

2 Microalgae pigments : Structures, properties, extraction/purification and applications

2

Ecological diversity of microalgae and cyanobacteria



ENHANCE
MICROALGAE

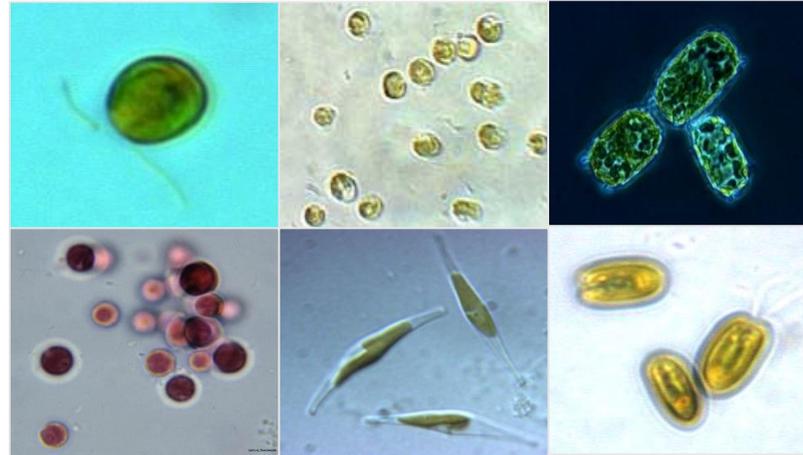
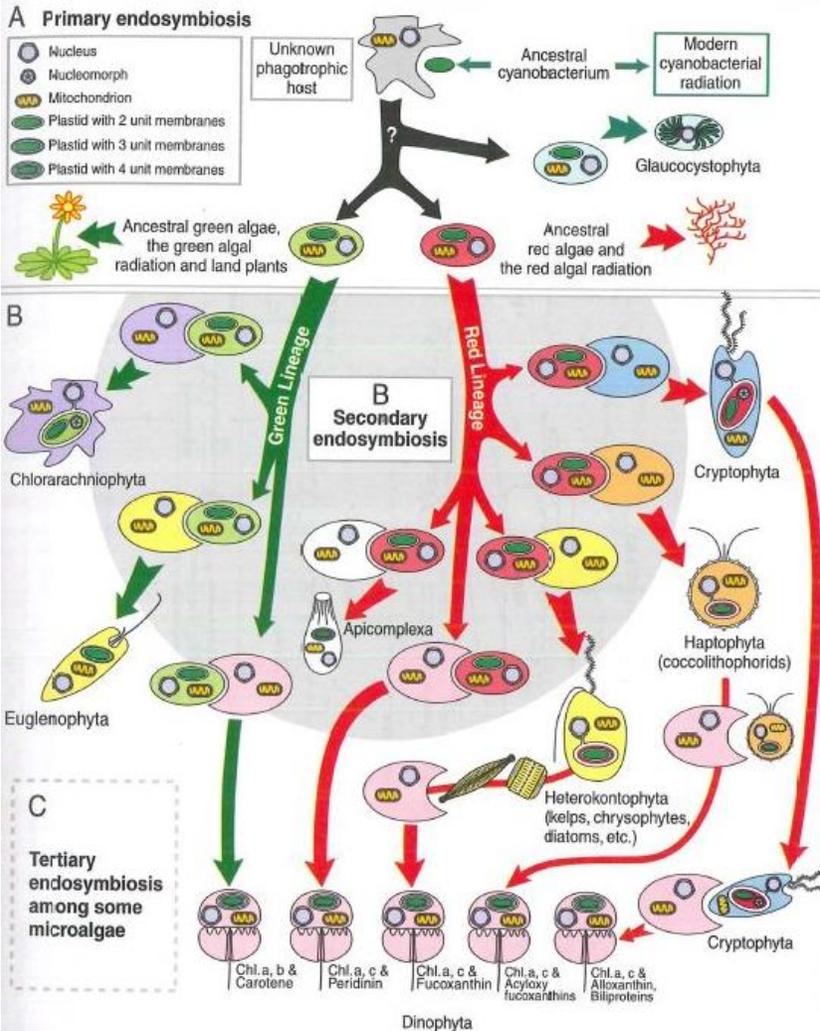


