Photosynthetic Bacteria

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Photosynthesis in Bacteria

- Content
  - Introduction
  - Photosynthetic Bacteria
  - Purple Bacteria
  - Green Bacteria
  - Cyanobacteria
  - Prochlorophytes

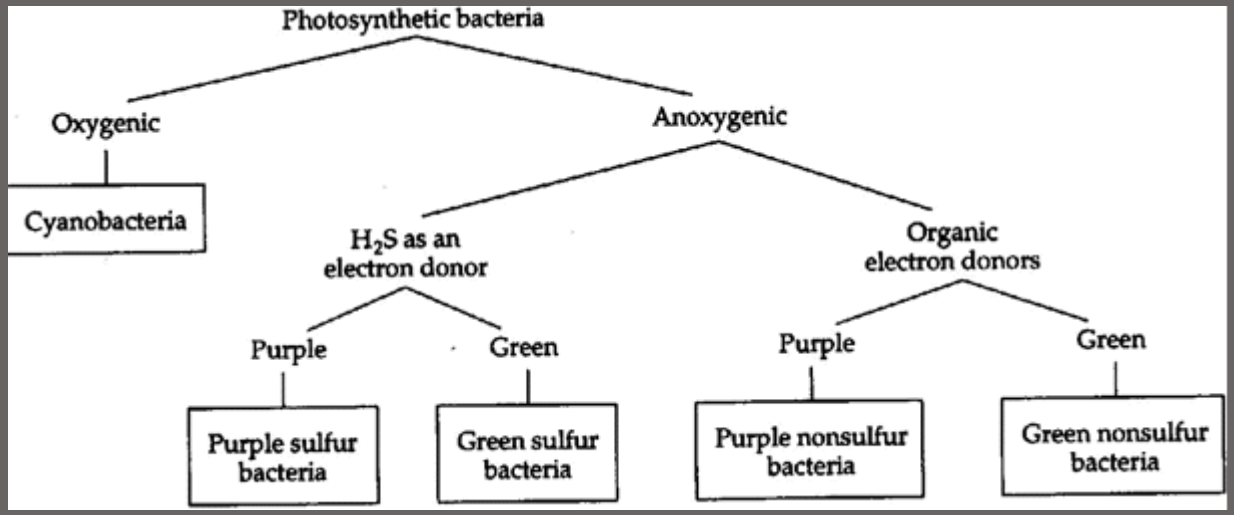
Photosynthesis in Bacteria

Introduction

- Photosynthesis is the conversion of light energy into chemical energy .
- Procaryotes that can convert light energy into chemical energy include the photosynthetic cyanobacteria, the purple and green bacteria and the "halobacteria" (actually archaea).

Photosynthesis in Bacteria

Types of Photosynthesis in Bacteria



Photosynthesis in Bacteria

Common Name	Example	Phylum	Comments	Electron Donor for CO_2 Reduction	Oxygenic or Anoxygenic
Cyanobacteria	*Anabaena*	Cyanobacteria	Plantlike photosynthesis; some use bacterial photosynthesis under anaerobic conditions	Usually H_2O	Usually oxygenic
Green nonsulfur bacteria	*Chloroflexus*	Chloroflexi	Grow chemoheterotrophically in aerobic environments	Organic compounds	Anoxygenic
Green sulfur bacteria	*Chlorobium*	Chlorobi	Deposit sulfur granules inside cells	Usually H_2S	Anoxygenic
Purple nonsulfur bacteria	*Rhodospirillum*	Proteobacteria	Can grow chemoheterotrophically as well	Organic compounds	Anoxygenic
Purple sulfur bacteria	*Chromatium*	Proteobacteria	Deposit sulfur granules inside cells	Usually H_2S	Anoxygenic

Photosynthesis in Bacteria

Purple and Green Photosynthetic Bacteria

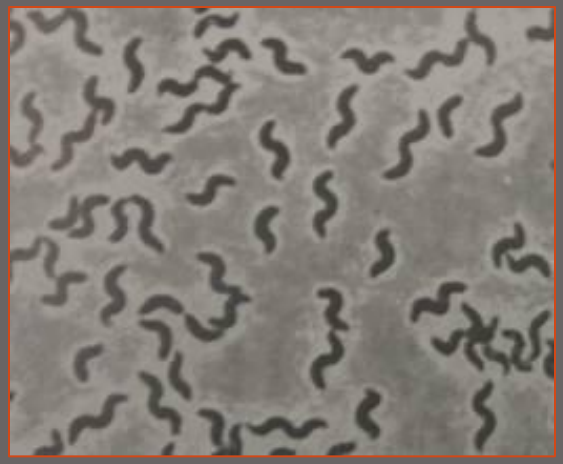
(The Anoxygenic Photosynthetic Bacteria)

- Belong to the family – *Rhodospirillales*
- Gram-Negative
- Anaerobic
- Contain – Bacteriochlorophyll and Carotenoid
- Primitive than Oxygenic (Cyanobacteria), present when oxygen was not available in earth.
- Their habitat is usually the deep sediments of freshwater - lakes, ponds and Marine
- Absorb – 725-745 nm(Red Light)
- 1035 nm IR
- 400 – 550 nm – Blue light (Depth to lake)

Photosynthesis in Bacteria

Purple Non- Sulfur Bacteria

- Contain - Bacteriochlorophyll a or b and carotenoid
- (Family -*Rhodospirillaceae*)
- Example -
- *Rhodospirillium* – Helical
- *Rhodopsudomonas* – Rod shaped
- *Rhodomicrobium* - Ovoid

