

# JBEI

Joint BioEnergy Institute



# Overview



# JBEI is an 11-year old DOE-funded Bioenergy Research Center

Partners - 5 DOE National Labs, 6 Universities



UNIVERSITY OF CALIFORNIA  
SANTA BARBARA



# **JBEI Mission and Goals**

# JBEI's Mission

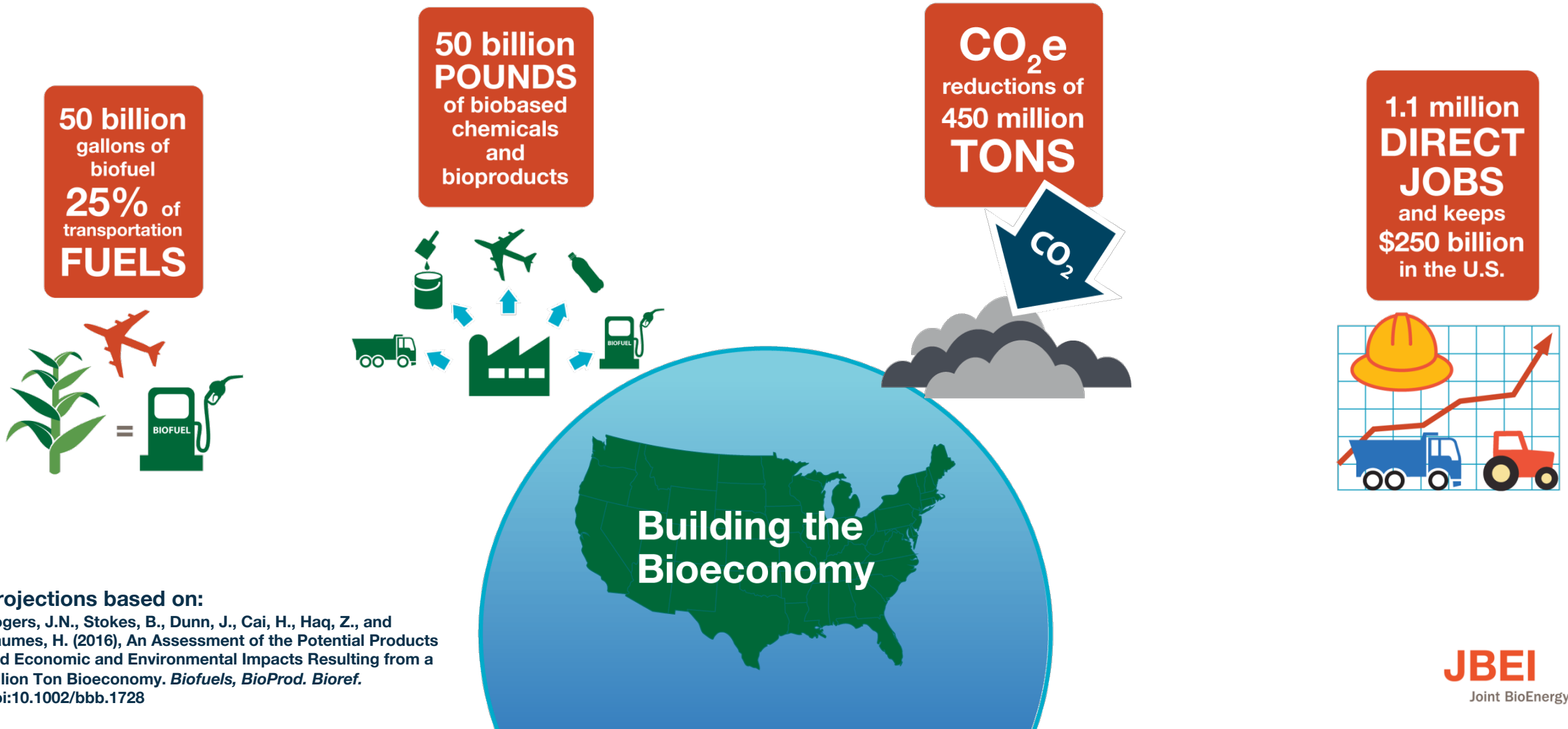
Establish the **scientific knowledge** and **new technologies** to transform the maximum amount of carbon available in bioenergy crops into biofuels and bioproducts.



