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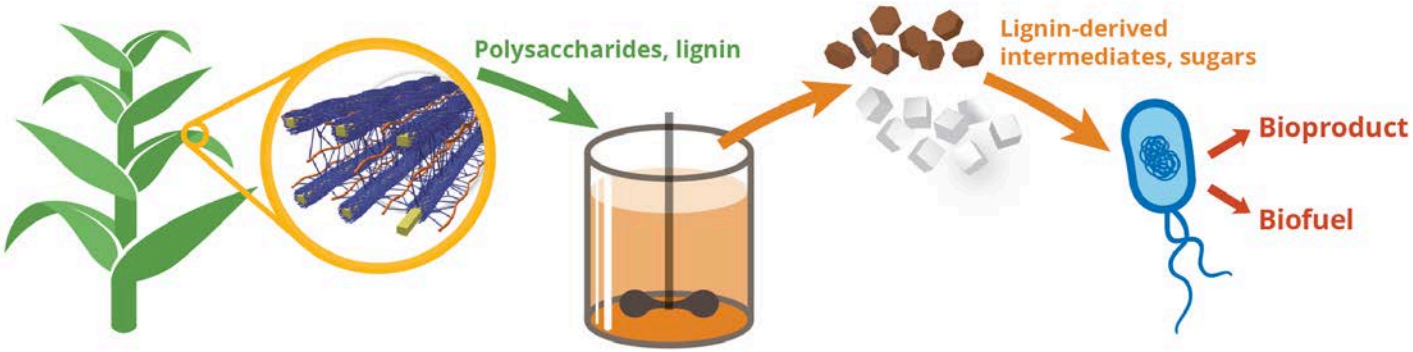
Center Overview



2 November 2017

JBEI’s Mission

Establish the scientific knowledge and new technologies to transform the maximum amount of carbon available in bioenergy crops into biofuels and bioproducts.

JBEI's product and economic goals

- Fuel replacements at ≤ **$4.00 per gallon** without a bioproduct
- Fuel replacements at < **$2.50 per gallon** when bioproducts are co-produced with the fuel
- **Drop-in, commodity bioproducts** that can compete with the same petroleum-derived molecules and that reduce biofuel prices
- **Novel bioproducts** that cannot be efficiently produced from petroleum, have desirable properties, and reduce biofuel selling prices.

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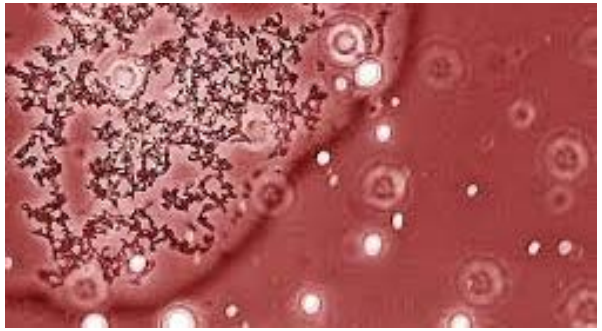
JBEI's science to achieve those goals

- **Engineered bioenergy crops** with low susceptibility to disease and drought that can be readily deconstructed into sugar and aromatic intermediates

- An **integrated, feedstock agnostic deconstruction process** using ionic liquids that liberates ≥ 90% of sugars and lignin-derived intermediates

- Engineered microorganisms that **simultaneously utilize the sugars and lignin-derived intermediates** to produce targeted biofuels and bioproducts at industrially relevant titers, rates, and yields (TRY)



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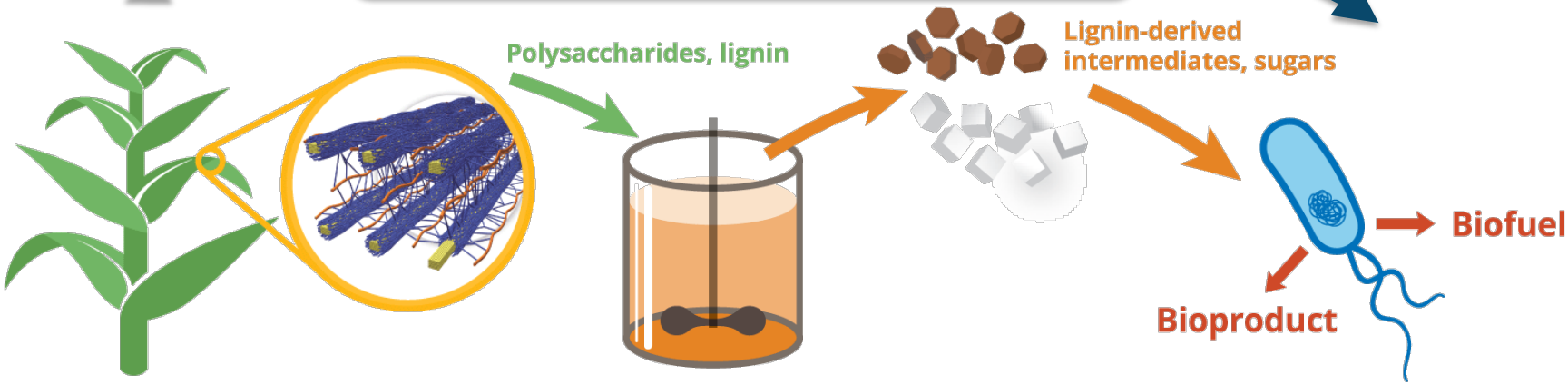
Science and technology proposed to achieve JBEI's goals

