

Biological Catalysis

A gateway to Industrial Biotechnology

Commercial Opportunities from Biological Catalysis

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Reasons to use Biological Catalysis

“Green” Chemistry
Chiral Intermediates
Avoid Protecting Groups
Environmental advantages

- Cost reduction
- Competitive advantage
- Process development
- Impurity elimination
- Reduce heavy metal use
- Cleaner effluent streams
- Shorter manufacturing routes
- Renewable resources
- Natural labelling
- Low temperature
- Low energy
- Neutral reaction conditions
- Selectivity in complex structures
-

Limitations to use of Biological Catalysis

Access to the technology

No-one has all the answers

No-one has all the ideas

Limited only by your imagination

Commercial examples

Real examples used to make, or save, money.

Difficult Chemistry

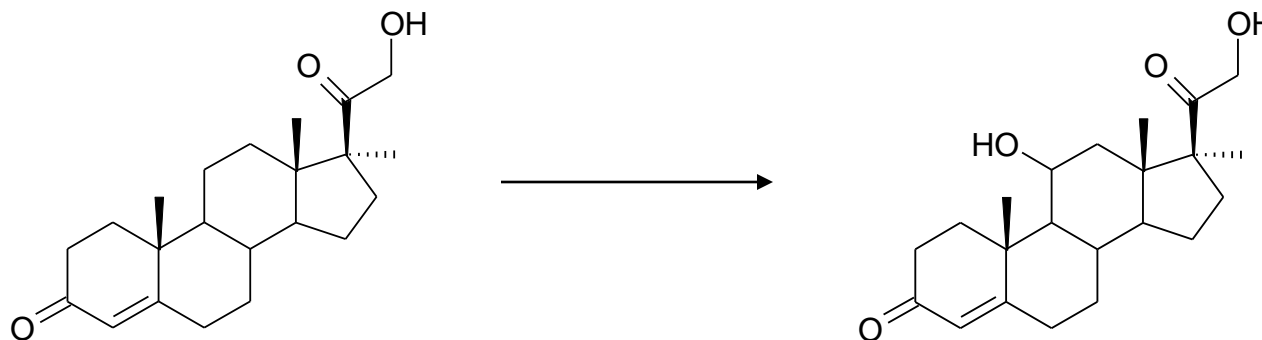
Steroids

1948

Curvularia lunata

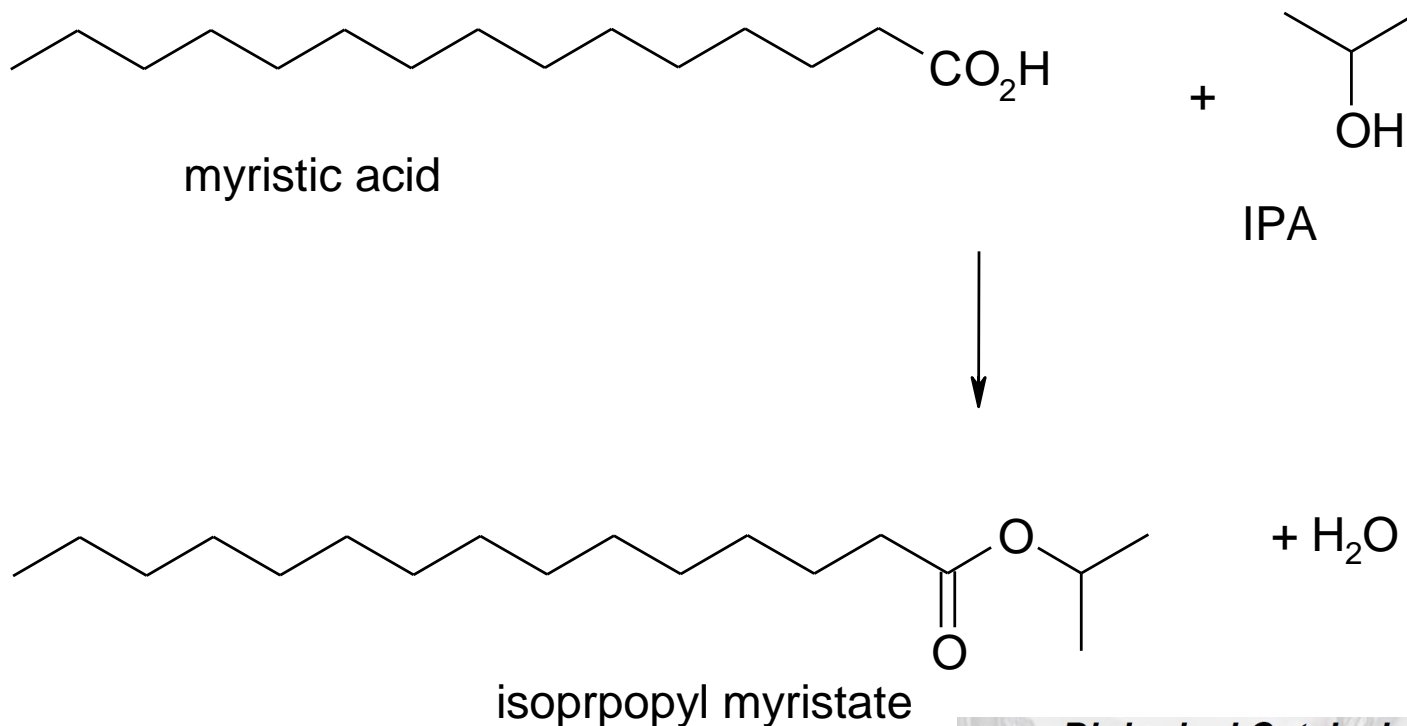
Hydrocortisone

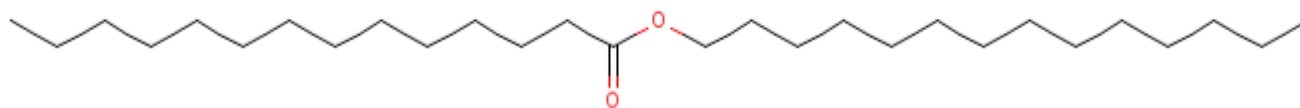
Many similar transformations



Simple Chemistry

e.g. **Cosmetic esters**





Myristyl myristate

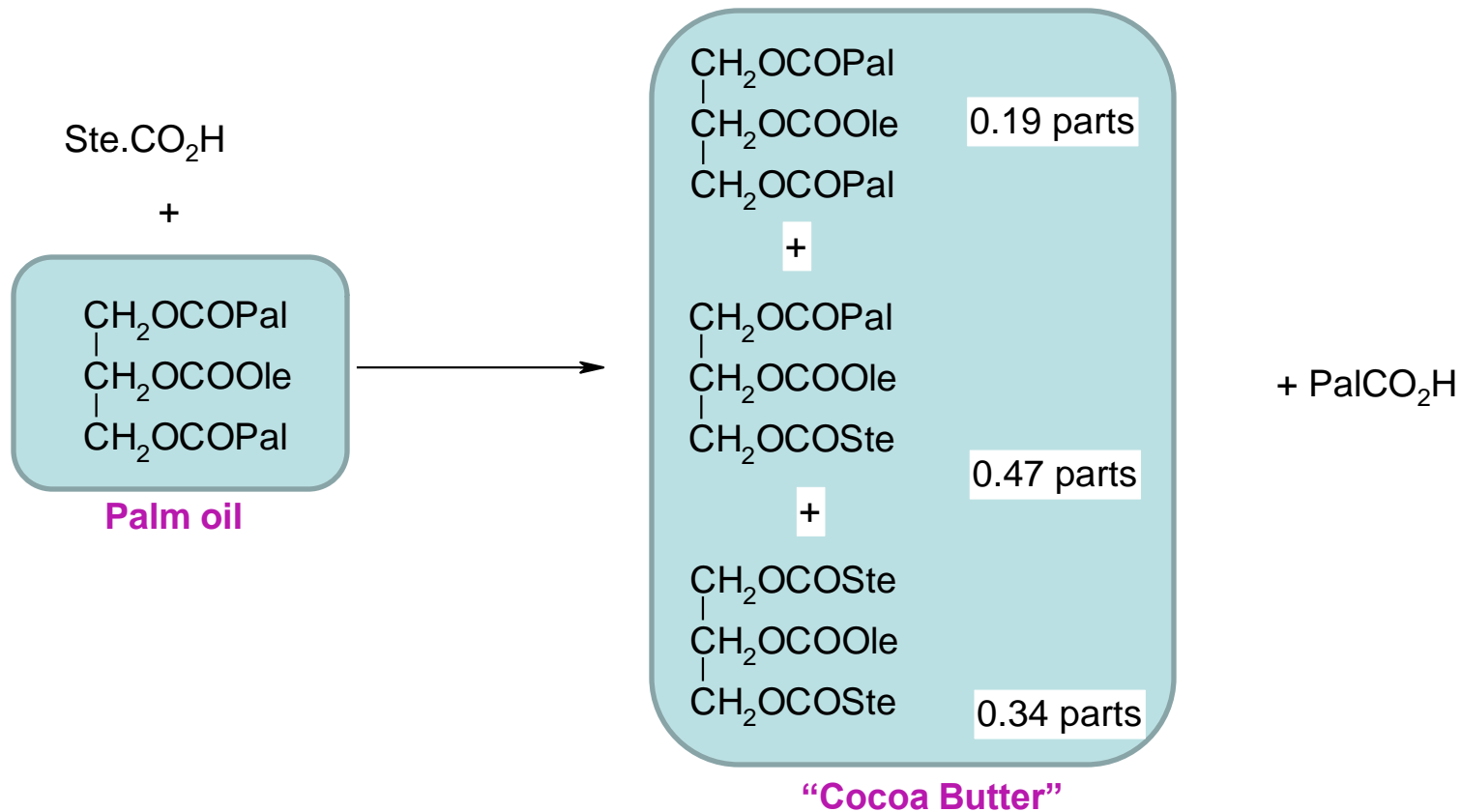
- Energy consumption reduced by 60%
- Emission of pollutants reduced by 60-90%
- Emission of greenhouse gases reduced by 62%

Chemical process: 5 purification steps: temp: up to 240°C

Biocatalytic process: 0 purification steps: temp: up to 60°C

Simple, but Specific, Chemistry

Cocoa Butter



Simpler Chemistry

Flurbiprofen

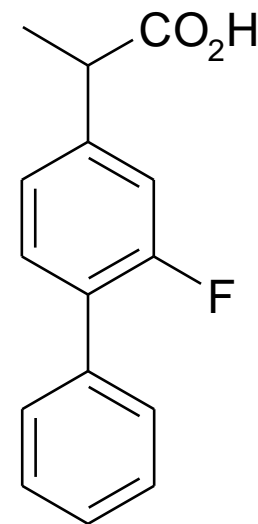
Non-steroidal anti-inflammatory agent
marketed as a racemate

