



ADVANCED BIOFUEL PRODUCTION WITH ENERGY SYSTEM INTEGRATION

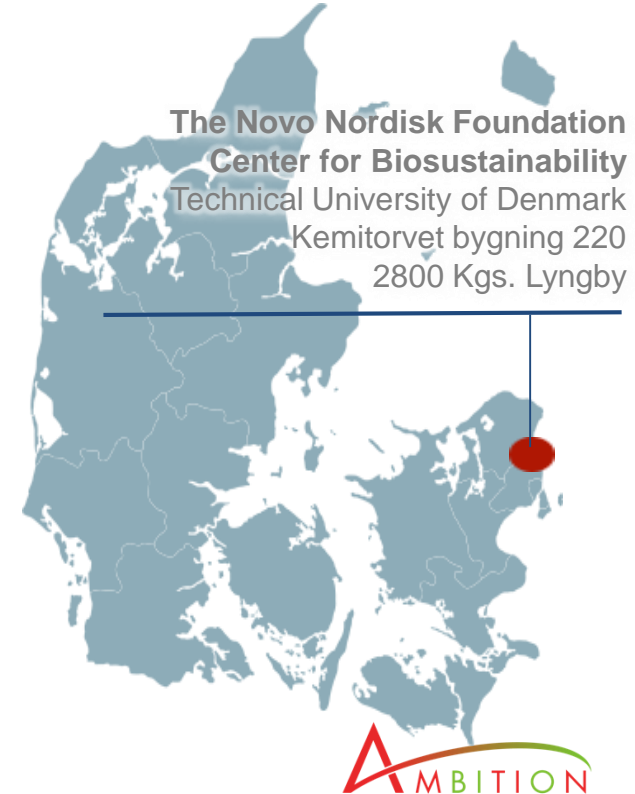
Syngas fermentation -biochemical challenges and opportunities

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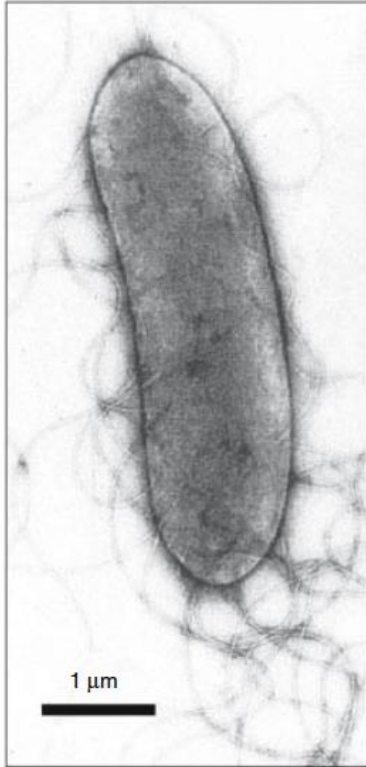


