WORKSHOP

Growing, Forming and Living (with) Microalgae

Johann Bauerfeind (M.Sc.), Contact: info@jbauerfeind.de, Bauhaus-Universität Weimar, 12-13.04.2023

AGENDA

Day 1

10:00am - 10:30am:	Introduction to the Workshop (Presentation)
10:30am - 11:00am:	Overview of Algae and Microalgae (Interactive Presentation)
11:00 am - 12:00pam:	Experiment 1 Microalgae in Water (Presentation & Experiment)
12:00pm - 1:00pm:	Lunch
1:00am - 2:00pm:	Overview of selected art and design works interacting with algae Cultivating
1:00pm - 2:00pm:	Cultivating Microalgae (Presentation & Experiment)
2:00pm - 3:30pm:	Experiment 2: Building a simple DIY bioreactor
3:30pm - 4:00pm:	Break
4:00pm - 5:00pm:	Hacking Microalgae - Working with Microalgae (continued)

AGENDA

Day 2

9:00am - 10:00am:	Working with Microalgae (continued)
10:00am - 11:00am:	Working with Microalgae (continued)
11:00am - 12:00pm:	Microalgae from a commercial perspective - Perspectives (Presentation)
12:00pm - 1:00pm:	Working with Microalgae (continued)
1:00pm - 2:00pm:	Lunch
2:00pm - 3:00pm:	Working with Microalgae (continued)
3:00pm - 4:00pm:	Documentation
4:00pm - 5:00pm:	Wrap-up and Q&A

DISCLAIMER

Due to time constraints, the language used in this presentation has been simplified to ensure accessibility and comprehension for our target audience. As a result, certain scientific terminology may be reduced or replaced with more easily understood terms.

Please note that while every effort has been made to ensure the accuracy of the content presented, some nuances and complexities inherent to the scientific context might be lost in this process. Rest assured, the presenter has made a conscious effort to carefully balance the need for simplicity with the requirement for scientific accuracy. We appreciate your understanding and encourage any questions or clarifications during the Q&A session following the presentation.

FOTO / VIDEO

Do you give your consent for documentation?

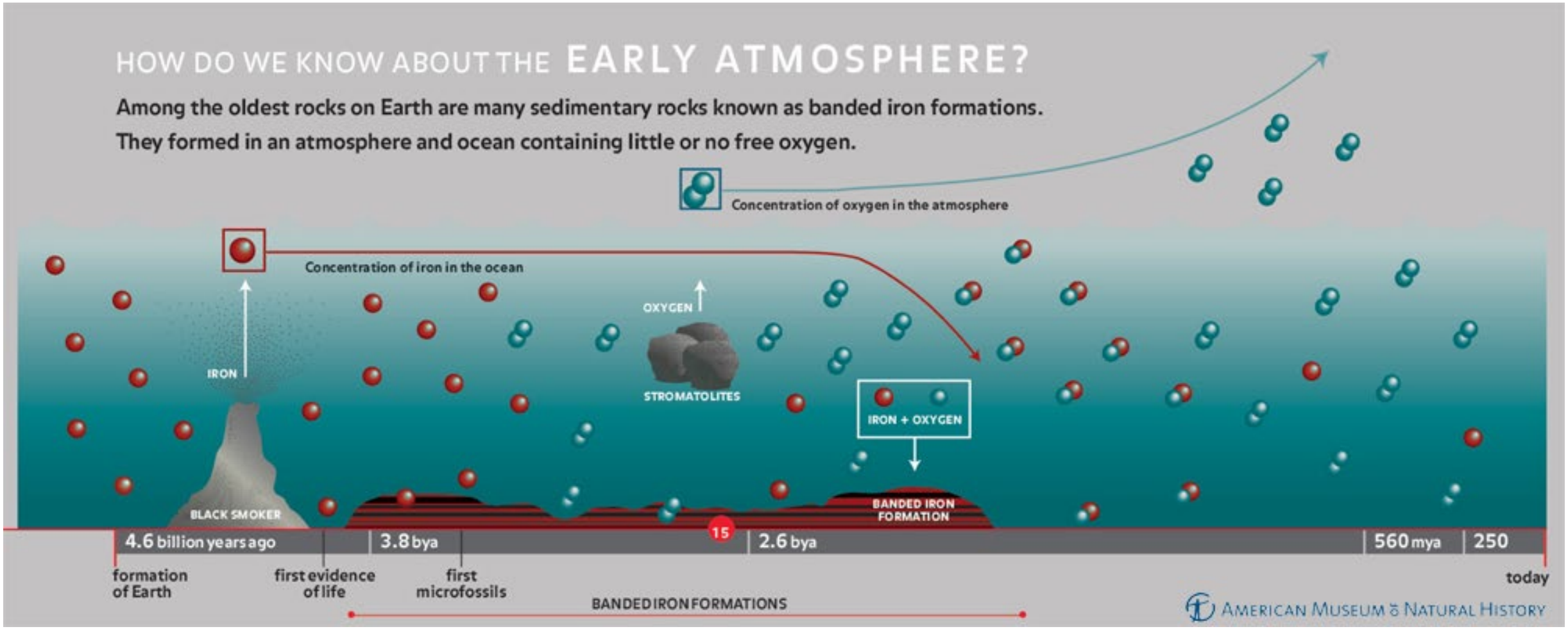
Where have you been noticing algae before?

- Have you been noticing algae before?

Chapter I

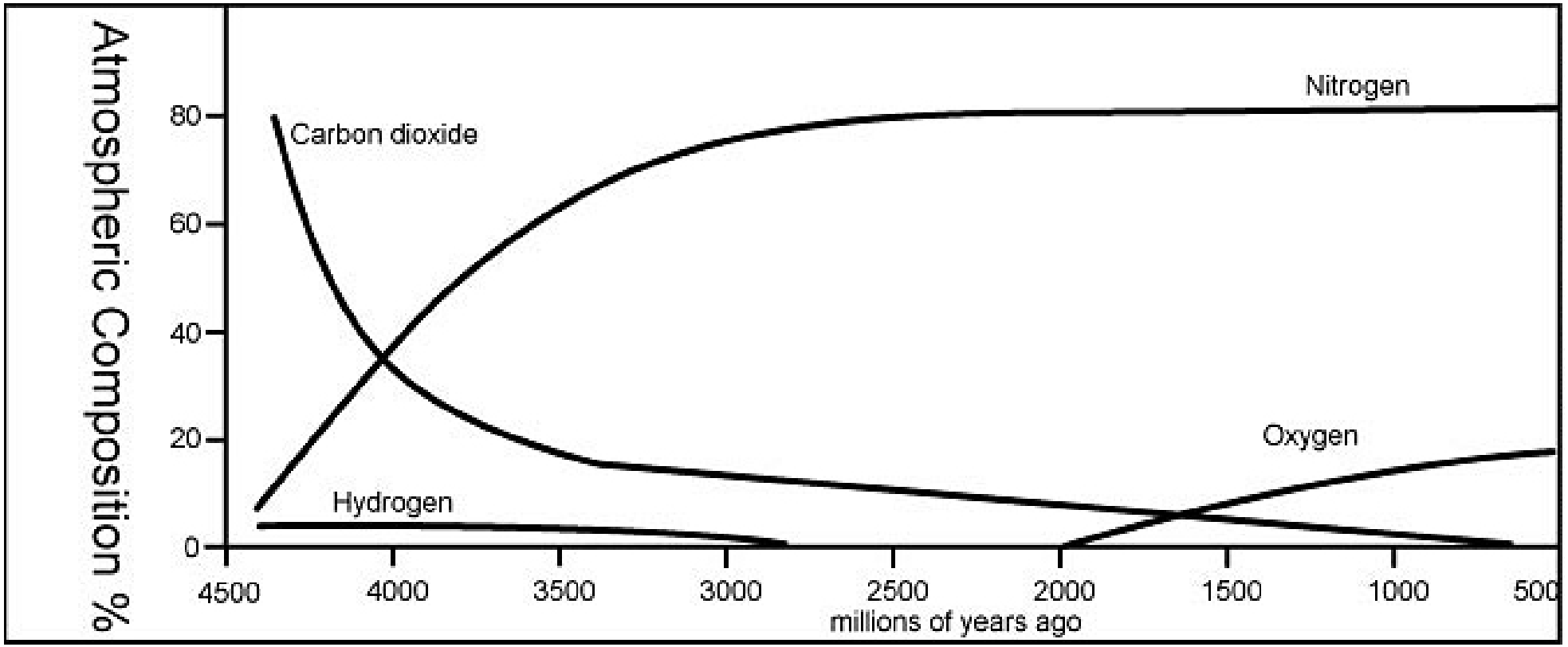
What are algae and where do they come from?

The oxygen-revolution



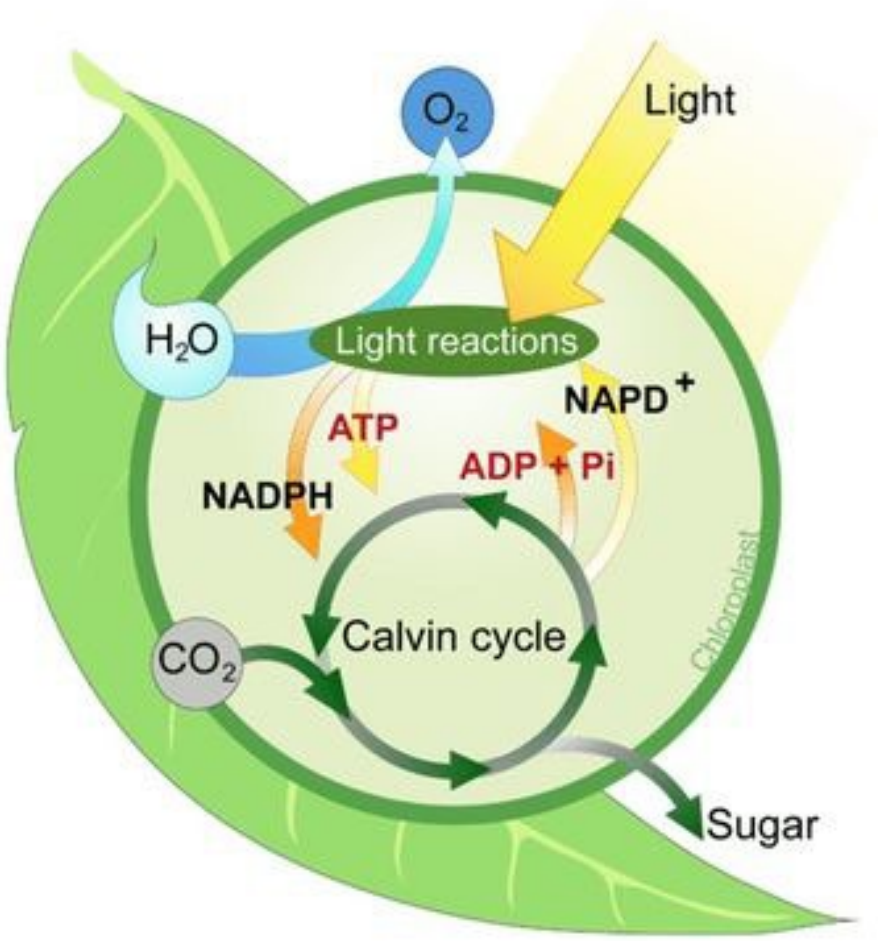
http://www.luckysci.com/wp-content/uploads/2014/09/banded-iron-formations.jpg

