

Community In Bloom

SCHOOLS

Gardening Engagement Activities For Students
Secondary

Name of Teacher:

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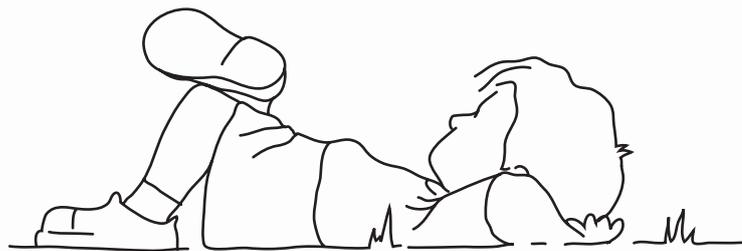
A Word from NParks

The Community In Bloom Schools Programme aims to promote gardening among schools and helps them develop innovative school gardens that beautify and teach.

To assist schools in this gardening programme, we have developed two teachers' resource books for Primary and Secondary levels. These books contain gardening engaging activities that capture your students' attention and interests, value-add to the curricula and encourage self-directed learning. They are specially designed to turn gardening activities (like weeding and pruning) into mini projects, and your school garden into an outdoor classroom, where students develop skills like science process skills, project management skills and teamwork.

We hope that you will find these activities useful in awakening your students' interests in the life sciences, our local heritage (local fruits, medicinal plants, Asian cuisines) and the environment. We also hope that through these engaging gardening activities, your students will grow a love for gardening and be more involved in the school garden.

Wishing you and your students many hours of joy and learning as you garden your school!



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The 'Community In Bloom Schools' Programme

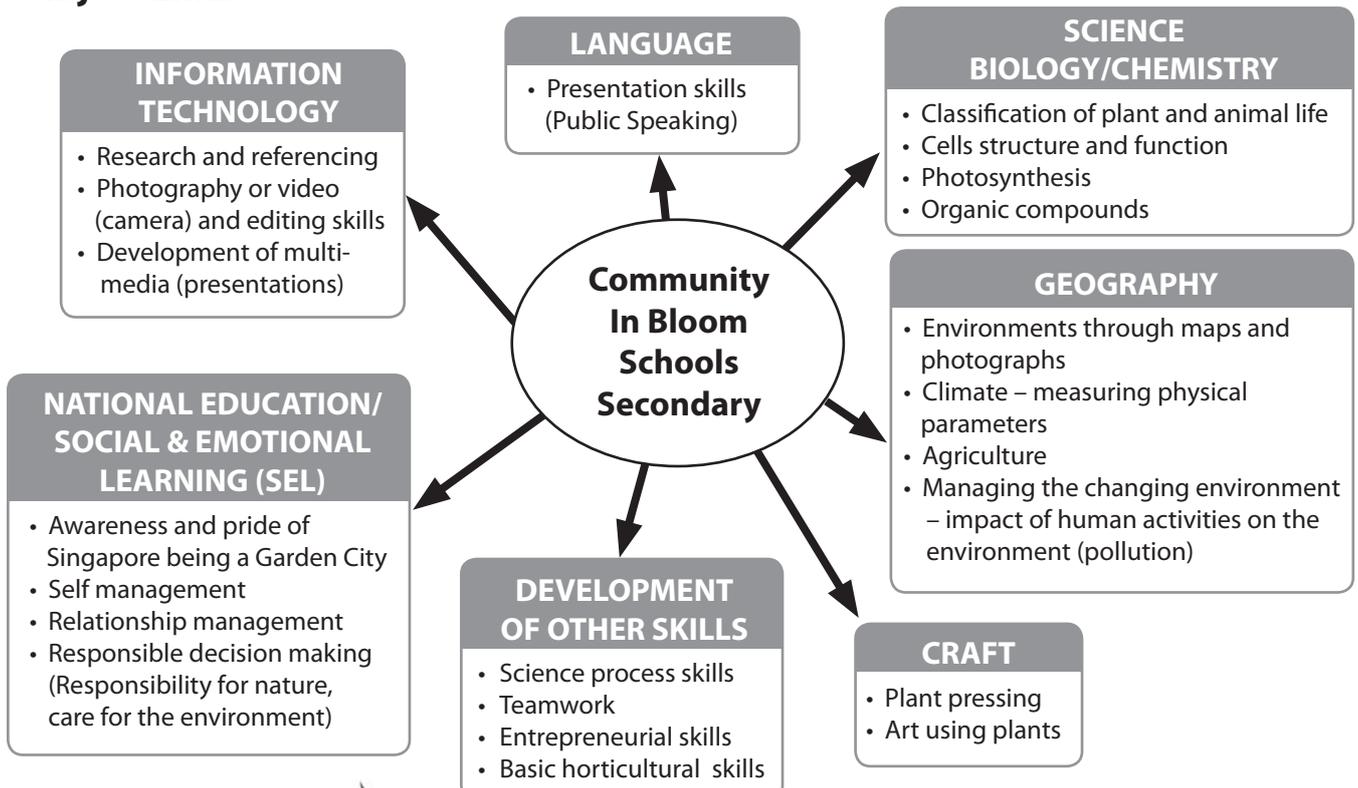
Aims

1. To help students discover science and the natural environment through fun nature, engaging and hands-on gardening activities.
2. To raise awareness of local ornamental plants, fruit trees, medicinal plants, as well as garden animals (insects and pests).
3. To turn the usual gardening activities into mini-projects where students can develop their process skills, entrepreneurial skills and creativity.
4. To encourage greater student involvement in the school gardens.
5. To provide a direct and relevant means of introducing the 'global dimension' into teaching and learning local and international partnership element within 'Community In Bloom' Programme.

Highlights



Subject Links

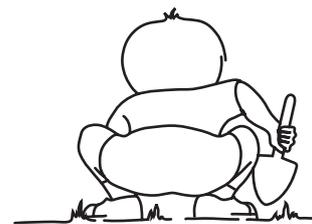


ABOUT CIB



How to Start

1. **Choose activities** that suit your learning objectives and schedule. Use the summary pages on page 6 to 9.
2. **Plan the Scheme of Work** using the Planning Sheet (on page 64).
3. **Read the lesson plan**, make preparations and get the materials.
4. **Recce** (conduct a reconnaissance) the school grounds and decide where the best place/garden in the school to conduct each activity is. Do not select an area too near a road or car park as this is unsafe. The garden should not be too near a classroom as the students carrying out the activity might be noisy and affect students in the nearby classroom.
5. **Facilitate/Conduct** it. Tips on conducting outdoor lessons can be found on page 4 and 5.
6. **Help students Reflect** on their experiences.



Tips on Conducting Activities

1. **Be aware of safety issues**
 - Have a first-aid kit on hand.
 - Be alert in case students get cut, injured, bitten, have asthmatic attacks or allergic reactions from touching plant sap.
 - Weather
 - a. Check the weather forecast before the activity at the NEA website: www.weather.gov.sg
 - b. Postpone or delay the outdoor component of the activity if there is lightning (school siren sounds). If at a park, phone the Lightning Advisory number at 62826821 to check if there is a Category 1 lightning risk in the area.
 - c. If there is haze and it reaches an “unhealthy” level, postpone the activity.
 - Brief students about safety. The briefing points are given below.
2. **Conduct a briefing** before the activity, preferably in the classroom where there are fewer distractions and where it is easier for students to hear you. Here are 3 areas to brief students about:



Activity	Expectations	Safety
<ul style="list-style-type: none"> • Introduce the activity - its objectives and outcomes. • Distribute the handout if there are any. • Run through what they have to do and clarify if they do not understand. Go through the questions, if any. • Show students how to use the equipment and remind them to take care of these. 	Inform students that they are expected: <ul style="list-style-type: none"> • Not to damage plants or hurt animals. • Not to damage school property. • To carry out the activities within the set time and place. • To make as little noise as possible, so as not to disturb classes nearby. • To be responsible for all equipment and clean up the area after the activity. 	Inform students that: <ul style="list-style-type: none"> • All outdoor activities will be stopped if the lightning siren sounds (Lightning Category 1). • They should wash their hands thoroughly after every activity. • They need to be careful of potentially “dangerous” animals like fire ants, bees, wasps, centipedes and keep away from them. • They need to tell the teacher immediately if they have been injured, cut, bitten, have rashes on the skin or have any other medical condition. • Be careful of plants with thorns or white sap (may cause irritation to the skin).

3. **Decide if you would like students to work individually or as a team**

We have made recommendations for each activity whether individual work or team work is more suitable. If students are working in teams, you can have 3 -5 members in each team and assign a leader and assistant leader.

4. **Create a photo journal**

Have a digital camera with you, or ask a photographer to join the group, to photograph students carrying out the activities, their projects, your school garden, interesting plants and animals etc. Make a slideshow to showcase these photos to the school.

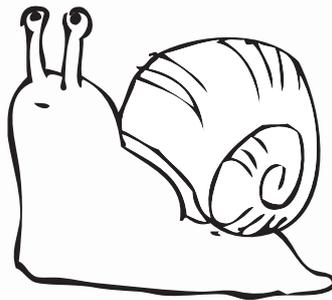
5. **Debrief to drive home learning**

The debrief is important in ensuring that the learning objectives/outcomes take place. Set aside at least 20 min at the end of each activity or the next day for debrief:

- Go through the answers for given questions.
- Ask more questions to spur them to think further.
- Commend students for their effort in being creative and completing their projects.
- Ask students to share their experiences, opinions and feelings.
- Explain more concepts about the topics covered. For older or more advanced students, you could ask them to “teach” the class about they had researched on or found out.
- Discuss the teamwork of their group and how they can improve this further.

6. **Have a conclusion and an extension activity**

Conclude each activity by summarising the main points learnt by students (content, SEL etc.). Decide on whether you would like to have an extension activity to continue with the topic/ theme of the current activity. We have included suggested extension activities in the summary table and lesson plans.



Summary of CIB Schools Activities

NO	ACTIVITY TITLE / DURATION	RECOMMENDED FOR:	THE ACTIVITY	SUBJECT LINKS / PROCESS SKILLS	SUGGESTED EXTENSION ACTIVITY
	<p><i>Students may visit the school garden occasionally or walk past planted areas of the school every day, yet not take notice of the plants in school or the animals they support! These activities help students recognise that their school has a large variety of plants - how they are different and how they can be classified and their importance to people. A rich plant collection will naturally attract a community of animals. Students will recognise common garden animals and whether they are harmful or beneficial to the plants.</i></p>				
1	Plant Symphony 1-2 hours	<ul style="list-style-type: none"> Lower Secondary Individual work 	Students become aware of the large variety of plants (high biodiversity in Singapore) and classify them scientifically (taxonomically).	Science Observing, comparing, classifying and communicating	<ul style="list-style-type: none"> Write and design plant labels for plants in school.
2	Garden Animals 2 hours	<ul style="list-style-type: none"> Lower Secondary Individual work/ teamwork 	Students observe, identify, classify and photograph animals in the garden and produce a guide to animals in the school garden. They discuss which animals are beneficial or harmful to plants.	Science and SEL Observing, classifying	<ul style="list-style-type: none"> Activity 4 Pest Busters.

NO	ACTIVITY TITLE / DURATION	RECOMMENDED FOR:	THE ACTIVITY	SUBJECT LINKS / PROCESS SKILLS	SUGGESTED EXTENSION ACTIVITY
<p>Green Thumbs</p> <p><i>A true gardener needs to spend time tending and caring for his/her plants. These activities turn mundane plant-care activities to fun projects, encouraging greater participation and developing greater interest in gardening.</i></p>					
3	New Plants from Old 3 sessions; 1-2 hours each. Each session should be about 2 weeks apart	<ul style="list-style-type: none"> Lower or Upper Secondary Individual work 	Students will grow new plants from seeds (sexual method) and through other asexual methods and learn to keep them healthy.	Science Observing, comparing, measuring, analysing	<ul style="list-style-type: none"> Care for plants or try other propagation methods. Sell their new plants as part of Activity 11 Home Grown Business.
4	Pet Busters 3 sessions; 1 hour each	<ul style="list-style-type: none"> Lower Secondary Teamwork 	Students observe and learn more about common garden pests. They do research on pesticides and also search for the "recipe" of an environmentally-friendly pest spray. They make the spray, try it on garden pests in school and evaluate its effectiveness.	Science, Geography and IT Observing, classifying, generating and evaluating	<ul style="list-style-type: none"> Students can offer their products as part of Activity 11 Home Grown Business.
5	Wildflower Guide 2 hours	<ul style="list-style-type: none"> Lower or Upper Secondary Individual work 	Students find, identify and photograph wildflowers in the school garden. They do research and create a wildflower guide. Students then weed the plants and compost them.	Science and IT Observing, comparing and classifying	<ul style="list-style-type: none"> Activity 6 Pruning Fun.
6	Pruning Fun 2 hours	<ul style="list-style-type: none"> Upper Secondary Individual work 	Students learn the importance of pruning plants; how to do it and use the clippings to create other products.	Science and Art & Craft Observing and generating	<ul style="list-style-type: none"> Students sell their plant products. Activity 11 Home Grown Business. Activity 7 Plant Sculptures.
7	Plant Sculptures 2 sessions; 1-2 hours each	<ul style="list-style-type: none"> Upper Secondary Teamwork 	Students go beyond normal pruning to take on sculpting existing plants in the school (topiary).	Science, Art and IT Observing and generating	<ul style="list-style-type: none"> Students make the trimmings into compost. Activity 11 Home Grown Business - students can offer this service as part of this activity. Students carry out other forms of topiary.

