Pollinators in Nature

Teacher Resources for Standards 1,3 and 5 aligned to the Primary Science Curriculum

BES-Net TT Project Pollinators in Nature

The United Nations Development Programme (UNDP) implemented the two-year project – Biodiversity and Ecosystem Services Network Trinidad and Tobago Project (BES-Net TT) - on behalf of the Government of the Republic of Trinidad and Tobago (2021-2023). The overall project goal was to conserve globally important biodiversity in Trinidad and Tobago by addressing the science, policy and practice of pollination and pollinator management. Three major outcomes of the project were:

1. Improved scientific knowledge of pollinators and pollination services in Trinidad and Tobago;
2. Improved conservation of pollinators and pollination services through improved plans and policies; and
3. The provision of education, tools and support to improve the practice and application of pollinator and pollination science in multiple contexts.

Further background information on the project is available at http://biodiversity.gov.tt/index.php/bes-net/bes-net-tt.html

One key project output under Outcome 1 was building public awareness and knowledge of pollinators and pollination. Students in local primary schools were identified as a main audience with which such knowledge should be built. A Communication Working Group reviewed curricula of certain subjects at that educational level and selected topics for which information on pollinators would be relevant. The team brainstormed on ideas to develop content for incorporation in curriculum delivery while adding information to inspire students to value and conserve our local biodiversity.

This resource was based on selected topics in the Primary Science Curriculum document, which are clearly indicated at the start of each section of this booklet. As far as possible, sections incorporate a basic introduction, a hands-on activity and links to additional resources that can be used in curriculum delivery. It should be noted that the treatment of the topic also integrates with other subject curricula, such as mathematics, social studies, agricultural science, language arts and art, and this is indicated in footnotes.

If any sections of the booklet are used, your feedback on the resource is welcomed. Please complete the Feedback Questionnaire at the back of the booklet and send to the Environmental Policy and Planning Division, Ministry of Planning (lena.dempewolf@planning.gov.tt). We hope you find these resources to be useful and that your students enjoy using them!

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Contents

Feeding Relationships

Standard 1: Investigate relationships that exist within ecosystems

Feeding relationships*[1]

All energy comes from the sun. Living things are able to obtain and use this energy through plants, which use sunlight, oxygen and water in a process known as photosynthesis to produce food. Animals, including insects, use the food produced by plants to obtain energy for growth and for carrying out their daily functions. While some animals only eat plants – these are called *herbivores* – some other animals feed on other animals to obtain their nutritional needs. Animals that eat other animals are called *carnivores*. Animals that feed on both plant and animal material are known as *omnivores*.

Each time an animal feeds on a plant or another animal, the food they take in transfers energy. Feeding relationships of organisms therefore enable flow of energy from one living thing to another.

Consider some animals that you may be familiar with and see if you can identify whether they are herbivores (eat only plant material) or carnivores (eat other animals). Note that food material may come in both solid and liquid form!

Activity: Classifying animals on the basis of their feeding habits

Name of Animal	**Food/s eaten**	**Feeding Habit Classification: Herbivore, Carnivore or Omnivore**
Iguana		
Mosquito		
Human being		
Butterfly		
Snake		
Duck		
Frog		
Bee		
Cow		
Bat		
Cockroach		
Hummingbird		
Corbeau		

[1] Also links to Standard 3: Interdependency among plants and animals

Activity: Feeding in adult and young animals

Sometimes in the growth and development of an animal from a young stage to an older one, there are changes in the feeding habit. The younger animal may eat very different foods from the adult. Consider the following animals and state the type of food you have observed the animal to eat in young and old stages of life.

Food types eaten by young and old stages of selected animals

Animal Adult Stage	Food eaten	Young Stage	Food eaten
Butterfly		Caterpillar	
 https://clipground.com/butterfly-clipart.html		 https://www.netclipart.com/isee/iixRboo_cute-cartoon-head-of-caterpillar-clipart/	
Frog		Tadpole	
 https://www.deviantart.com/misterbug/art/Tree-frog-Clipart-424164172		 https://www.istockphoto.com/illustrations/frog-eggs	
Cockroach		Nymph	
 https://clipground.com/cockroach-vector-png.html		 pestkilled.com	
Cow		Calf	
 https://clipartcraft.com/explore/cow-clipart-realistic/		 https://creazilla.com/nodes/11205-calf-clipart	
Human being		Baby	
 https://clipground.com/male-nurse-clipart-free.html		 https://clipground.com/black-princess-baby-girl-clipart.html	

Insect Life Cycles

Standard 3: Life cycles and feeding

Life cycles are stages of growth and development that living things experience. A plant's life cycle can begin with a seed, which develops into a seedling and this eventually grows into a mature plant. The mature plant then goes through seed production, beginning the life cycle once again. Similarly, animals' life cycles have various stages. The insect's egg hatches into a young stage of the insect which may or may not look the same as the adult insect. In insects, changes in appearance in the various stages of the life cycle are also seen.

In animals, apart from differences in appearance between young and adult stages, there may also be differences in the type of food which is eaten. This is seen often in insects, where the adult insect feeds on different foods than that fed upon by the younger stages of the insect. Because of this, some insects like butterflies, may be considered as pests in younger stages if their caterpillars eat the leaves of crops, but in the adult stage the butterfly may assist in pollination and therefore benefit crops!

First, let's learn about the different stages of the insect life cycle and next we will learn about differences in feeding among these stages.

Life cycle stages

The growth and development of insect eggs into adult insects is marked by many changes, including changes in appearance and in the food they eat (diet). When the egg of an insect hatches, the next stage of development is known as the larval stage or larva which is the young form of the insect.

The larva or young stage may look very different from the adult, or closely resemble the adult. The larvae of insects that look similar to the adult, are known as nymphs. Nymphs go through a series of moults as they grow in size, until they develop into adults. (In moulting, the body covering or exoskeleton is shed).

