Laboratoire d'Ingénierie des Systèmes Biologiques et des Procédés

Nic Lindley

UMR CNRS/INSA N°5504
Engineering and Systems Sciences (INSIS)
Biological Sciences (INSB)

UMR INRA/INSA N° 792
Microbiology and the Food Chain (MICA)
Science and Process Engineering of Agricultural Products (CEPIA)

Laboratory evaluated A+ en 2005 et en 2009

www.lisbp.fr

LISBP LABORATOIRE D'INGÉNIERIE DES SYSTÈMES BIOLOGIQUES ET DES PROCÉDÉS

OUTLINES
Tuesday 23rd June

FILLAUDEAU Luc
Overview of HTMS aims and context *~15'*
Description of LISBP *~ 15'*

LINDLEY Nicholas (LISBP head) ***~ 30'***
Presentation and visit of LISBP

Lunch time (CEMES)

GOMA Gérard (LISBP) *~ 90'*
Biomass and bio-economy: the international context

PHAM Tuan Anh & CAO Bach Xuan (SBFT) *~ 60'*
Pretreatment of lignocellulosic biomass: Steam explosion (rubber wood) and Organosolv (bagasse)

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INRA SCIENCE & IMPACT · cnrs · INSA TOULOUSE · Université de Toulouse

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Laboratory evaluated A+ in 2005 & 2009. Considered unique and outstanding in 2014

Scientific Objectives in 3 Keywords

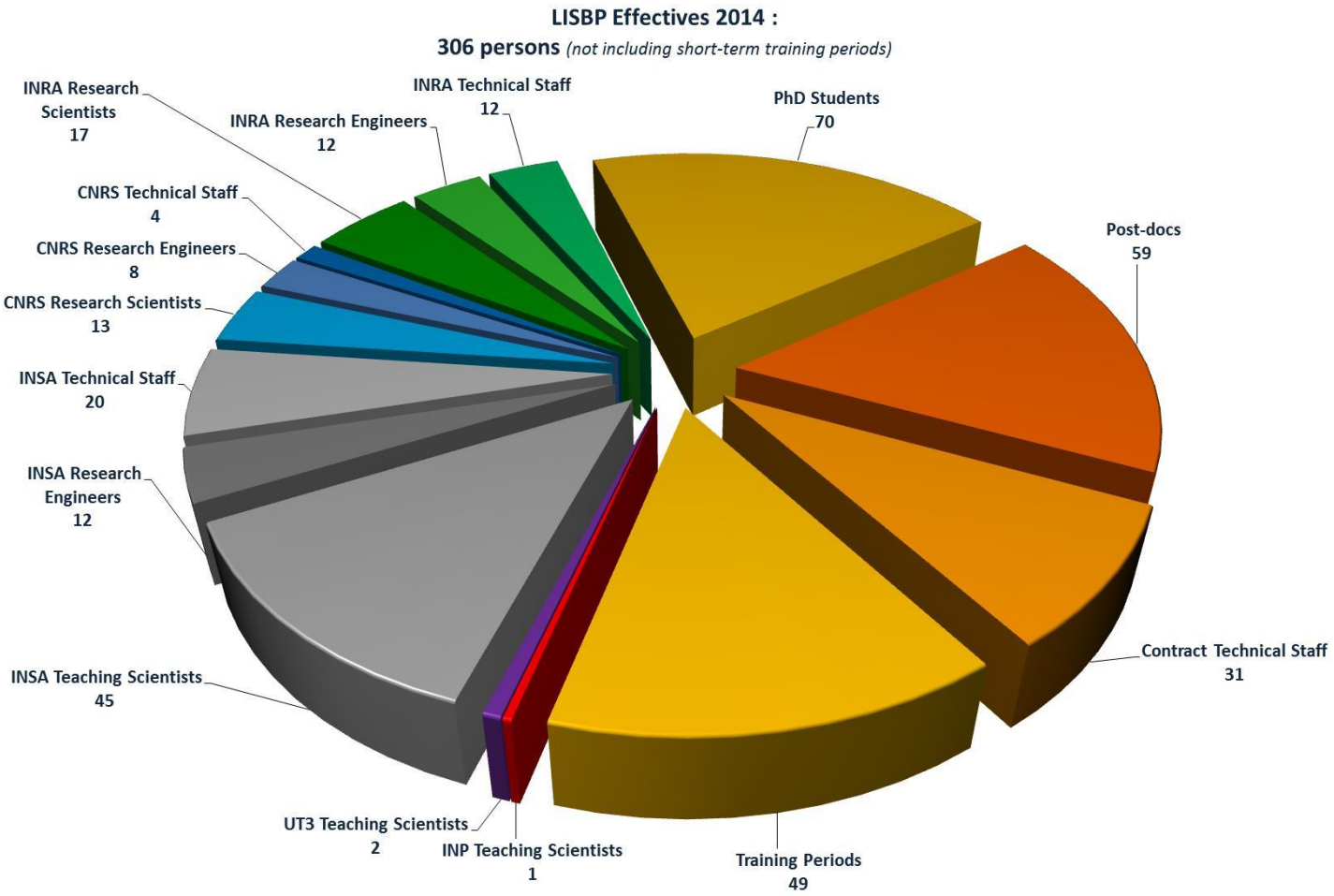
- **Engineering:** rational knowledge-driven improvement of a system's performance based upon in depth understanding of the underlying scientific mechanisms.