Lignin and polysaccharides (C6:C5) in crops matched to microbial engineering of pathways to minimize fuel price, as optimized through TEA & LCA



Feedstock
- Tailored lignin compositions
- 2.5x C6/C5 ratio
- Disease- and drought-resistant

Deconstruction
- ≥ 90% yields of sugars and lignin-derived intermediates
- Efficient biomass fractionation and separation

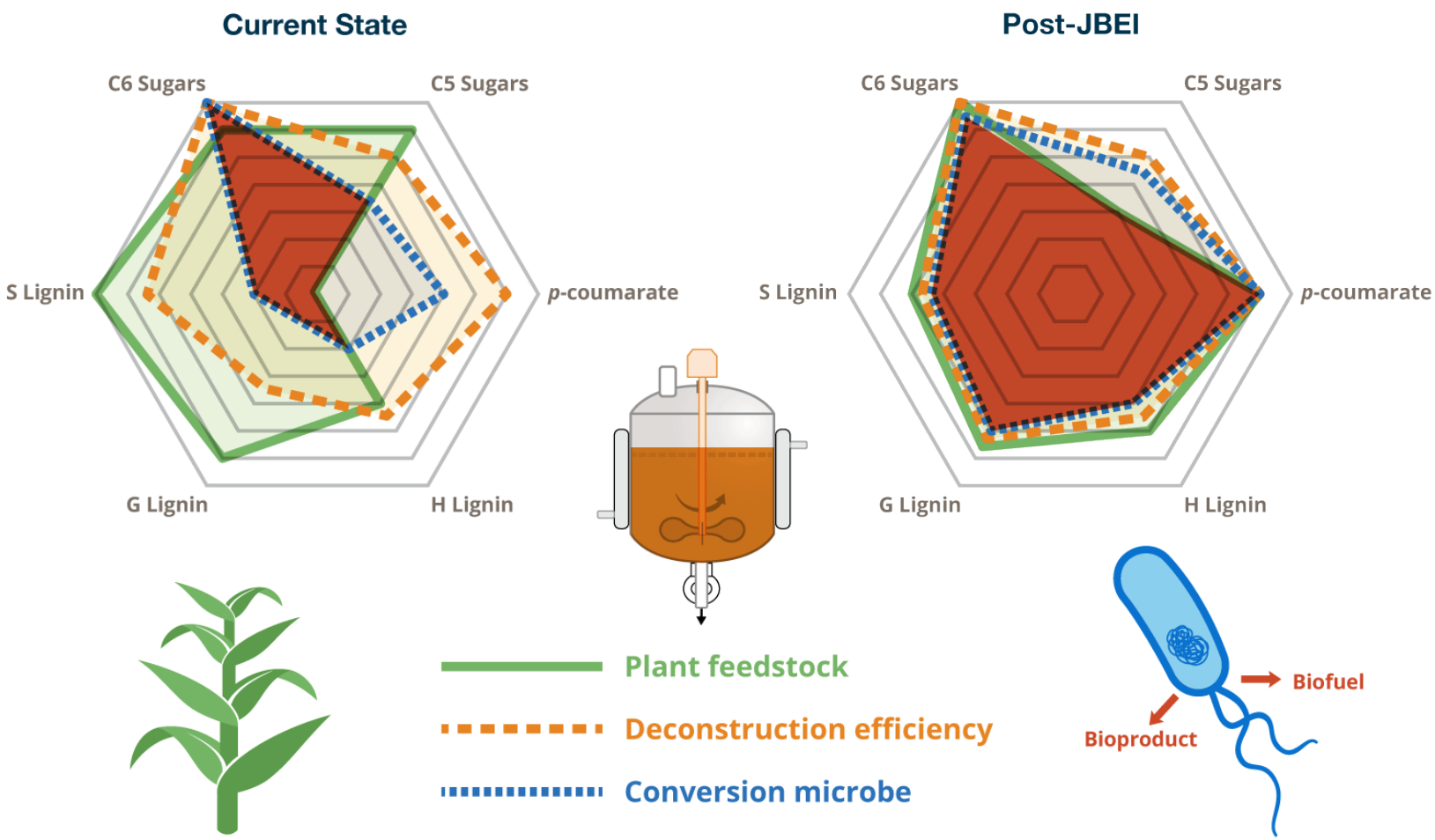
Conversion
- Lignin intermediates and sugars metabolized simultaneously
- Production of biofuels and bioproducts
- Tolerance to ILs, bioproduct, fuel

Feedstock agnostic deconstruction technology improved with engineered crops

ILs chosen to maximize product yield and minimize toxicity that enable process consolidation

Analytical and biosystems design technologies to enable all aspects of JBEI's research program

