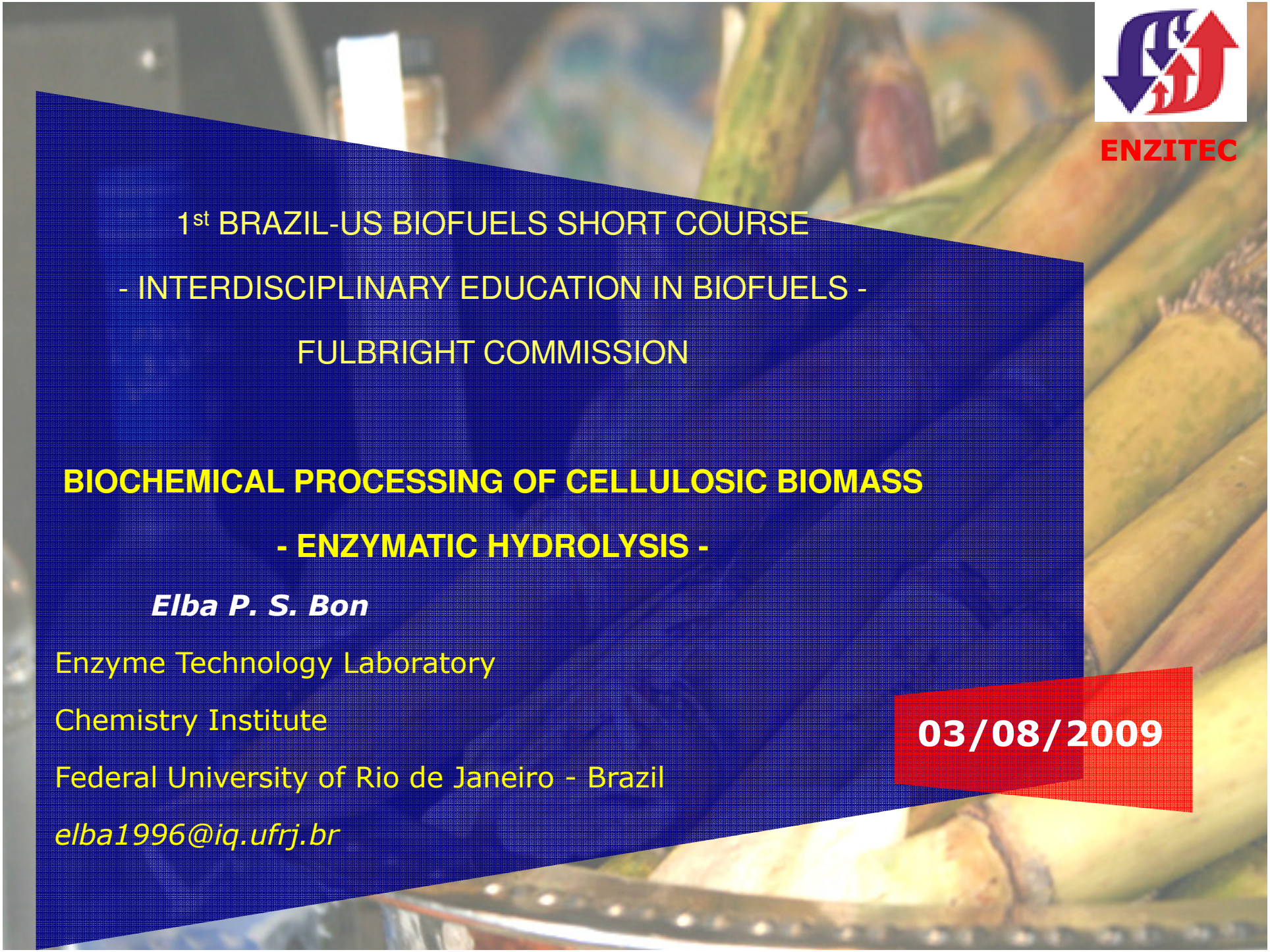

ENZITEC

1st BRAZIL-US BIOFUELS SHORT COURSE

- INTERDISCIPLINARY EDUCATION IN BIOFUELS -

FULBRIGHT COMMISSION

BIOCHEMICAL PROCESSING OF CELLULOSIC BIOMASS

- ENZYMATIC HYDROLYSIS -

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03/08/2009

ENZYMATIC HYDROLYSIS OF BIOMASS

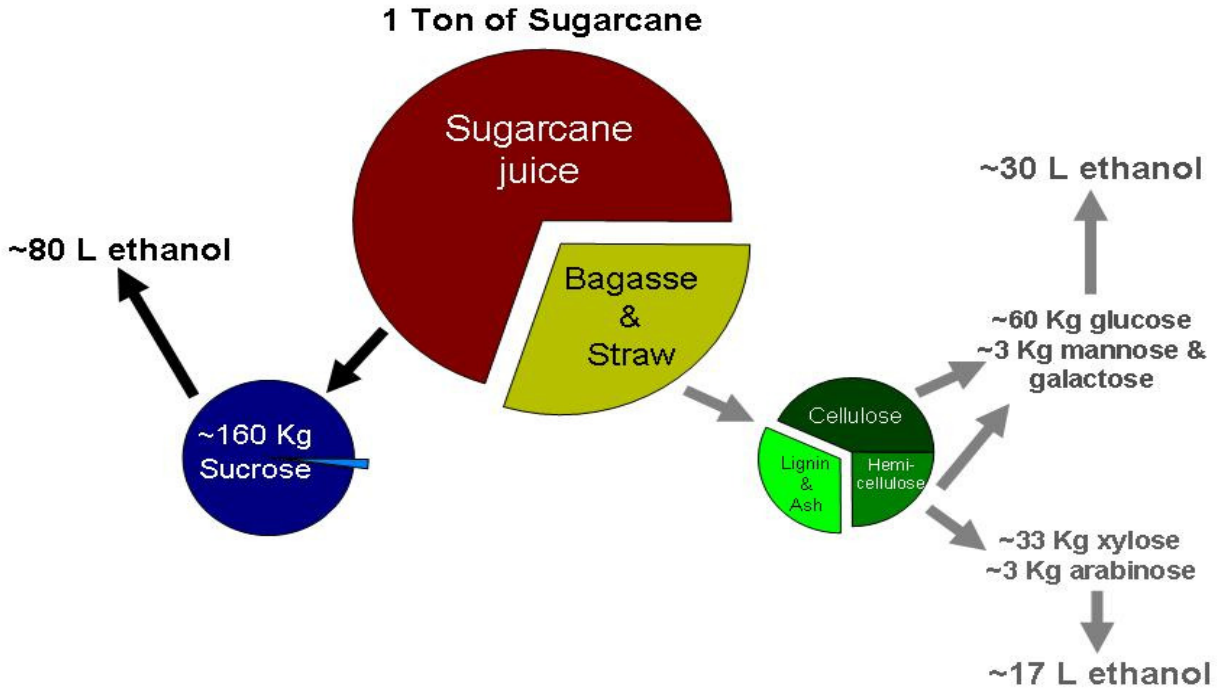
- LIGNOCELLULOSIC BIOMASS
- BIOMASS STRUCTURE
- BIOMASS MACROMOLECULAR COMPONENTS
- MAIN ENZYME ACTIVITIES
- ENZYME BLENDS
- BIOMASS HYDROLYSIS

EXAMPLE OF LIGNOCELLULOSIC BIOMASS

SUGARCANE PLANTATION

SUGARCANE BIOMASS

Sugarcane composition



Boris U. Stambuk, Elis C. A. Eleutherio, Luz Marina Florez-Pardo, Ana Maria Souto-Maior, Elba P. S. Bon (2008), Brazilian Potential for Biomass Ethanol: The Challenge of Using Hexose and Pentose Co-fermenting Yeast Strains, Journal of Scientific and Industrial Research, *in press* and Emmon H.W. & Atreya, A. (1982), Sadhana: The Science of Wood Combustion, **5:**4, 259-268

SUGARCANE BIOMASS

BAGASSE

STRAW

SUGARCANE BAGASSE COMPOSITION

Cellulose (~37%)	**→ C_6 sugars for ETHANOL (renewable liquid fuel)**
Hemicellulose (~28%)	**→ C_5 sugars for Ethanol, Bio-refineries or Enzymes Production**
Lignin (~21%)	**→ Poly aromatic hydrophobic structure (renewable solid fuel or chemical industry)**

Ethanol from sugarcane bagasse

- 88% bagasse used for co-generation (heat and electricity)
- New boilers will decrease bagasse use and increase surplus
- The use of straw for biomass ethanol or as fuel in the boillers will increase biomass availability
- 12% present surplus bagasse (10 million tonnes)
- Production of additional 2.4 billion L of ethanol from C6 sugars

