



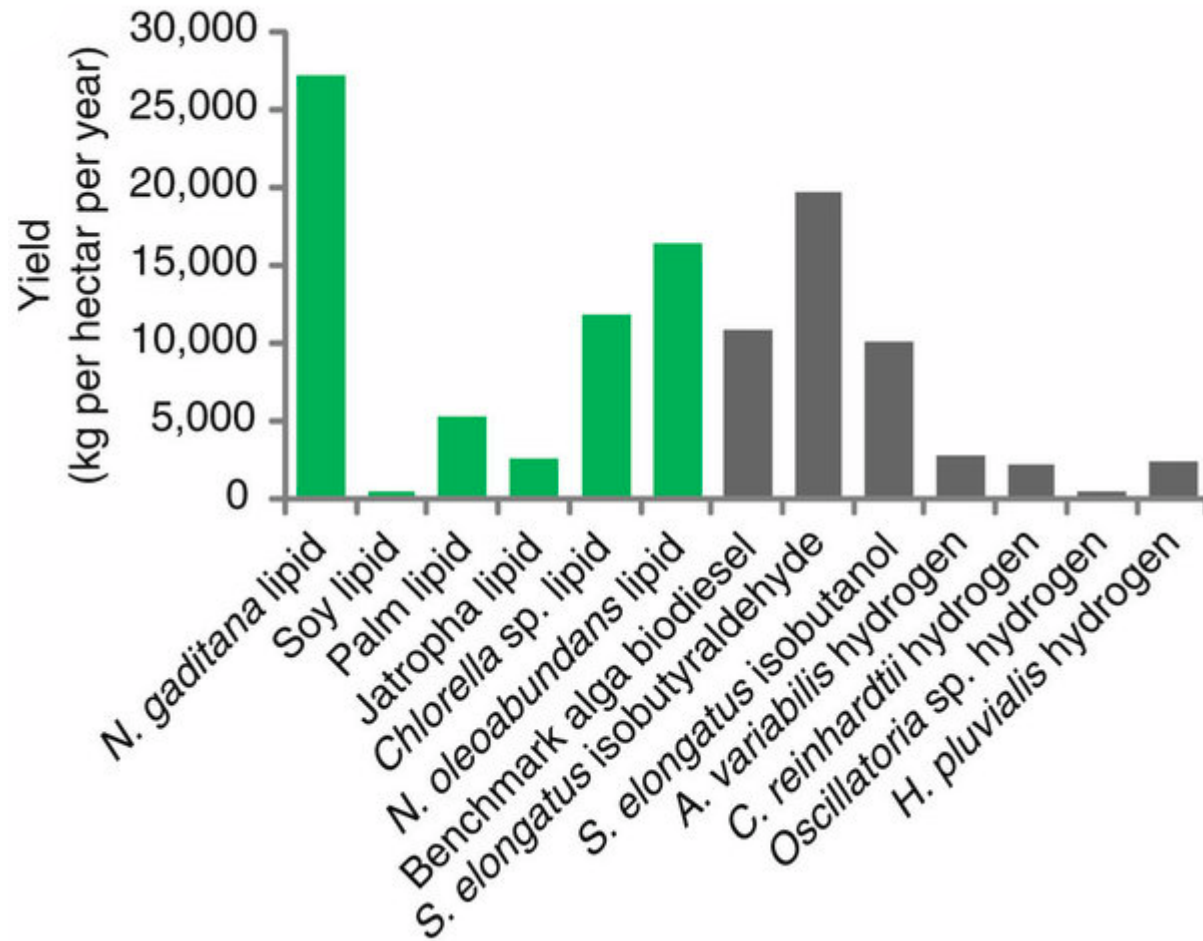
Optimizing algal productivity

Martin Hohmann-Marriott

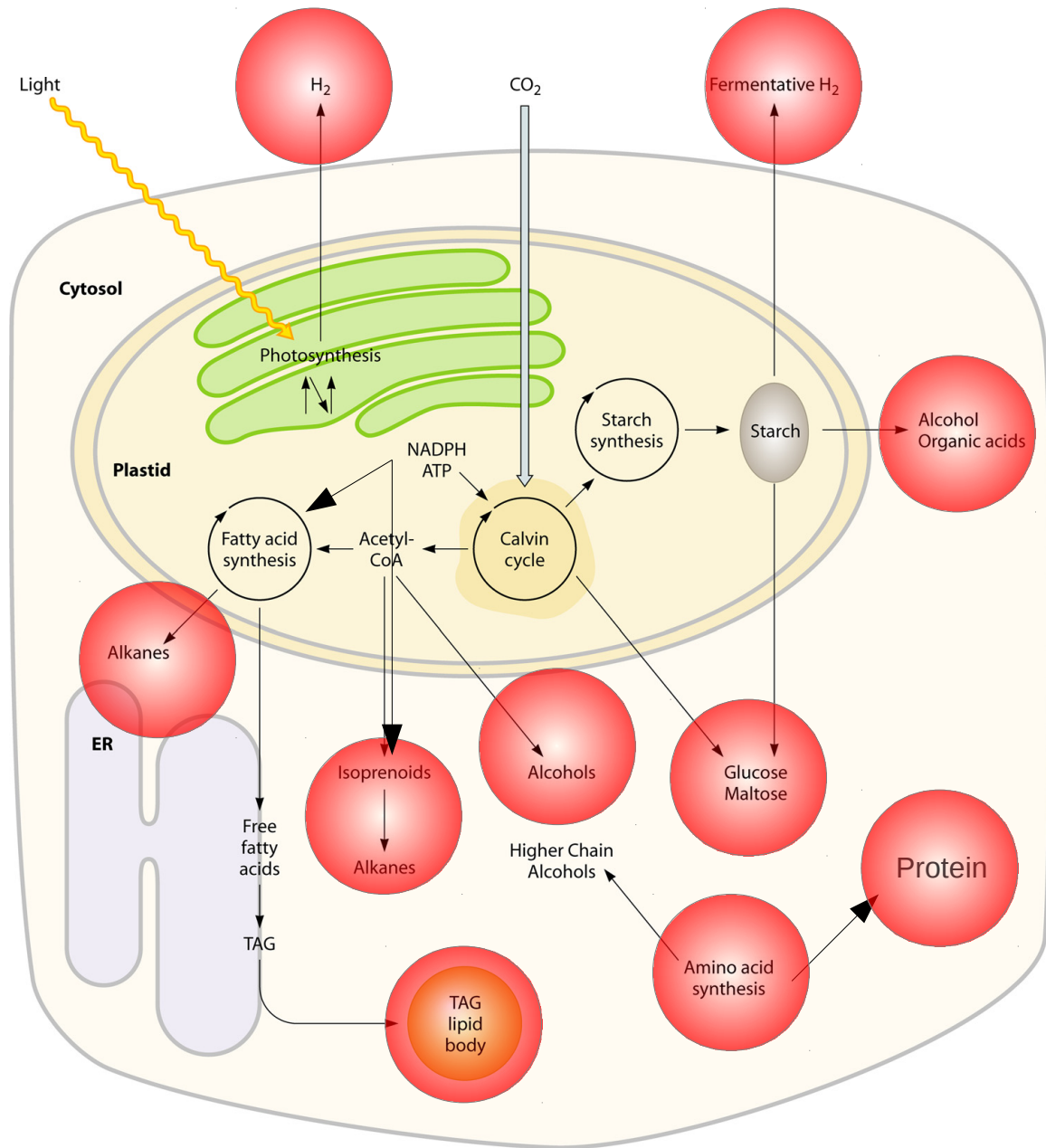
Department of Biotechnology

Norwegian University of Science and Technology

