

## 6<sup>th</sup> Grade: PLANTS (Plant Growth and Breeding)

### Rational of this unit

We often see flowers in our daily lives, but seldom view with any awareness of their structure or how their parts function. Here we shall investigate the structure of flowers found on the plants we see in our daily lives, and aim to make pupils understand that flowers are organs meant to leave offspring by understanding the names and functions of their different parts.

Different plants may have petals with beautiful colours, give nectar, and have pollen that is easily attachable to insects' bodies or easily carried in the air. These everyday phenomena are in fact related to pollination. Future generations of plants are born through the processes of pollination and fertilisation, in which plants continue leaving offspring. However, there are certain conditions necessary for the seeds produced by fertilisation to germinate.

It is hoped that the material provided here will be useful when raising actual crops.

### Objectives: what pupils are expected to achieve in this unit

- Understand that while the majority of flowers possess both male and female reproductive organs, there are those for which there are separate male and female plants.
- Observe flowers, taking interest in their outward appearance and cross-section. Understand the names of various parts such as the petal, sepal, pistil, stamen, anther, stigma, ovary, and ovule.
- Understand pollination in which pollen attaches to the stigma, and also fertilisation in which the reproductive cells within pollen and the ovules of the ovary fuse.
- Understand that following fertilisation the ovule becomes a seed, and the ovary becomes fruit.
- Understand the parts of the seed, and that the germ and radicle of the seed's embryo grow to become the next generation of plants.
- Consider through experimentation that proper conditions in terms of water, air and temperature are necessary for the seed to germinate.
- Understand logically through this unit that flowers are plants' reproductive organs.

### Interrelation of contents of each grade

\* The order below is as shown in the syllabus.

Grade	What to teach (Plants)
1 <sup>st</sup> Grade	<ul style="list-style-type: none"> <li>• Various plant life inhabiting the region</li> <li>• Main parts of plants</li> <li>• Edible parts of plants</li> </ul>
2 <sup>nd</sup> Grade	<ul style="list-style-type: none"> <li>• Planting seeds</li> <li>• Caring for plants – pulling wild grass and weeds, watering</li> <li>• Various leaves – colour, size, shape and feel</li> <li>• Different wild plant life</li> </ul>
3 <sup>rd</sup> Grade	<ul style="list-style-type: none"> <li>• How plants are useful to man – food, clothing, paper, baskets, furniture, tea, coffee, cocoa, medicine, shade, enclosure and aesthetics</li> </ul>
4 <sup>th</sup> Grade	<ul style="list-style-type: none"> <li>• Varieties of agricultural crops – food crops (grains, pulse, vegetables, fruits, tubers) and crops for profit (farm products used as drinks, fibres and oils taken from grains)</li> <li>• Regional weeds - blackjack, Sodom apples, goosefoot, spiderworts, Mexican marigold, and wood sorrel</li> </ul>
5 <sup>th</sup> Grade	<ul style="list-style-type: none"> <li>• Plant classes – green and non-green, flowering and non-flowering plants</li> <li>• Functions of exterior parts of plants – roots, stem, leaves, flowers and fruit</li> <li>• Types of roots – tap roots and fibrous roots</li> </ul>
6 <sup>th</sup> Grade (This unit)	<ul style="list-style-type: none"> <li>• Parts of the flower</li> <li>• Pollination – meaning and types of transmitters</li> <li>• Fertilisation – meaning and fusion process</li> <li>• Seed parts – monocotyledon seeds and dicotyledon seeds</li> <li>• Seed germination and conditions necessary for germination</li> </ul>
7 <sup>th</sup> Grade	<ul style="list-style-type: none"> <li>• Interdependence between plants – supporting other plants, acting as breeding grounds for other plants and providing shade for other plants</li> <li>• Interdependence between plants and animals – plants as food for animals, oxygen given off by photosynthesis of plants and carbon dioxide given off in animal respiration, plants as shelter for animals from heavy rain, animals that help in pollination, plants as medicine and nourishment for animals, and animal waste products being broken down for nourishment of plants</li> <li>• The food chain – meaning and examples</li> <li>• Agricultural crops and pests - the meaning of pests, types of pests, types which devastate crops growing in fields and pests which devastate storehouses</li> <li>• Influence of pests on agricultural crops – decrease in harvest yields, reduced quality of products, transmitting of diseases to crops, causing sickness in consumers</li> </ul>

	<ul style="list-style-type: none"> <li>• Extermination measures - scaring pests off, setting traps, picking them up, pulling weeds, spraying pesticides, trimming and pruning</li> <li>• Environmental adaptation of plants – arid and damp regions</li> <li>• Indicators of diseased crops - poor growth; discolouration of growing leaves, ears/heads or stalks/stems; dwarfism; withering and appearance of spots or stripes</li> <li>• Crop diseases and their influences – reduced harvest yield and quality</li> </ul>
8 <sup>th</sup> Grade	

## Before Starting this Unit

### Current learning status of the pupils

Up through the 5<sup>th</sup> grade, children in the 6<sup>th</sup> grade have studied material on plants closely related to their daily life, such as regional plant life, seed germination, caring for plants, different wild plant life, how plants are useful to man, varieties of agricultural crops, and weeds.

6<sup>th</sup> graders are also learning about reproductive organs in the *Human Body* unit. If you have already completed studies of the human body then pupils will already know that among people (animals) there are men (male) and women (female). If you introduce this section relating things to the *Human Body* unit, then it will make it easier to understand how plants are separated into male and female parts just like animals, and that the flower holds a plant's reproductive organs.

### Preparatory Notes

- It is acceptable to prepare worksheets as necessary in order to help children understand.
- Flowers and fruit seeds for observation are to be provided by the pupils themselves and brought to school, but as the teacher you should give pupils advance prompting to bring as wide a variety of samples as possible. You should also prepare a standard model at the school.
- Observation of germination conditions can be assigned as homework, but if doing so you will need to give appropriate instruction beforehand to clarify difference in conditions.

## Objectives to be achieved by competency

### Interest, motivation, and attitude

1. Taking an interest in the structure of plant's flowers and readily observe them.
2. Taking an interest in flower's transformation into fruit and seeds, and trying to understand pollination and fertilisation.
3. Taking an interest in the structure of seeds and readily observe them.

