Course Syllabus/Spring 2016

21:120:430 Plant Growth and Development (Writing-Intensive) and 26:120:563 Topics in Modern Plant Biology

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INSTRUCTORS: Dr. Edward G. Kirby
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OFFICE NUMBERS: Boyden 202 (EGK)
Boyden 314 (MCC)

COURSE LOCATIONS: Lecture (both): Conklin 445
Laboratory (PGD): Boyden 224

MEETING TIMES: Lecture (both): Tue, Thu, 4-5:20 P.M.
Laboratory (PGD): Wed 4-6:50 P.M.

COURSE DESCRIPTION:

Study of the dynamics of growth and development of plants as influenced by physiological and environmental factors. Focus will be on the regulation of gene expression during plant development. Lecture topics will address modern plant molecular biology approaches. Laboratory focuses on plant tissue culture and applications to plant biotechnology. Lecture: 3 h; laboratory: 3 h (120:430 only).

PREREQUISITES:

21:120:330 Plant Physiology, or permission of instructor.

TEXTS:


Supplemental Text:

**Grading Policy:**

Your grade for this course will be determined based on the categories listed in the table below.

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midterm examination</td>
<td>30%</td>
</tr>
<tr>
<td>Writing Assignments</td>
<td>10%</td>
</tr>
<tr>
<td>Laboratory notebook and reports (120:430 only)</td>
<td>30%</td>
</tr>
<tr>
<td>Research paper (120:563 only)</td>
<td>30%</td>
</tr>
<tr>
<td>Final examination</td>
<td>30%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100%</strong></td>
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</table>
# Course Syllabus/Spring 2016

## 21:120:430 Plant Growth and Development (Writing-intensive) and 26:120:563 Topics in Modern Plant Biology

**Schedule and Course Outline:** Dates listed by week; lectures will meet twice every week (Tue, Thu, 4-5:20 p.m.) in Conklin 445 and the laboratory will meet every week (Wed 4-6:50 p.m.) in Boyden 224. Please make sure to have access to course’ Blackboard site.

<table>
<thead>
<tr>
<th>DATE</th>
<th>TOPIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>JANUARY</td>
<td></td>
</tr>
<tr>
<td>19, 21</td>
<td>Introduction; concepts of growth, differentiation, and differential growth; reading scientific literature (Kirby; Cervantes)</td>
</tr>
<tr>
<td>26, 28</td>
<td>Genetic basis for plant development; regulation of gene expression (Cervantes)</td>
</tr>
<tr>
<td>FEBRUARY</td>
<td></td>
</tr>
<tr>
<td>2, 4</td>
<td>Plant cell walls; plant cell division; polarity (Kirby)</td>
</tr>
<tr>
<td>9, 11</td>
<td>Roots, shoots, and leaves (Cervantes)</td>
</tr>
<tr>
<td>16, 18</td>
<td>Floral apex, genes, and reproductive development (Kirby)</td>
</tr>
<tr>
<td>23, 25</td>
<td>Flowering: genetic and physiological mechanisms, florigen; embryo and seed development (Kirby)</td>
</tr>
<tr>
<td>MARCH</td>
<td></td>
</tr>
<tr>
<td>1, 3</td>
<td>Maturation and senescence; embryo, seed development, dormancy (Cervantes)</td>
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<td></td>
<td><strong>MID TERM EXAM: Thursday, March 3</strong></td>
</tr>
<tr>
<td>8, 10</td>
<td>Tropisms; light regulation of plant growth and development (Cervantes)</td>
</tr>
<tr>
<td>12-20</td>
<td><strong>SPRING BREAK</strong></td>
</tr>
<tr>
<td>22, 24</td>
<td>Auxin: biochemistry, physiology, and mode of action (Cervantes)</td>
</tr>
</tbody>
</table>
29, 31  Gibberellins: biochemistry, physiology, and action (Cervantes)

APRIL

5, 7  Cytokinins and ethylene (Kirby)

12, 14  Abscisic acid and other regulators of plant growth; Developmental mutants of plants (Cervantes)

19, 21  Plant immunity (Cervantes; Kirby)

26, 28  Transgenics (Kirby)

