Module 1: Delta-Notch (ODE systems, ODEs on a grid)

Author: Fabian Rost

Aim

- learn about ODE models (dynamics in morpheus, steady states analytically)
- develop first models

Description

Basic ODEs

- get to know what students know about ODEs and adjust the module to the pre-knowledge
- give them very simple sketches of biomolecular models, which they should translate into ODEs, e.g.

- could be translated to the following ODEs:

$$\begin{align} \dot A &= k_1 \\ \dot A &= k_2 A \\ \dot A &= - k_3 A \\ \dot A &= k_4 - k_5 A \end{align}$$

- discuss those ODEs by
  - calculate steady state (do not calculate the stability, to complicated for biologists)
  - simulate in morpheus

Delta-Notch

- then discuss the delta-notch sketch with two species
  - start with the Collier model
  - let them simplify the Collier model sketch (remove the delta or notch species)
  - let them develop an ODE for this system (they should be able to do so from the above examples)
  - they could come up with something like:

$$\begin{align} \dot X_1 &= c \frac{\theta^n}{\theta^n + X_2^n} - k X_1 \\ \dot X_2 &= c \frac{\theta^n}{\theta^n + X_1^n} - k X_2 \end{align}$$

- this system is bistable for certain parameter ranges, if the students are advanced they might find this out themselves

- bistable e.g. for $\theta=0.5$, $n=4$, $c=k=1$
- if they have this system running in morpheus go spatial and let them simulate the system on a square and hexagonal grid
- then you could also move to shaped cpm cells or even moving cells

- students won't do so much on their own in this session, it is a lot teaching on ODEs (don't be theoretical here, not enough time!) and introducing morpheus

Paper:

- Joanne R. Collier, Nicholas A.M. Monk, Philip K. Maini, Julian H. Lewis, Pattern Formation by Lateral Inhibition with Feedback: a Mathematical Model of Delta-Notch Intercellular Signalling, Journal of Theoretical Biology, Volume 183, Issue 4, 21 December 1996, Pages 429-446, ISSN 0022-5193, http://dx.doi.org/10.1006/jtbi.1996.0233.

Morpheus models

h ExponentialGrowth.xml |h

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