# ALL ABOUT ALGAE

TONI GLYMPH-MARTIN

SENIOR ENVIRONMENTAL MICROBIOLOGIST

# Algae

- Aerobic organisms that are photosynthetic and grow on simple inorganic compounds using light as an energy source
- Algae produce oxygen during the day and consume oxygen at night

# Algae

- Three major algae groups
  - brown algae (diatoms)
  - green algae
  - blue-green “algae” (bacteria)

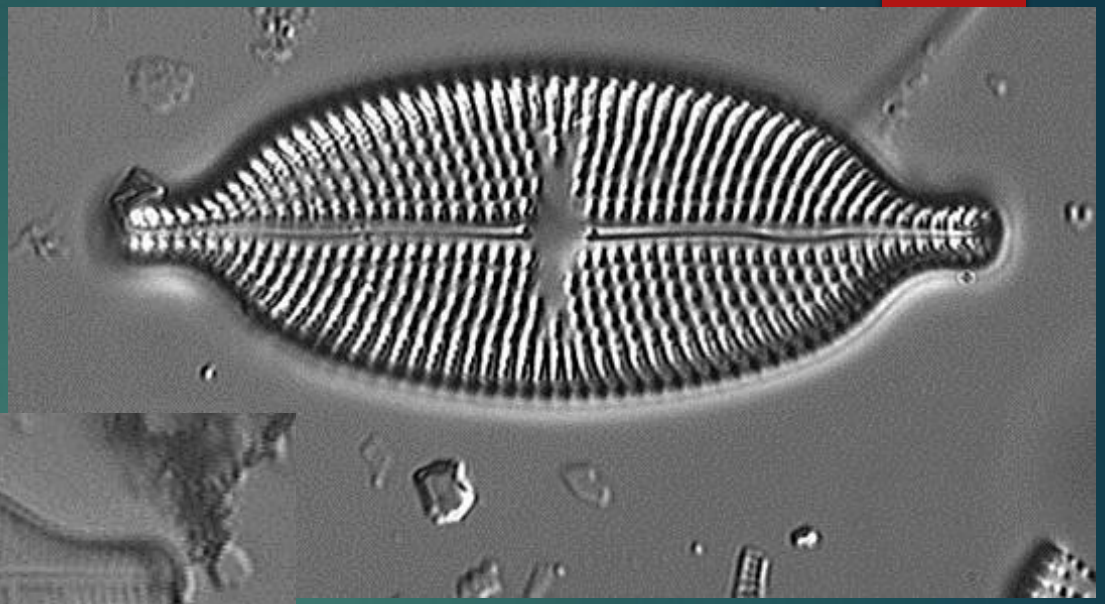
# Algae

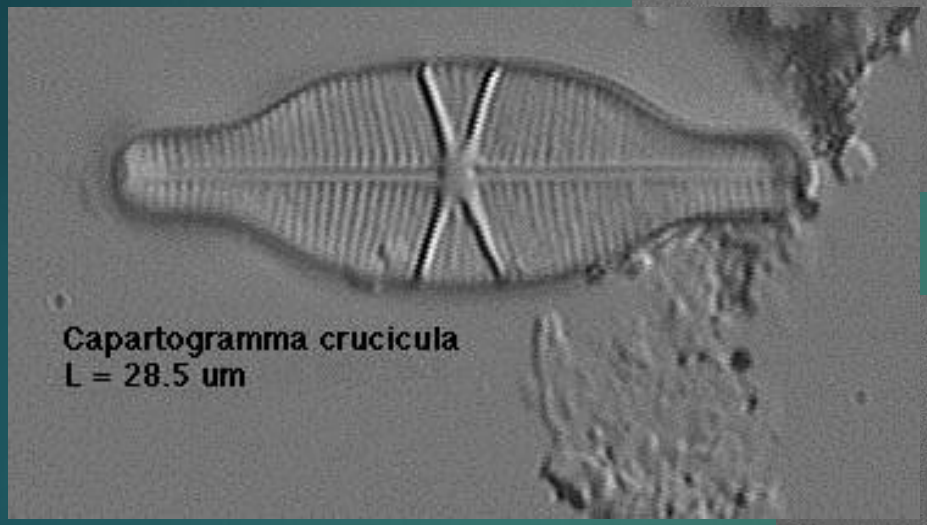
- Brown algae (diatoms)
  - Non-motile
  - Diatoms are predominate in the spring
  - During this time there are no predators to feed on the algae (no rotifers or daphnia)

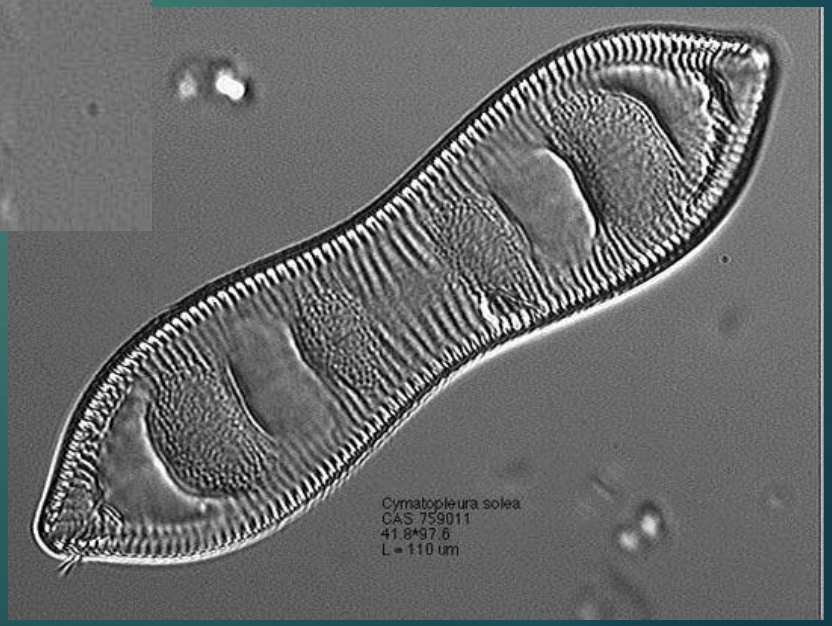
# Algae - Diatoms

- Unicellular
- Silica shell
  - Intricate & beautiful sculpturing
- Most exist singly
- Bilaterally or radially symmetrical

