Evolution Section

Lab Investigation #1: Hardy-Weinberg Equilibrium

Pre-Lab Activity
In general, you will need to watch the Blackboard pre-lab video and answer the short quiz before coming to class each week. You should review the syllabus and complete the "Syllabus and Academic Integrity" quiz. For this first day of class, we will allow you to complete the pre-lab after the first day, before the second day of lab.

In Lab Activity

Learning Objectives:
- Syllabus and intro to lab
- Meet group members
- Understand and articulate the steps of the scientific method

Developing a Scientific Mindset – Laboratory Investigation Proposal
This week you will develop your first lab investigation proposal. You should work with your group to develop your experiment based on the guiding question provided.

Guiding Question: Is the ECU population of *Brassica rapa* in Hardy-Weinberg equilibrium?

Copy the guiding question above into the table on the next page. Additionally, work with your group to create a hypothesis in the table on the next page, making sure you include justification for why you have come up with your hypothesis. Continue to fill out the table with your group, including what kind of data you will be collecting and what methods you will be using to collect your data. Part of the methods has been filled in for you, as it has changed from the protocol outlined in the Student's Guide. In the section "how will you analyze your data" include any data tables, or the type of data you will be collecting.

Laboratory Investigation #1 Proposal

The Guiding Question…

Hypothesis

What data will you collect?

How will you collect your data?

What safety precaution will you follow?

Additional steps in your method:

How will you analyze your data?

I approve of this
investigation.

_____   _____
Instructor's Signature   Date

Laboratory Investigation #1: Hardy-Weinberg Equilibrium
Part 2: Continuing Population Genetics

Pre-Lab Activity
Watch the video and complete the Genetics quiz before coming to class.

In Lab Activity

Learning Objectives
- Practice pipetting small amounts of liquid
- Experience the process of DNA extraction and PCR set up

Skills Activity - Pipetting
Pipettes Introduction:
Many biological laboratory experiments involve making observations and recording data obtained using a measuring instrument. For working with genetic material, very small volumes are needed because the genetic material is very small. Pipettes are used for precise measurement of small amounts of liquids precisely.

Skills Practice: Pipettes
We will first practice pipetting using the tubes of liquid provided. There will be two pipettes per table so you will work in pairs and take turns using the pipette. Since the pipette only goes to 20 microliters, how will you pipette 45 microliters of liquid?

Amount to pipette	Volume of pipette used (list all, if you use more than one)	TA signature for accuracy
45 microliters		
20 microliters		
5 microliters		

Developing a Scientific Mindset - DNA Extraction

Background: Read the introduction and background material (pages 1-8) from the "miniPCR Plant Genetics Lab Student's Guide" by miniPCR, which is provided in this section of the lab manual.

Protocol: Working in groups of 3, follow the procedure from the Plant Genetics Student's Guide for extracting DNA from the leaf of the plants that are provided for you. Once you have completed the DNA extraction, give your tube to your TA so they can run PCR. We will make two small adjustments to the procedure:

- Your group will only do one DNA extraction
- In step 5, you will use a small pestle to grind up the plant tissue

Guiding question: Is the ECU population of *Brassica rapa* in Hardy-Weinberg equilibrium?

Laboratory Investigation #1: Hardy-Weinberg Equilibrium
Part 3: Introduction to Hardy-Weinberg Equilibrium

Pre-Lab Activity
Watch the video and complete the Hardy-Weinberg Equation quiz before coming to class.

In Lab Activity

Learning Objectives
- Load plant DNA into gels for electrophoresis
- Introduction to solving Hardy-Weinberg problems

Practical Application - Loading Gels
This week each group will load a gel with the extracted plant DNA. Continue to fill out the table found on the next two pages. Be sure to include what kind of data you will be collecting and what methods you will be using to collect your data. In the section "how will you analyze your data" include any data tables, or the types of data you will be collecting.

Data collected and Observations (include both your group's data AND the class data)

Data Analysis and Results Part I

Was how your group identifying the samples, the same as the class consensus? If not, why might they be different?

Introduction to the Hardy-Weinberg Equation

In the final step of analyzing our data for this investigation we will seek to address the guiding question regarding the Hardy-Weinberg equilibrium of the *Brassica rapa* population at ECU.

