Mass CREST

MASSACHUSETTS CENTER FOR RENEWABLE ENERGY SCIENCE AND TECHNOLOGY

# "Fuels for the Future"

*A Mass-CREST*
*Energy Research Group*

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**University of Massachusetts Amherst**

# The Initiative

- **Mass-CREST Mission**

  To enhance the performance of renewable energy devices and systems by ten-fold within the next ten years

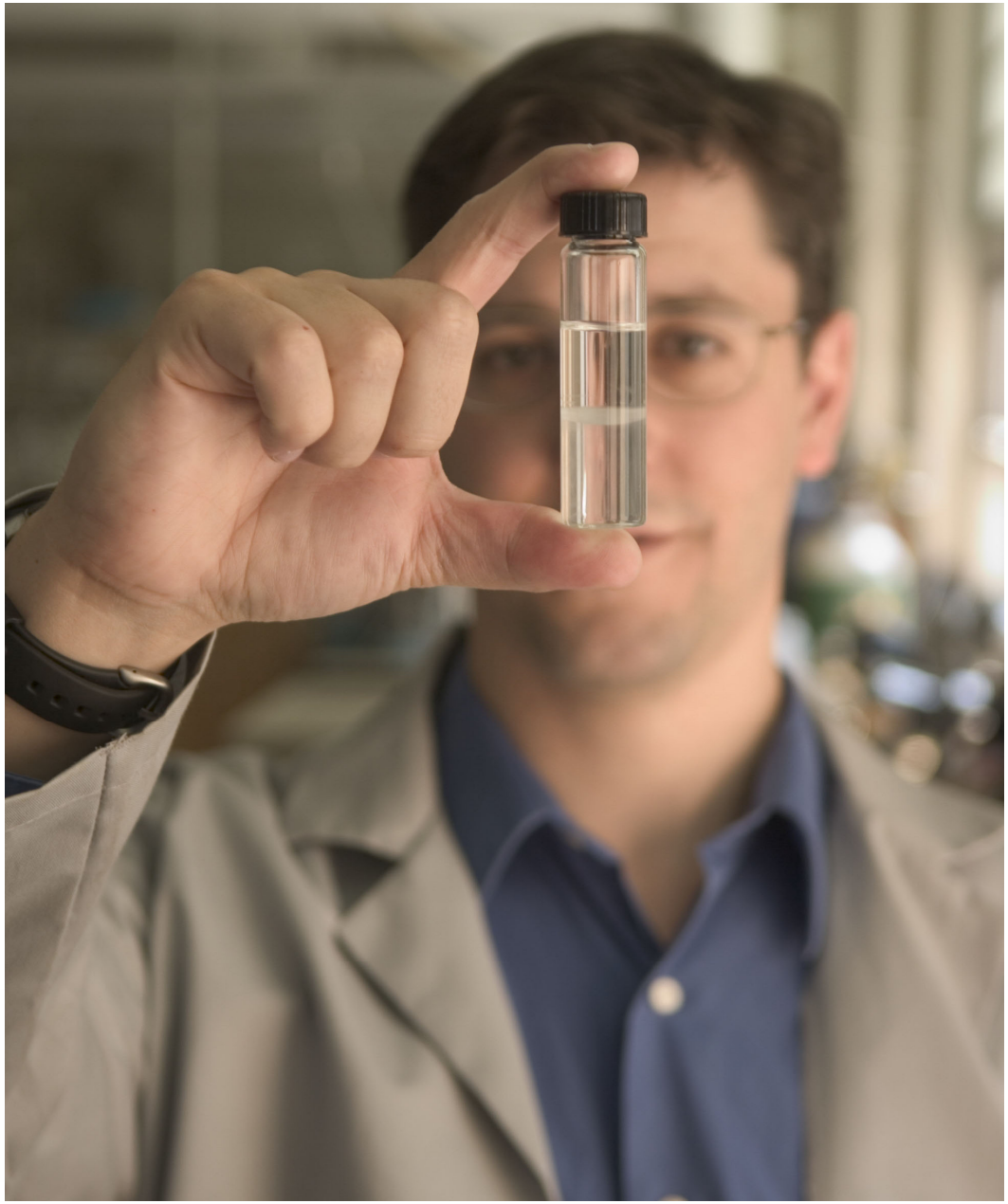
- **Energy Research Groups (ERGs)**
  - Photovoltaics (solar fuels)
  - Fuel cells and batteries
  - Fuels for the Future (cellulosic ethanol, bioalkanes, $H_2$)

# Fuels for the Future - ERG

Mass-CREST takes a multi-pronged approach to solving the biomass-to-fuel conversion problem.