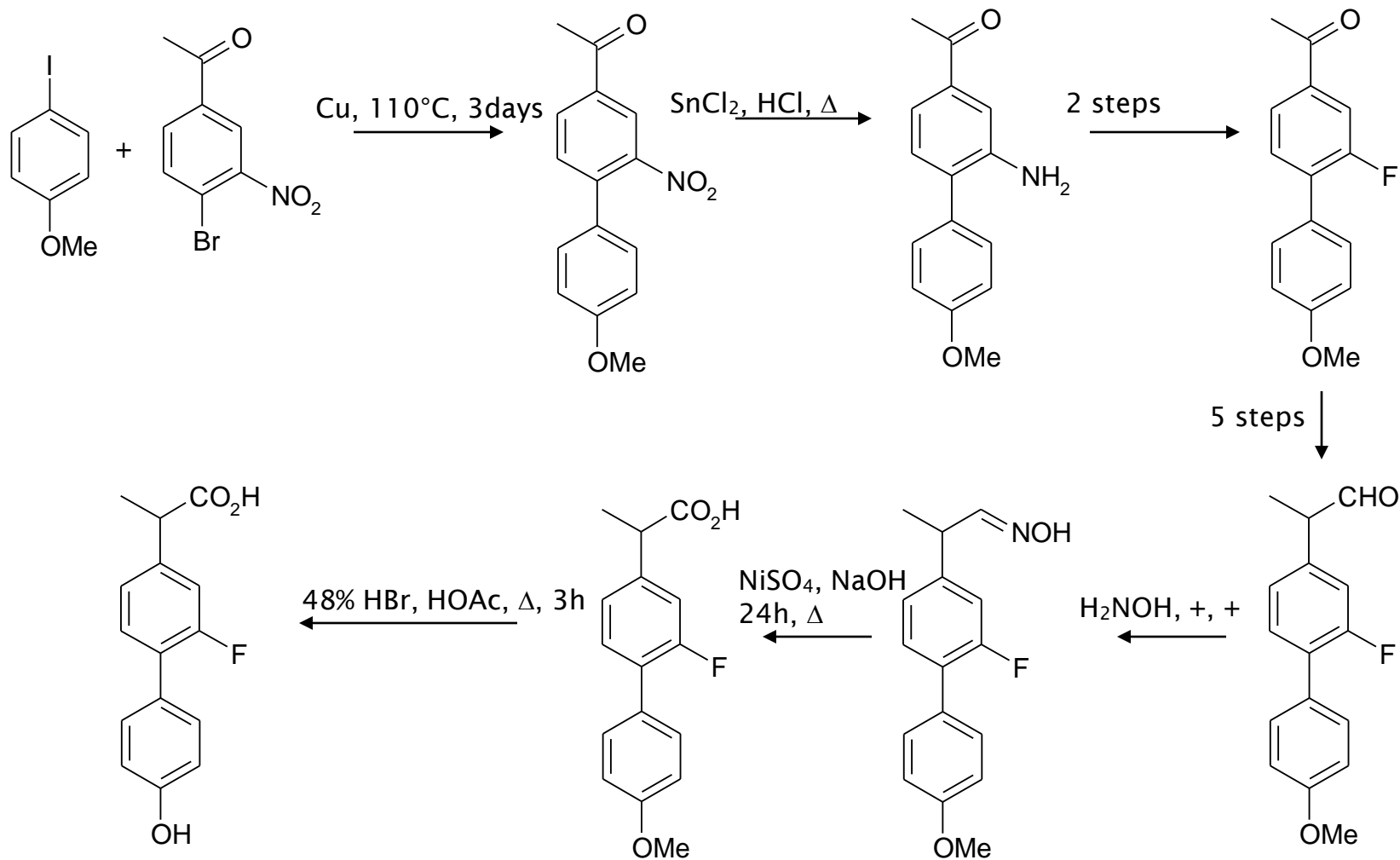
Mono-hydroxylated analogue required
has prostaglandin inhibitory activity