Algae versus Plants?



What is your molecule ?



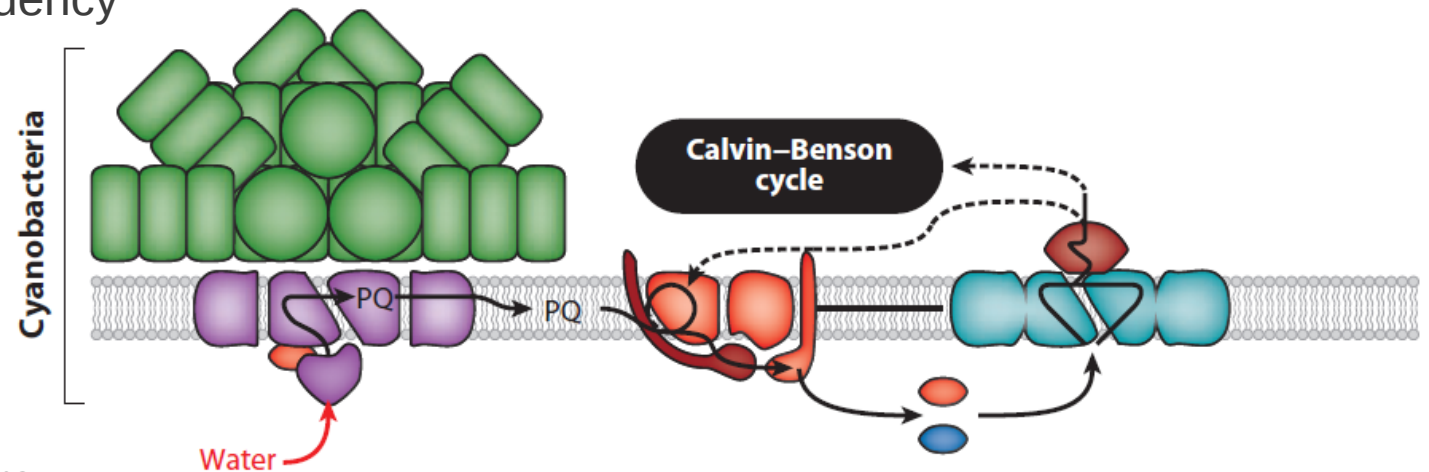
Productivity

Growth

- Cell division versus productivity / resource recovery
- Fight for nutrients
- Self shading