NO	ACTIVITY TITLE / DURATION	RECOMMENDED FOR:	THE ACTIVITY	SUBJECT LINKS / PROCESS SKILLS	SUGGESTED EXTENSION ACTIVITY
<p style="text-align: center;">Garden Produce</p> <p style="text-align: center;"><i>Through these activities, students quickly see how plants provide people with many products – beautiful designs which can be made into craft, food, materials, fusion dishes, and even fragrances and traditional medicines! Nurture the entrepreneurial spirit by converting the sale of these products into a business.</i></p>					
8	<p>Fusion Cooking 2 sessions; 1-2 hours each</p>	<ul style="list-style-type: none"> Lower Secondary Teamwork 	<p>Students identify common herbs, spices and vegetables (in the school garden, if these are available), carry out research for recipes using them. They create a new fusion recipe, using local herbs and spices and cook it.</p>	<p>Science, Home economics and IT</p> <p>Observing, classifying and generating</p>	<ul style="list-style-type: none"> Invite other teachers and students to taste. Plant herbs and spice plants in the school, create a herbs and spice garden. Make plant labels for spice plants at school. Sell their fusion food for Activity 11 Home Grown Business.
9	<p>Garden Cures 1-2 hours</p>	<ul style="list-style-type: none"> Lower Secondary Teamwork 	<p>Students identify local plants with traditional cures (in the school garden, if these are available). They take photos, write and design educational labels for these plants.</p>	<p>Science and IT</p> <p>Observing and generating</p>	<ul style="list-style-type: none"> Make and install the educational signs (e.g. as part of the subject Design and Technology). Create a medicinal garden in school or improve it. Create a medicinal plant trail for your school.
10	<p>Scent-sation 2 sessions; 1-2 hours each</p>	<ul style="list-style-type: none"> Lower Secondary Individual work 	<p>Students identify plants with scent (in the school garden, if these are available). They do research to find out the benefits of plants having scents and simple methods to extract these chemicals and make a product (essential oils, mosquito repellent).</p>	<p>Chemistry, Science/Biology</p> <p>Observing and generating</p>	<ul style="list-style-type: none"> Students create a new scent garden for the school.
11	<p>Home Grown Business 2-3 sessions; 1-2 hours each</p>	<ul style="list-style-type: none"> Lower and Upper Primary Teamwork 	<p>Students develop entrepreneurial skills by identifying products or services they can produce from the school garden, creating samples of their product/s and developing marketing materials for them.</p>	<p>Science and IT. Optional: CIP</p> <p>Observing, communicating, generating, evaluating and analysing</p>	<ul style="list-style-type: none"> Donate the earnings from the sale of the products to a non-profit organisation. Put back the earnings to the garden's uses.

NO	ACTIVITY TITLE / DURATION	RECOMMENDED FOR:	THE ACTIVITY	SUBJECT LINKS / PROCESS SKILLS	SUGGESTED EXTENSION ACTIVITY
<p>Special Gardens</p> <p><i>Many schools have garden plots which attract butterflies, showcase local fruits and/or simulate a desert habitat. Here are some suggested activities to be carried out in these gardens if your school has these garden plots. Finally, create a new design for an existing garden plot.</i></p>					
12	<p>Butterfly Haven 2 sessions; 2 hours each</p>	<ul style="list-style-type: none"> Lower Secondary Individual work 	<p>Students visit HortPark to observe and learn more about local butterflies. They identify, take photographs/video of local butterflies and create a presentation on local butterflies.</p>	<p>Science, IT Observing, classifying, comparing</p>	<ul style="list-style-type: none"> Create a butterfly park within school. Collect butterfly larvae and observe the rest of the lifecycle.
13	<p>Fruit Garden 2 gardening sessions; 2 hours each</p>	<ul style="list-style-type: none"> Lower Secondary Individual work 	<p>Students identify fruit trees and vegetable 'fruits' in the school garden, find out about other local fruits/vegetables through a survey and do research on them. They write educational labels for the fruit trees and vegetable fruit plants in your school garden.</p>	<p>Science, IT Observing</p>	<ul style="list-style-type: none"> Create an electronic 'local fruit' guide. Write and design signs for fruit trees in your school. Make suggestions for planting new fruit trees in the school.
14	<p>Desert Life 1-2 sessions; 1-2 hours each</p>	<ul style="list-style-type: none"> Lower Secondary Individual work/ teamwork 	<p>Students identify characteristics of cacti and other drought-tolerant plants which enable them to survive in a hot, dry desert habitat. They also observe the plot for the cacti and drought - tolerant plants in the school and evaluate how well these conditions simulate a desert/dry habitat. They then propagate a cactus or drought-tolerant plant from your school garden.</p>	<p>Science, IT Observing, measuring analysing</p>	<ul style="list-style-type: none"> Fieldtrip: visit parks with a collection of succulent plants (e.g. Singapore Botanic Gardens - Sun Garden, Evolution Garden). Sell their new cactus plants as part of Activity 11 Home Grown Business.
15	<p>My Dream Garden 3 sessions; 1-2 hours each</p>	<ul style="list-style-type: none"> Upper Secondary Teamwork 	<p>Students are assigned a plot in school. They draw a map of the plot and design a theme garden for it, which has to be creative, aesthetic and educational.</p>	<p>Science, Art, D & T, IT Observing, measuring, communicating, generating</p>	<ul style="list-style-type: none"> Submit a budget for their proposed garden. Plant the plot according to the best design.

1. PLANT SYMPHONY

Outcome

Students become aware of the large variety of plants (high biodiversity in Singapore) and classify them scientifically (taxonomically).

Duration	1-2 hours
Recommended for	Lower Secondary; individual work
Subject Links	Science
Process Skills	Observing, classifying, comparing and communicating
Equipment/ Materials	Optional: 1001 Garden Plants in Singapore, (2nd Edition), National Parks Board and A Guide to Herbs And Spices (Singapore Science Centre Guide).
Preparation	Photocopy Handout 1

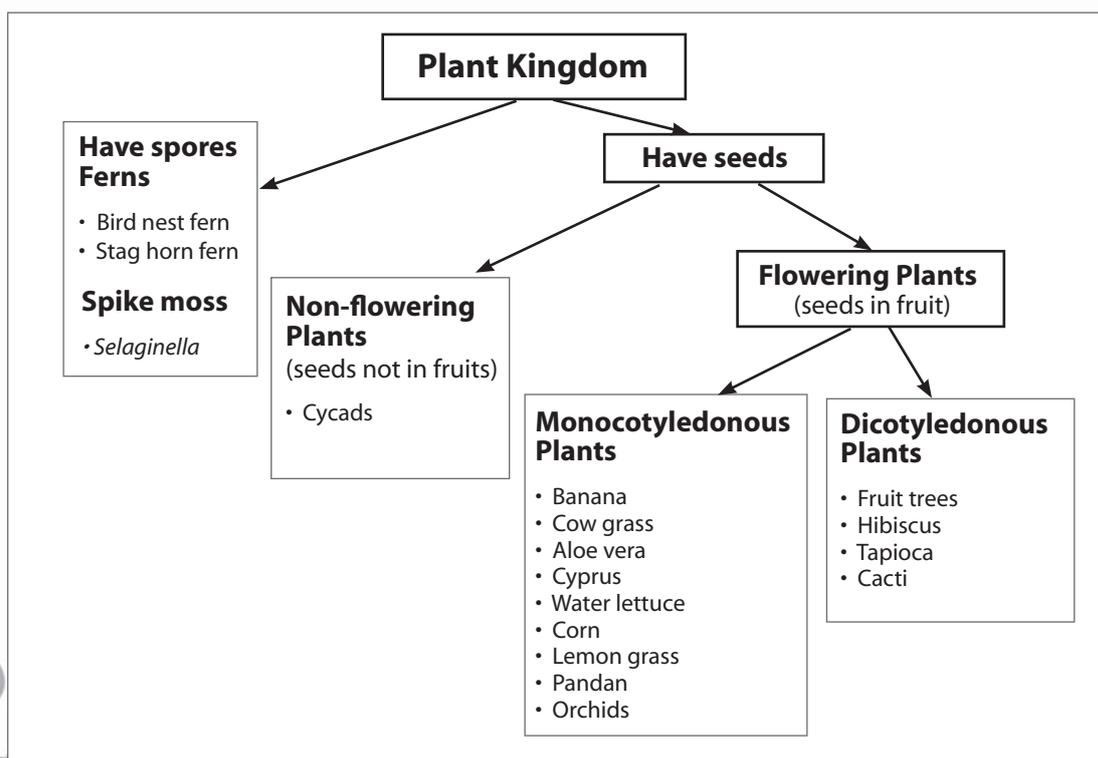
How to Conduct?

1. Distribute Handout 1 and explain the activity, highlighting the visual organiser on the handout.
2. After students have completed their classification, debrief the activity.

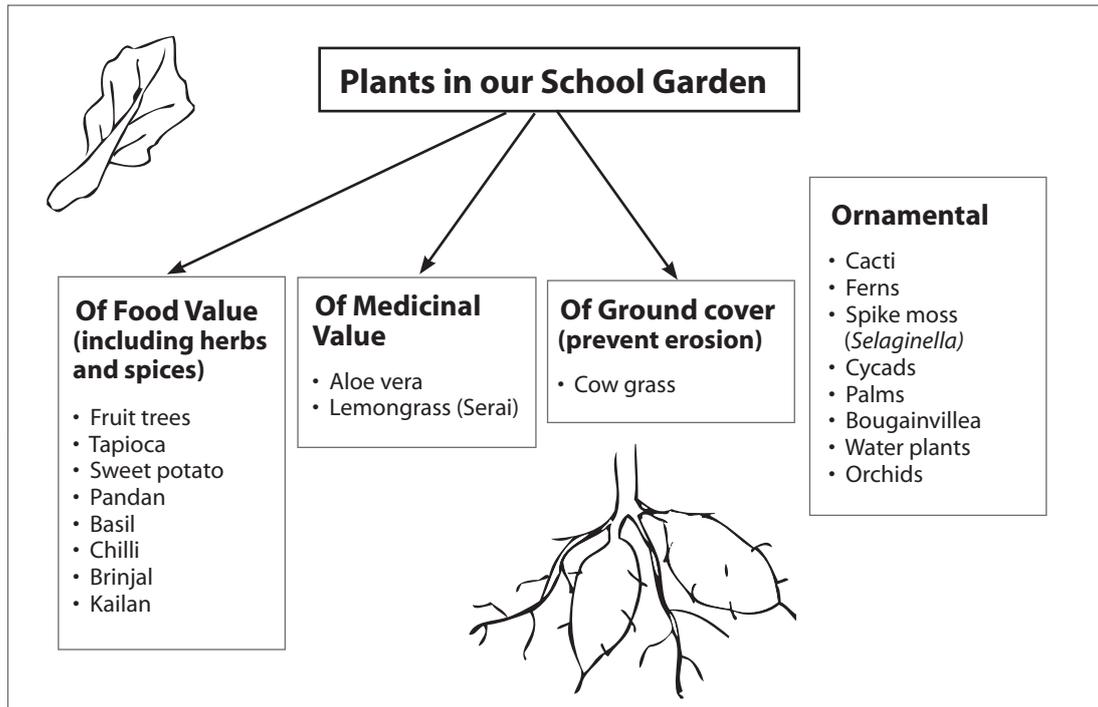
Debrief

1. Run through the two different ways of classifying plants in your school and questions on Handout 1. Here are some suggested answers:

Taxonomical Classification of Plants



Classification of Plants By Usage



Besides being classified taxonomically and by usage, how else can plants be classified?

- Plants can be classified according to:
 - Their growth form/size (trees, shrubs, herbs, etc.)
 - Their type of stem - woody or herbaceous (non-woody) stems
 - The amount of light the plant requires (sun-loving or shade plants)
 - The colour and shape of plants or leaves
- Ask students to give their opinion of the variety (biodiversity) of plants in the school (opinions may vary). Help students to recognise that Singapore has a large variety of plants (high biodiversity).
- Conclude that plants can be categorised/classified in many ways.
- Ask students to share with the class what they had learnt from this activity.

Suggested Extension Activities

Students carry out research, write and design plant labels for plants in school.





Name :

Members of your team :

PLANT SYMPHONY

Plants belong to the Kingdom Plantae. Within the Plant Kingdom is a large variety of plant types. Which of them have flowers, which do not? If they do not have flowers, how else can plants reproduce? Some are able to grow very tall, with water pumped to great heights of 40-60m to reach the leaves, while other plants creep along the ground. Explore your school garden and enjoy the symphony of plants!

Project Objectives

You have to:

Observe and list plants found in your school garden, identify and classify them scientifically (taxonomically) and by usage (ornamental, medicinal, vegetables/crops etc.).

Equipment/Materials

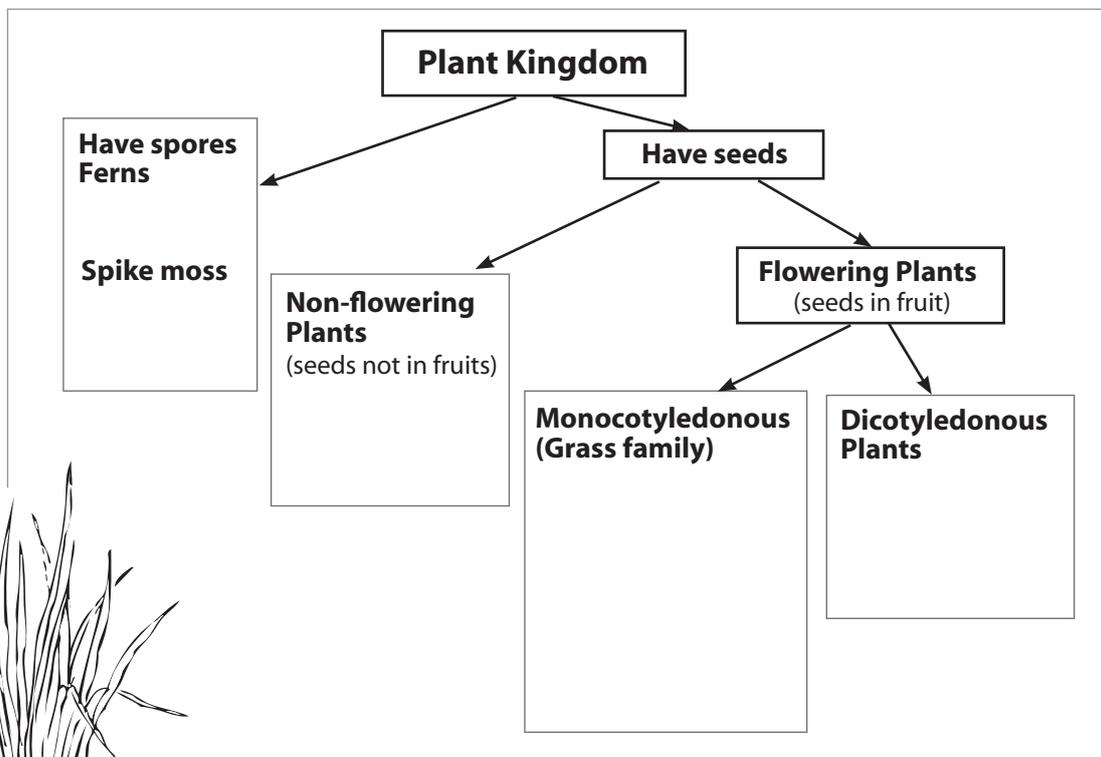
Optional: 1001 Garden Plants in Singapore, (2nd Edition) National Parks Board and A Guide to Herbs And Spices (Singapore Science Centre Guide).

