R&D+I offer in Biorefinery & Bioprocesses

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#ScienceForInnovation

INRAE: Science dedicated to life, humans, and the Earth

Our job

- ✓ **To produce and disseminate knowledge to help solve major global challenges**
- ✓ **To put this knowledge to work to foster innovation**

14 Research divisions

#InnoverAvecINRAE

Find more: https://www.inrae.fr/en

INRAE - Key figures*

>11000 FTE

50.5% 49.5%

2005 researchers
3179 engineers
3045 technicians
1850 PhD students
2029 trainees

Budget

75% permanent staff
25% non permanent staff

23% Own ressources
77% Public service grant

#InnoverAvecINRAE

*2020 data

Innovation - what we can do for you

An adapted response to every need

Do you want to develop new solutions (products, services or processes) ?

Collaborative R&D projects can contribute to cope technological and societal challenges.

Do you have a specific question or problem ?

We propose expertise, research & subcontracting services for short-term cooperation.

Do you need support for **result-oriented solutions**?

We provide asset-based services: skills, knowledge-related facilites, access to our platforms.

Are you looking for technical solutions **or technology transfer opportunities**?

Take a look at our technology offer & patent portfolio for licensing or for startup business creation.

#InnoverAvecINRAE

INRAE - Our fields of innovation

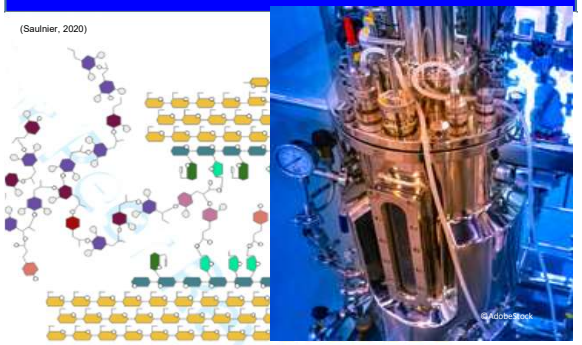
#InnoverAvecINRAE

From biomass to advanced biobased solutions

To meet market demand with a sustainable approach

Renewable feedstocks

(bio)Processes & intermediaries



Products & services
molecules, materials & energy

Advanced characterization methods | Biomass deconstruction | Biocatalysis - Fermentation | Industrial & environmental biotechnology | Fonctionalization | Formulation | Downstream processes | Ecodesign & LCA | Modelling & control |

Our expertise in biobased solutions by segment

Molecules

We design sober and efficient processes for the production of bio-based molecules for the chemical and agri-food sectors: antioxidants, pigments, fibers, emulsifiers and other bio-based substitutes for fossil resources, such as bioplastics and biofuels.

Materials

We develop sustainable materials for numerous applications (construction, packaging, textile) from renewable biomass to replace their petroleum-based equivalents. Flax or sunflower fibers, wood, food waste… so many resources for creation of new materials!

Energy & EB*

*Environmental Biotech

We aim to facilitate the transition to a more circular and bio-based economy by developing processes based on resource recovery, capable of creating value while treating bio-waste & waste water streams.

#InnoverAvecINRAE

(bio)Molecules

Overview

- Biomass fractionation, extraction, precision fermentation
- Platform molecules and use products (all fields of application)
- Drop-ins as well as new molecules/uses
- Properties of biopolymers during production, extraction and purification
- Bio-based binder to replace fossil-based resins
- Emulsions

Natural E163 pigment for food applications from grape pomace

Molecules

Success stories

ZELCOR
Zero Waste Ligno-Cellulosic Bio-Refineries

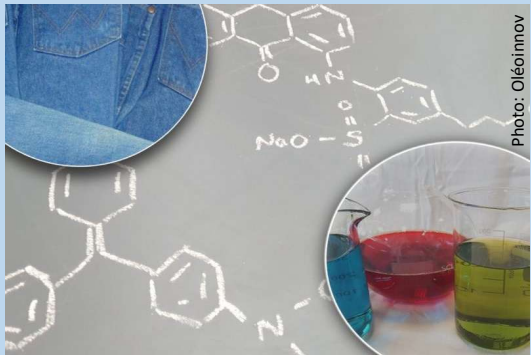
http://zelcor.eu/

The EU ZELCOR project (2016-2020) demonstrated the feasibility of **transforming lignocellulose biorefinery recalcitrant side streams into high added-value biobased products,** including fine chemicals by combining chemical and enzymatic catalysis with biological conversion by insects.

