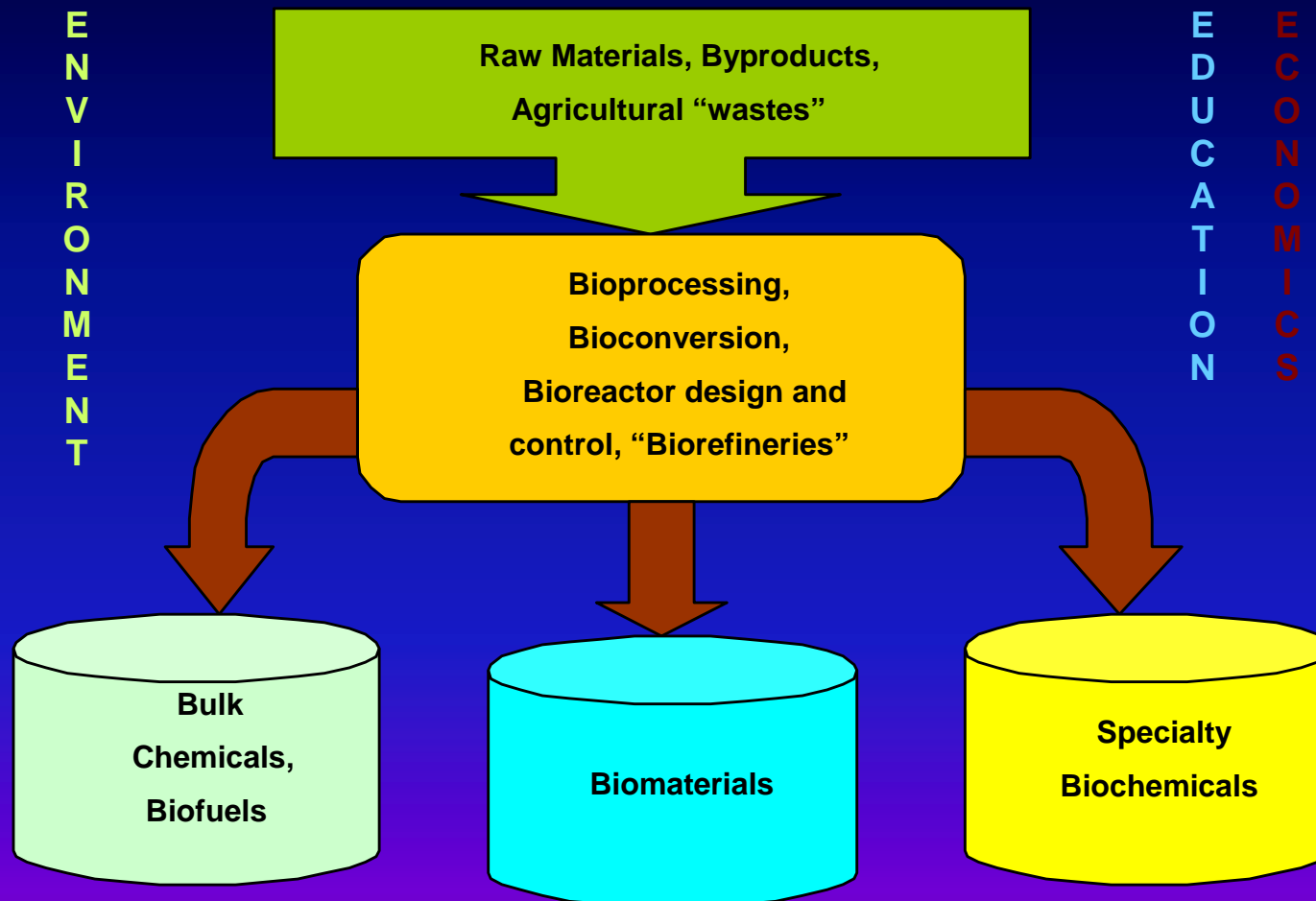


# S-1007 Multistate Research Committee

The Science and Engineering for a