

Photobioreactors:

Design Considerations for Sustainable High-Yield Algal Oil Production

Qiang Hu & Milton Sommerfeld

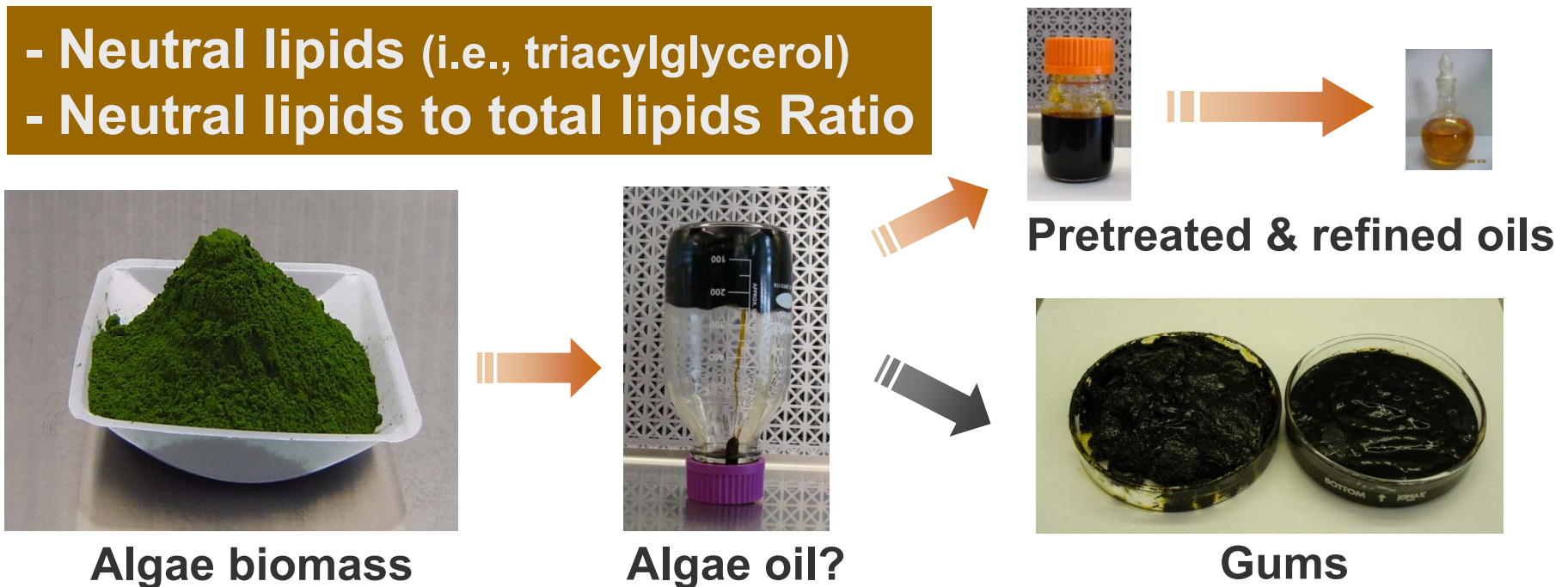
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(NREL-AFOSR Workshop, January 30, 2008)

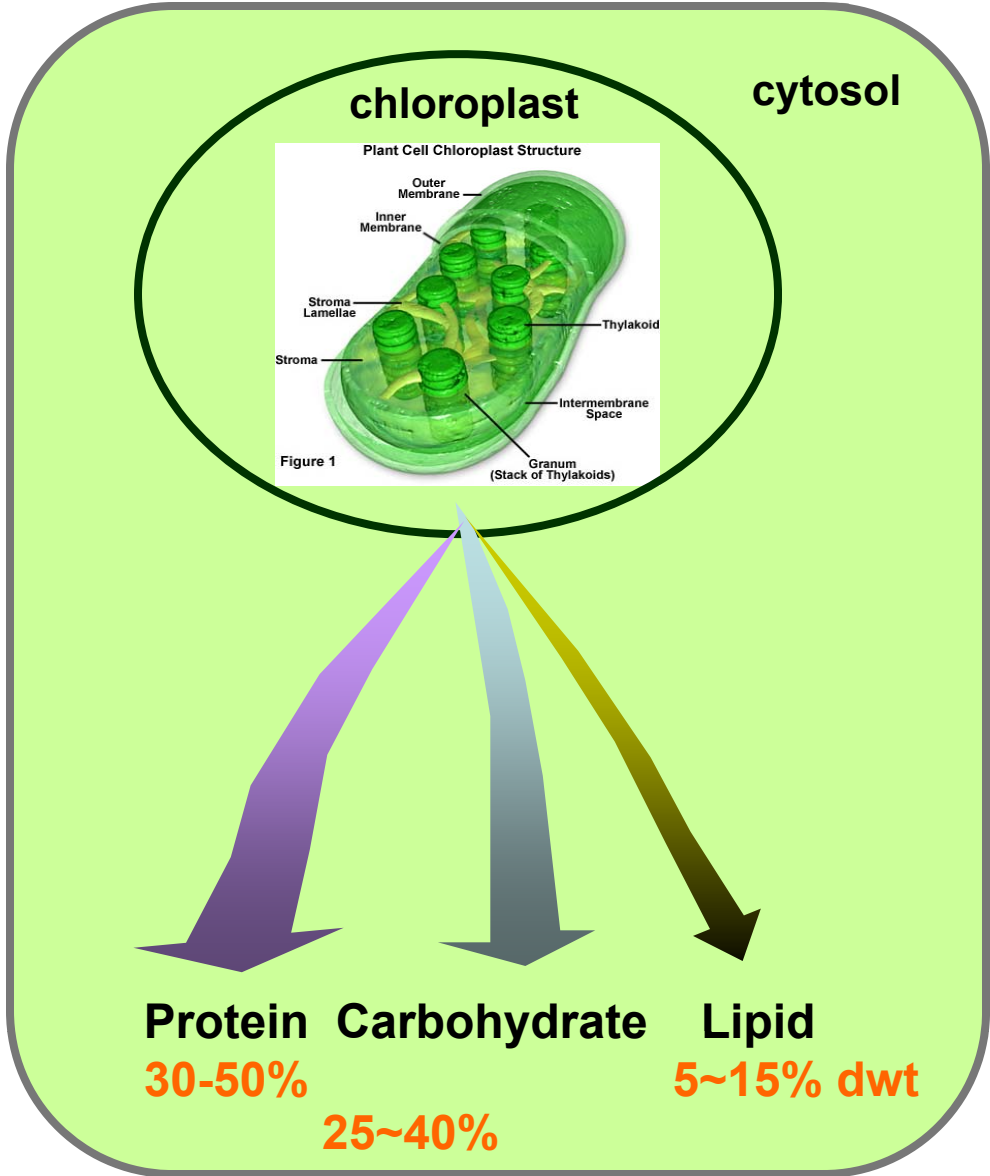
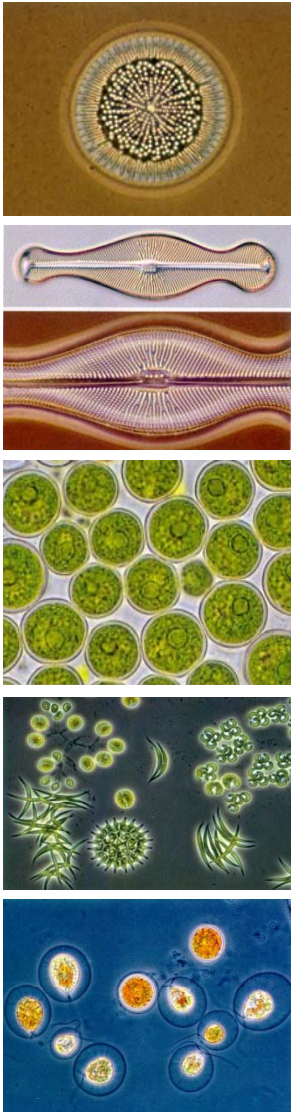
Total Lipids \neq Oil

