

A scanning electron micrograph (SEM) showing numerous green, elongated, and spiky microorganisms, possibly bacteria or protozoa, scattered across a textured, brownish surface. The organisms have a distinct head-like region and a tail-like region with fine, hair-like appendages. Some organisms are clustered together, while others are isolated. The background surface has a series of parallel, slightly raised ridges.

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AG/ENVIRONMENTAL

Community Science

DNA Collection Kit Design

Developed in partnership with:

Discovery Education and Ignited

In this Lesson Plan:

Print the **Teacher Section** → 

01	For Teachers	Page
	Lesson Overview	1
	Questions and Connections	2
	Pedagogical Framing	3
	Instructional Activities	
	Procedure: Day 1	5
	Procedure: Day 2	6
	Procedure: Day 3	7
	National Standards	8

Print the **Student Section** → 

02	Student Resources	Page
	Whiteboard Design Challenge Task List Capture Sheet	1-6
	DNA Test Kit Model Slides Student Example	7-10

This document is separated into two sections, For Teachers [T] and Student Resources [S], which can be printed independently.

Select the appropriate printer icon above to print either section in its entirety.

Follow the tips below in the Range field of your Print panel to print single pages or page ranges:

Single Pages (use a comma): T3, T6

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Cover Image

Bacteria in a water sample is a potential source of environmental DNA (eDNA).

DNA Collection Kit Design

DRIVING QUESTION

How can a user's perspective inform communication techniques?

OVERVIEW

The design process is a series of steps used to design a product (or a prototype) that takes into account all of the stakeholders. There are many different versions of this process, but all include stages during which the designers empathize with those involved, define the problem, brainstorm potential ideas, create a model, and then create a prototype. The process can be linear, but rarely is. The work at any one step in the process can require the designers to go back to other steps to reach their goals.

In this lesson, students will engage in a modified “whiteboard” design challenge to determine how to collect DNA that will be used to help solve their designated community-focused issue. They will use productive group work to explore design options, create a design, and then communicate it. All planning and designing will be completed on a “whiteboard” so that the brainstorming, thinking, and revising is documented. They will include the finalized diagram and plan for the kit and collection in the final pitch to stakeholders. Given constraints, they will not create a physical model.

ACTIVITY DURATION

Three class sessions
(45 minutes each)

ESSENTIAL QUESTION

How do researchers collect DNA?

OBJECTIVES

Students will be able to:

Identify the parts of the design process.

Empathize with individuals that will be using their product.

Define the problem they are trying to solve.

Ideate possible design solutions.

Design a visual model of their DNA Collection Kit.

Materials

Large white board or multiple sheets of poster paper

Markers (Dry Erase) (2 colors per group)

Whiteboard Design Challenge Task List Capture Sheet

DNA Test Kit Model Requirements Capture Sheet

Have you ever wondered...

How do businesses or individuals design a product?

The design process can have many variations, but the general form is the same throughout most industries. Designers want to create a product to solve a problem and take into account stakeholders' opinions. The process can sometimes be messy, but worth it in the end when they have a viable plan or product.

MAKE CONNECTIONS!

How does this connect to the larger unit storyline?

This will be a piece of the final proposal and is a design exercise for how the DNA will be collected. This is what the group would deploy to have the community take part in the project.

How does this connect to careers?

Product designers are essentially problem solvers. They develop an idea or a prototype to help solve a problem. Product designers can do this with software or hardware development.

Data analysts help teams collect, compile, and interpret data to determine the next step in a project. While data analysts are often mining large data sets for information, they also are sometimes involved in the designing of surveys or data collection techniques, as is featured in this lesson.

How does this connect to our world?

DNA identification technology is used to address many questions related to health and safety, environmental issues, and human interests. This lesson asks students to identify a collection technique that will enable DNA to be collected to help a community-focused problem.

Pedagogical Framing

Instructional materials are designed to meet national education and industry standards to focus on in-demand skills needed across the full product development life cycle—from molecule to medicine—which will also expose students and educators to the breadth of education and career pathways across biotechnology.

Through this collection, educators are equipped with strategies to engage students from diverse racial, ethnic, and cultural groups, providing them with quality, equitable, and liberating educational experiences that validate and affirm student identity.