- **Systems Biology:** biological systems respond in a complex and dynamic manner to their ambient environment. Understanding these interactions and the basic regulatory networks involved is a key objective for modern industrial biotechnology.

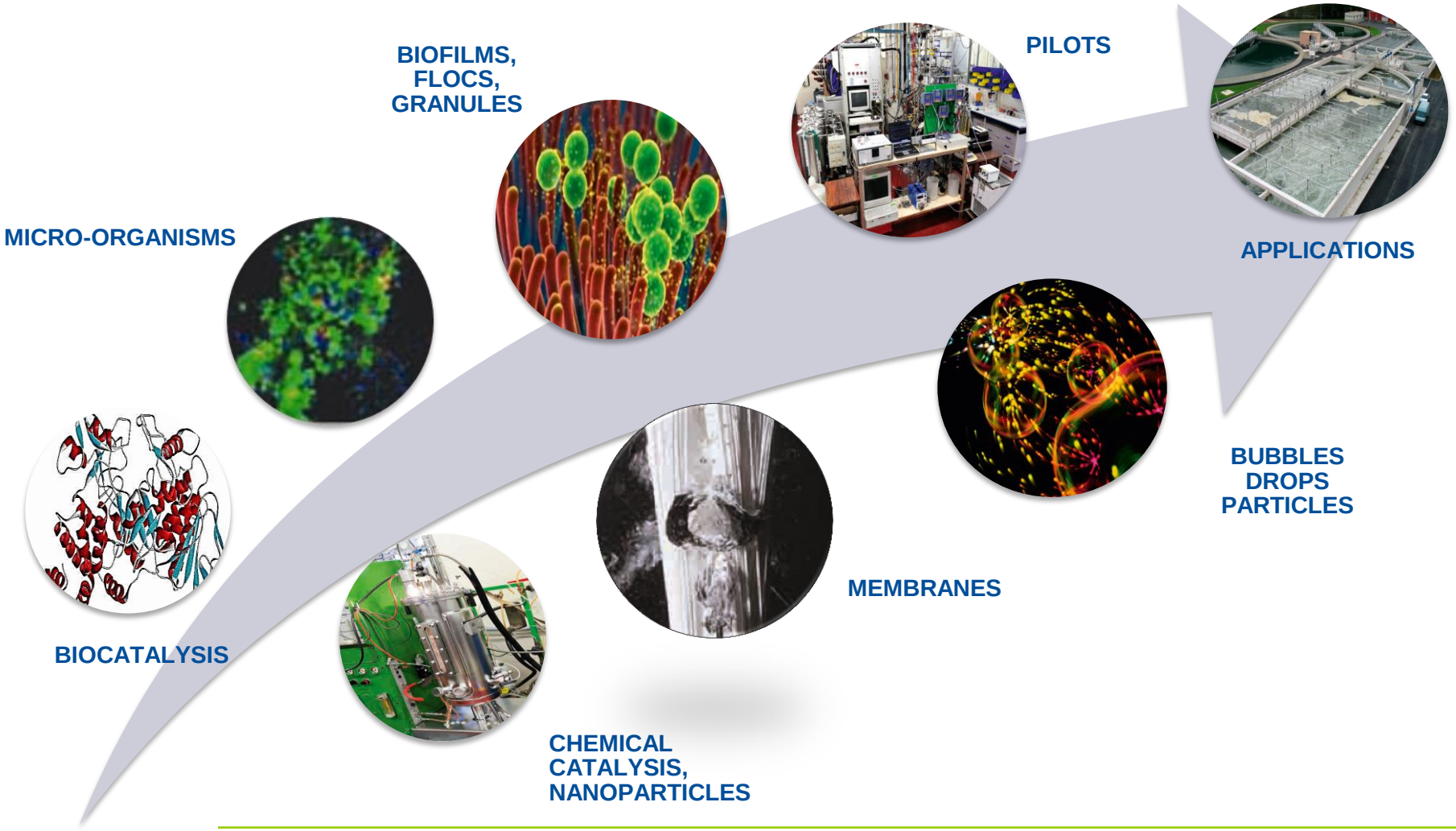
- **(Bio)Chemical Engineering:** most of our research will find its application in industrial processes. Understanding and exploiting the fundamental characteristics of such processes is critical to realistic process development.

