# DNA/ RNA/ Protein Synthesis with Mud Dauber Nests

(2-3 weeks)

## Authors

Leanne Thele

Sarah Daniel

Karisa Boyer

Sarah Cooper, RESET coach

## SUBJECT/GRADE LEVEL

**Subject Area**: Biology
**Grade Level**: 9-12

**Optional Area:** Physical Science

**Grade Level**: 9-12

## Materials

Engage: Students will need access to the video link and a way to write a screenplay OR do a voice-over.

Explore: Lab document, mud, water, Elmer's glue, containers or paper plates, toothpicks, plastic spoons, popsicle sticks, gloves, paper towels, droppers, plastic cups, pencils or straws, Q-tips.

Explain: document- digital/ hard copy per student
NOTE: Teacher can broadcast and class will work together if computer access is not possible. If students have computers, they can complete the activity independently.

Extend: document- digital/ hard copy per student
NOTE: Students will need computer access to complete the activity.

Evaluate: document- digital/ hard copy per student
NOTE: Students will need computer access to complete the activity.

Classroom Flier

## STANDARDS

### Next Generation Science Standards

- HS-LS-1-1 Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.
- HS- LS4-5 Biological Evolution: Unity and Diversity: Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
- HS- ETS1-2 Engineering Design: Design a solution to a complex real-world problem by breaking it

down into smaller, more manageable problems that can be solved through engineering.

## Mathematics Standards | Common Core State Standards

- CCSS.MATH.CONTENT.HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling. (*HS-PS2-6*)
- CCSS.MATH.CONTENT.HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (*HS-PS2-6*)

## English Language Arts Standards | Common Core State

- CCSS.ELA-LITERACY.SL.11-12.1.A: Come to discussions prepared, having read and researched the material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
- WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (*HS-PS1-3*)
- WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (*HS-PS1-3*)
- RST.11-12.1 (HS-PS2-6) Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- WHST.11-12 Write informative/explanatory texts, including narrating historical events, scientific procedures/experiments, or technical processes. (*HS-PS2-6*)

## LESSON OBJECTIVE(S)

- Students will compare and contrast the life cycle of the mud dauber and the caddisfly.
- Students will compare and contrast the diet of the mud dauber and caddisfly.
- Students will compare and contrast the anatomy of the mud dauber and caddisfly.
- Students will explore how the caddisfly and mud dauber create their shelters.
- Students will be able to explain the structure of DNA and compare and contrast DNA to RNA.
- Students will be able to describe the process of protein synthesis.
- Students will be able to transcribe and translate to create proteins given genes using simulations.
- Students will collect, organize and interpret data after building mud dauber tunnels.
- Students will record observations about the best method to build a mud dauber tunnel.

## CAREER CONNECTION(S)



Mentor Background: My name is Dr. Jesse Roberts, I'm a research chemical engineer within the Environmental Laboratory at the U.S. Army Engineering Research and Development Center (ERDC) in Vicksburg, MS. We provide solutions for tomorrow's environmental challenges by finding new ways to clean water and remediate environmental contaminants. My role focuses on developing and characterizing new materials for synthetic biology and environmental applications. Specifically, I work with graphene nanomaterials to remove harmful cyanotoxins from water sources that pose a significant risk to human health. I have my PhD in chemical engineering from the University of Arkansas where I focused on biomaterial development for tissue engineering and biosensing applications. My team serves to make the world better by developing and utilizing materials to provide sustainable water infrastructure through clean and safe water.

**STEM Careers:** entomologist, structural engineer, geneticist, chemical engineer, zoologist, ecologist

## ENGAGEMENT

**Brief Description:** What is this insect doing? While watching the video, you need to determine what is happening and why the insect is performing these tasks.

**Procedures:**

Mud Dauber wasp. They can be your friend.

Students will need to create a voice-over or write a script to describe what is happening in the video. Be the storyteller– what is happening in this video? Explain what is meant by the scientific name- what does it mean? How does that relate to what was observed in the video? Be prepared to share your ideas or turn in your script.

## EXPLORATION

Student Worksheet Tunnel Building Activity  Teacher Guide Tunnel Building Activity

**Brief Description:** Students will build and test differing amounts of glue adhesive in their own tunnel designs. Give students 2 different amounts of glue/water to represent 2 different proteins in saliva in the insects. Students will then construct 2 mud dauber tunnel nests and then test the nest tunnels for water resistance. Optional additional testing includes shaking on an earthquake shaker table or using a vise to test strength/ compression. Students will develop their own data table and interpret results and compare the 2 glue mixtures.