Units are designed to be problem-based and focus on workforce skill development to empower students with the knowledge and tools to be the change in reducing health disparities in communities.



SOCIAL-EMOTIONAL LEARNING

Students must use self-discipline and self-motivation to stay on task. Students need to communicate clearly with their groups. This lesson also asks students to listen actively, cooperate, and work collaboratively to problem-solve and negotiate conflict constructively. They will navigate social settings with differing cultural demands and opportunities, provide leadership, and seek or offer help when needed. In the design process, students will need to feel compassion and empathy for others. Students will consider ethical standards and safety concerns when designing the DNA test, and to evaluate the benefits and consequences of their design decisions for the well-being of the community.

CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

Students will use their research to design a DNA test kit that will be usable by the community. They will need to discuss effective ways to communicate the purpose and benefits of the test kit in linguistically and culturally responsive ways to the community, reflecting on their own cultural lens to recognize and address potential bias. The critical thinking required in the design process requires all students to meet high expectations of the lesson.

ADVANCING INCLUSIVE RESEARCH

Students will have the opportunity to discuss and consider the importance of purposefully including representation from underrepresented groups when developing solutions to community issues. They will also explore the most effective means to communicate these developments and plans to the communities considering there may be distrust or underdeveloped relationships with those groups.

COMPUTATIONAL THINKING PRACTICES

Students break problems into component parts, extract key information, and develop descriptive models to facilitate problem solving.

CONNECTION TO THE PRODUCT LIFE CYCLE

In this lesson, students go through the stages of the design process to identify the specific problem they are solving with GE technology, and begin modeling how they will collect DNA to address this challenge. This connects to both the **develop** phase of the product life cycle as students build a deep understanding of the community needs around their problem, and the **manufacture** phase as students start to design their final products.

Day 1

LEARNING OUTCOMES

Students will be able to:

Identify the parts of the design process.

Empathize with individuals that will be using their products.

INDUSTRY AND CAREER CONNECTION

Student roles connect to the process of product design and of project management. Students are building concrete skills in the realms of researching as a data analyst, recording the team's development of the product, and keeping track of their tasks and deadlines as project managers.



Procedure

Teacher Note > *The first two days of the lesson will focus on the process of design thinking. Students will each have a role in their groups and all documentation will be completed on a whiteboard or a series of poster papers.*

Whole Group (45 minutes)

1 Refer back to the idea of design thinking. Ask students if they remember the steps of the process, and then introduce the steps they will be using in this activity. See below. Please note that because students are not going to create the “kit,” the last stage is Model instead of Prototype.

- a. Empathize
- b. Define (the problem)
- c. Ideate
- d. Model

Teacher Note > *For more resources, teachers can use the [Design Thinking Bootleg](#) depending on student comfort level. This idea was introduced in previous units and again in Lesson 1 of this unit.*

2 Next, explain the roles of the group members. Every student will have an opportunity to assume each role.

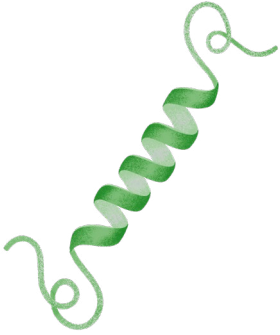
- a. Data Analyst (two students)—These students will complete the internet research, as well as utilize any community surveys or other information gathered during the unit to assist the other members of the group.
- b. Process Documenter (one student)—This student’s job is to document the brainstorming and design process on the whiteboard. All thinking should be documented. Single line cross-out should be used to document changes.
- c. Project Manager (one student)—This student will keep track of time and also be in charge of the checklist provided by the teacher. The checklist will include the task that needs to get done, and the maximum time the group should spend on the task.
- d. All students will work together to brainstorm and think about the task. While everyone is thinking, talking, and discussing, each student will assume one role to document and move the work forward.

3 Assign student groups a whiteboard space (may need to use the hallways). Once they get to their spaces, students need to decide what their job is going to be for the round. There are four rounds or steps, so

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Day 1

Continued



Procedure

each student will get a chance to do each job and be the Data Analyst twice. Be deliberate in the changing of tasks to make sure all students get a chance to complete each job.

