BIO 3450 MASTER SYLLABUS

I. College/School College of Science and Mathematics
Department Biological Sciences

II. Course Information

Course Title: Concepts in Biology I for Early and Middle Childhood Education
Course Abbreviation and Number: BIO 3450
Course Credit Hours: 3.5
Course Cross Listing(s) Abbreviation and Number: n/a
Check ("x") all applicable:

General Education Course___X__ Writing Intensive Course__X__
Service Learning Course_____ Laboratory Course__X___
Ohio TAG (Transfer Assurance Guide) Course _____
Ohio Transfer Module Course_____
Others (specify): Integrated lecture and lab: 1.5 credits lecture, 2 credits lab

III. Course Registration

Prerequisites: CHM 2450, minimum grade of C
Corequisites: n/a
Restrictions:

IV. Student Learning Outcomes

Element 6 courses emphasize scientific inquiry as a way to discover the natural world, and to explore fundamental issues of science and technology in human society. Specifically:

a. Understand the nature of scientific inquiry.
b. Critically apply knowledge of scientific theory and methods of inquiry to evaluate information from a variety of sources
c. Distinguish between science and technology and recognize their roles in society
d. Demonstrate an awareness of theoretical, practical, creative and cultural dimensions of scientific inquiry
e. Discuss fundamental theories underlying modern science

IW learning outcomes - Students will be expected to produce writing that:

- Demonstrates their understanding of course content,
- Is appropriate for the audience and purpose of a particular writing task,
- Demonstrates the degree of mastery of disciplinary writing conventions appropriate to the course (including documentation conventions), and
- Shows competency in standard edited American English.

BIO 3450 also has its objectives set by the Ohio Science Academic Content Standards. Upon success full completion of the requirements of this course, the student will have or be able to:

1. Demonstrate an understanding of basic botany, ecological principles and environmental education.
2. Demonstrate a working knowledge of heredity, biological growth and development.
3. Develop an understanding of the basic needs of living things and the relationship of those needs to the structure and function of the organism. Overall, plant systems will

be used as examples, including demonstration of a broad understanding of the function of various cell and tissue types, etc.

4. Design and conduct a biological investigation. Collect, display and interpret experimental data and draw conclusions.
5. Develop an understanding of the process of "doing biology", and a positive attitude toward conceptual understanding of the overall themes in biology and activity- based biology teaching. Also during the course of the term, students will become familiar with ways of accessing information on biological topics, as well as, information relevant to the development of appropriate hands-on instructional activities for elementary and middle level students.
6. Demonstrate the ability to communicate effectively in writing. Students will be expected to produce writing that
   a. Demonstrates their understanding of course content,
   b. Is appropriate for the audience and purpose of a particular writing task,
   c. Demonstrates the degree of mastery of disciplinary writing conventions appropriate to the course (including documentation conventions), and
   d. Shows competency in standard edited American English.

V. Suggested Course Materials (required and recommended)

Campbell, N.A., Reece, J.B., & Simon, E.J. (2010). *Essential Biology with Physiology* (3rd Ed.) Pearson/Benjamin-Cummings Publishing. ISBN: 0321602072

VI. Suggested Method of Instruction

Integrated laboratory and lecture, focused on using inquiry-based methodology as a model system for teaching science

VII. Suggested Evaluation and Policy

Assessment: Course grades will be based on the following:

Fast Plant Paper	20%
Midterm Exam	15%
Final Exam	15%
Homework Assignments	15%
Two Quizzes	15%
Science Journal	10%
Fast Plant Paper Drafts	5%
Attendance/Participation	5%

VIII. Suggested Grading Policy

The following standards shall be applied in order to determine final quarter grades:

93% or greater = "A"	70-77% = "D"
85-92% = "B"	69% or below = "F"
78-84% = "C"	

