Energy Biosciences Institute
Linking Biotechnology and Energy

March 25, 2010

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EBI Partners

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This Extraordinary partnership builds upon and extends strengths in the area of alternative biofuels.

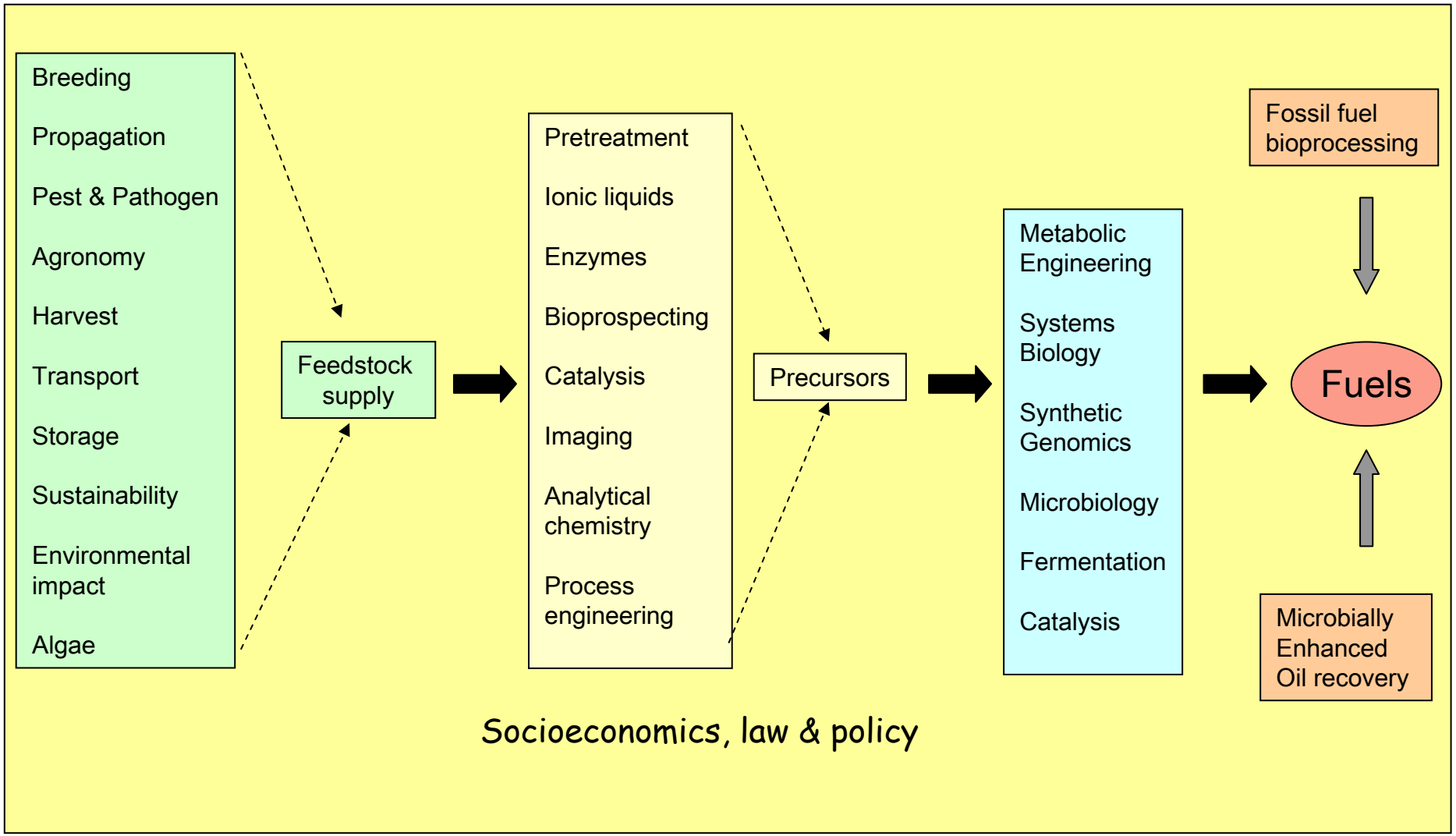
THE UNIVERSITY OF CALIFORNIA 1868

BERKELEY LAB

EBI design factors

- **A mission oriented multidisciplinary research institution**
- **Single organization doing open and proprietary work**
  - **Open work in Fundamental Energy Biosciences**
  - **Co-locate some BP researchers**
- **A substantial and long-term commitment to engage quality researchers ($500m over 10 years)**
- **Host at a world-class institution to maximize academic presence and interdisciplinary interaction.**

