Packet 3.4 - 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 do we design genetic engineering experiments?

Anchoring Phenomenon: In this activity, you will perform a bacterial transformation by inserting a plasmid into bacteria, allowing them to grow on special agar plates and glow under UV light. You'll learn about how bacteria can acquire new genes and new traits using restriction enzymes, and how scientists use this process in biotechnology to create GMOs.

Deeper Questions

1. How do scientists systematically collect and organize data?
2. How do our results compare to our hypotheses? And how do we know if our results are valid and reliable?
3. How can we explain the outcomes of our experiment using our understanding of atoms and molecules?

Schedule

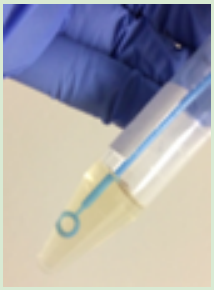
Part 1: Introduction
- Planning & Carrying Out an Investigation

Part 2: Data Collection
- What conclusion is supported by our data?

Part 3: Analysis
- How can we explain our results?

Part 4: Review & Assessment
- Explaining Our Outcomes

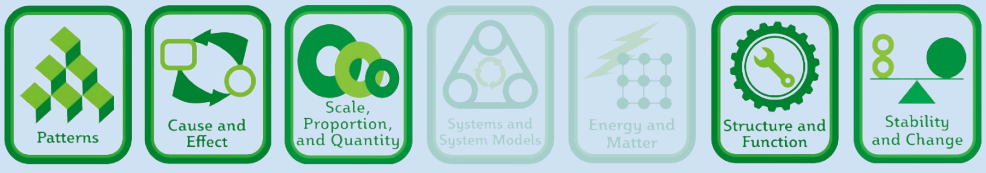
Part 5: Career Connections
- Reflection - Is this a potential career for me?



(Image Source)

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; Lab Protocol;

Part 1: Planning & Carrying Out an Investigation (3.4.1)

Overview: You will use standard components of scientific investigations to organize your investigation and prepare for data collection.

Research Question - *What are we wondering? What do we want to figure out?*
SEP: Asking questions (for science) and defining problems (for engineering).,

1. What question were you trying to answer with your experiment? Reach a consensus as a group or class and record a **research question** below.

   We wonder if _____

   _____

Hypothesis, Rationale, Variables, etc. - *Make a testable prediction based on evidence.*
SEP: Planning and carrying out investigations; Developing & using models.

2. Turn your **research question** into a **hypothesis**. A hypothesis is like a guess or a prediction – it is how you would answer your research question based on your existing knowledge. Fill in the blanks below:

   We predict that _____

   _____

3. Now provide a **rationale** for your hypothesis. A rationale states why you think your hypothesis might be right; it provides some evidence and/or logic that supports the validity of your hypothesis.

   We think this because: _____

   _____

   Note: it's totally ok if your hypothesis ends up being wrong. Either way we'll gain more info. We just need to take a stance for now.

4. Every experiment has two important components: a **dependent variable** & an **independent variable**.

   An **independent variable** is the thing you purposely changed to test your hypothesis and answer your research question. Generally speaking, an experiment should only have one independent variable.

   What is your independent variable? _____

   A **dependent variable** is what you measure to answer your research question and determine if your hypothesis is correct. You can have multiple dependent variables as long as they are relevant.

   What is your dependent variable(s)? _____

5. A **control** is a part of your experiment that does not receive any treatment so that we have something to compare to. It enables us to confirm if what we changed had any impact on the outcomes.

   In this experiment, what is your control? _____

6. **Sample size** and **trials** affect the validity of your findings. **Sample size** refers to how many points of data will be collected. **Trials** refer to the number of times you will repeat the experiment under the same conditions. The larger the sample size and the more trials you perform, the more useful and valid your findings are for answering your research question.

   *What is your sample size (how many points of data are being collected)?*_____

   *How many trials did you have?*_____ *How might your sample size and number of trials affect the reliability of your findings?*_____

   _____

7. **Constants** are the conditions that are kept the same between each replicate. If possible, an experiment should not be performed under changing conditions. This would make it impossible to determine whether our results were affected by our independent variable or by other changes. This would make our results less useful for answering our research question.

