FUTURELAB+

AG/ENVIRONMENTAL

Plant to Pharmaceutical

Ethical Collaboration

Developed in partnership with:

Discovery Education and Ignited

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

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

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Cover Image
The Solanaceae plant family is rich in bioactive metabolites and has played an essential role in traditional medicine.

AG/ENVIRONMENTAL / PLANT TO PHARMACEUTICAL

Ethical Collaboration

DRIVING QUESTION

What are the best practices for ethical collaboration between Indigenous communities and biotechnology researchers when developing new intellectual property during drug discovery?

OVERVIEW

For centuries, many Indigenous communities have looked to plants for remedies based on deep Traditional Ecological Knowledge (TEK) and practices. Students will explore the cultural, ethical, and social lenses that surround TEK before they gain hands-on experience with the technical details of TEK. Students will make ethical judgments about how to prioritize and unify different value systems as they consider different potential field sites.

In this lesson, students will explore a case study jigsaw to illuminate patterns in stakeholder interests and concerns. Students will participate in a philosophical chairs discussion on ethics of bioprospecting in regions of biodiversity and the concerns it raises in terms of ethical collaboration with Indigenous communities. Students will create a document of best practices for benefits sharing that will form a cornerstone of the final drug development project.

ACTIVITY DURATION

Five class sessions
(45 minutes each)

ESSENTIAL QUESTIONS

How do specific Indigenous cultures view biodiversity?

How do we navigate differences between Indigenous and non-Indigenous views regarding natural resources?

How do we ethically acknowledge the role of Traditional Ecological Knowledge in the development of intellectual property surrounding plant-based medicines?

OBJECTIVES

Students will be able to:

Identify various lenses of stakeholders involved in identifying plant resources for plant-based remedies and connect to careers.

Apply understanding of IP regulations for ethical collaboration to case studies and evaluate actions using stakeholder perspectives.

Create a classroom community that supports critical conversations surrounding complex issues that have no clear outcome.

Develop recommendations for biotechnology companies to ethically collaborate with Indigenous communities and local governments.

Materials
Student Guide
History of Aspirin Capture Sheet
History of Salicylic Acid to Aspirin Timeline Key Events Cards
“Who Owns That?” Capture Sheet
Stakeholder Perspective Profile Cards
Case Study Capture Sheet
Extension Option: Case Study Table for Primary Sources
Stakeholder Case Study Jigsaw Information Capture Sheet
Philosophical Chairs Capture Sheet
Nagoya Protocol Article Excerpts
Sticky Notes (Optional for Gallery Walk)
Best Practices for Ethical Collaboration Capture Sheet
Materials to Create Posters or Whiteboard and Markers
Computer
Internet access

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 will practice social awareness and relationship skills while engaging in critical conversations about the ethics of collaboration. Students will identify cultural and linguistic assets in contributions of Indigenous communities to knowledge and understanding of medicinal plant compounds. Students will develop and demonstrate cultural competency by acknowledging the value of Indigenous Traditional Ecological Knowledge (TEK). They will develop benefit sharing priorities that are appropriate across cultural differences.

CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

Students will recognize and redress bias in the system, bring real-world issues into the classroom, and promote respect for one another's differences. Incorporation of authentic voices regarding Indigenous perspectives allow opportunities for students to pursue personal connections.

ADVANCING INCLUSIVE RESEARCH

In this lesson, students explore the role of intellectual property (IP), and how scientists reference experiences of Indigenous communities to identify and develop novel plant-based medicines. Drawing upon the cultural knowledge of Indigenous communities surrounding plant-based medicine allows scientists to more effectively target a potential medicine rather than taking a needle-in-a-haystack type of search. Historically, Western science programs failed to acknowledge the importance of this foundational knowledge gleaned (sometimes forcibly) from Indigenous peoples. This lesson allows students to collaborate to create an ethical framework for the sharing of IP across cultures, and evaluate a tool that supports compensation for the role of Indigenous communities in the discovery of plant medicines.

COMPUTATIONAL THINKING PRACTICES

This lesson emphasizes global collaboration skills to examine issues from multiple perspectives as students share findings in a philosophical chairs discussion. Students will address issues with no clear outcomes, and will develop skills for working with ambiguity and open-ended problems by investigating stakeholder outcomes in the history of drug development.

CONNECTION TO THE PRODUCT LIFE CYCLE

During the **discovery** phase of the product development lifecycle, researchers are challenged to narrow their focus to the most promising potential drug targets. One strategy is to partner with Indigenous communities. This facilitates the discovery of effective medicinal compounds because of the deep cultural knowledge and experience that Indigenous communities have cultivated surrounding medicinal plants in their local environment. Biotech companies have a responsibility when utilizing this IP to develop ethical benefits sharing agreements with the Indigenous communities that provided the source information for their plant-based medicine discovery process.

Have you ever wondered…

What is intellectual property, and what role does it play in our everyday lives?

From iPhones to Taxol to the Beatles song catalog, intellectual property is the legal doctrine that enables companies and individuals to profit from new creations and prevents other entities from improperly copying unique technology or art. In the biotech realm, this licensing enables companies to invest in discovery and development of new drugs, knowing that they will hold the exclusive right to profit from that investment for a certain amount of time. When it comes to plant-based medicines, Indigenous communities are an essential source of knowledge underpinning the identification of novel compounds, and their contributions need to be acknowledged and compensated.

How do we compensate groups of individuals with different cultural beliefs and systems for their traditional knowledge?

Indigenous communities have deep traditional knowledge and practice with medicinal plants that are used by scientists as they search for bioactive plant compounds to develop new medicines. How do we share the benefits of a new drug with communities that may have an entirely different belief and value system from those that we are more familiar with?

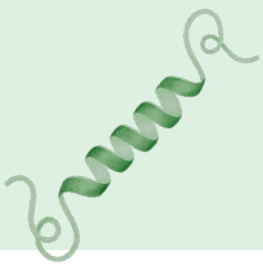
MAKE CONNECTIONS!

How does this connect to the larger unit storyline?

Indigenous communities have looked to plants for herbal remedies for centuries using deep Traditional Ecological Knowledge.

Western science and medicine have relied on Indigenous knowledge about plants and plant properties.

Ethical collaboration between Indigenous communities and outside groups requires acknowledgement of and compensation for intellectual property, and respect for diverse cultural beliefs.



How does this connect to careers?

Ethnobotanists study how different cultures use native plants for medicine, food, and other essential purposes. Ethnobotanists perform fieldwork, develop relationships among communities, governments, and scientists, and work in universities and non-profit organizations.

Corporate counsels are lawyers who are intimately involved in all stages of drug development, from regulatory to acquisitions to supply chain management. They are also responsible for drafting intellectual property (IP) agreements. Their ethics and adherence to local and international government regulations can decide the success of an IP agreement.

How does this connect to our world?

Trends in global health crises and inequalities point to the need for successful and ethical collaboration among majority world countries and wealthier countries.

Understanding the history of how “bioprospecting” impacts all stakeholder groups will help us more ethically reshape future interactions in the pursuit of medicines.

Biodiversity protection and sustainability is key to the health of all, from the planet to all inhabitants.

Day 1

LEARNING OUTCOMES

Students will be able to:

Analyze the significance of an everyday medicine, while examining its historic roots.

Construct a progression timeline and compare and contrast to show effects on stakeholders.

Infer how collaborating with Indigenous groups would have changed events.

Procedure

Whole Group (10 minutes)

1. Use think-pair-share to start. Ask students: Have you or a family member ever used aspirin? If so, do you know what for? What do you know about aspirin? What might life be like without medicines like aspirin?

2. Ask students: Where do many medicines originally come from?
   - **a.** Connect prior learning from Lesson 1 to discuss the origins of many medicinals.
   - **b.** Broadly share with students that today's lesson will look at the origins of aspirin.

3. Share with students that pharmaceutical companies seek knowledge from Indigenous communities who have a long history of using plant medicines. Successful collaboration among pharmaceutical companies and Indigneous communities will create a better product that benefits all stakeholder groups. Looking at the history of drug development, such as aspirin, will help develop awareness of where opportunities for collaboration exist.

4. Video on history of aspirin: *How aspirin was discovered* TED Ed (show until 3:03 minutes)

Whole Group (15 minutes)

1. Provide students with the *History of Aspirin Capture Sheet*. Ask the class to collaboratively construct a timeline on the whiteboard of the history of the development of aspirin, using the *History of Salicylic Acid to Aspirin Timeline Key Events Cards* provided.

Continues next page >

Day 1

Continued

Procedure

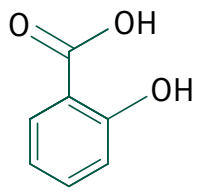
2 Have students formulate an alternative history with the given information on the event cards involving Indigenous groups with a history of using willow bark. The alternative history should benefit both Indigenous groups and western medicine developers. Students should:

- Compare and contrast the actual timeline to the alternate timeline.
- Brainstorm the stakeholder groups involved.
- Complete the *History of Aspirin Capture Sheet*.

Teacher Note > *As an extension for students who are particularly engaged, ask them to answer the following questions after constructing the timeline:*

- *Who are the stakeholder groups involved?*
- *Did all stakeholder groups benefit?*
- *What would the perspective of Indigenous groups be?*
- *How might they defend their knowledge and use of willow bark?*

Salicylic acid



3 Discuss as a class what you found from the timeline construction.

- History of the use of aspirin from the timeline activity: What steps were involved in the process of making aspirin?
- Chemically modifying molecules from video clip: Why might changes be made to molecular structure?
- What it means to be a stakeholder: How might different stakeholder groups view the same process or idea through very different lenses?

Teacher Note > *This activity frames out the rest of the week as "we can change the future" in terms of how biotechnology companies can successfully collaborate with Indigenous communities when seeking plant resources for medicines.*

Whole Group (5 minutes)

Share with students the term "bioprospecting," which has been defined as "the search for valuable chemical products in natural biological resources." This term raises concern as the practice frequently occurs in regions of biodiversity in developing nations, and the local communities whose knowledge led to important discoveries are not appropriately compensated. As a result, a document called the Nagoya Protocol was developed to provide protections for local and Indigenous communities collaborating with outside groups. Later in this lesson, students will have the opportunity to learn more about the Nagoya Protocol and consider how to share benefits across all stakeholder groups involved in the development of medicines.

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Day 1

Continued

Procedure

Small Group (15 minutes)

Groups will brainstorm and share out, or full group brainstorm. Compare and contrast both timelines:

- Who are the stakeholders in the example of the history of the development of aspirin from willow bark? How did they benefit?
- How would you (students) change the outcome?

