Microalgae: a global view of culture systems

Chaire de Biotechnologie CentraleSupélec

Dr. Rayen Filali
rayen.filali@centralesupelec.fr

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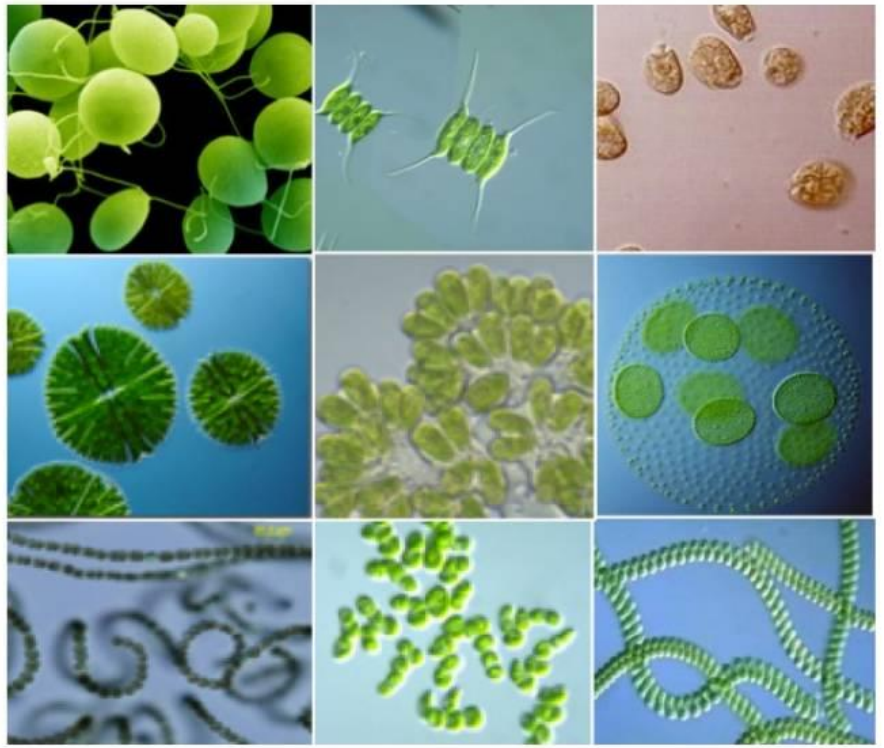
Interreg North-West Europe IDEA

Microalgae ?

- Lower aquatic plants: photosynthetic microorganisms
- Several morphologies (0.2 to 2 mm in diameter)
- High biodiversity: 1 to 10 million algae species
- Habitat: Marine or fresh algae
- Environmental benefits (fixation of CO_2, wastewater treatment)
- Pigments: chlorophyll, carotenoids and phycobiliproteins: biotechnological applications



https://www.ucl.ac.uk/biosciences/departments/structural-and-molecular-biology/smb-labs/purton-lab

Microalgae ?

"Phytoplankton"
the first producers of
of oxygen essential to the majority of living beings.


(https://news.algaeworld.org/2018/09/reaping-profits-from-microalgal-biorefineries/)

Environnemental impact

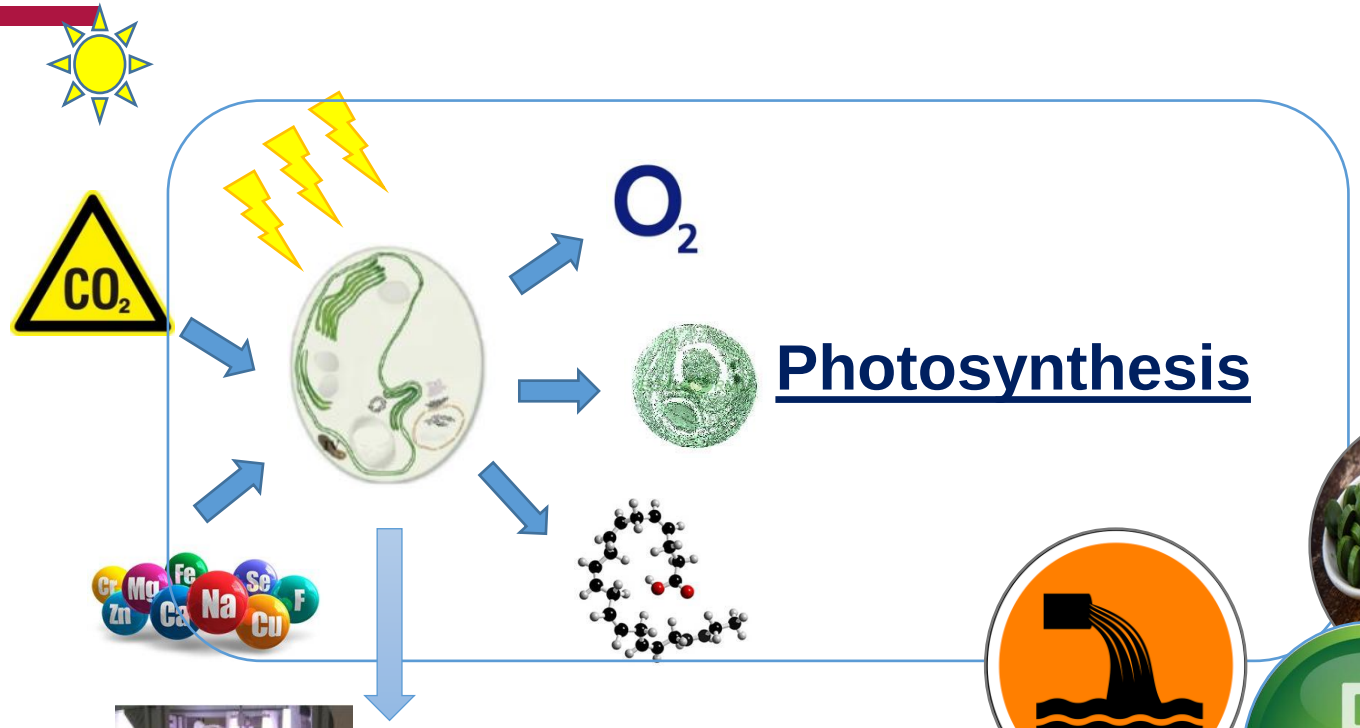
They are at the origin of the transformation of the atmospheric composition (CO_2 fixation and O_2 release)