The Novo Nordisk Foundation
Center for Biosustainability
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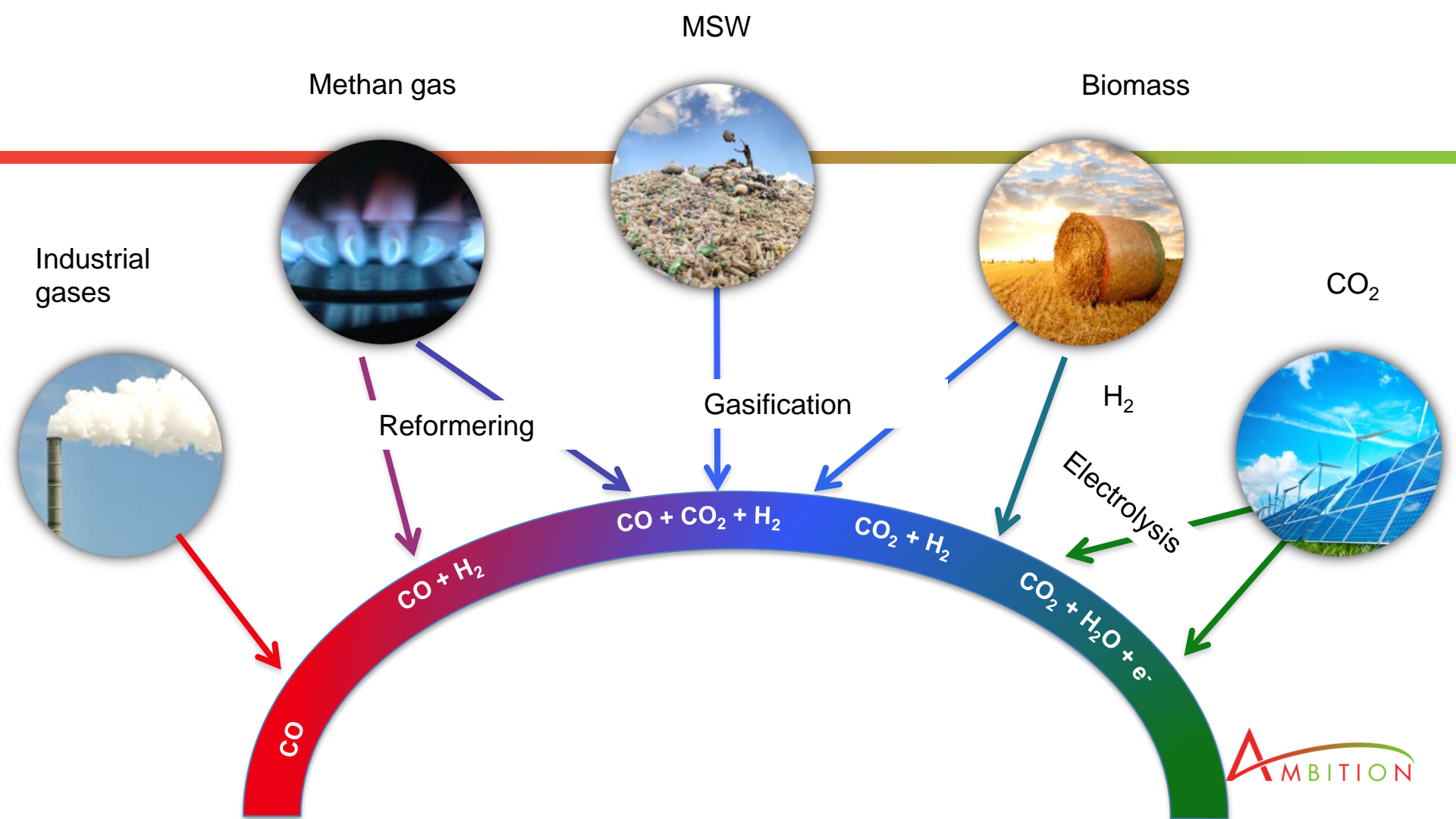