4. Trying to find out the conditions for seed germination.

### Scientific thinking and communication activities

1. Ability to infer that petals having beautiful colour and pollen being easily attached to the body of insects are related to pollination.
2. Ability to infer that both animals and plants have male and female organs, and that a new organism, the offspring, is created by fertilisation.
3. Ability to think of the conditions needed for seed germination.

### Knowledge, understanding, and skills in observation and experimentation

1. Ability to name the different parts of a flower.
2. Ability to observe the flower as a whole and construct a vertical cross-section of it for viewing.
3. Ability to explain that flowers have male and female organs.
4. Ability to explain the process flow from pollination to fertilisation.
5. Ability to give the names of the parts of a seed.
6. Ability to control conditions when conducting investigative experiments into germination conditions of seeds.

## Ideas behind the structuring the unit

We start off this unit by first observing the colour and shape of the flowers of plants seen daily. Next, we explain that flowers have a stamen (male part) and pistil (female part), and about the flow of pollination and fertilisation in which pollen is carried to the stigma of the pistil. This will further be expanded into investigating how the ovule produced through fertilisation grows into a new organism and conditions for seed germination.

As a final destination in this chain of learning, we shall aim for an understanding that flowers are reproductive organs, and that plants as living organisms try in various ways to leave offspring.

## Unit teaching plan

### (9 periods + 2 periods for the Final Unit Evaluation Test)

\* The numeric value in parentheses represents the corresponding period (e.g. 1) means the first period).

\* (Evaluation: Knowledge and Skills 1), (Evaluation: Interest 1), etc. indicate the points at which teachers can check whether the pupils have attained the goals specified in the section *Objectives based on the viewpoint*.

Sub-Unit	Description
<b>Introduction</b> (0 periods)	<ul style="list-style-type: none"> <li>Flowers have a pistil and stamen, and there are flowers that have beautiful colours and fragrances. <i>This gives a hint that flowers are the plant's reproductive organ.</i></li> <li>There are flowers which possess both the pistil and stamen within one flower, and also plants which are separated into male and female strains with male and female flowers.</li> </ul>
<b>1. Parts of the flower</b> (2 periods)	<ol style="list-style-type: none"> <li>Know that flowers are made up of the stem, sepal, corolla, stamen and pistil.               <ul style="list-style-type: none"> <li>Know the names, configuration and roles of the different parts. <i>(Evaluation: Knowledge and Skills 1)</i></li> </ul> </li> <li>Gather up various types of flowers from around home or school and confirm the structure of flowers through observation of the following parts:               <ul style="list-style-type: none"> <li>Sepal and petals</li> <li>Pistil and stamen</li> <li>Ovule within the ovary</li> </ul>               Finally, sketch the vertical cross-section of a flower. <i>(Evaluation: Interest 1, Knowledge and Understanding 2, Knowledge and Understanding 3)</i> </li> </ol>
Intermediate Review (No time allotted)	<ul style="list-style-type: none"> <li>Give the <b>Sub-Unit Review Test for Sub-Unit 1.</b> (Homework can be given depending on the progress of the class.)</li> </ul>
<b>2. Pollination</b> (2 periods)	<ol style="list-style-type: none"> <li>Understand the meaning of pollination.               <ul style="list-style-type: none"> <li>Meaning of pollination.</li> <li>Pollen holds the male reproductive cells, which in time reach the ovule at the base of the pistil.</li> <li>Within pollination there is self-pollination and cross-pollination. <i>(Evaluation: Thinking and Representation 1)</i></li> </ul> </li> <li>Know that there are various things which help carry pollen to the stigma.               <ul style="list-style-type: none"> <li>Wind, insects, birds, water, etc.</li> <li>Flowers for which pollen is carried by birds and insects use colour and scent to attract these carriers.</li> <li>Pollen is sticky so that it can easily attach itself to insects and birds.</li> <li>Flowers for which pollen is carried by the wind have long filaments and large anthers, and release light pollen in large amounts. The stigma sticks out of the flower to catch the floating pollen more easily. <i>(Evaluation: Knowledge and Skills 4)</i></li> </ul> </li> </ol>
Intermediate Review (No time allotted)	<ul style="list-style-type: none"> <li>Give the <b>Sub-Unit Review Test for Sub-Unit 1.</b> (Homework can be given depending on the progress of the class.)</li> </ul>
<b>3. Plant Fertilisation</b> (1 period)	<ol style="list-style-type: none"> <li>Understand that a seed is made with time when the male reproductive cells in pollen and the female reproductive cells in the ovule of the ovary combine.               <ul style="list-style-type: none"> <li>Once a pollen grain arrives on the stigma, its pollen tube extends within the style. The male generative cells in the pollen tube are carried to the ovary's ovule.</li> <li>Fertilisation refers to when the generative cells within the pollen tube and the female generative cells of the ovule combine.</li> <li>Following fertilisation, the ovule becomes a seed and the ovary becomes fruit. <i>(Evaluation: Interest 2, Thinking and Representation 2, Knowledge and Skills 4)</i></li> </ul> </li> </ol>
Intermediate Review (No time allotted)	<ul style="list-style-type: none"> <li>Give the <b>"3<sup>rd</sup> Sub-Unit Review Test."</b> (Homework can be given depending on the progress of the class.)</li> </ul>
<b>4. Parts of the Seed</b> (2 periods)	<ol style="list-style-type: none"> <li>Know the names of the parts of the seed.               <ul style="list-style-type: none"> <li>Confirm knowledge of the testa, hilum (fruit scar), cotyledon and micropyle.</li> <li>Plants with two cotyledons are called dicotyledons, and those with one are called monocotyledons. The nutrients needed for germination are stored in the cotyledon for dicotyledons, and in the endosperm for monocotyledons.</li> <li>If you break the cotyledon of a bean seed in two, within it is an embryo with a germ and radicle. <i>(Evaluation: Knowledge and Skills 5)</i></li> </ul> </li> <li>Confirm the structure of seeds through observation.               <ul style="list-style-type: none"> <li>Bring many different seeds and seeded fruit. The seeds should be left in water overnight. → Cut the fruit in half and take out the seeds. → Observe the structure of the seed, checking the hilum, micropyle and testa.</li> <li>Check for the fruit scar and style scar, which can be found on either side of a grain of maize. <i>(Evaluation: Interest 3)</i></li> </ul> </li> </ol>
Intermediate Review (No time allotted)	<ul style="list-style-type: none"> <li>Give the <b>"4<sup>th</sup> Sub-Unit Review Test."</b> (Homework can be given depending on the progress of the class.)</li> </ul>
<b>5. Seed Germination and Conditions Necessary for Germination</b> (2 periods)	<ol style="list-style-type: none"> <li>Understand germination.               <ul style="list-style-type: none"> <li>The process by which a seed becomes a seedling is called germination.</li> <li>The seed absorbs water from the micropyle, causing the seed to expand and break through the testa. The radicle grows roots once outside the micropyle. The germ grows small leaves. Nutrients from the cotyledon are used for germination, but once leaves grow the plant can develop its own nutrients.</li> <li>Water, air and appropriate heat levels are necessary for germination.</li> </ul> </li> <li>Check the necessary conditions for germination through experimentation.               <ul style="list-style-type: none"> <li>Confirm like conditions and change only one element per specimen, then conduct the experiment:</li> </ul> </li> </ol>
Intermediate Review (No time allotted)	<ul style="list-style-type: none"> <li>Give the <b>"4<sup>th</sup> Sub-Unit Review Test."</b> (Homework can be given depending on the progress of the class.)</li> </ul>