Basic research input for an integrated approach to modern industrial biotechnology with wide applications in energy (biofuels), synthons, biomaterials, pharmaceuticals, food and feed, water resources, etc

Research Personnel at LISBP



Cascade of competence



LISBP Research Teams

3 major domains: biocatalysis, microbiology and (bio)chemical engineering

Catalysis and Molecular Enzymatic Engineering
M. Remaud Pr. INSA

Molecular and Metabolic Engineering
G Truan DR CNRS

Biochips and Bionanotechnology
V. Leberre CR CNRS

Engineering and Metabolic Pathway Evolution in Prokaryotes
I.Meynial-Salles Ass.Pr. INSA

Metabolism of Prokaryotes
M Cocaign-Bousquet DR INRA

Physiology and Functional Genomics of Eukaryotes
JM. François Pr. INSA

Integrated Metabolism and Dynamics of Metabolic Systems
JC. Portais Pr. UT3

Microalgal Genome Engineering
F Daboussi DR INRA

Fermentation Advances & Microbial Engineering
S Guillouet Pr.INSA

Microbial Ecosystems and Purification and Recovery Bioprocess
M.Spérandio Pr.INSA

Transfer, Interface, Mixing
A Cockx Ass Pr.INSA

Separation, Oxidation and Hybrid Processes for Environnemental issues
C.Guigui Pr. INSA

Technology Platforms

Transcriptome-Biochips - http://get.genotoul.fr
Expertise and technology for the analysis of gene expression. Development of innovative technology for future generation of chip-based analysis.

Engineering and Screening for Original Enzymes (ICEO) - http://iceo.genotoul.fr
Combinatorial engineering to modify or improve existing enzyme properties in order to adapt the catalysts to specific conditions of use. Generation of large libraries of mutant genes. Metagenomic screening.

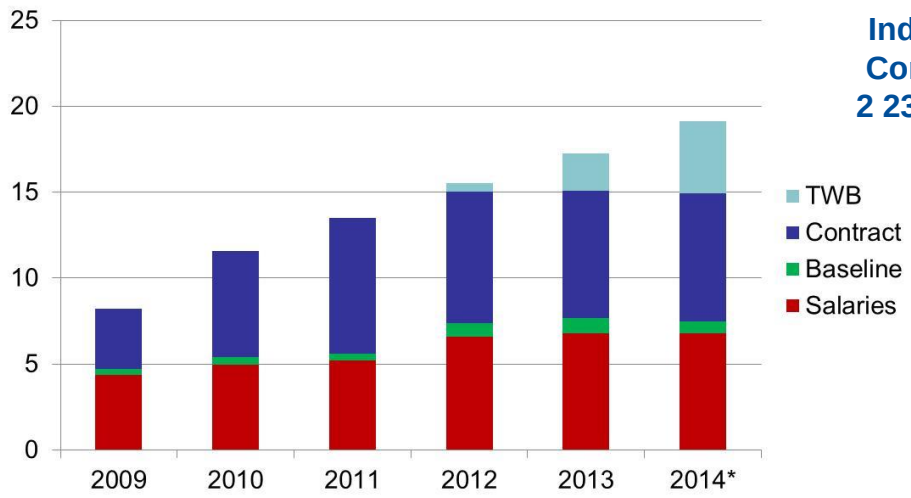
Metabolomics-fluxomics (MetaToul) - www.metatoul.fr
Expertise and state-of-the-art fluxomics NMR and MS methodologies for the functional analysis of metabolic networks. Major focus on appoaches for the quantification of intracellular metabolite concentrations.