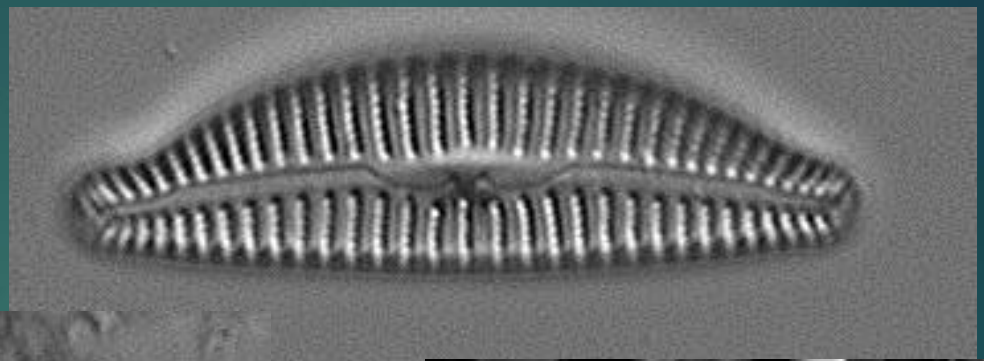
# Diatoms

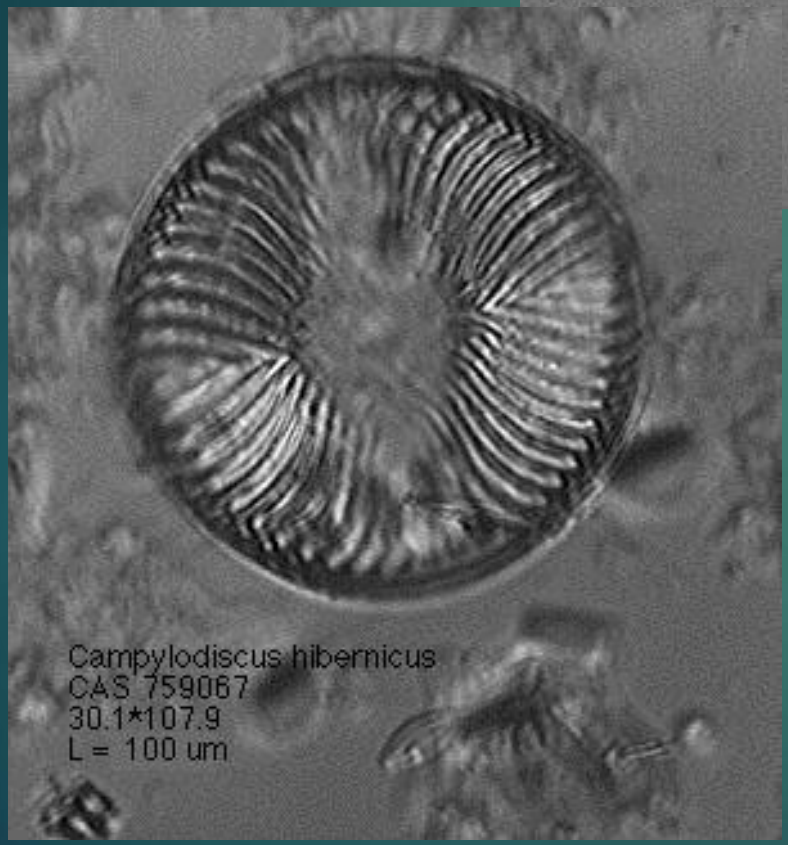


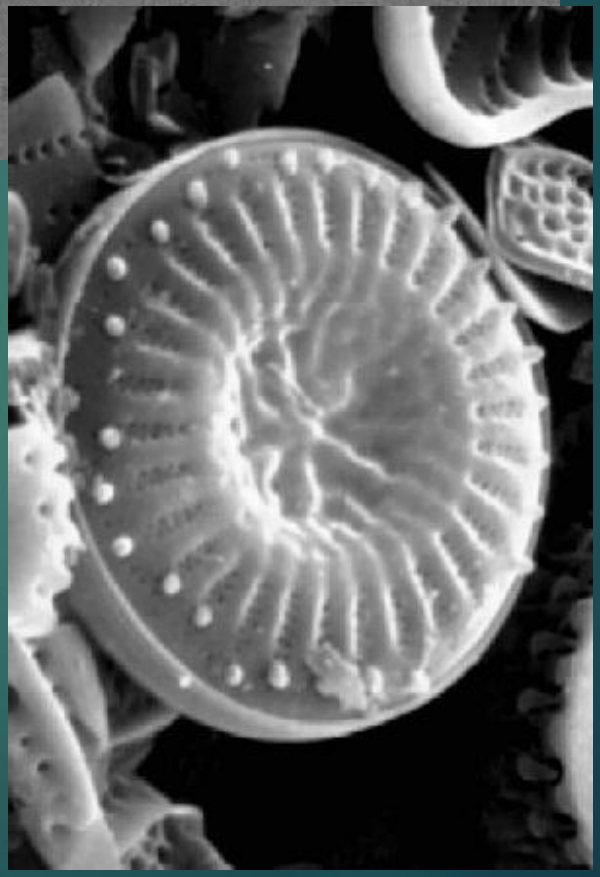

Capartogramma crucicula
L = 28.5 um


Cymatopleura solea
CAS 759011
41.8*97.6
L = 110 um

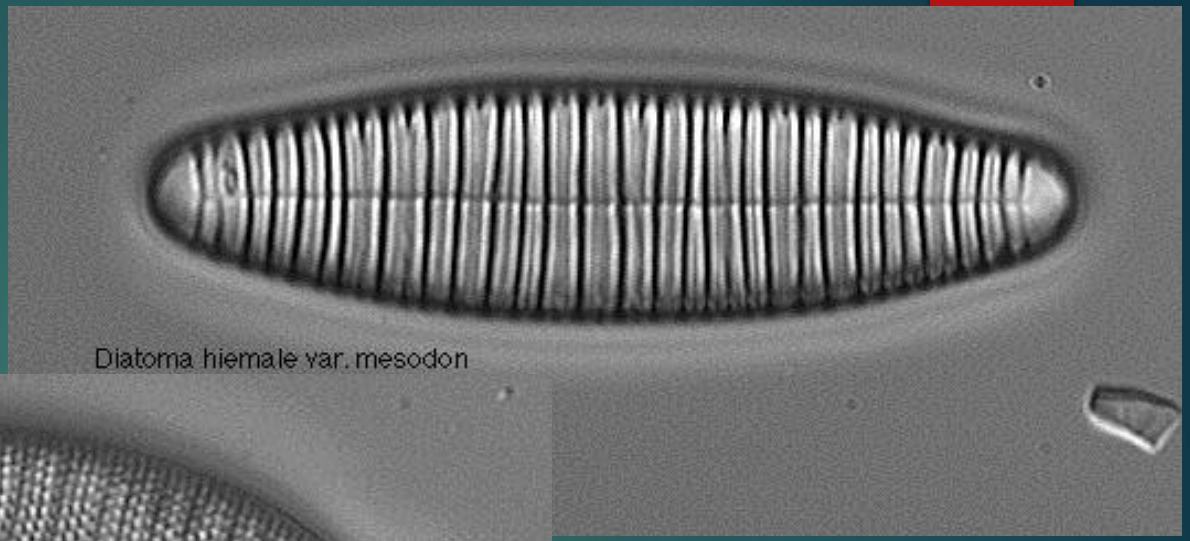
# Diatoms

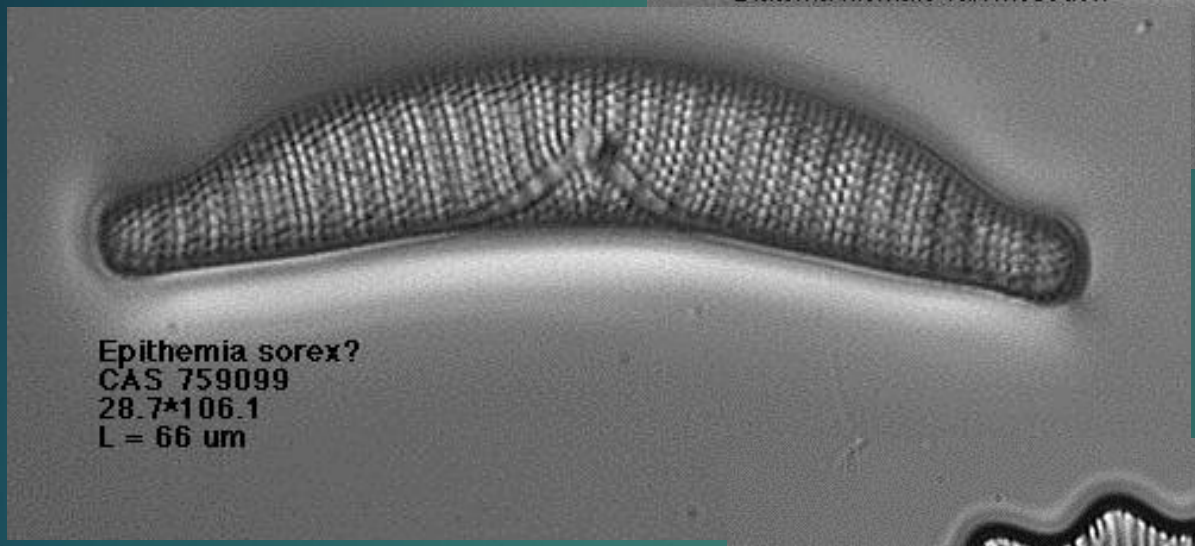


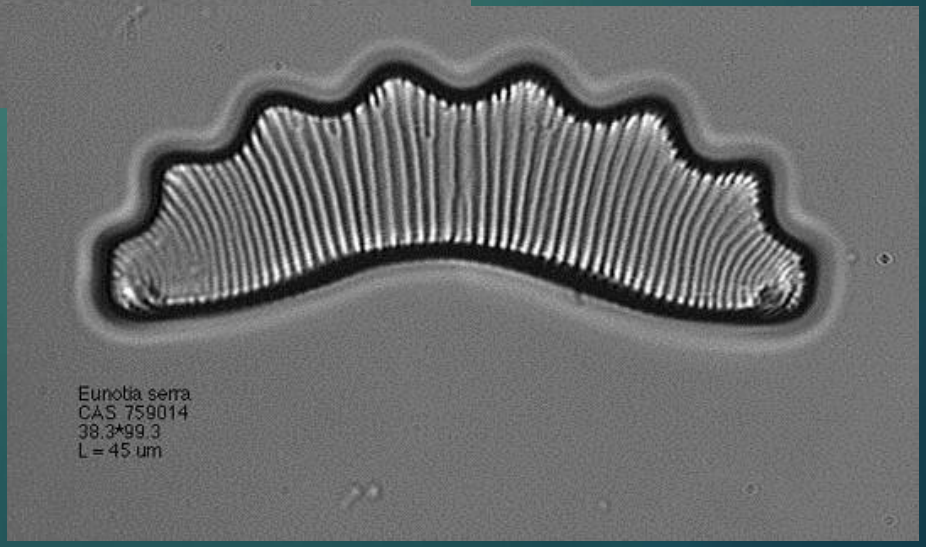


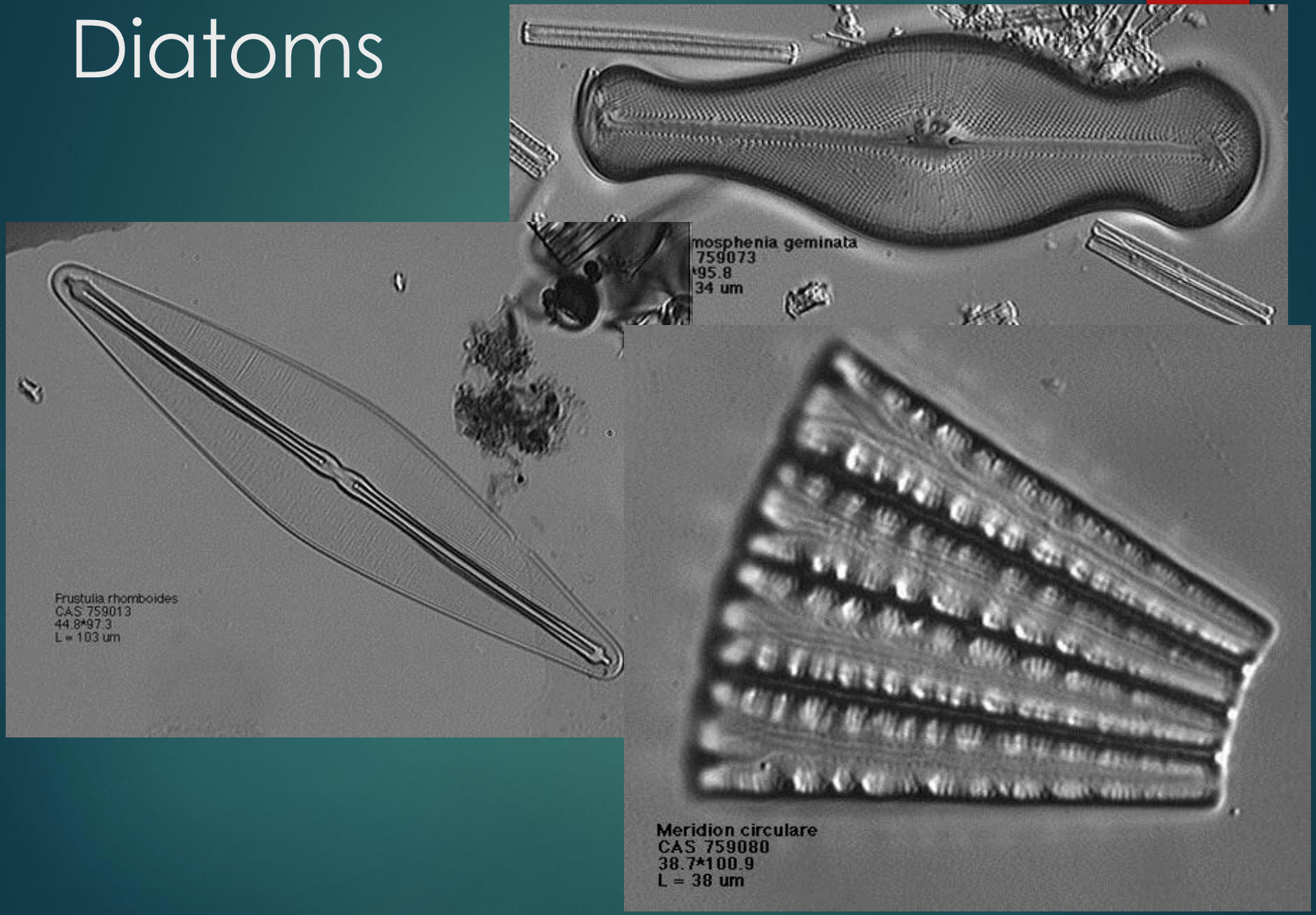
