

**PLANT CELL AND DEVELOPMENTAL BIOLOGY**  
(Formerly Plant Molecular Biology)  
**PCB 6528, section 7354, 3 credits**  
**SPRING 2013**

**MEETING TIME and PLACE**

MWF, 3<sup>rd</sup> Period (9:35 - 10:25 a.m.), 2318 Fifield Hall

**INSTRUCTORS**

**Kenneth Cline, Course Coordinator**

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**COURSE OBJECTIVES**

The main objective of this course is for students to obtain a basic knowledge of the organization, dynamics, and development of plant cells and organs. Students should additionally learn the experimental approaches commonly used in plant cellular and developmental biology research and critically evaluate literature that forms the basis for current knowledge in these fields.

This course has four modules that are classified as: cellular organization and evolution, organelle molecular biology, signal transduction, and plant development. Each module reintroduces student to the basic concepts of cell and organelle biology. Students are quickly propelled into analyzing primary literature as a source of scientific knowledge and taught how to read and critique papers, gather information from multiple sources independently, design experiments, and interpret data. Successful completion of PCB 6528 will establish a strong foundation for advanced specialty courses, will complement advanced courses in molecular biology, and will provide the tools necessary for a career in experimental sciences.

**LEARNING OBJECTIVES AND OUTCOMES**

In general, students who successfully complete the reading and discussion of current research papers and lecture presentations in all four modules will be able to:

- Critically read in detail and evaluate experimental science in the covered topics and be able to explain the experiments to others.
- Find the required background material necessary to understand primary papers through web and reference database searches and textbook consultation.

- Interpret experimental data in these areas in the context of the scientific question.
- Design experiments to test hypotheses using the information and techniques presented to them in lectures and papers.

## CLASS SCHEDULE

Month	Date	Topic	Instructor	Papers
January				
	M7, W9	Cell architecture and the origins of the organelles	Cline	
	F11	Discussion paper 1: peroxisome biogenesis	Cline	
	M14	Organelles and trafficking in the secretory system	Cline	
		Discussion paper 2;		
	W16	Trafficking in the secretory system	Cline	
	F18	Plastids and mitochondria; polar lipid trafficking	Cline	
	M21	Martin Luther King Holiday		
	W23	Plastids and mitochondria; protein trafficking	Cline	
	F25	Discussion paper 3; chloroplast protein trafficking	Cline	
	M28	Plastids and mitochondria; division, fission and fusion.	Cline	
	W30	Discussion paper 4;plastid division	Cline	
	Th31	Exam 1; Evening Exam	Cline	
February				
	F1	Cytoskeleton	Settles	
	M4	Cell Wall	Settles	
	W6	Discussion Paper	Settles	
	F8	Cytokinesis	Settles	
	M11	Discussion Paper	Settles	
	W13	Organelle genomes I	Chase	
	F15	Organelle genomes II	Chase	
	M18	Discussion paper - organelle genomes	Chase	
	W20	Organelle gene expression I	Chase	
	F22	Organelle gene expression II	Chase	
	M25	Discussion paper organelle gene expression	Chase	
	Tu26	Evening Exam2	Settles/Chase	
	W27	Prokaryotic signalling	Folta	
March				
	F1	Covalent Protein Tagging/Proteolysis	Folta	
	M4-F8	Spring Break		
	M11	Cytokinins and Ethylene	Folta	
	W13	Auxin Discussion Papers	Folta	
	F15	Brassinosteroids and Jasmonate	Folta	
	M18	Gibberellins- Discussion Paper	Folta	
	W20	Response to Cold and Heat	Folta	
	F22-			
	M25	Phytochrome Signaling and Integration	Folta	
	W27	Blue Light Signaling and Response	Folta	
	F29	Circadian Clocks	Folta	
April				
	M1	Flowering- Discussion Paper	Folta	
	T2	Evening Exam3 of Take Home Exam 3 due	Folta	
	W3	Cell Development- Intercellular Signaling	Settles	
	F6	Cell Development- Transcription Factors	Settles	
	M8	Cell Development - Germline and Imprinting	Settles	
	W10	Discussion Paper	Settles	

