

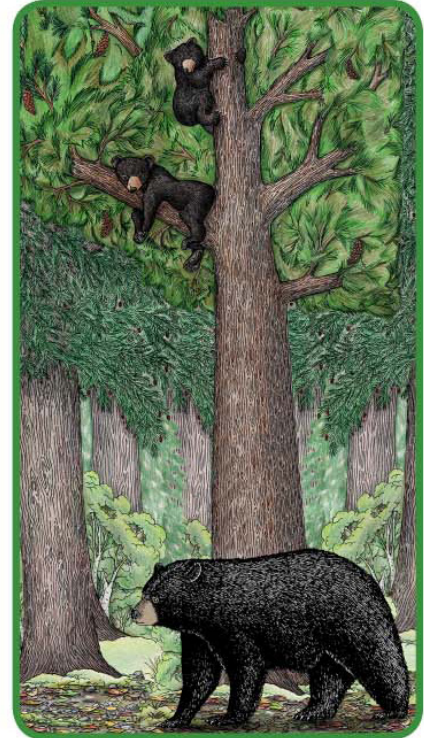
3 Disciplinary Core Ideas (DCI) for Growth and Development of Organisms



Parents feed offspring.



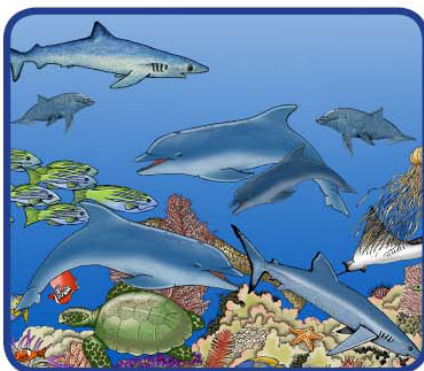
Parents groom offspring to protect them from insects and parasites.



Parents teach offspring protective behaviors.



Parents protect offspring from predators.



Parents work as group to protect offspring.



Parents build nests, dens or burrows to house offspring.



3 DCI for Growth and Development of Organisms

Science Bundle for the Grade 6-8 NGSS

From Molecules to Organisms: Structures and Processes



This bundle includes 24 resources about Growth and Development of Organisms including: Reading, Color Diagrams, Activities, Performance Tasks and Assessment (42 pages total). Copyright © 2020 Sheri Amsel • All rights reserved by author. Permission to copy for classroom use only. Electronic distribution limited to classroom use only.

Resources included in this Next Generation Science Standards Bundle include:

- Next Generation Science Standards covered in this Bundle
- Rubric Building Resource on how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction (1 page)
 - 1) Growth and Development of Organisms - Reproductive Behaviors - Reading (1 page)
 - 2) Animal Behaviors that Affect the Probability of Successful Reproduction Diagram (1 page)
 - 3) Increasing the Odds of Reproduction - Critical Thinking with Possible Responses (2 pages)
 - 4) Animal Behaviors that Affect the Probability of Successful Reproduction - Black Bears - Reading (1 page)
 - 5) Animal Behaviors that Affect the Probability of Successful Reproduction - Black Bears - Diagram (1 page)
 - 6) How Black Bears Increase the Odds of Reproductive Success - Research and Present (1 page)
 - 7) Characteristic Animal Behaviors that Increase Odd of Reproduction - Diagram (1 page)
 - 8) Animal Behaviors that Affect the Probability of Successful Reproduction - Barn Swallows - Diagram (1 page)
 - 9) Successful Reproduction in Barn Swallows - Critical Thinking with Possible Responses (2 pages)
 - 10) Nesting Behaviors that Affect the Probability of Successful Reproduction - Critical Thinking Activity with Possible Responses (3 pages)
 - 11) Animal Behaviors that Affect the Probability of Successful Reproduction in Bullfrogs Reading and Diagram (2 pages)
 - 12) Bullfrog Reproductive Behavior - Authentic Performance with Possible Responses Key (2 pages)
 - 13) Animal Behaviors that Affect the Probability of Successful Reproduction in Monarch Butterflies Reading and Diagram (2 pages)
 - 14) Monarch Butterflies Reproductive Behavior - Authentic Performance with Possible Responses Key (2 pages)
 - 15) Growth and Development of Organisms - Plant Reproduction Reading (1 page)
 - 16) Pollination in Flowering Plants - Close-Up Diagram (1 page)
 - 17) Life Cycle of a Flowering Plant (Deciduous Tree) Diagram (1 page)
 - 18) Spreading Seeds Diagram (1 page)
 - 19) Plants Depending on Animals - Scientific Reasoning with Possible Responses Key (2 Pages)
 - 20) Plants Depend on Animals for Pollination and Seed Dispersal - Diagram (1 page)
 - 21) Plants Depending on Animals II - Scientific Reasoning with Possible Responses Key (2 pages)
- Rubric Building Resource for Genetic factors as well as local conditions affect the growth of the adult plant. (1 page)
 - 22) Acid Rain - How Environmental Factors can Influence the Growth of Organisms Reading and Diagram (2 pages)
 - 23) The Rodent, Bee, and Brazil Nut Tree - Growth and Development of Organisms - Reading with Diagram. (2 pages)
 - 24) Brazil Nut Tree Life Cycle - Authentic Performance with Possible Responses (2 pages)

NEXT GENERATION SCIENCE STANDARDS

Disciplinary Core Ideas

LS1.B: Growth and Development of Organisms

- Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)
- Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5)

Science and Engineering Practices

Engaging in Argument from Evidence

Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

- Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.)

Crosscutting Concepts

Cause and Effect

- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Performance Expectations: Students who demonstrate understanding can:

MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. *[Clarification Statement:*

Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]

Performance Expectations: Students who demonstrate understanding can:

MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. *Clarification Statement: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.*

[Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.]

Rubric Building Resource:

*Observable features of student performance by the end of the grade:

LS1.B: Growth and Development of Organisms – Animals engage in characteristic behaviors that increase the odds of reproduction. • Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.

Performance Expectations - Students who demonstrate understanding can:

MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

1. Supported claims

a. Students make a claim to support a given explanation of a phenomenon. In their claim, students include the idea that characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

2. Identifying scientific evidence

a. Students identify the given evidence that supports the claim (e.g. evidence from data and scientific literature), including:

- i. Characteristic animal behaviors that increase the probability of reproduction.
- ii. Specialized plant and animal structures that increase the probability of reproduction.
- iii. Cause-and-effect relationships between:

1. Specialized plant structures and the probability of successful reproduction of plants that have those structures.

2. Animal behaviors and the probability of successful reproduction of animals that exhibit those behaviors.

3. Plant reproduction and the animal behaviors related to plant reproduction.

3. Evaluating and critiquing the evidence

a. Students evaluate the evidence and identify the strengths and weaknesses of the evidence used to support the claim, including:

- i. Validity and reliability of sources.
- ii. Sufficiency — including relevance, validity, and reliability — of the evidence to make and defend the claim.
- iii. Alternative interpretations of the evidence and why the evidence supports the student's claim, as opposed to any other claims.

4. Reasoning and synthesis

a. Students use reasoning to connect the appropriate evidence to the claim, using oral or written arguments. Students describe the following chain of reasoning in their argumentation:

- i. Many characteristic animal behaviors affect the likelihood of successful reproduction.
- ii. Many specialized plant structures affect the likelihood of successful reproduction.
- iii. Sometimes, animal behavior plays a role in the likelihood of successful reproduction in plants.
- iv. Because successful reproduction has several causes and contributing factors, the cause-and-effect relationships between any of these characteristics, separately or together, and reproductive likelihood can be accurately reflected only in terms of probability.

Growth and Development of Organisms - Reproductive Behaviors

Animals engage in characteristic behaviors that increase the odds of reproduction.

In **mammals**, females give birth to a small number young that are generally small and helpless at birth, yet they survive. This is because mammals feed and protect their young until they can survive on their own. Females produce milk (lactate) that they feed to their young (nursing) until the young can find and eat food on their own. Mammals provide a safe living space where they watch over young until they can survive out in the world. This might be a nest, den or burrow, a mother's protective pouch, or just a central place in the protective herd. Mammals also teach their young techniques for finding food and escaping predators, before they go out on their own.

Birds are born in hard-shelled eggs. Most bird parents build a nest in a tree, burrow, or tree hole and incubate the eggs with their own body heat to keep them warm and safe until they hatch. Hatchling birds are small and helpless. The parents bring them food and continue to keep them warm and dry. Birds will also teach their young how to get food and avoid danger. They will stay with them until they can fly, swim or run away on their own.

Amphibians include frogs, toads and salamanders. They lay a large number of soft eggs in the water. Most amphibians do not watch over their eggs or keep them safe after they hatch. Only a few hatchlings survive - but usually some *do* survive. The large number of eggs produced is their successful reproductive behaviour.

Reptiles include snakes, lizards and turtles. They lay a large number of leathery eggs on land buried in the sand, soil or brushpile. Most do not watch over their eggs or keep them safe after they hatch. Only a few hatchlings survive - but usually some *do* survive. The large number of eggs produced is their successful reproductive behaviour. Hatchlings dig out of their nest and make their own way to safety. Some reptile parents, such as the American alligator, do watch over the nest and hatchling for a while. This helps more offspring survive.

Insects lay many, many eggs on plants (or animals) on which their offspring can feed when they hatch. This gives them a chance to feed and grow. Insect parents usually do not watch over their eggs or keep them safe after they hatch. Only a few hatchlings survive - but usually some *do* survive. The large number of eggs produced is their successful reproductive behaviour.

Think about these different groups of animals and how each has their own characteristic behaviors that increase the odds of reproduction.