# Diatoms


Diatoma hiemale var. mesodon

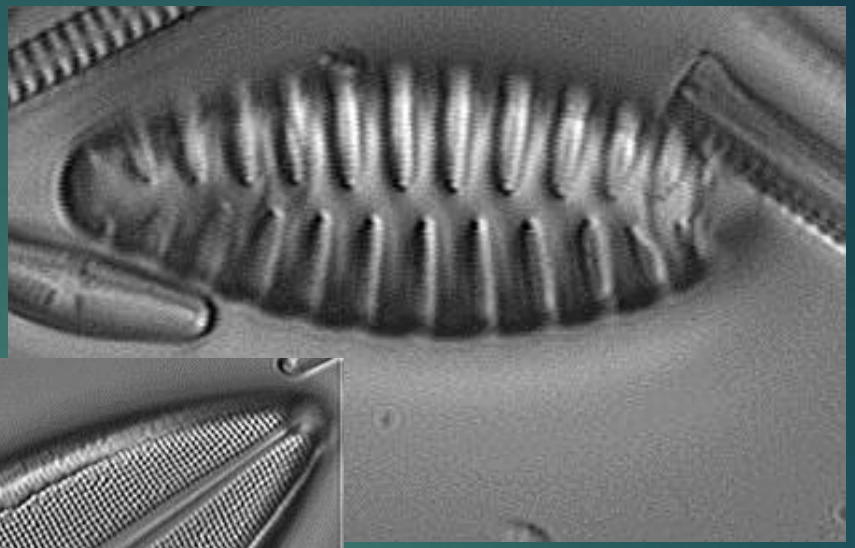

Epithemia sorex?
CAS 759099
28.7*106.1
L = 66 um


Eunotia serra
CAS 759014
38.3*99.3
L = 45 um

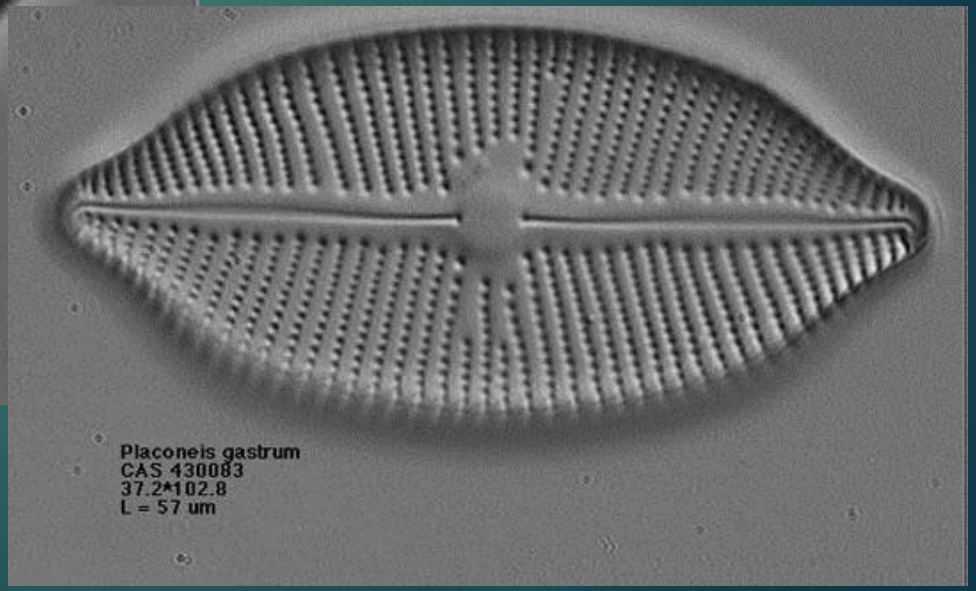
# Diatoms


mosphenia geminata
759073
95.8
34 um
Frustulia rhomboides
CAS 759013
44.8*97.3
L = 103 um
Meridion circulare
CAS 759080
38.7*100.9
L = 38 um