Light

- Quality (UV, green, red)
- Intensity
- Frequency



Temperature

- Membrane fluidity

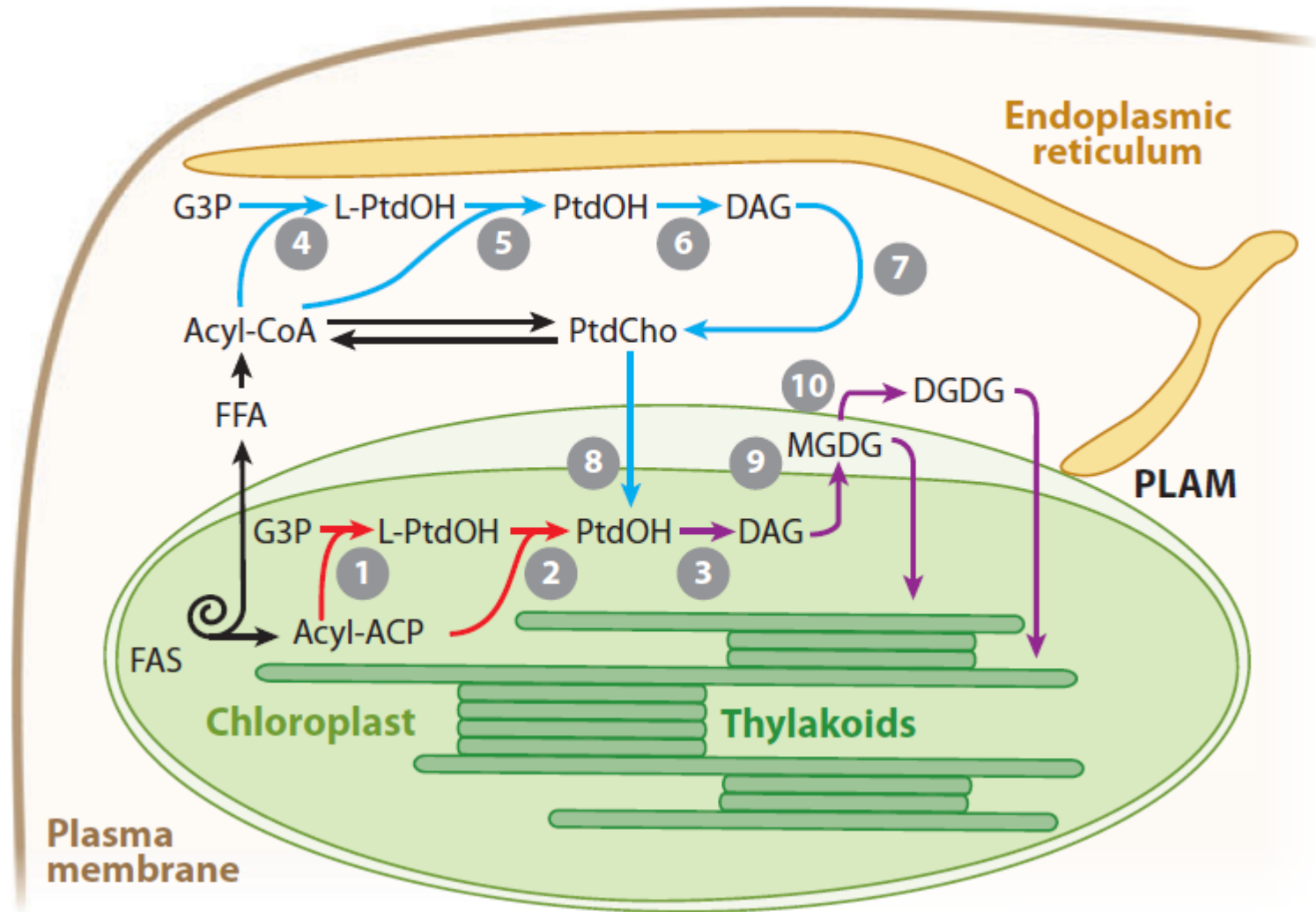
Oxygen

- Reactive oxygen species
- Hydrogen
- Lipids

Nutrients

- Starvation

Chloroplast lipid synthesis, export and import

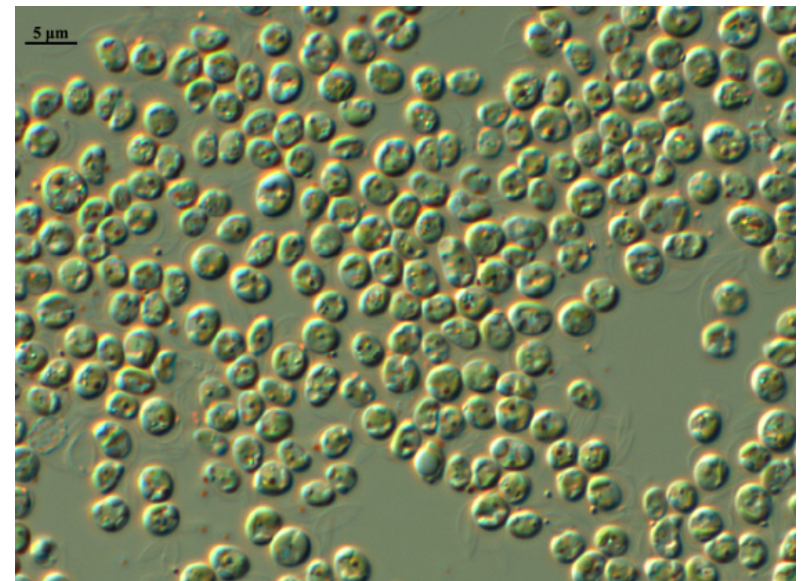
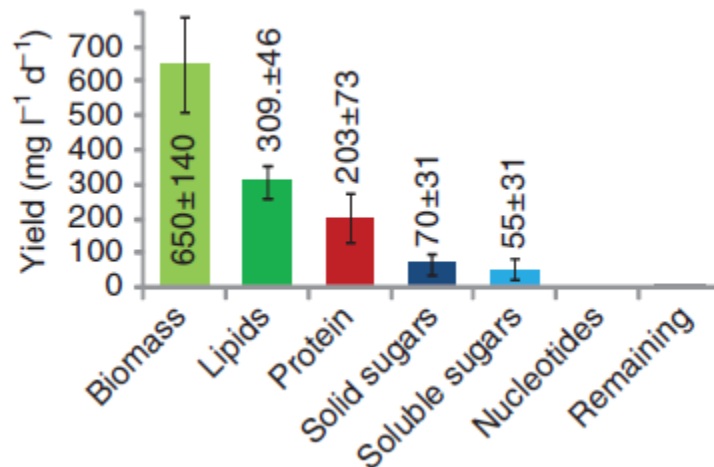


An integrative approach to lipid metabolism in *Nannochloropsis*

Laboratories
Researcher & Postdoc
Students:

Vadstein, Bones, Almaas, Hohmann-Marriott
Per Winge & Rahmi Lale
Alice Muehlroth, Gunvor Røkke, Jacob Lamb
Eirin Korvald, Ruben Sæther, Håkon Rui

