MEGA LECTURE

Kingdom Monera

CHAPTER – 6

BACTERIA

DISCOVERY

Bacteria was discovered by A.V. Leuwenhoek in 1676.

STRUCTURE OF BACTERIA

Bacteria are smallest and simplest living organism measures from 0.2m to 2 micron in breadth and 2 to 10 micron in length. They are strictly unicellular but some species remain associated with each other after cell division and form colonies.

A generalized bacterial cell consists of following structures.

(1)FLAGELLA

They are extremely thin appendages, which originate from basal body, a structure in the cytoplasm beneath cell membrane. Flagella help in bacterial locomotion.

(2)PILLI

They are hollow, filamentous flagella like appendages, which help in conjugation but not in locomotion.

(3)CAPSULE

It is a protective sheath made up of polysaccharides and proteins. It provides greater pathogenicity and protects bacteria against phagocytosis.

(4) CELL WALL

Bacterial cell wall mostly made up of amino acids, sugar and chitin. It surrounds the cell membrane, determine shape and protects bacteria from osmotic lyses. Most bacteria have a unique macromolecule called Peptidoglycan in addition to it. Sugar molecules, teichoic acid, glyco proteins and lipo polysaccharide are also present.

(5)CELL MEMBRANE

- It is present inside the cell wall attached to it at few places containing many pores.
- It is made up of lipids and proteins.
- It acts as a respiratory structure.

(6)CYTOPLASM

Bacterial cytoplasm is granular containing many small vacuoles, glycogen particles and ribosomes.

(7)MESOSOMES

- These are the invaginations of the cell membrane into the cytoplasm.
- They are in the form of vesicles, tubules or lamella.
- They help in the DNA replication, cell division, respiration and export of enzyme.

(8)BACTERIAL HEREDITARY MATERIAL

- Bacterial hereditary material DNA is found as concentrated structures called Bacterial chromosomes or chromatin bodies. It is mostly scattered in the cytoplasm.
- A small fragment of extra chromosomal circular DNA, called Plasmid is also present.

FIGURE 6.1 (FROM TEXT BOOK)

MEGA LECTURE

CLASSIFICATION OF BACTERIA

ON THE BASIS OF SHAPE

On the basis of shape bacteria can be divided into four categories.

(1)COCCI

- These are spherical or rounded bacteria presents in the form of mono, diplo or streptococcus form.
- They are non-flagellated and cannot move from one place to another place.

FIGURE (FROM TEXT BOOK)

(2)BACILLI

- Bacilli are rod shaped bacteria, can be present in the form of diplo or streplobacilli.
- They may be flagellated and can move from one place to another.

FIGURE (FROM TEXT BOOK)

(3)SPIRILLA

- These are spiral or cork, screw shape bacteria also known as spirochetes.
- It includes chlamydia and rekettia.

FIGURE (FROM TEXT BOOK)

(4)VIBRIO OR COMMA

- These are slightly curved bacteria like vibrio cholera.
- They may be flagellated and can move.

ON THE BASIS OF RESPIRATION

On the basis of respiration bacteria can be divided into two main types.

(1)AEROBES

Require oxygen for respiration.

(2)ANAEROBES

Respire with out oxygen

Sub-classes of this classification are as follow:

(A)FACULTATIVE BACTERIA

Respire with or without oxygen.

(B)MICRO AEROPHILIC BACTERIA

Require low concentration of oxygen for growth

(C)OBLIGATE ANAEROBES

These bacteria only survive in absence of oxygen.

(D)FACULTATIVE ANAEROBES

These bacteria use oxygen but can respire with out it .

(E)OBLIGATE AEROBES

These bacteria only survive in the presence of oxygen.

ON THE BASIS OF NUTRITION

Bacteria can be divided into four main types on the basis of nutrition. Which are as follow.

(1)SAPROTROPHIC BACTERIA

- These bacteria depend on the dead organic matter for their nutrition.
- They are mostly present in the humus of soil and posses large number of enzymes that convert complex substances of humus to simpler compounds.

(2)SYMBIOTIC BACTERIA

- These bacteria are found associated with other living organism.
- They obtain their food from the host without harming it. E.g. Rizobium redicicola (Symbionts in the root nodules of pea family plants).

(3)PARASITIC BACTERIA

- These bacteria grow inside the tissues of other living organism
- They obtain food at the expense of their host.
- These bacteria lack certain complex system of enzymes therefore they usually depend upon host cell. E.g. Pneumococcus, Mycobacterium tuberculosis, Salmonella typhi.

(4)AUTOTROPHIC BACTERIA

- These bacteria can sythesize organic compound from simple inorganic substances.

Autotrophic bacteria can be divided into photosynthetic or chemosynthetic.

(A)PHOTOSYNTHETIC

- These bacteria contain green pigment chlorophyll, which is known as bacterial chlorophyll, or chlorobium chlorophyll.
- These pigments are present in mesosomes (invagination of the cell membrane in the cytoplasm)
- These bacteria utilize H2S during photosynthesis instead of water and liberate sulphur instead of oxygen.
- sunlight

(B) CHEMOSYNTHETIC

- These bacteria obtain their energy from oxidation of some inorganic substances like iron, hydrogen, nitrogen and sulphur compounds.