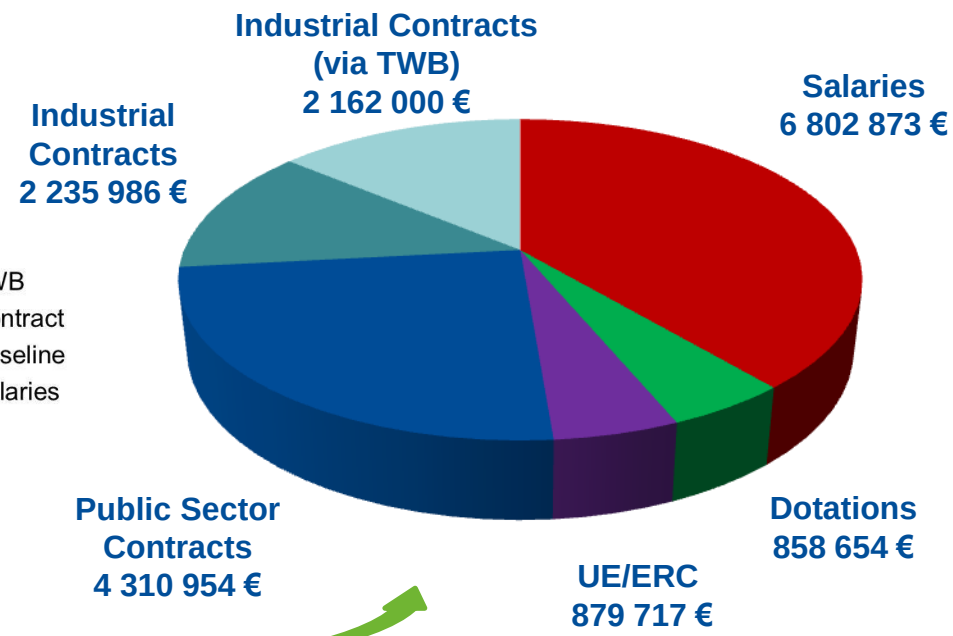
iFERM fermentation platform
Multi-laboratory fermentation platform covering high throughput mini-fermenters to highly instrumented set-ups and 300L pilot scale plant.

Budget

Consolidated Budget (salaries included)

- 8,5 M€ in 2009 to 15 M€ since 2012
- additional resources via TWB since 2012 (expected 4 M€ in 2014)
- 17 European Union/ERC contracts (2009-2014)
- 4 *Science for the Future* contracts
- high success rate at national calls (>35% en 2014)

