



INNOVATIVE ALGAE BASED SOLUTIONS

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Olmix Group

Agenda

- I. OLMIX Vision
- II. ALGAE - Introduction
- III. MACROALGAE – Innovative molecules
- IV. MACROALGAE in Brittany
- V. OLMIX ALGAE processing technology
- VI. Nutrition and health algae based solutions

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OLMIX Vision



The challenge for modern agriculture :

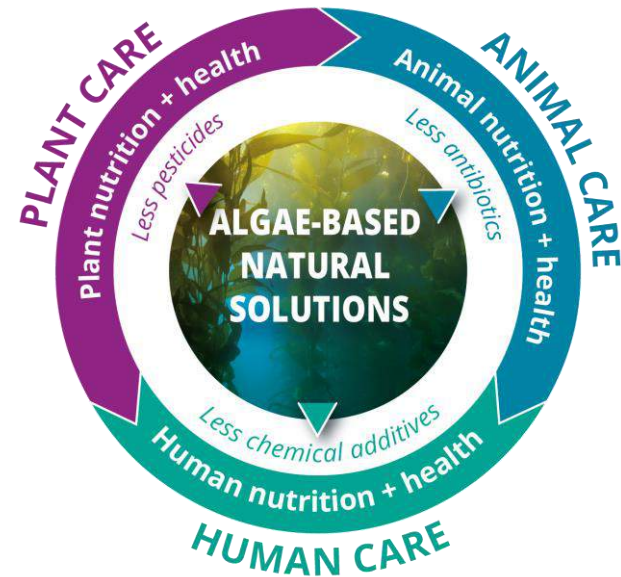
The world must produce **BETTER** and **MORE** with **LESS**

- to sustainably feed the planet
- to feed humans in a healthier way

A HEALTHY FOOD CHAIN THANKS TO ALGAE



- **Less pesticides**
- **Less antibiotics**
- **Less chemicals**



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Why algae?

Algae, a natural & renewable resource

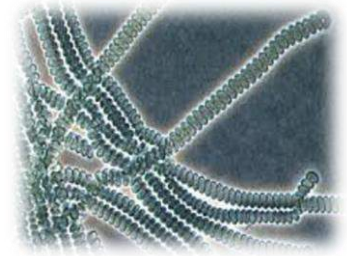


- **100% natural**
- Traditional use
- **Low risk for toxicity or ecotoxicity**
- Algae are among the **fastest growing plants in nature**
- Growth rates of up to 30% per day !
- Algae are not dependent on arable land or fresh water
- Algae **produce 70% of earth's oxygen**
- Algae play a vital role in reducing CO₂
- **Huge application potential** for plants, animals & humans with **Still a lot to discover !**

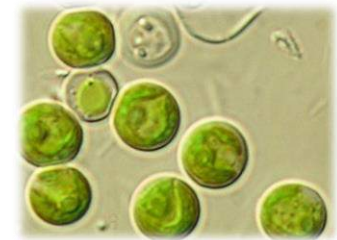
Algae & Seaweed - Definitions

Algae

- Living organisms with chlorophyll having oxygenic photosynthesis
- Their life cycle is generally realised in aquatic or humid environments (fresh or salt water)
- Do not have roots, flowers or seeds
- Sizes between 0,5 μm - 70 m
- A polyphyletic group including both procaryotic and eucaryotic organisms
 - Procaryotes (no nucleus) (ie : cyanobacteria - **blue green algae**)
 - Eucaryotes (with a nucleus)
 - **Microalgae** : unicellular : ex *Chlorella*
 - **Macroalgae** : multicellular : ex *Ulva*



Spirulina sp.



Chlorella vulgaris



Ulva sp.

Algae & Seaweed - Definitions

Seaweed (marine macroalgae)

Used to describe algae that are :

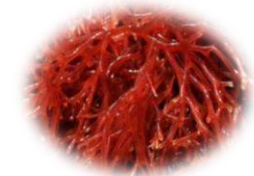
- Macroscopic
- Eucaryote
- Multicellular
- Marine

Divided in three groups:

- Green
- Red
- Brown



Green



Red



Brown

OLMIX group is specialized in Marine macroalgae

Green seaweed

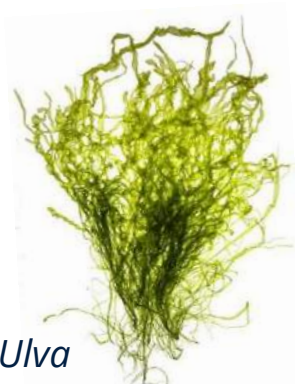


Polysaccharides: Ulvans
Colour due to: Chlorophyll a and b

Ancestors of terrestrial plants
(1 200 million years)
~1500 species



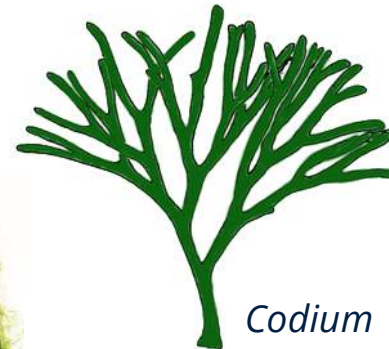
Ulva sp



Ulva intestinalis



Cladophora



Codium



Caulerpa

Red seaweed



Polysaccharides: Carrageenans and Agar

Colour due to: Phycoerythrin and Phycocyanin (Accessory pigments to chlorophyll a)

Sister group of plants and green seaweed
(1 200 Million years old)
~ 6500 species



Dulse



Nori



Palmaria



Chondrus



Mastocarpus

Brown seaweed



Polysaccharides: Alginates, Fucoidans and Laminarins
Colour due to: Fucoxanthin (Accessory pigments to chlorophyll c)

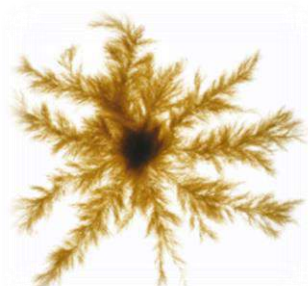


Fucus

Recent group of seaweed
(150-200 million years old)
~ 1800 species



Bifurcaria



Ectocarpus.