Matching plant composition and microbial metabolism to maximize conversion



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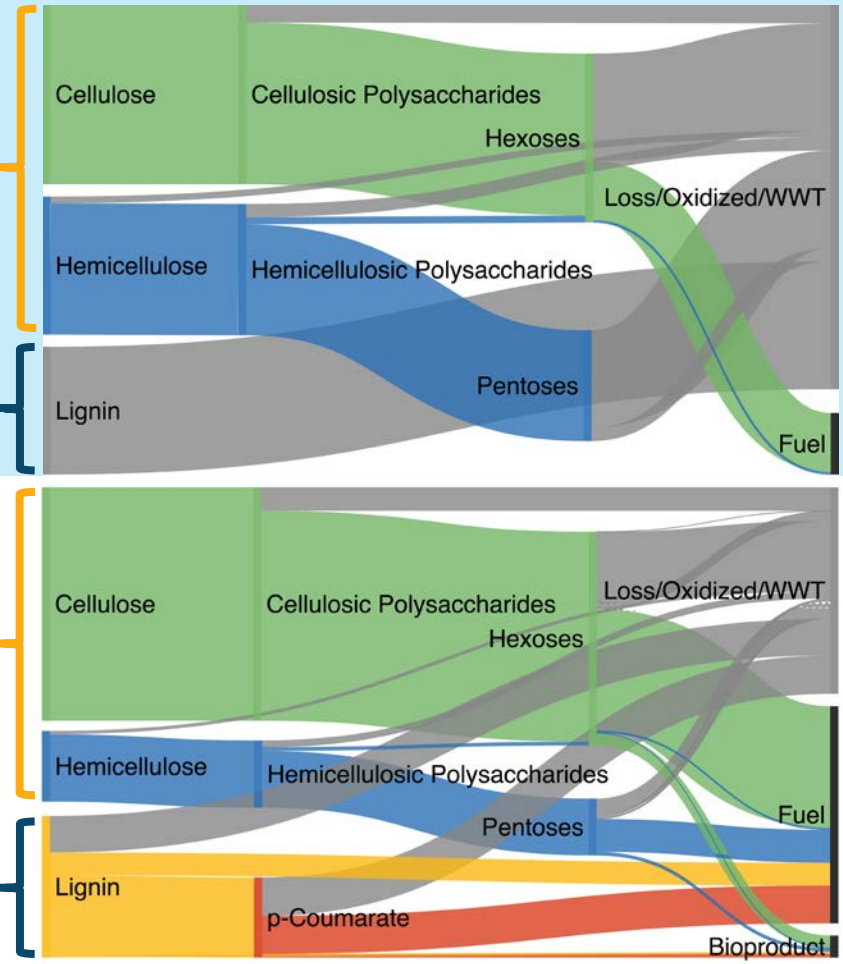
JBEI will significantly improve carbon-efficiency of biomass conversion

Before

After



2.5x C6/C5 ratio

Modified, easily cleaved lignin

Carbon efficiency increased 300%

Fuel production increased 270%

Targeted bioproduct

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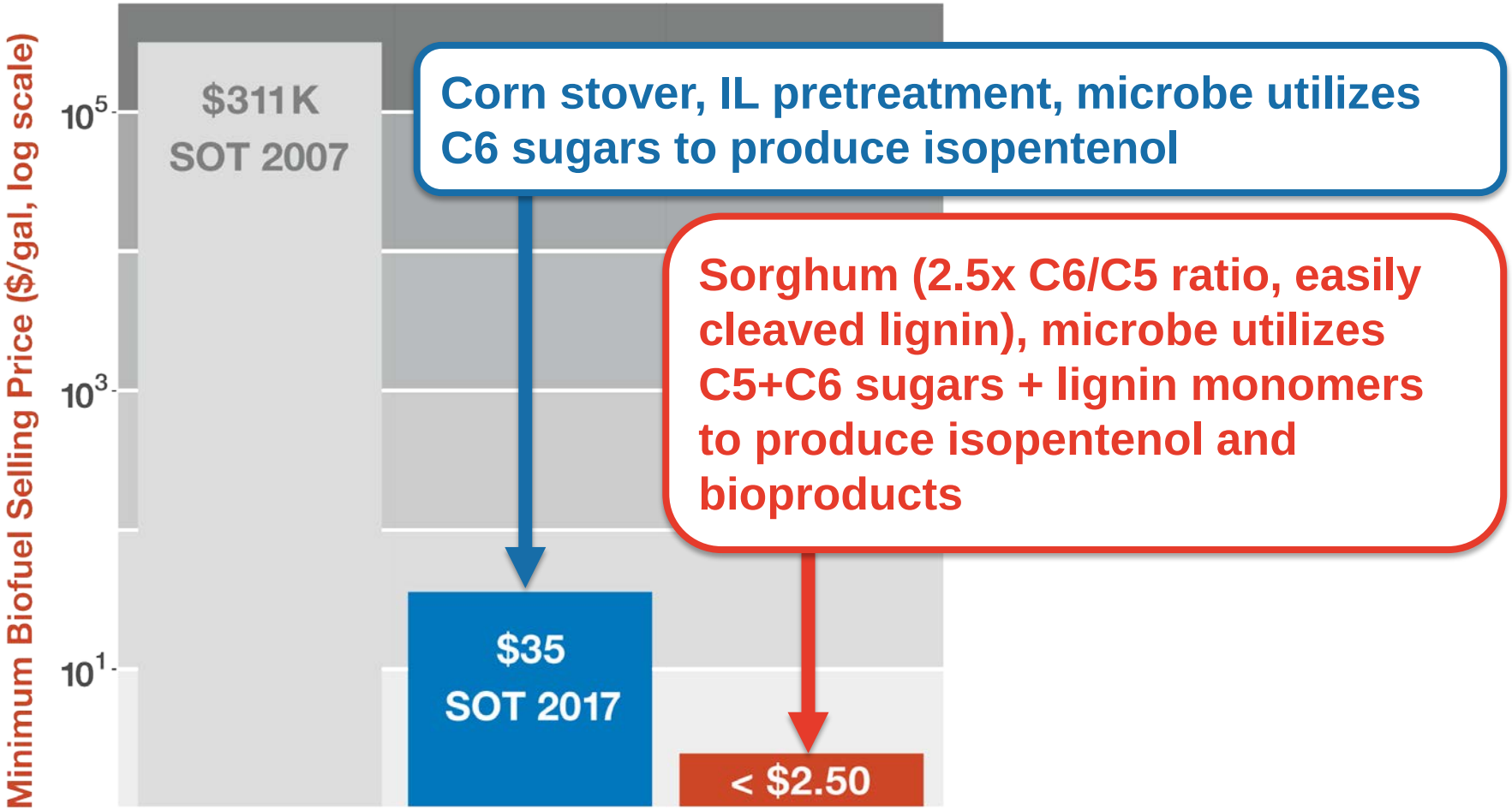
JBEI's targeted high-risk, high-payoff science will improve bioenergy economics