Day 2

Procedure

LEARNING OUTCOMES

Students will be able to:

Examine real-world examples of IP and how it is used in various industries.

Discuss the use of patenting of biologic and medicinal materials.

Analyze the difficulties of ownership of natural knowledge through the Myriad and CRISPR cases.

INDUSTRY AND CAREER CONNECTION

Ethnobotanists study how different cultures use native plants for medicine, food, and other essential purposes. Ethnobotanists perform fieldwork, develop relationships among communities, governments, and scientists, and work in universities and non-profit organizations.

Whole Group (5 minutes)	
1	Introduce the warm up and provide students with the *"Who Owns That?" Capture Sheet*.
2	Student should pair-share or table group about intellectual property (IP): What is IP? What kind of information is considered IP?

Small Group (10 minutes)	
1	Students will complete the top portion of the *"Who Owns That" Capture Sheet*, discussing different IP examples across various industries.
2	Students should share their responses in small groups.

Small Group (30 minutes)	
1	Have students complete the bottom half of the *"Who Owns That" Capture Sheet* by reading the article *The Complications Around Patenting Biotechnology*.
2	Students can share findings about requirements of patenting (subject matter eligibility, utility and novelty, non-obvious, not previously disclosed), challenges with patenting biological materials, and the Myriad and CRISPR cases.

Teacher Note > *This article focuses on Western patenting and regulatory practices. When companies from Western nations are engaging with Indigenous communities and their traditional ecological knowledge, it is important to remember groups hold different ideas about the meaning of "health," ownership of natural knowledge, and the use of natural resources. This will be explored throughout this lesson as well as in Lesson 4.*

As a possible extension, show students Supreme Court Unanimously Rules Human Genes Cannot Be Patented (eight minutes) on the Supreme Court's decision that human genes cannot be patented or discuss IP Handbook of Best Practices.

Day 3

LEARNING OUTCOMES

Students will be able to:

Discuss stakeholder lens profiles as a tool for reviewing a stakeholder's background.

Examine the challenges facing diverse stakeholder groups through case study research.

Construct a stakeholder perspective based on the examination of a case study.

Procedure

Whole Group (5 minutes)

Share the following think-pair-share scenario with students: Imagine there is a valuable natural resource in the region of your community. Examples might include a native plant with medicinal properties, an energy resource, a mineral resource, natural history or cultural artifacts, or even clean water. Outside groups are interested in accessing your resource.

What questions might your community have for these outside groups? What questions might your local government have?

Teacher Note > *Students might ask questions such as:*

- *How will the outside group access or extract the resource?*
- *How much of the resource is needed?*
- *How long will the outside group be present in the region?*
- *How long might the relationship between the community and the outside group last?*
- *How will the community be compensated?*
- *How might the local economy and community members benefit from this relationship (jobs, etc.)?*
- *How could local ecosystems be affected?*
- *How will local ecosystems be protected?*
- *How will any damage to ecosystems be rectified?*
- *How will local laws and regulations be monitored?*

Whole Group (10 minutes)

1 Share with students the *Stakeholder Perspective Profile Cards* to integrate stakeholder positions from the brainstorming session on Day 1 and connections to featured careers.

Teacher Note > *Lens profiles will provide students with background information to help understand key interests and perspectives about different stakeholders and careers involved in researching, obtaining, and developing medicines using whole plants or bioactive compounds.*

2 Assign stakeholder lenses (student choice or teacher preference) for case study research and the case study research organizer.

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Day 3

Continued

Procedure

3 Using the resource *Where the Rainforest Meets the Road* in the small group activity noted below, students will examine a case study highlighting the challenges facing diverse stakeholder groups and their interactions with regards to promoting economic growth while balancing traditional lifeways and creating a sustainable future. Students will complete the *Case Study Capture Sheet* based on their stakeholder perspective.

Potential featured stakeholders to introduce to students:

- Indigenous community representative
- Local government representative
- Ethnobotanist (or connected scientist position)
- Multinational corporation or biotechnology company and stockholders

Small Group (25 minutes)

Assign the *Where the Rainforest Meets the Road* case study article to read. Students should fill in the *Case Study Capture Sheet*. Questions for discussion include:

- How did the example outcome benefit (or not benefit) your stakeholder party?
- What were the interests of the stakeholder?
- What details from the case study provide evidence for your answer?
- What perspectives or voices seem to be missing from the case study?

Teacher Note > *As an optional extension for student groups to be challenged, allow them to identify a case study location that they would like to study from the list on the Extension Option Capture Sheet. They will document the stakeholders and the threats specific to that location (e.g., forestry, agriculture, urbanization, overharvesting, pollution) using primary literature, guided by the Case Study Capture Sheet. This option requires student independence and collaboration with group members to read and find information in professional level texts. Provide guidance on specific reading strategies, including skimming and using Ctrl+F or Command+F to locate key search terms and using Internet searches to further investigate the meaning of science vocabulary.*

Day 4

LEARNING OUTCOMES

Students will be able to:

Present a unique stakeholder perspective to peers.

Identify possible outcomes versus tradeoffs.

Analyze patterns and standouts in the case study with various stakeholder groups.

Procedure

Teacher Note > *It may be helpful to remind students that they have explored bioethics during the CRISPR bioethics lesson in Solution Seeking Microbes (Lesson 6) and in the Golden Rice bioethics lesson in Alternative Proteins (Lesson 5). This discussion focuses on a different bioethics scenario but relies on similar reasoning, including perspective taking among different stakeholders. The focus on bioethics continues from Day 4 through Day 6.*

Whole Group (5 minutes)	
1	Introduce jigsaw structure for groupings and as a note-taking tool.
2	Generate discussion norms for sharing perspectives. For guidance, teachers should read *Let's Talk About It!* from Learning for Justice.

Small Group (20 minutes)	
1	Using the *Stakeholder Case Study Jigsaw Information Capture Sheet*, stakeholders within each group should share their interests, concerns, outcomes, and tradeoffs as noted in the case study.
2	Students should fill in notes for other types of stakeholders in their group.

Small Group (15 minutes)

Ask students to regroup based on their stakeholder role. Homogeneous stakeholders across groups should discuss jigsaw results and identify any patterns in outcomes and tradeoffs in the case study, as well as any unique standouts demonstrating successful collaboration or non-exemplars.

Whole Group (5 minutes)

Have the class share patterns and standouts from the jigsaw, for example:

- Patterns in outcomes and tradeoffs
- Successful examples
- Non-exemplars

Teacher Note > *The **Student Guide** is designed to support students in the final assessment in Week 9 and in their unit project (Lessons 6–9). As an exit ticket (if time permits) or as homework, students should add to their **Student Guide** by completing the first question for Lesson 2.*

Day 5

LEARNING OUTCOMES

Students will be able to:

Contribute to a class-wide discussion on ethical resource extraction.

Reflect on the discussion to identify how it changed their perspectives.

Procedure

Whole Group (35 minutes)

1 Facilitate with students how to have a discussion where different opinions are respectfully shared and heard. Generating norms for sharing, listening, and responding will support creating a safe environment where students can:

- Connect a critical topic to shared principles like respect, fairness, and individual worth.
- Demonstrate an understanding of perspectives and experiences different from their own.
- Explore ways they can put their ideas into action.
- Respect and respond to the experiences of their classmates.

Teacher Note > *For guidance on facilitating this discussion with students, teachers should read Learning for Justice's Let's Talk: Facilitating Critical Conversations (see Section II) and Moderating a Discussion.*

2 Set up a philosophical chairs discussion to establish the ethical and philosophical ramifications around the reality of resource extraction. Determine a central discussion statement from the options below (teacher may choose to assign or have students select based on interest). Possible central discussion statement include:

a. Discovering involves identifying and publishing a description of a species and a specific commercial application. Discovering a species or compound should give you the right to commercialize it and market it for profit.

b. Living things and their constituent parts cannot be owned or marketed by private or government entities as they are public goods.

3 Hand out the *Philosophical Chairs Capture Sheet* (which contains the instructions for the discussion) and have students complete.

Individual Work (10 minutes)

Reflect on main points of student-generated discussion:

- What points or perspectives that you heard resonated with you?
- What points or perspectives that you heard did you disagree with?
- What points or perspectives that you heard feel like they need to be further explored?
- What points or perspectives did you feel like you did not hear about that should be considered?

Day 6

Procedure

LEARNING OUTCOMES

Students will be able to:

Analyze the Nagoya Protocol's effectiveness to protect underrepresented groups.

Create a visual proposal of changes to the Nagoya Protocol to present to their peers.

Propose best practices for ethical collaboration.

INDUSTRY AND CAREER CONNECTION

Ethnobotanists study how different cultures use native plants for medicine, food, and other essential purposes. Ethnobotanists perform fieldwork, develop relationships among communities, governments, and scientists, and work in universities and non-profit organizations.

Whole Group (3 minutes)

1 Share with the students the *Nagoya Protocol Article Excerpts*.

2 Invite students to share class-wide or in a think-pair-share one point from yesterday's freewrite at the end of the philosophical chairs discussion to lead into examining pieces of the *Nagoya Protocol*.

Whole Group (10 minutes)

Print and post on poster paper or a wall the *Nagoya Protocol Article Excerpts* and ask students to conduct a silent gallery walk.

- What regulations currently exist around collaborating with Indigenous communities and their TEK and resources?
- Students silently read and reflect on selected articles of the Nagoya Protocol with actual text and student-friendly language versions on posters.
- Students reflect on (ideas, comments, questions) the selected articles based on their learning from the week's case study jigsaw, stakeholder lenses, and the philosophical chairs discussion using sticky notes or writing directly on poster paper.

Small Group (27 minutes)

1 Place students in small groups to brainstorm: Is the Nagoya Protocol sufficient to protect the interests of unrepresented parties involved in biodiversity research?

- If yes, which parts are key to equitable and ethical collaboration?
- If not, what needs to be:
  - added?
  - removed?
  - changed or amended?

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Day 6

Continued

Procedure

2 Students should create a whiteboard or poster showing their group's proposal. Tell them to incorporate group ideas from brainstorming and small group discussion. For example:

- Strengths of Nagoya
- Weaknesses of Nagoya
  - How could elements of the Nagoya protocol be manipulated to serve personal interests?
- Case study example of how Nagoya protocol could have strengthened outcomes for all stakeholders
- What are the key features of ethical collaboration among all parties affected by or involved in development of plant resources for medicine? Incorporate key learning and examples from this week's activities:
  - Case study jigsaw findings
  - Student thinking from philosophical chairs
  - Connection between accessing TEK and isolating active compounds to patent

3 Students propose a group poster for how to alter or amend the Nagoya Protocol and make recommendations for future successful collaboration between all parties involved in identifying and accessing plant resources and TEK. Students should choose two main ideas from their group's proposal and briefly share them with the class.