The larvae that look very different from the adult insect spend a lot of time eating and then go through a phase in which the body becomes encased in a sac and rests. While resting, it goes through a further change in form. This stage is called a pupa.

FUN FACTS

The series of changes is called metamorphosis from the Greek words:
meta = change, morphe = form

Egg to larva to pupa to adult = Complete Metamorphosis
Egg to nymph to adult = Incomplete Metamorphosis

Activity: Bee/Butterfly Life Cycle[2]

The butterfly has a life cycle which demonstrates Complete Metamorphosis.

In this activity, the student is able to construct the life cycle of the butterfly as a craft project.

Materials:

- Four life cycle stages: egg on a leaf shape; larva; chrysalis or pupa; adult butterfly
- A template with a pre-printed shape to cut out
- Pen or marker
- Glue

Instructions:

1. Cut along the printed shape to obtain the template for construction of the life cycle.

2. Fold the template in half (with the printed side inward) so that the shape becomes two mirror image pieces.

3. Fold each half (outwards) so that the curved portions line up as mirror images.

4. Unfold the template and lay flat, with the printed side upwards.

5. Using the glue, glue the life stage pieces in the correct sequence, between the arrows.

6. Allow the glue to dry (about 5-10 mins).

7. Label the life stages (above or below each glued piece) using the pen or marker.

8. The template can be folded carefully as indicated in steps 1 and 2 above after the glue has dried.

9. You now have your personal copy of the butterfly life cycle… in the shape of a butterfly!

[2] Links with the Creative Arts as an art and craft activity

TEMPLATE

(see cutting instructions below)

THE LIFE CYCLE OF A BUTTERFLY

Instructions – cut around the butterfly shape (including around head and antennae) and along the dotted lines

Activity: Feeding in the life cycle

Think about some young stages of some insects and state whether they eat the same food as the adult stages or whether they eat a different food type. Conduct some online research if you are unsure!

Name of Insect	What does adult stage eat?	Does larval stage eat the same? What does larval stage eat?
Bee 		
Butterfly 		
Cockroach  miro.medium.com		
Mosquito  images.fineartamerica.com		

Nectar Feeders: Three of the adult insects above feed on liquid foods. The (female) mosquito feeds on blood and bees and butterflies feed on nectar. Nectar is a sweet, sugary substance that is found in plants, usually near to the base of the plant's flowers. The sugar produces fuel for the insect's energy needs.

Insects that feed on nectar have mouthparts which are formed into a tube-like structure known as a proboscis. The tube is very flexible and is usually coiled below the insect's head when not in use and is uncoiled and extended when in use.

Photograph showing butterfly proboscis extended and inserted into flower. (Photo credit: Celeste Chariandy)

Fun facts: Life during growth stages of insects

Different life stages of insects may exist in the environment in similar or different ways, and younger life stages may be cared by the adult insect or left on their own.

In the example of the butterfly given previously, the adult butterfly lays eggs on the leaves of a plant on which the larval form will feed. An example of this is the Monarch butterfly, whose younger or larval stage known as a caterpillar feeds on leaves of a plant known as milkweed.

Above: A Monarch butterfly at rest on a milkweed plant.

The adult lays eggs and does not return to care for the hatched larvae. As the larvae hatch onto the plant that they feed on, they are supplied with food for growth and development until they transform to the pupal stage or cocoon. When the adult butterfly emerges from the cocoon, it flies off to flowers from which it can obtain nectar.

There are other types of insects that take care of larval stages when these young stages hatch from the egg. A good example of these types of insects is the bee. Various stages of the bee all live together as a brood, in one structure known as a hive or colony. Hives of our local stingless bees (Meliponini) may be found in hollow trees, wall crevices or sometimes in the ground. The brood may take the form of flattened discs, composed of small chambers, stacked one on top of the other, or it may take the form of a mass of small chambers like bunches of grapes. In the colony, egg stages, larval stages and adult stages are all found. The adult stages are grouped into massive numbers of worker bees, smaller numbers of drone bees and a single queen bee.

Above: A colony of native bees in which worker bees are seen moving over the brood discs.

The queen bee lays all the eggs. Adult worker bees construct the cells of the brood. They place a single egg in each cell and cap the cell with a paper-like substance. When the eggs hatch, larval forms develop which look similar to the adult bee, but these larvae remain in cells and are regularly tended to and fed by the worker bees. The larvae are fed a mixture of pollen and nectar which is known as bee bread.

Flowers and Plant Reproduction

Standard 3: Parts of a flower

Flowers are very noticeable parts of a plant and play a major role in the plant's reproduction. The main parts of the flower and their functions are introduced.

Flowers can be found singly, or in bunches, they can be large or small, they also come in a variety of shapes, sizes and colours. Flowers are often visited by animals. What attracts the animals to these flowers? (Ask the students). Animals are attracted to flowers by the colours and the scents of the flowers, and the possibility of finding food which provides energy. The food is in the form of nectar, a sugary, liquid food, which is found commonly at the base of the flower and may be found on other locations on the plant structure.

A flower is made up of several parts. Even though flowers from different plants may look different, if a flower from any flowering plant is taken apart, the same basic parts can be identified. The diagram below gives the location and shape of some parts of a flower.

