

BIOS 2611

Integrative Genetics Laboratory Fall 2021

Crispy Leps Project Syllabus

This syllabus is subject to change.

Expectations

This is an unprecedented time. We all agree that the best way for you to learn is face-to-face. If we are required to move to an online format because of a covid outbreak, we will pivot this course to allow you to learn remotely. Whether we meet in-person versus remotely could change depending upon the health status of individuals in the classroom. You have a definite stake in your personal health and the community's health.

Our expectation is that everyone who is eligible will be vaccinated; vaccination significantly reduces likelihood of severe disease, including from the delta variant of SARS-CoV-2. Because the delta variant can be spread by vaccinated individuals, we also expect that everyone who is able to should wear a mask, correctly covering mouth and nose, when indoors. Both of these expectations are based on current CDC guidance. As that guidance is updated, we will communicate any new expectations via Canvas.

Weekly asymptomatic surveillance testing should be part of everyone's regular routine, regardless of vaccination status. Pick a time each week to get tested, and book it into your calendar. Details are here: <https://health.gatech.edu/coronavirus/testing>.

Sections

Section A1	Thursday	12:30-3:15 pm EDT	Boggs 1-69
Section A2	Thursday	3:30-6:15 pm EDT	Boggs 1-69

Co-requisite

BIOS 2611 & BIOS 2610 are co-requisites. You must enroll in both courses simultaneously. While this laboratory is the co-required companion to BIOS 2610, your grade in each course is independently earned. This course replaces BIOL 2355, and students cannot earn credit for both BIOL 2355 and BIOS 2611.

Course Description

This course is designed for students especially interested in learning key concepts and practical techniques in the field of genetics. Integrative Genetics Lab is a course-based undergraduate research experience (CURE), where students will design and conduct a genetics research project aimed at exploring aspects of transmission genetics, population genetics, and/or molecular genetics using a specific study system. This fall, students in the course will address the research question: how do specific genes affect flight and wing-related traits in species of lepidopterans.

As with all hypothesis-driven research, we use the research question above to generate testable and falsifiable hypotheses. We will design and conduct an experiment to test one of those hypotheses using CRISPR-Cas9 molecular genetics tools, and analyze the data to draw a conclusion.

We are asking real questions in a relevant study system, as scientists do; the work is new to you and also new to us, your teaching and prep team. Because of this, we'll probably encounter the primary frustrations of scientific research—assays that require troubleshooting, delays when protocols don't work perfectly at first pass, and results that don't match our thinking about the system. These types of problems are the reality of lab work and scientific inquiry. Learning how to navigate the process and solve the ensuing problems is the best training you can have to be resilient now, for your senior research experience, and to pursue careers in scientific research, medicine & human health, or other fields that require problem solving and logic.

By the end of this course, you will be able to:

1. Generate and craft a thorough, genetics-based hypothesis about genotype to phenotype effects of a gene of interest in one or more lepidopteran species
2. Design and conduct experiments and interpret results, incorporating scientific uncertainty and using appropriate statistical methods when relevant
3. Create and troubleshoot genetics lab protocols
4. Cite relevant genetics primary literature
5. Write effective and accurate notebook entries
6. Communicate work and findings in a written lab report in the style accepted by genetics scientific journals.
7. Use appropriate bench techniques, following all lab safety standards.

Time Commitment

The lab meets for up to 2 hours and 45 minutes each week, and usually has 1-3 hours of homework outside those meeting times. This course is 1.0 credit hour.

Instructor

Dr. Chrissy Spencer

Email: chrissy.spencer@biology.gatech.edu

Pronouns: she/her/hers

Office hours: I'm available on BlueJeans Tuesday 2-4 pm and by appointment (email for a meeting link).

Teaching Assistants

Nyssa Morgan

Email: nmorgan37@gatech.edu

Pronouns: she/her/hers

Office Hours: By appointment via email

Shraddha Krishnakumar

Email: skrishna60@gatech.edu

Office Hours: By appointment via email

Required Textbooks and materials:

Website: ingeneticslab.biosci.gatech.edu

Canvas site: Canvas BIOS 2611 Integrative Genetics Lab site

Text: same as for lecture; textbook is a useful reference

Lab Manual: There is no lab manual for purchase for this course. Instead resources will be provided on the course website.

Safety: Lab coat and safety glasses (see 'Lab Safety' below for details)

Other: Closed-toed shoes and long pants are required for every lab held in Boggs 1-69 (wet labs); calculators and laptops (one per group) are useful.

Lab Safety

Georgia Tech has a strict and strictly enforced policy regarding appropriate clothing in indoor laboratories where chemicals and organisms are used or manipulated. **Students not conforming with the following requirements will be asked to leave the lab** and will not be allowed to return without appropriate clothing:

1. **Face masks** should be worn inside the Boggs lab space. We will provide disposable face masks for use in lab.
2. **Long pants** must be worn in the laboratory.

3. **Closed-toed shoes** that cover the sides and top of the foot must be worn in the laboratory.
4. **Lab coats** must be worn when working at the bench. Students are responsible for keeping their lab coats in good condition and reasonably clean so as not to create a hazard. Lab coats must be 100% cotton and cover the wearer to the knees.
5. **Safety glasses** must be worn when working at the bench. Safety glasses must have side shields for splash protection and conform to the wearer's face. Glasses must be worn over prescription glasses and contact lenses. Please purchase your own safety glasses from the GT Bookstore or online before the second week of lab.

The laboratory safety policies will be discussed in detail in lab.