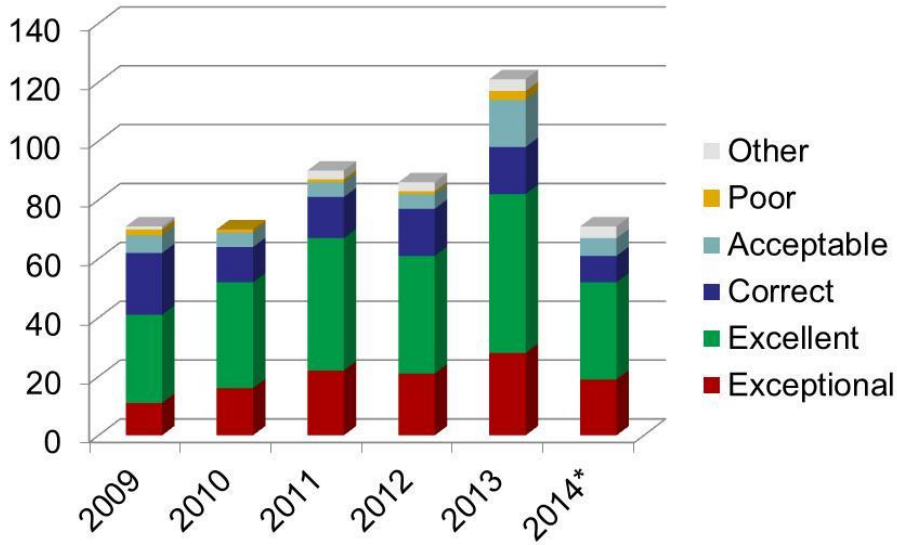


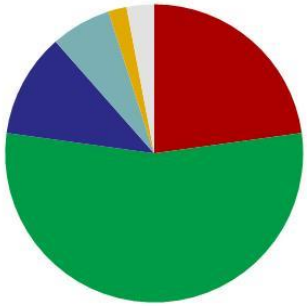


** Provisional budget for 2014 at 1st July*

Scientific Production (2009-2014)

- >500 publications in WoS journals
- >75% in 1st quarter journals (>20% in exceptional journals)
- Co-signatures (50% national / 30% international)



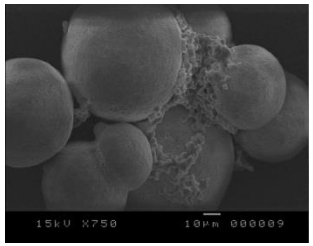


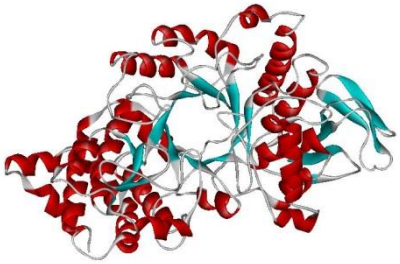
** Values for 2014 represent only the first half of the year*

INPI Innovation Trophy in 2007
>50 patents since 2007 (13 currently exploited)

Biocatalysis

Head of the group: Pr. Pierre MONSAN





~ Discovery, improvement and rational exploitation of high performance enzymatic biocatalysts based upon structure-function analysis.

~ Efficient synthesis of novel products :

- integrated use of microbiology, metagenomics and data mining coupled to molecular biology and 3D modelling
- technological expertise in production, enzyme stability and immobilisation in both batch and continuous reactors

Catalysis & Molecular Enzyme Engineering – Pr. Magali REMAUD (INSA)

Molecular & Metabolic Engineering – Dr. Denis POMPON (CNRS)

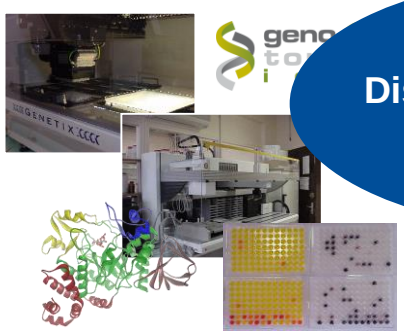
Biocatalysis

Natural diversity

Exploring Genomic and metagenomics libraries

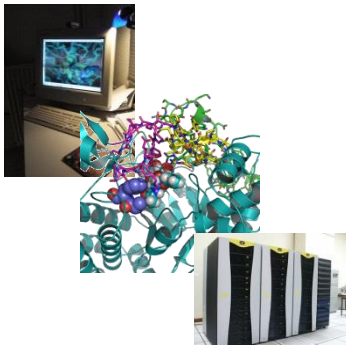
Artificial diversity

Directed molecular evolution
Rational engineering
Semi-rational engineering



Enzymes
Discovery, Conception & Engineering

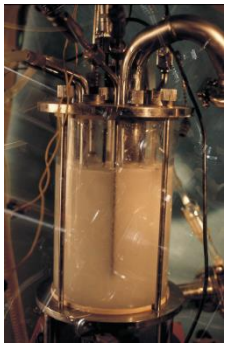
- Structure/Activity
- Computer-aided design



Enzyme-based processes

Synthetic biology

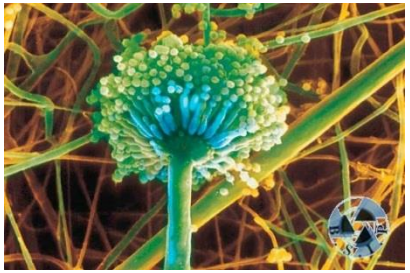
Physiology and Microbial Metabolism



Head of the group: Dr Nic LINDLEY

~ Systems biology approach to understand and metabolically engineer the microbial system for biotechnological purposes:

- production of high added value chemical synthons,
- production of safer food and novel pharmaceutical products.



