Bio
BIOTECHNOLOGY
INDUSTRY ORGANIZATION

Consumer Products Made with Industrial Biotechnology

Consumer Product	Old Manufacturing Process	New Industrial Biotech Process	Climate Benefits	Consumer Benefit
Bread 	Potassium bromate, a suspected cancer-causing agent at certain levels, added as a preservative and a dough strengthening agent	Genetically enhanced microorganisms produces baking enzymes to • Enhance rising • Strengthen dough • Prolong freshness	• Reduces CO2 emissions in grain production, milling and baking and transportation	• High-quality bread • Longer shelf life • Eliminates suspected carcinogen potassium bromate
Vitamin B2 	Toxic chemicals, such as aniline, used in a nine step chemical synthesis process (hazardous waste generated)	Genetically enhanced microbe developed for one-step fermentation process, using vegetable oil as a feedstock and sugar as nutrient	• Up to 33% reduction in energy use • 25% to 33% reduction in CO2 emissions	• Greatly reduces hazardous waste generation and disposal
Personal Care 	Chemical ingredients such as propylene glycol and butylenes glycol from petroleum used as solvents to mix ingredients	Genetically enhanced microbe produces 1,3 propanediol from renewable feedstocks, which can function as a solvent, humectant, emollient or hand-feel modifier	• 20% reduction of greenhouse gas emissions compared to petroleum PDO	• High purity • Environmentally sustainable and renewable process • Non-irritating for sensitive skin • Enhanced clarity
Cosmetics 	Mineral oil and petroleum jelly from fossil sources used as ingredients	Metathesis chemistry applied to convert renewable vegetable oils to replacement ingredients	• Reduction of process temperatures • Low toxicity products and byproducts	• Smoother, less greasy feel • Semi-occlusive film former • Enhanced hair-care properties

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Detergent 	Phosphates added as a brightening and cleaning agent	Microbes or fungi genetically enhanced to produce biotech enzymes, which are added as brightening and cleaning agents • Protease enzymes remove protein stains • Lipases remove grease • Amylases remove starch	• Elimination of water pollution due to phosphates	• Brighter, cleaner clothes with lower wash temperature • Energy savings
Textiles 	New cotton textiles prepared with chlorine or chemical peroxide bleach	Use of biotech cellulose enzymes to produce peroxides • allows low-temperature bleaching of textiles, at 65°C, and • at a neutral pH range	• 25% reduction in greenhouse gases • 25% reduction in non-renewable energy use	New fabrics have • lower impact on the environment • better dyeing results • a permanent soft and bulky handle
Paper 	Wood chips are boiled in a harsh chemical solution to yield pulp for paper making	Wood bleaching enzymes produced by genetically enhanced microbes to selectively degrade lignin and to break down wood cell walls during pulping	• Reduces use of chlorine bleach and dioxins in the environment	• Cost savings from lower energy and chemical use
Diapers 	Woven fabric coverings made from petroleum-based polyesters	Bacillus microbe ferments corn sugar to lactic acid, which is heated to create a biodegradable polymer for woven fabrics	• 50 to 70 % reduction in CO2 emissions	• Biodegradable. • End of life options include composting, rather than landfills

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Carpet 	Nylon fibers made from petroleum in a chemical reaction	Genetically enhanced microbe produces 1,3 propanediol, which is a building block for other polymers such as Nylon	• 20% reduction of greenhouse gas emissions compared to petroleum PDO	Fibers have • durability, elasticity and softness • permanent stain and ultraviolet ray resistance
Furniture 	Polyurethane foam produced from petroleum	Polyols (such as Cargill's BiOH or Dow's Renuva) derived from soy and other renewable feedstocks are chemically mixed with other ingredients to create a flexible foam	• 60% reduction of non-renewable energy • 23% reduction in total energy demand	• Comparable quality and properties to polyurethane foam
Polyesters 	Polyester, a synthetic polymer fiber, produced chemically from petroleum feedstock	Bacillus microbe ferments corn sugar to lactic acid, which is heated to create a biodegradable polymer (such as NatureWorks' Ingeo)	• 75% reduction of CO2, compared to PET • 90% reduction of CO2 equivalent compared to Nylon 6	PLA polyester • is biodegradable • does not harbor body odor like other fibers • does not give off toxic smoke if burned
Stone Washed Jeans 	Open pit mining of pumice. Fabric washed with crushed pumice stone and/or acid	Fabric washed with biotech enzyme (cellulases) to fade and soften jeans or khakis	• Less mining • Reduced energy consumption	• Softer fabric • Lower cost

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Synthetic Rubber 	Isoprene used in synthetic rubber produced from petroleum	Genetically enhanced microorganisms ferment BioIsoprene™ from sugars derived from renewable resources. BioIsoprene™ polymerized to synthetic rubber and other elastomers	• Reduced use of petroleum	• High purity and low cost • Predictable raw material cost and availability
Biofuels 	Petroleum is cracked and distilled into gasoline and byproducts, some of which are flared into atmosphere	Novel enzymes convert starches and cellulose in biomass into sugars. Genetically enhanced microbes convert sugars to a growing range of alcohols and esters	• 16% to 128% fewer greenhouse gas emissions • Cleaner burning: 30% fewer tailpipe emissions of nitrogen oxides and carbon monoxide	• Reduced volatility in raw material cost and availability • The ethanol industry created 240,000 domestic jobs in 2008
Fuel Ethanol 	Acid hydrolysis of starch	Enzymatic hydrolysis of starch and cellulose	• Reduces use of chemicals and energy, toxic byproducts • Ethanol reduces tailpipe emissions of benzene, a known carcinogen	• Lower fuel prices: Without ethanol, gas prices would increase 14.6% in the short term and 3.7% long term
Plastic Films 	Polyethylene made from natural gas liquids	Chemical building blocks fermented from sugar. Heat processing and mixing converts ethanol to a polyethylene	• 80% reduced use of fossil energy • Plastics can be fully biodegradable or recyclable	• Comparable quality and properties to petroleum-based polyethylene

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Food Serviceware 	Polystyrene products based on petroleum	Bacillus microbe ferments corn sugar to lactic acid, which is heated to create a biodegradable polymer (such as NatureWorks' Ingeo)	• 62% reduction in GHG emissions • 51 % reduction in non-renewable energy usage	• Compostable serviceware eliminates contamination of food waste with petro-based plastics
Beverage Packaging 	Polyester, a synthetic polymer fiber, produced chemically from petroleum feedstock	Bacillus microbe ferments corn sugar to lactic acid, which is heated to create a biodegradable polymer (such as NatureWorks' Ingeo)	• 59% reduction in GHG emissions • 47 % reduction in non-renewable energy usage	• Enables feedstock recovery (versus typical 'downcycling' that occurs with existing PET-based bottles)
Food Packaging 	Polypropylene made from petroleum	Bacillus microbe ferments corn sugar to lactic acid, which is heated to create a biodegradable polymer (such as NatureWorks' Ingeo)	• reduced use of fossil energy • Promotes long-term alternatives to litter problems	• Comparable quality and properties to petroleum-based polypropylene
Plastic Containers 	Plastics (olefins and styrenics) used for eating utensils, beverage and food containers, and personal care products made from petroleum	Naturally occurring microbial process genetically enhanced to produce polyhydroxyalkanoates (PHAs, such as Telles' Mirel). PHAs can also be grown in genetically engineered switchgrass plants	• 200% reduction in greenhouse gases • Reduces use of petroleum • Biodegradable and compostable	• Heat resistant • Compatible with production machinery, so no increased cost