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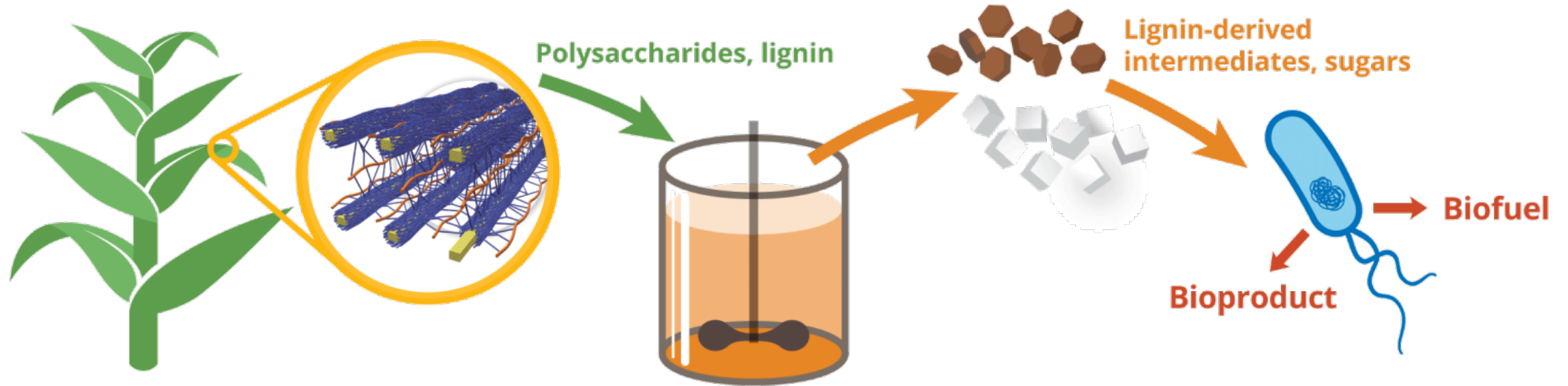


# The US has the potential to produce a billion dry tons of sustainable biomass by 2030, which could produce ...



Projections based on:  
Rogers, J.N., Stokes, B., Dunn, J., Cai, H., Haq, Z., and Baumes, H. (2016), An Assessment of the Potential Products and Economic and Environmental Impacts Resulting from a Billion Ton Bioeconomy. *Biofuels, BioProd. Bioref.*  
Doi:10.1002/bbb.1728