IX. Suggested Assignments and Course Outline

Week	Biology Topics	Reading	Assignment*
1	Scientific Practices, Science as a Way of Knowing, Experimental Design and Data	Ch. 1	
2	Living and Nonliving Things Cell Structure and Function	Ch. 4, 5	
3	Plant Structure, Reproduction, and Development	Ch. 16, 28, 29	Quiz 1
4	Plant Structure, Reproduction, and Development	Ch. 16, 28, 29	Fast Plant Paper Introduction Draft
5	Photosynthesis and Cell Respiration	Ch. 6, 7	
6	Photosynthesis and Cell Respiration	Ch. 6, 7	Fast Plant Paper Materials and Methods Draft
7	**Midterm** Insects and Metamorphosis, Life Cycles	Ch. 18, 19	**Midterm**
8	Food Chains/Webs, Cycles in Nature	Ch. 3, 19, 29	Fast Plant Paper Results Draft
9	Ecology and Communities	Ch. 18, 19	
10	Population Dynamics	Ch. 18, 19	Fast Plant Paper Total Draft
11	Population Dynamics	Ch. 18, 19	Quiz 2
12	Heredity and Reproduction	Ch. 8, 9, 26	Final Fast Plant Paper
13	How Populations and Biodiversity Evolve	Ch. 13, 14, 20	
14	Biodiversity in Ohio, Human Impacts on Biodiversity	Ch. 13, 14, 20	Science Journal

*****Homework will be regularly assigned either weekly or daily, depending on activity.

X. Other Information N/A

APPENDIX: LAB REPORT INSTRUCTIONS AND RUBRIC

Writing a Lab Report

Lab reports may vary in the format and contents included due to the type of investigation or purpose of the report. The following components will be required elements of reports submitted in this course. Please use this guide along with the grading rubric when writing all lab reports throughout the course.

Title

All lab reports must include a descriptive title that clearly identifies the independent and dependent variables in the experiment, as well as the species studied using its scientific name (if applicable). Scientific names include two parts – the first is capitalized and the second is not (ex: *Homo sapiens*). Follow conventional capitalization and punctuation. The title is centered and your name is centered directly below on the first page of the report, not on a separate title page. Do not include any other information. For example, a title for an experiment investigating the use of compost as a fertilizer for fast plants might be:

The effect of varying amounts of compost on the height of *Brassica rapa*

Jane Smith

Introduction

The introduction is typically a couple of paragraphs in length and begins with the rationale for why the experiment was conducted. Many times the rationale is related to initial observations or previous research so it is appropriate for the researcher to include a brief description of any interesting observations/experiments that were made that *led up to* the experiment. It is important to note here to NOT use pronouns in the lab report (i.e. I, we, my, our, etc…). A lab report is more formal writing and is written in the third person.

The second paragraph of the introduction should summarize background information found in scientific papers and resources regarding the specific problem or research question that is being addressed (i.e. NOT Wikipedia or blogs; but from scientific journals, museum / research organizations / government agencies websites, and science books). In addition, assumptions should be noted here. Assumptions are often things that can't be controlled but may significantly impact the results of the experiment. For example, when doing investigations that involve living organisms (such as meal worms) the researcher assumes that all organisms are basically the same unless something extremely unusual about the behavior suggests otherwise. (Later in the error analysis section the possible impact of any assumptions must be discussed.) This information should logically lead to a statement of the hypothesis tested in the investigation. Remember that the hypothesis is a suggested explanation for the observations described or for the problem stated here. In many cases multiple hypotheses (explanations) may be stated but only include those that were actually tested in the experiment being reported.

Materials and Methods

This section includes a list of materials for the experiment as well as a description of what steps were completed to test the hypothesis or hypotheses. Therefore, it needs to be written in the PAST TENSE. The information can be organized in paragraph form, chart form, or a combination of both. For this course, you will create a numbered list, beginning with your first step and ending with how and when you collected the data. You must include a complete and detailed list of materials used, the independent and dependent variables clearly defined, a list of controlled variables (if necessary, include a description of how this was done), number of trials/repetitions conducted, and specific steps taken in collecting data. (Remember, scientific papers only use metric measurements.) Enough information must be included so that someone

else could use your detailed list of materials and written procedure to replicate the experiment exactly.