Total Lipids: Substances that dissolve in organic solvents but not in water (e.g., phospholipids, glycolipids, triacylglycerol, sterols, wax, chlorophyll, carotenoids)

'Oil'/storage neutral lipids: Triacylglycerol, hydrocarbons

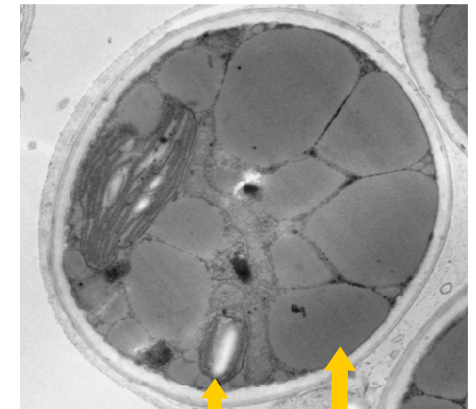
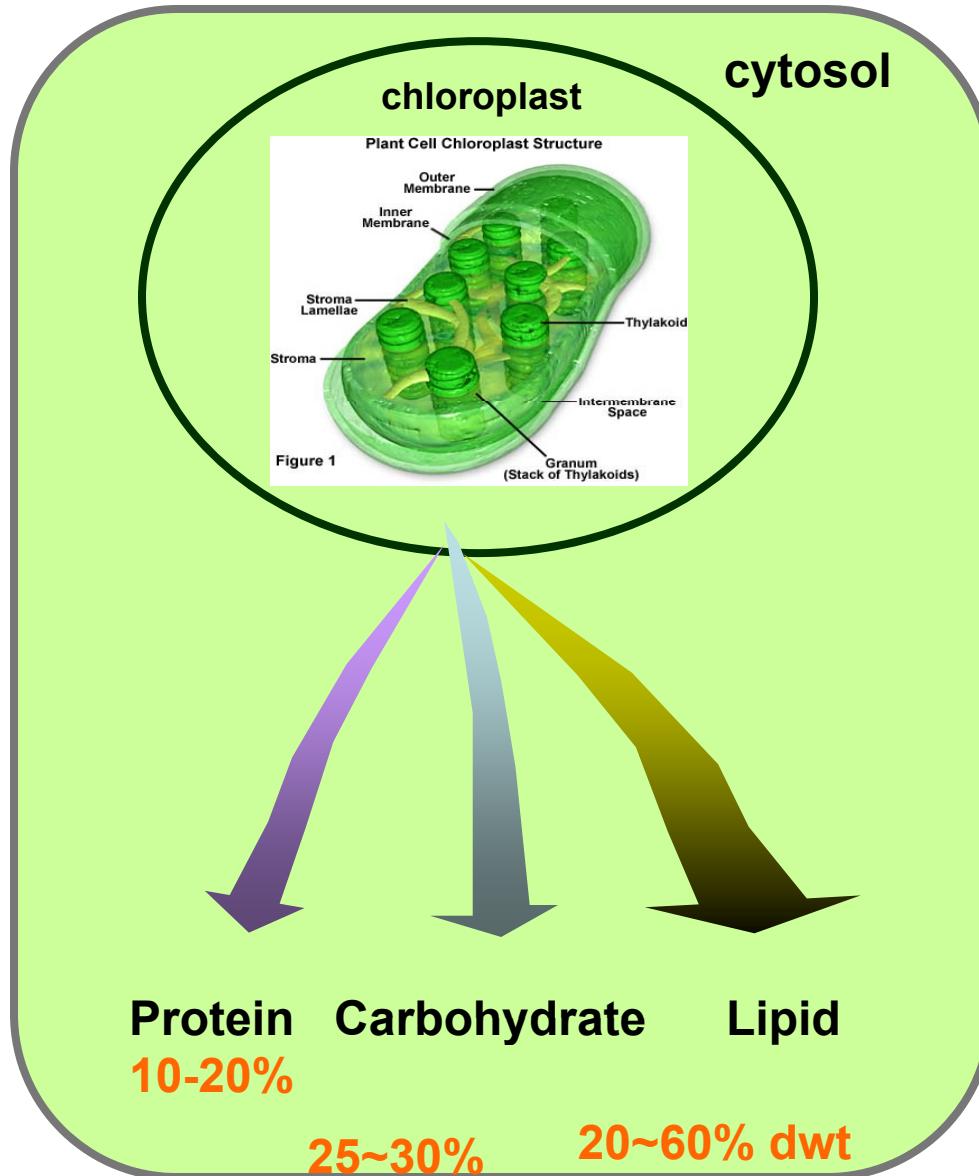
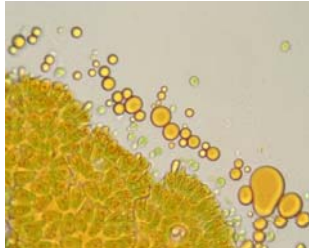
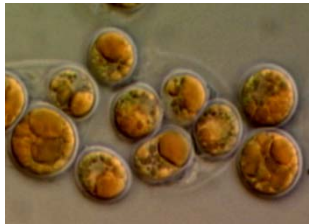
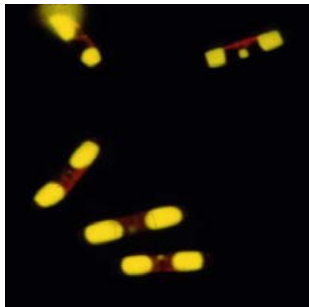


