

A microscopic image of plant cells, showing a grid-like structure of cell walls and internal organelles, tinted in shades of green and blue.

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AG/ENVIRONMENTAL


Plant to Pharmaceutical

Plants and Disease

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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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

Plants and Disease

DRIVING QUESTION

How are plant-based medicines designed for a specific patient population?

OVERVIEW

Welcome to Biotech Firm. We are excited to have you join one of our Project Teams! Our company strives to solve health problems for diverse patient populations by designing plant-based medicines. This week, we will explore the right career position for you based on your strengths and areas in which you would like to grow. Once hired for your Project Team, you will spend time identifying a plant medicine on which you would like to focus. This experience will provide creative collaborations, design opportunities, and market research explorations on which you can build your real-world skills and examine the steps in the development of a new drug compound.

In this lesson, students will research plant drug candidates and explore compounds for drug development. They will learn about the mechanism of action connected to a plant compound they have chosen, and how it treats disease. They will begin to build a patient profile for their drug and think about what is necessary for mass production.

ACTIVITY DURATION

Five class sessions
(45 minutes each)

ESSENTIAL QUESTIONS

How do particular plant compounds address and treat a specific condition?

How do biotech companies identify target patient populations?

How do Project Teams form and collaborate to solve problems and answer research questions?

OBJECTIVES

Students will be able to:

Identify a disease target and plant compound.

Build connections between the product life cycle and career pathways.

Analyze personal and collective strengths and areas for growth.

Apply critical reading strategies for analyzing primary source information efficiently.

Have you ever wondered...

What factors influence access to different types of medical treatments?

Beyond drug discovery and development, to truly be effective, a medicine needs to reach a patient to be able to treat that patient's medical concerns. In the United States, this access is mediated by insurance coverage, employment, spatial distribution of medical providers, and many other socioeconomic and political factors. Globally, this access can be further complicated by access (or lack thereof) to roads, electricity, clean water, qualified medical providers, and the cost of the medicine itself. As biotech firms innovate around new drug discoveries, they have the opportunity to facilitate treatment access to reach all patients in need, both in the United States and globally.

How plant compounds impact cellular function?

Some plant compounds mimic enzymes that are already present in the body, either upregulating or downregulating particular cellular functions. Other plant compounds bind to proteins, making them non-functional or altering the conformation so that a different metabolite is produced. Still other plant compounds affect cell replication or cell-to-cell signaling pathways.

How plant compounds arise in the first place?

All of these compounds serve diverse purposes in the plants themselves: mediating growth and reproduction; preventing predation by insects, mammals, birds, and reptiles; and avoiding parasitism and disease. Over time, these evolutionary pressures have resulted in a myriad of compounds that address the organismal need of the plant.

Materials

Student Guide

Common Medicinal Plant Menu

**Plant Medicine Menu of Options
Capture Sheet**

**How are plant-based medicines
designed for a specific patient
population?**

**Medicinal Plant Profile Capture
Sheet**

Career Exploration Capture Sheet

Career Profiles

Career Role Profile Capture Sheet

Drug Development Application

**Student Strengths and Areas of
Growth Reflection Capture Sheet**

**Project Team Collaboration
Agreement Capture Sheet**

**Individual Role Application for
Project Team Construction**

**Preliminary Background Research
Capture Sheet**

Gallery Walk Capture Sheet

Make Connections!

How does this connect to the larger unit storyline?

How do particular plant compounds address and treat a specific condition? How do drug developers determine who could benefit from their medicines? Students will identify a plant compound of interest and research how it interacts with the body on a cellular level, and begin defining a potential patient population.

Students will gain exposure to biotechnology career roles in a simulated Biotech Firm, based on interests and personal growth goals, by assuming a Project Team position as they develop a plant-based medicine to treat a disease or symptoms of various diseases. The necessary skills in various stages of product development will be demonstrated by students throughout the process, while collaboration and communication will be emphasized for various group levels: role, sub, and larger group.

How does this connect to careers?

Communications professionals are in charge of communicating a diverse array of scientific materials to a wide range of audiences. Their creativity in messaging and close collaboration with researchers, medical professionals, the media, and legal leads to engaging and targeted communication products.

Product and supply chain management professionals are responsible for taking a process that might take place in one lab to a process that scales up in multiple labs to accommodate hundreds, thousands, or even millions of patients, all while maintaining the quality and efficacy of the product. The skills needed include quantitative analysis, collaboration, communication with partners, an understanding of biochemical processes, and an understanding of logistics and supply chain issues.

Biochemists focus on how small molecules impact molecular processes within cells. They are amazing at figuring out direct and indirect ways to measure cellular changes that cannot be observed by eye or sometimes even with a microscope. They solve problems, create new methods to address questions without answers, and collaborate with other roles at the biotech firm to share their most promising work through presentations and written communication.

How does this connect to our world?

Students have the opportunity to envision themselves in various biotechnology careers in a concrete way.

Students will be able to understand how their work could positively impact the lives it touches.

This lesson series is designed for students to embody diverse career roles while also experiencing the product life cycle in a student-centered format.

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 self-awareness and self-management by using a growth mindset, identifying personal strengths and areas of growth, and setting personal goals. Effective collaboration and communication skills will be built into a multitude of steps throughout the week, prompting social awareness and relationship skill development.

CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

Students will bring real-world issues into the classroom by choosing a disease for which to develop and market a plant-based medicine to treat individuals, potentially in their own community. High expectations for all students are communicated through challenging, but scaffolded, tasks that require a collaborative effort, promoting respect for social, cultural, linguistic, and learning differences among students.

ADVANCING INCLUSIVE RESEARCH

The biotechnology workforce is diversifying over time, but not as quickly as the US population as a whole. By inviting students to join a Project Team at a simulated Biotech Firm, this lesson aims to help students identify as biotechnology professionals. This project works to build confidence in diverse K12 students in their professional skills, which will help them navigate a future STEM career and, in turn, aid in diversifying the biotechnology workforce.

COMPUTATIONAL THINKING

In this lesson, students are forming Project Teams consisting of three distinct career aligned roles (Finance, Molecular Modeling, and Communications) that will work collaboratively to model the full product life cycle, identifying a plant-based medicine and describing how to scale its production. To prepare for that task, students will articulate and set personal learning goals by analyzing their own strengths and areas of growth. Students will build on prior work in this unit to explore the real-world issue of designing a plant-based medicine for a particular patient population.

CONNECTION TO THE PRODUCT LIFE CYCLE

This lesson asks students to join a Project Team at a simulated Biotech Firm and to create a pitch on which they receive feedback from other Project Teams to identify a potential plant-based medicine. This provides an opportunity for each Project Team to give and receive feedback from peers and from the Project Team Lead (teacher), much as the Project Team Lead would provide a “go/no go” decision on a drug in the **discovery** phase of the product life cycle.

Day 1

LEARNING OUTCOMES

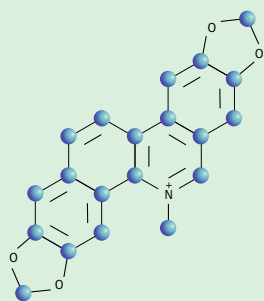
Students will be able to:

Conduct academic research through reputable internet sites.

Analyze potential benefits of plant compounds with certain ailments or diseases.



Sanguinarine



Procedure

Whole Group (10 minutes)

- 1 Ask students to pick a partner for a one-day activity. Each pair should claim one of the plants listed on the **Common Medicinal Plant Menu** as a research topic for the day.
- 2 Explain to the class that the goal of this lesson is to create an array of options of medicinal plants that students may choose to focus on for the Plant Medicine Biotech Project.