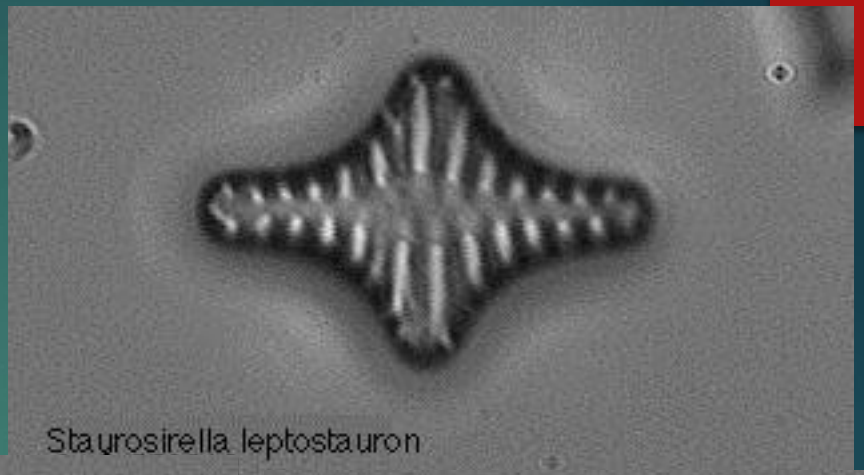
# Diatoms

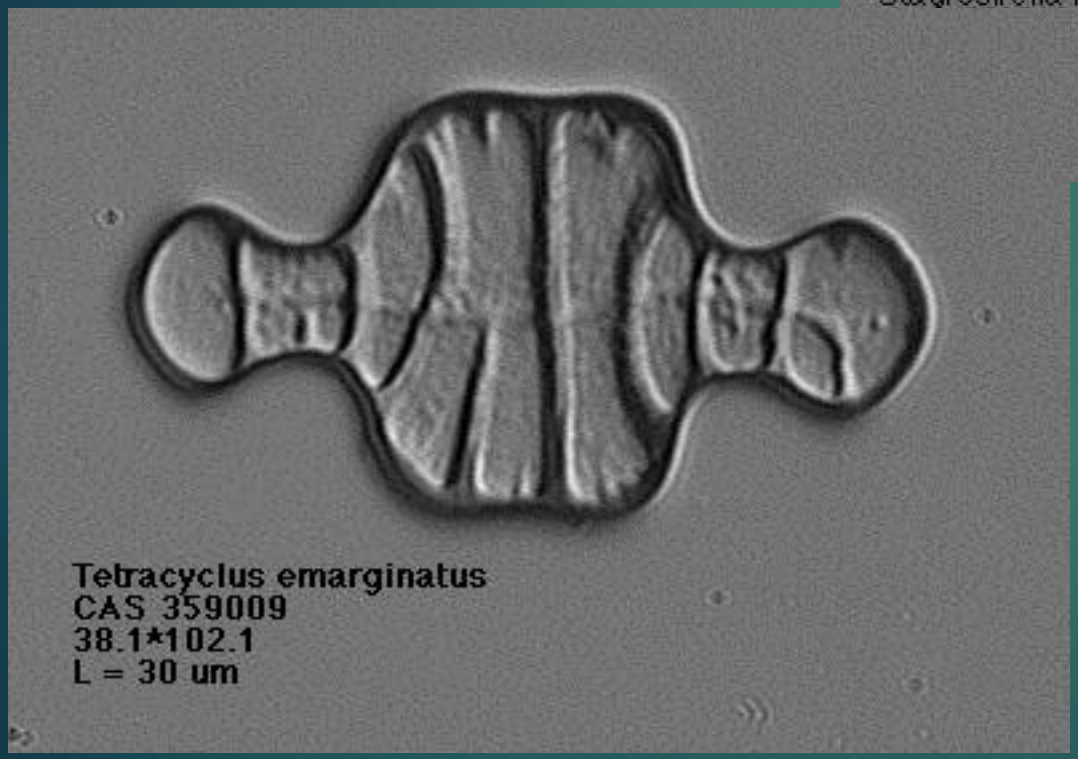


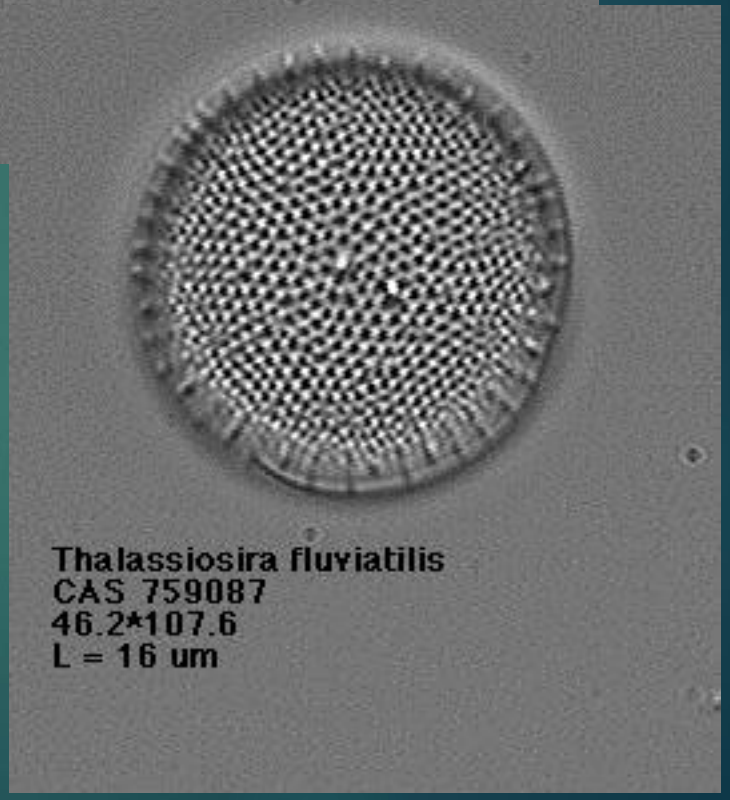

Neidium iridis
CAS 759002
36.9*101.0
L = 121 um


Placoneis gastrum
CAS 430083
37.2*102.8
L = 57 um

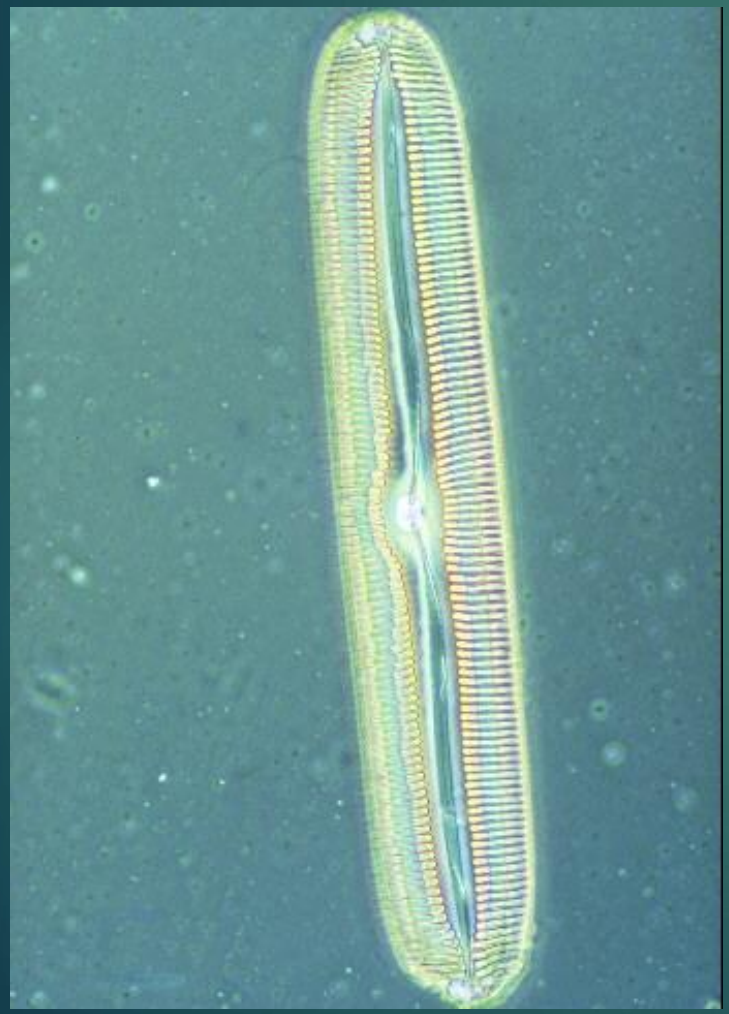
# Diatoms


Staurosirella leptostauron


Tetracyclus emarginatus
CAS 359009
38.1*102.1
L = 30 um


Thalassiosira fluviatilis
CAS 759087
46.2*107.6
L = 16 um

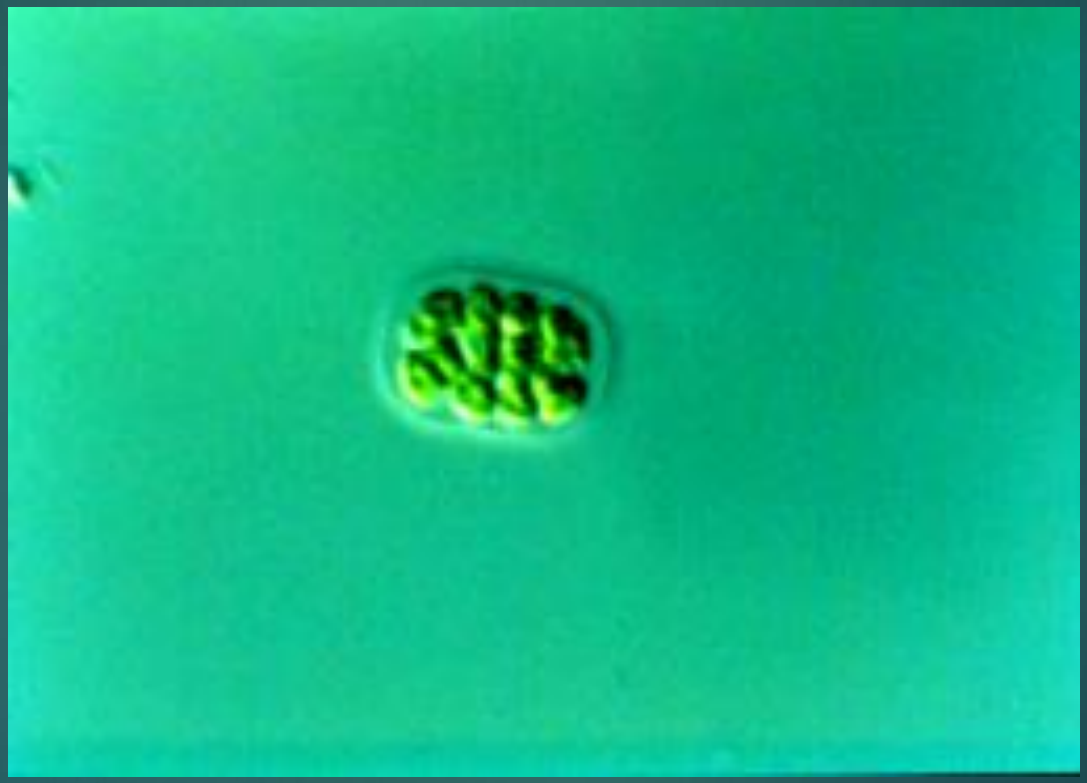
# Diatoms



# Green Algae

- Some are motile; flagellated
- Dominate during high light, high temperatures (summer).
- As the temperature warms and predators such as daphnia become active, the green algal species changes to those with spikes & horns (they can survive better).

