Integrated STEM Unit Planner

Grade 4 Science

Model a Pollinator

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PreK-12STEM

Community Training & Assistance Center (CTAC)

Tracy Unified School District

About the Integrated STEM Units

The integrated STEM units are a product of the partnership between Community Training and Assistance Center (CTAC) and Tracy Unified School District (TUSD) in California, funded in part through the Education Innovation and Research (EIR) program of the U.S. Department of Education in 2018. Teacher leaders came together to develop innovative units that align to STEM standards for student learning—namely the Next Generation Science Standards (NGSS) for California Public Schools, the Computer Science Content Standards derived from the national K-12 Computer Science Framework, and the California Common Core State Standards.

Each integrated unit brings together the following:

- an engineering design challenge
- one or more computational artifacts
- core science and math content
- language building opportunities
- engagement supports

Students in each grade level, pre-kindergarten through twelve, engage with the unit for about one or two months as part of their required coursework. The units are integrated and self-contained as a means to provide all students with equitable STEM experiences.

About the Partners

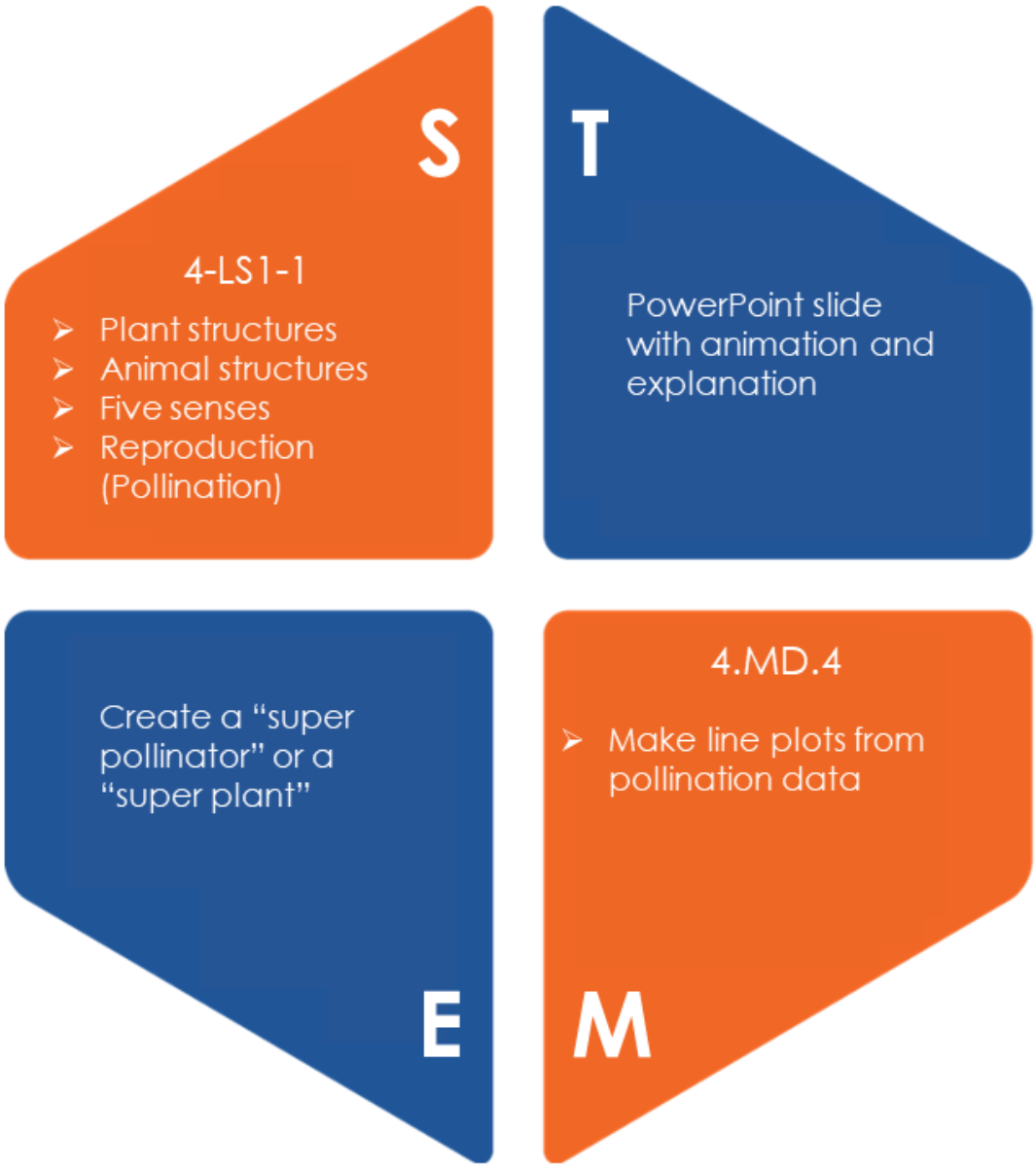
Community Training and Assistance Center (CTAC) is a national not-for-profit organization with a demonstrated record of success in the fields of education and community development. Tracy Unified School District, located in California's Central Valley, serves approximately 15,000 students. Fifty leading teachers from the district contributed to the development of the units. Computer Science integrations resulted with support from the San Joaquin County Office of Education and Bootstrap of Brown University.

