Packet 3.5 - Genetics & Biotech Unit

First & Last Name: _____ Period/Hour:_____

NOTE: Packets are due after completing Part 5. Check each page to be sure all blanks are completed.

Driving Question: How can we communicate our findings?

Anchoring Phenomenon: We have now completed an experiment in which we assessed whether we genetically engineered bacteria. How can we share our findings with other people? Why is this necessary? And how can we structure our writing to systematically share our findings with others?

Deeper Questions

1. How do scientists systematically report their findings?
2. How does peer review ensure more credible papers are published?
3. How should we organize scientific writing so that our work can be communicated as clearly and as efficiently as possible?

Schedule

Part 1: Introduction
- Review of Scientific Writing

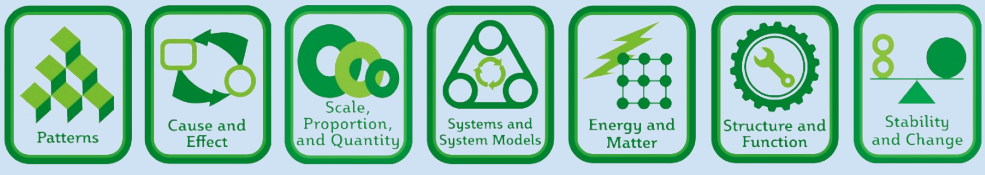
Part 2: Core Ideas
- Science Writing Core Ideas

Part 3: Investigation
- Creating a Scientific Poster or Presentation

Part 4: Review & Assessment
- Scientific Presentations

Part 5: Career Connections
- Peer Review Form & Sample Project Rubric

AFNR Standards: BS.02.05. Examine and perform scientific procedures using microbes, DNA, RNA & proteins. BS.03.04. Apply biotechnology principles, techniques and processes to enhance plant and animal care and production. AS.04.02. Apply scientific principles to select and care for breeding animals.
NGSS Standards (*PEs* & *CCCs are summarized below. SEPs are noted throughout the packet*).
HHS-LS3-1 - Role of DNA as instructions for traits inherited from parents via meiosis. LS-LS3-3 - Predicting likelihood of different traits in a population/offspring. LS-LS3-3 - Predicting the likelihood of different traits in a population/offspring. HS-LS1-1 - How the structure of DNA determines the structure of proteins and function.



Semester Schedule

3. Genetics & Biotech Unit
3.1: How does DNA affect crop and animal productivity?
3.2: How can we predict genetic inheritance?
3.3: How can DNA be modified to enhance species?
3.4: How do we design genetic & biotech experiments?
3.5: Analyzing and presenting our findings.

4. Sustainability Unit
4.1: What determines if food production is sustainable?
4.2: What methods improve sustainability in agriculture?
4.3: How can we design more sustainable food production?
4.4: Analyzing and presenting our findings

These materials were partly developed with assistance from artificial intelligence.

Resource Links: Class Website; Core Ideas; Writing Template; Lab Protocol; Example Presentation

Part 1: Review of Scientific Writing (3.5.1)

Directions -*You will use a fictional research paper to review the components of scientific writing. Use the column on the right to record key ideas, identify challenging words, and keep track of questions.*
SEP: Finding & Communicating Information.

Introduction. Can the introduction of the human insulin gene into *E. coli* bacteria enable them to produce insulin? We hypothesize that if the bacteria successfully take in and express the insulin gene, they will produce human insulin, which can be detected using biochemical tests.

Background Information. Insulin is a hormone essential for regulating blood sugar levels in humans (Brown et al., 2019). Traditionally, insulin was extracted from animals, but this process was inefficient and costly (Smith & Lee, 2020). Genetic engineering allows scientists to insert the human insulin gene into bacteria, enabling them to produce insulin in large quantities (Johnson et al., 2021). This study examines whether *E. coli* can be successfully transformed to express the human insulin gene.

Methods and Materials. A recombinant plasmid containing the human insulin gene and an antibiotic resistance marker was introduced into *E. coli* using heat shock transformation. Transformed bacteria were grown on nutrient plates containing antibiotics to select for successful transformations. Protein production was analyzed using SDS-PAGE and an insulin-specific enzyme-linked immunosorbent assay (ELISA).