Interreg
Atlantic Area

European Regional Development Fund



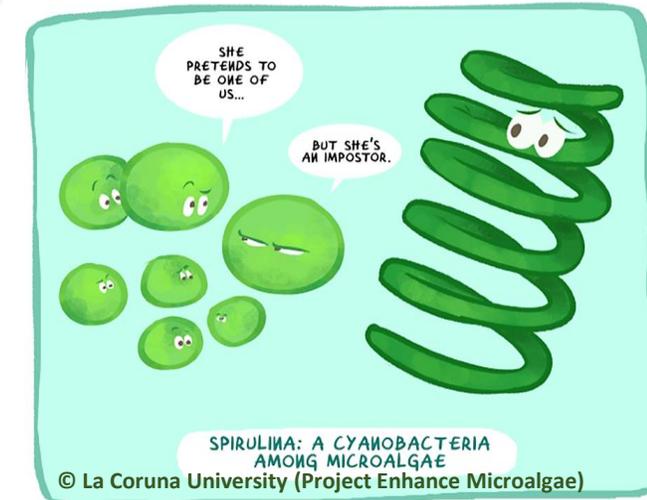
EUROPEAN UNION



Estimated : More than 1 million species
 Known : ~ 75 000 species
 Cultivated: ~ 50
 Commercially exploited: ~ 40

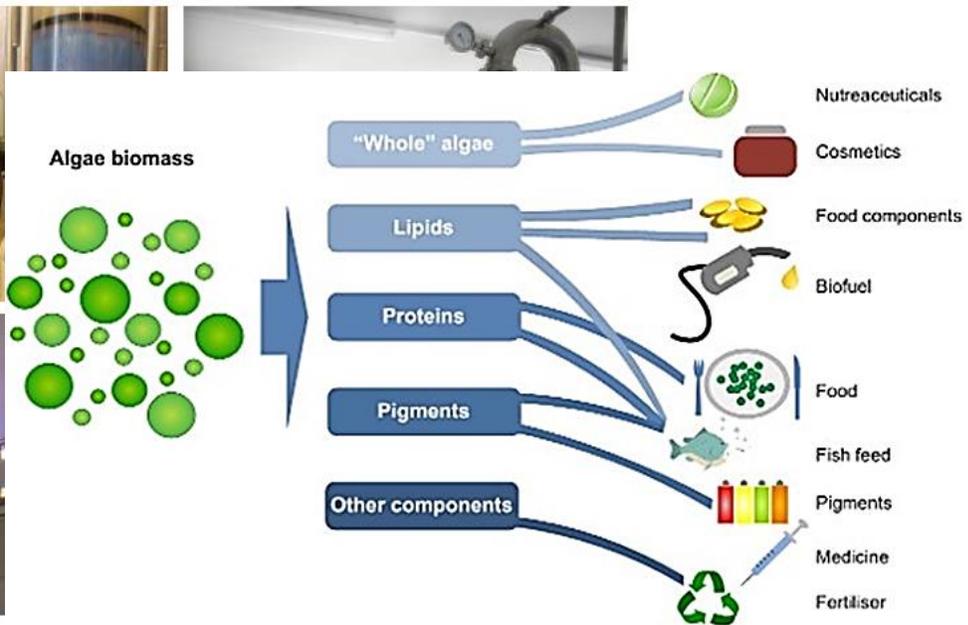
Eucaryotic, Procaryotic = cyanobacteria,
 mesocaryotic (dinoflagellates)
 Diverse and original pigments and secondary
 metabolites in link with a long evolutionary
 history and adaptation to diverse
 environments