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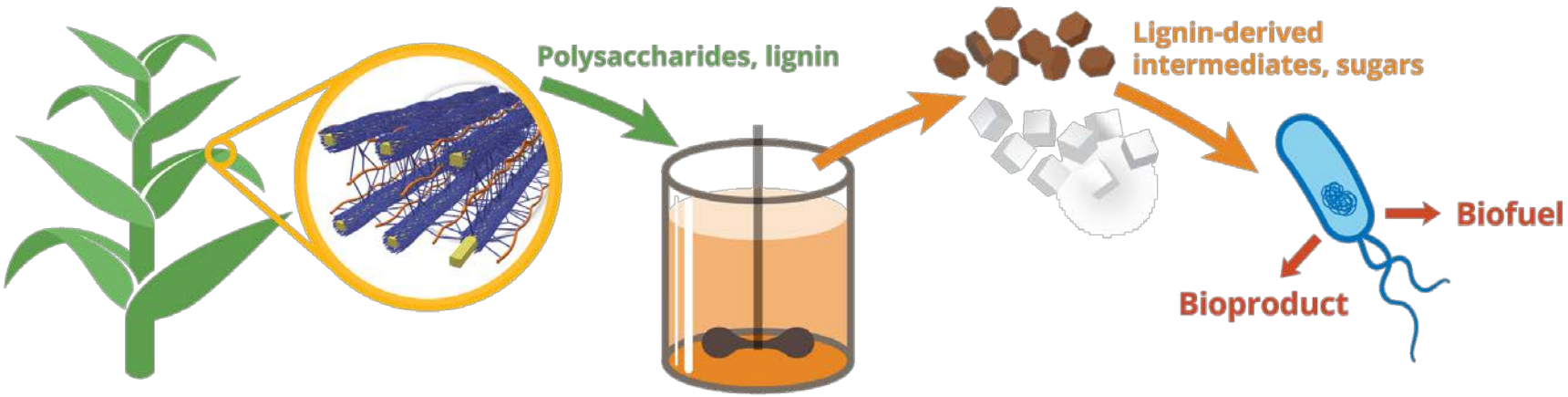
JBEI's priorities



Feedstock

- Sorghum (primary)
- Switchgrass
- Poplar

Deconstruction

- Ionic liquid pretreatment (primary)
- Ligninases (primary)
- Microbial communities

Microbes and targets

- *Pseudomonas putida* (primary)
- On-demand biofuels & bioproducts
- Biofuels with high TRY: isopentenol and methyl ketones

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JBEI partners

5 Nat'l Labs, 7 Universities, Many companies

Industry collaborators contributing resources
Aemetis; Intel; Technology Holding, LLC;
TeselaGen Biotechnology; Total New Energies USA

Industry collaborators
Afingen; Agilent Technologies; Ajinomoto North America; Amyris; Autodesk; CAFFI; Citrine; Compact Membrane Systems; Cummins Inc.; Dow AgroSciences; Dupont; Elevance; Forage Genetics; FuturaGene; General Motors; Genomatica; GC3; Ilium Technologies; Intelligen; LanzaTech; Lygos; Method; National Sorghum Producers; Novozymes; PolyOne; Proionic; REG Life Sciences, LLC; Sappi; Scienomics; Seventh Generation; WattsNets