# JBEI's priorities



## Feedstock

- Sorghum (primary)
- Switchgrass
- Poplar

## Deconstruction

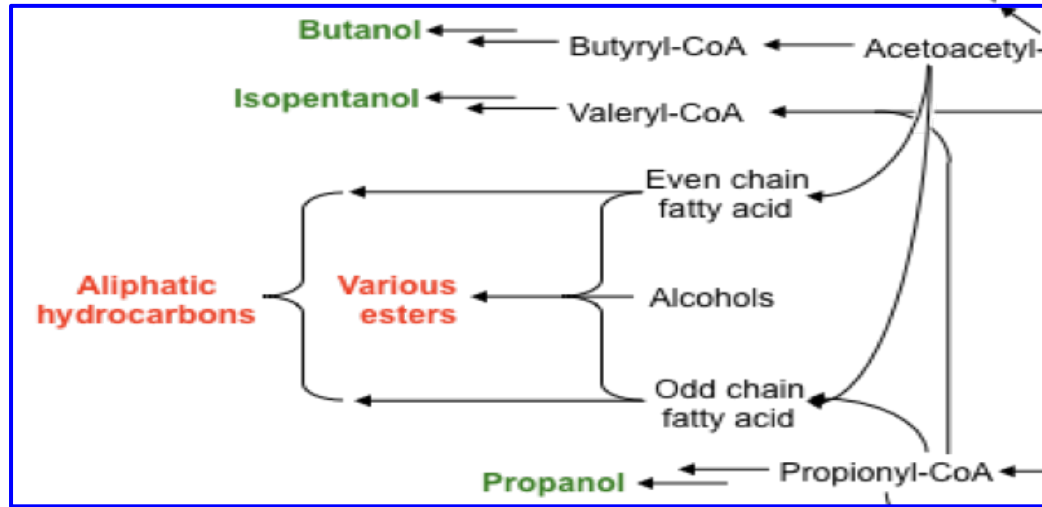
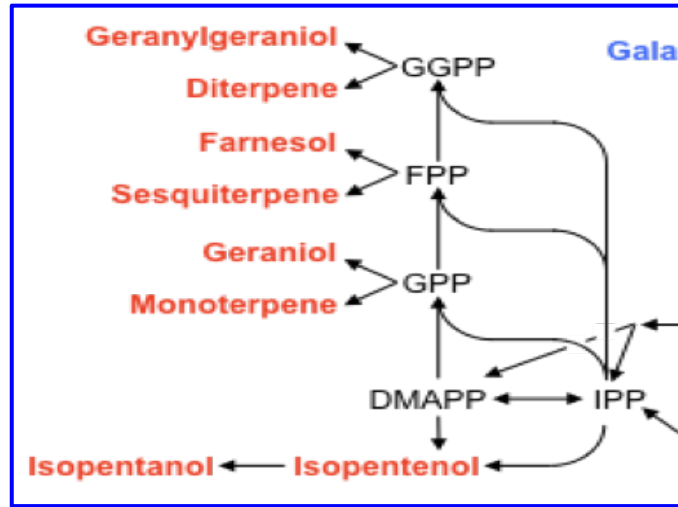
- Ionic liquid pretreatment (primary)
- Ligninases (primary)
- Microbial communities