Himanthalia



Macrocystis



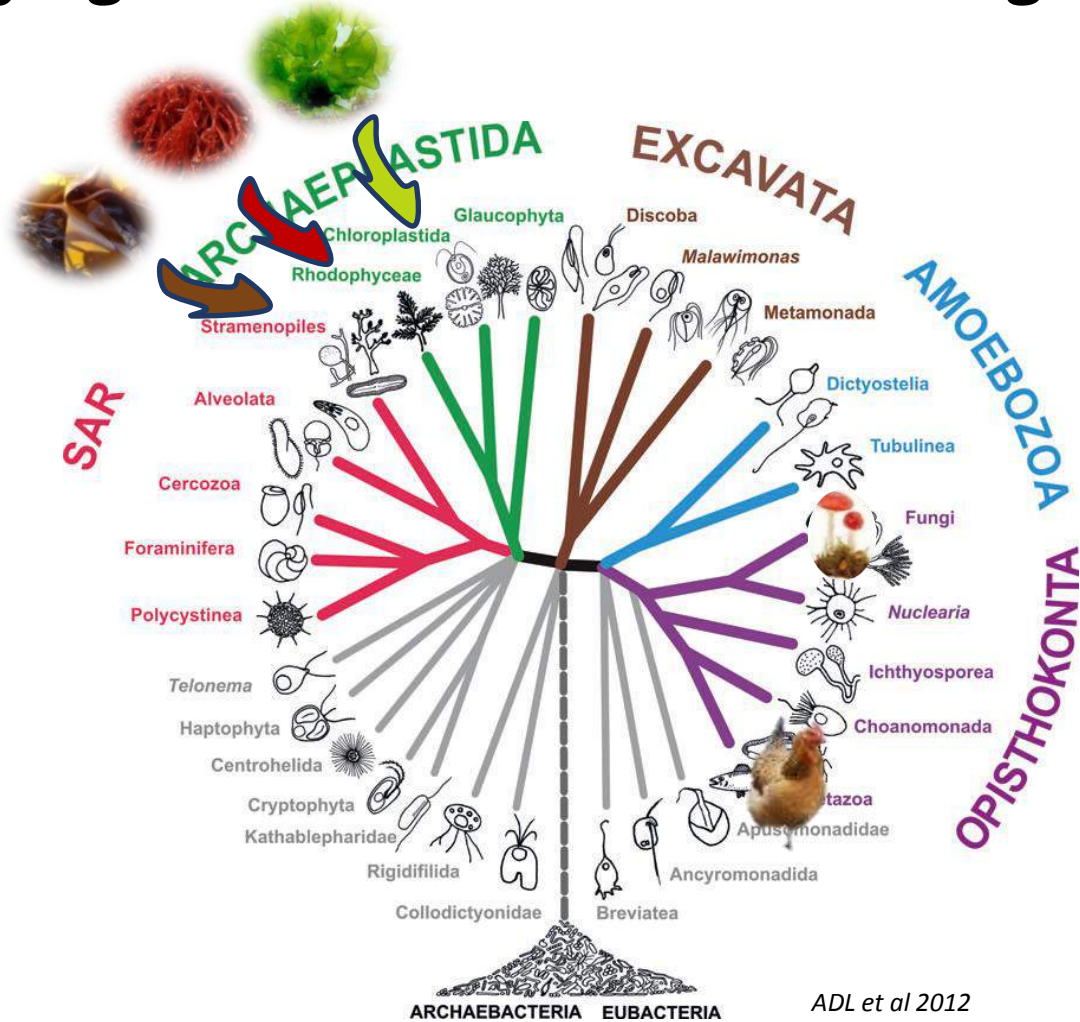
Ascophyllum



Laminaria

Seaweeds : large phylogenetic differences between groups

- Same origin
- But green, red and brown algae are as different as fungi and animals !
- → Sources of very variable compounds !



Main macroalgae components



- **Carbohydrates (20-70% of dry weight)**
 - Poly-anionic and sulfated polysaccharides
 - Alginates, fucoidans (Brown algae)
 - Carraghenans and agars (Red algae)
 - Ulvans (Green algae)
 - Insoluble carbohydrates
- **Proteins (1-35% of dry weight)**
- **Lipids (0,5-4% of dry weight)**
- **Minerals (10-30% of dry weight)**
 - Iron, Iodine, Copper, Potassium, Sodium, Calcium, Sulfate, Magnesium, Phosphorous, Chlorine, Manganese
 - Numerous trace-elements.
- **Pigments**
 - Phycobiliproteins (Red algae)
 - Carotenoids
- **Vitamins**
 - A, B1, B2, B6, B12, C, D3, E, K
- **Secondary metabolites**
 - Polyphenols, phlorotannins
 - Steroids
 - ...

Nutritional activities

Biological activities

Macroalgae - Current uses

Human food

- **As a vegetable or condiment, mainly in Asia :** Nori, Wakame, seaweed salads
- **Texturizing agents** (gelling agent – polysaccharides properties)
 - E400 E401 Alginate
 - E 406 Agar
 - E407 Carrageenan
 - E407a Semi-refined Eucheuma

- **Nutritional supplement:** proteins, minerals and vitamins
- **Functional food**

Agricultural uses

- Flour or meal
- Fertiliser and soil amendment

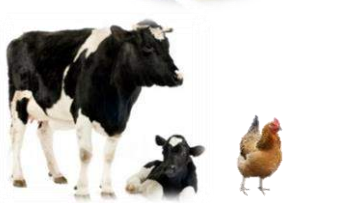
Industry

- Phycocolloids used as thickening, gelling or stabilizing agents, especially in the textile industry

Fine Chemistry

- **Cosmetics:** texturizing or active agents,
- **Pharmacy:** texturizing or active agents

FOOD: 65% ;
COLLOIDS : 30% ;
FINE CHEMISTRY : 5%



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Polysaccharides: introduction



