The cyanobacterium Synechocystis as a biological platform for production of petroleum substitutes using sunlight and CO_2

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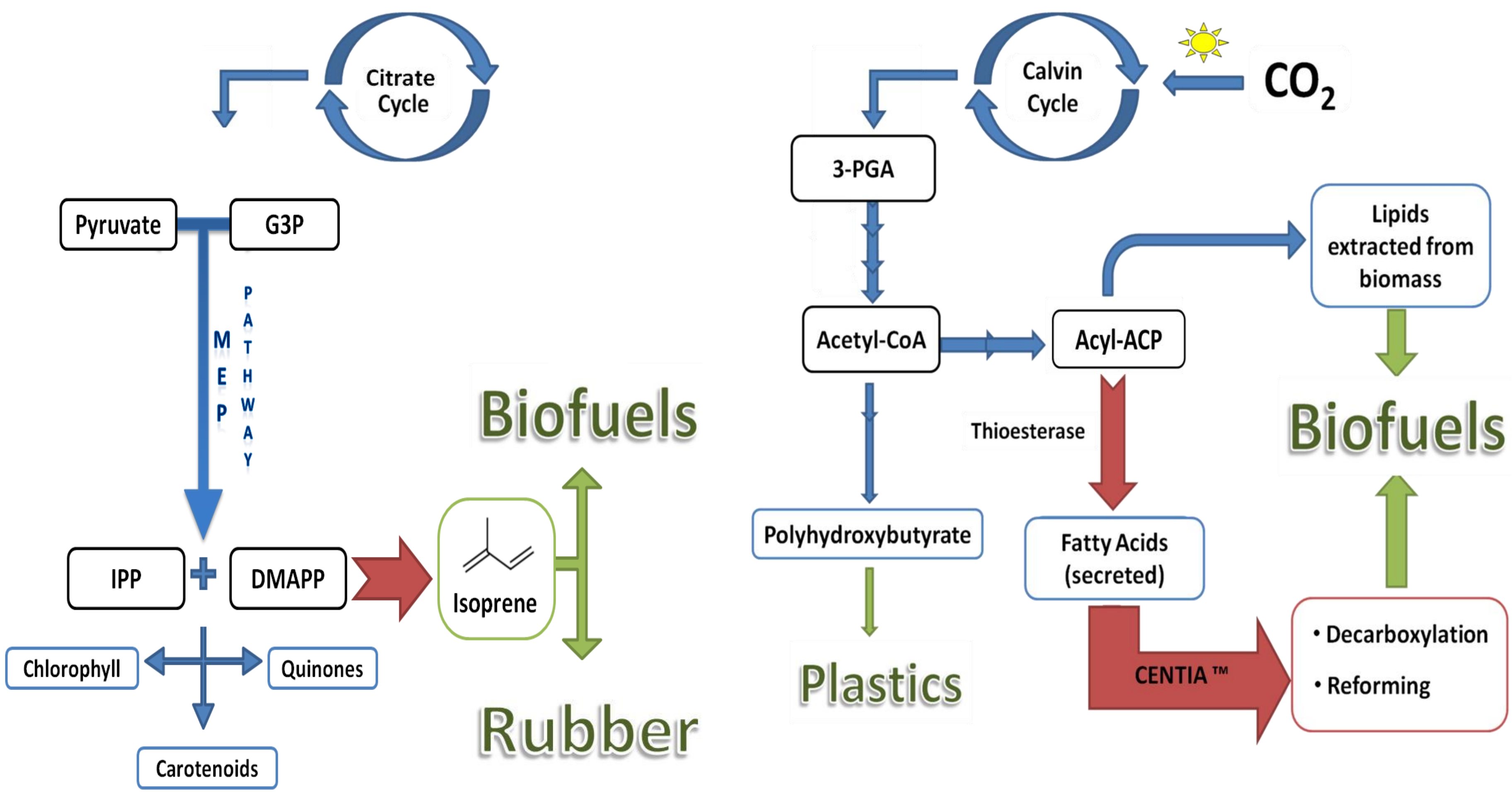
Background

- The US (and the world) face a climate and energy crisis
- US administration committed to a 17% reduction from 2005 levels by 2020
- First generation biofuels are not sustainable
  - “Food vs fuel” debate
- **Solar energy is the sole large-scale energy source that can eventually take the place of fossil fuels**

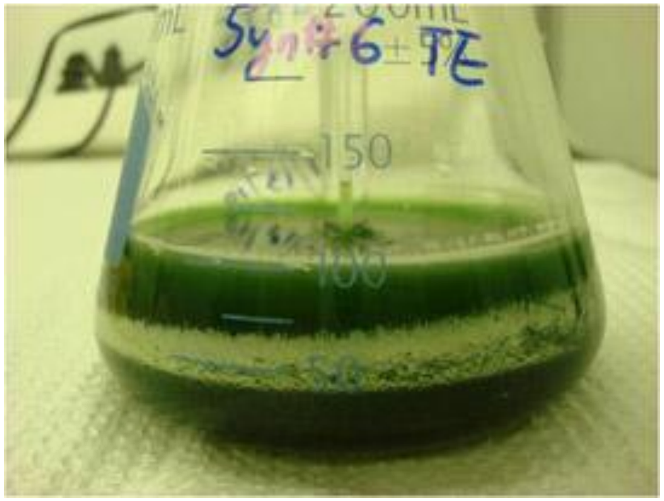
Synechocystis: A promising biotech platform