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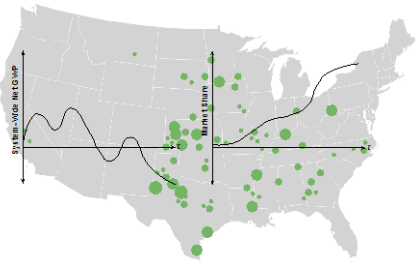
FA1: Sustainability
Goals and Objectives

- Predict the impact of JBEI research results on biofuel selling price and carbon efficiency
- Assess economic and environmental performance at U.S. national scale over multiple decades
- Ensure that engineered bioenergy crops are robust and sustainable



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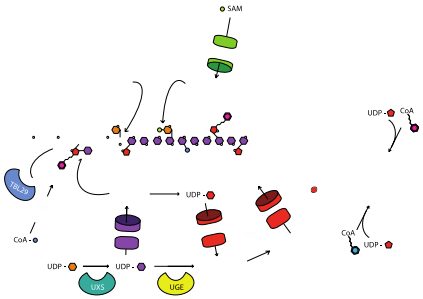
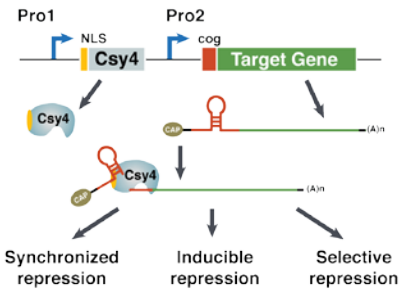
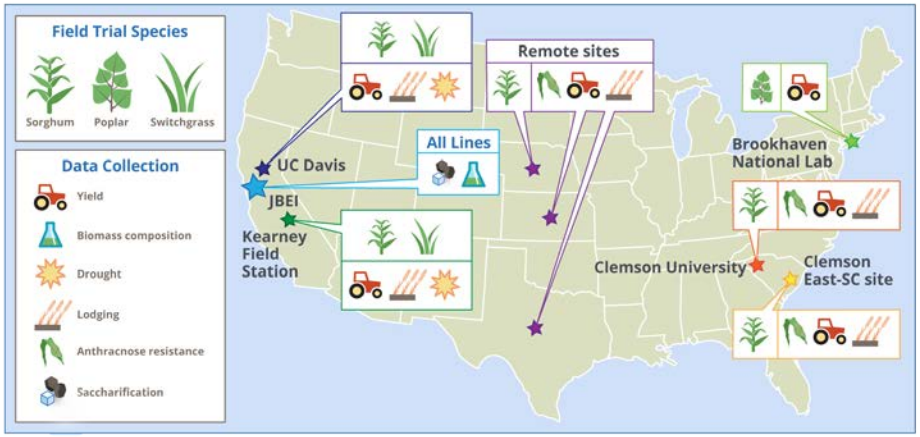
FA2: Feedstock Development
Goals and Objectives

- Develop a fundamental understanding of cell wall biology
- Develop tools to facilitate bioenergy crop improvement
- Engineer and field-test crops with improved biomass and sustainability traits







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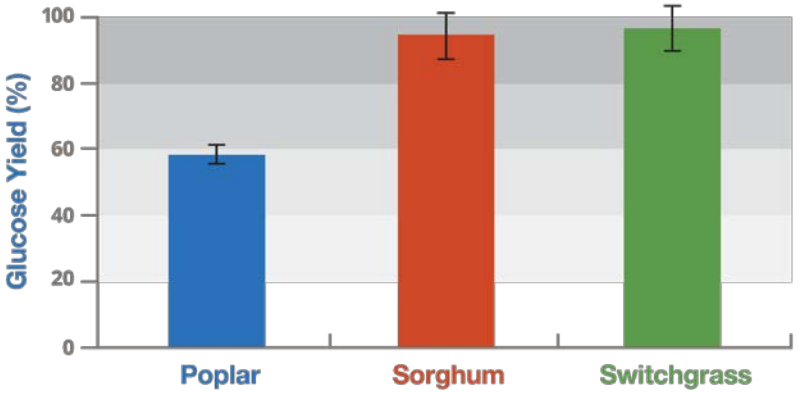
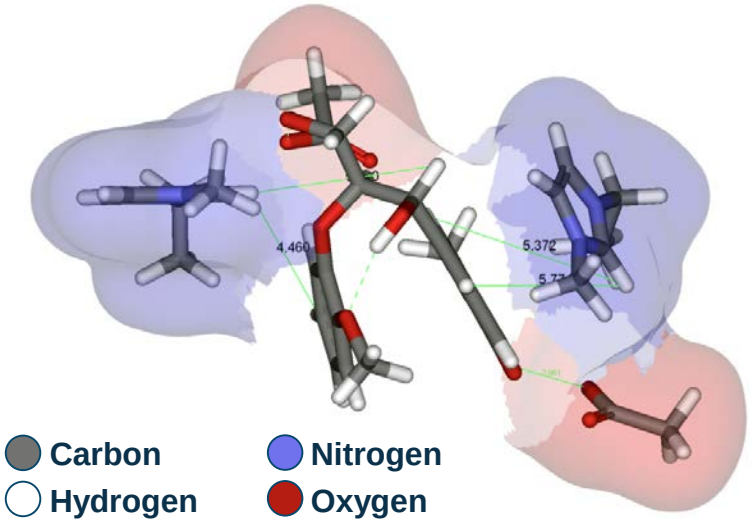
FA3: Deconstruction and Separation
Goals and Objectives

