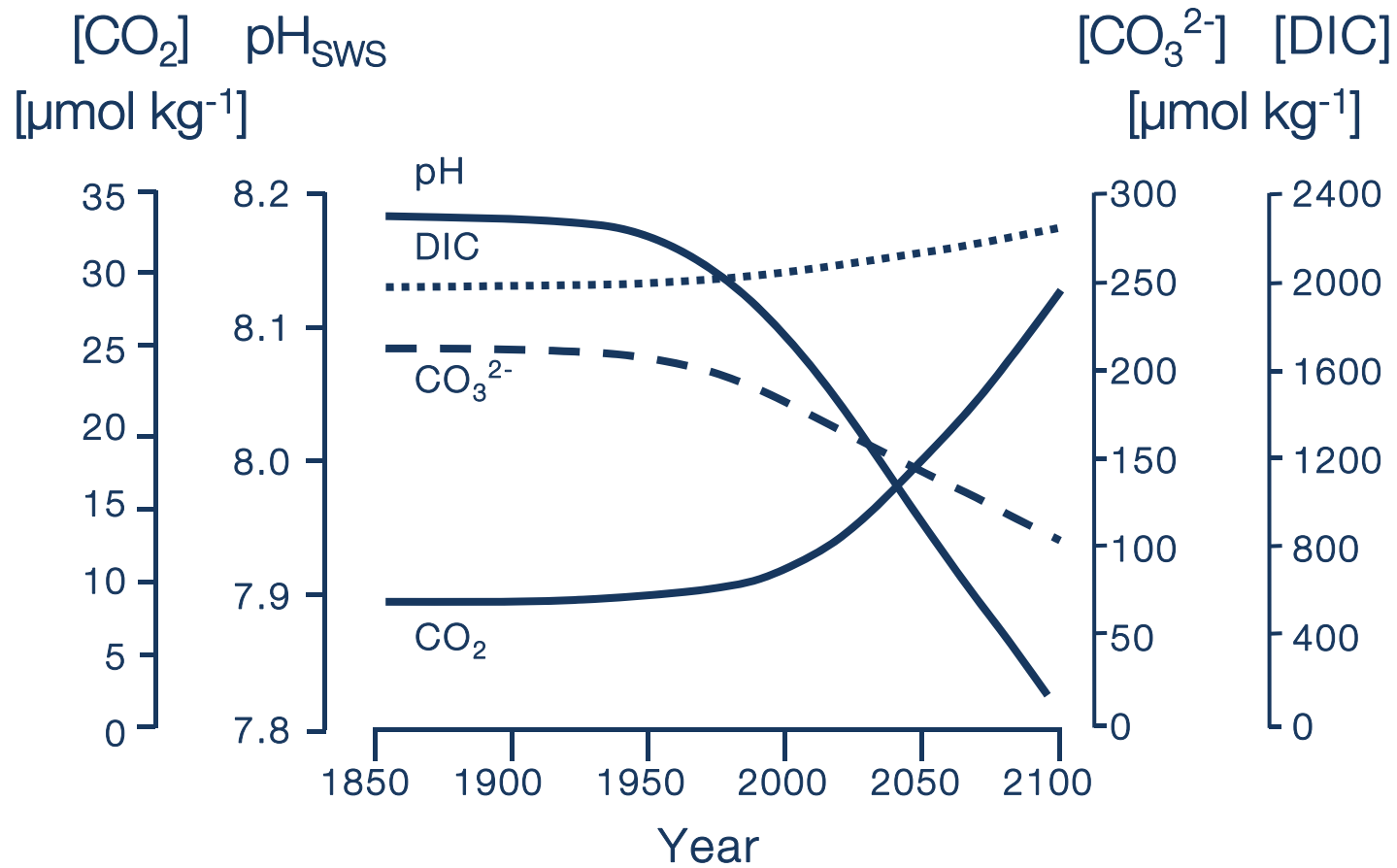




Transcriptomic responses of *Emiliana huxleyi* to Ocean Acidification

Sebastian D. Rokitta, Uwe John and Björn Rost

Ocean Acidification



After Wolf-Gladrow et al. (1999)