BIOMASS ETHANOL

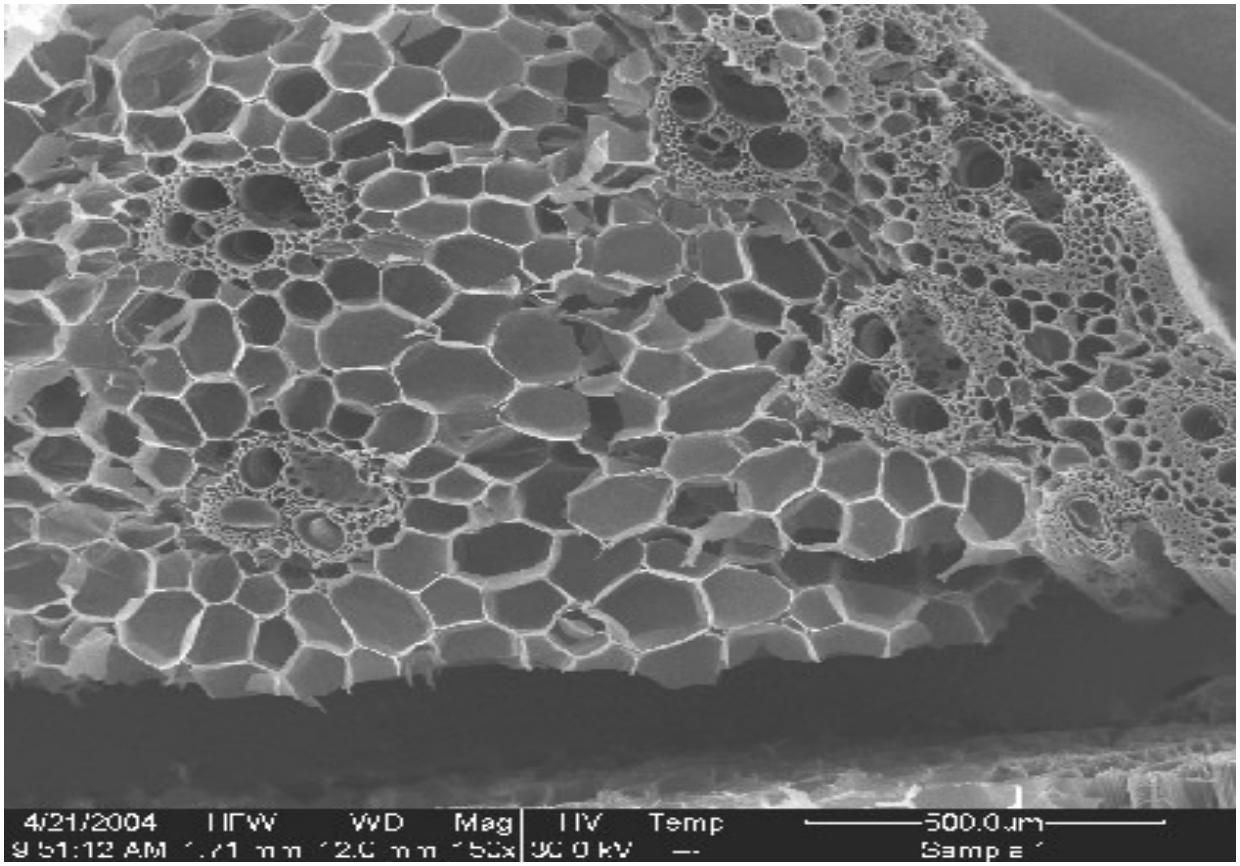
POTENCIAL

SUGARCANE BIOMASS

BAGASSE

STRAW

