From Fundamental research regarding the protein N-glycosylation pathways in microalgae to the production of microalgae-made biologics at industrial scale

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Professor University of Rouen Normandie, GlycoMEV lab

Adebiotech – Lille, July, 1st

HUB4GLYCO
Réseau Pathologies de la Glycosylation
RECHERCHE & INNOVATION

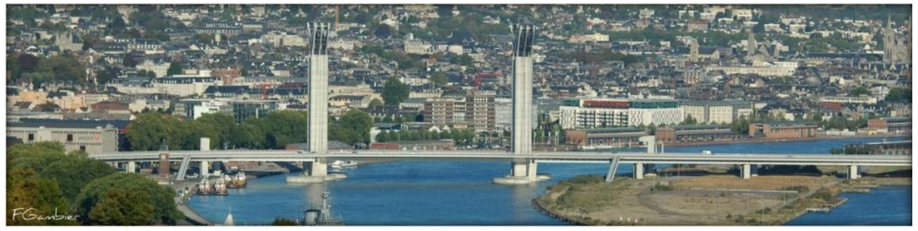
GLYCO-N
GLYCOprotein N-glycosylation from non-life to eukaryotes: a Doctoral Network to expand the knowledge on a ubiquitous post-translational modification of proteins
HORIZON-MSCA-2023-DN-01-01

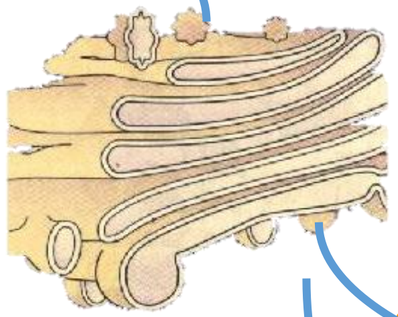
SMACC+
Interreg Atlantic Area
Co-funded by the European Union

AFT 2026
Advanced Fermentation Technology

GlycoMEV activities: Structure, biosynthesis and functional properties of plant and microalgae glycoconjugates

UNIVERSITÉ DE ROUEN NORMANDIE



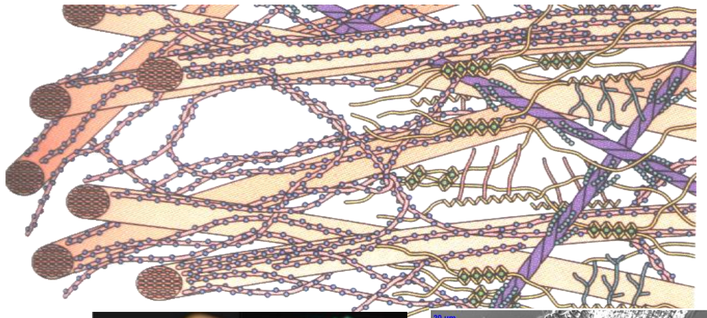


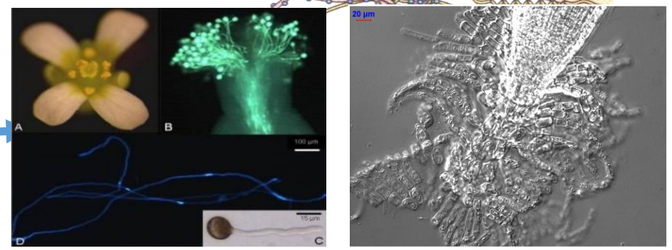
Inside

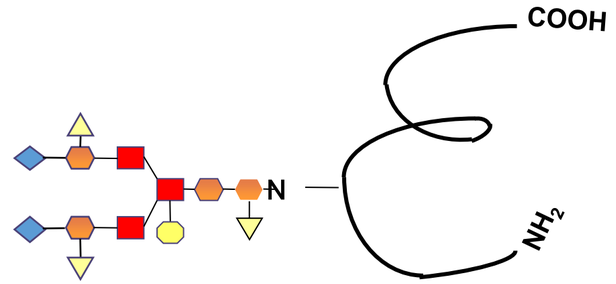
outside

Golgi apparatus

Cell wall polysaccharides







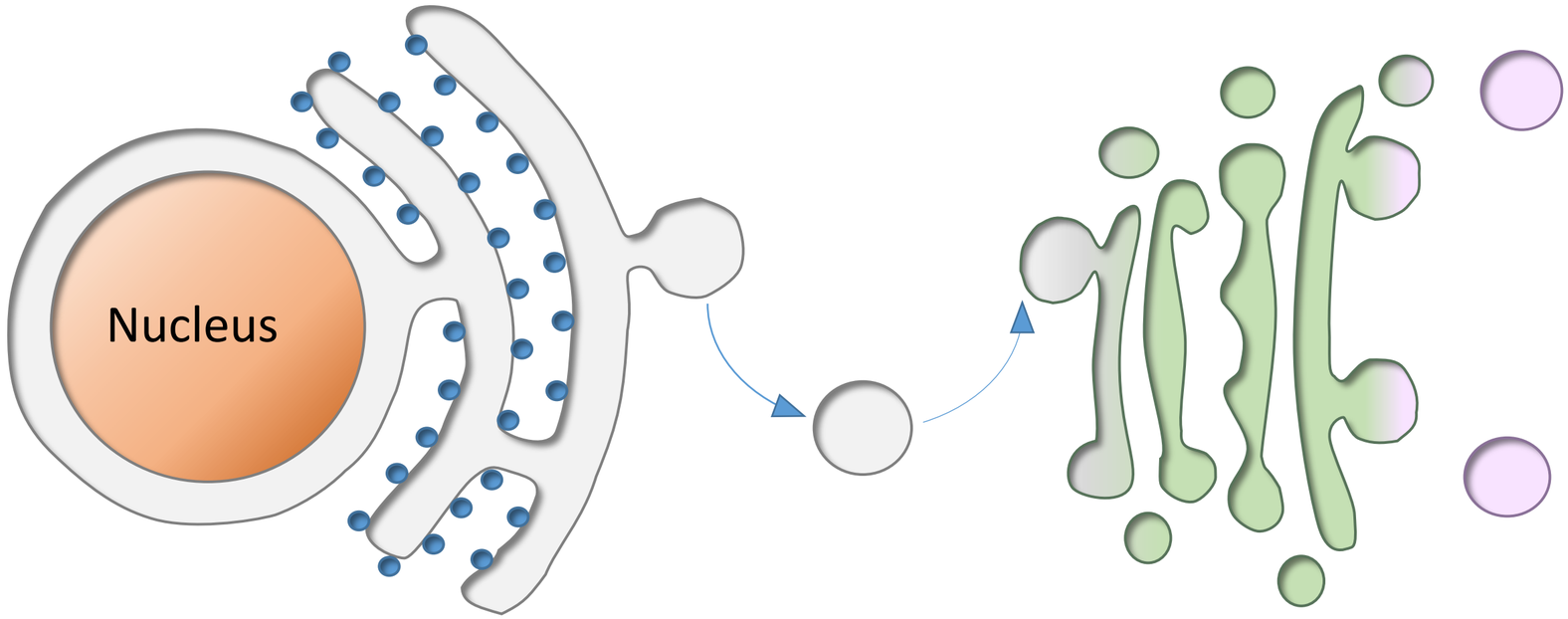
Glycoproteins

Towards understanding the protein *N*-glycosylation in microalgae

MICROALGAE

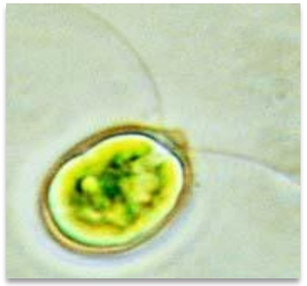
Endosplamic Reticulum (ER)