Teacher Note > For students who would benefit from more structure, the *Plant Medicine Menu of Options Capture Sheet* scaffolds some general information to support student research. Students can use the same plant from Lessons 4 and 5, but this may require independent internet research if the plant is not in the table. Students can also choose to intentionally choose a new plant to gain more breadth of understanding of medicinal plants.

Small Group/Pairs (30 minutes)

- 1 Instruct students to conduct internet research on the medicinal plant chosen to profile and answer the key questions noted below. Encourage students to seek .edu and .gov resources for quality information. If students have questions about the quality of a source, instruct them to ask a peer or ask a teacher to verify that the information seems reliable.
- 2 Have students fill in the *Medicinal Plant Profile Capture Sheet* with the answers to the key questions for their disease or plant treatment.

Teacher Note > Help students craft questions for search engines to facilitate searching, such as using key words, eliminating irrelevant words, using similar words, and using exact short phrases. Explain that students should spend only the allotted 30 minutes on this task, and it is okay if all of the questions are not fully answered. Students can be encouraged to choose the questions that they find most interesting.

Key Questions:

- What disease(s) are treated using the plant compound?
 - What patient populations are most impacted by this disease?
 - What are the main symptoms of the disease?
 - What are long-term outcomes of the disease?
- What patient populations are most impacted by this disease?
 - Can you classify these populations geographically or by ancestry group?
- What plant can be used to address the disease or symptoms being highlighted?
 - What cultural connections does this plant have for any specific Indigenous communities?
 - What ecological connections does this plant have to the broader ecosystem?

Day 1

Continued

Procedure

Whole Group (5 minutes)

- 1 Explain to students that Project Teams will share their completed *Medicinal Plant Profile Capture Sheets* with the class during Day 2. They will pitch why the plant they researched is worthy of focus for the class's "Biotech Firm."
- 2 Invite students to complete the *Career Exploration Capture Sheet* as homework. They should skim the five *Career Profiles*, and read the one that interests them most in detail. There are two short reflection questions associated with this task.
- 3 Invite students to preview the *Career Role Profile Capture Sheet* as homework. Encourage them to consider the professional skills listed in association with each potential Project Team role. Note that they will have class time to complete this during Day 2.

Teacher Note > *The professionals profiled represent roles that are intimately involved in the product life cycle, and would collaborate closely with the Project Teams involved in the student roles for the project, but are perhaps not specifically on analogous real-world teams themselves. Each profile will help give students an inside view of interacting professional roles involved in the product life cycle.*

Day 2

LEARNING OUTCOMES

Students will be able to:

Present findings of plant profile with regards to a specific condition.

Collaborate to form a product life cycle project.

Explore the various collaborations needed to make medicines.



Procedure

Small Group (15 minutes)

Ask student pairs to prepare to pitch their *Medicinal Plant Profile Capture Sheet*. When that Project Team is finished, have them write the name of the plant or disease on the board, creating a class bank of options for further engineering and research in Lessons 7–9.

Whole Group (5 minutes)

- 1 Introduce the Project Team formation process for the upcoming product life cycle project. Students will be provided with an application to indicate the role they are interested in and a plant if they have a preference.
 - a. Invite students to consider the roles described on the *Career Role Profile Capture Sheet*.
 - b. Ask students to apply to the role of their choice using the *Drug Development Application*. The responses to this form will be used by the Project Team Lead (teacher) to form groups of three or six students for the remainder of Lesson 6 and all of Lessons 7–9.

Teacher Note > *Have groups of six students (preferred option for student scaffolds and supports) or three (one student per role, for TAG students or students who feel strongly about research topics). Suggested tasks of Sub-Teams:*

Communication (see Communications career connection) Sub-Team (two students)

- *Pitch Presentation*
- *Patient Population*
- *Plant Ecology, Disease Profile, and Indigenous Connections*
- *Plant Compound and Cell Interactions (summary of Molecular model)/ Potential Treatment Mechanism*
- *Production Plan (summary of Finance plan)*
- *Summary of Benefits Sharing Agreement [Lesson 2]*

Finance (see Manufacturing and Supply Chain Management career connection) Sub-Team (two students)

- *Financial analysis*
- *Method of Scaling (large scale sustainable farming, biological synthesis, chemical synthesis).*
- *Benefits Sharing Agreement*

Modeling (see Biochemist career connection) Sub-Team (two students)

- *Three Molecular Models (of “normal” process, process in the diseased state, and medicinal process)*

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Day 2

Continued

Procedure

- 2 Explain the Project Team structure prior to students completing the application and share that the teacher, as the Project Team Lead, will be forming the Project Teams based on their applications and preferences.

Small Group (10 minutes)

Ask students to explore [Genentech Making a Medicine flowchart](#) to gain background information about the diversity of collaborative career roles involved in making medicines, sharing informally with each other about any new learnings gleaned from the interactive.

Individual Work (15 minutes)

Ask students to work individually on the [Student Strengths and Areas of Growth Reflection Capture Sheet](#), which gives them the opportunity to analyze their own professional assets.

Teacher Note > Use student input from the [Drug Development Application](#) to assemble Project Teams based on shared interest in disease targets or student interest in specific roles. Students will sit with these Project Teams for the rest of the Unit.

Day 3

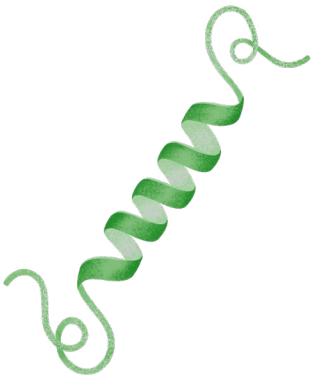
Procedure

LEARNING OUTCOMES

Students will be able to:

Form a Project Team based on a common interest and take on a specific role to play in the product pitch.

Formulate norms and common practices for the Project Team and Sub-Teams.



Whole Group (15 minutes)

Share with students the results of the [Drug Development Application](#) and announce groups and roles. Move students into groups based on Project Team assignments.

Teacher Note > *As a teacher, you could choose to have all Project Teams study the same plant, or encourage each group to select a unique plant for the project. The [Common Medicinal Plant Menu](#) provides plants that have different mechanisms of action from each other. Student groups focused on the same plant will still be able to create unique product pitches.*

Small Group (30 minutes)

Ask students to use the [Project Team Collaboration Agreement Capture Sheet](#) to establish norms and working goals (e.g., agreements on deadlines, agreements on collaborations, etc.) Each student will then finalize their specific roles on the Project Team. Each Project Team will finalize their plant selection.

Day 4

Procedure

LEARNING OUTCOMES

Students will be able to:

Conduct background research through the lens of role in role in Project Team.

Whole Group (5 minutes)

Introduce the [Preliminary Background Research Capture Sheet](#). Each role on each project group will have a different background research lens.

Small Group (40 minutes)

Ask each student to work with another student in the same role (Communications, Finance, Molecular Modeling) to use the [Preliminary Background Research Capture Sheet](#) to investigate the scientific background knowledge that is specific to their final product and summarize their research. Students should refer to the Rubric for Biotech Lesson 6 during their research to understand how their work will be evaluated. For students focusing on a plant from the [Common Medicinal Plant Menu](#), encourage them to begin with resources provided in the table.



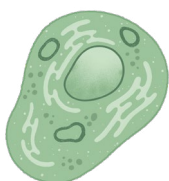
Day 5

LEARNING OUTCOMES

Students will be able to:

Share compound, disease target, roles, and collaboration plans.

Create a plan of action and set goals for the next stages of the project.



Procedure

Whole Group (20 minutes)

- 1 Invite Project Teams to share the following in a Gallery Walk format:
 - Plant and Bioactive Compound
 - Potential Application (disease target)
 - Collaboration Plan
 - Individual Roles on Sub-Teams
- 2 Ask “walking” students to take brief notes on the provided [Gallery Walk Capture Sheet](#) for 2–3 other Project Teams, depending on time. Teachers can pause students in 3–5 minute rotations to allow students to alternate between presenting their own work and listening to other Project Teams.