Algae Make Little Fat/Oil



LB
SG
Cell with low Storage neutral lipids

Algae Make Lot Fat/Oil

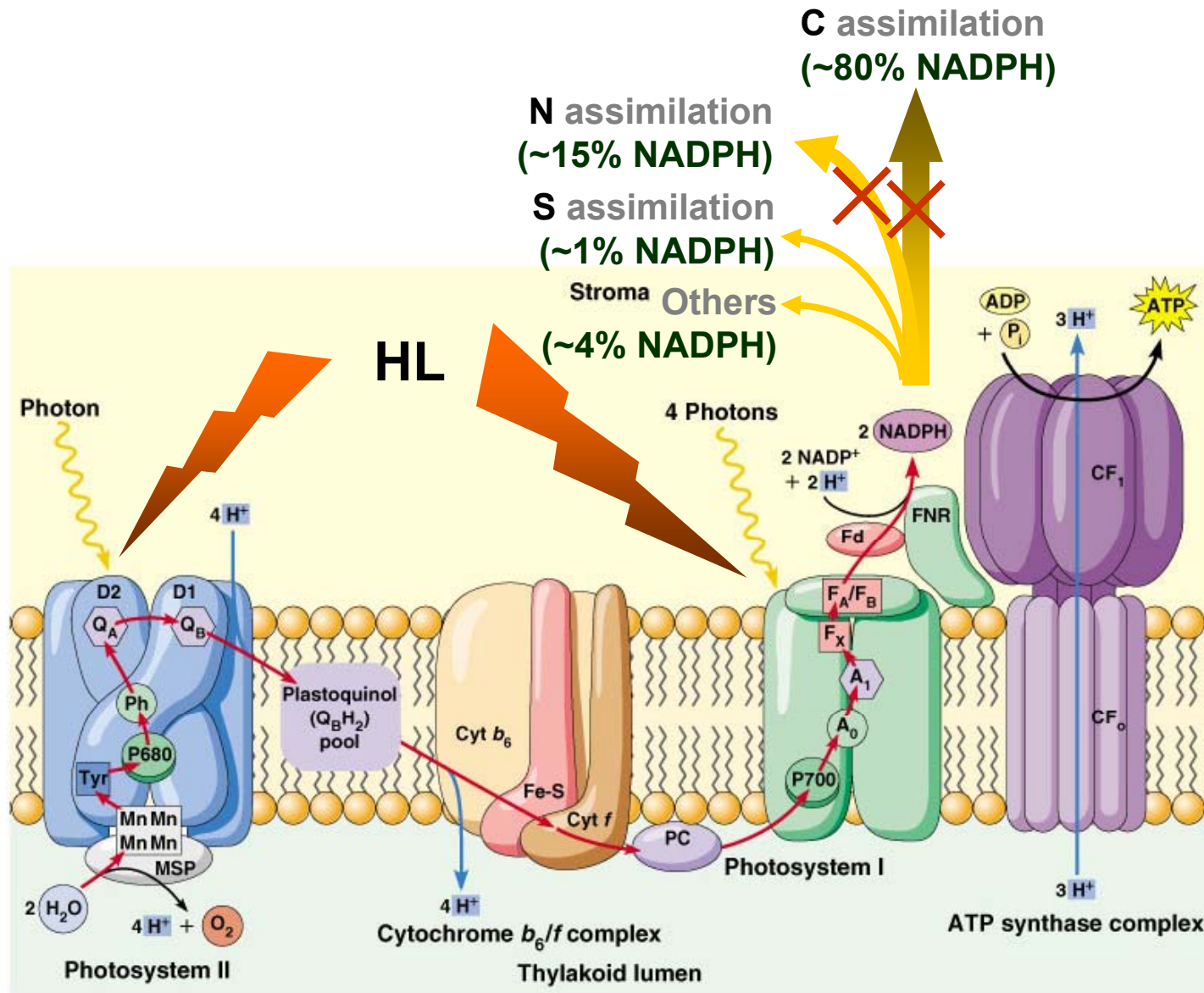


SG **LB**

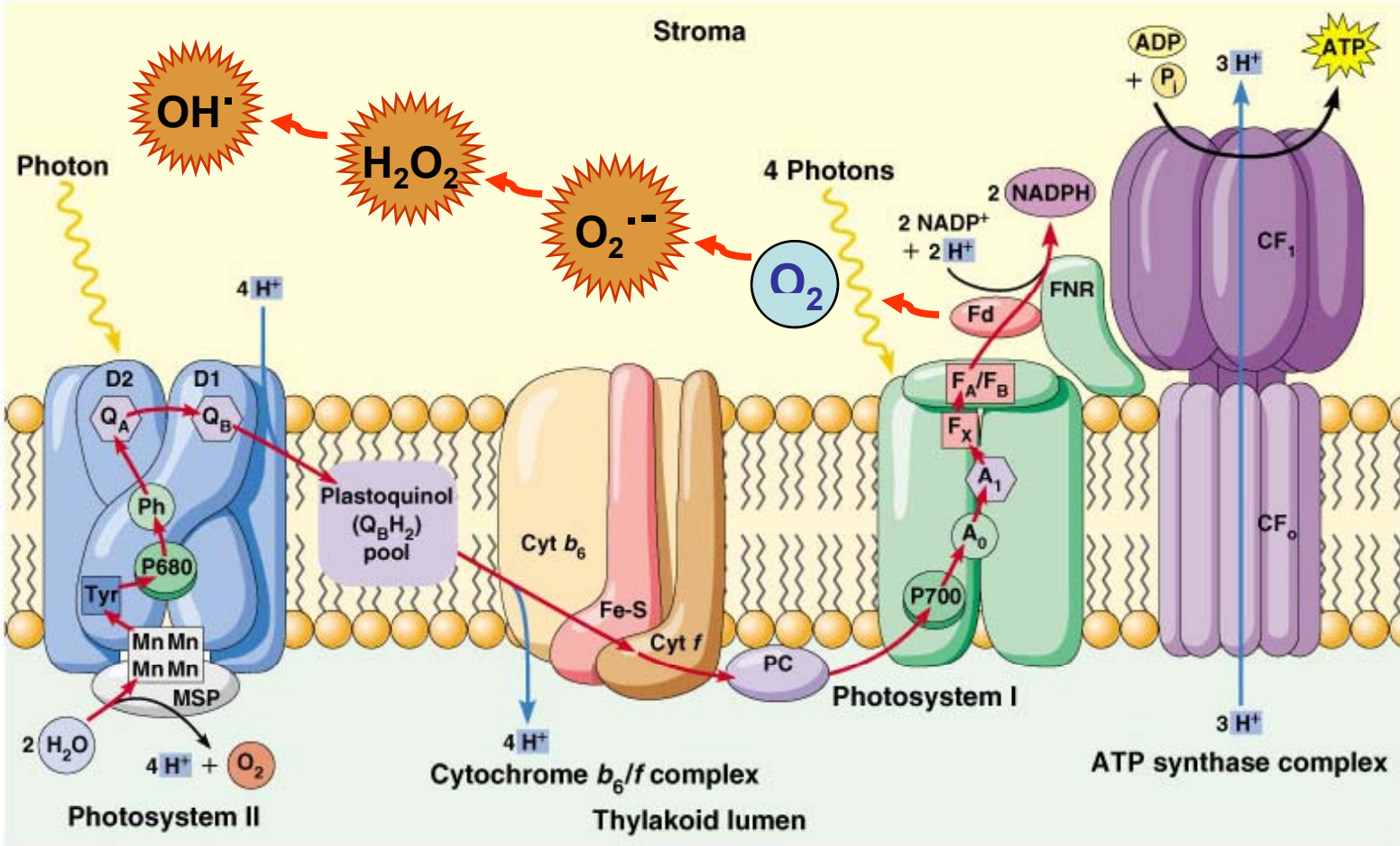


