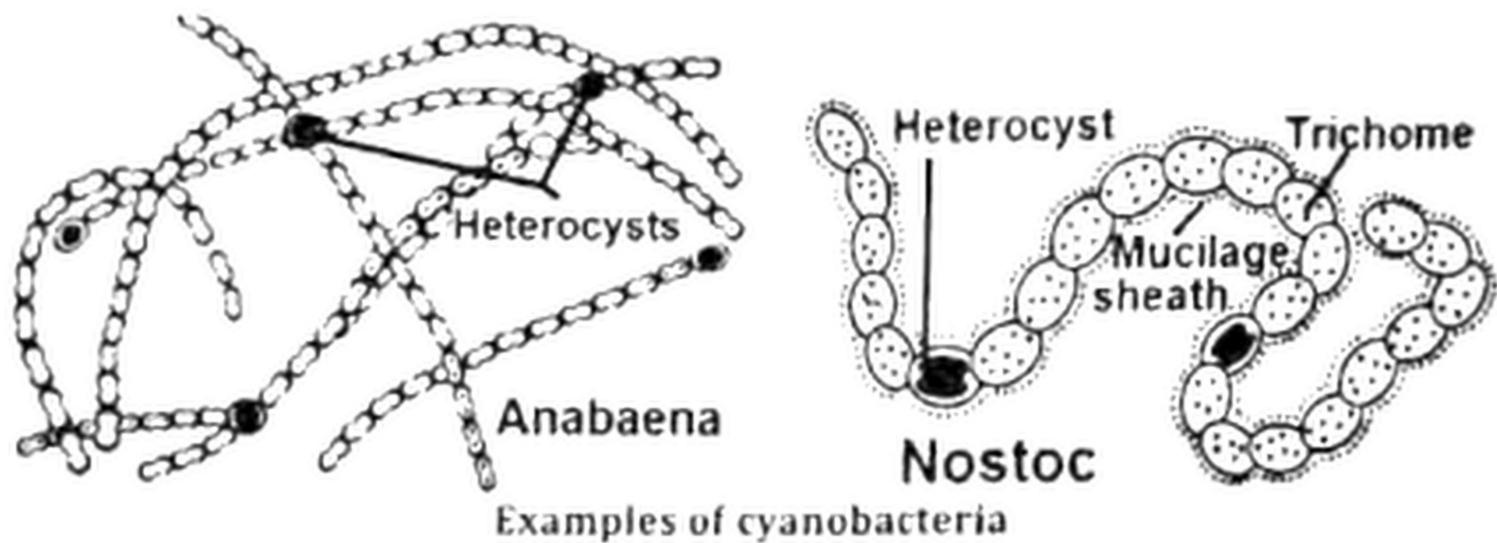
Pigment composition:

In addition to chlorophyll-a, cyanobacteria also use phycobilins as accessory pigment. **Phycocyanin**, a blue pigment is their predominant phycobilins.

Nitrogen fixer:

About one third of cyanobacteria are able to fix atmospheric nitrogen. In most cases nitrogen fixation occurs in **heterocysts**, which are without nuclei, thick walled cell found at certain intervals in the **trichome**. In Pakistan cyanobacteria.

e.g. ***Nostoc* and *Anabaena*** are purposely cultivated to increase the soil fertility, because of nitrogen fixation by these organisms.



Q2.

What are the components of bacteria cell envelop?

Ans: The cell envelop is the outer wrapping of bacterial cell which consist of:

1. Glycocalyx
2. Cell wall
3. Cell membrane

Note: However, cell membrane sometime considered as the part of bacterial protoplasm.

Critical Thinking

Although many bacteria can cause dangerous diseases in general, bacteria make life on earth possible. Why?

Ans: Bacteria serve as **recyclers of nature** as they are involved in decomposition of dead/complex organic matter in the environment. If the dead bodies are not decomposed the organic nutrients present in their bodies would not be released in the environment.

The organic carbon present in dead bodies might diminish all the carbon dioxide from the atmosphere. If there were no decomposer present on earth there would have been no photosynthesis as a result no food would have been produce by plants.

