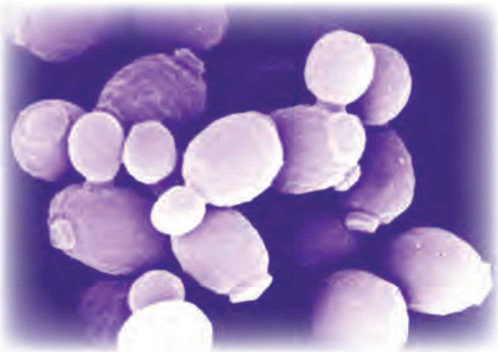
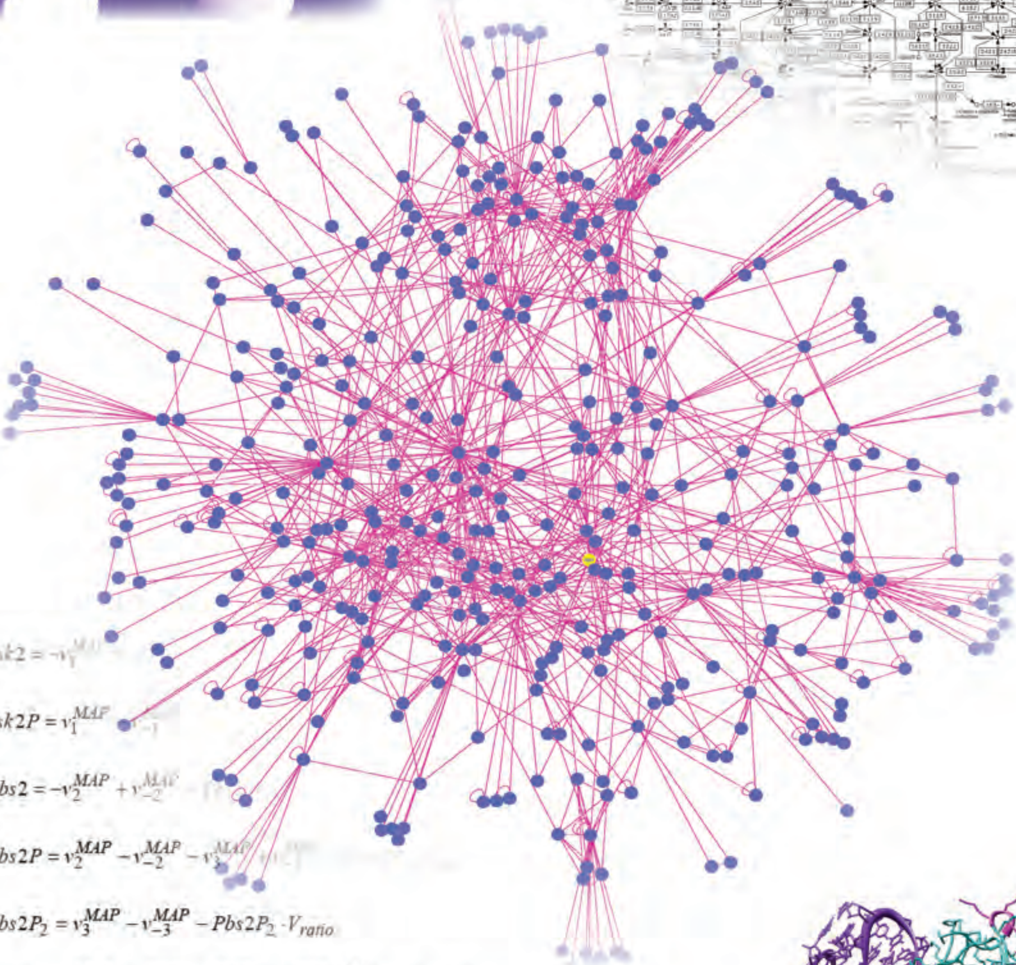




$$\frac{d}{dt}Ssk2P = v_1^{MAP} - \ldots$$

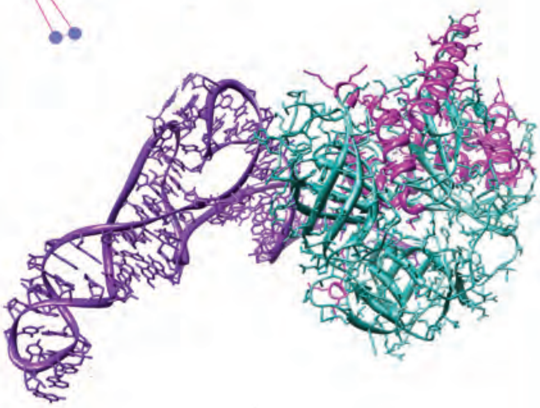
$$\frac{d}{dt}Pbs2 = -v_2^{MAP} + v_{-2}^{MAP} \ldots$$