The oxygen-revolution



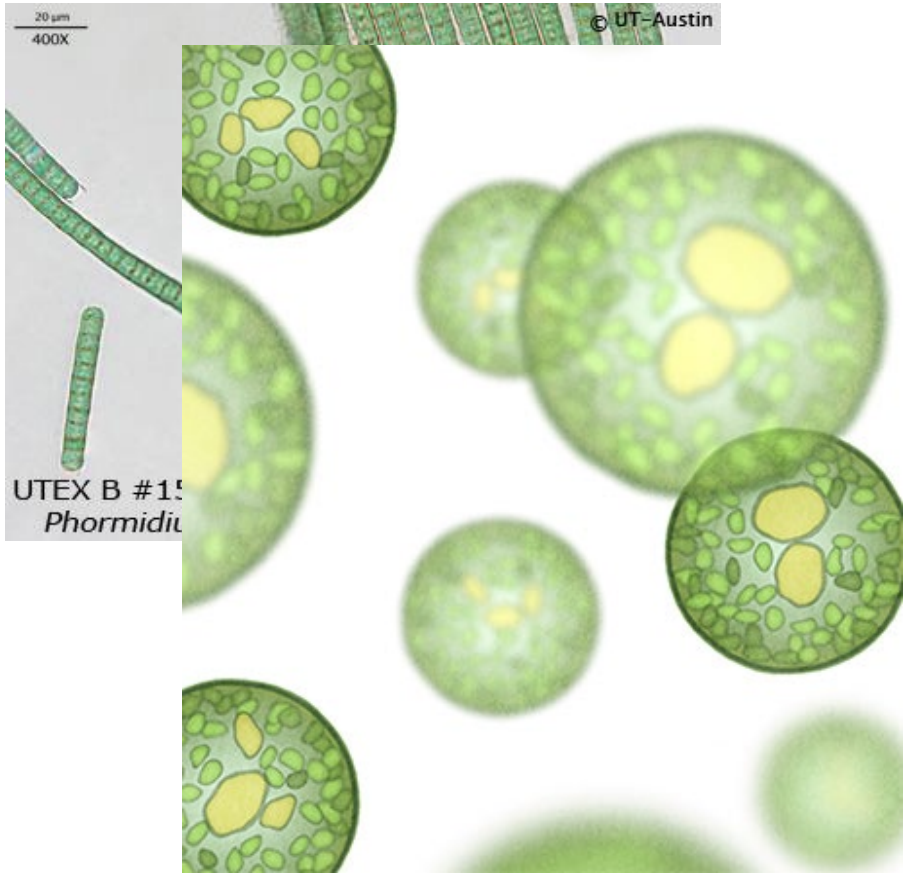
http://www.luckysci.com/wp-content/uploads/2014/09/banded-iron-formations.jpg

Photosynthesis

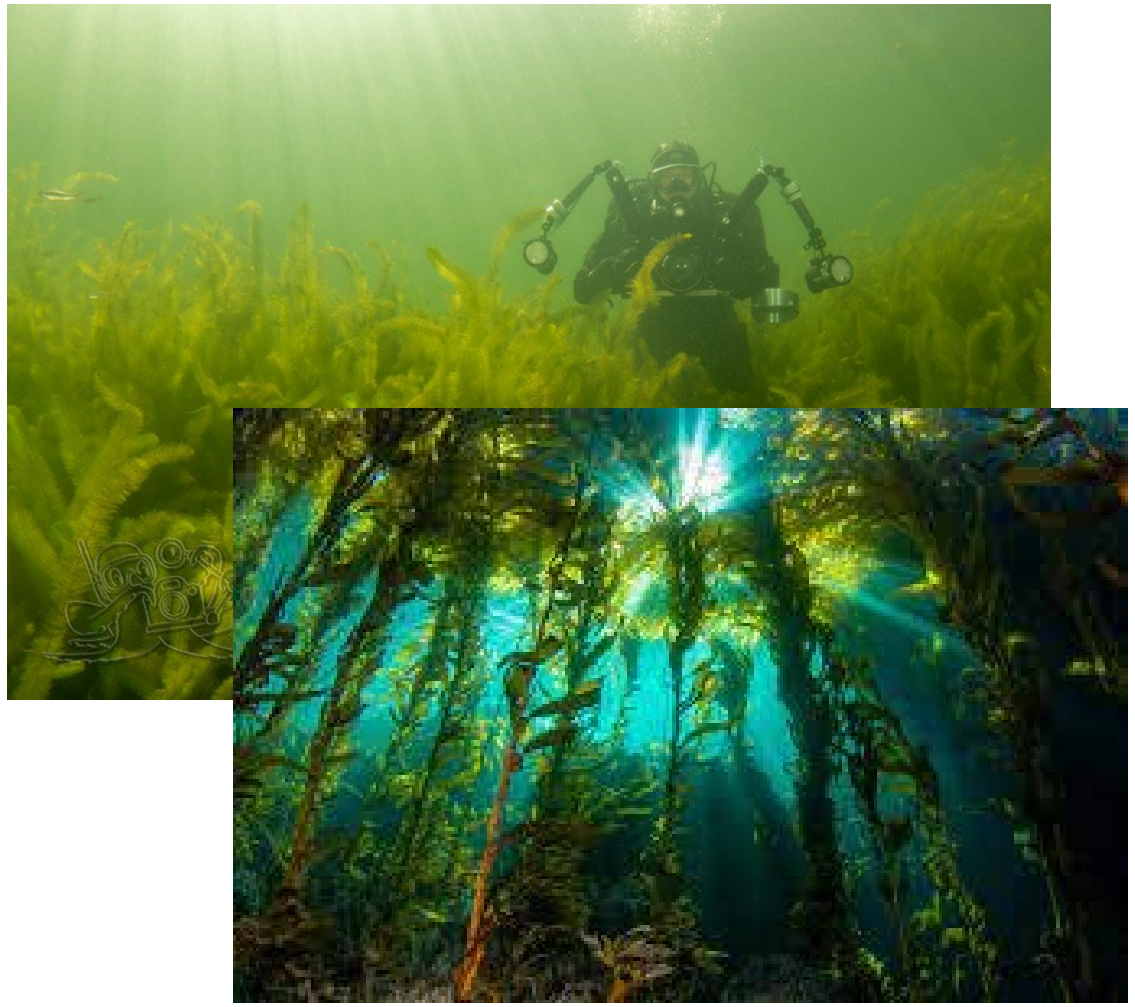


https://www.schweizerbart.de/papers/archiv_algolstud/detail/120/74727/Diversity_of_algae_and_cyanobacteria_growing_on_building_facades_in_France

Single-celled micro-algae



Macro-algae



Experiment 1

- Instructions:

1. Label the two vessels as "Light" and "Dark" using a marker or tape.
2. Measure equal amounts of water (e.g., 100 mL) and pour it into each vessel.
3. Add an equal volume of cyanobacteria culture (e.g., 5 mL) to each vessel, ensuring that the initial concentration is the same for both. Gently swirl the vessels to mix the water and cyanobacteria.
4. Place the "Light" vessel under a bright lamp or in a sunny spot near a window, ensuring it receives consistent light exposure throughout the experiment.
5. Place the "Dark" vessel in a dark area, such as a cupboard or a box, where it will not be exposed to any light.
6. Observe the vessels for a period of 6-8 hours. Pay close attention to the "Light" vessel and look for tiny bubbles forming around the cyanobacteria. These bubbles are oxygen produced as a result of photosynthesis.
7. Take notes on your observations, including the presence of bubbles in the "Light" vessel, and any differences in the appearance or behavior of the cyanobacteria between the two vessels.
8. At the end of the observation period, compare your findings and discuss how light exposure influenced the cyanobacteria's ability to perform photosynthesis, as evidenced by the formation of oxygen bubbles.

- Remember to handle the cyanobacteria culture and vessels with care, and always follow any safety precautions provided by your instructor.