Results

This section should include all experimental data and also be in PAST TENSE. The data may be qualitative (descriptive and not numerical) and/or quantitative (numerical). Data should be displayed in data tables and graphed when appropriate. These should be integrated with text highlighting any important patterns or trends the reader should particularly notice. Graphs are extremely important for displaying data and indicating relationships between the independent and dependent variables. Be sure that data tables include appropriate column and row titles (with units) and that graphs contain clearly labeled axes (with units). All tables and graphs should only contain summarized, averaged data and have a title (with number – "Table 1" for tables or "Figure 3" for graphs) place above them in the text. You do not need to illustrate the same information in table and graph form – choose the most appropriate for illustrating the patterns you want the reader to notice.

This section should also include some text (in a separate paragraph) that directs the reader's attention to major findings/trends in the data. You should NOT include any analysis of findings, explanations or inferences but rather make a statement in paragraph form about what the data indicates (ex. the graph indicates a linear relationship between age and height).
See examples below.

Figure 1. Distance traveled by mealworms over time.

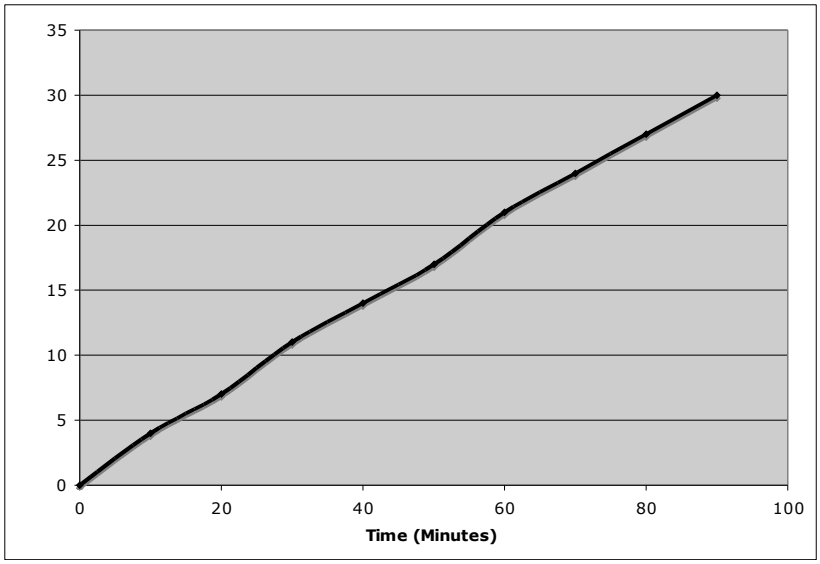

Table 1. Time to dissolve fertilizer at different water temperatures.

Temperature of Water (^oC)	Average Time to Dissolve (sec)
0	156
25	78
50	54
75	31
100	22

Dry fertilizer dissolved fastest in 100^oC water. Overall, as water temperature increased, the dissolving time decreased.

Note that if the analysis was complex and requires further description, this should to be done in this section. For example, if the researcher must carry out additional steps with the data, such as running statistical analyses like t-tests, then those steps are described in a separate paragraph in this section of the report.

Discussion and Conclusion

This section discusses patterns in the data and draws conclusions about whether your hypothesis is supported or refuted. A well-written conclusion is extremely important and should include statements that are substantiated with data from the experiment. Many times this is the only section of a journal article that is read! As a guide, answer the following six questions in your conclusion. (Do not write out the actual questions.) Typically a paragraph or more is devoted in answering each question; however, sometimes the same paragraph may contain the answer to several of the questions. Just be sure you have fully answered EACH question in this section of the report. Also, remember this is a description of what you DID so it should also be in PAST TENSE. The steps below closely follow the grading rubric.

