Systems Biology Program
National Centre of Biotechnology (CNB-CSIC)
Madrid, Spain

The impact of Synthetic Biology in Microbial Biotechnology

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Jornadas Bioeconomía Argentina
Innovación y desarrollo para un futuro sostenible

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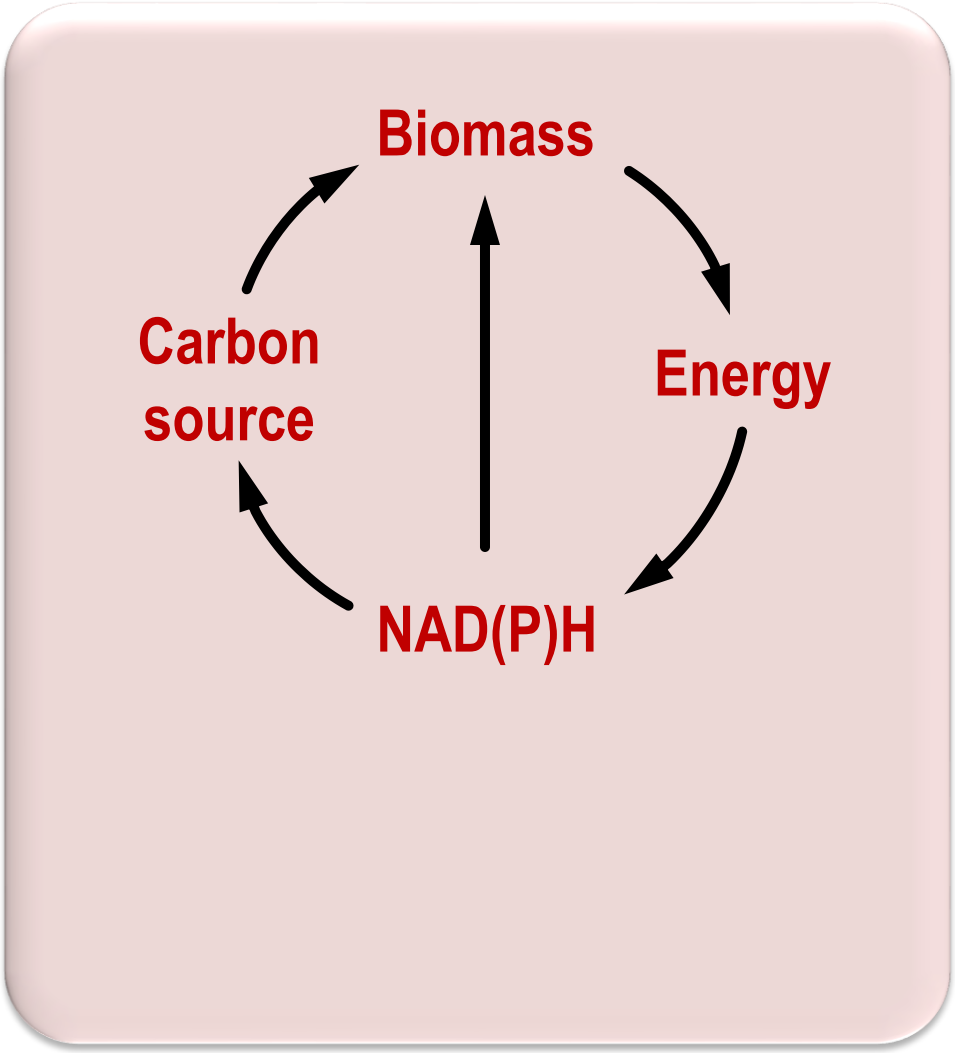
Microbial Biotechnology

Biomass (*inoculants, single cell protein*)
Polyhydroxyalkanoates
Single cell oil
Amino acids
Rhamnolipids
Citrate
Pigments

Biofuels (*ethanol, butanol, 2,3-butanediol,* H_2, CH_4)
1,2-Propanediol
1,3-Propanediol
Triacylgycerols
Succinate
Propionate
Specialty chemicals