Teacher Note > *Project Teams may not have all of their details on the patient population, disease characteristics, and cellular interaction with plant compounds fully documented yet. This is okay and will be fleshed out in later tasks during Lesson 7. Students listening to presentations can ask presenters clarifying questions that will help guide them in their research. Providing Project Teams with Gallery Walk notes from their peers may be helpful.*

Small Group (25 minutes)

- 1 Using their Gallery Walk experience, ask Project Teams to create a “want list” of resources or remaining questions needed to begin their work on the product creation (Lesson 7).
- 2 Invite students to use remaining time to preview the Project Team Process Journal section of the **Student Guide**, which provides an overview of the key steps and collaboration in Lessons 7 to 9.

National Standards

Next Generation Science Standards

LS1-2 From Molecules to Organisms: Structures and Processes

Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Science and Engineering Practices

Asking Questions and Defining Problems

Ask questions to clarify and refine a model, an explanation, or an engineering problem.

Developing and Using Models

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

Career and Technical Education (CTE)

A2.6

Prepare a presentation comparing the benefits and harm that can be the result of biotechnology innovations in both the research and application phases and which course of action will result in the best outcomes.

A4.5

Discuss the structure and function of the macromolecules that compose cells, including carbohydrates, lipids, DNA, RNA, and protein molecules

A7.3

Describe intellectual property.

A7.6

Articulate issues of ethical concern, including plagiarism, copyrights, trademarks, and patents and use online data resources and searchable databases to investigate a copyright, trademark, or patent.

A9.4

Cite examples of plant parts or extracts used as pharmaceuticals.

A9.5

Use the Internet to find information about traditional pharmaceuticals, herbal remedies, and recombinant pharmaceuticals.

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National Standards

CTE <i>Continued</i>	3.1 Identify personal interests, aptitudes, information, and skills necessary for informed career decision making.
	9.2 Identify the characteristics of successful teams, including leadership, cooperation, collaboration, and effective decision-making skills as applied in groups, teams, and career technical student organization activities.

Medicinal Plant Profile Capture Sheet**ANSWER KEY****Do not share with students****Directions**

Use the template below to create a Medicinal Plant Profile for the plant your Project Team chooses.

*Key Questions***1 What disease(s) are treated using the plant compound?**

What are the main symptoms of the disease?

What are long term outcomes of the disease?

2 What patient populations are most impacted by this disease? [geographically, or by ancestry group]**3 What plant can be used to address the disease or symptoms being highlighted?**

What are the main symptoms of the disease?

What are long term outcomes of the disease?

Answers will vary. Below is a student example.

Plant and Active Compounds: <ul style="list-style-type: none"> — Piper betle for anti-inflammatory properties, India — Bioactive compound: allylpyrocatechol — More possibilities: Some medicinal plants with antiasthmatic potential: a current status 	Potential Treatments and Applications: <ul style="list-style-type: none"> — Disease: Asthma — Asthma causes swelling of the airways, which reduces the flow of air from the nose and mouth to the lungs. Symptoms include trouble breathing, wheezing, coughing, and tightness in the chest. Asthma can be exercise-induced, caused by irritants in the workplace (gases, dust, fumes), or allergy-induced. Asthma can be deadly.
Patient Population: <ul style="list-style-type: none"> — 1 in 13 people have asthma — Leading chronic disease in children — More frequent in male children and female adults — Environmental (pollution) and socioeconomic factors exacerbate asthma in different communities — About 1 in 9 (11%) non-Hispanic Blacks of all ages and about 1 in 6 (17%) of non-Hispanic Black children had asthma in 2009, the highest rate among racial/ethnic groups — Asthma limits an individual's ability to work, attend school, and participate in regular activities that promote quality of life 	What led you to choose this plant? <ul style="list-style-type: none"> — My brother and I have asthma. Growing up, I could not always play sports or go outside when air quality was poor, and I couldn't own pets. I always need to keep my regular long-acting inhaler and a shorter-acting "rescue" inhaler on my person. It gets expensive! My brother has had to miss a lot of school because of his asthma. — Traditional asthma medicines may include side effects, including throat irritations, thrush, dry mouth, dizziness, headache, nausea, and vomiting. I am a little worried about the effects of long-term steroid use on my body.

Gallery Walk Capture Sheet**ANSWER KEY****Do not share with students****Directions**

Fill out one copy of this capture sheet for at least two other Project Teams' Preliminary Background Research as you explore the Gallery Walk.

Answers will vary with the plant chosen. Below is an example.

Plant or Disease Name: Willow	Why is this disease or plant treatment worthy of investment? Headaches are one of the most common pain conditions, with more than 75 percent of adults having had a headache in the last year. As a pain reliever, Willow could be used to treat headaches.		
Project Team Members: Names Here			
Plant Ecology	Willow is a type of tree. It lives along river banks. Willow reproduces after 15–20 years with seeds and flowers.	Patient Population or Disease Background Information	This is used as a pain reliever and a fever reducer.
Indigenous Community Connections and Historical Uses	Indigenous people all over Earth use willow bark and leaves in tea to relieve fever and pain.	Plant Molecule Interactions with Cell in Disease State	Salicylic acid prevents the production of inflammatory compounds in cells.
What did you learn about this plant or disease that you did not realize before? I learned that this plant takes a long time to grow, and that it can provide low-cost pain relief or free pain relief without having to kill and harvest the whole tree.		What questions or suggestions do you have for this Project Team as the students begin developing their communication plan, financial analysis, and molecular models? I wonder what other applications exist for salicylic acid? Is it used to treat other conditions as well?	

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Common Medicinal Plant Menu

Directions

Listed here are some of the more commonly known plants and potential documented applications for those plants. This table is only a sampling of medicinal plants; many more have been used to treat a wide range of health ailments.

Review the table and make a note of a few options that you would like to consider as your focus for the final engineering design project.

Plant	Potential Applications	Plant Part
Aloe	Treats burns, swelling, redness, and provides pain relief	Leaves
Calendula	Treats skin irritations, burns, rashes, wounds, digestive inflammation, GERD, and provides ulcer relief	Flowers
Chamomile	Treats gastrointestinal disturbances, anxiety, and inflammation	Flowers
Cinnamon	Has antioxidant, anti-inflammatory, and antimicrobial properties, and potentially acts against neurological disorders	Bark
Dandelion	Provides liver, kidney, and digestion support	Leaves, root
Echinacea	Used to treat colds, flu, and infections, and promotes wound healing	Leaves, stalk, root
Feverfew	Treats migraines and fever	Leaves
Foxglove	Has cardiac stimulating properties (high toxicity)	Leaves
Garlic	Treats bacterial, viral, fungal, and parasitic infections, promotes immune health, has antitumor and antioxidant properties	Clove
Ginger	Treats nausea and has, potential anti-cancer properties	Root
Ginseng	Used to increase energy and for stress maintenance	Root
Goldenseal	Used as an antiseptic, and to treat skin irritations and diarrhea	Root, rhizome

Sources

University of Rochester Medical Center's *A Guide to Common Medicinal Herbs*, Traditional Medicinals' *Tulsi 101*, Indiana Medical History Museum's *Guide to the Medicinal Plant Garden*, National Library of Medicine's *List of Herbs in the NLM Herb Garden* and Rain-Tree Publishers' *Plant Based Drugs and Medicines*.