Results. Bacteria that received the insulin gene successfully grew on antibiotic-containing plates, indicating successful transformation. Protein analysis confirmed the presence of human insulin in these bacteria, while non-transformed bacteria did not produce insulin.

Discussion and Conclusion. We hypothesized that *E. coli* could be genetically modified to produce human insulin. The results supported this hypothesis, demonstrating successful transformation and insulin production. Future research should optimize insulin yield and explore large-scale production methods for medical applications.

Reference List

Brown, T., et al. (2019). The Role of Insulin in Glucose Regulation. *Endocrinology Review*, 18(3), 145-159.
Johnson, P., et al. (2021). Advances in Recombinant Insulin Production. *Biotechnology Advances*, 12(1), 67-82.
Smith, R., & Lee, J. (2020). The Evolution of Insulin Therapy: From Animal Sources to Recombinant DNA. *Journal of Medical Biotechnology*, 22(4), 201-214.

Data Dive Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*

1. **What are the key points from this reading?**
2. **How is this an effective example of scientific writing?** In what ways does this paper reflect how scientists communicate with each other in a systematic and predictable manner?
3. **How could this writing be improved?** What changes would make this a more effective example of scientific writing?
4. **In what ways is their experimental design effective?** How would their methods result in valid and reliable results?
5. **How could their experimental design be improved?** What changes would result in more valid and more reliable results?
6. **How can this paper prepare us to write more effectively when we prepare our own presentations later in this packet?** How might we use this to enhance our writing and prevent mistakes?

Be prepared to share your group's ideas in a full class discussion.

Part 2: Core Ideas (3.5.2)

Overview: In this activity, you will review a short presentation you used previously to ensure you remember all key points about scientific writing.

Driving Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Developing & Using Models

1. What is a peer reviewed journal? What are the benefits and drawbacks of these journals?
2. What occurs at a research conference? How might this affect work published in journals?
3. Why do scientists use such a rigid style of writing and communication?
4. How should the title of a scientific paper or presentation be written to be effective?
5. What is an abstract and what does it include?
6. What content does the introduction include?
7. What is the purpose of including background information in the introduction?
8. What is the purpose of the methods section and how is it usually written?
9. What is the purpose of the results section and how is it usually written?
10. How should a caption for a graph be written?
11. What is the purpose of the discussion & conclusion? What info does it include?
12. How should a paper cite its sources?

Part 3: Science Writing (3.5.3)

Overview: Effective communication is vital in science. Scientists must share their findings to allow others to build upon their work and make new discoveries. Scientists write using a standardized format to ensure consistency and predictability. This enables readers to locate specific information more quickly. You can see an example in Part 1 of this packet. Science writing includes the following components:

1. **Title**: a title includes the study subject, independent and dependent variables, and the outcome. Authors are usually listed alphabetically by last name below the title. You should also include your school.
2. **Abstract**: this is a summary of the entire publication. It summarizes key info as succinctly as possible.
3. **Introduction**: this summarizes the study subject, the research question (RQ), hypothesis, and rationale. It should also describe how the independent & dependent variables are related. It also provides a brief overview of the methods and how they relate to the RQ and hypothesis.
4. **Background Information**: these are the concepts & facts from credible sources to help the reader understand your work. All facts should be followed by parenthetical citation indicating the source [(Author, Year) (Smith, 2022)]. Include images or visual data to help your reader understand how changes at the cell or molecular level affect observable outcomes and changes.
5. **Methods & Materials**: this summarizes how the experiment was conducted. It should resemble a cookbook recipe with enough detail that others could replicate your work. Justify *how* your methods enable you to test your research question & hypothesis. Critique the effectiveness of your methods - how were they effective and how could they be improved?
6. **Results**: this provides all relevant data and observations from your experiment. It should also include at least one graph or table summarizing your data. A caption should describe trends and patterns data using ratios or percentages, and how these relate to the RQ and hypothesis. Both the x- and y-axis must be labeled. Explain if your data is reliable. Acknowledge your data's limitations for testing your hypothesis.
7. **Discussion & Conclusion**: First, restate your RQ & hypothesis, and explain whether your data support or refute your hypothesis. Then use data and evidence from your investigation and other sources to support your conclusions about the phenomenon you investigated and identify cause-and-effect relationships. Next, critique the strength of your evidence and conclusions and acknowledge their limitations. Conclude by proposing a solution to a problem using your data, evidence, and information. Consider alternative arguments/explanations/solutions and use evidence to critique their validity.
8. **Reference List**: this is the alphabetical list of all the sources used to create your paper. All sources used for this experiment should be cited using APA citation (*Last Name. First Name. (Year). Title. Source.*). Anything cited in this section should also be cited parenthetically (Author, Year) where it is mentioned in your presentation. For example, if you use research by J. M. Tisdall about soil organic matter, you would cite this in two places:
   1) A parenthetical citation after the sentence with the info: (Tisdall, 2020).
   2) A full citation in the References: Tisdall, J. M. (2020). Formation of soil aggregates and accumulation of soil organic matter. In *Structure and organic matter storage in agricultural soils* (pp. 57-96). CRC Press.