Suggested Steps

1. Go to your school garden. Observe and list down all the major plants you can find.
2. With your list of plants, classify them in 2 different ways, using these visual organisers:



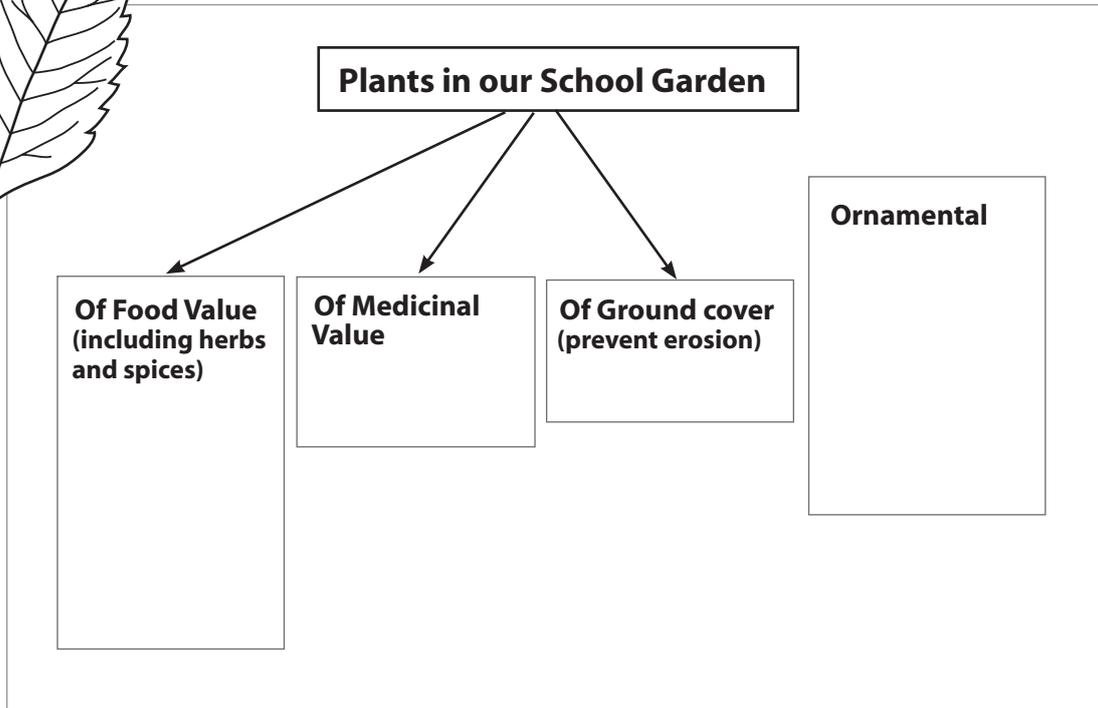
Taxonomical Classification of Plants



HANDOUT 1



Classification of Plants By Usage



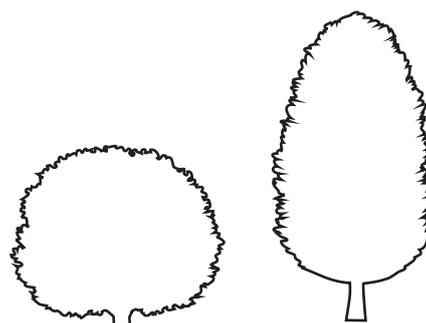
Did you know that plants can also be classified according to growth forms/size:

- Tree** A tall plant (at least 6m when fully grown), often with one main trunk.
- Shrub** A bush-like plant, with many branches instead one trunk. General height it can reach: between 1m - 6m when fully grown.
- Herb** A plant which does not grow taller than 1m when fully grown. Usually with green, soft stems (not woody).
- Climber** A plant with weak stems, able to grow up a support to obtain optimum sunlight.

Besides being classified taxonomically and by usage, how else can plants be classified?

Tips

Get help for identification using the NParks Plant Reference
<http://www.floraweb.nparks.gov.sg>



HANDOUT 1

2. GARDEN ANIMALS

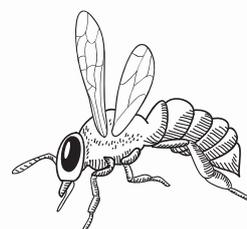
Outcome

Students observe, identify, classify and photograph animals in the garden and produce a guide to animals in the school garden. They discuss which animals are beneficial or harmful to plants.

Duration	2 hours
Recommended for	Lower Secondary; individual work/teamwork
Subject Links	Science and SEL
Process Skills	Observing and classifying
Equipment/ Materials	Optional: A Guide to Common Garden Animals (Singapore Science Centre Guide Book) and digital camera.
Preparation	Photocopy Handout 2

How to Conduct?

1. Assign students into teams.
2. Distribute the handout, explain the activity and run through the main points on the handout.
3. Explain how they are to classify the animals:
 - Scientifically (taxonomically), in groupings like insect, mollusc, worm, bird, fish etc.
 - Whether the animal is beneficial to plants or harmful to plants (garden pest).
4. Explain how some animals are beneficial to the garden. These animals:
 - eat insects or pests (e.g. spiders, lizards and birds)
 - pollinate flowers (e.g. bees, sunbirds and butterflies)
 - help disperse seeds (e.g. birds and bats)
 - help loosen soil and improve soil quality and drainage (e.g. earthworms)
 - help breakdown dead plant material (e.g. woodlice, termites)
5. Explain what garden pests do. Pests harm the plants:
 - by eating the leaves of plants (e.g. grasshoppers, caterpillars, bagworms, garden snails)
 - by sucking plant sap (e.g. leaf hoppers, mealy bugs, scale insects)
6. After observing the animals in the school garden, consolidate all teams' animal lists and run through the classifications.



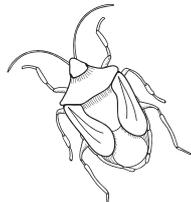
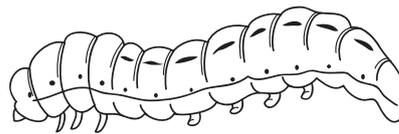
Scientific classification of common animals in schools

Invertebrates (no backbone)		
Insects Garden cockroach Ants Bees Wasps Termites Dragonfly Butterflies and moths Aphids Scale insects Mealy bugs Leaf hoppers Grasshoppers Beetles e.g. ladybirds Bagworms	Worms Earthworms Arthropods Spiders Centipedes Millipedes Mites	Molluscs Land snails Slugs Crustaceans Woodlice

Scientific classification of common animals in schools

Vertebrates (with backbone)		
Birds Sun birds Mynahs Sparrows	Amphibians Asian toads Banded bullfrogs	Reptiles Changeable lizards Garden lizards Blind snakes

Classification of animals according to whether they are beneficial or harmful to plants:

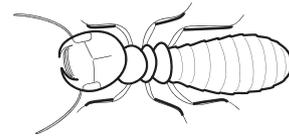
Beneficial Animals	Harmful animals (Garden pest)
<p>Animals that eat dead or decaying animals/ cleans up the garden: Garden cockroach (insect) Ant (insect)</p> <p>Animals which pollinate flowers: Bee (insect) Sun bird (bird) Butterfly or moth (insect)*</p> <p>Animals that eat pests Wasp (insect) Dragonfly (insect) Spider (arthropod) Centipede (arthropod) Asian toad (amphibian) Banded bullfrog (amphibian) Changeable lizard (reptile) Garden lizard (reptile) Mynah (bird) Sparrow (bird)</p> <p>Animals that improve soil Earthworm Woodlice</p> <p>Animals that help break down decaying wood: Termite (insect) Woodlice</p>	<p>Animals that suck sap: Aphids (insect) Scale insects (insect) Mealy bugs (insect) Leaf hoppers (insect)</p> <p>Animals that eat leaves: Grasshoppers (insect) Bagworms (insect) Land snails (mollusc) Slugs (mollusc) Caterpillars (insect)*</p>  

*Butterflies, moths and their caterpillars are both beneficial and harmful.

- Bring students to the computer room to download the photos from their digital cameras. They are to carry out web research and create their animal guides for the school garden.

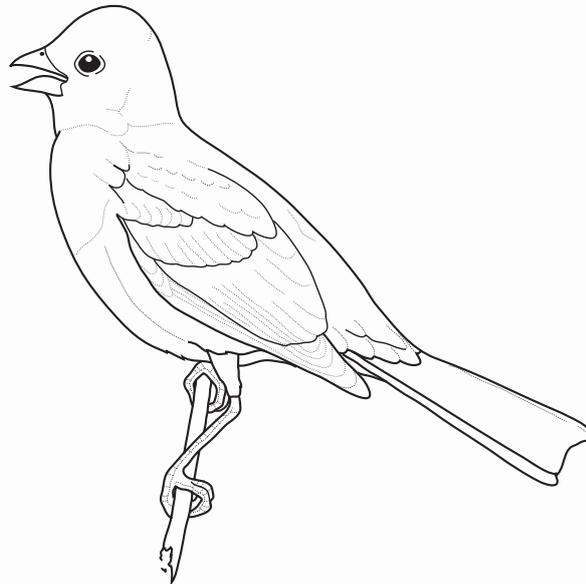
Debrief

1. Ask each team to showcase their animal guide to the class.
2. Suggested questions to pose to students:
 - What were the animals doing?
 - Where were the animals found and why? (Taking shelter under leaves, structures etc. Why? They do this to escape from predators and the heat of the sun, to stay in an area of high humidity to prevent drying out e.g. for slugs).
 - Is the biodiversity (variety of species) of animals high in the school? (Usually, it is not as high as that in a park or forest.)
 - How would one attract more beneficial animals into your school garden? (Maintain a lush garden to attract birds and other natural predators of pests; growing plants that produce nectar will attract pollinators to the garden.)
3. Conclude that animals will naturally come to a garden – to find food or shelter. Some may even live there (colonise a garden). We hope the activity has helped them to be more aware of these common garden animals.



Suggested Extension Activities

Students can carry out Activity 8 Pest Busters.



Name :

2

Members
of your team :

GARDEN ANIMALS

Where there are plants, animals will soon follow. Gardens bring nature to the school – turning bare land (with only grass) into a rich, lush habitat, teeming with life! The school gardens can be an exciting place for encountering insects, frogs and birds. Some may even nest and breed in the garden! Your garden will also attract unwanted animals, which we term as 'pests'. Instead of enriching the garden, these harm and weaken plants. But which is which? Which are the garden-friendly animals and which are the pests?

Project Objectives

Your team has to/ You have to:

1. Observe, identify, list, photograph and classify animals in the garden.
2. Create an animal guide for your school garden.

Be careful of potentially dangerous animals like centipedes, bees, fire ants and wasps. Stay away from them!

Suggested Steps

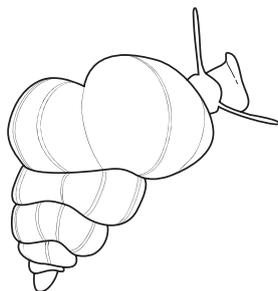
1. Go to your school garden to observe, photograph and identify animals for about 30min.
2. With your list of garden animals, classify these animals in different ways - scientifically and whether they are beneficial or harmful to plants in the garden.

Equipment/Materials

Optional: A Guide to Common Garden Animals (Singapore Science Centre Guide Book) and digital camera.

Tips

- Where can you find the animals? Animals are seldom found in the open. Most of them can be observed under leaves, or even under concrete slabs or underground. Why?
- Some interesting animals which you can look out for are frogs (and tadpoles), blind garden snakes, slugs, different types of birds and butterflies.



3. NEW PLANTS FROM OLD

Outcome

Students will grow new plants from seeds (sexual method) and through other asexual methods and learn to keep them healthy.

Duration	3 sessions; 1-2 hours each. Each session should be about 2 weeks apart.
Recommended for	Lower or Upper Secondary; individual work
Subject Links	Science
Process Skills	Observing, comparing, measuring and analysing
Equipment/ Materials	<p>For planting into existing school garden plots: Seeds (suggested species include Balsam, Plume Celosia, Chai Sim, Kai Lan or <i>Amaranth</i> or seeds from existing plants in the school), stem cuttings (e.g. Sweet Potato, Sugar Cane, Dill, whole onions), leaves (e.g. <i>Sansevieria</i>), ferns (for division), soil/potting mix, spades, watering cans.</p> <p>For container planting: pots or containers (reuse Styrofoam boxes) and permanent markers for labelling.</p> <p>Optional: digital camera and Community In Bloom: A Concise Guide to Tropical Gardening.</p>
Preparation	<p>Photocopy Handout 3</p> <ul style="list-style-type: none"> • Decide on whether students will be planting in a garden plot or in a container. • Decide where in school the students are to plant their new plants or place the containers. Be aware of the safety of this area (near traffic, roof top etc.). Seek permission to use the plot if you have to. • Arrange for school staff to water the students' plants during the weekends.

How to Conduct?

Session 1

1. Distribute Handout 3 and briefly run through the main points on the handout.
2. Highlight the differences between sexual and asexual reproduction and their advantages.
3. Bring students around the school, show them selected plants and explain how they are propagated. Here are some common plants and their methods of propagation:
 - **Stem cuttings** - Sweet potato, sugar cane, Hibiscus, *Dracaena* spp, Bougainvillea, guava
 - **Offshoots/ offsets** - *Heliconia*, Lemon grass, banana, sugar cane, bamboo, gingers
 - **Dividing** - Boston fern, *Calathea*
 - **Leaves** - Snake plant, Begonia, African Violet

4. For a brief introduction to propagating plants, see pages 23 - 25 of the Community In Bloom: A Concise Guide to Tropical Gardening.
5. Demonstrate how to plant seeds/stem cutting.
6. Distribute equipment and materials to each team and let them plant their seeds and other plant parts.
7. Briefly run through how to grow healthy plants – they need sunlight, be watered regularly and given fertilisers.
8. Ask students to water the plants and reminding them of their responsibility to water their plants daily and check for garden pests frequently.

Session 2 (2 weeks after Session 1)

1. Check on how plants have grown. If plants have died or not grown well, ask students to replant or change the conditions.

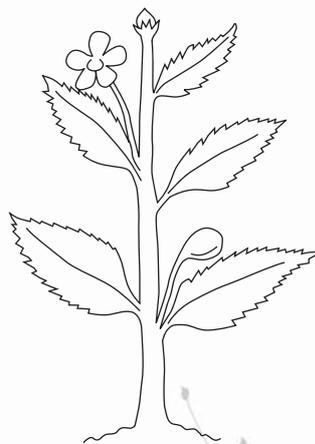
Debrief

Session 3 (4 weeks after Session 1).

1. Bring students to see the plants they had planted. Commend students who have propagated healthy new plants.
2. If plants have died or not grown well, help students to troubleshoot why and identify the problems.
 - Plants died because the team forgot to water them.
 - A pest ate the new plants/shoots.
 - Plants are weak because they did not receive sufficient light.
 - Sometimes, seedlings rot and die because of over-watering or poor soil (insufficient drainage).
3. Recap what plants need for healthy growth (correct amount of sunlight, water, nutrients).
4. Why are asexual methods sometimes advantageous? (Take a shorter time to produce new plants; used for preserving a good strain of plant e.g. durian strains; only method of propagation for plants which do not flower often in our climate.)
5. Ask students to share with the class what they have learnt from this activity. Alternatively, you could ask them to fill in the reflection sheet in Annex 3 and discuss their reflections.