In preparation for this analysis, we will begin to work through some Hardy-Weinberg examples during class. There is also an assignment on Canvas that allows you the chance to practice these problems on your own. Any not completed during lab should be completed for homework, to be discussed in the next lab period.

Laboratory Investigation #1: Hardy-Weinberg Equilibrium
Part 4: More Hardy-Weinberg Equilibrium

Pre-Lab Activity
Watch the video and complete the Speciation and Extinction quiz before coming to class.

In Lab Activity

Learning Objectives
- Calculate HWE from plant lab data
- Practice HWE problems

Practical Application - Data Analysis
Record the data from all the 1201 sections into your results table on the following page. Using these data, make a claim related to the guiding question above and your hypothesis from last class.

Data Analysis and Results Tables

Claim

Laboratory Investigation #1: Hardy-Weinberg Equilibrium
Part 5: Developing an Argument

Pre-Lab Activity
View How to Write a Lab Report and submit the HWE questions on Canvas. Review the data from last class and the introductory material on argumentation so you can be prepared to create a whiteboard.

In Lab Activity

Learning Objectives
- Develop an argument, discuss arguments with your peers, and revise the argument based on feedback

Argumentation Session for Plant DNA investigation
Use the white board on your table to reconstruct the table below for the *Brassica rapa* investigation.

Reminder: Each group will leave one member at the table to present their argument and the remaining group members will move around the room to other groups. At each table the presenter will begin a discussion of the results with the visiting group. The students should compare results and question each other's findings and method. You may then revise your whiteboard based on your observations and feedback.

Guiding Question:

Hypothesis:

Claim:

Summary of Results:	Justification of the Claim using Evidence:

Assignment: Each group will take a photo of their revised whiteboard and upload it to Canvas for grading.

Argumentation Session Whiteboard Grading Rubric (30 points)

	10pts	8pts	6pts	4pts	2pts	0pts
Guiding Question 1. Include the guiding question that was assigned	██	██	██	██		
Hypothesis 1. Is testable and based on sound reasoning.	██	██	██			
Claim 1. A statement if you support or reject the hypothesis you developed for the guiding question.	██	██	██			

Summary of Results
  1. Include the all the section data in summary table
  2. Hardy Weinberg calculations for the plant data
  3. Chi square calculation using Excel.						

Justification of the Claim using the Evidence
  1. What data collected, and analysis was used to state your claim.
  2. Relevance of the evidence using scientific concept/principles
  3. Evidence with actual scientific information.						

Lab Report #1 (160 points)

Guiding Question: Is the ECU population of *Brassica rapa* in Hardy-Weinberg equilibrium?

Lab Report: Once you have completed your work, you will prepare a scientific paper (*investigation report)* that consists of seven sections. Your report should answer these questions in 3 pages. This report must be typed, and any diagrams, figures, or tables should be embedded into the document. Generally, your paper should not be more than 6 pages long with figures, tables and reference section included. ALL DOCUMENTS MUST BE SAVED AS MICROSOFT WORD OR PDF. WE WILL NOT ACCEPT ANY DOCUMENT SAVED IN PAGES. The rubric on the following pages clarifies the expectations for the paper.

Parts of Paper:

Title and Abstract: Write a summary of the entire paper in one to two paragraphs.
- A reviewer or reader should be able to understand the concept, the project completed, and know what your findings are and why.

Introduction: What concept were you investigating and how does it relate to the guiding question?
- Use the background information you gained from reading the published paper on *Brassica rapa*.
- This should include your question, and hypothesis/prediction
- You may need to look up more background information to help write this paper.

Materials and Methods: How did you go about your work and why? This needs to be in paragraph form, and not just listing each step. Write so someone else can follow the procedure.
- What kind of data did you collect?
- What methods did you use to collect these data?
- What kind of statistical analysis did you use and why?

Results: Describe your findings and cite your figures/tables.
- This should be done in paragraph form and should not just be a sentence that states: "The results are found in figure 1."
- Tables and figures can be embedded here or placed together at the end of your paper. Either way, they should be referenced in your results.
- Review a peer review journal article or ask your TA if you need help with the result section. This is one of the most common places for students to lose points.

