



Applied Engineering **in** Brussels

How the University Colleges of Brussels contribute to R&D



By InduTec



InduTec asbl - Technological Transfer Center

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INDUTEC, the Technology Transfer Centre for your Innovation (www.indutec.be)

InduTec is a dynamic Technology Transfer Centre whose mission is to enhance the exchange of technology and innovation between companies and industrial engineering faculties in the Brussels Region. By monitoring projects from concept to implementation, *InduTec* offers promotional opportunities and state-of-the-art experience to those faculties, and enables companies to reap the benefits of a quality science 'business incubator'.

A company's technological knowledge base is the foundation on which internal product and process innovations are generated. However, technological knowledge is not accumulated solely through internal learning processes. Increasingly, companies are turning to external sources in the technology supply chain to acquire the technological know-how they need to introduce product and process innovations. Thus, the successful structuring and executing of partnerships with external "technology source" organizations, such as the Technology Transfer Centre - *InduTec*, is often critical to competitive success in technologically dynamic environments.

The research activities of the industrial engineering faculties in the Brussels Region are future-oriented and innovative. The industrial engineering faculties collaborate with industrial and economic actors in Belgium and abroad through

- contract research (industrial research projects, technical feasibility studies, pre-competitive development, ...)
- economic valorisation (transferring R&D results through existing or new companies)
- protection of intellectual property, licencing agreements, spin-off guidance, ...

It all passes through *InduTec*, that knows how and where to find the appropriate competencies in the industrial engineering faculties to respond to the requests of industry.

If you are looking for new partnerships in managing your technological innovation, do not hesitate to contact our Technology Transfer Centre.

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Areas of Expertise



Biotechnological Sciences (HELDB)



Biological and biotechnological activities are essentially undertaken by the Biotechnology Unit, and the Brewery and Fermentation Unit located within the Institut Meurice.

As a result of their expertise, their partners and their advanced technical equipment these units address the current needs of industry and provide solutions for challenges in the biotechnology industry.

The units are specialized in:

- The upgrade and validation of protein fermentation and purification processes;
- Yeast physiology, the organoleptic stability of fermented beverages and the development of new fermentation processes;
- The production of dry or liquid micro-organisms (probiotics, starters for the food industry, bioepuration, biofungicides etc.);
- The development of bioprocesses within an environmental technology framework (biofiltration, bioremediation, denitrification etc.) and studies on the configuration of new bioreactors;
- The numeric modelling of biotechnology processes and fluid flows in reactors.

The following research units are involved in Biotechnology activities (primarily units of the HELDB - IM department):

The BioTechnology Unit
The Brewery and Fermentation Unit
The Microbiology Unit



RESEARCH PROJECTS

BTU

Since its foundation, the BTU has entered into almost 50 medium-term R&D agreements covering a wide range of activities across a variety of bio-industries, and has signed up in excess of 200 yearly contracts of researchers in the biotechnology sciences (fermentation technologies, protein purification, the drying of biomaterials and environmental engineering).

Examples of innovative research achievements, strategic collaborations and technology transfers include:

- The development of fermentation processes with high biomass concentrations
- The development of new fermentation processes (batch, fed-batch and continuous process) with free or encapsulated living cells for the food, environmental and pharmaceutical sectors
- Downstream processing development (UF, centrifugation, cell disruption etc.)
- The purification of recombinant proteins produced by genetically modified micro-organisms (*E. coli*, *L. lactis*, *P. pastoris*, *S. cerevisiae*, etc.)
- The production of natural antagonists: organic acids, bacteriocins, biofungicides
- Formulation by drying processes, immobilization/coating of biological products and stability studies during storage
- The isolation of natural strains of industrial significance (enzyme secretion, xenobiotic metabolism)
- The production of microbial starters for food and environmental technology
- Environmental technology: production of micro-organisms presenting special degradation metabolism, innovative bioprocess treatments for waste water and air pollution
- Computer-based design and liquid flow simulations of bioreactors

In addition to these applied research projects, the Biotechnology Unit uses its own funds to develop more fundamental research projects through theses or final course papers:

- The development of high-cell density fermentation procedures: propagation of bacteria (*E. coli*, lactobacteria, *Bacillus*, *Pseudomonas* etc.) and natural or recombinant yeasts (*Saccharomyces*, *Pichia*, *Candida* etc.)
- A study of the special physiology induced by the inclusion of *S. cerevisiae* in a calcium-alginate matrix (primary amino-acid and carbon metabolism, stability of genetically manipulated strains)
- A study of the biosynthesis of bacteriocin by a strain of *Carnobacterium Piscicola*
- A study of malolactic fermentation in *Oenococcus oeni* in an immobilised system
- A study of the physiological parameters permitting the drying of bacterial (including lactobacteria) and yeast biomasses with high survival rates
- A study of the utilisation of fructo-oligosaccharides by *Bifidobacterium*
- Optimisation of recombinant proteins production by lactobacteria and the development of the capture stage using expanded bed chromatography techniques
- Selection of micro-organisms that degrade hydrocarbons

Furthermore, the Chemical Engineering Department of the BTU Unit has developed R&D activities concerning the purification of residual industrial effluent and, more specially, for the treatment of airborne Volatile Organic Compounds (VOCs). The work focuses primarily on the degradation of solvents and xenobiotics emitted by various industrial activities, and aims to develop biological treatments by biofiltration that offer the best elimination capabilities.



BREWERY & FERMENTATION UNIT

The Department of Brewing Sciences and Fermentation Technology is involved in research on yeast physiology, the organoleptic stability of fermented beverages, and the study of new fermentation processes in order to meet teaching requirements and the needs of industry.

Examples of research:

- Study of yeast cell physiology for industrial applications
 - Carbonyl compound reduction by yeast
 - Yeast as a eukaryotic model for cosmetic or pharmaceutical studies
 - Ester production during fermentation
 - Genetic manipulation and improvement of brewing yeast
 - Improved fermentation performance
 - Modification of biosynthetic fluxes to avoid off-flavour compounds
 - Nutritional characteristics of beer (folates, polyphenols etc.)
 - Study of the antioxidant production of yeast after oxidative stress

- Organoleptic stability properties of fermented products
 - Organoleptically stable fermented beverages
 - Microbial produced aromatic substances
 - Analyses of flavour active compounds in fermented beverages
 - Use of free and immobilized enzymes to improve beer stability
 - Use of natural antioxidants

- New Fermentation Technology
 - New bioreactor designs
 - New fermentation processes : Fed-batch and immobilized cell systems, on-line measurements
 - Process improvements such as beer filtration
 - Selection of industrial yeasts for brewing purpose, bioethanol production etc.





RECENT RESEARCH PROJECTS

ADFILBI - Beer filtration using a synthetic filter.

Abstract: In order to obtain a bright beer, brewers must refine and stabilise their product after maturation. The most common technique is filtration by body feeding (using a natural filter aid such as the kieselguhr). However, despite satisfactory results, the kieselguhr poses operational and environmental problems, e.g. storage of this powdery product in a dry place, processing, toxicity and disposal (due to its inability to be regenerated). Beer filtration using a synthetic filter aid seems to be an alternative to prevent most of the above mentioned difficulties. Two polymers have been identified and tested in comparison with the kieselguhr. Candidates have been selected based on physico-chemical characteristics such as the size, morphology and surface aspect, size distribution, wetting ability and processing.

Scientists: M. Libouton (IM), L. Van Nedervele (IM), D. Daoust (UCL), J.J. Biebuyck (UCL), M. Slavons (UCL).

Partners: Brasserie de Silly, Brasserie de Brunehaut, Sopura.

Technological Domain & Keywords: agro-food technology, brewery, clarification, filtration, polymers, regenerable supplements, surface and boundary layers.

BIOFIL - Treatment of industrial gas effluent containing VOCs

Abstract: Development of an effective system for the treatment of industrial gas effluent containing Volatile Organic Compounds (VOCs) by implementing cell immobilisation in a biofiltration procedure.

Scientists: X. Nicolay (IM), P. Therasse (Meurice R&D).

Partners: Sima-Saca s.a.

Technology Domain: environmental biotechnology, air pollution treatment, cell immobilisation.

Keywords: VOC, biofiltration, immobilisation.

FONGICAP - Enzyme production.

Abstract: Enzyme production: integration of modern techniques for the culture of filamentous fungi to maximise enzyme production.

Scientists: X. Nicolay (IM), M. Depoorter (Meurice R&D).

Partners: Wetlands Engineering, M^r Bols - UCL, M^{me} S. Van Hulle.