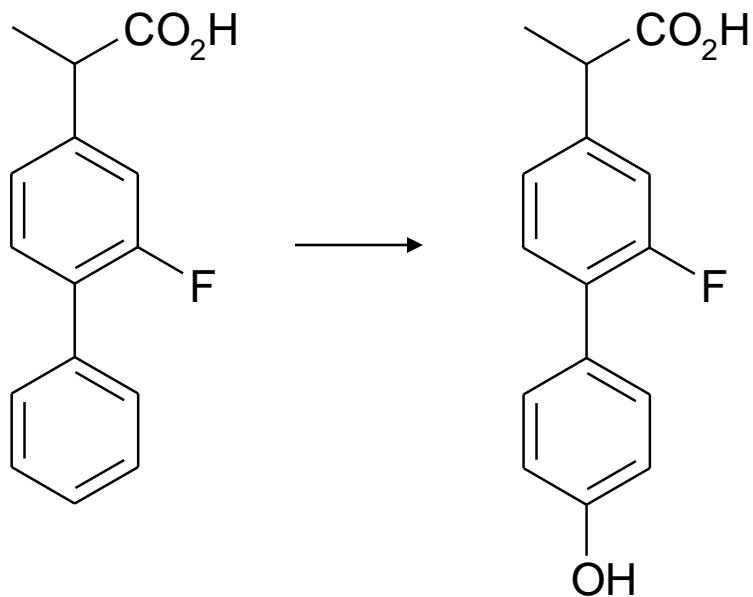
Alternative synthesis

Complex

6 chemical stages from 4-iodoanisole







Cunninghamella echinulata sp.