	F12	Organ Development - Polar Auxin Transport	Settles
	M15	Organ Development - Transcription Factors	Settles
	W17	Discussion Paper	Settles
	F20	Organ development – Epigenetic regulation	Settles
	M22	Organ Development- hormone crosstalk	Settles
	W24	Discussion Paper	Settles
May	F3	Final Exam 7:30-9:30 AM (unless students agree on a different time)	Settles

## PREREQUISITES

PCB 5065 Advanced Genetics and PCB 5530 Plant Molecular Cell Biology or equivalent

## READING

There is no required textbook for this course. However, there will be a great quantity of required reading in the form of review and research articles from the primary literature. These will be provided in electronic format. Discussion papers will be provided one week prior to the scheduled discussion. Papers will be emailed to students or the references given, allowing students to download papers, which will be freely available to members of the UF faculty and student body through the library system. Students are queried for availability of computers and color printers and accommodations will be made to ensure that each student has access to high quality reproductions of class notes and research papers. Each section of the course will feature a discussion paper from the current literature. The following books may be useful for background reading on various topics.

1. Molecular Biology of the Cell, 4th edition. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. New York: Garland Science; 2002. This book is available in search mode on NCBI's Pubmed
2. Biochemistry and Molecular Biology of Plants, B. Buchanan, W.Gruissem & R. Jones, 2000, ASPP (ISBN 0-943088-39-9) Wiley and sons.

A complete list of required review and research papers for each of the four sections of the course are listed at the end of this syllabus.

## CLASS ATTENDANCE

Students are expected to attend all class sessions. Attendance at sessions featuring a Discussion Paper is mandatory. Class attendance and participation are a major component of student's grades.

## CLASSROOM ETIQUETTE

You are expected to be courteous to your fellow students, be on time and turn off your cell phones. Your attendance at all classes is a firm expectation, but if you are ill or an emergency occurs, you are expected to contact your instructor prior to the scheduled class time.

## GRADING POLICY

The four sections of this course will be graded independently and non-cumulatively. The final grade will be determined by performance on 4 sections. In general, each will be worth 100 points, but this value will be normalized based on the number of class periods. Homework will be assigned and graded and will constitute 10% of the grade. Active participation in class discussions of research papers is an essential part of this course and will constitute 10% of the grade.

The exam will test student comprehension of the material and ability to apply it to novel situations and will constitute 80% of the grade. Instructors for each module will communicate their breakdown of points among participation in lecture discussions, paper discussions, homework, and exams.

The final grading scale is based on historical performance cut offs, as shown in the table below:

Letter Grade*	Grade Points**	Percentage
A	4.0	80-100
B+	3.33	70-79
B	3.0	60-69
C+	2.33	55-59
C	2.0	40-54
E	0	<39

\* Letter grades below C are not considered passing grades at the graduate level, therefore not included. Letter grades A- and B- do not reflect a statistically different performance at the graduate level and also not included.

\*\* Information on current UF general grades and grading policies can be found at <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx> and at the Graduate Catalog at <http://gradcatalog.ufl.edu/content.php?catoid=2&navoid=762#grades>

## EXAMS

The course is divided into four sections with an exam following the completion of each section (see schedule). Exams are either closed book and closed notes or take home; see syllabus. If a student has another exam scheduled for the time of a PCB 6528 exam, or if a PCB 6528 exam falls on a religious holiday that a student traditionally observes, an alternate time will be arranged for that student's exam. Please notify the instructor of these conflicts in advance of the exam. Students who cannot take a scheduled exam due to illness or last minute emergencies should contact the instructor prior to the exam if at all possible. Arrangements will be made for a makeup exam in those cases.

## ACADEMIC HONESTY, SOFTWARE USE, CAMPUS HELPING RESOURCES, SERVICES FOR STUDENTS WITH DISABILITIES

### ACADEMIC HONESTY

In 1995 the UF student body enacted an honor code and voluntarily committed itself to the highest standards of honesty and integrity. When students enroll at the university, they commit themselves to the standard drafted and enacted by students.

