PLANT DISEASE EVALUATION : Bacterial Plant Disease Component

We shall explain:-

1. Morphology of Bacteria
2. Classification and taxonomy of plant pathogenic bacteria
3. Some economically important plant pathogenic bacteria
4. Control of bacterial plant diseases
5. Practical Considerations

1. Morphology of Bacteria.

- Bacteria - a group of single-cell microorganisms with procaryotic cellular configuration.

- The genetic material (DNA) of procaryotic cells exists unbound in the cytoplasm of the cells.

- No nuclear membrane, which is the definitive characteristic of eukaryotic cells such as those that make up plants and animals.

- Until recently, bacteria were the only known type of procaryotic cell, and the discipline of biology related to their study is called bacteriology.

- In the 1980's, with the outbreak of molecular techniques applied to phylogeny of life, another group of procaryotes was defined and informally named "archaebacteria".

- This group of procaryotes has since been renamed Archaea and has been awarded biological Domain status on the level with Bacteria and Eukarya.

- The current science of bacteriology includes the study of both Domains of procaryotic cells, but the name "bacteriology" is not likely to change to reflect the inclusion of archaea in the discipline. Actually, many archaea have been studied as intensively and as long as their bacterial counterparts, but with the notion that they were bacteria.

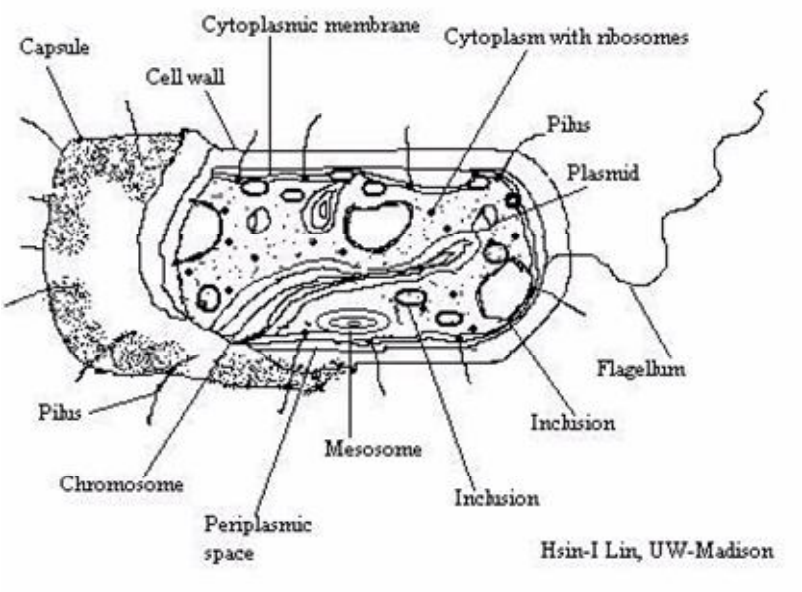
STRUCTURE

- Three architectural regions (See figure below)

o appendages (proteins attached to the cell surface) in the form of flagella and pili;

o cell envelope consisting of a capsule, cell wall and plasma membrane;

o cytoplasmic region that contains the cell genome (DNA) and ribosomes and various sorts of inclusions.



Schematic drawing of a typical bacterium.

✓ Flagella are filamentous protein structures attached to the cell surface that provide swimming movement for most motile procaryotic cells.

✓ Fimbriae and Pili are interchangeable terms used to designate short, hair-like structures on the surfaces of procaryotic cells. Fimbriae are shorter and stiffer than flagella, and slightly smaller in diameter. Like flagella, they are composed of protein.

o A specialized type of pilus the F or sex pilus, mediates the transfer of DNA between mating bacteria, but the function of the smaller, more numerous common pili is quite different.

o Common pili (almost always called fimbriae) are usually involved in adherence (attachment) of procaryotes to surfaces in nature.

✓ A rigid cell wall protects the delicate cell protoplast from osmotic lysis.

✓ The cell wall of Bacteria consists of a polymer of disaccharides cross-linked by short chains of amino acids (peptides). This molecule is a type of peptidoglycan, called murein.

✓ In the Gram-positive bacteria (those that retain the purple crystal violet dye when subjected to the Gram-staining procedure) the cell wall is a thick layer of murein.

✓ In the Gram-negative bacteria (which do not retain the crystal violet) the cell wall is relatively thin and is composed of a thin layer of murein surrounded by a membranous structure called the outer membrane. Murein is a substance unique in nature to bacterial cell walls.

✓ Also, the outer membrane of Gram-negative bacteria invariably contains a unique component, lipopolysaccharide (LPS or endotoxin), which is toxic to animals. The cell walls of Archaea may be composed of protein, polysaccharides, or peptidgolycan-like molecules, but never do they contain murein. This feature distinguishes the Bacteria from the Archaea.