GRADING:

Midterm Examination 30%
Writing assignments 10%
Laboratory notebook and reports (120:430 only) 30%
Research paper (120:563 only) 30%
Final Exam 30%
TOTAL 100%
## Course Syllabus / Spring 2016

### 21:120:430 Plant Growth and Development

**Laboratory Calendar**

**Instructor:** Mr. Anthony Brusa  
<eu.sclateri@gmail.com>

**Schedule and Course Outline:**

The laboratory will meet every week (Wed 4-6:50 p.m.) in Boyden 224. Please make sure to have access to course’s [Blackboard](https://blackboard.rutgers.edu) site.

<table>
<thead>
<tr>
<th>Date</th>
<th>Lab Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 21</td>
<td>No lab</td>
</tr>
</tbody>
</table>
| January 27   | Introduction to Plant Growth and Development:  
|              | Developmental; morphology  
|              | *Lab safety; lab notebooks, laboratory reports*                             |
| February 3   | Somatic embryogenesis in conifers: Effects of abscisic acid*                |
| February 10  | Auxins and cytokinins: Cotyledon cultures of Douglas fir (*Pseudotsuga menziesii*) |
| February 17  | The use of plant mutants in plant developmental biology                      |
| February 24  | Dynamics of cell suspension cultures of white spruce                        |
| March 2      | Gibberellin and barley aleurone                                               |
| March 9      | Gibberellin and barley aleurone II*                                          |
| March 12-20  | SPRING BREAK                                                                 |
| March 23     | Protoplast isolation and culture: tobacco mesophyll protoplasts              |
| March 30     | Pollen culture: Boron effects on pear pollen                                 |
| April 6      | Analysis of transgenic poplar plants                                          |
| April 13     | *Arabidopsis* gravitropic mutants                                            |
| April 20     | Laboratory conclusion                                                        |

*indicates laboratory reports will be required for these exercises
GRADING OF THE LABORATORY

Attendance at all laboratory sessions is required and attendance will be taken.

The laboratory portion of the course is worth 30% of your final grade, as follows:

1. Laboratory Notebook (15 points)
   You must keep a bound notebook of your experiments, their methods used, results, and conclusions.

   You must have a bound, quad-ruled laboratory notebook available at the Rutgers Bookstore (Barnes & Noble) and at New Jersey Books. When you get your note book, number the pages in ink and set aside the first two pages as a table of contents.

   You must be prepared for each lab exercise. At the beginning of each laboratory class period your lab instructor will check your notebook. It must include:
   o The title of the experiments we are scheduled to do that day
   o The date
   o A statement of the objective or purpose of the experiment
   o A list of materials and equipment needed for the experiment.

   During the laboratory period, record what was done and the data you collect. When you have finished the experiment have your lab instructor initial your notebook. You must include your results, analysis, and conclusions in the notebook. How you record your results will be different for each laboratory. The necessary graphs, calculations, and observations are described in the laboratory hand-outs.

   Three times during the semester your lab instructor will collect the notebooks and grade the results and conclusions.

2. Laboratory Reports (15 points)
   You are required to submit two formal laboratory reports on the following lab exercises:

   1. Somatic embryogenesis in conifers
   2. Dynamics of cell suspension cultures of white spruce

Refer to the Writing Guide for Laboratory Reports for the specific format for your laboratory reports.
INTRODUCTION:

You will be required to write TWO 4-5 page lab reports. The preparation of a good lab report begins long before you start the experiment.

Before arriving at the lab to conduct your experiment, you should have a clear understanding of your objective and your prediction about the general pattern of the results for the experiment. Also, it is CRITICAL that you organize your lab notebook in such a way that the techniques are clearly stated, including any variation from the lab hand-outs, and that the data and calculations are easily accessed and clearly legible. During your experiment, record your results in the form of tables or graphs. All numbers should be fully labeled and listed with units, so that they are understandable to someone who wasn’t there when you collected the data. (For example, you may decide to combine your data with data collected by another group.)

Also write down any problems you encountered that might affect the validity of your results. These notes will be extremely helpful when you discuss the validity and significance of your findings at the end of the report.