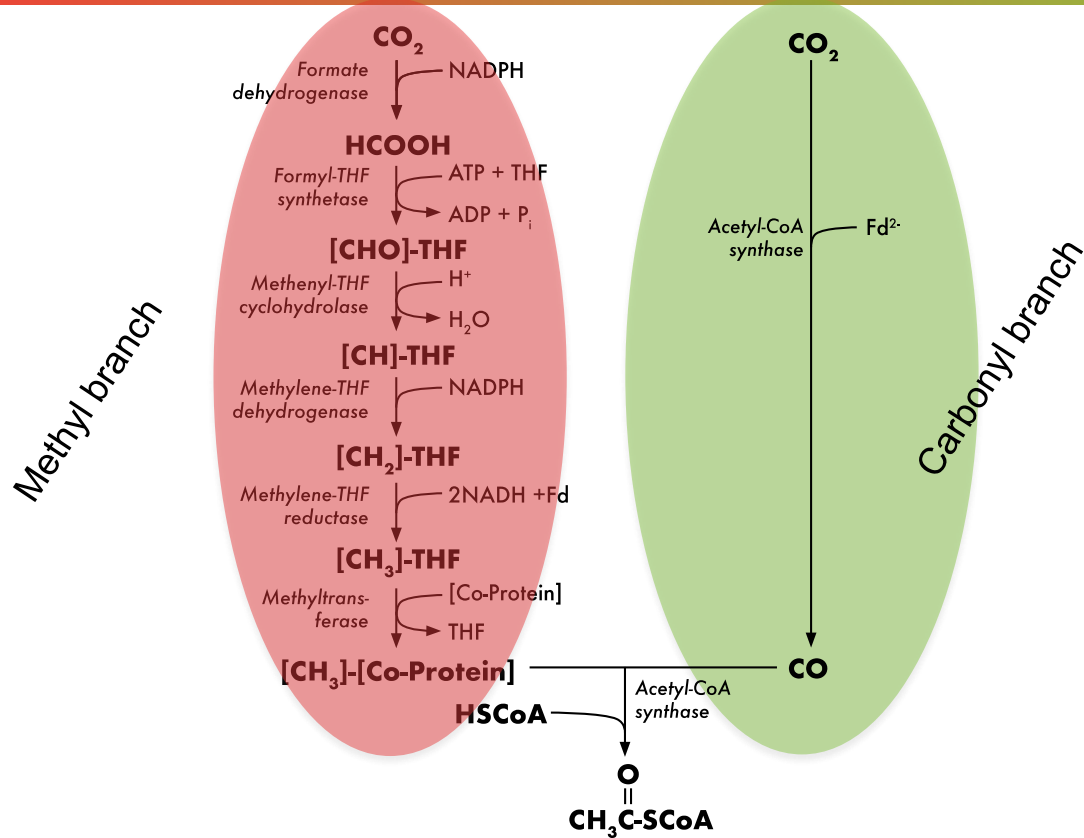
Historical highlights

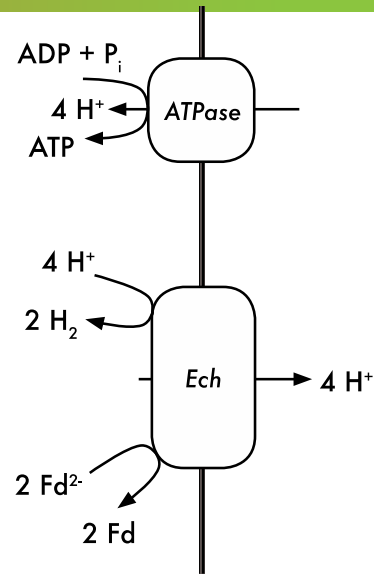
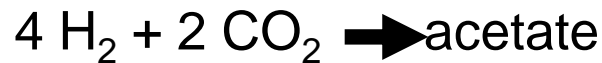
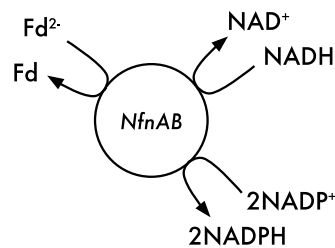
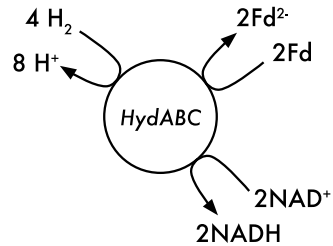
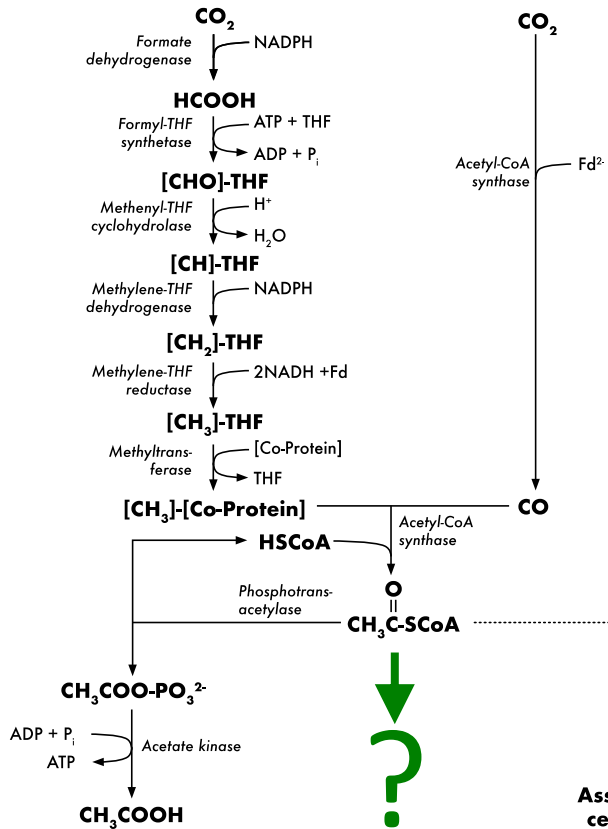


- 4000 mil Origin of life
- 1932 Acetogenesis reported in $H_2 + CO_2 \rightarrow$ acetate
- 1936 First organisms isolated
- 1938 First organisms lost
- 1942 Isolation of an thermophilic acetogen
3 acetate from 1 glucose
- 1945-52 Acetate from $^{14}CO_2$ or $^{13}CO_2$
- 2004 - Demonstration and commercialization
(Lanzatech, Coskata, INEOS Bio)