Evaluation

Grades will be calculated on the following scale:

A: $\geq 90.0\%$

B: $\geq 80.0\%$ and $< 90.0\%$

C: $\geq 70.0\%$ and $< 80.0\%$

D: $\geq 60.0\%$ and $< 70.0\%$

F: $< 60.0\%$

Points will be based on the following:

Attendance & Participation (15%)

This course meets in person. Given that we are working collaboratively to perform experiments and collect data on an on-going project, there is no mechanism to “make-up” a lab. While we expect each student to attend every lab and to be present for the entire lab period, we are in a pandemic. If you are sick, in isolation for covid, or in quarantine for possible covid exposure, we ask that you not come to class. Instead, email Dr. Spencer immediately to communicate that you will not be in class and plan to participate remotely on a bluejeans session with your teammates, if you are well enough to do so. While far from ideal, this is the safest solution we can implement in the current circumstances.

For non-illness related reasons, if you must miss a laboratory, notify the instructor by email as soon as possible, preferably before the missed lab. There will be no make-up laboratories. Vacation, work commitments, and social events are not acceptable reasons to miss lab. Examples of legitimate reasons to miss a lab include serious illness, illness or death in your immediate family, and participation in official university activities. You will be required to provide documentation for excused absences.

Genetics Lab requires cooperative use of materials, awareness of lab safety protocols, preparedness before class, and effective interaction in class. Each class period, we will assess your participation in class. Student use of a cell phone for non-lab business during lab may result in 0 participation points for that lab period. If you are in a situation where you must leave your phone on, please alert the instructor ahead of time and step outside to take the call. You are encouraged to check in with the course instructors at any time during the semester to gauge your participation score to date.

Pre-lab assessments (15%)

These will be available on Canvas/Quizzes on the Tuesday before each lab. Pre-labs concentrate on the upcoming lab material and are due by 11:59 pm on the Wednesday before each lab. Late submissions will not be accepted. If you miss a pre-lab due to an unexcused absence from lab, you will receive a zero for that pre-lab. You should plan to complete the assigned reading before attempting the pre-lab. Pre-labs are open-book but individual, non-collaborative assignments. There are 10 Prelabs, 8 of which will count toward the Pre-lab assessments grade.

Lab Notebooks (20%)

What: You will keep your notebook electronically through our Canvas site. Each week each student provide a weekly report or update of all progress on the project. Details of what to include are in the rubric below and in each Canvas Assignment for the notebook. A thorough lab notebook will be fundamental to write accurate lab write-ups.

When: Lab notebooks should be updated after lab each week **by Friday midnight**. We suggest when possible that students not leave lab before uploading their notebook entry, because real time documentation is the best practice. On time submission is 25% of lab notebook grade. For the remaining 75% of the grade, we will assess the notebook for content, accuracy, and completeness, following the rubric provided below. Notebooks will be monitored, graded, and commented weekly. Comments are provided to help students improve future lab notebook entries.

Own work: In your notebook, you are to **write in your own words**, even if you are working with a team on the experiment. The only exceptions to this are:

- team-devised protocols,
- data, which should be proofread carefully, and
- tables and figures. These may be created mutually by your team members and then shared within your team. They should be critically examined for accuracy.

If a teammate made a mistake that you preserve in your notebook and work, you own that error as well. Therefore, data entry and analysis are best done collaboratively, with proofreading, rather than by one member of the team. Anything you write in your lab notebook may be used word-for-word by you in your lab report, though the notebook is typically best used as draft language to be revised for the lab report. The lab notebook rubric is at the end of this syllabus.

Individual Lab Report Sections (20%)

During the semester, you will generate a full laboratory report in the style of a scientific journal. This report will be written in stages; each stage will receive peer and/or instructor feedback. All lab reports are individual assignments. While lab work is done collaboratively, every component of the lab report, except shared tables and figures (see Notebooks), should be generated by the report's author in that author's own words and working non-collaboratively. There will be many writing assignments due during the semester to encourage you to test your ideas in writing. Each will be submitted electronically to Canvas/Assignments, according to the schedule below, and will be due by the beginning of lab. A late assignment will be reduced one letter grade (10%) for each 24-hour period that it is late.

For notebooks and reports, you may want or need to set up an appointment for interactive writing assistance from tutors in the Communication Center (communicationcenter.gatech.edu) in the CULC. The Communication Center is an excellent resource for professional writing like lab reports but also for job cover letters, personal statements, and more.

Team Lab Report (20%)

Science is rarely done by solo researchers. Instead, teams work together, as you will experience in the lab this semester to collaborate on an outcome. The written result of team research is also co-authored by many. Working together with multiple contributors should generate a research paper that is synergistic, meaning more than the sum of its parts.

The final lab report in this course is a team product--one lab report for the entire group. A complete version 1 lab report (which means a finished document, not just a draft) will be due as a shared document at the end of the last class meeting. Instructors will read, grade, and provide feedback via canvas. The grade can be adjusted by applying the feedback to rewrite those parts of the document. **The final Lab Report version 2 document will be due on Canvas/Assignments on the Final Instructional Class Day by 11:59 pm.**

The Lab Report Rubric is below and on Canvas. TAs and Instructor grade independently according to the rubric, then compare grades and comments. The instructor assigns final grades. All members of the lab section agree to accept the same grade.

Writing Assistance: For written assignments, you may as an individual or as a class want or need to set up an appointment for interactive writing assistance from tutors in the Communication Center (communicationcenter.gatech.edu) in the CULC. Viewing and absorbing the content from the Avoiding Plagiarism workshop from the GT Library and information on Canvas will help prevent any concerns about academic integrity.