Individual (5 minutes)

1 Share that students will ultimately pitch a plant-based medicine to target a specific disease involving the different stakeholder groups they have learned about for their Plant to Pharmaceutical project. Ask:

a. From what you learned in this lesson, what should shape stakeholder interactions in this process?

b. What are the key "Rules of Engagement" for ethical collaboration among scientists, biotechnology companies, local governments, and the Indigenous communities that have held traditional ecological knowledge about medicinal properties of plants for centuries?

2 Tell students to complete the *Best Practices for Ethical Collaboration Capture Sheet* using their thinking from above.

Teacher Note > *As an exit ticket (if time permits) or as homework, students should add to their* ***Student Guide*** *by completing the second question for Lesson 2.*

National Standards

Next Generation Science Standards

LS2.A: Interdependent Relationships in Ecosystems
Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.

LS2.C: Ecosystem Dynamics, Functioning, and Resilience
A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.

LS4.D: Biodiversity and Humans
Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

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National Standards

Next Generation Science Standards *Continued*	**Science and Engineering Practices** Obtaining, evaluating, and communicating information Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.
Career and Technical Education (CTE)	**A1.5** Evaluate the impact of biotechnological applications on both developing and industrial societies, including legal and judicial practices. **A2.4** Understand the critical need for ethical policies and procedures for institutions engaged in biotechnology research and product development. **A7.3** Describe intellectual property. **9.5** Understand that the modern world is an international community and requires an expanded global view.

Educator Resources

History of Salicylic Acid to Aspirin Timeline Key Events
Actual Events Cards

Directions
Cards depicting actual events are outlined with a solid green line. Cards depicting alternative events are outlined with a dotted black line. Print out all cards to create a timeline on your whiteboard or chalkboard.

1500 BCE

Prehistoric populations used willow bark for pain relief for 3500 years.

Continues next page >

Educator Resources

History of Salicylic Acid to Aspirin Timeline Key Events

Actual Events Cards

Continued

1763

Edward Stone notes the bitter taste of willow is similar to the taste of South American cinchona bark used for fever reduction, experiments with willow as fever reducer.

1820s

European scientists extract salicin from willow bark.

Continues next page >

Educator Resources

History of Salicylic Acid to Aspirin Timeline Key Events

Actual Events Cards

Continued

1897

Felix Hoffman chemically modifies molecules related to salicin to create acetylsalicylic acid and to prevent gastritis.

1899

Bayer markets acetylsalicylic acid patents as Aspirin.

Continues next page >

Educator Resources

History of Salicylic Acid to Aspirin Timeline Key Events

Actual Events Cards

Continued

1910s

Bayer's patent to aspirin expires; the Bayer company name and trademark is purchased by Sterling Products Company, later Sterling Winthrop.

1994

Bayer buys Sterling Winthrop's business, gaining back rights to the Bayer name and logo.

Continues next page >

Educator Resources

History of Salicylic Acid to Aspirin Timeline Key Events

Actual Events Cards

Continued

Present

Aspirin (and related drug products)
sell to consumers for +/- $3.3 billion per year.
All profits go directly to Bayer
and shareholders.

Continues next page >

Educator Resources

History of Salicylic Acid to Aspirin Timeline Key Events
Alternative Events Cards

Directions
Cards depicting alternative events are outlined with a dotted black line. Cards depicting actual events are outlined with a solid green line. Print out all cards to create a timeline on your whiteboard or chalkboard.

Late 1800s–Present

Indigenous communities who have grown and used willow bark for centuries are engaged to sustainably farm willow trees and other plant sources of salicin.

Continues next page >

Educator Resources

History of Salicylic Acid to Aspirin Timeline Key Events

Alternative Events Cards

Continued

Early 1900s–Present

Pharmaceutical companies extract and purify salicylic compounds from Indigenously farmed willow trees and other plant sources of salicin compound.

Mid 1900s–Present

Active collaboration between Indigenous communities farming willow trees and pharmaceutical companies; stakeholders share profits.

History of Aspirin Capture Sheet

ANSWER KEY **Do not share with students**

Directions
Use this notes sheet to record general information about the stakeholders in the history of aspirin activity.

Provided here is the History of Salicylic Acid to Aspirin Timeline Key Events, Actual Events Cards. Students will likely summarize the events in two to three sentences for their answer.

1. In two or three sentences, summarize the development of aspirin in the Actual Timeline.

1500 BCE: Populations have used willow bark for pain relief for 3500 years.

1763: Edward Stone notes that the bitter taste of willow is similar to the taste of South American cinchona bark used for fever reduction; experiments with willow as a fever reducer.

1820's: European scientists extract salicin from willow bark.

1897: Felix Hoffman chemically modifies molecules related to salicin to acetylsalicylic acid to prevent gastritis.

1899: Bayer markets acetylsalicylic acid patents as Aspirin.

1910s: Bayer's patent to aspirin expires; the Bayer company name and trademark is purchased by Sterling Products Company, later Sterling Winthrop.

1994: Bayer buys Sterling Winthrop's business, gaining back rights to the Bayer name and logo.

Present: Aspirin (and related drug products) sell to consumers for +/- $3.3 billion per year. All profits go directly to Bayer and shareholders.

2. In two or three sentences, summarize the development of aspirin in the Alternative Timeline.

Prehistoric Period: Populations have used willow bark for pain relief for 3500 years.

1763: Edward Stone notes that the bitter taste of willow is similar to the taste of South American cinchona bark used for fever reduction; experiments with willow as a fever reducer.

1820's: European scientists extract salicin from willow bark.

1897: Felix Hoffman chemically modifies molecules related to salicin to acetylsalicylic acid to prevent gastritis.

Late 1800s–Present:Indigenous communities who have grown and used willow bark for centuries are engaged to sustainably farm willow trees and other plant sources of salicin.

Early 1900s–Present: Pharmaceutical companies extract and purify salicylic compounds from indigenously farmed willow trees and other plant sources of salicin compound.

Mid 1900s–Present: Collaboration between Indigenous communities farming willow trees and pharmaceutical companies; stakeholders share profits based on a history of traditional ecological knowledge, sustainable land use practices, and benefit sharing practices. Companies and communities regularly meet to discuss whether benefit sharing practices are still favorable to both parties

Continues next page >

History of Aspirin Capture Sheet

ANSWER KEY **Do not share with students**

Continued

3. Brainstorm: How did the two stakeholders listed below benefit from the development of aspirin? List benefits in the actual timeline and your brainstormed alternative timeline.

Stakeholder	How They Benefitted	Discussion Notes
Indigenous Communities	Actual timeline: no benefit Alternative timeline: shared benefits with pharma companies potentially including profits, livelihood, and jobs; responsibly protected environment	Answers will vary.
Pharmaceutical Companies and Shareholders	Actual timeline: all financial benefits from drug development process and TEK Alternative timeline: financial benefits from drug development process; access to TEK, source of willow for extraction of salicylic compound	Answers will vary.

Continues next page >

History of Aspirin Capture Sheet

ANSWER KEY **Do not share with students**

Continued

4. Imagine going back in time and being part of the team who developed and patented aspirin. How might you decide to engage different stakeholders? What might you do to change the future?

Answers will vary, but students may indicate based on provided alternatives or an alternative they generated using their own ideas that engaging stakeholders and benefit sharing produces the most positive outcome for all. Land and resource protection by using sustainable practices, providing jobs and income for all stakeholder contributions, and continually reviewing benefit sharing agreements to ensure relevance can promote a more equitable and ethical collaboration.

***Who Owns That?* Capture Sheet**

ANSWER KEY **Do not share with students**

Continued

1. Read the scenario below and think about the questions.

	Scenario	What is the intellectual property?	Who are the stakeholders?
a	A well-known T-shirt manufacturer created a logo that is used on T-shirts produced in another county. Who should get the profits for the sales of the T-shirts? Is intellectual property being appropriated?	*Example: The T-shirt could be the IP, or the logo design could be the IP.*	*Example: The T-shirt manufacturer and the logo designer.*
b	A television program uses a plot and characters very similar to another show. Should the program obtain permission to use the copyrighted elements of the original show? Why or why not? Is intellectual property being appropriated?	The plot and characters of the TV show.	The creators of the original and the new shows.
c	An architect copies the design of a building and sells it to a client. What should be done? Who should pay? Is intellectual property being appropriated?	The designer of the building.	The designer of the building and the owner of the building.
d	Scientists isolate a gene mutation that causes a particular condition. Other organizations want access to this information for further research, including potential therapies. Should the scientists be able to control or patent this discovery? Is it their intellectual property?	This is a tricky one. The law around patenting genes varies based on jurisdiction. Human genes cannot be patented in the United States because they are products of nature. DNA that has been manipulated in a lab may be patented *Can genes be patented?*	Scientists who isolated the gene mutation, and organizations who want to develop therapies based on it.

Source: *US Department of State's Intellectual Property: Yours, Mine and Ours.*

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***Who Owns That?* Capture Sheet**

ANSWER KEY **Do not share with students**

Continued

3. Answer the following questions about the reading.

a	What is necessary for a utility patent in the United States?	1	Subject matter must be eligible.
		2	Subject matter must have utility and novelty.
		3	Subject matter must be non-obvious.
		4	Subject matter must not have been previously disclosed.
b	What is necessary to be eligible for a patent in the European Union?	1	Invention must be new.
		2	Invention must be industrially applicable.
		3	Invention must involve an inventive step.
c	How do the requirements of the United States and the European Union differ?		Broadly, in the European Union, fewer inventions qualify for a patent.
d	According to the article, what are three complexities, or "grey areas" that can make patenting biological materials challenging?	1	It can be hard to demonstrate that the product is a biotechnology product and not a natural one.
		2	It can be hard to demonstrate that one was the first in the world to do a specified action.
		3	Biological material is capable of reproducing itself and can change and morph.

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***Who Owns That?* Capture Sheet**

ANSWER KEY **Do not share with students**

Continued

e Break down the Myriad and CRISPR example:

Who are the stakeholders involved in this case?	Myriad Genetics, Broad Institute, and the University of California, Berkeley
What is the story behind the case?	Both Broad and UC Berkeley claim invention of the technology and therefore the rights to commercialize products developing with the gene editing tool.
Describe the outcome of the case:	Broad Institute patents were upheld in the United States, but some of their CRISPR patents in Europe were revoked.

f How do patents protect the intellectual property of biotechnology companies?