**The Honor Pledge: We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity.**

On all work submitted for credit by students at the university, the following pledge is either required or implied: **"On my honor, I have neither given nor received unauthorized aid in doing this assignment."**

Students should report any condition that facilitates dishonesty to the instructor, department chair, college dean, Student Honor Council, or Student Conduct and Conflict Resolution in the Dean of Students Office. (Source: 2011-2012 Undergraduate Catalog)

It is assumed all work will be completed independently unless the assignment is defined as a group project, in writing by the instructor.

This policy will be vigorously upheld at all times in this course.

## SOFTWARE USE

All faculty, staff and students of the university are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against university policies and rules, disciplinary action will be taken as appropriate.

## CAMPUS HELPING RESOURCES

Students experiencing crises or personal problems that interfere with their general well-being are encouraged to utilize the university's counseling resources. The Counseling & Wellness Center provides confidential counseling services at no cost for currently enrolled students. Resources are available on campus for students having personal problems or lacking clear career or academic goals, which interfere with their academic performance.

- **University Counseling & Wellness Center, 3190 Radio Road, 352-392-1575, [www.counseling.ufl.edu/cwc](http://www.counseling.ufl.edu/cwc)**  
 Counseling Services  
 Groups and Workshops  
 Outreach and Consultation  
 Self-Help Library  
 Training Programs  
 Community Provider Database
- **Career Resource Center, First Floor JWRU, 392-1601, [www.crc.ufl.edu](http://www.crc.ufl.edu)**

## SERVICES FOR STUDENTS WITH DISABILITIES

The Disability Resource Center coordinates the needed accommodations of students with disabilities. This includes registering disabilities, recommending academic accommodations within the classroom, accessing special adaptive computer equipment, providing interpretation services and mediating faculty-student disability related issues.

0001 Reid Hall, 352-392-8565, [www.dso.ufl.edu/drc](http://www.dso.ufl.edu/drc)

## LIST OF REQUIRED REVIEW AND RESEARCH PAPERS

Week	Required Reading Papers
1/ 9-13	de Duve C. The Birth of Complex Cells. Scientific American 1996. April pp50-57
	de Duve C. The origin of eukaryotes: a reappraisal. Nat Rev Genet. 2007.8(5):395-403.
	Detail Paper: Hoepfner D, Schildknegt D, Braakman I, Philippsen P, Tabak HF. Contribution of the endoplasmic reticulum to peroxisome formation. Cell. 2005
	Tabak HF, Hoepfner D, Zand A, Geuze HJ, Braakman I, Huynen MA. Formation of peroxisomes: present and past. Biochim Biophys Acta. 2006. 1763(12):1647-54. (Background review)
1/ 16-20	Endosomal functions in plants. Otegui MS, Spitzer C. Traffic. 2008 Sep;9(10):1589-98
	The plant Golgi apparatus--going with the flow. Hawes C, Satiat-Jeunemaitre B. Biochim Biophys Acta. 2005 Jul 10;1744(3):466-80.
	Detail Paper: Sparkes IA, Ketelaar T, Ruijter NC, Hawes C. Grab a Golgi: Laser trapping of Golgi bodies reveals in vivo interactions with the endoplasmic reticulum. Traffic. 2009 10: Pages 567 – 571. This is short; make sure you watch the online movies.
1/ 23-27	Lopez-Juez E, Pyke KA. Plastids unleashed: their development and their integration in plant development. Int J Dev Biol. 2005;49:557-77.
	Logan DC. The mitochondrial compartment. J Exp Bot. 2007;58(1):1225-43

	Mechanisms of lipid transport involved in organelle biogenesis in plant cells. Benning C. <i>Annu Rev Cell Dev Biol.</i> 2009;25:71-91.
	Osteryoung KW, Nunnari J. The division of endosymbiotic organelles. <i>Science.</i> 2003 302(5651):1698-704.
	Detail Paper: Glynn JM, Froehlich JE, Osteryoung KW. Arabidopsis ARC6 coordinates the division machineries of the inner and outer chloroplast membranes through interaction with PDV2 in the intermembrane space. <i>Plant Cell.</i> 2008;20:2460-70.

