

Course Title	Understanding Plants		
Programme Title	Undergraduate Programme-Biology Major		
Mode	M1	Level	3
Course ID	BIO	Credits	3
Course Type	Core	Semester	V
Academic Year	2017-18		
Course Development Team	Jayanti Ray-Mukherjee [discussions with Michal Gruntman*, Merav Seifan**, and Omer Falik**]		

Rationale

The study of plants is central to the study of Biology. This is a core course in the fifth semester of the Biology Program and hence compulsory for Biology major students and can serve as an elective for Biology minor students. This is a level 3 course and hence has a prerequisite of Introductory Biology I and II. This course will utilize and integrate concepts from other courses, such as, molecular biology and biochemistry (3rd semester), ecology and evolution (4th semester), and Biophysics (5th semester). This is a level 3 course and will be taught through discussion of relevant research papers and text materials.

Objectives

Through this course the students will be able to develop their abilities in two aspects:

1. To be able to identify how compare how ecology and evolution has shaped plant form, function, and their interactions.
2. To be able to observe and recognize the network of different functions and interactions in the plant world and how that shapes plants' fate in a community.
3. Critically analyze and evaluate research papers and synthesize ideas from a paper, discuss and lead discussions.
4. Conceptualize relevant questions in plant science, design experiments through projects, collect, and analyze data.
5. Interpret data and synthesize different concepts in plant science through the interdisciplinary nature of biology.

Unit Description

The suggested course title, “Understanding Plants” is to understand the true nature of “*botane*”, what the ancient Hellenes meant by, ‘*able to perceive and to react to what is happening in their environment at the level of sophistication far surpassing that of humans*’. The overarching goal of this course is to learn about the evolutionary consequences of different form and function and how it shapes plant strategies and interactive outcomes in a community. Through discussions of relevant text materials, the instructor will aid the student to acquire a deep understanding of the philosophies of plant form, function, interactions, and behavior.

This course will have 3 units. Each of these units will undertake a research-based approach, where students will be engaged either individual or group project (based on the unit)

A. Plant form and function (3 weeks):

This section will cover the study of shapes and forms, how these forms relates to function and how form and functions have been shaped through evolution.

Through research-based approach this section will cover the following topics;

- Evolution of shoot structure and its function
- Evolution and diversification of roots and its function
- Canopy evolution and function
- How does structural evolution influence plant interactions?

B. Plant and their interactions (7 weeks):

This section will cover the study of plant interactions and how these interactions shape community dynamics. This unit will involve the apprehension of plant and their interactions at an evolutionary level. Through research-based approach this section will cover the following topics;

- Pollination as mutualism
- Herbivory or plant predation
- Dispersal as mutualism
- Mimicry or the mirror world
- Carnivory and predation in plants

C. Plant senses and behavior (4 weeks):

This section will cover the study of plant perceptions, signaling, and behavior. This unit will involve the apprehension of plant and their interactions at a proximal level. Through discussion-based approach this section will cover the

following topics that will help students to analyze and evaluate (myth versus reality);

- What a plant sees?
- What a plant hears?
- What a plant feels?
- What a plant smells?
- What a plant remembers?

Schedule and Readings

Classes will be largely discussion based along with interactive lectures, where students will be asked to lead discussions and organize their ideas and present relevant topics. In addition to this, videos will be used to demonstrate topics under various categories.

Week-wise course syllabus:

The readings in the following table are tentative and will be used as discussion topics. Excerpts from these readings will be assigned to the students.

Unit	Week	Topic	Readings and other resources
Unit 1: Plant form and function	1	Introduction to syllabus and course	Movie: Life of plants
	1	Evolution of photosynthesis, shoot structures and specialized organs for terrestrial life.	Selected topics from chapters 2 & 3 of the book Evolution of plants.
	2		
	2		
	3	Evolutionary trends in root and canopy structure; Biogeographical distribution of global vegetation	Selected topics from chapters 4, 6, & 7 of the book Evolution of plants
	3		
	4		
	4	Structural evolution and plant interactions	Class debate and discussion
	5	EXAM 1 (Written)	
Unit 2: Plant and their interactions	5	Introduction to species interactions, mechanisms of species coexistence, and competition	Harison, Smith, and Slobodkin 1960, Am Nat. Murdock 1966, Am Nat. Refs: Wright 2002 Oecologia & Wilson 1990 New Zealand Journal of Ecology
	6		
	6	Plant-pollinator interactions: cost of sex, types of pollen dispersal,	Bell 1985 Proc. R. Soc. Lond; Kunin 1993 Ecology.
	7		
	7		