- **Chemical approaches**– development of novel biomass conversion catalysts:
  - Zeolite catalysts
  - Oxide catalysts
- **Biological approaches**

# Fuels for the Future - ERG



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# Fuels for the Future - ERG

Mass-CREST takes a multi-pronged approach to solving the biomass-to-fuel conversion problem.

- **Chemical approaches** – development of novel biomass conversion catalysts
  - Oxide catalysts
  - Zeolite catalysts
- **Biological approaches**
  - Combining research in plant and microbial biology to devise systems and processes for cellulosic ethanol production

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# Cellulosic Ethanol Technology

## Consolidated Bioprocessing of Biomass to Ethanol by *Clostridium phytofermentans*

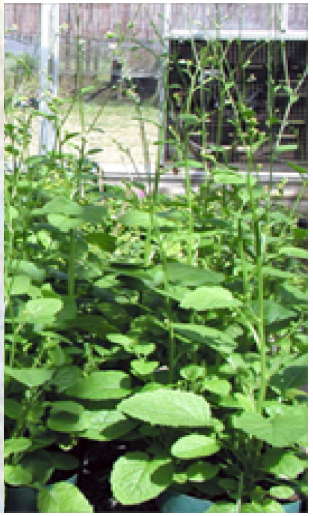
- A technology for the production of **cellulosic ethanol** utilizing a novel bacterium with unique properties

# Cellulosic Ethanol Technology

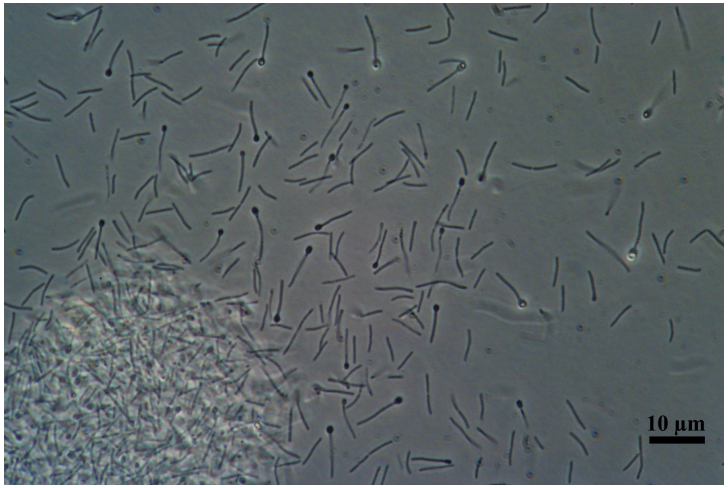
## The Technology

### Consolidated Bioprocessing of Biomass

- single-step biomass-to-ethanol process
- simple, effective strategy to overcome the recalcitrance of cellulosic biomass
- novel bacterium *Clostridium phytofermentans:*



