

Cracking the Case, One Molecule at a Time

Biochemistry

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Grade Level	9th – 10th Grade
Subject	Science
Course	Biology

Essential Question

What are the different macromolecules essential for the structure and function of living organisms?

Summary

In this lesson, students assume the roles of detectives and explore the foundational molecules of living organisms. They will investigate a mystery through a series of hands-on activities including isolating DNA from a strawberry, testing for the presence of lipids, proteins, and carbohydrates, and analyzing an electrophoresis gel. To conclude their investigation, students must draw conclusions using the evidence they have uncovered and summarize what they learned about macromolecules, what they are made of, and how they are essential to living organisms.

Snapshot

Engage

Students create a claim regarding the importance of macromolecules and argue opposing viewpoints.

Explore

Students follow lab procedures and extract DNA from a strawberry.

Explain

Students classify the different types of macromolecules.

Extend

Students investigate the different types of molecules that are present in select foods using the carbohydrate test, lipid test, and protein test.

Evaluate

Students review a gel electrophoresis and evaluate their test results to determine which suspect committed the crime.

Standards

ACT College and Career Readiness Standards - Science (6-12)

SIN404: Identify similarities and differences between experiments
EMI505: Determine which experimental results or models support or contradict a hypothesis, prediction, or conclusion

Oklahoma Academic Standards for Science (Grades 9, 10, 11, 12)

B.LS1.1: 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.

Attachments

- 3-2-1 Video—Cracking the Case.docx
- 3-2-1 Video—Cracking the Case.pdf
- C.E.R.—Cracking the Case.docx
- C.E.R.—Cracking the Case.pdf
- DNA Isolation—Cracking the Case.docx
- DNA Isolation—Cracking the Case.pdf
- Lesson Slides—Cracking the Case.pptx
- Lipids, Proteins, and Carbohydrates Labs—Cracking the Case.docx
- Lipids, Proteins, and Carbohydrates Labs—Cracking the Case.pdf
- Macromolecules Note Catcher—Cracking the Case.docx
- Macromolecules Note Catcher—Cracking the Case.pdf
- R.E.R.U.N. Rubric—Cracking the Case.docx
- R.E.R.U.N. Rubric—Cracking the Case.pdf
- Social Media Post—Cracking the Case.docx
- Social Media Post—Cracking the Case.pdf
- Suspects—Cracking the Case.docx
- Suspects—Cracking the Case.pdf
- The Results—Cracking the Case.docx
- The Results—Cracking the Case.pdf

Materials

- Lesson Slides (attached)
- C.E.R. handout (attached; one half sheet per student)
- DNA Isolation handout (attached; one per student)
- Lipids, Proteins, and Carbohydrates Labs handout (attached; print two-sided; staple; one per student)
- Suspects handout (attached; one per group or student)
- Social Media Post handout (attached; one half sheet per group)
- R.E.R.U.N. Rubric handout (attached; one per student)
- Macromolecules Note Catcher handout (attached; one per student)
- The Results handout (attached; one per group)
- 3-2-1 Video handout (attached; optional; one half sheet per student)
- Zip-top bag (one per group)
- Shoe box (or other type of cardboard box)
- Notebook paper

Materials for DNA Isolation lab

- Strawberries (two per group of 3–4 students)
- Resealable quart-sized plastic bags (two per group of 3–4 students)
- Dish detergent (two teaspoon per group of 3–4 students)

- Salt (one teaspoon per group of 3–4 students)
- Water
- Coffee filters (one per group of 3–4 students)
- Plastic cups (two per group of 3–4 students)
- Rubbing alcohol (1/2 cup per group of 3–4 students)
- Coffee stirrers/pipettes/inoculation loops (one per group of 3–4 students)

Materials for Lipids, Proteins, and Carbohydrates labs

- Hot plates
- 250 mL beakers (one per group of 3–4 students)
- Test tubes (five per group of 3–4 students)
- Test tube rack (one per group of 3–4 students)
- Tongs (one set per group of 3–4 students)
- Pipettes (two per group of 3–4 students)
- Benedict's solution
- Eye drop bottle (one per group of 3–4 students)
- Biuret solution
- Brown paper towels
- Diced eggs (one per group of 3–4 students)
- Sugar
- Vegetable oil
- Potatoes
- Water

30 minutes

Engage

Use the attached **Lesson Slides** to guide the lesson.

Display **slide 3** and read aloud the essential question, “What are the different macromolecules essential for the structure and function of living organisms?” Then, move to **slide 4** and read the learning objectives aloud.

Move to **slide 5** and give each student one copy of the attached **C.E.R.** handout. Invite students to participate in the Claim, Evidence, Reasoning, Test, Improve (C.E.R.T.I.fy Your Thinking) strategy. Have students read the prompt in the “Claim” box and write a claim about which macromolecule is most essential to life.

Have students conduct research on their claim. As they research, encourage them to record three specific pieces of evidence that support their claim in the “Evidence” boxes on the handout. Make sure students cite the source of each piece of evidence.

After students have had sufficient time to research, display **slide 6**. Designate four areas of the room to represent each of the four macromolecules: carbohydrates, proteins, lipids, nucleic acids. Have students move to an area of their choice. Share with students that they will represent their chosen macromolecule in a class debate about which macromolecule is most essential to life.

Teacher's Note: Debate Facilitation Process

Prior to facilitating a class debate, establish how the debate will be conducted and share the process with your students. Some recommended procedures are listed below:

1. Choose one side to start the discussion. Consider starting with the side that has the fewest students.
2. Have one person from that side respond with one piece of evidence that supports their claim.
3. Give the other sides time to give a rebuttal backed by their evidence.
4. Repeat this process for 5–10 rounds, giving all groups multiple opportunities to share.
5. Ask group members if anyone would like to switch sides based on the evidence shared.
6. Have each group spend 30 seconds discussing a final statement as to why their side is correct.
7. Invite a spokesperson from each group to share their group’s final statement.