### Intermediate Review

(No time allotted)

• Give the **"2<sup>nd</sup> Sub-Unit Review Test"**  
(Homework can be given depending on the progress of the class.)

5) Understand that a seed is made with time when the male reproductive cells in pollen and the female reproductive cells in the ovule of the ovary combine.

• Once a pollen grain arrives on the stigma, its pollen tube extends within the style. The male generative cells in the pollen tube are carried to the ovary's ovule.

• Fertilisation refers to when the generative cells within the pollen tube and the female generative cells of the ovule combine.

• Following fertilisation, the ovule becomes a seed and the ovary becomes fruit.

*(Evaluation: Interest 2, Thinking and Representation 2, Knowledge and Skills 4)*

• Give the **"3<sup>rd</sup> Sub-Unit Review Test."**

(Homework can be given depending on the progress of the class.)

6) Know the names of the parts of the seed.

• Confirm knowledge of the testa, hilum (fruit scar), cotyledon and micropyle.

• Plants with two cotyledons are called dicotyledons, and those with one are called monocotyledons.

The nutrients needed for germination are stored in the cotyledon for dicotyledons, and in the endosperm for monocotyledons.

• If you break the cotyledon of a bean seed in two, within it is an embryo with a germ and radicle.

*(Evaluation: Knowledge and Skills 5)*

7) Confirm the structure of seeds through observation.

• Bring many different seeds and seeded fruit. The seeds should be left in water overnight. → Cut the fruit in half and take out the seeds. → Observe the structure of the seed, checking the hilum, micropyle and testa.

• Check for the fruit scar and style scar, which can be found on either side of a grain of maize.

*(Evaluation: Interest 3)*

• Give the **"4<sup>th</sup> Sub-Unit Review Test."**

(Homework can be given depending on the progress of the class.)

8) Understand germination.

• The process by which a seed becomes a seedling is called germination.

• The seed absorbs water from the micropyle, causing the seed to expand and break through the testa.

The radicle grows roots once outside the micropyle. The germ grows small leaves. Nutrients from the cotyledon are used for germination, but once leaves grow the plant can develop its own nutrients.

• Water, air and appropriate heat levels are necessary for germination.

9) Check the necessary conditions for germination through experimentation.

• Confirm like conditions and change only one element per specimen, then conduct the experiment:

	<p>A: Germination occurred in which can?</p> <p>B: What conditions were given in that can?</p> <p>C: What conditions were missing from the cans that did not germinate?</p> <ul style="list-style-type: none"> <li>The necessary conditions for germination are water, air and appropriate heat levels.</li> </ul> <p>(Evaluation: Interest 4, Thinking and Representation 3, Knowledge and Skills 6)</p>
Intermediate Review (No time allotted)	<ul style="list-style-type: none"> <li>Give the "5<sup>th</sup> Sub-Unit Review Test."</li> </ul> <p>(Homework can be given depending on the progress of the class.)</p>
Unit End Review (2 periods)	10-11) Give the "Final Unit Evaluation Test."

## Lesson Plan

### 1. Parts of the Flower (2 periods: 1<sup>st</sup> – 2<sup>nd</sup> period)

#### Goals of this sub-unit

- Know the names, configuration and roles of the different parts of the flower.
- Observe the structure of the flower and be able to record the results.
- Know that there are plants like maize in which both male and female parts are found on different parts of the same plant, and also plants like the pawpaw in which male and female parts are found on separate plants.

#### Material Preparations

- Recording worksheet
- Various flowers (Androgynous plants, diclinous plants, male strains and female strains, etc. Prepare those which you do not expect pupils to bring), sharp razor blades and pins (enough for all pupils)
- Picture book, samples (for use for presenting flowers which cannot be acquired)

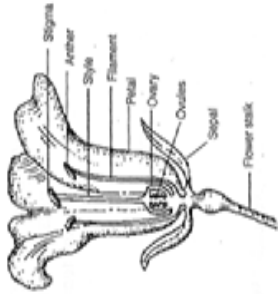
#### Period 1: Names of Parts of the Flower

	Learning flow and activity	Teaching Hints and Advice
<b>Introduction</b> 5 minutes	<ul style="list-style-type: none"> <li>Flowers have a stamen and pistil.</li> </ul> <p>→ Most flowers have both a stamen and pistil, but some only have one or the other.</p> <ul style="list-style-type: none"> <li>There are flowers with beautiful petals and fragrances, and those which have nectar.</li> </ul>	<ul style="list-style-type: none"> <li>Let pupils know that the majority of flowers possess both male and female parts, but some only have either male or female parts.</li> </ul> <p>→ Speaking as plainly as possible, give an example using a common plant.</p>
<b>Questions</b> Learn the names of the parts of the flower.	<ul style="list-style-type: none"> <li>Learn the names of the parts of the flower and record.</li> </ul>	<ul style="list-style-type: none"> <li>Pass out worksheets and have pupils fill it in as you go</li> </ul>
<b>Presentation</b>		