Terms of Use

Contents

Big Picture

Unit Emblem



Focal Standard

4-LS1-1 Construct an argument that plants and animals have internal and external structures to support survival, growth, behavior, and reproduction. [Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.] [*Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems*.]

Overview

Sequence 1: Teachers engage students with an anchoring phenomenon that shows various plants (see resource folder). The unit connects to the California Native American tribes because their survival depended upon the animals and environment around them. Throughout the unit, students will discover the relationship between plants and animals. During the entry event, teachers present the driving essential question: How do plants and animals survive, grow, and reproduce? This question connects the concepts of all the supporting questions:

- How are specific structures of plants and animals important to its survival?
- How do animal systems help them respond to their environment?
- What type of information is transmitted through different animal senses?
- What role does light play in how animals and people see and respond to the environment?

Using the anchoring phenomenon of un-pollinated plants, student will be able to explain the importance of a healthy pollinating population, culminating in their own engineered plant or pollinator, the basis of the design challenge. Students will begin to ***ask*** questions about the challenge including: What plants have pollen or seeds that move? How do pollen or seeds move?

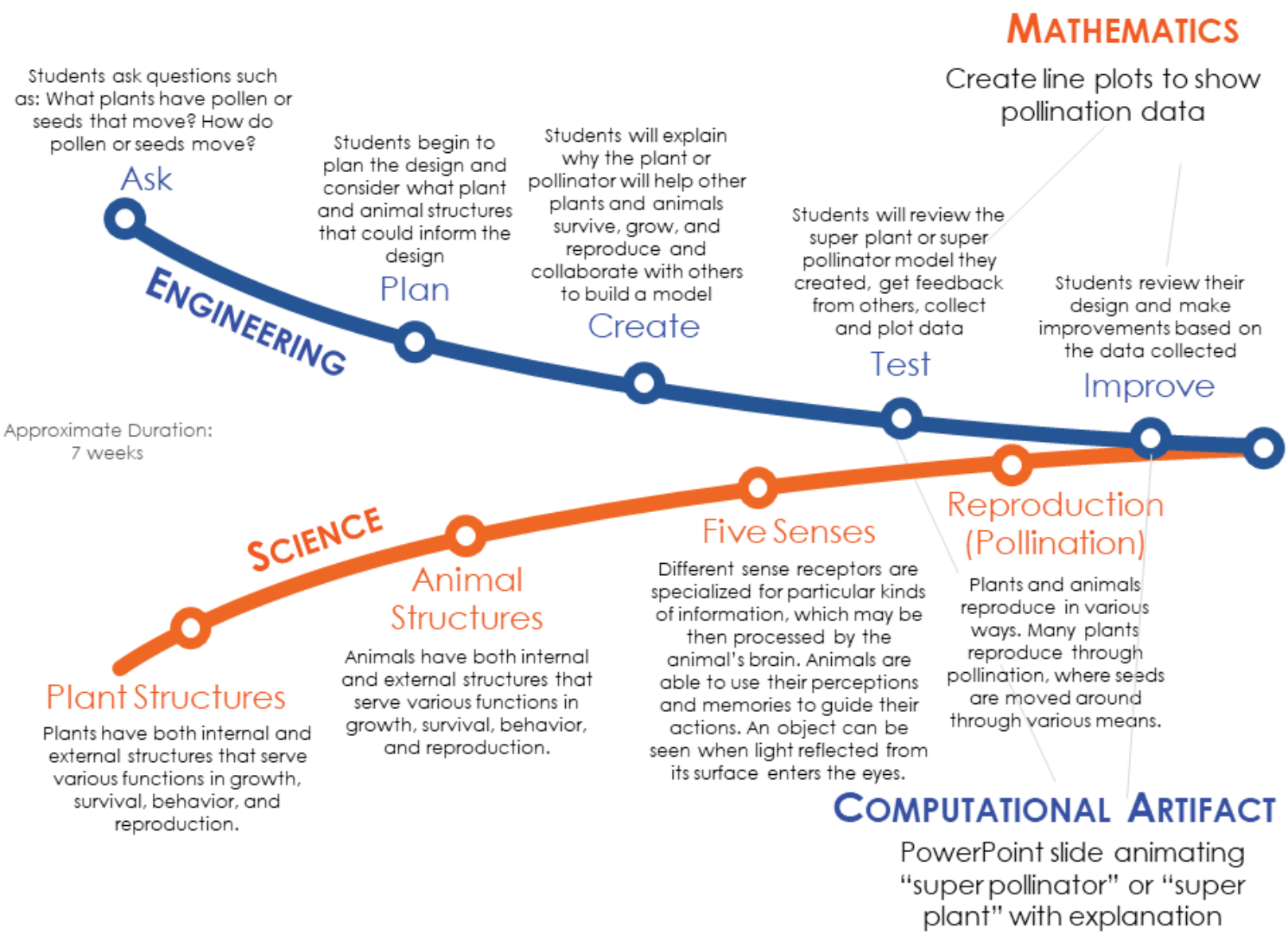
Sequence 2: The unit begins with the investigation of animal structures and the eye. The lessons progress to involve how animal senses and the brain tell animals how to respond to their environment. The unit includes pollinators, such as the bee and bat, how they interact with plants, and how plants and pollinators affect human food consumption. Using knowledge gained about pollination, students will ***plan*** their "super plant" or "super pollinator" to solve the problem that crops are not always pollinated.