Coccolithophores



Photo: NASA, PML

Biological carbon pumps

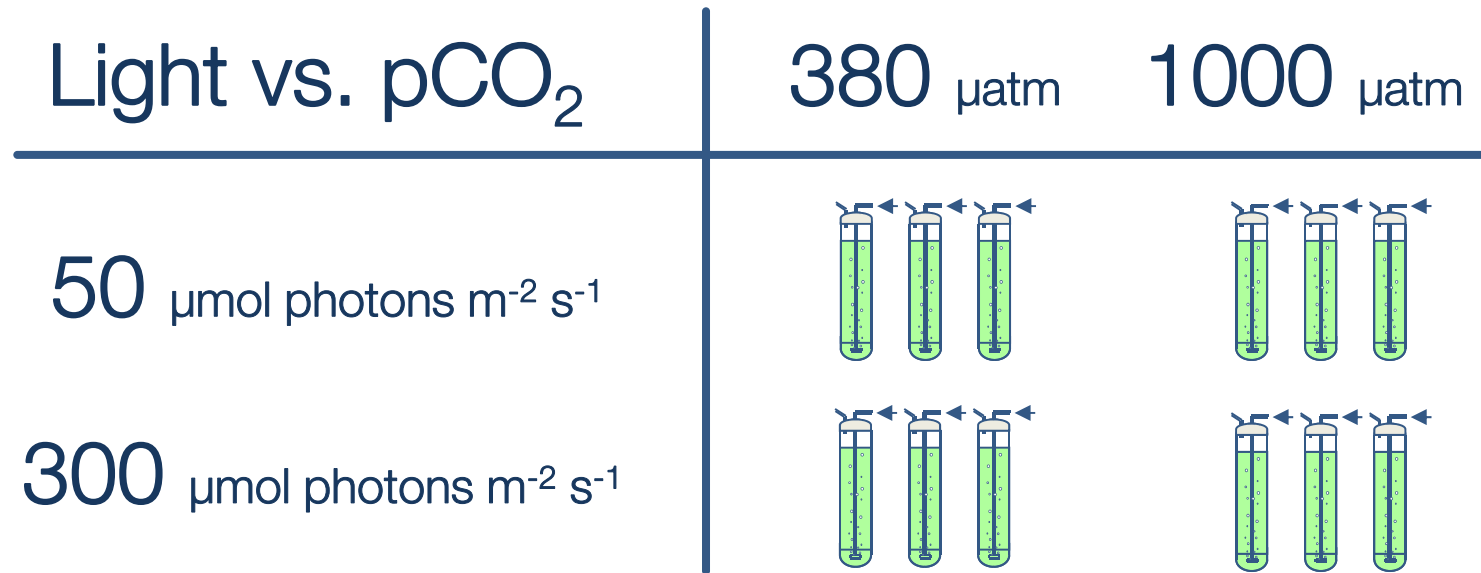
OA-responses in *E. huxleyi*

Study	Strain	Growth	P _{PIC}	P _{POC}	PIC:POC
Feng et al. 2008	CCMP371 ^c	☐	☑	☐	☑
Iglesias-Rodriguez et al. 2008	NZEH _R	☑	☑	☑	☐
Hoppe et al. 2011	RCC1256 _A ^c	☑	☑	☐	☑
	NZEH _R	☐	☑	☑	☑
Langer et al. 2009	RCC1212 _B ^o	☐	☑	☐	☑
	RCC1216 _R ^o	☐	☑	☐	☑
	RCC1238 _A ^c	☐	☐		☐
Lefebvre et al. 2012	RCC1256 _A ^c	☑	☑		☐
	CCMP371 _A ^c	☐	☑	☑	☑
	RCC1216 _R ^o	☐	☐	☐	☐
Richier et al. 2011	PLYB92/11 _A ^c	☐	☑	☑	☑
Rokitta and Rost 2012 (Low light)	RCC1216 _R ^o	☐	☑	☑	☑
Rokitta and Rost 2012 (High light)	RCC1216 _R ^o	☐	☐	☐	☐
Sciandra et al. 2003	TW1	☐	☑	☑	☐
Shi et al. 2009	NZEH _R	☐	☑	☑	☑
	Sum	☐ ☑ ☑ ☑	☐ ☑ ☑ ☑	☐ ☑ ☑ ☑	☐ ☑ ☑ ☑
		12 - 3 -	3 2 10 -	6 6 1 2	6 - 9 -

Modified from Hoppe et al. (2011)