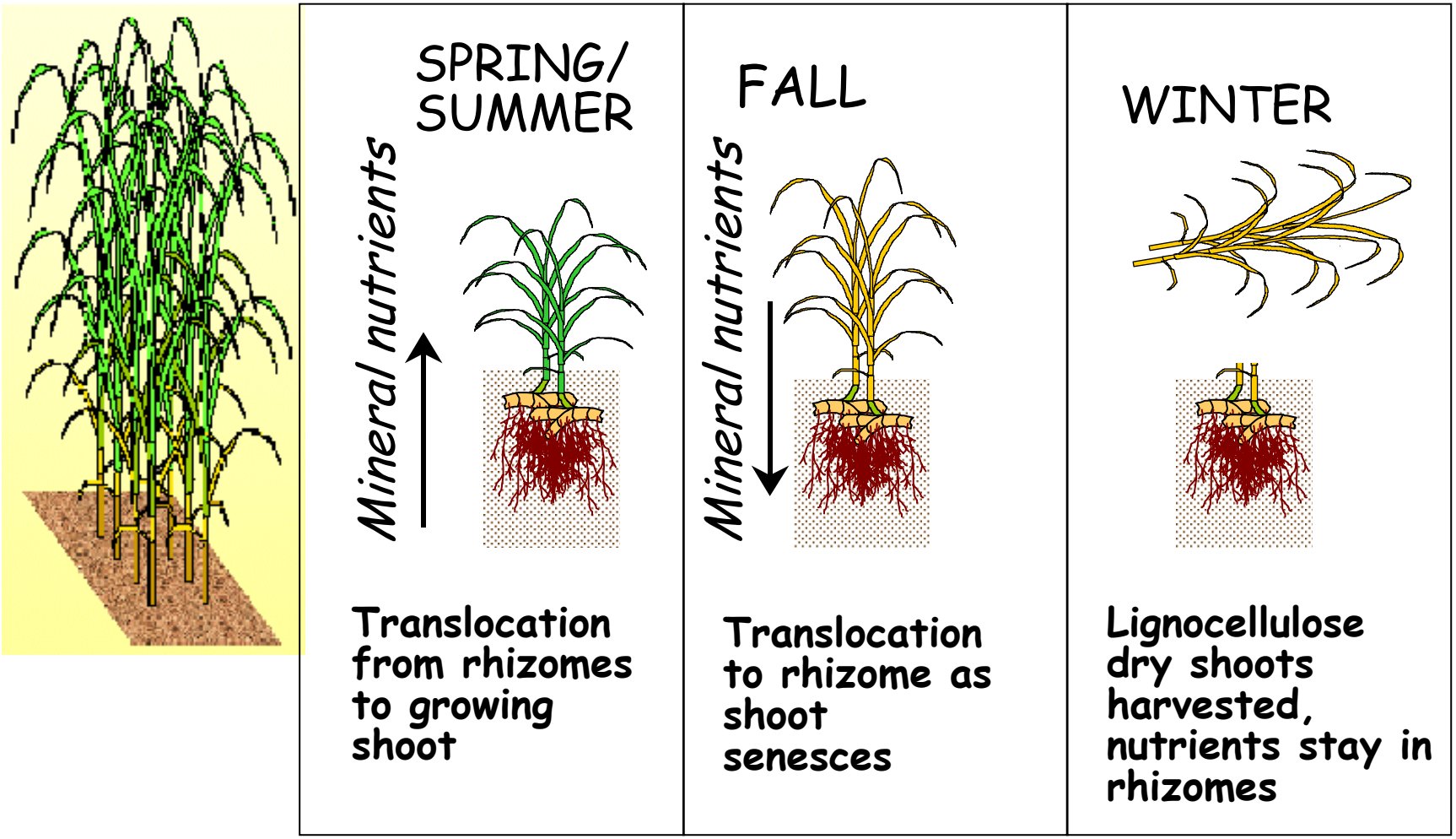
Technical reach of the EBI



Summary of LC research priorities

- **Develop energy crops and associated agronomic practices**
- **Identify or create more active catalysts for conversion of biomass to sugars and sugars to fuels**
- **Develop improved industrial microorganisms**
- **Develop new types of microorganisms that produce and secrete hydrophobic compounds**
- **Understand the social, economic, and environmental implications**