Biobased Industry and Economy



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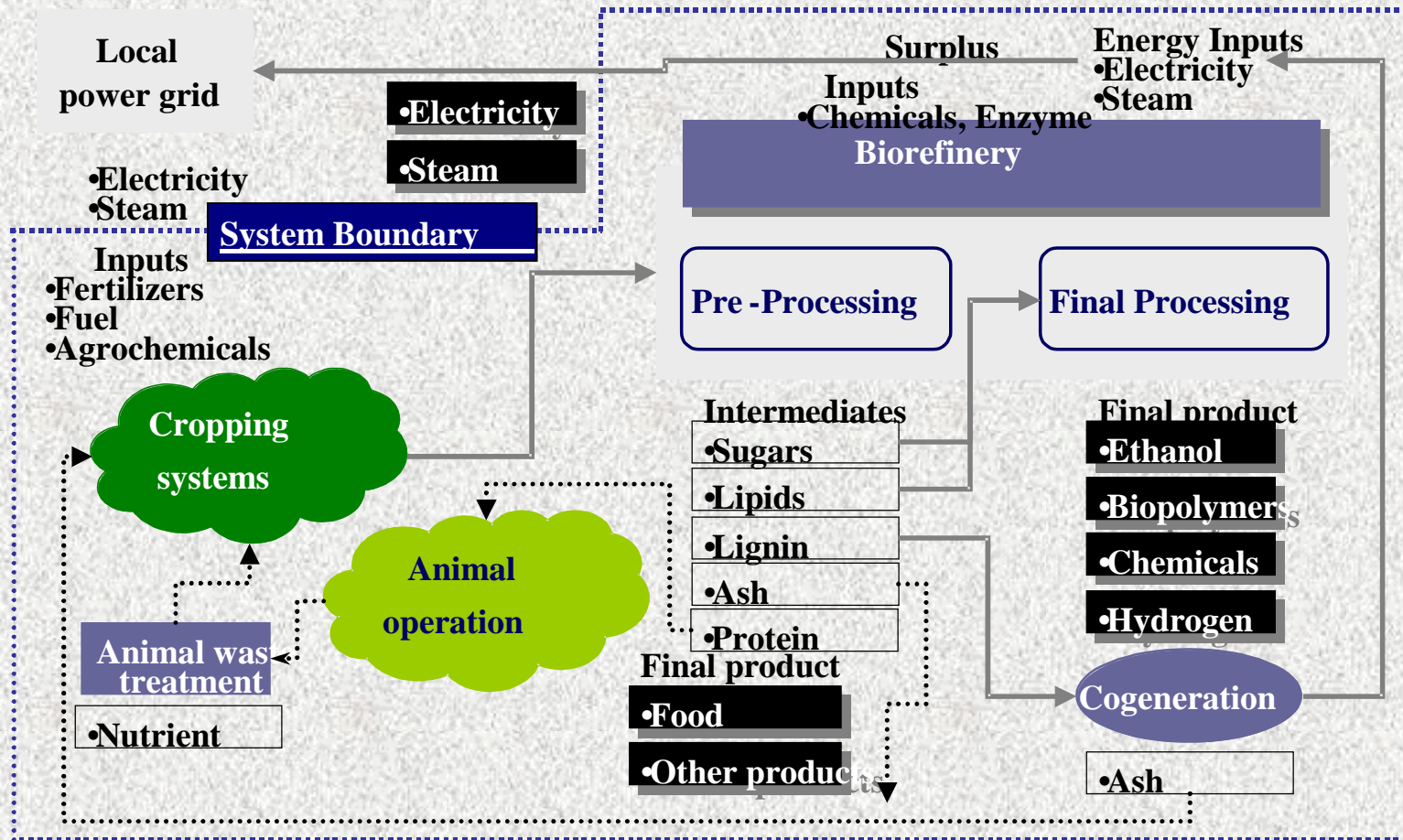