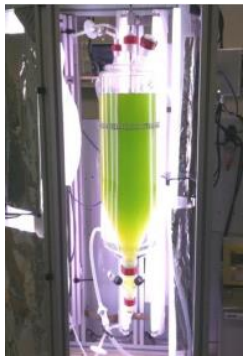

(https://pondnaturals.com/ingredient-category/microalgae/)

Traditional foodstock

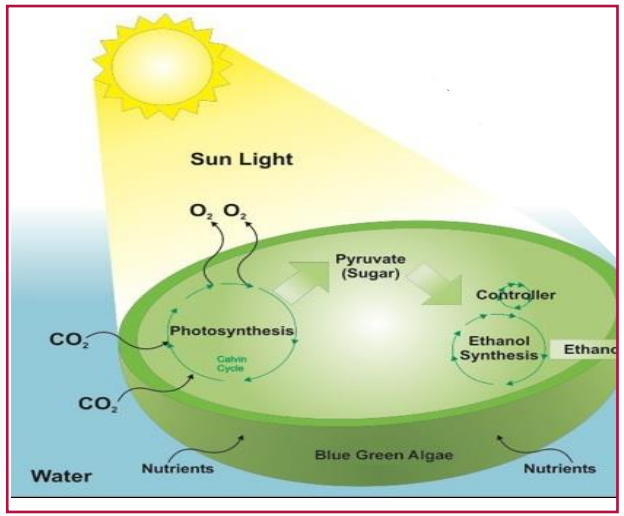
Used as a dietary supplement for human food as a major source of protein

Microalgae, a photosynthetic micro-plant !