Nitrogen use efficiency



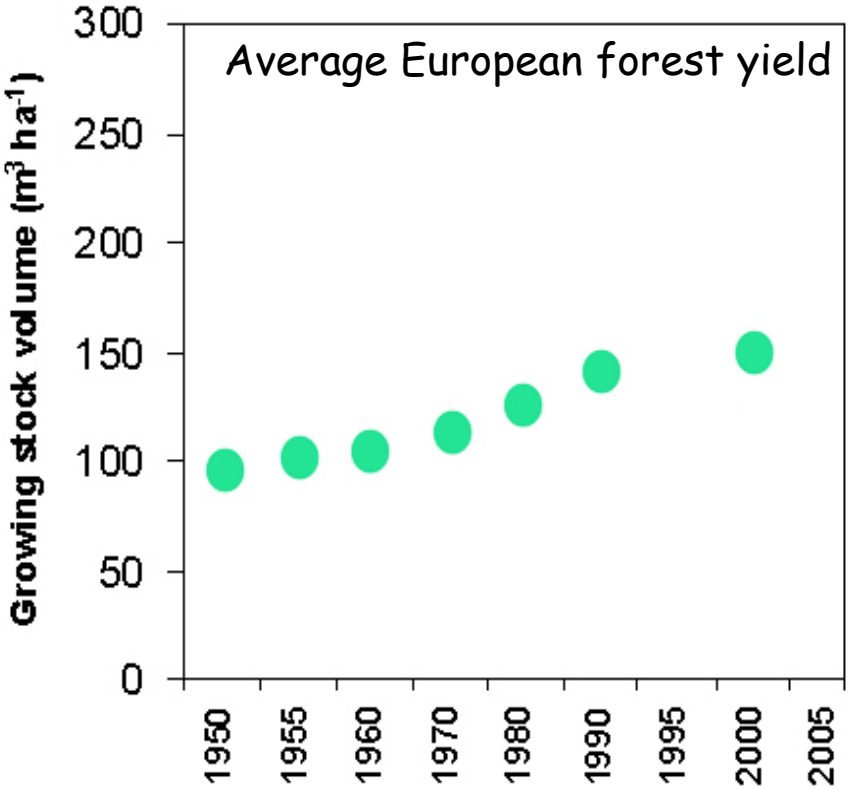
Courtesy of Steve Long et al

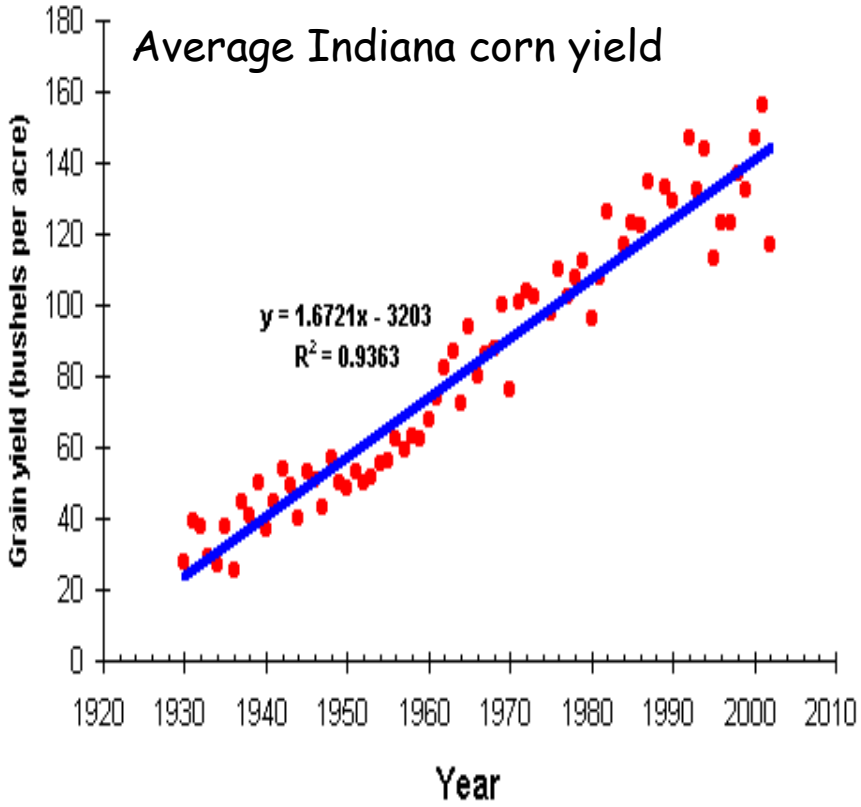
Miscanthus giganteus

Yield of 26.5 tons/acre observed by Long & colleagues in Illinois, without irrigation

Courtesy of Steve Long et al

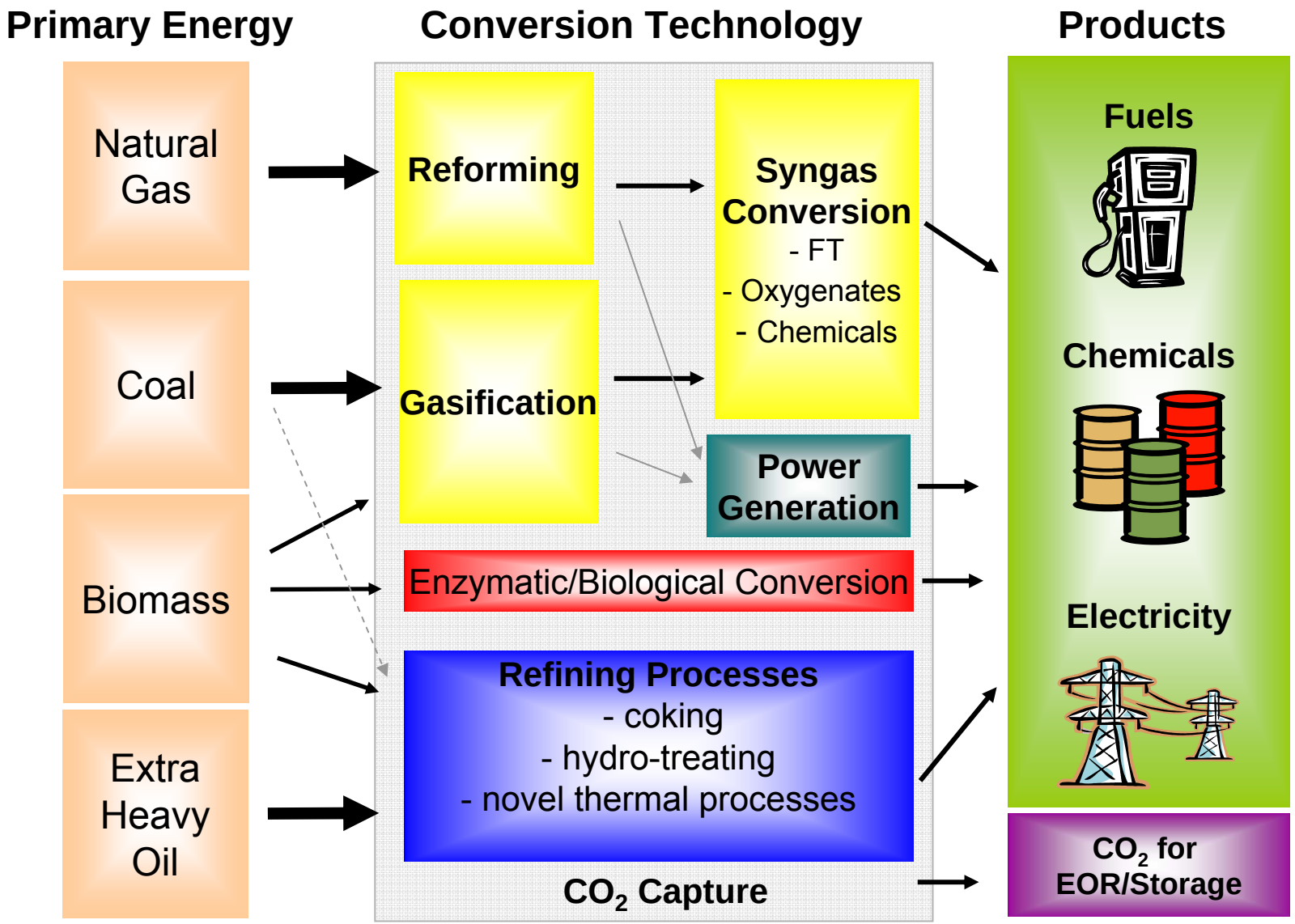
Crop yields have been strongly increased but biomass yields have not