Golgi apparatus

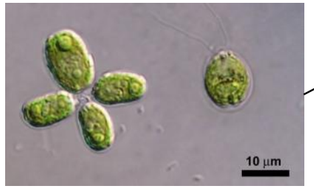


Synthesis of the precursor → *N*-glycan maturation → *N*-glycan complex

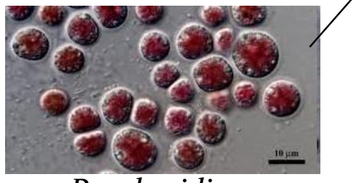
Microalgae are unicellular organisms that possess a big capacity of adaptation and an extreme diversity



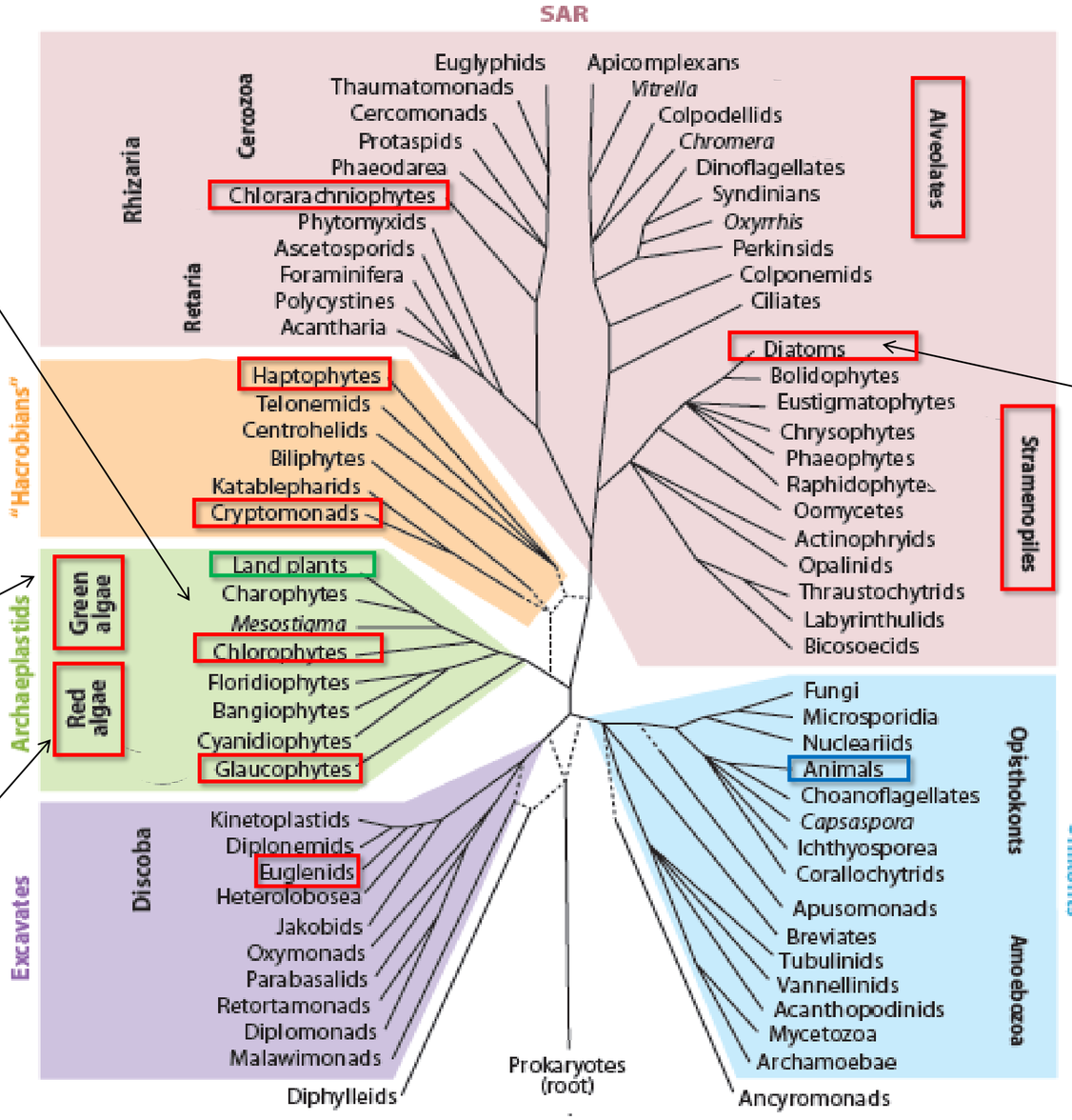
Chlamydomonas reinhardtii



Chlamydomonas pacifica



Porphyridium cruentum

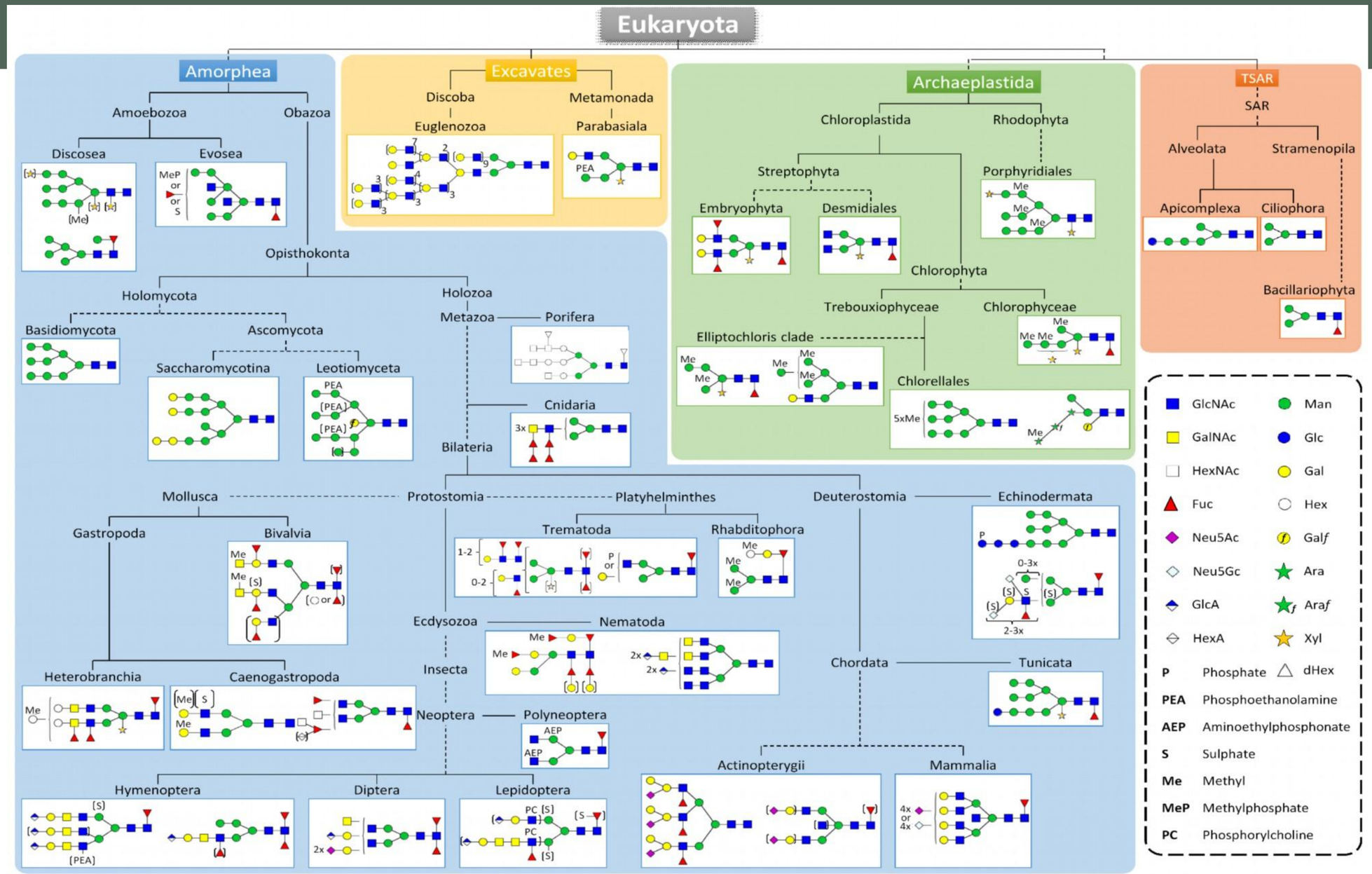


Phaeodactylum tricornutum

Thalassiosira pacifica

Modified from Keeling et al., 2013