Nannochloropsis
Genome 30.35
Mbases Genes 3.558



<https://ncma.bigelow.org/node/1/strain/CCMP1179>

Radakowits et al (2012) Nature Communications

Nannochloropsis

Genetic affiliation

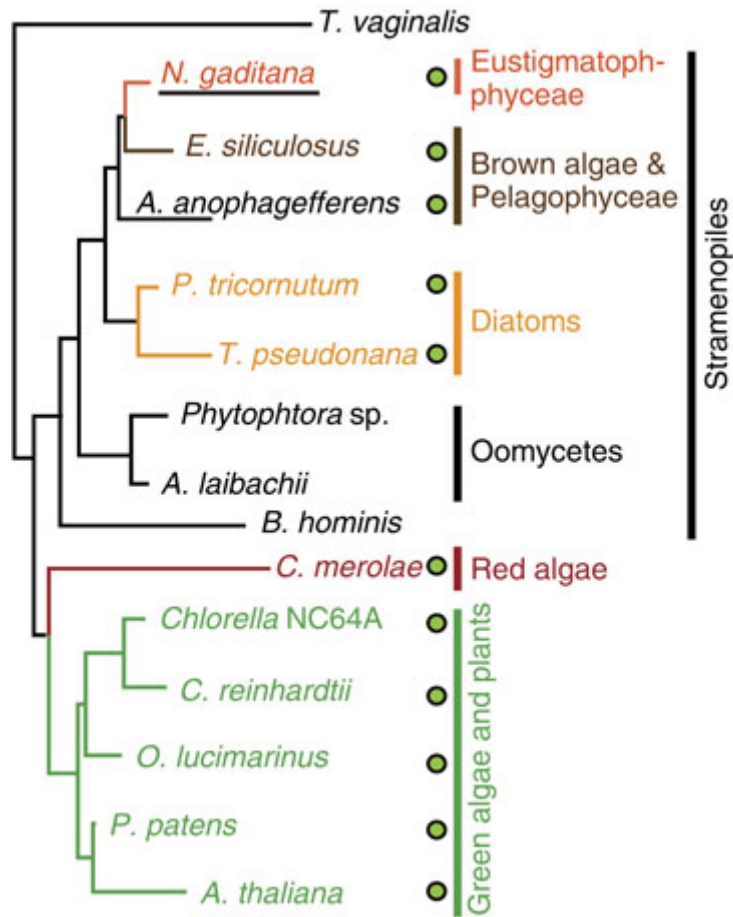


Table 1. Strains of *Nannochloropsis* and status of genomic sequencing efforts

Species	Strain	Year Isolated	Location isolated	Genomic sequencing ^a
<i>Nannochloropsis gaditana</i>	CCMP526	1985	Lagune de Oualidia, Morocco	completed
<i>Nannochloropsis gaditana</i>	CCMP527	1952	Great South Bay, Long Island, New York, USA	in progress
<i>Nannochloropsis gaditana</i>	CCMP532	1956	Milford, Connecticut, USA	
<i>Nannochloropsis gaditana</i>	CCMP536	1965	Sayville, New York, USA	
<i>Nannochloropsis gaditana</i>	CCMP1775		Cadiz Bay, Cadiz, Spain	
<i>Nannochloropsis gaditana</i>	CCMP1894	1995	Comacchio Lagoons, Ferrara, Italy	
<i>Nannochloropsis granulata</i>	CCMP529	1958	Continental Shelf, North Atlantic, off of USA East coast	in progress
<i>Nannochloropsis granulata</i>	CCMP534	1986	Bigelow Laboratory dock, West Boothbay Harbor, Maine, USA	
<i>Nannochloropsis granulata</i>	CCMP535	1965	Sayville, New York, USA	
<i>Nannochloropsis granulata</i>	CCMP1662	1993	Skagerrak, North Atlantic	
<i>Nannochloropsis limnetica</i>	CCMP505	1971	Morehead City, North Carolina, USA	in progress
<i>Nannochloropsis limnetica</i>	CCMP2260	1996	Arrowwood Lake, North Dakota, USA	
<i>Nannochloropsis limnetica</i>	CCMP2267	1996	Arrowwood Lake, North Dakota, USA	
<i>Nannochloropsis limnetica</i>	CCMP2271	1996	Jim Lake, North Dakota, USA	