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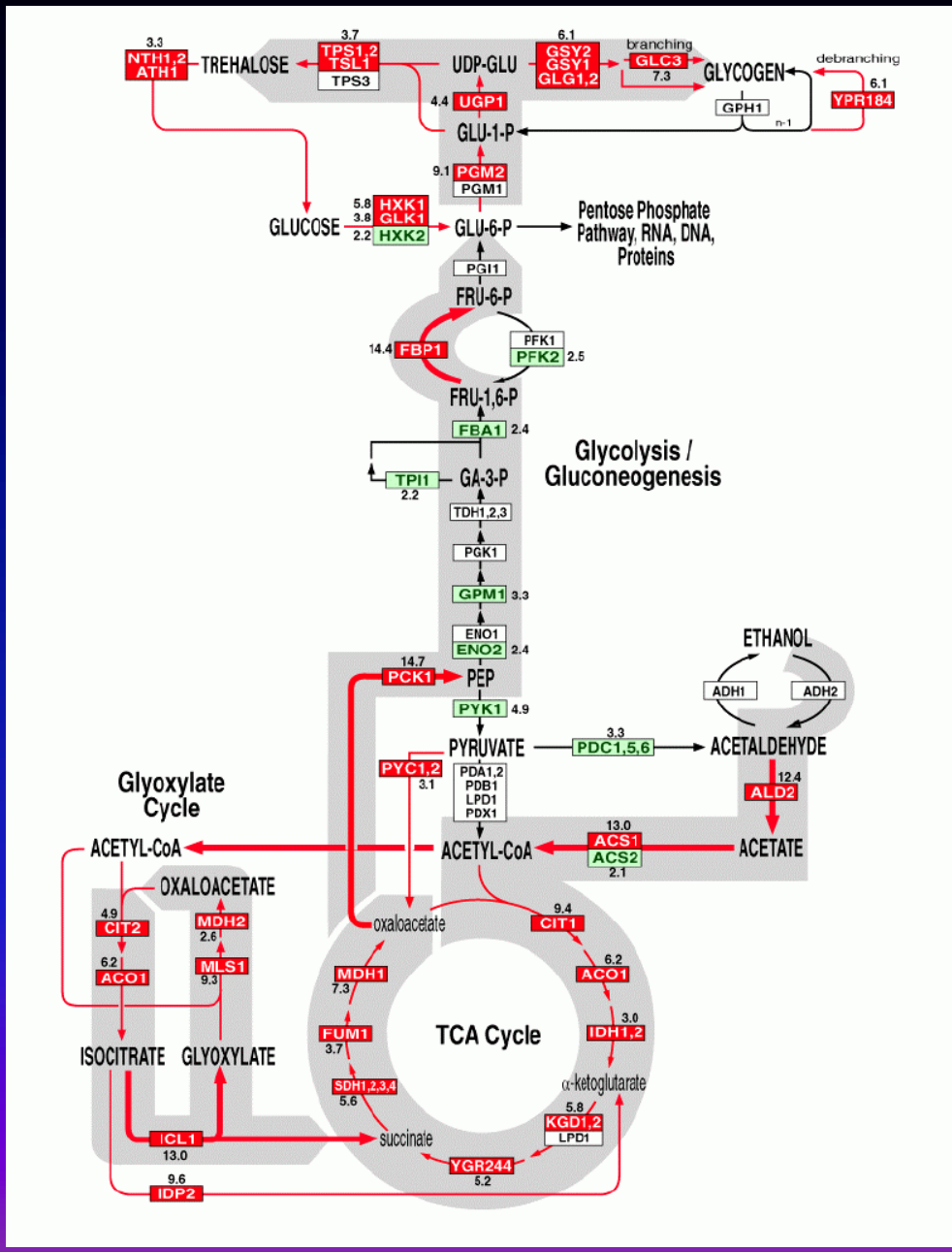
**Any others?**