## Microbes and targets

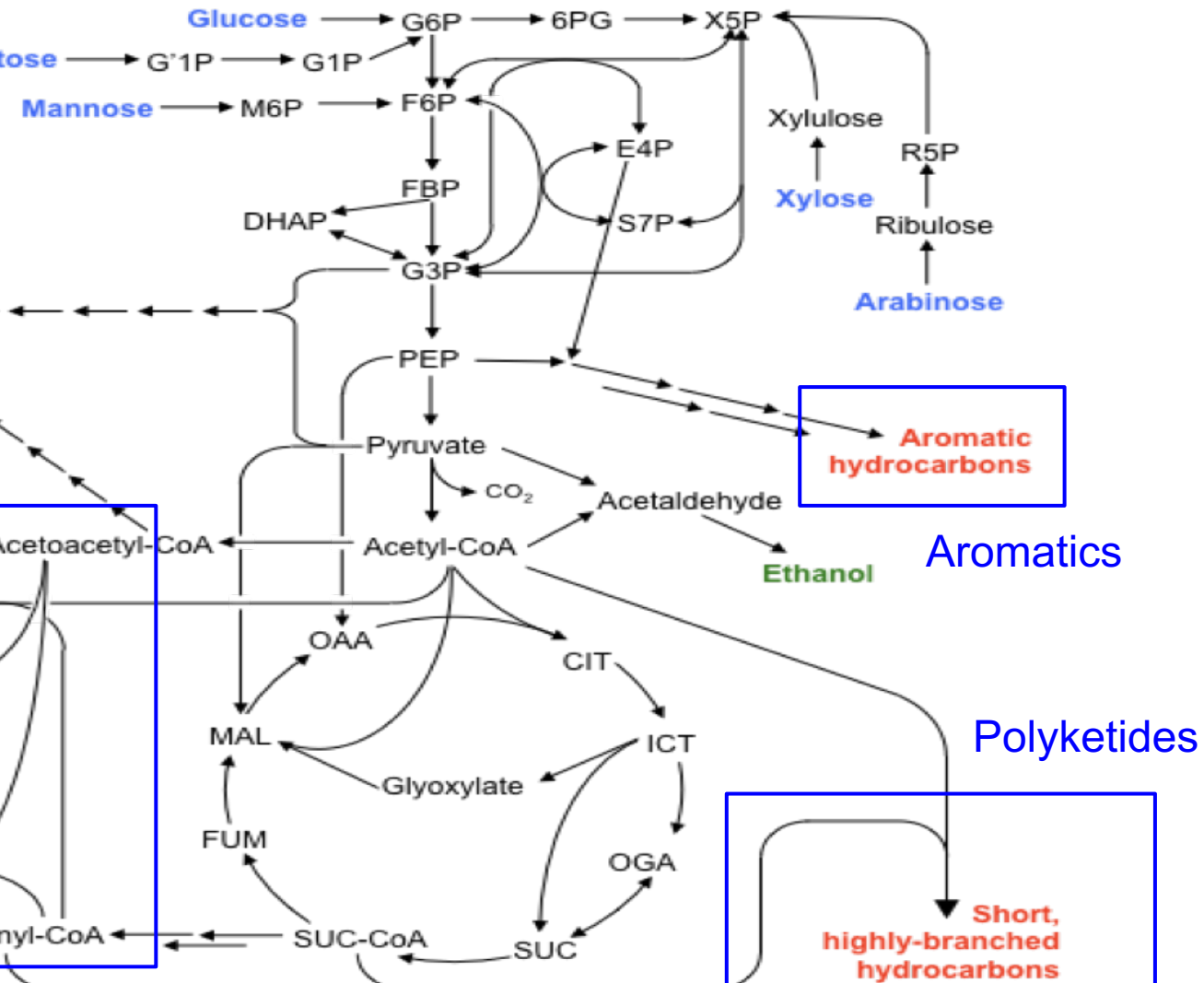
- Host *Pseudomonas putida* (primary)
- biofuels & bioproducts

# JBEI scientists have engineered many biosynthetic pathways

Isoprenoids



Fatty Acids



Aromatics

Polyketides

Short, highly-branched hydrocarbons

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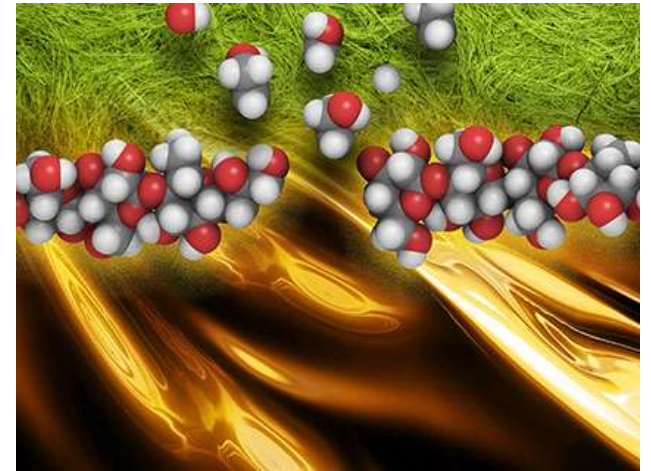
# Some bio-molecules made by JBEI (most have associated IP)