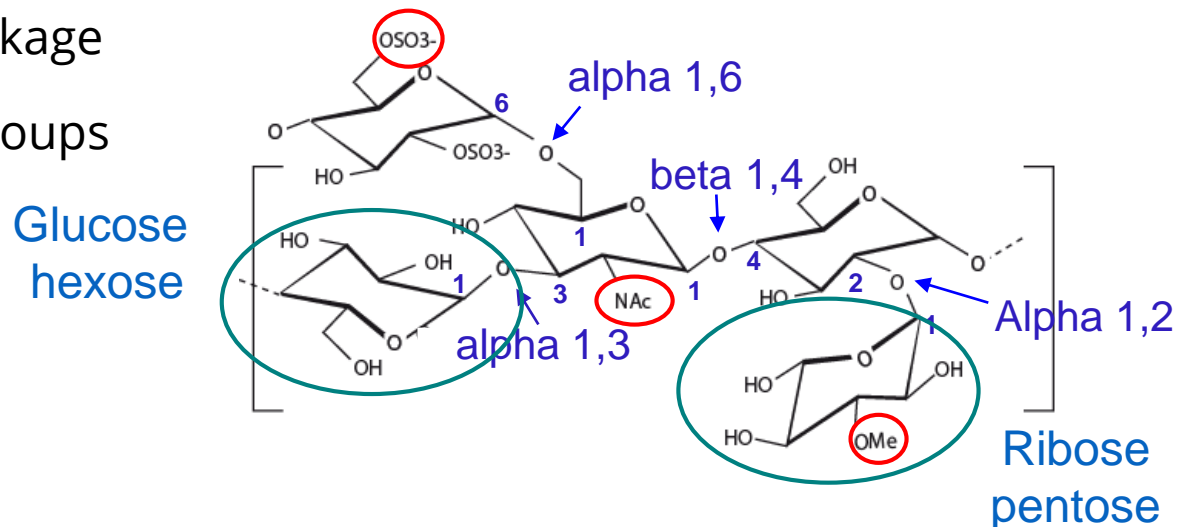
The most abundant renewable materials found on land and in the ocean



Polysaccharides: High molecular weight polymers of sugars available in a variety of structures

Variable structure depending on:

- Sugar
- Glycosidic linkage
- Functional groups

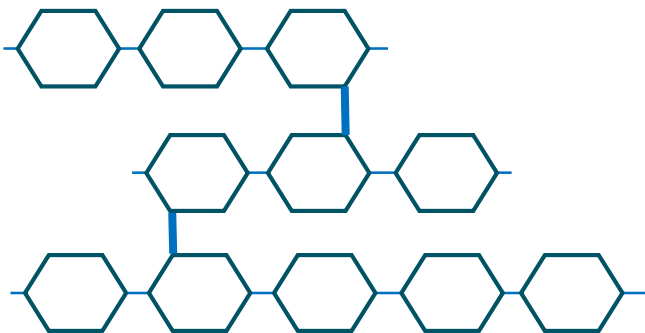


Polysaccharides: High potential of variable structures

Homo-polysaccharides
unbranched



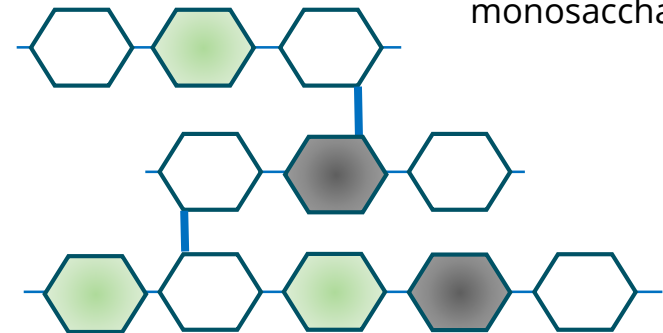
branched



Hetero-polysaccharides
unbranched



branched



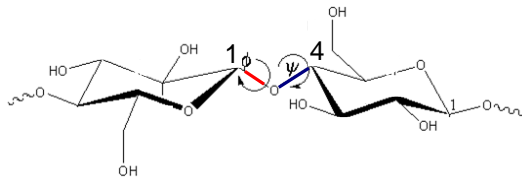
The different colors represent different monosaccharides

One hexasaccharide
→ 10¹² combinations (Laine, 1994)

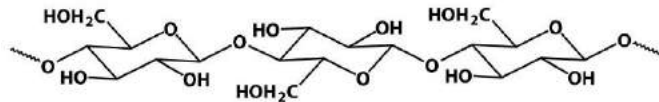
Polysaccharides:

Change of linkage in a regular chain change properties

Ex. of amylose, cellulose:



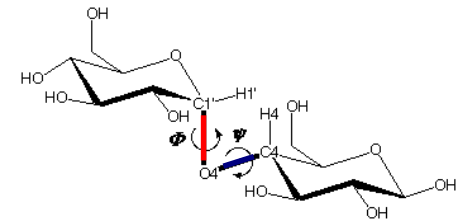
Cellulose (β 1,4-glucan)



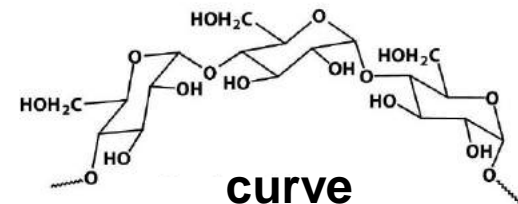
Linear



Sheet \rightarrow fibrous



Amylose (α 1,4-glucan)

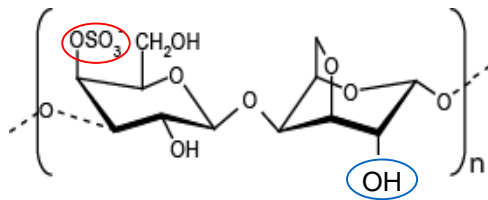


Helix \rightarrow gel

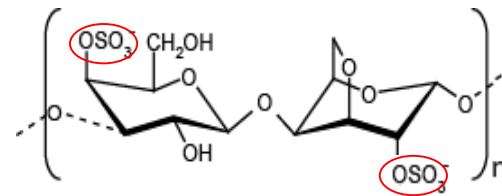
Polysaccharides:

Increase of substitution **change properties**

Ex. of carrageenans



Kappa-carrageenan



Iota-carrageenan



Helix → solid gel



Helix → soft gel

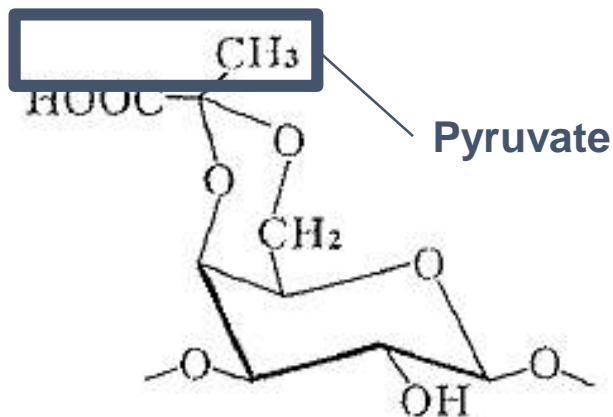
Polysaccharides:

Change in functional groups **change of biological activity**

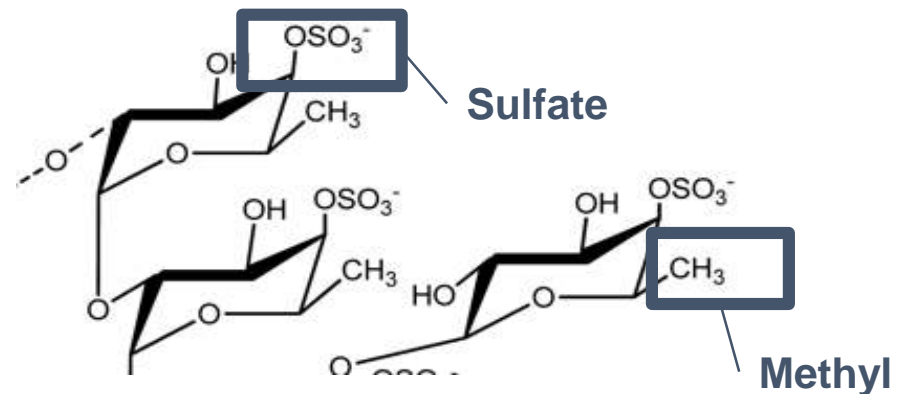
Examples:

- **Pyruvate:** — $\text{CH}_3\text{-CO-COO}^-$
- **Methyl:** — CH_3
- **Sulfate:** — SO_3^-

Pyruvate residues in λ Carrageenan

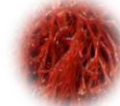


Permethylated and Sulfated Fucoidan



S Hirase et al, 1972 ; E McCandless, 1979 ; Q Zhang et al, 2005

Macroalgae cell walls polysaccharides specificities



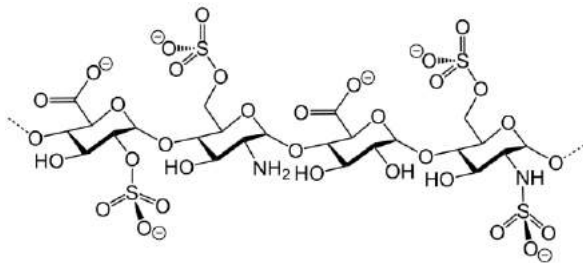
	Terrestrial plants	Green algae	Red algae	Brown algae
	Neutral polysaccharides			
Structure	Cellulose	Cellulose	Cellulose	Cellulose
Energy	Starch	Starch	Floridean starch	Laminarin
	Polyanionic polysaccharides			
Matrix				
Carboxylated (COOH)	-Pectic acid -Pectins			Alginic acid
Sulfated (SO ₃ ⁻)	X		Agars Carrageenanes	Fucoïdans
Carboxy-sulfated	X	Ulvans		

No sulfated polysaccharides in terrestrial plants / microalgae / yeast
→ Unique to marine algae

Comparing biological activities with Animal sulfated polysaccharides

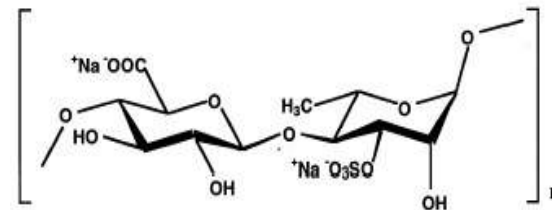
HEPARIN

- Anti-inflammatory
- Immunomodulation
- Antitumoral
- Anticoagulant and antitrombotic



ALGAL SULFATED POLYSACCHARIDES

- Anti-inflammatory (Kim et al. 2009; Hong et al. 2011)
- Immunomodulation (Kim et al. 2012; Berri et al. 2013)
- Mucin production stimulation (Barcelo et al. 2000)
- Antioxidant (Baky et al. 2009; Zhang et al. 2010; Souza et al. 2006)
- Antilipidemic (Hassan et al. 2011)
- Antiviral (Wang et al. 2012)
- Antitumoral (Veeraperumal et al. 2012; Baky et al. 2009)
- Anticoagulant and antitrombotic



Polysaccharides – Biological activities

Algal cell wall polysaccharides **ulvan, fucoidans & carraghenans**: different compositions but similar biological activities



- 3D structure (branching)
- High variety of sugars
- Rare sugars (rhamnose)
- Sulfate content -
Phylogenetic analogy with
glycosaminoglycanes (ex :
heparin)



- Anticoagulant & antithrombotic
- Anti-infectious
- Immune-modulating
- Antioxidant
- Lipid metabolism
- Wound healing
- ...

Marine algal Polysaccharides

Structure function relationship

	Antiviral activity	Immuno-modulation	Complement inhibition	Antioxidant activity	Metal chelating Free & hydroxy radicals scavenging	Anticoagulant properties
High Sulfate content	↑	↑		↑		↑
Desulfatation		↓				
High Sulfate/fucose ratio					↑	↓
High Molecular weight	↑					↑
Low Molecular weight		↑	↑			↓
Position of sulfate groups						↑
High ramification			↑			



= increased activity



= reduced activity

Seaweeds - Future uses

Based on knowledge on bioactive components



Plant health

- Elicitor effect on bacterial and fungal pathogens
- Biostimulant effects : Improvement of nutrient uptake
- Regulation of soil life

→ **Reduction of pesticide use**

Animal health

- Immunomodulating agent
- Anti-infectious agent
- Regulator of the intestinal flora
- Gut protection effect

→ **Reduction of antibiotic use**

Human health

- Antiviral properties
- Immuno-regulation properties
- Anti-tumor properties (cancer)
- Reduction of central nervous system disorders

→ **Reduction of chemical products use**

Extraction: key to reveal the full potential !