Cell with high Storage neutral lipids

Why and When Algae Make Oil



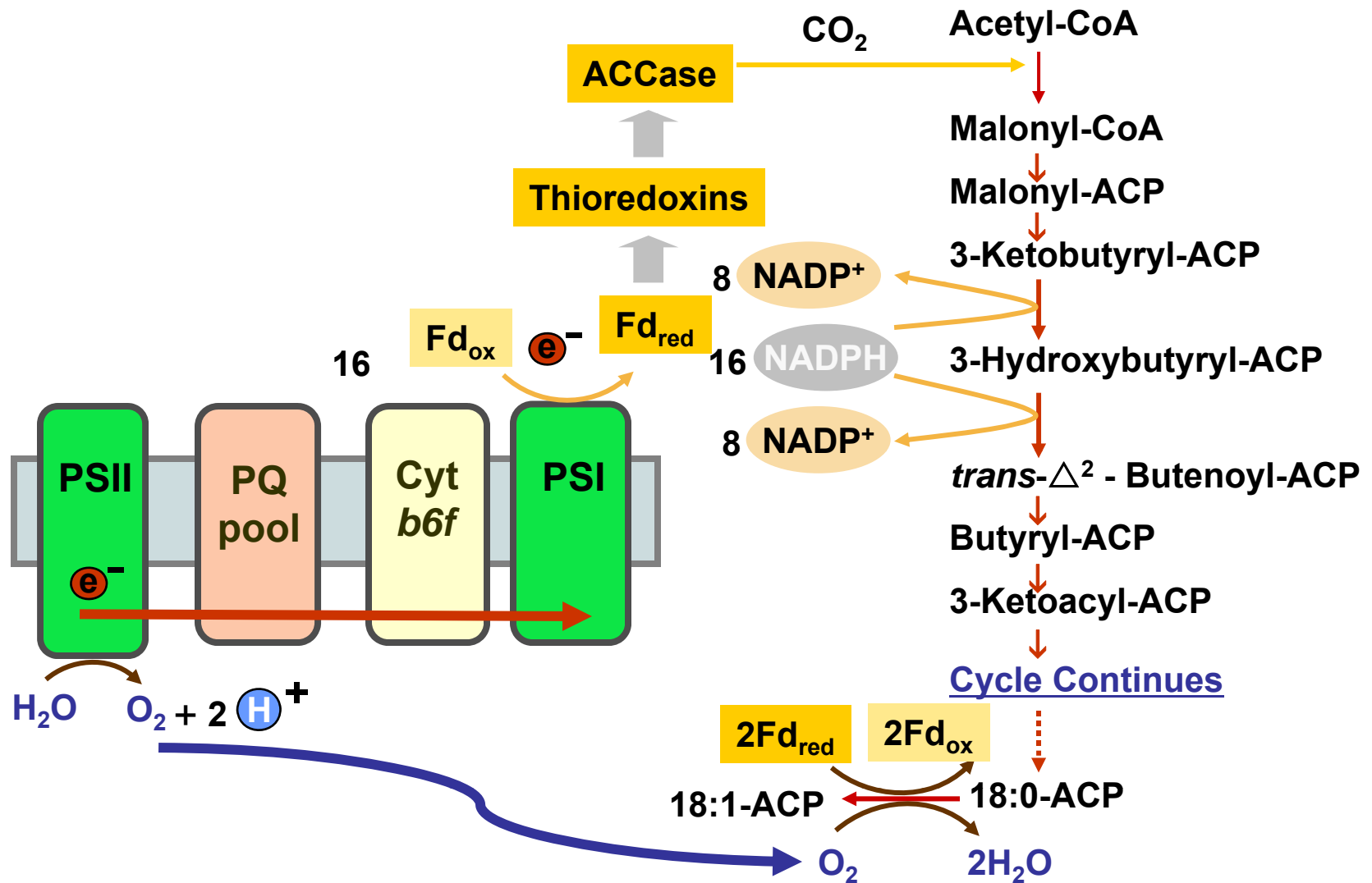
Stress Induced ROS Production



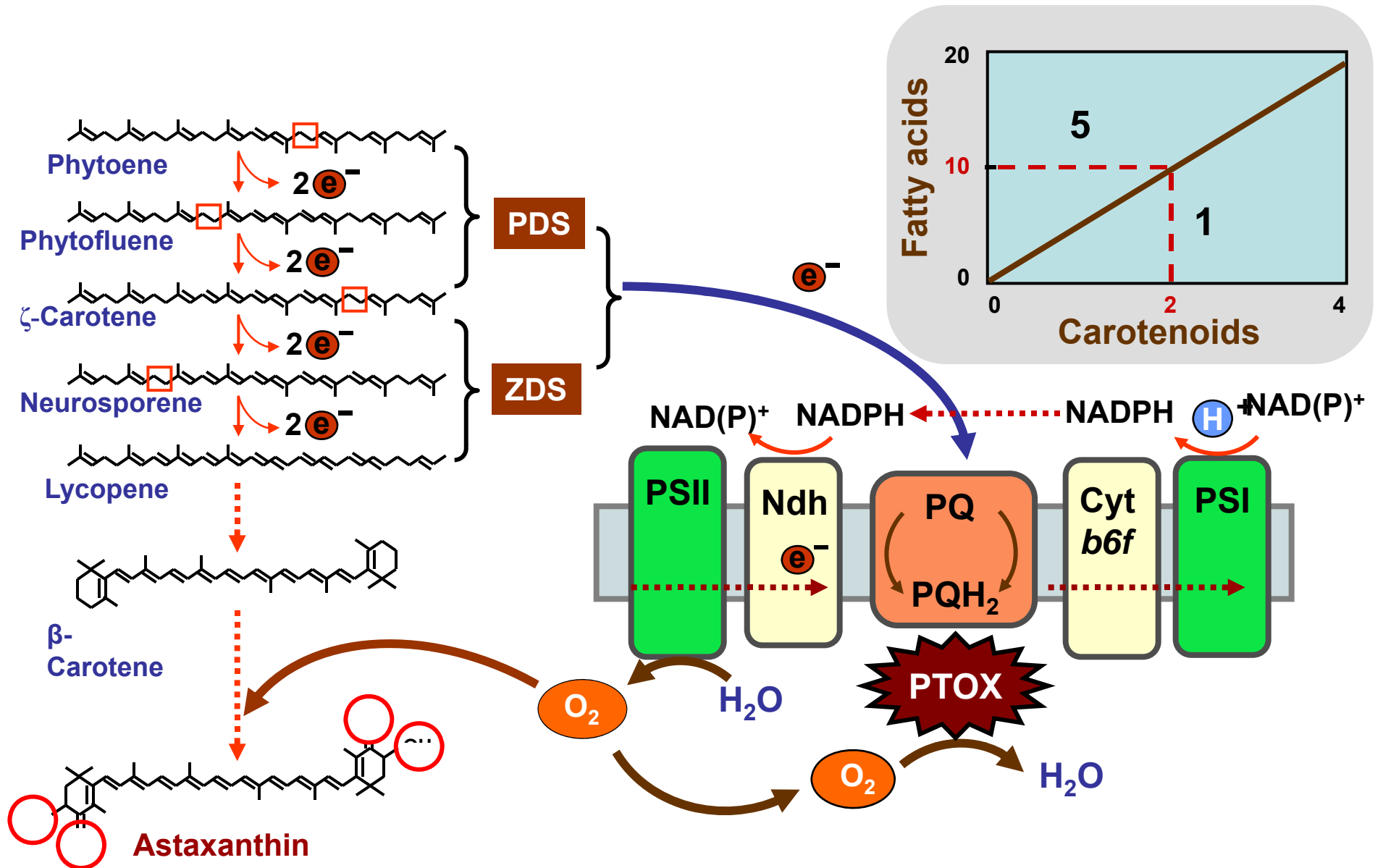
