Synthetic Biology and Advanced Manufacturing - A Chemical Industry Perspective

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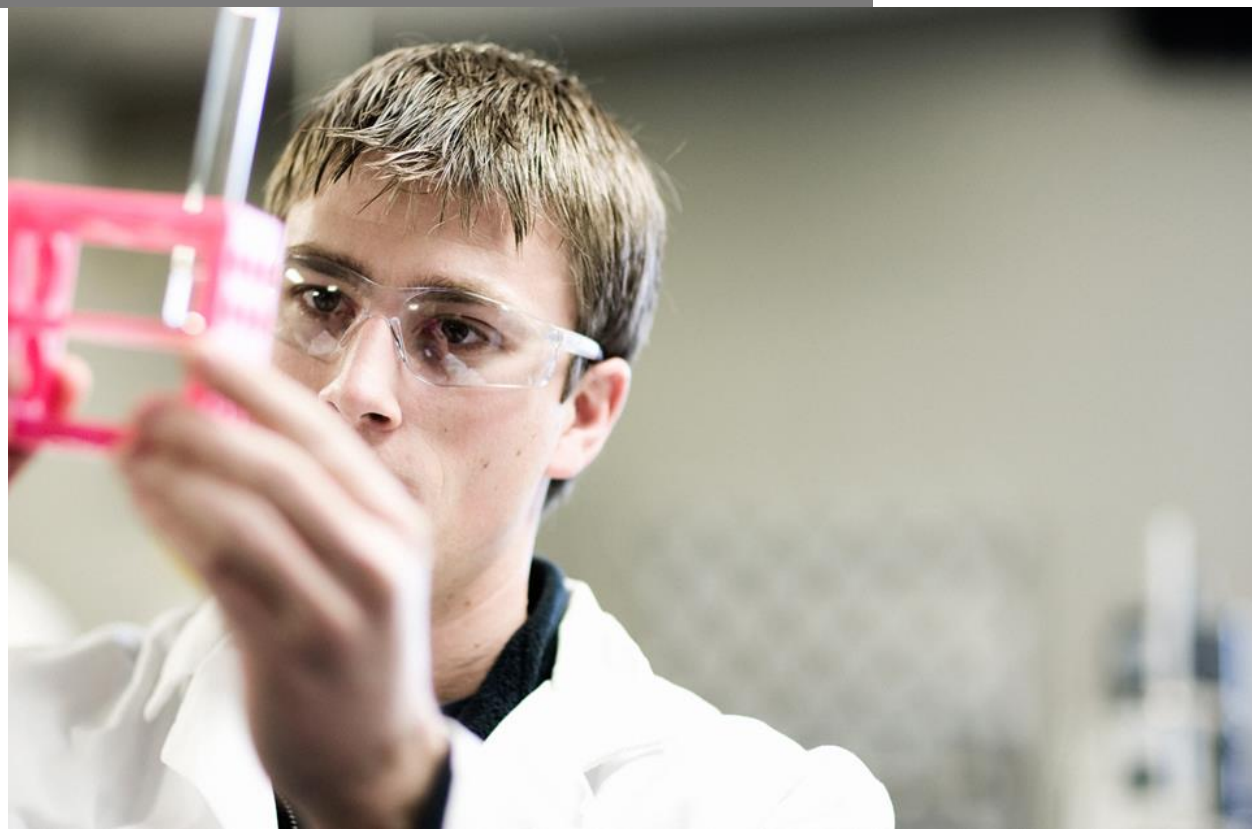