$$\frac{d}{dt}Pbs2P = v_2^{MAP} - v_{-2}^{MAP} - v_3^{MAP} \ldots$$

$$\frac{d}{dt}Pbs2P_2 = v_3^{MAP} - v_{-3}^{MAP} - Pbs2P_2 \cdot V_{ratio}$$

$$\frac{d}{dt}Hog1 = -v_4^{MAP} + v_{-4}^{MAP} - v_{trans2}^{Hog1} + v_{trans1}^{Hog1} \cdot \frac{V_{nuc}}{V_{cyt}} - Hog1 \cdot V_{ratio}$$

$$\frac{d}{dt}Hog1P = v_4^{MAP} - v_{-4}^{MAP} - v_5^{MAP} + v_{-5}^{MAP} - Hog1P \cdot V_{ratio}$$

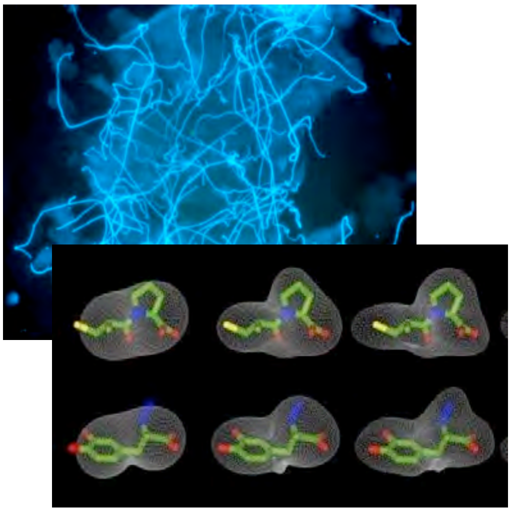


UNIVERSITY OF ABERDEEN

Systems Biology Programme

Systems Biology at the University of Aberdeen

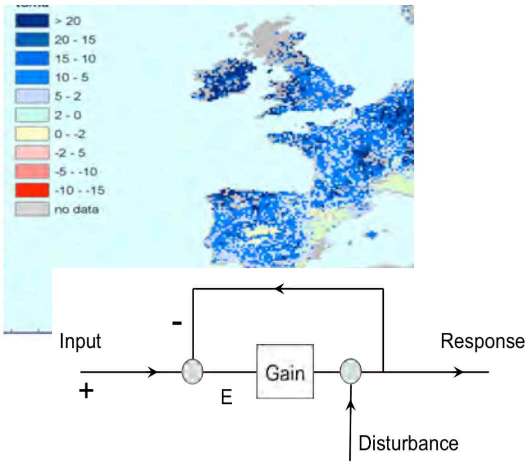
Systems biology is the application of mathematical modelling to help understand how biological processes function and are controlled. At the University of Aberdeen, research in this new area is being driven by close collaborations between physical scientists and biologists, using modelling as a lever to facilitate greater insight into the nature of highly complex biological systems. Working across discipline boundaries, mathematical modelling is used hand-in-hand with experimental validation and testing in the laboratory to generate and test new biological hypetheses.



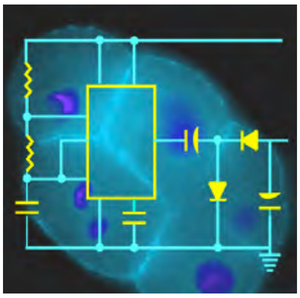
The interdisciplinary systems biology research teams draw upon expertise of physicists, biologists, computing scientists and engineers from the Schools of Natural and Computing Sciences, Engineering, Medical Sciences, Medicine and Dentistry, Biological Sciences, and the Rowett Institute. Significant Research Council funding supports this thriving network of collaborating researchers.