Small Group (33 minutes)

- 1 Once students have their jobs, give the Project Manager the Empathize Task List portion of the [Whiteboard Design Challenge Task List Capture Sheet](#). This can also be projected on the board, but because student groups may need to spread out, paper copies may be necessary.
- 2 Go over the reminders at the top of the task list to help guide the process and allow students to work more productively.
- 3 Then, as soon as everyone knows their jobs, the 15 minutes begin for Step 1: Empathize. Teacher will survey the room as students work.
- 4 After 15 minutes, students rotate jobs.
 - a. Data Analyst 1 to Project Manager
 - b. Project Manager to Data Analyst 2
 - c. Data Analyst 2 to Process Documenter
 - d. Process Documenter to Data Analyst 1
- 5 After a brief job recap and distribution of the next task list, the second 15 minutes start to complete the Define The Problem portion of the [Whiteboard Design Challenge Task List Capture Sheet](#).

Whole Group (2 min)

- 1 At the end of the 15 minutes, have students record on the whiteboard what tasks they completed to document for the next day.
- 2 Depending on availability of whiteboard space, save the board for the next day or roll up the poster paper to use the next day.

Day 2

LEARNING OUTCOMES

Students will be able to:

Define the problem they are trying to solve.

Ideate possible design solutions.

Procedure

Whole Group (7 minutes)

- 1 Have students return to the location they worked the previous day and get out the whiteboard or poster paper.
- 2 Give students two to three minutes to read the whiteboard to refresh their thinking from the previous day. The goal will be to “pick up where they left off.”

Small Group (37 min)

- 1 Rotate jobs from the day before and make sure everyone knows their roles.
 - a. Data Analyst 1 to Project Manager
 - b. Project Manager to Data Analyst 2
 - c. Data Analyst 2 to Process Documenter
 - d. Process Documenter to Data Analyst 1
- 2 Once students have their jobs, the Project Manager gets the Ideate Task List portion of the *Whiteboard Design Challenge Task List Capture Sheet* from the teacher. Students can begin working and have 26 minutes to complete the task list.
- 3 After the time is completed, students will move to their final roles to complete the Model portion of the *Whiteboard Design Challenge Task List Capture Sheet*. They will have 10 minutes.

Whole Group (1 min)

- 1 Depending on availability of whiteboard space, save the board for the next day or roll up the poster paper to use the next day.
- 2 Give students high fives on the way out the door. They worked hard!

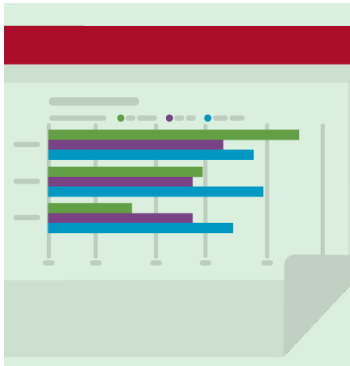


Day 3

LEARNING OUTCOMES

Students will be able to:

Design a visual model of their DNA Collection Kits.



Procedure

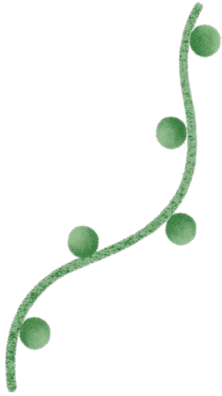
Whole Group (5 minutes)

- 1 Students now need to finalize their diagram models and create slides that they will use in their Elaborated Pitch Deck that will be explained in Lesson 11.
- 2 Outline the requirements for the slides using the [DNA Test Kit Model Requirements Capture Sheet](#).
- 3 Assign each student a role in the productive group work or let them choose.
 - a. Data Analyst (one student)—This student will be in charge of the whiteboard or poster paper. This student will support the work with all the information generated in the design process and make the Pitch Notes.
 - b. Slide Preparers (two students)—These students will make the slides based on the support from the other group members.
 - c. Project Manager (one student)—This student will keep track of time and also be in charge making sure the final slides meet the requirements.