Source: European Forest Institute (www.efi.fi)
Indiana Agricultural Statistics Service

The fungibility of carbon



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Key Challenges
LC conversion technology

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- **Overcoming the recalcitrans of LC biomass**
- **Efficiently utilizing all sugars**
- **Producing better fuel molecules beyond ethanol**
- **Creating a highly productive, stable host organism**

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Lignin occludes polysaccharides

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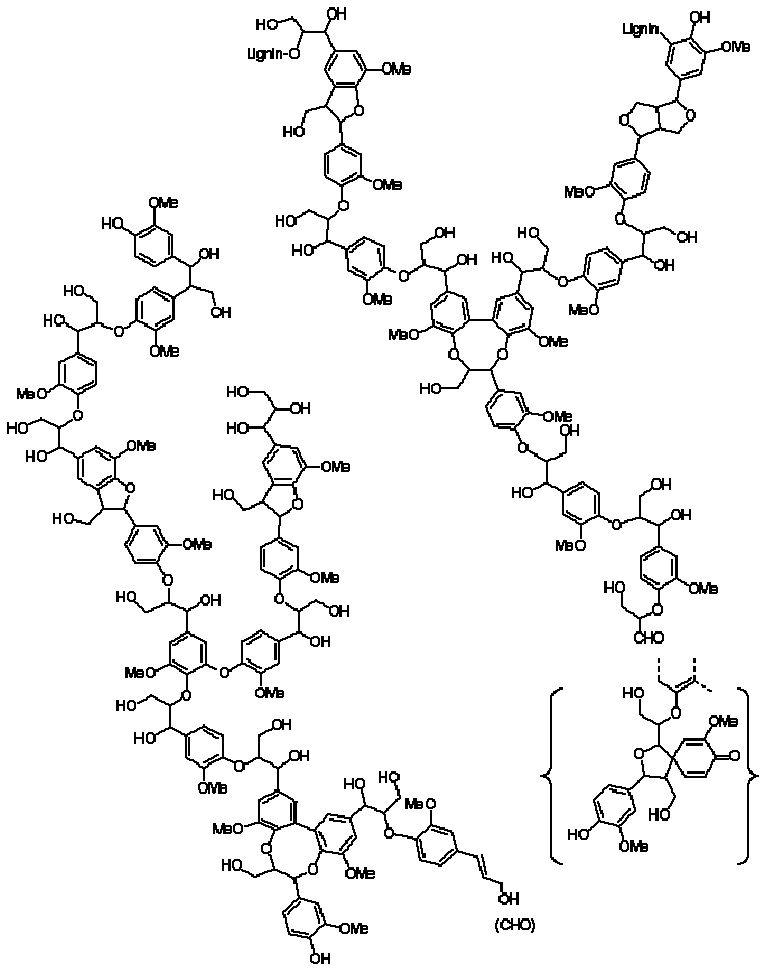