Agenda

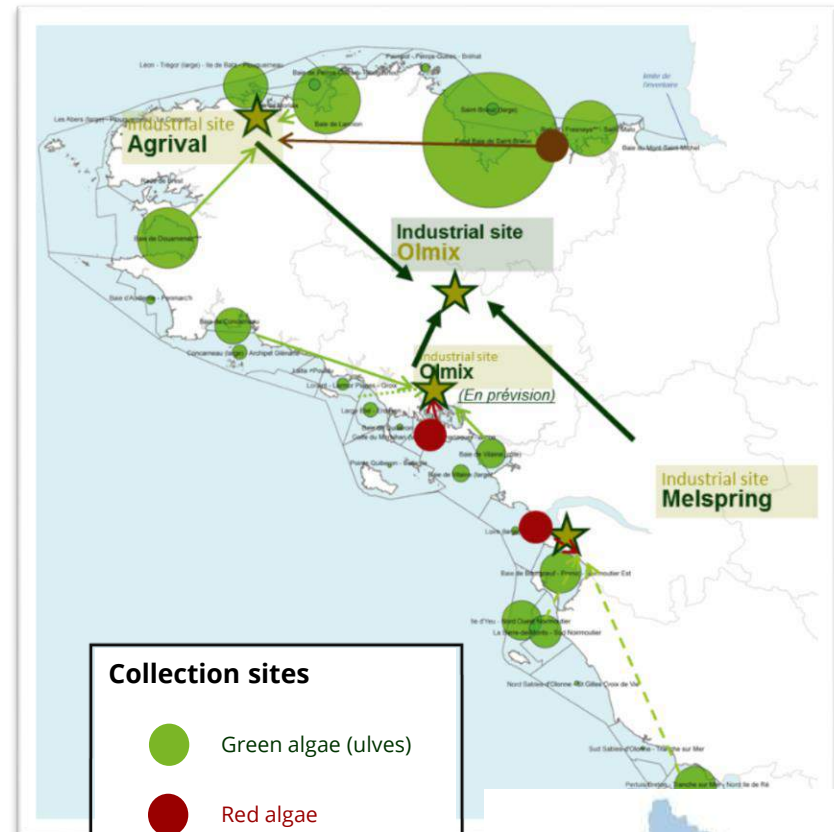
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BRITTANY - Olmix seaweed collection sites

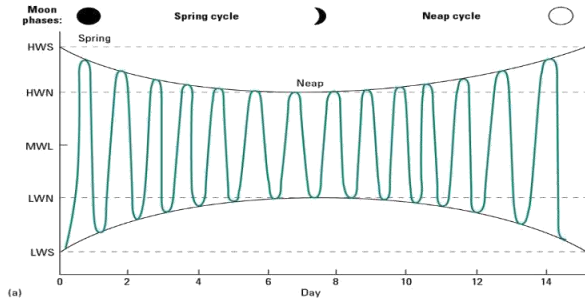
Brittany

- ✓ 2,730 km of coastline
- ✓ 700 species of seaweed
- ✓ 7% of worlds diversity : diversity hot spot
- ✓ Harvest of biomass from natural populations: on beach, in sea, beach cast and aquaculture

75,000 – 80,000 T/year (wet weight)
2nd producer in Europe



BRITTANY - Tides



Tidal heights:

Average worldwide	2 m
Penmarc'h	5.5 m
Saint-Malo bay	12 m
Mont-Saint-Michel bay	15 m
Bay of Fundy (Canada)	16 m



Roscoff, tidal range 10 m



Strong tidal currents

- Thorough mixing
- Constant nutrient levels
- Less contaminants



BRITTANY - Heritage and present uses of seaweeds

18th century

Use of algae as fertilisers



19th century

Extraction of iodine from Kelps



20th century

Extraction of hydrocolloids from algae



E 400- E405 Alginate
E 406 Agar-agar
E 407 Carrageenans
E 407a Semitransformed Eucheama

21st century

Extraction of biocompounds for food, feed, plants and biotechs



- ✓ Several research centers specialised in seaweed
- ✓ 60 companies in the marine biotech sector

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OLMIX Macroalgae resources

- ✓ Natural stocks of green and red seaweed
- ✓ Non attached seaweed populations harvested fresh
- ✓ Annual species
- ✓ Low impact on seaweed biodiversity



Ulva armoricana



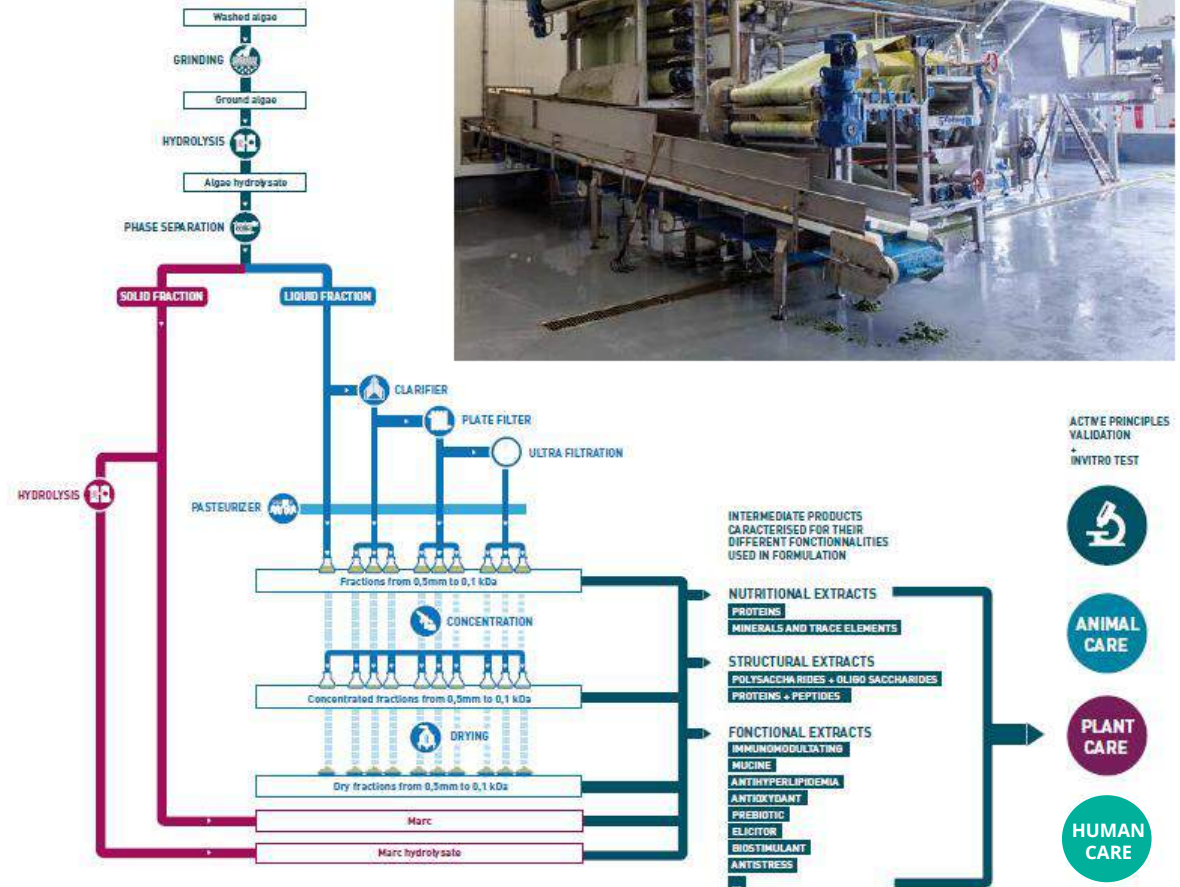
Solieria chordalis

Olmix - Macroalgae processing technology

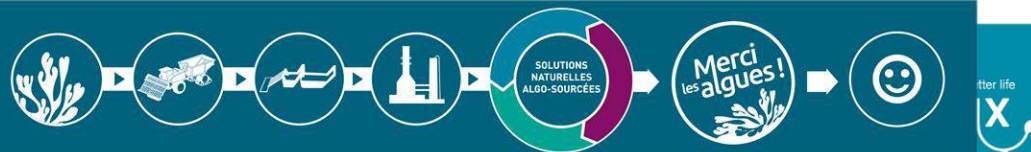
OLMIX, expert in algae processing
 From harvest to final innovative products