Small Group (40 min)

- 1 Take the work from the previous days and see the requirements on the [DNA Test Kit Model Requirements Capture Sheet](#).
- 2 Students submit the slides when completed for feedback before their final artifact (Lesson 11). The finalized slides will be a part of the Lesson 11 Final Artifact Portfolio of Supporting Evidence that students will make.

National Standards



Next Generation Science Standards

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

Science and Engineering Practices

Developing and Using Models

Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Career and Technical Education (CTE)

A4.0

Recognize basic concepts in cell biology and become familiar with the laboratory tools used for their analysis.

A5.0

Integrate computer skills into program components.

A6.1

Apply knowledge of symbols, algebra, and statistics to graphical data presentation.

A9.0

Understand that manufacturing represents interconnectedness between science and production.

Anchor 2.5

Communicate information and ideas effectively to multiple audiences using a variety of media and formats.

Anchor 2.8

Understand and use correct medical terminology for common pathologies.

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Whiteboard Design Challenge Task List Capture Sheet

Directions

Assign each member of your team a role. Every student will have the opportunity to take on each role.

- *Two Data Analysts will gather information compiled throughout the unit.*
- *One Process Documenter will document all of the group's thinking.*
- *One Project Manager will track time and the checklist.*

Review the reminders. These will enable your group to be more productive.

Work your way through the tasks listed under each goal.

Reminders

- 1** You are responsible for your role in the group. Feel free to encourage others, but do not do the work for them.
- 2** Make sure you document all of the process on the whiteboard. Do not erase or fully scribble out. If you want to cross something out, draw one line through it so that you can still see the thought process.
- 3** Diagrams are great; make sure to include labels so it is clear what you were drawing.
- 4** Be neat and efficient. This is not the final product.
- 5** Stick to your time limit. This keeps the process moving and prevents you from getting stuck on one area of your design. Remember, your time limit includes both reading about the task as well as completing it.
- 6** Rely on the research and the information you have already collected about your plan and proposal.
- 7** Check off the parts of the Task List you get done. If you do not get something done, the Project Manager can add it to the list of tasks to revisit. If you have extra time, go back to the parts that you still need to complete.
- 8** Everyone contributes!

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Whiteboard Design Challenge Task List Capture Sheet

Continued

Step 1	Empathize	
Goal	For Step 1, the goal is to “walk in the shoes” of the community member who will be doing your collection so that you have a clear understanding of the individual (or group) doing your collecting.	Total Time Needed: 15 Minutes

Task		Time to Complete	Check when Completed
Who will collect the DNA?	Give a description of the person you plan to collect the DNA for you in the community. Try to give as much detail as possible.	3 minutes	
How many samples and therefore people will you need to collect?	Quantify how many samples you will need. How many people need to collect DNA for your project to be successful? Should they collect more than one sample of the same DNA?	2 minutes	
What barriers or issues may the community face to do the collection?	Transportation? Access to DNA? Willingness to collect?	2 minutes	
What are some solutions to these barriers?	For each of the barriers listed, provide a solution(s). When thinking of solutions, try to empathize with the individuals who will do the collecting.	2 minutes	

Use this space to list tasks to revisit and discuss further, if there is time.

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Whiteboard Design Challenge Task List Capture Sheet

Continued

Step 2	Define the Problem	
Goal	<i>For Step 2, the goal is to identify the task in detail.</i>	<i>Total Time Needed: 15 Minutes</i>

Task		<i>Time to Complete</i>	<i>Check when Completed</i>
Where is the DNA that needs to be collected?	Where, specifically, should the DNA be collected? Are there multiple locations?	2 minutes	
What else will be collected besides just DNA?	What else will be in the collection? How much of that item will be collected?	2 minutes	
Think about potential problems with accessing the DNA.	What could get in the way of accessing the DNA? Could there be contamination from another source of DNA?	3 minutes	
What is a potential problem getting the DNA back to you?	How will the collected DNA be transported? Is refrigeration required?	2 minutes	
Write out your detailed problem.	Using your answers to the above questions, write out your detailed problem using the starter: <i>We need to...</i>	6 minutes	

Use this space to list tasks to revisit and discuss further, if there is time.