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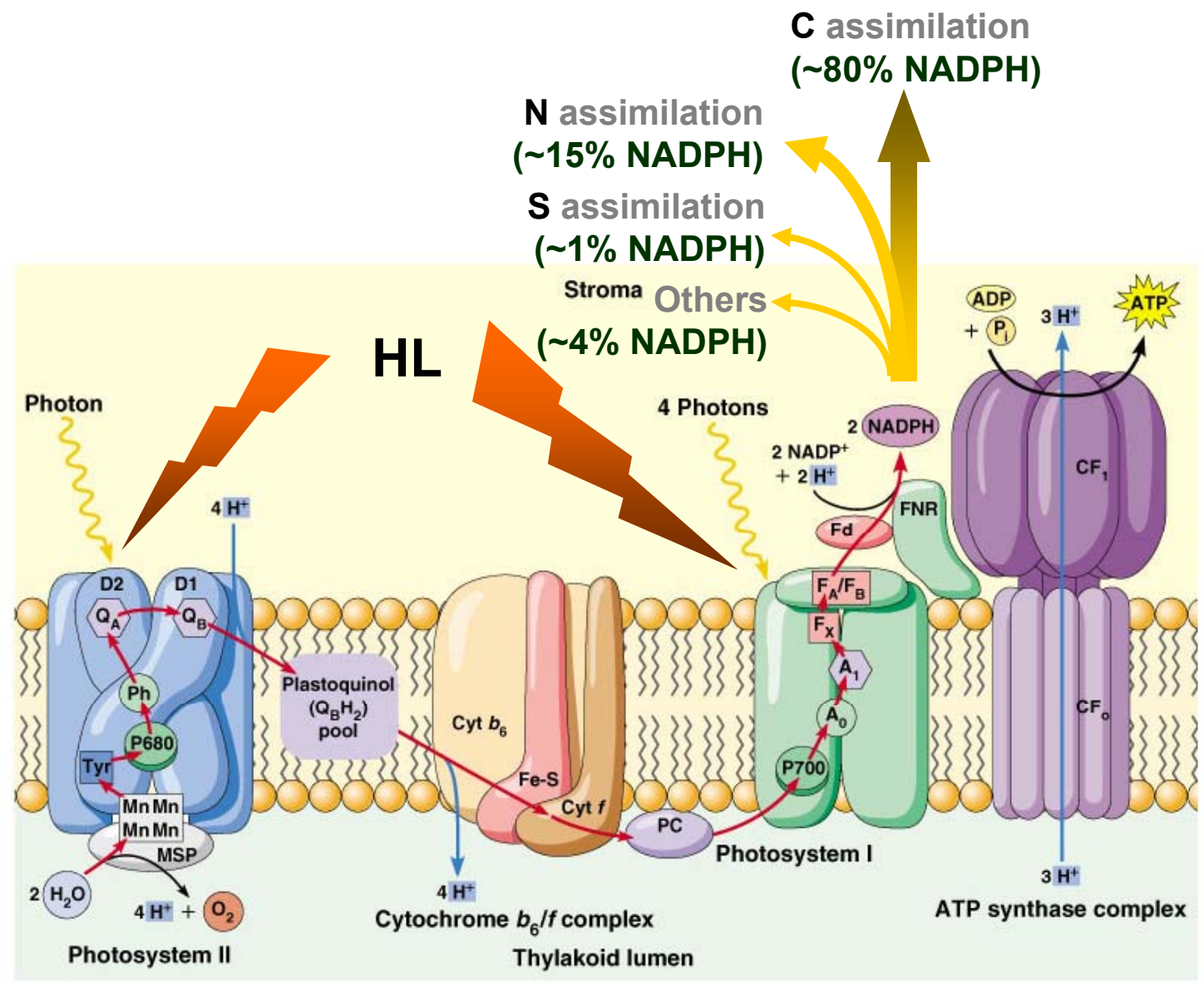
Draining Photosynthetic Reductants through the Lipid Biosynthesis