<i>Nannochloropsis limnetica</i>	CCMP2272	1996	Arrowwood Lake, North Dakota, USA	
<i>Nannochloropsis oceanica</i>	CCMP531		Qingdao, China	in progress
<i>Nannochloropsis oceanica</i>	CCMP1779	1979	Kuwait Institute for Scientific Research, Kuwait	in progress
<i>Nannochloropsis oceanica</i>	LAMB0001			completed
<i>Nannochloropsis oceanica</i>	OZ-1			in progress
<i>Nannochloropsis oculata</i>	CCMP525			in progress
<i>Nannochloropsis oculata</i>	CCMP2195	1968	Tunis, Tunisia	
<i>Nannochloropsis salina</i>	CCMP369	1986	Narragansett Bay, Rhode Island, USA	
<i>Nannochloropsis salina</i>	CCMP537	1986	Narragansett Bay, Rhode Island, USA	in progress
<i>Nannochloropsis salina</i>	CCMP538	1964	Pamlico Sound, North Carolina, USA	
<i>Nannochloropsis salina</i>	CCMP1776	1965	Skate Point, Isle of Cumbrae, Scotland, UK	in progress
<i>Nannochloropsis salina</i>	CCMP1777	1965	Skate Point, Isle of Cumbrae, Scotland, UK	
<i>Nannochloropsis salina</i>	CCMP1778	1966	Skate Point, Isle of Cumbrae, Scotland, UK	
<i>Nannochloropsis</i> sp.	CCMP821	1969	Narragansett Bay, Rhode Island, USA	
<i>Nannochloropsis</i> sp.	CCMP1780			
<i>Nannochloropsis</i> sp.	CCMP1997	1994	Sargasso Sea	
<i>Nannochloropsis</i> sp.	CCMP2001	1998	Great South Bay, Long Island, New York, USA	
<i>Nannochloropsis</i> sp.	CCMP2904	2006	Microcystis cove, Klamath Lake, Oregon, USA	

^aGenome status from NCBI.

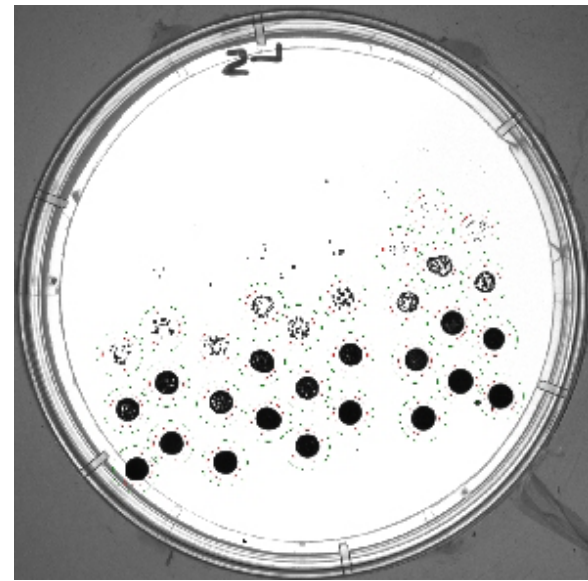
Nutrient requirements & growth

Haakon Rui

- pH, salinity, light level, temperature
- Development of artificial inorganic medium for *Nannochloropsis*