~ 6 teams with complimentary approaches:

functional genomics, functional genetics, metabolic regulation of complex metabolic networks, metabolic flux analysis and mechanistic modelling based upon enzymes activities and quantitative transcriptomic, proteomic and metabolite analyses.

Engineering & Metabolic Pathway Evolution in Prokaryotes – Ass.Pr. Isabelle MEYNAL-SALLES (INSA)

Metabolism of Prokaryotes – Dr. Muriel Cocaign-Bousquet (INRA)

Physiology & Functional Genomics of Eukaryotes – Pr. Jean-Marie FRANÇOIS (INSA)

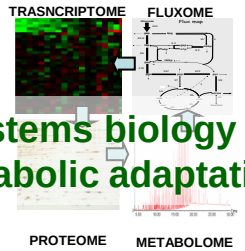
Biochip & Bionanotechnology – Dr. Véronique LEBERRE (CNRS)

Integrated Metabolism & Dynamics of Metabolic Systems –Pr. Jean-Charles PORTAIS (UT3)

Microalgal Genome Engineering – Dr Fayza DABOUSSI (INRA)

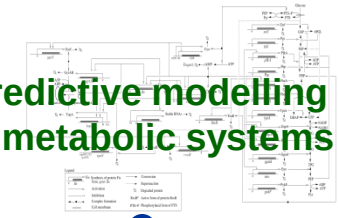
Microbial Physiology and Metabolism

From basic knowledge …

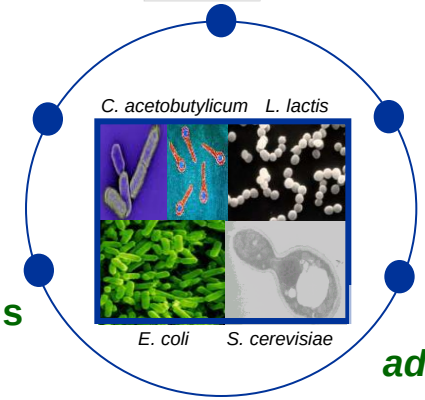


Systems biology of metabolic adaptation

Comprehensive analysis of metabolism



Predictive modelling of metabolic systems



Metabolic engineering

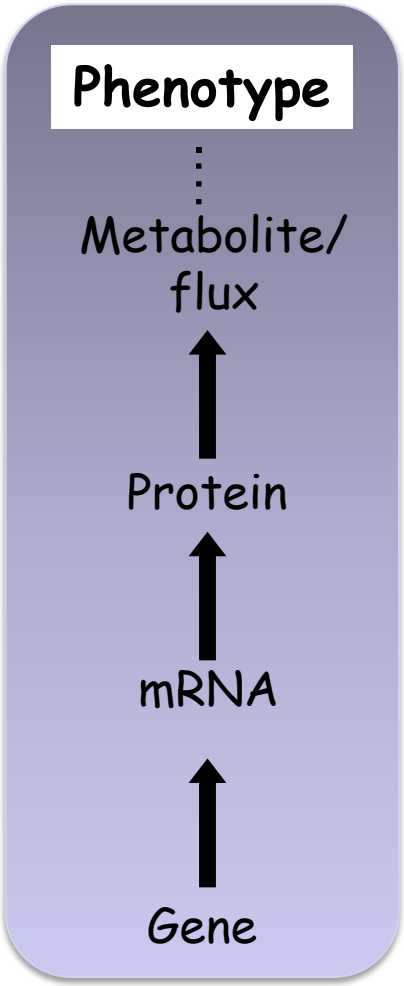
In vivo metabolic adaptation & evolution