UNIQUE & AHEAD ALGAE TECHNOLOGY

ALGAE active principles research process



Health & Nutrition Pou



ter life X

Olmix – Macroalgae processing technology

OLMIX, expert in algae processing

From harvest to final innovative products

Harvest



Innovative harvesting material

Olmix – Macroalgae processing technology

OLMIX, expert in algae processing

From harvest to final innovative products

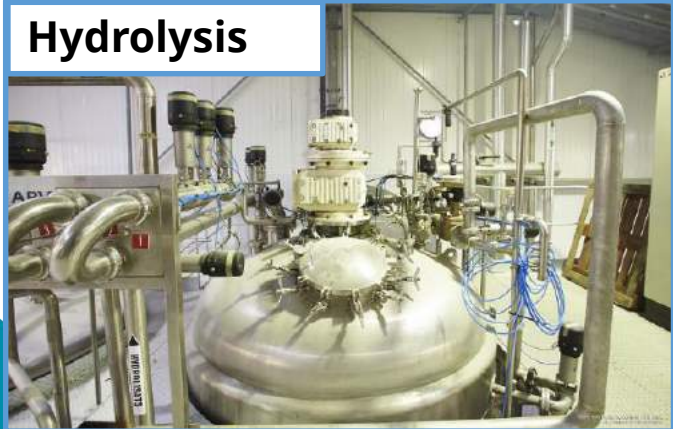
Washing



Phase separation



Hydrolysis



Extraction



A fully
dedicated
bioraffinery

Olmix - seaweed processing technology

OLMIX, expert in algae processing

From harvest to final innovative products

Characterisation



Final products



Quality control



Full traceability from collection to final products

Olmix – Macroalgae processing plant

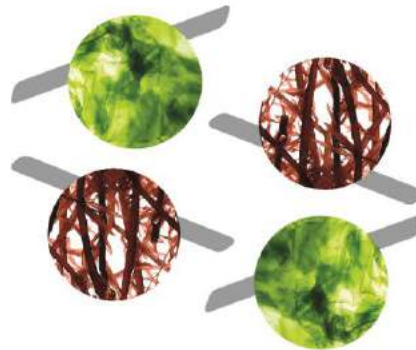


**UNIQUE & AHEAD
ALGAE TECHNOLOGY**

Olmix - seaweed based technologies



AMADÉITE®



OEA®



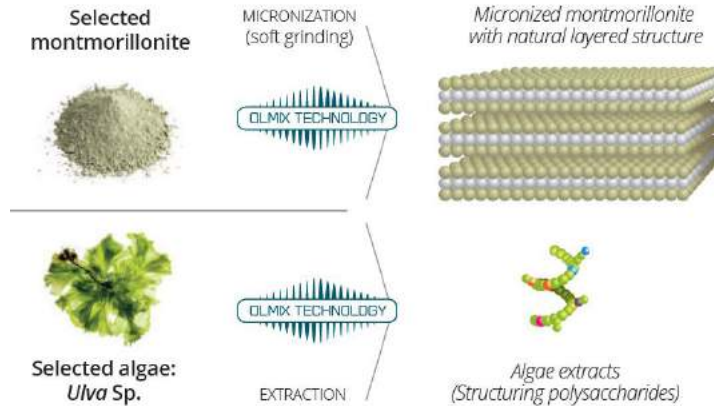
MSP®

OLMIX'S ALGAE TECHNOLOGIES

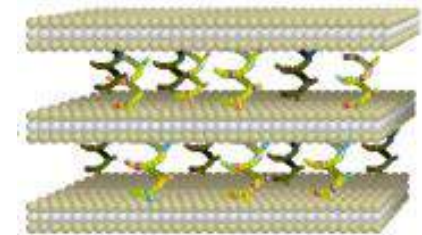
Algae polysaccharides as **STRUCTURAL** material



THE POWER OF AMADEITE®



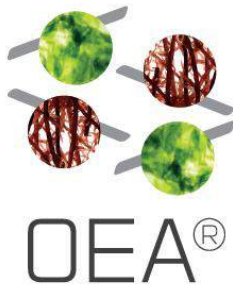
INTERLAYERED ALGOCLAY



➤ Bind toxins

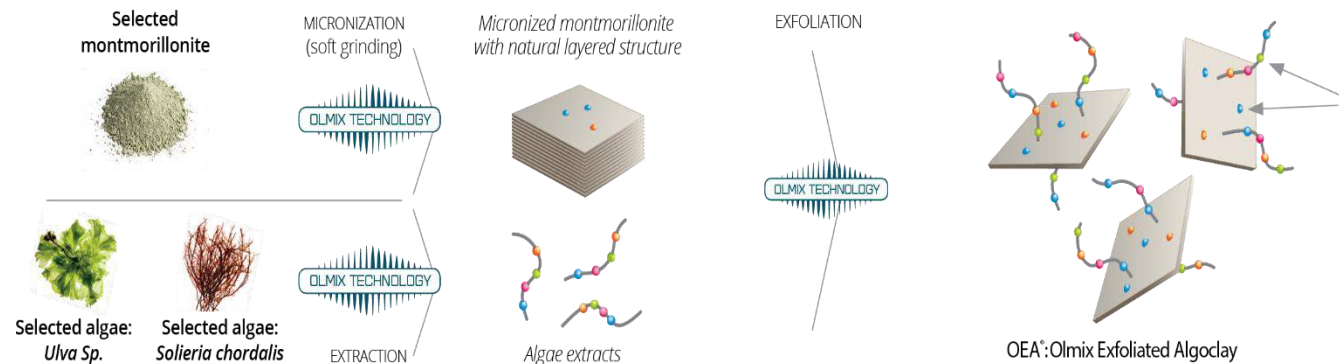
OLMIX'S ALGAE TECHNOLOGIES

Algae polysaccharides as **STRUCTURAL** material



for a better life
olmix Group

THE POWER OF OEA®



EXFOLIATED ALGOCLAY

➤ Boost digestive enzyme activity



OLMIX'S ALGAE TECHNOLOGIES

Algae polysaccharides with **BIOLOGICAL** properties



MSP®

**OLMIX
SULFATED
POLYSACCHARIDES**



for a better life
olmix Group



Collection
Récolte

Washing
Lavage

Phase separation
Séparation de phase

Hydrolysis
Hydrolyse

Extraction
Extraction

Characterisation
Caractérisation

Final products
Produits finis

Quality control
Contrôle qualité



➤ **Biological activities**
Immunity
Lipid metabolism Mucin
secretion

THE POWER OF MSP®

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OLMIX group algae based product range