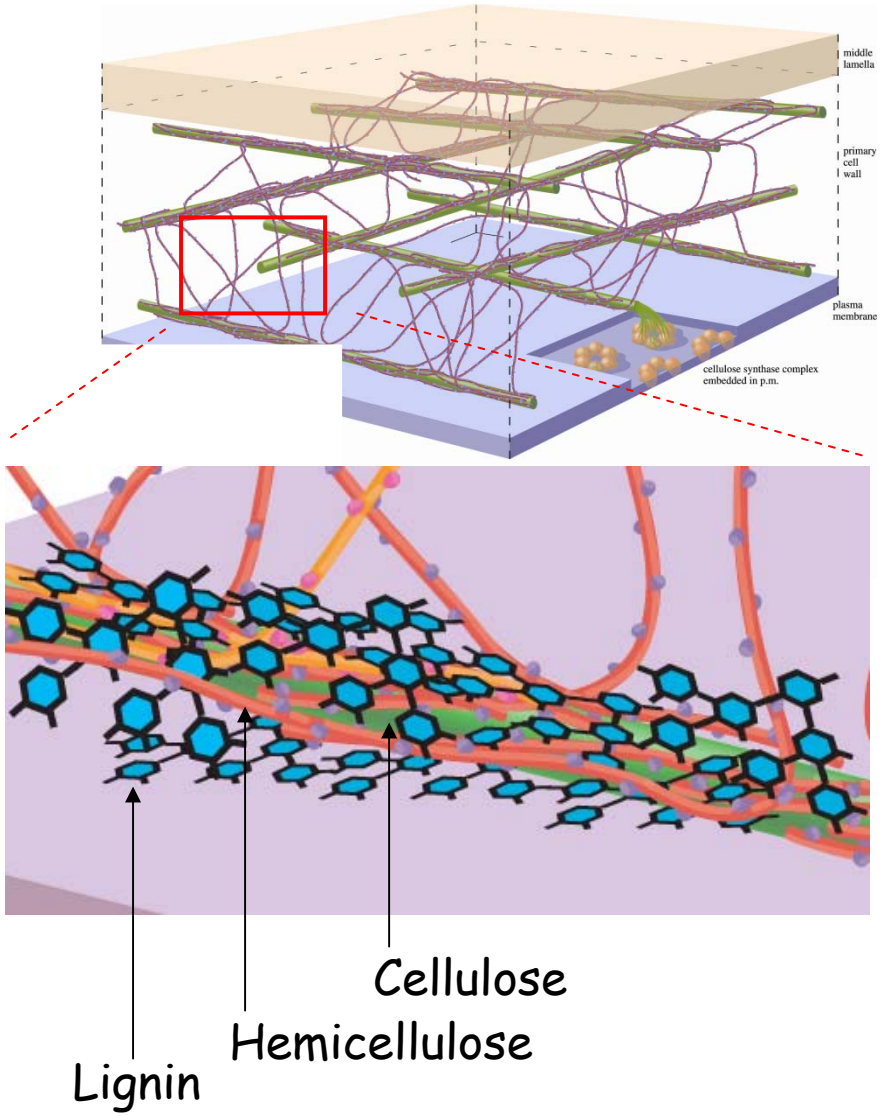

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Possible routes to improved catalysts