25 minutes	<p>the names in your worksheet.</p> <p>→ The part connecting the flower to the plant is called the <i>flower stalk</i>.</p> <p>→ A leaf-like part called the <i>sepal</i> protects the growth of the flower bud.</p> <p>→ The part consisting of the petals is called the <i>corolla</i>.</p> <p>→ The <i>stamen</i> consists of an <i>anther</i> holding male reproductive cells called <i>pollen grains</i> and the long, thin <i>filaments</i> to which the anther is attached.</p> <p>→ The <i>pistil</i> is made up of the <i>stigma</i> which pollen attach to and the <i>style</i>. The <i>ovary</i>, which holds the female reproductive cells called <i>ovules</i>, is found inside the base of the style.</p> <p>→ Know that there are plants that do not have both stamen and pistil in one flower, like the pawpaw which has male and female trees and maize which has male and female flowers.</p>	<p>through the flower part names.</p> <p>(Refer to pg. 108 regarding worksheet)</p> <ul style="list-style-type: none"> <li>If you can show pupils several ordinary examples of dioecious plants as well as male and female flowers then it will aid in understanding. If you cannot provide actual plants then pictures or diagrams are also acceptable.</li> </ul>
<b>Summary</b> 5 minutes	<ul style="list-style-type: none"> <li>Recheck the contents of your worksheet to be sure there are no mistakes.</li> </ul>	<ul style="list-style-type: none"> <li>Instruct pupils to bring the worksheet filled out in this period for observations in the next period.</li> </ul> <p>→ Having them turn them in is also fine as this will allow you to avoid pupils forgetting their sheets in the next period.</p> <p>(Evaluation: Knowledge and Skills 1) Ability to name the different parts of a flower.</p>

#### Period 2: Observation of Flower Structure

	Learning flow and activity	Teaching Hints and Advice
<b>Introduction</b> 5 minutes	<ul style="list-style-type: none"> <li>Show the flowers brought to class.</li> <li>Check the worksheet filled out in the last period studying the structure of flowers.</li> </ul>	<ul style="list-style-type: none"> <li>Have a number of different varieties of flowers prepared for which pollen grains can be observed to pass out to children unable to bring their own.</li> <li>Draw an exploded view of the diagram from the worksheet on the blackboard.</li> </ul> <p>(Refer to pg. 109 regarding worksheet)</p> <ul style="list-style-type: none"> <li>Give thorough warning on safe use of razors and pins.</li> <li>Materials: flowers, razor blades, pins</li> </ul>
<b>Questions</b> Observe the structure of flowers.		

<p><b>Observation</b> 25 minutes</p>	<p>• Observe the structure of flowers.</p>  <p>KLB Primary Science Pupils' Book for Standard Seven (p.22)</p>	<ul style="list-style-type: none"> <li>• Give various observation points to ensure pupils properly record what they investigate.</li> <li>• Summarise the results on the blackboard. Having pupils draw a picture on the board will make things even easier to understand.</li> <li>• Warn pupils that there are flowers for which the sepals are indistinguishable from petals, and to pay attention to the colour and scent of the petals.</li> <li>• Urge pupils to observe the stigma particularly closely.</li> </ul>
<p>→ Check the sepals and petals.</p>		<p>(<i>Evaluation: Interest 1</i>) Taking an interest in the structure of plant's flowers and readily observe them.</p>
<p>→ Remove the petals in order to observe the stamen and pistil.</p>		<p>(<i>Evaluation: Knowledge and Skills 2</i>) Ability to observe the flower as a whole and construct a vertical cross-section of it for viewing.</p>
<p>→ Observe the pistil's style and stigma.</p>		
<p>→ Observe the stamen's filaments and anther, as well as the pollen grains attached to the anther.</p>		
<p>→ Split the style down to the bottom with a razor blade and observe the ovules within the ovary.</p>		
<p>→ Count the number of flowers.</p>		
<p>• Record the flower parts observed in your worksheet.</p>		
<p><b>Summary</b> 5 minutes</p>	<p>• Check the flowers to see that they have male and female parts.</p>	<p>• Summarise observations of flower structure such that it ties in to study of pollination in the next period. (<i>Evaluation: Knowledge and Skills 3</i>) Ability to explain that flowers have male and female organs.</p>

## 2. Pollination (2 periods: 3<sup>rd</sup> – 4<sup>th</sup> period)

### Goals of this sub-unit

- Understand the meaning of pollination.
- Understand the methods of pollination.

### Material Preparations

- Recording worksheet
- Various flowers – several self-pollinating and cross-pollinating varieties
- Picture book, samples (for use in presenting flowers which cannot be acquired)

### Period 3: Meaning and Types of Pollination

	Learning flow and activity	Teaching Hints and Advice
<p><b>Introduction</b> 5 minutes</p>	<p>• Confirm observations from the last period that flowers have male and female parts, as well as the appearance of the stigma and pollen grains in the anther.</p>	<ul style="list-style-type: none"> <li>• Have pupils confirm flower structure, reviewing the worksheets from periods 1 and 2.</li> <li>• Pass out the worksheets. (Refer to pg. 109 regarding worksheet)</li> </ul>
<p><b>Questions</b></p>	<p>Learn about pollination.</p>	
<p><b>Presentation</b> 25 minutes</p>	<p>• Learn the meaning of pollination. → Understand that the process by which pollen grains attach to the stigma is referred to as pollination.</p> <ul style="list-style-type: none"> <li>• Learn about the types of pollination. → Understand that there is self-pollination and cross-pollination.</li> </ul> <p>Understand that in self-pollination everything occurs in one plant, and that in cross-pollination two separate plants are involved.</p>	<ul style="list-style-type: none"> <li>• Let pupils understand that the pollen grains in the stamen's anther, the male organ, attach to the pistil's stigma, the female organ.</li> <li>• Explain that when a flower pollinates itself, or pollen grains from the male flower attach to the stigma of a female flower on the same plant, this is called self-pollination. You can give maize as an example.</li> <li>• Explain that when pollination occurs between two different plants, as in a male strain and female strain of the same variety, this is called cross-pollination. You can give the pawpaw as an example.</li> </ul> <p>(<i>Evaluation: Thinking and Representation 1</i>) Ability to infer that petals having beautiful colour and pollen being easily attached to the body of insects are related to pollination.</p>
<p><b>Summary</b> 5 minutes</p>	<p>• Complete the worksheet. • Recheck the contents of your worksheet to be sure there are no mistakes.</p>	<ul style="list-style-type: none"> <li>• Instruct the pupils to bring the worksheets next period.</li> <li>• Having them turn them in is fine as this will allow you to avoid pupils forgetting their sheets in the next period.</li> </ul>