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The miracles of science™

Success Factors for Biotech-Derived Chemicals

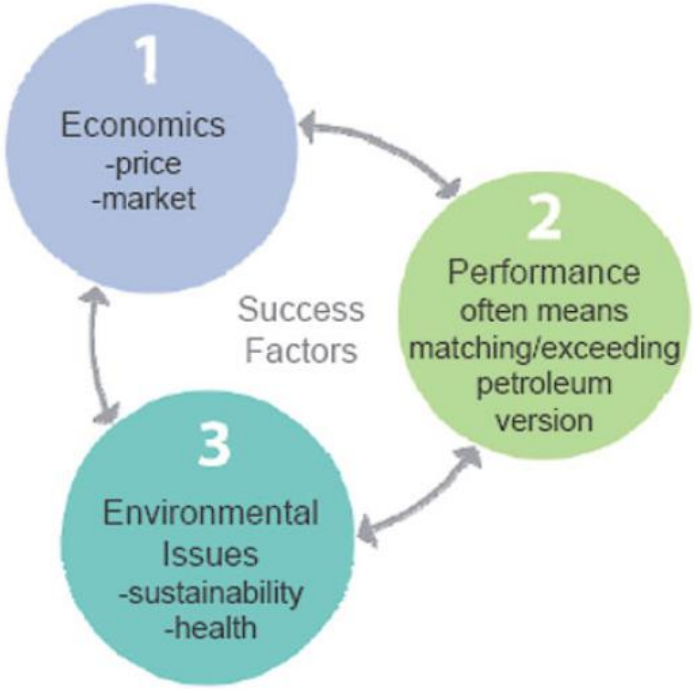

Figure 2. Factors determining competitive advantages for biomass-derived chemicals. Commercial success and competitive advantages for biotechnology enabled, biomass-derived chemicals relies upon the three interdependent factors, 1. economics, 2. performance, and 3. environmental factors.

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Many Theoretical Routes to Renewable Chemicals