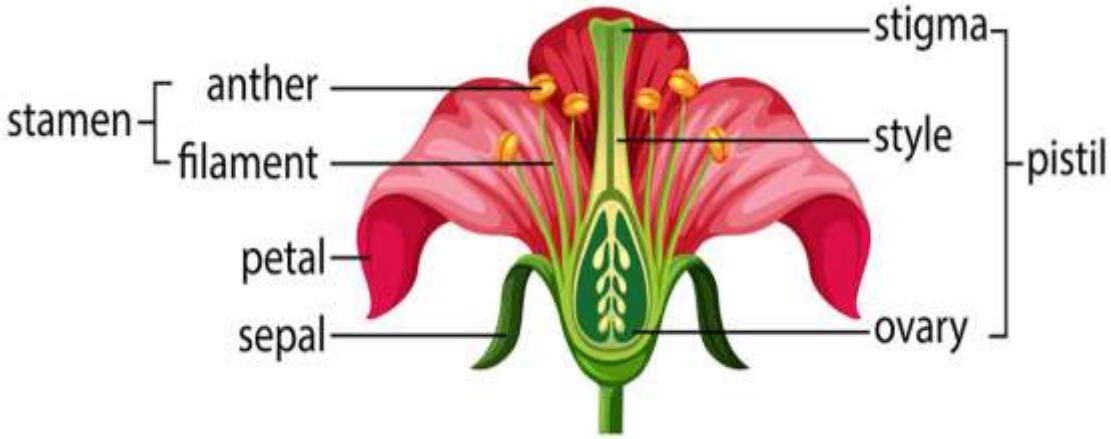


Diagram showing labelled parts of a flower (Source: media.geeksforgeeks.org)

These are the main roles performed by these structures in a flower:

Sepals: these structures enclose and protect the emerging flower (bud) and are usually green and leaf-like. When the flower is opened, sepals lay flat at the base of the flower, at the top of the flower stalk.

Petals: these are the brightly coloured parts of the flower, arranged in a ring, which bring attention to the plant and attract insects and pollinating organisms. Petals may be numerous or few, layered or fused. Sometimes petals bear coloured lines that radiate outwards from the centre of the flower; these are *nectar guides,* which are common in flowers that are pollinated by bees. The guides direct the insect to the location of nectar stores.

Stamen: this is the male reproductive structure of the plant which is made up of the **anther** and **filament.** The filament is a slender, upright part of the stamen, upon which are borne sac-like anthers.

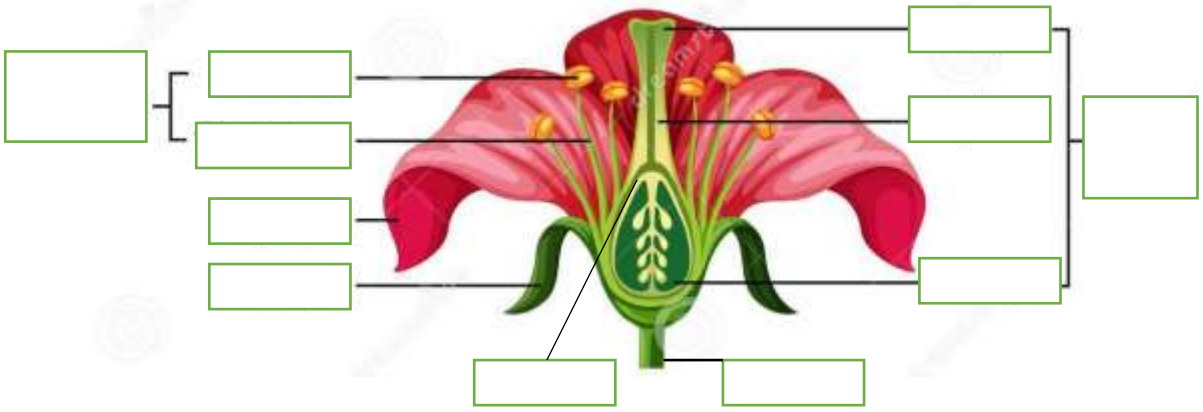
Anthers produce **pollen grains**, which contain male reproductive cells. The filament extends outwards from the flower, to make the pollen grains, accessible to pollinating organisms.

Pistil: this stucture is comprised of several parts and constitutes the female reproductive part of the plant. It is swollen at the base within the central part of the flower and encloses the **ovary** which contains female reproductive cells or **ovules**. Extending upwards from the ovary, the pistil narrows into a slender tube known as the **style**, at the top of which is found a sticky pad known as the **stigma**. Thestigma's sticky surface is effective in trapping transferred pollen, in the process of pollination.

Pollen that lands on the stigma germinates and grows a pollen tube down the style to the ovary. There, the male and female cells fuse in a process known as fertillization. The fertillized ovary grows, producing seeds and the area surrounding the ovary is changed into a fruit. Not all flowers are pollinated by animals, some also become pollinated through transfer of pollen by wind currents or by water.

Follow-up activities: Parts of a flower

Parts of a flower



1. Make enlarged copies of the diagram above. Let students revise the parts of a flower and then have them fill in the blanks with the names of the plant parts which they have memorized.

2. Let students collect and bring a variety of flowers to class (Hibiscus flowers and Pride of Barbados flowers are good choices for this exercise). Let them work in groups to <u>either:</u>
    i. draw one of the flowers in a notebook/drawing book and label the parts of the flower they have drawn <u>or</u>
    ii. dissect the flower, taking out each part that was previously identified; stick the individual parts onto a sheet of Bristol board with an identification label placed/written below each part. The completed exercise can be displayed on the classroom wall.

3. Complete the "fill in the blanks" activity on the next page.

Recap Activity: Parts of a Flower[3]

Complete these sentences using words from the word bank below.

1. A flower is usually made up of several parts which are arranged in _____ inside each other.
2. The sepal is the outermost ring. It _____ the flower when it was in bud.
3. The petals of a plant are often _____ _____ to attract _____.
4. The stamens are the _____ parts of the plant which produce the yellow, dust-like _____.
5. The carpel is the _____ part of the plant which produces the _____ once _____ has taken place.
6. A flower can be pollinated by _____, _____ or by _____.
7. When a flower is pollinated by _____ the _____ go to feed on the _____ of the flower.
8. They brush against the _____ and collect the _____. Then they brush against the _____ of the same or different flower and pass on the pollen that way.
9. When a flower is pollinated by _____ the _____ blows the pollen. In this case the flowers usually have small or non-existent petals.
10. The pollen reaches the carpel at the place called the _____. It grows a _____ down i

WORD BANK

animals animals anthers brightly coloured female fertilization fruit fruit insects insects male nectar ovary pollen pollen pollen tube protected rings stigma stigma style wind wind wind water

[3] Links with Language Arts for expansion of vocabulary.