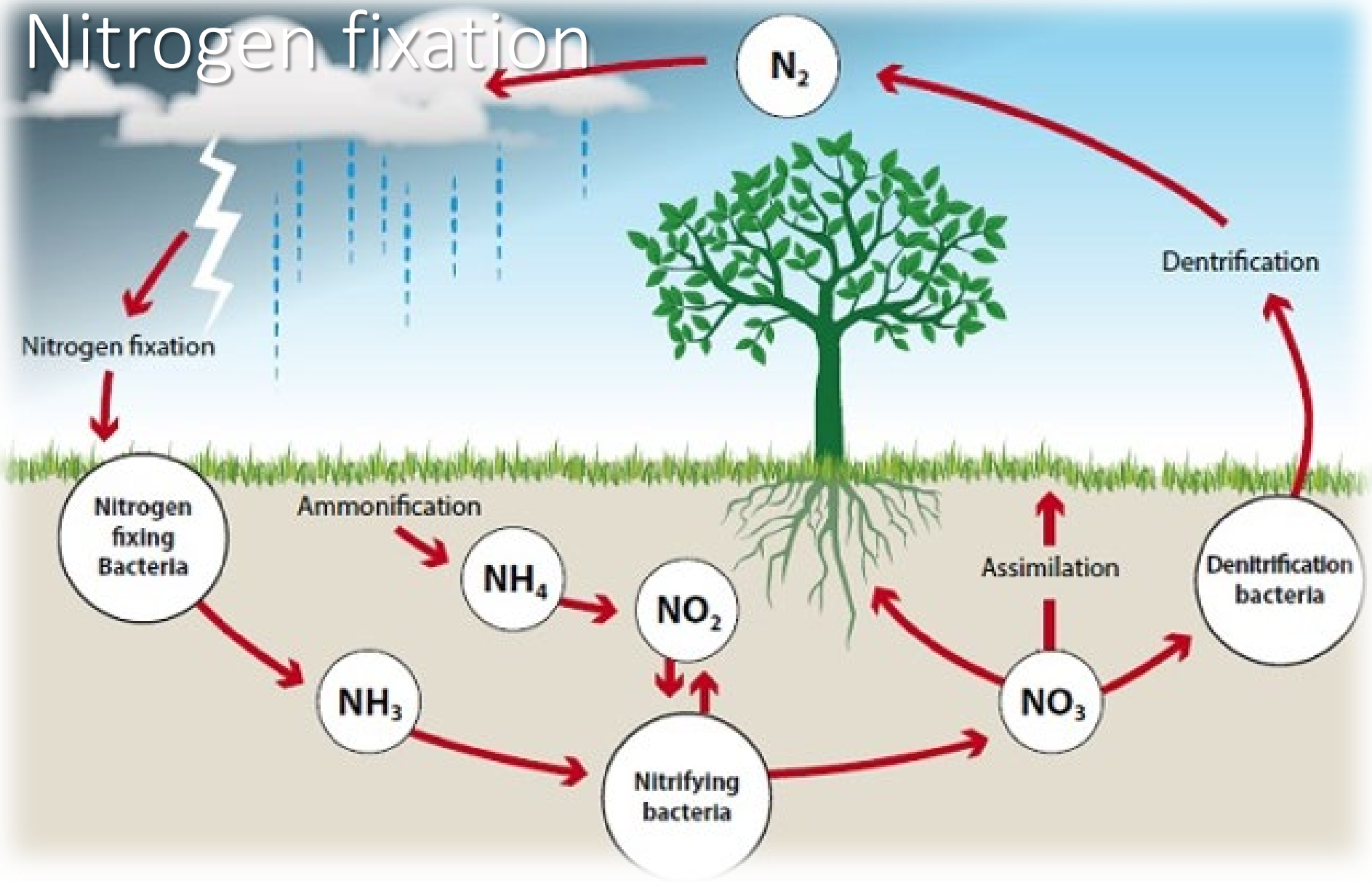
Chapter II

Ecological role of algae

CO_2 fixation

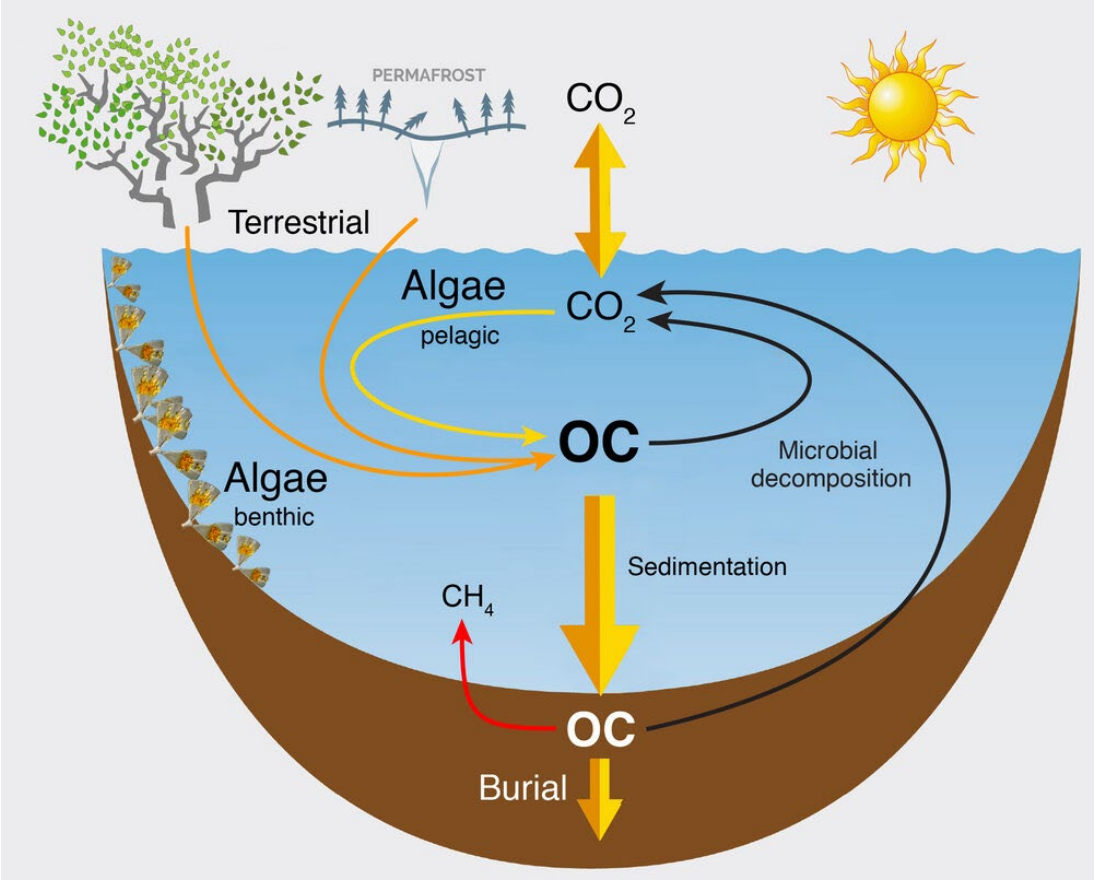
Primary settlement

Nitrogen fixation



Ecological role

- Primary producers
- Primary settlers
- Carbon fixation
- Nitrogen fixation
- Bioremediation (filtration of heavy metals and other toxic compounds)



https://www.caryinstitute.org/science/research-projects/understanding-lake-carbon-cycles#:~:text=Lakes%20are%20hotspots%20in%20landscape,altered%20by%20anthropogenic%20environmental%20change.

Research Task 1 (20 min + 10 Min)

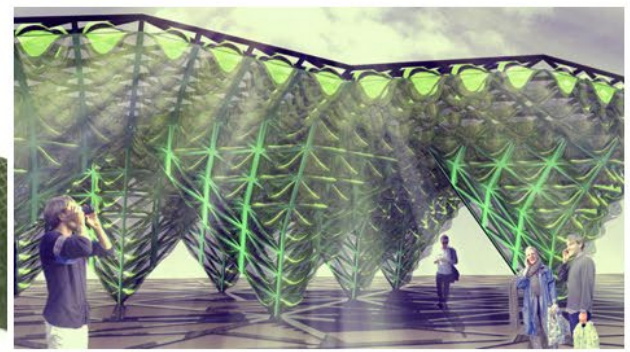
- Choose 1 of the following algae and shortly research the following questions
  - Where do they live?
  - What special ability do they have and how does it work?
  - What specific conditions do they need to grow?
  - Can they be found in todays products and if yes in which?
  - Opt. Do you find a source for getting an active culture?

1. *Noctiluca scintillans*
2. *Arthrospira platensis*
3. *Chlorella Vulgaris*
4. *Botryococcus braunii*
5. *Haematococcus pluvialis*
6. *Laminaria spec.*
7. *Klebsormidium flaccidum*
8. *Aphanitomenon flos-alquae*

Chapter V

Microalgae in collected architecture, art and design projects


EXPO




ERWERK & ARUP: THE ALGAE
MINT
MICROALGAE INTEGRATION
www.mint-engineering.de

- http://www.synbicite.com/news-events/2017/nov/15/breathing-chandeliers-and-algae-sculptures-bionic-/

Marco Poletto
Claudia Pasquero

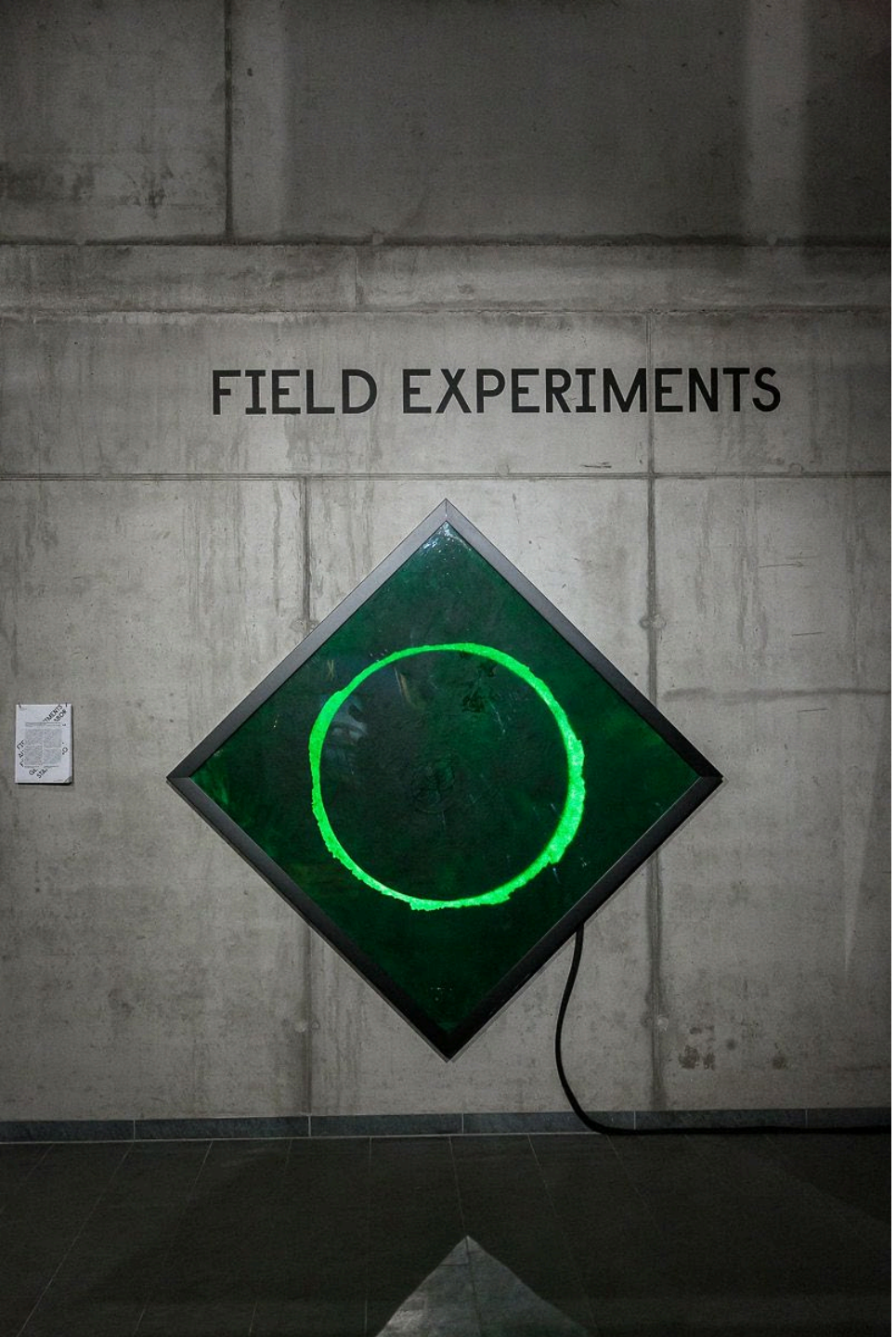
https://www.designboom.com/technology/ulrim-the-coral-algae-farming-07-11-2019/

Jacob Douenias
Ethan Frier
2015

NUTRIENT SOLUTION by Ina Turinsky and Andreas Wagner 2017
©BURG

Algaegraphs

[lia giraud creates living photographs with microscopic algae]