- Discover and demonstrate feedstock agnostic, biocompatible ionic liquids
- Generate intermediates (sugars, lignin-derived intermediates) at ≥90% yields
- Develop predictive deconstruction tools





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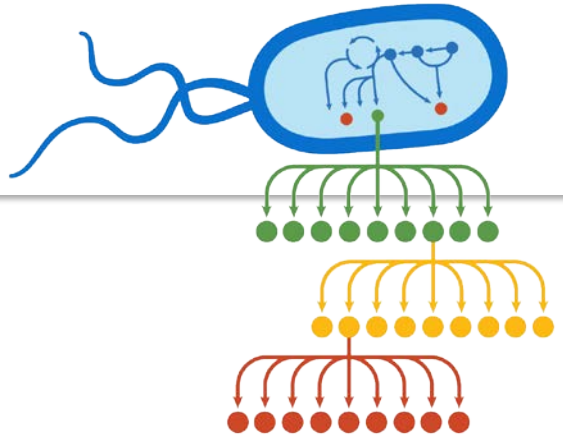
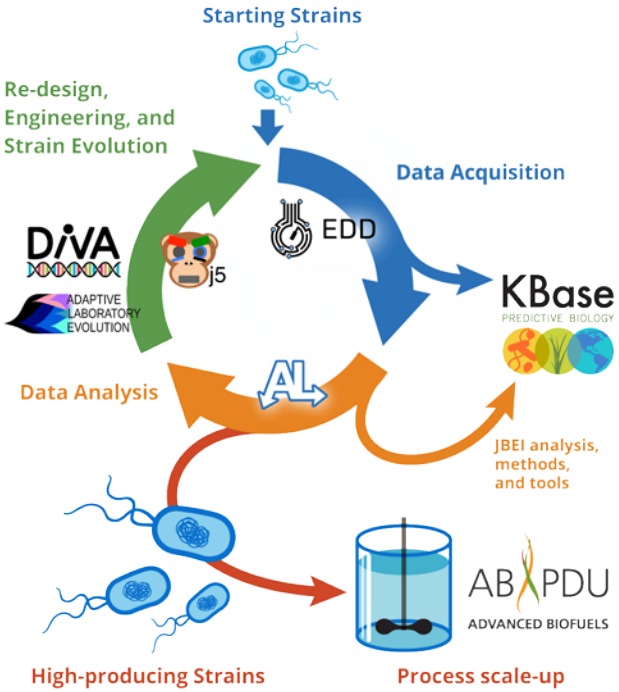
FA4: Conversion
Goals and Objectives



- Establish a broad platform to optimize and select pathways to diverse biofuels and bioproducts
- Develop microbial hosts to maximize utilization of biomass components
- High-throughput and predictive tools to systematically increase TRY and enhance scale-up



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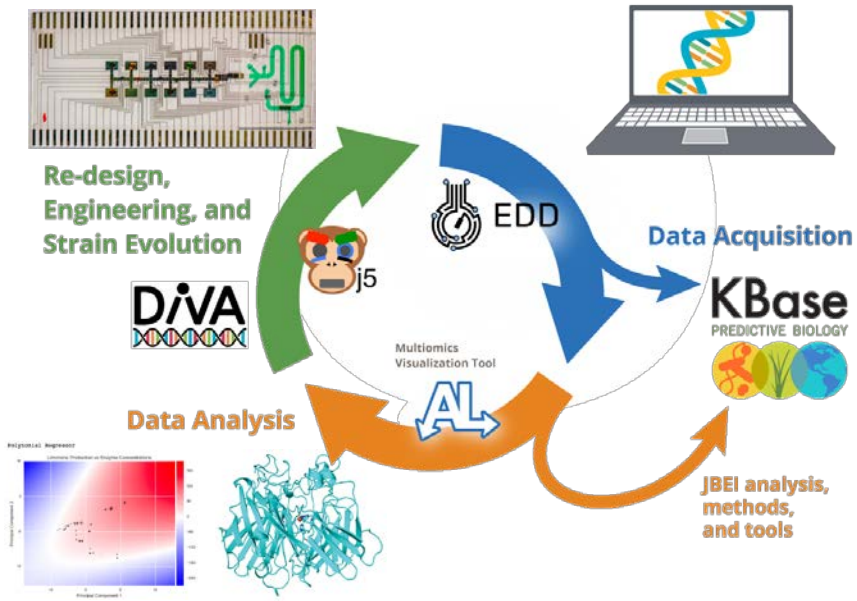
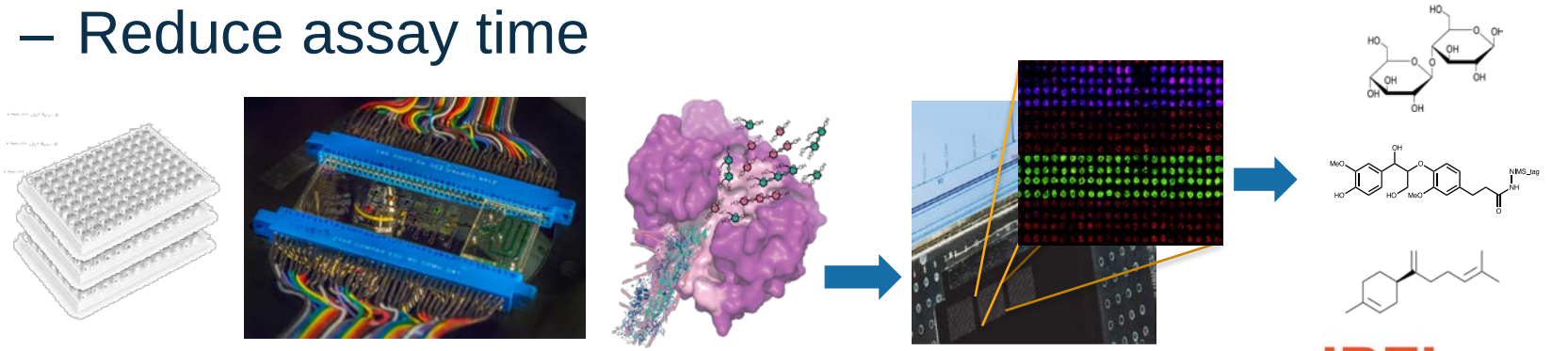
ET: Enabling Technologies
Goals and Objectives