1. Restate the hypothesis of the experiment and your prediction. This will remind the readers what you set out to investigate and what you predicted would happen.
2. What were the major findings relative to the hypothesis and your prediction; i.e. what is your claim? Was the research hypothesis supported or refuted?
3. Relative to the claim just stated, now focus the readers' attention on the trends or patterns (or lack of patterns) in your *experimental* data that support or refute your hypothesis. Be sure to discuss <u>HOW</u> the data or trends specifically support or refute your hypothesis.
4. Repeat step 3 but this time present and discuss other evidence that supports your claim. This could be background information discussed in your introduction or new information from other scientific resources. A huge part of scientific investigations is to show how individual experimental results fit into the broader knowledge base.
5. Is your claim reliable? That is, do you trust your collected data on which your claim is based? Why or why not? This is your chance to discuss any errors in the collected data whether or not you believe they heavily impacted the results. Typically at least one paragraph is devoted to this. A pattern in the data may or may not emerge but the following bullets should be addressed in either case to be sure you can state your claim is reliable.
   - Discuss possible *causes* for observed minor fluctuations or outliers in the collected data that may be attributed to *random* error. *Random errors* are fluctuations in the measurements due to limitations of the measuring device or experimental equipment. Random errors typically result from the researcher's inability to take repeated measurements in exactly the same way each time, which then results in differences in the measurements. (Outliers are data points that fall far outside an identified pattern.) Also,

be sure to tell the reader how you tried to minimize this random error when you did your data analysis (i.e. Did you conduct multiple trials and average the results?). Never include errors in calculations as a source of error because a good researcher will notice these and immediately make corrections!

- If *systematic* error is observed in the data, identify the *cause* of the error and discuss how it was corrected for when you did your data analysis (i.e. Was the scale not properly calibrated so you had to adjust all measurements after the data was collected?). *Systematic errors* occur when all (or most) of the measurements are either higher or lower than the actual result.

6. Discuss how errors or assumptions made may have impacted the collected data and resulting pattern or lack of pattern. For example, extreme outliers (possibly due to measurement errors) on one side of a best-fit line on a graph may have skewed the best-fit line in that direction. As a second example, the assumption that all mealworms behave identically may have severely impacted your results if you have an over-active group of mealworms in your sample. In all cases errors and assumptions may cause you to make a claim that isn't quite correct and the reader needs to be made aware of *specifically how* these may have impacted your results. Also, are there shortcomings in the experimental design? What could the researcher do next time to minimize error and make the results more reliable? (i.e. Should more trials have been taken? If so, suggest how many. Should more mealworms have been used? Is so, suggest how many.)
7. Discuss suggestions for further study. For example, does your conclusion suggest any additional hypotheses or other items of interest to investigate? Indicate them here.
8. Wrap up the section with a final "conclusion" paragraph. This ties together the entire report for the reader. As a guide, you may wish to make this paragraph five sentences in length with the first sentence devoted to summing up your introduction, the second sentence a statement about what you did in the experiment, the third sentence a brief description of your results, the fourth sentence a statement explaining the results, and the fifth sentence indicating your conclusion from the study. In reality this paragraph could be used as the abstract (single paragraph) typically found at the beginning of a journal article providing the reader a brief summary of the paper that follows.

References

The resources used during the investigation and writing of the lab report, should be referenced in this section. In this class you will use the APA (American Psychological Association) format and specific details can be found at http://owl.english.purdue.edu/owl/resource/560/01/ or on the handout provided in class.

Final Check! Check your spelling and grammar. Have someone read your report. Consult the lab report grading rubric!