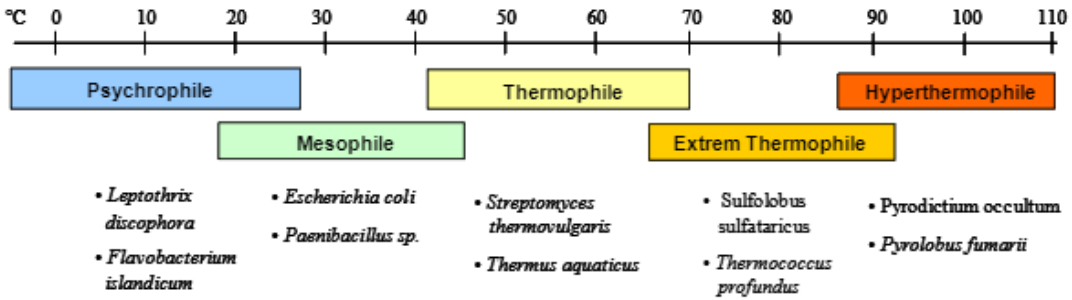
Algae wall by Solaga

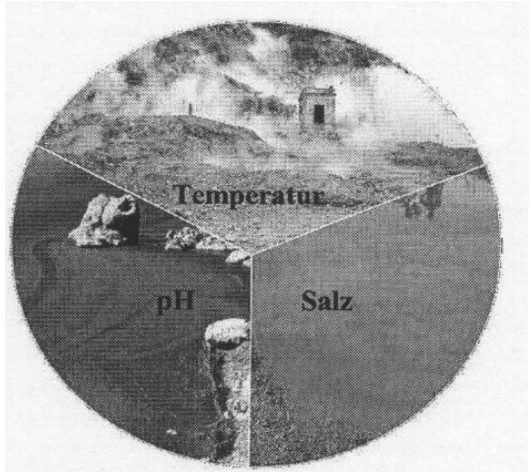
Living Canvas 2019, State Studio Berlin
Fara Peluso x Solaga

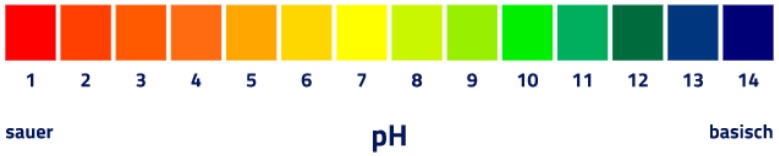
Chapter III

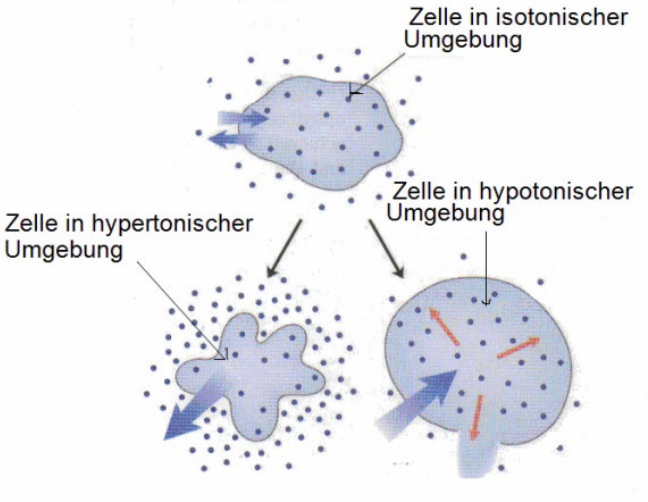
Basics of growing microalgae

Needs of a microbe

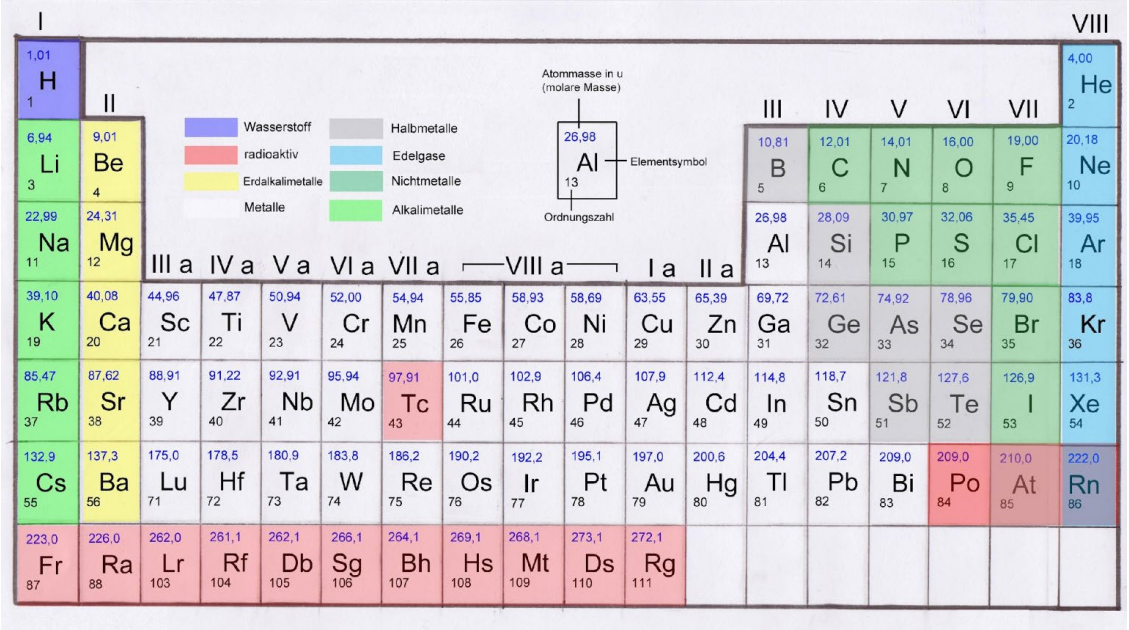




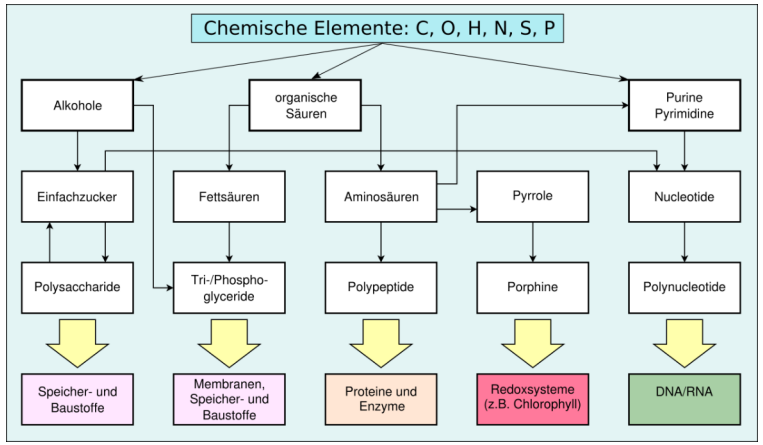




Needs of a microbe



What for?



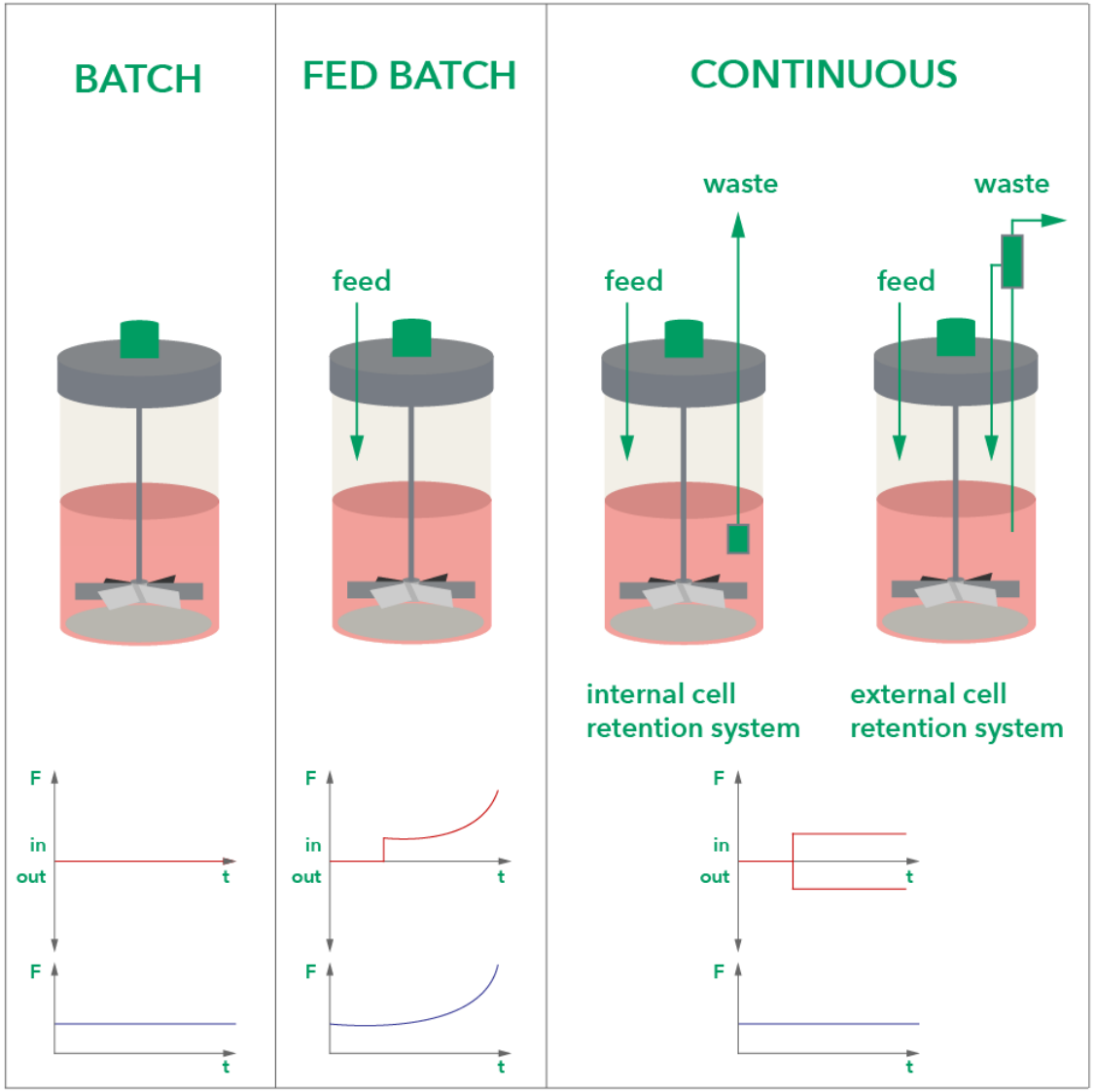
– **Macroelements: mainly for building up the cellular structure: C, O, H, N, P, S, K, Ca, Mg, Si**

– **Trace elements: e.g. for enzymes, vitamins, hormones: Iron (Fe), copper (Cu), zinc (Zn), manganese (Mn), cobalt (Co), selenium (Se), Fluorine (F) and iodine (I) (animals, humans)**

Fe, Mn, Cu, Zn, molybdenum (Mo), boron (B) and chlorine (Cl) (plants)

Nutrients

- Complex-Media
  - Flower fertilizer
  - Forrest soil extracts
- Minimal-Media
  - BG11



