PLS 620 - Plant Molecular Biology

T,Th, 8-9:15 AM, N12 Agriculture Science Center North
Prerequisites- undergraduate genetics, BCH607, or consent of instructor
Credits: 3
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Office hours: Fridays, 10:00 - 11:30 AM

This course is intended to be a treatment of current concepts of plant molecular biology. It will be a literature-based course, supplemented by handouts and reading lists. The course will deal as much as is possible with topics that are unique to plants. Current aspects of molecular biology that are relevant to the course content will be covered as well; however, these lectures will not be a review of topics that should have been retained from introductory genetics and biochemistry courses. Also, they will not be a substitute for a molecular biology course.

The course will cover the following areas:

1. Gene structure, expression, and regulation in plants - an overview of nuclear and organelle gene structure, function, and expression, with emphasis on aspects that are unique to plant genes.
2. Genomics, systems biology, etc. - development of *Arabidopsis* as a model for molecular genetic studies in plant biology, with examples that show the utility of a multifaceted approach; an introduction to systems approaches, with some emphasis on applications of concepts
3. *Agrobacterium tumefaciens* and the genetic engineering of plants - mechanism of gene transfer from *Agrobacterium* to plants, strategies for gene transfer in plants, selected topics pertaining to plant genetic engineering.

There will be no textbook. Lecture notes and assigned reading will be provided on CD's; the relevant files will be in pdf format, allowing ready access from any computer platform.

50% of the grade will be determined by performance on a series of problem sets that will be assigned periodically throughout the semester. There will be four such assignments. Students will have one week to complete each set, and should note that late problem sets will not be accepted.

An additional 20% of the grade will be derived from a research article dealing with a characterization of one or more *Arabidopsis* genes. The research article will be based on computer-derived data that can be obtained from a number of public domain databases. The purpose of this exercise is to introduce students to the concept of "data mining", and to present research findings in a formal written form.

Finally, students will be required to complete a review paper, and to present a short (20-30 min) talk on the subject. This project will make up the remaining 30% of the grade.

Tentative course outline (two 1.5 hour lectures per week):

Month	date	Topic
		GENE EXPRESSION IN PLANTS:
August	24	Introduction; "gene expression" project overview; Control of gene expression
	29	Control of gene expression (continued)
	31	mRNA biogenesis
September	5	mRNA biogenesis (continued)
	7	mRNA biogenesis (continued)
	12	Protein biosynthesis and turnover; 1st set handed out; ; "gene expression" papers due
	14	Messenger RNA stability
	19	Gene silencing
	21	Gene silencing (continued)
	26	Chloroplast gene expression
	28	Chloroplast gene expression (continued)
October	3	Plant mitochondria; 2nd set handed out
	5	Transposable elements
	10	**GENOMICS AND SYSTEMS BIOLOGY**
		Arabidopsis - biology and genetics
	12	Arabidopsis - genome properties
	17	Integrated approaches: ethylene signalling
	19	Genomics and systems biology
	24	Genomics and systems biology (continued) ; 3rd set handed out
	26	Genomics and systems biology (continued)
	31	**GENE TRANSFER AND GENETIC ENGINEERING:**
		Agrobacterium tumefaciens: biology, molecular biology
November	2	*Agrobacterium tumefaciens*: molecular biology
	7	Genetic engineering of plants - approaches
	9	Genetic engineering of plants – approaches (continued)
	14	Genetic engineering of plants - applications; 4th set handed out
	16	tba
	21	tba
	28	presentations
	30	presentations
December	5	presentations
	7	presentations

PLS620 – Guidelines and suggestions for first assignment

Your first assignment this semester will be to complete a short research paper that describes various characteristics of one or more Arabidopsis genes. I have two ulterior motives for giving you this assignment. One is a simple one – to have you go through the exercise of assembling, collating, and presenting data in a form suitable for submission to a journal. The second is to push you to use internet resources to research different aspects of genes and their functions. This means, first and foremost (for me), that you are comfortable with the logic and anatomy of genes and their expression – that you know what a gene will "look like" when transposed into a genome.

The starting point for this assignment will be an Arabidopsis gene designation. I have selected, rather randomly, about twenty such numbers for you to choose from. You will have no more starting information than this – everything else will come from your internet browsing. The paper itself will take on the form of a journal article, with a very abbreviated Methods section (this will consist largely of URLs, and perhaps of descriptions of some computer-based analysis programs). The introduction will consist of an overview of the gene from which the accession sequence is derived – basically, a short review of the function of the encoded protein. The sorts of results that will be presented will (ideally) include the following: an overview and detailed "picture" of the Arabidopsis gene or gene family, chromosomal location(s), transcript map, predicted polypeptide sequence, other mRNA features, expression information, phylogenetic comparisons, and other items of your own choosing. Of course, the exact nature of the paper will vary from student to student. In any case, all of these data will be obtained from various databases, or from the use of computer programs along with data obtained from databases. What is most important is that you derive an accurate and critically-viewed "picture" of the gene – the DNA sequence, protein sequence, intron/exon map, possible or known untranslated regions in the mRNA, etc. Finally, your discussion will consist of a summary of what you learn from the database mining, and the formulation of a hypothesis or model for future study.

The following list of URLs should be a good starting point for your work:

The entry for Genbank, Pubmed, and other general databases (and for BLAST):

www.ncbi.nlm.nih.gov

The most comprehensive Arabidopsis site: www.Arabidopsis.org

Another Arabidopsis site that is useful for placing sequences on the physical map, and for identifying full-length cDNAs and insertion mutants:

http://signal.salk.edu/cgi-bin/tdnaexpress

A site that allows a great deal of “virtual” gene expression analysis (you need to register to use the site – there is no cost):

https://www.genevestigator.ethz.ch

Name	e-mail address	First assignment
		At4g31580
		At1g23820
		At4g10020
		At2g45070
		At5g41150
		At1g65380
		At5g51700
		At2g01350
		At2g13650
		At1g47830
		At3g28500
		At2g46030
		At5g66400
		At4g23680
		At1g68540
		At3g60210
		At1g75690
		At1g29490
		At2g41410
		At5g14040

		At1g43890

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Topics for review articles - Fall 2006

1. Nitrogen fixation - nod gene expression and function
2. Site-directed recombination and "gene targeting" in plant systems
3. Transport of proteins into the chloroplast
4. Metabolic engineering
5. The evolutionary origin of maize - molecular and physiological aspects
6. Risk assessment with transgenic crops – issues, case studies
7. Cytokinin signal transduction
8. Signal transduction in plant-pathogen interactions
9. Sugar sensing and signaling
10. Flowering – floral organ determination
11. Lateral root formation
12. Self-incompatibility
13. Circadian rhythms – underlying mechanisms
14. Light perception and signaling
15. Environmental effects on flowering time
16. Cold tolerance
17. Heat shock proteins
18. Translation mechanisms used by RNA viruses