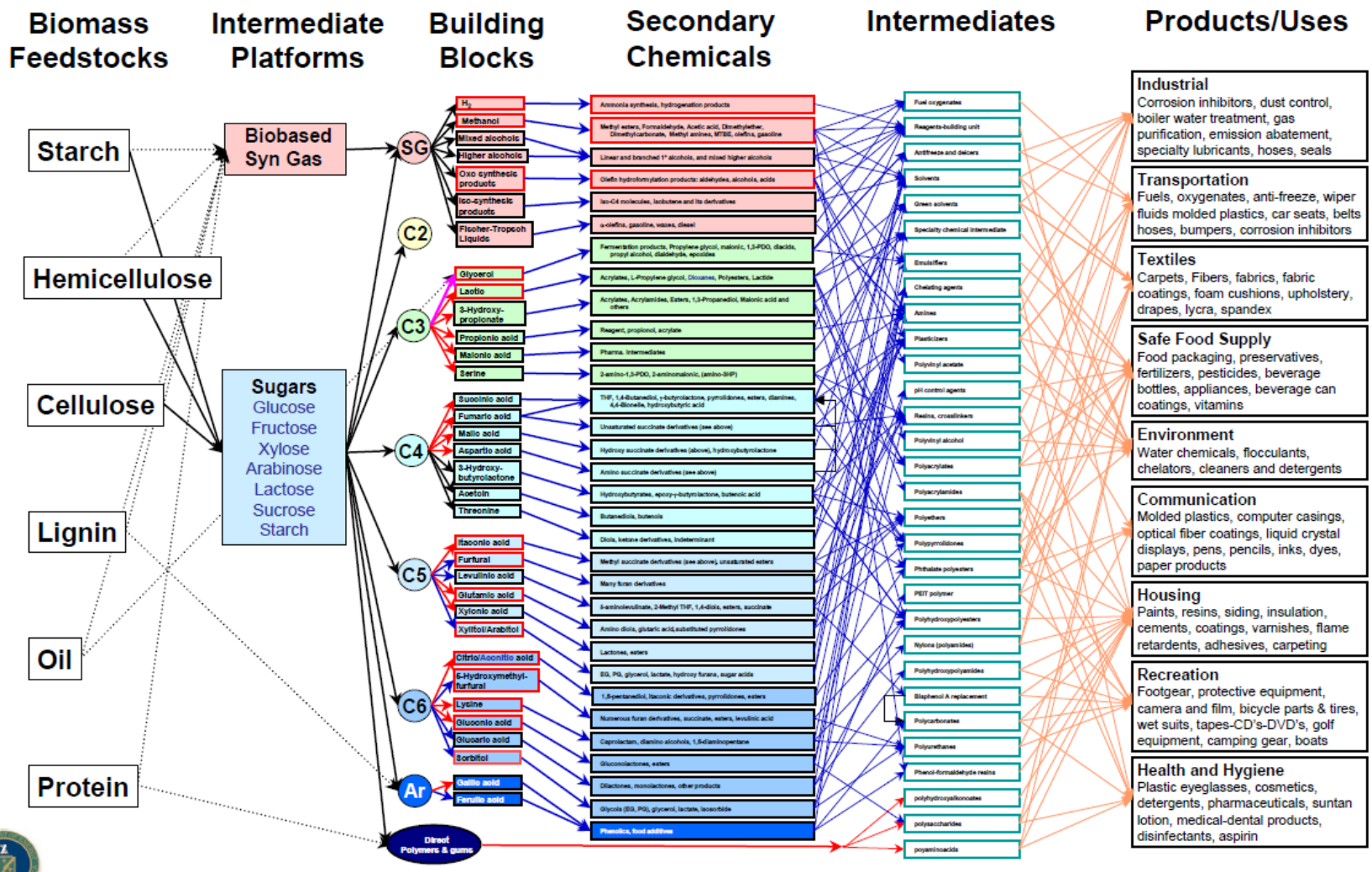
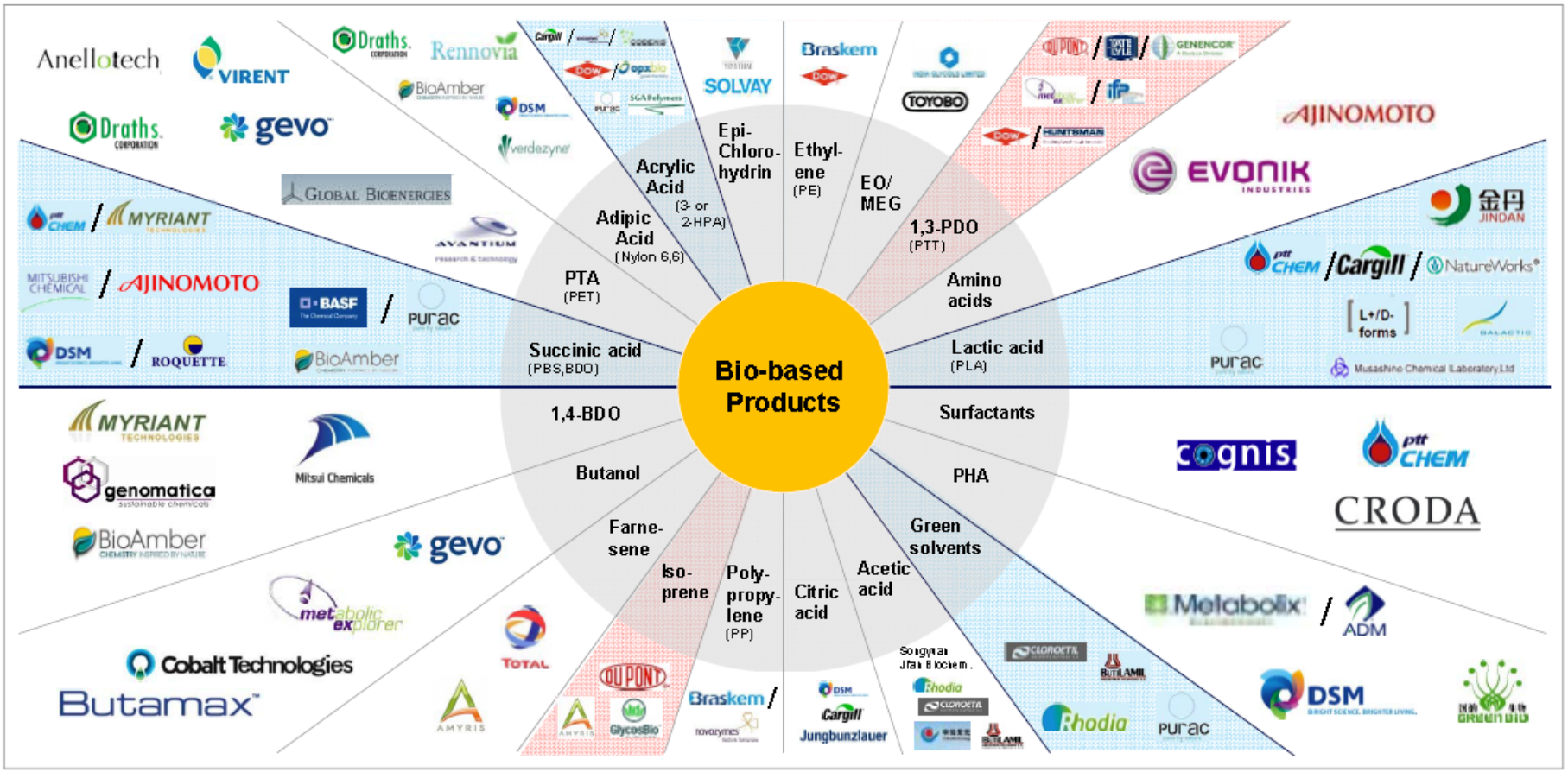