Huge diversity of *N*-glycans in the microalgae



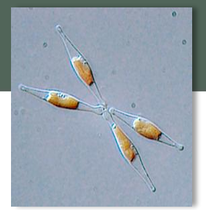
Toustou al., 2022 biological reviews

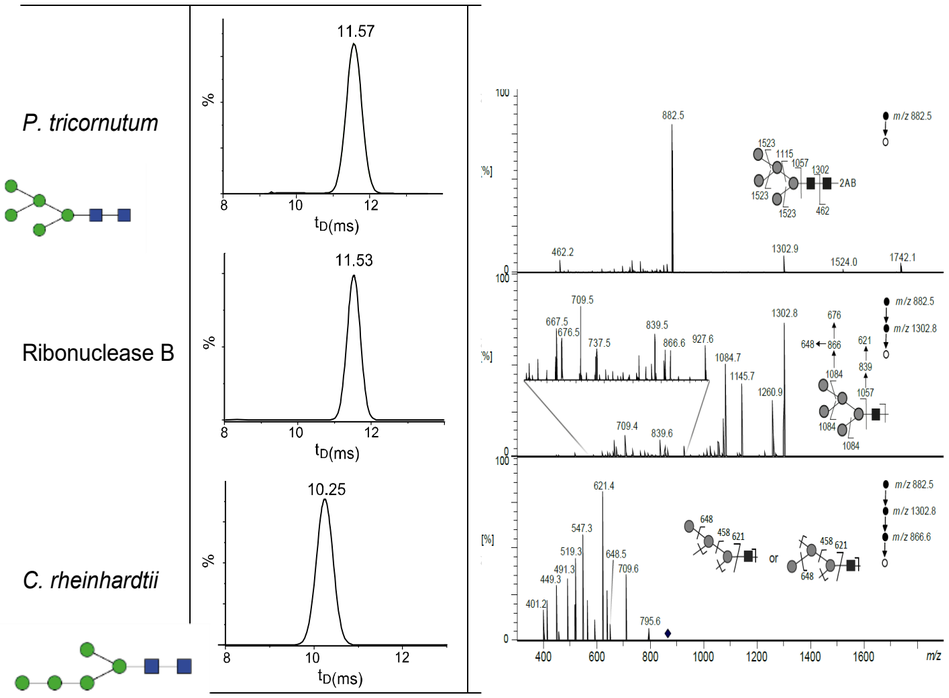
GLYCOprotein *N*-glycosylation from non-life to eukaryotes: a Doctoral Network to expand the knowledge on a ubiquitous posttranslational modification of proteins

(2024-2028)

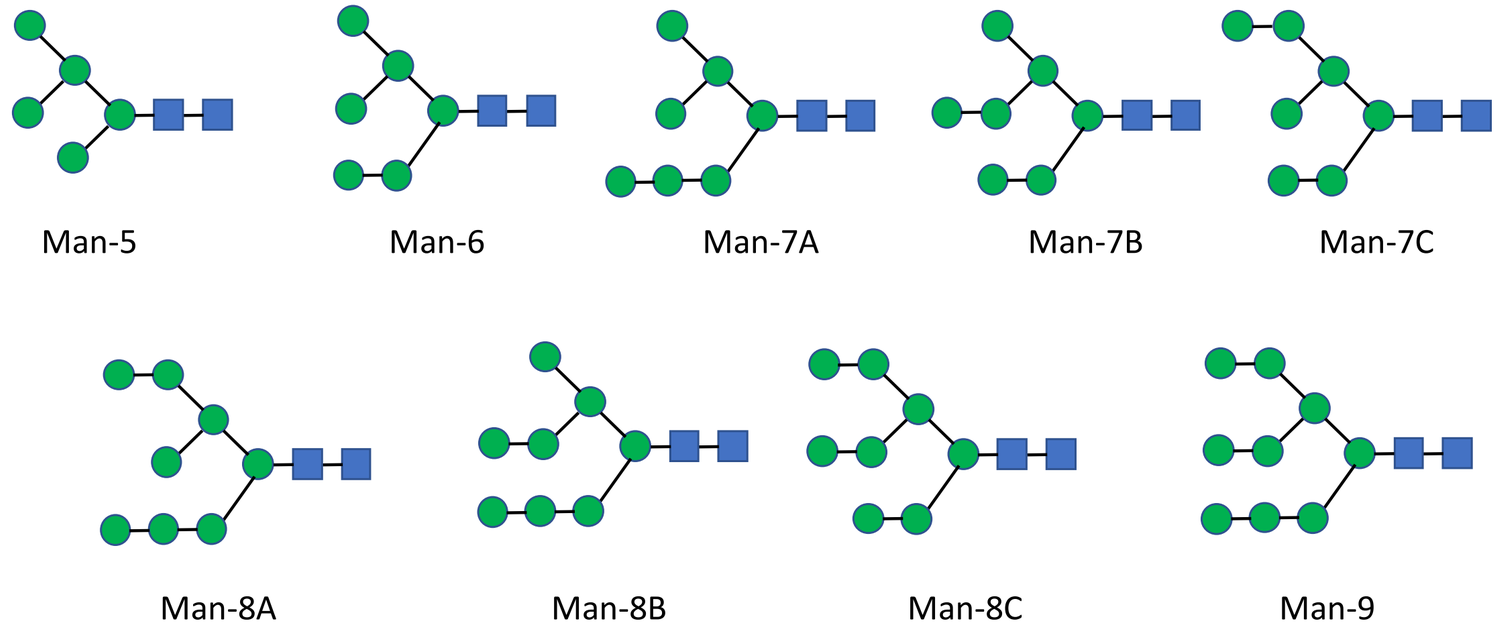
https://glyco-n.eu/

Phaeodactylum is producing identical oligomannoside *N*-glycans as the ones synthesized by mammalian cells