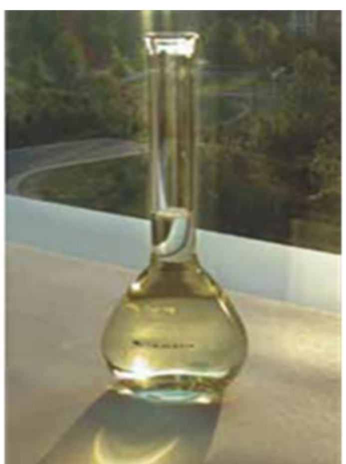
- Can use CO_2 as its sole carbon source and can grow in fresh and ocean water
- Does not compete for arable land (grown in bioreactors)
- High growth rates
- Genome is sequenced and its easily tranformable

Strategy: engineering to divert carbon from existing metabolic pathways



Optimum approach: Secretion vs disruption (Fatty acids)





- *Synechocystis* has been transformed with a heterologous thioesterase to produce and secrete fatty acids (laurate).
- We have achieved daily production rates of 100-200 μM laurate by:
  - Increasing the metabolic flux towards fatty acid synthesis
  - Deleted genes for reutilization of fatty acids
- Fatty acids can be chemically converted by the Centia™ process (developed at North Carolina State University) to biogasoline and jet fuel

Optimum approach: Secretion vs disruption (isoprene)

- *Synechocystis* has been transformed with a synthetic isoprene synthase based on poplar

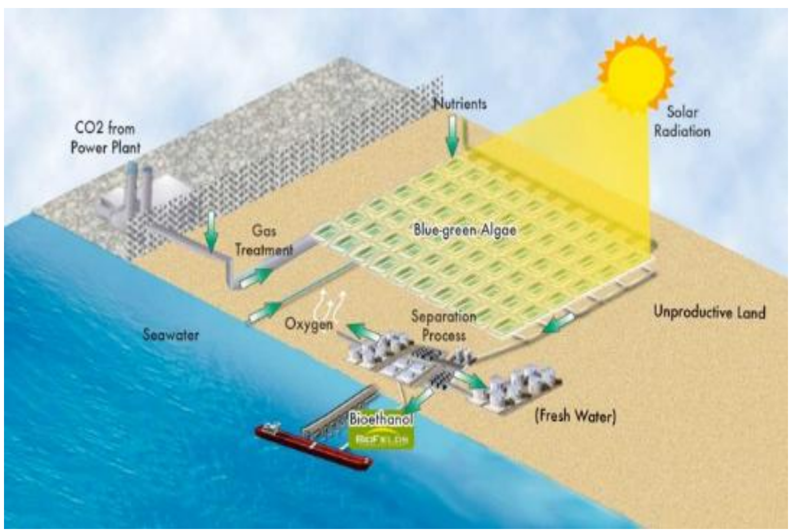
- Athough rates not comparable to laurate, we have achieved daily production rates of 10-15 μM isoprene

- Strategy for improving rates:
  - Modification of MET pathway by overexpressing its genes; this pathway produces precursors for isoprene and other important pigments
  - In situ extraction/recovery/concentration

SCALE-UP

COMMERCIAL FEASIBILITY

GOOD IMPACT ON ENVIRONMENT/SOCIETY



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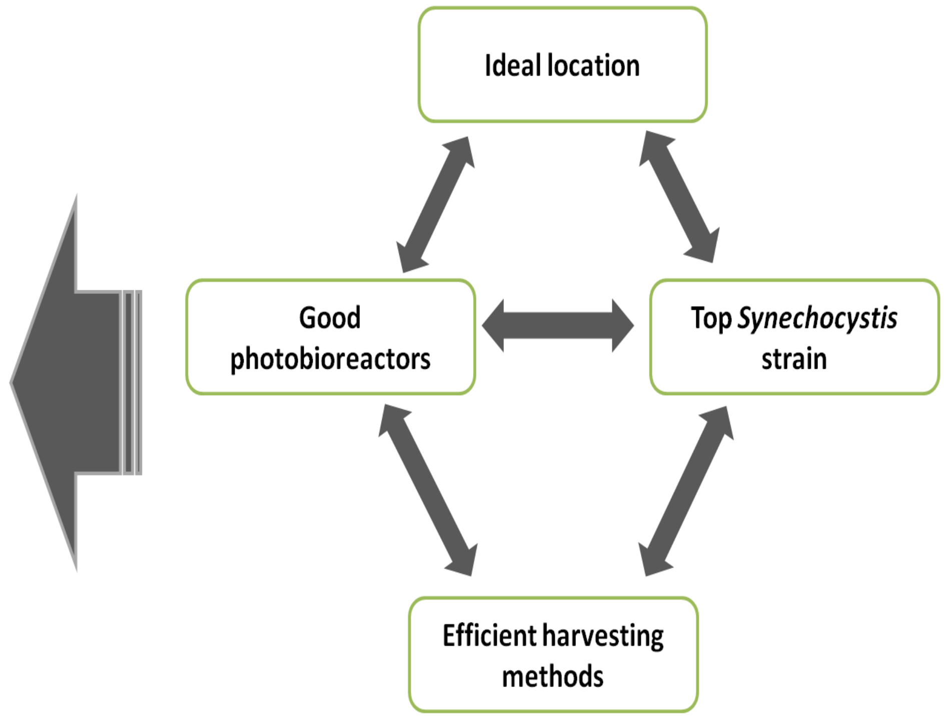

Acknowledgements

arpa·e

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