Adapted from: Koenig, K. (2010). *Foundations in scientific literacy and problem solving: SM 145 course manual*. (2nd Ed. – Version D). Dayton, OH: Wright State University

Bio 345 Lab Report Grading Rubric

Scientific Ability	Missing (0)	Inadequate (1)	Needs improvement (2)	Complete (3)
Title				
Is able to write an appropriate title	Title not included	Title not appropriate given report	Appropriate title, missing details of DV and/or IV and/or species	Title clearly stated & appropriate (includes DV, IV and species)
Introduction				
Is able to identify rationale for experiment	Rationale not included	Rationale not appropriate for given hypothesis	Rationale appropriate but missing critical, relevant details	Rationale clearly stated and appropriate for hypothesis
Is able to describe sufficient background information on IV from scientific resources	Background information on IV missing	Background information on IV not appropriate to support hypothesis	Background information on IV appropriate but missing critical & relevant details	Background information on IV clearly supports hypothesis
Is able to describe sufficient background information on IV specific effect on plants from scientific resources	Background information on IV specific effect on plants missing	Background information on IV specific effect on plants not appropriate to support hypothesis	Background information on IV specific effect on plants appropriate but missing critical & relevant details	Background information on IV specific effect on plants clearly supports hypothesis
Is able to identify assumptions that may affect outcome	No attempt is made to identify any assumptions	Attempt is made to identify assumptions, but assumptions are not relevant to hypothesis	Relevant assumptions are identified but are not significant to the outcome	All assumptions are correctly identified and discussed
Is able to identify the hypothesis to be tested	No mention of hypothesis	Attempt to identify hypothesis but not testable	Hypothesis stated but relationship of variables unclear	Hypothesis is complete, testable, and clearly stated
Materials and Methods				
Is able to create a *detailed* materials list that can be used by others	Materials list not included	Materials list included but missing key materials	Materials list included but missing important equipment details	Materials list complete including specific equipment details
Scientific Ability	**Missing (0)**	**Inadequate (1)**	**Needs improvement (2)**	**Complete (3)**
Is able to conduct a reliable experiment that tests the hypothesis	Experiment does not test the hypothesis as stated	Experiment tests hypothesis, but due to design it is unlikely to lead to a correct judgment	Experiment tests hypothesis, but design has only moderate chance of conclusive judgment	Experiment tests hypothesis and has high likelihood of leading to a conclusive judgment

Is able to decide parameters to be measured and clearly identify IV and DV	The parameters measured are irrelevant	Only some parameters relevant	The parameters are relevant, but IV and DVs are not clearly identified	The parameters are relevant and independent and dependent variables are clearly identified.
Is able to identify and make use of control variables	Control variables not implemented	Only some control variables are implemented	Control variables implemented but not clearly stated as such	Control variables both implemented and clearly stated
Is able to communicate details of the procedure clearly and completely	Diagrams are missing and/or experimental procedure is missing or extremely vague	Diagrams present but unclear and/or procedure is present but important details are missing	Diagrams and/or experimental procedure present but minor omissions or vague details	Diagrams and/or experimental procedure are clear and complete
Results				
Is able to identify and describe a pattern (or lack of pattern) in data	No attempt is made to search for a pattern	Pattern described is irrelevant or inconsistent with the data	Pattern has minor errors or omissions	Pattern represents the relevant trend in the data
Is able to record and present data in a meaningful way via data tables (units identified)	Data are either absent or incomprehensible	Some important data are absent or incomprehensible	All important data present, but effort needed to comprehend or too much raw data	All important data are present, averaged, organized, and recorded clearly in data table
Is able to clearly title and label IV and DV in data tables	Title, IV and DV are absent or incomprehensible	Title, IV or DV are missing or incomprehensible	Title, IV and DV are present but in appropriate or need units	Title, IV and DV are all present and appropriate with units
Is able to record and present data in a meaningful way via graphs	Data are either absent or incomprehensible	Some important data are absent or incomprehensible	All important data present, but effort needed to comprehend or graph is missing units/labels	All important data are present, organized, and recorded clearly in graph