Experiment 2

- Building a simple bioreactor: -> Work in the Lab

Part 1: Setting up the bioreactor

1. Clean glas containers
2. Construct ports and making them air tight
3. Add aluminum foil to protect ports after autoclaving
4. Add tubing for bubbling
5. Test the set-up regarding
    1. Bubbling
    2. Mixing
    3. Various
6. Fill with destilled water
7. Autoclave

Experiment 2

- Building a simple bioreactor: -> Work in the Lab

Part 2: Preparing the nutrients and media (under sterile bench after autoclaving

1. Remove the aluminium foil of the gas inlet and carefully and cleanly add a syringe filter on the inlet
2. Add BG11 50x, add pH-buffer to the water
3. Add the inoculation culture
4. Prepare a monitoring program to control pH and growth

AGENDA

Day 2

10:00am - 11:00am:	Working with Microalgae (continued)
11:00am - 11:30pm:	Microalgae from a commercial perspective - Perspectives (Presentation)
11:30pm - 12:00pm:	Next steps
12:00pm - 1:00pm:	Lunch
1:00pm - 3:00pm:	Working with Microalgae (continued)
3:00pm - 4:00pm:	Documentation, Wrap-Up and Q&A

Next steps

1. Own ideas and projects?
2. Optimization liquid culture
3. Culturing biofilms and air cultures
4. Free experimenting with Biomass
5. Establishing a clean culture management

Chapter III

Light

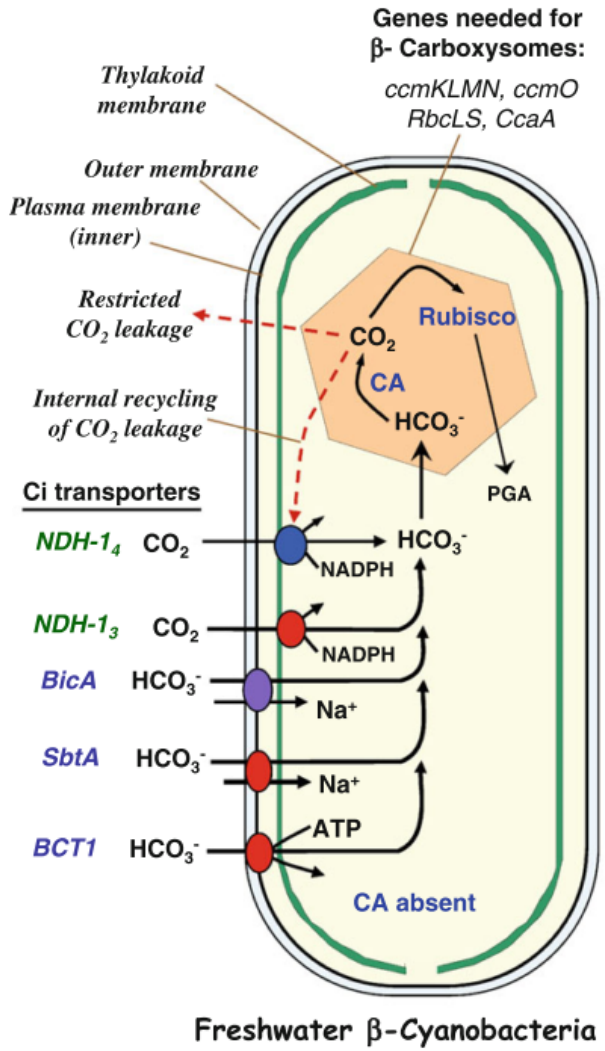
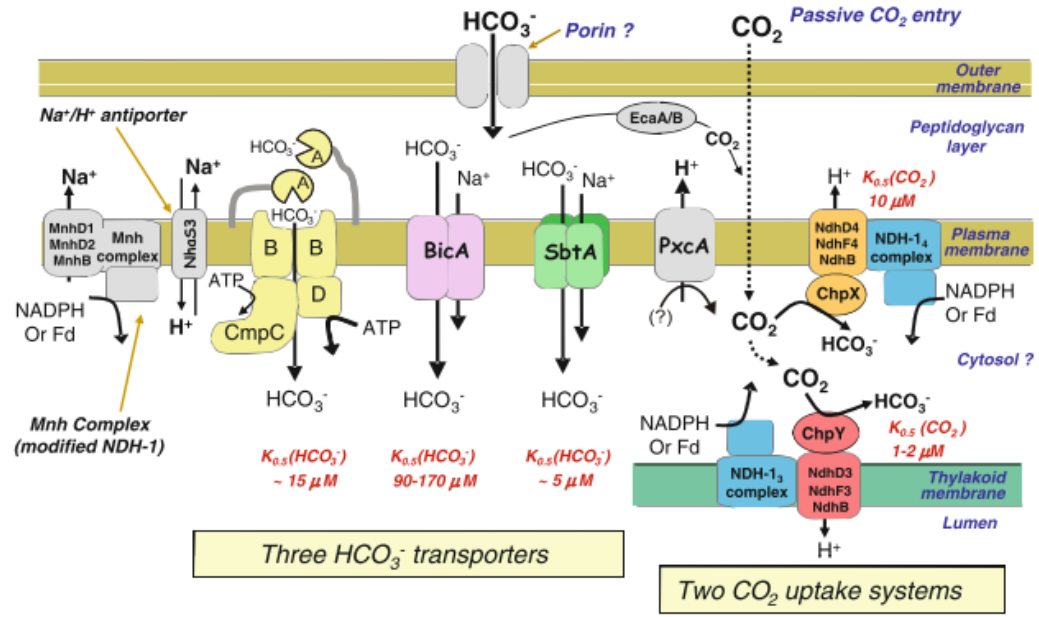
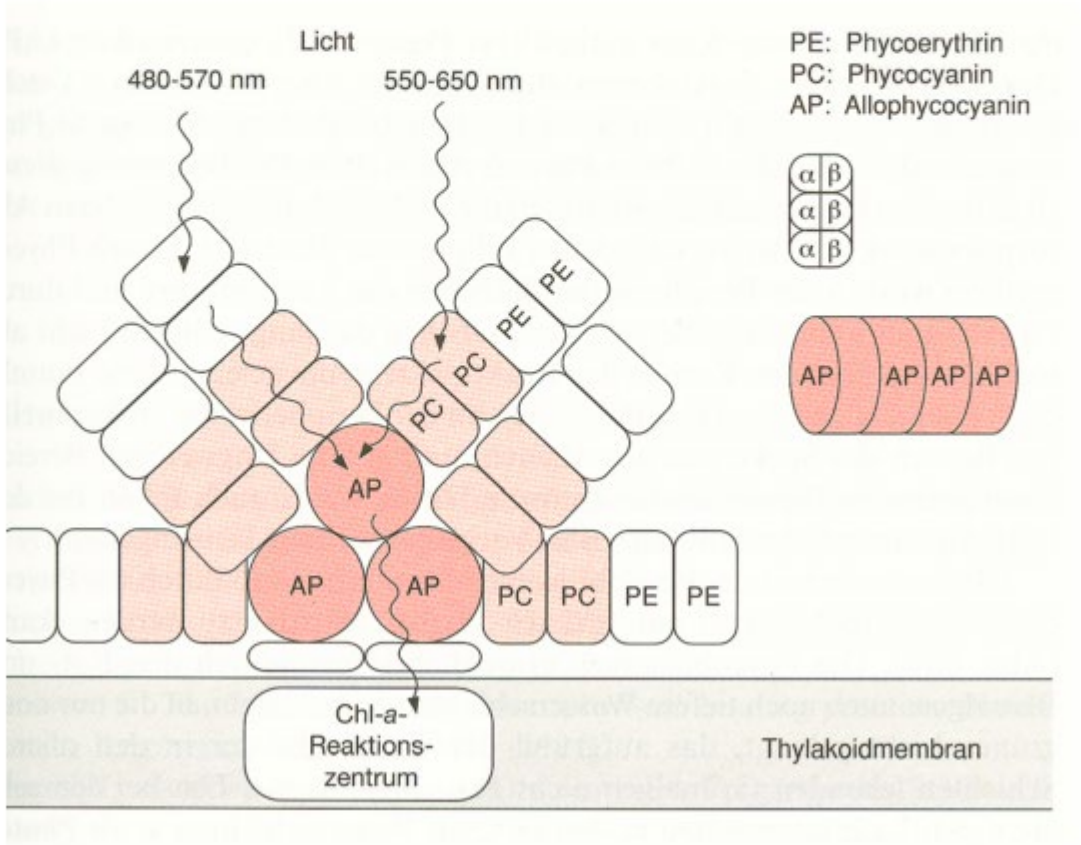


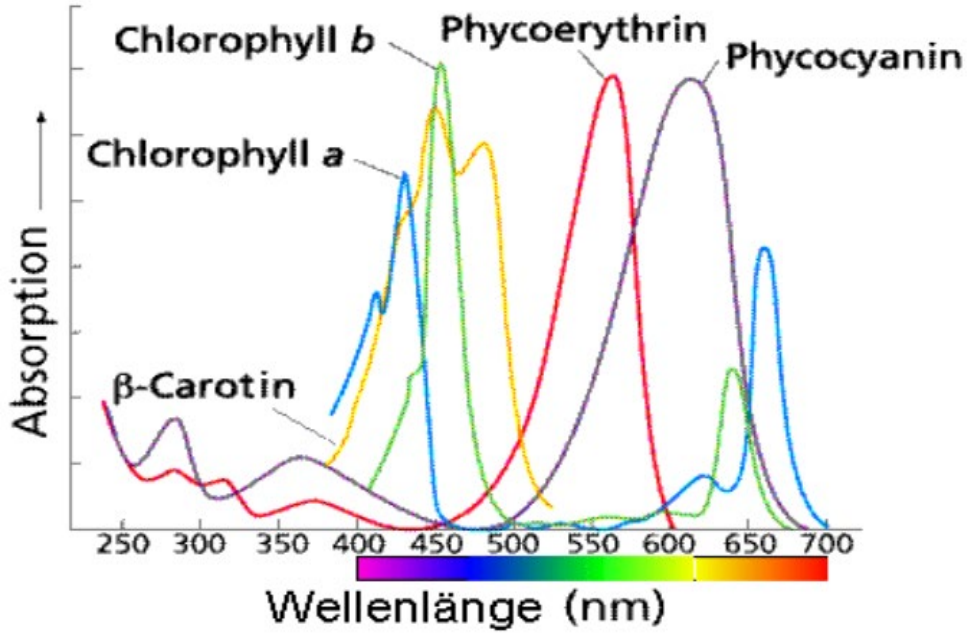
Fig. 2 Scheme summarising some of the differences between the five known Ci uptake systems (*coloured components*). Ancillary components that do have, or may have, a secondary role in supporting Ci uptake are shown in *grey*