**Please sign up**



# Biopharmaceutical Mechanisms

- Macro
  - Whole animal system
  - Whole plant system (glycosylation limitation)
  - Whole insect system ( “ ” )
- Micro
  - Mammalian Cell Culture
  - Plant cell culture
  - Insect cell culture (baculovirus mechanism)
  - Bacterial and fungal culture (*E. coli*, *S.cerevisiae*, *Pichiae*)
- Molecular
  - Genomics, Proteomics, Metabolomics, Systems Biology
  - Chaperone mechanisms



Byproduct	Primary Substrate	Primary enzyme /Microbial strain	Product
Animal waste	Complex	( <i>M. flagellate</i> )	Methane
Wood fibers	Xylan	<i>Clostridium</i> sp. SAIV1	Ethanol
Potato/ Sweet potato	Glucose	Alcohol dehydrogenase ( <i>K. marxianus</i> )	Ethanol (thermophilic pathway)
Dairy waste	Lactose	$\beta$ -galactosidase	Glucose and Galactose
Oily waste	Lipids	Lipase (esterases)	Fatty acids
Rice brokens	Glucose	( <i>C. acetobutylicum</i> )	Acetone/butanol (30/60)
Rice straw	Xylose	Citrate synthase	Citric acid
Switchgrass	Xylose	Lactose dehydrogenase ( <i>L. delbrueckii</i> )	Lactic acid (30 million kg/yr)
Sugarcane bagasse	Xylose Pyruvate	Pyruvate decarboxylase ( <i>Acetobacter</i> sp.)	Acetic acid
	Acrylonitrile	Nitrile hydratase	Acrylamide (15,000 tons/yr)
Corn stover	D-xylulose	Xylose reductase ( <i>C. tropicalis</i> ) <sup>2</sup>	Xylitol ▲
Corn starch	Glucose	Glucose isomerase	High fructose corn syrup (8 million tons/yr)
Molasses (sugarcane)	Sucrose	Fumarase ( <i>B. ammoniagenes</i> )	L-malic acid
	Glucose	AcetylCoA carboxylase ( <i>C. glutamicum</i> )-biotin	L-glutamic acid (340,000 tons/yr) MSG
	Glucose	Aspartic amino transferase ( <i>E. coli</i> )	L-phenylalanine (Aspartame synthesis)
	Glucose	Aspartase ( <i>E. coli</i> )	L-aspartic acid
	Glucose	L-aminocaprolactam hydrolase ( <i>C. laurentii</i> )	L-lysine (70,000 tons/yr) (\$2/lb)
	Glucose	( <i>P. fluorescens</i> )	L-histidine
	Glucose	Penicillin amidase ( <i>P. chrysogenum</i> )	6-aminopenicilloic acid (7500 tons/yr)
	Glucose	( <i>B. licheniformis</i> )	Proteases (\$236 mil/yr)
	Glucose	( <i>B. amyloliquefaciens</i> )	Amylases (\$70 mil/yr)
	Glucose	( <i>Rhizopus, Aspergillus</i> )	Other enzymes (\$92 mil/yr)
	Glucose	<i>Anthrobacter simplex</i>	Prednisolone
Specific	Serum	Hybridomas	Monoclonal antibodies
Media	Serum	Human fibroblasts	Interferon
	Serum	Monkey kidney cells	Polio vaccine