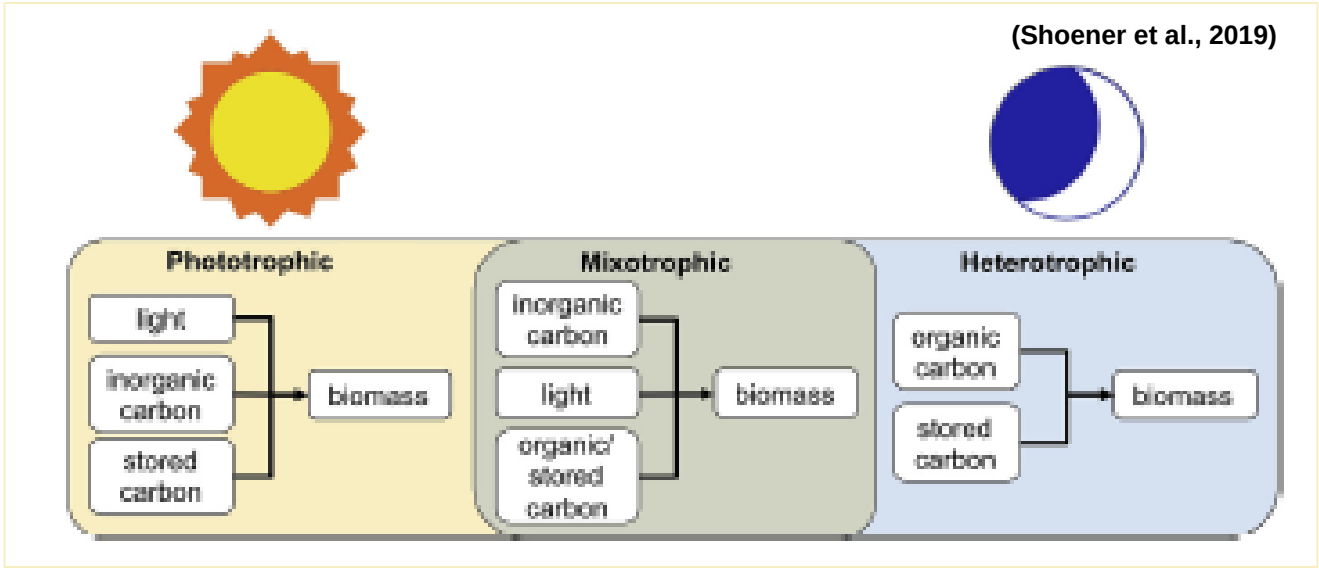




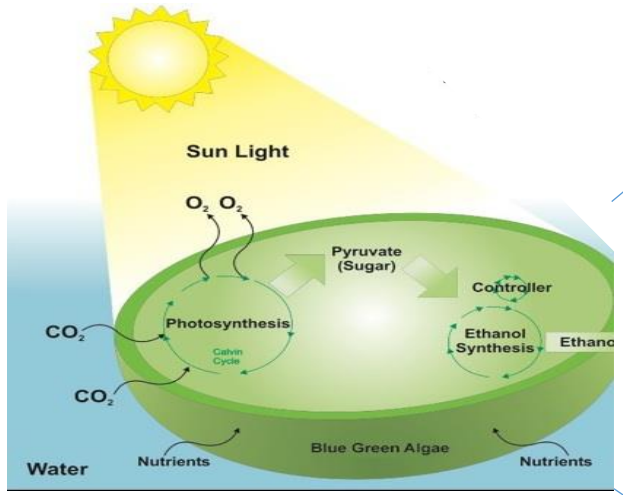
Microalgae, metabolism

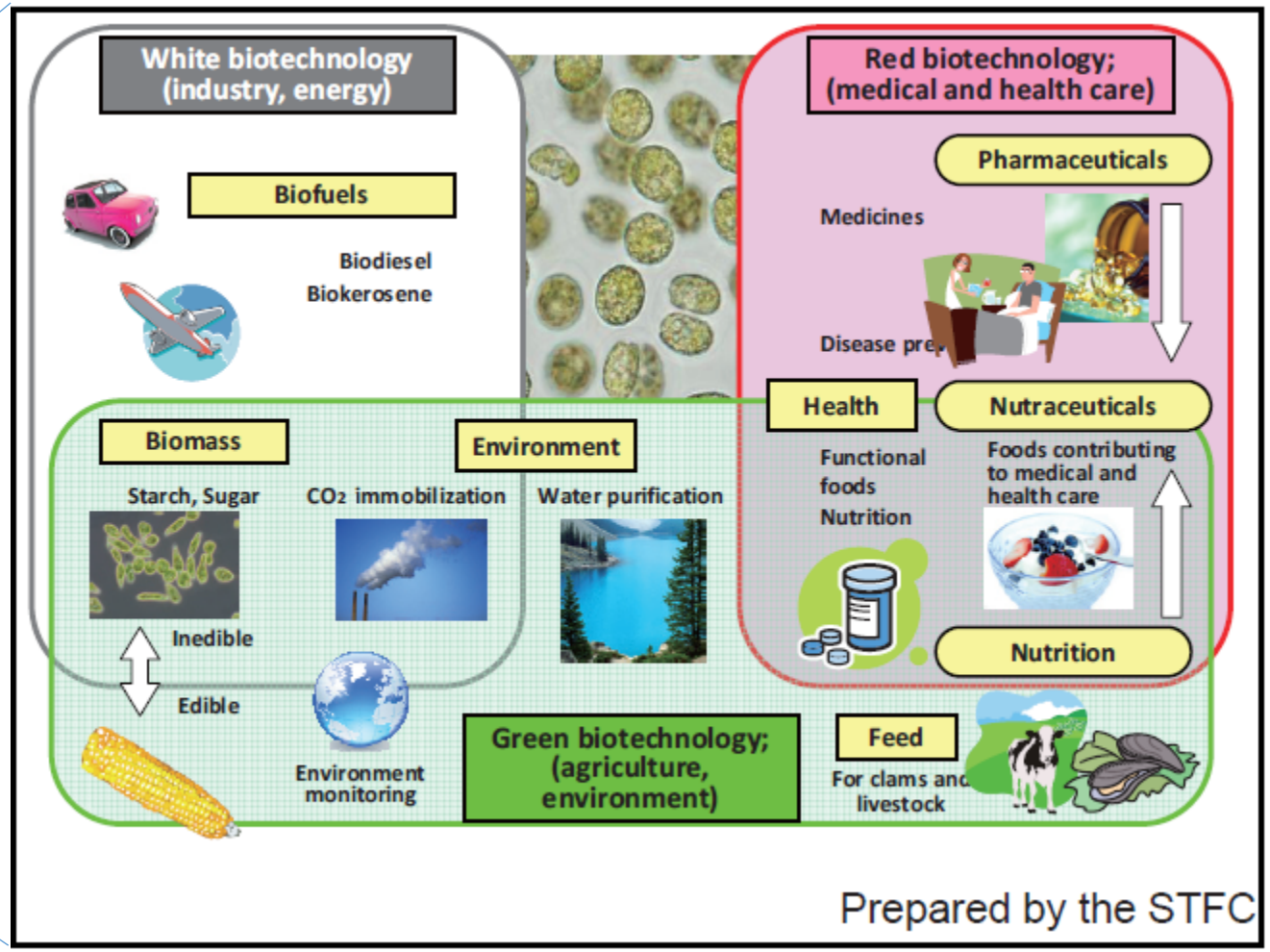


(Shoener et al., 2019)



Applications of microalgae

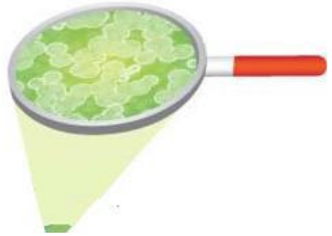




➢ **Promising microorganisms: several applications!**

Microalgae, general process concept

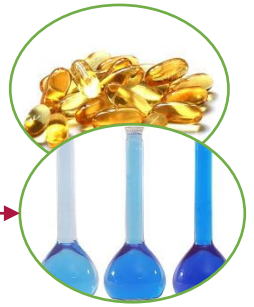
Microalgae process



- **Microalgae**: photosynthetic microorganisms considered as an interesting resource in various applications