# Green Algae



# Green Algae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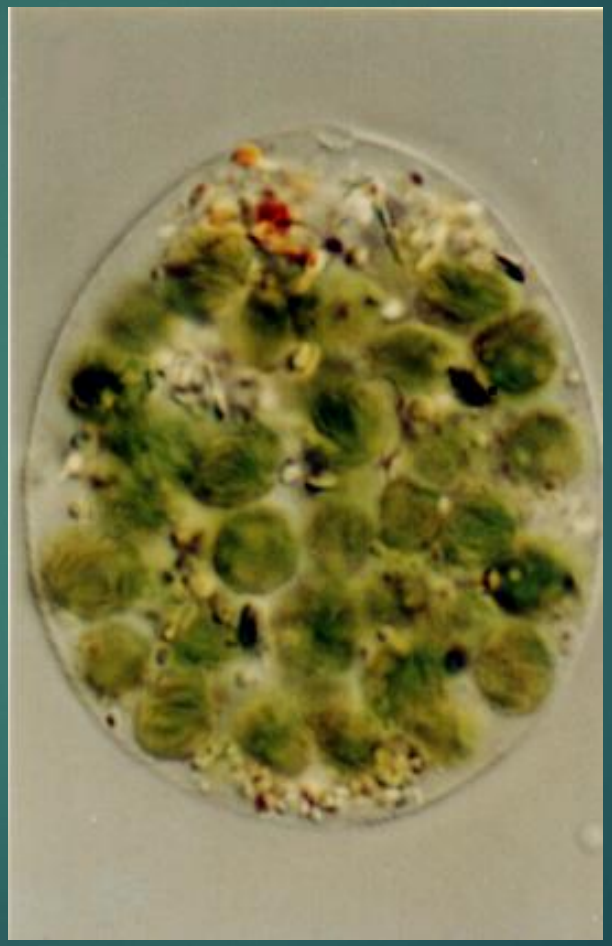

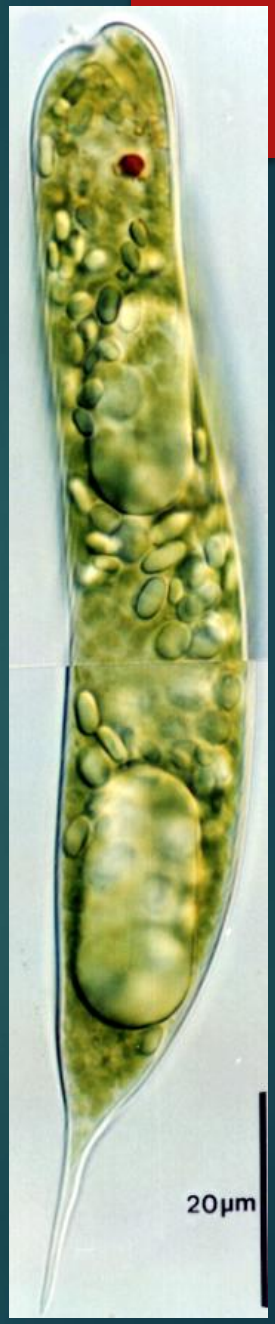

# Green Algae

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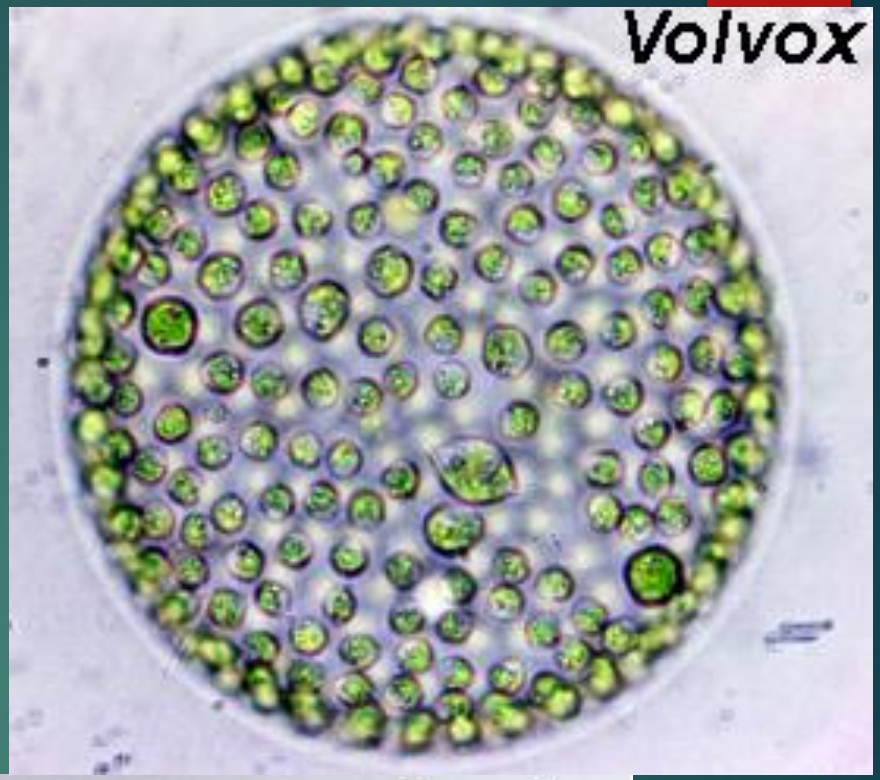
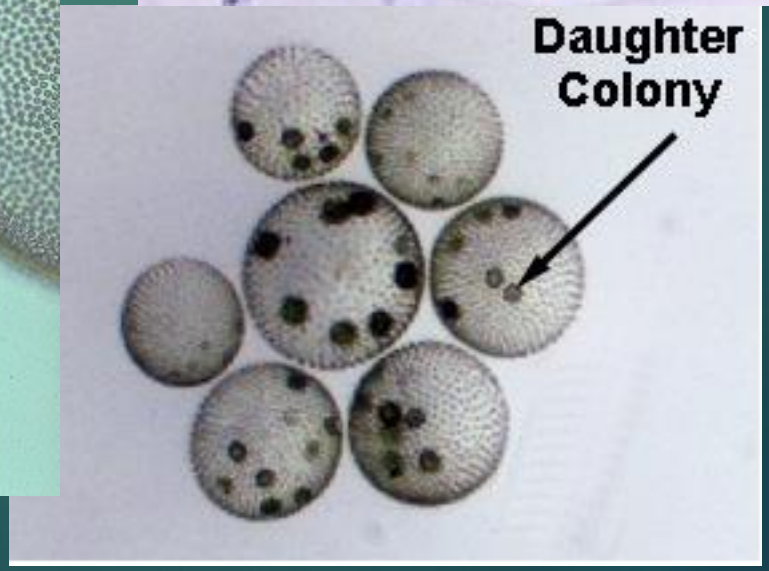
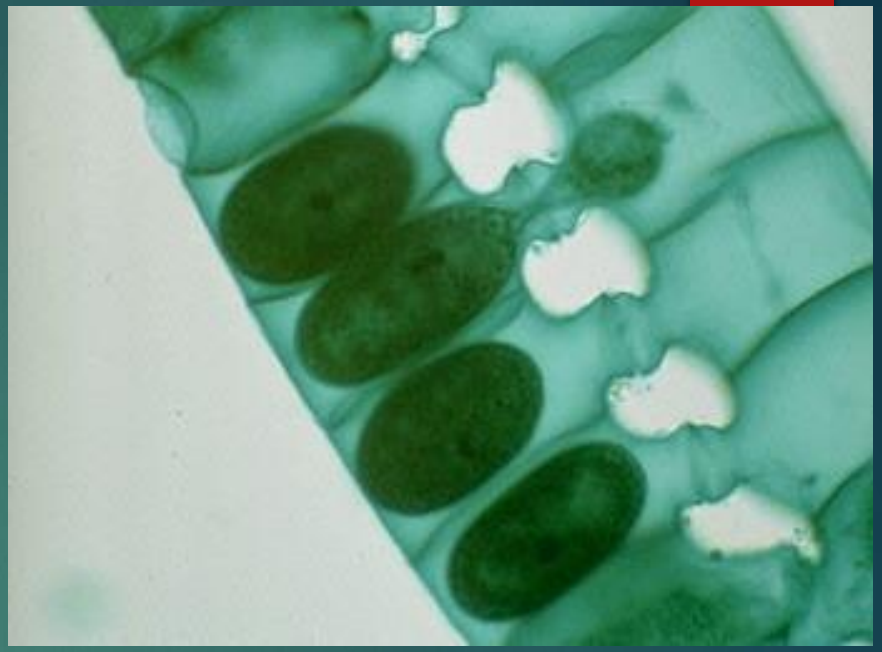