Suggested Extension Activities

- Students can continue to care for plants or try other propagation methods.
- Students can sell their new plants as part of Activity 11 Home Grown Business.





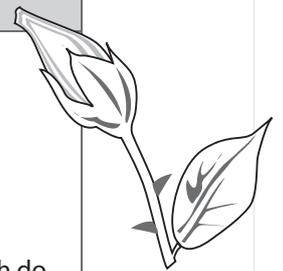
Name :

Members of your team :

NEW PLANTS FROM OLD

Plants can reproduce by sexual (seeds or spores) or asexual (cloning) methods. Here is a comparison of sexual and asexual reproduction:

Sexual reproduction - through seeds, spores	Asexual reproduction - through stem cutting, offshoots, dividing, suckers or offshoots, leaf cutting, etc.
<ul style="list-style-type: none"> The new plant has DNA different from both parents. This allows the new plants to adapt better to changes in the environment, increasing their chances for survival. <p>Implications for Gardening</p> <ul style="list-style-type: none"> Used for crossing 2 plants with desired characteristics to get a new plant with both these characteristics. 	<ul style="list-style-type: none"> New plants are clones of their parent plants (same genetic material). <p>Implications for Gardening</p> <ul style="list-style-type: none"> Takes a shorter time to produce new plants. Used for preserving a good strain of plant e.g. durian strains. Only method of propagation for plants which do not flower often in our climate.



Project Objectives

You have to:

- Identify some common plants in the school garden.
- Find out how they are commonly propagated (seeds, dividing, suckers or offshoots, leaf cutting, marcotting etc.).
- Plant seeds, plant parts and keep them growing healthily.
- Water and monitor plants daily for 4 weeks.

Suggested Steps

- Go to the school garden and identify some common plants there.
- Find out how these plants are commonly propagated (from a book or your teacher).
- Obtain the seeds and plant parts provided by your teacher or from the school garden. (Seeds, suckers or offshoots, stem, root or leaf cuttings).
- Prepare the soil in the new plant bed or pots/container. Plant the seeds, offshoots, root or leaf cuttings etc. at regular intervals (5-10cm apart), depending on the size of the plant. For stem cuttings, remove all leaves from the cutting and stick each stem at regular intervals into the soil, with the buds facing upwards.
- Check your new plants and water them once every day or every 2 days. Remove pests if there are any.

Equipment/Materials

For planting into existing school garden plots: Seeds (suggested species include Balsam, Plume Celosia, Chai Sim, Kai Lan or *Amaranth* or seeds from existing plants in the school), stem cuttings (e.g. Sweet Potato, Sugar Cane, Dill, whole onions), leaves (e.g. *Sansevieria*), ferns (for division), soil/potting mix, spades, watering cans.

For container planting: pots or containers (reuse Styrofoam boxes) and permanent markers for labelling.
Optional: digital camera and Community In Bloom: A Concise Guide to Tropical Gardening.

Tips

- See pages 23-25 of the Community In Bloom: A Concise Guide to Tropical Gardening for a brief introduction to propagating plants.
- Do some research on how plants can be reproduced.

4. PEST BUSTERS

Outcome

Students observe and learn more about common garden pests. They do research on pesticides and also search for the “recipe” of an environmentally-friendly pest spray. They make the spray, try it on garden pests in school and evaluate its effectiveness.

Duration	3 sessions; 1 hour each
Recommended for	Lower secondary; teamwork
Subject Links	Science, Geography and IT
Process Skills	Observing, classifying, generating and evaluating
Equipment/ Materials	Spray bottle, blender and ingredients for pest removal sprays (to be determined by the students).
Preparation	Photocopy Handout 4

How to Conduct?

1. It is recommended that students carry out Activity 2 Garden Animals before this activity.

Session 1

1. Distribute Handout 4, explain the activity and briefly run through the main points on the handout.
2. After students go around the school gardens to look for garden pests, bring students to the computer room to do their web research to answer the questions on pesticides and to search for an environmentally-friendly spray for garden pest.
3. Students make a list of the ingredients and equipment they need to buy or bring for the next session.
4. Discuss the differences between commercially-available pesticides and environmentally-friendly pest sprays.

Aspects for comparison	Commercial pesticides	Environmentally-friendly (organic) sprays
Toxicity	<ul style="list-style-type: none"> • Very poisonous – affects not only insects, but may poison or kill other animals in the gardens. • A health risk to humans including causing cancers, liver damage, allergies etc. 	<ul style="list-style-type: none"> • Does not affect many animals nor humans, not toxic.
How it works	<ul style="list-style-type: none"> • Kills by poisoning – stopping of body processes. 	<ul style="list-style-type: none"> • Chilli and garlic deters the animal from the plant; oils clog up the breathing tubes of insects, detergent removes surface tension, allowing water to enter the breathing tubes and “drown” the insect.
Other effects	<ul style="list-style-type: none"> • Pollutes the surrounding land and water. 	<ul style="list-style-type: none"> • Breaks down and becomes harmless.

Session 2

1. Students bring or buy the equipment and materials.
2. They make the pest spray and fill a few spray bottles.
3. Students go to the plants with garden pests and spray them with their spray. They mark the locations of the garden pest with an "experiment in progress" sign.

Session 3 (1-2 weeks later)

4. Students to check on the plants for garden pests to evaluate the effectiveness of their spray.
5. If the spray had been ineffective, they can search for a more effective formula and try it out.
6. Debrief the activity.

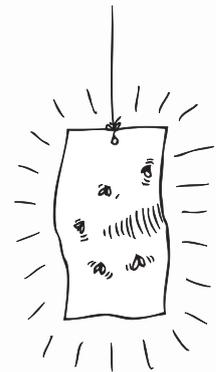
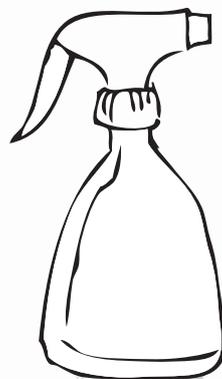


Debrief

1. Commend teams with well-researched projects.
2. Ask students: What are other environmentally-friendly products or methods for removing pests?
 - Natural, biodegradable, or soap-based pest/weed sprays. Oil-based sprays act to clog up the openings of the spiracles (breathing tubes) of the insect pests, while soap-based sprays break the surface tension, allowing water to enter the spiracles and 'drown' the insect.
 - Barrier nets - to prevent flying pests from reaching plants.
 - Sticky tape or surfaces - to attract and trap flying adult insect pests.
 - Attracting the natural predators of the pest-insects (e.g. lizards, birds by providing a lush habitat for them to live in).
 - Removing pests by hand.
3. Question to pose to students: Can we label our environmentally-friendly product as 'organic'? (No, products have to be certified by an organic farming authority before being labelled as 'organic'.)
4. Ask students what they have learnt through this activity. Alternatively, you could ask them to fill in the reflection sheet in Annex 3 and discuss their reflections.

Suggested Extension Activities

- Students can sell their pest spray recipe as part of Activity 11 Home Grown Business.





Name :

4

Members of your team :

PEST BUSTERS

The spraying of chemical pesticides is one of the most commonly used methods for removing pests. However, pesticides are essentially poisons. They pollute the environment and may adversely affect the living things (including human beings) they come into contact with. Today, environmentally-friendly methods of pest management are gaining popularity. They are generally slower in action, but sufficiently effective and do not pollute the environment. This makes it safer for us and our plants. In this activity, you get to make or build your own products and test them out on the pests in your school garden!

Project Objectives

Your team has to:

1. Look for garden pests in the school.
2. Research and make an environmentally friendly pest spray and try it out.
3. Check the effectiveness of this spray and improve on it, if necessary.

Be careful of potentially dangerous animals like centipedes, bees, fire ants and wasps. Stay away from them!

Equipment/Materials

Make a list of equipment and materials you need from your research. Get all these for Session 2.

Suggested Steps

Session 1 - Look for pests in the school garden. Do research:

- to find out more about pesticides and answer the questions below.
- to search for an environmentally-friendly spray for garden pests.

Session 2 - Make the spray and use it on the garden pests.

Session 3 - Evaluate the spray's effectiveness in removing the pests and improve on it if necessary.

Do research to find out the differences between commercially available pesticides and environmentally-friendly pest sprays.

Aspects for comparison	Commercial pesticides	Environmentally-friendly (organic) sprays

HANDOUT 4

5. WILDFLOWER GUIDE

Outcome

Students find, identify and photograph wildflowers in the school garden. They do research and create a wildflower guide. Students then weed the plants and compost them.

Duration	2 hours
Recommended for	Lower or Upper Secondary; individual work
Subject Links	Science: classification and IT
Process Skills	Observing, comparing and classifying
Equipment/ Materials	Gloves, plastic bags, changkol/trowel and digital camera. Optional: A Guide to the Wildflowers of Singapore and A Guide to Medicinal Plants (Singapore Science Centre Guide Book).
Preparation	Photocopy Handout 5. Conduct a reconnaissance of the school garden to identify areas for weeding and where you could set up a compost heap (a shady humid area is most suitable).

How to Conduct?

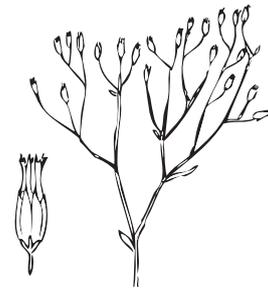
1. Ask students what weeds are (unwanted plants) and why gardeners remove them (they compete with garden plants for sunlight, water and nutrients; some may spread disease to our garden plants).
2. Distribute Handout 5, explain the activity and briefly run through the main points on the handout.
3. Bring students to the garden area and start the activity. Guide them as they identify and photograph the wildflowers.
4. After weeding, ask students to bring the plants to a designated place for composting.
5. Show students how to compost the weeds:
 - Dig a shallow hole in the designated area and place weed plants into it.
 - Scatter soil over the plant parts. Add more weeds. Continue to alternate between the soil and weed layers, ending with a soil layer at the surface.
 - Water the compost pile and keep it moist.
6. After composting, students do research on the wildflowers and create a wildflower guide. Debrief the activity.

Debrief

1. Ask students to show the class their wildflower guides.
2. Discuss the questions on their handout:

a) Why are weeds such “successful” plants?

- They grow very fast and have short life cycles.
- They are hardy plants, adapted to grow in places with harsh conditions (e.g. high temperature, little water).
- They reproduce rapidly, producing large number of seeds.
- They have very efficient methods of seed dispersal and their seeds are adapted for the agent of dispersal. For example, the seeds of the Common Vernonia (*Vernonia* sp.) are very small and have parachute structures which are dispersed by wind. Others have hooked seeds for dispersal by animals (e.g. Love Grass).



b) What are the benefits of composting?

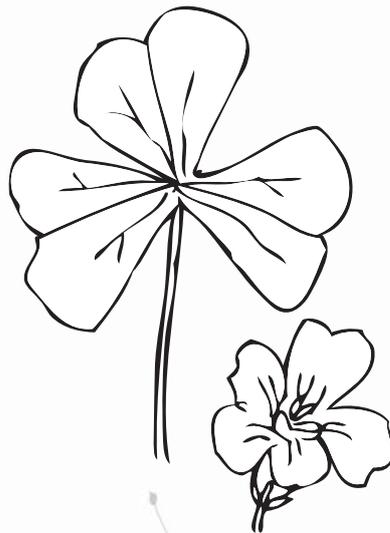
- Composting reduces the amount of waste produced, prolonging the lifespan of our landfill.
- Composting results in compost, which can be used to fertilise soil.

Additional Information

- Some common weeds include Common Vernonia (*Vernonia cinerea*), Hairy Spurge (*Euphorbia hirta*), Pick-a-back (*Phyllanthus niruri*) and Yellow Wood Sorrel (*Oxalis corniculata*).
- Some wildflowers such as Lesser Clover-leafed Desmodium (*Desmodium triflorum*) and Asian Pennywort (*Centella asiatica*) have medicinal value.
- Wildflowers from the legume family, like the Clover-leafed Desmodium (*Desmodium* spp.), are able to fix nitrogen in the soil in their root nodules. They are sometimes grown as ground cover to help prevent erosion.

Suggested Extension Activities

- Activity 6 Pruning Fun - weed plants can be used to make nature bookmarks.





Name :

Members of your team :

WILDFLOWER GUIDE

Weeds are defined as 'unwanted plants'! In our gardens, they compete with our garden plants for nutrients, water, space and light. Weeds make our plant beds look untidy and some even spread diseases to other plants! From a biological view, their persistence and ever-presence indicate how successful they are. Perhaps, we can give them a more indiscriminating name of 'wildflowers'. Look closely at them and you will discover how lovely some of them are!

Project Objectives

You have to:

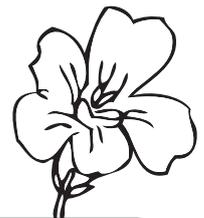
1. Find wildflowers in your school garden, identify and photograph them. Do research on them and create a wildflower guide.
2. Weed these unwanted wildflowers and compost them.

Equipment/Materials

Gloves, plastic bags, changkol/trowel and digital camera. Optional: A Guide to the Wildflowers of Singapore and A Guide to Medicinal Plants (Singapore Science Centre Guide Book).

Suggested Steps

1. Go to the designated area in the school garden with your digital camera and wildflower guidebook (optional).
2. Find all the wildflowers (weeds), identify them and photograph them. Then, pull the plants out and place them into the plastic bag. Wear gloves when weeding.
3. After everyone has finished weeding, compost the weeds at the location indicated by your teacher. Here is how you make compost:
 - a) Dig a shallow hole in the designated area, place weed plants into it.
 - b) Scatter soil over the plant parts. Add more weeds. Continue to alternate between the soil and weed layers, ending with a soil layer at the surface.
 - c) Water the compost pile and keep it moist.
4. After composting, do research on wildflowers you had found and create a wildflower guide.
5. Try these questions:



a) Why are weeds such "successful" plants?

b) What are the benefits of composting?

HANDOUT 5

6. PRUNING FUN

Outcome

Students learn the importance of pruning plants, how to do it and use the clippings to create other products.

Duration	2 hours
Recommended for	Upper Secondary; individual work
Subject Links	Science and Art & Craft
Process Skills	Observing and generating
Equipment/ Materials	Gloves, secateurs (gardening scissors) and plastic bag. Optional: Community In Bloom: A Concise Guide to Tropical Gardening.
Preparation	Conduct a reconnaissance of the school to select plants that need pruning (e.g. Bougainvillea, Fig plants, hedges). Decide what you would like student to do with the clippings or give them a choice. Obtain the needed materials accordingly.