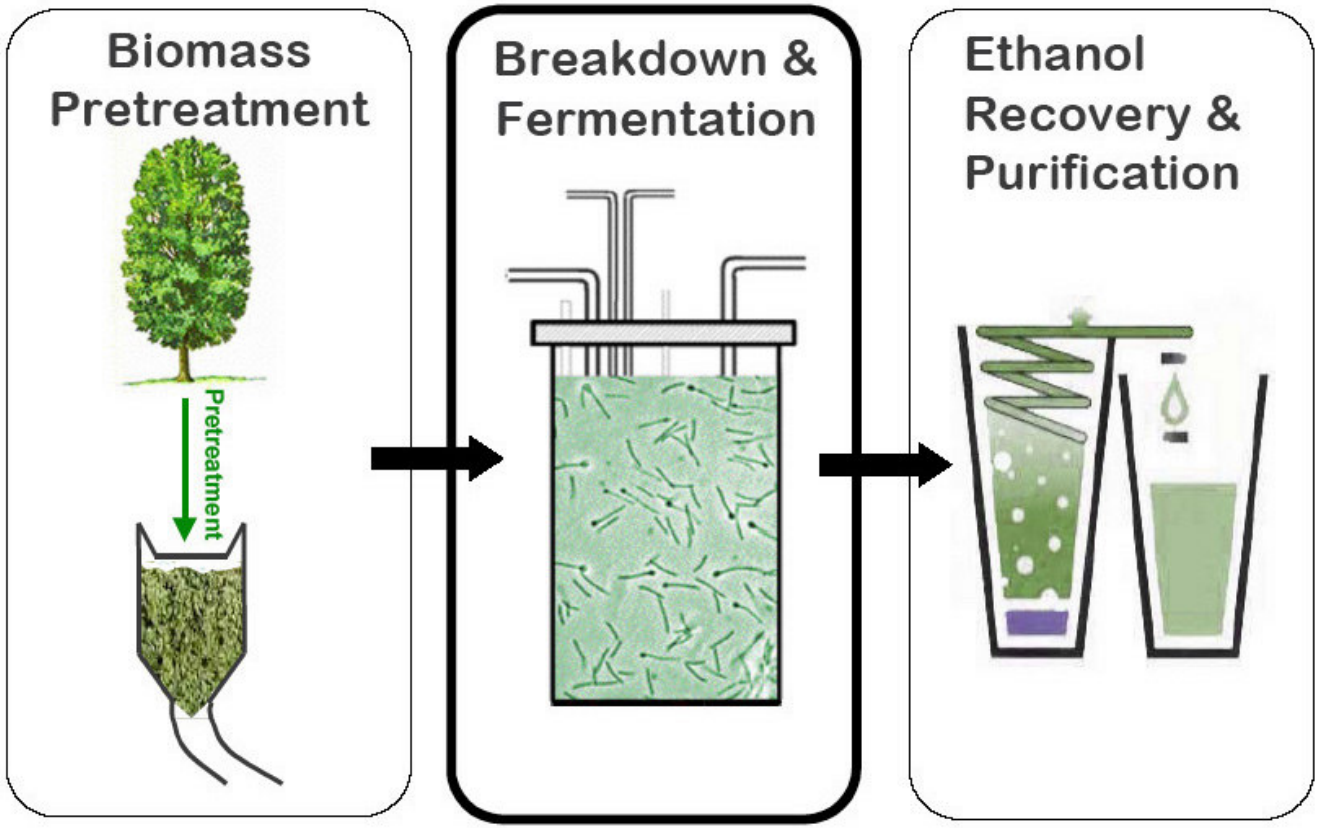
C-phy →



# Cellulosic Ethanol Technology

## The Technology

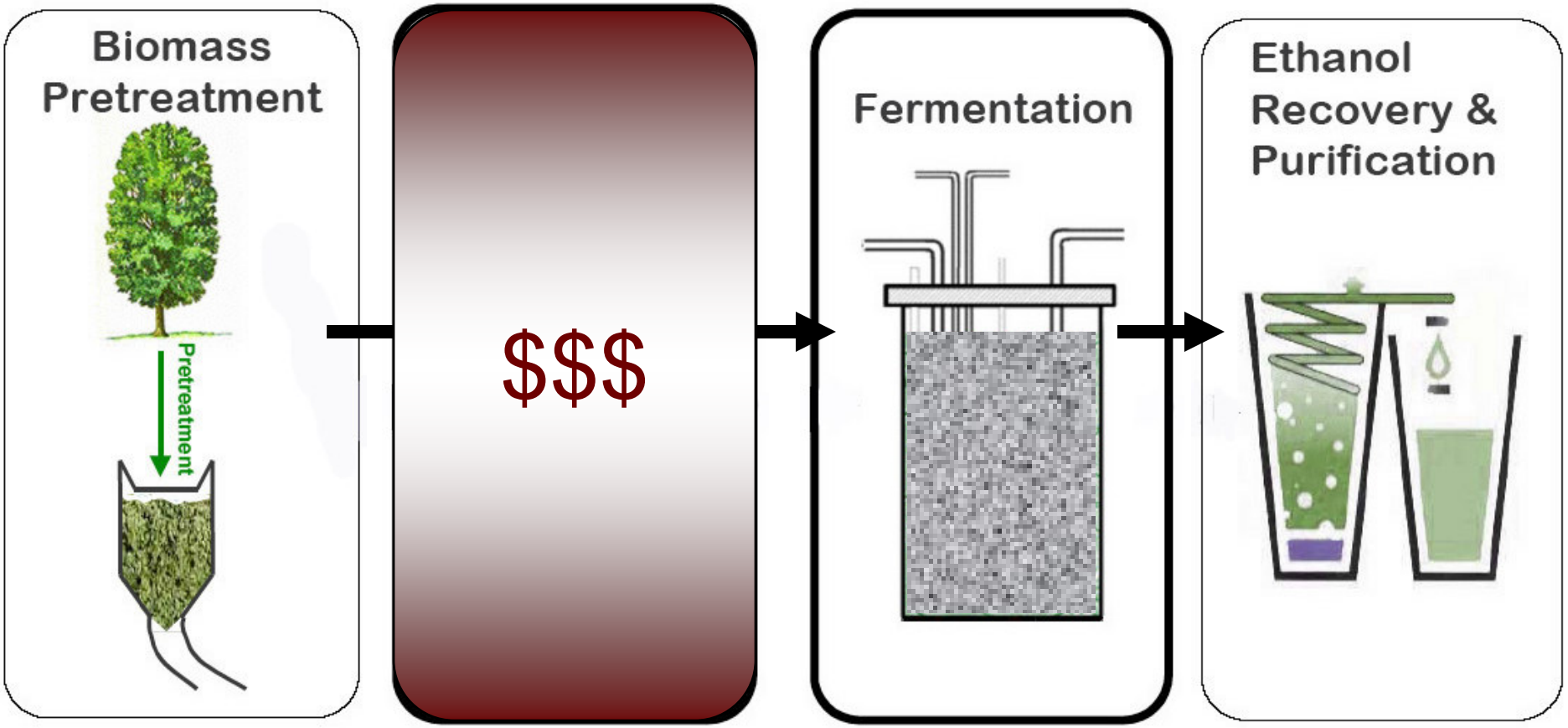
### Consolidated Bioprocessing of Biomass