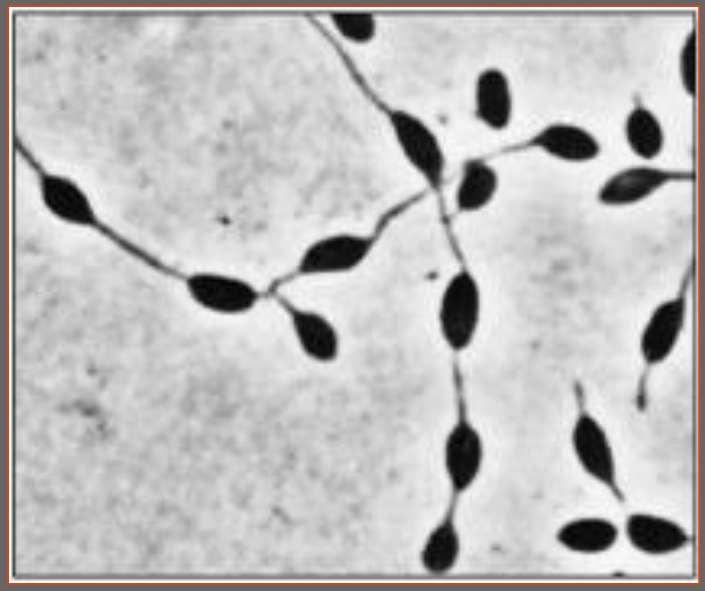


Rhodospirillum rubrum

Rhodospirillum rubrum

Rhodopseudomonas palustris

Rhodospirillum centenum



Rhodomicrobium vannielii

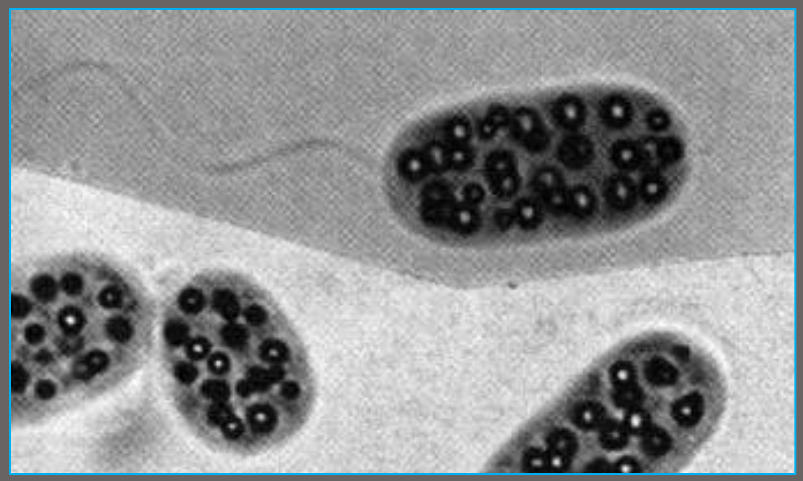
Photosynthesis in Bacteria

Purple Sulfur Bacteria

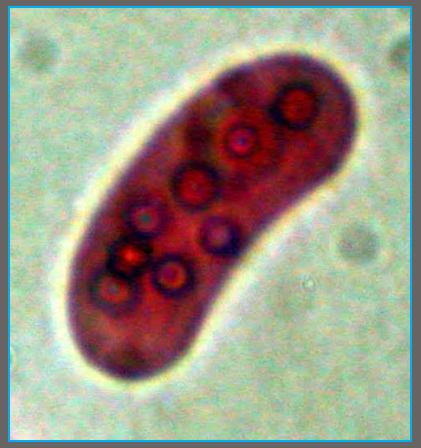
- Contain - Bacteriochlorophyll a or b and carotenoid
- (Family -*Chromatiaceae*)
- Example -
- *Chromatium* – Ovoid to Rod
- *Thiocystis* – Coccoid
- *Thiospirillium* – Helical
- *Lamprocystis* – Diplococci

The *purple sulfur* and *green sulfur bacteria* use reduced sulfur compounds, such as hydrogen sulfide (H_2S), instead of water, and they produce granules of sulfur (S^0) rather than oxygen, as follows:

$$(2)\ 2H_2S + CO_2 \xrightarrow{\text{light}} (CH_2O) + H_2O + 2S^0$$



Chromatium okenii



Chromatium okenii

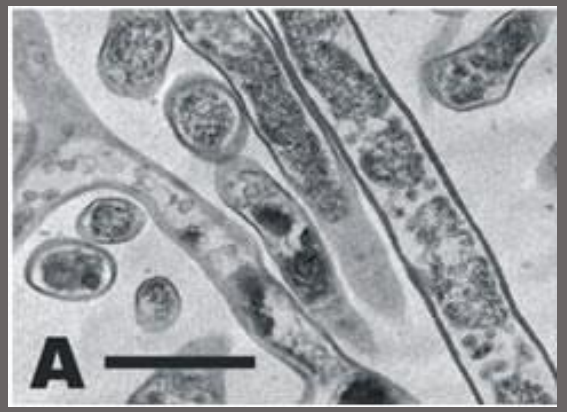
Thiospirillum sp.

Thiocystis

Photosynthesis in Bacteria

Green Non-Sulfur Bacteria

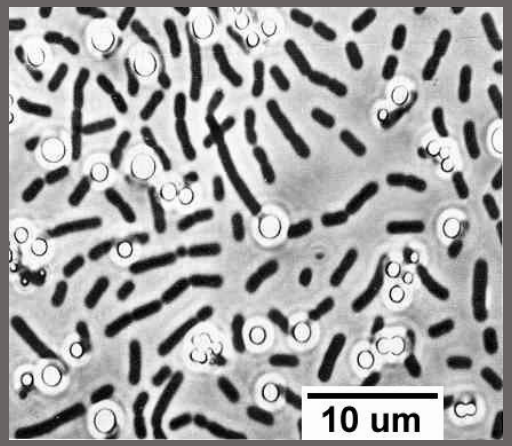
- Family - *Cloroflexaceae*
- Genus *chloroflexus*
- Thermophilic – optimum (52 to 60°C)
- Occur in hot spring, it form green or orange mats
- Filamentous
- Gliding Motility



Photosynthesis in Bacteria

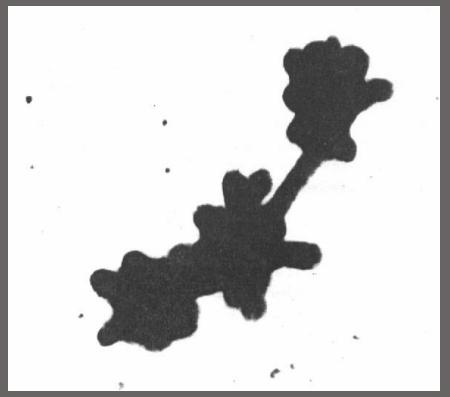
Green Sulfur Bacteria

- Family - *Chlorobiaceae*
- Example – *Clorobium* – Ovoid or Rod shaped
- *Prosthecochloris* – Star shape