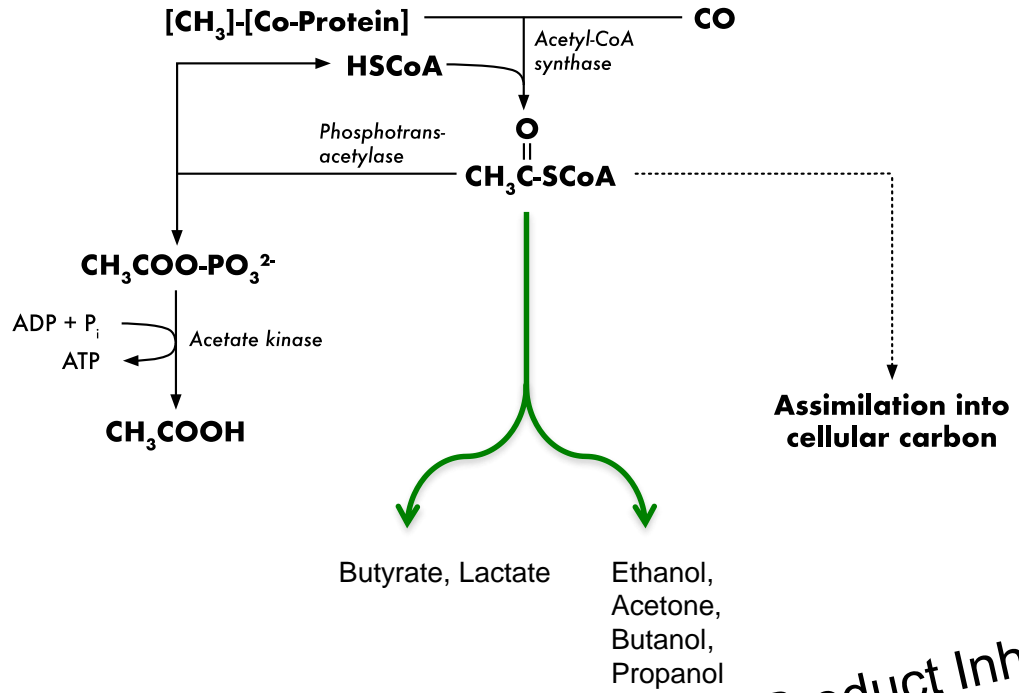


Wood-Ljungdahl Pathway

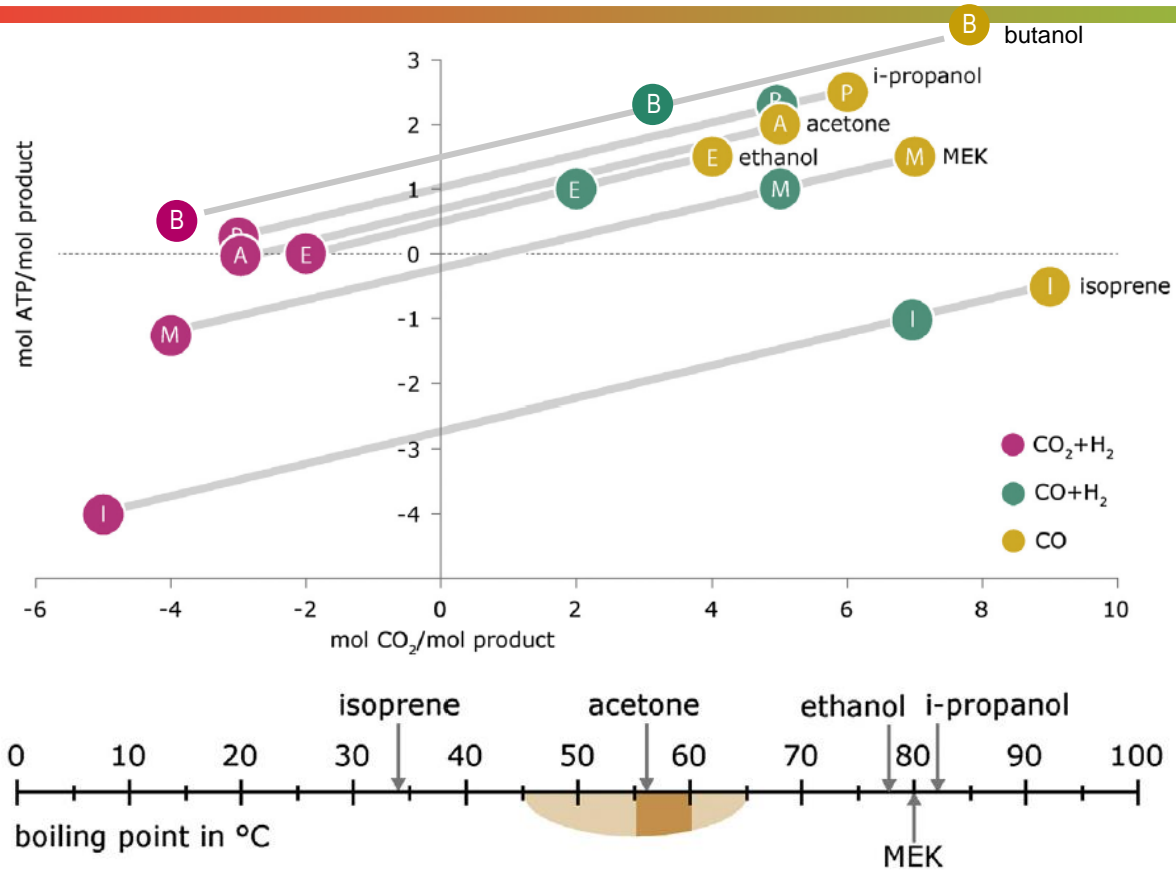




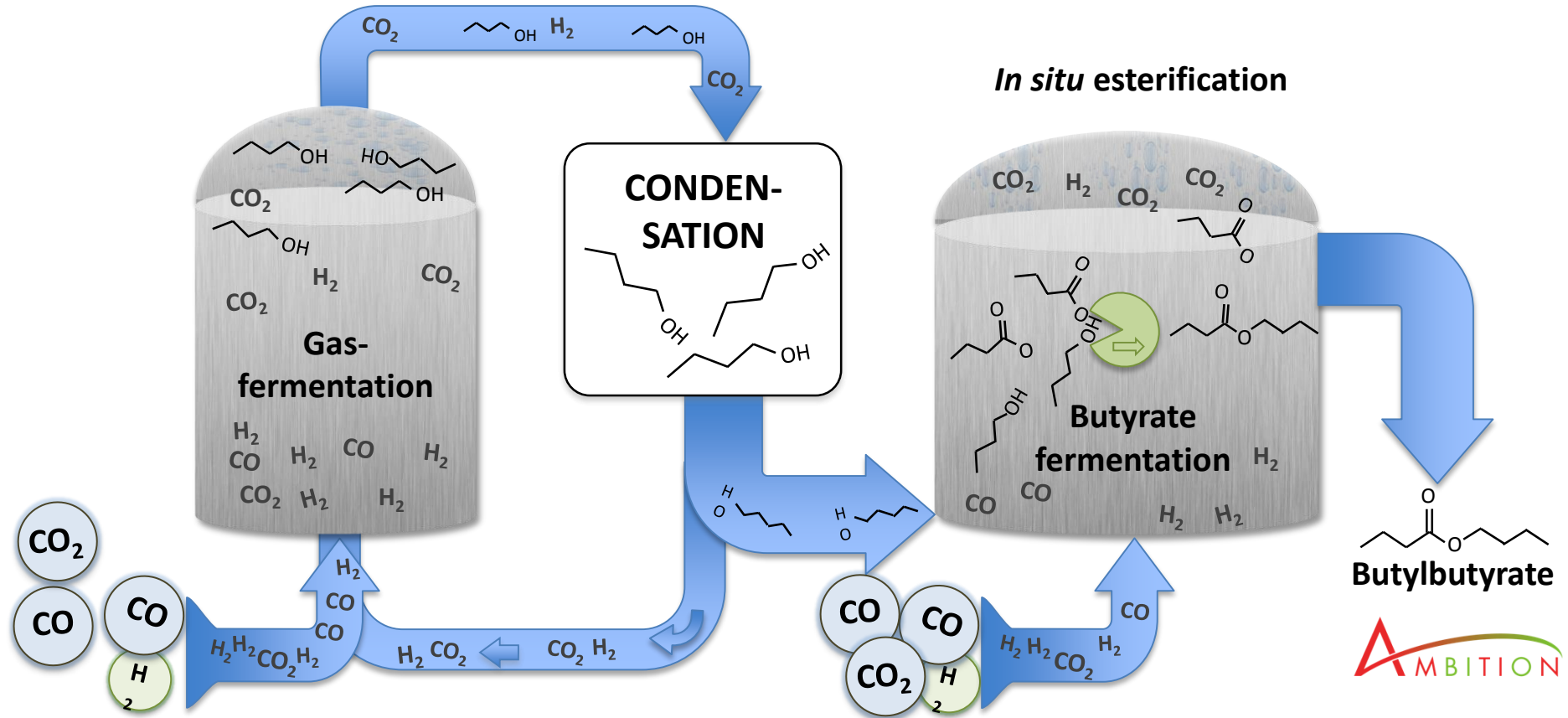
+ 0.5 ATP



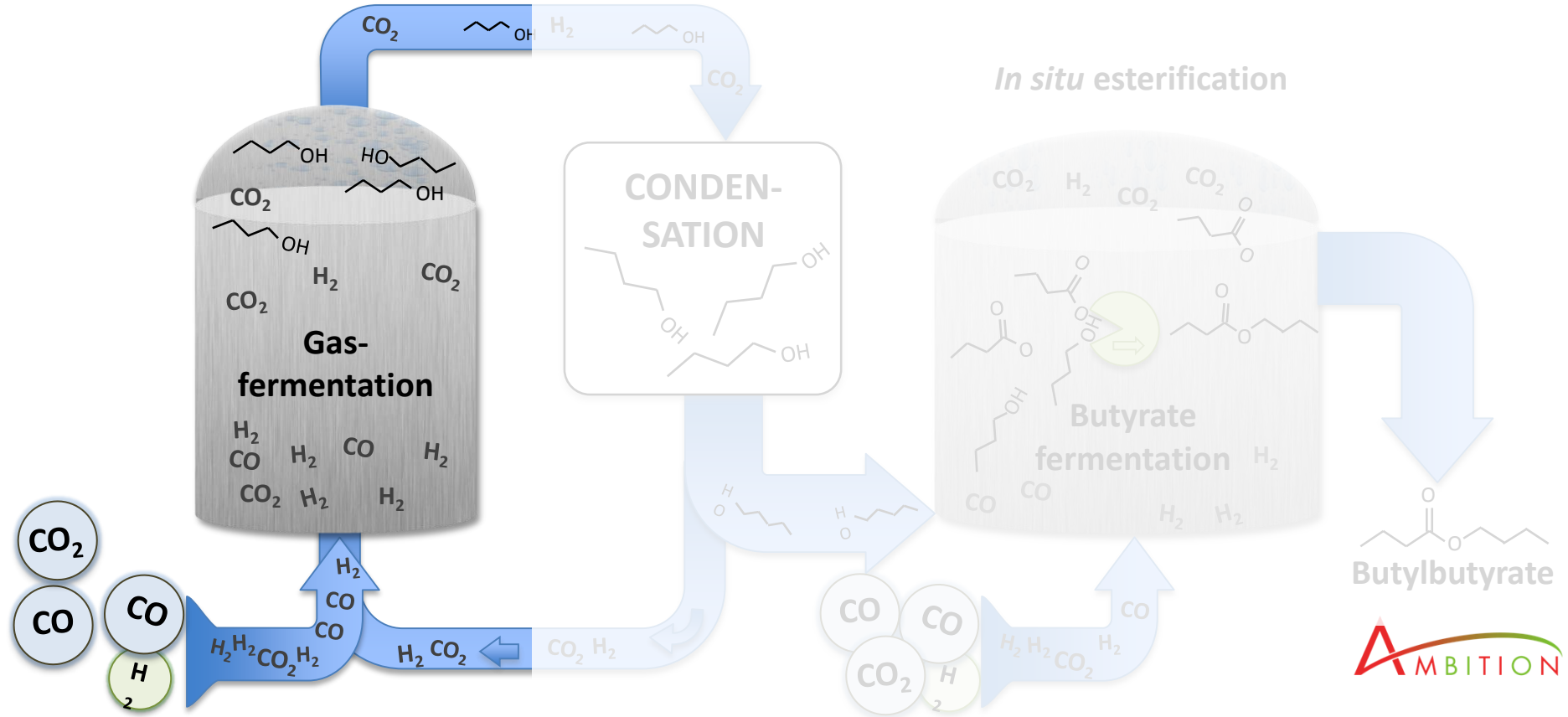
Product Inhibition

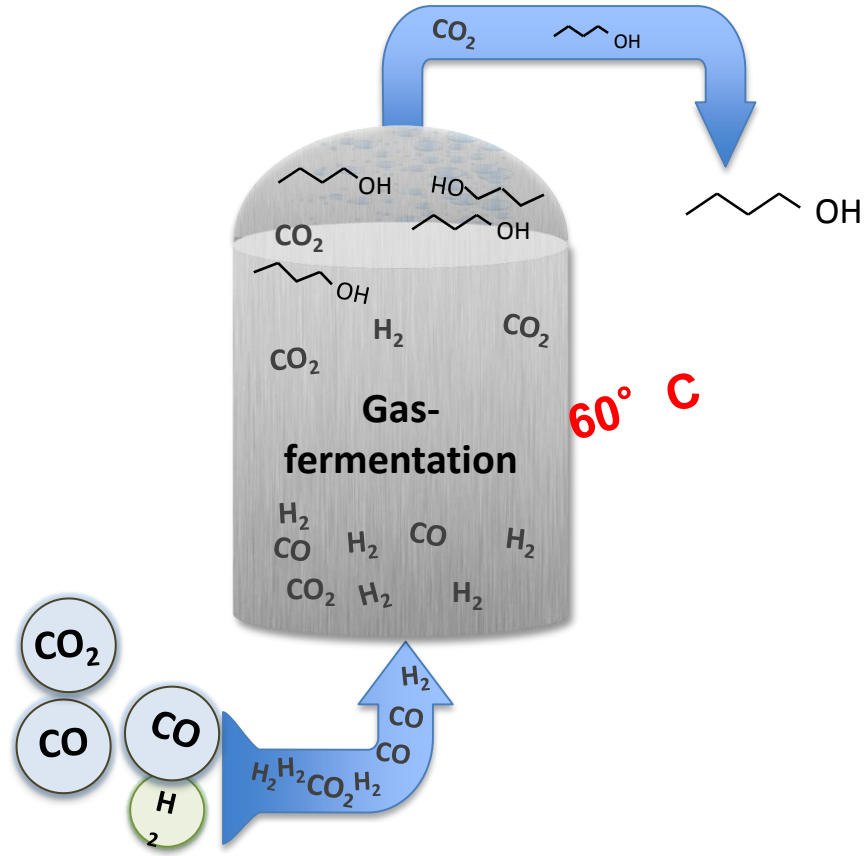