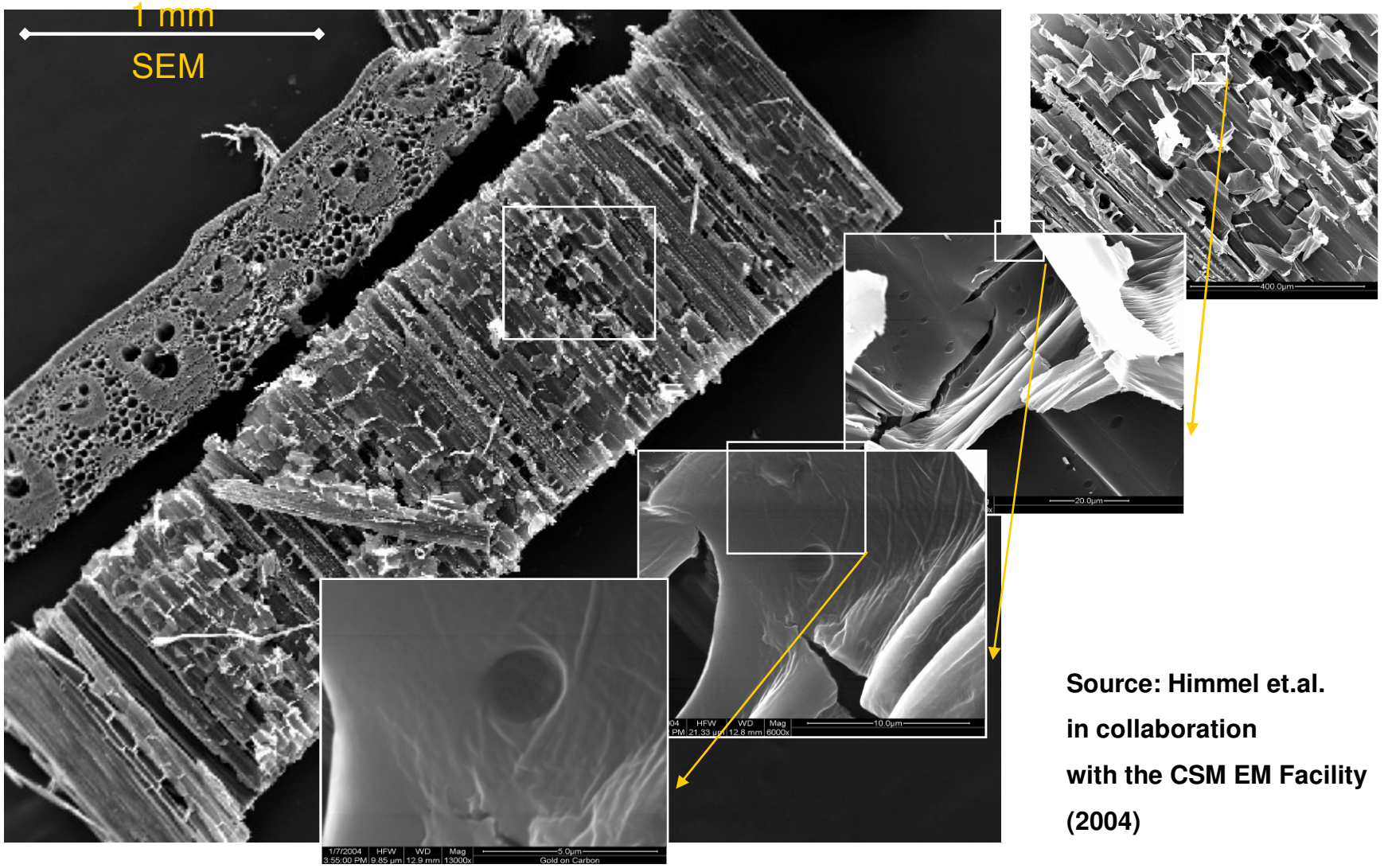
Cellular Structure of Biomass (cell wall of plant cells)