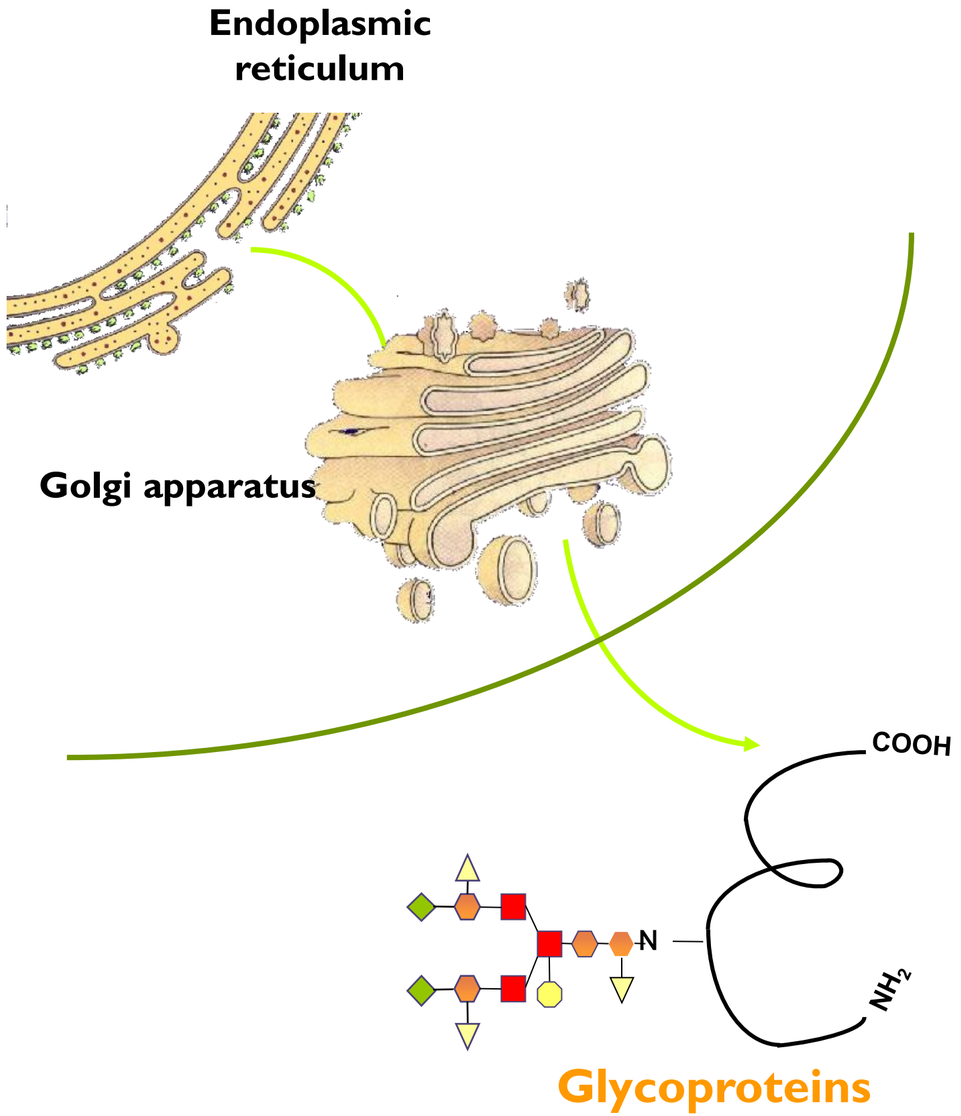


IMS-MS and ESI-MSn



Dumontier et al., 2021

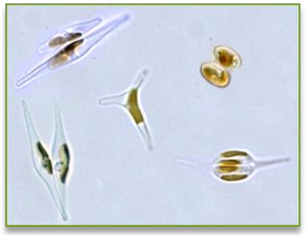
Phaeodactylum as a cell biofactory for the production of biopharmaceuticals