Part 3B: Scientific Writing Checklist (4.4.3b)

Overview: Use your findings to create a poster, paper, or presentation. Your work needs all of the following.

1. Introduction	Criteria	Yes!!!	Kind of	Not Yet
1a	Create a testable research question (RQ) based on an authentic real-world phenomenon.			
1b	Develop a hypothesis based on the RQ that can be directly measured with data.			
1c	Provide a rationale for the hypothesis based on models, data, credible evidence, and/or reasoning.			
1d	Identify the independent variable (IV) & dependent variables (DV); explain the relationships between them.			
1e	Explain how specific changes to this system (IV) affect outcomes/stability in this system (DV).			
	Practices: Asking Questions, Planning & Conducting an Investigation, Crosscutting Concepts: Stability & Change	Total		/20
2. Background	Criteria	Yes!!!	Kind of	Not Yet
2a	Accurately summarize scientific information needed to understand the RQ and hypothesis.			
2b	Evaluate various sources of information and use only credible & accurate sources in project.			
2c	Properly cite all sources used in the project with both parenthetical *and* APA formats. Parenthetical: (Last Name, Year) APA: Last Name, First Name. (Year). Title. Source.			
2d	Communicate ideas effectively across multiple formats (written, visual, verbal, etc.).			
2e	Explain how cell structures and/or molecular substances affect measured functions & outcomes.			
	Practices: Obtaining, Evaluating, and Communicating Information, Crosscutting Concepts: Structure & Function	Total		/20
3. Methods	Criteria	Yes!!!	Kind of	Not Yet
3a	Provide a detailed materials list summarizing all items needed for this investigation.			
3b	Summarize the methods so others could easily replicate the same experiment.			
3c	Explain how the methods specifically answer the RQ and test the hypothesis.			
3d	Critique the limitations of your methods (e.g., sample size, trials, authenticity, relevance to RQ, etc.).			
3e	If using a model, simulation, or model organism, summarize why it was chosen and how it effectively represents a more complicated phenomenon.			
	Practices: Planning & Conducting an Investigation, Crosscutting Concepts: Models	Total		/20
4. Results	Criteria	Yes!!!	Kind of	Not Yet
4a	Collect and analyze data and explain key trends and patterns across your data.			
4b	Create an effective visualization of your data (graph, chart, etc.) with labeled parts and a detailed caption.			
4c	Use mathematical functions (ratios, rates, percents, etc.) to make accurate conclusions about your data.			
4d	Assess the validity of your data using statistical methods (e.g., standard error) and/or by comparing with other credible sources of info & evidence.			
4e	Acknowledge and explain the limitations of your data and its ability to address your RQ and hypothesis.			
	Practices: Analyzing and Interpreting Data, Mathematics and Computational Thinking, Crosscutting Concepts: Patterns, Scale, Proportion, & Quantity	Total		/20
5. Discussion	Criteria	Yes!!!	Kind of	Not Yet
5a	Restate your RQ & hypothesis, and explain whether your data support or refute your hypothesis.			
5b	Use data and evidence from your investigation and other sources to support your conclusions about the phenomenon you investigated and identify cause-and-effect relationships.			
5c	Critique the strength of your evidence and conclusions and acknowledge their limitations.			
5d	Propose a solution to a problem using your data, evidence, and credible information.			
5e	Consider alternative arguments/explanations/solutions and use evidence to critique their validity.			
	Practices: Constructing Explanations, Evidence-based Arguments, Crosscutting Concepts: Cause & Effect	Total		/20
6. General	Criteria	Yes!!!	Kind of	Not Yet
6a	Demonstrate techniques and processes to modify a species (BS.03.01)			
6b	Examine and perform scientific procedures using microbes, DNA, RNA, & proteins (BS.02.05)			
6c	Document accurate lab records and demonstrate safe handling of lab materials (BS.02.01/03)			
6d	Explain relationships between the role of DNA and the traits of organisms (HS-LS3-1)			
6e	Project is free of errors (factual, spelling, grammar, etc.) and reflects the work of adult professionals.			
6f	Students collaborated to evenly divide work, overcome obstacles, and effectively use time & resources.			
	Practices: Constructing Explanations, Evidence-based Arguments, Crosscutting Concepts: Structure & Function, Models, Patterns, Cause & Effect	Total		/24