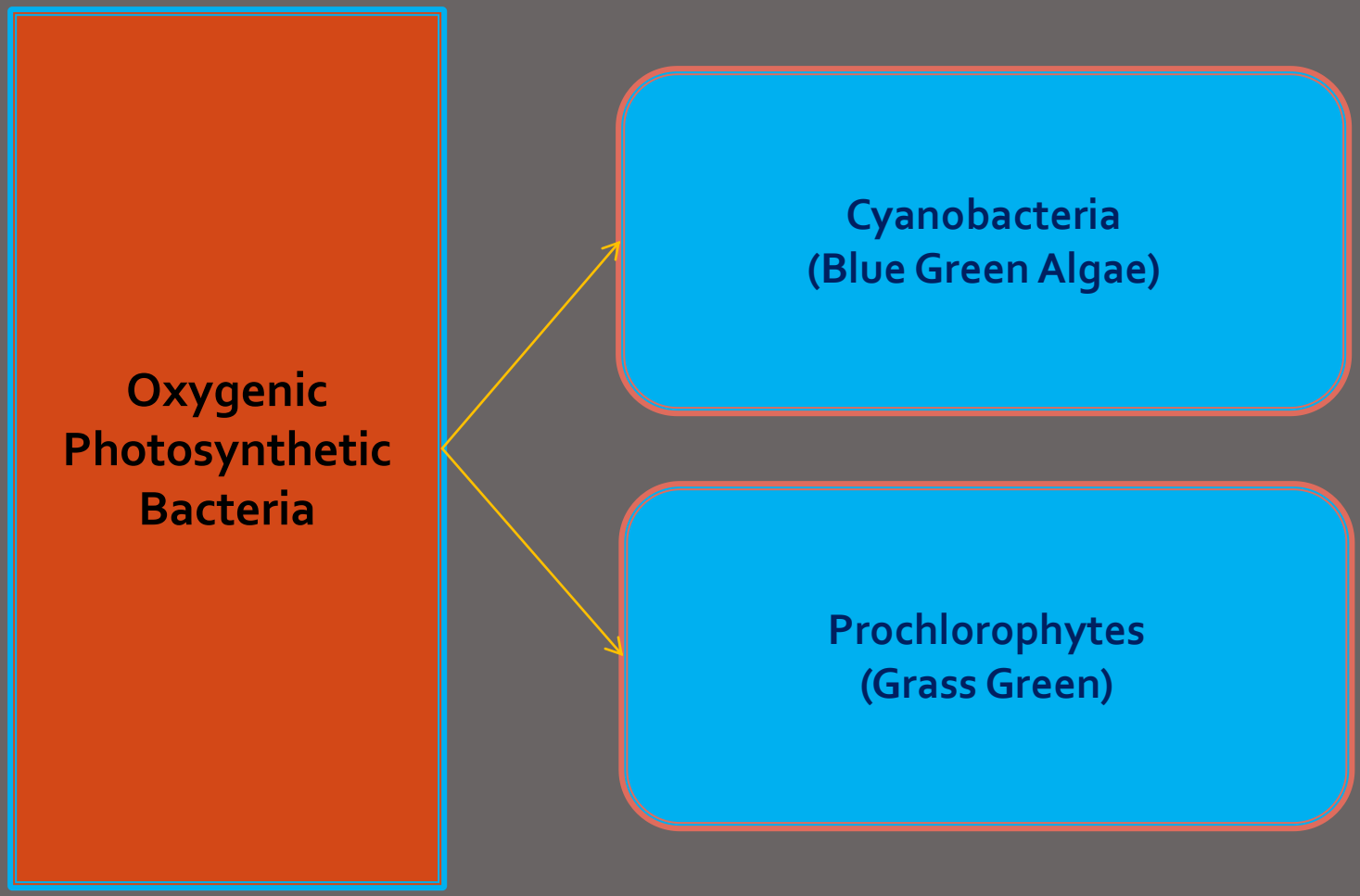
***Chlorobium** limicola*

Chlorobium ferrooxidans



Prosthecochloris aestuarii

Photosynthesis in Bacteria



Photosynthesis in Bacteria

Cyanobacteria (Blue Green Algae)

- Non motile – flagella absent, Gliding motility
- Found in freshwater, soil and marine
- Grow as mat on the soil surface
- Adds organic matter to soil
- Symbionts with water fern, Angiosperm, Protozoans etc.
- Some are thermophilic

Photosynthesis in Bacteria

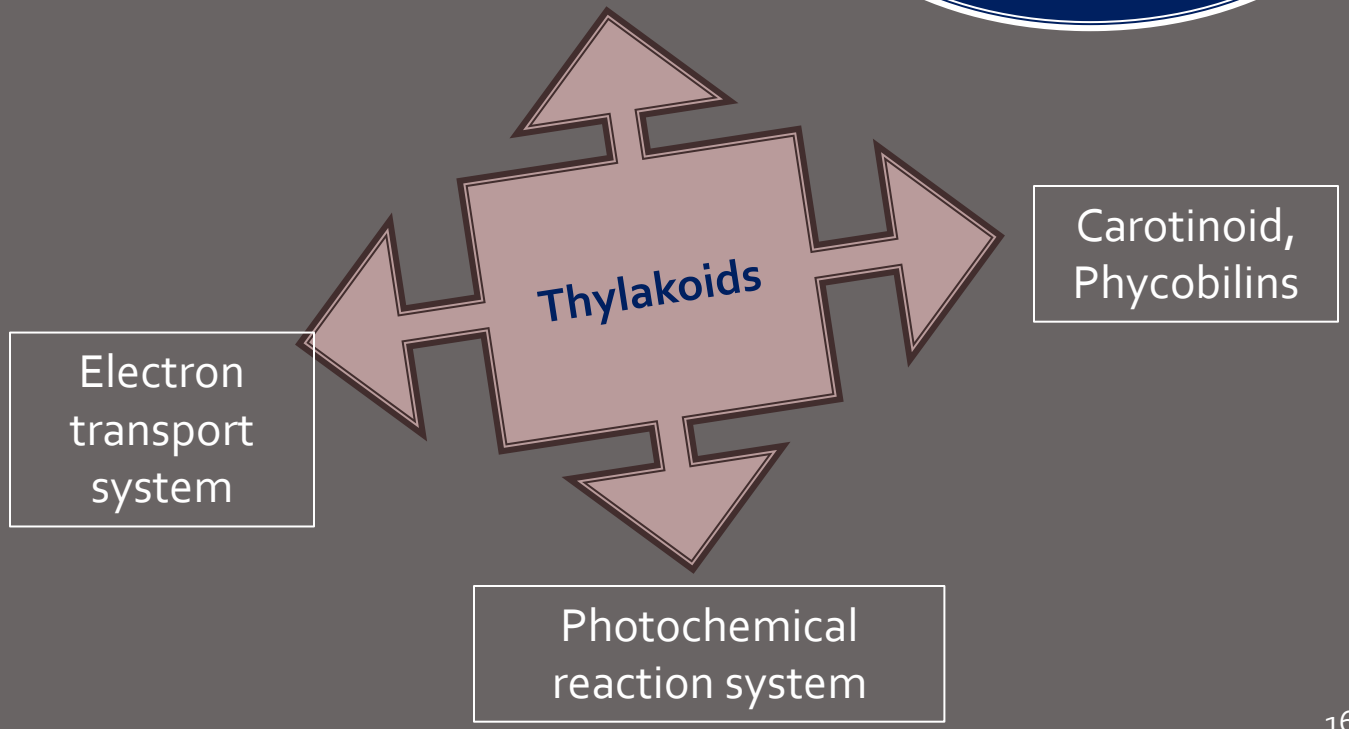
Cyanobacteria (Blue Green Algae)