# Green Algae



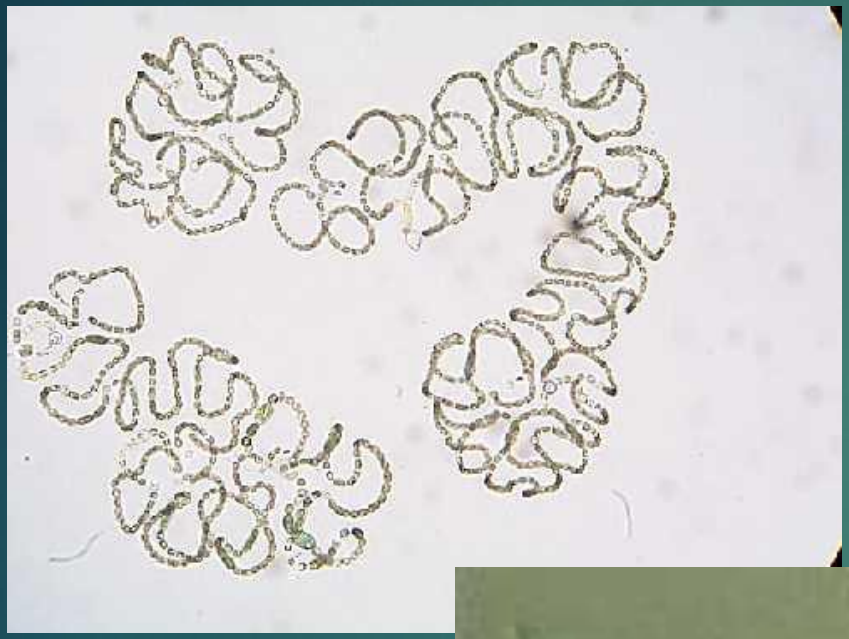
# Blue-green Algae (Cyanobacteria)

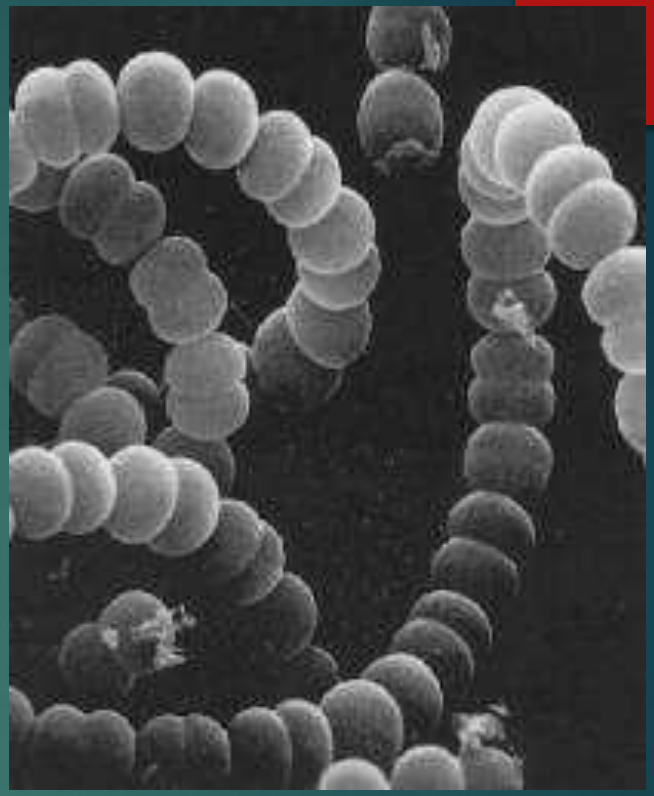
- Can survive high predator levels
- Dominate in low temperature, low light conditions (fall).
- Many species produce odorous and toxic by-products

# Blue-green Algae

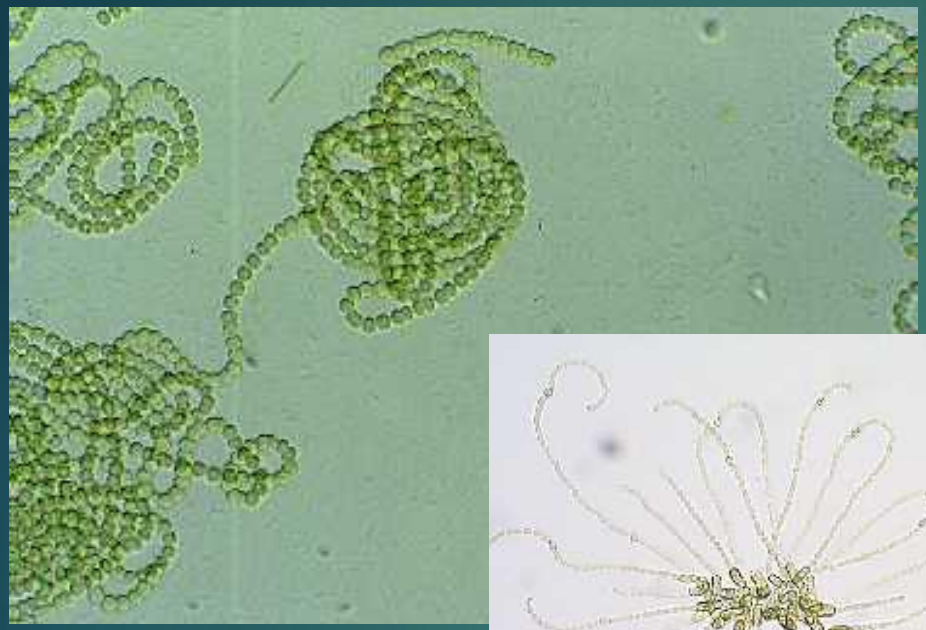
- Require little energy for cell function
- Grows faster than others at low light
- Few natural enemies; can maintain stable population