### Period 4: Methods of Pollination

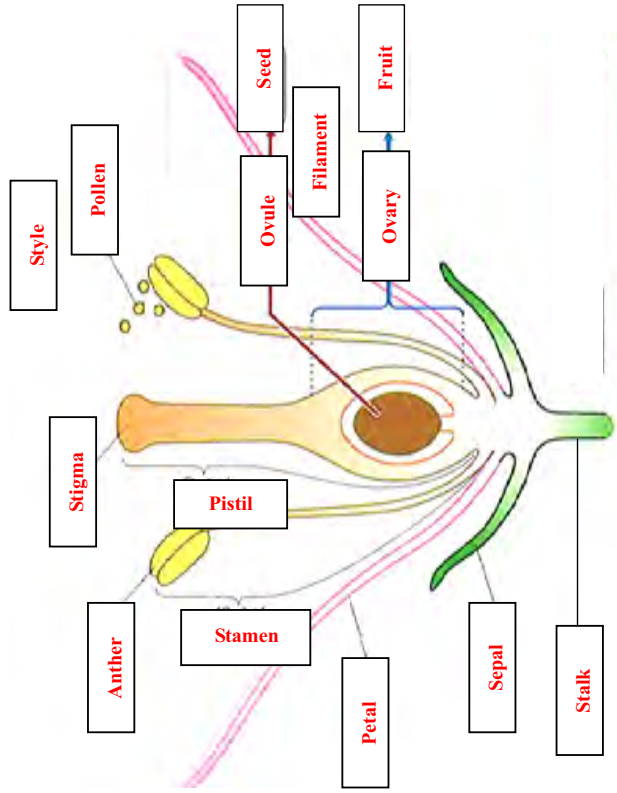
	Learning flow and activity	Teaching Hints and Advice
<p><b>Introduction</b> 5 minutes</p>	<p>• Recall what pollination refers to as studied in the last period.</p>	<ul style="list-style-type: none"> <li>• Recheck the observation results recorded in your worksheet from the last period.</li> </ul>
<p><b>Questions</b></p>	<p>How does the pollen from the stamen attach itself to the stigma of the pistil? And how do separate bodies such as male and female flowers or male and female strains pollinate?</p>	
<p><b>Presentation</b> 25 minutes</p>	<p><i>Mediums of pollination</i> → Understand that insects, wind, birds and water can</p>	<ul style="list-style-type: none"> <li>• Explain that pollen grains are shaped to be easily</li> </ul>

	help in pollination. <i>Characteristics of wind-pollinated flowers</i> → Small flowers, many have green petals, large anthers attached to limp filaments that release large amounts of small, light pollen grains in the lightest of winds. The stigma is shaped to catch the floating pollen more easily.	carried by wind, and stigmas are shaped to catch the pollen carried by wind more easily. • Showing pupils an actual wind-pollinated flower such as maize, or alternately a picture or diagram showing the anther, pollen grains and stigma will make it easier for them to understand.
	<i>Characteristics of insect-pollinated flowers</i> → Petals are colourful with scents, some have nectar, flowers are larger, anthers that make small amounts of sticky pollen grains to stick firmly to the body of insects, and sticky stigmas that pollen grains carried by insects can easily attach to.	• Showing pupils an actual insect-pollinated flower such as a sunflower or Bougainvillea, or alternately a picture or diagram will make it easier for them to understand.
<b>Summary</b> 5 minutes	• Understand that flowers are designed to make pollination easier.	• Give a summary that can double as an introduction to the next period, fertilisation. <i>(Evaluation: Knowledge and Skills 4)</i> Ability to explain the process flow from pollination to fertilisation.

### Finding out the Names of the Parts of the Flower

**Date:** \_\_\_\_\_ **Class:** \_\_\_\_\_ **Name:** \_\_\_\_\_

1. Enter the names of the parts of the flower in the blanks of the following figure.



2. Try to give examples of plants having flowers with this same structure.  
We shall observe flowers in detail in the next period.

- ( ) ( ) ( )  
( ) ( ) ( )

\* Keep this worksheet for the next class.

### Observing the Structure of Flowers

Date: \_\_\_\_\_ Class: \_\_\_\_\_ Name: \_\_\_\_\_

**1. Material Preparations for Observation**

Flowers (bring with you to class), razor blade, pin

**2. Observation Procedure**

- 1) Observe the sepals and petals.  
→ Are there sepals? → What colour are the petals? → Does the flower have a scent?
- 2) Take off the petals to observe the pistil and stamen.  
→ Observe the end of the pistil's style well, and try touching it.  
→ Observe the shape of the stamen's anther well, and find out what is inside of it.
- 3) Split the pistil's style down to the swell at the base (the ovary) using a sharp razor blade, pin it back and observe.  
→ Could you see the ovules within the ovary?

**3. Recording the Observation**

- 1) Write down what you noticed while observing sepals and petals.

( \_\_\_\_\_ )

- 2) Write down what you noticed while observing the pistil and stamen.

( \_\_\_\_\_ )  
( \_\_\_\_\_ )

- 3) Draw a sketch of the stamen, pistil and cross-section of the ovary in the frames below.