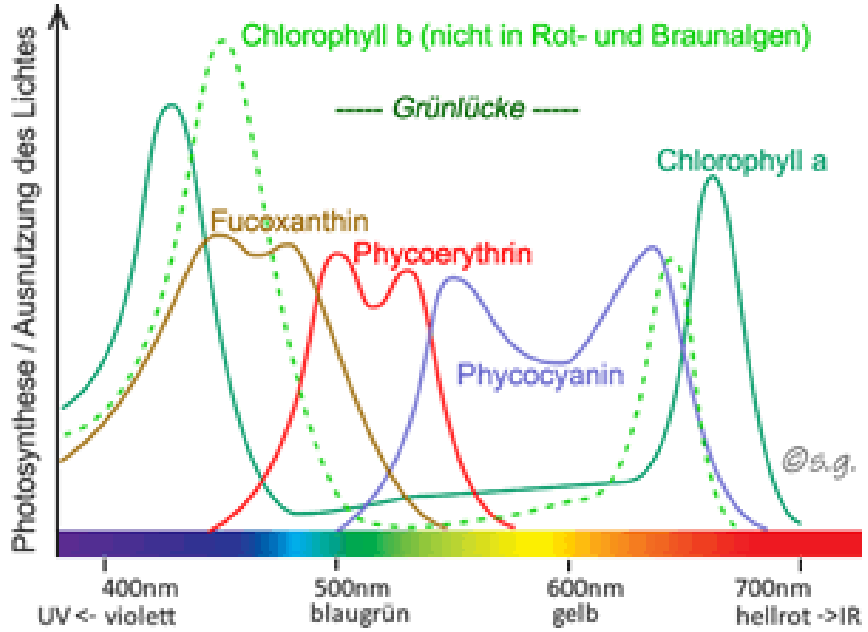


2. Antennen in Cyanobakterien-Phycobilosomen

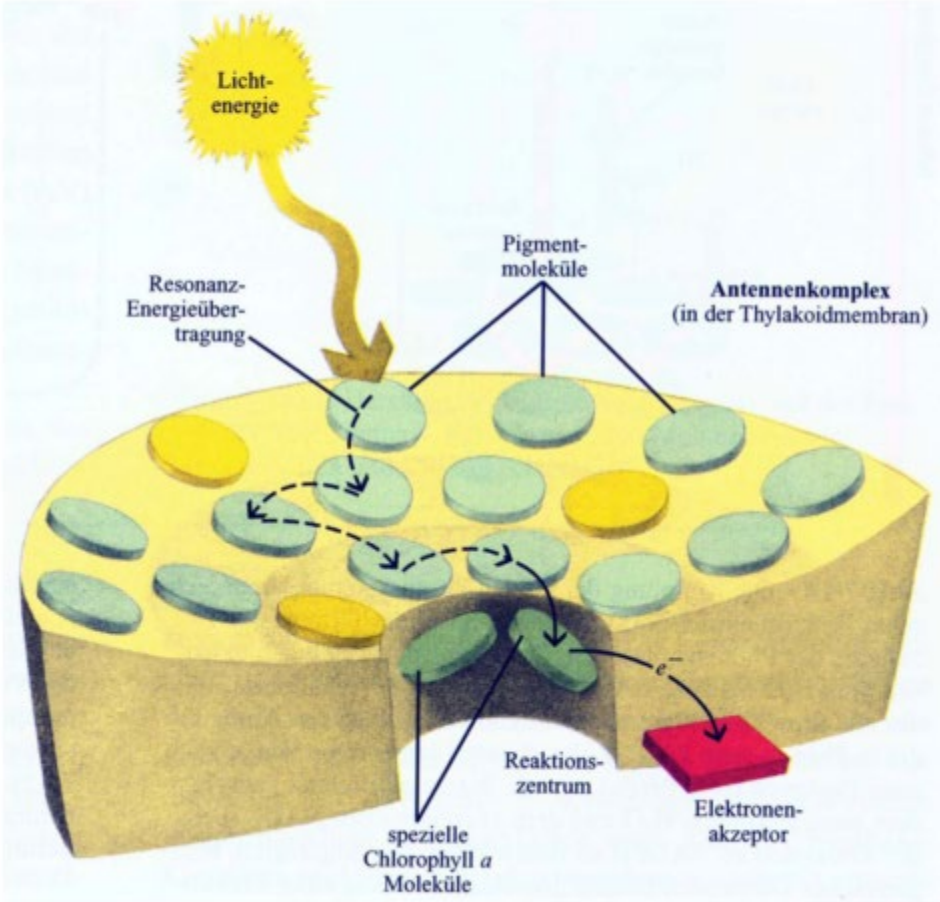
Phycobilisomen in Cyanobakterien







Energieübertragung: Trichter-Prinzip (I)



Die Reaktionszentren wirken als Energiefalle

Chapter IV

Microalgae in solid cultures

Chapter IV

Air Algae

Air Algae

Species:

- *Trentepohlia aurea*
- *Gloeocapsa*
- *Chroococcus (Chroococcale)*
- *Nostoc*
- *Pleurococcus vulgaris*

-> Some are able to produce Sporopollenin, which helps to combat drought stress

Suitable Conditions:

- Wet and shady spots to protect the algae from excessive light stress
- Water saturation through mist and air
- Fertile grounds: pH-neutral of moderate alkaline surfaces such as
  - Wood
  - Courque
  - Mortar
  - Bricks
  - Limestone
  - Textiles

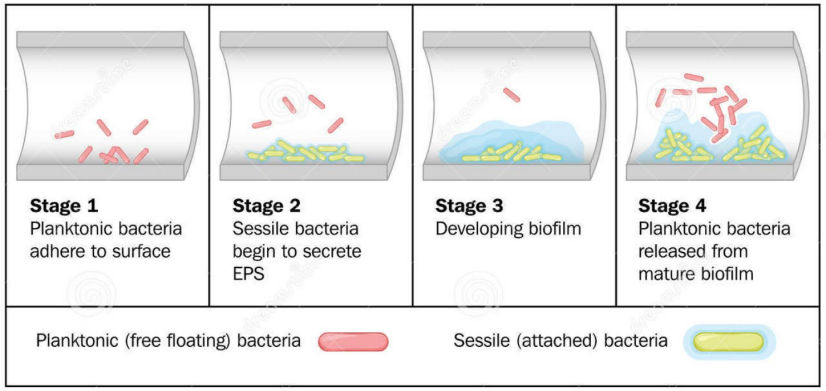
- „Risks“
  - Drought and light stress changes aesthetics
  - Contamination -> smelly but not dangerous in an outside setting
  - Attraction of biodiversity