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Whiteboard Design Challenge Task List Capture Sheet

Continued

Step 3	Ideate
Goal	For Step 3, the goal is to brainstorm all possible ideas for your kit. Total Time Needed: 26 Minutes

Task		Time to Complete	Check when Completed
How will the DNA be collected from the location?	What will the collection device look like? How will that device reduce contamination? How will the device solve issues that were outlined in the <i>Empathize</i> or <i>Define the Problem</i> steps? Are there other options that may also work? Include all possible ideas.	12 minutes	
How will the collection device be packaged?	Packaging to distribute? Packaging to collect? Any other issues with packaging that you can anticipate?	4 minutes	
Write a list of possible directions that the community will need to complete the DNA collection.	For ideas on how to write clear directions, consider those you encounter on packaging, for example, a box of rice. Use the information gathered during the <i>Empathize</i> step to make the directions accessible. What other factors do you need to think about?	10 minutes	

Use this space to list tasks to revisit and discuss further, if there is time.

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Whiteboard Design Challenge Task List Capture Sheet

Continued

Step 4	Model
Goal	<p><i>For Step 4, the goal is to use the work from the other three steps to create a draft diagram model of your collection kit. This should include all the details you think will be important for a successful collection, but will not finalize the model.</i></p> <p><i>Total Time Needed: 10 Minutes</i></p>

Task		Time to Complete	Check when Completed
Identify ideas you want to include in the final model.	Go back through the entire whiteboard and with a different colored marker highlight, circle, or otherwise denote items (ideas) you want to include in the final model.	7 minutes	
Justify why these ideas are important.	With the items identified, justify why they are important to solving your “problem” from Step 2 or empathizing with your community from Step 1.	3 minutes	

Use this space to list tasks to revisit and discuss further, if there is time.

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DNA Test Kit Model Requirements Capture Sheet

Directions

Complete two to three slides modeling the DNA Test Kit that your group would use to collect the DNA from the community. This is the DNA that will provide the data to help answer the question or solve the community-focused problem. These slides will be part of the Elaborated Pitch Deck, which is part of the Final Artifact in Lesson 11.

Requirements

The following requirements should be included on as few slides as possible. The slides will be finalized when you create your Elaborated Pitch Deck. Use the table below as a checklist to be completed by the Project Manager.

Requirement	Check when Completed
1 Drawing or diagram of collection device	
2 Drawing or diagram of packaging	
3 Directions for collection of DNA	
4 Directions for collection of used kits (to get the data back)	
5 General explanation of project	
6 Confidentiality statement (if appropriate)	
7 Pitch Notes <i>These should not be included on the slides, but should be documented to be used during the pitch. Pitch notes could include ideas about how to show empathy to stakeholders, potential ways to ensure confidence in the plan, or general information about how to explain the product model.</i>	

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DNA Test Kit Model Slides

Student Example

Directions

Briefly review these slides as a model for your pitch deck.

Note how this model includes all the items from the DNA Test Kit Model Requirements in as few slides as possible.