   *What is being kept constant in this experiment?*_____

   _____

   _____

Methods & Materials - *How did you test your hypothesis?* *SEP: Planning and carrying out investigations.*

8. What materials did you need to test your hypothesis? Record all these items below.

   We used the following: _____

   _____

9. On the next page, summarize all of the steps that were needed to complete this experiment. Remember, your methods section should read like a recipe in a cookbook - you should provide clearly written steps that specifically outline everything that someone would need to do to repeat your experiment. You may not need all of the space provided.

Part 2: Data Collection (3.4.2)

Overview: You will carry out your experiment and collect data to answer your research question and address your hypothesis.

Results & Data - *What do our data indicate?*
SEP: Analyzing and interpreting data. Using mathematics and computational thinking.

Directions:

1. Use the space below to determine what data you will collect and how it will be organized (e.g., how will you set up a table to collect and organize your data?).
2. Carry out your experiment as described in your accepted proposal.
3. Record your data below.
4. Create a graph based on your data on the following page and provide a caption.

Part 3: Data Analysis (3.4.3)

Overview: You will determine whether your data support or refute your hypothesis, and develop explanations for if, how, and why your treatment enabled genetic engineering.

Discussion & Conclusion - *Is our hypothesis supported by our data? How does this relate to our research question? What conclusions can we reach based on this investigation?*
SEP: Constructing explanations & designing solutions. Making evidence-based arguments. Obtaining, evaluating, & communicating information.

1. Restate your hypothesis - *We predicted:* _____

   _____

2. Was your hypothesis supported by your data? Yes / No / Not sure (*circle one*).

3. Summarize how you know your outcome was successful or unsuccessful. Cite your data from your positive and negative controls as specific forms of evidence to support your claim.

   _____

   _____

   _____

4. How is it possible to insert a gene from one species into the genome of another species?

   _____

   _____

   _____

5. How could we improve our experiments to have more valid and reliable findings in the future?

   _____

   _____

   _____

Part 4: Review & Assessment (3.4.4)

Overview: In small groups and/or as a class, attempt to make sense of the outcome of your experiment by collaborating to answer the questions below.

1. Summarize your findings. Based on the class averages, what happened? What were the key findings?
2. What do these data indicate regarding your research question? Do your findings support or refute your group's hypothesis? Explain.
3. How could these findings be explained using ideas we have addressed previously in this class? In particular, address…
    a. How DNA and proteins affect traits.
    b. How DNA stores information for assembling proteins.
    c. How DNA can be analyzed using PCR Electrophoresis.
    d. How restriction enzymes can be used for genetic engineering.
4. How do these findings relate to food production? How might this expand our understanding of this issue? How might we design solutions for this problem using this information?
5. How valid are these findings? Do your data answer this question definitively? Are there ways in which we could re-do this experiment to improve the validity of our data?
6. What questions remain unanswered? What is still unclear to you or members of your group? What questions emerged as a result of this work? (If a scientist is doing their job effectively, their work will almost always result in new questions).
7. What are the next steps? If time and resources allowed, would it make most sense to a) repeat the experiment in exactly the same manner; b) change the experiment to improve the data it can produce; c) develop a new investigation based on these findings; or d) something else?

Your instructor may choose to meet with individual groups. If so, raise your hand when you are ready. Your instructor will listen to your responses. If you are ready to move on, they will sign below. Alternatively, they may ask you to submit your written answers individually or in groups.

This activity was successfully completed: _____ *(instructor signature)*

Part 5: Career Connections Reflections (3.4.5)

Overview: In small groups or individually, meet with your instructor to discuss the career you profiled in this unit. Be prepared to address the following questions:

1. What career did you profile? Why did this career interest you?
2. Are you more or less likely to pursue this career as a result of what you learned?
3. Does the educational requirements for this career match what you are willing and capable of doing after graduation?
4. What questions or concerns do you have about your future after graduation?

This activity was successfully completed: _____ *(instructor signature)*