- Cellulase enzyme production, cellulose breakdown, and fermentation are consolidated in a single step in a bioreactor

# Cellulosic Ethanol Technology

## Existing Technology

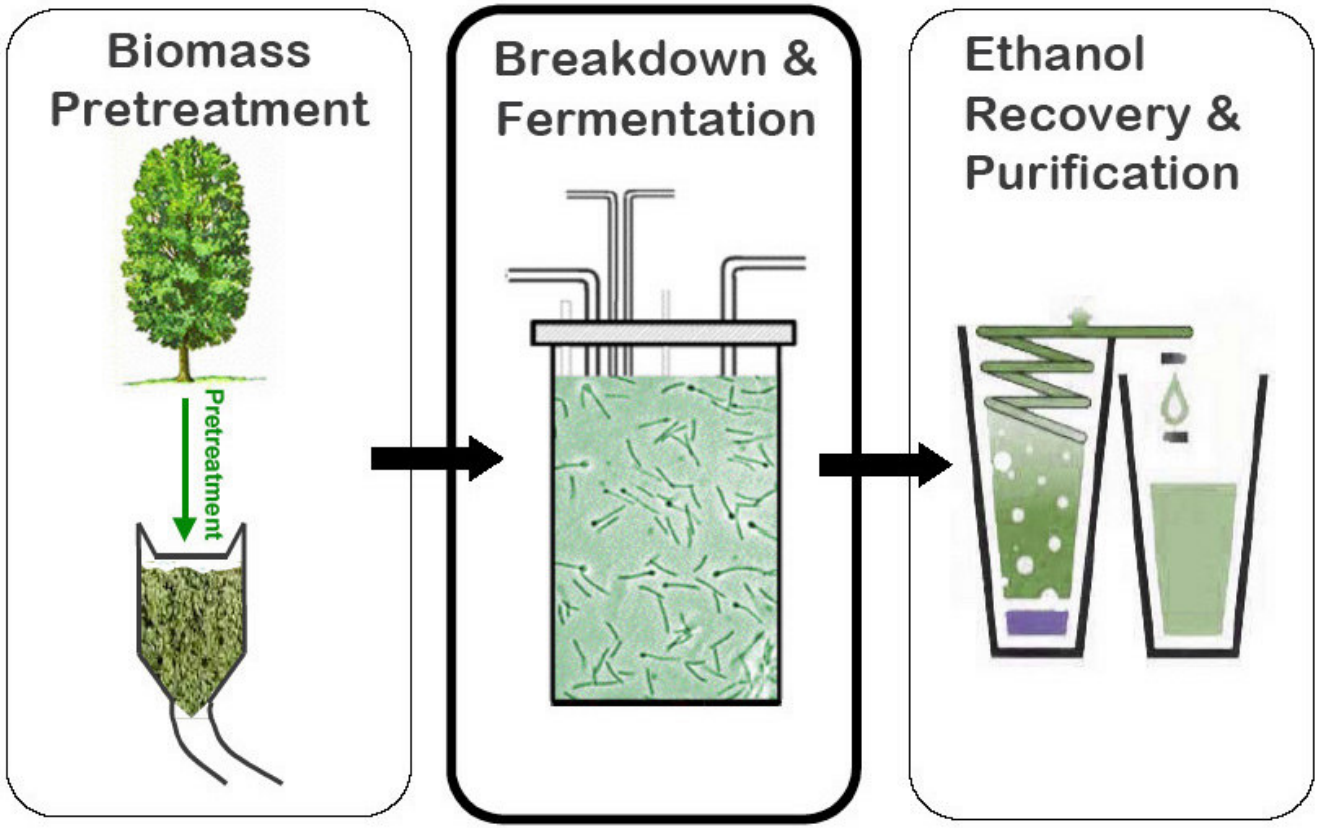



- Current cellulosic ethanol processes requires **enzymes $$$**

# Cellulosic Ethanol Technology

## Our Technology

### Consolidated Bioprocessing of Biomass

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# Cellulosic Ethanol Technology