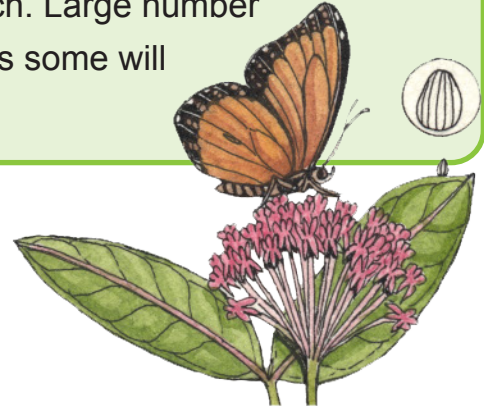
Animal Behaviors that Affect the Probability of Successful Reproduction

LS1.B Growth and Development of Organisms: Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)

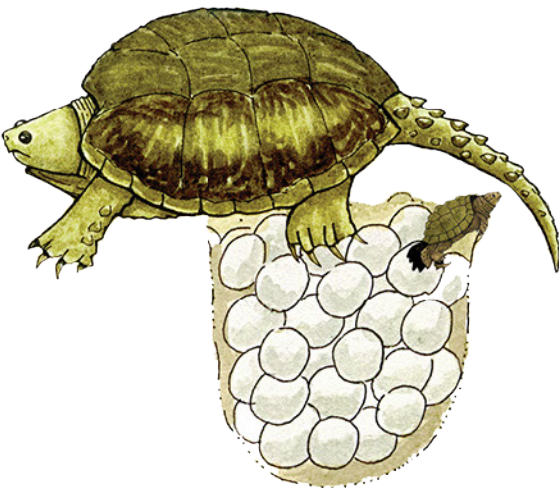
Amphibians: Lay many soft eggs in the shallow water so they won't dry out. They all hatch at once.



Insects: Lay many, many eggs on plants (or animals) on which offspring can feed once they hatch. Large number of eggs insures some will survive.

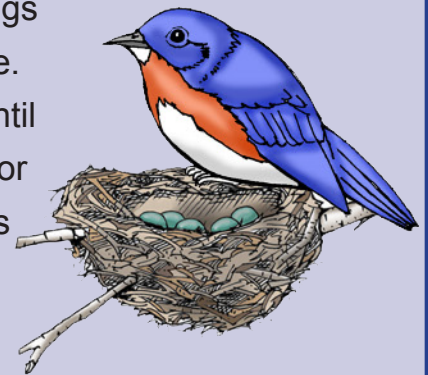


Reptiles: Lay many leathery eggs in a hole dug in sand or soil above water line. Large number of eggs insures some will survive.



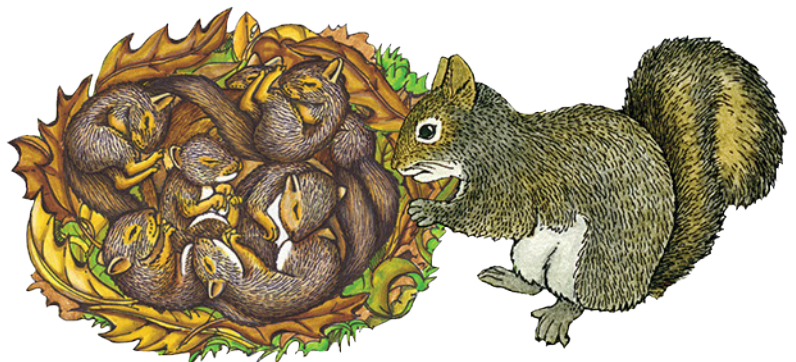
Birds:

- Build nests and incubate eggs to keep them warm and protected until they hatch.
- Keep new hatchlings warm, fed and safe.
- Stay with young until they can fly, swim or run from predators and find food on their own.



Mammals:

- Nurse young on protein rich milk.
- Provide safe living space.
- Protect them from threats.
- Teach them to find food and avoid predators until they are independent.



Increasing the Odds of Reproduction - Critical Thinking

Animals engage in characteristic behaviors that increase the odds of reproduction. Think about the different groups of animals and how each has their own characteristic behaviors with their offspring. Choose an animal from each group (e.g. squirrel, robin, bullfrog, painted turtle, grasshopper), research and compare how it's parental behaviors might affect its offspring's' survival.

Mammals

Birds

Amphibians

Reptiles

Insects

Increasing the Odds of Reproduction - Critical Thinking (Possible Responses)

Animals engage in characteristic behaviors that increase the odds of reproduction. Think about the different groups of animals and how each has their own characteristic behaviors with their offspring. Choose an animal from each group (e.g. squirrel, robin, frog, painted turtle, grasshopper), research and compare how it's parental behaviors might affect its offspring's survival.

Mammals

A squirrel builds a nest in which it has its young. It lines it with soft fur that it pulls from its own pelt. It then keeps them warm and dry and nurses them for several weeks. They will learn foraging and survival behaviors from the parent or other squirrels before going out on their own.

Birds

A robin builds a nest in which it lays its eggs. It then incubates them (keeps them warm) until they hatch and then uses its body to keep them warm and dry. It, along with its mate. It will then each insects and worms, partially digest them, and then regurgitate it up for their young to eat. They stay with them until they are old enough to fly away (fledge).

Amphibians

Bullfrogs lay a mass of eggs in the shallows of a pond, lake, wetland, or even a muddy puddle so they won't dry out. They do not wait for the eggs to hatch or protect their young generally (some species of frogs do carry their eggs on their backs where the tadpoles hatch and stay until they start to develop).

Reptiles

Painted turtles lay a several dozen leathery of eggs in a hole they dig in sand or soil on the shore above the waterline. They do not wait for the eggs to hatch or protect their young.

Insects

Grasshoppers lay masses of eggs just under the soil. They do not wait for the eggs to hatch or protect their young.

Animal Behaviors that Affect the Probability of Successful Reproduction in Black Bears

Black bear females give birth to their young while in their dens in a deep sleep – called *torpor*. The cubs stay snuggled up to their mother for warmth, **nursing on her protein-rich milk** until spring. When spring arrives, the female leads her small cubs out of the den and introduces them to the outside world. They will learn about **foods they can eat**, how to locate them and, in the case of fish, catch them. She will keep nursing them for almost eight months while they are learning. They will learn about **predators**, such as coyotes, mountain lions, and male bears, and other things that can hurt them. She will teach them to climb large trees to **escape danger** and they will practice staying up in the branches while she feeds on the ground nearby. They will learn to note these *babysitter trees* and will climb them when they feel threatened. The female bear will **groom her cubs**, licking off burrs and cleaning cuts and injuries. A mother bear knows the **sounds her cubs make when they are hungry** or frightened and will lead them to a safe place to nurse. If her cubs **call out in fear or distress** she will come running to protect them. This is why it's important to never get between a female bear and her cubs.

The female bear will *wean* (stop nursing) her cubs in their first fall. By then, the cubs have learned the foods they need to eat to fatten themselves up for winter. They will stay with her in her den that second winter, but in the spring, when they are about a year and a half old, she will chase them away to start lives of their own.

Each of these behaviors of the female bear affect the probability of keeping her young alive – so increase the chances of successful reproduction.

Mammals generally have fewer young over their lifetime than other kinds of animals, but spend the most amount of time and effort protecting and training them until they can survive on their own. Think about each of the things the female black bear does to increase the probability of her young surviving. Compare her behaviors to other mammals, such as a squirrel, deer, or even a human.

Performance Expectations - Students who demonstrate understanding can:

MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

Animal Behaviors that Affect the Probability of Successful Reproduction in Black Bears

Parents groom offspring to protect them from insects and parasites.

Parents teach offspring protective behaviors.

Parents build dens to house offspring until they are old enough to be out in the world.

Parents protect offspring from predators.

Parents feed offspring and teach them to find their own food.

How Black Bears Increase the Odds of Reproductive Success

Research and Present

Think about the different behaviors that female bears do to protect their young. Prepare a presentation using scientific reasoning that demonstrates how these behaviors help with reproductive success. Do research about black bears. Gather evidence and state an argument about those behaviors and how they affect reproductive success. Use the following questions to guide your research:

- 1) How do specific behaviors of the female bear affect the **success of her cubs' survival**?
- 2) What **empirical evidence** and **scientific reasoning** supports an explanation for how these behaviors affect reproductive success?
- 3) Discuss situations where the bear's behaviors with her cubs might not help them survive a change in their environment (e.g. forest fires, raiding campgrounds, confronting humans, etc.)
- 4) Develop a **visual aid** to help clarify your argument supporting your explanation.
- 5) Take some notes below and proceed.

Performance Expectations - Students who demonstrate understanding can:

MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

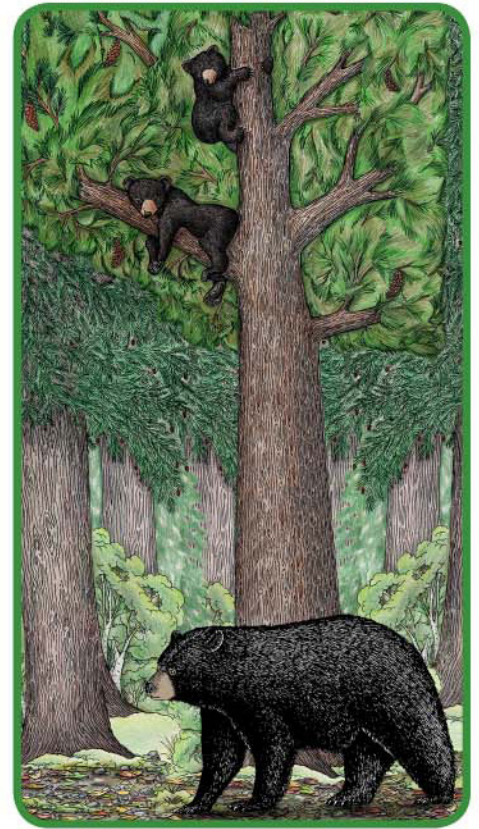
Characteristic Animal Behaviors that Increase Odds of Reproduction



Parents feed offspring.



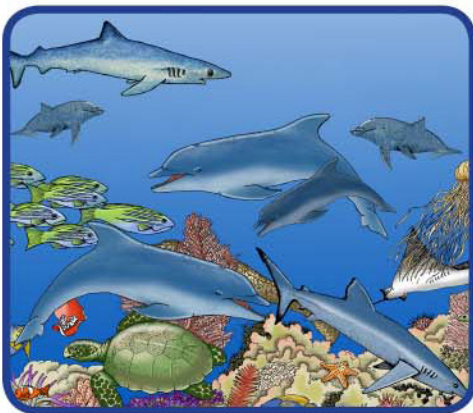
Parents groom offspring to protect them from insects and parasites.



Parents teach offspring protective behaviors.



Parents protect offspring from predators.



Parents work as group to protect offspring.