How to Conduct?

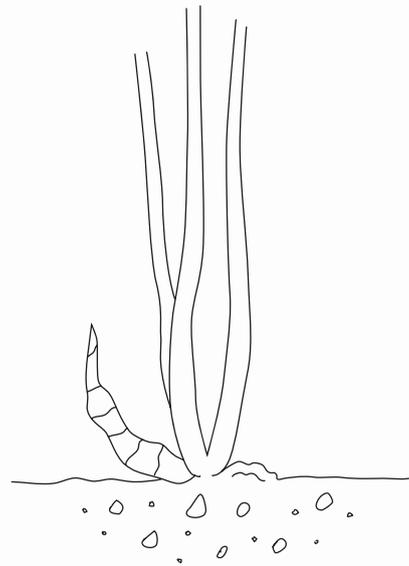
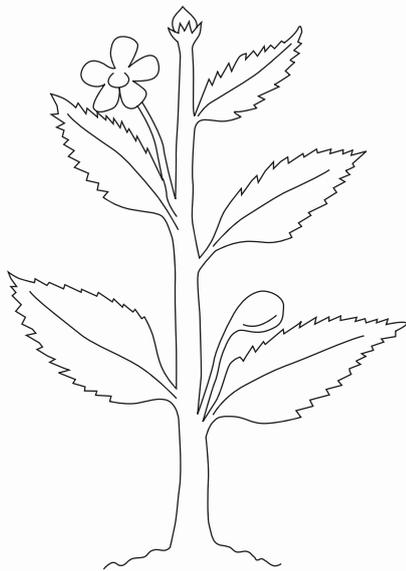
1. Ask what pruning is (cutting or removing branches or parts of trees).
2. Why do plants need to be pruned? (Plants are pruned to improve their health, control their shape and growth form and to encourage them to produce more flowers, buds or fruits). For basic information on pruning, see pages 34-36 of the Community In Bloom: A Concise Guide to Tropical Gardening.
3. Distribute the handout, explain the activity. Students will prune plants selected by you. They will collect the clippings and use them for one or two of the following:
 - Make plant pressings.
 - Make plant art (e.g. leaf prints on paper, bags, or imprinted in cement etc.).
 - Make compost.
 - Propagate new plants (continue with Activity 7 Growing New Plants).
4. Bring students to the garden and point out the plants which need pruning. Demonstrate how to prune a plant.
5. Distribute gloves, secateurs and plastic bags and start the activity.
6. When pruning has been completed, ask students to collect the plant parts into a bag and move to the canteen or classroom to carry out the next activity using these clippings.
7. For each activity, guide students on how to carry out the craft/composting activity.
8. After the students finish their tasks, debrief the activity.

Debrief

1. Observe students' products and praise students for their creative designs.
2. Recap the benefits of pruning.
3. Discuss the question: What is the significance of reusing the clippings? (To reduce waste, prolonging the life of our landfill, recycling the nutrients locked up in the plant parts.)

Suggested Extension Activities

- Students can sell their plant products as part of Activity 2 Home Grown Business.
- Students can try Activity 7 Plant Sculpture, an extension of pruning.





6

Name : _____

Members of your team : _____

PRUNING FUN

While pruning may add new life to your plants or keep them in shape, the clippings are often bagged and thrown away. Here are some creative ways of re-using these biodegradables – you can help save the environment (by reducing waste) and create attractive products from nature!

Project Objectives

You have to:

1. Learn why plants need to be pruned and how to do it.
2. After pruning, use the clippings for one or two of the following:
 - Make plant pressings.
 - Make plant art (e.g. leaf prints on paper, bags, or imprinted in cement etc.).
 - Make compost.
 - Propagate new plants.

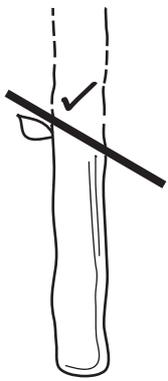
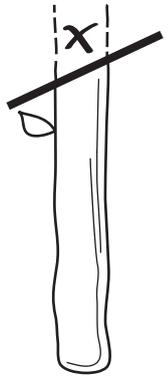
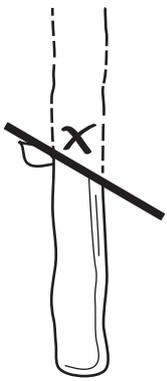
Be careful with the secateurs and shears. Watch out for plants with thorns!

Equipment/Materials

Gloves, secateurs (gardening scissors) and plastic bag.
Optional: Community In Bloom: A Concise Guide to Tropical Gardening.

Suggested Steps

- Wear gloves when pruning.
- Prune off dead and diseased parts of the plants first (for the latter, to prevent these from spreading to other plants).
- It is important to prune with the correct cut. This helps the plants to heal quickly and prevents rotting and fungal growth. See pages 35-36 of the Community In Bloom: A Concise Guide to Tropical Gardening.
- Collect plant clippings into a bag.

Right way to cut	Wrong ways to cut		
			
	<p>This cut slopes towards the bud. Rain or sap may collect at the bud and cause it to rot.</p>	<p>This cut is made too far from the bud, an unsightly stub is left.</p>	<p>This cut is made too near the bud, which may damage the bud.</p>

TO MAKE PLANT PRESSING

You need: secateurs, newspaper, scissors, large books (e.g. phonebook), heavy weights (bricks), coloured paper, laminator and laminating film.

Preparation: Cut newspaper sheets to about A4 sizes.

1. After pruning, sort through the clippings and collect complete and undamaged plant parts (flowers and leaves).
2. To make the pressing: arrange the plant part on a piece of A4 sized newspaper. Gently press it down and cover it with another piece of newspaper. Place the pressing between the pages of a large phonebook. Have a few pressings in each phonebook. Place a heavy weight (brick) on the phonebook and keep it in a dry place for about 1-2 weeks.
3. After 1-2 weeks, check the pressings. Discard any plant pressing with fungal growth. Select the best plant pressings and proceed with the lamination.
4. Place selected pressings between the sheets of a laminating film or place them on a coloured paper.
5. Close the sheets of the laminating film and insert it through a pre-heated laminating machine. Cut the laminated plant pressings to the desired shapes. Add trimmings (e.g. ribbon for bookmarks) if needed.

TO MAKE COMPOST

You need: chankol/trowel and garden soil.

1. With a changkol/trowel, dig a shallow hole in the designated area, place weed plants into it.
2. Scatter soil over the plant parts. Add more weeds. Continue to alternate between the soil and weed layers, ending with a soil layer at the surface.
3. Water the compost pile and keep it moist.
4. Check on the compost pile once a week. The pile needs to be kept damp and turned (mix up bottom and top layers) once every 2-3 weeks, to improve aeration and hasten the composting process.
5. In 2-3 months, you can use the compost for plants in the school garden to improve soil condition.

TO MAKE PLANT CRAFT

You need: secateurs, cloth, T shirt, canvas bag or art paper, fabric paint for cloth, poster paint for paper, sponge or brushes and old newspapers.

1. After pruning, sort through the clippings and collect complete leaves (or fern fronds).
2. Select the leaf or fern and paint it with the appropriate paint using a brush or sponge.
3. Place the painted surface onto the cloth, bag, T-shirt or paper surface and press gently.
4. Carefully peel away the leaf or fern and let the painted surface dry. (some leaves only allow a single use).
5. Use the cloth to sew interesting products (e.g. pencil cases) or the paper to make bookmarks, gift wraps etc.

TO PROPAGATE PLANTS (for selected plants only)

You need: secateurs, spade or trowel and garden soil.

1. After pruning, collect seeds and long stems from the clippings. Only selected plants can be propagated by stem-cuttings (e.g. Japanese Rose, Dill, Basil, Bouganvillea).
2. Prepare the soil in the new plant bed. Plant the collected seeds in regular intervals (5-10cm apart for small seeds or stems, approx. 20cm apart for larger seeds and stems).
3. For stem cuttings, remove all leaves from the cutting and stick each stem at regular intervals into the soil, with the buds facing upwards.
4. Water the seeds or stem-cuttings.

7. PLANT SCULPTURES

Outcome

Students go beyond normal pruning to take on sculpting existing plants in the school (topiary).

Duration	2 sessions; 1-2 hours each
Recommended for	Upper Secondary; teamwork
Subject Links	Science and Art
Process Skills	Observing and generating
Equipment/ Materials	Secateurs, shears (large gardening scissors) and gloves. Optional: digital camera and prizes.
Preparation	<ul style="list-style-type: none"> • Photocopy Handout 7. • Conduct a reconnaissance of the school to select plants (shrubs are best) in your school which are suitable for topiary (e.g. Bougainvillea, Fig plants, hedge plants). It is recommended that these plants be shrubs (not trees) of less than 1.5m and do not contain sap. • Inform your school's Operations Manager of your intention. • Inform the school gardener or landscape contractor not to prune your students' 'sculpture' plants during the period of the project. • Decide if you would like to make this a competition and obtain the prizes.

How to Conduct?

1. It is recommended that students carry out Activity 6 Pruning Fun, before this activity.

Session 1

2. Ask students what topiary is (the art or practice of trimming and shaping plants into ornamental shapes) and how it can be carried out (by pruning, or training a plant to grow into a frame).
3. Distribute Handout 7 and run through the activity.
4. Let students do research on topiary for 20min.
5. After this, bring students to the garden and assign each team to a plant. Get them to draw out a design for their team's plant and submit this to you for comments and approval.

Session 2

6. Give teams your feedback on their topiary designs.
7. Bring students to the garden and demonstrate how to cut and shape a plant (see Activity 6).
8. Distribute gloves, secateurs and plastic bags and get teams to start sculpting their plants.
9. When students have completed their sculpting, ask the teams to make a short class presentation about their sculptures.
10. Debrief the activity.

Debrief

1. If it is a competition, announce the winners and give out prizes (if any).
2. Commend on outstanding plant sculptures.

Suggested Extension Activities

- Students compost the trimmings.
- Activity 11 Home Grown Business - students can offer this service as part of this activity.
- Students carry out other forms of topiary.

Name : Members
of your team :

PLANT SCULPTURES

In this activity, pruning takes on a twist, where you become sculptors of a living media – plants in your school! Welcome to the art called 'topiary'! Topiary is cutting and trimming of plants into ornamental shapes. It also includes training plants to grow into particular shapes.

Project Objectives

Your team has to:

1. Cut and "sculpt" a plant in school.

Be careful with the secateurs and shears. Watch out for plants with thorns!

Suggested Steps

Session 1

1. Do research to find out more about topiary from websites, books and experienced gardeners.
2. Your teacher will assign a plant for your team to sculpt. The common species include *Bougainvillea* spp., *Syzigium companulatum*, Wild Water Plum (*Wrightia religiosa*), figs (*Ficus* spp.), *Ixora* (*Ixora* spp.) and *Duranta* spp.
3. As a team, brainstorm ideas for topiary designs, select one and submit to your teacher for feedback and approval. Get them to draw out a design for their team's plant and submit this to you for comments and approval.

Equipment/Materials

Secateurs, shears (large gardening scissors) and gloves.
Optional: digital camera.

Session 2

4. Finalise your team's design.
5. Collect your gloves, shears or secateurs and start shaping your plant.
6. Optional: Take photographs of your team's plant/s before, during and after sculpting.
7. Make a short class presentation about your team's sculpture.
8. Return your equipment and wash up.

Tips

- Optional: Compost the trimmings.
- Consult your 'gardener' friends or the school gardener for advice!

8. FUSION COOKING

Outcome

Students identify common herbs and spices (in the school garden, if these are available) and carry out research on recipes that use them. They create a new fusion recipe, using local herbs and spices, and cook it.

Duration	2 sessions; 1-2 hours each
Recommended for	Lower Secondary; teamwork
Subject Links	Science, Home economics and IT
Process Skills	Observing, classifying and generating
Equipment/ Materials	Optional: A Guide to Herbs and Spices (Singapore Science Centre Guide Book). If you do not have these in the school garden, buy some local herbs and spices.
Preparation	Photocopy Handout 8. Book the home economics room. Conduct a reconnaissance of your school to locate herb and spice plants.

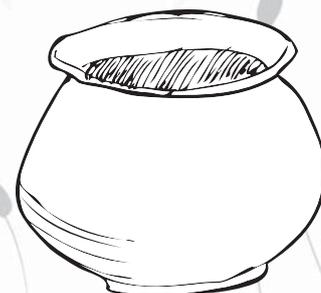
How to Conduct?

Session 1

1. Assign students into teams.
2. Distribute Handout 8, explain the activity.
3. If there are herbs and spice plants in your school garden, bring students to observe and identify them. If not, buy some local herbs and spices for students to observe.
4. Bring them to the computer room and start them on their research on selected local herbs and spices.
5. Discuss what fusion cooking is (cooking that combines ingredients and techniques and seasonings from different cuisines).
6. Ask students to create a new fusion recipe using a few local herbs and spice, give their dish a name and submit it to you. Give them your feedback on their recipes and help them make improvements if needed.
7. Ask them to buy and bring the ingredients for their recipe for Session 2.

Session 2

8. Students bring the ingredients for their recipes and/or harvest spices from the garden.
9. They cook their fusion recipes and make a presentation about them.

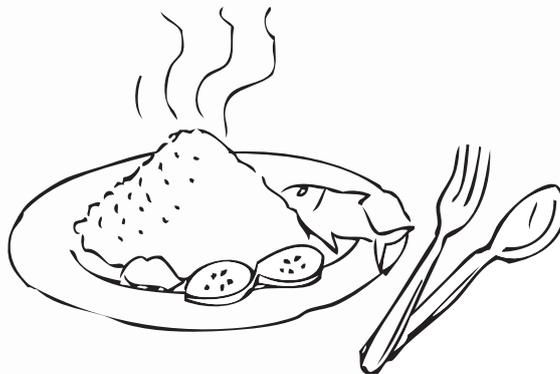


Debrief

1. Commend teams with well-researched and tasty new dishes (or creative names!).
2. Discuss the health benefits of some herbs, spices and root plants:
 - Indian Curry leaf (*Murraya koenigii*) – rich in vitamins and minerals.
 - Basil (*Ocimum basilicum*) – good source of magnesium, potassium iron, calcium and vitamins A and C.
 - Coriander (*Coriandrum sativum*) - known to contain a natural antihistamine, vitamin C and bioflavonoid which helps in reducing allergic reactions. (e.g. hay-fever).
 - Sweet potato (*Ipomoea batatas*) - known to have anti-oxidant effect, anti-inflammatory properties; good source of vitamins A, C and B6, manganese, potassium, iron and dietary fibre.
 - Mint (*Mentha* spp.) - Menthol is an essential oil derived from the mint plant. It is used in aromatherapy.
 - Lime plant (*Citrus aurantifolia*) - excellent source of vitamin C.

