Bio-Ethanol Research within LU BIOFUELS

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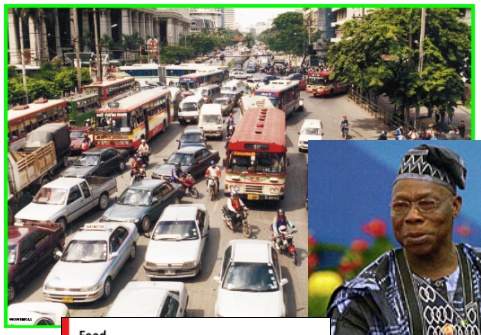
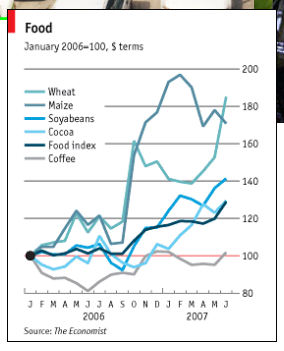
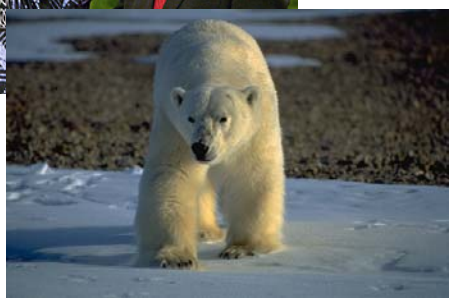


Increasing demand

Limited supply



Food supply

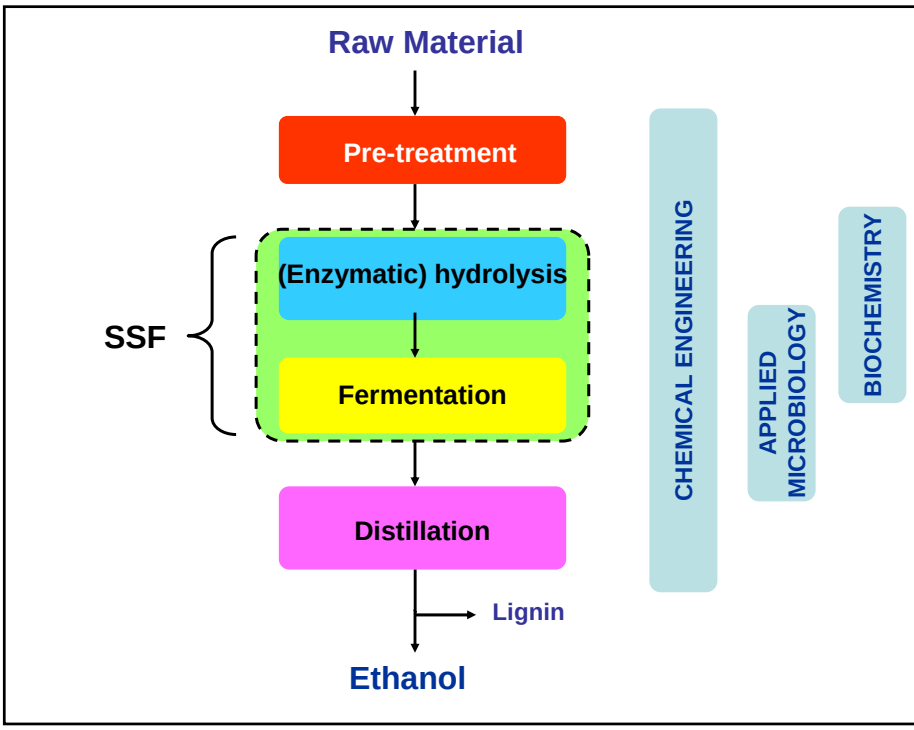


Global warming

Sugar/Starch

must be replaced with

Lignocellulose



Research challenges

- ⇗Sugar yield in the hydrolysis
  - Process optimisation in the pretreatment
  - Enzyme development
- ⇗ Yield in fermentation
  - Utilisation of all sugars
  - Improved fermentation technology
- ⇗ Productivity
  - Handling of yeast and enzyme inhibition
- ⇘ Enzyme costs
  - More active and stable enzymes
  - Lower cost of production
- ⇘ Downstream & investments costs
  - Higher concentrations