Sequence 3: Students will work in small groups to ***create*** their plant or pollinator, using available materials, considering what structures should be in place for the most effective pollination. Students will begin to write a narrative story to explain how the structures and functions of plants and animals help them survive, and to tell the story of how the plant or pollinator that was created interacts with its environment.

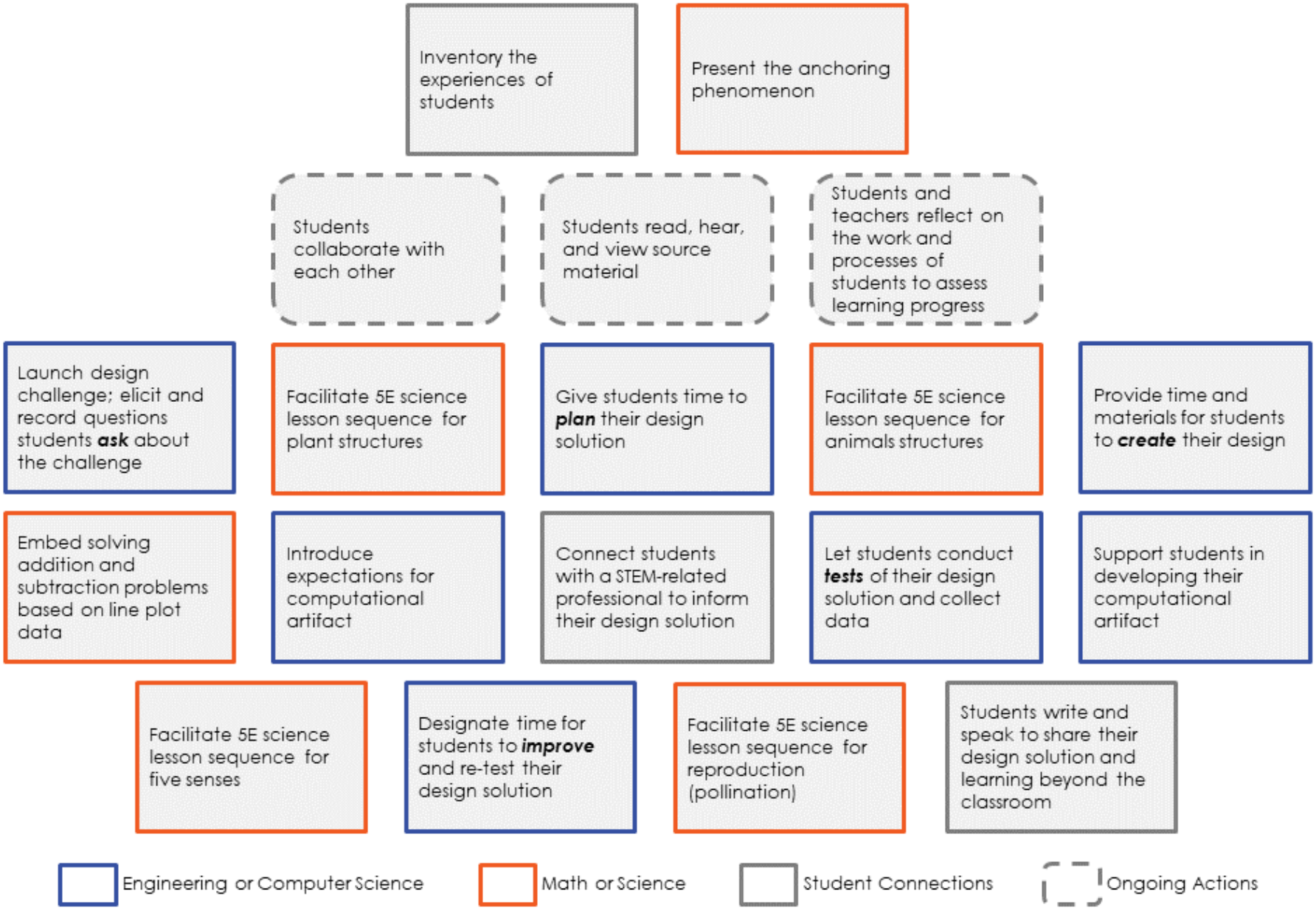
Sequence 4: Students then begin to ***test*** their prototype, collecting data in the form of feedback from others about the effectiveness of the design. Work continues on examining the five senses in animals, and how information is transmitted.