Suggested Extension Activities

- Invite other teachers and classes to try your students' dishes.
- If the school does not have these herb and spice plants in the school, plant them and create a herbs and spice garden.
- Students make plant labels for the herbs and spice plants in the school garden.
- Students sell food at the school's annual carnival as part of Activity 11 Home Grown Business.



Name :

8

Members
of your team :

FUSION COOKING

We are privileged to live in a country with many cultures. Each culture came with its distinct cuisine, which uses characteristic ingredients and techniques. However, as our country becomes more cosmopolitan, the fusion of food from different cultures becomes common. In this activity, you take the 'best of all worlds' by experimenting with new recipes using some of the herbs, spices and food plants in your school garden.

Project Objectives

Your team has to:

1. Identify some common local herbs and spices (in the school garden, if these are available).
2. Select a few herbs and carry out research on these plants, health benefits and recipes that use them.
3. Find out what "fusion cooking" is. Create a new recipe by integrating recipes from different cultures. Give your new recipe/dish a name.
4. Cook your new dish.

Equipment/Materials

Optional: A Guide to Herbs and Spices (Singapore Science Centre Guide Book), ingredients for their recipe.

Suggested Steps

Session 1:

1. Observe and identify some herb and spice plants (in the school garden or those given by your teacher).
2. Go to the computer room to do research on these herbs and spices e.g. health benefits and some recipes that use them. Find out what fusion cooking is.
3. Brainstorm your team's own new fusion recipe. Write it out, give it a creative name and submit it to your teacher for feedback.

Session 2:

4. Obtain the ingredients and try cooking your team's fusion recipe.
5. Ask your teacher and friends to try and feedback on the new dish.
6. Make a short class presentation about your team's fusion dish.

Tips

- Imagine you can combine western and/or eastern tastes! The possibilities are endless!
- Note the types of herbs and spices that some cuisines often combine (e.g. ginger and lemon grass for Thai dishes).
- You can recreate someone else's fusion dish, but do give credit to the original chef!



9. GARDEN CURES

Outcome

Students identify local plants with traditional cures (in the school garden, if these are available). They take photos, write and design educational labels for these plants.

Duration	1- 2 hours
Recommended for	Lower Secondary; teamwork
Subject Links	Science and IT
Process Skills	Observing, generating
Equipment/ Materials	Digital camera and A Guide to Medicinal Plants (Singapore Science Centre Guide Book). If you do not have these plants in the school garden, buy some. See the list below.
Preparation	Photocopy Handout 9. Conduct a reconnaissance of your school to locate these plants.

How to Conduct?

1. Assign students into teams.
2. Distribute the handout, and explain the activity.
3. If there are medicinal plants in your school garden, bring students to observe and identify them. If not, buy some local herbs and spices for students to observe. Ask students to photograph the plants.
4. Bring the students to the computer room to do research on these local medicinal plants and then write and design educational labels for them.



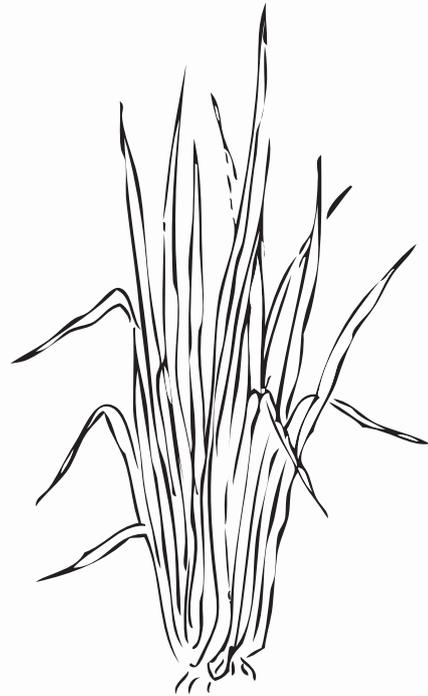
Debrief

1. Discuss the variety of local plants with traditional medicinal uses:
 - **Indian Curry leaf** (*Murraya koenigii*) – Traditionally known to acts as a disinfectant, aid digestion, ease diarrhoea and a potential medicine for curing diabetes.
 - **Ginger** (*Zingiber officinale*) - Traditionally known to help cure flu, poor digestion and nausea.
 - **Basil** (*Ocimum basilicum*) - Known to have anti-bacterial, anti-inflammatory properties.
 - **Coriander** (*Coriandrum sativum*) - Known to contain a natural antihistamine, vitamin C and bioflavonoid which helps in reducing allergic reactions (e.g. hay-fever).
 - **Sweet potato** (*Ipomoea batatas*) - Known to have anti-oxidant effect and anti-inflammatory properties.
 - **Mint** (*Mentha* spp.) - Traditionally used to treat stomach ache and chest pain. It aids digestion and is diuretic. Menthol is an essential oil derived from the mint plant. It is used as a medicine and in aromatherapy.
 - **Lemon grass** (*Cymbopogon citratus*) - Known to promote good digestion, cool fever (through inducing the body to perspire), relieves cramps and headaches.
 - **Asian Pennywort** (*Centella asiatica*) - The Chinese use it to improve appetite, aid digestion and treat sores and ulcers. Boiled as a “cooling drink”.

2. Commend teams with well-researched, written and designed educational labels.
3. Ask students: Can these traditional medicines be useful today and in the future? (Yes, as germs like bacteria and viruses become resistant to the old medicines/drugs, traditional medicinal plants could be the source of new medicines/drugs.)

Suggested Extension Activities

- Make and install the educational signs (e.g. as part of the subject Design and Technology).
- Improve the medicinal plant garden.
- Create a medicinal plant trail for your school.



Name : Members
of your team :

GARDEN CURES

Plants contain many organic chemicals which may have anti-bacterial or anti-inflammatory properties. Many of our local plants, including herbs and spices, grasses, wildflowers and even fruit trees were used traditionally by elders in our culture. In this activity, we search for these traditional cures found in our own backyard - they may be the sources of medicines for our current diseases!

Project Objectives

Your team has to:

1. Identify some common local medicinal plants (in the school garden, if these are available).
2. Select a few and carry out research on the plants. Design and write educational labels for these plants.

Equipment/Materials

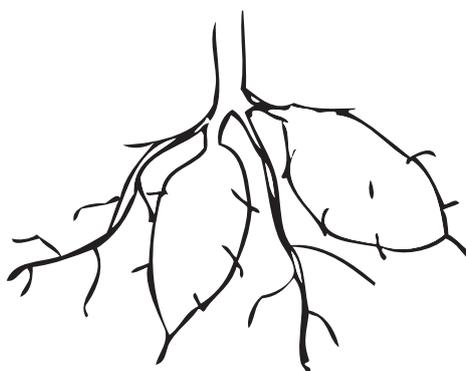
Digital camera and A Guide To Medicinal Plants (Singapore Science Centre Guide Book).

Suggested Steps

1. Observe and identify some local medicinal plants (in the school garden or those given by your teacher). The book "A Guide to Medicinal Plants" (Singapore Science Centre Guide Book) is very useful. Take photographs of these plants.
2. Go to the computer room. Download your photos and do research on these local medicinal plants and then write and design educational labels for them.
3. Check among your friends from other cultures on different uses for the same medicinal plants.

Tips

- Ask your grandparents or parents about some traditional medicines used in your culture. Find out if these plants are growing in your school garden.



10. SCENT-SATION

Outcome

Students identify plants using scent (in the school garden, if these are available). They do research to find out the benefits of plants having scents and simple methods to extract these chemicals and make a product (essential oils, mosquito repellent etc.).

Duration	2 sessions; 1-2 hours each
Recommended for	Lower Secondary; individual work
Subject Links	Chemistry and Science/Biology
Process Skills	Observing and generating
Equipment/ Materials	Optional: a fragrant flower or a bottle of floral perfume, A Guide to Herbs and Spices (Singapore Science Centre Guide Book) and 1001 Garden Plants in Singapore, (2nd Edition) National Parks Board. If you do not have these scented plants in school garden, buy some or collect from other places. See the list below.
Preparation	Photocopy Handout 10. Conduct a reconnaissance of your school to locate these plants.

How to Conduct?

Session 1

1. Pass a fragrant flower around the class or let students smell some floral perfume.
2. Distribute the handout, explain the activity.
3. If there are scented plants in your school garden, bring students to observe and identify them. If not, buy or collect some for students to observe and smell.
4. Bring students to the computer room to do their web research. Discuss the handout answers with them. Ensure each has selected a scented plant and a do-able extraction method.
5. Ask them to buy and bring the materials and equipment for the extraction (according to their research) during Session 2. Examples are alcohol, oil, food press (i.e. garlic press), pot and bottles for keeping the essential oils.

Session 2

6. Guide them as they extract their chemicals.

Debrief

1. Discuss some common scented plants found in Singapore:

Plants that release their scents	Plants which have scents in their plant parts (need to be crushed to smell the scent)
<p>Plants and trees with fragrant flowers</p> <p>Tembusu (<i>Fragrea fragrans</i>) Frangipani (<i>Plumeria rubra cultivar</i>) Cape Jasmine (<i>Gardenia jasminoides</i>) Angelonia (<i>Angelonia salicariaefoli</i>) Ylang Ylang (<i>Cananga odorata</i>)</p> <p>Plants with fruits that give off a smell</p> <p>Durian (<i>Durio sp.</i>) Champedak (<i>Artocarpus integer</i>) Jackfruit (<i>Artocarpus heterophyllus</i>)</p>	<p>Mosquito plant (<i>Citronella spp.</i>) Lemon grass (<i>Cymbopogon citratus</i>) Basil (<i>Ocimum basilicum</i>) Pandan (<i>Pandanus amaryllifolius</i>) Curry leaf plant (<i>Murraya koenigii</i>) Mint (<i>Mentha spp.</i>) Lime (<i>Citrus aurantifolia</i>) Ginger (<i>Zingiber officinale</i>)</p> 

2. Discuss the questions in Handout 10:

a) **What causes fragrance in plants?**

- Organic compounds produced in their leaves or flowers (petals) e.g. in Pandan, piperidine-like alkaloids are the compounds which give them their fragrance.

b) **How does having fragrance benefit plants?**

- Flowers have fragrance to attract pollinators like moths and bees to help pollinate their flowers.
- Organic compounds causing fragrance can be found in many parts of plants – bark, fruit and even roots! One main function is to protect the plant from being eaten and damaged by animals (especially insects). These organic compounds act as toxins or poisons which the animals will avoid.

c) **How have people used fragrances in plants?**

- To make scented products like perfumes, essential oils, insect repellents, soaps, etc.
- To flavour food (e.g. fragrant herbs and spices)
- In aromatherapy (the use of extracts from plants to promote health and well-being, as a form of alternative medicine)

d) **Some simple methods of extracting fragrances**

- Expression** – Commonly used to extract oils from the rinds of citrus. Rinds are squeezed by hand and a sponge used to collect the essential oils. To make it easier to extract, the rinds are soaked in water and then turned upside down (cells containing the oils will break apart) and the oils will drip down and be soaked up by the sponge.
- Cold Pressed** – The plant part is squeezed mechanically to force the oils out. Used for nuts, seeds, rinds of citrus. The extracted oils contain water, but in time, this water will evaporate and leave behind just the essential oils.
- Infusion** (solvent-extraction) – The use of water or oil (hot or cold) to extract the compounds from ‘damaged’ plant parts. This can be used for extracting herbs like rosemary and other compounds (e.g. lemon scent).

Additional information and terminology on fragrance

- What are essential oils? They are any concentrated, hydrophobic liquid containing volatile aroma (fragrant) compounds from plants.
- Essential oils can be extracted from different parts of plants including leaves, flowers, fruits, bark and even roots.
- **Other methods of extracting fragrances (not in the scope of this activity):**
 - o **Distillation** – The plant material is heated and the volatile fragrant compounds are then able to separate and be condensed.
 - o **Solvent Extraction** (alcohol) – The use of alcohol to extract the organic compounds.

Suggested Extension Activities

- Students create a new scent garden for the school.



Name :

10

Members
of your team :

SCENT-SATION

Scents or fragrance is a very powerful trigger to our human brains. Some smells can be calming (lavender), others invigorating and mind-clearing (lemon and mint). Some of the best fragrances are made by plants. In this activity, you will learn how to make your own scented products. While doing so, ponder this: why do plants produce fragrance?

Project Objectives

You have to:

1. Identify local scented plants.
2. Carry out research on a few simple methods to extract chemicals from these plants and produce your team's own scented product/s (essential oils, mosquito repellent etc.).

Equipment/Materials

According to your team's research: alcohol, oil, food press (i.e. garlic press), pot and bottles for keeping the essential oils.

Suggested Steps

Session 1

1. Observe and identify some local scented plants (in the school garden or those given by your teacher).
2. Go to the computer room to do research on scented plants and answer these questions:
 - a) What causes fragrance in plants?

- b) How does having fragrance benefit plants?

- c) How have people used fragrances in plants?

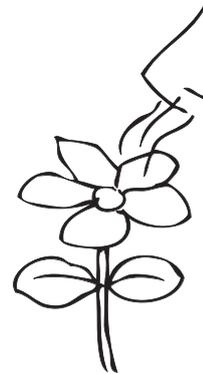
- d) Select a scent (e.g. lemon oil). Do research on a simple method for extracting the scented chemical from its plant.

Session 2

1. Obtain the necessary equipment and materials and extract the chemical.
2. Keep your product in attractive bottles and design labels for them. Give your product a creative name.
3. Ask your teacher and friends to give feedback about your team's new scented product.

Tips

- The scent of plants is strongest in the morning and evening.
- You can refer to the 1001 Garden Plants in Singapore, (2nd Edition) National Parks Board or the Plant Reference website <http://www.floraweb.nparks.gov.sg>



11. HOME GROWN BUSINESS

Outcome

Students develop entrepreneurial skills by identifying products or services they can produce from the school garden, creating samples of their product/s and developing marketing materials for them.

Duration	2-3 sessions; 1-2 hours each
Recommended for	Lower & Upper Secondary; teamwork
Subject Links	Science and IT, Optional: CIP
Process Skills	Observing, communicating, generating, evaluating and analysing
Equipment/ Materials	Materials are specific to each product. Optional: prizes.
Preparation	Decide if you would like this activity to be a class or level competition Photocopy Handout 11.

How to Conduct?

Session 1

1. Assign students into teams.
2. Distribute the Handout 11 and explain the project. Brainstorm different products that can be obtained from plants and select one. Guide students in their choices.
3. Project planning (equipment, materials to buy etc.)