Research at Chemical Engineering

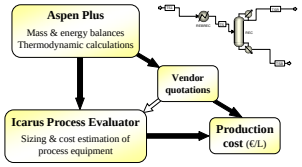
Pretreatment & hydrolysis technology

⇨ steam pretreatment unit

Optimisation using different catalysts and feedstocks

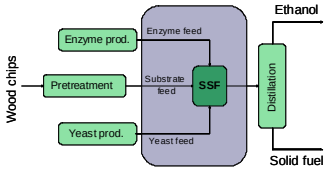
Techno-economic evaluation

⇨ Identification of economic bottlenecks in the process design



Fermentation technology

Process optimization
- process robustness
- productivity in SHF and SSF
- co-fermentation of pentose and hexose sugars
- strain adaptation



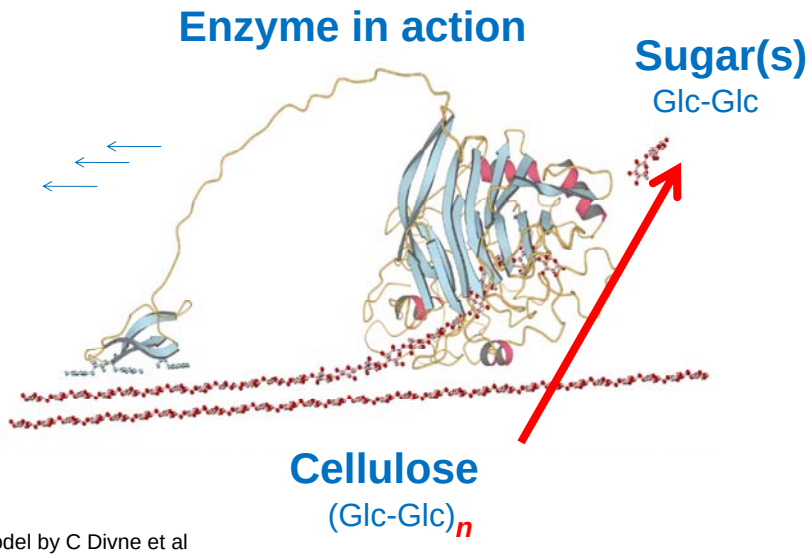
Chemical Engineering

Current group of researchers working on ethanol from lignocellulose at the department:

- Prof. Guido Zacchi, Prof. Gunnar Lidén, Dr. Mats Galbe, Dr. Ola Wallberg, Eng. Christian Roslander
- Ph.D students Karen Cabero, Cristhian Carrasco, Borbala Erdei, Kerstin Hoyer, Elisabeth Joelsson, Krisztina Kovacs, Stefano Macrelli, Sanam Monavari, Kim Olofsson, Magnus Wiman

In addition guest researchers and diploma workers are also active at the department

Research at Biochemistry



Enzyme model by C Divne et al

Research at Biochemistry

More than 15 enzymes are needed to convert lignocellulose

To reach optimal enzyme blends we focus on:

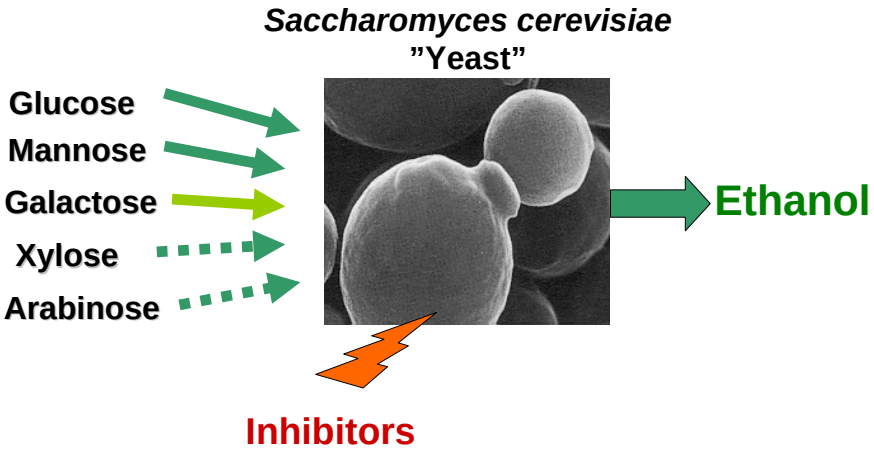
- Enzyme discovery and development

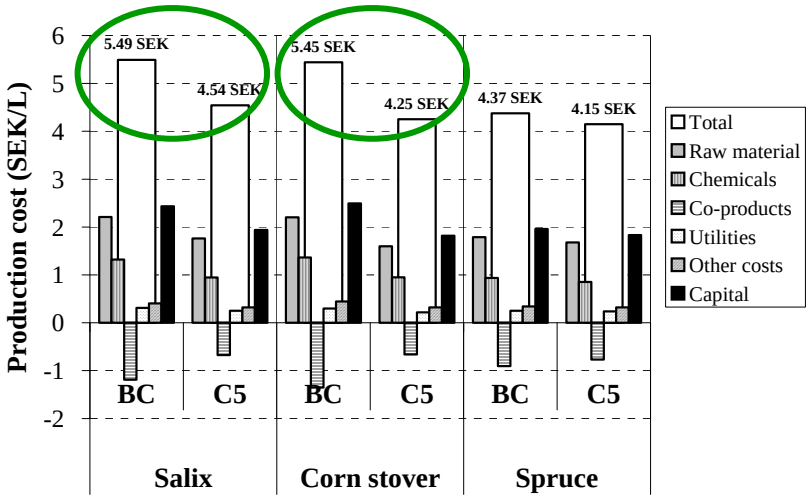
  (molecular genetics and 3D structures)
- Enzyme synergy and productivity

  (enzyme binding and kinetics)
- Realistic substrates and conditions

Henrik Stålbrand (PI), Folke Tjerneld (PI), Anna Rosengren, Patricia Pavon Orozco, Omid Hekmat, Hans-Olof Johansson. Previous: 11 PhD students, 3 post docs

Research at Applied Microbiology

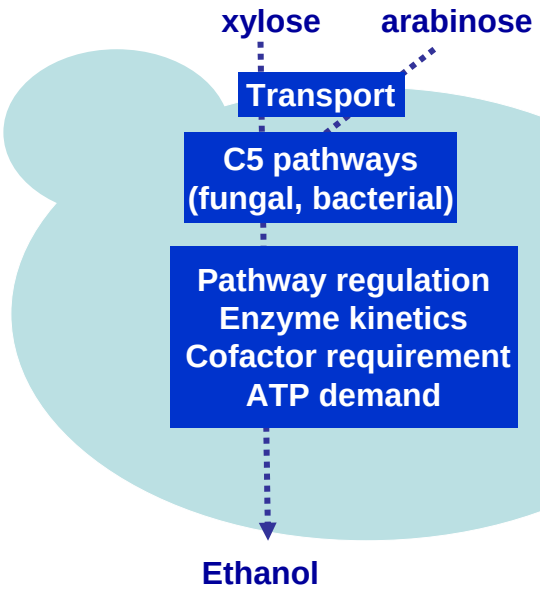




Sassner et al (2008) Biomass & Bioenergy 32, 422-430, 2008

C5 conversion to ethanol reduces cost >20%

C5 fermentation



Kaisa Karhumaa
Johan Hallborn
Mats Walfridsson
Nina Meinander
Eva Palmquist
Kerstin Skoog
Anna Eliasson
Camilla Christensson
Karin Träff
Fredrik Wahlbom
Björn Johansson
Anna Lönn
Mark Gardonyi
Marie Jeppson
*João Almeida**
Oskar Bengtsson
*Nadia Skorupa Parachin**
*Rosa Garcia Sanchez**
David Runquist
Basti Bergdahl
*Maurizio Bettiga**
Bärbel Hahn-Hägerdal
*Marie Gorwa-Grauslund**

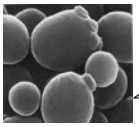
Yeast tolerance

Furaldehydes
Weak acids
Phenolics

Lactic acid bacteria

Inhibition mechanisms
Detoxifying enzymes/proteins
Yeast adaptation/selection
Process optimisation

Eva Palmquist
Lisbeth Olsson
Kerstin Skoog
Simona Larsson
Boaz Laadan
*João Almeida**
Violeta Sanchez Nogue
Valeria Wallace
*Marie Gorwa-Grauslund**



Applied Microbiology

Chemical Engineering

Annelie Petersson
Tobias Modig
Andreas Rudolf
Magnus Wiman
Kim Olofsson
Gunnar Lidén

Fed-batch SSF + Recombinant xylose-utilising yeast

Condition	Overall ethanol yield (g/g added)	Converted[1] xylose (%)	Xylitol yield (g/g xylose converted)	Ethanol (g/L)
7% WIS	0.38	38%	25%	32.9
7% WIS – fed-batch	**0.40**	**68%**	25%	**34.8**
9% WIS	0.29	14%	32%	33.2
9% WIS – fed-batch	0.28	32%	12%	**34.9**

Olofsson et al. (2008) J Biotechnol 134:112-120

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Vetenskapsrådet