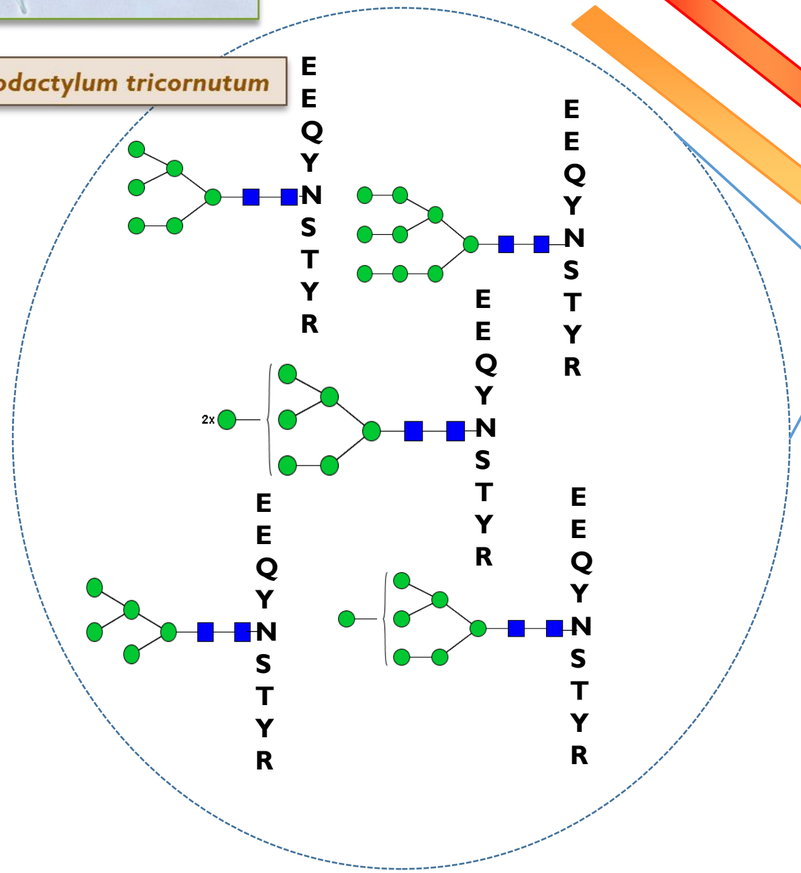
Glycoproteins

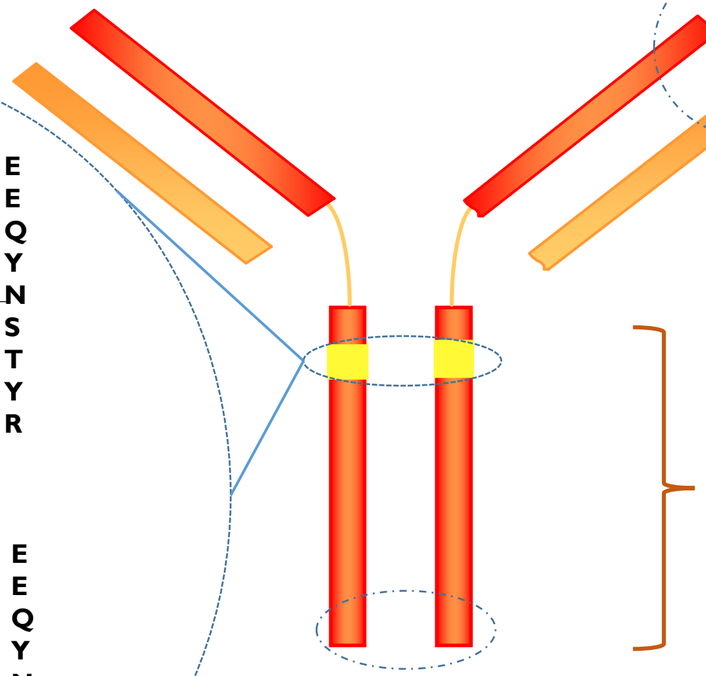
Alternative expression systems

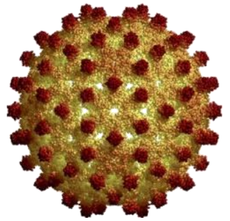
Production and characterisation of a human recombinant antibody directed against the Hepatitis B virus antigen



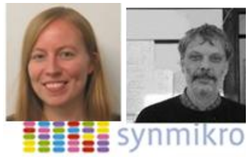
Phaeodactylum tricornutum







		K_D
FcγRI	anti-HBsAg	330 ±20 pM
	human IgG1	73 ±12 pM
FcγRIIIa	anti-HBsAg	182 ±11 nM
	human IgG1	542 ±13 nM



synmikro

Zentrum für
Synthetische Mikrobiologie

St George's
University of London

Hempel et al., 2011; Hempel and Maier, 2012; Vanier et al., 2015; Vanier et al., 2018

WOMEN TechEU

Funded by the European Union

FRANCE 2030

LABELISED DEEP TECH

La FRENCH TECH

bpifrance

BEST STARTUP CATEGORY

PRIX GALIEN USA

NOMINEE 2025

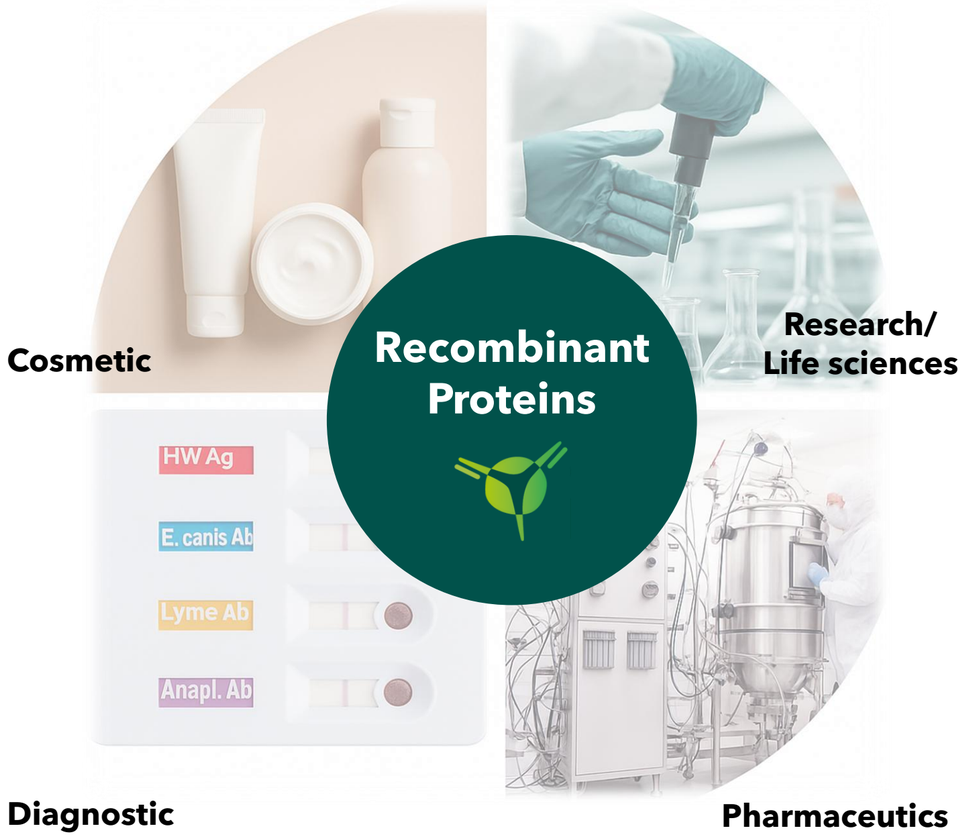
alga biologics

Next-Gen microalgae cell biofactories, sustaining Life

www.algabiologics.com

Issues with current conventional models

Recombinant proteins are a fast-growing market, powering innovations across an expanding range of industries.

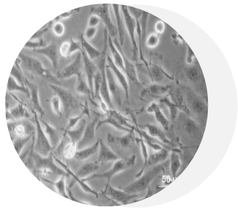
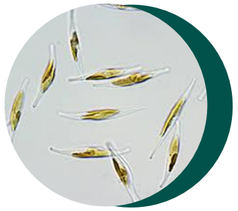


Today's conventional production systems face critical limitations:

- **Costs & accessibility**
- **High Environmental Footprint**
- **Risk of viral and endotoxin contamination**

Our patented innovative solution

Microalgae cell biofactory: a game-changing platform

	Mammalian cells	Bacteria	Yeast	Phaeodactylum tricornutum
				
Production of complex proteins (e.g antibodies)	✓	✗	✗	✓
Human like glycosylation	✓	✗	✗	✓
Risk of contamination	✗	✗	✗	✓
Simplicity of culture media	✗	✗	✗	✓
Low production costs	✗	✓	✗	✓

4-patent portfolio already granted with extension in different countries
built on 12+ years of pioneering research by Muriel Bardor and her team – internationally recognized

SUSTAINABLE DEVELOPMENT GOALS

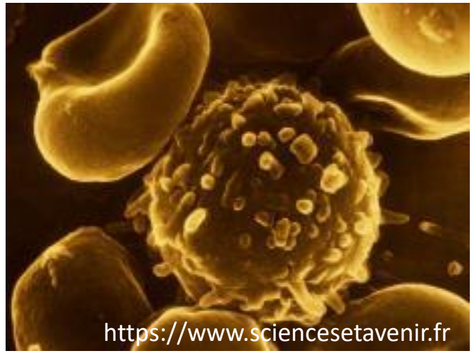
3 GOOD HEALTH AND WELL-BEING
5 GENDER EQUALITY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION