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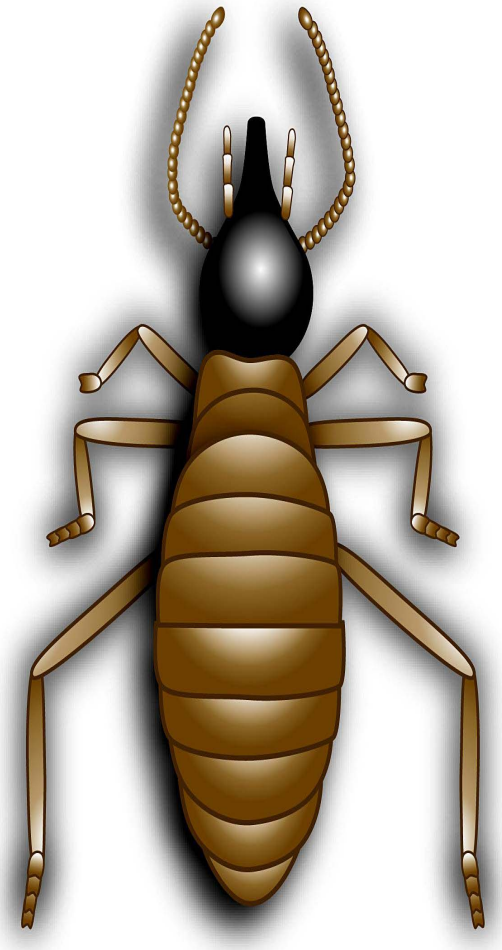
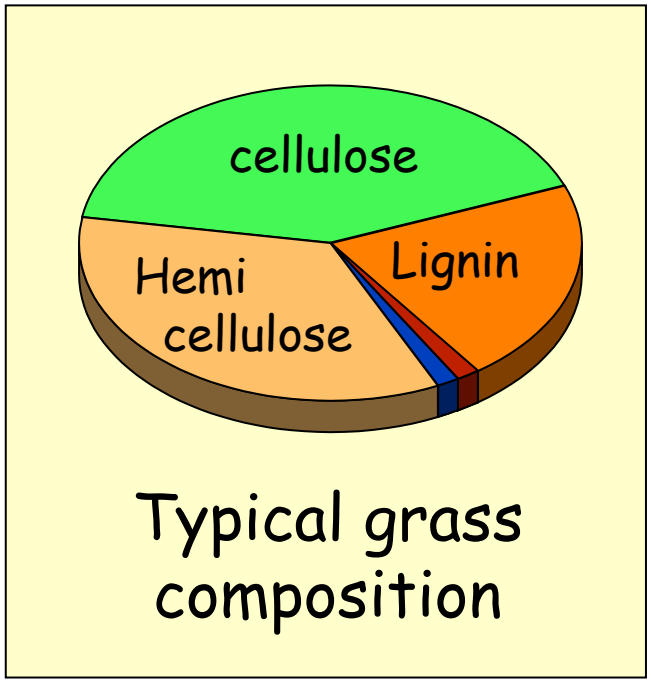
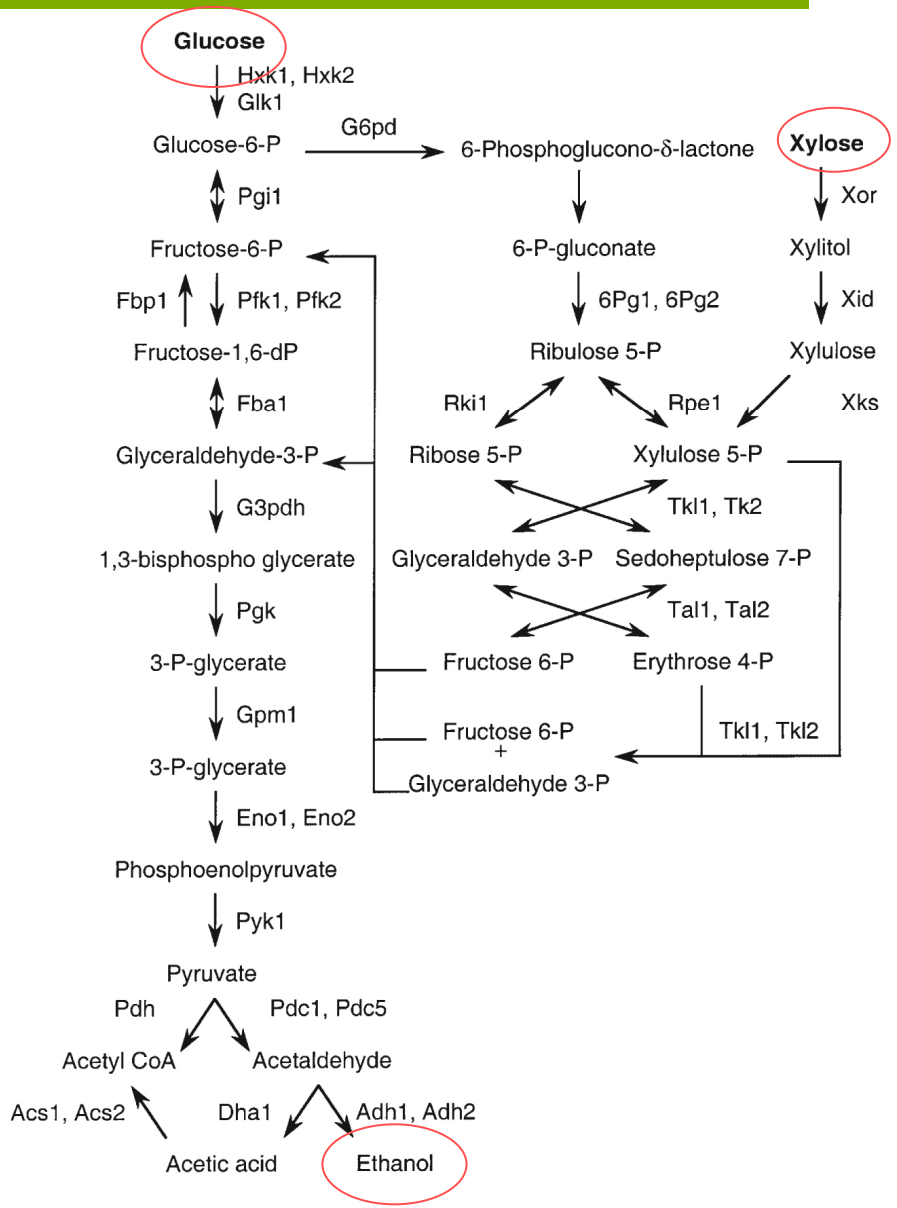
- Explore the enzyme systems used by termites for digesting lignocellulosic material
- Same for ruminants
- Compost heaps and forest floors are poorly explored
- In vitro protein engineering of promising enzymes
- Develop synthetic organic catalysts (for polysaccharides and lignin)