- isopentenol
- monoterpenes/pinene
- bisabolene
- isoprenoids with novel numbers of backbone carbon
- isoprenyl alkanooates
- sesquiterpenes for jet fuel
- methyl ketones
- fatty acid-derived aldehydes & diacids
- fatty alcohols
- fatty acids in *S. cerevisiae*
- dicarboxylic acid methyl esters
- 1-deoxyxylulose-5-p
- bio-toluene
- tranilast/anthranilates
- carboxylic acids
- 3-hydroxycarboxylic acid and ketone,
- alkyl lactones
- macrocyclic ketones
- lactams and lactam analogs
- 2-pyrrolidone
- gamma lactones
- dicarboxylic acids, including adipic acid
- alpha-olefins
- trimethylpentanoic acid
- hydroxytyrosol



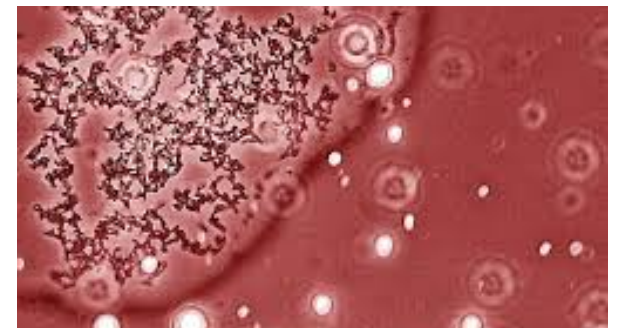
# The Challenges

- Controlled feedstock engineering: reduce lignin, increase sugars and control sugar types, produce intermediates directly in plants
- Difficulty in deconstructing and separating bioenergy crops into targeted intermediates
- Lack of a cheap robust pretreatment technology
- Expensive depolymerization enzymes
- Lack of efficient and affordable microbial routes to drop-in biofuels and bioproducts



# JBEI's science will provide

- **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  $\geq 90\%$  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)



# JBEI's technologies will enable

- Fuel replacements at  $\leq$  **\$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.



# **JBEI Industry Partnerships**

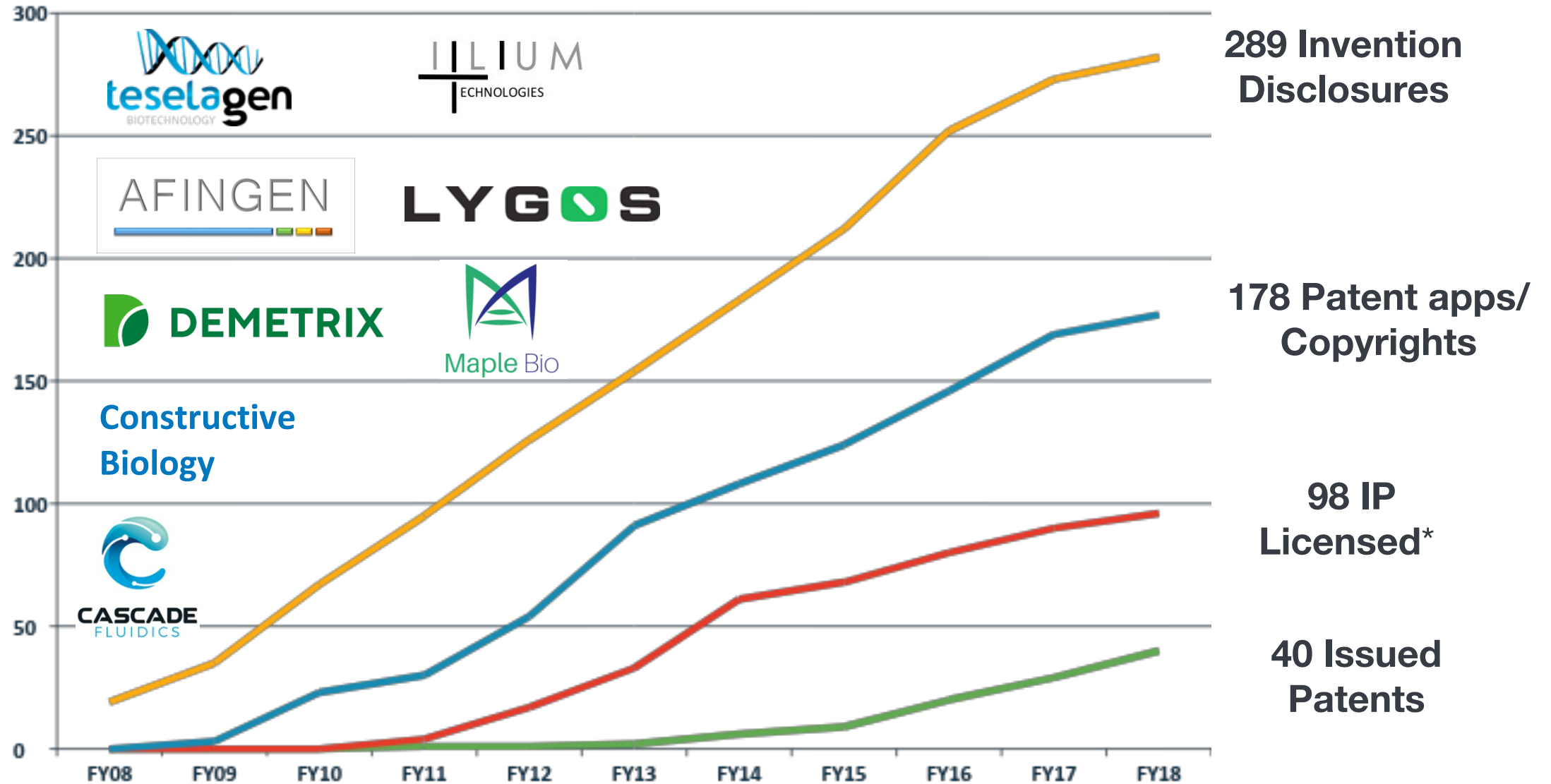
# JBEI capabilities that companies can leverage through research partnerships