Structure of corn stover - Acknowledgement NREL - USA

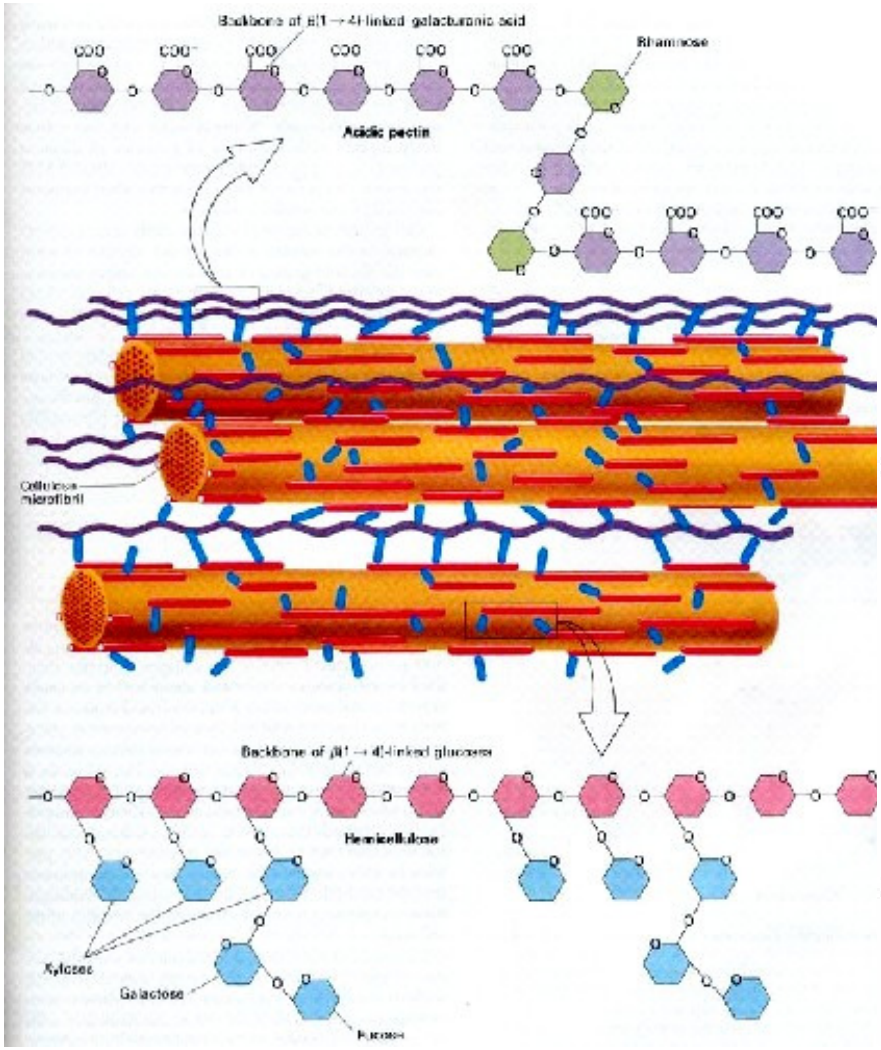
STRUCTURE OF CELL WALLS

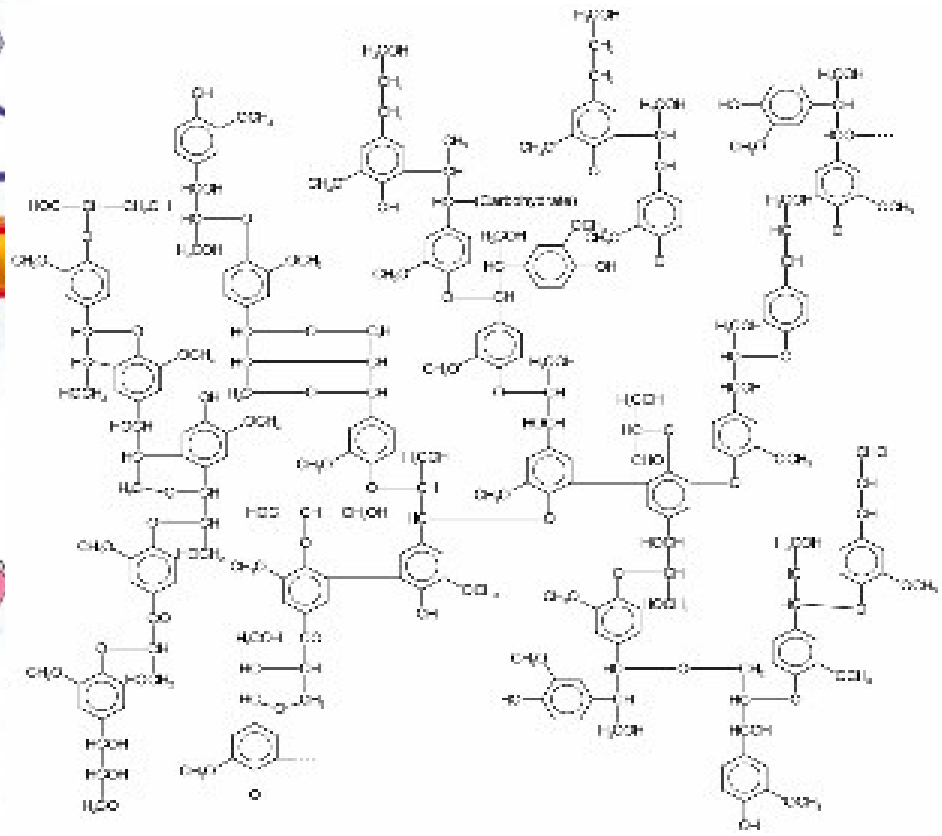
- LIGNOCELLULOSE -



Source: Himmel et.al.
in collaboration
with the CSM EM Facility
(2004)