A textbook vision of microbial metabolism



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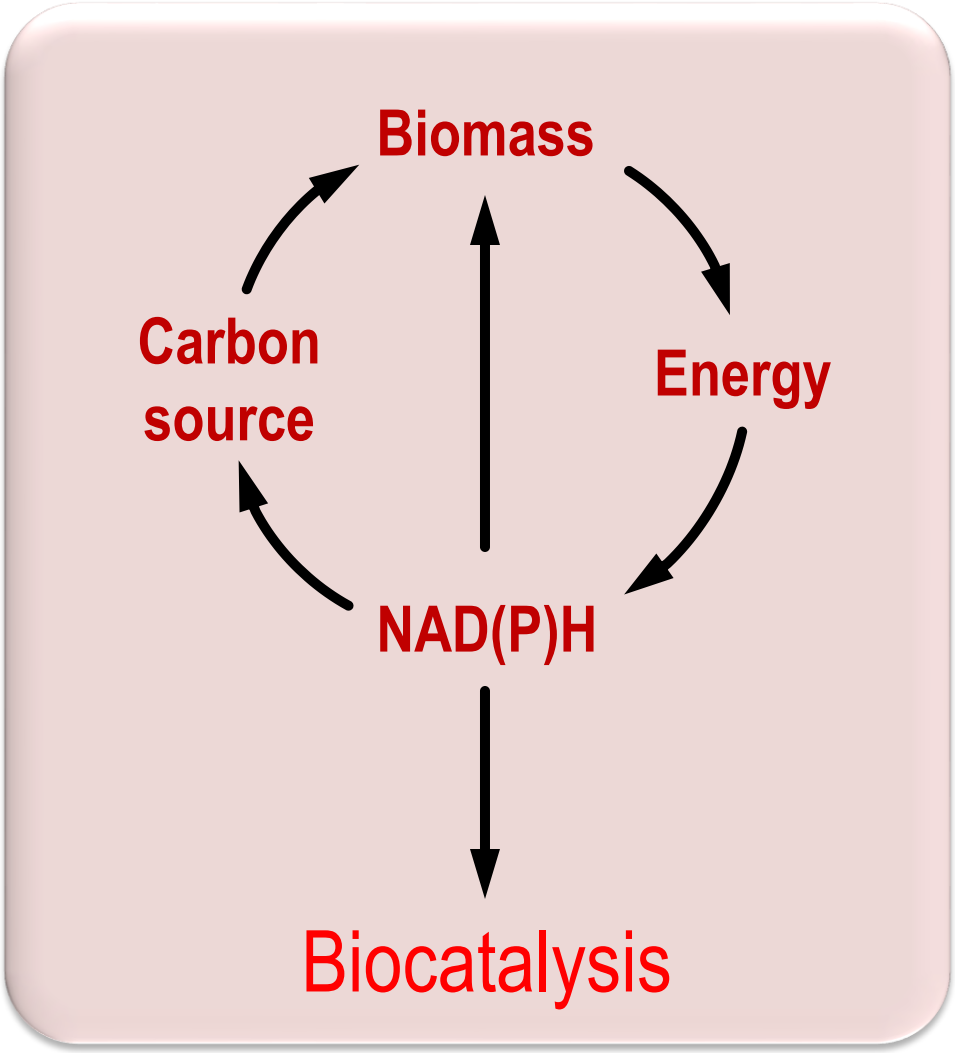
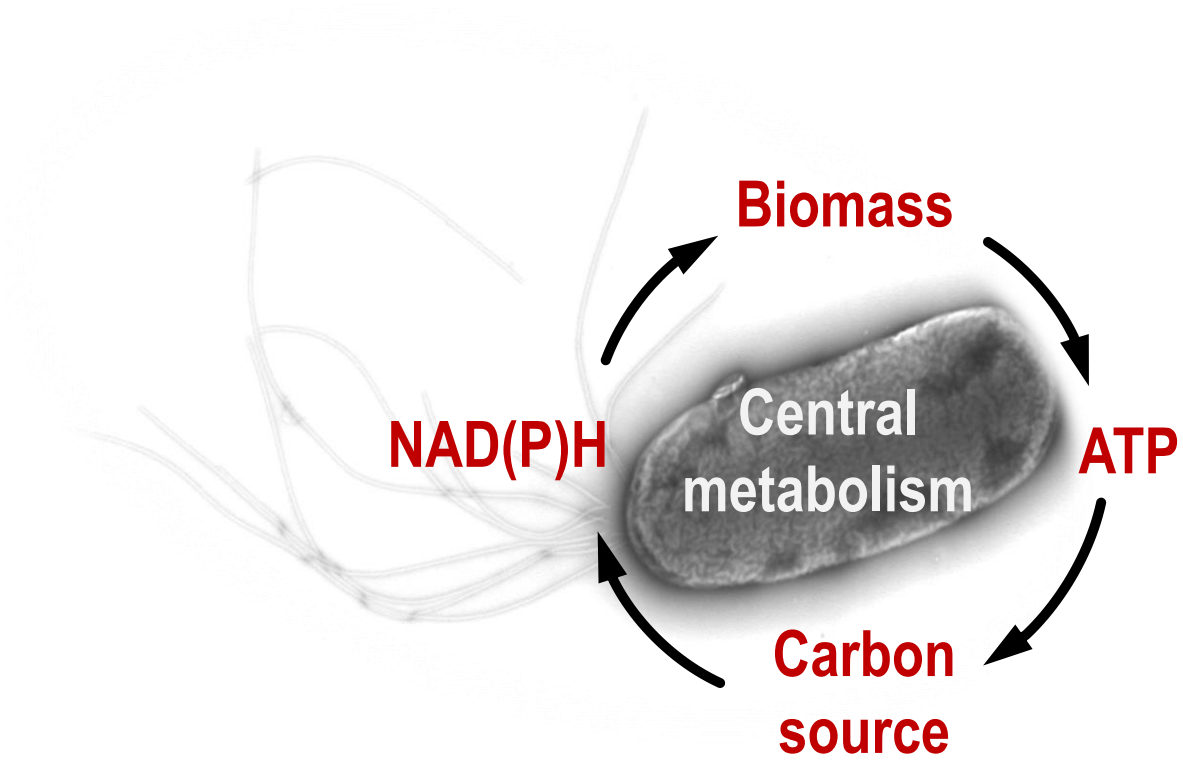
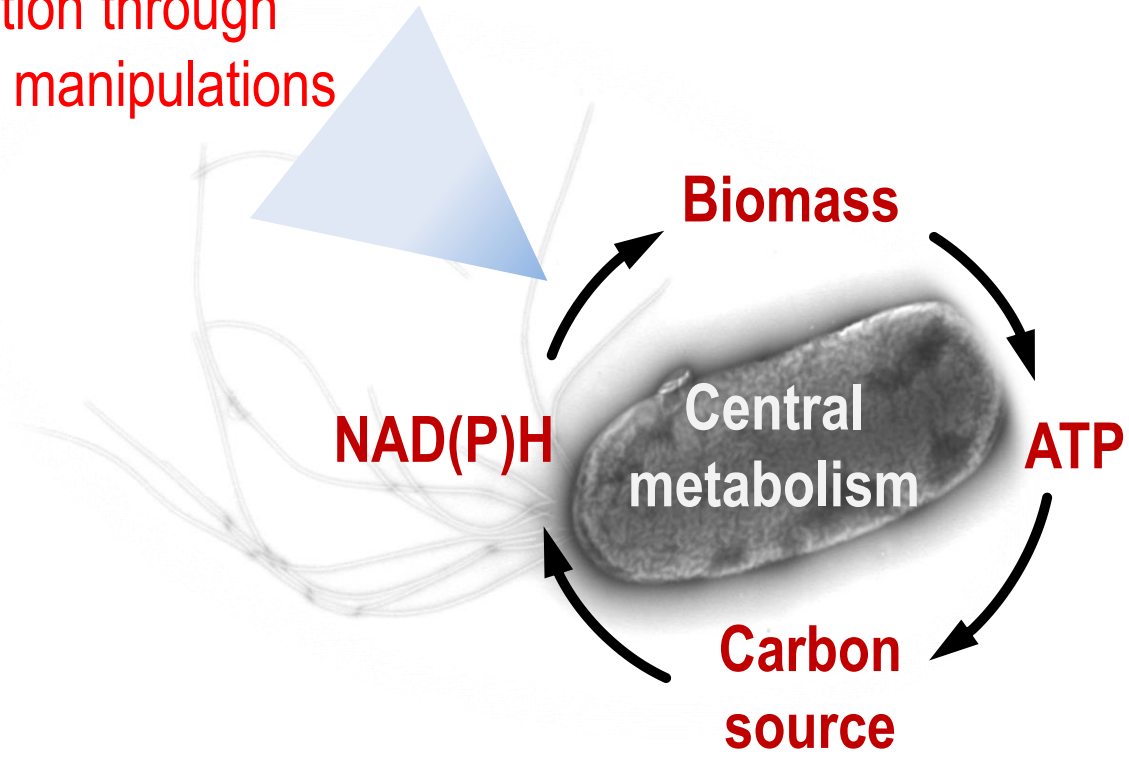