Parents build nests, dens or burrows to house offspring.

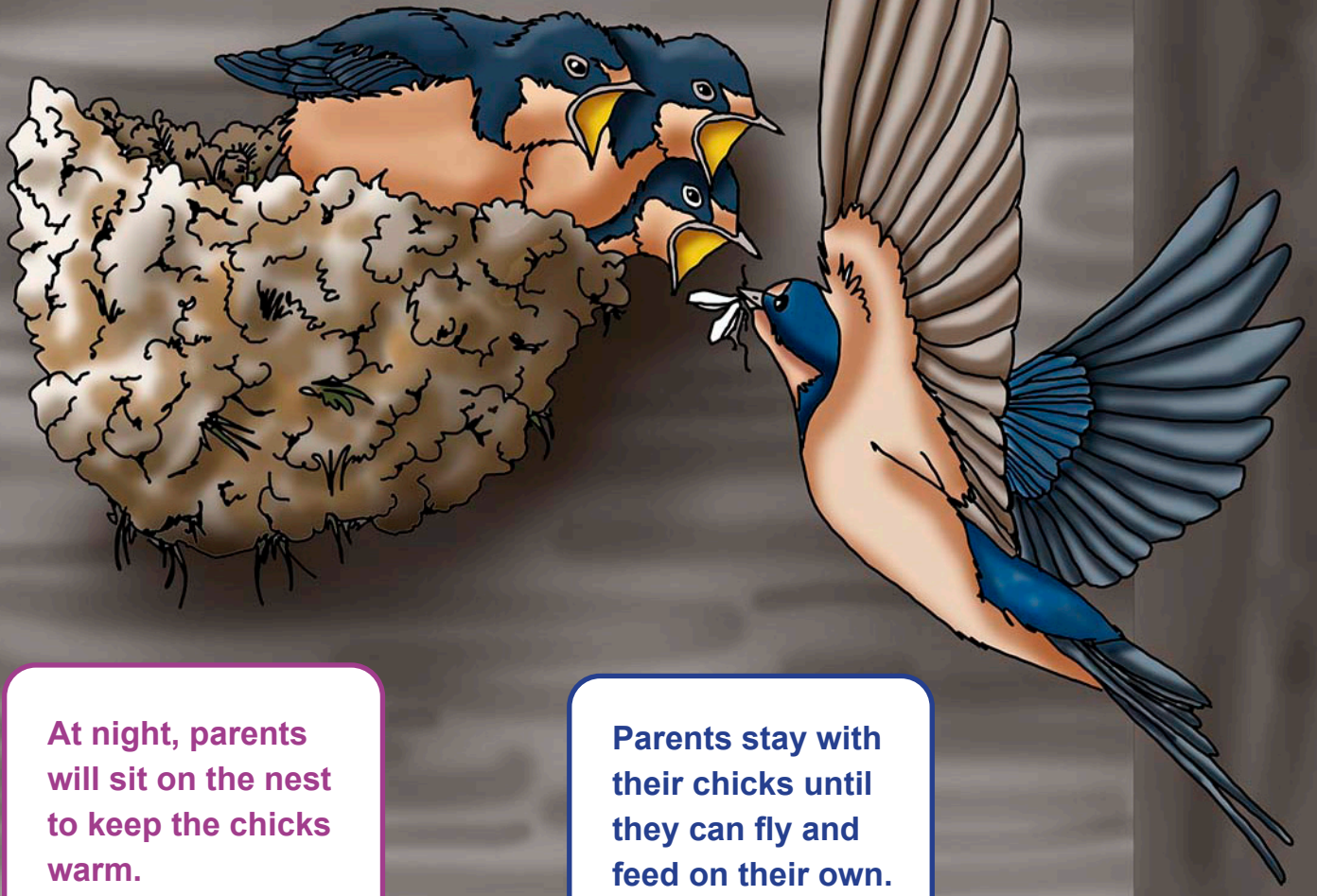


Animal Behaviors that Affect the Probability of Successful Reproduction in Barn Swallows

Parents work together to build an open cup nest of mud and grass up under an overhang or on a ledge or shelf.

Both parents incubate the eggs to keep them warm.

Once the chicks hatch, the parents take turns bringing them insects to eat.



At night, parents will sit on the nest to keep the chicks warm.

Parents stay with their chicks until they can fly and feed on their own.

Performance Expectations - Students who demonstrate understanding can:

MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

Successful Reproduction in Barn Swallows - Critical Thinking

Barn swallow parents work together to **build an open cup nest** of mud and grass up under an overhang or on a ledge or shelf under porches, in barns and under bridges. They line nests with grass stems and feathers. Swallows will also nest in nest boxes put out in open fields. Both parents **incubate the eggs** to keep them warm. Once the chicks hatch, the **parents take turns bringing them insects** to eat. When a parent approaches the nest, the chicks raise their heads, open their mouths and peep loudly. Parents stuff insects into the chicks' open mouths. When they've had enough to eat, the chicks settle down to rest. At night, when it's colder, the **parents sit on the nest to keep the chicks warm**. They stay with their chicks until they can fly and catch insects on their own.

Using scientific reasoning, list how the behaviors of swallows affects the success of chick survival?

1) Nest shape and location: _____

2) Both parents taking turns incubating the eggs: _____

3) Both parents taking turns feeding the chicks: _____

4) The chicks responding to parents' approach with food: _____

5) Both parents staying with chicks until they can fly and catch insects: _____

LS1.B Growth and Development of Organisms: Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)

Successful Reproduction in Barn Swallows - Critical Thinking (Possible Responses)

Barn swallow parents work together to **build an open cup nest** of mud and grass up under an overhang or on a ledge or shelf under porches, in barns and under bridges. They line nests with grass stems and feathers. Swallows will also nest in nest boxes put out in open fields. Both parents **incubate the eggs** to keep them warm. Once the chicks hatch, the **parents take turns bringing them insects** to eat. When a parent approaches the nest, the chicks raise their heads, open their mouths and peep loudly. Parents stuff insects into the chicks' open mouths. When they've had enough to eat, the chicks settle down to rest. At night, when it's colder, the **parents sit on the nest to keep the chicks warm**. They stay with their chicks until they can fly and catch insects on their own.

Using scientific reasoning, list how the behaviors of swallows affects the success of chick survival?

1) Nest shape and location: Nests built under the eaves of a porch, bridge, or barn protects the eggs and then the chicks from rain, direct sun, wind and predators that can climb trees. The cup shape helps keep growing chicks in the nest after they start to grow and move more.

2) Both parents taking turns incubating the eggs: The parents taking turns incubating the eggs means that they are always kept warm and dry and protected from predatory birds (crows or cuckoos).

3) Both parents taking turns feeding the chicks: The parents taking turns feeding the chicks means more food reached their offspring. It also allows the parents to not get worn out by parenting. If one parent is killed while raising young, there is still one parent to take care of them until they fledge.

4) The chicks responding to parents' approach with food: The aggressive nature of the chicks response to a parent approaching with food may affect who gets fed first. Potentially this could mean getting more food than a sibling.

5) Both parents staying with chicks until they can fly and catch insects: Both parents feeding, protecting, training, and monitoring chicks until they can fly and find food, helps give chicks a huge advantage toward surviving to adulthood.

LS1.B Growth and Development of Organisms: Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)

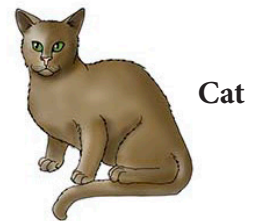
Nesting Behaviors that Affect the Probability of Successful Reproduction

There are many threats that nesting songbirds face when raising young. Hawks and crows patrol from the sky looking for unattended and accessible chicks. Weasels climb trees to steal eggs and/or chicks from their nests. House cats prey on fledging chicks in trees and on the ground. A cold snap, excessive heat, heavy rain or wind can wipe out a whole nest of chicks. Birds build nests to try and protect against threats. On answer sheet, assess the threat from each of these predators and weather factors (on right) to each of the 3 different kinds of nests (on left), using scientific reasoning.

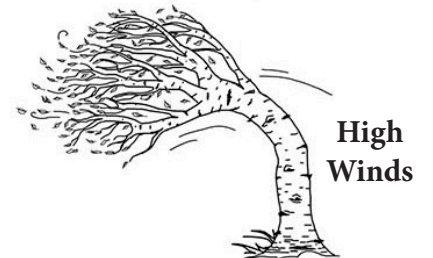
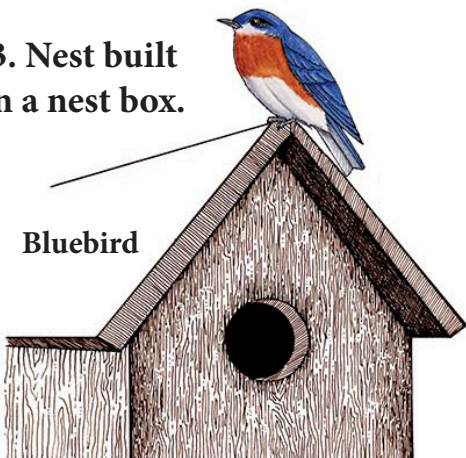
1. Nest built in trees.



2. Nest built under porch eaves.



3. Nest built in a nest box.



Performance Expectations: Students who demonstrate understanding can: MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

Nesting Behaviors that Affect the Probability of Successful Reproduction - Critical Thinking

Use scientific reasoning to describe how each of the following nesting locations would be affected by the different predators and weather factors.

1) Nest in trees: _____

2) Nest under porch eaves: _____

3) Nest in nesting box: _____

LS1.B Growth and Development of Organisms: Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)

Nesting Behaviors that Affect the Probability of Successful Reproduction (Possible Responses)

Use scientific reasoning to describe how each of the following nesting locations would be affected by the different predators and the three weather factors.

1) Nest in trees: Nests in trees would be vulnerable to weasels and cats that can climb into the branches and reach them. They would also be vulnerable to a cold snap, heavy rain or high wind. They might do better in a heat wave as tree foliage would provide shade, while allowing wind to come through. Depending upon the kind of tree the nests are built in and how open the forest cover is, they could be vulnerable to hawks and crows.