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Common Medicinal Plant Menu

Continued

Plant	Potential Applications	Plant Part
Hyssop	Treats intestinal inflammation, respiratory infections, urinary tract infections, and skin irritations	Flower tops, leaves
Lavender	Treats stress, high blood pressure, eczema, and psoriasis	Flowers
Lemon balm	Treats insomnia, stomach ailments, anxiety, and herpes sores	Leaves
Lupine	Treats nausea and stops hemorrhaging	Leaves
Milk thistle	Treats liver conditions, high cholesterol, and has potential anti-cancer properties	Fruit
Nettle	Treats allergies, enlarged prostate, joint pain, and high blood pressure, and is used for blood sugar control	Leaves
Oregano	Is antibacterial, antifungal, antiparasitic, and is used to treat respiratory conditions	Leaves
Peppermint	Used as an antiseptic and to treat gastrointestinal issues, tension, and headaches	Leaves
Rosemary	Used as a disinfectant and to treat, headaches, fever, and address circulation trouble	Leaves and oil
Skullcap	Used to treat insomnia, depression, fever, high blood pressure, and tension	Roots and leaves
St. John's wort	Used as an antidepressant and to treat gastrointestinal problems	Flower, leaves
Thyme	Has antiseptic, antifungal, and antiparasitic properties, and is used to treat cough and bronchitis	Flowers, leaves and oil
Tulsi	Has antimicrobial properties, and is used to treat cold, cough, asthma, bronchitis, sinusitis, and headache	Leaves and flowers
Turmeric	Has anti-inflammatory and potential anti-cancer properties, and is used to treat skin diseases	Root
Valerian	Used to treat insomnia and anxiety	Root
Yarrow	Used to treat wounds, cuts, abrasion, and bruising	Flowers and leaves

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Plant Medicine Menu of Options Capture Sheet

Directions

Select one or a few plants to research. Use the sources suggested here to guide your research to complete the [Medicinal Plant Profile Capture Sheet](#).

Adapted from *Modes of Action of Herbal Medicines and Plant Secondary Metabolites*

Plant Species <i>Relevant to Communications Team, Finance Team</i>	Substance (Class) <i>Relevant to Molecular Modeling Team</i>	Mode of Action <i>Relevant to Molecular Modeling Team</i>	Properties / Applications <i>Relevant to all three teams</i>	General Sources for Chemistry and Botany
<i>Camptotheca acuminata</i> (cancer tree)	Camptothecin (alkaloid)	Inhibitor of DNA topoisomerase	Used for tumor therapy	Chemistry: Camptothecin / C20H16N2O4 Ethnobotany and Indigenous Connections: Ethnobotany of Camptotheca Decaisne: New Discoveries of Old Medicinal Uses
<i>Catharanthus roseus</i> (Madagascar periwinkle)	Dimeric Vinca alkaloids (alkaloid)	Inhibits microtubule assembly	Used for tumor therapy	Chemistry: Molecular docking and pharmacogenomics of vinca alkaloids and their monomeric precursors, vindoline and catharanthine We suggest using internet research to learn more about the botany and Indigenous connections of this plant from a .gov or .edu site. If you have questions about the reliability of a particular source, ask your teacher for guidance.
<i>Coffea arabica</i> (Arabian coffee)	Caffeine (alkaloid)	Inhibits phosphodiesterase and adenosine receptors	Used as a stimulant	Chemistry: Caffeine / C8H10N4O2 We suggest using internet research to learn more about the botany and Indigenous connections of this plant from a .gov or .edu site. If you have questions about the reliability of a particular source, ask your teacher for guidance.
<i>Digitalis lanata</i> (woolly foxglove)	Digitoxin, digoxin (terpenoid)	Inhibits the Na ⁺ / K ⁺ ATPase	Used to treat heart insufficiency	Chemistry: Digitoxin / C41H64O13 See Digoxin inhibition of Na⁺/K⁺ ATPase Capture Sheet Botany: Digitalis: The flower, the drug, the poison / American Association for the Advancement of Science
<i>Pilocarpus jaborandi</i> or <i>Pilocarpus microphyllus</i>	Pilocarpine (alkaloid)	Agonist of mAChR	Used for glaucoma treatment	Botany: Pilocarpus or Jaborandi, Pilocarpus microphyllus Chemistry: Pilocarpine
<i>Sanguinaria canadensis</i> (bloodroot)	Sanguinarine (alkaloid)	DNA intercalator	Used for its antibacterial and antiviral properties	Chemistry: Sanguinarine We suggest using internet research to learn more about the botany and Indigenous connections of this plant from a .gov or .edu site. If you have questions about the reliability of a particular source, ask your teacher for guidance.

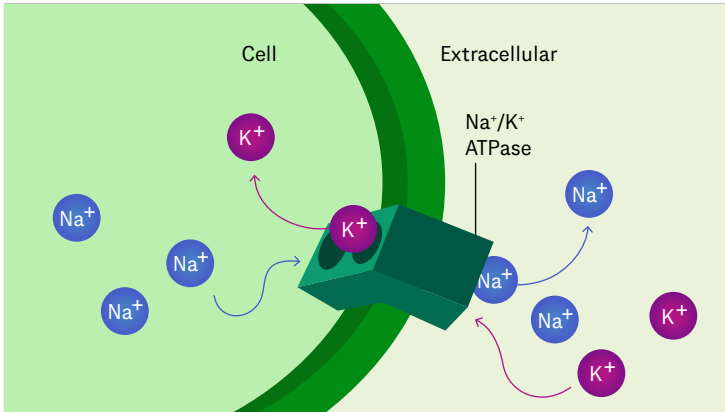
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Digoxin inhibition of Na^+/K^+ ATPase Capture Sheet

Directions

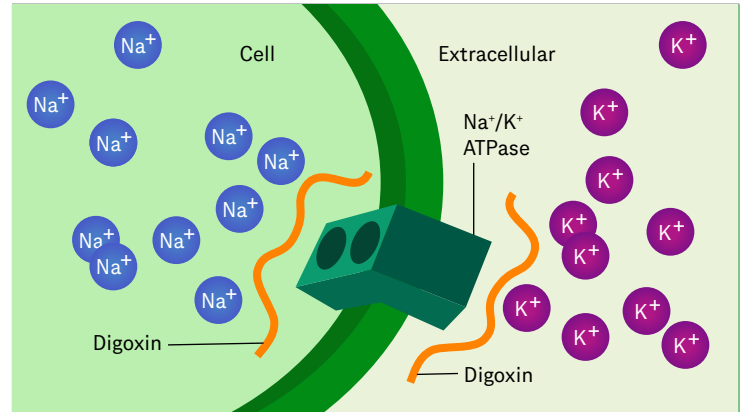
The images below show the effects of digoxin on the Na^+/K^+ ATPase, also known as the sodium potassium pump, as a therapeutic treatment for heart problems.

Normal movement



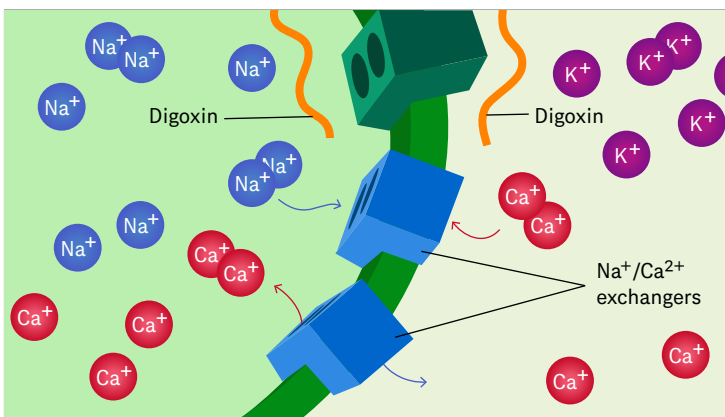
Normal movement of sodium (Na^+) and potassium (K^+) in a cell through the Na^+/K^+ ATPase. For every ATP molecule that the pump uses, three sodium ions are pumped out of the cell (exported) and two potassium ions are brought in. The sodium potassium pump plays a key role in regulating heart rate.