Part 4: Science Presentations (3.5.4)

Overview: You will be presenting your findings as a group to conclude this unit's project. For your presentation, you will need to break up roles below among the people in your group. If you have less than four people, some individuals may need to do multiple sections. Be sure to address all of the following as you present. You can have speaking notes. However, avoid speaking directly from notes if possible when presenting.

Partner 1: Introduction

1. Begin by stating the research question, hypothesis, and rationale.
2. Identify the independent and dependent variables and explain the relationship between them.
3. Next, summarize background information that your audience will need to understand in order to comprehend and appreciate your work. For example, if you are discussing animal growth, you need to provide information about how animal cell function enables animal bodies to function and gain mass.

Partner 2: Methods

1. Begin with a summary of the methods you used to test your hypothesis (*To test this hypothesis, we*…)
2. Then state all the materials used to conduct your experiment (*We used the following materials*…)
3. Address sample size, trial numbers, and constants; explain how these affect your data's reliability.
4. Critique your choice of model organism; explain how it is effective for investigating this phenomenon.

Partner 3: Results

1. Begin with a graph of your data. Summarize the patterns and trends in the data. Be sure to explain how the x-axis and y-axis are labeled to support your audience's understanding.
2. Next, fully explain whether the results support, refute, or do not affect your hypothesis using mathematical analysis (ratios, percentages, etc.).
3. Assess the validity of your findings using either statistical analysis and/or comparing to other similar studies.
4. Conclude by addressing other observations made during the experiment that might be relevant.

Partner 4: Conclusion

1. Begin by restating the research question and hypothesis.
2. Next, explain whether your team has decided that your hypothesis is correct or incorrect based on your data (or if you are unable to determine this at this moment). Justify this stance with evidence/reasoning.
3. Third, state the confidence you have in your results. Is this enough to answer your research question once and for all? Are your methods able to provide data that fully supports valid conclusions?
4. Propose a solution for a real-world problem using your data and evidence.
5. Address possible alternative arguments or explanations for your work and critique their validity.

Questions: You should prepare for follow-up questions from your instructor. Potential examples include:

1. How do animals grow and gain mass? What occurs at the atomic and molecular to enable this?
2. What occurs during cellular respiration? Where does this process occur? Why is it important to cells?
3. What occurs during biosynthesis? Where does this process occur? Why is it important to cells?
4. How did your treatment affect animal growth and productivity? How do you think it changed the movement of atoms & molecules into or out of the cell? How did it affect cell function?
5. Who might benefit from your work? How and why would your findings be useful to others?
6. How does your work reflect core principles of scientific investigations? How could it be improved?

Part 5: Career Connections: Peer Review (3.5.5)

Overview: In small groups or individually, you will rank each other's contributions to your work. This will help you to better understand any strengths and weaknesses that might affect your job performance in the future.

Directions: Please evaluate your group as well as yourself on the basis of contributions and effort on a scale of (did nothing) 1 to 5 (outstanding). Provide a reason for your score – why did you give that score?

Group Member Name: _____ Score: 1 2 3 4 5 (*circle one*)

Reasoning for this score: _____

_____

Group Member Name: _____ Score: 1 2 3 4 5 (*circle one*)

Reasoning for this score: _____

_____

Group Member Name: _____ Score: 1 2 3 4 5 (*circle one*)

Reasoning for this score: _____

_____

Your Name: _____ Score: 1 2 3 4 5 (*circle one*)

Reasoning for this score: _____

_____