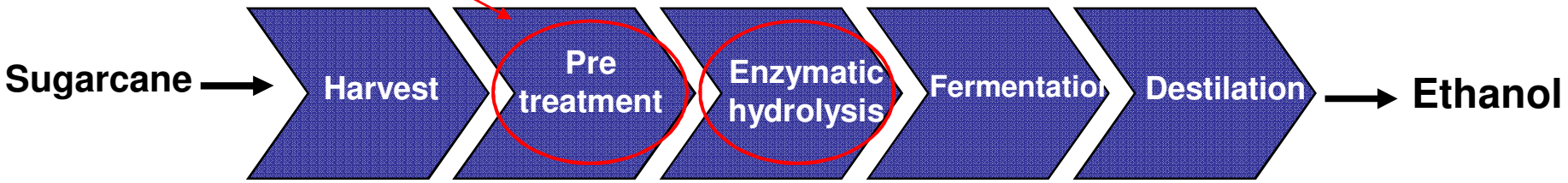
MOLECULAR COMPOSITION OF LIGNOCELLLULOSE: (CELLULOSE - HEMICELLULOSE – PECTIN - LIGNIN)

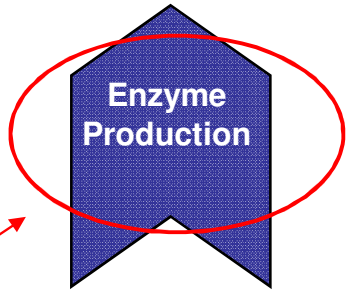




BIOMASS ETHANOL - Process Overview

- **Steam explosion**
- **Milling**





***Trichoderma reesei* RUT C30**

and *Aspergillus awamori*

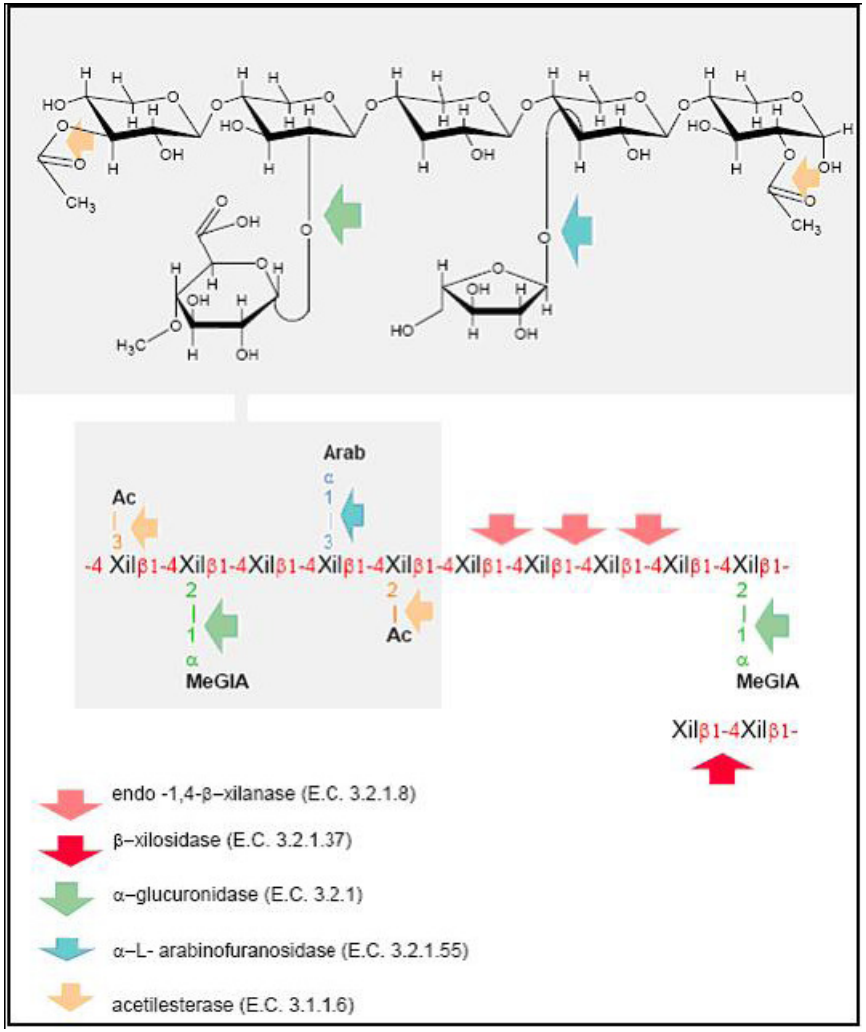
ENZYMES THAT HYDROLYSE CELLULOSE AND HEMICELLULOSE

CELLULASES

- ENDOGLUCANASES
- EXOGLUCANASES
- β-GLUCOSIDASE

HEMICELLULASES

HEMICELLULOSE



HEMICELLULASES

- xylanases
- β-xylosidases
- α-1-arabinofuranosidases
- α-glucuronidases
- acetyl xylan esterases
- α-galactosidases

"BIOMASS ENZYMES" PRODUCTION PRINCIPLES

- Enzyme cost contribution and effectiveness depends on the biomass source and pre-treatment conditions
- Development of "tailored made" ENZYME BLENDS for sugarcane biomass
- Development of "tailored made" enzyme according to the sugarcane biomass pretreatment
- Use of crude "cellulase/xylanase/accessory enzymes" preparations
- "In house" production to reduce cost

Sugarcane biomass enzymatic hydrolysis

SUCARCANE BAGASSE

Sugarcane Bagasse