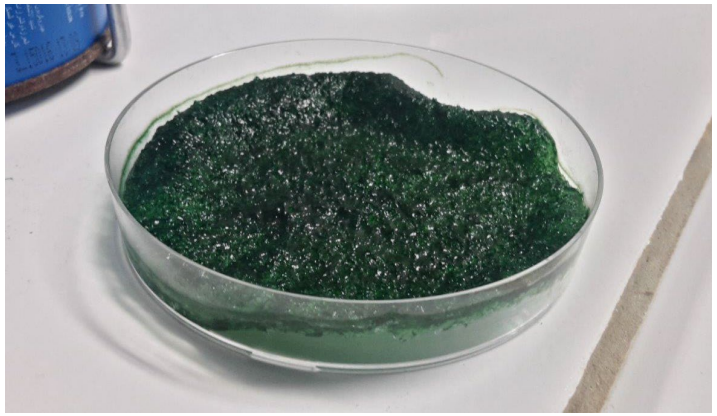
Examples

Chapter IV

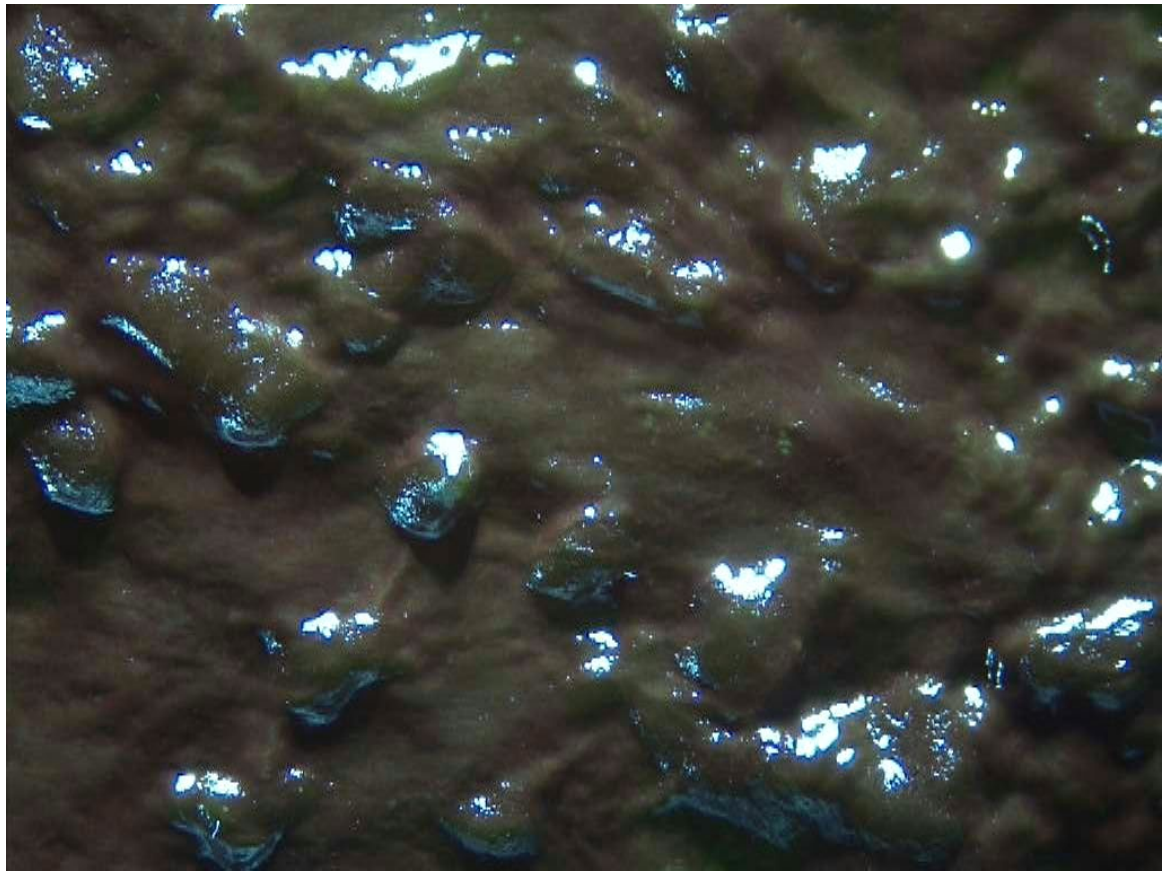
Microalgae biofilms

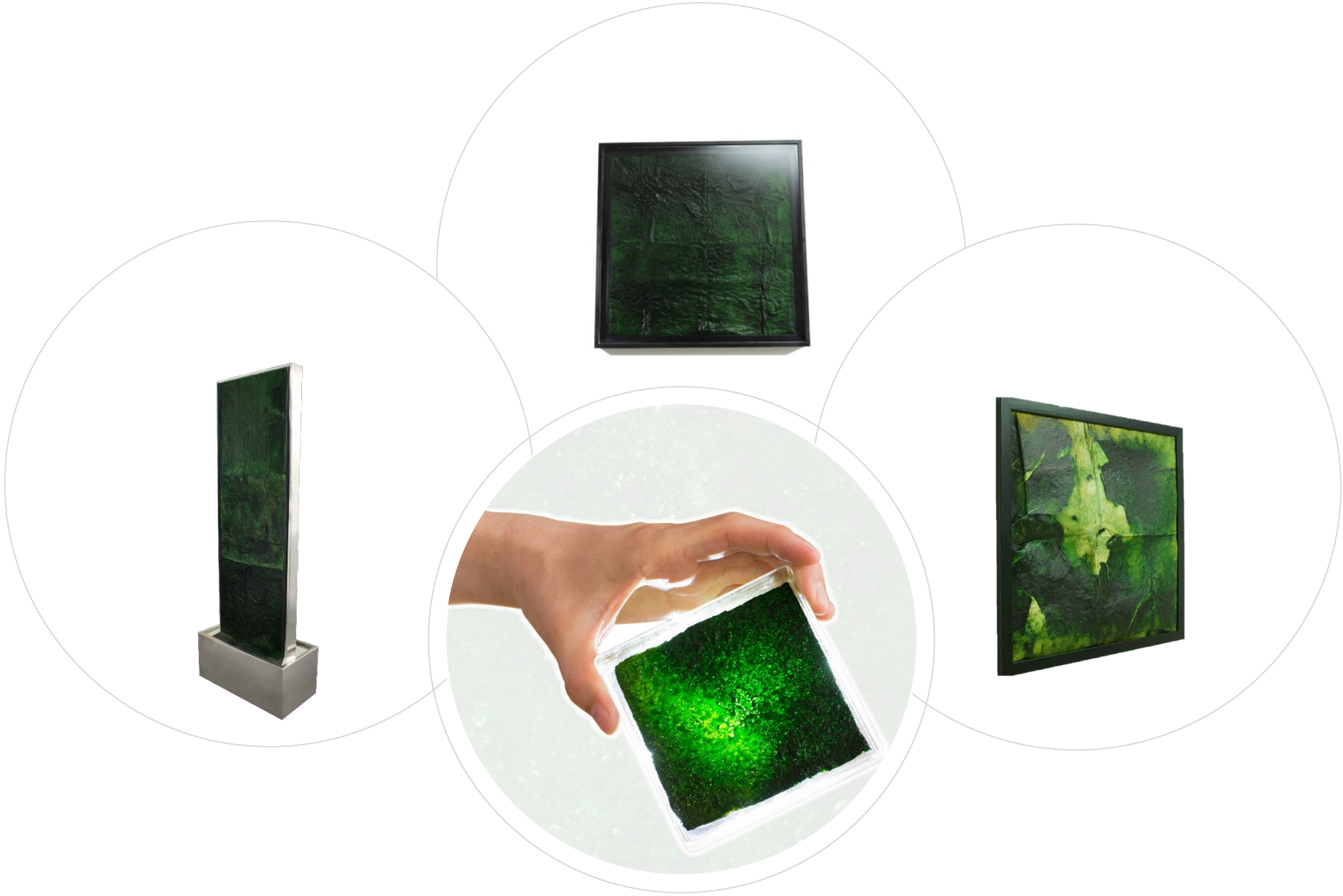
Exkurs: Biofilme – natürliche persistente Immobilisierungen