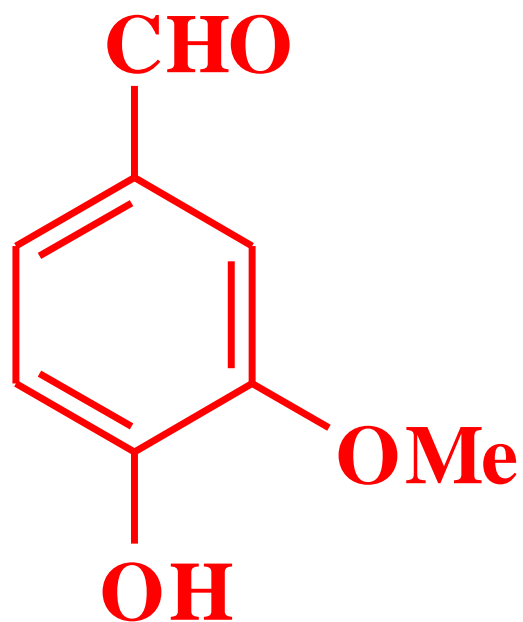
>97% solution yield

Hundred grams made at ~2 g/l

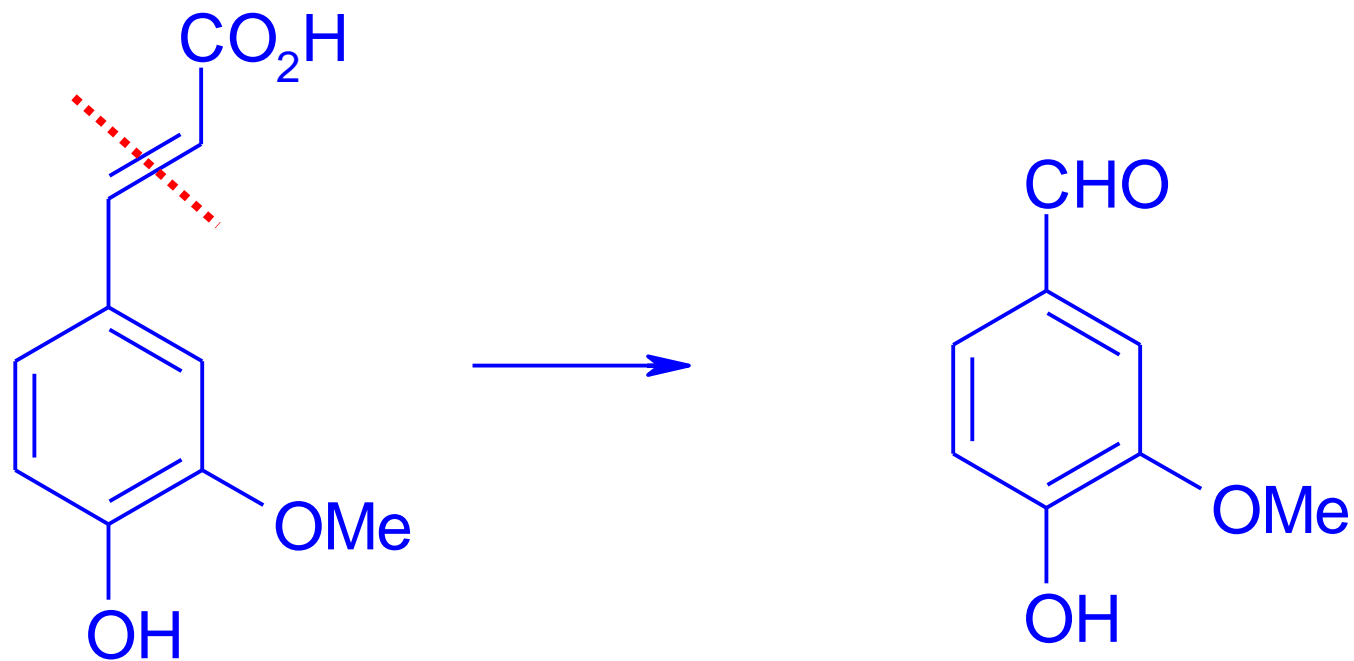
Natural Chemistry

Vanillin

2% w/w in vanilla beans
0.2% w/w in vanilla extract



Natural Vanillin



Cleaner Cheaper Chemistry

Lotrifiban; GSK