Session 2

4. Create the products.
5. Develop marketing materials – write-ups and design. Give feedback to students.
6. Develop a presentation.

Session 3

7. Complete creating marketing materials and presentation.
8. Class presentations by teams.



Debrief

1. Commend students with outstanding garden products and marketing materials. Optional: announce the winners, if it is a competition and give out prizes (if any).
2. Ask students to share what they had learnt from the project.

Suggested Extension Activities

- Donate the earnings from the sale of the products to a non-profit organisation.

Name : Members
of your team :

HOME GROWN BUSINESS

The plants in your school garden can be a resource for producing your own natural products. In the process of producing some useful products, you will learn many skills including gardening skills, chemistry skills (extracting chemicals from plants), craft skills (candle-making, plant pressing) and entrepreneurial skills.

Project Objectives

Your team has to:

1. Identify products (or services) you can produce from the school garden.
2. Do research, create and submit samples of your product/s.
3. Develop marketing materials (fun write-ups) for your products.

Suggested Steps

Session 1

1. Brainstorm and identify potential products that can be made from plants in the school garden.
2. Carry out research and narrow down to one or two product/s. Ask your teacher and friends to give feedback about the product/s (usefulness, saleability, etc.).
3. Project planning – plan how you will produce your products, materials and equipment needed, etc.
4. If your school does not have any or sufficient plants for creating your product/s, propose to your teacher-in-charge for new plants to be obtained and planted in the school.

Session 2

5. Obtain the materials needed and create your product.
6. Test and improve your product to ensure that it is of high quality. For example, if they are potted plants, you need your plants to be healthy and pest free; if you are producing a scented product, ensure good quality ingredients and hygiene when preparing them.
7. Start developing marketing materials – write and design interesting brochures and tags/labels to go with your product (you can include its significance and benefits, species of plants or plant parts used, etc.)
8. Prepare a presentation to “sell” your product.

Session 3

9. Complete creating your marketing materials and presentation
10. Make a class presentation about your product. Include the key points and highlights of your garden-based business.

Tips

- Your team can concoct new products from your garden (fusion)!
- Your team can select attractive containers (e.g. pots or little bottles), to add interest to your products.

Some examples of products from plants commonly found in a school garden:

- Potted plants
- Bookmarks with plant pressing
- Essential oils
- Scented candles
- Natural mosquito repellent
- Plant art on cloth bags, pencil cases etc.

12. BUTTERFLY HAVEN

Outcome

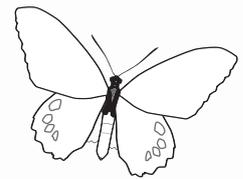
Students visit HortPark to observe and learn more about local butterflies. They identify, take photographs/video of local butterflies and create a presentation on local butterflies.

Duration	2 sessions; 2 hours each
Recommended for	Lower Secondary; individual work
Subject Links	Science, IT
Process Skills	Observing, classifying, comparing
Equipment/ Materials	Digital camera. Optional: A Guide to Common Butterflies of Singapore (Singapore Science Centre Guide Book).
Preparation	Photocopy Handout 12. Plan a fieldtrip to HortPark and inform Hortpark staff of your field trip details – Tel: 64715601 or email: NPARKS_HortPark@nparks.gov.sg

How to Conduct?

Session 1

1. Bring students to HortPark. Distribute Handout 12 and explain the activities.
2. If needed, show students:
 - Nectar-producing plants that provide food for adults and 'host' plants for adult female butterflies lay their eggs on.
 - How to identify butterflies using the butterfly guide.
 - How to look for caterpillars and butterfly eggs (under the leaves of the host plants).



Session 2

3. Let students do research to answer the questions on Handout 12. Discuss the questions with them.
 - a) How many types of butterflies do you think we have in Singapore? (About 280 species.)
 - b) What is the difference between a butterfly and a moth?

Aspects	Butterflies	Moths
Antennae	Club-like	Feathery
Colouration	Usually brightly coloured	Usually not brightly coloured
Resting stance	Wings erect and held together when resting	Wings open and folded over its back while resting
Period of activity	Usually active during the day	Usually active at night

c) What kind of plants are adult butterflies attracted to?

(Nectar producing plants which:

- Have brightly coloured flowers - red, yellow, orange, pink, or purple
- Have flat-topped or clustered flowers
- Have flowers with short flower tubes e.g. Ixora, Lantana, Common Asystasia)

d) What are host plants? (Plants on which female butterflies lay their eggs, which are also the plants hatched caterpillars feed on.)

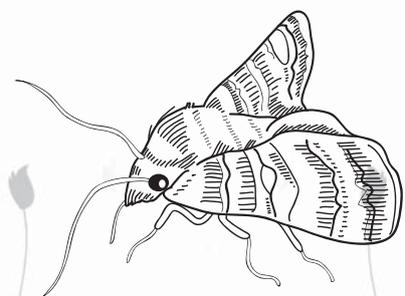
e) Find the host plants for these common butterflies:

Common name Scientific name	Host Plant
Lime butterfly <i>Papilio demoleus malayanus</i>	<ul style="list-style-type: none"> • Lime plant (<i>Citrus</i> sp.)
Lemon Emigrant <i>Catopsilia pomona pomona</i>	<ul style="list-style-type: none"> • Cassia trees (e.g. <i>Cassia</i> spp.)
Common Mormon <i>Papilio polytes romulus</i>	<ul style="list-style-type: none"> • Lime plant (<i>Citrus</i> sp.) • Indian Curry leaf plant (<i>Murraya Koenigii</i>)
Common Grass Yellow <i>Eurema hecabe contubernalis</i>	<ul style="list-style-type: none"> • Peacock Flower (<i>Caesalpinia pulcherrima</i>) • Seven Golden Candlesticks (<i>Cassia alata</i>) • <i>Albizia</i> sp.
Plain Tiger <i>Danaus chrysippus chrysippus</i>	<ul style="list-style-type: none"> • Giant Milkweed (<i>Calotropis gigantean</i>)

4. Students download their photographs/video clips and identify the butterflies if they have not yet done so. They are to write and develop a presentation on local butterflies.
5. Select a few students to deliver their presentations to the class.
6. Debrief the activity.

Debrief

1. Commend good presentations.
2. Ask students to share what they had learnt during the activity.



Additional information

Here is a list of common butterflies and their host and food plants:

Common Butterflies Common name <i>Scientific name</i>	Host Plant (where eggs are laid and caterpillars develop on)	Food plant (source of nectar for adults)
Lime butterfly <i>Papilio demoleus malayanus</i>	• Lime plant (<i>Citrus</i> spp.)	Any nectar-producing flower
Lemon Emigrant <i>Catopsilia pomona pomona</i>	• Cassia trees (e.g. <i>Cassia</i> spp.)	
Common Palmfly <i>Elymnias hypermnestra agina</i>	• Palms (e.g. Alexandra Palm)	
Common Mormon <i>Papilio polytes romulus</i>	• Lime plant (<i>Citrus</i> spp.) • Indian Curry leaf plant (<i>Murraya Koenigii</i>)	
Common Grass Yellow <i>Eurema hecabe contubernalis</i>	• Peacock Flower (<i>Caesalpinia pulcherrima</i>) • Seven Golden Candlesticks (<i>Cassia alata</i>) • <i>Albizia</i> sp.	
Cycad Blue <i>Chilades pandava pandava</i>	• Cycads (e.g. <i>Cycas revoluta</i>)	
Lesser Grass Blue <i>Zizina otis lampa</i>	• Mimosa plant (<i>Mimosa pudica</i>)	Coat buttons (<i>Tridax procumbens</i>)
Chocolate Pansy <i>Junonia hedonia ida</i>	• Family <i>Acanthaceae</i> (e.g. <i>Justicia</i> and <i>Strobilanthes</i> spp.)	Any nectar-producing flower
Leopard <i>Phalanta phalantha phalantha</i>	• Weeping Willow tree (<i>Salix</i> spp.)	<i>Lantana</i> , <i>Ixora</i>
Plain Tiger <i>Danaus chrysippus chrysippus</i>	• Giant Milkweed (<i>Calotropis gigantean</i>)	Any nectar-producing flower
Great Eggfly <i>Hypolimnas bolina jacintha</i> Blue Pansy <i>Junonia orithya wallacei</i>	• Common Asystasia (<i>Asystasia intrusa</i>)	

Suggested Extension Activities

- Students create a butterfly park within school. They make suggestions for new plants that attract butterflies (food or host plants) to be planted in the school garden and get involved in the planting and caring of these plants.
- Students can collect the larvae of the butterfly and keep them in an enclosure until they pupate and emerge as adults. If possible, the students could film the different stages of development in the box.



12

Name :

Members of your team :

BUTTERFLY HAVEN

Butterflies are found almost everywhere in Singapore. Some butterflies prefer forests or fields, while others live around road-side trees and gardens. Gardeners have a mixed reaction to them – on one hand the adult butterflies visiting the garden add colour and wonder to the garden; on the other hand, their voracious caterpillars damage leaves of our plants! One solution is to designate selected plants as host plants and be willing to have caterpillars devour these up, for the sake of the continual existence of local butterfly species!

Project Objectives

You have to:

1. Observe local species of butterflies within and at the gardens and within the butterfly enclosure in HortPark.
2. Make a listing of butterflies; photograph and make video clips of butterflies observed.
3. Carry out research to answer questions on butterflies.
4. Create a short presentation on Butterflies in Singapore.

Equipment/Materials

Digital camera. Optional: A Guide to Common Butterflies of Singapore (Singapore Science Centre Guide Book).

For information on butterflies in Singapore, please refer to: <http://butterflycircle.org> <http://butterfly.nss.org.sg/>

Suggested Steps

Try these questions:

a) How many types of butterflies do you think there are in Singapore?

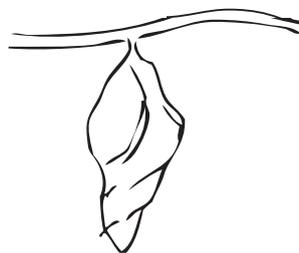
b) What is the difference between a butterfly and a moth?

c) What kind of plants are adult butterflies attracted to?

d) What are host plants?

e) Find the host plants for these butterflies:

Common name of Local Butterflies <i>Scientific name</i>	Host Plant
Lime butterfly <i>Papilio demoleus malayanus</i>	
Lemon Emigrant <i>Catopsilia pomona pomona</i>	
Common Mormon <i>Papilio polytes romulus</i>	
Common Grass Yellow <i>Eurema hecabe contubernalis</i>	
Plain Tiger <i>Danaus chrysippus chrysippus</i>	



13. FRUIT GARDEN

Outcome

Students identify fruit trees and vegetable 'fruits' in the school garden, find out about other local fruits/vegetables through a survey and do research on them. They write educational labels for the fruit trees and vegetable fruit plants in your school garden.

Duration	2 gardening sessions; 2 hours each
Recommended for	Lower Secondary; individual work
Subject Links	Science and IT
Process Skills	Observing and generating
Equipment/ Materials	Digital camera. Optional: A Guide to Fruits and Seeds (Singapore Science Centre Guide Book)
Preparation	Photocopy Handout 13

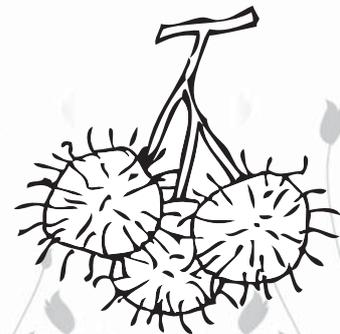
How to Conduct?

Session 1

1. Introduce the activity by talking about fruits:
 - A 'fruit', as a botanical term, is a fertilised and ripened ovary of a flowering plant. Hence, fruits include mangos and apples, but also tomatoes, brinjal, chilli etc.
 - Fruits are healthy food. They are rich in vitamins (especially vitamins C, A, E, B6), minerals (like potassium) and fibre.
 - Ask them if they have heard about fruits like the Duku and Chempadak. Explain that this activity is on local, tropical fruits (those that can grow in a hot and wet climate, like that in Singapore).
2. Distribute the handout, explain the activity and briefly run through the main points on the handout.
3. Students go to the school garden to identify, list and photograph the fruit trees present.
4. Guide them to create good survey questions on local fruits and vegetables. Comment on the quality of their surveys so they can make improvements. Let students carry out the survey.

Session 2

5. Guide them as they analyse and consolidate the data collected.
6. Have them present their findings to the class.



Debrief

Session 1

1. Discuss other local fruits that are not found in school:



Here are some common local fruits in the region:

<ul style="list-style-type: none"> • Madras thorn • Nam nam • Duku • Pulasan • Rambutan • Jambu Air • Chempedak • Jackfruit • Chiku • Durian • Breadfruit • Banana • Custard Apple • Soursop • Papaya 	<ul style="list-style-type: none"> • Mango • Mangosteen • Belimbing • Starfruit • Guava • Dwarf Guava • Buah Salak (snakefruit) • Sweet Tamarind • Green orange (mandarin) • Kedondong • Quini (mango) • Cachew nut • Buah (Indian) Cherry
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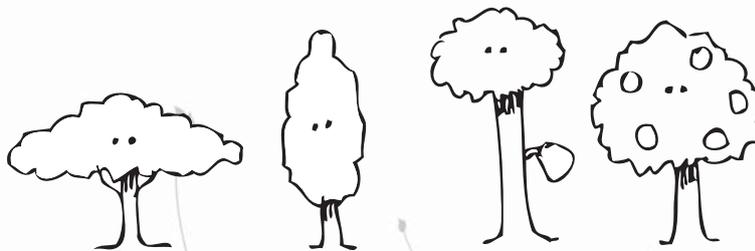
2. Discuss the nutritional value of fruits: Fruits are good for our health. They are a rich source of vitamins (especially vitamins C, A, B6, thiamine, niacin, E), minerals (e.g. potassium) and fibre.

Session 2

3. Each team presents their survey questions and results.
4. Comment on their findings.

Suggested Extension Activities

- Students create an electronic 'local fruit' guide to raise awareness about them.
- Students do research on fruit trees, and then write and design signs for fruit trees in your school garden.
- Students make suggestions to plant new local fruit trees in your school garden and get involved in planting and caring for them.



Name : Members
of your team :

FRUIT GARDEN

A 'fruit', as a botanical term, is a fertilised and ripened ovary of a flowering plant. Hence, fruits include not only mangos and apples, but also tomatoes and chilli. How many local fruits or vegetables can you name? In this activity, we take a closer look at the local fruit trees and vegetables in your school garden and help raise awareness about them.

Project Objectives

You have to:

1. Identify and list local fruit trees and vegetable found in your school garden.
2. Find out whether people are aware of local fruits and vegetables through a survey.

Equipment/Materials

Digital camera. Optional: A Guide to Fruits and Seeds (Singapore Science Centre Guide Book).