> 200 pigments and derivatives identified



2

An industrial potential For high-added value products



2 Illustration of microalgae pigment diversity



ENHANCE
MICROALGAE

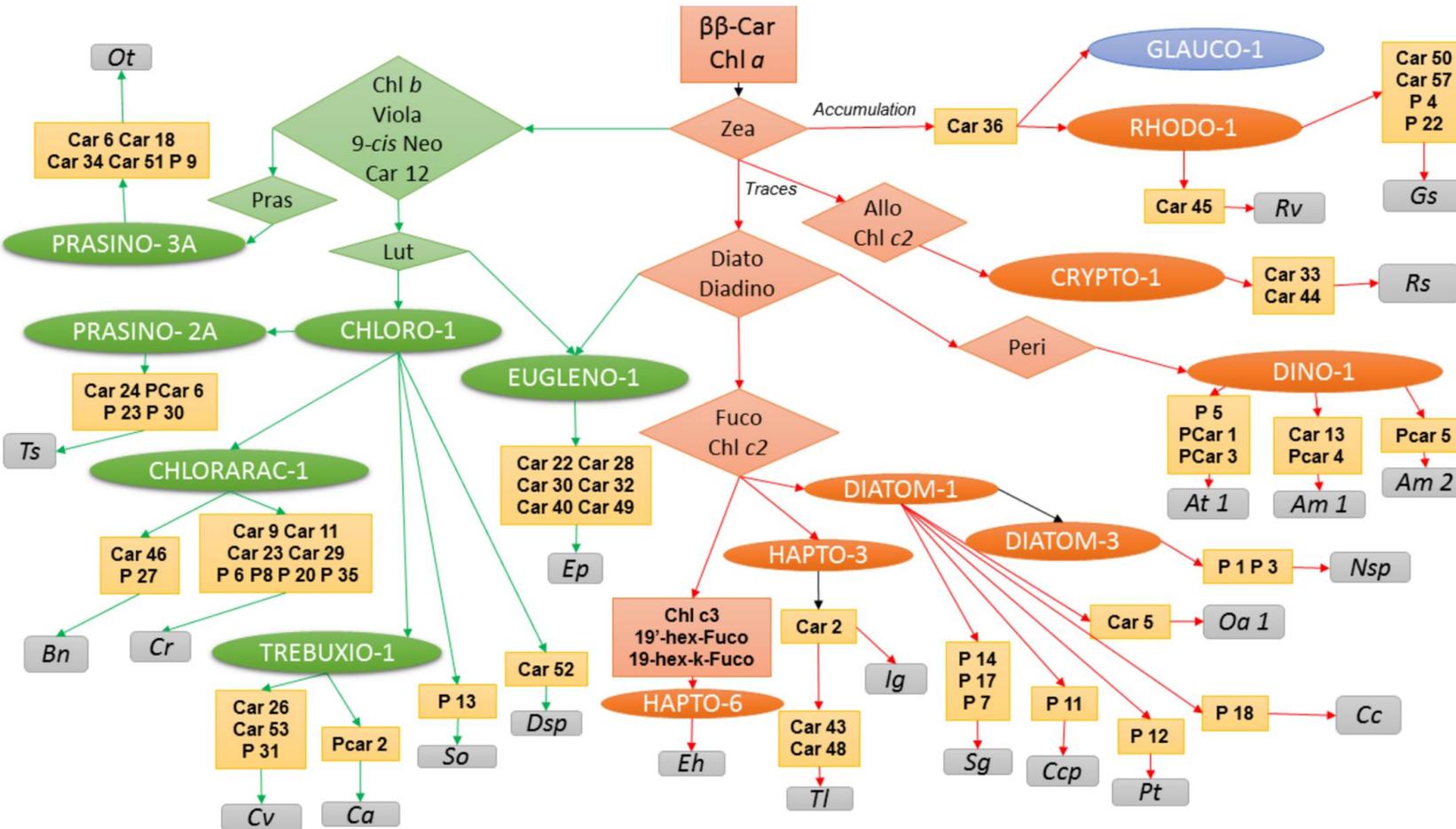


Interreg
Atlantic Area

European Regional Development Fund



Dichotomous keys for microalgae strain identification by pigment composition.



Sevire B, *et al.* (2017) Community analysis of pigment patterns from 37 microalgae strains reveals new carotenoids and porphyrins characteristic of distinct strains and taxonomic groups. PLOS ONE 12(2): e0171872.

2 Chlorophylls and derivatives

Main properties

Porphyrins

Apolar to moderately polar

Deep green pigments
Some polar derivatives are gray
(e.g. pheophorbide *a*)

Thermolabile > 40°C
Photosensitive

Extraction/purification
At lab/industrial scale

Maceration/soaking in
ethanol/acetone

Ultrasonication

Microwaves-assisted

Supercritical CO₂

Chromatography
(column, TLC, Flash,
preparative HPLC, CPC)

Markets and application

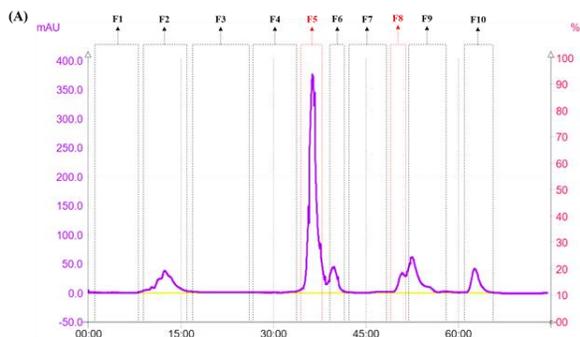
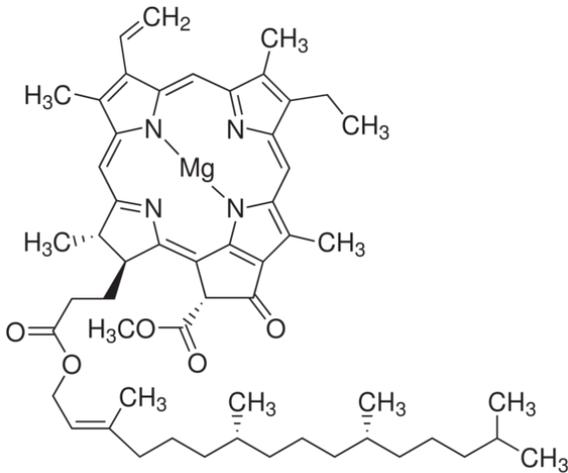
Food and cosmetics