- The microalgae sector is still at the exploratory stage: several technological challenges

Screening of species → **Culture** → **Harvesting** → **Downstream processing**

Liquid fraction



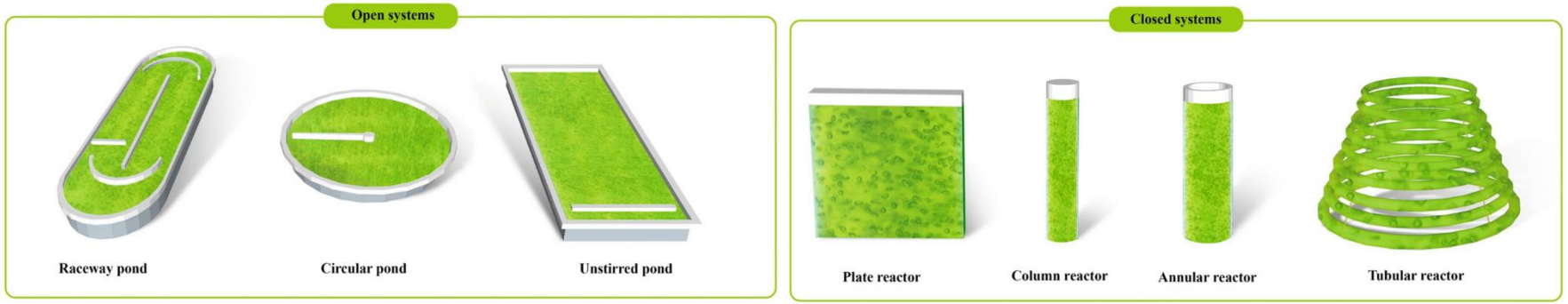
Algae residue

Biomass

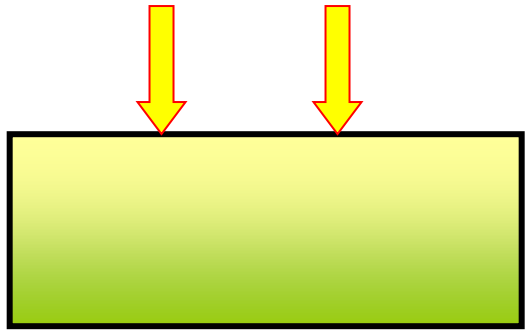
Set-up of a microalgae culture process :

innovative, productive and economical technology

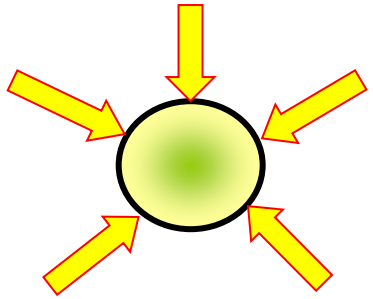
Microalgae culture systems



(Zerrouki et al., 2019)