The promise of Genetic Engineering



The promise of Genetic Engineering

Rational modification through genetic engineering manipulations



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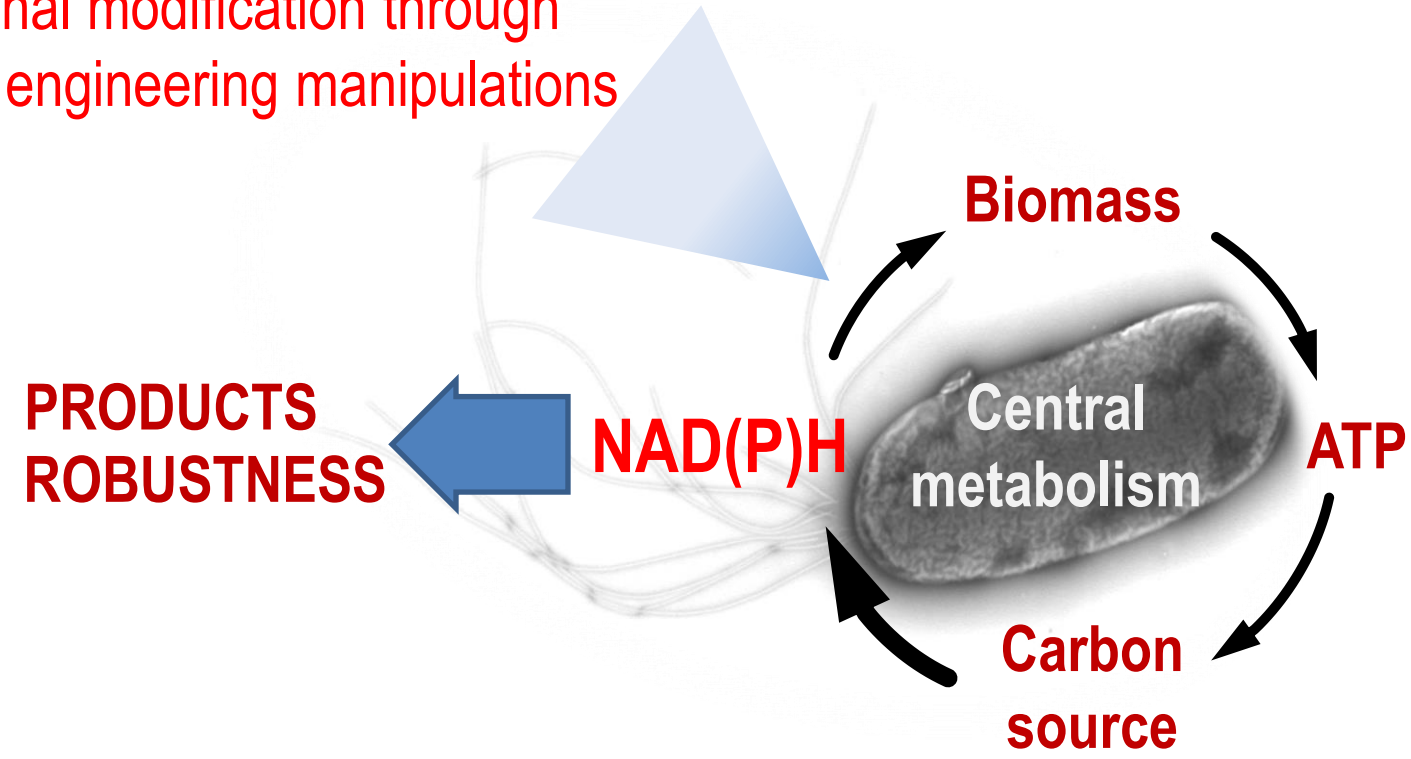