Increasing Product Value



1 Murty and Chandra (1997)

2 Hortisu et al. (1992)

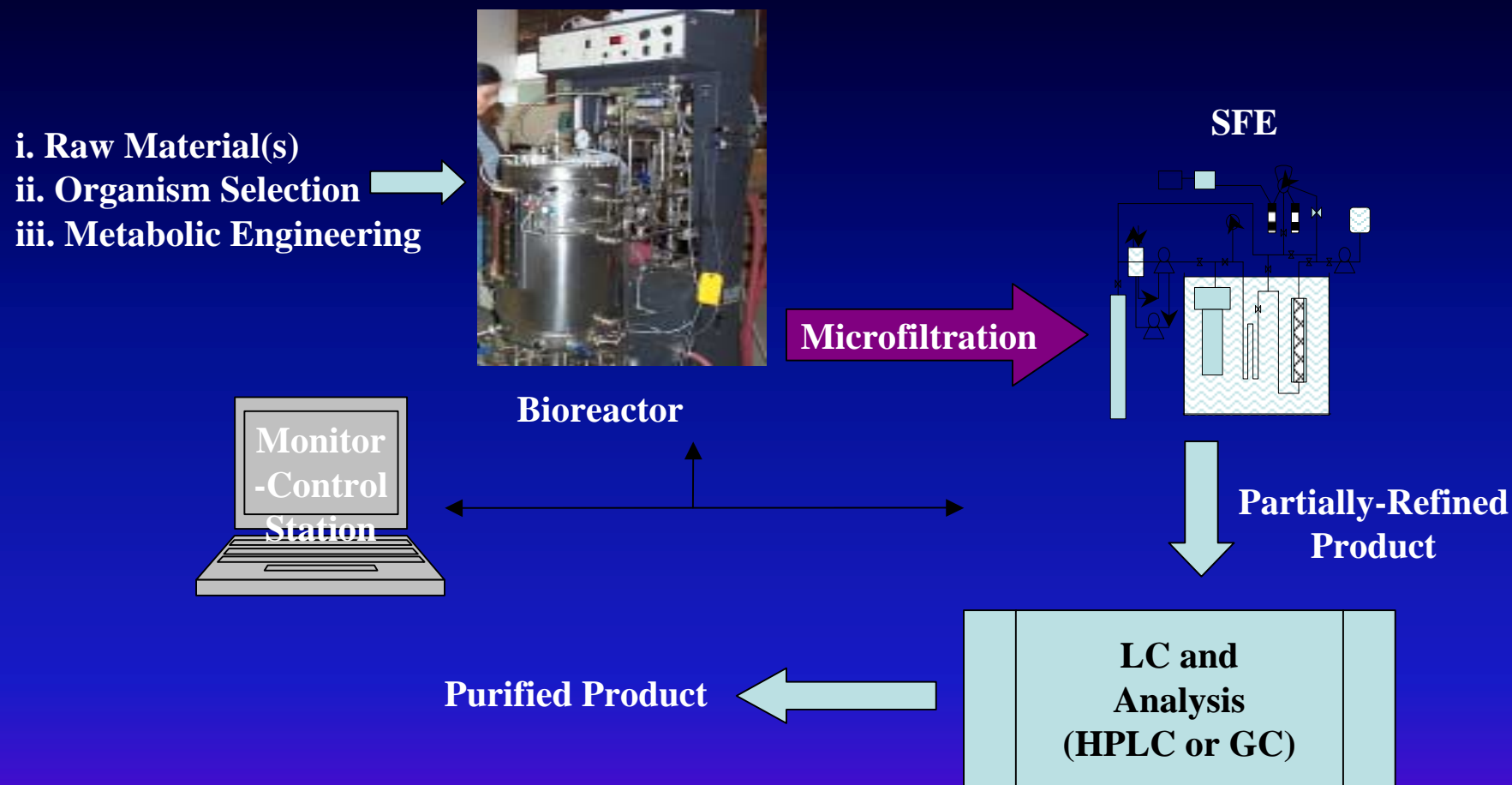
# Examples of Research

University Collaborations

# Research at Clemson University

- Fungal production of essential fatty acids and SFE fractionation
  - Walker, Hui, Kuan, Heaton, Cantrell
- Algal production of polar lipids and proposed hydrogen co-production
  - Drapcho, Brune, Walker
- “Microalgae Platform”
  - Brune, Benemann

# Bioconversion and SFE Process



**Figure 1. Typical bioprocess for bioconversion of raw materials to nutraceutical and specialty biochemicals. Primary separation procedures include ultrafiltration (UF), supercritical fluid extraction (SFE) and liquid chromatography (LC). Analytical techniques include gas chromatography (GC) and high pressure liquid chromatography (HPLC).**