After finishing the experiment, take a few minutes and THINK about what you did and the results. It’s very important to write these reflections down immediately. If you don’t, you may be lacking crucial information that you will need to write the discussion section of your report. This reflection might take the form of answers to pre-lab questions, assessment of the other group’s response to your experiment, or further questions.

Here are a few questions you might ask yourself after finishing an experiment.

- Have I answered any of my questions from the pre-lab?
- What constructive criticism did the other group give me/us?
- How can I summarize what I’ve learned?
- What questions do I still have?
- If I/we had it to do over, what would we do differently?

Although what follows is the standard arrangement for a scientific report, you do not have to write the sections in that order. Begin with the easiest sections. Perhaps describing Methods will be easiest because you’ll simply be reporting what you did. Next you may want to describe your Results. Then prepare your graphs and tables and finish writing the other sections of your lab report. Write a quick first draft, getting down any of your ideas on paper. Once all the sections have been written, you can arrange them in the proper order for the report.

Lab reports should be written using MSWord, or other word processing software. Word will allow you to create tables very simply. Graphs can be created in MSExcel and then easily imported into your Word document.
CONTENT OF THE LAB REPORT:
Your lab report must have the following sections:

Title: A concise statement of the question(s) addressed in the experiment

Introduction: Background information and significance of the question under investigation

Methods: A brief description of the experiment and what you did.

Results: Presentation of your data, including observations, tables, and graphs

Discussion: Evaluation of the significance of the results; answers to questions in lab handouts

Conclusions: A concise statement of the conclusions you draw from the experiment

SECTIONS OF YOUR LAB REPORT

Title: The title is a statement of the problem; you can simply take your question and reword it as a statement.

Question: What is the effect of different wavelengths of light on hypocotyl growth of kidney beans?

Title: The Effect of Different Wavelengths of Light on Hypocotyl Growth in Kidney Beans

You should also be specific about type of plants you are using in the experiment. Titles must be informative, specific, and concise. Avoid superfluous phrases such as "studies on" or "investigation on".

Example: The effect of different wavelengths of light on hypocotyl growth in kidney beans. (NOTE: Except for the title, each section of the paper should have a heading.)

Introduction: The Introduction gives enough background to allow the reader to appreciate the significance of the problem being investigated in the experiment and to be able to relate it to the larger issues in the field. You should also explain briefly how you intend to approach the problem and why this approach will answer the question which the study is asking.

Example:
We performed this experiment to answer the question: What is the effect of different wavelengths of light on hypocotyl growth? (NOTE: The question is clearly stated.)

The introductory videotape (Seedling Development, 2004) showed that in many plants the hypocotyl, or the part of the stem between the cotyledons and the radicle, is the part of the plant responsible for upward growth of the seedling. It is known that quality (wavelength) of light affects such plant processes as seed germination and photosynthesis (Curtis and Barnes 1989). This led us to investigate the effect of light quality on hypocotyl growth. (NOTE: Background information is presented on the various aspects of the experiment: hypocotyls, quality of light, and growth.)

Methods: When writing the Methods section:

Use the past tense.

NOT: Place the thermometer in the beaker.

INSTEAD: The thermometer was placed in the beaker.

State specifically what you did.

NOT: We used some salt.

INSTEAD: We placed 10 mg NaCl in a 125 mL beaker.

Results: In the results section you should present your data in an organized, readable form. You must present your results in some numerical fashion; a descriptive narrative is not acceptable.

Numerical data is normally presented in tables, while relationships between factors are shown in graphs. Graphs, drawings, and anything else which is not a table are called figures.
Tables and figures are numbered sequentially so that in the text you can refer to Table 1, Table 2, Figure 1, Figure 2, etc. All tables and figures must have titles which describe their contents.

**Examples:**

Table 1: Average hypocotyl length after 10 days

<table>
<thead>
<tr>
<th>Light</th>
<th>Hypocotyl length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>blue</td>
<td>25.0</td>
</tr>
<tr>
<td>green</td>
<td>100.0</td>
</tr>
<tr>
<td>red</td>
<td>30.0</td>
</tr>
<tr>
<td>white</td>
<td>25.0</td>
</tr>
<tr>
<td>darkness</td>
<td>120.0</td>
</tr>
</tbody>
</table>

Figure 1: Hypocotyl Elongation in Light and in Darkness

These are only some of the ways data could be presented. Remember that any table or figure which is shown in the Results section of your lab report must also be mentioned in the Discussion section.