Technology Domain & Keywords: dye treatment, industrial waste water treatment, laccase, white rot fungi, fermentation.

FUNGIMMO - Fungi immobilization.

Abstract: Mycelium immobilization; development of a stable polymer matrix resistant to the pressure exerted by growing mycelium; study of the effect of immobilisation in this inclusion matrix on the production of metabolites of industrial interest secreted by the immobilised strain.

Scientists: B. Massart (IM), E. Offerman (Meurice R&D).

Partners: Beldem sa - M^r T. Dauvrin.

Technology Domain & Keywords: biotechnology, immobilization, mycelium, polymeric matrix for biomass inclusion.

LACSTABY - Development of a system of plasmid stabilisation.

Abstract: Development of a system of plasmid stabilisation based on the use of poison/antidote genes in lactobacteria. This project aims to endorse this system in order to consolidate the use of lactobacteria for the heterologous expression of proteins presenting therapeutic or technological interest.

Scientists: A. Durieux (IM), M. Duyck (Meurice R&D).

Partners: UCL (Unit Gene), Prof. P. Hols - Delphi Genetics s.a., M^r P. Gabant.

Technology Domain & Keywords: acid bacteria, biotechnology, heterologous expression, pharmaceutical, plasmidic stability, poison/antidote system, production technology.



Areas of Expertise



Biotechnological Sciences (HELDB)

SOPURA - *microbicide effects of cleaning and disinfectant solutions*

Abstract: A study of the microbicide effects of cleaning and disinfectant solutions in accordance with European food, brewing and soft-drink industry standards. The same microbicide effects have been studied further in relation to the action of the naturally occurring constituents found in essential oils (which can be used in the food industry).

Scientist: P. Maurer (IM).

Partners: SOPURA (Courcelles).

Technological domain & Keywords: bacteria, bactericide effects, fungicide and sporicide yeast, food microbiology, cleaning and disinfectant solutions, challenge tests, mold.

SPINBIOF - *The biofiltration of industrial gas effluent using controlled salting out*

Abstract: The biofiltration of industrial gas effluent using controlled salting out. This project aims to enhance biofiltration and ensure high degradation rates by implementing an idea inspired by soil and water treatment (controlled salting out).

Scientists: X. Nicolay (IM), D. Ortolani (IM).

Partners: Sima-Saca Gheysen, ENVISAN International.

Technological Domain and keywords: environmental technologies, pollution management, (bio)polymers, biotechnology, biofiltration, VOC, continuous inoculation, controlled salting out.

YPCFERM - *Characterization and potential use of a peptidic factor extracted from yeast during fermentation*

Abstract: Yeast performance and vitality are not constant parameters during successive fermentations (especially on high gravity wort). In fact, yeast is being exposed to many stresses like osmotic, thermic and ethanol shocks. Studies have shown that a yeast peptide complex (YPC) obtained by the alcoholic extraction of yeast stimulates yeast metabolism. Under brewing conditions, it has been shown that this peptide factor reduces the main negative effects of high gravity brewing. It not only enhances the fermentation rate, the final attenuation and the resistance to ethanol and osmotic stresses, but also maintains the stability of yeast performance during successive high gravity wort fermentations. The aim of this study is to present the effect of this innovative peptide factor on yeast metabolism, resistance to stress and to identify an action plan.

Scientists: B. Levaux (IM), M. Dillemans (IM), A. Debourg (IM), L. Van Nederveelde (IM).

Partners: Bières de Chimay.

Technological Domain & Keywords: agro-food, bioethanol production, brewery.



CONSULTING SERVICES & TRAINING

A variety of consulting services are provided to industry in biotechnological applications and in more specific fields such as brewery engineering.

BIOTECHNOLOGICAL APPLICATIONS

Fermentation: selection, isolation and characterization of microbial strains such as yeasts and bacteria (which are of particular interest to industry).

Protein Purification: development of protein or peptide purification processes, development of specific purification protocols in relation to the properties of the proteins or peptides to be purified.

Drying of biomaterials: freeze drying, fluidized drying and spray drying of vegetable extracts and fermentation by-products.

Environmental Engineering: purification of residual industrial effluent, treatment of airborne Volatile Organic Components (VOCs), degradation of solvents and xenobiotics, development of a biological treatment plant through biofiltration which offers the best decontamination capabilities.