Features of Animals

Standard 3: Distinguishing features of animals

Pollination can be carried out in several ways, with pollen transfer occurring on wind currents, by movement of water, or by being moved by animals. The animals that carry out pollination are called pollinators. Their work is very essential, as two thirds of the world's plant species depend on pollination by animals and one-third of the foods we eat are produced from plants that are pollinated by animals. In this section, you will learn about the features of flowers that attract pollinators and the features of some animals that assist in pollination.

A wide variety of pollinators

Pollinators belong to a wide range of animal groups. Many types of insects including bees, wasps, butterflies, beetles and ants can be seen visiting flowers, in pursuit of nectar which they consume as a liquid food for energy.

Apart from insects, there are other animals that transfer pollen during visits to flowers, including species of birds, lizards and bats.

Humans may accidentally brush against pollen on flowers, capturing pollen on clothing which can then be transferred to other flowers. Persons engaged in horticultural business may also deliberately pollinate flowers by hand, using special tools.

What attracts a pollinator?

Scientists have determined that the shape, colour and sometimes scent of some flowers have attractions for particular types of pollinators.

Scent is a powerful signal which draws some pollinators to particular flowers. No two flowers have exactly the same scent. Bees and flies are generally attracted to flowers with sweet scents and beetles to flowers with musty or fruity scents. The scent level is highest when the pollinators are active: bees and butterflies are attracted to flowers whose scent is highest in the daytime while bats and moths are attracted to flowers whose scent is highest at night. Birds have no sense of smell and flowers those they pollinate generally are unscented.

The birds are however attracted by colour and visit mainly red and yellow flowers, as do butterflies. Some flowers also have nectar guides that are invisible to humans, but direct pollinators, mainly bees, to the location of nectar. Flower shape and size also provide visual cues to pollinators. Beetles and butterflies pollinate flowers that open widely and provide a 'landing pad' for the insect. Trumpet-shaped flowers are pollinated by hummingbirds, which are able to reach deep into the flower to obtain nectar because of their long, narrow beaks.

Features of some animals that facilitate pollination

Most animals visit plants and the flowers of plants to obtain food. The food obtained from flowers in most cases is nectar, but animals also eat leaves, collect resins, or use plants to seek shelter or hide from predators. Bees visit flowers to collect pollen which is used to feed their developing young. Even though pollination may not be the intention of floral visitors, in trying to access nectar from flowers, pollen is taken up or deposited. In this section, the features of four different types of animals which facilitate uptake of pollen are described.

The Bee

The bodies of many bees are covered with many hairs, and this is concentrated on the abdomen. When the bee lands on the flower to collect nectar and pollen, the hairs on the body also trap pollen grains. Visiting another flower of the same species, the trapped pollen is transferred to the flower's stigma. Some bees carry out "buzz pollination" in which their wing vibration causes pollen grains to fall off the anthers and be captured on the body!

The Bat

Bats that eat fruits, insects and nectar have potential involvement in pollination. Depending on the flower and the bat, the bat's access to nectar may involve climbing into the flower. Here it is surrounded by anthers and because the bat is so hairy, it leaves the flower with its head, chest and back covered in pollen! Bats that feed hovering outside the flower may have extremely long tongues. When inserted into the flower to access nectar, the hairy head traps pollen.

The Butterfly

Butterflies tend to land on 'flat' flowers, which provide a resting place for their slender, elongate legs. While at rest, the butterfly feeds on nectar using its proboscis. Because of its long legs, butterflies' bodies are often not in direct contact with the anthers, but its head and mouth parts, feet and lower legs are, so pollen sticks on to these parts and can thus be transported to another flower.

The Hummingbird

Hummingbirds are attracted to flowers that are usually tubular-shaped, red, fuschia or purple and which produce large amounts of nectar. When the hummingbird's long beak enters the flower, the anthers touch the bird's head, transferring pollen. The vibration of the bird's wings may also cause pollen to be knocked off the anthers. Since these flowers produce a lot of nectar, the bird spends some time feeding to meet its energy demand.

Photos: (1) https://sites.google.com/a/natickps.org/honeybees/collecting-honey/how-much-pollen-do-honeybees-colle
(2) https://www.gardeningknowhow.com/garden-how-to/beneficial/bats-as-pollinators.htm
(3) https://www.flickr.com/photos/11734005@N07/41005857500/
(4) https://www.pinterest.com/pin/hummingbird-and-her-favorite-red-flower-by-william-lee-on-500px--256071928795385848/

Follow-up activities: Features of Animals

1. ***Mimic pollination***

   Try to mimic the pollination process using simple materials.

   - You will need: two (2) paper or plastic plates, a bag of brightly coloured orange-coloured snacks (e.g. cheese balls, corn curls etc), a fabric glove (e.g. a garden glove) or a microfibre cloth and a rubberband, a piece of microfibre cloth cut into a circular shape (large enough to fit inside the plate).
   - Crumble the snacks and place into an empty plate; spread evenly. This plate will represent the anther with pollen grains.
   - Take the circular piece of microfiber cloth and place in the second plate. This plate will represent the stigma.
   - Allow the children to take turns putting on the glove and then lowering their hand onto the plate filled with the crumbled snack. (If you use the microfiber cloth, wrap the cloth around the hand and secure with a rubberband). The glove/cloth represents the pollinator organism. Some pieces of the snack should attach to the glove/cloth.
   - Next, place the glove/cloth onto the circle of microfibre cloth that is in the second plate. You should notice that some of the snack has now adhered to the circular piece of microfibre cloth. The transfer of snack in this way represents the transfer of pollen grains from anther to stigma by the organism in the process of pollination.