Week	Required Reading Papers (continued)
1/ 30-2/1	Jarvis P, Robinson C. Mechanisms of protein import and routing in chloroplasts. <i>Curr Biol.</i> 2004 14(24):1064-77.
	Herrmann JM. Converting bacteria to organelles: evolution of mitochondrial protein sorting. <i>Trends Microbiol.</i> 2003 11:74-9.
	Protein transport into chloroplasts. Li HM, Chiu CC. <i>Annu Rev Plant Biol.</i> 2010;61:157-80.
	Emanuelsson O, von Heijne G. 2001. Prediction of organellar targeting signals. <i>Biochim Biophys Acta.</i> 12;1541(1-2):114-9. Review. This will help you use the online trafficking prediction programs
	Detail paper: Reconstitution of protein targeting to the inner envelope membrane of chloroplasts. Li M, Schnell DJ. <i>J Cell Biol.</i> 2006.175(2):249-59.
2/6-13	Blanchoin et al (2010) Actin dynamics in plant cells: a team effort from multiple proteins orchestrates this very fast-paced game. <i>Curr Opin Plant Biol</i> 13(6):714-723. doi:10.1016/j.pbi.2010.09.013
	Pastuglia M, Bouchez D. Molecular encounters at microtubule ends in the plant cell cortex. <i>Curr Opin Plant Biol.</i> 2007 Dec;10(6):557-563.
	Mutwil et al (2008) Cellulose synthesis: a complex complex. <i>Current Opinion in Plant Biology</i> Volume 11, Issue 3, Pages 252-257.
	Crowell EF, Gonneau M, Vernhettes S, Höfte H. (2010) Regulation of anisotropic cell expansion in higher plants. <i>C R Biol.</i> 333(4):320-324.
	Paredes AR, Somerville CR, Ehrhardt DW. Visualization of cellulose synthase demonstrates functional association with microtubules. <i>Science.</i> 2006 312(5779):1491-1495.
	Müller S, Wright AJ, Smith LG. Division plane control in plants: new players in the band. <i>Trends Cell Biol.</i> 2009 Apr;19(4):180-8.
2/15-17	Walker KL, Müller S, Moss D, Ehrhardt DW, Smith LG. (2007) Arabidopsis TANGLED identifies the division plane throughout mitosis and cytokinesis. <i>Curr Biol.</i> 17(21):1827-1836.
	Wicke S, GM Schneeweiss, CW dePamphilis, KF Müller, D Quandt (2011) The evolution of the plastid chromosome in land plants: gene content, gene order, gene function. <i>Plant Mol Biol.</i> 76:273-97
2/20	Kubo, T and KJ Newton (2008) angiosperm mitochondrial genomes and mutations. <i>Mitochondrion</i> 8:5-14
	Stegemann S, M Keuthe, S Greiner and R Bock (2012) Horizontal transfer of chloroplast genomes between plant species. <i>Proc Natl Acad Sci USA [Epub ahead of print]</i> www.pnas.org/cgi/doi/10.1073/pnas.1114076109
	Stegemann S and Bock R (2009) Exchange of genetic material between cells in plant tissue grafts. <i>Science</i> 324:649-51
2/22-24	Liere, K, A Weihe and T Borner (2011) The transcription machineries of plant mitochondria and chloroplasts: Composition, function, and regulation. <i>J Plant Physiol</i> 168:1345-60.
	del Campo, EM (2009) Post-transcriptional control of chloroplast gene expression. <i>Gene Reg Sys Biol</i> 3:31-47
	Pogson BJ, Woo NS, Förster B, Small ID (2008) Plastid signalling to the nucleus and beyond. <i>Trends Plant Sci</i> 13:602-9
2/27	Schmitz-Linneweber, C and I Small (2008) Pentatricopeptide repeat PPR proteins: a socket set for organelle gene expression. <i>Trends Plant Sci</i> 13:663-670
	Pfalz, J, OA Bayraktar, J Prikryl and A Barkan (2009) Site-specific binding of a PPR protein defines and stabilizes 5' and 3' mRNA termini in chloroplasts. <i>EMBO J</i> 28:2042-2052
3/12	Hua and Vierstra, 2011, <i>Annual Review of Plant Biology</i> , 62:299-234
3/14	Argueso CT, Raines T, Kieber JJ. <i>Curr Opin Plant Biol.</i> 2010 Oct;13(5):533-9
	Zhao Q, Guo HW. <i>Mol Plant.</i> 2011 Jul;4(4):626-34.
3/19	Dharmasiri N, Dharmasiri S, Estelle M. <i>Nature.</i> 2005 May 26;435(7041):441-5.
	Kepinski S, Leyser O. <i>Nature.</i> 2005 May 26;435(7041):446-51.
3/ 23	Hirano K, Ueguchi-Tanaka M, Matsuoka M. <i>Trends Plant Sci.</i> 2008 Apr;13(4):192-9.
	<b>Discussion Paper:</b> Ueguchi-Tanaka M, Ashikari M, Nakajima M, Itoh H, Katoh E, Kobayashi M, Chow TY, Hsing YI, Kitano H, Yamaguchi I, Matsuoka M. <i>Nature.</i> 2005 Sep 29;437(7059):693-8
3/26 -28	Phytochrome signaling mechanisms and the control of plant development. Chen M, Chory J. <i>Trends Cell Biol.</i> 2011 Nov;21(11):664-71. Epub 2011 Aug 17.
	Light-regulated plant growth and development. Kami C, Lorrain S, Hornitschek P, Fankhauser C. <i>Curr Top Dev Biol.</i> 2010;91:29-66
3/30	The circadian system in higher plants. Harmer SL. <i>Annu Rev Plant Biol.</i> 2009;60:357-77
4/2	Photoreceptor regulation of CONSTANS protein in photoperiodic flowering. Valverde F, Mouradov A, Soppe W, Ravenscroft D, Samach A, Coupland G. <i>Science.</i> 2004 Feb 13;303(5660):1003-6.