Step 1



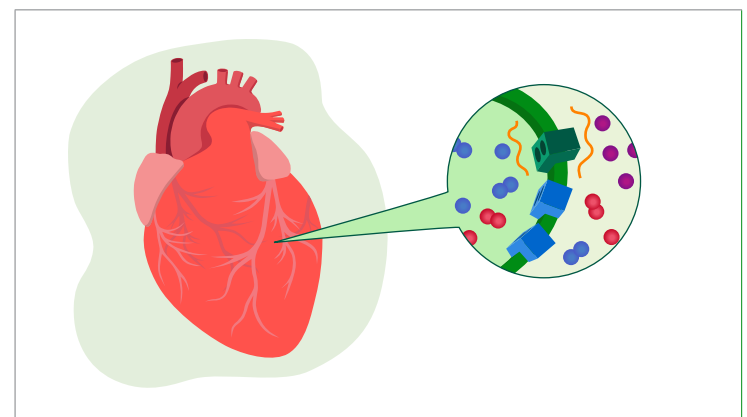
Digoxin inhibits the movement of sodium and potassium.

Step 2



This causes an increase in intracellular levels of sodium, resulting in a reversal of the action of the sodium-calcium exchanger.

Step 3



This leads to increased amounts of calcium, which results in increased myocardial contractility (the force of heart contractions) and decreased heart rate. This reduces strain on the heart and helps it maintain a normal, steady, and strong heartbeat.

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Medicinal Plant Profile Capture Sheet

Directions

Use the template below to create a Medicinal Plant Profile for the plant your Project Team chooses.

Key Questions

1 What disease(s) are treated using the plant compound?

What are the main symptoms of the disease?

What are long term outcomes of the disease?

2 What patient populations are most impacted by this disease? [geographically, or by ancestry group]

3 What plant can be used to address the disease or symptoms being highlighted?

What are the main symptoms of the disease?

What are long term outcomes of the disease?

Plant and Active Compounds:	Potential Treatments and Applications:
Patient Population:	What led you to choose this plant?

6

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Career Profiles

Tatiana Dominquez

*Genentech Patient Foundation,
Experience Design Lead*



What is the role of the Access Solutions team? How do you use communication skills in this role?

Genentech Access Solutions (AS) is a resource for people who need help understanding insurance coverage and costs related to Genentech medicines.

The Genentech Patient Foundation is one of the patient support services offered by Genentech. The Foundation gives free Genentech medicine to people who don't have insurance coverage or who have financial concerns. Living with a serious illness can come with many challenges, and we believe that getting Genentech medicines shouldn't be one of them.

An essential part of delivering these services to patients is working collaboratively across different teams to provide patients and their care teams with the best possible financial support options. In this role, I have the opportunity to collaborate with the Foundation's leadership team, the Foundation board of directors, and other AS partners to identify short and long-term strategic services to support patient access challenges, with evolving market demands."

What types of communication and collaboration (written, oral, presentations, etc.) are essential to your role at GNE?

In this role, building collaborative working relationships and mobilizing cross-functional teams is important to help develop and deliver an excellent experience for patients and providers. This includes communication via email, collaborating with different stakeholders via live brainstorming sessions and team meetings, and creating presentations to communicate project plans and outcomes.

What is the most exciting part of your job/career? What's most challenging?

The most exciting part of my role is the opportunity to partner with so many brilliant minds across Genentech with a common purpose to serve patients. The most challenging part at times can be prioritizing the most important work that will yield the greatest impact. There are always going to be so many ideas and areas of opportunity to improve on, but we can't tackle them all at the same time.

How do you build empathy and compassion with patients in need? What is your role within GNE as a patient ally/advocate?

We have an incredible team of Foundation Specialists that connect with patients and providers on a daily basis, and I have the opportunity to work closely with this group. This team does an incredible role in ensuring that our patients receive the Genentech medicine they need, and they also ensure that they amplify the voices of patients by sharing their feedback on how to improve the services. My role is to ensure that we are really listening to our patients and creating actionable steps to address their needs.

As a caregiver for my parents, I understand how scary it can be to receive news about a diagnosis like cancer. Having a team of trusted individuals to guide you through the complexities that health insurance can be and assure you that you are going to receive access to the medicine that you need is incredibly important for patients.

Continues next page >

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Career Profiles

Continued

What is one piece of advice you would give your younger self?

I would tell my younger self that there is so much power in my own voice and story. Sometimes we spend so much energy trying to present ourselves in ways that are not always true to who we are, but there is so much freedom and power in owning your story and presenting our whole selves at work. It will propel you forward to do even greater work.

If you could learn any new skill, what would you learn and why?

I love learning new things even though it can feel scary at times. I recently started to learn how to swim and I love it! I love the grandeur of the ocean but in the past have been afraid to go in because I couldn't swim. I am looking forward to enjoying it more!

What is one social cause you really care about?

I am really passionate about health equity. The CDC defines health equity as when every person has the opportunity to “attain his or her full health potential” and no one is “disadvantaged from achieving this potential because of social position or other socially determined circumstances.” I believe that everyone should have access to the healthcare that they need, and within the Foundation we are striving towards contributing to this vision.

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Career Profiles

Continued

Roxane Kyauk

*In Vivo Sciences,
Project Manager*



How does your work fit into the process of discovering and manufacturing a novel drug compound?

I help scientists with the operations management of their projects that are used for preclinical studies. I work directly with an external vendor, and I am the main point of contact to help resolve any issues that arise between our scientists and their company.

What skills do you use on a daily basis?

Empathy. I interact with many different functions throughout the company and externally. It is helpful for me to think about how they may receive a particular request or critique and adjust as needed. Depending on personality/temperament of people, will differ (e.g., some appreciate small talk, others don't).

Attention to detail. I review some contracts and need to make sure there are no mistakes with pricing or typos. Organization and record keeping helps with tracking the various aspects of the many projects I help manage and identifying ways to improve processes. Also allows for accessing metrics we can present to stakeholders to show progress after implementing process improvement solutions.

What is the most exciting part of your job/career? What's most challenging?

The most exciting thing is knowing and seeing the impact I have on accelerating the drug development process by alleviating scientists of certain operational issues that come with managing their projects so they have more resources to focus on what they care most about—the science!

The most challenging thing so far has been learning all new processes, but there are many resources and people willing to help.

How does working at a small biotech company compare to working at a larger biotech company? What is similar about the corporate culture? What is different?

Similarities—patient focused and science driven. Working with people who are passionate about the company mission.

Differences—Bigger company: stability and fringe benefits (shuttles, gym, child care, free food/happy hours, corporate discounts)

Smaller company: Impact of your work is more apparent and you have more visibility to leadership. More opportunity for professional growth because you are involved/exposed to more aspects of drug development.

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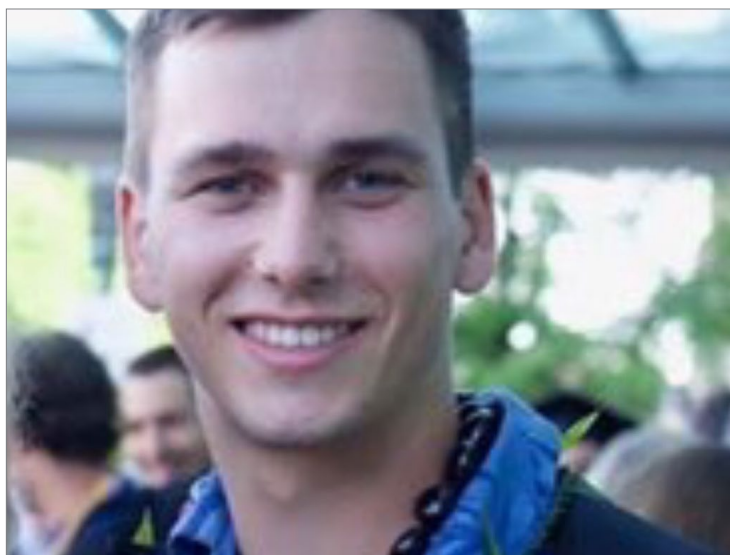
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Career Profiles

Continued

Cameron Paton

*Oregon Health Sciences University,
Research Assistant*



What do you do and how did you get here?