The Holy Grail of Genetic Engineering

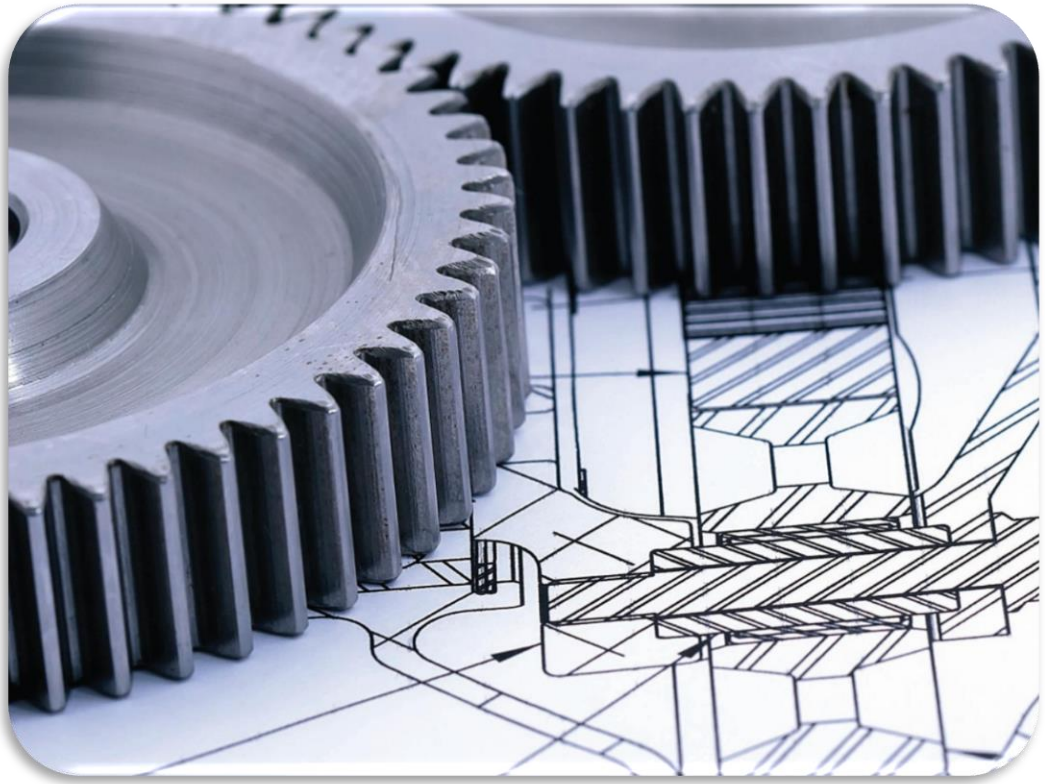
Rational modification through
genetic engineerin