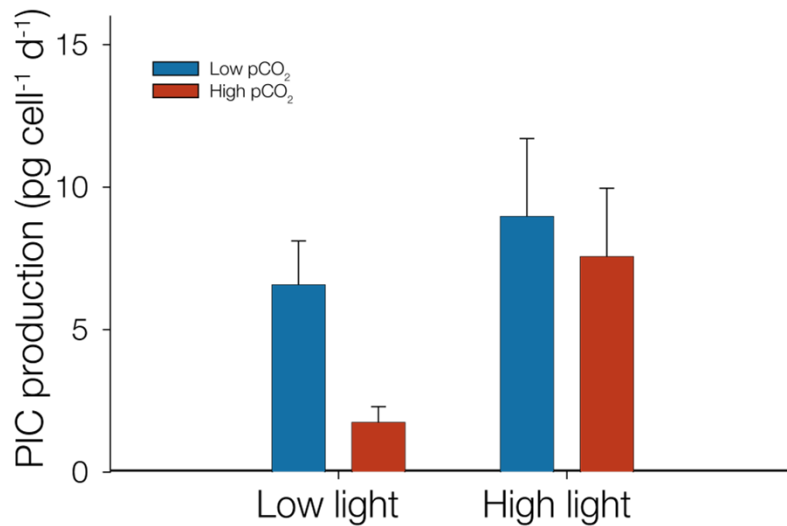
Energization?

The matrix approach



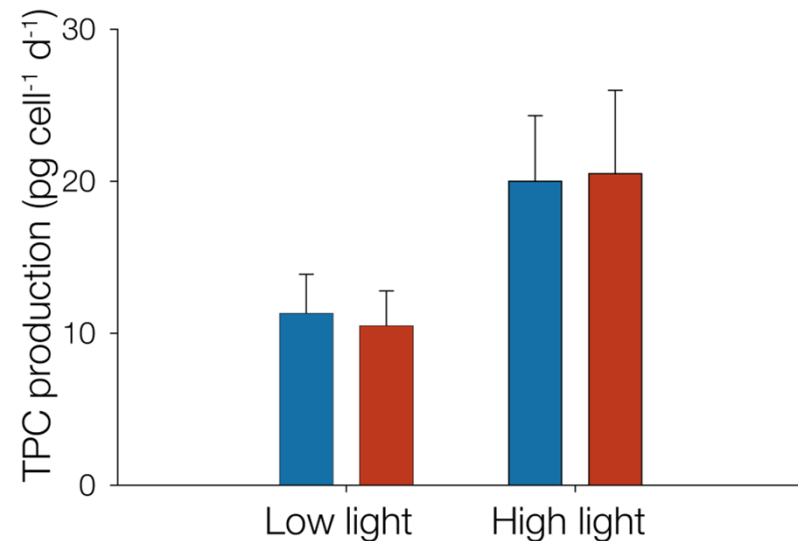
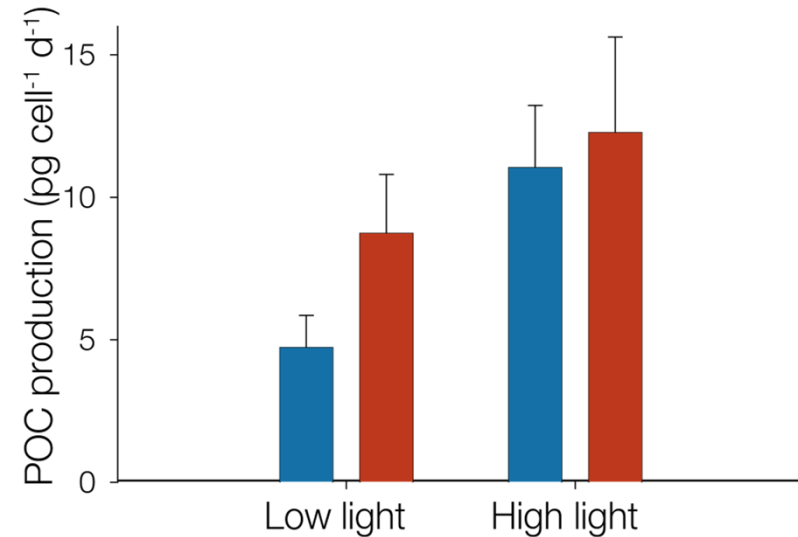
- Acclimation data (μ , POC, PIC)
- Physiology (C_i acquisition, light reactions)
- Transcriptomics (gene expression)