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DNA Test Kit Model Slides

Student Example

Continued



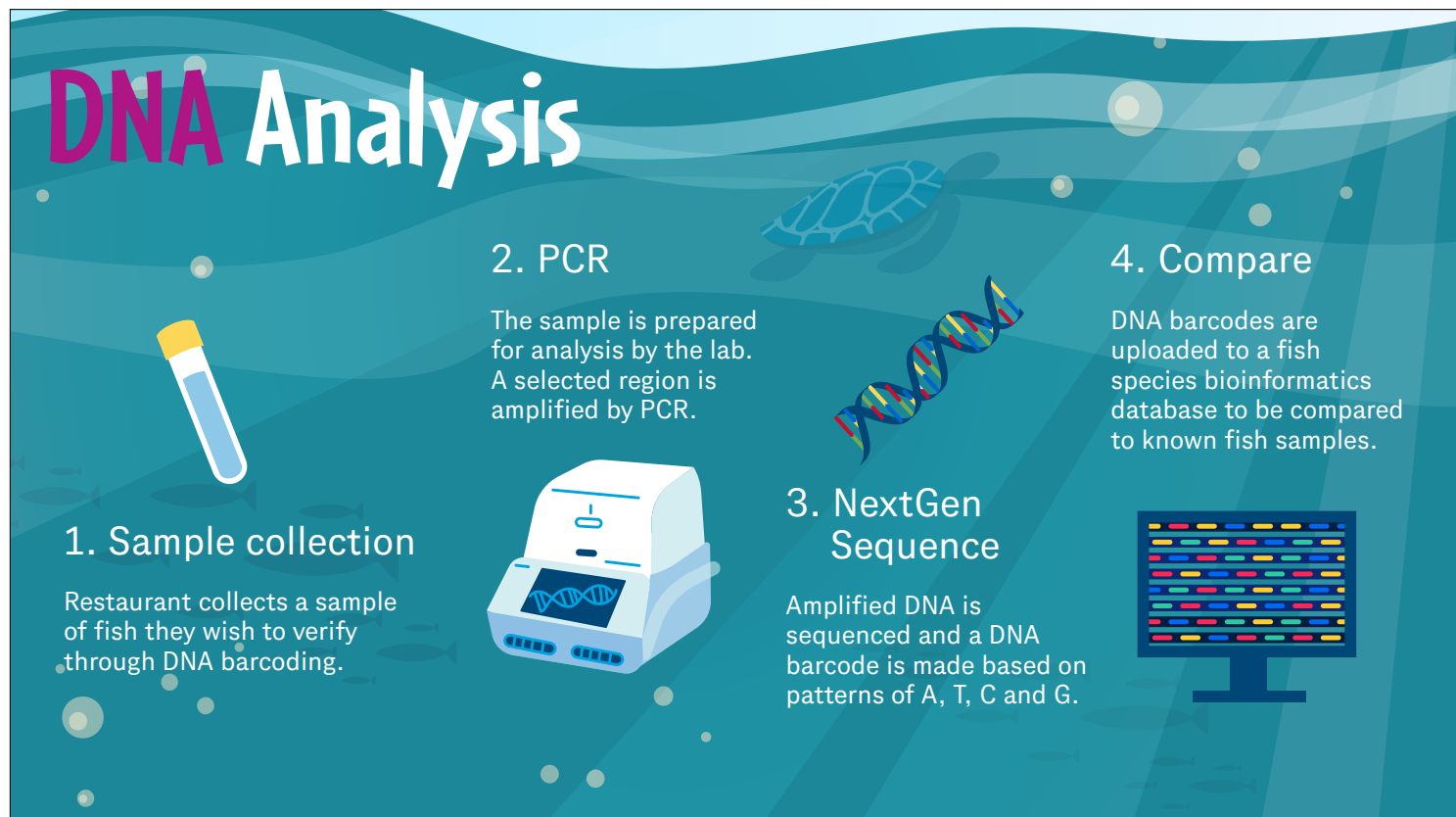
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DNA Test Kit Model Slides

Student Example

Continued



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DNA Test Kit Model Slides

Student Example

Continued

Sustainable Salmon Certification Service

Thank you for starting the journey to verify the species and source of the salmon you are serving at your restaurant! With this knowledge, you can help make sustainable choices for your menu, advertise these sustainable choices, and attract customers who value sustainability.

Follow the instructions below to collect, package, and send your sample for testing.



DNA Sample Collection Kit Instructions

- 1 Select a salmon sample on which you would like to perform DNA analysis. The sample can be fresh, frozen, canned, dried, or pickled.
- 2 Cut a pencil eraser-sized sample of tissue from the salmon you would like to verify. Use a freshly washed blade for each sample being processed and cut on a clean surface to prevent contamination from other samples.
- 3 Place the sample in a vial provided in the DNA testing kit. Each kit contains 10 vials. Keep samples in the refrigerator until you are ready to ship.
- 4 Fill in one label for each vial. Be specific about the vendor from which you obtained the sample and the species the salmon was marketed as so the DNA technology can verify this information.
- 5 Once you have collected your samples, ship the package with one-day shipping using the enclosed return label. Sustainable Salmon Certification Service will contact you with results of the DNA analysis.