Discussion: What is your argument?
- State your claim again.
- Things to think about while discussing your results:
  - Does your data support your hypothesis?
  - Are there alternate explanations for your results?
  - Are there any factors that could influence whether or not the population was in equilibrium?

References
- Minimum of 3 references from a peer-reviewed journal
- Each reference properly formatted and cited in the text

BIOL 1201 Research Paper Grading Rubric

	Excellent 20 pts	15 pts	Average 10 pts	5 pts	Poor 0 pts
Title and Abstract Title is relevant and descriptive Abstract summarizes the experiment Includes the question to be answered by research Hypothesis is concisely stated Results are described briefly Conclusion is briefly stated.					
Introduction Includes question to be answered by research Background information is relevant to the question and is cited correctly. Hypothesis is testable and based on sound reasoning.					
Materials and Methods A clear description of how the proposed research.					
Results Results and data are clearly recorded, organized so it is easy for the reader to see trends All appropriate labels and titles are included.					
Discussion Summarize the essential data used to draw conclusions. Conclusions follow data- not wild guesses or leaps of logic Discusses applications of research to real world Hypothesis is rejected or accepted based on the data					
Analysis The data and observations are analyzed accurately, trends are noted, and enough data was taken to establish a conclusion					
References Minimum of three references from peer reviewed sources are listed References are properly formatted Each reference is cited within the text					
Format Neat, organized with headings, few spelling/grammar errors. Proposal follows the format rules in the guidelines					
Total possible points: 160 points					

Laboratory Investigation #2: Introduction to Phylogenetics

Pre-Lab Activity
Watch the videos and complete the Cladograms quiz before coming to class. Remember to submit your Plant DNA paper draft for peer review!

In Class Activity

Learning Objectives:
- Create a phylogenetic tree based on leaf morphology and compare with a tree based on genetic data
- Experience one way to analyze phylogenetic data
- Interpret evolutionary relationships

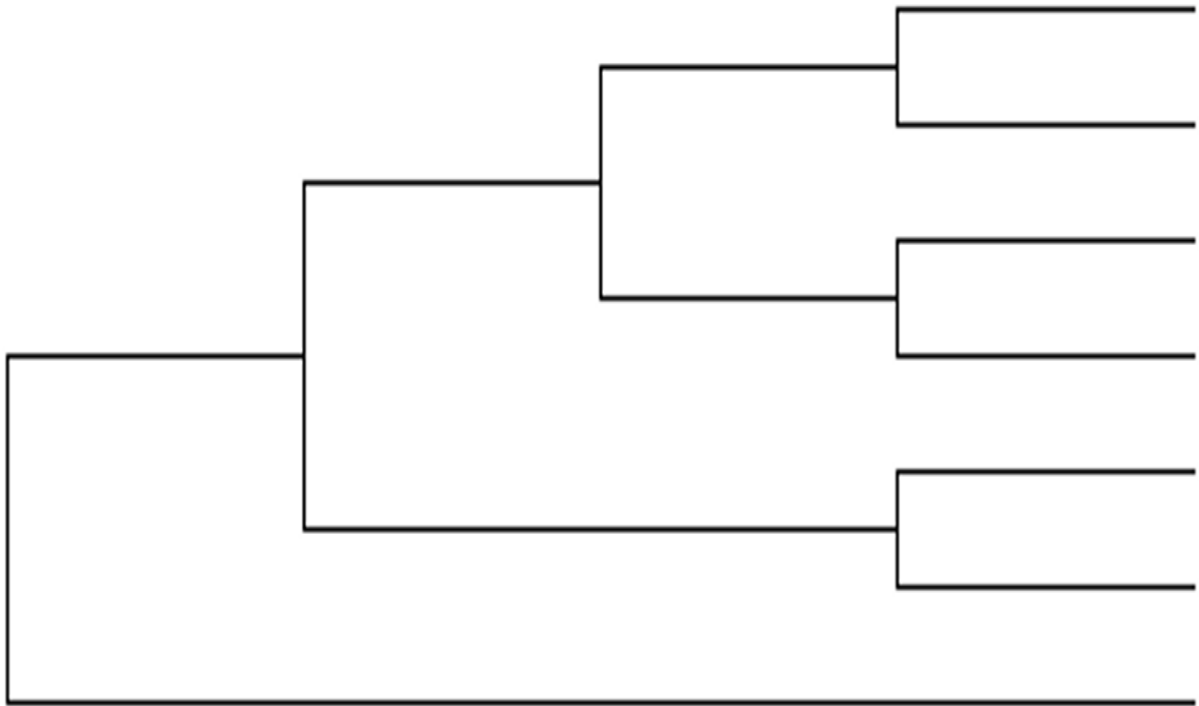## *Developing a Scientific Mindset – Create a Phylogenetic Tree*

Guiding Question: Do the two phylogenetic trees, one constructed using leaf morphology and one constructed using plant DNA sequences, agree?