LOCOMOTION IN BACTERIA

- Some bacteria can move from one place to another with the help of a wipe like structure flagella.
- Flagella allow bacteria to disperse into new habitats, to migrate towards nutrients and to leave unfavorable environment.
- Flagellated bacteria show orientation towards various stimuli, a behavior called Taxis.
- Some bacteria are chemo tactic, phototectic or magnetotaxic.

GROWTH IN BACTERIA

In favorable conditions bacteria can grow, very rapidly. There are some factors affecting growth of bacteria such as Temperature, nutrient availability, PH and ion concentration. Bacterial growth can be divided into four main phases, which are as follows

(1)LAG PHASE

It is inactive phase during which bacteria prepare them for division.

(2)LOG PHASE

In this phase bacteria grow and multiply very rapidly.

(3)STATIONARY PHASE

In this phase bacterial multiplication is equal to bacteria death rate.

(4)DECLINE/DEATH PHASE

In this phase death is more rapid then multiplication rate.

REPRODUCTION IN BACTERIA

Usually asexual reproduction is present in bacteria which is as follow

FISSION

Fission is the fastest mode of bacterial asexual reproduction (Binary Fission)

- It usually takes place in favorable conditions.
- Hereditary material DNA in the form of chromatin body replicates.
- After the replication of hereditary material a constriction appears in the middle of the cell, which later splits it into two parts.
- Newly form bacterial cells grow in size and form nature bacterial cells.
- The single fission takes place in 20-30 minutes.

ENDOSPORE FORMATION

- It is the method of bacterial survival under unfavorable conditions. Following are the main characters of this process.
- During this process, the whole protoplasmic content gets shrink into a small mass.
- A cyst is formed inside the parental wall around constricted protoplasm to form endospore.
- On the return of favorable conditions parental wall raptures due to decay and endospore is set free.
- In the end, this endospore enlarges to form a mature bacterial cell.

FIGURE 6.4 (BINARY FISSION IN BACTERIA)
FIGURE 6.5 (FORMATION OF ENDOSPORE)

GENETIC RECOMBINATION IN BACTERIA

Genetic changes with the help of which bacteria adopt new characteristics (drugs resistance pathogenic ability) is known as Genetic recombination

Three types of genetic recombination are present in bacteria, which are given as follow.

1.CONJUGATION

Simple process of genetic recombination in which genetic material is transferred from one bacteria to another through a conjugating tube. Conjugation in bacteria was discovered by Joshua Lederburg and Edward L.Tatum in 1946

EXPERIMENT

J.laderberg and E.Tatum performed an interesting experiment in order to prove conjugation in bacteria. Following are the main steps of this experiment.

1. They selected a wild type bacteria (E-coli) and obtain (triple nutritional mutants) different from one another.
2. Wild-type was capable of synthesizing six substances symbolized as A, B, C, D, E and F.
3. Mutant type I was capable of synthesizing three substances symbolized as A, B and C but not D, E and F.
4. Mutant type II was capable of synthesizing three substances D, E and F but not A,B and C.
5. These mutant type I and II were grown together in the growth medium having all the six substances A, B, C, D, E and F.
6. After several hours, three types of bacteria were detected after nutritional test which were,

i. Both mutant I and mutant II types.
ii. Wild type bacteria synthesizing all the six substances.
iii. A new type of bacterial strain requiring all the six substances for growth.

In this experiment, appearance of wild type and one new type is an evidence that conjugation had taken place.

2. TRANSDUCTION

It is the mode of genetic recombination in which genetic material is transferred from one bacteria to another by a third party, which is usually bacteriophage.

This process was experimentally carried out by Lederberg and Zinder in 1952.

EXPERIMENT

1. In this experiment, a bacteriophage is made to attack a bacterium known as “donor” (D).
2. The injected DNA of bacteriophage multiply to form a large number of daughter phages.
3. The donor bacterium (D) gives some of its genetic material “D” to the multiplying particles.
4. The phages released from this donor bacterium contain the genetic material of phage plus a little piece of the donor genetic material “D”.
5. These new phages then made to attack a new bacterium known as “Recipient” (R).
6. These recipient bacterium is not destroyed like the donor in order to reproduce normally. In this way, genetic material of the donor bacterium is carried to the recipient bacterium by a bacteriophage and this process is known as Transduction.

3. TRANSFORMATION

In this process, genetic information transfers from one bacteria to another by producing a change it (undergo a change).

This type of genetic recombination was first proved by Fred Griffith in 1928.

EXPERIMENT

Griffithi injected a small quantity of R-type bacteria and a large quantity of heat killed S-type bacteria into the same mouse.