Developing high-throughput screening methods

Jacob Lamb



Establishing genetic system and protein expression

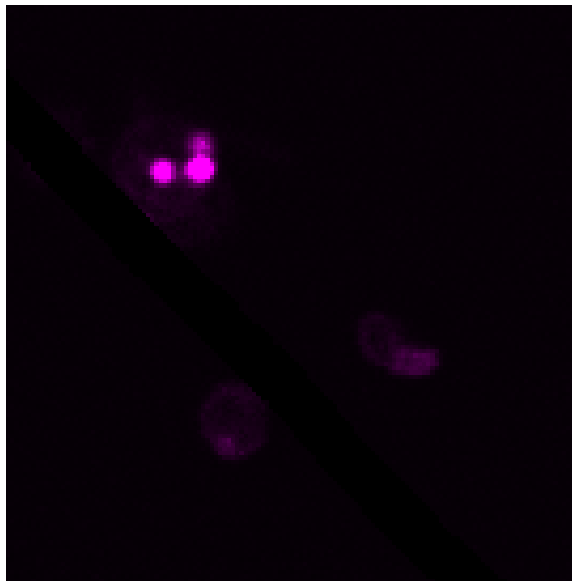
Rahmi Lale

- Nuclear transformation
- Chloroplast transformation
- Inducible protein expression (chloroplast import)

Classical breeding

Ruben Sæther

- Repetitive selection for *Nannochloropsis* strains with high lipid content
- Nile red / Bodipy staining analysis for lipid content



Nannochloropsis

Photosynthesis and light harvesting

Gunvor Røkke

- PAM fluorometry
- Oxygen and hydrogen evolution

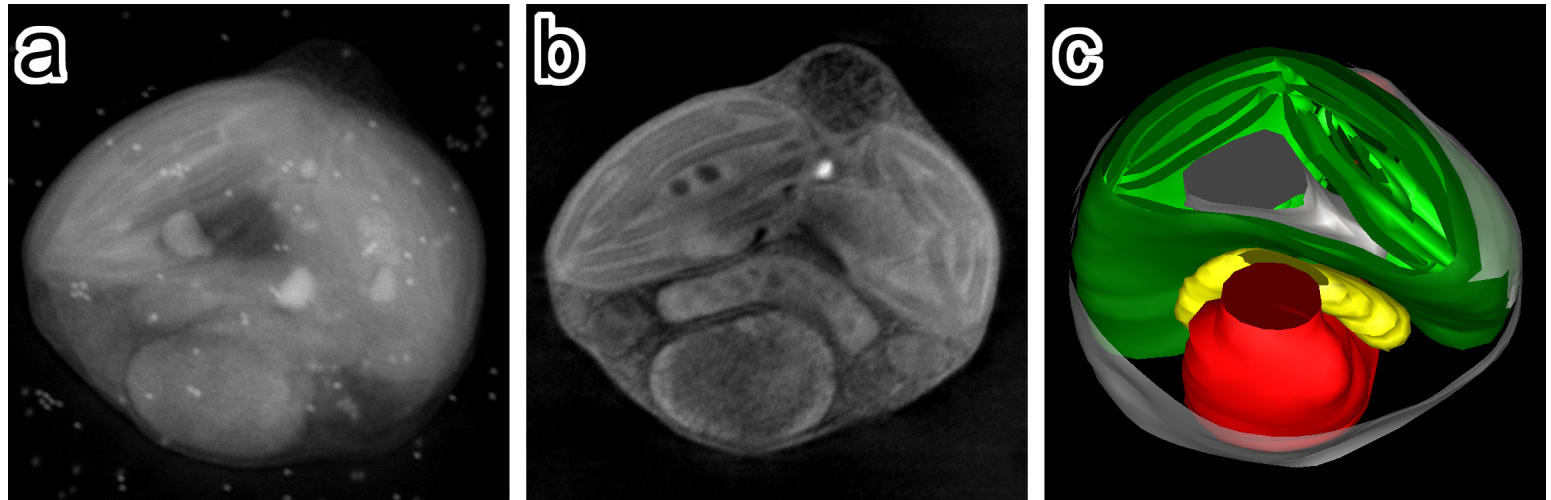
Metabolic profiling of carbon metabolism