Stamen



Pistil



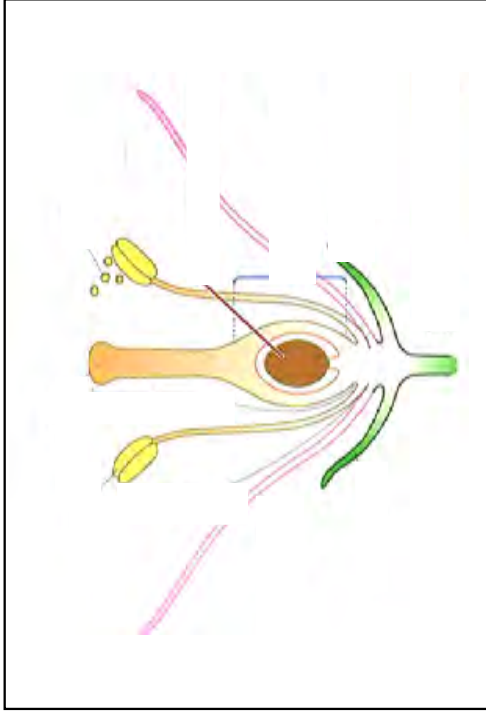
Ovary cross-section

\* Keep this worksheet for the next class.

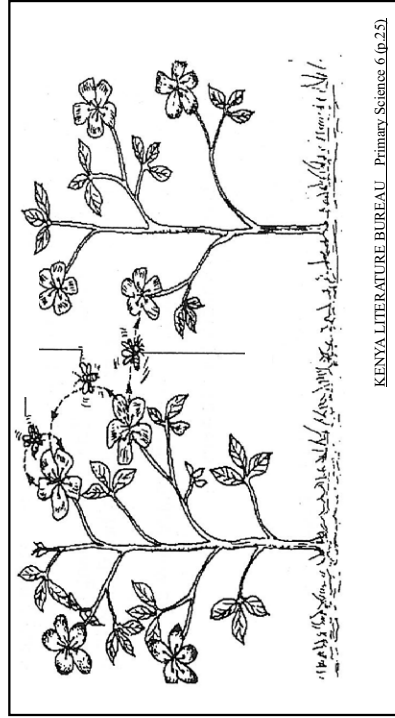
### Observing Pollination

Date: \_\_\_\_\_ Class: \_\_\_\_\_ Name: \_\_\_\_\_

- 1. Show how pollination works in the figure below.



- 2. Enter arrows showing the movement of pollen in self-pollination and cross-pollination in the figure below.



\* Keep this worksheet for the next class.

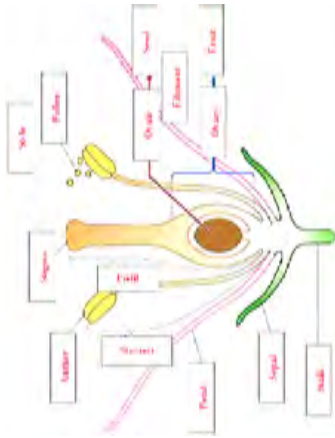
### 1<sup>st</sup> Sub-Unit Review Test

\* given after end of 2<sup>nd</sup> period

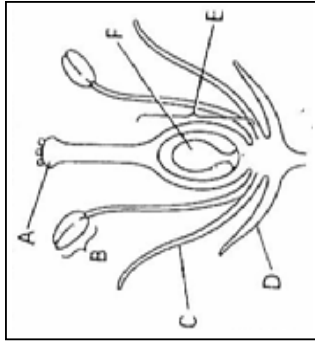
Class: \_\_\_\_\_ Name: \_\_\_\_\_

1. Answer the following questions on the structure of flowers.

(i) Write the names of the flower's parts in the blanks.

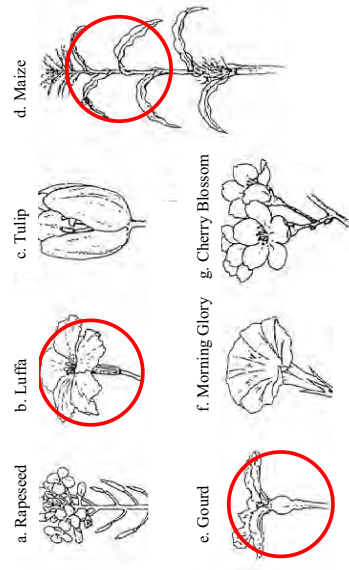


(ii) Which of A – F in the figure to the right correspond to the descriptions in a) – d) below?



- a) Pollen is released from here. ( B )
- b) Pollen attaches to here. ( A )
- c) This grows into a seed. ( F )
- d) This grows into the fruit. ( E )

2. Of the flowers below, circle the ones which are divided into male and female flowers.



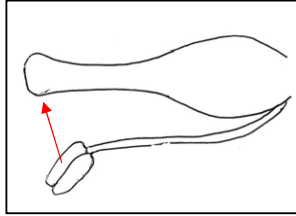
### 2<sup>nd</sup> Sub-Unit Review Test

\* given after end of 4<sup>th</sup> period

Class: \_\_\_\_\_ Name: \_\_\_\_\_

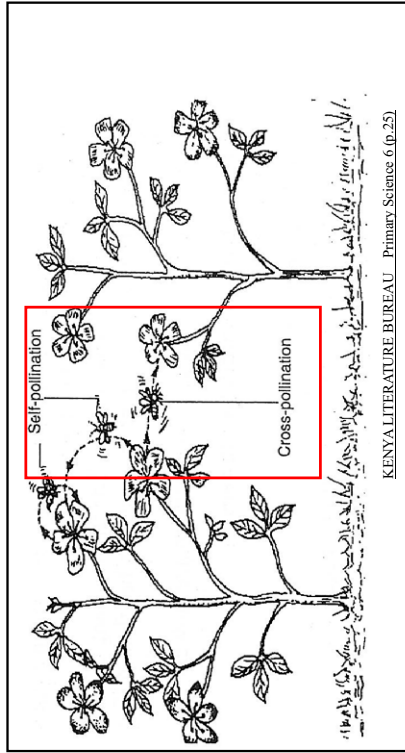
1. Answer these questions about pollination.