2. ***Me, the pollinator***[4]

   Design a costume/mask/headpiece based on a certain type of pollinator (bird, bat, bee, butterfly) and a flower of appropriate shape and colour for the pollinator. Demonstrate how pollination is carried out by the pollinator.

3. ***Match the pollinator game***

   Play a game matching pollinator to flower type (see following page)

4. ***Observations in the garden***

   Carry out an observation activity in the school garden.

   - Allow the children to observe flowers in the school garden and the animals visiting the flowers.
   - Let them take notes on the shape and colour of the flower, and the type of animal visiting the flower*. (n.b. for safety reasons, do not encourage the children to sniff flowers).
   - On return to the classroom, collate the data. Determine if any trends are seen in terms of a certain type of pollinator being associated with flowers of a particular shape and/or colour.
   - Allow the students to discuss the data, account for trends and propose conclusions.

[*You can upload photographs of animals and plants to iNaturalist platform at https://www.inaturalist.org/ to get help in identification of these living things.]

[4] Links with the Creative Arts – Theatre Arts in costume design and dramatic delivery

Match the pollinator game

In this game, some clues are given to help match a pollinator or pollination method to a flower type. The clues support the background information on how colour, shape, size and scent of flowers may attract particular pollinator types, so it is advisable to recap this information with the students before playing the game. The list of clues below will assist.

Materials: 1 list of clues 2 labelled cubes

Instructions:
Create the game cubes by using small cereal boxes (the single serving size) and images on the following pages. One box should be covered with drawings representing six pollinators/pollination method and the other box with the photographs of six different flowers (print in colour).

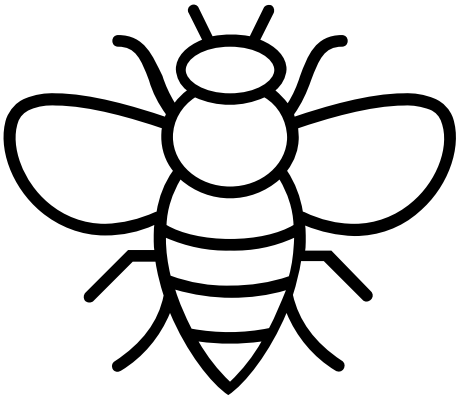
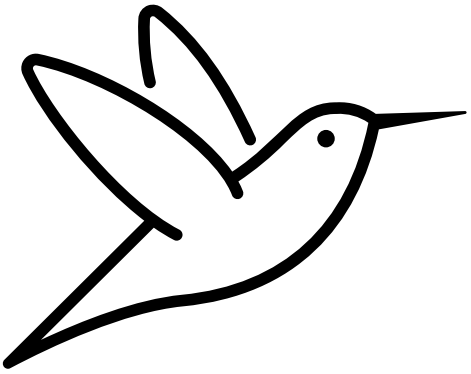
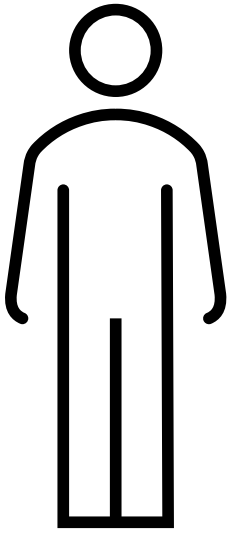
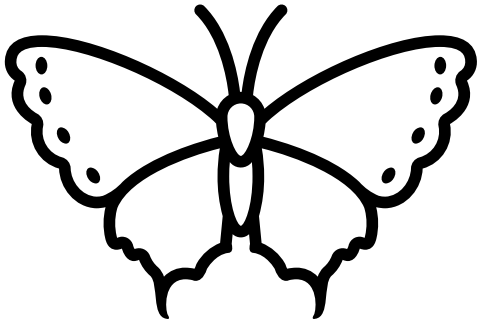
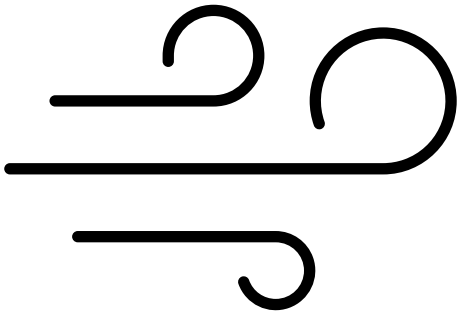
You can divide a group of players into two smaller groups to play this game.

Option 1: The two teams in turn get to roll the cube with the flower types (like rolling die). The team must look at the photograph on the upper face of the cube and guess how the flower is pollinated, using only choices from the second cube. After 6 throws each, the team with the most correct responses wins.

Option 2:
The two teams in turn roll both cubes. The team then determines if the pollinator type on the upper face of the cube matches the flower being pollinated on the second cube. The team getting all six correct matches first wins the game.

Note: some of the flowers may have more than one pollinator type. For the purpose of this game, however, only six specific matches can be agreed upon at the start of the game. At the end of the game the two teams can discuss why specific flowers may have more than one pollinator type.

Bat pollinated flowers • Bloom at night • Large and pale-coloured or white • Strong fruity or musky fragrance	**Butterfly pollinated flowers** • Brightly coloured (red, orange, yellow) • Strong fragrance, open in the day • Have nectar guides, 'flat'
Bee pollinated flowers • Usually are in shades of blue or yellow • Have strong scents • Have nectar guides	**Human (hand) pollinated flowers** • Usually are of commercial importance • Are grown in greenhouses Are lacking natural pollinators
Hummingbird pollinated flowers • Brightly coloured (red, fuschia, purple) • Have curved, tubular shapes • Odourless	**Wind pollinated flowers** • Do not have scents or nectar • Have small or no petals Produce large amounts of pollen

SALVIA 	**WATERMELON** 
BANANA 	**CORN** 
ZINNIA 	**VANILLA** 

Loss of Our Local Biodiversity

Standard 3: Problems associated with loss of native species[5]

Biodiversity is a shortened version of the term biological diversity, which refers to the diversity of living things. All across the world we have a rich mixture of plants and animals that live in a range of habitats and environments that experience differences in temperature, rainfall and water availability.