Effective Team Dynamics (10%)

Teams rarely work perfectly unless the members consider their contributions and those of their teammates, and these imperfections can be augmented in teams working remotely, as our will be. To help teams work at their best, this course embeds the GT [effective team dynamics](#) curriculum, and we will have training and multiple touch points throughout the semester to help each student bring their best strengths to their team. This process involves self-reflection, team reflections, and feedback on what is going well and how things that aren't going well can go better. Reflections will be according to a provided template and due on Canvas/Assignments throughout the semester. See Canvas for specific due dates.

Late Assignments Policy

We expect work to be submitted on time because it is good professional courtesy, it allows for peer reviews to happen in a timely manner, and it helps us assess where you are in your project development. A standard late work policy of 10% off per day is in place for this course, with the exception that lab notebooks are either on time or not on time. If you need additional time because of extenuating circumstances, email Dr. Spencer at chrissy.spencer@biology.gatech.edu to make arrangements.

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Georgia Tech's Academic Honor Code, please visit <http://www.catalog.gatech.edu/policies/honor-code/> or <http://www.catalog.gatech.edu/rules/18/>.

We have noticed that students and faculty have different definitions of academic integrity, so we invite students to complete the How to Write for Academics / Avoiding Plagiarism module on Canvas.

Any student suspected of cheating, lying about course matters, stealing classroom materials, or plagiarizing on a quiz, exam, or assignment, or helping others commit a violation of the Honor

Code will be reported to the Office of Student Integrity, which will investigate the incident and identify the appropriate penalty for violations.

Note that plagiarism is the unattributed use of the words or ideas of others. Plagiarism includes reprinting the words of others without both the use of quotation marks and citation. As direct quotes are seldom used in scientific writing, you are expected to rephrase the words of others and provide the citation. Plagiarism on any assignment, including Pre-labs, progress reports, and laboratory reports, will be referred to the Office of Student Integrity for adjudication. If you have any questions regarding your assignments and plagiarism, we encourage you to consult with any of us before you submit the assignment.

Accommodations

If you have learning needs that require some accommodations for you to succeed in this course, please contact the Office of Disability Services as soon as possible (disabilityservices.gatech.edu) to make an appointment to discuss your needs and to obtain an accommodations letter. We will arrange to accommodate your learning needs based on their recommendations.

Inclusivity

As members of the Georgia Tech community, we all commit to creating a learning environment in which all of our students feel safe and included. Because we are each individuals with varying and unique needs, the course instructors rely on your feedback to achieve this goal. To that end, we invite you to enter into dialogue with us about the things we can start doing, continue to do, or stop doing to make our mutual classroom an environment in which every community member feels valued and can engage actively.

Academic Support

Georgia Tech offers a variety of free learning and communications support options. Learn about free tutoring resources at success.gatech.edu or at the Center for Academic Success's tutoring desk in Clough Commons 273. For assistance with revising lab reports or building and polishing a reflection or position piece, consult the Communications Center (Clough Commons 447 or commlab.gatech.edu).

Additional resources for academic support include:

- Center for Academic Success (success.gatech.edu)
 - 1-to-1 tutoring (success.gatech.edu/1-1-tutoring)
 - Peer-Led Undergraduate Study (PLUS) (success.gatech.edu/tutoring/plus)

- Academic coaching (success.gatech.edu/coaching)
- Residence Life's Learning Assistance Program
 - (housing.gatech.edu/learning-assistance-program)
 - Drop-in tutoring for many 1000 level courses
- OMED: Educational Services (omed.gatech.edu/programs/academic-support)
 - Group study sessions and tutoring programs
- Communication Center (communicationcenter.gatech.edu)
 - Individualized help with writing and multimedia projects
- Academic advisors for your major (advising.gatech.edu)

Personal Support

In your time at Georgia Tech, you may find yourself in need of support. Below are some resources available on campus.

- The Dean of Students studentlife.gatech.edu 404-894-6367
 - Select “request assistance” to communicate with the Dean’s office
 - Located in Smithgall Student Services Building on the 2nd floor
- Counseling Center: counseling.gatech.edu 404-894-2575
 - Located in Smithgall Student Services Building on the 2nd floor
 - Services include short-term individual counseling, group counseling, couples counseling, testing and assessment, referral services, and crisis intervention. Their website also includes links to state and national resources.
 - Students in crisis may walk in during business hours (8am-5pm, Monday through Friday) or contact the counselor on call after hours at 404-894-2204.
- Students’ Temporary Assistance and Resources (STAR):
 - studentlife.gatech.edu/content/star-services
 - Can assist with food, housing needs, interest-free emergency loans, and interview attire when you are on the job market.
- Stamps Health Services: health.gatech.edu 404-894-1420
 - Primary care, pharmacy, women’s health, psychiatry, immunization and allergy, health promotion, and nutrition
- OMED Educational Services: omed.gatech.edu
- Women’s Resource Center: www.womenscenter.gatech.edu 404-385-0230
- LGBTQIA Resource Center: lgbtqia.gatech.edu 404-385-2679
- Veteran’s Resource Center: veterans.gatech.edu 404-385-2067
- Georgia Tech Police: 404-894-2500

Schedule (Subject to change)

Note: **There is a major assignment due on the final instructional class day.**

Note that there is a Lab Notebook entry due every Friday beginning 8/27 and ending 11/19.

Other assignments and deadline are also in Canvas; any adjustments in assignment due dates will be reflected on Canvas.

