

CITY UNIVERSITY OF NEW YORK GRADUATE SCHOOL  
Ph.D. PROGRAM IN BIOLOGY – 2011 PLANT SCIENCES FIRST EXAMINATION

**SESSION I. ESSAY to submit before the morning session. (TOTAL 100 points)**

**Instructions:** Submit the Session I essay in hard copy and in electronic form as a PDF file. Do not put your name on either, use your student number for filename and for marking the hard copy. Make sure that in “properties” there is no notation of “author”.

Present a subject, problem, hypothesis, theory, or controversy you consider important to plant sciences. **The essay must be hypothesis driven.** The essay should show relevance across the botanical subdisciplines. The essay should be both a review and a synthesis and demonstrate the level of scholarship, criticism, and independent thinking we require at the doctoral level. Your topic may be a large or a small one; broad or highly specialized; and you must communicate how the chosen topic is relevant to a major concept. We wish to measure the ability to understand and to synthesize information and ideas from more than one discipline of biology.

The paper should have a title and begin with a **one paragraph abstract/summary which includes your hypothesis** (hypothesis sentence should be in *italics* and include the word “hypothesis”). The paper should be paginated and written with 11 pt. Arial or equivalent font, one-inch margins, and a **maximum of five (5) pages of double spaced text** followed by a minimum of 15 (complete) literature citations provided in the format required by the journal, *Plant Physiology* (see: <http://www.plantphysiol.org/misc/ifora.shtml>).

Following the literature citation section, provide the names (from faculty in the CUNY Biology PhD program) of two potential “reviewers” along with their areas of expertise which you feel make them appropriate to reviewers of your manuscript.

*Note: an essay based largely on the published work or grant proposals of faculty staff members or scientists at other institutions is not acceptable. The essay must be your own idea and not the product of a collaborative effort. Faculty should not be consulted in development of your essay.*

**SESSION II. MORNING (TOTAL 300 points)**

**Instructions:**

A- Answer basic botany definitions **Choose 10 questions. 5 points each.**  
50 points total)

B- Answer short answer botany questions (100 points) **Choose 5 questions. 10 points each.** 50 points total)

C- For your exam, **choose 5 out of 6 subject areas (PLANT SYSTEMATICS, PLANT MORPHOLOGY, PALEOBOTANY, BIostatISTICS, PLANT PHYSIOLOGY, PHYTOCHEMISTRY)** and answer only one essay per subject area. You will complete **two** essays in the morning session (200 points) and **three** essays in the afternoon session (300 points). Each essay is worth 100 points for a total of 500 points for the essays.

**SESSION III. AFTERNOON (TOTAL 300 points)**

**Instructions:** Of the remaining essay subject areas, choose three subjects (three essays) to complete.

### **A. Basic Botany, definitions.**

Choose 10 questions. 5 points each.

*Provide brief definitions of the following:*

1. Guard cell
2. C-4 photosynthesis
3. Rubisco
4. Vessel
5. Spongy mesophyll
6. Lichen
7. Seed fern
8. Tepal
9. Blue green alga
10. Dikaryotic
11. Endosperm
12. Rhizobia
13. Apoplast
14. Coenocyte
15. Micropyle
16. Andromonoecious
17. Peristome
18. Metaphase II
19. Meristem
20. Conjugation

### **B. Basic Botany, short answer.**

Choose 5 questions. 10 points each.

*Briefly answer the following:*

21. What is double fertilization in the plant life cycle? Which groups have this character?
22. How many different genomes are there in a typical diploid plant cell? What is the inheritance of each of these?
23. Briefly explain the hypothesis for the origin of chloroplasts?
24. What is the general equation for respiration?
25. What is the difference between a parasite and a mycoheterotroph (mycotroph)?
26. What are the properties and functions of vessels in land plants?
27. Is the progeny of self fertilization genetically identical to the parent? Why or why not?
28. What is the dominant phase of the lifecycle in each of the following groups: mosses, ferns, gymnosperms, angiosperms?
29. What is alternation of generations in the land plant lifecycle?
30. Give three examples of characters that show convergence and/or adaptation in desert plants.