> Systems biology approaches are being deployed across a wide variety of research areas that cover a complete range of scales, from molecular to continental

The combined modelling and experimentation approaches represented by systems biology are being deployed across a wide variety of research areas that cover a complete range of scales, from molecular to continental; for example, some groups are using systems biology approaches to probe the regulation of biochemical pathways and cellular networks, while others utilise modelling techniques to understand the roles of environmental flux of carbon and nitrogen in climate change processes.



One of the key strengths of the Systems Biology Programme is the breadth of biological research and system scales to which University researchers are applying mathematical modelling. This diversity of interests provides enhanced opportunities for complementary expertise within systems biology to cross-fertilise. The University is therefore well positioned to apply systems biology to the medical sciences, human physiology and nutrition, and environmental biology, thus linking modellers in the School of Natural and Computing Sciences with biologists in the Institute of Medical Sciences, the Rowett Institute and the Institute of Biological and Environmental Science.



Systems Biology research areas

Mathematical modelling is being used in a number of systems biology projects across the Programme;

Bacterial responses to electrophile stress

Microorganisms utilise a wide repertoire of metabolic responses to deal with the range of stress-inducing chemicals encountered in the environment. One such class of compounds, the electrophiles, are particularly toxic, and can be generated as a metabolic by-product as well as being found in the environment. Key microbial electrophile stress response pathways in *Escherichia coli* are being modelled to further understand how rapid responses to these threats are mobilised.

Host-fungal pathogen interactions;

The pathogenic fungi *Candida albicans* and *Candida glabrata* are a significant cause of superficial and systemic infections. The ability of *Candida* to successfully infect the human host is dependent upon its ability to sense and respond to the combinations of environmental stresses it encounters as the host immune system mounts a defence. The sensing of combinations of stresses by *Candida* is being modelled to understand how microorganisms integrate multiple environmental inputs and process them to organise an appropriate response.

Cell and Tissue Systems

At the level of different cells and tissues, systems biology projects are focused on understanding different medically important physiology processes. These include modelling of complex patterns of neuronal electrical activity, processing by the brain of information from the visual field, and modelling chaotic blood flow patterns in healthy and diseased blood vessels. Cell and developmental processes, including the embryogenesis of multi-cellular organisms, represent some of the most complex and challenging of biological systems to study. Systems biological approaches are being employed to study cell-cell contacts and signalling during embryogenesis, and the regulation of gene transcription during development.

Modelling of macro and molecular scale processes

The breadth of system scales being studied using predictive modelling is best exemplified by projects analysing protein-protein and protein-ligand docking interactions at the molecular scale. This can be contrasted with ongoing modelling of continental scale flux of carbon and nitrogen in the environment, where knowledge of elemental flux between soil, vegetation and atmosphere is integrated with the effects of agricultural policy and climate change.