Tumor and antibacterial
photosensitizers for
phototherapy

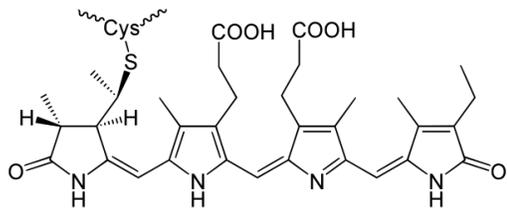
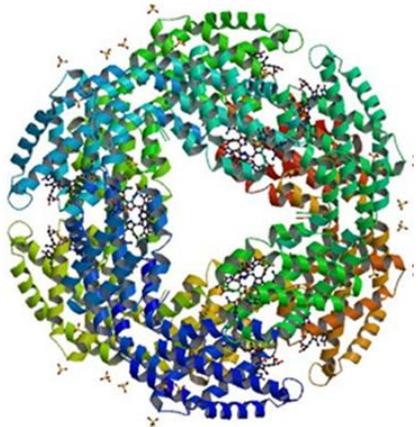
Estimated price
(Pharma grade)

Chl *a*: 200 €/mg

Pheophorbide *a*:
450€/100 mg



2 Phycobiliproteins



Main properties

Proteic pigments containing linear tetrapyrrolic chromophores

Highly polar and highly fluorescent

3 main pigments
Phycocyanin (Blue)
Phycoerythrin (Pink)
Allophycocyanin (Gray)

Thermolabile $>40^{\circ}\text{C}$
Photosensitive

Extraction/purification At lab/industrial scale

Maceration/soaking in Water followed by column purification (size-exclusion chromatography) to remove other proteins

Supercritical CO_2

Ultrasonication

Microwaves-assisted

Chromatography (column, TLC, Flash, preparative HPLC, CPC)