Productivity:
0,06 – 0,1 g/L day

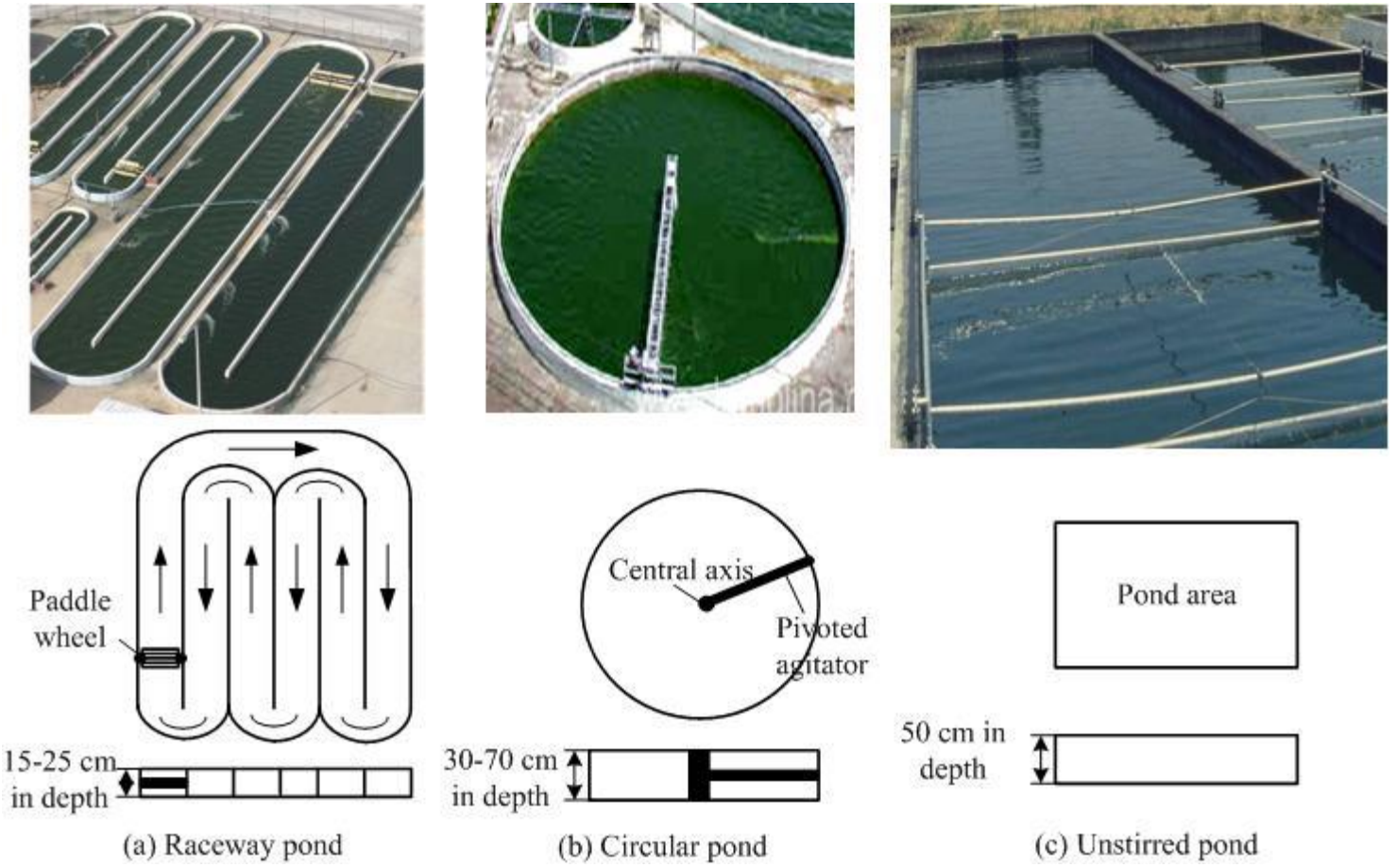


Productivity:
0,09 – 2,7 g/L day

	Open system	Closed system
CO_2 biofixation yield	Low	High
Water losses	High	Low
Growth rate	Low	High
Control law	Difficult	Easy