Please note that the tables and figures are placed in the body of your lab report, not in a separate appendix at the end.

**Keep the following in mind as you prepare graphs for your lab reports:**
- Use Excel spreadsheets to create graphs and import the graphs and other figures into your word processing document (e.g., MSWord).
- Use the entire area of the graph to display your data. Choose appropriate intervals for your data axes, and label them clearly along the axes.
- If there is more than one set of data on a graph, differentiate the lines using different tick symbols and label each line (data set) clearly.

In addition to tables and figures, the results section should have a brief text which draws the reader's attention to the important data. Remember, you are selling the reader on your experiment, so tell the reader what you think is important. However, do not tell the reader why it is important in the Results section. Save these explanations for the Discussion section.
Example:
*In Table 1, notice that average hypocotyl length is greatest in darkness and green light (100.0 and 120.0 mm, respectively), while in blue, red, and white light, hypocotyls are much shorter (25.0, 30.0, and 25.0 mm, respectively). In Figure 1 the rate of hypocotyl elongation is greater in darkness that in white light.*

**Discussion:** The discussion should interpret the results, explain their significance, and explain any weaknesses in the experimental methods or design. This is the most important section of your paper. It is also the most difficult section to write.

**Complete your Introduction and Results sections before you begin writing the Discussion section.** You can outline the contents of the discussion by taking the following steps.

- Answer your experimental question.
- Below the answer, list references to specific data which led you to your conclusions. If you have obtained results from colleagues in class, list that information as well.
- Write down the predictions you made before you started the experiment. Do your results confirm your predictions or not?
- Write down what you know about the biology involved in your experiment. How do your results fit in with what you know?
- List weaknesses you have identified in your experimental design. You will need to tell the reader how these imperfections may have affected your results. In Plant Physiology lab, our experiments are subject to constraints of time and facilities; you will not be able to do a "perfect" experiment. It is important to understand (and acknowledge in your report) how these limitations affect the validity of your conclusions.
- List any problems which arose during the experiment itself. Unforeseen difficulties with the procedure may affect the data and should be described in the discussion.

Example:
*Our experiment was designed to investigate the effect of different wavelengths of light on hypocotyl elongation in kidney beans.*

**NOTE:** The question or problem addressed by the experiment is repeated.)

*First, we looked at whether the presence or absence of light has any effect on hypocotyl growth. Our results, as seen in Figure 1, show that kidney beans kept in the dark had a much greater rate of hypocotyl elongation than beans grown in white light. Dark-grown plants reached an average hypocotyl length of 120 mm, while light-grown plants were only 25 mm tall. However, we observed that the light-grown plants were dark green and appeared to be sturdy and healthy. The dark-grown plants were very pale and yellowish in color, and they were not able to stand upright by the fifth day of the experiment. The difference in coloration is presumably due to differences in the presence plant pigments such as chlorophyll.*

**NOTE:** Take the data in manageable pieces; don't try to compare everything to everything else at once. Note that the reader's attention is directed to a specific table (rather than just saying "Looking at the data, you can see that ... "), and that significant pieces of data are pointed out. Tell your readers what they should look at! A personal observation is added here. The appearance of the plants was not considered to be potentially significant when the experiment was designed, but the investigator noted differences while collecting other data, so he/she reports them here.)

*White light, then, inhibited hypocotyl elongation. We used three of the components of white light, red, green and blue, to determine the effect of color, or wavelength, on hypocotyl elongation. Table 1 shows average hypocotyl elongation after 10 days. It shows that red and blue light are most similar to white light in their effect. The average hypocotyl length in white light was 25 mm. Average length was the same in blue light, and it was 30 mm in red light. Green light had an effect similar to darkness: hypocotyl growth was promoted, averaging 100 mm in green light and 125 mm in darkness. The appearance of the plants in red and blue light was also similar to the appearance of the plants in white light, while the green light plants looked like the dark-grown plants.*
NOTE: A preliminary conclusion is reached, and the author goes on to discuss the rest of the data. Again, significant data are mentioned specifically.