Biological gas conversion



Biological gas conversion





Identifying thermophilic acetogen

Characterizing the strain

Optimizing growth (media, conditions etc.)

Establishing genetic tools

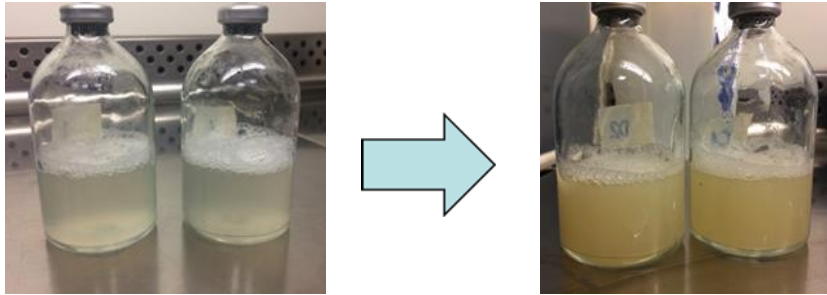
Finding genes responsible for production of butanol

Characterizing the proteins (thermostability)

Integrating the pathway into the selected strain

Cultivation optimization

Cultivation optimization of *M thermoacetica* resulted increased growth and postponed sporulation.



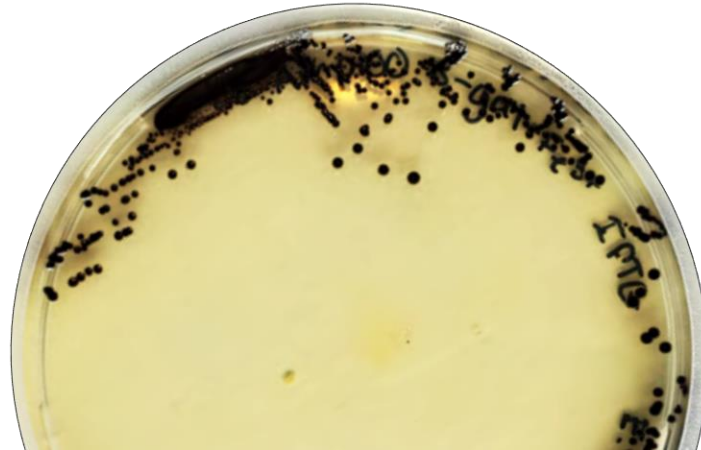