Date	Week	Before Lab (PreLabs due Wednesday by noon)	In Lab
8/26	Week 1	NA	Project overview / Designing sgRNAs
9/2	Week 2	PreLab: Recombinant DNA training	Select sgRNAs for order / Design Primers / Lab Safety
9/9	Week 3	Reading & PreLab: TBA	PCR and sgRNA digestion protocols / Pipetting, Dilutions, Solutions
9/16	Week 4	PreLab: PCR	Testing sgRNAs in vitro
9/23	Week 5	Writing: Reflection	Gel / PCR clean up / Digest PCR product with sgRNAs
9/30	Week 6	PreLab: Gels	Gel to determine efficacy and efficiency / Microinjections1
10/7	Week 7	Writing: Methods	Microinjections2
10/14	Week 8	PreLab: ImageJ download	Microinjections3 / Monitor development / ImageJ intro
10/21	Week 9	Writing: Introduction	Scientific Writing on a Team / Monitor development
10/28	Week 10	Reading & PreLab: TBA	Phenotyping1 / Journal Club1
11/4	Week 11	Reading & PreLab: TBA	Phenotyping2 / Journal Club2
11/11	Week 12	Reading & PreLab: TBA	Phenotyping3 / Journal Club3 / Sequence interesting phenotypes
11/18	Week 13	Writing: Results Writing: Reflection	Data analysis / Team Paper working session / Analyze sequence results
11/25	Week 14	NA	<i>Thanksgiving Holiday</i>
12/2	Week 15	NA	Team paper working session / Version 1 Lab Report due
12/7	Last class day	Team Paper due - Tuesday by 11:59 pm	NA
	Last day of final exams	Writing: Reflection - Thursday by 11:59 pm	NA

Rubrics

I. Overview

Your lab notebook will be a valuable asset to your experiments and written assignments for this semester. Each entry of your lab notebook should document clear, organized, and detailed notes of the work writing and referencing protocols, at the bench, reading the published literature, and in discussion with others about ideas. Each entry should include these criteria:

Lab Notebook		
Criteria	Ratings	Pts
Clear and organized logically with title, sections, captions as needed		3 pts
Concise		3 pts
Accurate and Precise		3 pts
Lists goal, purpose, or hypothesis		3 pts
Describes assay or experimental design in a replicable way, referencing protocols if relevant		3 pts
Data and observations clearly detailed and summarized as relevant, with reference to a data sheet		3 pts
Draws a conclusion about the work and establishes a next step		3 pts
		Total Points: 21

Lab notebooks will be monitored and graded several times throughout the semester. Grades will be based on content, accuracy, and completeness according to the rubric detailed on the next page. A thorough notebook will be critically important for creating an accurate and complete lab report.

In your notebook, you are to write in your own words, even when working in a team. However, tables and figures may be shared within your team, and we also encourage data analysis to be done collaboratively rather than by one member of the group.

II. Tips to Creating an Effective Lab Notebook

1. Before class, review any materials and last week's result.
2. Include notes or steps on how to operate lab equipment: micropipettors, thermal cyclers, centrifuges, gel rigs and power supplies. In any lab setting, you are expected to be able to operate equipment after being taught, but if you don't recall, please ask rather than risk injury to yourself or damage to lab equipment.
3. Write down ALL observations/data including "bad" results or mistakes made. Even "failed" experiments are valuable (in fact, that's most of scientific research), and these will be helpful when writing your lab report.
4. Don't wait. Record data right away in your lab notebook. Don't rely on your memory; you can forget what happened during your experiment if you wait to write down observations at home.
5. Track edits. If next week you need to update your previous entry, make a new section called Errata from Week # and enter the correction.

Genetics Lab Report Rubric (for exploratory science or hypothesis-driven research)

Modified 8/25/2021

Criteria	Demonstrating (9-10 points)	Level of Achievement			
		Demonstrating	Emerging	Beginning	Absent
<i>Abstract (10 points)</i>	<p>Parts a-f flow seamlessly, with clarity, accuracy. Convinces the reader of the importance of the work and compels them to read the full paper. Is concise and to the point, at under 300 well-chosen words.</p> <p>Contains parts:</p> <ul style="list-style-type: none"> (a) Introduces purpose or motivation for experiment. (b) States the question your experiment is designed to address and its scientific merit. (c) Briefly summarizes experimental approach. (d) Describes major findings and interpretations. (e) Links findings back to question or hypothesis. (f) Describes importance & significant implications of experiment. 				
<i>Introduction (10 points)</i>	<ul style="list-style-type: none"> • Provides a complete summary of ideas the reader needs to know to understand the research question, including why it is important and how it impacts society. • Ends in a succinct but complete statement of the research topic. • Briefly reviews the relevant parts of the general genetics topic under study and why the study system is appropriate to address the research question. • Links the purpose for the experiment to relevant genetics, scientific, and ethical concepts, as relevant. • Ideas are organized and flow smoothly. • Content is clearly presented and accurate. 				
<i>Methods (10 points)</i>	<ul style="list-style-type: none"> • Opens with a clear and succinct description and purpose of the experiment and what evidence is needed to answer the research question. • Describes the experimental design with the appropriate treatments, controls, and replicates and how this design will address the question. • Names and describes the protocols used with information necessary to replicate but assuming the reader is versed in genetics techniques, while briefly stating the purpose for each protocol. • Selects and correctly explains the correct analysis (e.g., statistical test) for the data & question, indicates what evidence will be necessary to draw a conclusion, showing the logic behind the decision. • Ideas are organized and flow smoothly. • Content is clearly presented and accurate. 				
<i>Results (10 points)</i>	<ul style="list-style-type: none"> • Begins with 1-2 well-written sentences that clearly describe the major findings of the research. • Provides relevant details of each finding in the same order as the methodology. • Reports findings from the data analysis, without explanations or conclusions about the data. • When needed, supports findings with the correct statistical approach. • Findings correspond exactly to data in lab notebook. • Entirely accurate with no errors in logic or concept. • Words are chosen deliberately and judiciously. 				