2) Nest under porch eaves: Nests build under porch eaves are protected from rain, sunlight and wind. They would still be vulnerable to a cold snap or even an extreme heat wave. They would be out of sight of hawks and crows, but it would be possible for a weasel to climb up and attack them. There is also a bigger chance for there to be house cats around that might pounce on fledging offspring.

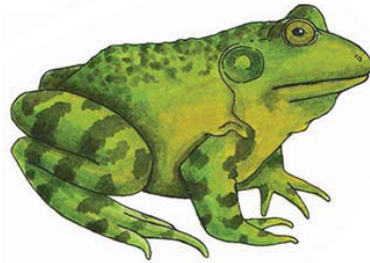
3) Nest in nesting box: Nests in nest boxes are protected from rain, sunlight and wind, but they would still be vulnerable to a cold snap or a heat wave. Nesting boxes are out in the sun, so extreme heat can be very dangerous to the chicks inside. The chick in a nest box would be out of sight to hawks and crows. It would be possible for a weasel to climb up and get them. There could be house cats around that might pounce on fledging offspring.

LS1.B Growth and Development of Organisms: Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)

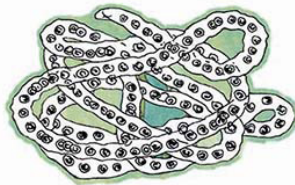
Animal Behaviors that Affect the Probability of Successful Reproduction in Bullfrogs

If you have ever lived near a pond, you may have heard the **deep, loud call** of the American bullfrog as it calls to a mate. Bullfrogs mate in the spring and the **females lays thousands of eggs** in the shallow water near shore. This **keeps them from drying out**, but also **protects them from hungry fish** found deeper in the pond. The **eggs hatch all at once**, forming a profusion of movement that makes them difficult to isolate for predators. Still, only a few tadpoles survive to become adults. They have gills at first, so don't need to come to the surface to breathe. They can hide among the pond vegetation and eat small insects. As they grow and go through the metamorphosis toward their adult form, their **mottled coloring is good camouflage**, hiding them from fish and hungry birds. By the time they reach their impressive adult size, they have developed lungs to breath air and **powerful legs to launch themselves after prey** - fish, worms, insects, small ducks, other frogs, and even turtles.

Male bullfrogs have a deep, loud call that attracts females to mate.



Tadpoles breathe through gills so never have to come near the surface of the water until they are adults.

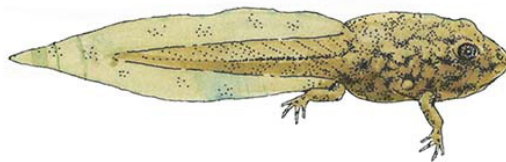
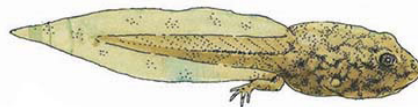


Bullfrogs lay thousands of eggs in the shallow water near shore where they won't dry out.



Bullfrog tadpoles have camouflage coloring.

All the eggs hatch at once.

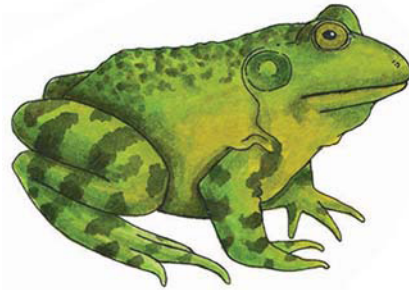


Bullfrogs develop powerful back legs to launch themselves after prey and escape predators.

LS1.B Growth and Development of Organisms: Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)

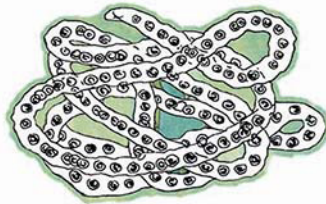
Animal Behaviors that Affect the Probability of Successful Reproduction in Bullfrogs

Male bullfrogs have a deep, loud call that attracts females to mate.



Tadpoles breathe through gills so never have to come near the surface of the water until they are adults.

Bullfrogs lay thousands of eggs in the shallow water near shore where they won't dry out and hungry fish can't reach them.



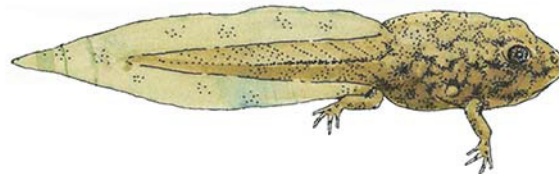
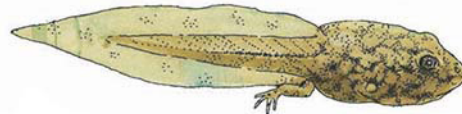
Bullfrog tadpoles have camouflage coloring.



All the eggs hatch at once forming a profusion of movement that makes them difficult to isolate for predators.



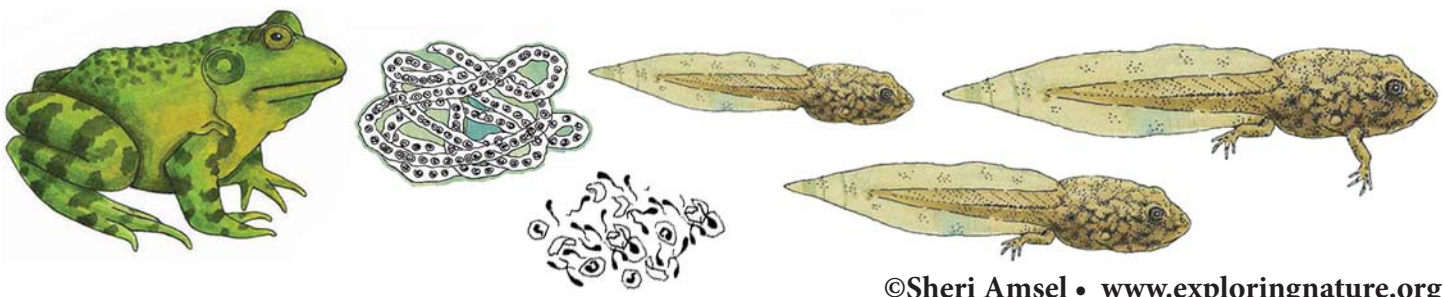
Bullfrogs develop powerful back legs to launch themselves after prey and escape predators.



LS1.B Growth and Development of Organisms: Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)

Bullfrog Reproductive Behavior - Authentic Performance

Dr. Doubt has stated that bullfrogs don't have any characteristic behaviors that increase the odds of reproduction compared to mammals, who expend a lot of energy caring for their offspring. Your job, as an investigative zoologist, is to use an argument based on empirical evidence and scientific reasoning to support an explanation for how bullfrogs use characteristic behaviors and specialized physical traits to increase the probability of reproductive success – and prove him wrong! (Hint: Research the characteristic behaviors that help their reproductive success and list them below with your scientific reasoning. Produce visual aids as well, if they help prove your argument.)



Bullfrog Reproductive Behavior - Authentic Performance (Possible Responses)

Dr. Doubt has stated that bullfrogs don't have any characteristic behaviors that increase the odds of reproduction compared to mammals, who expend a lot of energy caring for their offspring. Your job, as an investigative zoologist, is to use an argument based on empirical evidence and scientific reasoning to support an explanation for how bullfrogs use characteristic behaviors and specialized physical traits to increase the probability of reproductive success – and prove him wrong! (Hint: Research the characteristic behaviors that help their reproductive success and list them below with your scientific reasoning. Produce visual aids as well, if they help prove your argument.)

1. Bullfrogs attract a mate with a loud call.

2. Bullfrog females lays thousands of eggs in the shallow water near shore. This keeps them from drying out, but also protects them from hungry fish found deeper in the pond.

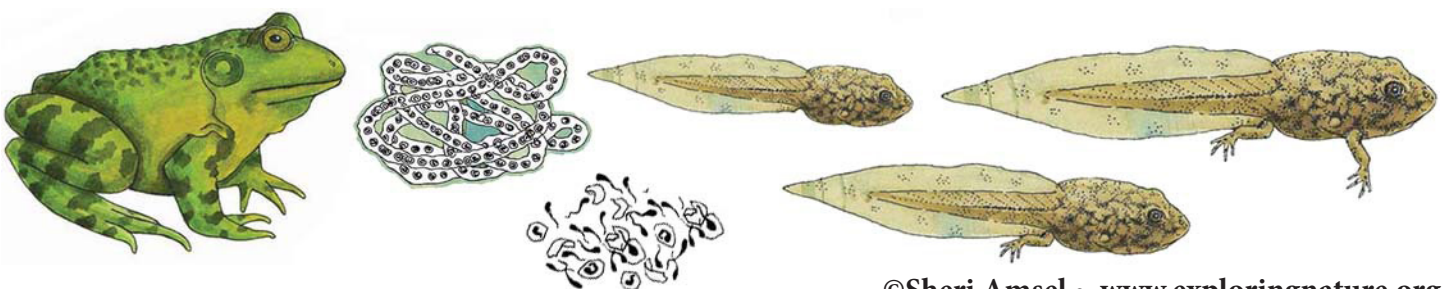
3. The eggs hatch all at once, forming a profusion of movement that makes them difficult to isolate for predators.

4. Bullfrog tadpoles have gills at first, so don't need to come to the surface to breathe where they can be eaten by birds.

5. Bullfrog tadpoles hide among the pond vegetation and eat small insects to avoid being eaten by fish.

6. As they grow and go through the metamorphosis toward their adult form, their mottled coloring is good camouflage, hiding them from fish and hungry birds.

7. By the time they reach their adult size, they have developed lungs and powerful legs to pursue prey.



Animal Behaviors that Affect the Probability of Successful Reproduction in Monarch Butterflies

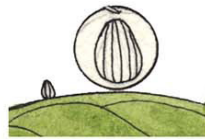
Monarch butterfly caterpillars are one of the only animals that can eat milkweed leaves. Their milky sap is poisonous to most other animals. This has an added advantage of making the adult Monarch butterflies poisonous to predators. Their bright orange color warns off birds that they would not make a good meal. Monarch butterflies **lay their eggs on the leaves of milkweeds**. When the eggs hatch, the tiny caterpillars (also called **larvae**) can start to eat the leaves immediately. They grow quickly and develop a black, white, and yellow striped pattern, which advertises the fact that they are also poisonous and not edible to predators. Never leaving the safety of the milkweed plant, the Monarch caterpillars eat and grow and finally reach a size that triggers the final step of their **metamorphosis**. They form a shiny **chrysalis** where they will dissolve and reform in to an adult butterfly. This is called **pupation**. When the adults finally emerge, they mate and lay eggs and the cycle begins again.