PRODUC
ROBUST

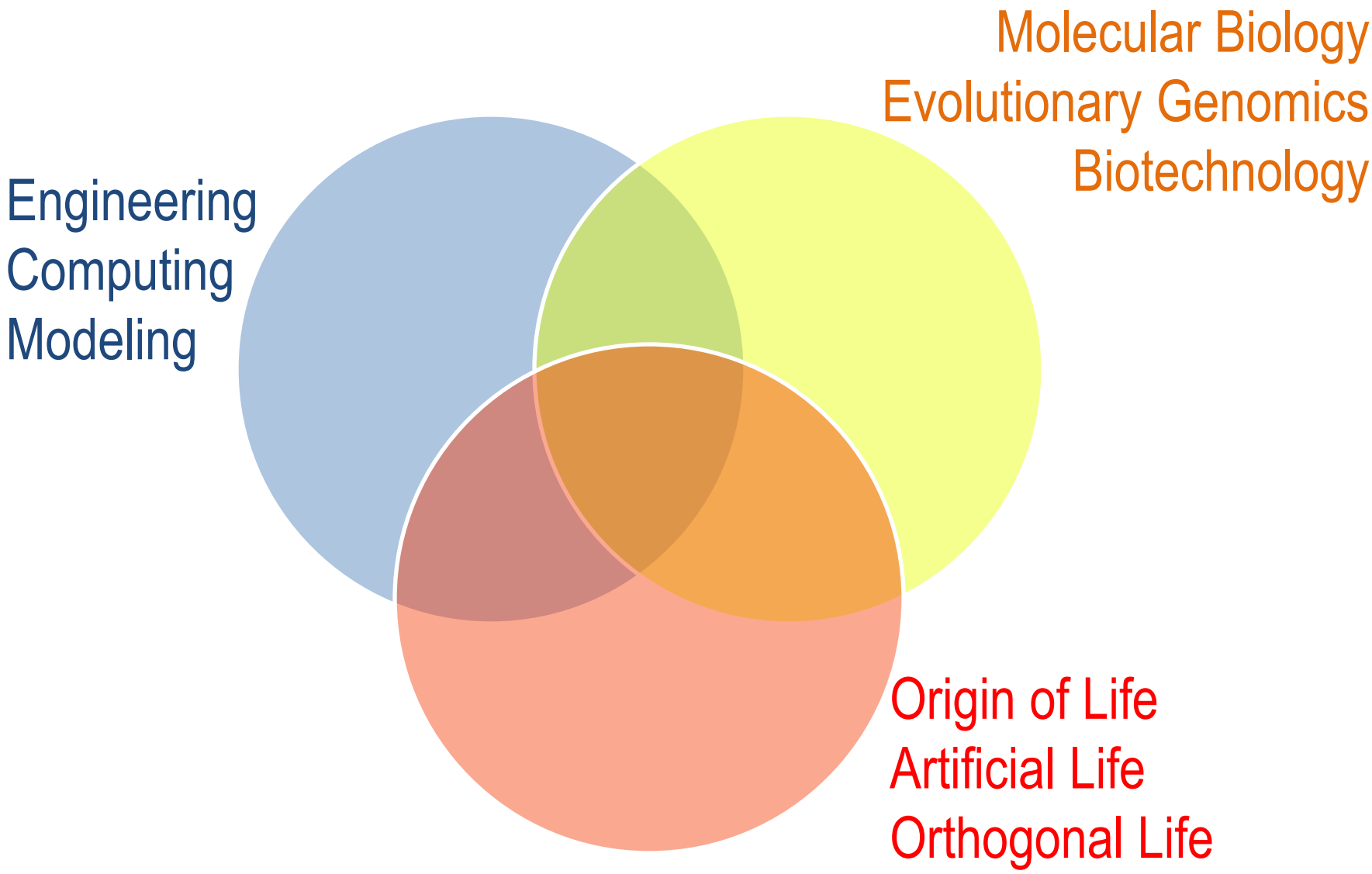
ATP

Synthetic Biology

Looking at *live systems* using enginering as a metaphore/interpretative frame



The three roots of Synthetic Biology



The promise of Synthetic Biology

The promise of Synthetic Biology

TAMING

The promise of Synthetic Biology

TAMING

CYBORGIZATION

The central question…

How to

- describe,
- de-construct, and
- re-construct

the **extant** biological complexity?