<p><i>Discussion (10 points)</i></p>	<ul style="list-style-type: none"> • Begins with a statement that clearly relates the main result(s) to the research goal, then interprets those results well and accurately with respect to the research goal. • References specific data from the study as evidence to decide if the research goal was met. • Uses scientific concepts accurately and convincingly to explain how the research goal is addressed. • Describes important & significant genetic, scientific, and ethical implications of experiment, as relevant, connecting back to ideas in the introduction. • Addresses other issues as appropriate and without overemphasis, such as problems that occurred, sources of uncertainty in the lab procedure or findings, comparison of findings to others' findings and explanation for differences, improvements or extensions. • Overall, the content and ideas presented are in support of the research question, goal, or hypothesis. • Clearly written with deliberate word choice, correct grammar, and syntax; carefully proofread; with cohesive and logical flow of ideas. 				
<p><i>Figures & tables (10 points)</i></p>	<ul style="list-style-type: none"> • Selects the best graph or table type to represent the data as a descriptive summary (mean, median, etc) with error bars when uncertainty needs to be represented. • Orients the data with the independent or response variable on the y-axis. • Graph formatting is minimal, and has axis labels and legend, if needed. • Caption describes the result clearly and simply in an active-voice sentence, giving the direction of the result when relevant; located below figure or above table. • At the point in the text where the result is described, figure/table is clearly referenced in text parenthetically, not as the subject or object of the sentence. • While these visuals are part of the results, they are located after the discussion in the lab report document. 				
<p><i>Literature Cited (10 points)</i></p>	<ul style="list-style-type: none"> • Lists of all published literature cited in the lab report, formatted in the style of the journal <i>Genetics</i>. • Avoids work that is not peer-reviewed. • Cites as many appropriate peer-reviewed scientific papers as necessary to support the information and arguments made in the report. • Includes peer-reviewed articles sought out and vetted for appropriate content and concepts by the author, as well as articles provided to the class. • Avoids citing websites, unless appropriate and unavoidable. • All citations listed are also cited in text, and vice versa. • The in-text citations are located with the concept they reference, not shuffled to the end of a sentence or paragraph. • In-text citations flow well with the writing if included as the subject or object of a sentence, or are parenthetical. For example: "Spencer and colleagues (2018) found that frunctons exhibit traits of living organisms,..." and "Frunctons exhibit traits of living organisms (Spencer and Spencer 2000)." 				
<p><i>Writing (10 points)</i></p>	<ul style="list-style-type: none"> • No errors in writing (grammar, syntax, and spelling). • Entire work uses words carefully, minimizing excess while retaining clarity and accuracy. 				
<p><i>Format (10 points)</i></p>	<ul style="list-style-type: none"> • Title is specific and clearly conveys a summary of the lab report findings, without a separate title page. • Written entirely in sentences organized as paragraphs, with appropriate paragraph breaks between ideas. • Organized into the sections outlined in this rubric, separated by headings in bold, without page breaks. • Uses technical terminology minimally and correctly, abbreviating or italicizing consistently and according to the conventions of a <i>Genetics</i> style journal (e.g. species names, gene and allele names). See http://www.genetics.org/content/prep-manuscript#references. • Page formatting follows these conventions: Times New Roman 12 pt font (even for headings); 1 inch margins; single-spaced; pages are numbered. 				

Guide to Writing Genetics Lab Reports: Overview

The instructions provided here are crucial for developing a good Biology lab report. Chemistry or engineering reports are **not** biology reports. High school biology reports are **not** college-level biology reports. The lab reports you will write in this class are based on the format and requirements for publication of research in genetics-related scientific journals. You should learn the correct way to condense protocols into an appropriate Methods section, how to present data effectively, and how to draw conclusions from the data and explain the significance. Here are three websites that provide additional detail on how to construct strong lab reports:

<http://ncsu.edu/labwrite/>

<http://abacus.bates.edu/~ganderso/biology/resources/writing/HTWtoc.html>

Your lab report will be graded according to the Genetics lab report rubric available in this lab manual. In brief, you will be graded on completeness (all sections, figures, tables, etc. are present), content (material is appropriate, accurate, referenced as needed, etc), presentation (sub-sections are organized, transitions are clear, figures are properly labeled, etc) and spelling and grammar. Please *proofread*: spell-check programs are not designed to catch mistakes in scientific terminology. If writing does not come easily to you or English is not your native language, please take advantage of the writing services in the CommLab in Clough Commons (<http://www.communicationcenter.gatech.edu>) to improve your written (and other) communication skills.

Some questions to ask while preparing your report:

1. What question was the experiment trying to ask and how was the experiment designed to answer that question?
2. What are your controls? Every good genetics experiment needs positive and negative controls to allow you to determine if the experiment truly worked. Some experiments in this lab course may not have all possible controls due to limitations in time or materials; in those cases you should consider what the appropriate control could be.
3. How many samples did you look at (replication)? In order to show trends, you can't look at just one sample, you need to look at several. How can you *statistically* represent the patterns you see in your data?
4. What do your data mean? Did your controls work as expected? Do the data answer the question being asked? How could you do things better? What else needs to be done (future directions)?

Guide to Writing Genetics Lab Reports: Lab Report Format

Your lab report should contain the following *labeled* sections:

Title: Construct a phrase that clearly describes the content of the paper/experiment. The title reveals the key result.

Example: “DNA Fingerprinting” is too broad, while “Comparison of RFLP versus SINE analysis to distinguish crime scene evidence” explains the *what & why* of the experiment.

Abstract: The abstract helps the reader to understand the larger document by acting as a summary or “pre-reading” of the key points. The abstract describes the question your experiment is designed to address and its scientific merit. The abstract should be concise yet complete. See the lab report rubric for specifics on what we look for in a good abstract.