Biotechnology companies with protected IP minimizes risk for investors and facilitates decision making about potential investments.

Patents allow biotechnology companies to commercialize their products without infringing on the IP rights of others.

Patents prevent others from selling the same invention of a biotech company for a certain period of time.

Case Study Capture Sheet

ANSWER KEY **Do not share with students**

Directions

The source you are about to read is technical and challenging. The task is not to read every word, but to examine the document to construct a narrative from a particular point of view. Document bullet-pointed summaries from the perspective of your stakeholder. You can skim, focus on particular sections of high relevance, or use other reading strategies to accomplish the task in the time allotted.

Answer for the Indigenous Community Member Stakeholder.

Your Source	*Your Stakeholder*
Where the Rainforest Meets the Road biographic story by Kate Schimel	Indigenous Community Member

1	Stakeholder related call outs found when skimming the source document Use Stakeholder Perspective Profile Cards.	An Indigenous Community Member is concerned about conservation of species, wants to continue traditional land use practices and protect sacred lands (such as ancestral burial sites), but also needs funds for schools and medical expenses for villagers. Oil palm plantations and logging operations have cut into local forest space. Papua New Guinea is inhabited by 152 different clans that have existed for approximately 50,000 year.
2	How does your stakeholder interact and collaborate with other roles at this particular field site? For example, what is working well? What sources of conflict are there, if any?	This stakeholder voted for a community-driven conservation effort allowing sustainable agriculture and some infrastructure (roads), but realized the need to balance resident's needs for services requiring income. Conservation efforts struggle to meet the needs of growing populations and still protect the forests. Community leaders continue to educate about conservation and biodiversity, but also work to develop plans to generate income for cash crops such as nuts, vanilla, and coffee to fend off large agricultural and extraction industries that clear out forests and scar the land.

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Case Study Capture Sheet

ANSWER KEY **Do not share with students**

Continued

3 What happened in the case study, from your stakeholder's viewpoint? For example, what is working well? What could be improved?	Community members have worked to preserve biodiversity and traditional land use in the rainforest as the forest is seen as essential for life. As the population has grown, community leaders have had to balance the need for income with the negative effects that using natural spaces and resources cause, such as deforestation or damage from developing infrastructure (like roads). Without the help of government and other collaborators, community leaders may feel up against an impossible situation of surrendering resources to clear cutting and degradation of land and natural habitats or standing in the way of progress and economic development that can affect community members.
4 Analyze your source's motivations and credibility. For example, are their references credible? Why did they create this document? Who is the target audience for this document?	The author wrote this piece for the California Academy of Sciences. It is noted that she is interested in "the intersection of people and the natural world." The author's motivation for this piece is to show the complicated interactions between traditional, Indigenous groups, and non-Indigenous groups living together in a modern world. When groups of people have different belief and value systems, collaborating in ways that are equitable (fair and appropriate according to the needs of each different group) can be challenging. A "win" for one group may be a "loss" for another group or ecosystem.

Case Study Capture Sheet

ANSWER KEY **Do not share with students**

Continued

Answer for the Local Government Stakeholder.

Your Source	*Your Stakeholder*
Where the Rainforest Meets the Road biographic story by Kate Schimel	Local Government

1 Stakeholder related call outs found when skimming the source document Use Stakeholder Perspective Profile Cards.	Income can be made from logging, gold mining, and oil palm plantations, but this will impact conservation of biodiversity. Indigenous residents want to preserve biodiversity and traditional ways of life, but also recognize the need for income. Local governments must work with the 152 clans that hold land in a traditional land ownership system. It is difficult to protect the environment by regulating outside companies that extract natural resources.
2 How does your stakeholder interact and collaborate with other roles at this particular field site? For example, what is working well? What sources of conflict are there, if any?	Conservation at times clashes with the interest in opening up lands as population growth continues. Local leaders (including Indigenous community members) have fought for fair compensation for logging and oil palm. Forest assessments were conducted to determine the cost of plants, animals, and other natural resources lost if not protected and used sustainably. Conflicts over land use (barring protected lands from development or opening up protected lands to new uses) have stirred conflicts among people living in the region. When people become frustrated with limitations or are suffering from a lack of resources, they might ignore regulations.

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Case Study Capture Sheet

ANSWER KEY **Do not share with students**

Continued

3 What happened in the case study, from your stakeholder's viewpoint? For example, what is working well? What could be improved?	Protecting the interests of the 152 clans in the country and working with landowners who wish to manage land using traditional, sustainable methods requires local governments to regulate outside access from foreign companies who seek resources. With population growth, there are challenges with balancing economic, infrastructure (such as roads), and social service (such as healthcare) needs and protecting natural lands and resources.
4 Analyze your source's motivations and credibility. For example, are their references credible? Why did they create this document? Who is the target audience for this document?	The author wrote this piece for the California Academy of Sciences. It is noted that she is interested in "the intersection of people and the natural world." The author's motivation for this piece is to show the complicated interactions between traditional, Indigenous groups, and non-Indigenous groups living together in a modern world. When groups of people have different belief and value systems, collaborating in ways that are equitable (fair and appropriate according to the needs of each different group) can be challenging. A "win" for one group may be a "loss" for another group or ecosystem.

Case Study Capture Sheet

ANSWER KEY **Do not share with students**

Continued

Answer for the Scientist or Conservation Group Stakeholder.

Your Source	*Your Stakeholder*
Where the Rainforest Meets the Road biographic story by Kate Schimel	Scientist or Conservation Group

1	Stakeholder related call outs found when skimming the source document Use Stakeholder Perspective Profile Cards.	A scientist would be concerned with conserving species such as the birdwing butterfly that are threatened by habitat loss due to resource use. Scientists and conservation groups can help local communities develop and maintain conservation areas and work with local leaders.
2	How does your stakeholder interact and collaborate with other roles at this particular field site? For example, what is working well? What sources of conflict are there, if any?	Biologists have conducted field expeditions in the region and noted new species and suspect many more could be identified. Numerous conservation groups (which include anthropologists and other scientists) supported community leaders with conservation efforts. Smaller groups have developed smaller conservation areas, but larger efforts have not always been successful—maintaining relationships across different stakeholder groups can be difficult.

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Case Study Capture Sheet

ANSWER KEY **Do not share with students**

Continued

3 What happened in the case study, from your stakeholder's viewpoint? For example, what is working well? What could be improved?	Scientists and conservation groups documented biodiversity in the region, noting new species and the likelihood of more. They worked with local Indigenous community members to help create conservation areas. Often the conservation groups are not local, but international. It was noted that when NGOs (non-government organizations) do not work closely enough and maintain positive relationships with local governments, efforts fall apart when developing conservation areas.
4 Analyze your source's motivations and credibility. For example, are their references credible? Why did they create this document? Who is the target audience for this document?	The author wrote this piece for the California Academy of Sciences. It is noted that she is interested in "the intersection of people and the natural world." The author's motivation for this piece is to show the complicated interactions between traditional, Indigenous groups and non-Indigenous groups living together in a modern world. When groups of people have different belief and value systems, collaborating in ways that are equitable (fair and appropriate according to the needs of each different group) can be challenging. A "win" for one group may be a "loss" for another group or ecosystem.

Case Study Capture Sheet

ANSWER KEY **Do not share with students**

Continued

Answer for the Multinational Company and Stockholders Stakeholder.

Your Source	*Your Stakeholder*
Where the Rainforest Meets the Road biographic story by Kate Schimel	Multinational Company and Stockholders this could be a foreign biotechnology company if the target resource was a medicinal plant

1	Stakeholder related call outs found when skimming the source document Use Stakeholder Perspective Profile Cards.	This stakeholder group would be interested in identifying resources that can be extracted, developed, and could earn profit. Cooperation and collaboration with local governments and indigenous communities would be very important to protect the local environment and all inhabitants. In this article, the stakeholder group that is similar to the role of a biotechnology company and its stockholders is represented by major industries such as oil palm, natural gas, and logging, as well as the multinational companies that are a part of those industries.
2	How does your stakeholder interact and collaborate with other roles at this particular field site? For example, what is working well? What sources of conflict are there, if any?	Large industries (in this article, represented by multinational companies interested in oil palm, logging, and natural gas) have cut into forests and cleared out entire hillsides. This has caused violence, cut off access to services like healthcare, and resources such as timber have been harvested illegally and exported. Oil palm has been sought after as biofuel, but this is causing deforestation at an alarming rate, contributing to climate change, habitat loss, and the inability for locals to grow their traditional foods.

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Case Study Capture Sheet

ANSWER KEY **Do not share with students**

Continued

3 What happened in the case study, from your stakeholder's viewpoint? For example, what is working well? What could be improved?	This is a region with a lot of natural resources. It lacks infrastructure that can be provided by outside companies developing industries like logging, palm oil, and natural gas that could benefit everyone. Valuable resources in conservation areas are off limits, but the demand for them globally is high and a lot of profit could be made. The community would be able to benefit financially. Regulations protecting natural areas of biodiversity would need to be relaxed or loosened, opening up more lands to outside development.
4 Analyze your source's motivations and credibility. For example, are their references credible? Why did they create this document? Who is the target audience for this document?	The author wrote this piece for the California Academy of Sciences. It is noted that she is interested in "the intersection of people and the natural world." The author's motivation for this piece is to show the complicated interactions between traditional, Indigenous groups and non-Indigenous groups living together in a modern world. When groups of people have different belief and value systems, collaborating in ways that are equitable (fair and appropriate according to the needs of each different group) can be challenging. A "win" for one group may be a "loss" for another group or ecosystem.

Stakeholder Case Study Jigsaw Information Capture Sheet

ANSWER KEY **Do not share with students**

Directions
Use this document to record the various perspectives of all stakeholders from your case study information source.

1. Record the perspective of each stakeholder in your group according to your case study information source by completing the table below.

Your Source	*Your Stakeholder Perspective*
Where the Rainforest Meets the Road biographic story by Kate Schimel	Answers will vary.