Monarch butterflies, like the milkweed they feed on as caterpillars, are toxic to birds.



Hatching caterpillars can start feeding immediately and never have to leave the safety of the milkweed plant.

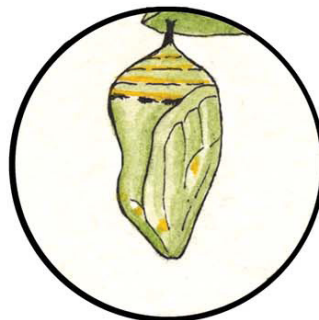
The Monarch butterfly's bright orange color warns predators that they would not make a good meal.



Monarch caterpillars feed on milkweed, which is toxic to birds and makes them toxic as well.



Monarch butterflies lay a single egg on many milkweed leaves.



Monarch caterpillars form their chrysalis underneath large milkweed leaves, out of sight of predators.

Animal Behaviors that Affect the Probability of Successful Reproduction in Monarch Butterflies

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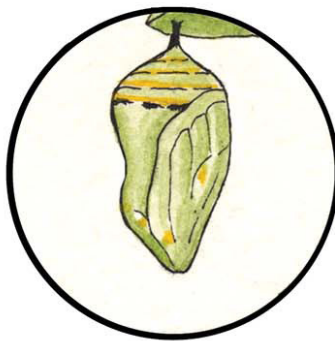
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Monarch caterpillars form their chrysalis underneath large milkweed leaves, out of sight of predators.

LS1.B Growth and Development of Organisms: Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)

Monarch Butterfly Reproductive Behavior - Authentic Performance

Dr. Doubt has stated that Monarch butterflies don't have any characteristic behaviors that increase the odds of reproduction compared to mammals, who expend a lot of energy caring for their offspring. Your job, as an investigative zoologist, is to use an argument based on empirical evidence and scientific reasoning to support an explanation for how Monarch butterflies use characteristic behaviors and specialized physical traits to increase the probability of reproductive success – and prove him wrong! (*Hint: Research the characteristic behaviors that help their reproductive success and list them below with your scientific reasoning. Produce visual aids as well, if they help prove your argument.*)



Monarch Butterfly Reproductive Behavior- Authentic Performance (Possible Responses)

Dr. Doubt has stated that Monarch butterflies don't have any characteristic behaviors that increase the odds of reproduction compared to mammals, who expend a lot of energy caring for their offspring. Your job, as an investigative zoologist, is to use an argument based on empirical evidence and scientific reasoning to support an explanation for how Monarch butterflies use characteristic behaviors and specialized physical traits to increase the probability of reproductive success – and prove him wrong! (*Hint: Research the characteristic behaviors that help their reproductive success and list them below with your scientific reasoning. Produce visual aids as well, if they help prove your argument.*)

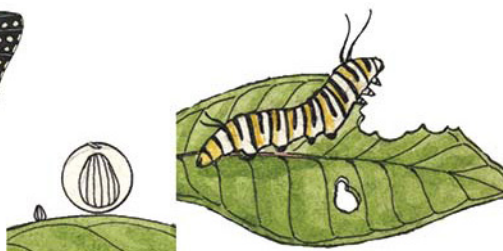
1. Monarch butterflies lay their eggs on milkweed leaves, which their young will eat when they hatch.

2. The caterpillars feed, grow, pupate into a chrysalis and hatch out into an adult butterfly, all while never leaving the safety of the milkweed plant.

3. Monarch butterfly caterpillars can feed on a plant that other animals cannot eat because it is toxic. This provides them with a food for which there is little competition.

4. Both the butterfly and the caterpillar are toxic themselves from eating the toxin in the milkweed leaves which makes them safe from predators.

5. Both the butterfly and the caterpillar have distinctive coloring to warn off would be predators.



Growth and Development of Organisms - Plant Reproduction

“Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.”

When flowering plants reach their adult size, they begin to develop **flowers**. The flowers house the male and female parts of the plant. The **pollen** from the male part of the flower has to reach the female part of the flower for **pollination** to occur. After pollination, the flower develops into a **fruit** that houses the plant’s **seeds**. Most plants depend on animals to help pollinate their flowers - insects, birds and even bats. Animals are attracted to flowers by their bright colors and sweet smell, which signals the availability of nectar on which they can feed. Hummingbirds use their long bill to reach deep inside long, tubular flowers to collect nectar. While inside, their feathers pick up pollen. When they fly to the next flower, the pollen on their feathers touches the inside of that flower – pollinating it. Some night blooming flowers have a scent that attracts bats. They will go from flower to flower licking up pollen and nectar and pollinating the flowers as they go. Most flowers, though, are pollinated by insects – bees, butterflies, moths and flies. Insects pick up pollen while they are inside each flower and bring it on to the next – pollinating it. Just by their sheer numbers compared to other animals, insects are the most effective pollinators. Once a flower is pollinated, it develops into a fruit, inside which, grows its seeds.

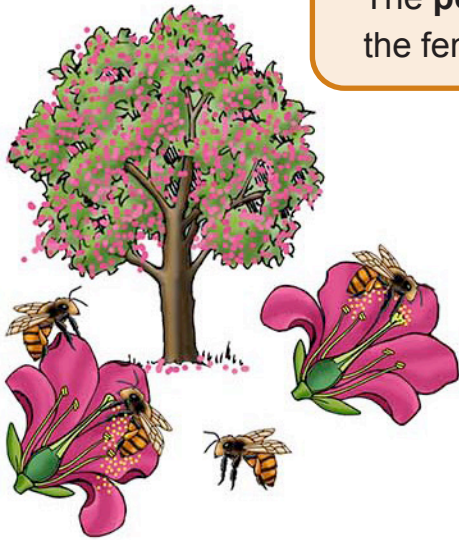
Non-flowering plants, such as conifers, release an abundance of pollen into the air and the wind blows it around. Some of it reaches the female cones to complete pollination.

After the seeds develop, the plant has to spread them out into the world. This is called **seed dispersal**. Some seeds have hooks or barbs that attach to the fur of passing animals. Later the animal may bite or scratch off the itchy burr, spreading the seeds onto new ground. Other seeds form inside a fruit, such as apples, pears, blueberries and raspberries. This attracts animals to eat them. The seeds are then spit out or go through the animal’s digestive tract to be defecated onto the ground, where they can start to grow. Animals, such as squirrels and chipmunks, collect seeds and bury them to store them. For an acorn, this is not only spreading the seeds, but planting it in the ground as well.

Some seeds have developed traits to use the wind to get their seeds out in the world. A dandelion’s seeds have fluffy parachutes. Maple seeds have spinning wings, called *samaras*. Both these traits help the seeds fly away from the parent plant to take root in their own sunny place.

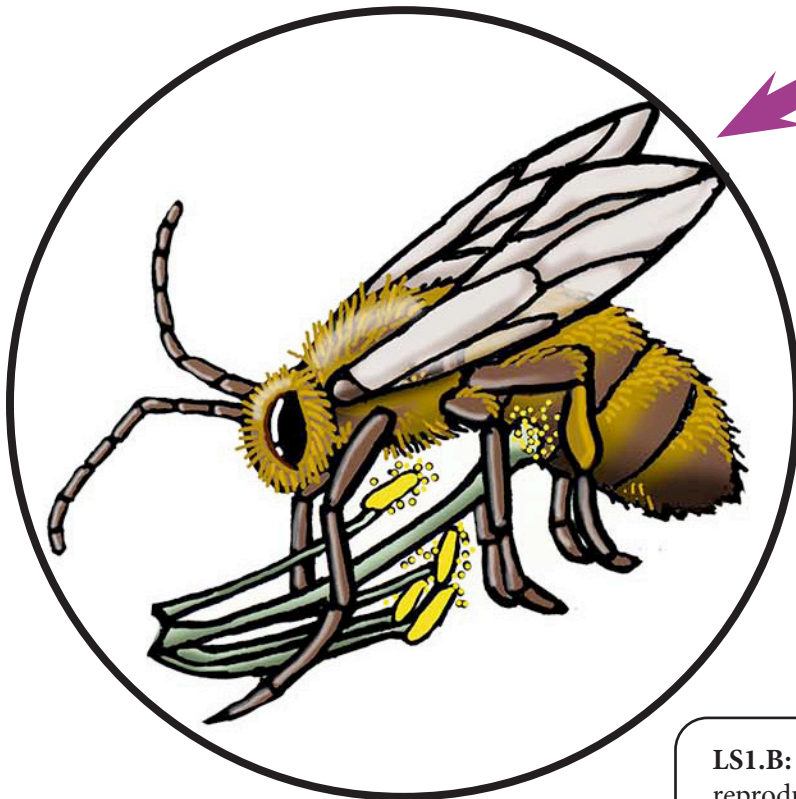
Pollination in Flowering Plants - Close-Up

The **pollen** from the male part of the flower has to reach the female part of the flower for **pollination** to occur.



Most flowers are pollinated by **insects**, which are attracted to them by their bright colors and sweet smell. These traits signal the availability of nectar on which the insect can feed.

While inside the flower, the bee picks up pollen, which sticks to its body. The flower's **stamens** are designed to brush pollen onto the underside of a visiting insect.

