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# New Bioengineering Learning Modules to Be Disseminated

CACHE has developed three biosystems educational modules which make use of computational tools to illustrate important concepts. These tools consist of code, a brief description of the problem under investigation, and a homework problem that makes use of the module. They are undergoing review and will be released soon.

One of these modules is a MATLAB/Simulink implementation of a signal transduction pathway with relevance to the body's response to certain types of inflammation. The module shows that the system can be described by component balances if a detailed representation of the process is needed. However, a transfer function model which focuses on representing the input-output behavior of the key components of the pathway can capture the dynamic behavior very well. Furthermore, the signaling pathway includes a feedback loop which down-regulates protein expression to turn the signal off after a certain time. In some cells, this feedback loop does not work properly resulting in the signal being always turned to "on" which can play a role in certain types of cancer; the transfer function model can also accurately describe this scenario by cutting open the feedback loop.

Another module deals with metabolic flux analysis in a yeast model. This module consists of the stoichiometric coefficients of the metabolic pathway used for the conversion of glucose to ethanol. Several different scenarios, e.g., different number of measurements or measurement uncertainty, are analyzed which result in underdetermined, overdetermined, or completely defined stoichiometric models. The module presents the different scenarios and the accompanying homework problem focuses on the discussing and analyzing the results for these different cases.

The third module illustrates feedback control of blood sugar via insulin injection. Type 1 diabetes patients have poorly controlled blood sugar and need intervention, either in the form of bolus injections or automatic injections via an insulin infusion pump, to maintain a stable level of blood glucose over time. The module includes a MATLAB/Simulink implementation of a model which can be used for designing control strategies, such as an artificial pancreas would need.

Instructors interested in evaluating any of these three biosystems modules should contact Prof. Juergen Hahn (hahnj@rpi.edu) for further information.