… to efficient cell factories …

… and safe food products

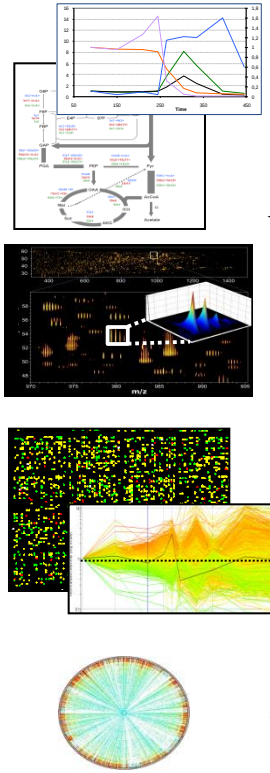
Applications: biofuels, chemical synthons, nutrition, pharmaceuticals, etc

Systems Biology Approach

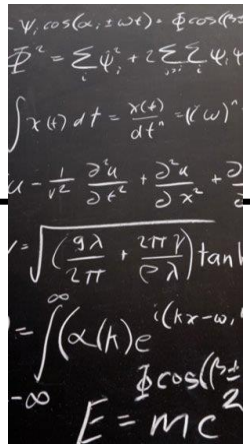


Adaptation

Systemic Biology



Mathematics



- ❑ Understanding : system description

Modeling

Bacterial phenotypes

Predict

Understand

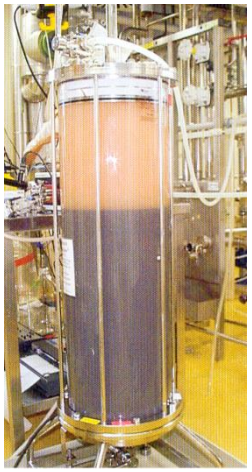
Nutritional Eng.
Metabolic Eng
Synthetic Biol.

Bacteria exploitation

Application

- ❑ Determinant Identification

Microbial Systems and Bioprocesses



Head of the group: Pr. Jean-Louis URIBELARRÉA

~ Analysis and understanding of the dynamic behaviour of microbial populations within bioreactors with a controlled environment, based upon the integrated use of fermentation technology, microbial physiology and process engineering.

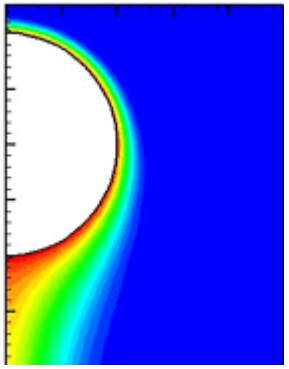
~ Study and exploitation of complex microbial consortia

~ Systemic analysis of microbial behaviour in reproducible and fully characterised fermentation conditions taking into account industrial constraints to develop innovative microbial bioprocesses.

Microbiological Engineering Systemic Analysis & Process Innovation – Pr. Stephane GUILLOUET (INSA)

Microbial Ecosystems, Purification & Recovery Bioprocessing – Pr. Mathieu SPÉRANDIO (INSA)

Transfer-Interfaces-Mixing



Head of the group: Pr. Philippe SCHMITZ

~ Experimental analysis and mathematical modelling of hydrodynamic, mechanical and physico-chemical phenomena involved in multiphase and reactive process environments.

~ Fluid mechanics and chemical engineering principles to determine the diffusional transfer characteristics in fluids containing dispersed inclusions.

~ Detailed studies of specific phenomena identified in pilot studies are performed in model systems and then extrapolated to achieve knowledge of the functional behaviour of complex reactions at the bioreactor level.

Transfer-Interfaces-Mixing – Dr. Arnaud Cockx (INSA)

Separation, Oxidation and Hybrid Processes for Environmental Issues

Head of the group: Pr. Corinne CABASSUD

~ New approaches in environmental engineering, water treatment and eco-designed processes.

- separation (*membranes, adsorption, chromatography*)
- reaction (*crystallization, oxidation*) and their limiting phenomena.