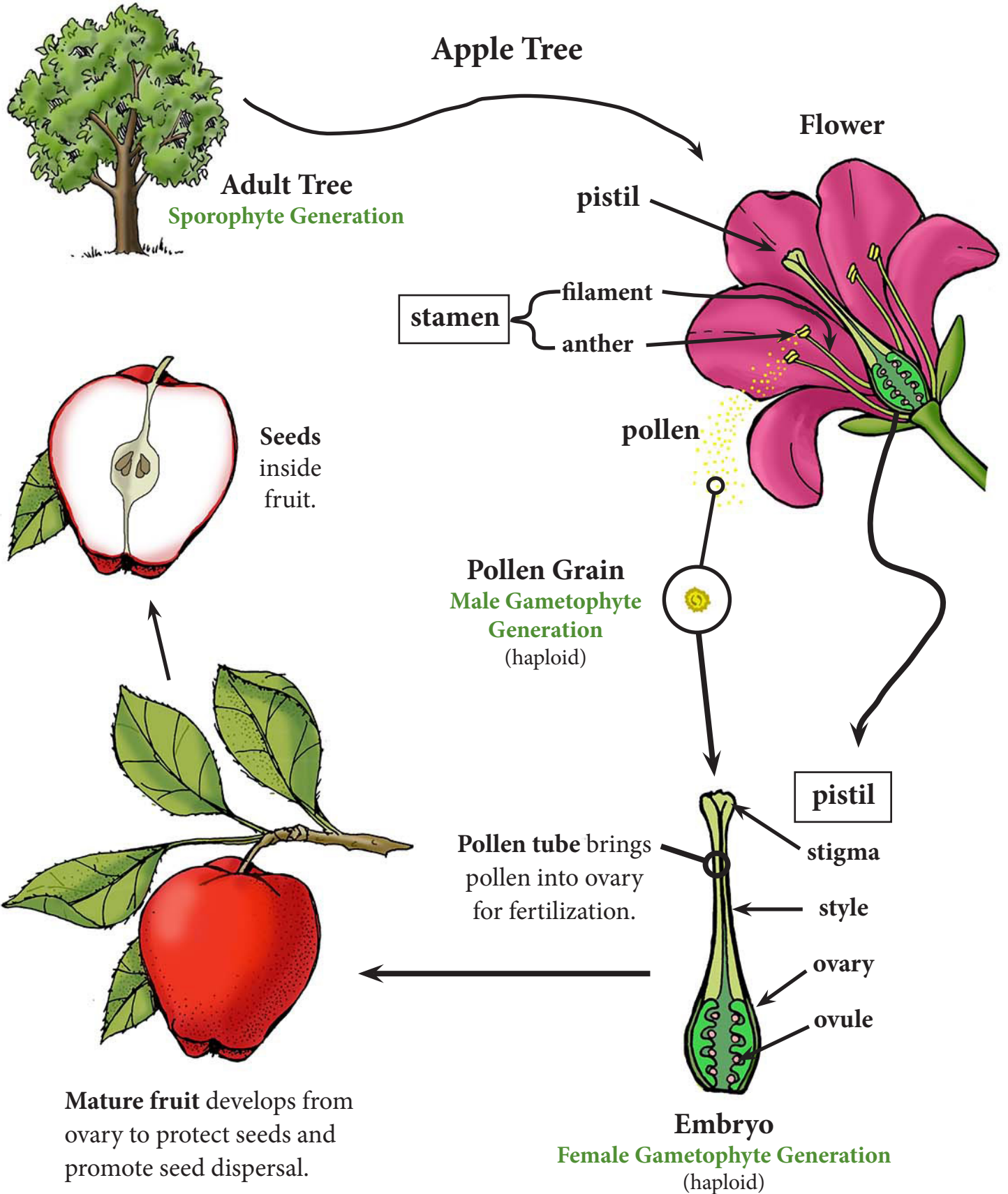


When the bee flies to the next flower, the pollen on its body touches the **pistil** in that flower completing pollination. Bees are responsible for pollinating thousands of flowers every day.

LS1.B: Growth and Development of Organisms - Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.

Life Cycle of a Flowering Plant (Angiosperm)

The specialized plant structures that affect the probability of successful reproduction in plants.



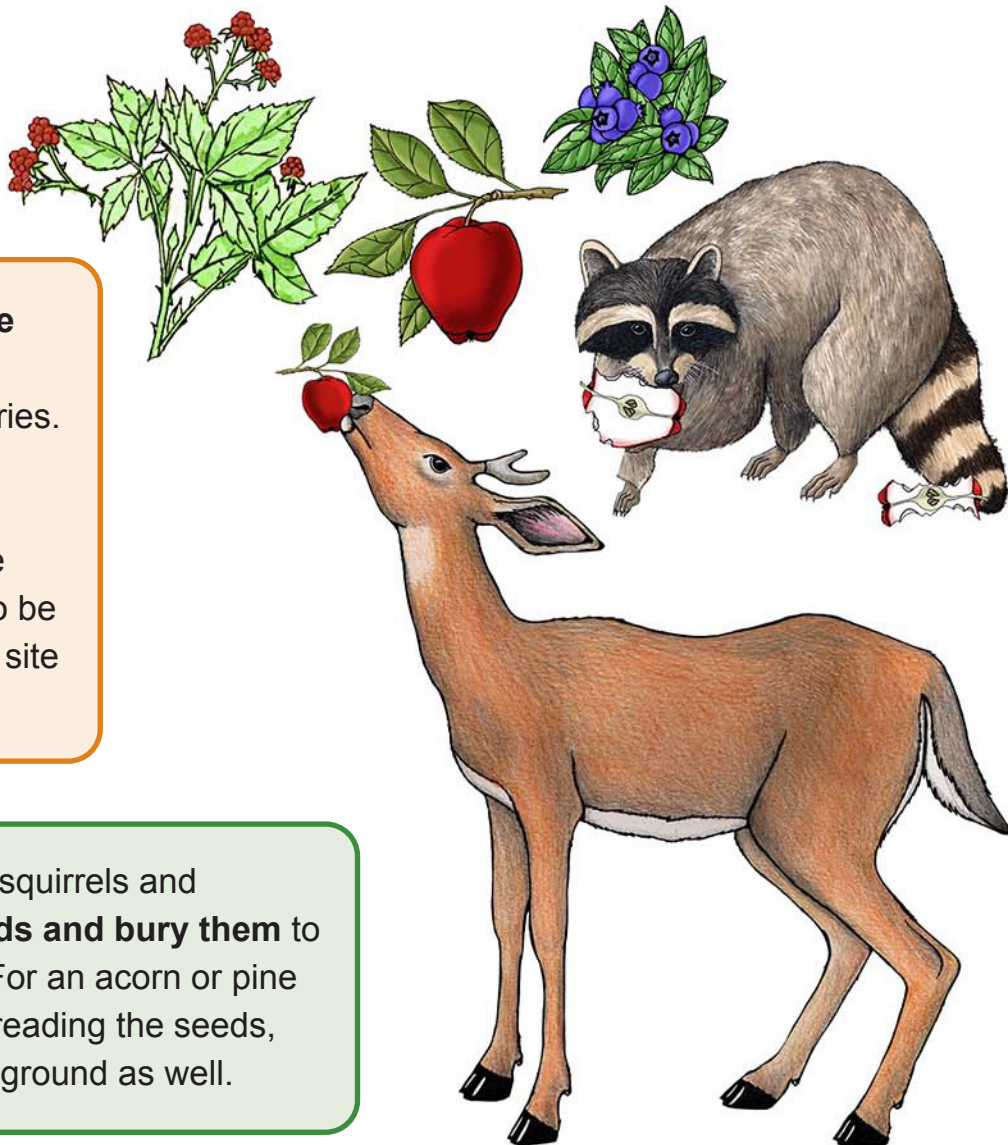
Seed Dispersal

LS1.B: Growth and Development of Organisms - Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.



Some seeds have hooks or barbs that **attach to the fur of passing animals**. Later the animal will bite or scratch off the itchy burr, spreading the plant's seeds.

Some **seeds form inside a fruit**, such as apples, blueberries, and raspberries. These attract animals to eat them. The seeds are spit out or go through the animal's digestive tract to be defecated out at another site where it can take root.

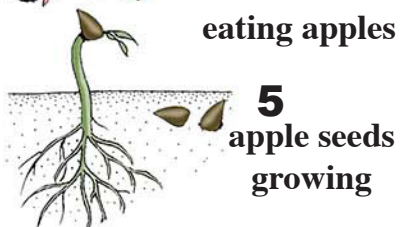
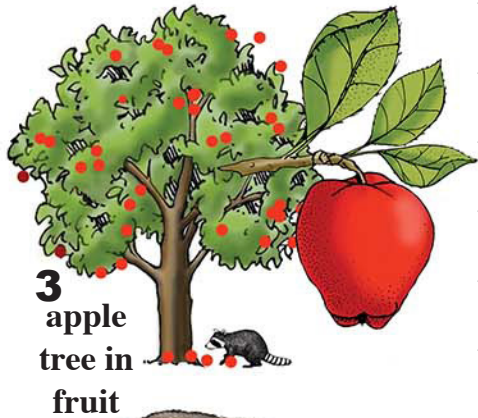
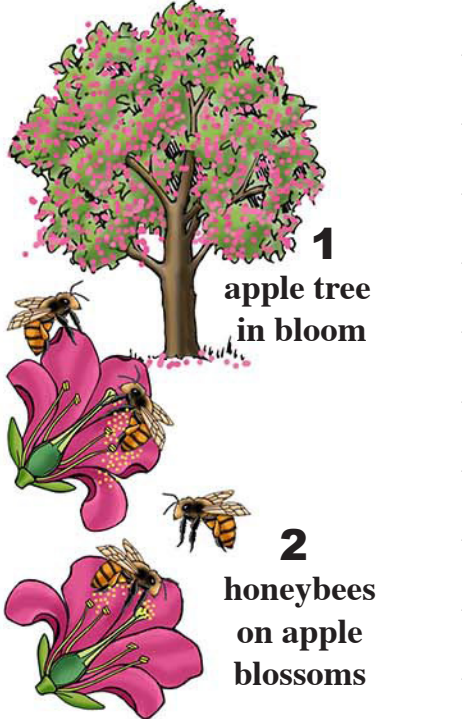


Some animals, such as squirrels and chipmunks, **collect seeds and bury them** to store them to eat later. For an acorn or pine cone, this is not only spreading the seeds, but planting them in the ground as well.