# Samples of oil extracted by different extraction methods compared to commercial sample of refined rice bran oil

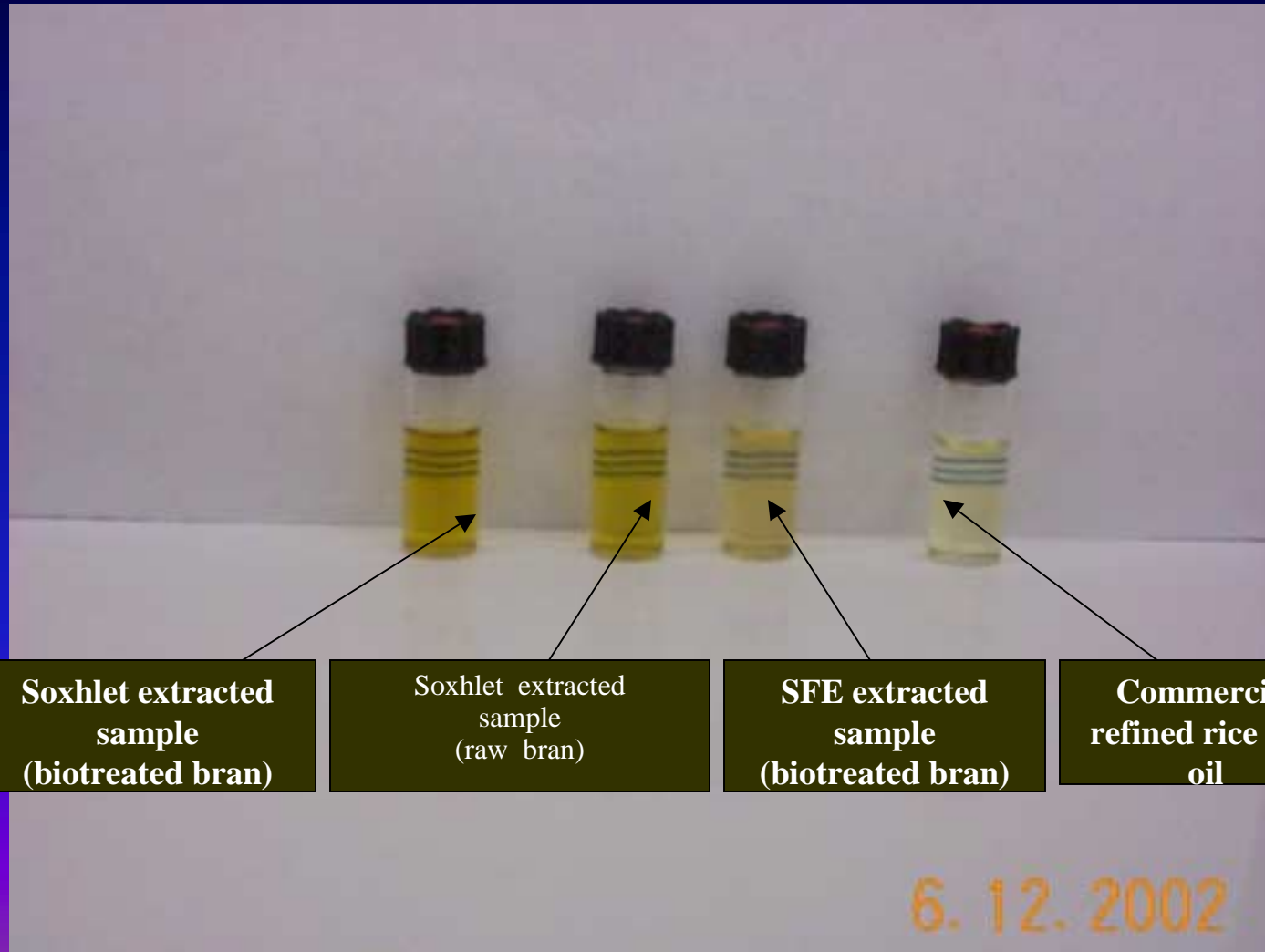
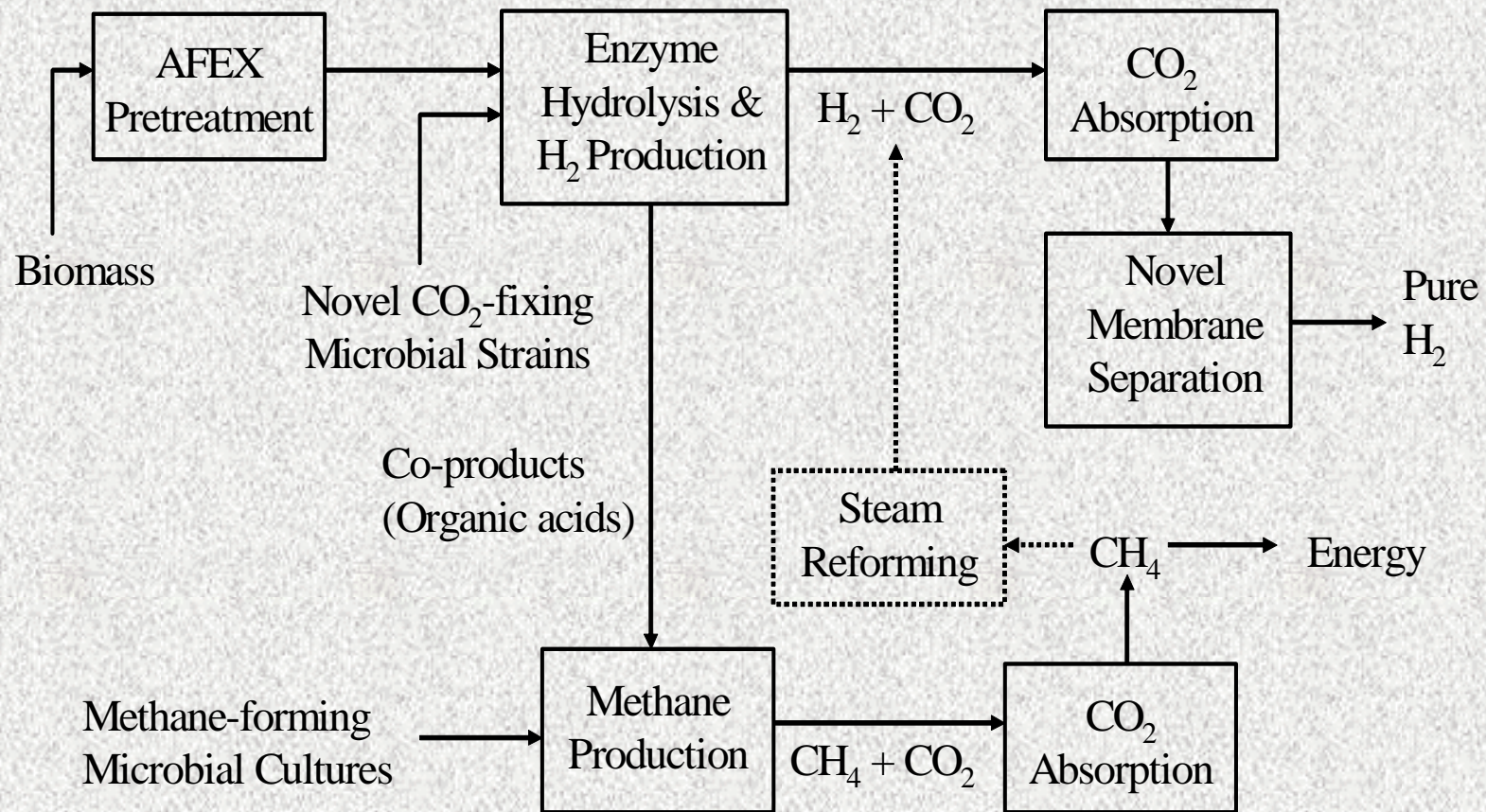


Figure 1. Conceptual Process Flow Diagram for Hydrogen Production from Biomass



# Research at Washington State University

- Manure conversion to sugars:
  - Analysis of manure components: cellulose, hemicellulose, lignin, sugar, protein, amino acids, and metal element,
  - Extensive studies were conducted on pretreatment
    - single stage acid hydrolysis, two-stage acid hydrolysis,
    - dilute acid hydrolysis, concentrated acid hydrolysis,
    - enzyme hydrolysis
    - combined acid and enzyme hydrolysis.
- Cull Potato conversion to lactic acid
  - Fungal and bacterial fermentation
- Whey/whey permeate conversion to nisin

# Research at Virginia Tech

- Protein separation from feedstocks
  - Aqueous two-phase extractions
  - Zhang
- Xylitol Bioproduction

# Research at LSU and University of Arkansas

- Low-cost pretreatment of bagasse
  - Delignification using singlet oxygen
  - Donal Day (LSU Audubon Sugar Institute)
- Characterization and extraction of antioxidants in blackstrap molasses
  - Julie Carrier (UARK), D. Day

?S