# Blue-green Algae

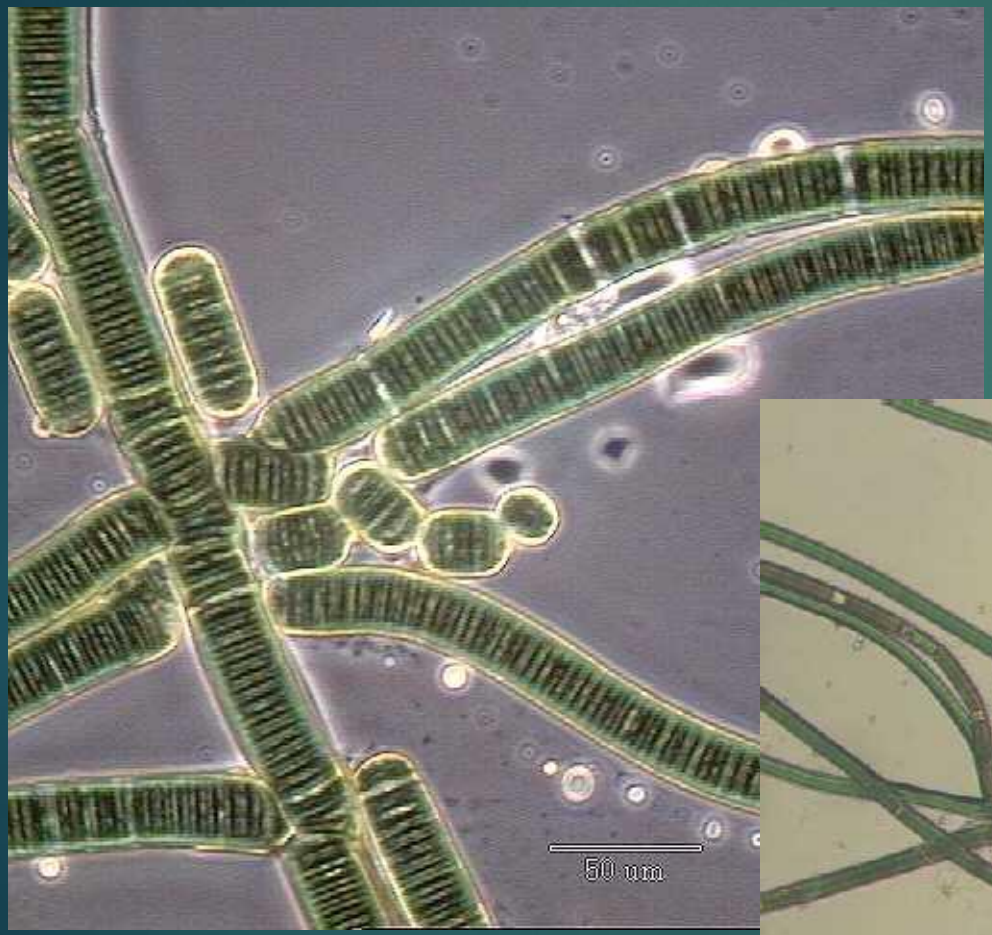


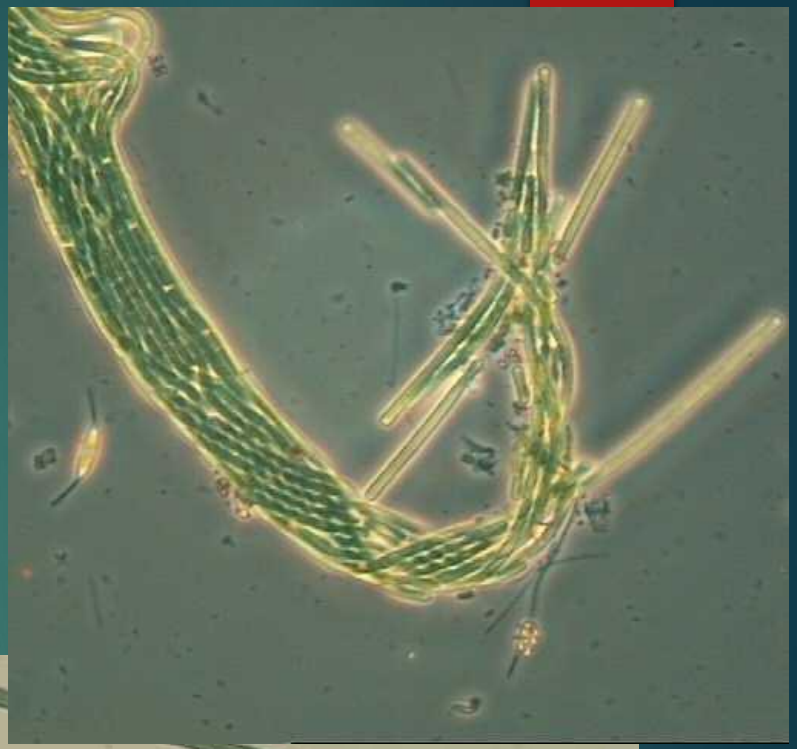


# Blue-green Algae




# Blue-green Algae



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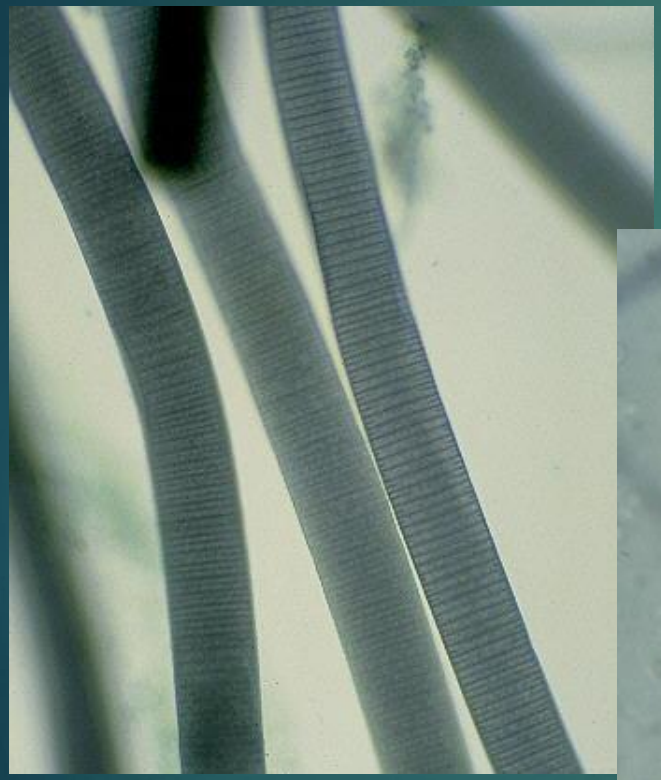

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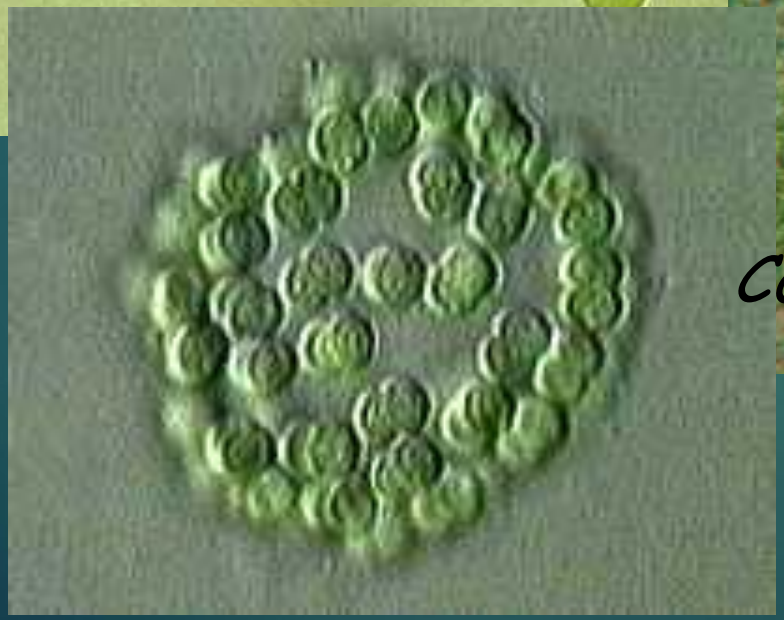
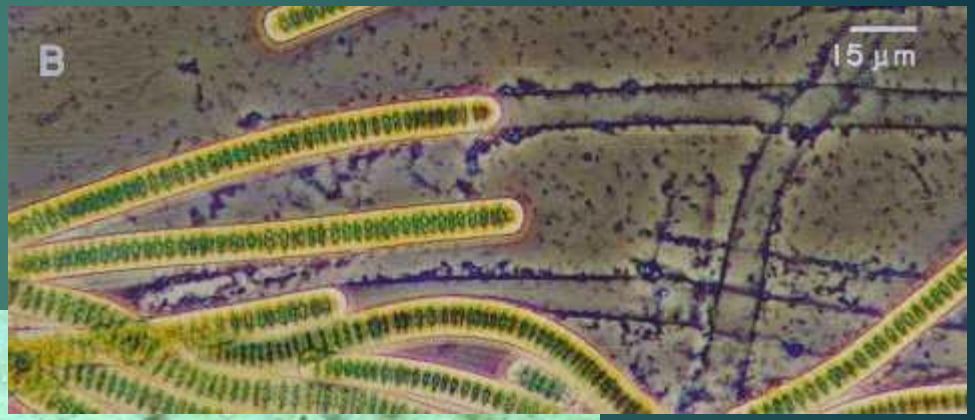