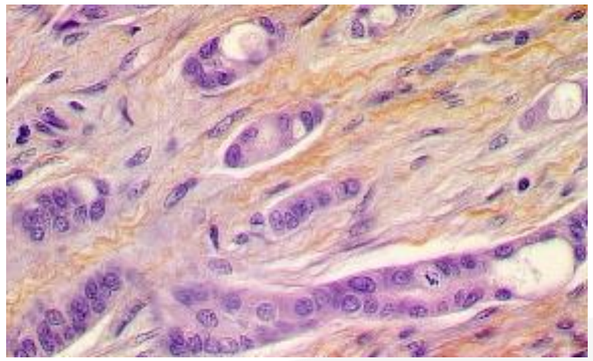
Production of microalgae based antibodies

For research and Diagnostic applications

Rituximab:

- Lymphome non hodgkinien
- 6th cause of death in France,
- 6th antibody used worldwide
- Market of 7 milliards US$





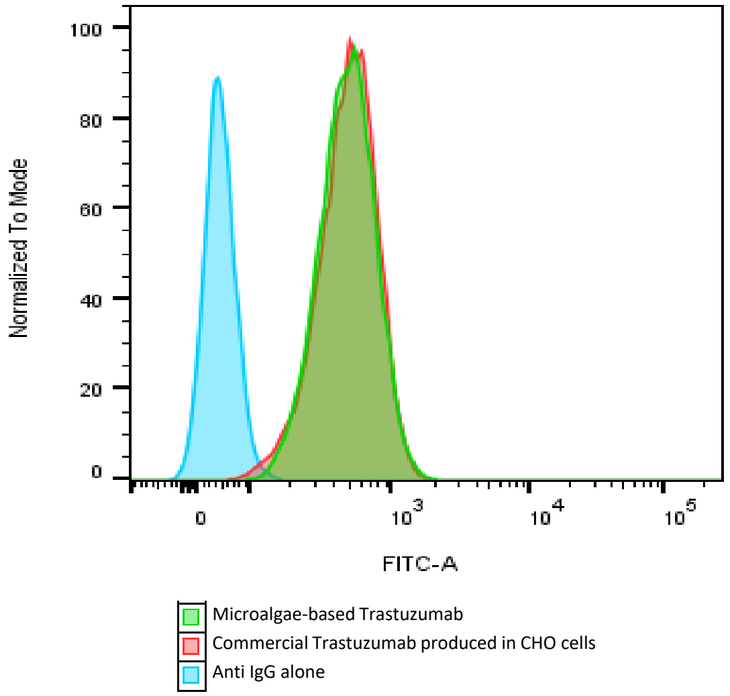
Trastuzumab:

- Breast cancer
- 1/3 of cancers in females
- 4th antibody used worldwide
- Market of 7 milliards US$

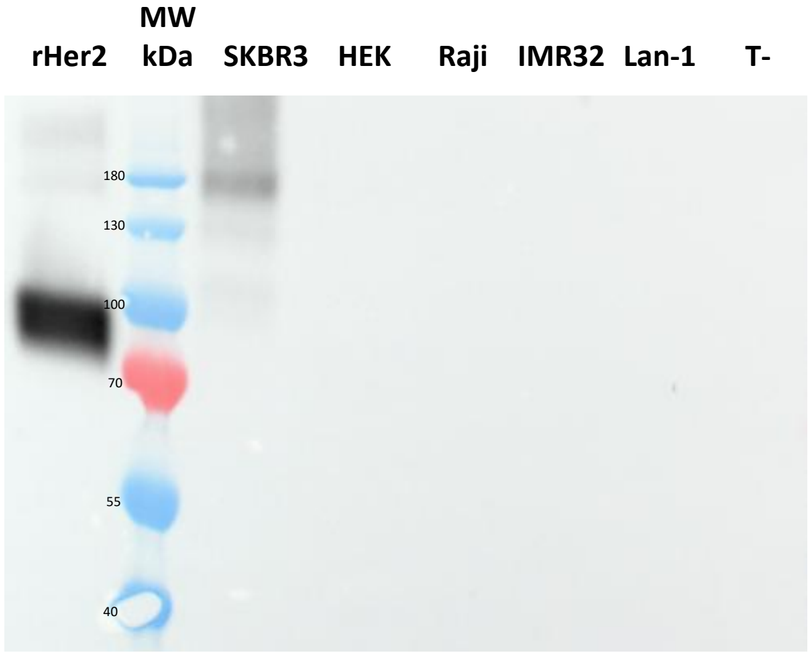
Microalgae-based TrastuzumAb is as efficient as CHO-based antibodies for research and diagnostic applications

Validated for FACS and WESTERN BLOT analyses

FACS



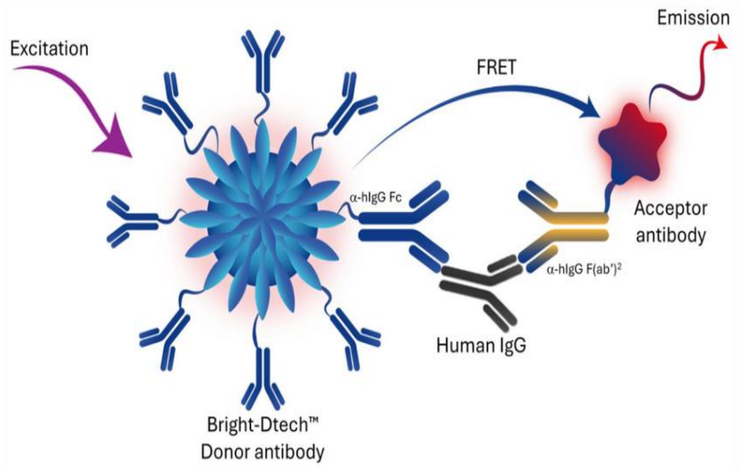
Western Blot



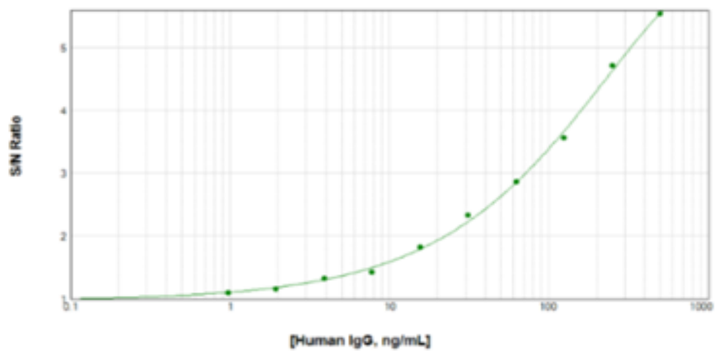
**Toustou/Salvetti et al., 2026 (in press in Plant Biotech Journal)*

Microalgae-based TrastuzumAb is as efficient as CHO-based antibodies for research and diagnostic applications