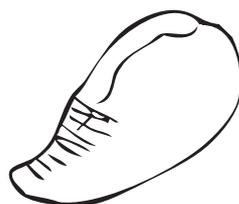
Suggested Steps

1. Go to your school garden and identify the fruit trees and vegetables found there.
2. Do research about them – information on the optimum growing conditions, fruiting season (how often it fruits), country of origin, how they are propagated, etc.
3. Develop a survey on local fruits and vegetables to find out those known by your parents and grandparents, as well as how much today's youths know about local fruits.
4. Get feedback on the survey questions from your teacher and classmates.
5. Carry out the survey. Target parents and grandparents, as well as your peers.
6. Analyse the results and present your findings.

Tips

To develop the survey, brainstorm facts you would like to know and convert these into questions. Try to make your survey easy and fast to carry out – avoid open ended questions. Give the respondent some choices to consider.

- Age range
- Local fruits and vegetables you have heard of (tick those you have heard of and include an 'others' response for any fruits you might have left out).
- Do they plant local fruit trees and vegetables in their gardens (include categories like "yes", "no" and "intend to")? If 'yes', what trees?



14. DESERT LIFE

Outcome

Students identify characteristics of cacti and other drought tolerant plants which enable them to survive in a hot, dry desert habitat. They also observe the plot for the cacti and drought-tolerant plants in the school and evaluate how well these conditions simulate a desert/dry habitat. They then propagate a cactus or drought-tolerant plant from your garden.

Duration	1-2 sessions; 1-2 hours each
Recommended for	Lower Secondary; individual work/teamwork
Subject Links	Science and IT
Process Skills	Observing, measuring and evaluating
Equipment/ Materials	Data loggers from school (with temperature and light sensors) and materials for propagation: pots, soil, gardening tools, gloves, seeds, plantlets, stem cutting and secateurs. Optional: digital camera.
Preparation	Photocopy Handout 14.

How to Conduct?

Session 1

1. Distribute the handout and explain the activity.
2. Distribute the data logger and let them carry out the measurements.
3. Go through the findings and answers with them.

Session 2

6. Help students obtain the materials for propagation. Guide them on propagation methods for cacti and drought-tolerant plants – ask expert gardeners for advice etc. Advanced students may even try grafting cacti (green succulent cacti with a red cacti at the top).

Debrief

Session 1

Go through their findings and answers:

Physical conditions of a cactus plot/garden

- Is the soil in your plot similar to that in a desert?**
The substrate/soil should be sandy or rocky to allow good drainage. If soil is water-logged (too much clay-based soil), the cacti and other drought-tolerant plants may rot and die.
- Is the recorded temperature in the plot similar to that in a desert?**
Temperature at the plot should be high, within the 30-35 °C range.
- Is this amount of light reflective of the conditions in a desert?**
Light levels should be high. The plot should be located in an area where it receives maximum sunlight, not shaded by buildings or trees. Expected light level is at least 2000 lux on a sunny day.

Conclusion

- d) **From your research and measurement of the physical parameters at your cactus plot, how do the conditions compare with those of a desert?**
See above.
- e) **Are the conditions at the plot suitable for the cacti and drought-tolerant plants in your school garden?**
See above.
- f) **What recommendations would you suggest to give them the conditions they need?**
See above. Cacti need very little watering.

Cacti Characteristics

Observe your cacti and other drought tolerant plants. What features do they have that help them adapt to desert conditions?

- Swollen green stems – Their stems have taken over the function of leaves and are the main photosynthetic parts of the plants. Inside the swollen stems are special water storage cells (tissue). During the rainy season, the stems store water and swell up; during dry months, the stems slowly contract as water is used up.
- Few or no leaves, with presence of thorns – In many cacti, leaves are reduced to thorns or spines! This helps the plant to save water by lowering evaporation (which is highest through leaves). Cacti with thorns have an extra protection against plant eaters (herbivores).
- Waxy surface of stems and leaves – There is a waxy cuticle coating on the upper-most layer of cells. This helps reduce water loss through evaporation.
- Ribs or tubercles (areoles) – Some cacti stems have ‘lumps’ of cacti tissue where the spines grow from, called tubercles. Other cacti have ribs. These features allow the stem section to swell or shrink without damaging the tissue on the surface.

Features which may not be apparent:

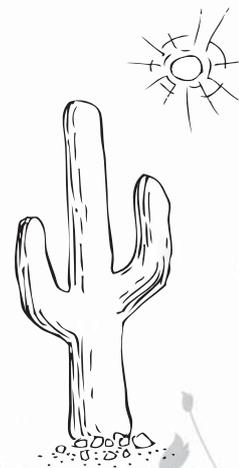
- Shallow, extensive roots – They quickly soak up water after a shower of rain. Some cacti have additional deep penetrating roots to reach ground water.
- Sunken stomata – If you cut a cross section of a cacti stem, you can see that the stomata are found in small ‘pits’. These are called ‘sunken stomata’ and they help reduce further loss of water.

Session 2

1. Discuss the question: How are cacti propagated? (New offshoots, division, cutting, starting from seeds, and grafting.)
2. Ask students to share with the class what they have learnt from this activity.

Suggested Extension Activities

1. Bring students on a field trip to visit a parks with a collection of succulent plants (e.g. Singapore Botanic Garden - Sun Garden and Evolution Garden).
2. Students can propagate and sell their new cactus plants as part of Activity 11 Home Grown Business.



Name :

14

Members
of your team :

DESERT LIFE

Imagine a place where rain does not fall for months! The ground is dry and sandy and the temperatures during the day reach 40° C or more! Not many plants are able to survive in such a habitat. Yet, there are some specialists! Cacti and drought-tolerant plants are mainly from the plant family Euphorbiaceae. These plants are adapted to living and reproducing in arid places. In this activity, we identify their characteristics which enable them to withstand such harsh conditions, as well as evaluate whether those in your school gardens are given suitable physical conditions.

Project Objectives

Your Team has to/You have to:

1. Measure the physical conditions in a cacti plot or garden.
2. Evaluate if these conditions at the cacti plot are similar to desert conditions
3. Observe cacti and drought-tolerant plants and list characteristics which help them adapt to desert-like conditions.
4. Select a cactus or drought-tolerant plant and propagate (reproduce) it.

Watch out for the thorns on cacti plants!

Equipment/Materials

Data loggers from school, (with temperature and light sensors) and materials for propagation: pots, soil, gardening tools, gloves, seeds, plantlets, stem cutting and secateurs.

Suggested Steps

Session 1

1. Go to a cactus plot or garden. Measure the physical conditions of the school cacti plot. Observe the soil conditions too.
2. Observe cacti and other drought-tolerant plants and note down key external features and adaptations. Optional: take photographs.
3. Do research to evaluate if the physical conditions of the cacti plot or garden are similar to desert conditions.
4. Do research to find out how to reproduce cactus plants.

Session 2

5. Obtain the materials (seeds, insets, pots, soil, gloves, spades etc.) and propagate some cactus plants.

Physical Conditions Of A Cactus Plot/Garden

Observe and record the following physical characteristics.

Location of your cactus plot:

Physical Characteristics	Reading/Observation
<p>Substrate Describe the type of soil in the plot</p>	
<p>Temperature Record the temperature and Time of day:</p>	
<p>Light levels Record the light level and weather condition (e.g. sunny, cloudy)</p>	

a) Is the soil in your plot similar to that in a desert?

b) Is the recorded temperature in the plot similar to that in a desert?

c) Is this amount of light reflective of the conditions in a desert?

Conclusions

d) From your research and measurement of the physical parameters at your cactus plot, how do the conditions compare with those of a desert?

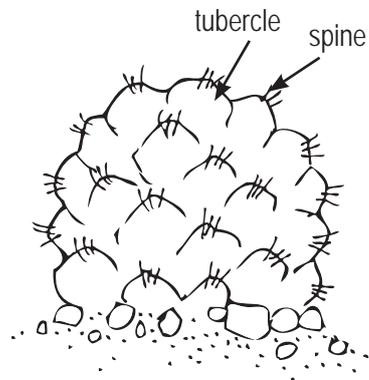
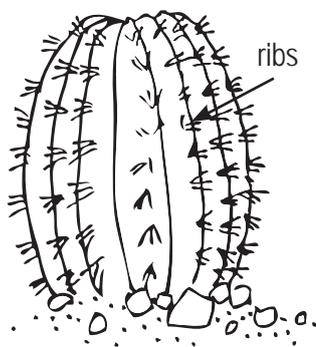
e) Are the conditions at the plot suitable for the cacti and drought-tolerant plants in your school garden?

f) What recommendations would you suggest to give them the conditions they need?

Cacti Characteristics

Observe your cacti and other drought-tolerant plants. What features do they have that help them adapt to desert conditions?

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15. MY DREAM GARDEN

Outcome

Students are assigned a plot in school. They draw a map of the plot and design a theme garden for it, which has to be creative, aesthetic and educational.

Duration	3 sessions; 1-2 hours each
Recommended for	Upper Secondary; teamwork
Subject Links	Science, Art, D & T and IT
Process Skills	Observing, measuring, communicating and generating
Equipment/ Materials	Measuring tapes, compass, data loggers from the school (with temperature and light sensors). Optional: prizes and Community In Bloom: A Concise Guide to Tropical Gardening.
Preparation	Decide if you would like this activity to be a class or level competition. Conduct a reconnaissance of the school to decide on plot/s for this activity. Please note that this section of garden need not be 'bare'. Students have to come up with an alternative design for the same space. Photocopy Handout 15.

How to Conduct?

Session 1

1. Assign students into teams.
2. Distribute the handout and explain the project.
3. Bring students to the plot/s and assign plot/s to them. Students to take measurements and complete a scaled map of the plot/s. Check their maps for scale and accuracy and give them feedback. Students also to map in the light intensities of different parts of the plot/s.

Session 2

4. Explain some key principles of good garden designs:
 - a. Garden designs meet the needs of the users. In this project, the new design needs to be:
 - **Aesthetic** (by having variety of colours, size of plants, some garden furniture/feature, etc.)
 - **Creative**
 - **Educational** (plants and other features are needed to teach a part of the syllabus)
 - b. Guide students to think of the users and what they need. For example, a variety of plants beautifies the school and inspires students and teachers, have benches/study area for students or have a tree to cool the surrounding area.
 - c. Choose plants which are suited to the physical conditions found in the garden e.g. a sunny area with afternoon sun could be planted with sun-loving species.
 - d. Start simple and not be too ambitious.
5. Students use their drawn map and design their team's garden. Give your comments on their draft designs.

Session 3

6. Teams make a presentation on their garden design and then submit them to you. Give your comments for each design.

Debrief

1. Commend teams with outstanding garden designs. If it is a competition, select the winning team/s and give out prizes.
2. Ask students to share what they had learnt from the project.

Suggested Extension Activities

- Students can do more research and submit a budget for their proposed garden.
- Students plant the plot according to the best design.

Name :

15

Members
of your team :

MY DREAM GARDEN

Beautifully designed gardens can change the whole atmosphere of a place. It can be a refuge to nature, a place to think and learn. Have you ever tried designing a garden that will make a big difference to your school? This is your team's chance!

Project Objectives

Your team has to:

1. Analyse, measure and draw the assigned plot in your school
2. Design a theme garden which is creative, aesthetic and educational

Equipment/Materials

Measuring tapes, compass and data loggers.

Suggested Steps

Session 1

1. Note down the permanent features in the garden (e.g. path, sheds, trees). Take measurements and draw a scaled map of the plot. Using a compass, include the North direction into the map.
2. Measure the light intensity of different parts of the garden plot. Map these conditions on your map.

Session 2

3. Use your drawn map to design your team's themed garden.
4. Brainstorm interesting and useful garden features you would like to have. You could even conduct a survey on what other students would like to see in the school garden.
5. Brainstorm the learning potential of your new garden (do research if you have to).
6. Once you have decided on the main design, decide on the details of each (e.g. size, material, plant species, location). Reflect all this in your garden design drawing.
7. Optional: Redraw the garden design using a computer programme or on paper. Add in colour and the compass rose. Draw a key and scale. Your team could even build a model!
8. Ask your teacher and friends to give comments and feedback about your team's design.

Session 3

9. Make a presentation of your garden designs and then submit it to your teacher. Decide on the presenters for your project and what the key points and highlights of your garden designs are.

Tips

- Do research on garden designs using the web or books.
- Decide on the theme/aims of your garden (what you want your garden to do) before you decide the features for the garden (e.g. ornamental, harvest garden, foliage, herbs & spices, formal/informal garden, English gardens)

Annex 1 Resources

WEB RESOURCES

NParks Websites

Community In Bloom, NParks Website
http://www.nparks.gov.sg/cib_intro.asp

NParks Website
<http://www.nparks.gov.sg>

Plant Reference
<http://www.floraweb.nparks.gov.sg>

NParks Gardening Blog – Garden Voices
http://www.nparks.gov.sg/blogs/garden_voices

Other Websites

Green Culture Singapore – Website and Discussion Forum
<http://www.greenculturesg.com/>

Singapore Gardening Society – <http://www.gardeningsingapore.org/>

Local Butterflies – <http://butterflycircle.org>
<http://butterfly.nss.org.sg/>

BOOKS

NParks Publications

- Boo Chih Min, Kartini Omar-Hor, Ou-Yang Chow Lin. 1001 Garden Plants in Singapore, (2nd Edition) National Parks Board, Singapore 2006. ISBN 981-04-9268-5
- Grace S.Y. Lim-Leng. Community In Bloom – A Concise Guide to Tropical Gardening. National Parks Board, Singapore 2007. ISBN 981-05-6796-0
- Trees of Our Garden City (2nd Edition)

Other Publications

Singapore Science Centre Guide Books:
 A Guide to the Wildflowers of Singapore,
 A Guide to Herbs and Spices
 A Guide to Common Horticultural Shrubs
 A Guide to Common Butterflies of Singapore
 A Guide to Medicinal Plants
 A Guide to Common Garden Animals
 A Guide to Fruits and Seeds

Annex 2 Teacher’s Planning Sheet For Community In Bloom Schools Activities

Students from:

Session	Term <input style="width: 50px; height: 20px;" type="text"/>	Activity	Equipment/ Materials	Preparation
	Week <input style="width: 50px; height: 20px;" type="text"/>			
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Turn your school garden and eco-garden into a living classroom! Let the activities in this book turn mundane gardening activities into meaningful and enjoyable lessons and projects to open your students' eyes to the marvels in your school gardens.

These activities, where relevant, integrate curricular topics and make them come alive! Students see life processes like photosynthesis, growth, reproduction, decomposition, food chains, adaptation for survival right before their very eyes! Students become 'in touch' with their environment, local plants and garden fauna and grow a healthy concern for the world around them!