PLANT CARE RANGE

The OLMIX **Plant Care** range enhances the essential functions of the soil and the plant, for a productive and sustainable plant production. Relying on high-tech ingredients, OLMIX solutions help limit the use of fertilizers and pesticides on lawns, specialty crops and field crops.

geO2 - neOsol humeO

- Activate soil microbial biomass
- Improve N-uptake
- Improve C-uptake
- Complemented with organic matter rich in carbon

stor-it

- Adapted to saturated soils
- Optimises drainage
- Improves soil aeration

External ecosystem

- Soil aeration - Purification
- Mineralization - Nutrition optimization
- Photosynthesis optimization
- Crop nutrition
- Germination optimization

Internal ecosystem

- Water retention
- Soil aeration
- Soil pH
- Soil temperature
- Soil moisture
- Soil nutrients
- Soil structure
- Soil texture
- Soil color
- Soil smell
- Soil taste
- Soil touch
- Soil sound
- Soil sight
- Soil smell
- Soil taste
- Soil touch
- Soil sound
- Soil sight

Biological Activators

- explOrer**
- primeO**
- marathon**
- melfert**
- vitalbase**
- akeo**
- matrix**

Stimulators with Fertilizers

- AlgoMel - SeaMel - Melgreen**
- agrOptim**
- seedup**

Foliar Fertilizers and Biostimulants

- melstar S**
- melspray**
- marathon Iron salt**

Fertilizers

ANIMAL CARE RANGE

Through innovations issued from algae, OLMIX **Animal care** has developed a full range of solutions acting on the 5 key factors influencing the welfare and the performance of livestock animals. The complete and adapted programs to each specie proposed by OLMIX contribute to reduce antibiotics use.

FOR FEED

mtx+

- Mycotoxin risk
- Secure performances
- Incorporated in the feed

mFeed+

- Boosts enzymatic activity in monogastrics
- Improves performance
- Better valorization of the feed
- Reduces the use of antibiotics

External ecosystem

- Environmental hygiene
- Mycotoxin risk
- Digestive efficiency
- Immunity
- Digestive welfare

Internal ecosystem

- High drying capacities
- Gas production
- Stress reduction
- Optimized egg laying performance
- Improves welfare
- Reduces ammonia emissions
- Prevents organic matter in the manure for soil fertility
- Licking buckets and lickstones for self-service
- Improves feed valorisation
- Adapted formula according to type of animals
- Valorizes the ration ingredients
- Ensures supply in essential materials
- Increases performance
- Secure performances
- Specifically designed for easy use on farm (practicality and hygiene)

FOR FARM

mistral

- Improves hygiene and welfare in the presence of animals
- High drying capacities
- Gas production
- Stress reduction

mistral^{light}

- Improves hygiene and welfare in the presence of laying hens
- Optimized egg laying performance
- Improves welfare

Z'fix

- Improves atmosphere in livestock buildings and manure quality
- Reduces ammonia emissions
- Prevents organic matter in the manure for soil fertility

Z'lick

- Boosts ruminants digestion by a self-service supply
- Licking buckets and lickstones for self-service
- Improves feed valorisation
- Adapted formula according to type of animals

stimul'Z

- Boosts ruminants digestion
- Valorizes the ration ingredients
- Ensures supply in essential materials
- Increases performance

mmis

- Mycotoxin risk
- Secure performances
- Specifically designed for easy use on farm (practicality and hygiene)

FOR VET

DigestSea

- Improves digestive functions
- Stimulates digestion
- Improves digestive and renal functions
- Protects the liver

Searup

- Reinforces natural defenses
- Improves resistance to stress
- Supports vaccination programs

SeaLyf

- Decreases digestive troubles and rehydrates
- Reduces digestive troubles
- Supports the water intake

SeaGut^{paste}

- Ensures digestive welfare of newborn piglets
- Limits digestive troubles
- Protects the digestive tract

SeaGut^{powder}

- Regulates naturally the digestive system of young ruminants
- Protects the digestive tract
- Increases weaning weight

Diet

- Regulates naturally the digestive system of young ruminants
- Reduces digestive troubles
- Supports the physiological digestion

ENVIRONMENTAL HYGIENE

DIGESTIVE EFFICIENCY

MYCOTOXIN RISK

DIGESTIVE EFFICIENCY

IMMUNITY

DIGESTIVE WELFARE

HUMAN CARE RANGE

OLMIX **Human Care** enhances natural properties of algae to develop algae-based natural solutions for the nutraceutical and food industry sectors.

AROMA CELTE

FOR HEALTH

Arma celte® food supplements range associates the benefits of essential oils and algae toward wellbeing, fitness and vitality daily. The Arma Celte® patented concept uses a calcareous red algae, lithothamn as solid carrier (powder) that has 100 functions: it allows a safe and easy to take intake and favours a good acid-base balance, vital for optimal biological functions.

FOR FOOD & BEVERAGE

For Food & Beverage range offers algae-based natural solutions for food industry companies involved in clean-label approach or willing to reduce the use of additives.

Fibersea

The algae-based ingredient for additive-free formulation:

- Sauces and dressings stabilisation
- Dairy products stabilisation

INGREDIENTS RANGE

OLMIX Group produces and distributes minerals as natural alternative solutions for fertilizers fields as golf courses, gardens, horticultural productions, field crops, as well as for animal feed.

Majority of our minerals are manufactured from co-products coming from the mining and chemistry industries. By adding value to these products, otherwise considered as by-product, we also contribute to a sustainable development.