A Stakeholder Name — Multinational Companyand Stockholder

1	Interest and Concerns Brief summary of what is important to this stakeholder	This stakeholder group would be interested in identifying resources that can be extracted, developed, and could earn profit. Cooperation and collaboration with local governments and indigenous communities would be very important to protect the local environment and all inhabitants.
2	Outcomes Summary of outcomes noted in information source	Large industries (in this article, represented by multinational companies interested in oil palm, logging, and natural gas) have cut into forests and cleared out entire hillsides. This has caused violence, cut off access to services like healthcare, and resources such as timber have been harvested illegally and exported.
3	Trade-offs Summary of tradeoffs identified in information source	Possible answers: — Some potential profits being redirected to conservation efforts — Some areas with valuable resources remaining protected; no extraction of resources — Meeting demands for more fair compensation for extracted resources

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Stakeholder Case Study Jigsaw Information Capture Sheet

ANSWER KEY **Do not share with students**

Continued

B Stakeholder Name Indigenous Community Member

1	Interest and Concerns Brief summary of what is important to this stakeholder	These stakeholders are concerned about conservation of species, want to continue traditional land use practices and protect sacred lands (such as ancestral burial sites), but also need funds for schools and medical expenses for villagers. Oil palm plantations and logging operations have cut into local forest space. Papua New Guinea is inhabited by 152 different clans that have existed for approximately 50,000 years.
2	Outcomes Summary of outcomes noted in information source	These stakeholders voted for a community-driven conservation effort allowing sustainable agriculture, some infrastructure (roads), but realized the need to balance resident's needs for services requiring income. Conservation efforts struggle to meet the needs of growing populations and still protect the forests. Community leaders continue to educate about conservation and biodiversity, but also work to develop plans to generate income for cash crops such as nuts, vanilla, and coffee to fend off large agricultural and extraction industries that clear out forests and scar the land.
3	Trade-offs Summary of tradeoffs identified in information source	Possible answers: — Negotiating land use and allowing for some infrastructure to be created — Negotiating with local government to maintain traditional land use practices

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Stakeholder Case Study Jigsaw Information Capture Sheet

ANSWER KEY **Do not share with students**

Continued

C Stakeholder Name Local Government

1	Interest and Concerns Brief summary of what is important to this stakeholder	Government understands that income can be made from logging, gold mining, oil palm plantations, but this will impact conservation of biodiversity. Indigenous residents want to preserve biodiversity and traditional ways of life, but also recognize the need for income. Local governments must work with the 152 clans that hold land in a traditional land ownership system. Regulating outside companies extracting natural resources to protect the environment and its inhabitants is challenging.
2	Outcomes Summary of outcomes noted in information source	Conservation at times clashes with the interest in opening up lands as population growth continues. Local leaders (including Indigenous community members) have fought for fair compensation for logging and oil palm. Forest assessments were conducted to determine the cost of natural resources lost if not protected and used sustainably. Conflicts over land use (barring protected lands from development or opening up protected lands to new uses) have stirred conflicts among people living in the region. When people become frustrated with limitations or are suffering from a lack of resources, they might ignore regulations.
3	Trade-offs Summary of tradeoffs identified in information source	Possible answers: — Allowing certain infrastructure to be created may have environmental impacts — Negotiations with Indigenous residents will require some concessions to meet conservation needs but also income needs

Continues next page >

Stakeholder Case Study Jigsaw Information Capture Sheet

ANSWER KEY **Do not share with students**

Continued

D Stakeholder Name Scientist

1	Interest and Concerns Brief summary of what is important to this stakeholder	A scientist would be concerned with the conservation of species lost due to habitat loss (such as the birdwing butterfly) caused by the taking of resources. Scientists and conservation groups can help local communities develop and maintain conservation areas and work with local leaders.
2	Outcomes Summary of outcomes noted in information source	Scientists and conservation groups documented biodiversity in the region, noting new species and the likelihood of more. They worked with local Indigenous community members to help create conservation areas. Often the conservation groups are not local, but international. It was noted that when NGOs (non-government organizations) do not work closely enough and maintain positive relationships with local governments, efforts fall apart when developing conservation areas.
3	Trade-offs Summary of tradeoffs identified in information source	Achieving goals may be difficult when negotiations with non-local groups become complicated. Some habitat loss will occur to accommodate infrastructure that may be necessary to support the local economy.

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Stakeholder Case Study Jigsaw Information Capture Sheet

ANSWER KEY **Do not share with students**

Continued

2. Share the outcomes and tradeoffs for your stakeholder perspective with stakeholders across different case study groupings in your class. Prepare by filling the table below.

	Stakeholder Name	Indigenous Communities	Local Governments	Multinational Companies and Stockholder Groups	Scientists and Conservation Groups
1	Patterns Seen in the Outcomes	Continually try to balance traditional practices with the need to generate income without harming the natural environment.	Continually try to accommodate the need for a growing economy but also the needs of numerous Indidgeous clans and communities attempting to practice and preserve traditional lifeways.	Must work with local governments and Indigenous communities to successfully cooperate and collaborate when looking to extract natural resources.	Can help local communities develop and maintain conservation areas and work with local leaders.
2	Patterns Seen in the Trade-offs	Previous actions in different regions have led to knowledge being taken without consent or compensation.	Local governments try to regulate the actions of companies from the outside.	Previous actions in different regions have led to violence, conflict, and mistrust among stakeholder groups.	Facilitating discussions and providing scientific information and resources may help develop shared understanding of the risks of habitat and species loss.
3	Unique Interactions or Collaborations Any standouts in your case study	Answers may vary.	Answers may vary.	Answers may vary.	Answers may vary.

Best Practices for Ethical Collaboration Capture Sheet

ANSWER KEY **Do not share with students**

Directions

Throughout Lesson 2, you have examined interactions between various stakeholders seeking access to genetic resources, from scientists and biotechnology companies, to local governments and the indigenous communities who are deeply connected to these resources.

1. Review and reflect on prior learnings.

   The patterns found in outcomes and tradeoffs seen through stakeholder lenses

   The complexities involved in commercializing natural compounds and patenting intellectual property

   The protections given indigenous communities and their traditional ecological knowledge

   The variety of benefits that can be shared among stakeholder groups of varying language, governmental, and belief systems

2. Next, pitch a plant-based medicine to target a specific disease involving the different stakeholder groups you have learned about.

   How should learnings from Lesson 2 shape stakeholder interactions in this process?

   What are the key "Rules of Engagement" for ethical collaboration among scientists, biotechnology companies, local governments, and the indigenous communities that have held traditional ecological knowledge about medicinal properties of plants for centuries?

   Agree position and the Disagree position. Cite specific examples from case studies where relevant.

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Best Practices for Ethical Collaboration Capture Sheet

ANSWER KEY **Do not share with students**

Continued

	Best Practices for Ethical Collaboration	Relevant Case Studues
1	Protection of resources in biodiversity hotspots during the timeline of drug development and beyond (future maintenance) should frame the process.	Our planetary systems function when in balance with each other. Maintaining biodiversity keeps our ecosystems healthy and functioning, protecting natural resources for the future.
2	Obtaining prior informed consent from local governments and Indigneous communities before acquiring traditional ecological knowledge (TEK)	Indigneous communities have held and used TEK forcenturies. Ethical collaboration means ensuring that all groups understand the purpose of interactions and conversations involving TEK before they happen.
3	Obtaining prior informed consent from local governments and Indigneous communities before accessing genetic resources	Many natural resources have spiritual significance to Indigenous communities. Permission for access to and acquisition of these resources needs to take this significance into consideration.
4	Obtaining prior informed consent must be done in a method inclusive of involving communities with different language and belief systems.	Working with local and Indigenous communities may mean interacting with groups who have very different language, culture, and belief systems. These belief systems must be accommodated when obtaining prior informed consent to ensure that all groups understand the collaboration terms.
5	Benefit sharing legislation and policy involving genetic resources and TEK should be based on equitable and mutually agreed upon terms appropriate to the stakeholders' economy, and account for future applications.	Benefits for TEK and genetic resources need to be agreed upon in advance to ensure that any benefits provided are usable and meaningful to all stakeholder groups.
6	Customs and protocols of Indigenous and local communities must be considered when upholding protective regulations involving TEK and genetic resources.	In addition to local laws and the Nagoya protocol protections, Indigenous community customs and laws must also be considered when accessing resources.
7	Benefit sharing should be directed back into conservation and sustainability efforts for the involved region.	Benefits—for example, financial—should be applied to the local region of the sought-after resource to protect biodiversity and promote long term sustainability.
8	Benefit sharing should include monetary and non-monetary compensation. Non-monetary benefits include things like joint ownership of IP, support for local economies and livelihoods, conservation practices, and recognition.	For some communities, providing only traditional financial benefits may not be useful. Some groups may prefer reinvestments that promote the economy or shared IP ownership.

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History of Aspirin Capture Sheet

Directions

Use this notes sheet to record general information about the stakeholders in the history of aspirin activity.

1. In two or three sentences, summarize the actual development of aspirin.

2. In two or three sentences, summarize the alternative timeline of aspirin development that you formulated.

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History of Aspirin Capture Sheet

Continued

3. Brainstorm: How did the two stakeholders listed below benefit from the development of aspirin? List benefits in the actual timeline and your brainstormed alternative timeline.

Stakeholder	How They Benefitted	Discussion Notes
Indigenous Communities		
Pharmaceutical Companies and Shareholders		

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History of Aspirin Capture Sheet

Continued

4. Imagine going back in time and being part of the team who developed and patented aspirin. How might you decide to engage different stakeholders? What might you do to change the future?

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Who Owns That? Capture Sheet

Directions

With a partner or table group, discuss what you think intellectual property (IP) is. Can you think of an example to describe your ideas?

To get your thinking started, IP is defined as:

Creative ideas and expressions of the human mind that have commercial value and are entitled to the legal protection of a property right.

The major legal mechanisms for protecting intellectual property are copyrights, patents, and trademarks. IP rights enable owners to select who may access and use their intellectual property and to protect it from unauthorized use.

Source: *ipHandbook of Best Practices*

What "kinds" of information allow businesses to make a profit? For example, if you wrote a song, are the words and arrangement of the musical notes for the different instruments intellectual property?

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Who Owns That? Capture Sheet

Continued

1. Read the scenario below and consider the questions.

	Scenario	What is the intellectual property?	Who are the stakeholders?
a	A well-known T-shirt manufacturer created a logo that is used on T-shirts produced in another county. Who should get the profits for the sales of the T-shirts? Is intellectual property being appropriated?	*Example: The T-shirt could be the IP, or the logo design could be the IP.*	*Example: The T-shirt manufacturer and the logo designer.*
b	A television program uses a plot and characters very similar to another show. Should the program obtain permission to use the copyrighted elements of the original show? Why or why not? Is intellectual property being appropriated?		
c	An architect copies the design of a building and sells it to a client. What should be done? Who should pay? Is intellectual property being appropriated?		
d	Scientists isolate a gene mutation that causes a particular condition. Other organizations want access to this information for further research, including potential therapies. Should the scientists be able to control or patent this discovery? Is it their intellectual property?		