Routes to fermentation of all sugars are known





Jeffries & Shi Adv Bioch Eng 65,118

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Routes to potential fuels

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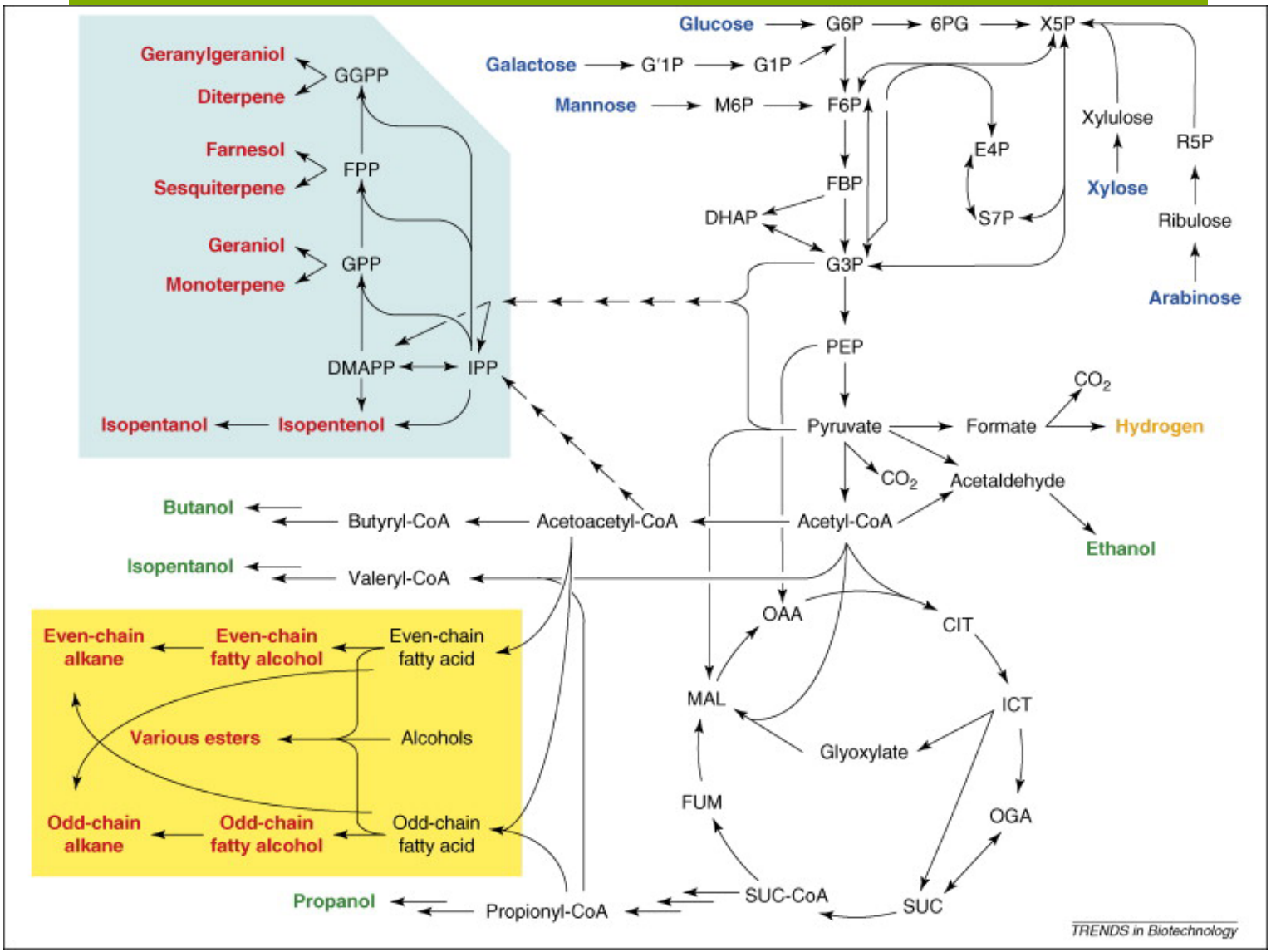
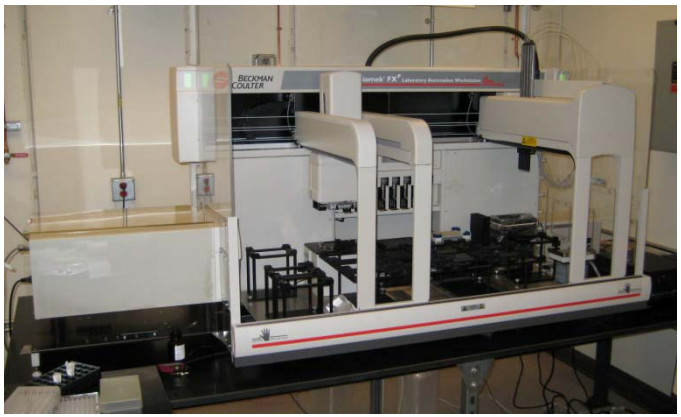


Fortman et al, Trends Biotechnology 26,375

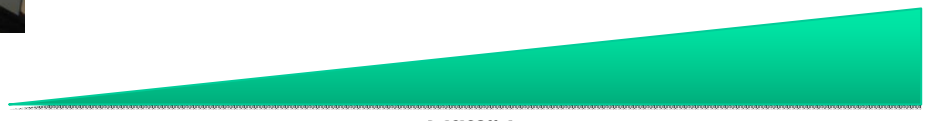
Robotics have enabled high throughput assays