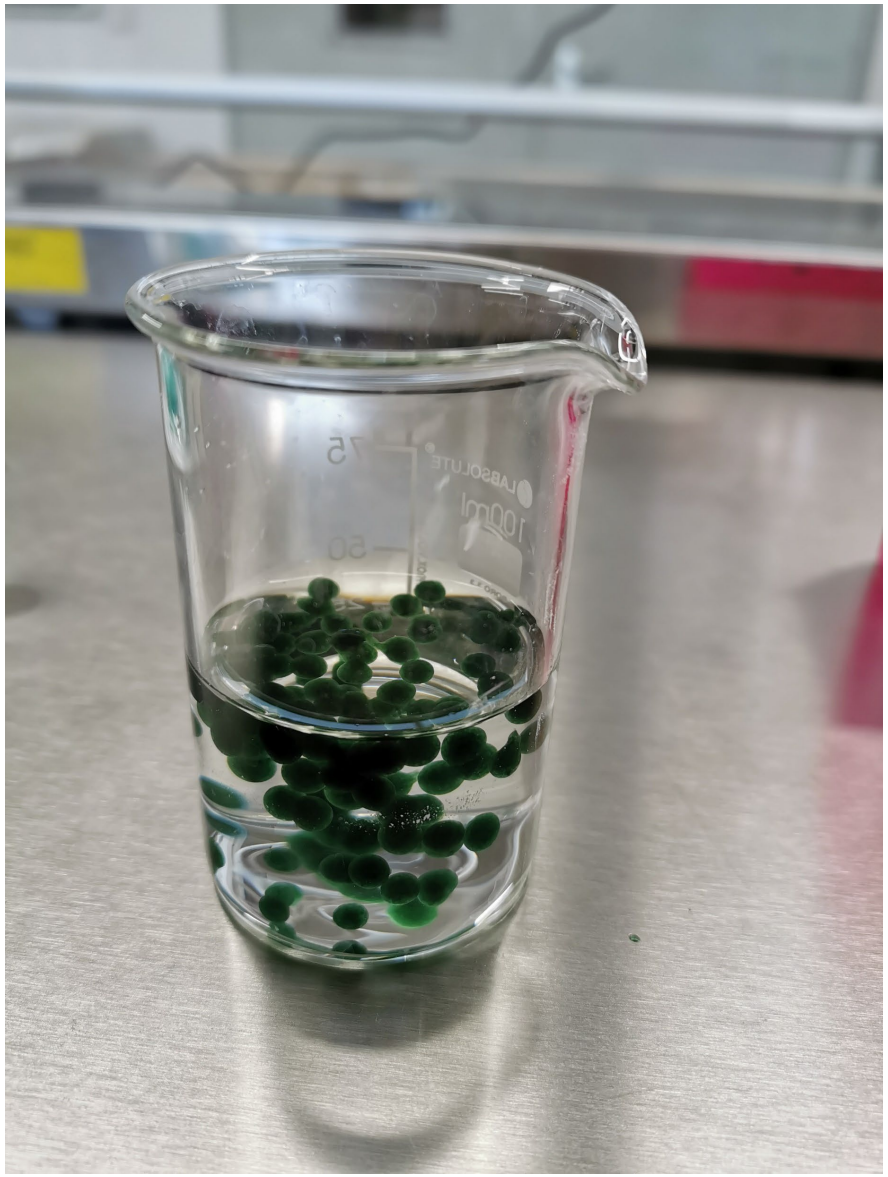
© solaga

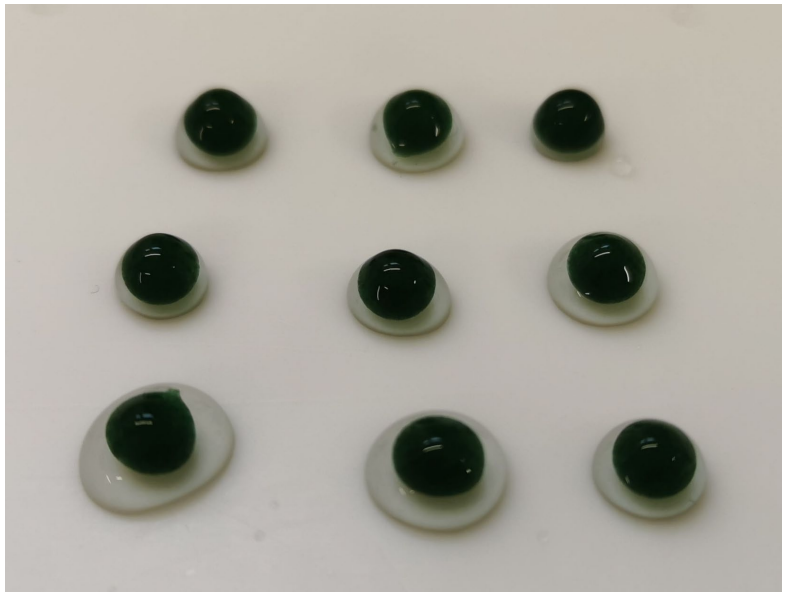


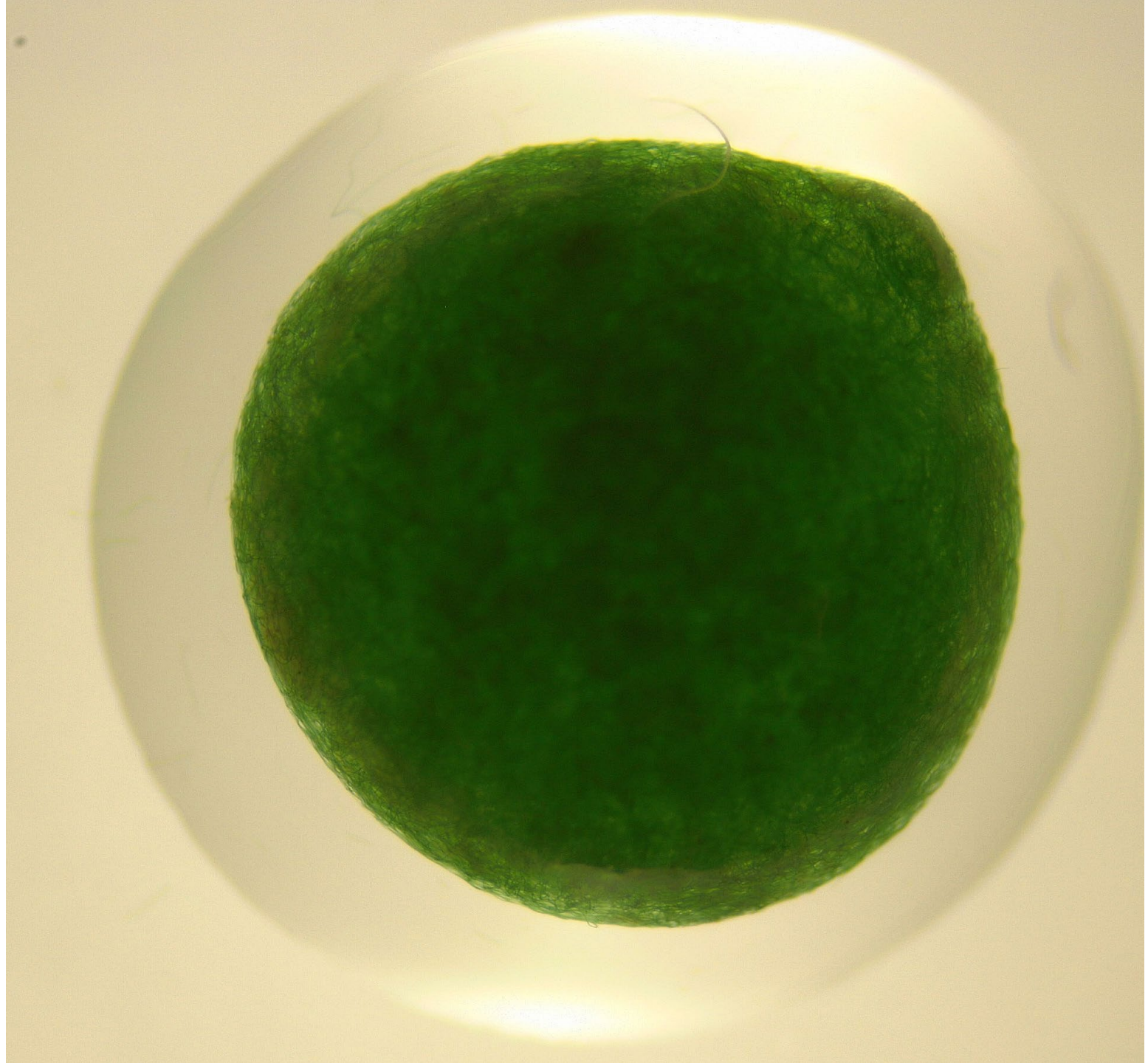


Chapter IV

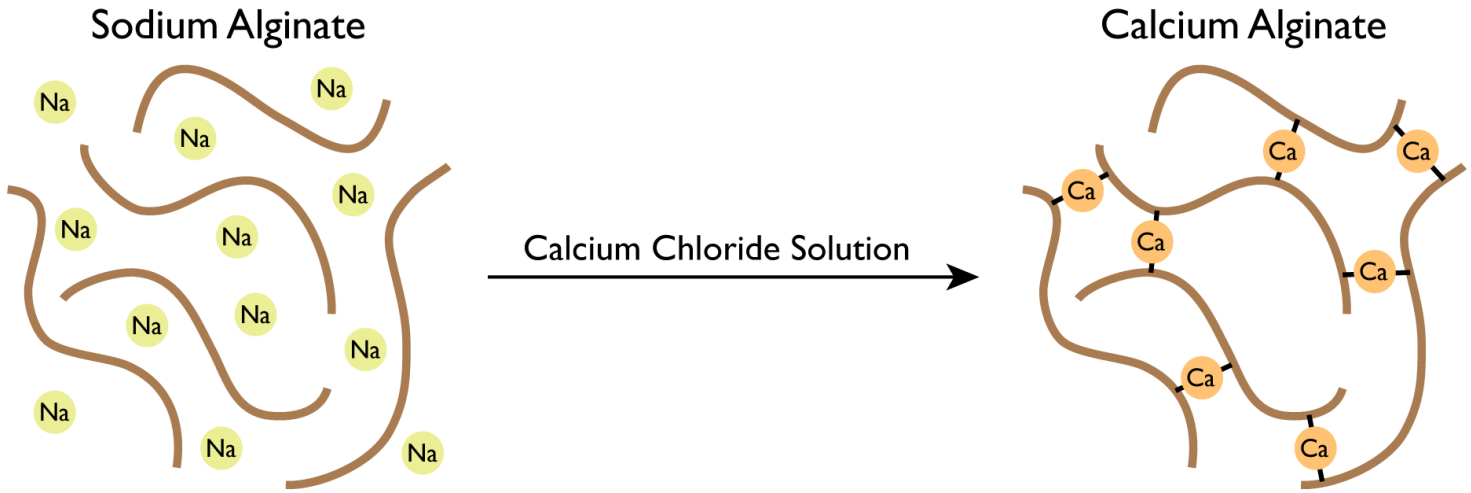
Microalgae in hydrogels

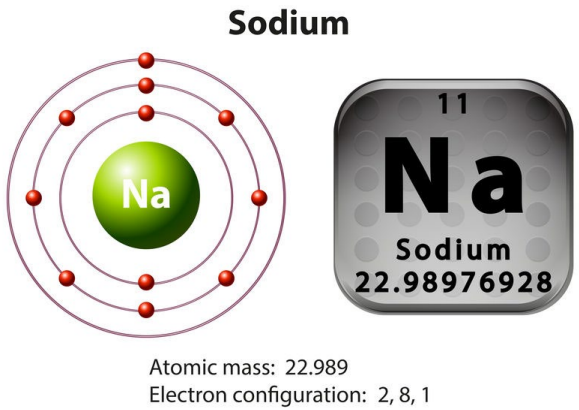


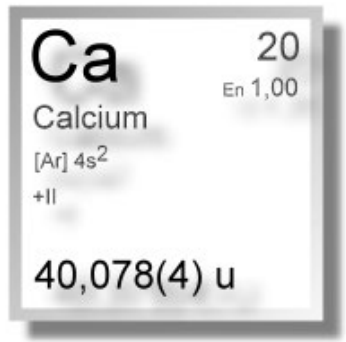


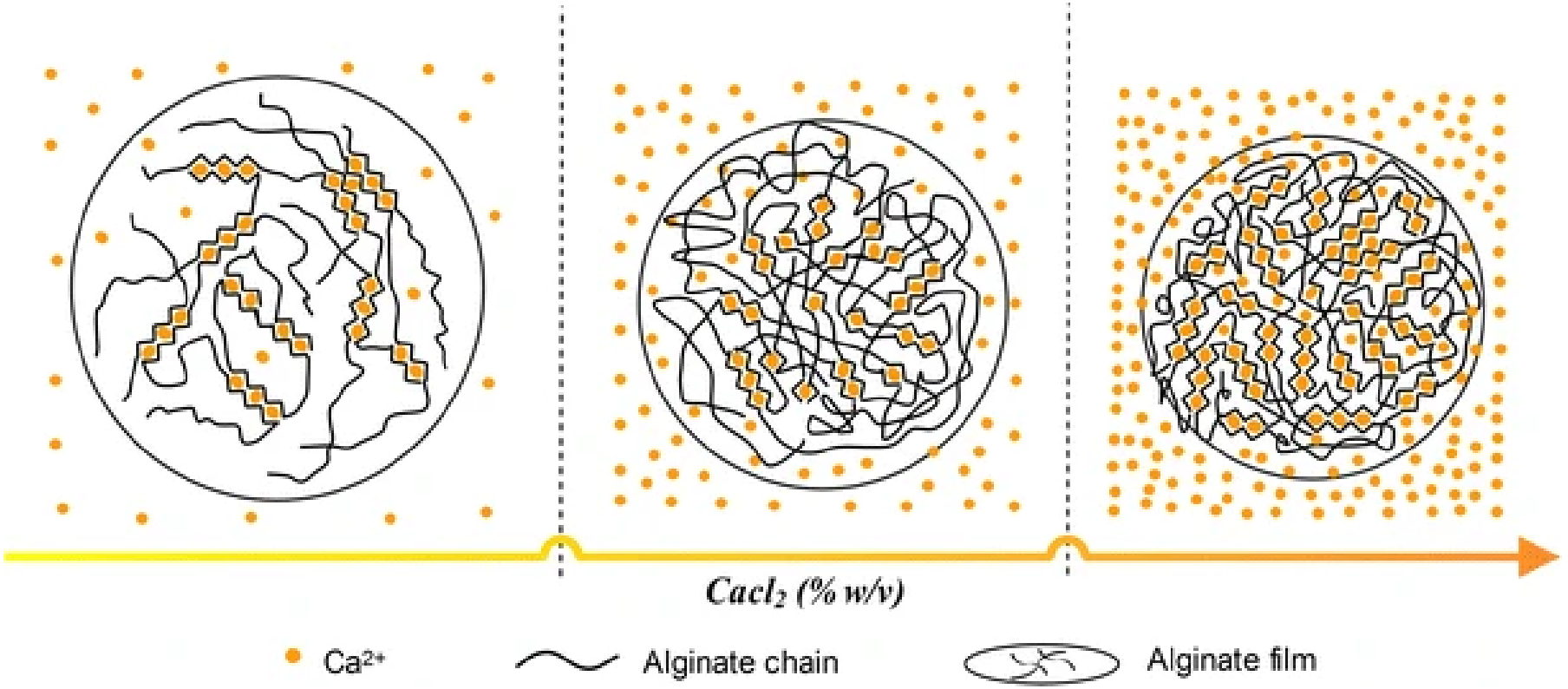


Sphärifikation mit Alginat und Ca2+









https://link.springer.com/article/10.1007/s10853-016-9880-0/figures/4

Immobilisierungsarten von Mikroorganismen

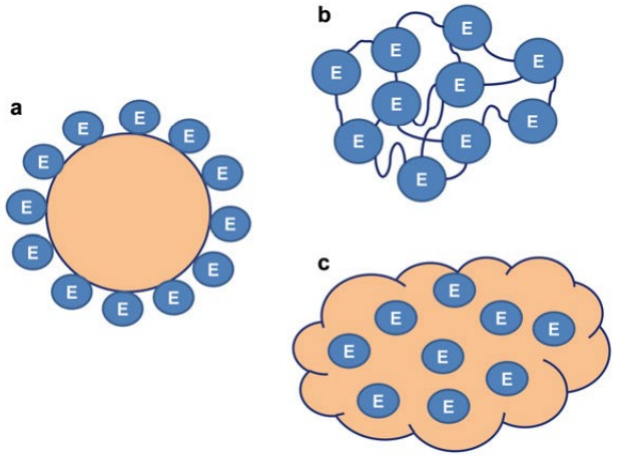


Abb. 8 Schematische Darstellung der drei Immobilisierungstypen: (**a**) Bindung an einen Träger, (**b**) Quervernetzung, (**c**) Einschlussimmobilisierung

Tab. 4 Ausgewählte Beispiele von Trägermaterialien für die Immobilisierung

Immobilisierungsart	Trägermaterial	Enzym	Referenz
Bindung an einen Träger	keramische Monolithe mit Wabenstruktur Glaskörper	*Myceliophthora thermophila* Laccase *Trametes versicolor* Laccase *Aspergillus niger* Glucoseoxidase	[Plagemann et al. 2014]
	Acrylharz	*Candida antarctica* Lipase B	[Cabrera et al. 2009]
	Polymethacrylat beschichtete Glaskörper	*Bordetella bronchiseptica* Arylmalonatde-carboxylase	[Aßmann et al. 2017]
	Eupergit C	Penicillin Amidase	[Katchalski-Katzir und Kraemer 2000]
Einschlussimmobilisierung	Alginat	*Gluconobacter oxydans*	[Wang et al. 2013]
	Hydrogele basierend auf polymerisierten ionischen Flüssigkeiten	*Candida antartica* Lipase B	[Grollmisch et al. 2018]
	Langkettige Alkohole und Glycerolderivate	*Myceliophthora thermophila* Laccase	[Engelmann und Kragl 2018]
	UV-gehärtete Polyurethanbasierte Materialien	*Lactobacillus kefir* Alkoholdehydrogenase Glucosedehydrogenase	[Uhrich und Langemann 2017]
Quervernetzung		*Candida antartica* Lipase B	[Sheldon 2007]

https://link.springer.com/content/pdf/10.1007%2F978-3-662-56444-8_35-2.pdf

Chapter IV

Microalgae in industry

Embracing Biofilms

Rather than fighting the micro-organic coating that tends to accumulate in any moist environment, BioProcess Algae embraces them.