Markets and application

Food (Beverages) and cosmetics

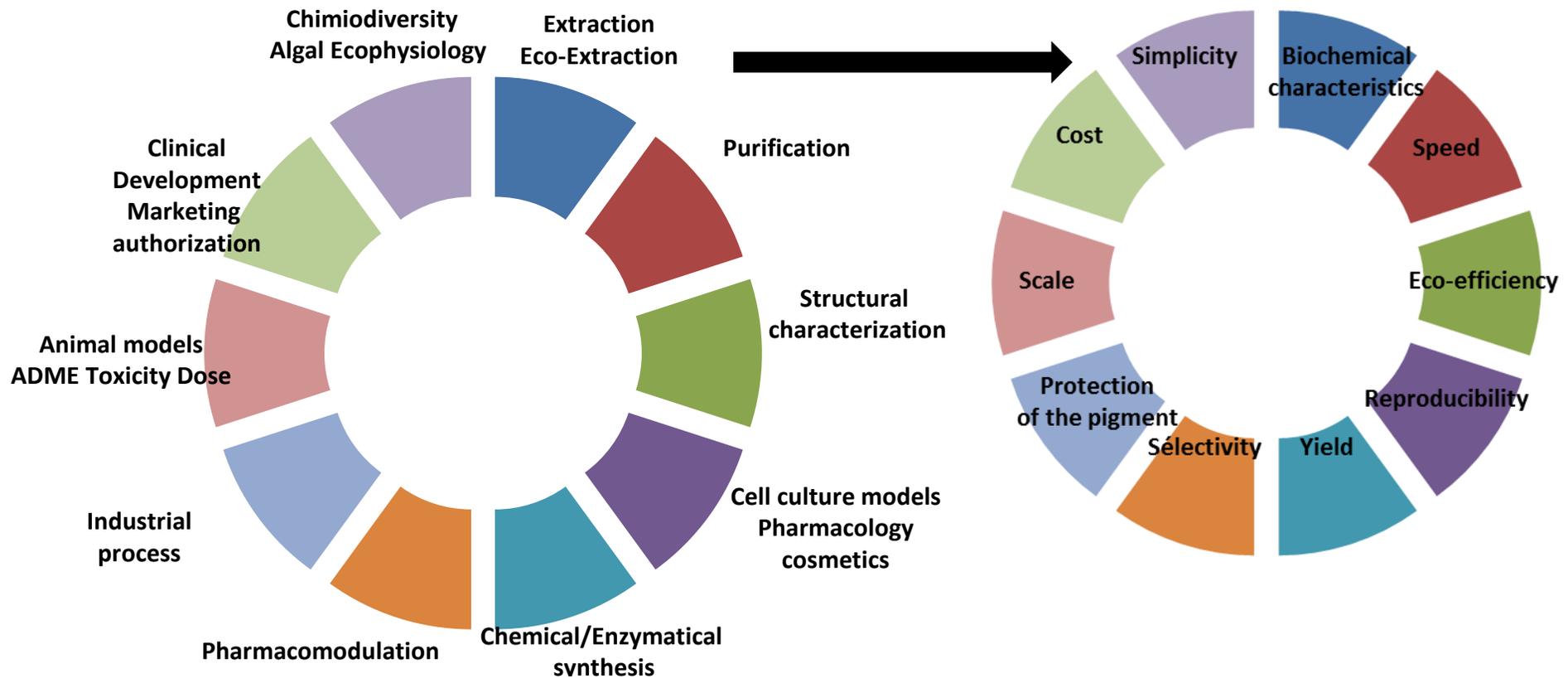
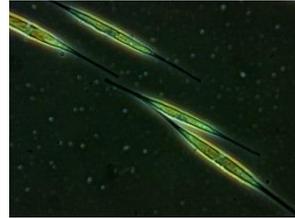
Fluorochromes coupled to antibodies for immunofluorescence (diagnosis, cell biology)

Estimated price (Pharma grade)

C-PC from Spirulina
20 €/mg

R-PE from rhodophytes
150€/mg

2 From microalgae to pigments and bioactivity



2 Conclusion on microalgae pigments



ENHANCE
MICROALGAE



Positive points

A very high chemical diversity

Most microalgae pigments have no oral toxicity in humans

Biological, photophysical and pharmacological activities of high interest for food, feed, cosmetics and health applications

High value allowing good valorization of algal biomass by bio-refinery

The biological and physical behaviour of these pigments is well known allowing high yields extraction and efficient purification processes

Points to improve

Only few pigments are purified at industrial scale, many bioactive pigments are not sold in high amounts, high cost and energy to purify them

Many *in vitro* and animal studies confirm their potential for health but only few have obtained a market authorization because of development costs and restrictive legislation

Need to find new innovative applications (e.g. microalgae pigments as chemosensitizers to anticancer drugs, or for antibacterial phototherapy).

2 Selected references



ENHANCE
MICROALGAE



Japanese Carotenoids database: carotenoiddb.jp

Mimouni V. *et al.* The potential of microalgae for the production of bioactive molecules of pharmaceutical interest. *Current Pharmaceutical Biotechnology* 13(15), 2733-2750, 2012.

Talero E. *et al.* Bioactive compounds isolated from microalgae in chronic inflammation and cancer. *Marine Drugs* 13(10), 6152-6209, 2015.

Juin C. *et al.* UPLC-MS^E profiling of phytoplankton metabolites: Application to the identification of pigments and structural analysis of metabolites in *Porphyridium purpureum*. *Marine Drugs* 13, 2541-2558, 2015.

Lefranc F. *et al.* Algae metabolites: from in vitro growth inhibitory effects to promising anticancer activity. *Natural Products Reports*, DOI 10.1039/C8NP00057C, 2018.

Haguet Q. *et al.* Antimelanoma activity of *Heterocapsa triquetra* pigments. *Algal research* 25, 207-215, 2017.

Serive B. *et al.* Community analysis of pigment patterns from 37 microalgae strains reveals new carotenoids and porphyrins characteristic of distinct strains and taxonomic groups. *Plos one* 12(2):e0171872, DOI: 10.1371/journal.pone.0171872, february 2017.

Thank you for your attention!

Contact : laurent.picot@univ-lr.fr

**Please visit the Interreg EnhanceMicroalgae website
<https://www.enhancemicroalgae.eu/>**



ENHANCE
MICROALGAE



Interreg



Atlantic Area

European Regional Development Fund