(i) Write in the needed parts in the figure on the right and explain pollination.



Pollination is when ( **the pollen that comes out of the anther at the end of the stamen attaches to the stigma at the end of the pistil** ).

(ii) Enter arrows in the figure below and explain the difference between self-pollination and cross-pollination.



• Self-pollination is:

( **when pollen from the stamen's anther attaches to the stigma at the end of the pistil on the same flower, or when pollen attaches to the stigma at the end of the pistil of a different flower on the same plant.** )

• Cross-pollination is:

( **when the pollen of one individual attaches to the pistil of a different individual of the same variety.** )

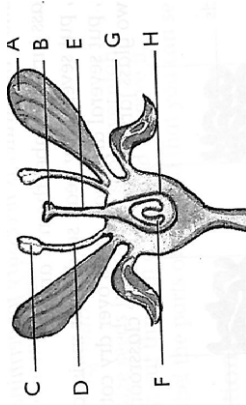


### Final Unit Evaluation Test

\*Done at Unit End

Class: \_\_\_\_\_ Name: \_\_\_\_\_

1. Look at the structure of the flower shown in the figure on the right and answer the following questions.



Oxford: Science in Action 6 (p.24)

(i) Give the names of parts A, B, C and F.

A ( **Petal** ) B ( **Stigma** )

C ( **Anther** ) F ( **Ovule** )

(ii) Divide **B, C, D, E, F, and H** into pistil and stamen parts.

Pistil ( **B, E, F, H** )

Stamen ( **C, D** )

(iii) Which of **B – H** makes pollen?

( **C** )

(iv) Which of **A – H** becomes the seed?

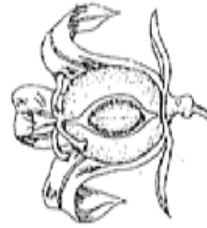
( **F** )

(v) Which of **1 – 3** below does not have both a pistil and stamen in the same flower as shown in the figure above?

1) Primrose 2) Maize 3) Dandelion ( **2** )

2. The figure on the right is a cross-section of a paw-paw flower.

Look at the figure and answer the following questions.



(i) Is this pawpaw a male or female flower? Also give the reason for your decision. ( **female** )

Reason: ( **Because there is a stigma, ovary and ovule** )

KENYA LITERATURE BUREAU Primary Science 6 (p.24)

(ii) What can you do to be absolutely sure that plants such as the pawpaw divided into male and female plants will pollinate?

( **Plant female and male strains close to one another** )

3. Read the following paragraph and answer the questions below.

In flowers like the primrose, a tube called the **(A)** extends when **(B)** attaches to the pistil's stigma. **(B)** goes down the style and reaches the **(C)** inside the ovary, then the pollen nucleus within **(B)** and ovule nucleus within **(C)** combine.

(i) Write in the appropriate terms for **(A) – (C)** below.

(A) ( **Pollen tube** ) (B) ( **Pollen** ) (C) ( **Ovule** )

(ii) What is the process described in the first underlined portion called? ( **Pollination** )

(iii) What is the process described in the second underlined portion called? ( **Fertilisation** )

(iv) Write the letter of all items which describe self-pollination. ( **(a)(c)** )

(a) Pollen attaches to the stigma on the same flower.

(b) The flower's pollen attaches to the stigma of a different individual of the same variety.

(c) Pollen attaches to the stigma of a different flower on the same individual.

4. Write which of **A – D** below gives characteristics of insect-pollinated flowers. ( **B, C** )

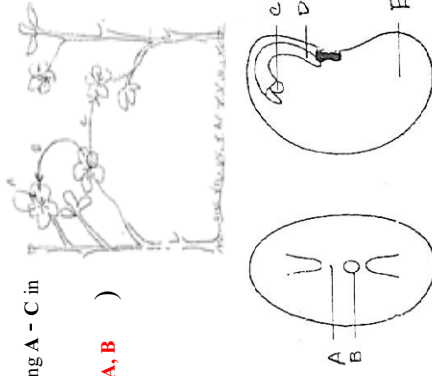
A. Pollen spores are large and made in high volume.

B. Some produce nectar.

C. They have brightly coloured petals.

D. They are covered in hair and have wing-like stigmas.

5. Give the letter of all examples of self-pollination among **A – C** in the figure to the right. ( **A, B** )



6. Answer looking at the figure on the right of a bean seed.

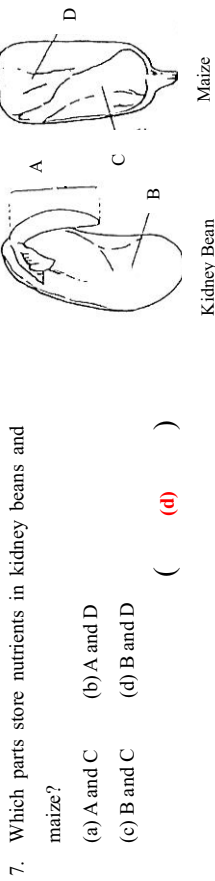
(i) Write in the names of **A – E** in the figure.

A ( **Ovule** ) B ( **Hilum** )

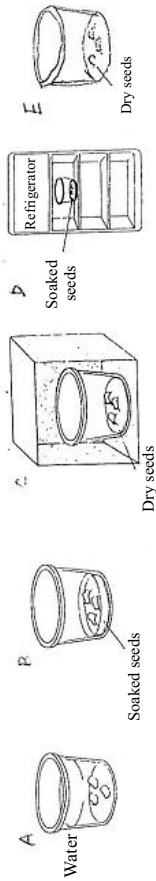
C ( **Germ** ) D ( **Radicle** )

E ( **Cotyledon** )

- (ii) Give the function of A.
- ( **Absorbs water during germination. The radicle sticks out from it.** )



8. A germination experiment was conducted using kidney beans as given below. Answer the following questions.



- (i) In the blanks below, write a Y for the options between A – E which will germinate, and an N for those that will not.  
A ( **N** ) B ( **Y** ) C ( **N** ) D ( **N** ) E ( **N** )
- (ii) Which of A – E in the figure above should you compare in order to find out whether 1 – 3 below are necessary conditions for germination? Also, write an X on the condition that you do not know with the given information.  
1) Proper temperature ( **B and D** ) 2) Moisture ( **B and E** ) 3) Light ( **X** )

9. You sowed 10 maize seeds and 5 of them grew. When you tried to eat the maize you harvested from the 5 plants you raised, it did not look very healthy. Fields which plant a lot of maize do not have this problem. Give the reason why in the blank below.