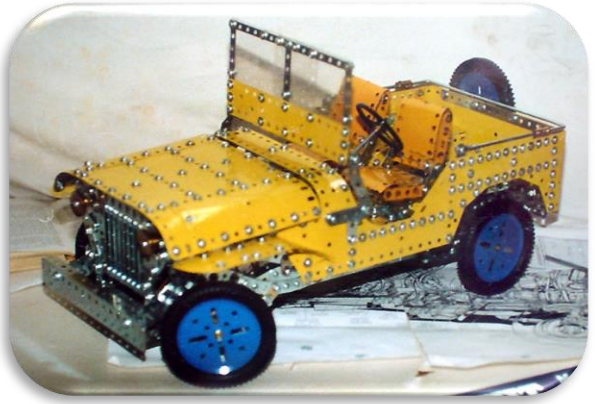
omics

Systems Biology &
Metabolic Engineering

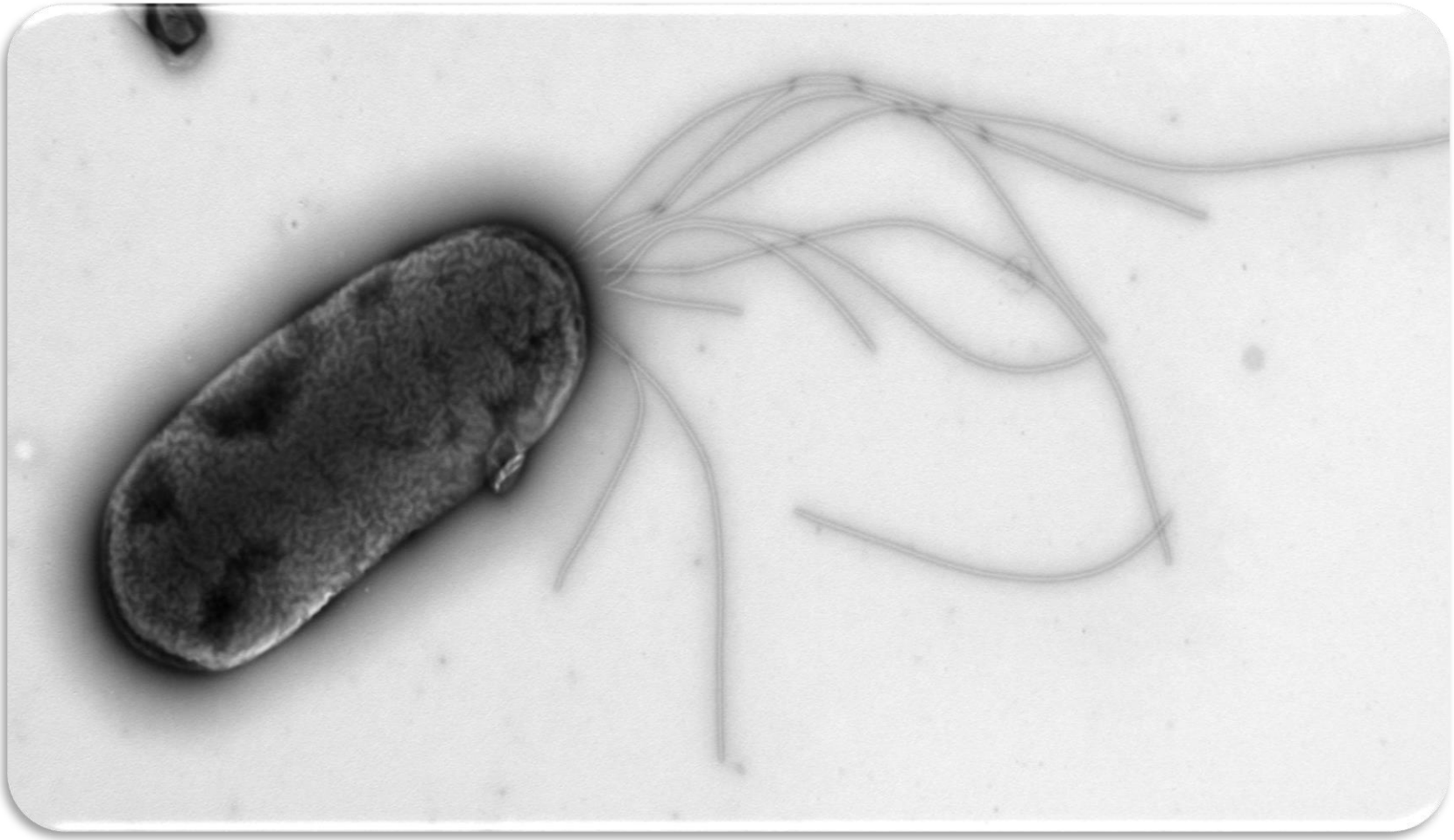
omics

Systems Biology &
Metabolic Engineering

Synthetic Biology



Pseudomonas putida KT2440

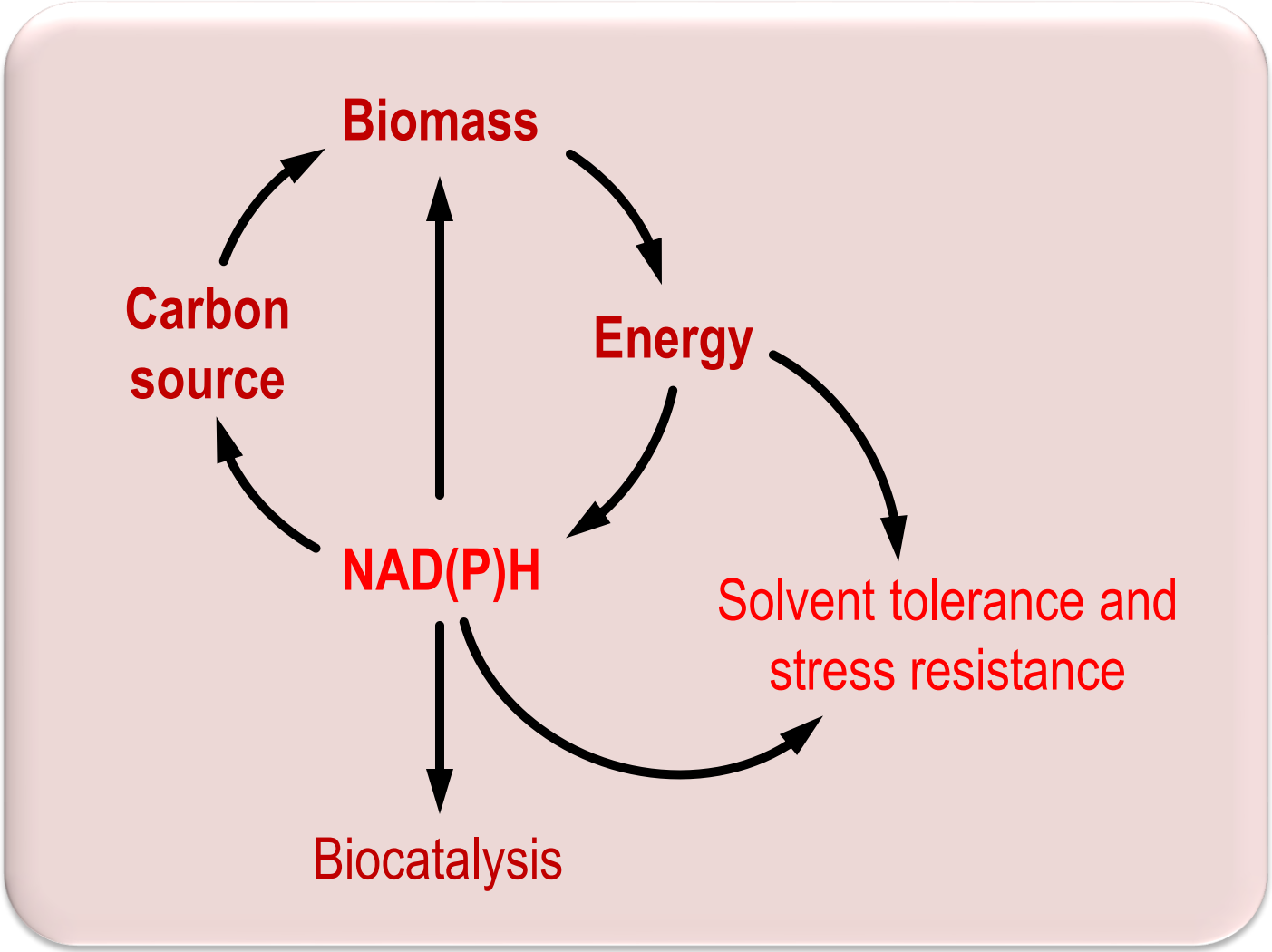


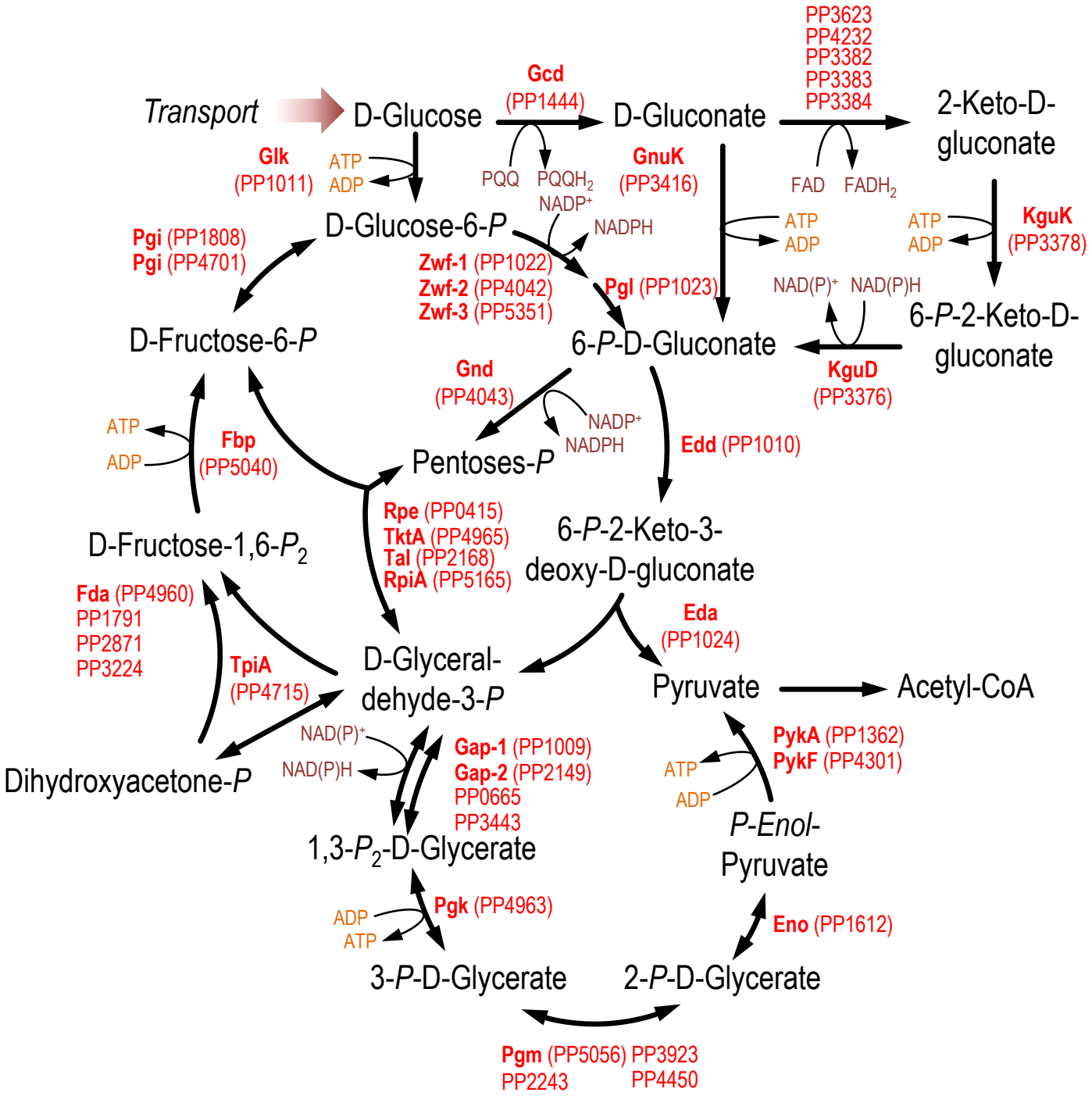
Nikel *et al*. (2014) *Nature Reviews Microbiology* **12:** 368-379

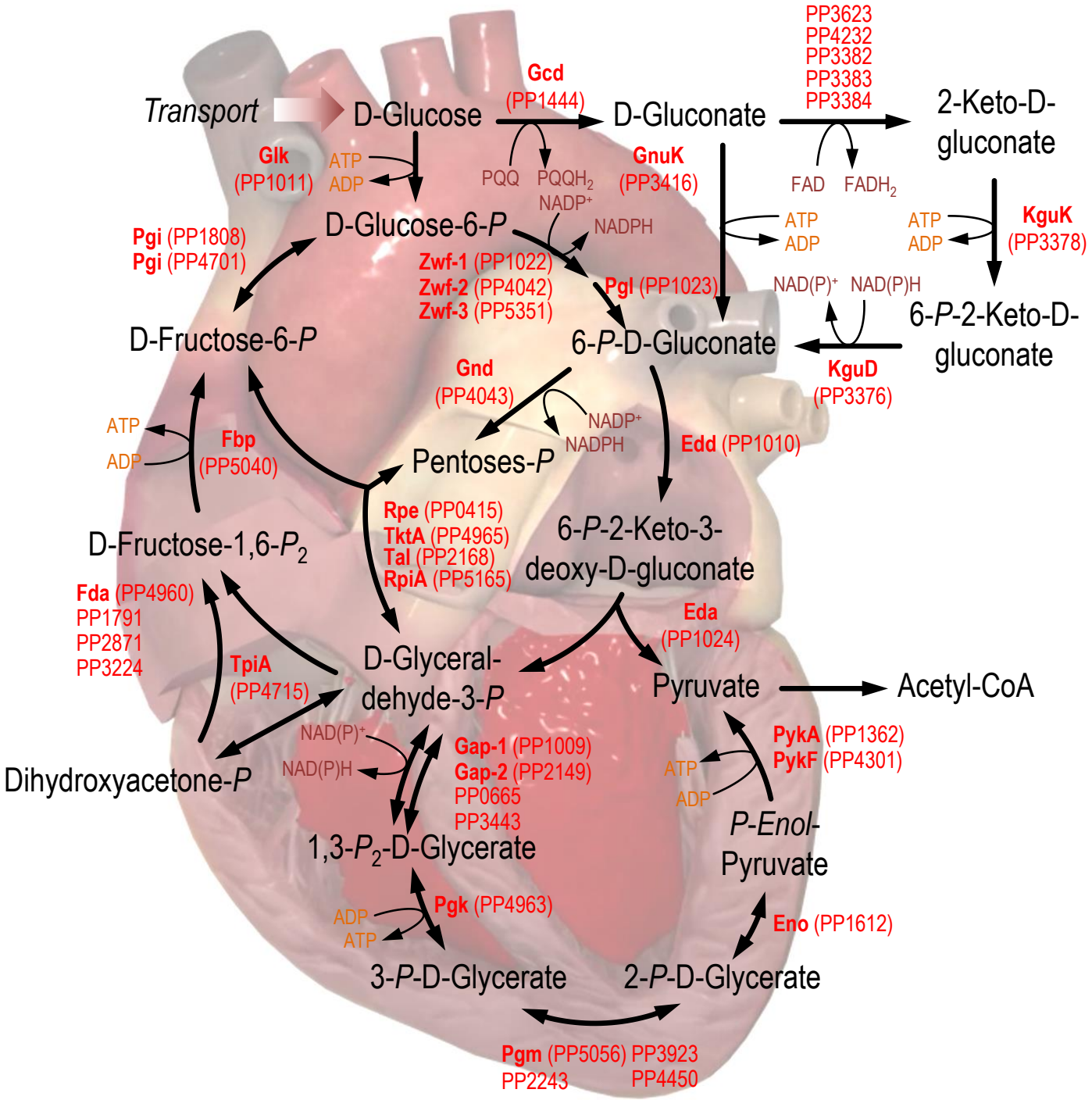
Pseudomonas putida KT2440 as a model organism for biotechnological processes

- Non-pathogenic (and *GRAS* certified).
- Complete genome sequence available and molecular tools described.
- Extensively studied for biodegradation of aromatic compounds.
- Useful for *in situ* bioremediation processes and other industrial applications (*e.g.*, biotransformations).
- Remarkable adaptability to thrive in different environments.