I am a Research Assistant 2 in the Monk Lab at Oregon Health & Science University (OHSU) in Portland, Oregon. I got here by pursuing my interest in science through academic research. I was exposed to academic research at Lewis & Clark College, where I had the privilege to work in the Binford Laboratory to study the biochemical characteristics of spider venom toxin proteins. I really wanted to do more than what was asked of me as a student in my lab courses. I expressed my passion to my teacher and future mentor and was given the opportunity to volunteer in their lab as a research assistant. After graduating from Lewis & Clark College, I wanted to continue in academic research. I sought out employment opportunities at OHSU, a highly prestigious academic institution near Lewis & Clark College, which led me to the current position I am in.

What skills do you use on a daily basis?

The biggest and most important skill in my role is time management and organization. Carefully cataloging my research, protocols, and notes, has ultimately allowed me to be successful and created more opportunities for me in research. In terms of physical skills, I work with pipettes daily setting up reactions like PCR, restriction digest, and DNA purification. As a research assistant, I don't directly conduct my own research, but assist senior scientists and postdoctoral scholars in their research. As such, I perform many commonplace techniques like the ones mentioned. Another valuable skill is the ability to critically think and communicate effectively with others. Academic research relies heavily on these two skills, and while they are challenging, are foundational to academic research and drive discovery.

What is the most exciting part of your job/career? What's most challenging?

The most exciting part of my job is generating new data and executing experiments. Academic research is a process-driven 'thing' and while ultimately results are the goal of any research, the most important aspect is the methods or the way in which the research is conducted. Additionally, science is largely based on failure. Handling failure is not something that students and young adults are conditioned to handle. For those reasons, handling failure has been the most challenging aspect of my job. Research takes a tremendous amount of persistence and in most cases stubbornness. It's also important to note that failure or a failed experiment are not a reflection of who you are as a scientist.

Where do you hope to be in five years, career wise?

In five years, I will be finishing my doctoral training from Dartmouth College. I chose to pursue a doctoral degree to receive professional training building off my previous research experience. Following the completion of my graduate degree, I plan to pursue a postdoctoral research position or a career in teaching. Postdoctoral research will allow me to conduct my own research similar to the work in my graduate degree. I am considering a career in teaching, more specifically teaching hands-on research, because of the impact my undergraduate mentor has had on my personal experience. Simply put, I want to create research opportunities for students interested in science.

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Career Profiles

Continued

If you could learn any new skill, what would you learn and why?

I would like to learn more languages. I speak some French and read French well, but not fluently. I think learning new languages is a very practical skill that will allow you to meet new people and experience new cultures. I mean who doesn't want to travel the world?

What is one social cause you really care about?

I care about creating equal opportunities in science and opportunities for students to become involved in research. The field of academia traditionally is not very diverse, but science is something that everyone regardless of race, gender, and socioeconomic class can contribute to. Research opportunities should not be tailored to exclusively privileged students, but should be incorporated in education universally. As an educator, I will make it a mission to create more opportunities in science to increase diversity and participation for students regardless of their background.

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Career Profiles

Continued

Anna Kang Liu

Genentech,
Principal Bioethics Leader



How do you define bioethics? Can you provide one and two short examples of how bioethics impacts the work of making medicines at Genentech (e.g., key considerations)?

Bioethics combines medicine, law, and applied philosophy. Bioethicists think about the ethical aspects of biomedical research and its consequences, particularly for areas where there are ethical tensions and no established practices. Bioethics pushes scientists to acknowledge that they operate within a society in which diverse perspectives and values must be engaged, and creates a framework to facilitate those discussions to inform decisions and progress.

Bioethics impact example: A Roche/Genentech research team working on a potential treatment for babies born with a disease called spinal muscular atrophy (SMA) requested bioethics guidance. SMA is a rare genetic disease that causes progressive muscle weakness and in its severe form can be life-threatening.

A diagnosis of SMA typically comes as a tremendous shock for parents and can lead to a highly emotional period for families. There are psychosocial impacts for parents that could lead to them agreeing to anything that might help their baby, without full consideration of alternatives. Roche's Bioethics Group recommended that the team include an increased emphasis on the clinical trial informed consent process that includes ensuring that parents are fully informed of alternative options and other important considerations that should be taken into account prior to agreeing to enroll their babies in any trial.

If you could learn any new skill, what would you learn and why?

I would love to learn how to speak Spanish fluently. I enjoy learning new languages and traveling, and, living in San Francisco. I could use the skill in a very practical way.

What is the most exciting part of your job/career? What's most challenging?

The most exciting part of my career has been the opportunity to change jobs/roles while working for the same company. I've had over ten different roles. Each role has allowed me to contribute in a new and meaningful way and has enabled me to have a broad perspective on developing new medicines to treat people with serious or life-threatening medical conditions.

The most challenging aspect is keeping up with the rapid changes both internally and externally. This includes technology and regulations which continue to evolve and force innovation and agility.

What is one piece of advice you would give your younger self?

Take risks and think long term! In college, I decided not to study abroad because I felt that I should graduate from college in four years and taking an extra year to study abroad seemed irresponsible. I regret this as the international experience would have been enriching and exciting. Also, when I first started working at Genentech, I thought about pursuing a Masters Degree in Public Health (MPH) but I thought it was too late. 20+ years later, I'm finally getting my MPH as a full time working mom. Don't be afraid to take risks along the way, it will pay off in the long run!

What is one social cause you really care about?

Addressing childhood adversity and social determinants of health through intervention and education. This is an emerging area of public health interest that I've been following and hope to get involved in.

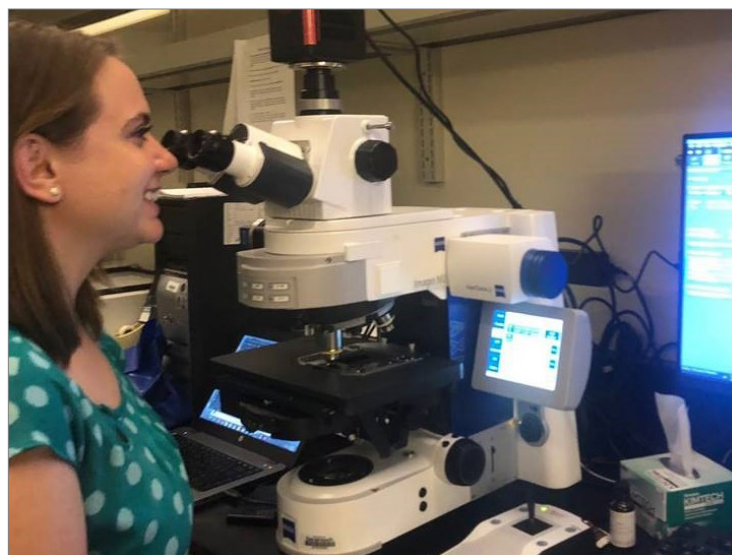
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Career Profiles

Continued

Danielle Mandikian

Genentech's Preclinical & Translational Pharmacokinetics (PTPK) department, Senior Scientist



How does your work fit into the process of discovering and manufacturing a novel drug compound?