Science Titbits

Gram staining is a method of differentiating bacterial species into two large groups (Gram-positive and Gram-negative). The name comes from the Danish bacteriologist Hans Christian Gram, who developed the technique.

Gram staining differentiates bacteria by the chemical and physical properties of their cell walls. In a Gram stain test, Gram-positive bacteria retain the crystal violet iodine or CVI complex (primary dye), while safranin or fuchsin, a counterstain (secondary dye) is then added which gives all Gram-negative bacteria a red or pink colouring.

Peptidoglycan:

The term peptidoglycan is derived from the peptide and sugars (glycan) that make up the molecules. Synonyms for peptidoglycan are **murein** and **mucopptide**.

Science Titbits

Recently, some microbiologists have divided the growth curve into six phases by the letters a to f as follows:

- a) Lag phase-Growth rate is zero.
- b) Acceleration phase-Increasing growth rate.
- c) Exponential phase-Constant growth rate.
- d) Retardation phase-Growth rate is decreasing.
- e) Maximum stationary phase-Growth rate is zero.
- f) Decline phase-Growth rate is negative (death).

Teacher's Point

Teacher would guide the student draw a graph to present the time taken in each phase of bacterial growth and the number of bacteria.

Phases of growth (Escherichia coli):

Phase	Time taken in phases of growth	Number of Bacteria
Lag phase	10 minutes	1
Log phase	210 minutes	1024
Stationary phase	210 to 310 minutes	2304
Death phase	310 to 510 minutes	0

Teacher's Point

Teacher would ask the students to relate the causes of food poisoning and the sanitation conditions in restaurants.

Science, Technology and Society Connections

❖ **List some biotechnologies utilizing bacteria.**

Escherichia coli has been used to produce protein products of recombinant DNA technology, such as insulin, human growth hormone etc. Genetic engineers often use a plasmid vector to introduce new genes into plant cells. The plasmid they use is from soil bacterium *Agrobacterium tumefaciens*. *Saccharomyces cerevisiae* (yeast) has been used to produce hepatitis B vaccine, alpha and gamma interferons.

Science, Technology and Society Connections

- ❖ **Narrate how bacterial diseases have affected human societies in the past.**

The plague or “Black Death” which killed 100 million people during the mid-fourteenth century, is caused by highly infectious bacteria, *Yersinia pestis*, spread by the fleas carried by infected rats. In 1994, an outbreak of plague occurred in India for the first time in 30 years. Tuberculosis, a bacterial disease has killed millions of people in the past and also thousands of people all over the world including Pakistan.

Streptococcus pneumoniae, causes pneumonia has killed a large number of people in the past.

Science, Technology and Society Connections

- ❖ **Suggest how can we stop any epidemic to occur in future?**

Prevention is better than cure, so the measure to prevent any epidemic are:

Massive programs of immunization for vaccine preventable diseases, e.g. tuberculosis, hepatitis B, polio etc. must be launched. Detection of cases at the earliest and to treat them properly is the goal. Complete quarantine of persons or domestic animals which have been exposed to communicable diseases. Supply of safe drinking water. Control of vector disease, e.g. mosquitoes, house flies at larval stages and adult stage. To educate people for improving hygiene practices like washing of hands. If any communicable disease occurs it should be notified immediately, e.g. pneumonia, polio, etc.

Science, Technology and Society Connections

❖ **Justify why it is important to disinfect articles of food and utensils before use?**

It's very important to disinfect articles of food and utensils before use because, if they aren't properly clean, bacteria could spread to food and make you ill.

OR

Cleaning and sanitizing the utensils are essential because it helps us to be more secured, far from bacteria and other causes of illness. It is also important to store the utensils properly for us to avoid accidents.

Because if the utensils are not clean, sanitized or stored properly, it can cause a lot of trouble. If the children will use the utensils and they are not clean and sanitized, it can make them sick.

Activity

1. Identification of bacteria from curd, mouth, or bacterial culture and observation of bacterial culture for different shapes and sizes.
2. Staining bacteria using Grams staining technique.
3. Preparation and observation of the temporary mount of root nodule bacteria.
4. Study of Nostoc, Ocillatoria and Anabaena from fresh or preserved material.