✓ Cytoplasmic Constituents:-

o Include chromosome and ribosomes. The chromosome is typically one large circular molecule of DNA, more or less free in the cytoplasm.

o Procaryotes sometimes possess smaller extrachromosomal pieces of DNA called plasmids.

o The total DNA content of a cell is referred to as the cell genome.

o The ribosomes of procaryotes are smaller than cytoplasmic ribosomes of eukaryotes. Procaryotic ribosomes are 70S in size, being composed of 30S and 50S subunits. The 80S ribosomes of eukaryotes are made up of 40S and 60S subunits.

o Ribosomes are involved in the process of translation (protein synthesis), but some details of their activities differ in eukaryotes, Bacteria and Archaea. Protein synthesis using 70S ribosomes occurs in eukaryotic mitochondria and chloroplasts, and this is taken as a major line of evidence that these organelles are descended from procaryotes.

- Cytoplasmic inclusions.
  - are distinct granules that may occupy a substantial part of the cytoplasm.
  - E.g. carbon and energy reserves may be stored as glycogen (a polymer of glucose) or as polybetahydroxybutyric acid (a type of fat) granules.
  - Polyphosphate inclusions are reserves of PO_4 and possibly energy; elemental sulfur (sulfur globules) are stored by some phototrophic and some lithotrophic procaryotes as reserves of energy or electrons. Some inclusion bodies are actually membranous vesicles or intrusions into the cytoplasm which contain photosynthetic pigments or enzymes.

2. Classification and taxonomy of plant pathogenic bacteria

Species of bacterial plant pathogens come from seven genera:

1. Agrobacterium

a. Rhizosphere and soil inhabitants

b. mostly cause galls and deformations on roots or stems,

c. short rods, motile,

2. Clavibacter (Corynebacterium)

a. only gram-positive genus,

b. cause systemic infections producing galls and wilts,

c. slender rods, non-motile,

3. Erwinia

a. some cause necrotic or wilt diseases,

b. others cause soft rots,

c. motile rods,

4. Pseudomonas

a. localized rots, e.g. leaf spots and blights,

b. many produce a greenish, water-soluble pigment in culture,

c. motile rods,

5. Xanthomonas

a. leaf spots and blights

b. small, motile rods,

6. Streptomyces

a. the only one that produces hyphae, no crosswalls,

b. all are soil inhabitants,

c. many produce antibiotics,

7. Xyllela

a. xylem inhabiting, fastidious bacteria.

3. Some Economically Important Plant Pathogenic Bacteria.

1. *Xanthomonas oryzae*: bacterial blight of rice

2. *Pseudomonas (Ralstonia) solanacearum*: bacterial wilt.
Wide host range including tobacco, tomatoes, potatoes, banana.

3. Xanthomonas campestris pv. campestris: Black Rot of Cabbage

4. *Erwinia amylovora*: Fire Blight of Pear

5. *Xanthomonas campestris* pv. *vesicatoria*: bacterial spot, vegetables, peppers, tomato.

6. *Erwinia carotovora*: soft rot of vegetables and potatoes

7. *Clavibacter sepedonicum*: ring rot of potatoes

8. *Pseudomonas syringae*: bacterial blight

9. *Agrobacterium tumefaciens*: crown gall

10. Mycoplasmalikeorganisms, MPLO: Aster yellows

11. *Xylella fastidiosa*: Pierce's Disease of Grapes

12. *Xanthomonas campestris* pv. *citr*i: Citrus Canker

4. Control of bacterial plant diseases

A. Host Resistance: (main mechanism)
-resistance is often unstable as pathogens can evolve quickly.

B. Sanitation

C. Crop Rotation

D. Vector Control

E. Seed Sterilization: bacteria can enter seed during flowering.

F. Chemical Control: antibiotics -not widely applied.

G. Biological Control.

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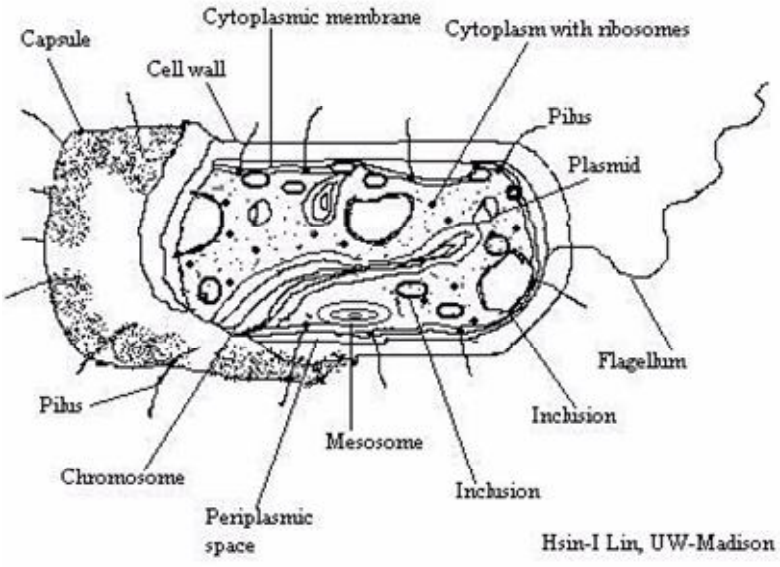

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