Importance of culture system selection
Potential of hybride systems

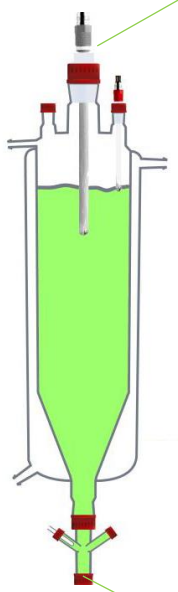
Open systems

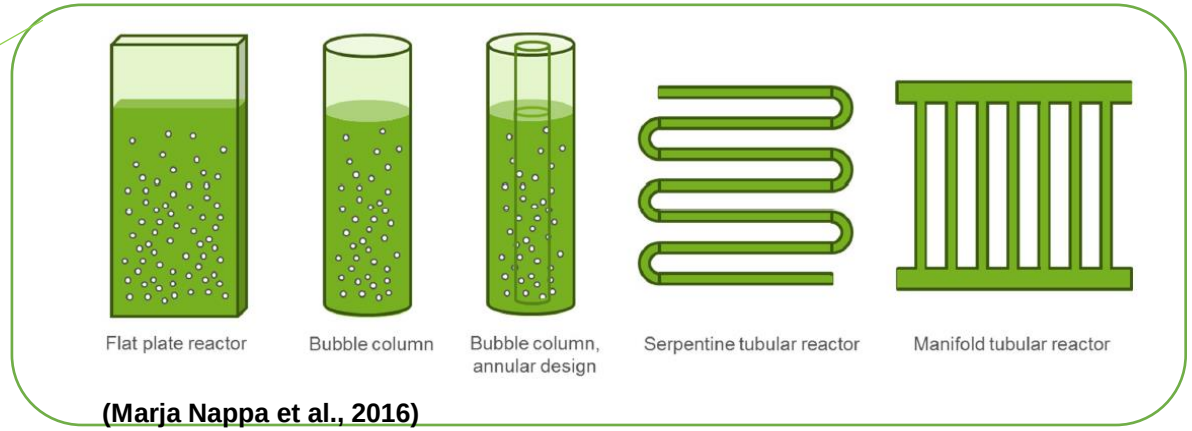


(Ying Shen, 2009)

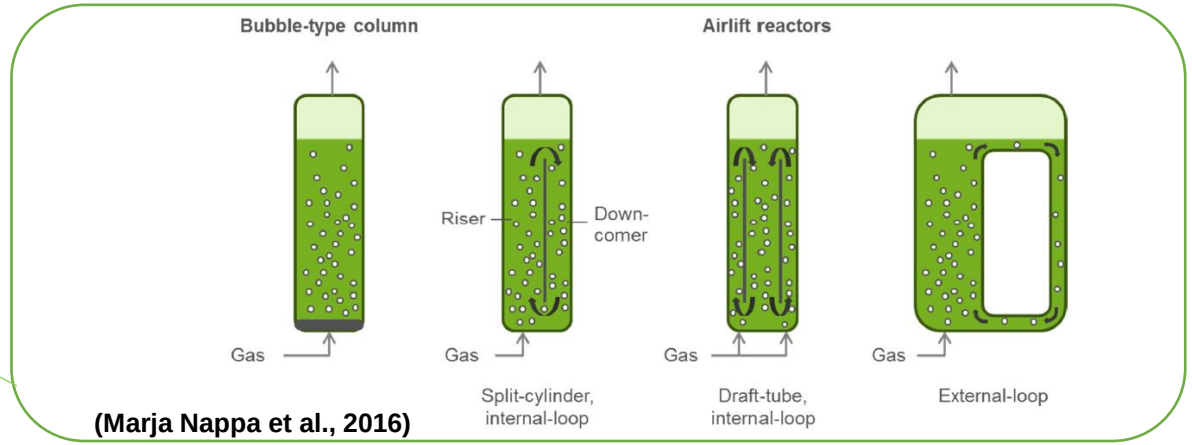
- Raceway pond: widely used for large-scale algal biomass production
- Low cost of construction and simplicity of installation and maintenance
- Biomass productivity impacted by evaporative losses, easily contaminated cultures, photoinhibition in the summer, light used by the cells, and diffusion of CO_2
- Most important design parameters of a raceway pond: the working depth and the hydraulic retention time (HRT)

Closed Systems, PBR





(Marja Nappa et al., 2016)

