2.4F: Inclusion Bodies and Organelles Used for Photosynthesis

Skills to Develop

1. Name three major types of photosynthetic bacteria and briefly describe where its photosynthetic system is located.

2. State the function of the following inclusion bodies:
   A. cyanophycin granules
   B. carboxysomes
   C. gas vacuoles
   D. polyhydroxybutyrate and glycogen granules
   E. magnetosomes
   F. volutin granules and sulfur granules

There are several major groups of photosynthetic bacteria: cyanobacteria, purple bacteria, green sulfur bacteria, green nonsulfur bacteria, heliobacteria, and acidobacteria. Comparing the cyanobacteria, the purple bacteria, and the green bacteria:

The cyanobacteria carry out oxygenic photosynthesis, that is, they use water as an electron donor and generate oxygen during photosynthesis. The photosynthetic system is located in an extensive thylakoid membrane system that is lined with particles called phycobilisomes that contain light-harvesting phycobiliproteins.

- Photograph of the cyanobacteria *Anabaena*.
- Photograph of the cyanobacteria *Oscillatoria*.

The green bacteria carry out anoxygenic photosynthesis. They use reduced molecules such as H₂, H₂S, S, and organic molecules as an electron source and generate ATP, NADH and NADPH. The photosynthetic system is...
located in ellipsoidal vesicles called chlorosomes that are independent of the cytoplasmic membrane.

- Transmission electron micrograph of a green sulfur bacterium with chlorosomes.

The purple bacteria carry out anoxygenic photosynthesis. They use reduced molecules such as H₂, H₂S, S, and organic molecules as an electron source and generate ATP, NADH and NADPH. The photosynthetic system is located in spherical vesicles called chromatophores or lamellar membrane systems that are continuous with the cytoplasmic membrane.

- Transmission electron micrograph of a purple bacterium.

### Other Inclusion Bodies

- Cyanobacteria contain large inclusion bodies called cyanophycin granules that store nitrogen for the bacteria.
  - Transmission electron micrograph showing cyanophycin granules.
- Cyanobacteria, thiobacilli, and nitrifying bacteria, organisms that reduce CO₂ in order to produce carbohydrates, possess carboxysomes containing an enzyme used for CO₂ fixation.
  - Transmission electron micrograph showing carboxysomes.
- Purple and green photosynthetic bacteria, cyanobacteria, as well as some other aquatic bacteria contain gas vacuoles. These are aggregates of hollow protein cylinders called gas vesicles that are permeable to atmospheric gas, enabling the organism to regulate buoyancy.
  - Photomicrograph showing gas vacuoles in cyanobacteria.
- Some bacteria produce inorganic inclusion bodies in their cytoplasm, including volutin granules that store phosphate, and sulfur granules that store sulfur.
  - Photomicrograph showing volutin granules.
- Some bacteria produce organic inclusion bodies containing either polyhydroxybutyrate granules or glycogen granules as an energy reserve.
  - Transmission electron micrograph showing polyhydroxybutyrate granules.
- Some motile aquatic bacteria are able to orient themselves by responding to the magnetic fields of the earth because they possess magnetosomes, membrane-bound crystals of magnetite or other iron-containing substances that function as tiny magnets.
  - Transmission electron micrograph of magnetosomes.

### Summary

1. Oxygenic photosynthesis uses water as an electron donor and generates oxygen during photosynthesis.
2. The cyanobacteria carry out oxygenic photosynthesis.
3. Anoxygenic photosynthesis uses reduced molecules such as H₂, H₂S, S, and organic molecules as an electron source and generates ATP, NADH and NADPH.
4. The green bacteria and the purple bacteria carry out anoxygenic photosynthesis.
5. Various inclusion bodies are found in certain bacteria that carry out different specialized functions.
Questions

Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.

1. Matching

_____ Carry out oxygenic photosynthesis, that is they use water as an electron donor and generate oxygen during photosynthesis. The photosynthetic system is located in an extensive thylakoid membrane system that is lined with particles called phycobilisomes. (ans)

_____ Carry out anoxygenic photosynthesis. They use reduced molecules such as H₂, H₂S, S, and organic molecules as an electron source and generate NADH and NADPH. The photosynthetic system is located in spherical or lamellar membrane systems that are continuous with the cytoplasmic membrane. (ans)

_____ Carry out anoxygenic photosynthesis. They use reduced molecules such as H₂, H₂S, S, and organic molecules as an electron source and generate NADH and NADPH. The photosynthetic system is located in ellipoidal vesicles called chlorosomes that are independent of the cytoplasmic membrane. (ans)

A. green bacteria
B. purple bacteria
C. cyanobacteria

2. Matching

_____ inclusion bodies that store nitrogen (ans)

_____ inclusion bodies that serve as an energy reserve (ans)

_____ inclusion bodies that store phosphate (ans)

_____ inclusion bodies that let aquatic bacteria regulate buoyancy (ans)

A. cyanophycin granules
B. carboxysomes
C. gas vacuoles
D. polyhydroxybutyrate and glycogen granules
E. magnetosomes
F. volutin granules

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