Plants Depending on Animals - Scientific Reasoning

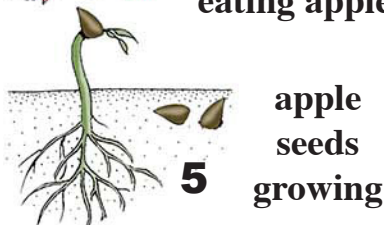
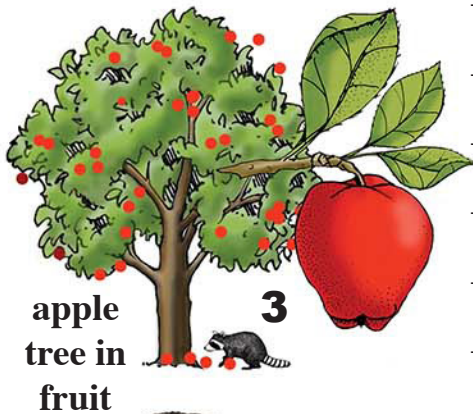
Use scientific reasoning to support an explanation for how specialized plant structures of the apple tree affect the probability of successful reproduction and how both pollination and seed dispersal is affected by animal behaviors. Use the diagram on the left to guide your narrative.



Performance Expectations - Students who demonstrate understanding can:
MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

Plants Depending on Animals - Scientific Reasoning (Possible Responses)

Use scientific reasoning to support an explanation for how specialized plant structures of the apple tree affect the probability of successful reproduction and how both pollination and seed dispersal is affected by animal behaviors. Use the diagram on the left to guide your narrative.



1. Apple trees blossom in the spring when hungry

insects are looking for nectar.

2. Honeybees (and other insects) are attracted to the

sweet smell of the apple blossoms. They fly into the

flowers to collect nectar. Pollen on the stamens touch

and adhere to the insects. When they fly to the next

flower, the pollen on their undersides will touch the pistil

and pollinate that flower. They do this over and over

pollinating thousand of blossoms a day.

3. Each pollinated flower will develop into a fruit (an

apple), inside of which grows the plant's seeds.

4. The apples will attract animals to the tree. They eat

the fruit and the seeds inside. They move on. Later, the

animal will defecate the seeds onto the ground.

5. Some of the seeds will survive to sprout into new

apple trees.

Performance Expectations - Students who demonstrate understanding can: MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

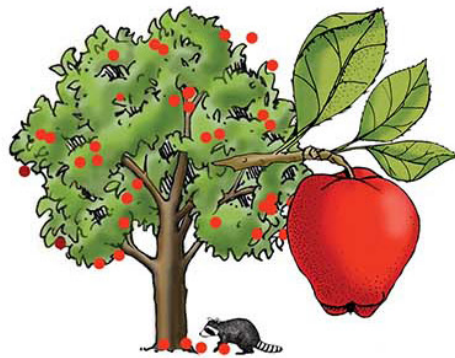
Plants Depend on Animals for Pollination and Seed Dispersal

Flowering plants (including deciduous trees) grow flowers with bright colors and a sweet scent to attract pollinators – insects, birds, and even bats.



The flower then develops a fruit in which grows the plant's seeds. Now the plant has to find a way to spread its seeds out into the world. Some seeds have hooks or barbs that attach to the fur of passing animals. Later the animal may bite or scratch off the itchy burr, spreading the seeds inside.

When a bee enters a flower to collect nectar, it picks up pollen, which sticks to its body. The flower's stamens are designed to brush pollen onto the underside of a visiting insect. When the bee flies to the next flower, the pollen on its body touches the pistil in that flower completing pollination. Bees are responsible for pollinating thousands of flowers every day.



Still other seeds form inside a fleshy fruit, such as apples, pears, blueberries and raspberries. This attracts animals to eat them. The seeds are then spit out or go through the animal's digestive tract to be defecated out in another location where they can sprout.

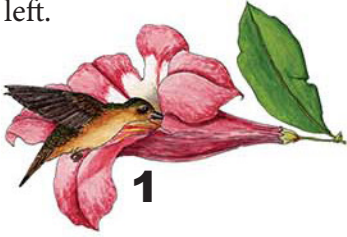


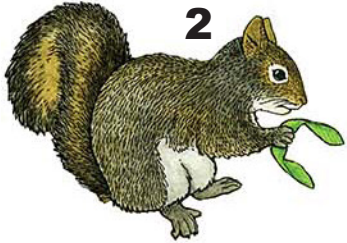
Some animals, such as squirrels and chipmunks, collect seeds and bury them to store them, accidentally planting them.

LS1.B: Growth and Development of Organisms - Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.

Plants Depending on Animals II - Scientific Reasoning

Use scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of plants with regard to the examples shown on the left.











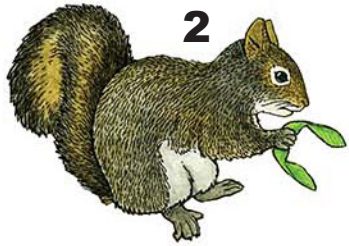
LS1.B: Growth and Development of Organisms - Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.

Plants Depending on Animals II - Scientific Reasoning (Possible Responses)

Use scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of plants with regard to the examples shown on the left.



1. The development of tubular flowers that can be pollinated by hummingbirds with their long beaks is an advantage to the flower's reproduction and the survival of the hummingbird.



2. Maple seeds (samaras) are structured to spiral sway from their parent tree where they can be picked up by animals like the squirrel. The squirrel may gather and store the seeds, planting some for later, some of which may grow into trees.



3. Monarch butterflies lay their eggs on milkweed leaves. The caterpillars that hatch out can eat the poisonous foliage without hard and after pupating into adults will pollinate the flowers.



4. Bees are exceptional pollinators bringing pollen from flower to flower, sometimes reaching thousands on one day.



5. When pollinated flowers grow into flashy fruits that house their seeds, they provide a delicious lure for animals to eat them and carry them away from the parent plant to deposit the seeds (when they defecate) to a new location.

LS1.B: Growth and Development of Organisms - Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.

Rubric Building Resource:

*Observable features of student performance by the end of the grade:

LS1.B: Growth and Development of Organisms - Genetic factors as well as local conditions affect the growth of the adult plant.

Performance Expectations - Students who demonstrate understanding can:

MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. *[Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.]*

1. Articulating the explanation of phenomena

- a. Students articulate a statement that relates the given phenomenon to a scientific idea, including the idea that both environmental and genetic factors influence the growth of organisms.
- b. Students use evidence and reasoning to construct a scientific explanation for the given phenomenon.

2. Evidence

- a. Students identify and describe evidence (e.g. from students' own investigations, observations, reading material, archived data) necessary for constructing the explanation, including:
 - i. Environmental factors (e.g., availability of light, space, water; size of habitat) and that they can influence growth.
 - ii. Genetic factors (e.g., specific breeds of plants and animals and their typical sizes) and that they can influence growth.
 - iii. Changes in the growth of organisms as specific environmental and genetic factors change.
- b. Students use multiple valid and reliable sources of evidence to construct the explanation.

3. Reasoning

- a. Students use reasoning, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to connect the evidence and support an explanation for a phenomenon involving genetic and environmental influences on organism growth. Students describe their chain of reasoning that includes:
 - i. Organism growth is influenced by multiple environmental (e.g., drought, changes in food availability) and genetic (e.g., specific breed) factors.

*provided by the NGSS website

Acid Rain

How Environmental Factors can Influence the Growth of Organisms

Acid Rain is created when large industrial facilities (e.g. Midwestern utilities) burn coal or oil which gives off sulfur, nitrogen, and carbon into the air. Their smokestacks carry these waste gas emissions into the clouds where they mix with water vapor to form weak acids – sulfuric, nitric, and carbonic acids. The wind patterns of North America carry pollutants from busy cities, factories and industrial centers in the Midwest for hundreds of miles east to the Northeastern U.S. and Canada. When the moisture in the clouds grows heavy enough, it falls as rain - **acid rain (or snow)**. The forests and communities of the northeastern U.S. and Canada have been the victim of acid rain that started as air pollution from Midwestern utilities for the last 100 years.

When acid rain falls into lakes and streams, it can make the water so acidic that fish and frog eggs won't hatch. It corrodes limestone buildings, walkways, and statues. Acid rain can slow the growth of trees. It leaches calcium out of conifer needles which makes them more susceptible to winter damage. It also leaches the calcium and magnesium from the soil. Calcium and magnesium are important for the health of the forest because these components are "base cations." They act as natural buffers in the soil, keeping it from being too acidic. Once they are depleted, the aluminum in the soil dissolves and can be absorbed by trees and plants and acts as a toxin that damages them. In sugar maples, the damage starts to show up as a die off in the top of the crown of the tree. The first sign of acid rain damage to a hardwood forest is when maple crowns start to change color in the fall earlier than the rest of the tree.

Much has been done to decrease acid rain in the last few decades. In 1990, congress passed **Clean Air Act Amendments** which require companies to reduce their sulfur emissions. One way they do this is by installing "scrubbers" in their smokestacks. They release a liquid alkaline that mixes with the emissions and traps 80-95% of the sulfur pollutants before it can escape into the air. But soils take thousands of years to develop so recovery is very, very slow.

Performance Expectations - Students who demonstrate understanding can:

MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Acid Rain's Dead Journey

Industrial facilities burning coal, oil or gasoline give off sulfur, nitrogen, and carbon into the air which mix with water vapor to form weak acids – sulfuric, nitric, and carbonic acids.

These toxic clouds are carried by the prevailing winds for hundreds of miles east, before dropping their acidic rain or snow on the Northeastern U.S. and Canada.



Midwestern
Utilities

Forests, Waterways,
Buildings, and
Monuments of the
Northeastern U.S.



When acid rain falls into lakes and streams, it can make the water so acidic that fish and frog eggs won't hatch.



Acid rain leaches calcium out of conifer needles which makes them more susceptible to winter damage.



The first sign of acid rain damage in hardwood forests is when maple crowns start to change color in the fall earlier than the rest of the tree.

Performance Expectations - Students who demonstrate understanding can:
MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

The Rodent, the Bee, and the Brazil Nut Tree

Growth and Development of Organisms

Most plants have flowers that are pollinated by many kinds of insects and seeds spread by many kinds of animals. There is one plant though, that needs one single animal to pollinate it and one single animal to release its seeds – the mighty Brazil nut tree.

Brazil nut trees are found only in the rainforests of South America. They are huge – growing up to 200 feet tall, towering over the rest of the forest canopy. Their seeds are as big as cannonballs, as hard as rock, and can weigh up to 5 pounds. Nut collectors have to wait until after the trees have dropped all their seeds before going into the forest to collect them.