### C. Essays

For your exam, **choose 5 out of 6 subject areas (PLANT SYSTEMATICS, PLANT MORPHOLOGY, PALEOBOTANY, BIostatISTICS, PLANT PHYSIOLOGY, PHYTOCHEMISTRY)** and answer only one essay per subject area. You will complete **two** essays in the morning session (200 points) and **three** essays in the afternoon session (300 points). Each essay is worth 100 points for a total of 500 points for the essays.

#### PLANT SYSTEMATICS

(Choose only ONE of the two essays, 100 points)

1. For the paper by Crayn et al. (2004), answer the following questions. Your answers should be written in your own words, as complete sentences, and not as lists or fragments.

**A.** Why were the Bromeliaceae chosen for a study of adaptive radiation and the origins of CAM photosynthesis? (10 points)

**B.** What was the authors' rationale for the sampling of taxa that they chose? How do you know that they provided the best possible selection of taxa? Practical considerations aside, would it be better to sample more taxa? (20 points)

**C.** What are "inferred indels" and why is the coding of these characters important for the phylogenetic analysis? (10 points)

**D.** What is the authors' explanation of their decision to use "successive weights analysis"? What is *your* explanation of the authors' decision to do this? (10 points)

**E.** What are the "data partitions" that are discussed by the authors? (10 points)

**F.** Please explain the following methodology: "The character states 'C3' and 'CAM,' and 'terrestrial' and 'epiphytic' were mapped onto the strict consensus tree by using MACCLADE 3.08a." (20 points)

**G.** Looking at Fig. 2, what is your interpretation of the evolutionary relationship between life form and photosynthetic pathway? How does the authors' interpretation differ from yours? Looking at these features separately, what can you say about the origin of each (epiphytism, CAM photosynthesis)? (20 points)

2. For the paper by Hughes & Eastwood (2006), answer the following questions. Your answers should be written in your own words, as complete sentences, and not as lists or fragments.

**A.** Why do the authors wish to address questions about the timing and rates of speciation in *Lupinus*? Why would the authors compare their results for *Lupinus* with those found for African cichlid fish? (10 points)

**B.** In the introduction, how do the authors explain the difference between speciation rates in African cichlids and those of bird, arthropod, and plant radiations that have been examined? Provide an alternative explanation. (20 points)

**C.** Provide an interpretation of Fig. 3, and explain what it says about the origin(s) and relationships of Andean *Lupinus*? Is the Andean clade unambiguously derived from the Mexican Clade? (20 points)

**D.** How does one calculate a “per-lineage speciation rate”? What units are used to express this rate? Please explain one potential source of uncertainty in this calculation. (20 points)

**E.** The authors interpret the data to suggest that Andean *Lupinus* has diversified at a higher rate than other angiosperm clades that have “island-like diversifications.” In what sense are the Andes “island like”? How do the authors explain the rate difference between the Andes and other “islands”? (20 points)

**F.** What is the limitation of traditional DNA sequence data to provide resolution in groups that have relatively recent diversifications? How did the authors overcome this limitation for the *Lupinus* study? (10 points)

## PLANT MORPHOLOGY

(Choose only ONE of the two essays, 100 points)

3. For the paper by Imiachi and Kato (1991), answer the following questions. Your answers should be written in your own words, as complete sentences, and not as lists or fragments.

**A.** What was the objective of this paper (20points)?

**B.** What were the major findings of this paper (20 points)?

**C.** What is a rhizophore and what are the hypotheses regarding rhizophore identity (20 points)?

**D.** The rhizophore is an enigmatic plant structure. If you were going to study rhizophores, which species would you choose and why? From among the hypotheses listed above, which would you choose to test? What techniques would you use and what data would you collect? Describe some potential outcomes, how you would interpret the results, and how they would bear on your hypothesis. (40 points)

4. For the paper by McClellan (1993), answer the following questions. Your answers should be written in your own words, as complete sentences, and not as lists or fragments.