- Metabolic engineering and modeling
- Synthetic biology expertise and tools
- Plant engineering for predictable cell wall composition
- Enzyme discovery, engineering, high-throughput screening, and expression
- Biomass pretreatment and process development
- Systems biology
- Proteomics and metabolomics
- Development of bio-routes to improved fuels and industrial/specialty chemicals and nutraceuticals
- Microfluidics and microassays

# Industry-friendly partnerships

- True collaborations
- Companies can embed employees at JBEI
- Regular project team meetings to evaluate progress and adjust research as needed
- DOE funders encourage industry engagement
- Partners attend JBEI retreats and receive early notice of JBEI IP

# Companies can also license JBEI Patents and Software



As of 3/31/2018

\*Licensed IP that Includes patents, patent applications, foreign patent applications and copyright  
 Plus: one JBEI affiliated invention disclosure and agreement; not included here

# JBEI interactions with industry





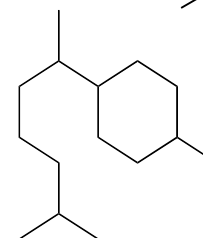
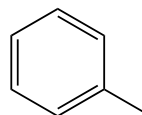
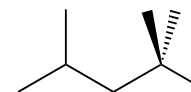
**Future directions**

# Engineered Microorganisms: Biomass → Fuels



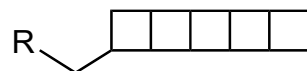
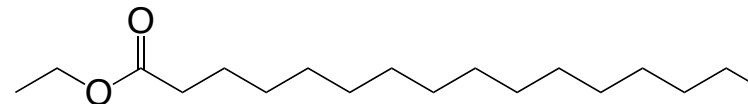
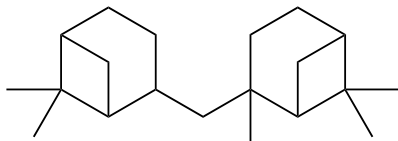
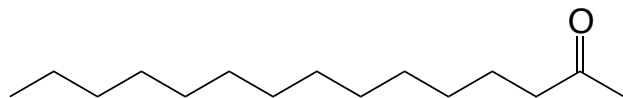
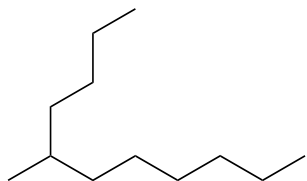
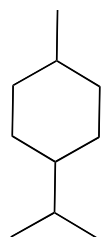
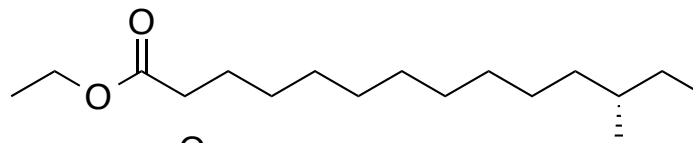
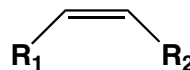
## Gasolines

- High octane
- Short-chain alkanes
- Many branches
- Some aromatics



## Diesels

- Appropriate cetane numbers
- Long-chain alkanes
- Few branches
- Some aromatics

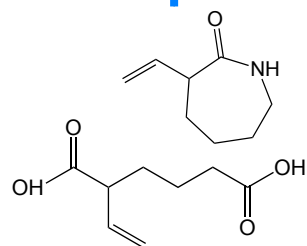
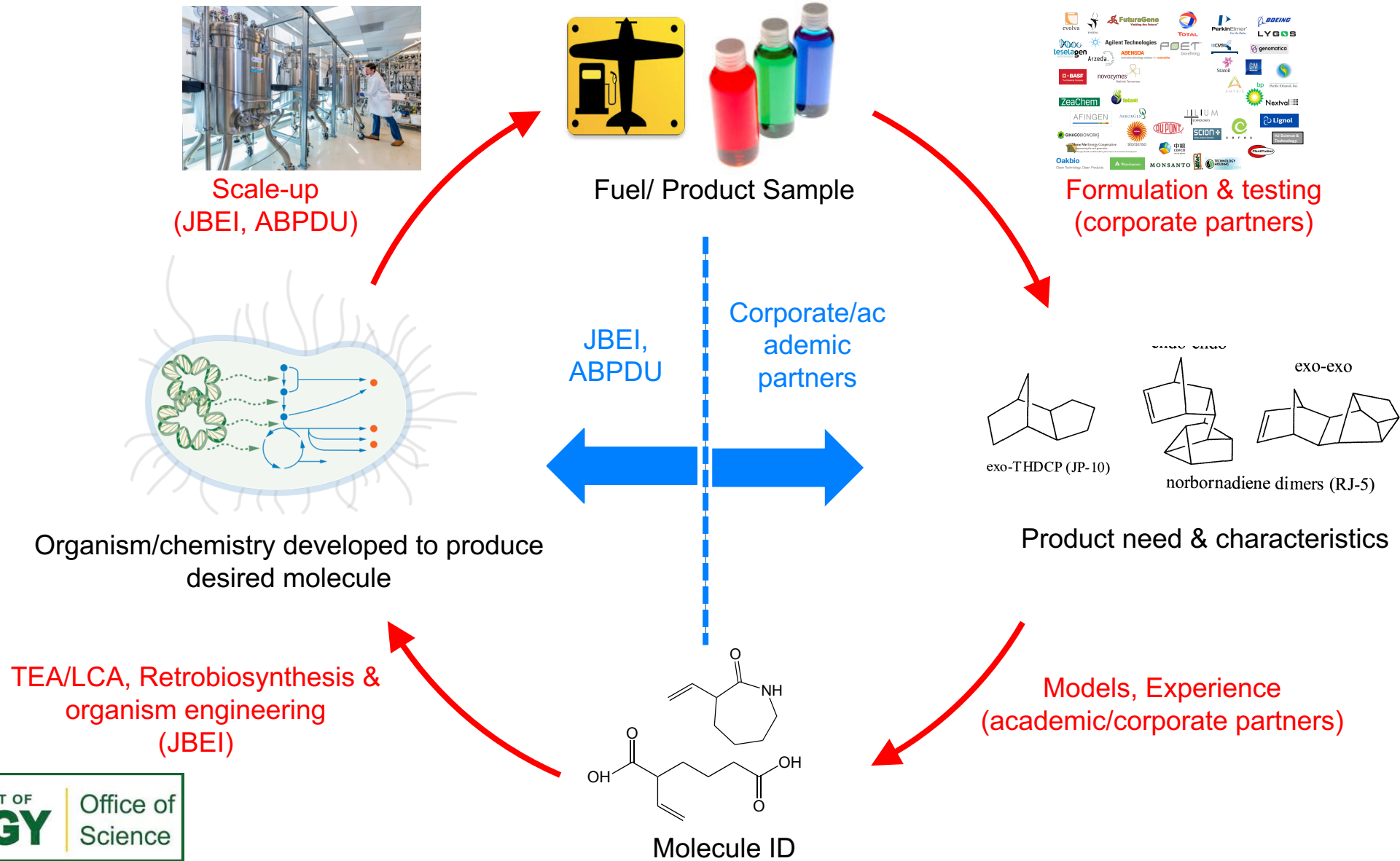