Sequence 5: Students reflect on their data and discussions and revise the plan to ***improve*** their model. Student will create a PowerPoint slide, animating the path a pollinator may take to a plant, as well as use a text box to explain how plants and pollinators need each other for survival, growth, and reproduction. Students will complete their narrative story to demonstrate an understanding of the systems and functions of a plant or animal. Students will use dialogue and transitional words to inform the reader of its systems and structures and how the plant or pollinator came to be "super". The story will be presented to second graders.

Integrated Unit Storyline



Integrated Unit Wayfinder



STEM Dive

Engineering

Design Challenge: Create a "super plant" or a "super pollinator" to solve the problem that plants are not always being pollinated.

Type of Engineering: Botanist

The Engineering Design Process (EDP) and Engineering Standards

EDP Step	Standard and Grade Band End Points from the *Framework*
Ask *What plants have pollen or seeds that move? How do pollen or seeds move?*	**3-5-ETS1-1.** Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. • Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)
Plan *Plan the design and consider what plant and animal structures that could inform the design*	**3-5-ETS1-2.** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. • Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) • At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)
Create *Students collaborate with others to build a model*	
Test *Collect feedback and data on the effectiveness of their design*	**3-5-ETS1-3.** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. • Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3) • Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)
Improve *Review the design and make improvements based on the data collected*	

Computer Science (Technology)

Computer Science Integrations

Description of Student Engagement

Students create a Microsoft PowerPoint slide to describe their "super plant" or "super pollinator".

Computational Artifact

Definition: Anything created by a human using a computational thinking process and a computing device. A computational artifact can be, but is not limited to, a program, image, audio, video, presentation, or web page file. (Source: College Board, 2016)

- Students create a Microsoft PowerPoint slide, animating the path a pollinator can take to a plant and including a text box to explain how many plants and pollinators depend on one another for survival, growth, and reproduction.

Hardware

Definition: The physical components that make up a computing system, computer, or computing device. (Source: MDESE, 2016)

- Computer

Software (includes programs, applications, websites, etc.)

Definition: Programs that run on a computing system, computer, or other computing device. (Source: k12cs.org)

- Microsoft PowerPoint

Standards

- **3-5.DA.8** Organize and present collected data visually to highlight relationships and support a claim.
- **3-5.DA.9** Use data to highlight and/or propose relationships, predict outcomes, or communicate ideas.

Science

Focal Standard

4-LS1-1 Construct an argument that plants and animals have internal and external structures to support survival, growth, behavior, and reproduction. [Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.] [*Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems*.]