This treatment proved fatal as mouse surprisingly suffered from Pneumonia and died.
The autopsy of the mouse revealed the presence of living S-type bacteria in the mouse in addition to R-type.
From this experiment Griffith concluded that,
The live R-type bacteria had been transformed into live S-type bacteria due to transfer of some material from dead S-type, cells.
Thus this transformation occurred due to genetic recombination in R-type bacteria.
In his experiment, he had been working on two strains of bacteria "Pnemococcus". One strain is known as smooth type (Virulent and causes Pneumonia) while the second strain is known as (Rough type (Non-Virulent and does not cause pneumonia).
NOTE: (IMPORTANCE OF BACTERIA (USEFUL AND HARMFUL BACTERIA)FROM BOOK PAGE # 116 (OLD BOOK – 2003)

VACCINATION

DEFINITION

Inoculation of host with inactive or weaken pathogens or pathogenic products to stimulate protective immunity.

- In case of subsequent natural infection with the same pathogen the immune system easily recognized the invader and comfortably managed to overcome the pathogen.
- A vaccine can taken orally (Polio vaccine) or injected into the body (Tetanus Vaccine).

IMMUNIZATION

DEFINITION

It is a process of induction of specific immunity by injecting antigens, antibodies or immune cells.

- Immunity can be protective or curative in nature.
- It promotes increased immunity against specific diseases.

CYNOBACTERIA (BLUE GREEN ALGAE)

MAIN CHARACTERISTICS OF CYNOBACTERIA

- They are prokaryotic unicellular autotrophic organisms mostly occur in colony form.
- They posses double layered cell wall.
- The protoplasm differentiated into an outer colored region chromoplasm, which contain various pigments in which chlorophyll "a" and phycocyanin are more important.
- Inner colorless region of the protoplasm is known as centroplasm.
- They are mostly aquatic (fresh water)
- Sexual reproduction is absent.
- Asexual reproduction takes place by means of Harmogonia, zoospores, akinates and fragmentation.

NOSTOC

Nostoc is a typical example of blue green algae.

STRUCTURE

- Nostoc is a filamentous prokaryotic algae in which filaments are intermixed in a glatinous mass-forming ball like structure known as coenobium.
- A single filament look like a chain of beads.
- Each filament is unbranched and has a single row of rounded or oval cells.
- Each cell has double layered wall, outer thick wall is made up of cellulose mixed up with pectic compounds. While inner thin layer is made up of cellulose only.
- The protoplasm is differentiated into an outer colored region (chromoplasm) and an inner colorless region (centroplasm).
- The chromoplasm various pigments like chlorophyll, axanthophylls, carotene, phycocyanin and phycoerythrin.
- Ribosome's, pseudovacuoe and reserve food in the form of cynophyceae starch are present.

- Hereditary material is present in cytoplasm with out the nuclear membrane.
- In Nostoc filaments slightly larger, colorless cells with thick walled known as "Heterocyst" are present. The function o Heterocyst is nitrogen fixation, food storage and multiplication of filament during unfavorable conditions.

NUTRITION

- It is an autotroph and prepares its food in the presence of sunlight.
- It also capable of fixing atmospheric nitrogen and converts it into nitrates in order to prepare amino acids and proteins, this activity takes place in Heterocysts.

REPRODUCTION

- Only asexual reproduction is present which takes place by following methods.

(1)HORMOGONIA

- A portion of the filaments between two heterocysts is known as Hormogonia.
- During favorable conditions, filaments break up at the junction of each Heterocyst.
- The end cells of each homogonous divide to form long filaments of Nostoc.

(2)AKINETES

- It is the method of survival during unfavorable conditions.
- These are non-motile spores, formed from certain vegetative cells.
- Each akinete contains an outer layer "exospore" and inner layer "endospores".
- On the return of favorable conditions, each akinete germinates by rupturing exospore and formed independent filaments by simple cell division.

IMPORTANCE OF CYNOBACTERIA

- They release oxygen as a by-product during photosynthesis.
- Many are capable of fixing atmospheric nitrogen.
- They are first colonizers of moist soil.
- Nostoc anabena is used as nitrogen fertilizer in agriculture due to its nitrogen fixing ability.

MONERA

- Discovery of bacteria A.V.Leuventoek.
- Size of bacteria = 0.2-2 micron (breadth)
- = 2-10 micron (length).
- Cell wall of bacteria made up of peptidoglycan.
- Arch bacteria do not contain peptidoglycan.
- Bacterial replications, cell division, respiration, export of enzymes = By means of mesosomes (invaginations of cell membrane)
- Saprophytic bacteria form humus (important component of soil)
- Photosynthetic bacteria = use H_2S in photosynthesis instead of water.
- Chlorobium chlorophyll or bacterial chlorophyll discovered by Von Nell 1930.

DIVERSITY OF LIFE

- Father of taxonomy = Charles Linneus.
- Genetics = final tool in classifying living organism.
- Basic unit of Biological classification = species.
- Five kingdom system of Robert Whittaker = 1969.
- Discovery of Virus = Iwanosky 1892.
- TMV Virus discover by Wendell Stanley in 1935.
- Size of Virus = 20nm-250nm.
- AIDS is caused by Human Immune Deficiency Virus (HIV)
- As a result of lytic cycle of bacterio phage 100-200 daughter phage viruses are produced.