The only animal that can open the seed pods to eat the seeds is a large rodent called an agouti. Weighing about ten pounds, with sharp teeth, the agouti can gnaw through a Brazil nut pod to reach the 25 delicious seeds inside. The agouti bury the seeds it doesn't eat right away to save them for later. Some grow into new Brazil nut trees, when there is enough sunlight and moisture. This has earned the agouti the nickname – *seed spreader*.

Every year, in the beginning of the rainy season, the Brazil nut trees flower. Their beautiful blooms last for just one day. They are big, tightly coiled flowers with a heavy hood. It takes a big, strong insect to get inside to collect nectar and pollen. Only one insect can do the job – the female orchid bee. These bees are perfect for pollinating Brazil nut tree flowers. They are big and strong and have a very long tongue that can reach down into the coil of the flower to its nectar. Orchid bees don't live everywhere though. They are only found in wild rainforests that are home to a very special orchid. The male orchid bees pollinate the orchid's flowers and get covered by their strong scent and color. This attracts the female orchid bees to mate and, when they are in bloom, she will also visit the Brazil nut blossoms to feed and pollinate.

To grow Brazil nuts, a rainforest must have Brazil nut trees, agoutis to open the nuts, female orchid bees to pollinate the flowers, and orchids for male bees to pollinate and attract the females. This only happens in a very wild rainforest. When farmers try to grow Brazil nut trees on plantations, they usually fail. Without a healthy rainforest full of orchids, there are no female orchid bees to pollinate the Brazil nut flowers – so no Brazil nuts will grow.

Today, as the South American rainforests are being cut down, the future of the Brazil nut tree is in danger. Only healthy rainforests with orchids, orchid bees and agoutis can keep the life cycle of the Brazil nut going for the future.

LS1.B Growth and Development of Organisms: Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5)

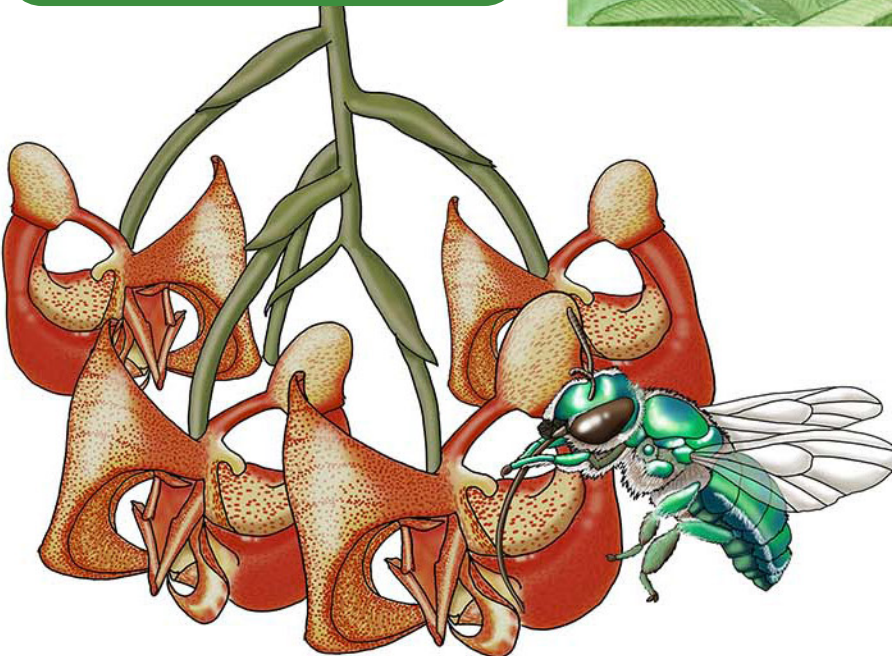
The Rodent, the Bee, and the Brazil Nut Tree

To grow Brazil nuts, a rainforest must have Brazil nut trees, agoutis to open their nuts, female orchid bees to pollinate the flowers, and orchids to feed and fulfill the life cycle of the bees.



The **agouti** is the only animal that can open the tough Brazil nut seed pods. They eat the seeds inside or bury them for later. This allows some to grow into new Brazil nut trees.

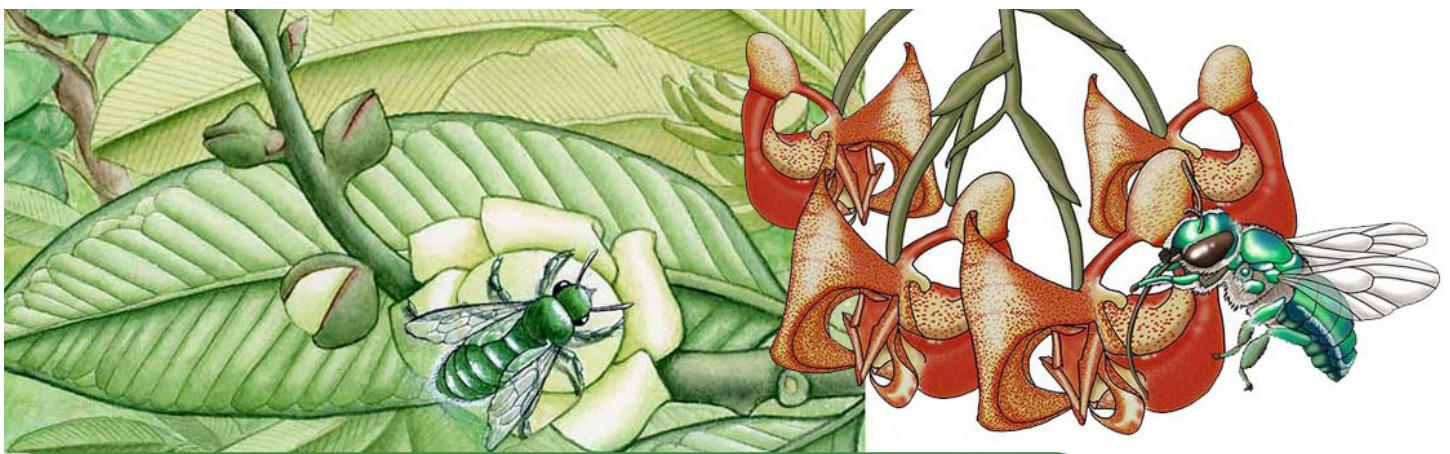
The females **orchid bee** is the only insect that is strong enough to enter the tightly coiled flowers of the Brazil nut tree and, with their very long tongue, can reach down far enough to pollinate them.



Orchid bees only live in very wild rainforest where one species of **orchid** is found and male orchid bees pollinate it's flowers and get covered by its strong scent and color. This attracts the females to complete their life cycle.

Brazil Nut Tree Life Cycle - Authentic Performance

You are a wildlife biologist hired to consult on a Brazil nut plantation. The Brazil nut trees are healthy and strong, but are not producing any Brazil nuts! It is your job to figure out why. Use the information you've learned about the life cycle of the Brazil nut tree to explain why the plantation trees are not growing any Brazil nuts.



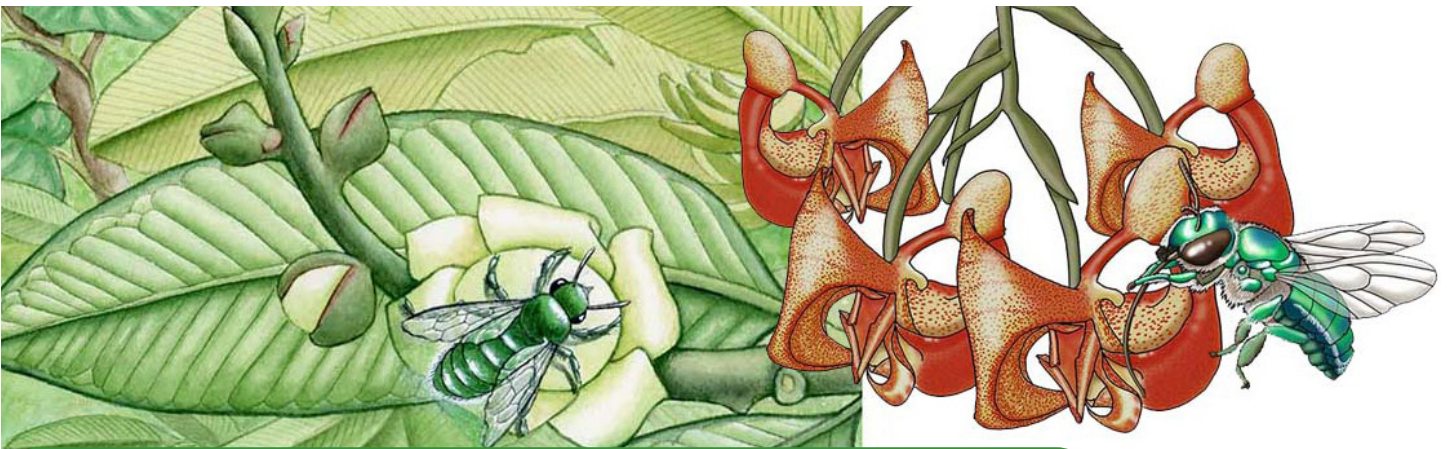
Performance Expectations - Students who demonstrate understanding can:
MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Brazil Nut Tree Life Cycle - Authentic Performance (Possible Responses)

You are a wildlife biologist hired to consult on a Brazil nut plantation. The Brazil nut trees are healthy and strong, but are not producing any Brazil nuts! It is your job to figure out why. Use the information you've learned about the life cycle of the Brazil nut tree to explain why the plantation trees are not growing any Brazil nuts.

From your research, you will know that Brazil nut trees need a specific, large bee to pollinate their flowers – the female orchid bee. In addition, orchid bees are only found in very wild forests where a specific bucket orchid (*Coryanthes vasquezii*) grows. Male orchid bees pollinate the orchid and the smell attracts female orchid bees to mate. Without the orchid, the bees don't reproduce, so disappear from that forest. Without the bees, the Brazil nut blossoms don't get pollinated.

To increase Brazil nut production, the plantation, would have to hand pollinate the blossoms, which would be a challenge as they are tightly coiled flowers with a heavy hood. Or they would have to import the bucket orchids and bees and provide a wild location near the plantation for them to colonize.



Performance Expectations - Students who demonstrate understanding can:
MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.