	8		
	8	Dispersal as mutualism	Janzen 1969 Evolution Wenny 2000 Biotropica
	9		
	9	Plant-herbivore interactions: cost of herbivory, defence mechanisms, energy pathway,	Baldwin and Schultz 1983 Science, Baldwin et al. 2006 Science. Belsky 1986 Am Nat. Crawly 1986 TREE
	10		
	10	Mimicry or the mirror world, evolution of mimicry and mimicry in plants	Schiestl 2005
	11		
	11	Carnivory and predation in plants	Campbell Biology Clarke et al. 2009 Biology Letters
	12	EXAM 2 (Written)	
Unit 3: Plant senses and behavior			
	12	Introductory discussion to plant senses and signaling; what plant sees and smells	Baldwin and Schultz 1983 Science, Baldwin et al. 2006 Science. Chory 2010 The Plant Journal Runyon et al. 2010 Science
	13		
	13		
	14		
	14		
	15	What plant feels, hears, and remembers	Shepherd 2005 Cell and Molecular Biology Creath and Schwartz 2004 J Alt. Medicine.
	15		
	16		
	16	FINAL EXAM (Viva)	

Books (specific materials/chapters from these texts will be assigned)

- Aber, A. 2012. The natural philosophy of plant form. Cambridge University Press, New York, USA.
- Roberts, K. 2007. Handbook of plant science. Wiley-Blackwell, West Sussex, England, UK.
- Willis, K. J. and McElwain, J. C. 2014. The Evolution of Plants. Oxford University Press. Oxford UK.
- Herrera, C. M. and Pellmyr, O. 2002. Plant-Animal Interactions. Blackwell Publishing, Malden, MA. USA.
- Reece et. al. 2014. Campbell Biology, 10th edition, Pearson Education Inc., Glenview, IL, USA.

Journal articles:

Assigned readings:

- Baldwin, J.T. and Schultz, J.C. 1983. Rapid changes in tree leaf chemistry induced by damage: evidence for communication between plants. *Science* 221: 277-279.
- Bell, G. 1985. On the function of flowers. *Proceedings of the Royal Society of London Series B, Biological Sciences* 224:223-265.
- Chory J. 2010. Light signal transduction: an infinite spectrum of possibilities. *The Plant Journal* 61: 982-991.
- Clarke, C.M., Bauer, U. Lee, C.C., Tuen, A.A., Rembold, K. and Moran J.A. 2009. Tree shew lavatories: a novel nitrogen sequestration strategy in a tropical pitcher plant. *Biology Letters* 5: 632-635.
- Belsky, A.J. 1986. Does herbivory benefit plants? A review of the evidence. *The American Naturalist* 127: 870-892.
- Crawley, M.J. 1987. Benevolent herbivores? *TREE* 167-168.
- Harrison, N.G., Smith, F.E., and Slobodkin, L. B. 1960. Community structure, population control, and competition. *The American Naturalist* 94: 421-425.
- Murdoch, W.W. 1966. "Community structure, population control, and competition" – A critique. *The American Naturalist* 912: 219-226.
- Shephard, V.A. 2005. From semi-conductors to rhythms of sensitive plants: a research of J.C.Bose. *Cellular and Molecular Biology* 51: 607-619.
- Wenny D. G. 2000. Seed dispersal of a high quality fruit by specialized frugivores: high quality dispersal? *Biotropica* 32: 327-337.
- Wright, S.J. 2002. Plant diversity in tropical forests: a review of mechanisms of species coexistence. *Oecologia* 130: 1-14.

Optional readings:

- Baldwin, I.T. Halitchke, R., Paschold, A., von Dahl, C.C., and Preston, C.A. 2006 Volatile signaling in the plant-plant interactions: "Talking trees" in the genomics era. *Science* 311: 812-815.
- Creath, K. and Schwartz, G.E. 2004. Measuring effects of music, noise, and healing energy using a seed germination bioassay. *Journal of Alternative and Complementary Medicine* 10: 113-122.
- Kunin, W.E. 1993. Sex and the single mustard: population density and pollinator behavior effects on seed-set. *Ecology* 74: 2145-2160.
- Nisbet, E.G. and Sleep, N. H. 2001. The habitat and nature of early life. *Nature* 409: 1083-1091.
- Runyon, J.B., Mescher, M.C. and De Moraes, C.M. 2006. Volatile chemical cues guide host location and host selection by parasitic plants. *Science* 313: 1964-1967.
- Schiestl, F.P. 2005. On the success of a swindle: pollination by deception in orchids. *Naturwissenschaften* 92: 255-264.

Wilson, J.B. 1990. Mechanisms of species coexistence: twelve explanations for Hutchinson's Paradox of the Plankton: Evidence from New Zealand plant communities. New Zealand Journal of Ecology 13: 17-42.

Assessment

- A. Quizzes, assignments, and exams (50%):** There will be three quizzes (10%) covering three units, four assignments (20%), and two oral exams (20%), one at the end of the semester and one at the end of unit 2. This will serve to assess objectives 1 & 2 and evaluate students on knowledge of the subject matter.
- B. Presentations and leading discussions (20%):** A group of students (2-3) will be given chance to lead a discussion and synthesize and present it to the class and face peer-review. This will test their skills in analyzing and synthesizing topics in science and improve their presentation skills.
- C. Group project (30%):** A group of students (4 each) will be asked to come up with project ideas from any of the three units of the course. They will be carrying out the project throughout the course and present their findings towards the end of the semester. Assessment will be on 1-page individual proposal (5%), project work and sharing of responsibilities (10%), poster presentation (10%), and participation and answering questions in front of poster (5%).