To guarantee the quality of our ingredients dedicated to the feed industry, our supplier partners are rigorously selected according to our specifications, our factories are certified FAMI-QS or GMP+ and we follow a product release procedure ensuring compliance with European feed regulations.

COPPER SULFATE PENTAHYDRATE
Cupramel 25

IRON SULFATE HEPTAHYDRATE

MANGANESE SULFATE

IRON SULFATE MONOHYDRATE
Ferrovel 30

ZINC SULFATE MONOHYDRATE

MANGANESE OXIDE

ZINC OXIDE 72

ZINC OXIDE 75



FOR FARM

mistral

Improves hygiene and welfare in the presence of animals



- High drying capacities
- Skin protection
- Stress reduction

mistral^{Layer}

Improves hygiene in the presence of laying hens



- Optimized egg-laying performance
- Improves welfare



Improves atmosphere in livestock buildings and manure quality



- Reduces ammonia emissions
- Preserves organic matter in the manure for soil fertility



Boosts ruminants digestion by a self-service supply



- Licking buckets and lickstones for self-service
- Improves feed valorization
- Adapted formulas according type of animals



Boosts ruminants digestion



- Valorizes the ration ingredients
- Ensures supply in essential minerals
- Increases performance

mmis

Mycotoxin risk



- Secures performances
- Specifically designed for easy use on farm (microgranulated) and in layer feed

FOR FEED

MTX+

Mycotoxin risk



- Secures performances
- Incorporated in the feed

mFeed+

Boosts enzymatic activity in monogastrics



- Improves performance
- Better valorization of the feed
- Enables the use of by-products

ENVIRONMENTAL HYGIENE

DIGESTIVE EFFICIENCY

MYCOTOXIN RISK

MYCOTOXIN RISK

DIGESTIVE EFFICIENCY

FOR VET

DigestSea

Improves digestive functions



- Stimulates digestion
- Improves digestive and renal functions
- Protects the liver

Searup

Reinforces natural defenses



- Improves resistance to stress
- Supports vaccination programs

SeaLyf

Decreases digestive troubles and rehydrates



- Reduces digestive troubles
- Rehydrates
- Stimulates the water intake

SeaGut Paste

Ensures digestive



- Limits digestive troubles
- Protects the digestive tract

SeaGut Powder

Ensures digestive



- Protects the digestive tract
- Increases weaning weight

Diet

Regulates naturally the digestive system of young ruminants



- Reduces digestive troubles
- Facilitates the physiological digestion

DIGESTIVE EFFICIENCY

IMMUNITY

DIGESTIVE WELFARE

Transversal R&D

- Innovation for 3 activities
- Objectification of algae properties
- **12% people & 6% turnover**
- **Dedicated Biotech center & laboratory**
- Ideally located in Brittany at the heart of marine research land
- **International partnerships**
- **Ambitious collaborative projects**
- **20 patents** (all activities)



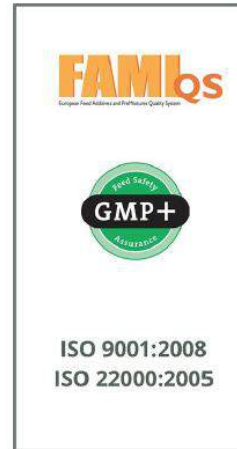
OUR R&D PARTNERS



Driven by INNOVATION

Transversal Process development

- Turn R&D projects to reality
 - Cost effective products
 - **600 m² pilot plant**
 - **10 certified plants**
-
- Clay grinding & particle size selection
 - Trace elements processing
 - **Algae bio-refinery – Algae cracking**
 - **Algae + clay complexation processes**
 - Granulation process



WORLDWIDE presence

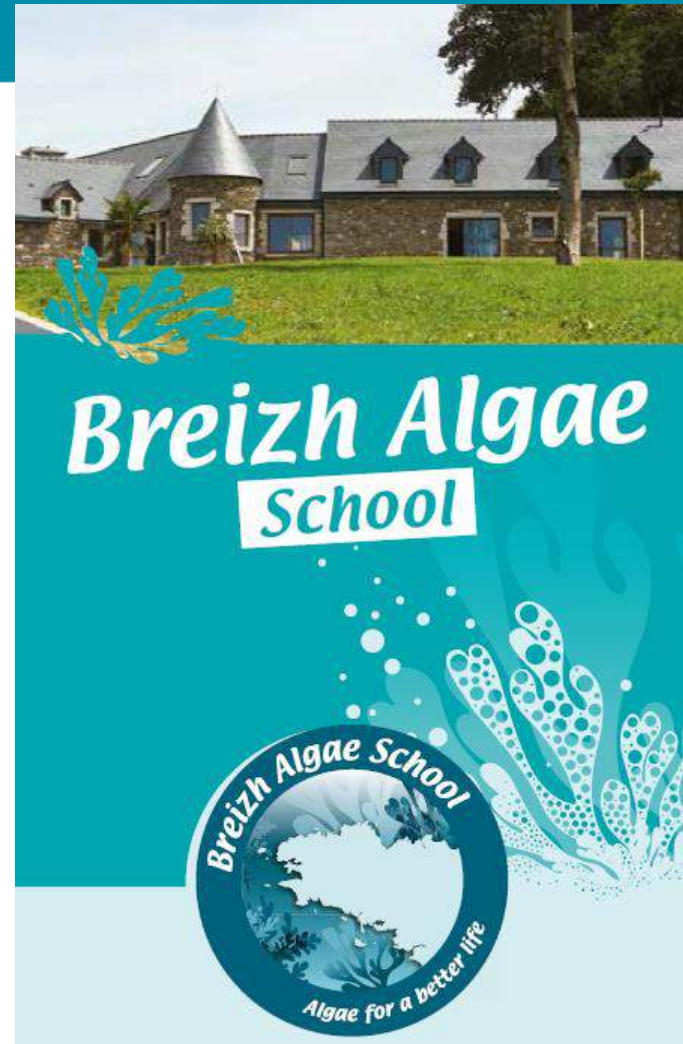
TO in 2017 : 150 M€ / Headcount : 800

27 implantations
11 industrial sites
➤ 10 in Europe
➤ 1 in Asia



Breizh Algae School : unique !

- **What ?** Training on :
 - New agriculture challenges
 - Algae to build a healthy food chain
 - In room training combined with practical situations (at school+on the field in Brittany agricultural land)
- **From who ?** Lecturers : Olmix teams + professional institutes... (IFIP, ISPAIA, INRA...)
- **For who ?** Students / Partners / Customers



***Thanks for
your
attention!***