Introduction: Provide the context and purpose of the experiment. This is accomplished in three steps:

1. Summarize the broad state of knowledge pertaining to the general topic
2. Identify how the goals of this experiment fit to this knowledge: provide the relevance of the experiment.
3. State the specifics of what was done in the experiment: present your hypothesis and/or objectives.

Background information needs to be cited. Use the introduction to say what you studied in your experiment *and* what broader gaps in general biological and genetical knowledge your experiment addresses.

Example: “We tested the effects of overexpressing a protein involved in purine catabolism to address whether and how this technique could be used to correct a disorder associated with toxic buildup of deoxyadenosine.”

You should take it a step further by trying to convince your reader why they should care. Imagine that you are explaining the experiment and its importance to another biology undergraduate or researcher. Imagine the questions that they might ask you as you are explaining what you did and try to address them in the background.

Example: “Adenosine deaminase (ADA) deficiency leads to severe combined immunodeficiency (SCID), which is a devastating immunological disorder affecting 1 in 100,000 live births (add citation here), yet the treatment of ADA-SCID through gene therapy techniques to restore the protein has not been widely investigated.”

The last idea in your Introduction is a clear statement of your hypothesis. Be explicit in your comparisons, and state the direction of the predicted effect when possible:

“More...than...” “Different...from...” “Difference between ____ and ____”

Example: “We hypothesized that more viable cells would be cultivated after treatment with exogenous adenosine deaminase than from cultures that were not treated.”

And note that “If..., then...” statements make lousy hypotheses.

Make sure that your introduction follows a logical train of thought. No big leaps of logic. Go from giving background on the state of the field to background on the particular aspect of interest to finally background on YOUR system or question. End with a sentence describing your main objectives, the explicit hypothesis you are going to test, and a BRIEF sentence or two on how you tested it.

Example: “We describe here an experiment to test the hypothesis that treatment of adenosine deaminase-deficient cells with the missing protein will lead to a greater number of viable cells over a period of time than untreated cells. We expressed the protein following transfection with an engineered plasmid and then monitored for cell viability over a period of time.”

Methods: This provides all necessary information so that another scientist could repeat your experiment: What did you do, how did you do it? Be specific and use scientific terms for the materials or equipment used. However, do not provide a “shopping list” of the materials needed nor a step-by-step protocol. We do not need to know you used a black sharpie to label your sample tube, but we do need to know what reagents you used, or the name of kit used. **Example:** “We isolated RNA following the manufacturer’s protocol (Invitrogen RNA Isolation Kit #lvg2543) for whole insect tissue samples, modified to grind samples in liquid nitrogen.” Your protocols gave specific volumes of reagents, but in the methods convert these to concentrations. For example, 1 ul of 10 mM primer in a 25 ul reaction volume becomes 0.4 mM.

Explain why you used the control(s) that you used. **Example:** “Because the protein was expressed from a plasmid, we used an empty vector without the gene of interest to ensure the efficacy of plasmid transformation.”

Try to think of the questions that a reader will have about how you did your experiment and make it as clear as possible, without including extraneous details. Avoid including details about how many times to pipette a sample after adding a reagent and whether you stood while you added the solution as opposed to sitting. Methods are not a timeline of events but rather an ordered list of the experimental design stages. Be direct and state the reaction conditions, temperature settings or chemical information important to replicate your study in another lab. **Example:** “We conducted the assay at room temperature in a laminar flow hood.” Other pertinent details are size or concentration of sample, how many replicates and what constituted an independent replicate, the statistical tests you used, etc...

If you used statistical methods to analyze your data, the names of these tests should be given, as well as a description of the input data for each test, at the end of your methods section.

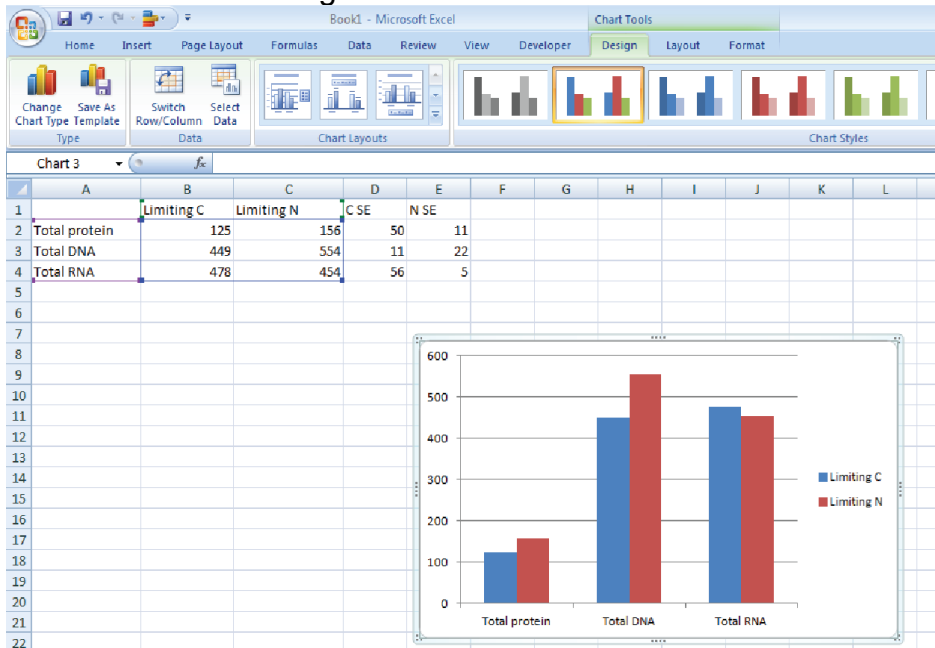
Results: Describe what you found in a paragraph(s) of text that refer to your figures and tables. Figures and tables alone do not make a complete Results section! Your results are the take-home message of what your data say. Use figures or tables to represent important trends or results of your analyses, and be sure these are cited in the textual description. The tables and figures should be placed at the end of the entire document, numbered, in order. Results should be a summary of data and observations; you should not include raw data. The text should summarize what you found, giving means \pm SE or SD. Tell what happened clearly and concisely without interpretation. Use figures to highlight the main point(s). *Use statistics to make your point, but don't make the statistics your point.* Instead of saying: “We got a p-value of 0.001 meaning our results were significant,” say instead “The treatment had significantly more growth than the control, according to a two-tailed t-test ($t = 0.87$, $df = 1$, $p = 0.001$).” Explain exactly what the statistical test was testing. Don't just report a Chi-square value and expect the reader to know what you were testing.