# Blue-green Algae

*Filamentous*

# Blue-green Algae



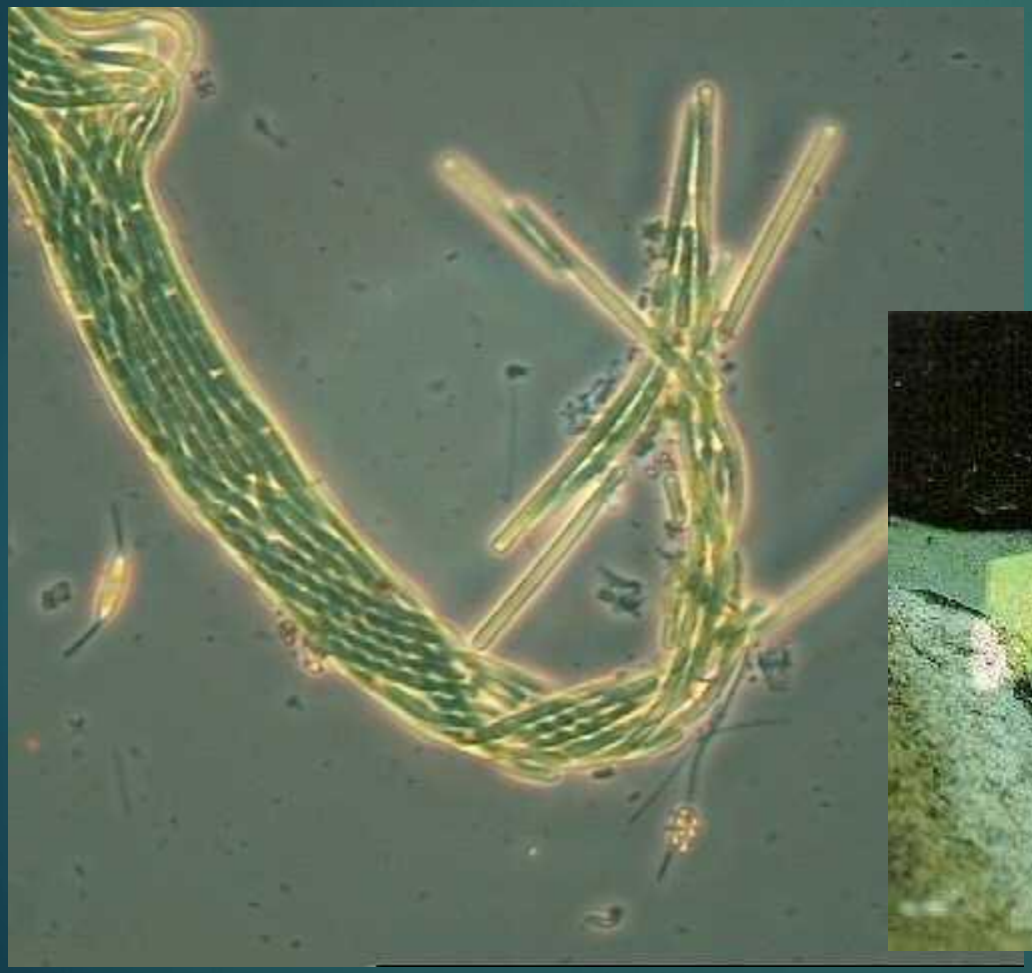

*Filamentous*

# Blue-green Algae

*Branching*

*Spiral*

# Blue-green Algae

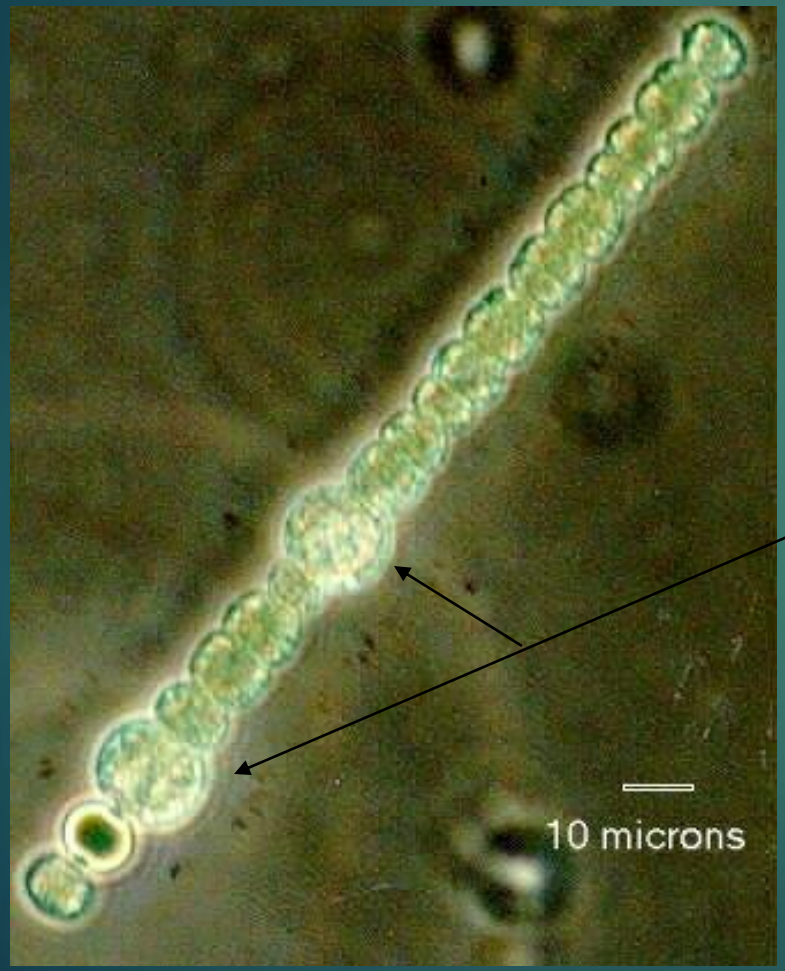


*Mat-forming*

# Blue-green Algae "The Survivors"

- "Ultra-violet absorbing sheath pigments"
- Can flourish in environments where no other micro-algae can exist
- Can withstand high concentrations of sodium chloride
- Can survive extremely high *and* low temperatures

# Blue-green Algae




*Gas vesicles*

# Blue-green Algae

- *Gas Vesicles*
  - buoyancy regulation
  - as light decreases buoyancy increases
  - sensitive to prolonged periods of high light intensity
  - can adjust vertical position in water column to find a suitable "niche" for growth

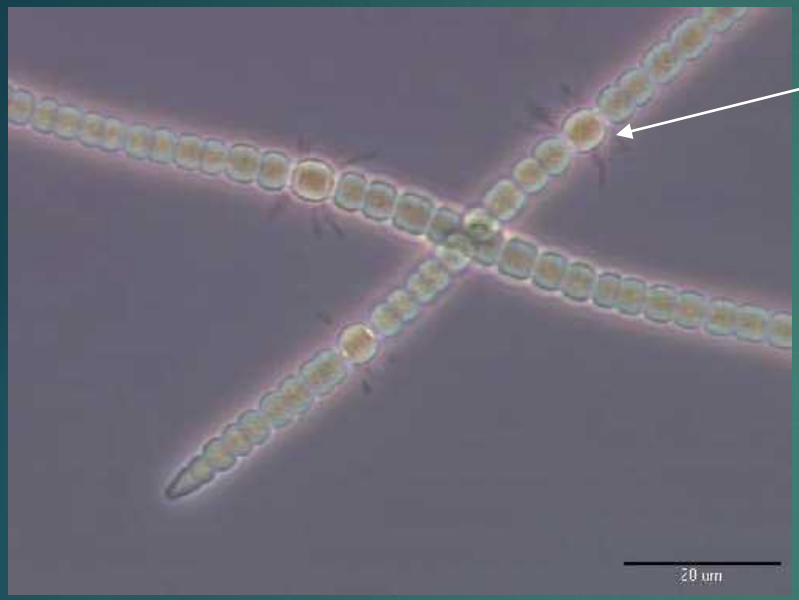
# Blue-green Algae


# Blue-green Algae

# Blue-green Algae

- *Akinetes*
  - large thick-walled cells used for storing reserve nutrients
  - can store essential nutrients
  - helps blue-green algae survive unfavorable conditions

# Blue-green Algae




# Blue-green Algae

- *Heterocysts*
  - nitrogen fixation
    - store nitrogen
  - can convert nitrogen to ammonia to use as food source
  - high affinity for nitrogen and phosphorus
  - They can out compete other organisms when nitrogen or phosphorus is limited.

# Blue-green Algae

- Strong natural affinity for nitrogen and phosphorus
- Substantial storage capacity for phosphorus (enough to perform 2 to 4 cell divisions)
  - resulting in a 4 to 32 fold increase in biomass

# Blue-green Algae

- Requires a lower N:P ratio
  - 18:1 for green algae
  - 12:1 for blue-green algae
- Ecostrategists
  - Can effectively suppress the growth of other algae
  - Can establish itself the next year without seasonal succession

# Algal Growth Patterns

| *Season* | *Growth Condition* | *Dominant Organism* |
|---|---|---|
| Winter | Low light, low temp | None |
| Spring | High light, low temp | Diatoms |
| Summer | High light, high temp | Green Algae |
| Fall | Low light, high temp | Blue-green Algae |

# Understanding Algae

- Nutrient Requirements
- pH
- Alkalinity

# Understanding Algae

- Dissolved Inorganic Carbon is found in 3 forms in water
  - Carbon Dioxide ($CO_2$)
  - Bicarbonate ($HCO_3^-$)
  - Carbonate ($CO_3^{2-}$)

# Understanding Algae

- $CO_2$ (carbon dioxide) is readily used by algae because it can fuse through the cell membrane.
- $HCO_3^-$ (bicarbonate) can be used by some algal species and need specific transport mechanisms to enter the cell.
- $CO_3^{2-}$ (carbonate) is generally unusable by algae.

# Blue-green Algae Control

- In most cases Algae overgrowth problems are caused by Blue-green "algae"
- What encourages algae growth?
  - Inorganic carbon
  - Nutrients
  - Time

# Blue-green Algae Control

- Time is the most influential factor in blue-green algal growth
- Extended Fall weather
- Slower growth rate
  - diatoms - 1 to 2 doublings/day
  - green algae - 1.5 to 2.5 doublings/day
  - blue-green - 0.3 to 1.4 doublings/day

# Blue-green Algae Control

- Blue-green algae are able to photosynthesize at lower $CO_2$ concentrations than green algae
- Blue-green algae have the competitive advantage under low free $CO_2$ conditions.

# Understanding Algae

- Nutrient Requirement
  - Inorganic Carbon
  - Nitrogen
  - Phosphorus

Inorganic Carbon : Nitrogen : Phosphorus =

288 : 12 : 1