Validated for ELISA



POLY-DTECH

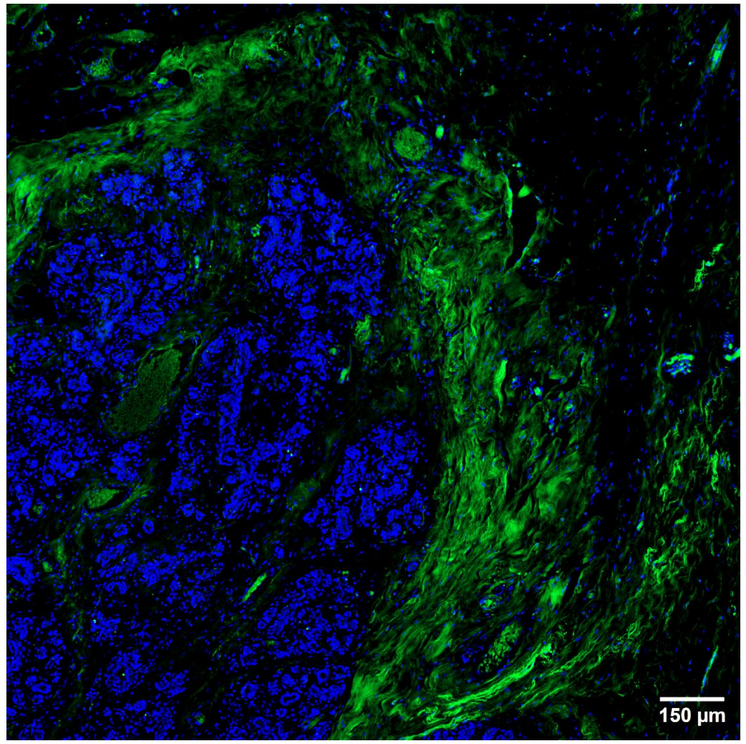


LOD = 0,6 ng/mL - LOQ = 2,6 ng/mL

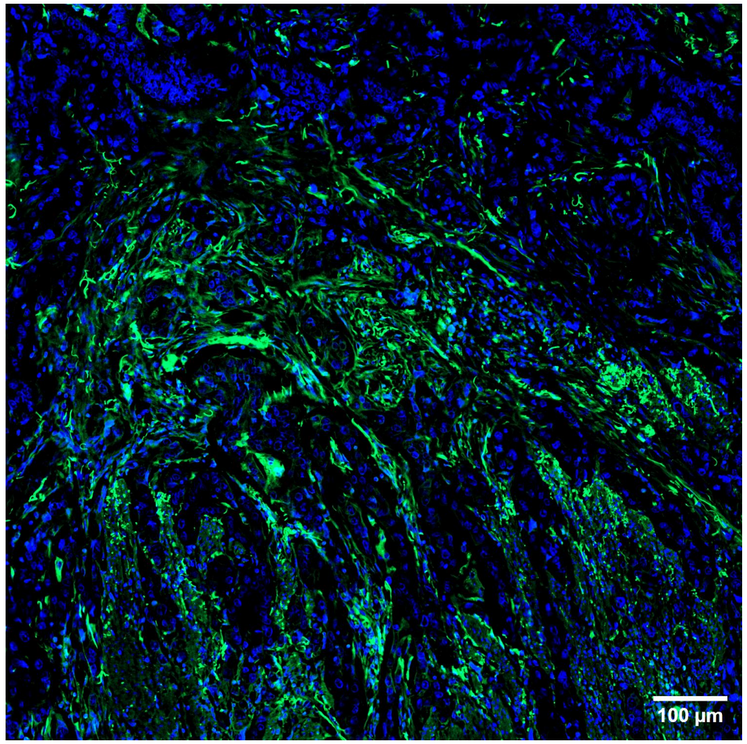
"Working with Alga Biologics has been a great pleasure: professionalism and scientific rigor were the order of the day. ***The Trastuzumab antibody produced in microalgae was successfully integrated into our detection tests*** *dedicated to this target. It enabled us to generate data and standard curves that could be used in diagnostic tests after clinical validation."* Joan Goetz, eMBA, PhD, CEO of POLY-DTECH

Microalgae-based TrastuzumAb is as efficient as CHO-based antibodies for research and diagnostic applications

Validated for Immunohistochemistry (IHC)



*Specific staining of HER2+ human breast tumor with microalgae-based TrastuzumAb**



*Specific staining of HER2+ human stomach tumor with microalgae-based TrastuzumAb**

**Toustou/Salvetti et al., 2026 (in press in Plant Biotech Journal)*

Pharmaceutical applications: production of an antibody targeting neuroblastoma

alga biologics

i-Lab

Finalist 2023

Solid tumor affecting **25,000 children worldwide every year** with an annual increase of +1,5% per year[1]

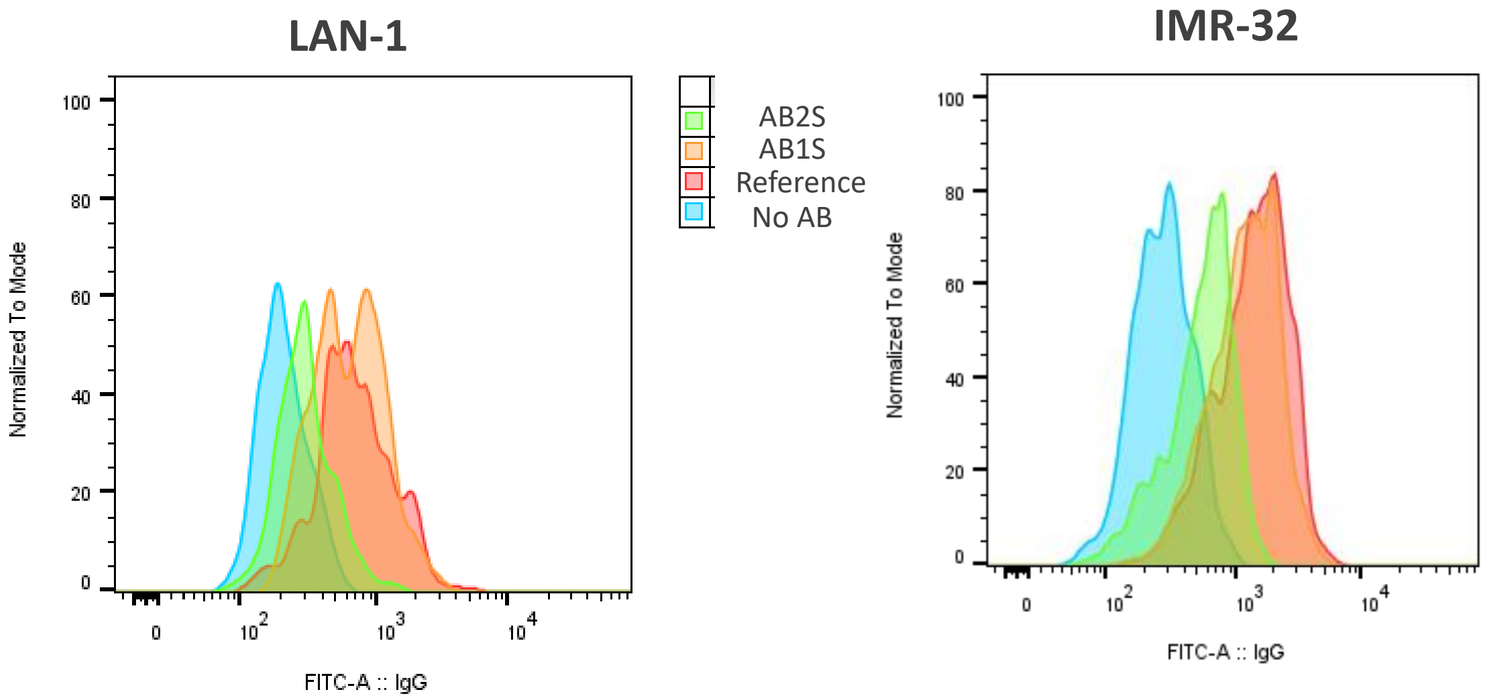
Currently, only 2 antibodies on the market produced in mammalian cells (limited efficacy, high cost)