There is a lot that has to happen to get discoveries on the bench all the way to the bedside of patients. My group participates in this process in three different ways:

- 1) We figure out where drugs go in the body, what they do when they get there, and what biological processes govern this. This information can help people understand if a therapy works or what we need to fix in order to get it to work. It can also give a heads-up for any potential dangers so we can fix them or be prepared before it moves to clinical trials.
- 2) We also work on improving or even inventing new diagnostic tools for pre-clinical and clinical research. So for example, we have done some work to improve cancer imaging methods to make them more sensitive and safe. This is super important when you want to catch cancer earlier or track responses to therapies to make sure you are on the right course of action.
- 3) One of my favorite things that we focus on is trying to come up with new treatment strategies. We have a unique opportunity to work with other scientists across campus to create new drug targeting methods. Not only is it fun to work in such a challenging area, but it's so important to never become complacent. As scientists, we need to constantly push ourselves to learn and stay on the cutting edge of research. There are still so many diseases out there and we know that one strategy cannot work for everything.

What skills do you use on a daily basis?

I'd say there are about three skills that I rely on daily. The most important thing is actually pushing myself to try things when I am ~99% sure that I can't. That may sound silly, but it is the thing that has helped me the most. I also get more progress by not expecting myself to be perfect or the expert on everything. This allows me to work with experts in many different fields in a more collaborative and fruitful way. Lastly, I spend a lot of time diving into microscopy and learning how to improve analysis by using machine learning and automation methods.

What is the most exciting part of your job/career? What's most challenging?

The most exciting part of my career is knowing that whatever I work on is always directly tied to what a patient will be exposed to. I know that my work matters and I love that I can use all my energy to do something that can help someone. The most challenging part is being patient. I am always so excited to see how things work out, but I am often working on stuff that will take a very long time to know the real results.

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Career Profiles

Continued

Where do you hope to be in five years, career wise?

I hope to be in the same position I am in now, but with a larger lab. My group is just now starting to grow and I have so many hopes for what we can accomplish. I love the idea of being able to train more scientists and seeing what they grow into.

What is one piece of advice you would give your younger self?

I would tell myself not to worry so much about the details of the path I want to follow. I feel like when I was younger I was always worried if I was making the right decision. Looking back on it, as long as a young scientist is staying positive and taking small steps forward, you can't go wrong. It's impossible to completely plan a career journey when you have no idea what opportunities will arise along the way.

If you could learn any new skill, what would you learn and why?

I am trying to learn how to do woodworking to make furniture. I don't really care about what I am making, but I love to work with my hands. I think it's my version of meditation. I like to be able to do things that force me to be in the moment vs. lost in my head. Anything like that is great for helping me stay grounded and keeps my true priorities in perspective.

What is one social cause you really care about?

I am very passionate about mentoring young scientists. I volunteer to mentor multiple people per year. It is such a wonderful but confusing time for people in their career development; and I know from experience how hard it can be. I was the first in my family to go to college, and there are so many more barriers that young scientists face besides just getting into a school and finding opportunities. I really enjoy being someone who can not only teach/guide someone through the technical parts, but also someone who can relate to others about some of the other harder to manage parts like juggling how to support your family or even guilt about trying to do something that is focused on what you want vs. what others want. Making a career choice is always difficult and often intimidating. Trying to facilitate support to make that a positive experience for a young person is extremely important for the next generation of scientists and unbelievably rewarding.

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Career Role Profile Capture Sheet

Directions

Read the following message from the Project Team Lead.
Then review the descriptions of each team along with the key skills required.

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Welcome to the Biotech Firm!

I am your Project Team Lead. I am responsible for creating teams that are most likely to develop successful plant-based medicines. Using this Drug Development Application, apply for the position below that best suits your career learning goals, and strengths and areas of growth.

To be able to apply for roles on these Project Teams, it might be helpful to learn a little about the available positions.

Communications Strategy Team

The Communications Strategy Team is the glue that holds the rest of the team together. The members of this team are responsible for understanding the ins and outs of the financial plan and the molecular model so that they can share the team's goals and rationale with internal company executives and external parties. The Communications Strategy Team ensures that the FDA, shareholders, and the press agree with the company's strategy, so other teams can move forward with research and development of a plant-based medicine.

Key Responsibilities for the Communications Strategy Team:

- Effectively collaborate with other roles, and translate highly technical work into a more general audience and to particular audiences for specific purposes.
- Communicate using written, visual, and oral forms.
- Iterate as new revisions are made to both the finance plan and the molecular models based on feedback, and also to incorporate feedback on messaging strategy and target audience from the Project Team Lead (teacher).

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Career Role Profile Capture Sheet

Continued

Finance Plan Team

The Finance Plan Team has a very Important role on our Project Team. In order for a drug to reach a patient in the US medical system, it must generate a profit for the company producing it. To understand whether a drug will make a profit, we must understand the dynamics of the manufacturing and supply chain involved in producing it. Additionally, for plant-based medicines, compounds have often been identified and isolated based on knowledge gained from collaborations with indigenous communities and as such, your Finance team is also responsible for building a benefits sharing agreement based on your research in Lesson 2 on the Nagoya Protocol. Your team will evaluate the possible strategies for scaling production [either sustainable agriculture and purification of compound, biological synthesis or chemical synthesis]. You are responsible for completing these two products and then supporting the Communications Team in accurately translating your work for different audiences in their communications strategy.

Key Responsibilities for the Finance Plan Team:

- Create and analyze different modes of production.
Consider sustainable agriculture and purification of compound, biological synthesis, or chemical synthesis.
- Estimate cost and profit of different modes of production.
Include environmental and climate impact in analysis.
- Consider and describe potential risks.
- Develop appropriate Benefits Sharing Agreements for all involved stakeholders, including indigenous communities, based on the plant compound.

Molecular Modeling Team

This team will deep dive into the cellular chemistry of the plant compound and its effects on particular cell types, noting any unknowns—gathering enough information to outline the mechanism of action of how the medicine helps treat a particular condition. Many scientists utilize this skill set to communicate across disciplines and create hypotheses to test in labs and in clinical trials of the science, dosing regimes, and clinical uses of particular medicines. It is also a key tool used to explain how a particular plant-based treatment works to patients, doctors, and other clinical populations.

Key Skills for the Finance Plan Team:

- Spatial reasoning
- Creativity
- Design thinking
- Iteration
- Research and communication

Good Luck!

Project Team Lead

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Drug Development Application

Directions

Complete this form to help the Project Team Lead
(your Teacher) create Project Teams for your Unit Project.

Name	First <hr/> Last								
Class Period	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4								
Team Selection	Do you want to join a team based on: <hr/> <input type="checkbox"/> The role you would have on the team (i.e., which product you are working on). <hr/> <input type="checkbox"/> The disease or plant your team is studying <hr/> <input type="checkbox"/> Other (please specify): <hr/>								
Plant or Disease Target Selection	Mark in a box below your first (1), second (2) and third (3) choices. <table border="1" data-bbox="277 1079 1377 1360"> <tr> <td data-bbox="277 1079 813 1150">Cancer Tree: Tumor Therapy</td><td data-bbox="813 1079 1377 1150">Pilocarpus: Glaucoma (eye) Treatment</td></tr> <tr> <td data-bbox="277 1150 813 1222">Madagascar Periwinkle: Tumor Therapy</td><td data-bbox="813 1150 1377 1222">Bloodroot: Antibacterial/antiviral Therapy</td></tr> <tr> <td data-bbox="277 1222 813 1293">Coffee: Stimulant</td><td data-bbox="813 1222 1377 1293">Yew tree: Tumor Therapy</td></tr> <tr> <td data-bbox="277 1293 813 1360">Foxglove: Heart Medicine</td><td></td></tr> </table> <hr/> I want to propose an alternative plant. My plant suggestion is: <hr/>	Cancer Tree: Tumor Therapy	Pilocarpus: Glaucoma (eye) Treatment	Madagascar Periwinkle: Tumor Therapy	Bloodroot: Antibacterial/antiviral Therapy	Coffee: Stimulant	Yew tree: Tumor Therapy	Foxglove: Heart Medicine	
Cancer Tree: Tumor Therapy	Pilocarpus: Glaucoma (eye) Treatment								
Madagascar Periwinkle: Tumor Therapy	Bloodroot: Antibacterial/antiviral Therapy								
Coffee: Stimulant	Yew tree: Tumor Therapy								
Foxglove: Heart Medicine									
Role Selection	My first choice for role is: <input type="checkbox"/> Communications <input type="checkbox"/> Molecular Modeler <input type="checkbox"/> Financial Analyst								
Notes	Anything else I should know?								