SteamTreated Sugarcane Bagasse

ENZYMATIC HYDROLYSIS EXPERIMENTS

- 130 g/L of treated sugarcane bagasse
- ENZIME blend – 10 FPU/g
- Sodium citrate buffer pH 4.8
- Temperature - 50ºC
- Agitation - 200 rpm

STBA HYDROLYSIS RESULTS

BIOMASS HYDROLYSATE

Glucose Syrup

60 g/L (87%Yield)

Ethanol fermentation

Lignin

Solid hydrophobic fuel

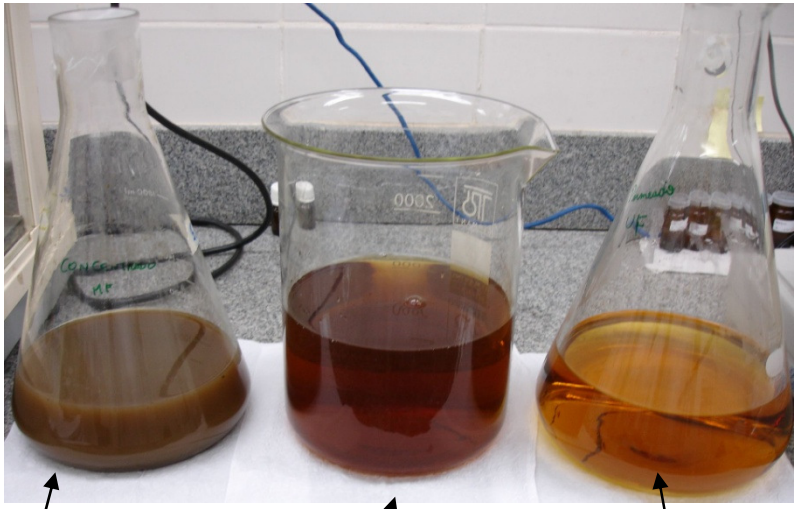
Membrane Bioreactor

Prof. Suely Freitas (freitasp@eq.ufrj.br)

School of Chemical Engineering / UFRJ

- Biomass hidrolysates lignin separation
- Sugars syrups concentration
- Enzyme recovery

Membrane Bioreactor



Biomass hydrolisate

Microfiltrate
(enzyme separation and recovery)

Ultrafiltrate
(glucose and xylose separation)

Ministério da Ciência e Tecnologia

BRASIL UM PAÍS DE TODOS GOVERNO FEDERAL

MCT/FINEP PROJECT

2009 – 2013

Scaling up of fungi – *Trichoderma* and *Aspergillus*, *c*ellulolytic and xylanolytic enzymes production and its use for biomass hydrolysis pretreated by steam explosion and milling

Federal University of Rio de Janeiro

Federal University of Santa Catarina

BIOMM TECHNOLOGY


Thank you!