Replacement of palladium catalyst, used at 70°C, in organic solvent, in a high pressure hydrogenation.

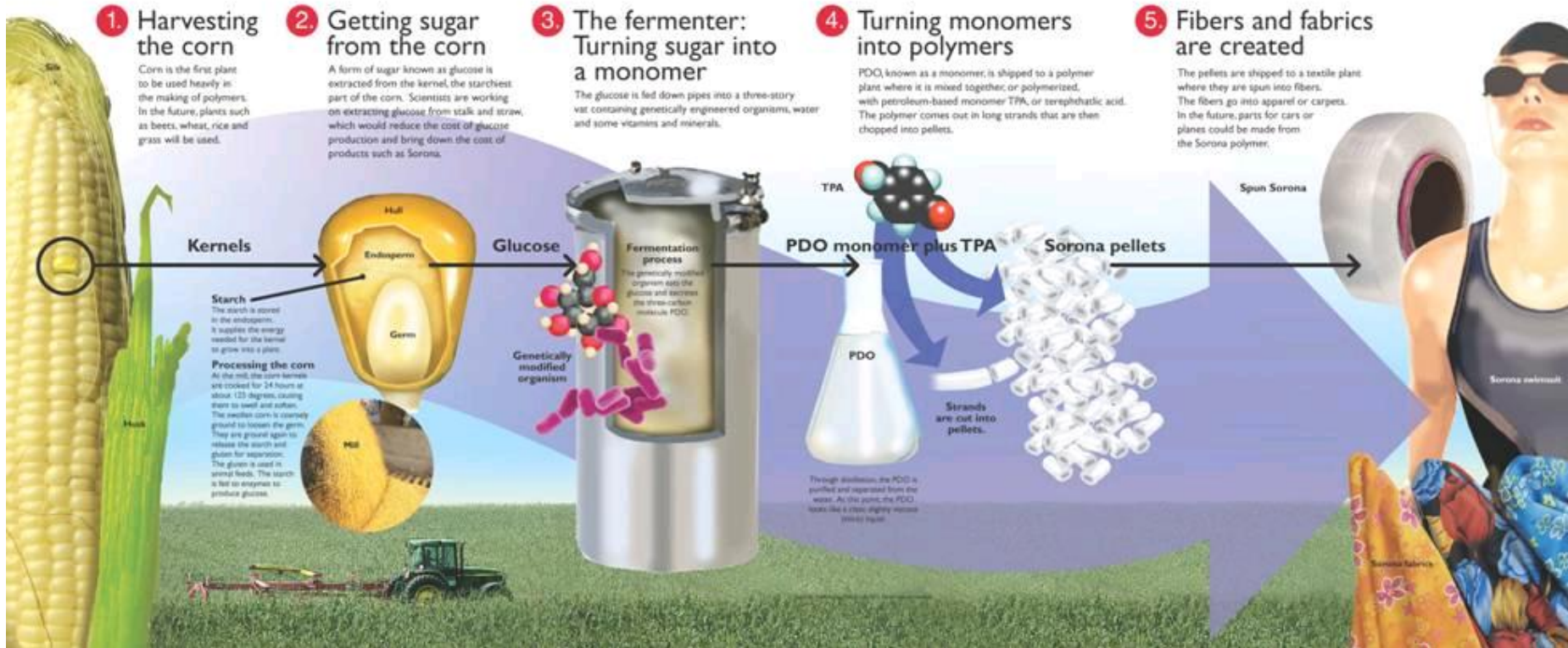
- Increased yield
- Reduced environmental impact
- Replacement of hazardous operations
- Reduced cost
- Reduced reactor time