Phenomenology



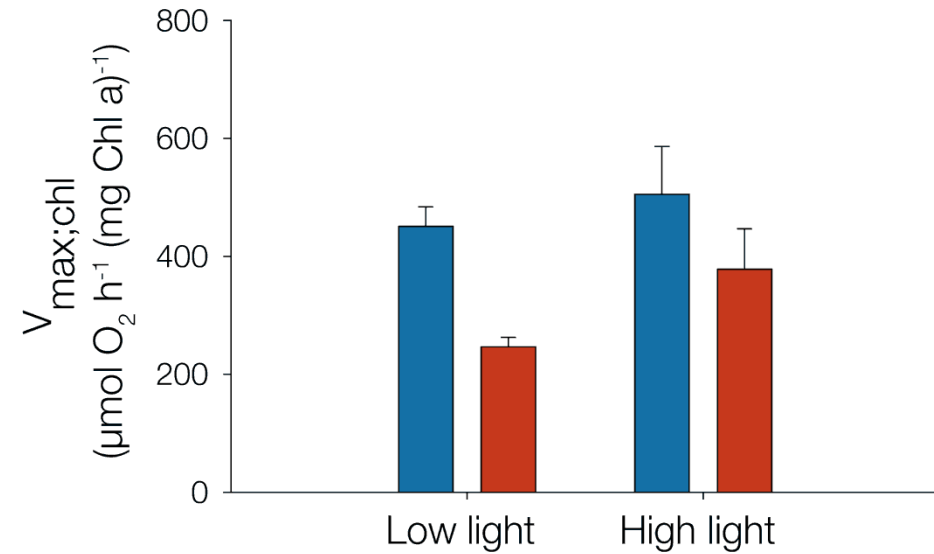
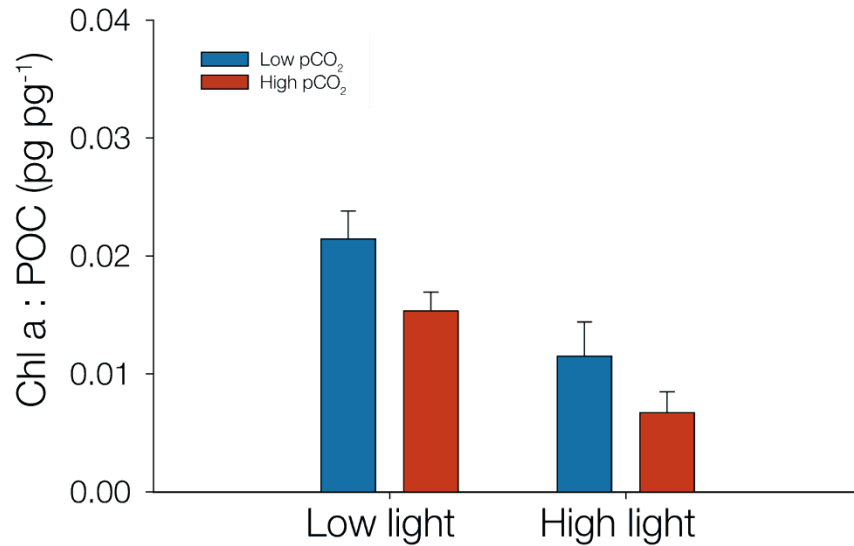
- PIC production drops (especially under low light!)
- POC production is boosted (especially under low light!)
- TPC production is insensitive

Rokitta & Rost (2012)



Physiology

Rokitta & Rost (2012)



- More POC despite less pigmentation and O₂ evolution

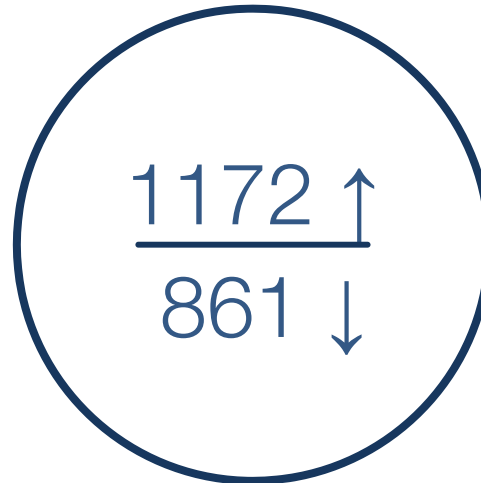
→ Improved energy efficiency under OA

Gene expression?