Source: *US Department of State's Intellectual Property: Yours, Mine and Ours.*

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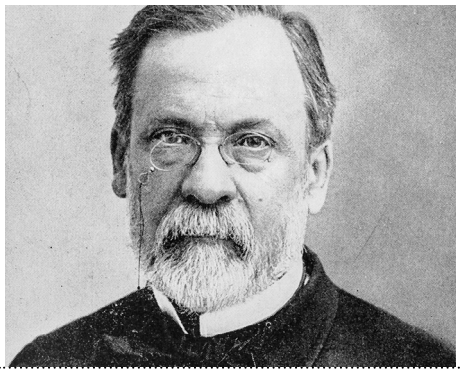
Who Owns That? Capture Sheet

Continued

2. Read the following paraphrased summary of The Complications Around Patenting Biotechnology.



Louis Pasteur patented a new yeast-making method in 1873.

Advances in biotechnology might not have been possible without intellectual property laws known as patents. In 1873, microbiologist Louis Pasteur patented a new yeast-making method at the French Patent Office in what would later become known as pasteurization. A few examples of patented products and procedures that save lives are insulin, blood transfusions, anti-cancer drugs, and autoimmune drugs. Despite their critical role in the field of biotechnology, patenting laws are an extremely complicated process behind scientific advancements. Biotechnology patents are considered utility patents, which are available for the discovery of new and useful machines, manufacturing processes, composition of matter. These patents are also available for improvements for existing processes that are considered new and useful. When an inventor applies for a patent, they must demonstrate that their creation meets certain eligibility requirements. In the United States, the US Patent & Trademark Office set five elements for patentability. To qualify, an invention must fall under subject-matter eligibility, have utility and novelty, be non-obvious, and have not been previously disclosed. In Europe, the European Patent Office states that a patentable invention can be a product process or an apparatus. To be eligible for a patent, an invention must be "new, industrially applicable, and involve an inventive step." When different EU member states apply for patents with the European Patent Office, their patent receives national validation in every state part of the European Patent Convention.

In biotechnology, the biggest challenge in patenting a biotechnology product is demonstrating that it is a biotechnology product and not a natural one. The inventor must also demonstrate that their invention is first in the world to do its specified action. The patentability of biological materials is often a source of controversy for that reason. Some argue that biological materials are mere discoveries and cannot be patented, while others assert that some biological materials are human-made inventions and can be patented.

Another source of complexity is from the fact that biological material is capable of reproducing itself. Genetics often lies at the center of patentability controversy. A key legal case in the field took place in 2013 against Myriad Genetics. The company had a series of patents involving two genes that are linked to a high risk of developing breast cancer, giving them exclusive control over research and diagnostics involving these genes.

Similarly, the gene-editing tool CRISPR-Cas9 has been the center of controversial patent disputes. In this case, two entities applied for patents: the Broad Institute and the University of California, Berkeley, sought to claim the rights to commercialize products developed with the gene-editing tool. The decisions of the US and European patent offices wildly differ. In the United States, the Broad's Institute patents were upheld over the University of California, whereas in Europe some of the Broad Institute's key CRISPR patents have been revoked.

The business models of most biotechnology companies rely heavily on intellectual property rights with patents often being their most important asset owned. Strong intellectual property position helps minimize risk for investors. Patents demonstrate that a company has the freedom to commercialize its product without infringing on the intellectual property rights of other companies. Understanding the complications and limitations of biotechnology patnest is essential to the field of biotechnology and the rate of innovation.

Source: Labiotech.eu's *The Complications Around Patenting Biotechnology and Oyez's Association for Molecular Pathology v. Myriad Genetics.*

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Who Owns That? Capture Sheet

Continued

3. Answer the following questions about the reading.

a What is necessary for a utility patent in the United States?

1

2

3

b What is necessary to be eligible for a patent in the European Union?

1

2

3

c How do the requirements of the United States and the European Union differ?

d According to the article, what are three complexities, or "grey areas" that can make patenting biological materials challenging?

1

2

3

Continues next page >

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Who Owns That? Capture Sheet

Continued

e Break down the Myriad and CRISPR example:

Who are the stakeholders involved in this case?

What is the story behind the case?

Describe the outcome of the case:

f How do patents protect the intellectual property of biotechnology companies?

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Stakeholder Perspective Profile Cards

Directions
Review these cards to understand key interests involved in researching, obtaining and developing plant-based medicines.

Indigenous Community Representative

Interests

Being recognized as part of the land and ecosystems, living as a part of the environment and managing their local surroundings sustainably for the future, sustainable survival, independence from outside groups and systems, fair and agreed upon type of compensation for knowledge.

Concerns

Protecting natural resources that may have spiritual significance, outsiders who may not understand or respect their cultural systems, loss of biodiversity, resources acquired without consent, unintended consequences related to a discovery.

Government

Interests

Compensation for resources and knowledge, intellectual property rights, job creation.

Concerns

Loss of biodiversity and resources, inadequate or unfair compensation for resources and knowledge, regulatory and permitting requirements not properly followed, intellectual property rights.

Scientist (researcher, botanist, ethnobotanist)

Interests

Protection of ecosystems and biodiversity, documentation and knowledge of biodiversity and resources, publication and authorship, replicating testing results.

Concerns

Loss of biodiversity, unethical treatment of indigenous communities. Domestic local scientists and international scientists may hold different perspectives.

Biotechnology Company and Stockholders

Interests

Acquiring knowledge of bioactive plant compounds, following local government regulations with necessary permits to acquire plant material, successful development of plant-based medicines, obtaining patents of plant compounds.

Concerns

Differing cultural and value systems creating roadblocks, timeline of drug development, replicating testing results.

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Case Study Capture Sheet

Directions

The source you are about to read is technical and challenging. The task is not to read every word, but to examine the document to construct a narrative from a particular point of view. Document bullet-pointed summaries from the perspective of your stakeholder. You can skim, focus on particular sections of high relevance, or use other reading strategies to accomplish the task in the time allotted.

Your Source	*Your Stakeholder Perspective*

1 Stakeholder related call outs found when skimming the source document Use Stakeholder Perspective Profile Cards.	
2 How does your stakeholder interact and collaborate with other roles at this particular field site? For example, what is working well? What sources of conflict are there, if any?	

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Case Study Capture Sheet

Continued

3 What happened in the case study, from your stakeholder's viewpoint? For example, what is working well? What could be improved?	
4 Analyze your source's motivations and credibility. For example, are their references credible? Why did they create this document? Who is the target audience for this document?	

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Extension Option Capture Sheet

Case Study Table for Primary Sources

Directions

As a group, use one of the primary source links below to complete the assignment.

Location	Primary Source Link	Summary
Ecuador	*Biopiracy or fallacy? Identifying genuine biopiracy cases in Ecuador* *Global Biopiracy: Patents, Plants, and Indigenous Knowledge* *Indigenous Knowledge, Intellectual Property and Biopiracy: Is a Global Bio* *International biopiracy versus the value of local knowledge* *Synergy Between Traditional Ecological Knowledge and Conservation Science Supports Forest Preservation in Ecuador*	The Ecuadorian Working Group on Prevention of Biopiracy (EWGPB) was set up to use the legal system to thwart biopiracy. They analyze complaints to determine the legal case for biopiracy, and identify options for legal actions. They also bring awareness to the public about these challenges through videos, news and reports. Some examples of the cases the EWGPB focused on include the Andean bean, Amazonian frog, and medicinal plants in the Awa Reserve.
Columbia	*Use, management and local ecological knowledge of Sabal mauritiiformis in the Colombian Caribbean* *Intellectual Property in European Union Economic Partnership Agreements with the African, Caribbean and Pacific Countries: What way Forward after the Cariforum EPA and the interim EPAs?*	The leaves of palms in the genus *Sabal* have been used for thatching in the Caribbean for over a thousand years. In Colombia, *Sabal mauritiiformis* have been used since pre-Hispanic times. Indigenous communities, such as the Zenu people, still use these leaves because of their beauty and durability. The growth of tourism on the northern beaches of Colombia has popularized facilities thatched with *S. mauritiiformis*. Users must obtain permission for the use and extraction of these leaves, providing a balance between conservation of the plant and market optimization.
Madagascar	*Conservation and Environmental Management in Madagascar* *Land and languor: ethical imaginations of work and forest in northeast Madagascar* *Madagascar —Main Details; Case Studies in Biopiracy Pharms and Farmers*	Traditional ecological knowledge of medicinal plants in Madagascar is divided into two groups, specialist/spiritual plant knowledge and nonspecialist/secular medicinal plant knowledge. Human practices, such as the clearing of natural habitats and overexploitation of natural resources, have devastated flora and fauna, and are the leading cause of biodiversity degradation. In 1996, the National Strategy for Sustainable Management of Biodiversity (NSSMB) was established to improve the living conditions of the entire population, to be involved in the development process including international trade, and to support feasible alternatives.

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Extension Option Capture Sheet

Case Study Table for Primary Sources

Continued

Location	Primary Source Link	Summary
California	*California rice breeder pursues his passion* *Hybrid wild rice production utilizing cytoplasmic—genetic male sterility system* *The Taming of a Grain—The Story of California Wild Rice*	Ron Phillips of the University of Minnesota has completed the genome for Wild Rice. This information is important for the genetic and crop improvement studies using genetic tools such as cloning. NORCAL Wild Rice of California has patented Wild Rice using the improved commercial production. Indigenous people are exploring options to stem the patenting and genetic alteration of Wild Rice in fear that genetically altered plants will contaminate naturally occurring beds and undercut naturally harvested Wild Rice.
New Zealand	*Global Biopiracy Patents, Plants, and Indigenous Knowledge* *Bioprospecting ... or biopiracy? : access to biological diversity and benefit sharing in the New Zealand context* *Bioprospecting Policy Framework*	The Mataatua Declaration on the Cultural and Intellectual Property Rights of Indigenous Peoples was established by nine Indigenous nations in New Zealand. Numerous products and applications such as medicines, cosmetics, and adhesives, owe their development to bioprospecting in the Bay of Plenty region. This group would like to provide scientists and industry access to traditional knowledge on the uses of plants through an ethical process that compensates for the knowledge. These types of innovations could have a great impact on New Zealand's economy and its residents.
Hawaii	*SB1425—Hawaii State Legislature* *Native Hawaiian Law Summaries: Selected Recent Law Review Articles* *Say No To GMO Bananas in Hawaii*	Senate Bill Number 1425 prohibits further bioprospecting and biopiracy in Hawaii until proper regulations of these practices are put into place. Papaya farmers rapidly adopted genetically engineered papayas without the necessary protections in place, leading to genetic pollution of natural papayas. The Hawaiian Department of Agriculture is seeking approval to being trials of genetically engineered bananas on the islands, but fears that these would have a similar negative impact have been expressed.