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Student Strengths and Areas of Growth Reflection Capture Sheet

Directions

Our class is forming a Biotech Firm with different Project Teams, each focusing on a specific plant compound that could be scaled to produce a medicine for a disease or condition. Our Firm needs to decide on which plan(s) to invest money and your designs and research are essential to the decision-making process.

1. Individually, you will apply to fill one specific professional role on this Project Team for the duration of the project. To assess which role might best suit your learning needs, we are first asking you to reflect on your strengths and areas of growth.

You can use the list below, or [Proficiency Levels for Leadership Competencies](#) from the US Office of Personnel Management for ideas about your own strengths. On the website's Table of Contents, each core competency is linked to a rubric with more specific self-evaluation support.

21st Century Skill	Strength (Project Task)	Area of Growth Project Task)
Initiative (referred to as decisiveness on page 14) and Self-Direction (referred to as accountability on page 11)		
Problem Solving page 16		
Communication oral: page 25, written: 27 and Collaboration Pages 7, 8, and 10		
Flexibility page 3 and Adaptability page 4		
Creativity and Innovation page 1		

Continues next page >

Continued

2. Write an intro paragraph to a cover letter you might use to apply to the role which you are most interested on the Project Team.
 - a. Be sure to emphasize how you are uniquely qualified to contribute to team goals in this role.
 - b. Describe the core competency (from *Proficiency Levels for Leadership Competencies*) that is your focal area of growth for the project.

[illegible]

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Project Team Collaboration Agreement Capture Sheet

Definition

The Project Team Collaboration Agreement is a roadmap for the completion of your plant medicine project. The purpose is to address critical team challenges to support members when problem solving throughout the project.

Use this document as a tool that:

- Keeps individual team members accountable to Project Team Goals
- Defines common expectations for everyone on the team (norms)

Directions

Our class is forming a Biotech Firm with different Project Teams each focusing on a specific plant compound.

1 Project Team Information	Team Name
	Role
	Name
	Phone
	Email
	Communications
	Communications
	Finance
	Finance
	Molecular Modeler
	Molecular Modeler

Continues next page >

Project Team Collaboration Agreement Capture Sheet

Continued

2	21st Century Skills Inventory	Name	Strengths	Areas of Growth

Continues next page >

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Project Team Collaboration Agreement Capture Sheet

Continued

3 Identifying Potential Barriers	<p>When answering the questions, consider these types of obstacles:</p> <ul style="list-style-type: none"> • personal style differences • work styles • learning styles • priorities and commitments • external pressures • personalities • differing expectations • conflict style (avoid or confront) • experience, • topical expertise • logistics • level of commitment • level of perfectionism • control and delegation • time management • scheduling 	<p>What are the most common mistakes that you see teams make?</p>
		<p>How do you think you can avoid those mistakes?</p>
		<p>What are your internal and external pressures?</p>

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Project Team Collaboration Agreement Capture Sheet

Continued

4 Set Team Performance Expectations	<p>These ground rules represent your common expectations of how people will interact on the team and must be clear, simple, and relevant.</p> <p><i>The questions and expectations shown here are examples. Please edit to make specific to your team's collaborative culture.</i></p>	<p>General Group Discussion Questions</p> <p>One thing that I expect from everyone on my team is...</p> <p>Regardless of the situation, we need to always...</p> <p>It is unacceptable for someone on this team to...</p> <p>How do we handle violations in "the grey area?"</p> <p>What happens if...</p> <p>Project Team Performance Expectations (add, remove, or modify as needed)</p> <p><i>Every team member shall, to the best of his or her ability:</i></p> <p>Strive to complete all assigned tasks before or by deadlines.</p> <p>Complete all tasks to the best of his or her ability.</p> <p>Listen carefully and attentively to all comments at meetings.</p> <p>Accept and give criticism in a professional manner.</p> <p>Focus on results before the fact, rather than excuses after.</p> <p>Provide as much notice as possible of problems with commitments.</p> <p>Attend and participate in all scheduled group meetings, real or virtual.</p>	
5 Our Commitment	<p>We collaborated to create the above norms and agreements. Our signatures indicate our commitment to utilize the norms above to communicate clearly and constructively while pursuing team goals.</p>	Signature	Date

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Preliminary Background Research Capture Sheet

Directions

Use this template to compile and share your Project Team’s preliminary findings.



Project Team Name

Be creative. Connect your team’s work at *Biotech Firm* to the plant on which you are focusing.

Place photo of the plant here	Communications	Name 1
		Name 2
	Finance	Name 1
		Name 2
	Molecular Modeling	Name 1
		Name 2

Continues next page >

Preliminary Background Research Capture Sheet

Continued



Communications Plant of Focus:
Team

Describe the plant ecology.	Where is the plant found on the planet?	
	Is this plant abundant or threatened?	
	Where is the plant found in the ecosystem?	
	How long does the plant live? How does it reproduce?	
Create a profile of diseases that it may treat.	Patient population <i>geographic ancestry</i>	
	Disease symptoms	
	Disease impacts on cells	
	Disease outcomes	

Continues next page >

Preliminary Background Research Capture Sheet

Continued



Finance Team Plant of Focus:

Which patients are impacted by the disease your plant compound treats?	Age of onset (if known)	
	Geographic ancestry (if known)	
	Gender/sex impacted (if known)	
	Any other facts to know	
Explore any indigenous community connections to the use of your specified plant.	What part of the world is your plant from?	
	Cultural connections and uses	
	Historical uses	
	Any other facts to know	

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Preliminary Background Research Capture Sheet

Continued



Molecular
Modeling Team

Plant of Focus:

Show how the plant molecule interacts with cells to change the disrupted cellular process using simple, labeled drawings.	Normal cellular process	How disease alters normal cell process	How plant compound interacts with a cell

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Gallery Walk Capture Sheet

Directions

Fill out one copy of this capture sheet for at least two other Project Teams' Preliminary Background Research as you explore the Gallery Walk.

Plant or Disease Name:		Why is this disease or plant treatment worthy of investment?	
Project Team Members:			
Plant Ecology		Patient Population or Disease Background Information	
Indigenous Community Connections and Historical Uses		Plant Molecule Interactions with Cell in Disease State	
What did you learn about this plant or disease that you did not realize before?		What questions or suggestions do you have for this Project Team as the students begin developing their communication plan, financial analysis, and molecular models?	

FUTURELAB+

Rubric for Biotech Lesson 6

Asking Questions and Defining Problems

Observable Features of the Background Research Presentation	Meets Expectations 8–10 points	Progressing 5–7 points	No attempt 0 points
Communications Team			
a. Identifies a plant from which a plant-based medicine is sourced and characterizes its ecology.			
b. Identifies a condition (or conditions) that the plant might address and discusses what is known about the patient population.			
Finance Team			
a. Describes demographic data about the patient population.			
b. Identifies Indigenous community connections to the medicinal plant.			
Molecular Modeling Team			
a. Describes how cells function in humans that are not impacted by the disease or condition.			
b. Describes how cells function in humans with the disease or condition.			
c. Describes how the plant compound interacts with the cell to change the impacts of the disease or condition on the cell.			
Final Score			
Grade			