Figure 3 – Analogous Model of a Biobased Product Flow-chart for Biomass Feedstocks

Biomaterials Competitive Landscape



Source: Morgan Stanley

Early Commercialization of Bioproducts

Table 2. Early commodity scale bioproducts

Chemical	Companies	Brand name(s) and annual production	Application
1,3 Propanediol (PDO) $C_3H_8O_2$	DuPont Tate & Lyle	Zemea® and Susterra® – 135 million lbs.	Cosmetics, personal care and home cleaning products, aircraft deicing, antifreeze and heat-transfer industrial fluids DuPont™ Sorona® carpet
Polylactic acid (PLA) $C_3H_6O_3$	NatureWorks LLC	Ingeo® – 300 million lbs.	Food grade plastics – utensils, wrap, containers, packaging
Polyhydroxyalkanoate (PHA) $CH_2[OCH(R)(CH2)_xCO]_nCH_2$	Metabolix SyntheZyme	Mirel® from Telles – 110 million lbs.	Packaging for cosmetic products and food products, injection-molded durable goods such as cell phone cases, hand-held devices
Polyethylene C_2H_4	Braskem	Green polyethylene – 400 million lbs.	Food packaging, drink bottles, plastic bags, trash containers, car parts
Polyols HO-R-OH	BiOH	BiOH polyols	Foam for furniture, bedding, automotive, carpet, construction, coatings, sealant, adhesive, and elastomers

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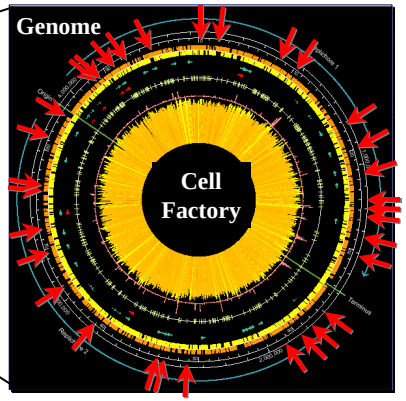
Bio-PDO™ (1,3 Propanediol)

Economic Production of PDO

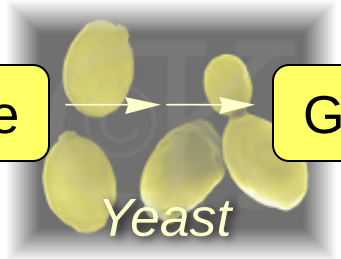


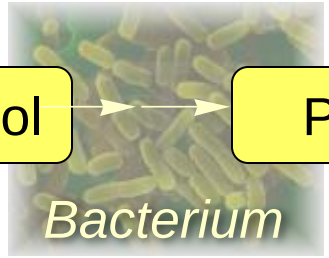
E.coli has been programmed to increase Bio-PDO™ production 500-fold

Corn Grain

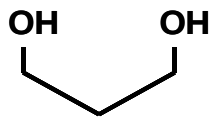
In Nature:
two microorganisms convert glucose to PDO stepwise

Starch → Glucose → Glycerol → PDO





Biotech Application:
a single microorganism to effect the conversion

Glucose → Programmed *E. coli* → 

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Industrialization of Biology:
A Roadmap to Accelerate Advanced Manufacturing of Chemicals

Statement of Task

In order to realize the full benefit of research investments intended to enable the advanced manufacturing of chemicals using biological systems, an ad hoc committee will develop a roadmap of necessary advances in basic science and engineering capabilities, including knowledge, tools, and skills. Working at the interface of synthetic chemistry, metabolic engineering, molecular biology, and synthetic biology, the committee will identify key technical goals for this next-generation chemical manufacturing, then identify the gaps in knowledge, tools, techniques, and systems required to meet those goals, and targets and timelines for achieving them. It will also consider the skills necessary to accomplish the roadmap goals, and what training opportunities are required to produce the cadre of skilled scientists and engineers needed. While focused on industrial manufacturing of chemicals, the roadmap challenges identified here will also be relevant to applications in health, energy, environment and agriculture by advancing the tools and techniques required for new development in these areas. .....