Related Content Standards

4-LS1-2 Use a model to describe that animals receive different types of information through senses, process the information in their brain and respond to the information in different ways. [Clarification Statement: Emphasis is on systems of information transfer.] [*Assessment Boundary: Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function*.]

4-PS4-2 Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. [Assessment Boundary: Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.]

Anchoring Phenomenon

Teachers engage students with an anchoring phenomenon by viewing images that show various plants (see resource folder).

Content Outline

Below is a content outline for the science content in this unit. It includes the key concepts within the unit along with an approximate number of days it would take to facilitate a sufficient amount of student learning experiences. For each key concept, key learnings appear, which come from the grade band endpoints in *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (source: https://www.nextgenscience.org/framework-k-12-science-education). The storyline begins with an anchoring phenomenon.

Key Concept	Key Learnings	# of Days
Plant Structures	• Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)	8
Animal Structures	• Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)	8

Key Concept	Key Learnings	# of Days
Five Senses	• Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2) • An object can be seen when light reflected from its surface enters the eyes. (4-PS4-2)	8
Reproduction (Pollination)	• Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1) • Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2)	8

Science and Engineering Practices	Crosscutting Concepts
1. Asking questions and defining problems **2. Developing and using models** 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations and designing solutions **7. Engaging in argument from evidence** 8. Obtaining, evaluating, and communicating information	1. Patterns **2. Cause and effect** 3. Scale, proportion, and quantity **4. Systems and system models** 5. Energy and matter 6. Structure and function 7. Stability and change

Note. Bolded items are called out specifically in the standards cluster for this unit.

Mathematics

Description of Student Engagement

Students generate line plots of their data to represent how far the pollinators carry seeds.

Standards for Mathematical Content

4.MD.4 Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Solve problems involving addition and subtraction of fractions by using information presented in line plots. For example, from a line plot find and interpret the difference in length between the longest and shortest specimens in an insect collection**.**

Standards for Mathematical Practice

MP.1 Make sense of problems and persevere in solving them.

MP.2 Reason abstractly and quantitatively.

MP.3 Construct viable arguments and critique the reasoning of others.

MP.4 Model with mathematics.

MP.5 Use appropriate tools strategically.

MP.6 Attend to precision.

MP.7 Look for and make use of structure.

MP.8 Look for and express regularity in repeated reasoning.

Note. Bolded items are emphasized in this unit.

English Language Arts and Development

Reading Standard: Key Idea and Details

RI.4.1 Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

RI.4.2 Determine the main idea of a text and explain how it is supported by key details; summarize the text.

Reading Standard: Craft and Structure

RI.4.4 Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a grade 4 topic or subject area.

Writing Standard: Text Types and Purposes

W.4.3 Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.

Writing Standard: Production and Distribution of Writing

W.4.4 Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1-3 above.)

W.4.5 With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, and editing. (Editing for conventions should demonstrate command of Language standards 1-3 up to and including grade 4 here.)

Speaking and Listening Standard: Comprehension and Collaboration

SL.4.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.

Speaking and Listening Standard: Presentation of Knowledge and Ideas

SL.4.4 Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

SL.4.5 Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes.

Unit Vocabulary

The following terms reflect the core vocabulary students should understand and use in this unit.

- **behavior**: A behavior is anything that an organism does involving action and response to stimulation or the response of an individual, group, or species to its environment. (Source: https://www.merriam-webster.com/dictionary/behavior)

- **communication**: Communication is a process by which information is exchanged between individuals through a common system of symbols, signs, or behavior. (Source: https://www.merriam-webster.com/dictionary/communication)

- **depth perception**: Depth perception is the ability to judge the distance of objects and the spatial relationship of objects at different distances. (Source: https://www.merriam-webster.com/dictionary/depth%20perception)

- **ecosystem**: An ecosystem is a geographic area including all the living organisms (people, plants, animals, and microorganisms), their physical surroundings (such as soil, water, and air), and the natural cycles that sustain them. All of these elements are interconnected. Managing any one resource affects the others in that ecosystem. Ecosystems can be small (a single stand of aspen) or large (an entire watershed including hundreds of forest stands across many different ownerships). (Source: https://www.fws.gov/athens/ecoteams.html)

- **external structure**: External structures are the visible components of a plant or animal. This would include things like the stem, leaves, and flowers of plants and the arms, legs, eyes, and ears of animals.