4x increase in OD and 3x increase in acetate concentration

Tool development

Genetic reporter system

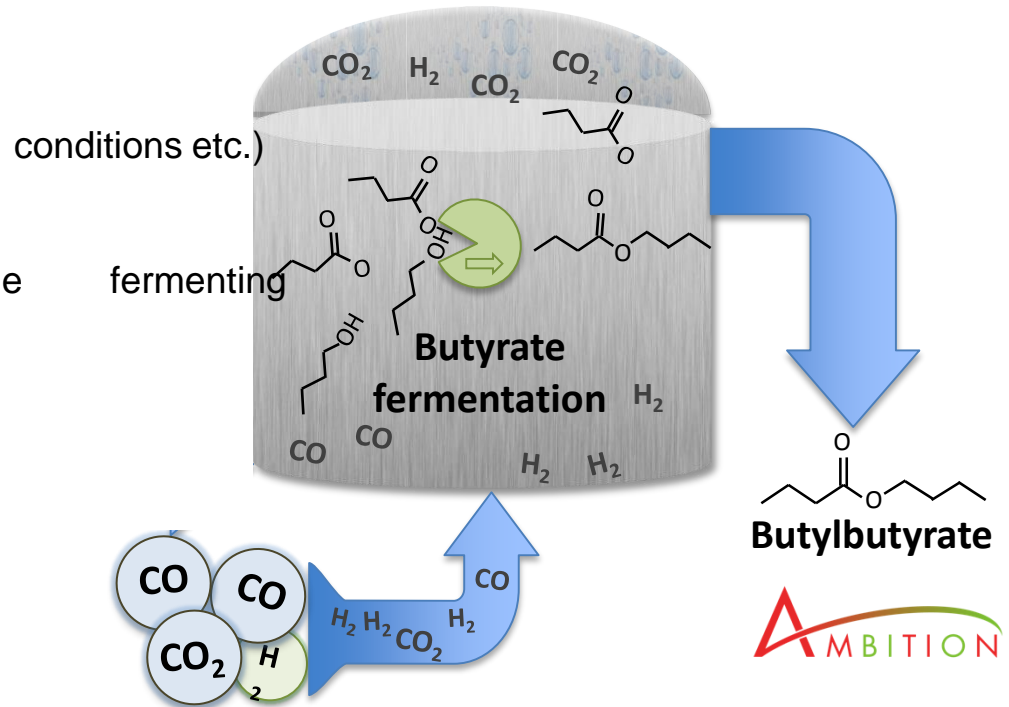
Anaerobe/aerobic marker system was developed. It is working at temperatures from 37-60° C in a broad range of organisms.