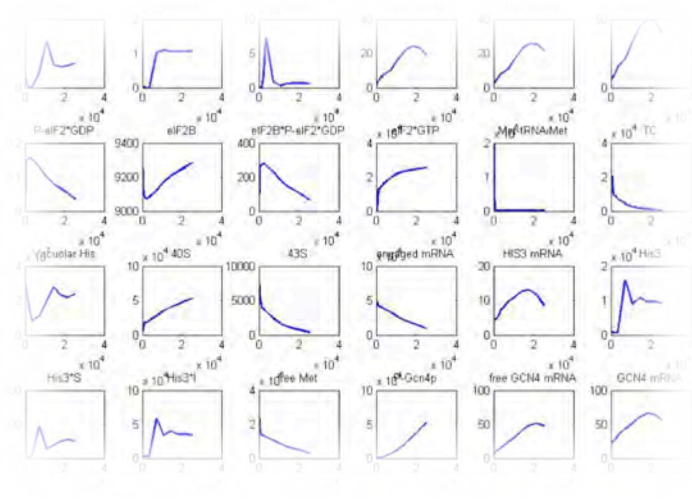
Modelling microbial cell biology

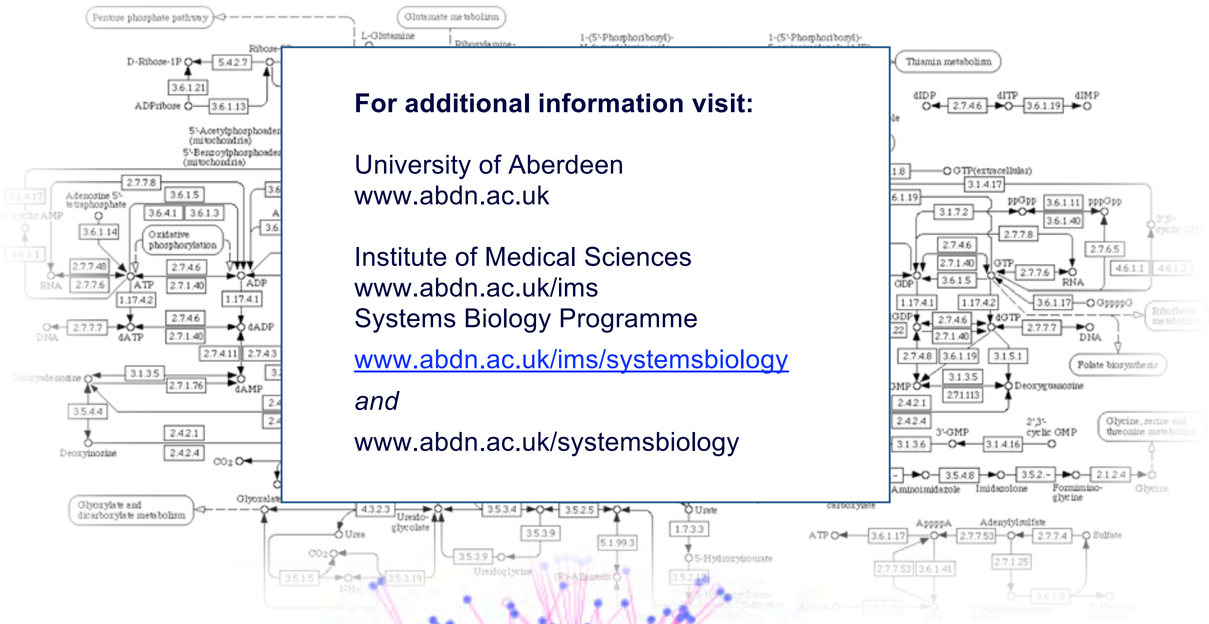
Interdisciplinary teams are employing systems biology approaches to learn more about key processes in microbial gene expression. A number of metabolic processes in the model organism *Saccharomyces cerevisiae*, including protein synthesis and ribosome traffic on mRNA populations, DNA synthesis at the level of chromosome replication, and transcriptional and translational responses to amino acid starvation, are being represented using deterministic and stochastic models.

Modelling techniques and approaches

Systems biology at Aberdeen is underpinned by the application of a range of approaches to model and predictively understand biological systems. Non-linear dynamics methodologies are being employed to develop deterministic as well as stochastic models of *in vivo* biology. The modelling of non-linear systems is also being applied to understand the impact of chaos on biological system behaviours.

Model-based technology (MBT), encompassing Machine Learning and Qualitative Reasoning, is also being applied in biological modelling, allowing researchers to understand the dynamic behaviour of a system without being restricted by the need to precisely define its parameters.





For additional information visit:

University of Aberdeen
www.abdn.ac.uk

Institute of Medical Sciences
www.abdn.ac.uk/ims
Systems Biology Programme
www.abdn.ac.uk/ims/systemsbiology

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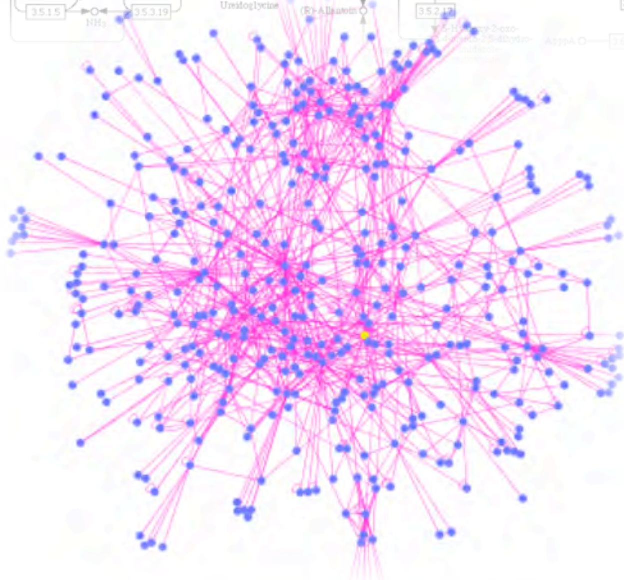

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