Week	Required Reading Papers (continued)
4/4-23	Miwa H, Kinoshita A, Fukuda H, Sawa S. Plant meristems: CLAVATA3/ESR-related signaling in the shoot apical meristem and the root apical meristem. <i>J Plant Res.</i> 2009 Jan;122(1):31-9.
	Dong J, Bergmann DC. Stomatal patterning and development. <i>Curr Top Dev Biol.</i> 2010;91:267-97.
	Ishida et al (2008) A Genetic Regulatory Network in the Development of Trichomes and Root Hairs. <i>Annu Rev Plant Biol.</i> 2008;59:365-86 NOTE- only pp. 365-369 are relevant
	Kurata et al (2005) Intercellular movement of transcription factors. <i>Curr Opin Plant Biol.</i> 8:600-605.
	Bolduc et al (2008) Dual Functions of the KNOTTED1 Homeodomain: Sequence-Specific DNA Binding and Regulation of Cell-to-Cell Transport. <i>Sci Signal.</i> 2008 Jun 10;1(23):pe28
	<b>Discussion Paper:</b> Xie Z, Lee E, Lucas JR, Morohashi K, Li D, Murray JA, Sack FD, Grotewold E. Regulation of cell proliferation in the stomatal lineage by the Arabidopsis MYB FOUR LIPS via direct targeting of core cell cycle genes. <i>Plant Cell.</i> 2010 22(7):2306-21.
	Feraru E, Friml J. (2008) PIN polar targeting. <i>Plant Physiol.</i> 147(4):1553-9.
	Bowman JL, Floyd SK.(2008) Patterning and polarity in seed plant shoots. <i>Annu Rev Plant Biol.</i> 59:67-88.
	<b>Discussion Paper:</b> Huang F, Zago MK, Abas L, van Marion A, Galván-Ampudia CS, Offringa R. Phosphorylation of conserved PIN motifs directs Arabidopsis PIN1 polarity and auxin transport. <i>Plant Cell.</i> 2010 22(4):1129-42.