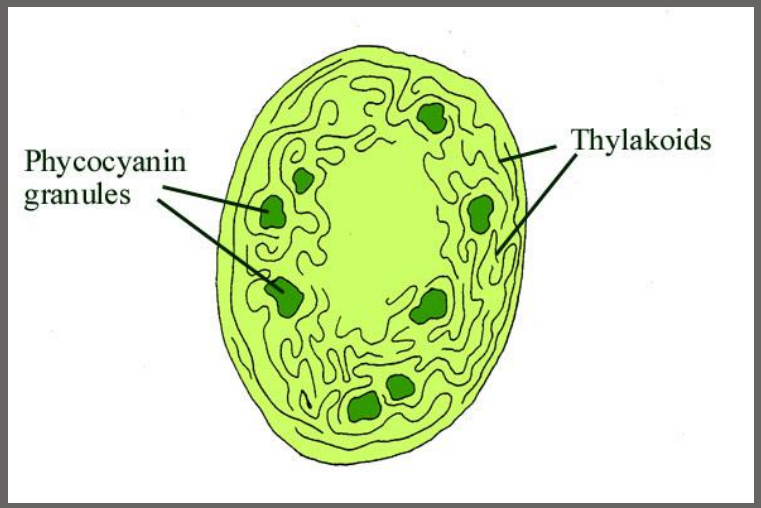
- Contain chlorophyll a, not bacteriochlorophyll
- Absorb red light of 680 to 683 nm
- Other pigment –
- Water insoluble – Carotinoids and
- Water soluble – Phycobilins
- Absorb light and transmit to chlorophyll
- Blue Phycobilins (Phycocyanin and Allophycocyanin) – found in all cyanobacteria, absorb 500 to 650 nm.
- Red Phycobilins (Phycoerythin) – found in some species, absorb 470 to 600 nm.

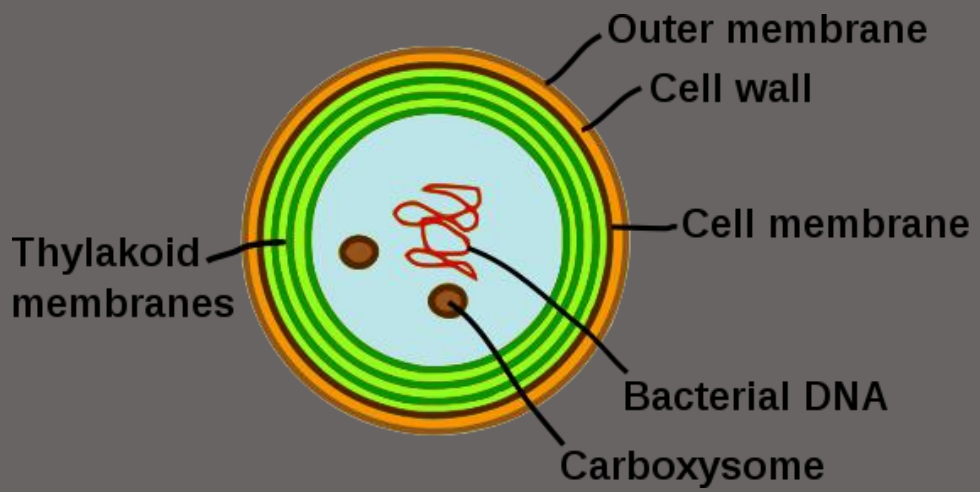
Photosynthesis in Bacteria

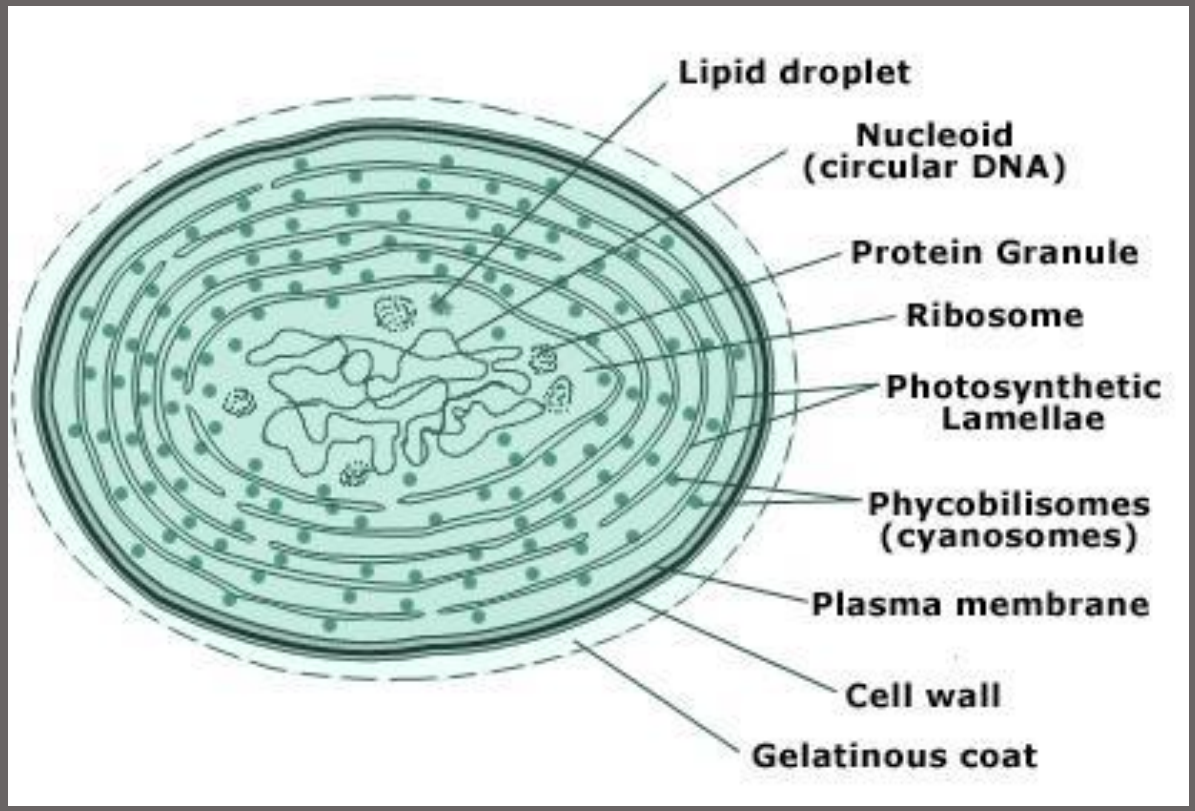
Cyanobacteria (Blue Green Algae)