Redox balance enables growth on (and resistance to) non-conventional C substrates




Transport
D-Glucose
Gcd (PP1444)
D-Gluconate
PP3623
PP4232
PP3382
PP3383
PP3384
2-Keto-D-gluconate
Glk (PP1011)
ATP
ADP
PQQ
PQQH2
GnuK (PP3416)
FAD
FADH2
D-Glucose-6-P
NADP+
NADPH
ATP
ADP
ATP
ADP
KguK (PP3378)
Pgi (PP1808)
Pgi (PP4701)
Zwf-1 (PP1022)
Zwf-2 (PP4042)
Zwf-3 (PP5351)
Pgl (PP1023)
NAD(P)+
NAD(P)H
6-P-2-Keto-D-gluconate
D-Fructose-6-P
6-P-D-Gluconate
KguD (PP3376)
Gnd (PP4043)
NADP+
NADPH
ATP
ADP
Fbp (PP5040)
Pentoses-P
Edd (PP1010)
Rpe (PP0415)
TktA (PP4965)
Tal (PP2168)
RpiA (PP5165)
D-Fructose-1,6-P2
6-P-2-Keto-3-deoxy-D-gluconate
Fda (PP4960)
PP1791
PP2871
PP3224
Eda (PP1024)
TpiA (PP4715)
D-Glyceral-dehyde-3-P
Pyruvate
Acetyl-CoA
NAD(P)+
NAD(P)H
Gap-1 (PP1009)
Gap-2 (PP2149)
PP0665
PP3443
PykA (PP1362)
PykF (PP4301)
ATP
ADP
Dihydroxyacetone-P
P-Enol-Pyruvate
1,3-P2-D-Glycerate
ADP
ATP
Pgk (PP4963)
Eno (PP1612)
3-P-D-Glycerate
2-P-D-Glycerate
Pgm (PP5056)
PP2243
PP3923
PP4450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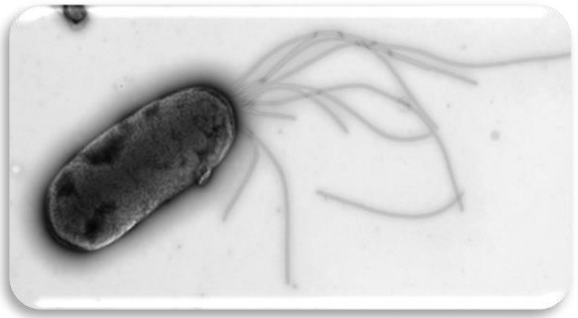
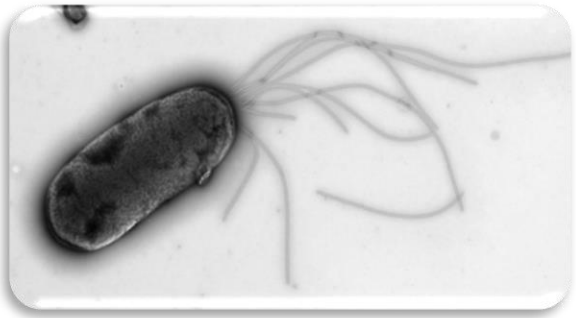
Changing the lifestyle of *P. putida* through Synthetic Biology



Changing the lifestyle of *P. putida* through Synthetic Biology

ATP generation gene from
Escherichia coli



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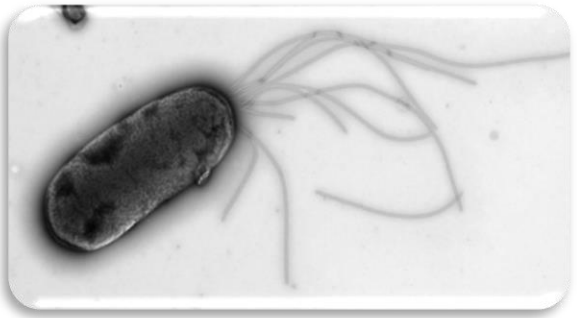
NAD^+ regeneration genes from *Zymomonas mobilis*



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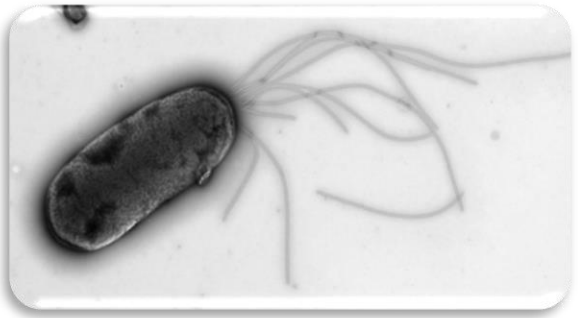

Haloalkane degradation genes
from *Pseudomonas pavonaceae*

Changing the lifestyle of *P. putida* through Synthetic Biology

P. putida strain able to survive in the absence of O_2 and capable of degrading the pollutant 1,3-dichloropropene

Nikel and de Lorenzo (2013) *Metabolic Engineering* **15:** 98-112

Synthetic Biology & Microbial Biotechnology

Better than Nature!

Thanks!...