Alice Muehlroth

- Quantitative mass spectrometry analysis

Structure Compartmentalization

- light and electrom microscopy



Ostreococcus tauri

Microarray

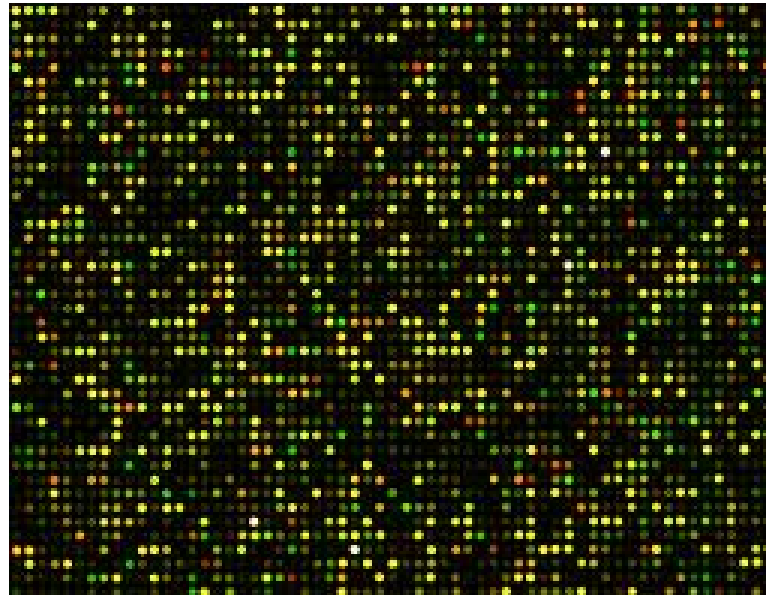
Per Winge + Gunvor Røkke & Alice Muehlroth

Nannochloropsis CCMP 1779

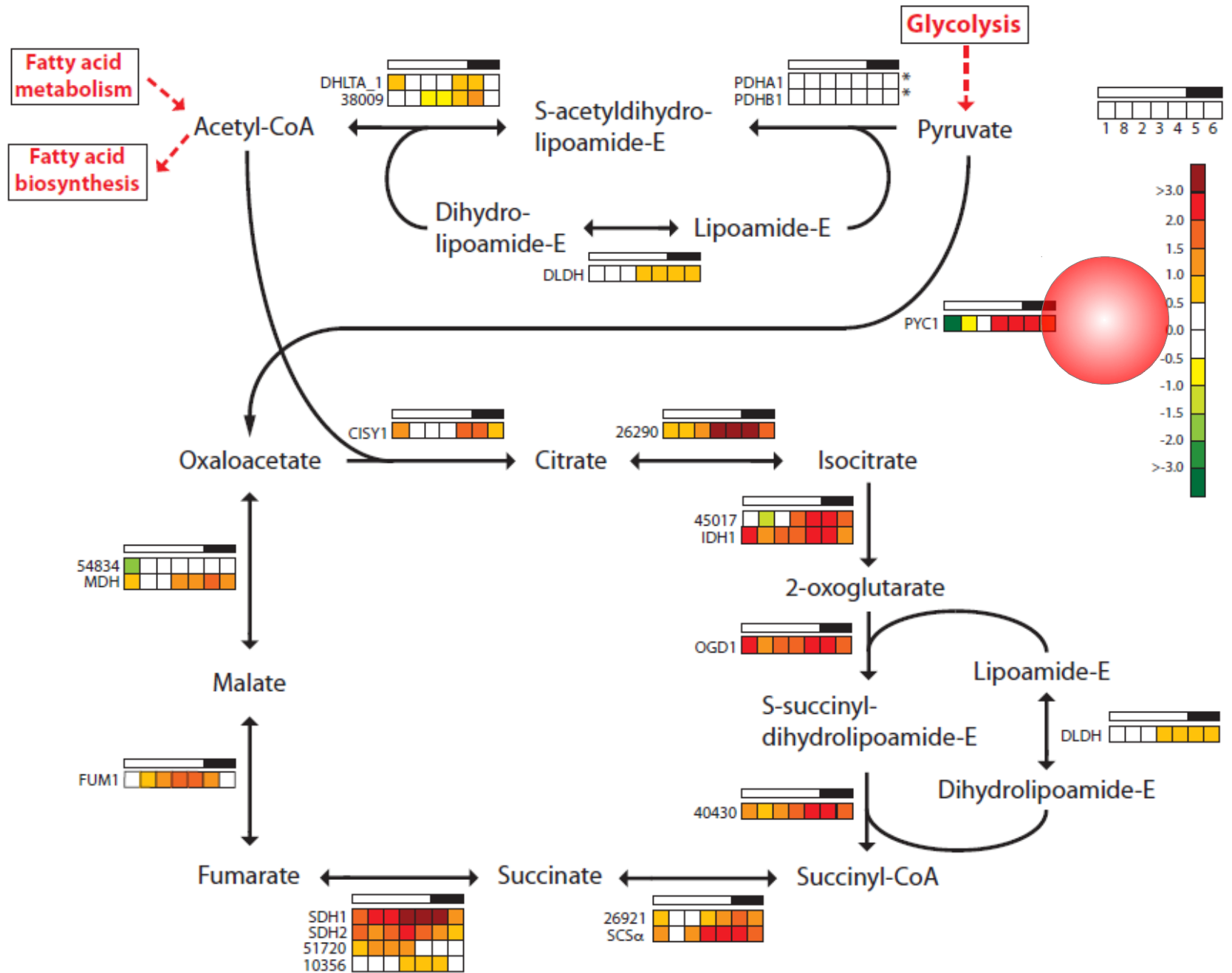
Optimized probes using Benning lab genes models.