Develop new technologies and methods to meet current & future needs in biofuels research

- Increase throughput
- Decrease reagent use
- Increase fidelity
- Reduce assay time





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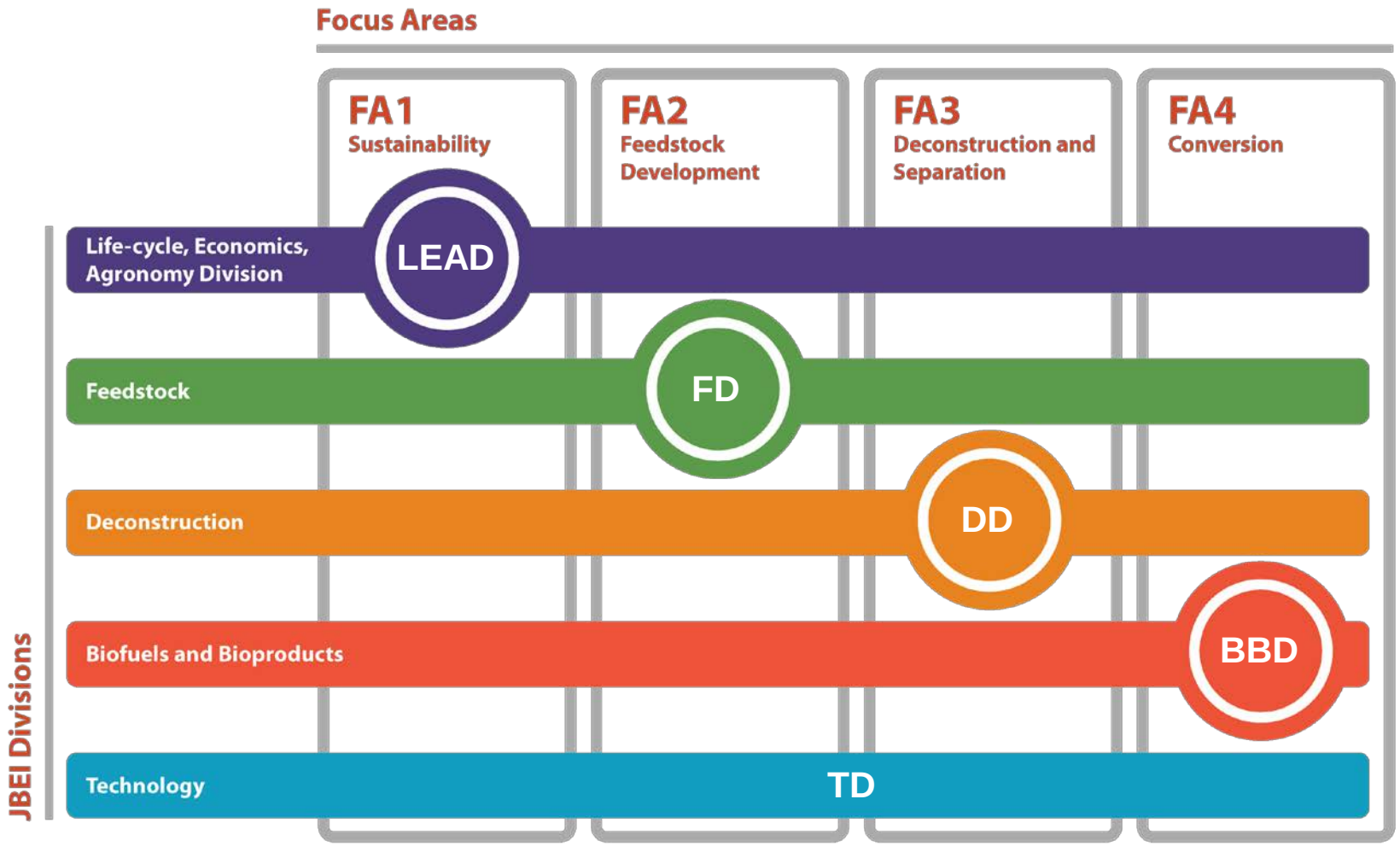
Focus areas are integrated across all JBEI divisions