Consuming O₂ through Carotenogenesis

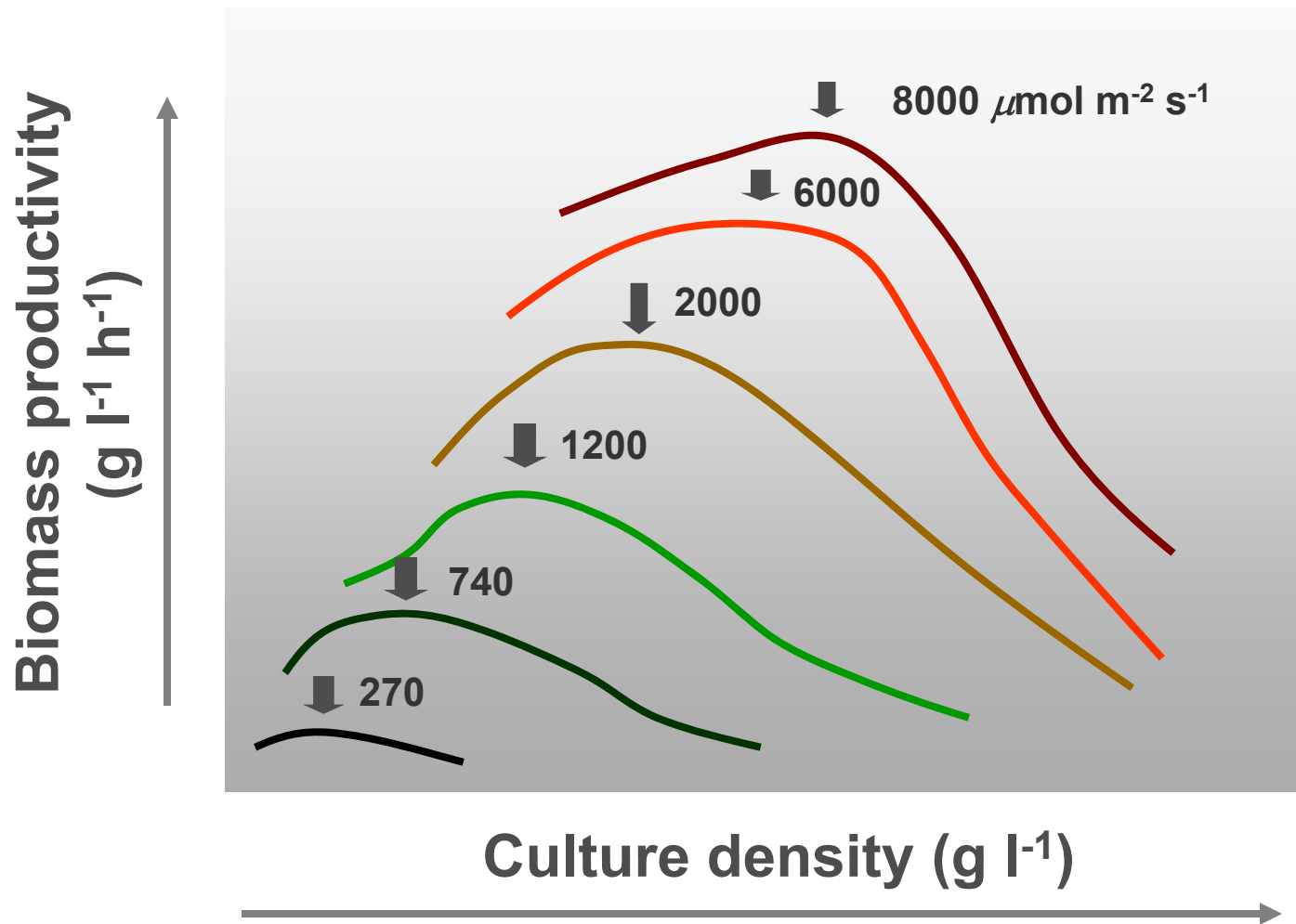


Strategies for Induction of Neutral Lipid

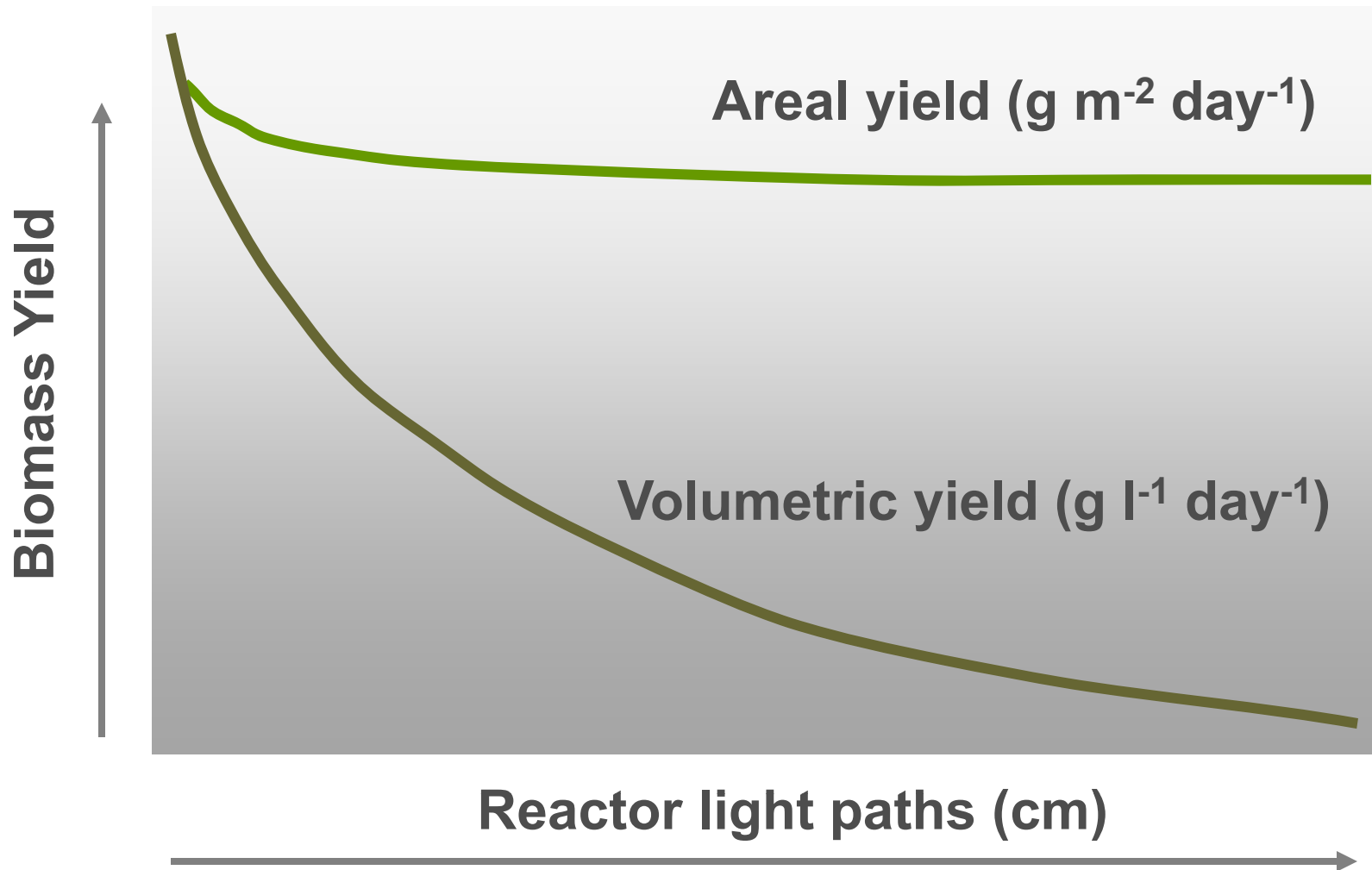