Each country of the world is home to plants and animals which have lived there over time and are **native** to the country. In addition, each country may now be an adopted home for plants and animals that may not have been in that country originally but have now adjusted to the conditions of their 'adopted' country. These are said to be '**naturalized**' species.

As well, there may be animals and plants that are foreign in origin (**exotic**) and are competing with the animals and plants that are native to the country. This 'competition' may involve eating the food that native species would normally eat, or living in the habitats that would normally be occupied by the native species. These are said to be '**invasive species**'.

Native species are very important components of a country's local biodiversity. Native plant species have developed a close relationship with their pollinators over time. These pollinator species are critical to the reproduction of these plants. The pollinators have adapted to the shape, size and sometimes scent of these flowers, so that when they visit flowers to feed on nectar, they are able to pollinate. Non-native species may not have these adaptations and may be unable to take the place of native pollinators. Anything which hampers local pollinators will also hamper plant reproduction.

The reverse is also true: pollinator species also rely on native plants to survive. The pollinators have come to depend on these plants for nectar and other products, such as resins. If native plants are removed, the pollinators which have developed this feeding relationship may not have alternative food sources for survival. Hybrid versions of some plants/flowers may have different physical features from native types, which prevent pollinators from accessing nectar stores, impacting their feeding and survival success. Reduction or removal of native plants by introduction of hybrids, therefore, negatively affects the country's biodiversity.

Activity: Word Search[6]

A	C	P	Z	B	S	H	L	O	Z	O
E	X	O	T	I	C	Y	B	G	E	V
U	D	L	J	O	T	E	I	A	S	N
W	B	L	I	D	U	M	N	B	P	O
X	S	I	V	I	Z	Q	V	H	E	G
P	Q	N	S	V	D	E	A	I	C	L
I	O	A	H	E	F	C	S	U	I	Y
N	A	T	U	R	A	L	I	Z	E	D
A	V	O	D	S	P	W	V		S	H
L	B	R	G	I	X	H	E	X	F	A
L	Y	N	A	T	I	V	E	J	O	Z
R	G	I	H	Y	B	R	I	D	Q	M

Find the hidden words below in the grid.
Use your dictionary and find their meanings.

Biodiversity
Exotic
Hybrid
Invasive
Native
Naturalized
Pollinator
Species

[5] Also link to Standard 3: Interdependency among plants and animals
[6] Link to Language Arts – Vocabulary

Threats to pollinators and ways to address them

Standard 5: Local issues affecting agriculture at the national and/or international level

Anything which hampers the free access of pollinators to the flowers of crop plants has the potential to also impact the levels of food production. Pesticides are used by many farmers to control the pests that visit their crops and feed on various parts of the plant. Caterpillars, aphids, ants and whiteflies are some of the pests that can severely affect food production if they feed on plant leaves, sap, roots or produce.

Some farmers may use chemical pesticides to quickly kill pests to save their crops. Some pesticides are very toxic and may kill not only these pests but may also affect other animals, including the very animals that are needed to carry out pollination. For this reason, farmers, including backyard gardeners, are encouraged to use safer chemicals or other methods of pest control. Only by being selective in pest control to remove the targeted pests, can pollinators be protected, and food production be secured.

The following activities will help in understanding the impacts of pesticides on pollinators and give hints on alternative ways of carrying out pest control on crops.

Activity 1: Video Story and Comprehension Exercise

Here is a short, animated video - A story about VIPs and VAPs - that explains what can happen if pollinators are killed by pesticides and what can happen if alternative pest control methods are used.

Show the video story and then discuss the questions on the following page with your students.

Link: https://www.youtube.com/watch?v=lKBwg-tulDY

Duration: 3 minutes 40 seconds

Activity 2: Pollinator Math

Pollinator Math is a hands-on activity/game which will demonstrate the impact of pesticide application on non-targeted organisms. The activity requires some students to perform the role of flowers and others to perform the role of pollinator species. The activity can be done twice in order to allow students to perform calculation of averages or may be done in a single cycle. Teachers require some preparation of materials. [n.b. Teachers need to ensure that students follow instructions carefully to have the most benefit from the exercise].

Follow-up questions for "A story of VIPs and VAPs"[7]

1. What were the VIPs in this story?

The VIPs were V_ _ _ I _ _ _ _ _ _ _ _ P _ _ _ _ _ _ _ _ _ _ _ .

2. Why are these VIPs important in Mr. Joe's garden?

The VIPs are responsible for P _ _ _ _ _ _ _ _ _ _ _ , which is the transfer of P _ _ _ _ _ G _ _ _ _ _ from one flower to another.

3. What were three examples of pollinators seen in the story?

Three pollinators seen in the story were the B _ _ _ _ _ _ _ _ the L _ _ _ _ _ _ and the B_ _ .

4. What plant in Mr. Joe's Garden was able to help him keep away pests?

The plant in Mr. Joe's garden that helped him to keep away pests was the M _ _ _ _ _ _ _ also known as G _ _ _ _ .

5. What pest was found in the neighbour's garden?

The pest found in the neighbour's garden was the C _ _ _ _ _ _ _ _ _ _ _ .

6. Apart from the pest, what other small animals did you notice in the neighbour's yard among the seedlings?

I also saw the following animals in the neighbour's yard: _____

7. Why did the neighbour spray the plants with chemicals?

The neighbour sprayed the plants with chemicals in order to _____

8. Do you think Mr. Joe was happy that the neighbour sprayed chemicals on the plants? _____

9. What did the neighbour say he was getting rid of in his yard?

The neighbour said he was getting rid of V _ _ _ A _ _ _ _ _ _ _ P _ _ _ _ .