Since plants need light for photosynthesis, we did not expect to find so much growth in the dark. Possibly this is a mechanism the plant uses to try to reach the proper kind of light. The elongation is caused by an accumulation of a hormone which stimulates plant growth (Smith, personal communication). We were also puzzled by the apparent lack of chlorophyll in the plants grown in darkness and green light, since chlorophyll is also needed for photosynthesis, which provides the plant's energy. We hypothesize that the plants in the dark must be getting energy for growth from a source other than photosynthesis, possibly from the seed.

NOTE: The author is attempting to explain the results. Explanations might be available in the literature (e.g. the textbook), or further research might be required. Your lab instructor or lecture professor may be able to provide additional insight which can be added to your discussion. Note the citation form (Smith is the lab instructor). The results of an experiment often provide questions to investigate in the next experiment.

Our experiment supports the idea that wavelength of light affects hypocotyl elongation. Elongation is inhibited by white light, specifically by the red and blue components of white light. Darkness and green light promote hypocotyl elongation. We also observed that wavelength of light affects the pigments present in the plant; kidney beans grown in red, blue or white light appeared to have much more chlorophyll than those grown in darkness or green light.

NOTE: The conclusion is stated. Remember, the conclusion can only be based on the results of your experiment, not on speculations. The author of this paper was surprised at the growth of plants in the dark, but the author had to conclude that plants do grow in the dark. "The organism is always right."

We think the number of plants used provided adequate replication to give us confidence in these conclusions. However, we can make these conclusions only about kidney beans, since we did not have time to duplicate the experiment using other plant species.

NOTE: Discuss any weaknesses you recognize in your experimental design and think of how the experiment might be improved. If you had any problems carrying out the experiment you should also discuss the effect of these problems on your results. Acknowledging the weaknesses in your experiment is not a sign of a poor experiment or a poor paper. It shows that you truly understand your experiment!

Conclusions: Your conclusions may be mentioned in three sections of your paper: introduction, discussion, and conclusion. In the conclusion section, paraphrase your conclusion rather than repeat the exact wording you used before. If your readers did not understand your initial version, another one may help them. Be precise. Your conclusion need only be one or two sentences long.

Example:
We found that hypocotyl elongation was most inhibited by red and blue components of white light, and was promoted by green light and darkness.

STYLE TIPS FOR WRITING LAB REPORTS
Good scientific writing should "communicate the exact truth as simply as possible". Keep this in mind as you write and edit.

Write short, direct sentences.
NOT: Generally we can say that the plants we experimented on this semester increased in weight in all experimental conditions.
INSTEAD: The plants increased in weight in all experimental conditions.

Use words that have clear and exact meanings.
The plants grew well at 28°.
INSTEAD: The plants increased in weight by 20% in ten days at 28 °C.

Avoid unnecessary words and phrases.
NOT: Needless to say, the experiment shows ....
INSTEAD: The experiment shows ....

NOT: In general, the first trial ....
INSTEAD: The first trial ....

Avoid double hedging.
NOT: It is possible that the plants might have ....
INSTEAD: The plants might have ....

NOT: It could be inferred that salt probably caused ....
INSTEAD: Salt probably caused ....

The active voice is usually clearer than the passive voice because it uses fewer words and tells who performed the action.
NOT: The subjects were seated at computers. Numbers were flashed on the screen. The corresponding key was pressed and then the reaction time was flashed upon the screen. Next, the reaction time was recorded.
INSTEAD: Subjects sat at computers. When a number flashed on the screen, the subjects pressed the corresponding key. The reaction time then appeared on the screen and the subjects recorded it.

Make clear what you are comparing.
NOT: Women’s reaction times are faster than men.
INSTEAD: Women react faster than men react.

LAB REPORT FORMAT
Each section of your paper should begin with a heading (Introduction, Methods, Results, Discussion, and Conclusions). The title page, which doesn’t have a heading, should be on a separate sheet of paper.