Transcriptomics

OA responsive genes

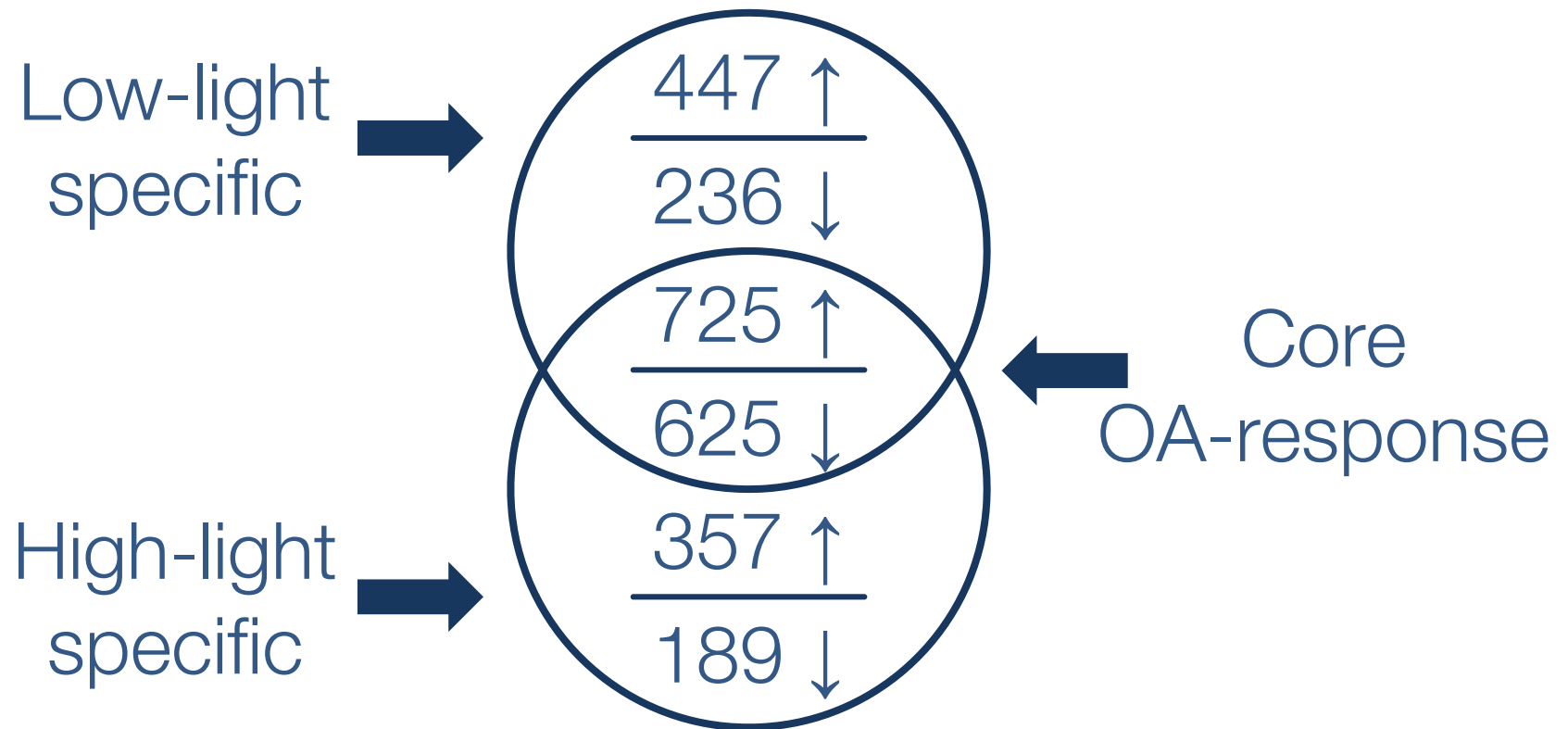
Low-light
acclimation



High-light
acclimation



Transcriptomics



Transcriptomics

Carbon metabolism

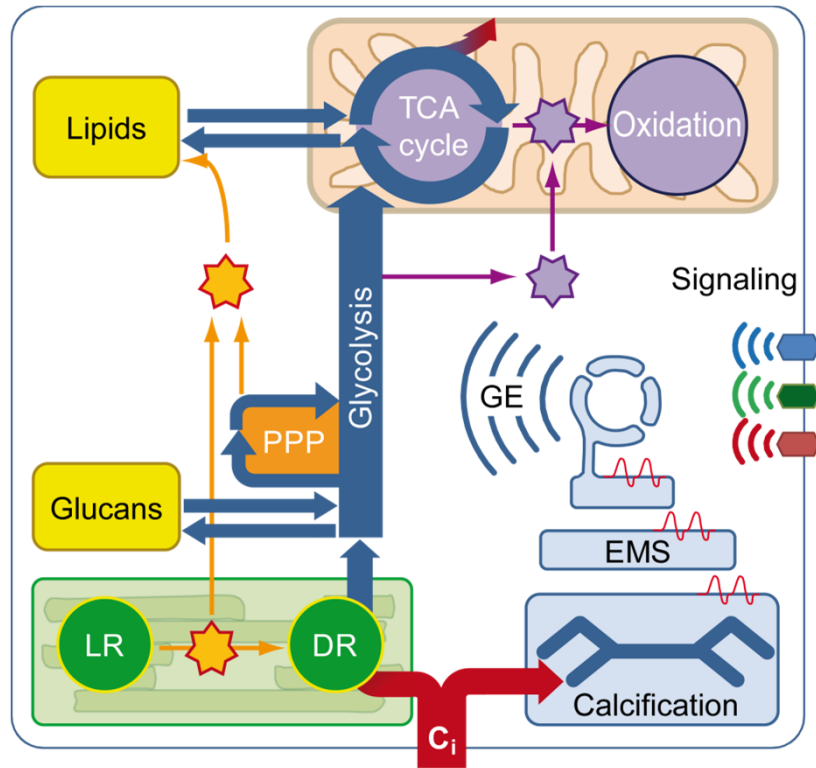
Light physiology

Signalling