**A.** This paper explores one particular set of experiments to study heteroblasty. What is heteroblasty? What is heterochrony? What is the relationship between these terms? (20 points)

**B.** What was the objective of this paper and what methods were used? (20 points)

**C.** Do you think the study species chosen were appropriate for this study? Explain. (20 points)

**D.** This paper explores one particular set of experiments to study heteroblasty. Design a unique set of experiments to study heteroblasty in a different taxon (i.e., something other than *Begonia*). Which plant would you choose to study and why? State a hypothesis that you would test. What techniques would you use and what data would you collect? Describe some potential outcomes, how you would interpret the results, and how they would bear on your hypothesis. (40 points)

## PALEOBOTANY

(Choose only ONE of the two essays, 100 points)

5. For the paper by Rothwell and Nixon (2006), answer the following questions. Your answers should be written in your own words, as complete sentences, and not as lists or fragments. (100 points)

**A.** What is the primary goal of the study? (10 points.)

**B.** What was the source of data that the authors used to reconstruct phylogenies? Why did they use data from these sources? (10 points)

**C.** Why do the authors de-emphasize the resultant phylogenetic trees produced by their study? (20 points)

**D.** Why is it important to examine the large-scale evolutionary relationships of land plants? (20 points)

**E.** Based on this study, provide an example of a euphyllophyte group that remains systematically problematic. In what way is it problematic? What course do the authors suggest to clarify the systematic placement of this group? Does this seem tenable? (20 points)

**F.** Suppose you were called upon to teach a course in Plant Taxonomy. Based on the results of this study, would you include fossil taxa? Describe how you would organize the information about land plants and what sequence you would follow in your coverage of plant diversity. Why? (20 points)

6. For the paper by Kenrick and Crane (1991), answer the following questions. Your answers should be written in your own words, as complete sentences, and not as lists or fragments (100 points)

- A.** What is the primary question that the authors are attempting to address? (10 points)
- B.** What is the reason for using water-conducting cells for this study? (10 points)
- C.** What are G-type and S-type tracheids? Why would the structure of water-conducting cells be problematic in a phylogenetic study that includes fossils? (20 points)
- D.** Which taxa are considered tracheophytes? Based on the results, how many independent origins of water-conducting cells are indicated? (20 points)
- E.** What are the larger implications of this study's findings on phylogenetics of both living and fossil plants? (20 points)
- F.** Suppose you were called upon to teach a course in Plant Taxonomy. Based on the results of this study, describe how you would organize information about embryophyte plants, especially in terms of the distinctions between vascular and non vascular plants? Would you address the phylogenetic relationships in a single lecture or at different times through the semester? Why? Would you include fossil plants? Why? (20 points)

## **BIOSTATISTICS**

(Choose only ONE of the two essays, 100 points)

7. For the paper by Marshall et al. (2009) answer the following questions. Your answers should be written in your own words as complete sentences and not as fragments or lists.

- A.** What statistical methods were used and why do you think the investigators chose these methods? (20 points)
- B.** Provide a critical review of the statistical handling of "ratios." (20 points)
- C.** Tree seedling size at time zero in the experiment was not presented. Explain how this variable could be dealt with statistically to see if it had a significant effect on the outcome of the experiment. (20 points)
- D.** Comment on the statistical quality and completeness of Figure and Table legends. (20 points)
- E.** Suggest and defend alternative statistical methods. (20 points)

8. For the paper by Katz et al. (2010) answer the following questions. Your answers should be written in your own words as complete sentences and not as fragments or lists.