Survival rate < 50% [2]

[1] Tas et al., 2020 Eur J Cancer 47-55; [2] Dominique Valteau-Couanet et al., (2019) Medecine/Science

Microalgae-based DinutuximAb is able to bind specifically to neuroblastoma cells lines

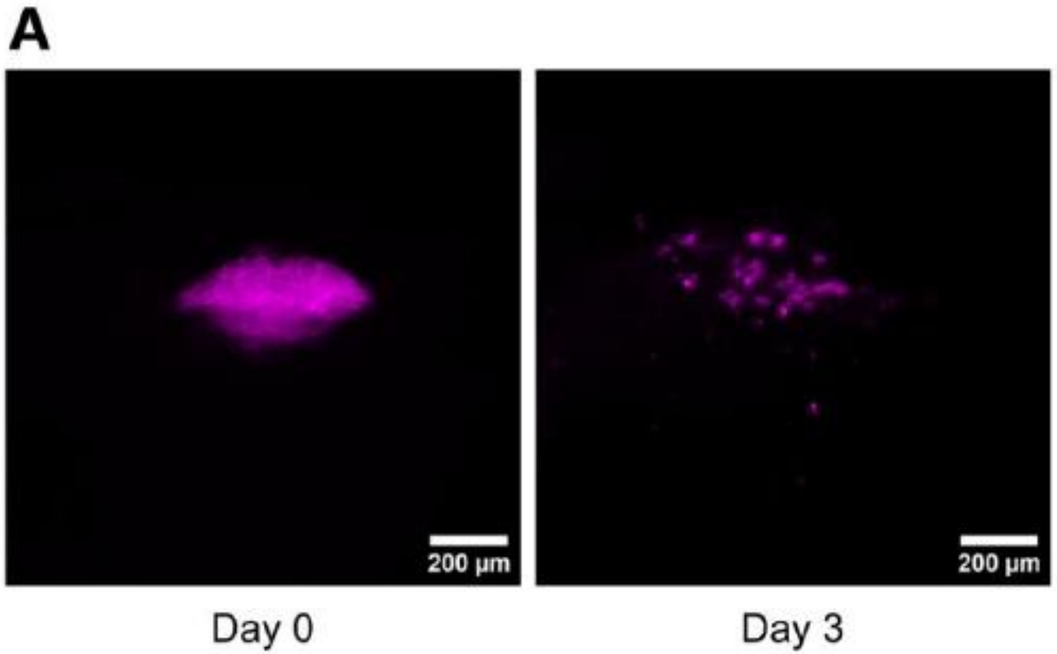
Validation of the antigen binding

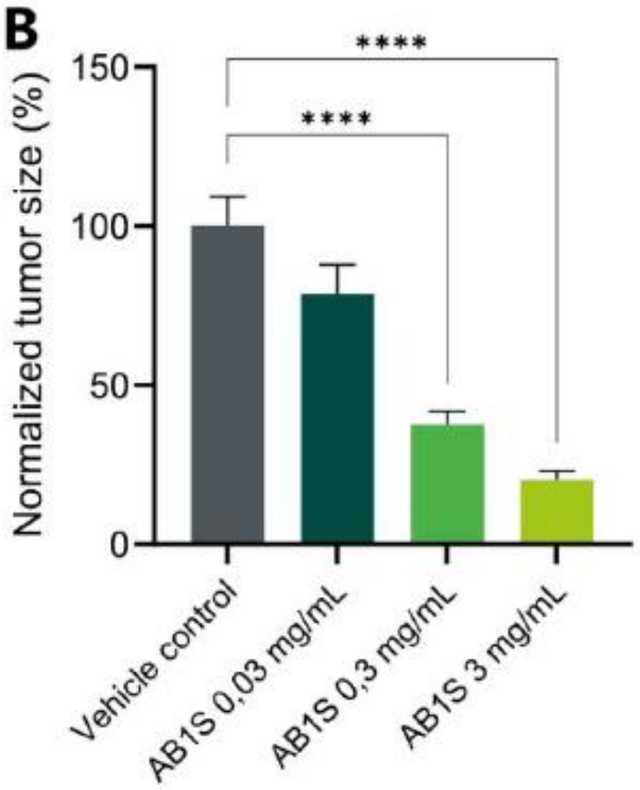


LAN-1, established in 1977 from a bone marrow metastasis of a 2-year-old boy with stage IV neuroblastoma
IMR-32 neuroblast cells isolated from brain tissue that exhibits neuroblastoma

Microalgae-based DinutuximAb is able to degrade tumors *in vivo*

Xenograft of Lan-1 in zebrafish embryos

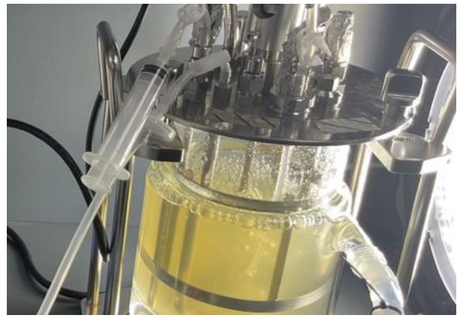




On the way to industrialization

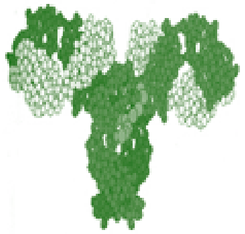
From 200 mL to 200L in three years

Culture chamber (> 100mL)



PBR (1, 10, 20 and 40L)

PBR (200L)



Purity: 99,8%

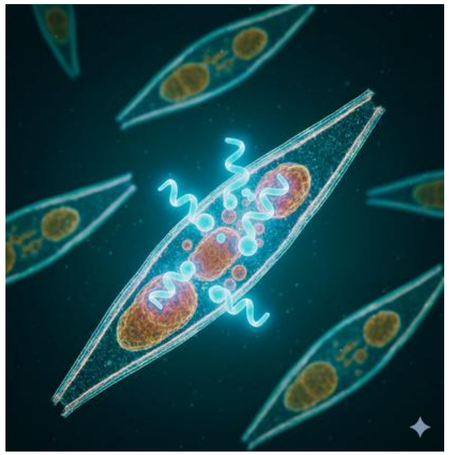
R&D → **Production and purification**

Technology de-risked, yield improvement (600X) and scale-up proven @200L

–

Alga has successfully operated a 200L launching unit, allowing commercialization of first products

Take home message



Microalgae are able to produce correctly folded antibodies that are as effective as CHO-based antibodies for research, diagnostic and therapeutic applications

Aknowledments

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Samy Al-Bourgol, France Bioimaging

Pr Nicolas Piton
France Blanchard
Kylian Jouie

Sébastien Calbo

Projet cSMART

They are supporting us

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NORMANDIE filière algues

mabdesign THE BIOTHERAPY EXPERT

COSMETIC VALLEY 30

La FRENCH TECH ROUEN NORMANDY

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