If the results can be described in a graph, these are generally easier to interpret than a table. You should not present the same data in several ways; choose the one best way. Given a choice between table and graph, go for the more visual of the two, e.g. if your table is just going to report means \pm standard errors (SE), report it graphically. Please note: if you can calculate a mean, then you can calculate the SE. You should always add SE bars to your graph in this case. The default SE bar in Excel is a standard distance away from the mean; this is incorrect, and you will need to enter the correct values. Seek help from your TA if you have never added SE bars to a graph. Figures and

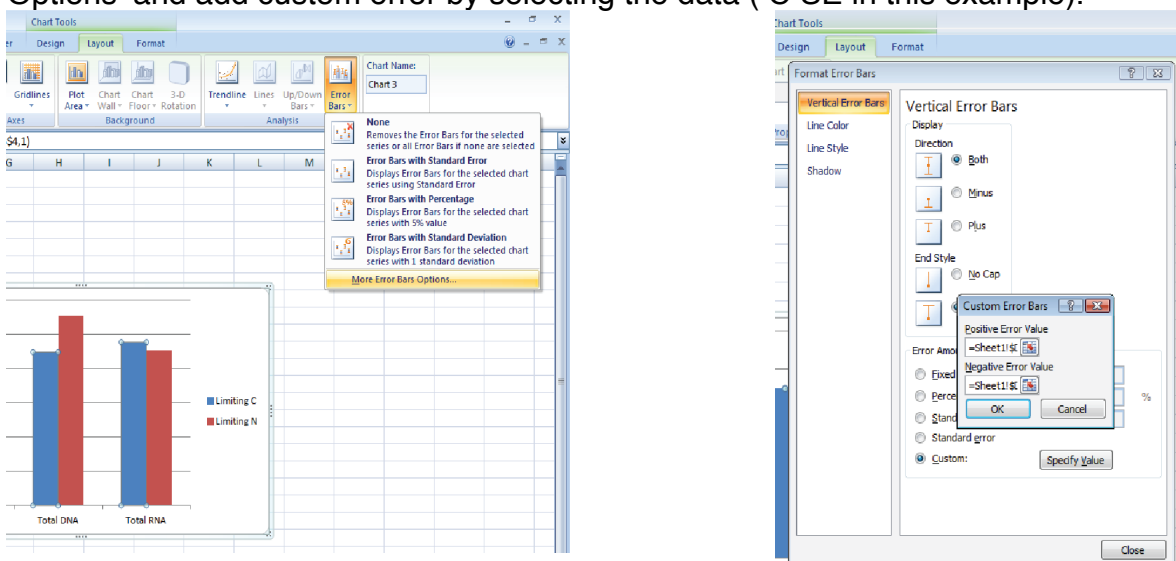
tables should be labeled Figure 1 or Table 1 in the order in which they are referred to in the text. Each visual aid should have a descriptive caption (1-2 sentences) explaining what they represent. Captions belong *below* a figure, or *above* a table. Figures and tables can be inserted within the body of the text.

Refer to the following for help creating graphs in Microsoft Excel.

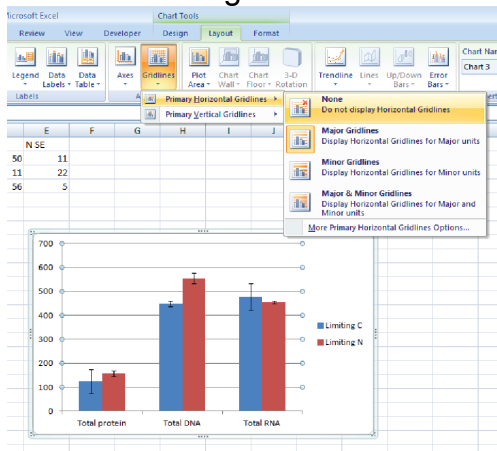
1. Select the data to be graphed and choose the type of graph you wish to use. The graph options can be found under the 'Design' tab.



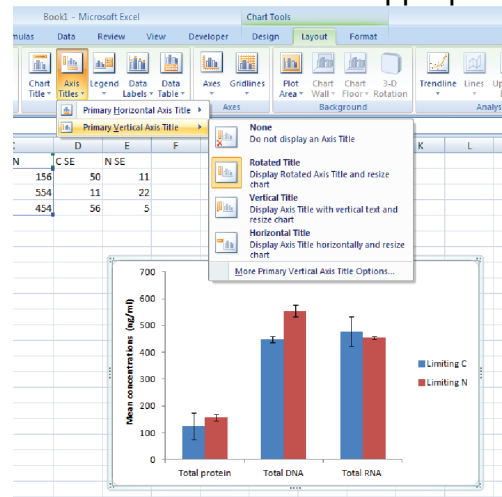
2. Addition of error bars – The option to add error bars can be found under the 'Layout' tab. You can click and select the data series you wish to add the error bars to. On the other hand, you can click on the 'Error Bars' tab and it will ask you to select the data series you wish to add the error bars to. In this example, error bars are being added to the 'Limiting C' data series. Click on the 'More Error Bar Options' and add custom error by selecting the data (C SE in this example).