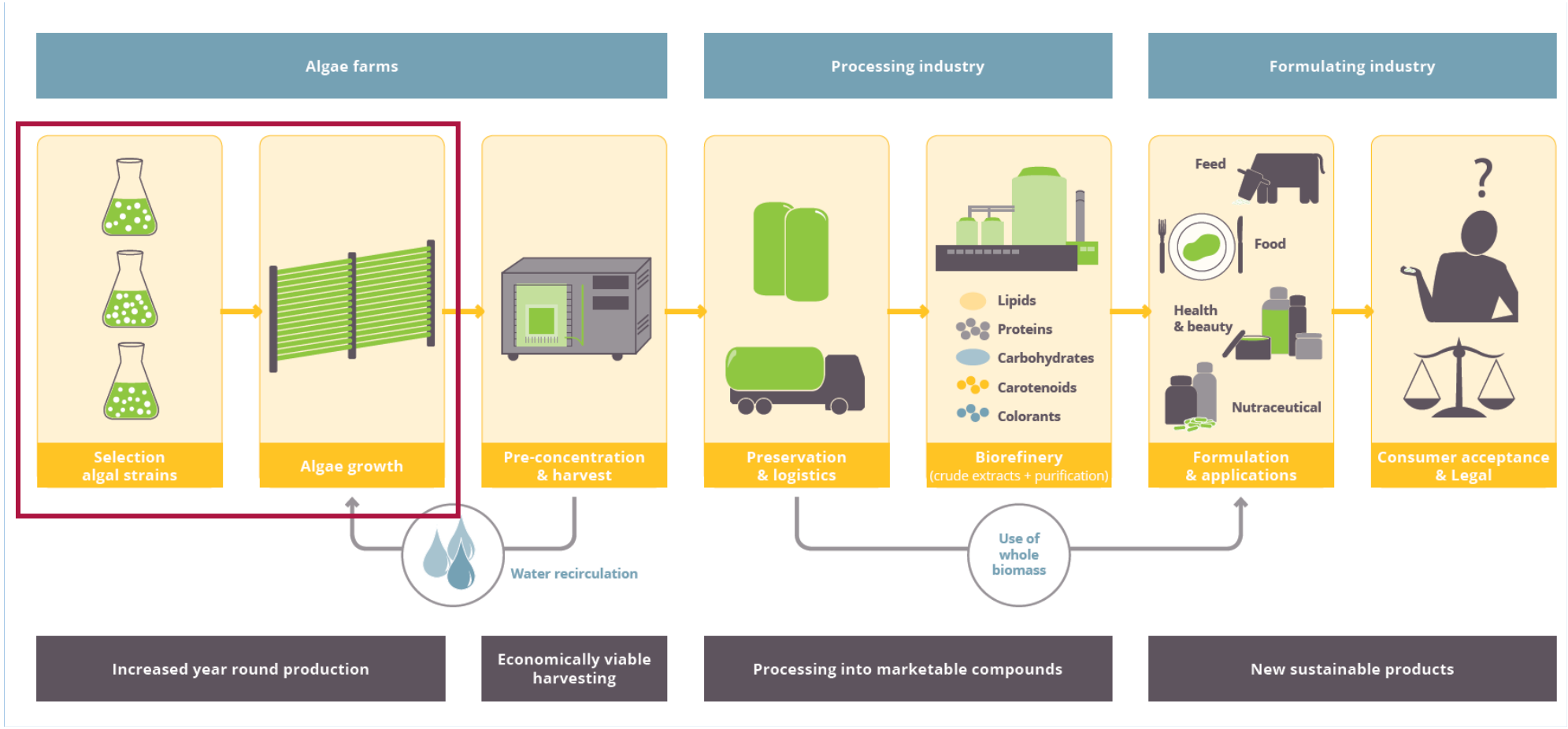


(Marja Nappa et al., 2016)

- Various design and mode of operation
- Construction materials: glass or plastic; rigid or flexible
- System adapted to algal species that cannot be grown in open systems
- Higher productivities and cost investment than ponds
- Energy requirement
- Scale-up is more difficult because of engineering issues related to gas/liquid mass transfer, energy efficient mixing and cooling of the culture

Microalgae culture process in IDEA Project

IDEA - Implementation & Development of Economic viable Algae-based value chains in NWEurope

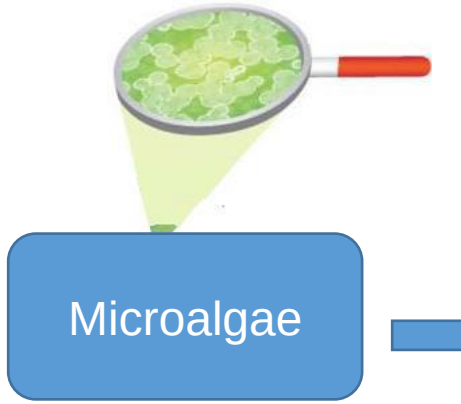


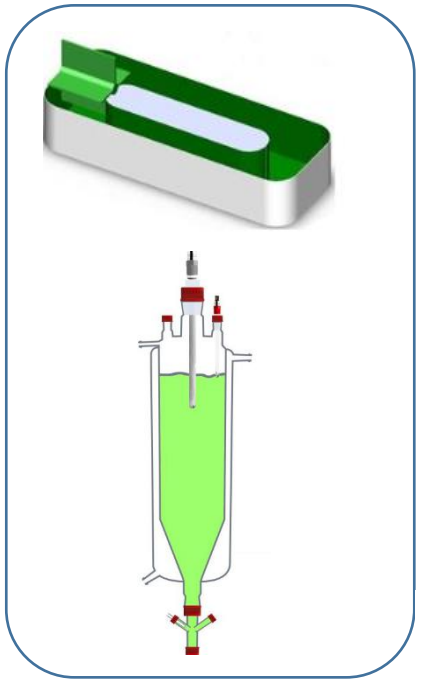
Aim of the microalgae culture step!