10. Who harvested more produce? Mr. Joe or his neighbour? _____ harvested more produce.

11. In whose yard did the animals remain, in Mr. Joe's yard or Mr. Joe's neighbour's yard?

The animals remained in _____.

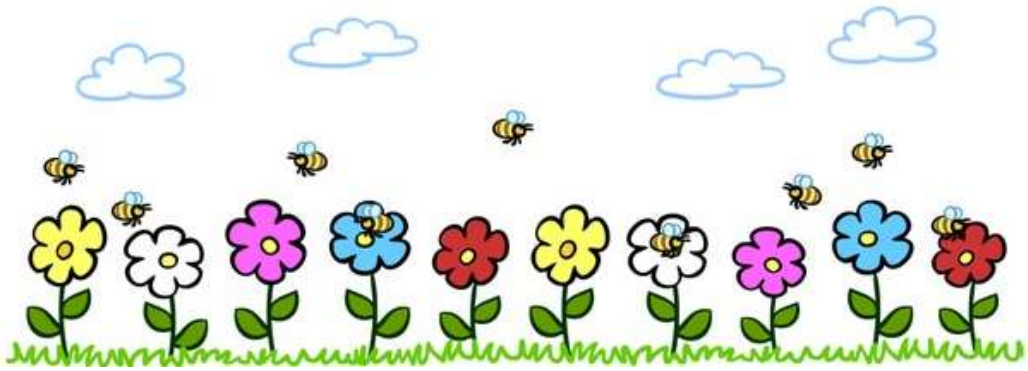
12. What caused the animals to disappear? _____

Write down anything else that you learned about from this story in the space below.

_____

[7] Link with Language Arts – Comprehension Exercise

Activity: Pollination Math[8]



What you need:

- A group of students
- Laminated pictures of flowers with elastic loops
- Washable coloured markers (at least 6 different colours)
- Recording sheets

Instructions:

1. This is a whole-class activity. Select four to six students to be bees/bees and butterflies. Ask two students to take on the role of recorders. Let the rest of the class represent crop plants.

2. Line up the students representing crop plants (Encourage the students to set the scene: crops are often planted in rows, there are two flower types these can represent two crop types). Let each of the 'crop plants' hold two flower motifs affixed on their fingers using elastic loops (Animate the activity, let them hold their flowers in different "poses").

3. Allow the pollinators to take turns visiting the flowers; each will have a washable marker of a different colour. Pollinators must visit the flowers one at a time and spend at least 15 seconds with a flower (Say "Fly!" to alert them to move). Two pollinators cannot visit the same flower at the same time; while at a flower, they put a mark (1, 2 etc) on the flower to document the visit.

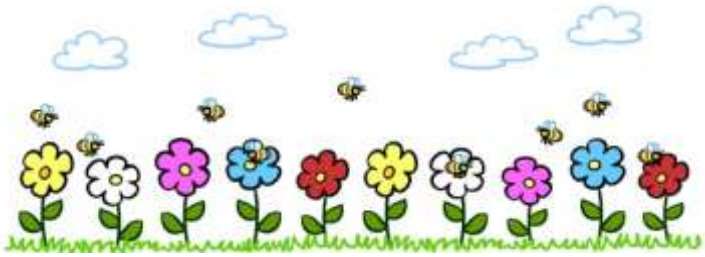
4. After 15 seconds the pollinator leaves the flower; it should not return to any flower it has already visited, but it can visit another flower on the same 'crop plant'. Each pollinator must ensure that the mark it makes on the flower is not placed on top of a previous mark.

5. Give pollinators a total of 2 minutes to do their visits. After 2 minutes, transfer the flowers to the recording students. The students must write down how many marks are on each flower (= how many pollinators have visited) and how many flowers have marks of each colour marker (=how many flowers each pollinator was able to visit).

6. Clean the flower surface at the end of each cycle. Repeat the exercise with i) half the number of 'bees' and with ii) 2 bees, keeping the same time limit and the same number of plants/flowers.

[8] Link to Mathematics - Numeracy

Pollination Math – Recording Sheet



	First Cycle	Second Cycle	Final Cycle
Number of Pollinators			2
Number of Crop Plants (fixed number)			
Number of Flowers (fixed number)			
Number of Flowers Visited			
Number of flowers visited by Pollinator #1			
Number of flowers visited by Pollinator #2			
Number of flowers visited by Pollinator #3			
Number of flowers visited by Pollinator #4			
Number of flowers visited by Pollinator #5			
Number of flowers visited by Pollinator #6			

Discussion

a.	How many crop plants were in the field?	
b.	How many flowers were available to be visited by bees?	
c.	In the first run of the exercise, how many bees were available to pollinate?	
d.	How many flowers were visited in total by the bees in the 3-minute time period?	
e.	What was the *average* number of flowers visited by a bee?	
f.	In the second run of the exercise, how many bees were available to pollinate?	
g.	How many flowers were visited in total by this reduced number of bees in 3 minutes?	
h.	What was the *average* number of flowers visited by a bee this time?	
i.	In the last run of the exercise with 2 bees, how many flowers were visited in 3 minutes?	
j.	What was the *average* number of flowers visited by a bee this time?	

What do you notice about the number of flowers that are visited as the number of bees lessen?

_____

What does this mean for how much pollination is carried out with less bees?

_____

What does this mean for the quantity of food that can be produced when there are less bees?

_____

Ways to help pollinators

From the information shared previously, we can see that pollinators face many threats, one of which is through indiscriminate pesticide use. To address this problem, safer methods of pest control are recommended; a few tips are given for use in small gardens like the home garden or school garden.

Be able to identify pests in the garden.

Remember that not all insects are pests. Some insects around your plants may be pollinators doing the important job of pollen transfer to help your plants produce. It is important to observe your plants, document the animals you are seeing and identify those which are causing harm – the pests - as the animals to control.

Physically remove pests from the plant, where possible.