## How does our C-phy CBP technology compare?

**Our process:**

- **single-step biomass-to-ethanol process**
  - ✓ ***Reduced complexity***
- **process incorporates enzyme production**
  - ✓ ***Separate enzyme production unnecessary***

**Impediments to commercializing existing technologies:**

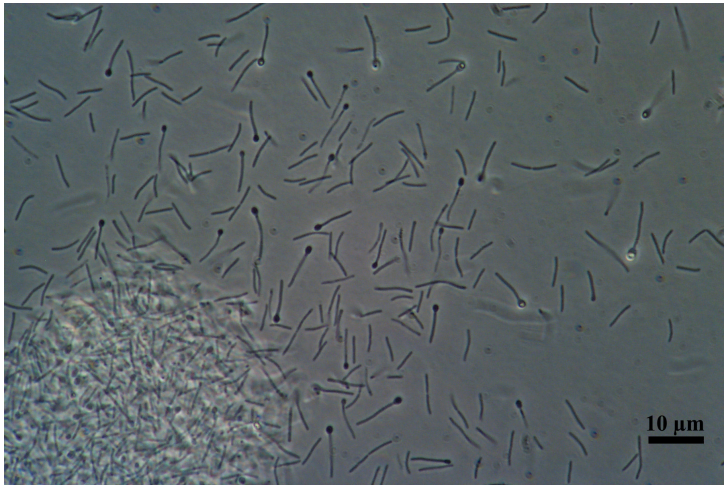
- ✓ ***Process complexity***
- ✓ ***Enzymes are expensive!***

# Cellulosic Ethanol Technology

## Unique properties of C-phy make this technology possible

- simultaneously ferments multiple different components of biomass
- ferments unusually high concentrations of cellulose
- high ratio of ethanol to other products

C-phy →

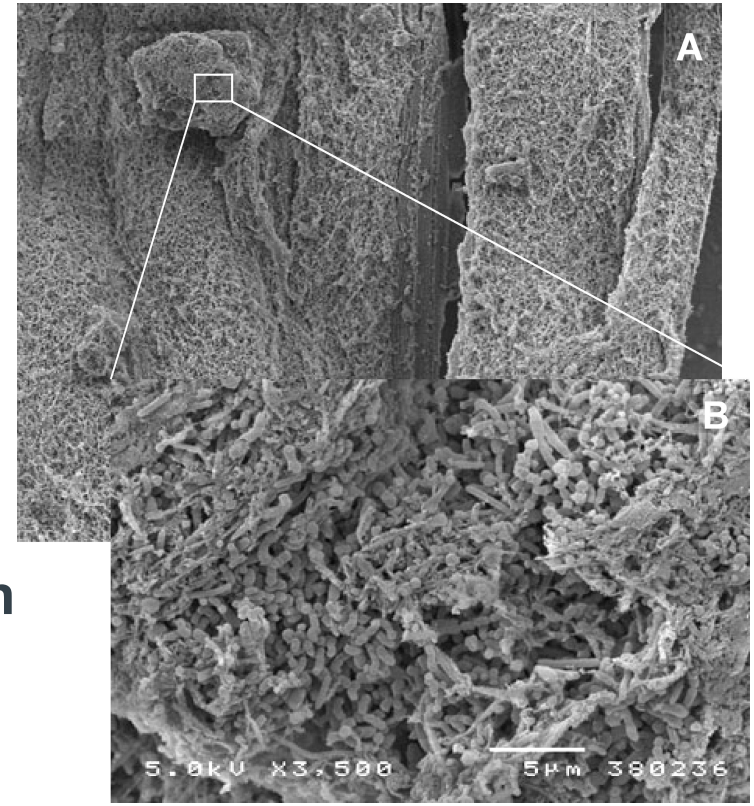


# Cellulosic Ethanol Technology

**Unique properties of C-phy make this technology possible**

**Cellulose ↓**
**Ethanol**

SunEthanol




**C-phy → growing on cellulose**

# "Fuels for the Future"

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***Thank you!***