**Procedures:**

1. Build 2 tunnel mud dauber nests: one from each cup of liquid and dirt. Label them as liquid A & B.
2. Take pictures of them right away and again when they are dried.
3. Make a data table to collect your data and compare the 2 nests. Here is the things you will need to measure or observe:
    a. Mass of nest
    b. Length of nest

c. Width of nest
d. Width of opening
e. Record the time it takes for water to enter the nest
f. Count the number of drops until water dampens Q-tip

## Procedure for water resistance test:

Place your nest on a dry paper towel. Insert a Q-tip. Do this gently so it does not break. Lay a damp paper towel over the top of the nest and then slowly begin to drop water on the middle of the nest one drop of water at a time. After 1 minute of dropping drops onto the nest, carefully remove the damp paper towel and make observations about the exterior of the nest and its water resistance. Then gently remove one Q-tip at a time seeing if they feel wet ( this means water got into the nest) record your observations of the Q-tip. If it is still dry, repeat the above instructions for another minute and check again. Record data until the Q-tip is damp and/or you can see the water getting inside your nest.

## Optional Test: Procedure for earthquake shaker test

Place your nest on the earthquake shaker test. Start with the lowest amount of shake and go up every 30 seconds until it is destroyed or begins to fall apart. Repeat for the second nest. Record your observations and the amount of time until it begins to disintegrate.

## Optional Test: Procedure for compression test

Select one nest. Prepare the vice: Ensure the table vice is securely mounted to a stable work surface. Make sure it is clean and in proper working condition

Position the item: Plae the item to be tested between the vice jaws. Ensure it is centered and aligned properly for accurate compression testing.

Apply gradual pressure: slowly turn the vice handle or crank to begin applying pressure to the item. Start with light pressure and gradually increase it while monitoring the behavior of the item. Counting the number of turns until it collapses.

Observe deformation: Continuously observe the item as pressure is applied. Note any visible changes, such as bending, cracking, or flattening. Pay attention to any signs of structural failure.

Record results: Take measurements or photographs at various stages of compression to document the results accurately. Record observations and the number of turns in the data table.

Repeat for 2nd nest.

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## EXPLANATION

**Brief Description:** Students learn about the structure of DNA, then learn DNA Replication and the Central Dogma in Protein Synthesis (transcription and translation). Students then do some simulation exercises and create proteins using given genes.

**Procedures:**

1. Day 1 and 2: Students will learn the structure of DNA and then practice DNA Replication- assess checking for understanding.
    a. DNA Structure
    b. DNA Workshop

2. Day 3: Students learn about RNA and compare and contrast DNA to RNA -assess checking for understanding.
    a. DNA VS RNA Structure
    b. DNA Replication and Animation
3. Day 4: Students learn Transcription and Translation and Practice -assessment.
    a. Protein Synthesis
    b. Practice
    c. Transcription Practice
4. Day 5: Using simulations students create proteins from genes provided.
    a. Protein Synthesis Simulation

## EXTEND/ ELABORATE

**Brief Description:** In this activity, students will compare and contrast the life cycle, diet, anatomy, and other features of the caddisfly and the mud dauber.

**Procedures:**
Using the linked resources in the Google doc, students will answer the questions regarding caddisfly anatomy, diet, life cycle, and other characteristics of this insect. They will explore similar aspects of the mud dauber. The students will discuss their findings in a whole group discussion. As a class, a Venn diagram will be constructed in order to compare and contrast these two insects. Individual responses can also be collected for a formative assessment grade.

Google doc: Caddisfly vs Dirt Dauber Lesson 2023

Google doc answer key: Caddisfly vs Dirt Dauber Lesson 2023 ANSWER KEY

Middle school/ ELL/ Modified lesson plan:

D Caddisfly vs Dirt Dauber Lesson 2023 OPTION B

Middle school/ ELL/ Modified lesson plan:

Caddisfly vs Dirt Dauber Lesson 2023 OPTION B ANSWER KEY

## EVALUATION

**Brief Description:** Using a hypothetical DNA sequence of a mud dauber protein, students will be asked to decide which other hypothetical protein is closest to the original. They will have to practice transcribing DNA to RNA codons and then translate to amino acid sequences using a codon wheel.

**Procedures:**
Worksheet: Mud Dauber Protein Synthesis Activity

Answer Key: Mud Dauber Protein Synthesis Activity ANSWER KEY

## REFERENCES


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