Scientific Ability	Missing (0)	Inadequate (1)	Needs improvement (2)	Complete (3)
Is able to clearly title and label IV and DV in graphs	Title, IV and DV are absent or incomprehensible	Title, IV or DV are missing or incomprehensible	Title, IV and DV are present but in appropriate or need units	Title, IV and DV are all present and appropriate with units
Discussion and Conclusion				
Is able to restate hypothesis with appropriate prediction	No attempt made to restate hypothesis or prediction	Either a restated hypothesis or prediction is missing	Hypothesis is restated but prediction is not appropriate	Hypothesis is restated and an appropriate prediction is made
Is able to make a reasonable claim	No mention of whether the hypothesis was	A claim is stated but it is not consistent with actual	A reasonable claim is stated but some	A reasonable claim is stated that is consistent

whether hypothesis was supported or refuted	supported or refuted	outcome of the experiment	inconsistencies with actual outcome of the experiment	with actual outcome of experiment
Is able to provide *experimental* evidence that supports claim	No attempt made to discuss *experimental* evidence that supports claim	Weak attempt made to discuss *experimental* evidence that supports claim	Good attempt made but some *experimental* evidence is clearly missing	*Experimental* evidence supporting claim is presented correctly and completely
Is able to provide *additional* evidence that supports claim (i.e. scientific resources)	No attempt made to discuss *additional* evidence that supports claim	Weak attempt made to discuss *additional* evidence supporting claim	Good attempt made but some *additional* evidence is clearly missing	*Additional* evidence that supports claim is presented correctly and completely
Is able to identify errors and assumptions, then explain their impact on results	No attempt made to identify possible errors; no discussion on impact of errors or assumptions	Weak attempt to identify errors; no discussion on impact of errors or assumptions	Good attempt to identify errors; minimal discussion on impact of errors or assumptions	All errors are correctly identified; thorough discussion impact of errors or assumptions
Is able to identify short-comings in experimental design and suggest specific improvements	No attempt made to identify any shortcomings in the experimental design	Attempt made to identify short-comings, but described vaguely with no specific suggestions for improvements	Some shortcomings identified and some improvements suggested, but not all aspects of the design are considered	All major shortcomings of the experiment are identified and specific suggestions for improvement are made
Is able to suggest a revised hypothesis to test in future investigations	Revised hypothesis is needed based on results but none is stated	Revised hypothesis is suggested but it is not written as a testable question	Revised hypothesis is suggested but it is not consistent with the results of the experiment	Revised hypothesis is suggested and it is consistent with all relevant evidence

Grammatical Considerations	Missing (0)	Inadequate (1)	Needs improvement (2)	Complete (3)
Is able to organize report into clear sections, easy to follow	Writing is aimless and disorganized, hard to follow	Organization is minimal and difficult to follow flow of report	Somewhat organized with some areas difficult to follow	Clearly organized and easy to follow flow of report
Is able to use proper spelling, grammar, and punctuation	Many errors making report very difficult to comprehend	Multiple errors, distracting to reader	Few errors, but generally correct	No errors
Is able to write without using personal pronouns	Personal pronouns used	No personal pronouns used throughout report	N/A	N/A
Is able to write in the past tense	Past tense not used or used occasionally	Past tense used appropriately throughout report	N/A	N/A
Is able to write numbers metric system with decimals	Metric system and decimals not used	Metric system and decimals used throughout report	N/A	N/A
Is able to cite references using APA style in text	Does not cite references in text	Cites some references in text or uses style other than APA	Cites all references and uses APA style correctly in text	N/A
Is able to create a reference list in APA style	Does not create a reference list	Reference list missing some resources or is not in APA style	Reference list is thorough and uses APA style correctly	N/A

Adapted from materials provided by the Rutgers University Physics and Astronomy Education Research (PAER) group [http://paer.rutgers.edu/ScientificAbilities/Rubrics/default.aspx]