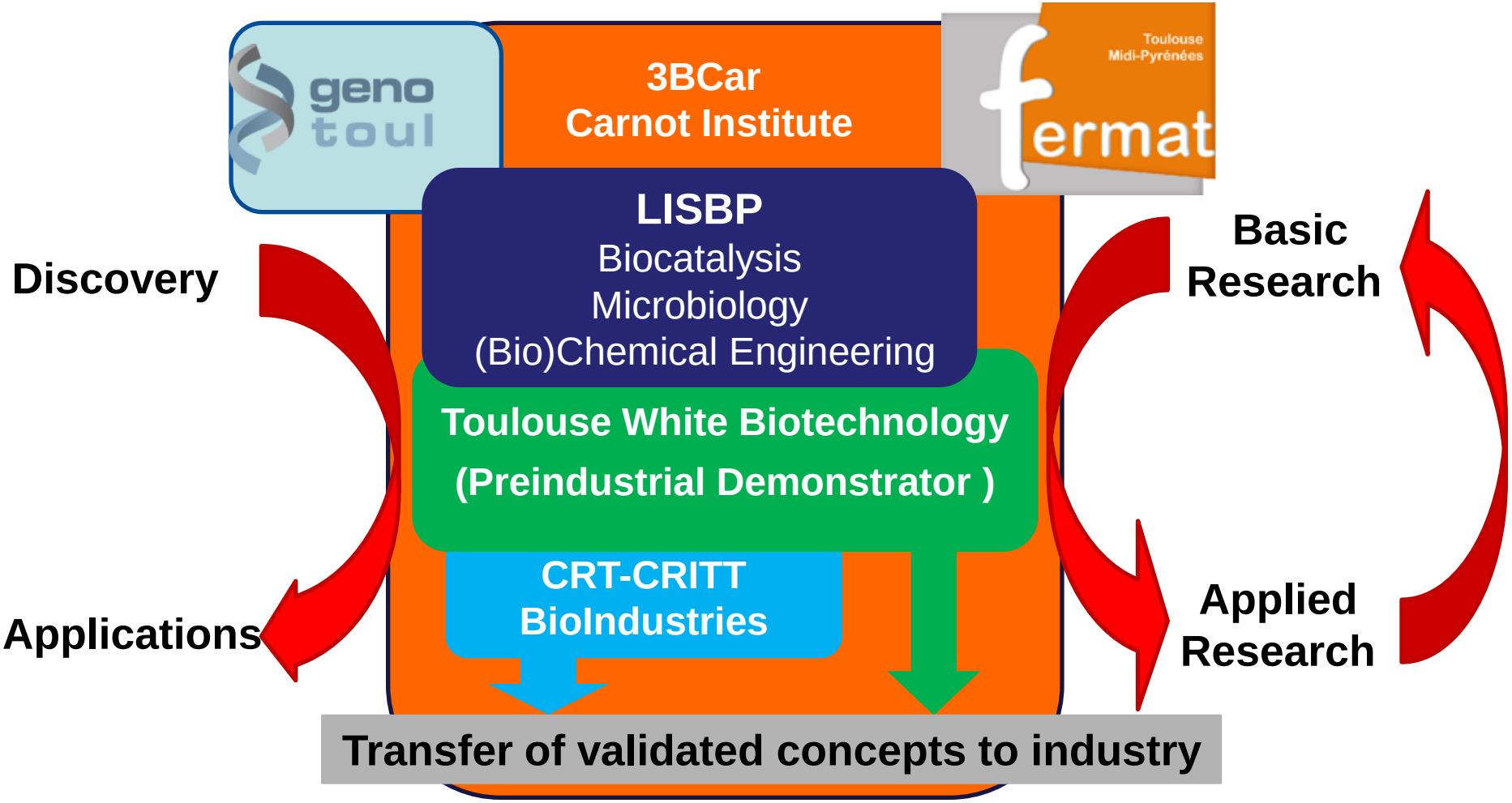
~ Analysis and optimization of these processes for complex liquids (*water, effluents, biological fluids, green juices, urine*) for their treatment or valorisation.

~ Sustainable and integrated processes involving hybrid processes based on separation and (bio) reactions (*ex: membrane bioreactors*)

~ Modelling tools for process eco-design and life cycle analysis.

Separation, Oxidation & Hybrid Processes for Environmental Issues – Pr. Christelle GUIGUI (INSA)

Toulouse Center for Industrial Biotechnology



LISBP : a large panel of expertise and integrated approaches

…for understanding molecular phenomena underpinning biological systems

… the physico-mechanical characteristics of complex environments

…and to thereby rationally develop innovative processes for industrial biotechnology

see website www.lisbp.fr for further details