## Jet fuels

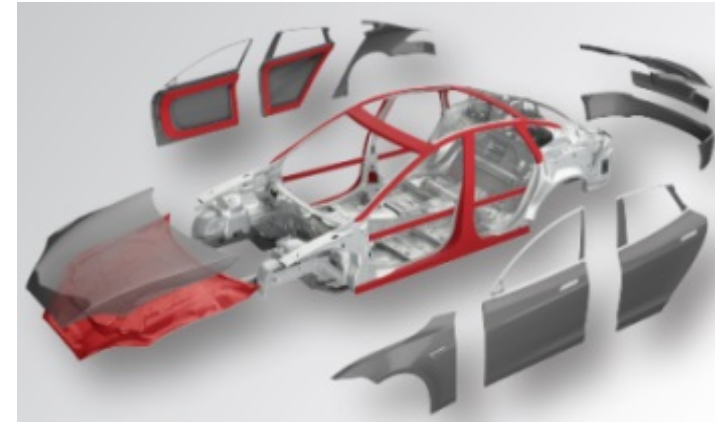
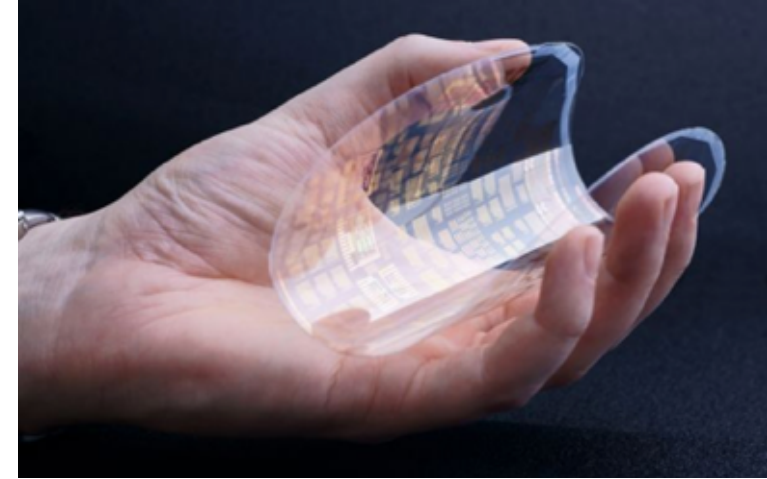
- Long-chain alkanes
- Few branches
- Some aromatics



# How JBEI can work with industry and academics to develop new fuels and products



# High performance materials for clothing, electronics, airplanes, and automobiles



# Biodegradable and recyclable plastics