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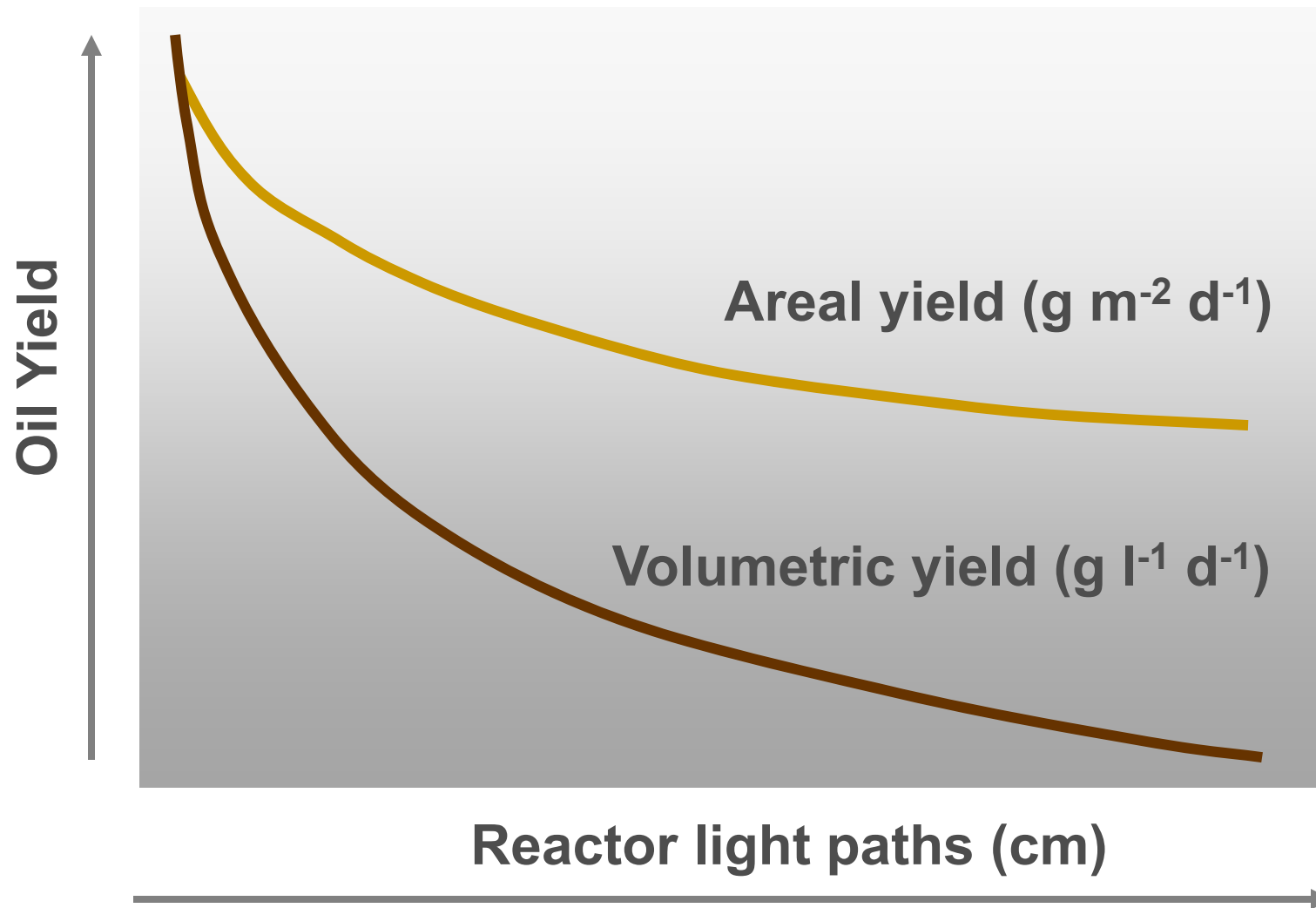
Biomass Productivity as a Function of Light Intensity