- A.** What statistical methods were used and why do you think the investigators chose these methods? (20 points)

- B. Provide a critical review of the use of the t-test and of the reporting of p-values. (20 points)
- C. Comment on the use of “correlation” (i.e., Table 2; Fig. 2, 3, 4; first sentence of Discussion). (20 points)
- D. Comment on the statistical quality and completeness of Figure and Table legends. (20 points)
- E. Suggest and defend alternative statistical methods. (20 points)

## PLANT PHYSIOLOGY

(Choose only ONE of the two essays, 100 points)

9. Answer the following questions about the paper Rodriguez et al. (2006). Your answers should be written in your own words.

- A. What was the main hypothesis of this study? Briefly describe how the authors evaluated this using transgenic lines. (10 points)
- B. What is SDS-PAGE? Briefly explain figure 2 in the paper. Where is the plant FNR localized in the cell? What is the evidence for this localization in the study? (25 points)
- C. Ferredoxin is an important iron sulfur protein required in photosynthesis. Explain the linear and cyclic electron flow and the complete electron transport system and Calvin cycle and the role of ferredoxin in photosynthesis. Why do the plants have cyclic and linear electron flow? (30 points)
- D. “Plants expressing various levels of FNR failed to show significant differences in CO<sub>2</sub> assimilation rates when assayed over a range of light intensities and CO<sub>2</sub> concentrations.” Why? Explain in detail. What was the conclusion of the study? Based on the conclusions of the study, if you were to propose a new study, what would be the main hypothesis of the study? Explain the rationale for the study. (35 points)

10. Answer the following questions about the paper Chen et al. (2010). Your answers should be written in your own words.

- A. How did the authors assess the expression of FRO2 and FIT genes in the WT and auxin and NO-related mutants? How do you assess the tissue specific expression pattern of FRO1, IRT1 and FER genes and the regulation of these genes during Fe deficiency and sufficiency? (20 points)
- B. Based on figure 7, what is the role of FIT1 and FRO2 in Fe homeostasis? Where are FIT1 and FRO2 expressed in plants and under what conditions? (20 points)
- C. In the study, aux1-7, and axr1-3 are both auxin insensitive mutants but they responded differently to iron deficiency. Why? What is the role of auxin in iron homeostasis? Explain in detail the role of auxin and NO in Fe homeostasis. Does one even precede the other? How and what is the evidence provided in the paper? (20 points)

- D. Explain in detail the mechanism of Fe transport (xylem and phloem) from the soil solution to the possible final locations in aerial tissues, discussing the various transport mechanisms that would be required to traverse this distance. In particular, highlight the difference in Fe transport and accumulation between the Col-0 and *fit* mutants. (30 points)
- E. What is the difference between strategy I and strategy II plants? Explain the different mechanisms of Fe acquisition between the 2 groups. (10 points)

## PHYTOCHEMISTRY

(Choose only ONE of the two essays, 100 points)

- 11. For the paper by Jaki *et al.*, 2008, answer the following:
  - A. What is the principle hypothesis or the research question addressed in this paper? (20 points)
  - B. What are pentacyclic plant triterpenes, and how are they biosynthesized? (20 points)
  - C. Discuss one of the analytical chemical techniques in the paper, and the advantages and disadvantages to this method. (20 points)
  - D. Based on Figure 1, analyze what happens to the antimicrobial activity of ursolic acid as the purity of the compound varies. (20 points)
  - E. What implications does this research have for researchers looking at biologically active constituents from plants? (20 points)
  
- 12. For the paper by Geller *et al.*, 2009 answer the following:
  - A. What is the principle hypothesis or the research question addressed in this paper? (20 points)
  - B. What are the biologically active constituents from black cohosh and red clover, and why were these plants selected for this study? (20 points)
  - C. Define vasomotor symptoms, and discuss how they are measured. (20 points)
  - D. Using the data in Figure 2, explain the major findings for black cohosh. (20 points)
  - E. How would you change the study if you were to do further work on these botanicals? (20 points)