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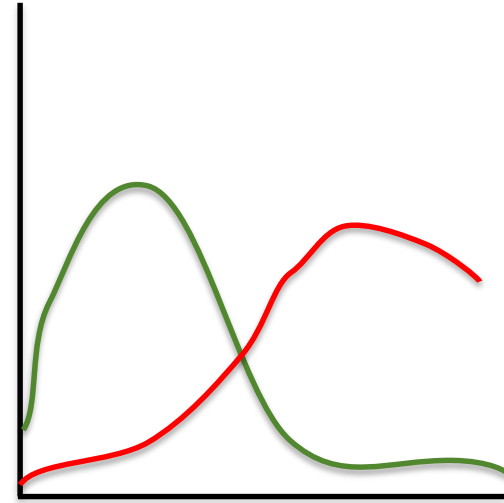
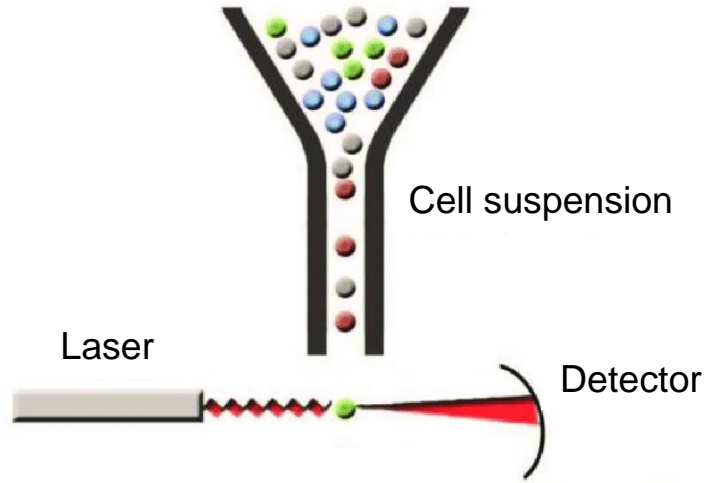


- Identifying butyrate producing acetogens
- Characterize and benchmark the strains
- Optimizing growth and productivity (media, conditions etc.)
- on gases
- Assess different gas compositions effect on the organism
- Assess new esterases
- Optimize enzymatic esterification

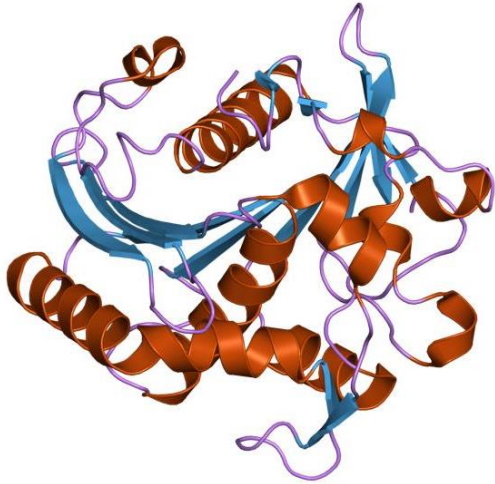
In situ esterification



Assess the influence of inhibitors on the fermenting organisms



Esterification



Develop methods for measuring the production

Screen different lipases

Optimize enzymatic esterification

Perform the esterification in the fermentation broth, *in situ*

Evaluate the detoxifying effect

Future challenges

Adaption of strains

Expressing the butanol pathway in the thermophilic host

Process integration

Scale up



Acknowledgement



novo nordisk fonden

Thanks for your attention