3. Remove the grid-lines.



4. Add Axis-Titles where appropriate



Discussion: Describe how the data relate back to your initial hypothesis/objective. Provide logical arguments explaining what the results mean and how your data relates to the hypothesis you laid out in the Introduction section. If the results of your statistical test cannot be stated in terms of your hypothesis, you need to re-assess the statistical test you used (or use a more testable hypothesis in future experiments). Compare how your results agree or contrast with your expectations and previously published experiments that relate to your goals. Acknowledge any errors in your protocol. Then set aside those errors and based on your results as they stand, suggest logical and interesting experiments for future researchers.

Again, think about your reader and imagine the conversation that a reader might have as they read your writing. What questions would they have? How would you use information from the literature to talk about what your results may have meant or what needs to be done next? Only include relevant information, and explain the connection to your results. If information doesn't pertain to your experiment, don't include it (don't just ramble on and on about the general topic or "things that could have affected your results").

Beginning researchers are pretty good at discussing to excess what they might have done wrong to skew or confound their experiments. This is not the best way to interpret your work. Instead, pick the most likely and relevant explanation(s) for why you rejected your main hypothesis or hypotheses, and back them up with background literature. Instead of saying "perhaps the protein expression didn't make a difference in cells lacking a native protein," take a stand and confidently talk about your interpretations.

Bad: "Another factor that could have affected our results was the temperature" (followed by no explanation of how temperature would influence our data/results).

Good: "We conducted the experiment in standard laboratory conditions at room temperature. However, true physiological conditions would require an adjustment to 37°C to mimic the natural context in which this protein would be expressed in the human body (add citation here). Thus, the lack of viable cells following expression of the protein was possibly due to improper folding of the protein or low levels of expression."

Literature Cited*: This contains the items specifically referred to within the text in alphabetical order. Items you read but did not specifically cite in the text of your paper should not be included. Format your literature cited according to the style of the journal Genetics

(<http://www.genetics.org/site/misc/ifora.xhtml#REFERENCES>). Notice that there is no example of how to cite a website; websites generally are not appropriate to cite in scientific writing.

In-Text citations (<http://biology.luther.edu/paper.htm>): In the text of your paper, do not use footnotes or quotes. Instead, where you have included relevant information from the literature *in your own words*, acknowledge the source using the author and date format as shown in the following examples:

As discussed by Friesen *et al.* (2004), invasion experiments show that the two ecomorphs of bacteria co-exist through frequency-dependent selection.

Wet monarchs are significantly more susceptible to rapid freezing than dry monarchs (Larsen & Lee 1994).

If there are *more* than two authors of a source, cite the reference by the first author name and *et al.* along with the date. For example:

Leafhopper behavior is affected by ... (Larsen *et al.* 1992).

Larsen *et al.* (1992) observed new behaviors in leafhoppers...

Tables and Figures: The tables and figures should be placed at the end of the entire document, numbered, in order. Each table should have a title above it and an explanation or key to symbols below, if needed. Each figure should have a complete caption below it that restates the key finding of the figure.

General writing style:

Use **active voice** to make your sentences clear and concise. (If you don't know the difference between "active voice" and "passive voice," please ask your TAs or look it up.)

Use **past tense** throughout your paper, with some exceptions in the Introduction and Discussion. When you are providing background information or describing current unknown questions in science, it is okay to use present tense. But your text describing the hypotheses (typically the last paragraph of the Intro and the first paragraph of the Discussion) should be in past tense. See the **good** example above in the Discussion section.

In this class, we encourage you to use 1st person ("I" or "we"), past tense, but don't use first names when referring to yourself or your lab partner. Appropriate ways to address individuals in the report are limited: first initial first name and last name (G. Burdell) or last name only (Burdell).

Bad: "The plasmid that the experimenters decided to use was obtained from the Jordan laboratory."

Good: "We obtained the plasmid from the Jordan laboratory."

Note: You may find yourself in situations (e.g., other classes, other fields of study, or other countries) where you are encouraged to write in 3rd person. As long as you are **consistent** in your writing style and do not resort to excessive wordiness, we will not penalize you for writing in 3rd person.

Citing sources: Find the information you need, put it in your **own** words (don't quote!), and cite the source in text. Consider that in a Literature class, *how* something is said is as important as *who* said it ("To be, or not to be: that is the question" W. Shakespeare); in science, we are not concerned with how something was said, only *who* said it. So you should summarize another scientist's ideas/results and then provide their information. Any ideas/information that did not originate in your brain must be cited. Consult a writing reference or published papers (e.g. in the journal *Genetics*) for proper citation format.

Appropriate Verbs:

- Test (the hypothesis)
- Develop
- Determine
- Provide
- Isolate
- Characterize
- Identify
- Restore
- Implement
- Generate
- Facilitate

Some words/things to avoid:

- Prove– the scientific method is a process of elimination, and rarely can we eliminate every option. This means we cannot prove (or disprove) anything.
- Disprove (see above)
- This/That/It at the beginning of a sentence (*it* usually isn't clear to what you are referring)
- Appears
- Believe
- Think
- Obviously/clearly (this makes assumptions on what the reader is thinking)
- Very
- Excessive commas (look up the basic comma rules if you don't know them)
- Making statements about absolutes e.g. "X never happens" or "X always happens"
- Using words in their "common" sense (i.e., their definition outside of science) if those words also have specific scientific or statistical definitions.
Examples: significant, correlate, normal, sample, isolate, extract