Biomass Yield as a Function of Reactor Light Path



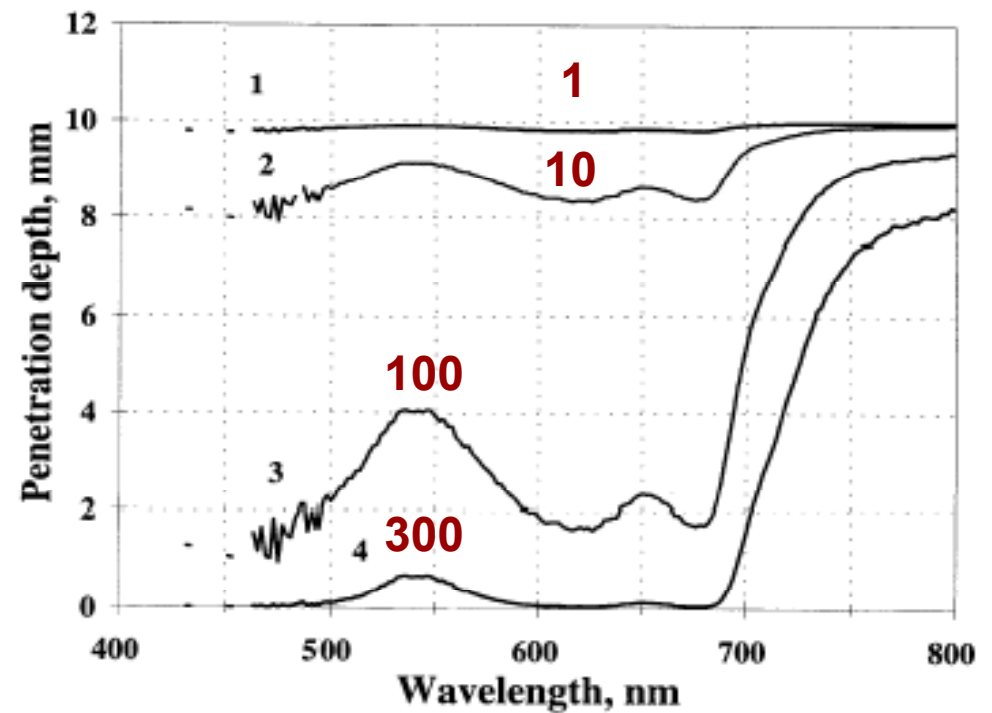
Oil Productivity as a Function of Reactor Light Path



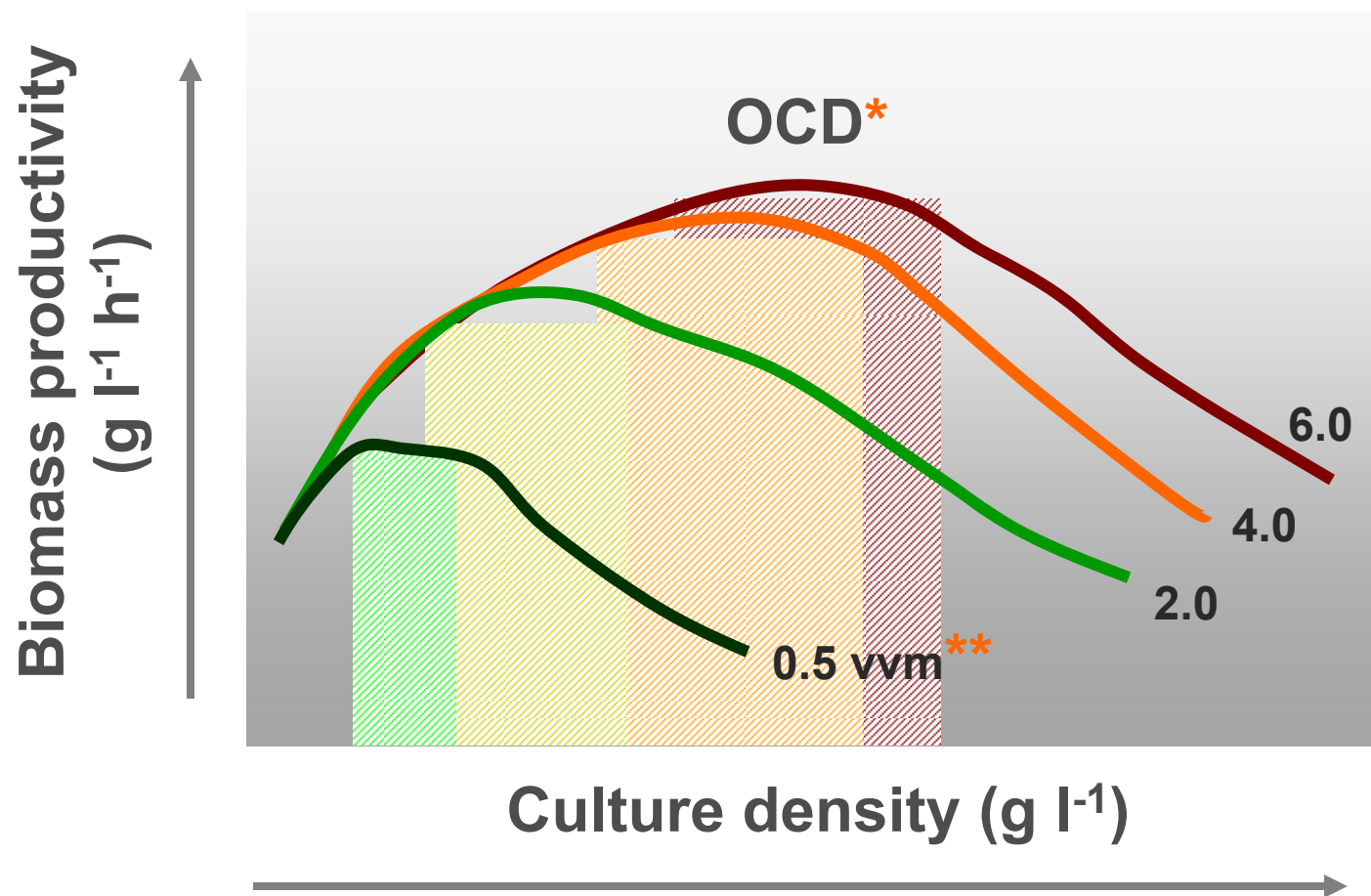
Light Penetration Depth as a Function of Algal Density



Chlorophyll (mg l^{-1}):



Biomass Productivity as a Function of Culture Mixing



* OCD: Optimal cell density (g l⁻¹)

** vvm: air volume/liquid volume/minute

A Concept of Hybrid Algae Production System

