**Dynamic Flux Balance Analysis**

**Expectations**

*Learning Objectives*

Each student should be able to:

* Explain dynamic flux balance analysis.
* Describe the strengths and limitations of dynamic flux balance analysis.
* Describe the difference between the regular flux balance analysis and the dynamic flux balance analysis.
* Describe the strengths and limitations of dynamic flux balance analysis.
* Describe the capabilities of the Matlab Property Editor.
* Explain how minimal media is modeled.
* Explain the difference between minimal and K-12 media.

*Prerequisites*

* Course Introduction
* Matlab Tutorial
* Flux Balance Analysis Overview
* E.coli Core Model
* Cobra Toolbox
* Robustness Analysis & Phenotype Phase Plane Analysis
* Flux Variability Analysis & Parsimonious Analysis
* Gene/Reaction Knockouts
* Randomized Sampling

**Resources**

*Required Readings*

1. Varma, A. and B. O. Palsson (1994). "Stoichiometric flux balance models quantitatively predict growth and metabolic by-product secretion in wild-type Escherichia coli W3110." Applied and Environmental Microbiology 60(10): 3724-3731.

*Recommended Readings*

1. Becker, S. A., A. M. Feist, et al. (2007). "Quantitative prediction of cellular metabolism with constraint-based models: the COBRA Toolbox." Nature protocols 2(3): pp. 727-738.

**Classroom Activities**

*Presentations*

• Lecture Presentation *(“DynamicFBA-2021.pdf”)*

• Lecture supporting Matlab Files *(“dynamicFBA\_Matlab\_Files\_2021.zip”)*

*Laboratory*

* Lab #7 *(“Lab-7.docs”)*

**Reinforcement Activities**

*Examples*

* dynamicFBA Examples
  + Becker, S. A., A. M. Feist, et al. (2007). "Quantitative prediction of cellular metabolism with constraint-based models: the COBRA Toolbox." Nature protocols 2(3): pp. 731, 734.

**Assessment**

*Formative Assessment*

*Reflective Questions*

1. Explain the basic operation of dynamic flux balance analysis.
2. What are the key inputs required for dynamicFBA operation?
3. Why aren’t the fermentation products used as carbon sources after all the glucose has been used in an anaerobic environment?
4. In an environment with a large number of plotted metabolites how can the Matlab Property Editor be useful?
5. How is minimal media modeled in the Cobra Toolbox?
6. What is the difference between minimal and K-12 media?
7. What is the purpose of the concentration matrix in dynamic FBA?
8. What is the role of each of the dynamicFBA variables: substrateRxns, initConcentrations, initBiomass, tStep, nSteps, and plotRxns?
9. What are the strengths of dynamic FBA?
10. What are the weaknesses of dynamic FBA?

**References**

*Dynamic Analysis*

1. B. Ø. Palsson, “Systems Biology: Properties of Reconstructed Networks,” Cambridge University Press, 2006.
2. Lee, J. M., E. P. Gianchandani, et al. (2008). "Dynamic analysis of integrated signaling, metabolic, and regulatory networks." PLoS computational biology 4(5): e1000086.

*Dynamic FBA Growth Simulations*

1. Jamshidi, N. and B. O. Palsson (2010). "Mass action stoichiometric simulation models: incorporating kinetics and regulation into stoichiometric models." Biophysical journal 98(2): 175-185.
2. Becker, S. A., A. M. Feist, et al. (2007). "Quantitative prediction of cellular metabolism with constraint-based models: the COBRA Toolbox." Nature protocols 2(3): 727-738. - See section on Dynamic FBA growth simulations (batch growth simulations)- pp. 731,734
3. Varma, A. and B. O. Palsson (1994). "Stoichiometric flux balance models quantitatively predict growth and metabolic by-product secretion in wild-type Escherichia coli W3110." Applied and Environmental Microbiology 60(10): 3724-3731.