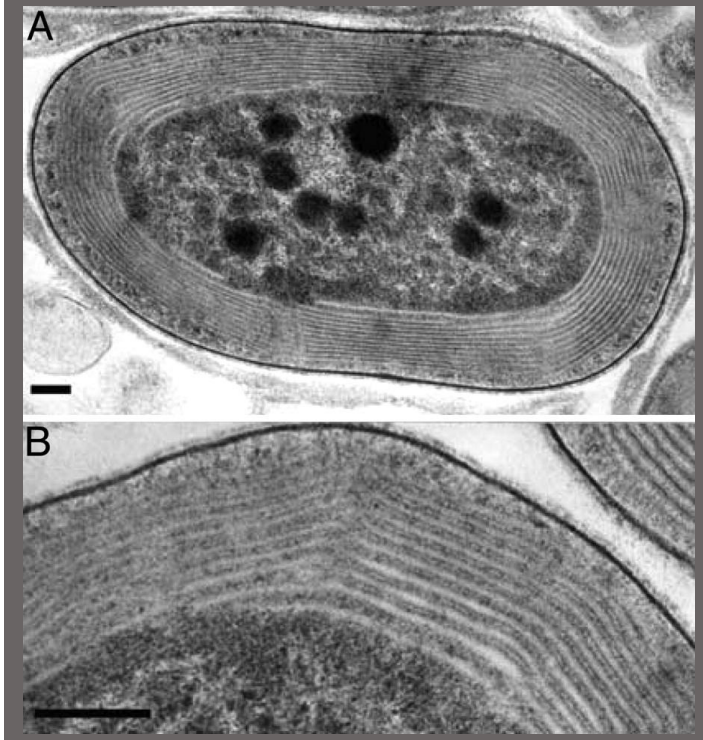
Photosynthetic apparatus in Cyanobacteria