Automated Pre-screening of feedstock-derived inhibitors of bacterial growth

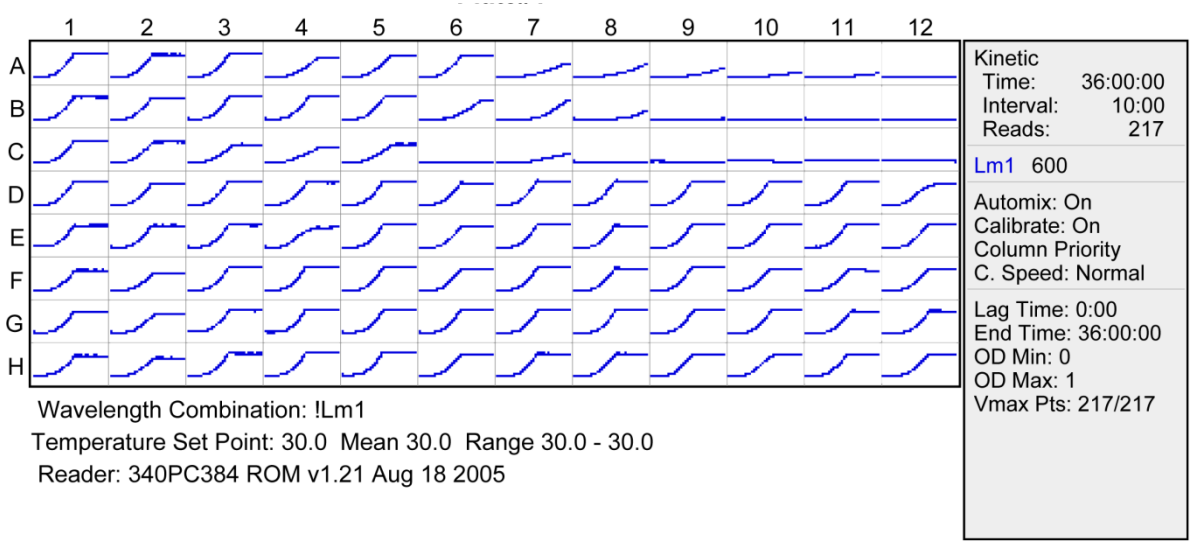


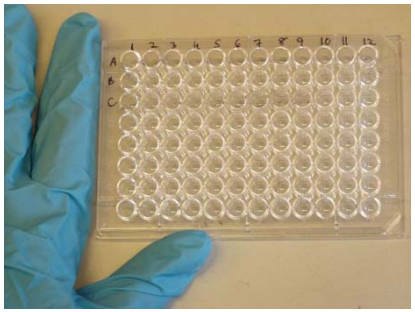
Biomek Robot

Inhibitor concentration



Inhibitors





96-well microtiter plate

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State of the science

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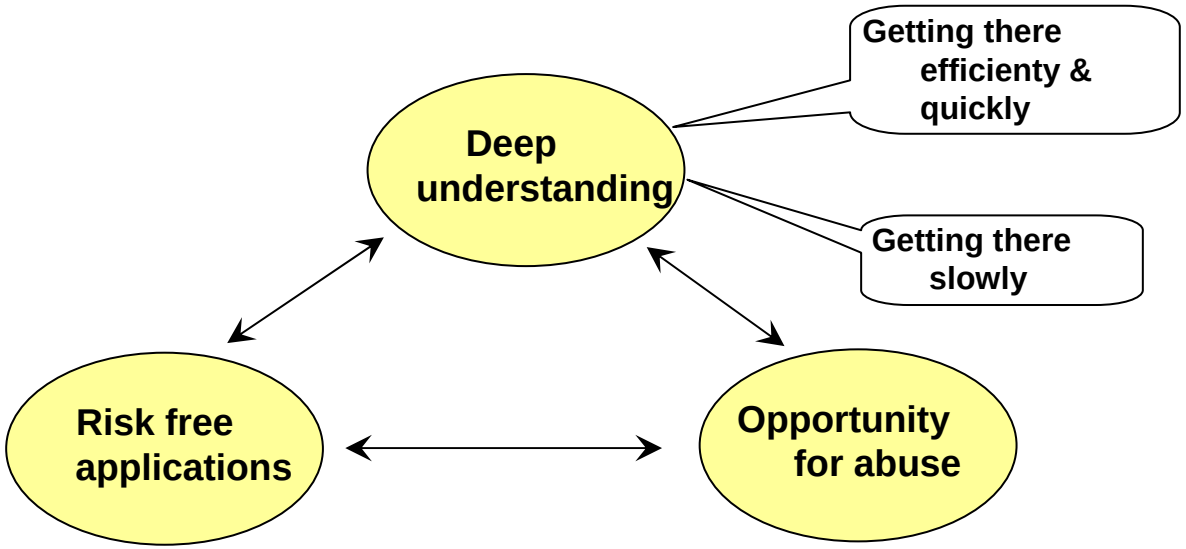
- Cheap sequencing → lots of new data
  → lots of unknown enzymes
  → even more poorly understood enzymes
- Various HighThroughput methods
  - analytics
  - “omics” profiling
  - biological selection
  → large amounts of empirical data to help inform genetics
- Creating deep understanding of biological systems
  - enzymes in context versus one off
  - signaling
  - regulation
- Demonstrating that we have really understood → SynBio
- Conducting efficient research

Definitions of SynBio vary

	Commercialization
• Building new organisms from the ground up	???
• Creating de novo solutions synthetically	5-10 years
• Use of gene synthesis products (e-mail genetic code → DNA in the mail)	Now
• Some degree of GM	Now
• Generation & application of systemic understanding	0-5 years

Governance and risks – a dilemma



Same dilemma with other technologies

- Nuclear
- Chemistry
- Electronics

→ **How to minimize the negatives while capturing the positives**

But

Infinite set of possibilities

Disclaimer

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