On a manufacturing scale, in a year around 3 tonnes of palladium catalyst could be replaced with 150 kg of resin immobilised enzyme.

1,3-propanediol

From corn to polymers and fibers

DuPont™ Sorona® is made from naturally occurring starch in the kernels of corn. In the next five years, researchers plan to find ways to use starch from the entire plant.



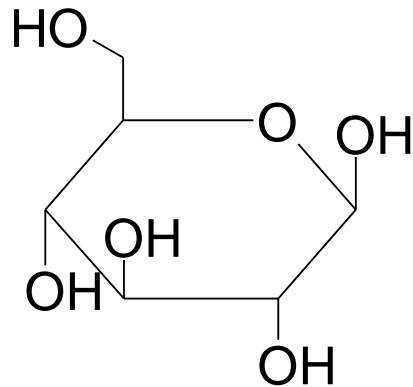
Tyres from Biomass Bio-Isoprene

- Genencor, a Division of Danisco, has developed technology for manufacturing isoprene from sugar cane, corn, corn cobs, switchgrass or other biomass.
- From 2015 all Goodyear tyres will be manufactured from this bio-isoprene
- Manufacturing a conventional tyre requires seven gallons of petroleum feedstock per tyre. Using Biolsoprene will reduce that down to then close to zero

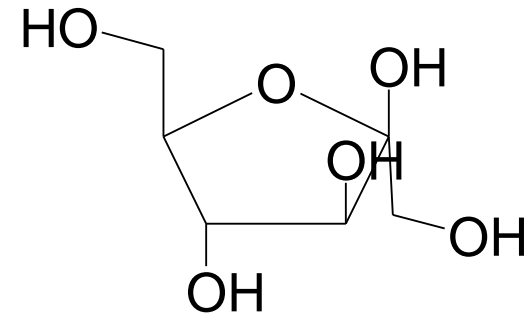


Isomer Chemistry

Glucose Isomerase



glucose



fructose

- high fructose corn syrup
- sweetener for soft drinks
- immobilised enzyme reaction
- 15,000,000 tons a year

Future Direction?

biorefineries & platform chemicals
biopolymers
health and nutrition; fatty acids
cosmeceuticals
surfactants
enzyme activities from novel sources
marine
more oxidoreductase reactions

and more.....

Biological Catalysis

Access to the technology

UK is a good place to do IB

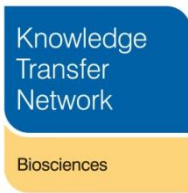
No-one has all the answers

IB SIG

No-one has all the ideas

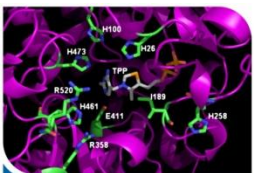
Dr Han Bevinakatti

Limited only by your imagination



Technology Strategy Board

Driving Innovation



Biological Resources for the Production of Materials, Chemicals and Energy