Created in 2019, after six years of collaboration between INRAE, Aix-Marseille University, Terres Inovia and Terres Univia, the startup Oléoinnov **proposes biotechnological tools** (antioxidants, biocatalysts) for textile bleaching and industrial colored effluent treatment.

oléoinnov
Vers une chimie biosourcée

https://oleoinnov.com/

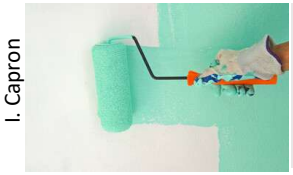


Molecules

Application examples

Markets

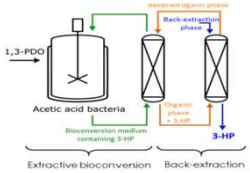
I. Capron



Hihg stability, surfactant-free Pickering emulsions preparations from wood nano-particles Highly stable emulsions, possibility to use particles of controlled size, polarity and texture for different applications.

Cosmetics | Phyto | Pharma | Agri-Food

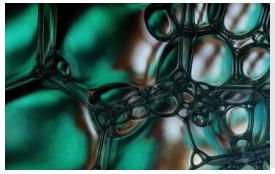
C. Saulou-B



Microbial process for the production of organic acids and hydroxyacids (continuous extraction) 3-HP concentration higher than 60 g.L-1, average volume productivity of 2.79 g.L-1.h-1 at lab-scale.

Agri-Food | Cosmetics | Chemistry | Health

Séverac



Green non-ionic surfactants of varying structures/sizes with different types of linkages and degree of branching for new ranges of excipients or cosmetic ingredients with HLB>14 that cannot be obtained chemically.

Cosmetics | Health | Chemistry

H. Fulcrand

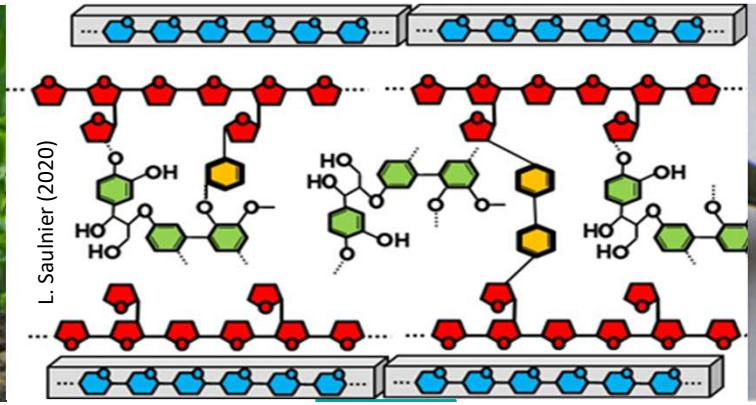
Biobased furylated polyphenols: custom-made functionalized platform molecules for speciality chemistry (resin, hardner agent). One-step, low-pollution, soft conditions production process from Douglas fir bark.

Chemistry | Automotive

Materials

Overview

- Bioplastics & alternatives to plastic
- Plant-based and other biobased materials (animal waste)
- Fibre-based materials & textiles
- Sustainable manufacturing processes economically competitive
- Characterization and processing of advanced biobased materials
- Functional materials and objects using 3D and 4D printing
- Nano-materials & composite materials (including recycling)



Materials

Success stories

https://flower-project.eu/language/en/

FLOWER
Flax composites, LOW weight, End of life and Recycling

Interreg France (Channel Manche) England

The main objective of the FLOWER project (2018–2023) was to develop **flax fibre reinforcements for the emergence of new products for the sport, automotive and advertising applications**. FLOWER covered the entire value-chain, from the production of flax fibres to commercialisation of end products and allowed the development of high performance, biodegradable, light-weight or recyclable products with reduced environmental impacts.

4FM - **F**ARE & **F**RD-LAB common laboratory for **F**uture **F**ibres and **M**aterials (FRD) aims to validate the results of projects carried out jointly by FRD and UMR FARE in an operational situation on the scale of Europe's largest hemp production basin. Hemp concrete was first used in house construction in 1986. Hemp shives are the fundamental ingredients in this biobased concrete. INRAE partnership with company FRD to improve the quality of hemp shives as well as that of other plant fibres.

INRAE
Université de Reims Champagne-Ardenne
frd Fibres Recherche Développement

Materials

Application exemples

Markets

S. Domenech

Biobased (100%) and biodegradable PLA with improved mechanical properties. Possibility of film production by flown film extrusion. Can be implemented on a large scale on existing industrial installations.