- **field of view**: The field of view is the area visible through the lens of an optical instrument. (Source: https://www.merriam-webster.com/dictionary/field)

- **optical**: Optical means of or relating to vision. (Source: https://www.merriam-webster.com/dictionary/optical)

- **pictorial model**: A pictorial model illustrates the structures and elements of an organism or some of feature using pictures.

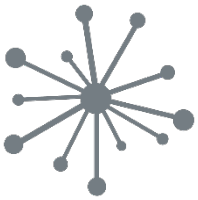
- **processes**: Processes are a series of actions, motions, or operations leading to some result. (Source: https://www.merriam-webster.com/dictionary/processes)

- **reproduction**: Reproduction is the process by which living things produce offspring. (Source: https://www.merriam-webster.com/dictionary/reproduction)

- **sense receptors (e.g., eyes, antennae, hair)**: Sense receptors are structures that are used by plants and animals to bring information in from their environment and use it to alter behavior or make decisions about what to do. For example, an ant may use antennae pick up a small scent and help it follow a scent trail to a food source. A Venus Fly Trap may sense a fly in its flower through touch sensors, and close up to allow it to digest the fly. And, humans can hear a loud noise, alerting them to potential dangers nearby.

- **survival**: Survival is the continuation of life or existence. (Source: https://www.merriam-webster.com/dictionary/survival)

Assessment Tools



Student Experience Inventory

Teachers can use the following prompts with students prior to the beginning of the unit or early in the unit in order to learn about students' experiences that relate to the unit. Teachers can make informed instructional decisions based on this learning, enabling tailored opportunities for students to make their own meaning.

Student Prompts

1. What is a plant or animal that you really like? Describe it for me.
2. Tell me about a pet you have or someone you know has (or one you have seen before). What are some of the different behaviors you have noticed?
3. Tell me about a time you turned a light on—any kind of light. What do you remember happened to what you could see?

Aligned Learnings

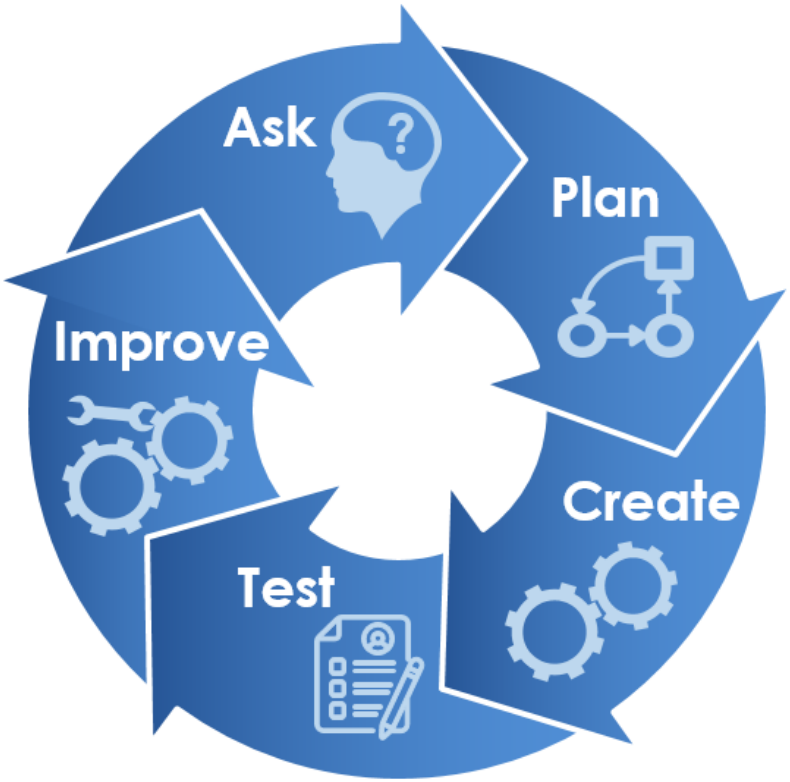
1. Responses to this item provide insight into students' experiences with plant and animal structures that support life functions. 4-LS1-1
2. Responses to this item provide insight into students' experiences with animal behaviors. 4-LS1-2
3. Responses to this item provide insight into students' experiences with the impact of light on vision. 4-PS4-2

Student Self-Assessment of Engineering

Improve:
Here is what would make my design better and why…

Ask:
Here is what I am wondering about before I plan my design…

Plan:
Here are my design ideas for the project…



Test:
Here are the data I collected…

Create:
Here is what I think about what I made compared to what I planned, and here is what I think will happen when I test it…

I am doing the work of a bioengineer.