BREWERY ENGINEERING

The Department of Brewing Sciences and Fermentation Technology is involved in research on yeast physiology, the organoleptic stability of fermented beverages and the study of new fermentation processes in order to meet teaching requirements and the needs of industry.

- Analysis of raw materials (barley, malt, hops)
- Analysis of wort and beer
- Expert panel in beer organoleptic evaluation
- Fermentation technology and engineering
- Determining organic acids, sugars and amino-acids
- New product development
- Tailor-made technical and theoretical training for brewery laboratory managers and operators
- Volatile compounds quantification
- Yeast selection
- Yeast maintenance and control
- Yeast propagation



Areas of Expertise



Biotechnological Sciences (HELDB)

SPECIALIST EQUIPMENT

SPECTROMETER:

- UV/Visible Spectrometer
- RX Spectrometer
- FTIR Spectrometer
- Spectro-Max plus
- SAA/SAE Spectrometer
- SAM

DEDICATED EQUIPMENT FOR FOOD ANALYSIS:

- Chromameter
- Dionex Chromatography systems equipment
- GC-FID
- GC-MS sniffing
- GC-GC-MS sniffing
- Glossmeter
- HPLC-VWD-RID
- LC-MS
- RT-PCR
- Climatic chambers (control of t°, hygrometry and lighting)

DEDICATED EQUIPMENT FOR BIOTECHNOLOGICAL APPLICATIONS:

- BL2 aseptic suite
- Climatic chambers (4° to 37°C)
- Autonomous LS1 fermentation room allowing class1 GMM manipulation (2l to 200l)
- Freeze-dryer Christ - Epsilon 2-8D
- NIRO spray dryers (2kg/h to 20 kg/h)
- Fluidised bed dryers (2 to 5 kg - GLATT, HAAG, AEROMATIC)
- Protein purification room
- PhastGel Electrophoresis
- Encapsulation equipment
- RT-PCR equipment

DEDICATED EQUIPMENT FOR BREWERY ENGINEERING:

Basic equipment for brewing and related quality control:

- Beer Analyser (Anton Paar)
- Carbo QC (Anton Paar)
- Fermentors and propagator up to 200L
- Foam stability (NIBEM - Haffmans)
- Hazemeter
- Headspace gas chromatography
- HPLC chains completely dedicated to determining amino-acids, sugars and organic acids (Millennium chromatography manager)
- Pilot plant microbrewery up to 150 l
- Standard mashing plant
- UV-Vis spectrophotometer





PUBLICATIONS

BIOTECHNOLOGY UNIT:

V. Nedovic, A. Durieux, L. Van Nedervele, P. Rosseels, J. Vandegans, A-M. Plaisant, and J-P. Simon. "Continuous cider fermentation with co-immobilized yeast and *Leuconostoc oenos* cells". *Enzyme Microb. Technol*, 2000, **26**: 834-839.

A. Durieux, X. Nicolay and J-P. Simon. "Continuous malolactic fermentation by *Oenococcus oeni* entrapped in Lentikats" *Biotechnology Letters*, 2000, **22**: 1674-1684.

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BREWERY UNIT

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Areas of Expertise



Biotechnological Sciences (HELDB)

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A. Pietercelie and A. Debourg. "Why vitamins are so important for brewing industry?". *Cerevisia: Belgian Journal of Brewing and Biotechnology*, 2003, **28(1)**, 26-30.

M. Dillemans, L. Van Nederveelde and A. Debourg. "Wort supplements: from yeast and for yeast". *Brewing Yeast Fermentation Performance, 2d Edition* by K. Smart, Blackwell Science 2003, 96-109.

A. Pietercelie and A. Debourg. "Refermented beers: an interesting source of folate". *Proceedings of the 29th EBC Congress Dublin, 2003*.

L. Van Nederveelde and A. Debourg. "Role of the branched chain amino acid aminotransferases on the production of volatile compounds by *Saccharomyces cerevisiae*". *Proceedings of the 29th EBC Congress Dublin, 2003*, 37.

G. Bourdaudhui, M. Dillemans, L. Van Nederveelde and A. Debourg. "Improved yeast resistance to stress using antioxidants extracted from *Saccharomyces cerevisiae*". *Proceedings of the 29th EBC Congress Dublin, 2003*, 41.

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Areas of Expertise



Biotechnological Sciences (HELDB)

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