Gene Expression and Systems Biology (Interface)
Mechanisms of Gene Expression (Plants4Life)

2019 Coordinator:
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Course website: https://zach-hensel.github.io/gem2019/ (live before 10 February)

Objectives

- To familiarize students with some mechanisms of regulating gene expression at the transcription and post-transcription levels including production and degradation processes;
- To offer study of selected topics at the cutting edge of advancing knowledge on prokaryotic and eukaryotic gene expression;
- To teach critical analysis of original experimental data and the scientific literature;
- To familiarize students with peer review of gene expression literature;
- To introduce stochastic simulation techniques from systems from systems biology that can easily be applied by non-expert scientists;
- To demonstrate how knowledge of gene expression mechanisms is being deployed in synthetic biology.

Talks (Lecturer)

T1 – Introduction, prehistory to the cutting edge: Foundations in genetics and evolution for molecular studies and recent developments in post-transcriptional regulation

T2 – The operon and transcriptional regulation: Transcription factors and other aspects of gene regulation in bacteriophage lysis/lysogeny

T3 – Bacterial gene expression mechanisms – size, activation, translation, degradation

T4 – Insights into gene expression from single-molecule studies

T5 – Eukaryotic gene regulation: promoter architecture, enhancers and histone modifications (Dr. Filipe Tavares-Cadete)

T6 – Eukaryotic genome conformation: chromatin folding at different scales – from loops to topologically associated domains to chromosomal compartments – and its impact on gene regulation (Dr. Filipe Tavares-Cadete)

AVX Seminar – Miguel Prazeres

T7 – Stochastic simulations: an easy (really!) method that can be applied to almost any problem in biology

T8 – Synthetic biology and Machine Learning: how do we get from simple gene circuits to engineering synthetic organisms? How are machine learning techniques changing studies of gene expression?

T9 – Movies: *The Scientist: The Race for the Repressor* (ABC News; provided by CSHL Library), Decoding Watson (PBS)

TP1 – Introduction to preprint peer review, team introductions, paper selections.

TP2 – Group work focusing on highlight article

TP3, TP4 – Group work focusing on preparing preprint journal club and reviews

Evaluation: A passing grade requires (1) active participation in class discussions, (2) participation in the team project evaluated by self and team evaluations, (3) meeting all assignment deadlines, (4) attending all lectures.

Team Projects

Overview: Teams will review the recent preprint literature, briefly summarize two recent research articles *broadly* relevant to the topic "Gene Expression Mechanisms" and of interest to all team members, prepare a "highlights" article to distribute to the class, and present the article to the class in a journal club format.

Preprint Requirements

- Must NOT be published in a peer reviewed journal (bioRxiv lists if articles are already published)
- The articles should be, roughly, "letter" length: ~1500–2500 words, ~3–5 figures (not including supplements)

Assignment deadlines: send written assignments to zach.hensel@itqb.unl.pt (.pdf or .docx please). The timelines for work on this are short and I do not expect a polished product!

- 23:59 11 Feb: **Summaries of 2 articles**. Each 3 sentences (1) What is the main question being asked, (2) What is the main method used to answer it, (3) What is the answer + why is it important. Also include links to the articles. Example (for doi 10.1073/pnas.1811589116 from Arraiano lab):

  This paper asks the question: what RNAs interact with the mRNA encoding the transcription terminator protein Rho? The authors used pulldown and sequencing to identify interacting RNAs, and in vivo and in vitro methods to characterize the interaction. They found that the noncoding RNA SraL interacts with the 5' UTR of the rho mRNA to protect it from premature termination, which is important for tuning transcription termination in different growth conditions.

- 23:59 13 Feb: **Highlight article**. One page (12 pt font single spaced) including 1 figure. The figure can be a composite of figures from the text with or without your own illustrations.

  Whenever you read a paper, ask yourself, "What questions are the authors trying to ask?" Ask yourself also, "What questions have they managed to answer?" which may not at all be the same as those they think they're asking, those they say they're asking, or those they are, in effect, asking. And ask yourself also, "What questions have they left unresolved" or "What questions get posed by the paper?" – Wally Gilbert

- 09:00 15 Feb: **Read**. Highlight articles will be distributed on Thursday morning. Read them all to have some familiarity with material to be presented on Friday.

- 09:00 16 Feb: **Evaluation**. Turn in self/team evaluation by email to zach.hensel@itqb.unl.pt

- Optional: **Preprint review**. One or more team members can write a preprint review that Zach will format and publish to prereview.org — here is an example: https://goo.gl/GX7ifh

Recommended Schedule

TP1 — Discuss with team members to identify team members' areas of expertise. List tasks that need to be done and assign them to group members with deadlines. Search the preprint literature using tools provided in class to identify 2 articles. Skim the articles, write three-sentence summaries, and e-mail them to zach.hensel@itqb.unl.pt

TP2 — Read the assigned article closely and discuss it with the group. Agree on tasks/deadlines required for the highlight article and preprint review presentation and begin work.

TP3 — Complete highlight article. Also distribute tasks for journal club presentation. Every team member should play some role for both the highlight article and the journal club presentation.

TP4 — Focus on completing journal club presentation. Key points: What are the claims made by the abstract? Are they proven in the paper? What if any experiments/analysis are missing? What is the next experiment that you would do? See the rubric on the course website for more information.