

Systems Biology

Exercise 1 – Databases of Metabolism

1. By consulting the databases KEGG and EcoCyc, evaluate which are the main differences regarding ATP and NADH production for the organism *Escherichia coli* if the main fermentative products are:

- a) ethanol
- b) acetic acid
- c) lactic acid

Which alternative seems the most advantageous?

Could the bacteria survive in anaerobic conditions in any of those cases?

Exercise 2 - Metabolic Flux Analysis

1. Lactic Acid Bacteria are often grown on complex media that are rich in amino acids, providing the carbon skeletons for biosynthesis. There is, therefore very little consumption of redox equivalents in the anabolic pathways. This results in a conservation of redox equivalents in the conversion of the energy source (glucose or lactose) to the primary metabolites (lactate, ethanol, acetate, formate and carbon dioxide). The catabolic pathway is therefore decoupled from growth and as such can be analysed separately. Additionally, in rich media the drain of precursor metabolites for growth is negligible and the EMP pathway can be considered linear, with no branch points.

Analyse the corresponding network below and answer the following questions:

- a) Draw the border of the system, identifying which metabolites enter or leave the cell.
- b) Which metabolites should be considered balanced?
- c) Derive the matrix S and the stoichiometric model in the format $S v = 0$
- d) How many degrees of freedom exist?
- e) *Exchange flux for Glucose is 1 mol/gDCW/h. Using Optflux, evaluate the maximum production capabilities for Lactate, Ethanol and Acetate. Discuss the results.*