One-Point Design Challenge Rubric

Criteria serve as a primary reference point throughout the engineering design process. Teachers use the criteria **to communicate expectations** and **to guide students**. With teacher guidance, students use the criteria to inform and reflect on their work.

Approaches Expectations *Notes on how to improve the project*	**Meets Expectations** *Criteria indicating success*	**Exceeds Expectations** *Notes on how project goes beyond expectations*
	Engineering Students participate in the 5-part engineering design process, use data, and make thoughtful improvements to their design. (3-5-ETS1-1, 3-5-ETS1-2, 3-5-ETS1-3)	
	Computer Science The computational artifact shows student success in using the animation and text box features of PowerPoint; the animation is 5-10 seconds in length (3-5.DA-8, 3-5.DA.9)	
	Collaboration Students contribute and support others with honesty and kindness. (SL.4.1.A-D)	
	Communication Students speak and write using target vocabulary to share thoughts and read (W.4.3, W.4.5, W.4.5) and listen to learn from others. (SL.4.4, SL.4.5)	
	Science Students accurately label the structures of the animal/ plant on a diagram, drawing or models as part of a design plan and explain with evidence why their plan/model will be effective. (4-LS1-1, 4-LS1-2, 4-PS4-2)	

Engagement

Community and Career Connections

During the unit, students engage with STEM professionals who can inform students' work at some point during the engineering design process. The interaction with STEM professionals serves a few purposes:

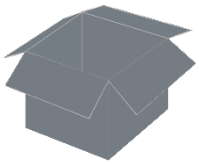
- Expose students to STEM as it applies in various careers
- Enrich student learning through collaborating with STEM professionals
- Help students see themselves doing the actual work of STEM

Below are a few potential STEM-related professionals that align to one of California's 15 industry sectors for Career and Technical Education:

- **Botanist** (Agriculture and Natural Resources)
- **Park Ranger** (Hospitality, Tourism and Recreation)
- **Pediatrician** (Health Science and Medical Technology)

The interactive experience will ideally be co-constructed by the teacher and professional. In coordinating with the professional, a few questions appear below that can be used to guide the planning and live interaction with students:

- **Botanist** (Agriculture and Natural Resources)
  - What changes have you seen in plant reproduction in recent years due to a reduction in pollinators?
  - What is being done to try to increase the number of pollinators?
  - Are there any kinds of plants that can be used help increase the number of pollinators in a field?
  - Is there anything the average person can do to increase pollinators?
- **Park Ranger** (Hospitality, Tourism and Recreation)
  - What changes have you seen in the number and variety of plants and animals you see in the park that you serve?
  - Do you record data on any changes that you see and what is done with that data?
  - What would you like people to know about how they interact with and may disrupt the environment in your park?
  - What does a typical day on the job look like?
  - What is one problem you are currently facing in your day-to-day work?
- **Pediatrician** (Health Science and Medical Technology)
  - What kinds of sensory problems do you often see in children?
  - How are sensory problems diagnosed in children when they are too young to speak?
  - What additional support do you provide to children who are deaf or have vision issues?
  - What are some things parents can do to protect the vision and hearing of their children?



Materials List

The items in the materials list below reflect total quantities for a class of 32 students, allowing for 8 groups of 4 students.

Consumable Equipment (classroom totals):

- ☐ 180 pipe cleaners
- ☐ 150 craft sticks
- ☐ 5 (2 ounce) bags of Cheetos®
- ☐ 30 rolls of clear tape
- ☐ 120 Q-tips or cotton swabs
- ☐ 180 Googly eyes
- ☐ 1 skein of yarn
- ☐ 90 cotton balls
- ☐ 150 paper straws
- ☐ 90 snack bags
- ☐ 30 envelopes

Distance Learning Modifications

In distance learning, the design challenge will be conducted by students individually at home. Student collaboration will need to occur remotely with a modified materials list.

Modified Materials List (student totals):

- ☐ 6 pipe cleaners
- ☐ 5 craft sticks
- ☐ 1 (2 ounce) bags of Cheetos®
- ☐ 1 roll of clear tape
- ☐ 4 Q-tips or cotton swabs
- ☐ 6 Googly eyes
- ☐ 1 meter of yarn
- ☐ 3 cotton balls
- ☐ 5 paper straws