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Extension Option Capture Sheet

Case Study Table for Primary Sources

Continued

Location	Primary Source Link	Summary
Indonesia	*Indonesia's strict new biopiracy rules could stifle international research* *Protecting Indonesia from biopiracy* *Indonesia steps up fight against biopiracy*	Indonesia has passed a new law to protect the country's natural resources from biopiracy, which is often associated with seeking patents to restrict their natural or general use. Indonesia's Ministry of Environment estimates that the country's medicinal plants alone are worth US $14.6 billion if they were marketed as finished products. The new law seeks to cover biodiversity materials, local specimens, social or cultural assets, material transfer agreements to take samples overseas for research, prohibitions on removal of or damage to biodiversity samples, rights to take criminal action by the government, and punishing or blacklisting foreign researchers who steal biodiversity samples.
Peru and Ecuador	*Traditional ecological knowledge and biodiversity management in the Andes of southern Ecuador* *Protecting Indigenous Knowledge against Biopiracy in the Andes*	The geographic complexity of Peru and Ecuador has led to these regions being consider some of the most diverse areas in the world. The Indigenous peoples near the Andes developed unique methods to promote the agricultural diversity of specific species, including potato, olluco, quinoa, and pajero. Despite a lack of protection at the national level, the International Convention on Biological Diversity and Convention 169 are two agreements that help to protect and benefit Andean civilizations' proprietary knowledge.
Asia-Pacific	*Plan to amend biopiracy rules would 'smother research,' biologists warn* *French institute agrees to share patent benefits after biopiracy accusations* *Traditional knowledge of biodiversity in Asia-Pacific: Problems of piracy and protection*	Over the past few decades, an immense amount of genetic information has been gathered by scientists from all around the planet and made available to the public for study or use. In efforts to protect biological information and knowledge, proposed changes to the Nagoya Protocol would require a country to request approval prior to utilizing gene sequences of animals and plants available to the public. Those opposed to these measures are worried that such protocols would stifle research that would greatly benefit humanity.

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Extension Option Capture Sheet

Case Study Table for Primary Sources

Continued

Location	Primary Source Link	Summary
Himalayas	*Biopiracy: Distrust Widens the Rich-Poor Divide* *Current status of ethnomedicinal plants in the Darjeeling Himalaya* *Bioprospecting in Garhwal Himalayas, Uttarakhand*	In 1994, the United States Department of Agriculture and the company W. R. Grace received a patent for a substance created from the seeds of the neem tree *(Azadirachta indica)* that prevents fungus growth. Six years later, the European patent office revoked that patent. Modern science can help to identify the bioactive compounds in medicinal plants by using mass spectrophotometry. This would also help to document traditional knowledge and practices. However, many countries are opposed to this practice, calling it biopiracy. They are concerned that doing so could undermine the livelihoods of farmers in developing countries.
Brazil	*The Dilemma of Plant Knowledge and Compensation for Native People Living in Brazilian Biomes* *Local ecological knowledge and its relationship with biodiversity conservation among two Quilombola groups living in the Atlantic Rainforest, Brazil* *Engaging Indigenous and academic knowledge on bees in the Amazon: implications for environmental management and transdisciplinary research*	The Amazon rainforest and coastal Atlantic Forest are Brazilian areas with a large amount of biodiversity. The peoples that have lived in these areas have learned to cultivate the land and its natural resources. There has been rising tension between the interests of the governments, scientists and local populations for the protection and use of this knowledge. As an example of the costs companies may face when attempting to access the resources that Brazilian forests offer, the Brazilian government fined cosmetic company Natura 21 million reais (~$4.5 million) for improper use of native Brazilian genetic material.
Philippines	*PHL biodiversity under siege from biopirates* *Companies Rush To Patent Wildlife Of The Philippines—OpEd*	Abelardo Aguilar, a Filipino scientist working for the American drug company Eli Lilly, isolated an antibiotic from a microorganism in soil. He chose its name, Ilosone, after the town the soil was sourced from, Iloilo. Eli Lilly got a patient for Ilosone and used it to produce erythromycin, an extremely well known antibiotic used around the world that earns Eli Lilly $120 million annually. Aguilar did not receive compensation for his discovery.

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Extension Option Capture Sheet

Case Study Table for Primary Sources

Continued

Location	Primary Source Link	Summary
Turkey	*Biopiracy of Turkey's purple carrot* *French institute agrees to share patent benefits after biopiracy accusations* *Biopiracy: When corporations steal Indigenous practices and patent them for profit*	In southern Turkey, one can purchase carrots in a wide variety of colors. Monsanto, a large agriculture company, had hopes to cultivate and market purple carrots, believing customers would be attracted to the healthy aspects associated with the natural plant pigments. The company was able to use various techniques to create the purple carrot, receiving rights to it and its varieties, demonstrating the ease to which someone could gain rights to another's seed.

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Stakeholder Case Study Jigsaw Information Capture Sheet

Directions
Use this document to record the various perspectives of all stakeholders from your case study information source.

1. Record the perspective of each stakeholder in your group according to your case study information source by completing the table below.

Your Source	*Your Stakeholder Perspective*

A Stakeholder Name

1	Interest and Concerns Brief summary of what is important to this stakeholder	
2	Outcomes Summary of outcomes noted in information source	
3	Trade-offs Summary of tradeoffs identified in information source	

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Stakeholder Case Study Jigsaw Information Capture Sheet

Continued

B Stakeholder Name

1	Interest and Concerns Brief summary of what is important to this stakeholder	
2	Outcomes Summary of outcomes noted in information source	
3	Trade-offs Summary of tradeoffs identified in information source	

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Stakeholder Case Study Jigsaw Information Capture Sheet

Continued

C Stakeholder Name

1	Interest and Concerns Brief summary of what is important to this stakeholder	
2	Outcomes Summary of outcomes noted in information source	
3	Trade-offs Summary of tradeoffs identified in information source	

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Stakeholder Case Study Jigsaw Information Capture Sheet

Continued

D Stakeholder Name

1	Interest and Concerns Brief summary of what is important to this stakeholder	
2	Outcomes Summary of outcomes noted in information source	
3	Trade-offs Summary of tradeoffs identified in information source	

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Stakeholder Case Study Jigsaw Information Capture Sheet

Continued

2. Share the outcomes and tradeoffs for your stakeholder perspective with stakeholders across different case study groupings in your class. Prepare by filling the table below.

Stakeholder Name

1	Patterns Seen in the Outcomes	
2	Patterns Seen in the Trade-offs	
3	Unique Interactions or Collaborations Any standouts in your case study	

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Philosophical Chairs Capture Sheet

Directions
Follow the steps below to have a philosophical chairs discussion about the ramifications of resource extraction.

1. Determine a Central Discussion Statement with your teacher and record it below.

_____

_____

_____

_____

2. Read your Central Discussion Statement and, using key learnings from Lesson 2, prepare for the Student Discussion by recording all arguments for both the Agree position and the Disagree position. Cite specific examples from case studies where relevant.

Agree Position

	Argument	Relevant Case Studues
1		
2		
3		

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Philosophical Chairs Capture Sheet

Continued

Disagree Position

	Argument	Relevant Case Studues
1		
2		
3		

Continues next page >

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Philosophical Chairs Capture Sheet

Continued

3. Review the Philosophical Chairs Rules of Engagement listed below.

Philosophical Chairs Rules of Engagement

1	Be sure you understand the central statement or topic before the discussion begins. Decide which section you will sit in (Agree side or Disagree side).
2	Listen carefully when others speak and seek to understand their statements even if you don't agree.
3	Wait for the mediator to recognize you before you speak; only one person speaks at a time.
4	You must first summarize briefly the previous speaker's argument before you make your response.
5	If you have spoken for your side, you must wait until three other people on your side speak before you speak again.
6	Be sure that when you speak, you address the ideas, not the person stating them.
7	Keep an open mind and move to the other side or the undecided section if you feel that someone made a good argument or your opinion is swayed.
8	Support the mediator by maintaining order and helping the discussion progress.

4. After reviewing the Philosophical Chairs Rules of Engagement, the Student Discussion begins. As students begin speaking and sharing their position, you are free to quietly switch sections or move to an undecided section.

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Philosophical Chairs Capture Sheet

Continued

5. Reflect on the main points of the philosophical chairs discussion in a post-discussion Free-Write.

Questions to Consider

1	What points or perspectives that you heard resonated with you?
2	What points or perspectives that you heard did you disagree with?
3	What points or perspectives that you heard feel like they need to be further explored?
4	What points or perspectives did you feel like you did not hear about that should be considered?

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Nagoya Protocol Article Excerpts

Directions
Skim these excerpts and consider: What regulations guide collaborations with Indigenous communities and their traditional ecological knowledge (TEK) and resources?

Article 5

Summary

Legislative/administrative/policy measures will be created and carried out to ensure that genetic resources and traditional ecological knowledge held by idigenous and local communities:

— Are shared based on fair and equitable mutually agreed terms between indigenous communities and outside groups.
— Include monetary benefits as well as non-monetary benefits that are appropriate for the indigenous community involved.
— Include future applications and commercialization.

Excerpt: Fair and Equitable Benefit-sharing

1. In accordance with Article 15, paragraphs 3 and 7 of the Convention, benefits arising from the utilization of genetic resources as well as subsequent applications and commercialization shall be shared in a fair and equitable way with the Party providing such resources that is the country of origin of such resources or a Party that has acquired the genetic resources in accordance with the Convention. Such sharing shall be upon mutually agreed terms.
2. Each Party shall take legislative, administrative or policy measures, as appropriate, with the aim of ensuring that benefits arising from the utilization of genetic resources that are held by indigenous and local communities, in accordance with domestic legislation regarding the established rights of these indigenous and local communities over these genetic resources, are shared in a fair and equitable way with the communities concerned, based on mutually agreed terms.
3. To implement Paragraph 1 above, each Party shall take legislative, administrative or policy measures, as appropriate.
4. Benefits may include monetary and non-monetary benefits, including but not limited to those listed in the Annex.
5. Each Party shall take legislative, administrative or policy measures, as appropriate, in order that the benefits arising from the utilization of traditional knowledge associated with genetic resources are shared in a fair and equitable way with indigenous and local communities holding such knowledge. Such sharing shall be upon mutually agreed terms.