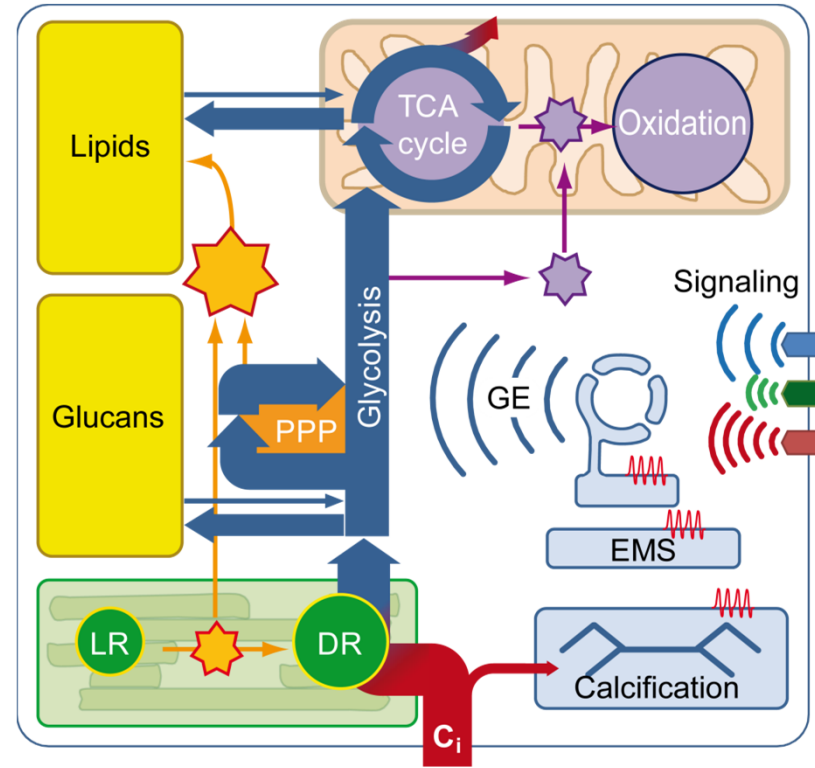
Ion fluxes

Pentose phosphate pathway ↑ Glycolysis ↓ Fatty Acid & Glucan anabolism ↑	Regulation of C fluxes ↑	Organelle shuttling ↑
Energy dissipation ↑	Energy dissipation ↑	
Lipid and IP ₃ signaling ↑		
Membrane potentials ↑		