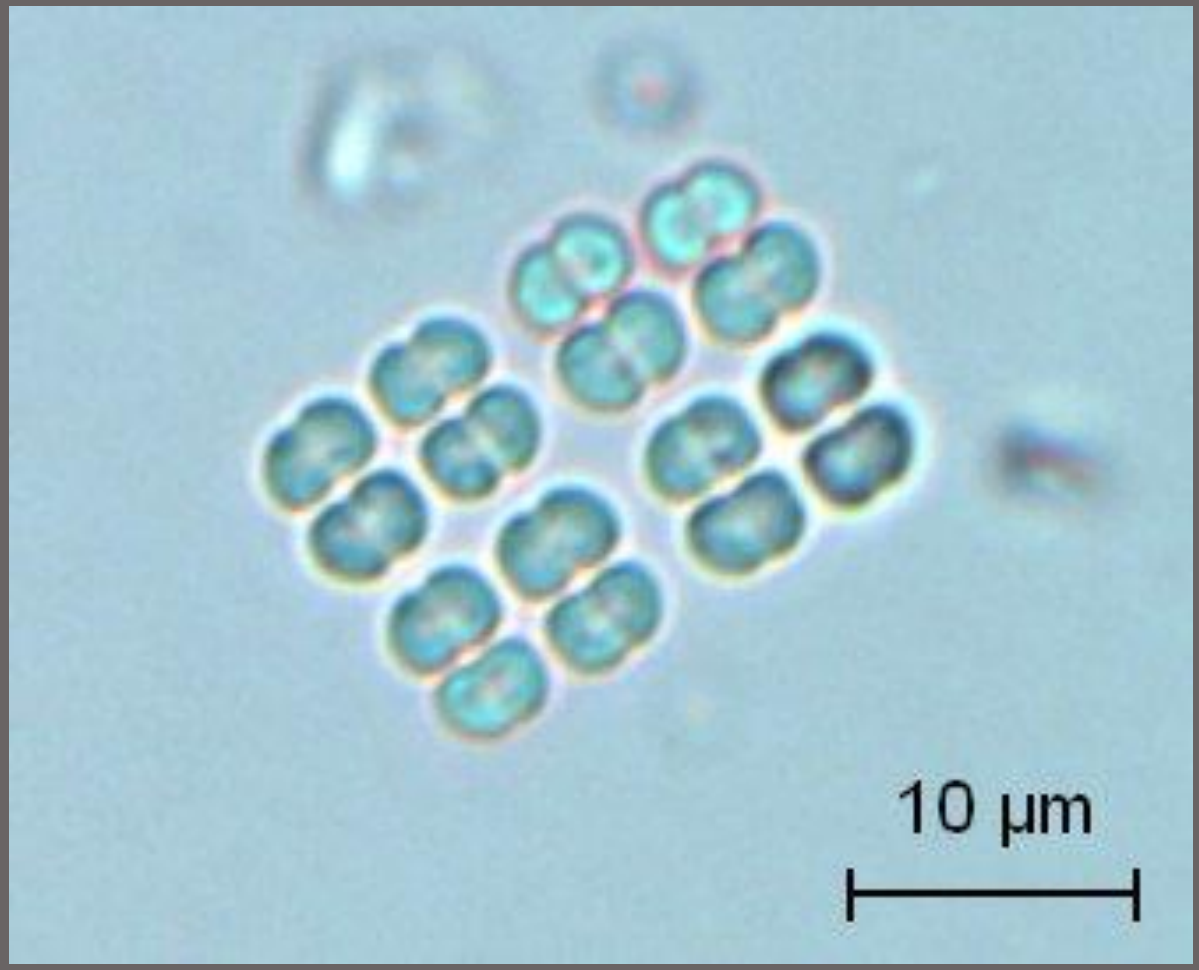



Phycocyanin granules
Thylakoids

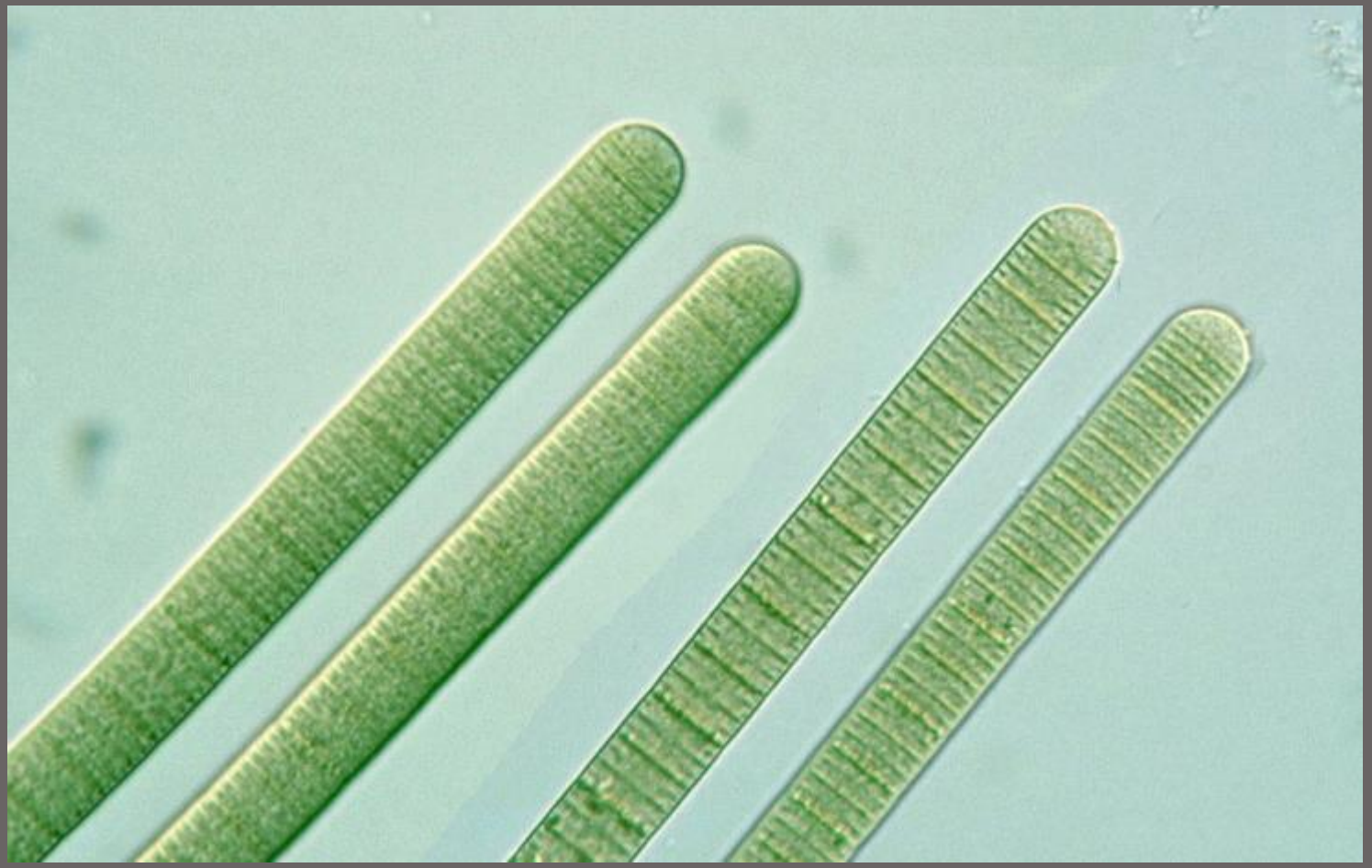

Outer membrane
Cell wall
Cell membrane
Thylakoid membranes
Bacterial DNA
Carboxysome


Lipid droplet
Nucleoid (circular DNA)
Protein Granule
Ribosome
Photosynthetic Lamellae
Phycobilisomes (cyanosomes)
Plasma membrane
Cell wall
Gelatinous coat