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Nagoya Protocol Article Excerpts

Continued

Article 6

Summary

Access to genetic resources requires prior informed consent from the country of origin, and includes indigenous and local communities when they have rights to such resources. Prior informed consent must be obtained in a timely, clear, and fair manner, and include criteria for how to appropriately involve indigenous and local communities.

Excerpt: Access to Genetic Resources

1. In the exercise of sovereign rights over natural resources, and subject to domestic access and benefit-sharing legislation or regulatory requirements, access to genetic resources for their utilization shall be subject to the prior informed consent of the Party providing such resources that is the country of origin of such resources or a Party that has acquired the genetic resources in accordance with the Convention, unless otherwise determined by that Party.
2. In accordance with domestic law, each Party shall take measures, as appropriate, with the aim of ensuring that the prior informed consent or approval and involvement of indigenous and local communities is obtained for access to genetic resources where they have the established right to grant access to such resources.
3. Pursuant to paragraph 1 above, each Party requiring prior informed consent shall take the necessary legislative, administrative or policy measures, as appropriate, to:
   (a) Provide for legal certainty, clarity and transparency of their domestic access and benefit sharing legislation or regulatory requirements;
   (b) Provide for fair and non-arbitrary rules and procedures on accessing genetic resources;
   (c) Provide information on how to apply for prior informed consent;
   (d) Provide for a clear and transparent written decision by a competent national authority, in a cost-effective manner and within a reasonable period of time;
   (e) Provide for the issuance at the time of access of a permit or its equivalent as evidence of the decision to grant prior informed consent and of the establishment of mutually agreed terms, and notify the Access and Benefit-sharing Clearing-House accordingly;
   (f) Where applicable, and subject to domestic legislation, set out criteria and/or processes for obtaining prior informed consent or approval and involvement of indigenous and local communities for access to genetic resources; and
   (g) Establish clear rules and procedures for requiring and establishing mutually agreed terms. Such terms shall be set out in writing and may include, inter alia:
      (i) A dispute settlement clause;
      (ii) Terms on benefit-sharing, including in relation to intellectual property rights;
      (iii) Terms on subsequent third-party use, if any; and
      (iv) Terms on changes of intent, where applicable.

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Nagoya Protocol Article Excerpts

Continued

Article 7

Summary

Any traditional ecological knowledge about genetic resources obtained from indigenous communities may only be acquired with prior and informed consent from the involved indigenous communities and mutually agreed upon terms in advance.

Excerpt: Access to Traditional Knowledge Associated with Genetic Resources

In accordance with domestic law, each Party shall take measures, as appropriate, with the aim of ensuring that traditional knowledge associated with genetic resources that is held by indigenous and local communities is accessed with the prior and informed consent or approval and involvement of these indigenous and local communities, and that mutually agreed terms have been established.

Article 9

Summary

Benefits that have come from the use of genetic resources should be directed back to conserve the biodiversity of the region that the genetic resources came from and promote sustainability.

Excerpt: Contribution to Conservation and Sustainable Use

The Parties shall encourage users and providers to direct benefits arising from the utilization of genetic resources towards the conservation of biological diversity and the sustainable use of its components.

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Nagoya Protocol Article Excerpts

Continued

Article 12

Summary

When upholding the Nagoya Protocol obligations, the customs and protocols of indigneous and local communities must be considered regarding accessing TEK and genetic resources and the sharing of benefits arising from this knowledge and resources.

Excerpt: Traditional Knowledge Associated with Genetic Resources

1. In implementing their obligations under this Protocol, Parties shall in accordance with domestic law take into consideration indigenous and local communities' customary laws, community protocols and procedures, as applicable, with respect to traditional knowledge associated with genetic resources.
2. Parties, with the effective participation of the indigenous and local communities concerned, shall establish mechanisms to inform potential users of traditional knowledge associated with genetic resources about their obligations, including measures as made available through the Access and Benefit-sharing Clearing-House for access to and fair and equitable sharing of benefits arising from the utilization of such knowledge.
3. Parties shall endeavor to support, as appropriate, the development by indigenous and local communities, including women within these communities, of:
   (a) Community protocols in relation to access to traditional knowledge associated with genetic resources and the fair and equitable sharing of benefits arising out of the utilization of such knowledge;
   (b) Minimum requirements for mutually agreed terms to secure the fair and equitable sharing of benefits arising from the utilization of traditional knowledge associated with genetic resources; and
   (c) Model contractual clauses for benefit-sharing arising from the utilization of traditional knowledge associated with genetic resources.
4. Parties, in their implementation of this Protocol, shall, as far as possible, not restrict the customary use and exchange of genetic resources and associated traditional knowledge within and amongst indigenous and local communities in accordance with the objectives of the Convention.

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Nagoya Protocol Article Excerpts

Continued

Article 15

Summary

All parties involved in the access of genetic resources and related knowledge, and benefit sharing agreements arising from those resources, will ensure that requirements around prior informed consent and mutually agreed upon terms have been followed. In situations where non-compliance has occurred, measures will be taken to address the situation and cooperate regarding any violations.

Excerpt: Compliance with Domestic Legislation or Regulatory Requirements on Access and Benefit-sharing

1. Each Party shall take appropriate, effective and proportionate legislative, administrative or policy measures to provide that genetic resources utilized within its jurisdiction have been accessed in accordance with prior informed consent and that mutually agreed terms have been established, as required by the domestic access and benefit-sharing legislation or regulatory requirements of the other Party.
2. Parties shall take appropriate, effective and proportionate measures to address situations of non-compliance with measures adopted in accordance with paragraph 1 above.
3. Parties shall, as far as possible and as appropriate, cooperate in cases of alleged violation of domestic access and benefit-sharing legislation or regulatory requirements referred to in paragraph 1 above.

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Nagoya Protocol Article Excerpts

Continued

Annex

Summary

Monetary benefits may include payments at different points in the relationship between all stakeholders. Benefits may not only be monetary compensation given directly to a stakeholder group, and can also include things such as joint ownership of intellectual property, training about genetic resources, strengthening of regulation, advancement of conservation practices, support of local economies, support for local food and livelihood security, and recognition.

Excerpt: Monetary and Non-monetary Benefits

1. Monetary benefits may include, but not be limited to:
   - (a) Access fees/fee per sample collected or otherwise acquired;
   - (b) Up-front payments;
   - (c) Milestone payments;
   - (d) Payment of royalties;
   - (e) License fees in case of commercialization;
   - (f) Special fees to be paid to trust funds supporting conservation and sustainable use of biodiversity;
   - (g) Salaries and preferential terms where mutually agreed;
   - (h) Research funding;
   - (i) Joint ventures;
   - (j) Joint ownership of relevant intellectual property rights.

2. Non-monetary benefits may include, but not be limited to:
   - (a) Sharing of research and development results;
   - (b) Collaboration, cooperation and contribution in scientific research and development programmes, particularly biotechnological research activities, where possible in the Party providing genetic resources;
   - (c) Participation in product development;
   - (d) Collaboration, cooperation and contribution in education and training;
   - (e) Admittance to ex situ facilities of genetic resources and to databases;
   - (f) Transfer to the provider of the genetic resources of knowledge and technology under fair and most favorable terms, including on concessional and preferential terms where agreed, in particular, knowledge and technology that make use of genetic resources, including biotechnology, or that are relevant to the conservation and sustainable utilization of biological diversity;
   - (g) Strengthening capacities for technology transfer;
   - (h) Institutional capacity-building;
   - (j) Training related to genetic resources with the full participation of countries providing genetic resources, and where possible, in such countries;
   - (k) Access to scientific information relevant to conservation and sustainable use of biological diversity, including biological inventories and taxonomic studies;
   - (l) Contributions to the local economy;
   - (m) Research directed towards priority needs, such as health and food security, taking into account domestic uses of genetic resources in the Party providing genetic resources;
   - (n) Institutional and professional relationships that can arise from an access and benefit-sharing agreement and subsequent collaborative activities;
   - (o) Food and livelihood security benefits;
   - (p) Social recognition;
   - (q) Joint ownership of relevant intellectual property rights.

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Best Practices for Ethical Collaboration Capture Sheet

Directions
Throughout Lesson 2, you have examined interactions between various stakeholders seeking access to genetic resources, from scientists and biotechnology companies, to local governments and the indigenous communities who are deeply connected to these resources.

1. Review and reflect on prior learnings.

   The patterns found in outcomes and tradeoffs seen through stakeholder lenses

   The complexities involved in commercializing natural compounds and patenting intellectual property

   The protections given indigenous communities and their traditional ecological knowledge

   The variety of benefits that can be shared among stakeholder groups of varying language, governmental, and belief systems

2. Next, pitch a plant-based medicine to target a specific disease involving the different stakeholder groups you have learned about.

   How should learnings from Lesson 2 shape stakeholder interactions in this process?

   What are the key "Rules of Engagement" for ethical collaboration among scientists, biotechnology companies, local governments, and the indigenous communities that have held traditional ecological knowledge about medicinal properties of plants for centuries?

   Agree position and the Disagree position. Cite specific examples from case studies where relevant.

Continues next page >

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Best Practices for Ethical Collaboration Capture Sheet

Continued

	Best Practices for Ethical Collaboration	Relevant Case Studues
1		
2		
3		
4		
5		
6		

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Rubric for Biotech Unit Challenge
Engaging in Argument from Evidence

Observable features of the philosophical chairs discussion and best practices for ethical collaboration	**Meets Expectations** 8–10 points	**Progressing** 5–7 points	**No attempt** 0 points
Research			
a. Students research stakeholder perspectives and analyze their unique challenges based on a case study.			
b. Students analyze stakeholder perspectives for outcomes, tradeoffs, patterns, and stand-outs.			
Philosophical Chairs Discussion			
a. Students provide evidence of stakeholder outcomes and tradeoffs, and suggest solutions based on stakeholder perspectives.			
Final Score			
Grade			

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Rubric for Stakeholder Perspectives
Constructing Explanations and Designing Solutions

Observable features of student performance	**Meets Expectations** 8–10 points	**Progressing** 5–7 points	**No attempt** 0 points
Research			
a. Students analyze the Nagoya Protocol excerpts and reflect on the philosophical chairs class discussion of outcomes and patterns to determine strengths and weaknesses of the protocol.			
Best Practices for Ethical Collaboration Student Recommendations			
a. Students evaluate Nagoya Protocol strengths and weaknesses, and communicate recommendations for ethical collaboration among stakeholder groups with regards to obtaining Traditional Ecological Knowledge and biological resources.			
Final Score			
Grade			