OA re-wires carbon fluxes



Present day
380 μ atm



Future
1000 μ atm

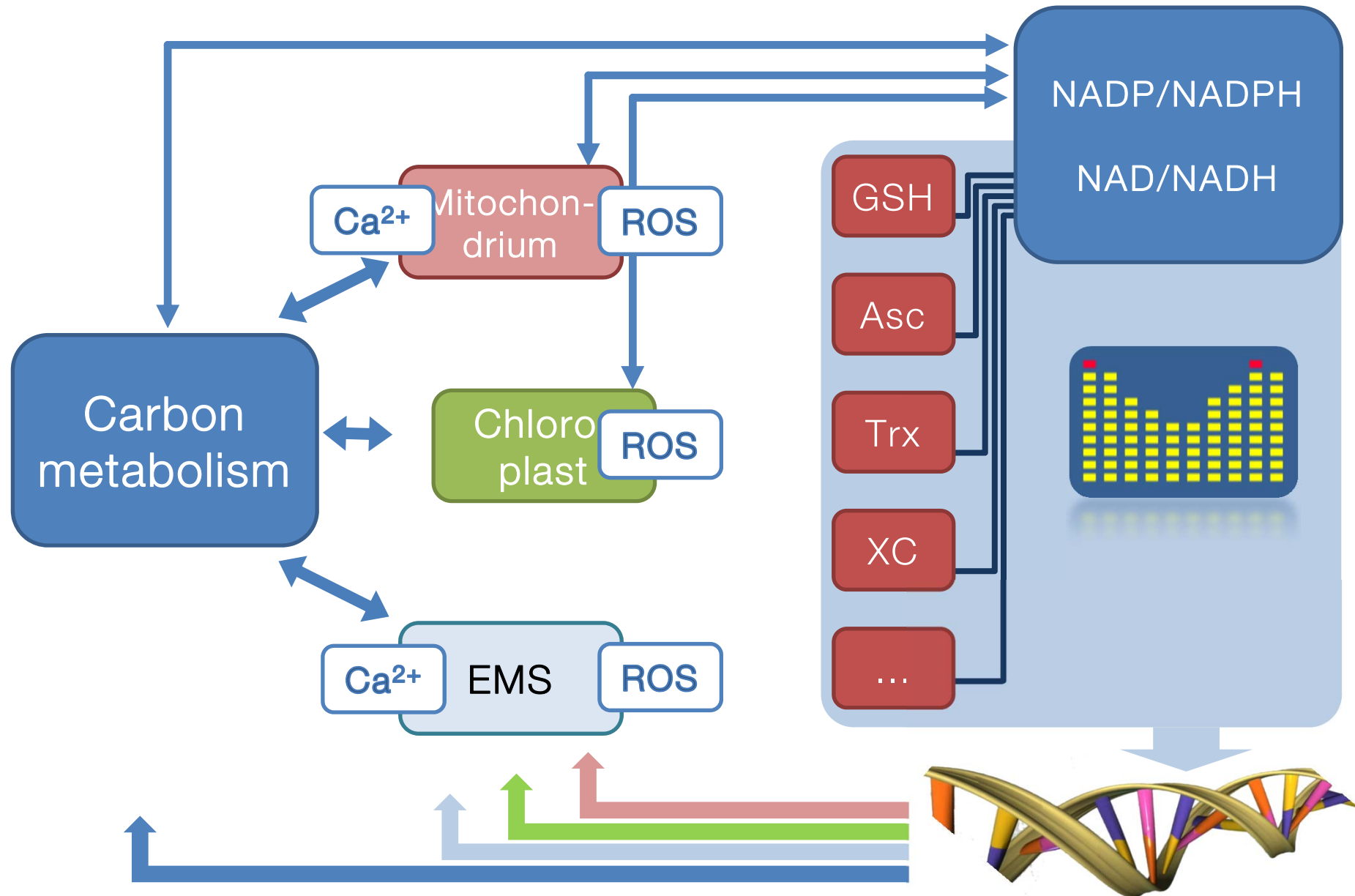


NADPH



NADH

OA affects the redox hub



Conclusions

- OA causes a shunting of carbon from calcification towards biomass production
- OA-Responses are modulated by energy availability and typically attenuated by high light
- OA affects cellular signaling and the redox hub and thereby re-wires carbon flux networks