This control is possible for large and easily identified pest species like the fall armyworm which is the larval form of a moth that is a pest of corn.

Use baited traps.

For pests such as slugs, the use of baited traps may prevent pests from coming onto plants and eating them. Place soapy water or beer into a small bowl near to the plant. The liquid will not harm the plant but it will attract the pest which will climb into the bowl and drown.

Introduce pest-repelling plants in the garden.

Some plants naturally repel pests, due to the presence of natural chemicals within the plants. As noted in the short video “A story of VIPs and VAPs”, marigold naturally repels nematodes, a thin worm which may burrow into some plants and affect their productivity. By planting marigolds alongside crops, nematodes will be repelled.

Use good soil and mulch.

When starting your garden and maintaining the garden, always use good starting material in the form of soil that is free from pests, and mulch that is made from clean, pest-free vegetation. If soil and mulch are already infested with pests and are applied to your garden, you are simply maintaining a cycle of pest introduction.

Monitor your garden regularly.

Regular monitoring of your garden will help you to observe when pests appear, which often gives you the opportunity to carry out control before the population of pests becomes unmanageable. When visiting your garden - for instance, when watering your crops - check the leaves and fruit and soil for unwanted pests and take action quickly.

Apart from controlling pests, it is also a good practice to take steps to encourage pollinators into your garden. Assisting pollinators in building their populations and having a safe habitat helps your garden and helps other gardens in your community.

Activity: Observation exercise in the garden

A garden is an ideal location to carry out observation exercises to learn about the pollinators of flowers. There are many different types of pollinators from a variety of animal groups. Most persons will identify different types of insects carrying out pollination, but other animals also can perform this function.

Scientists rely on their powers of observation to notice activities of animals in nature, and with repeated patterns of behaviour, they come up with a guess (hypothesis) which they test over and over again before they come up with a reasonable conclusion.

Make a visit to your garden at least once a week for a period of a month and note observations of the animals that you see visiting flowers. Capture your notes onto a simple data sheet, which documents the flower being visited and the animal visiting. After a month of observation, see whether you can suggest patterns of visits by a particular animal to a particular flower.

This exercise can be carried out by small groups of students or individual students. The more observations taken will provide you with more data to review. On the following page a data sheet and a worksheet are provided. Use the data sheet to capture notes and then use the worksheet which follows to document discussions of these notes.




Activity: Sharing thoughts on pollinators[9]

This introduction to pollinators provides much information about their life habits, their role in plant reproduction and food production, as well as the threats that they face for survival. Having shared this information and provided activities to further underscore key points and assist in review and retention of knowledge, this last activity encourages children to share what they have learned about pollinators in a creative way.

1. Write an essay on the role that pollinators play in the environment.

2. Compose a poem, calypso or spoken word piece on i) the types of pollinators found in a garden or ii) the value of pollinators to food production.

3. Write a story which describes the busy day of a pollinator. Ensure that you describe the type of flower visited by the pollinator in this story and what attracts the pollinator to this flower.

4. Write a letter to the Minister of Agriculture, Land and Fisheries, outlining what can be done to reduce the use of harmful chemicals on farms.

5. Develop a short list of instructions to share with the head of a 4H Club which is aimed at using safe measures of pest control in your school garden.

[9] Link to Language Arts – Creative Writing

Observation Exercise in the Garden - Data Sheet

Date of Exercise: _____ **Name of Observer: _____**

Observations		
#	**Flower visited: Name, colour, shape** (Drawing of flower may be added)	**Animals observed on flower** (Drawing of animal may be added)
1		
2		
3		
4		
5		

Observation Exercise in the Garden – Compilation of Results and Discussion

Data Compilation Table: List the different flowers visited and the numbers of each flower visitor seen at each flower type as compiled from all data sheets. (This table can be but onto the blackboard and students can each fill in their data).

	Flower visited: Name, colour, shape (Drawing of flower may be added)	**Flower Visitor (Name)**	**Flower Visitor (Numbers)**
1		**i.** **ii.** **iii.**	

The garden was visited by the class on a total of _____ occasions.

The number of observations taken by students was _____ observations.

The average number of observations taken on each visit to the garden was _____ observations.

(n.b. Average[10] is calculated by dividing the total number of observations by the number of visits)

The total number of different flower types observed was _____.

The total number of different flower visitors observed was _____.

The flower type at which most flower visitors was observed was _____.

These flower visitors were _____.

The most frequently seen flower visitor was _____.

In the completed data compilation table, for each flower type, circle the flower visitor that is most seen (possibly its preferred pollinator).

Can you suggest any patterns seen in terms of flower shape/colour and its most frequent visitor?

_____

_____

[10] Link to Mathematics – Calculation of average

Feedback Questionnaire

1. At what school do you teach? _____

2. What level do you teach? Standard 1 □ Standard 3 □ Standard 5 □ Other _____

3. Did you enjoy using the activities in this booklet? Yes □ No □

   Explain your answer _____

   _____

4. How many of the booklet's activities for your class level have you used?

   Approximately 25% □ 50% □ 75% □ 100% □

5. Did you find the content to be relevant to the curriculum? Yes □ No □

6. Was it easy or difficult to integrate content in your teaching? Easy □ Difficult □

7. Describe the experience the children had while taking part in these activities.

   _____

   _____

8. What did you like best about this resource? _____

9. What did you like least about this resource? _____

10. Were there other aspects of pollinators you would have liked to see in this booklet? If yes, please share these, below.

    _____

    _____

11. If you have any recommendations about how this resource may be improved, please share below.

    _____

    _____

    _____

Thank you for your feedback. Kindly send your completed form to bes-net.tt@gmail.com

This Teachers' Resource booklet was produced under the
Biodiversity and Ecosystem Services Network Trinidad and Tobago project.

Funding was provided by
the Government of the Republic of Trinidad and Tobago,
the United Nations Development Programme
and the Government of Germany, through the International Climate Initiative and SwedBio.