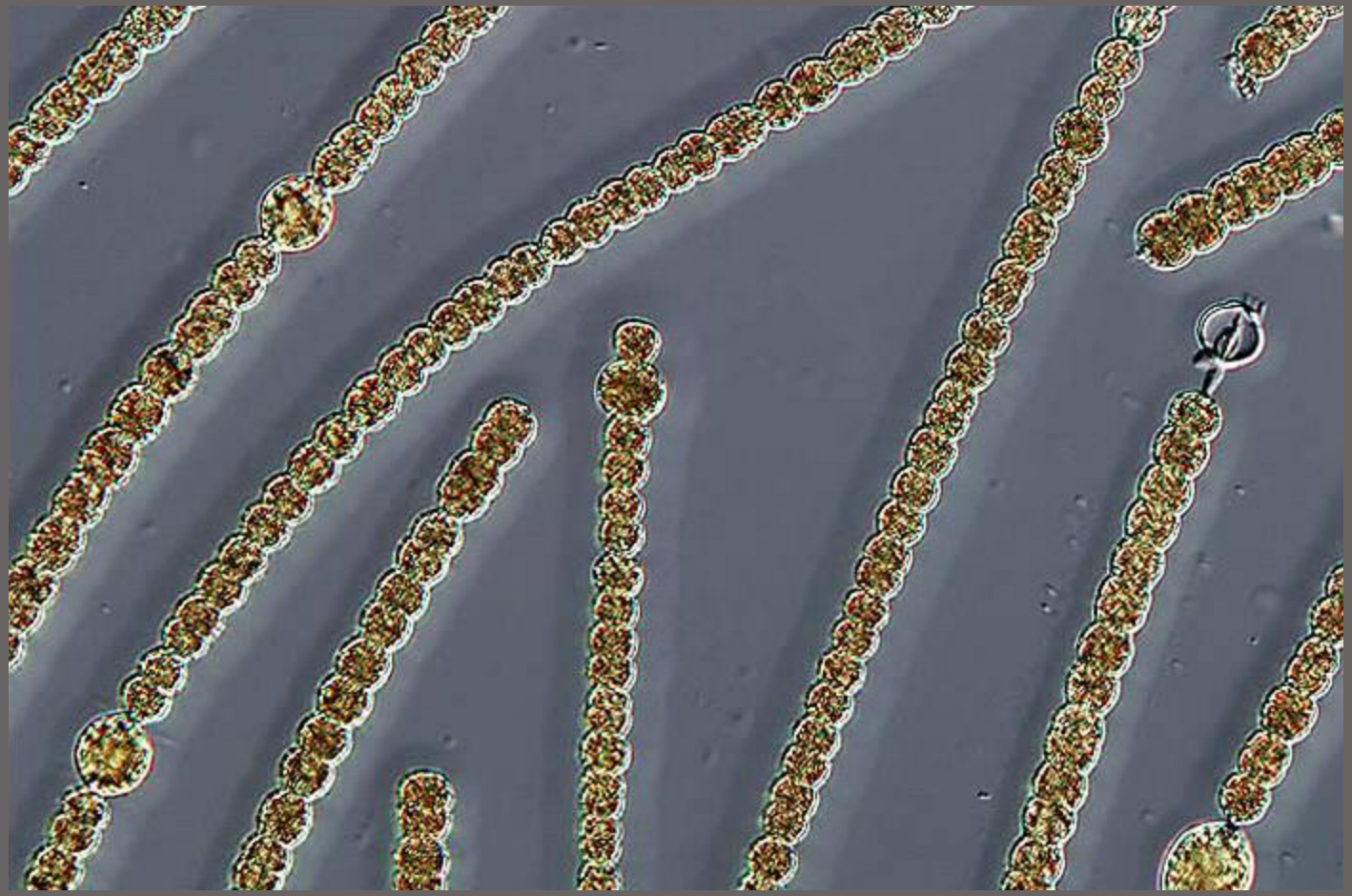

A
B



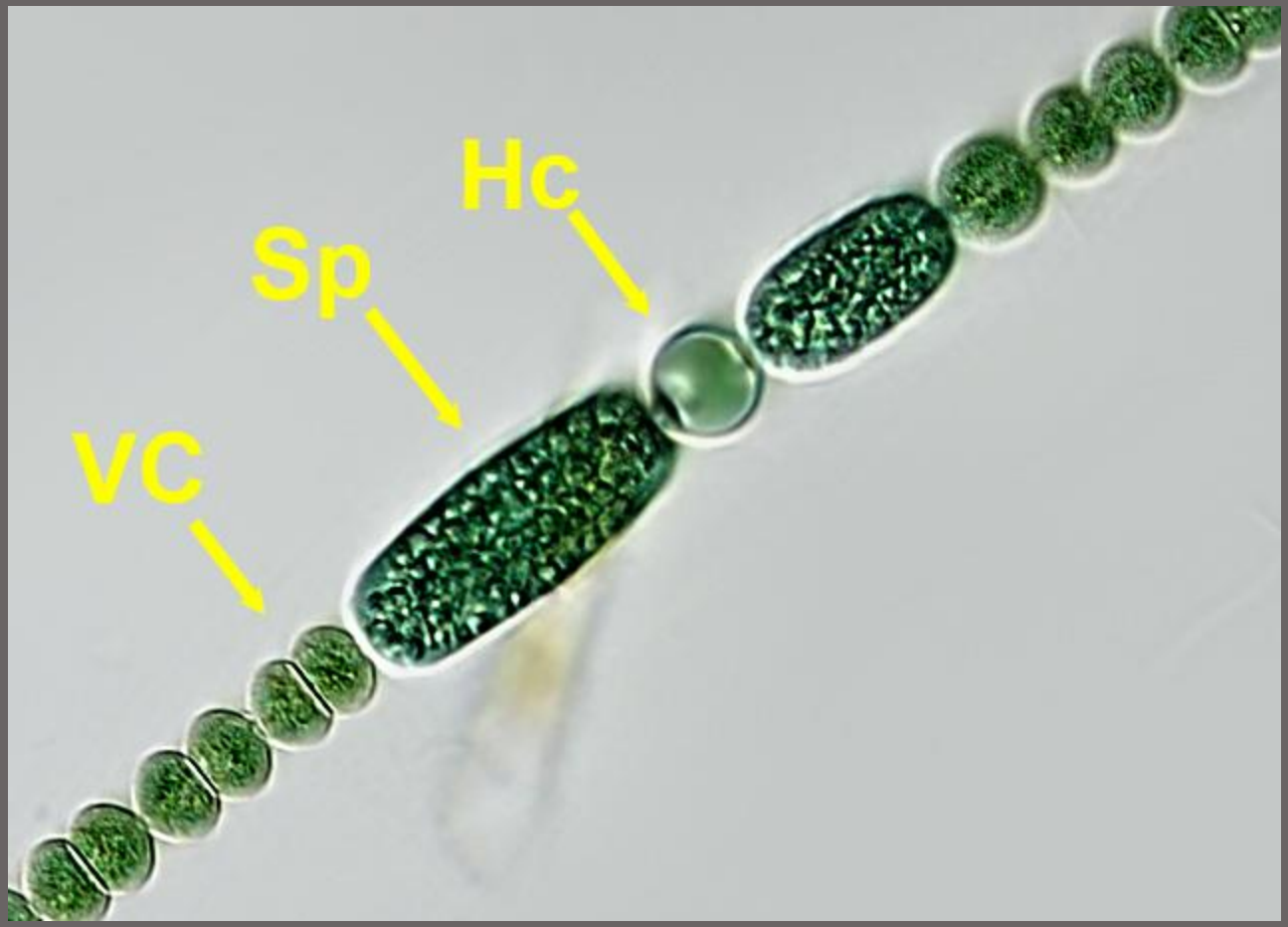
Merismopedia glauca
Coccoid – Cyanobacteria
Plankton of Soft water lake