Lead a class debate about which macromolecule is most essential with each area of the room representing one macromolecule. Encourage students to use the evidence they researched in the debate. After the debate, have students return to their seats to reflect on which macromolecule they now believe is most essential to life. Have them record the reasoning behind their decisions on the C.E.R. handout.

Optional Career-Focused Video

Consider sharing the video *Zoom Into Your Career - Caring for Communities with Caitlin Porterfield* with students. Distribute the **3-2-1 Video** handout to each student and have them complete the handout using the 3-2-1 strategy.

Embedded video

https://youtube.com/watch?v=hTCCrrQpbb4

30 minutes

Explore

Organize students into groups of 3–4. Move to **slide 7** and play the first 30 seconds of the *Law & Order Full Theme*. Inform students that they should now assume the roles of detectives. A crime has been committed and they must solve the case with their fellow teammates.

Pass out copies of the **DNA Isolation** handout. Read the two introductory paragraphs about the crime as a class. Pass out copies of the **Suspects** handout. Tell students that this handout has the five suspects listed. Share that, as students progress through the investigation, they should mark an "X" in the boxes of the suspects they rule out based on evidence. Through this process, students should narrow down the list of suspects to a single person by the end of the lesson.

Display **slide 8** and draw students' attention back to the DNA Isolation handout. Inform students that they should complete the procedures to collect DNA from an eaten strawberry found at the crime scene. Have students collect the materials listed on the handout for the lab. Then, have them complete the lab procedures to extract DNA from the strawberry.

Once students have extracted the DNA, have them place the DNA in a zip-top bag, then place the bags into the DNA Analysis box you prepared. Tell students that the samples will be shipped off to a laboratory for testing, which will take a while. Share that they will receive the lab results later in the lesson.

Display **slide 9** and give each group one copy of the **Social Media Post** handout. Tell students that investigators discovered this social media post made by the culprit. Have students read the post, which includes the following riddle:

"Five names are suspects, so search with care,

But one of these five wasn't even there!

Four have a clue from molecules you know,

while one has no connection—so out they go!

Think carbs, fatty treats, builders, and DNA lore,

these macromolecule clues will help you explore.

But wait—one suspect has nothing to do.

They were watching a basketball game when it all went askew!

So follow the clues and eliminate fast—

Which last name doesn't fit the macromolecule cast?"

Have students examine the riddle and determine if they can eliminate suspects from their Suspects handout.

20 minutes

Explain

Display **slide 10** and share that new evidence has been discovered. Tell students that, to process this evidence, they must gain an understanding of macromolecules to solve the crime.

Move to **slide 11** and pass out the **Macromolecules Note Catcher** handout. Inform students that there was more evidence found at the crime scene that pertained to food. Before they can study the food found, they need to know what the food could potentially be made of.

Move to **slide 12** and introduce the four types of macromolecules. Then, transition through **slides 13–17** to discuss the building blocks, functions, and different types of each macromolecule (nucleic acids, carbohydrates, proteins, and lipids).

60 minutes

Extend

Move to **slide 18** and return to the storyline. Organize students into their original detective groups. Pass out the **Lipids, Proteins, and Carbohydrates Labs** handout.

Display **slide 19** and inform students that they should now test the food molecules that the suspects ate to determine potential matches for the residue found at the crime scene. Through this process, they should be able to narrow down their list of suspects.

Provide students with the materials to conduct the lab. Then, have students conduct the lab according to the procedures on the handout. After they have tested the various foods, have them use the results to eliminate suspects from the Suspects handout.

30 minutes

Evaluate

Move to **slide 20** and play the first 30 seconds of the *Law & Order Full Theme*. Inform students that the lab results from the DNA extracted from the strawberry have returned.

Move to **slide 21** and show students an image of an electrophoresis gel. Review what an electrophoresis gel is used for. Inform students that they should review the results on the handout and determine which suspect committed the crime. Share that they must provide an explanation of who committed the crime using evidence they uncovered throughout the investigation. Pass out one copy of the **The Results** handout to each student.

Allow students time to identify their suspects. Then, move to **slide 22** to show the list of suspects. Click once to reveal the culprit.

Move to **slide 23** and give each student one copy of the **R.E.R.U.N. Rubric** handout and one sheet of notebook paper. Have students use the R.E.R.U.N. strategy to write a report about the activities they completed in the lesson and how the activities relate to the four types of macromolecules. Review the instructions and the rubric to ensure that students know what is expected of them.

Resources

- JupiterDoc. (2011, May 31). *Law & Order full theme (high quality)* [Video]. YouTube. https://www.youtube.com/watch?v=xz4-aEGvqQM&list=RDxz4-aEGvqQM
- K20 Center. (n.d.). 3-2-1. Strategies. https://learn.k20center.ou.edu/strategy/117
- K20 Center. (n.d.). Claim, evidence, reasoning, test, improve (C.E.R.T.I.Fy your thinking). Strategies. https://learn.k20center.ou.edu/strategy/827
- K20 Center. (n.d.). R.E.R.U.N. Strategies. https://learn.k20center.ou.edu/strategy/819
- K20 Center. (2026, April 23). *Zoom into your career - Caring for communities with Caitlin Porterfield* [Video]. YouTube. https://www.youtube.com/watch?v=hTCCrrQpbb4&t=5s