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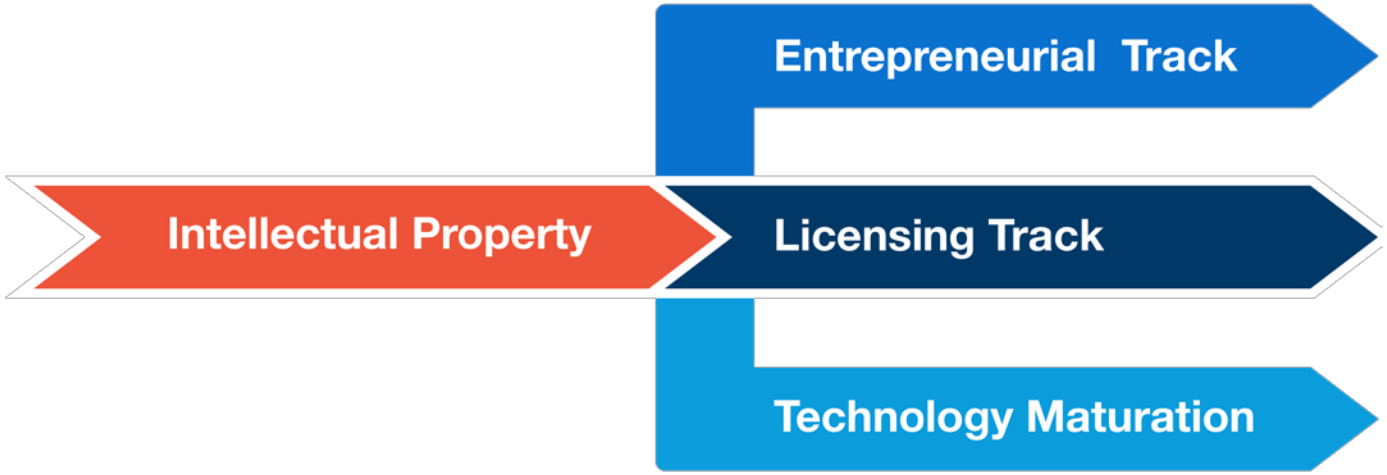
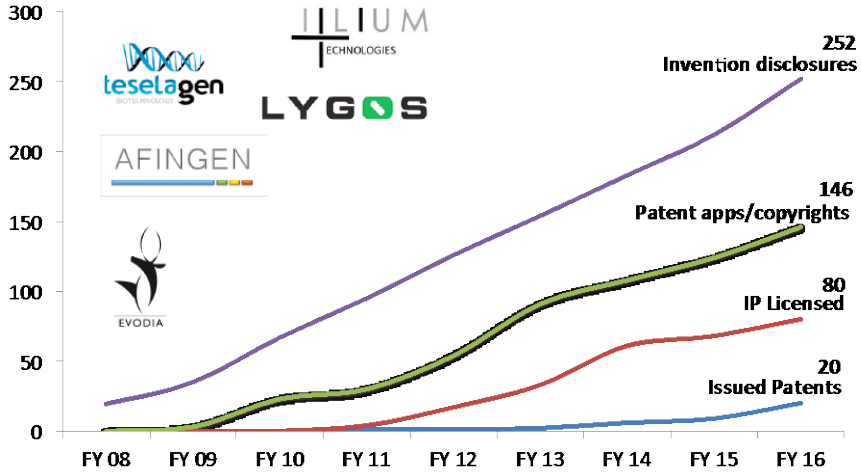
JBEI's approach to commercialization





- One-stop IP shop
- Fully executed IP management plan

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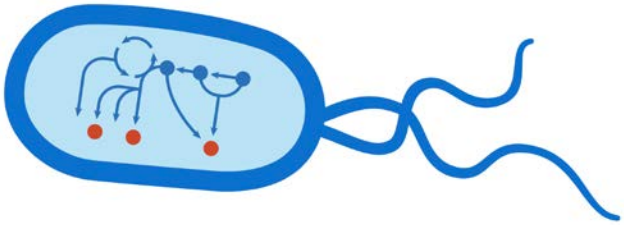
JBEI's impact

- Basic science in plant cell walls, biomass recalcitrance, and microbial physiology
- Biosystems predictive design tools for plants, microorganisms, and enzymes
- Feedstock agnostic deconstruction technologies
- Technologies to co-produce biofuels at <$2.50/gal and drop-in and novel bioproducts



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