Implementation on our partners

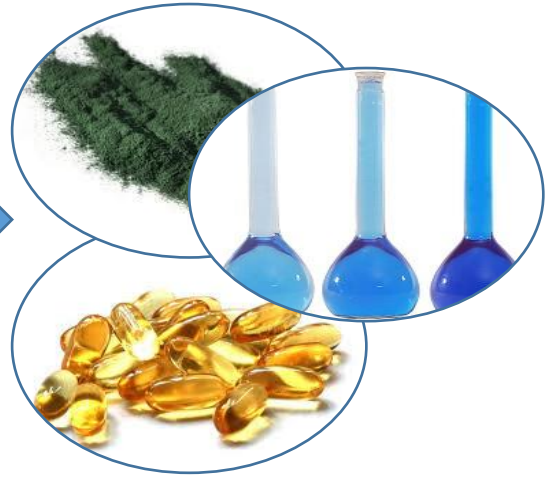
Scale-up

Culture systems





High value molecules



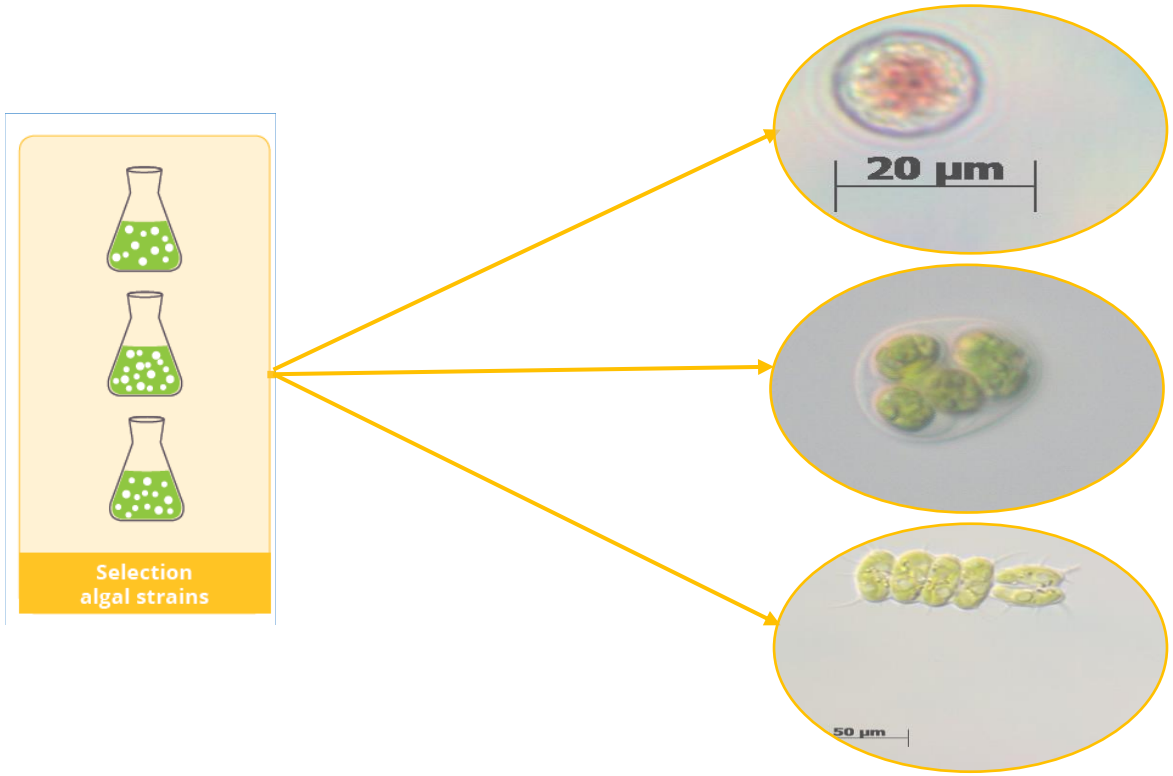
Growth condition:

North-West Europe seasonal condition

Low temperature
Low light

NWEurope conditions! Algae strains?

IDEA - Implementation & Development of Economic viable Algae-based value chains in NWEurope



Porphyridium purpureum

Chloromonas Typhlos

Mixed culture: *Chlorella, Scenedesmus& Synechocystis*

Optimization of the microalgae culture

- ***Growth performance of Chloromonas typhlos, Porphyridium purpureum and Scenedesmus consortia***

Experimental design

- Temperature
  - Cellular chemical composition
  - Uptake of nutriement and CO_2
  - Growth rate
- Light
  - Biomass accumulation
  - Lipid accumulation
  - Chlorophyll content

Sustainability of algae species for growing over all the year

Thank you for your attention