11972 gene models (includes chloroplast and the mitochondrial gene models)

15208 probes

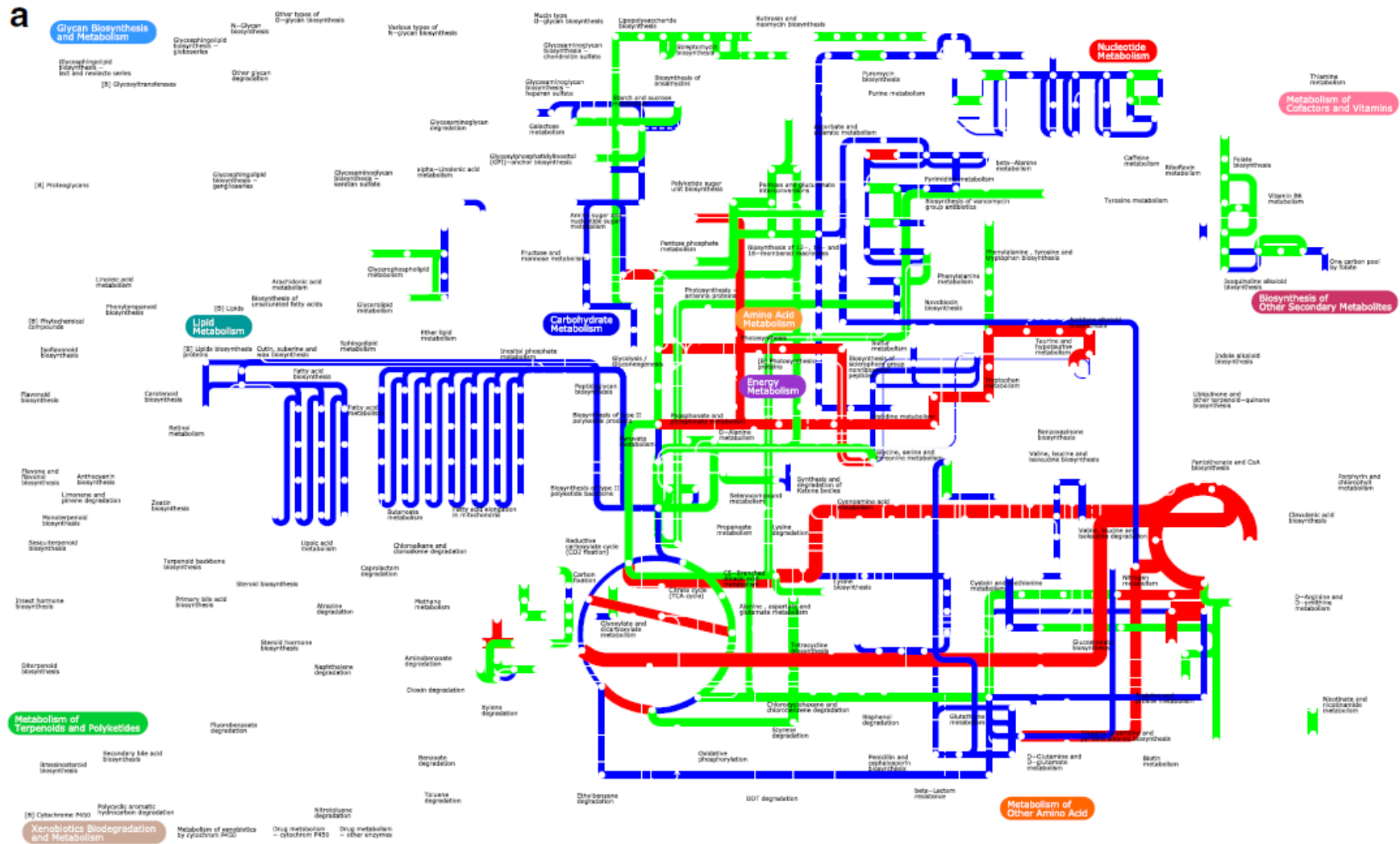


Nannochloropsis



Systems Biology / Flux Balance Analysis

Eivind Almaas & Eirin Korvald



Predicted change in metabolic pathway activity following temperature change. GX-FBA predicted change in activity of select pathways in *Y. pestis* biovar Mediaevalis in response to change in temperature from 26°C to 37°C



Alga products