TITLE PAGE:
  Title 2½ inches from top of page
  Your name
  Plant Growth & Development (21:120:330)
  Section (number or day and time)
  Lab instructor
  Due date for the lab report

Sample title page:

SUBSEQUENT PAGES:
  Top margin: 1½ inches
  Right margin: 1 inch
  Left margin: 1 inch
  Bottom margin: 1½ inches
  Page number: placed on the bottom of each page, left corner
  Spacing between lines: double space
HOW YOUR LAB REPORTS WILL BE GRADED

The following is a list of common mistakes students make on the basic elements of a lab report. Your INSTRUCTOR will use this sheet when grading your reports; If you want an A on your report (and who doesn’t?), pay particular attention to the items in italics. Correct grammar, spelling, punctuation, along with logical, easy to read writing style are also important.

Title:
- The title should communicate the subject investigated and nothing more.

Introduction:
- The experimental question should be clearly and specifically stated.
- Background information (elaboration) should be given.
- Background information should be relevant to question.
- *A brief description of the rationale for the experimental design should be given.*

Methods:
- The reader should be able to understand experimental design with information given.
- Results should not be given in the Methods section.

Results:
- Data should be properly summarized (e.g. give averages, not raw data).
- Data should be presented in an appropriate format (table or graph).
- *Data should be numerical; a narrative description does not suffice.*
- *Results should be presented neatly and clearly, without ambiguity.*
- Tables and Figures should be numbered sequentially and have appropriate titles, and labeled axes.
- Units of measurement should be given.
- Each table and figure included in Results section must be mentioned in Discussion section.
- *Important results should be pointed out (but not discussed) in the text of the Results section.*

Discussion:
- The question posed by the experiment should be answered or it should be stated that the results were inconclusive.
- Results which support conclusions should be cited specifically.
- Reasoning for conclusions should be given.
- *Discussion should show an understanding of the biology of your experiment.*
- *Results should be discussed in the light of other research or information available to you.*
- Weaknesses in the experimental design should be discussed.

Conclusions:
- Conclusions about the original question should be stated.
- Important results should be stated.
- Arguments for conclusions should not be given.
Plant Growth and Development

General Information

The majority of your time in this course will be spent in the biotechnology laboratories (224 Boyden), the greenhouses, and the culture room on the first floor of Boyden Hall. For your information, is almost always open and feels free to use the facilities there. My research lab (202-203 Boyden) is almost always open, therefore, do NOT hesitate to work outside the scheduled lab periods in my lab at any time convenient to you. However, please show restraint in upsetting the research underway in 202/203.

The following materials are to be supplied by students:

- 1 Quad-rulled laboratory notebook (NJ Books, or NJIT Bookstore)
- 1 loose-leaf binder for lab and lecture hand-outs
- Several Sharpie marking pens in various colors, including black
- Intelligence, diligence, and patience!
Rutgers-Newark Academic Honesty Policy:

Please review the following statement on academic honesty.

"Each student bears a fundamental responsibility for maintaining academic integrity and intellectual honesty in his or her academic work. For example, all students are expected to observe the generally accepted principles of scholarly work, to submit their own rather than another’s work, to refrain from falsifying data, and to refrain from receiving and/or giving aid on examinations or other assigned work requiring independent effort. In submitting written material, the writer takes full responsibility for the work as a whole and implies that, except as properly noted by use of quotation marks, footnotes, etc., both the ideas and the words used are his or her own. Failure to abide by the rules of scholarship is academically dishonest.

"Acts of plagiarism, cheating, or other forms of academic dishonesty are treated by the university as disciplinary matters. Procedures for dealing with these matters are set forth in the University Student Disciplinary Hearing Procedure."

In this class, instances of academic dishonesty will result in your failing of the exam or paper and a report to the Dean. Also see "Policy on Academic Integrity," available from the Dean’s office, and NJIT’s Academic Integrity webpage:

✓ http://academicintegrity.rutgers.edu/academic-integrity-at-rutgers
✓ http://studentconduct.rutgers.edu/
✓ http://www.njit.edu/academics/integrity.php