E. c(oil)i: The Lean, Green, Fat-Producing SynBio Machine

Manchester iGEM Team
Palm Oil

- Soaps and cosmetics
- Emulsifying agents
- Oil paints
- Varnishes
- Detergents
- Shaving cream
- Lubricants
- Food
- Biofuel
What Is Palm Oil?

- **Palmitic Acid**: 44% C16
- **Stearic Acid**: 4.5% C18
- **Oleic Acid**: 39.2% C18:1
- **Linoleic Acid**: 10.1% C18:2
Effects of Palm Oil Cultivation

58 Bn Tons of CO₂ Over the next 15 years
EXPERIMENTAL

Rob, Lorna, Tan, Tim, Divita, Marco
Aim: Palm Oil Production in *E. coli*

- Increase native palm oil acids in *E. coli* (palmitic and stearic acid)
- Introduction of non-native palm oil acid synthesis pathways in *E. coli* (oleic and linoleic acid)
Overproduction of Native Fatty Acids

Production Of Non-Native Fatty Acids

Synechocystis sp. PCC 603

β-hydroxy acyl-ACP

β-keto acyl-ACP

Malonyl-ACP (from glycolysis)

Fatty acyl-ACP

Fatty acyl-ACP

Free fatty acid, e.g. stearic acid:

Linoleic acid

Oleic acid

Δ9 desaturase

Δ12 desaturase

BBA_K1027003

BBA_K1027001

BBA_K1027002
Production Batches

**BATCH 1**
FAS Module

**INPUT:** ‘FAS MEDIUM’

**OUTPUT:** PALMITIC ACID

**OUTPUT:** STEARIC ACID
Characterisation

Samples → Orbitrap UHPLC-FTMS

Increase in linoleic acid production between wildtype and Δ12 expressing E. coli

Data showing metabolite profile of sample

Analysis of desired phospholipids

Identification of metabolites of interests
MODELLING

Jess, Elsa, Ralf
• 43 reactions
• 60 metabolites
• 267 parameters
Uncertainty Analysis

1. Information collected + Prior knowledge
2. Distribution for each parameter
3. Creation of a collection of models
4. Analysis of each model
5. Distribution of results

Uncertainty Analysis:

Raw Data

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### Uncertainty Analysis: Results

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**Elongation**

**Palmitic Acid**
Uncertainty Analysis: Results
Uncertainty Analysis: Conclusion

- **Potentials**
  - Gives ability to model complex and poorly experimentally measured systems
  - Creates unbiased models
  - Opportunities for different types of data analysis
  - Pinpoints areas for further study

- **Limitations**
  - Potential inability to reach steady state
• β-hydroxy acyl-ACP dehydrase
• Carried out in GROMACS
• Less Dynamic N-Terminals are more appropriate for His-tag addition.
HUMAN PRACTICES

Matt, Tan, Lorna, Rob, Elsa
Future perspectives in Synthetic Biology
A joint Academia/Industry discussion meeting
Friday 8th February 2013 in the MIB (10.00 – 16.00)

Introduced by Prof. Eriko Takano
Key Note speaker:
Prof. Ralf Wagner, From genes to genomes – starting point towards synthetic biology, Institute of Medical Microbiology and Hygiene, University Regensburg

Manchester Institute of Biotechnology
Discovery through innovation

Communication
Environmental Impact

Models created using Vortex
Economic Impact

The cost of crude palm oil (CPO) more than doubled in the period 2005-2013.
Modelling shift of demand on price of crude palm oil
• Palm oil has detrimental effects in many areas
• Synthetic palm oil is not a viable solution on its own
• Natural palm oil and synthetic palm oil can coexist
Conclusion
Acknowledgements

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Prof Eriko Takano and Prof Rainer Breitling

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Dr Karl Payne
Dr Nik Rattray
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Dr Neil Swainston
Dr Nicole Leferink
Dr Jayendra Shrankra
Beata Czajkowska
Nick Weise
Denis Abramov

Other:
Prof Mattheos Koffas
Dr Andy Balmer
Jérémy Férrant
All the industry representatives and local environmentalists who were happy to be interviewed for our human practices research
Find out more!

Wiki: 2013.igem.org/Team:Manchester
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