Oscillatoria limosa



Anabaena planctonica Brunnthaler, 1903

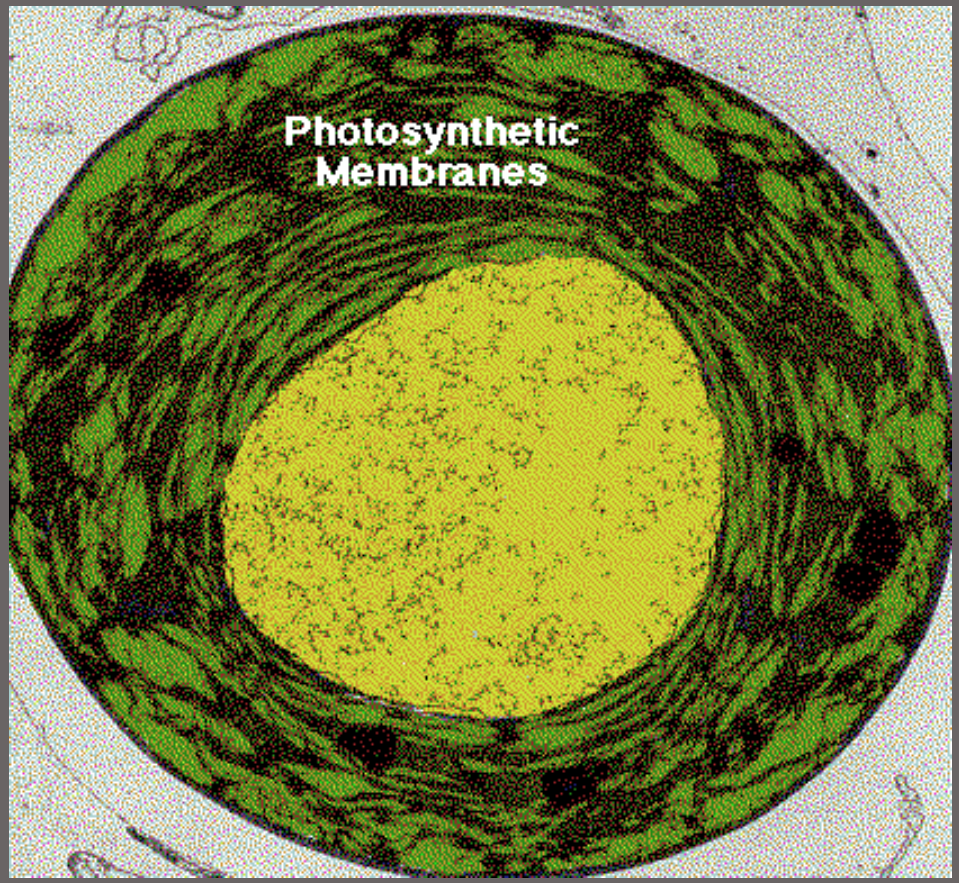


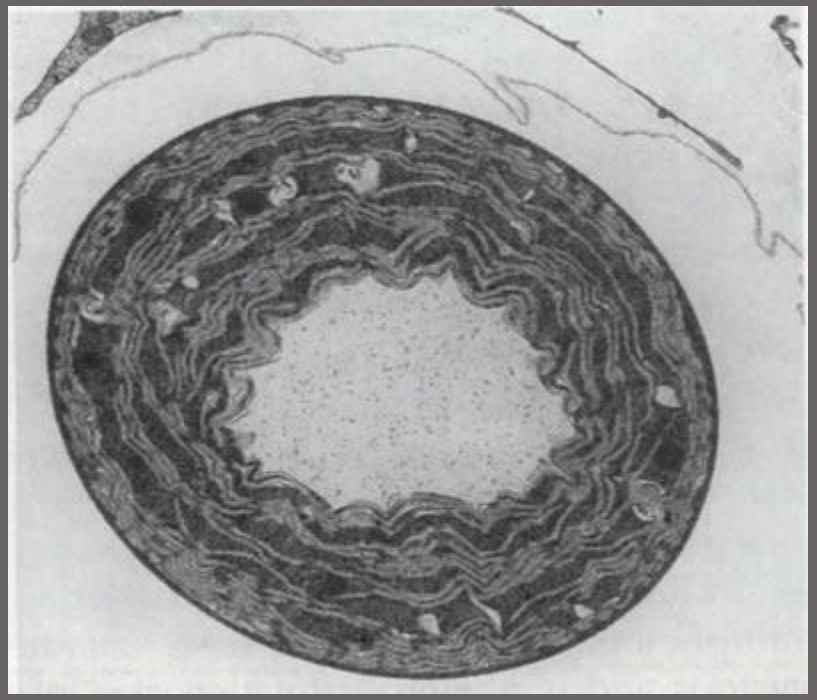
Cylindrospermum majus

Photosynthesis in Bacteria

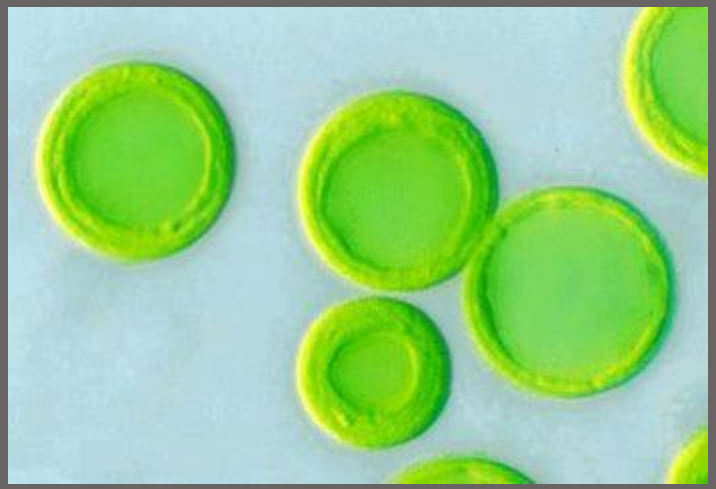
Prochlorophytes (Grass Green)

- Contain – chlorophyll b
- Lacks – Phycobillins
- Associate with marine invertebrate (ascidians)
- Not yet cultured
- Genus – *Prochloron* is only known





Prochlorophytes



Photosynthesis in Bacteria

- References
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  - Tortora, G. J., Funke, B. R. and Case C. L. Microbiology An Introduction, Benjamin Cummings New York, 10th Edition, 2010, p. 313.