Today in lab, you will work in your group to create a phylogenetic tree for the plant species located at your table. You will then compare your morphological tree with one constructed using DNA sequences for the same species. We will do a whiteboard/argumentation session for this activity at our next lab meeting.
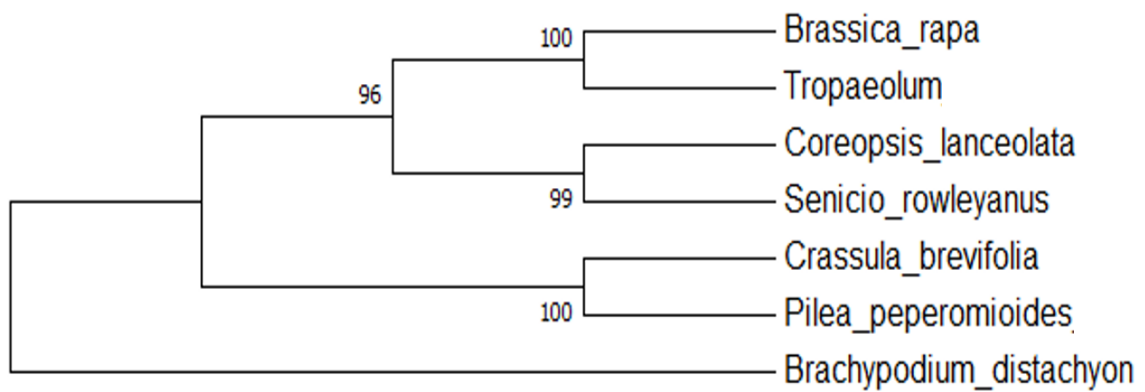
1. Do the morphological and genetic trees agree or disagree? Why?

2. What does this suggest about the evolution of these species?

Framework for Morphological Tree Construction

Phylogenetic tree constructed with DNA sequences.

100 — Brassica_rapa
— Tropaeolum
96
— Coreopsis_lanceolata
99 — Senicio_rowleyanus
— Crassula_brevifolia
100 — Pilea_peperomioides
— Brachypodium_distachyon

Laboratory Investigation #2: Introduction to Phylogenetics
Part 2: Plant Phylogenetic Trees

Pre-Lab Activity
Watch the videos and complete the Phylogenetics quiz before coming to class.

In Class Activity

Learning Objectives
- Develop an argument, discuss arguments with your peers, and revise the argument based on feedback

Argumentation Session for Plant DNA investigation
Use the white board on your table to reconstruct the table below for the Plant Phylogenetics investigation.

Reminder: Each group will leave one member at the table to present their argument and the remaining group members will move around the room to other groups. At each table the presenter will begin a discussion of the results with the visiting group. The students should compare results and question each other's findings and method. You may then revise your whiteboard based on your observations and feedback.

Guiding Question:

Hypothesis:

Claim:

Summary of Results:	Justification of the Claim using Evidence:

Assignment: Each group will take a photo of their revised whiteboard and upload it to Canvas for grading.

Argumentation Session Whiteboard Grading Rubric (30 points)

	10pts	8pts	6pts	4pts	2pts	0pts
Guiding Question 1. Include the guiding question that was assigned	██	██	██	██		
Hypothesis 2. Is testable and based on sound reasoning.	██	██	██			
Claim 3. A statement if you support or reject the hypothesis you developed for the guiding question.	██	██	██			

Summary of Results
    4. Include the all the section data in summary table
    5. Includes both phylogenetic trees						

Justification of the Claim using the Evidence
    6. What data collected, and analysis was used to state your claim.
    7. Relevance of the evidence using scientific concept/principles
    8. Evidence with actual scientific information.						