Packaging

Agri-food

C. Mayer

Biobased composite powders (10-200 microns) for additive manufacturing (selective laser sintering 3D printing) of materials. Modulation of the final properties by formulation (% PHA, waxes and lignocellulosic fillers).

Plasturgy

Packaging

Vandenbosche

Agromaterials production by bioextrusion of a solid lignocellulosic material seeded with fungal biomass; low density for building materials, packaging, thermal insulation, or high density after thermopressing.

Plasturgy

Building

Sports

Packaging

B. Bakan

Biosourced & recyclable shape memory elastomer from hydroxylated fatty acids. Breaking strength (10 mm/min): approximately 2 MPa. Elongation at break (10 mm/min): 150 - 250 %.- Solvent- and chain-blocker-free process.

Cosmetics

Phyto

Health

Pharma

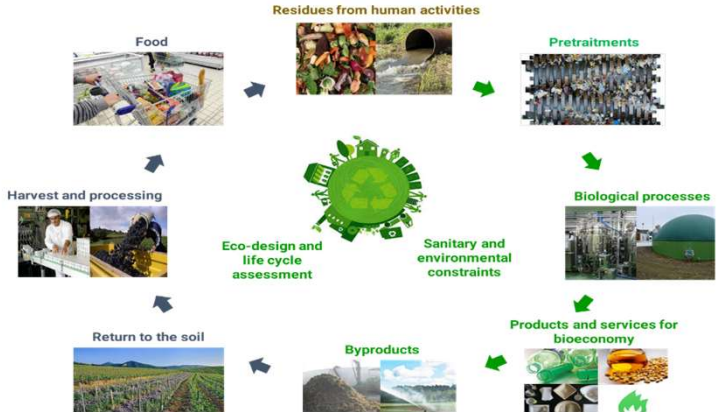
Energy & EB*

*Environmental Biotech

Overview

Exploring the potential of biodegradable waste streams as a feedstock and their role in closing loops of raw materials, nutrients, carbon and water

- **Renewable energy, biofuels**
- **Effluent &waste treatment and resource recovery: design, operation, and optimization of treatment facilities**
- **Anaerobic digestion, methanation, electro-fermentation**
- **CH4 & CO2 conversion**
- **Fate of micro-pollutants & biogas monitoring on-site**



Energy & EB*

*Environmental Biotech

Success stories

DECISIVE

http://www.decisive2020.eu/

While all households are expected to be able to sort biowaste at the source by late 2023*, the EU project DECISIVE (2016-2021, 14 partners) has focused on developing micro-scale anaerobic digestion (AD) in urban areas. DECISIVE **has led to full-scale testing of efficient micro-AD units at local level**, capable of producing both energy for local use and a biopesticide for farms.

BioEnTech **developped software and analytical solutions to optimize the performance of AD facilities**. Since its creation in 2013, more than 40 biogas plants in France and abroad have benefited from BioEnTech's pioneering technology, based on two families of patents with INRAE and INRIA. In 2022, SUEZ acquired BioEnTech, with the aim to accelerate its innovation efforts in AD.

SNAC®

MeMo®

IR-SCAN®

Energy & EB*

*Environmental Biotech

Application examples

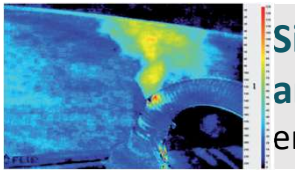
Markets

I. Gimbert

Lignocellulosic biomass pretreatment by filamentous fungi for biofuels or biogas production Improves delignification (30 to 50% wheat straw); wild, lignin-selective strain with a low cellulose and hemicellulose degradation.

Fuel | Energy | Biorefinery

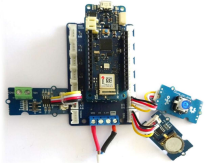
N. Auvinet



Simple and fast quantification of fugitive biogas emissions from anaerobic digestion installations for prevention of unwanted methane emissions and environmental and economic impact of these emissions.

Fuel | Energy | Biorefinery

R. Clément



Low-cost sensors for WWTP and DIY open hardware (dataloggers)
For physico-chemical, volumetric & energy on-line measurements.

WWTP | Energy

ML Daumer

Biological process for dissolving and recycling of iron and phosphorus in WWTP sludge, enabling phosphorus dissolution percentage between 50 and 75%.

WWTP | Energy

Our labs and platforms