( **Because you only planted a few plants, and pollen did not attach to all the flower stigmas.** )

### Student Questionnaires

1. What kinds of studying have you done in the past for the above test problems?

- 0. None at all This was done 10% of the time for all problems.
- 1. No This was done 30% of the time for all problems.
- 2. Average This was done 50% of the time for all problems.
- 3. Yes This was done 70% of the time for all problems.
- 4. Absolutely yes This was done over 90% of the time for all problems.

Answering Questions using Pictures and Diagrams in the Textbook or Illustrations Drawn on the

#### Blackboard

- 1. The Students answered the questions by walking up to the board and drawing diagrams or writing words. 0. 1. 2. 3. 4.
- 2. The teacher asked and answered the questions by drawing diagrams or writing words on the board. 0. 1. 2. 3. 4.
- 3. Questions were answered using pictures and diagrams in the textbook. 0. 1. 2. 3. 4.

#### Experiments

- 1. Did the students conduct any experiments or observations? 0. 1. 2. 3. 4.
- 2. The teacher conducted the experiments. 0. 1. 2. 3. 4.
- 3. The students conducted the experiments by following the teacher's instructions. 0. 1. 2. 3. 4.

#### Discussion and Thinking

- 4. We talked with friends in the class and thought about the problems. 0. 1. 2. 3. 4.
- 5. We thought about the problems carefully with friends and stated our ideas logically. 0. 1. 2. 3. 4.

6. We thought about the problems carefully when coming up with a hypothesis and after the experiment.

0. 1. 2. 3. 4.

**Understanding Ideas**

7. I was able to understand new ideas.

0. 1. 2. 3. 4.

8. I was able to see new viewpoint of looking at and thinking about science.

0. 1. 2. 3. 4.

9. I was able to grasp the principles hidden beneath the facts.

0. 1. 2. 3. 4.

**Application of Knowledge**

10. I was able to apply the new knowledge that I learned in school in my daily life.

0. 1. 2. 3. 4.

11. The teacher has explained that the new knowledge things the students are learning in school are connected with actual life.

0. 1. 2. 3. 4.

12. I was able to learn that the new principles and viewpoints toward science can be applied to a variety of different phenomena.

0. 1. 2. 3. 4.

**Pursuing Knowledge through Problem Solving**

13. We were first given a problem and then were to solve that problem.

0. 1. 2. 3. 4.

14. We made predictions, put them to the test, formulate scientific explanations, and put them to practical use.

0. 1. 2. 3. 4.

15. The students were asked to verify through the experiment that they had created a hypothesis as well as a plan for the observation.

0. 1. 2. 3. 4.

2. When you learned each unit for the above test problems, did you become interested in the material?

0. None at all

This was true 10% of the time for all problems.

1. No

This was true 30% of the time for all problems.

2. Average

This was true 50% of the time for all problems.

3. Yes

This was true 70% of the time for all problems.

4. Absolutely yes

This was true over 90% of the time for all problems.

**Interest and Motivation**

1. I was very interested in science lessons.

0. 1. 2. 3. 4.

2. I became more motivated to learn.

0. 1. 2. 3. 4.

3. I was interested in what we were learning from start to finish.

0. 1. 2. 3. 4.

**Concentration and Involvement**

4. I was actively engaged in learning the topic.

0. 1. 2. 3. 4.

5. I enjoyed learning the topic so much I lost track of time.

0. 1. 2. 3. 4.

6. I was very focused on learning topic material but at the same time, I was also very excited and enjoyed myself.

0. 1. 2. 3. 4.

**Cooperation and Collaboration**

7. I enjoyed the learning process while collaborating with friends.

0. 1. 2. 3. 4.

8. I was able to learn through cooperation and mutual support with my friends.

0. 1. 2. 3. 4.

9. I shared my experiments and ideas with my friends and we all had a fun time learning together.

0. 1. 2. 3. 4.

**Level of Earnestness and Enjoyment during Experiments**

- 10. The experiments were very enjoyable.
  - 0. 1. 2. 3. 4.
- 11. Since experiments need five senses, I carefully moved my hands and eyes when collecting the data.
  - 0. 1. 2. 3. 4.
- 12. During the experiments, I recorded my observations accurately and carefully.
  - 0. 1. 2. 3. 4.

**Spirit of Inquiry**

- 13. I began to have more an inquiring mind toward new discoveries.
  - 0. 1. 2. 3. 4.
- 14. I became very excited and curious about challenging the unknown.
  - 0. 1. 2. 3. 4.
- 15. I made a strong effort to learn what is known by trying to find examples, drawing illustrations, and through discussions and experiments.
  - 0. 1. 2. 3. 4.

**Logic and Objectivity**

- 16. I attempted to find plenty of evidence and facts to check whether my hypothesis held true.
  - 0. 1. 2. 3. 4.
- 17. I was able to confirm that the principles and concepts were true by applying them to actual life.
  - 0. 1. 2. 3. 4.
- 18. The explanations were very convincing and easy to understand for the entire class. I was very satisfied with the interpretations which were logical and accorded with the truth.
  - 0. 1. 2. 3. 4.

**Appendix  
Using a Microscope**

### Using a Microscope

**Eyepiece Lens:** Some can be exchanged to change magnification.

**Tube**

**Arm**

**Focus Knob:** Moves the stage.

**Objective lens**

**Stage clips**

**Stage**

**Reflective mirror**

**Turret:** Spun to change magnification of objective lens. Always start with the lowest magnification.

Some microscopes have moving tubes.

Always use both hands when carrying the microscope.

Do not use the microscope in an area with direct sunlight as it will hurt your eyes.

When you have finished observing, wipe the microscope down and put it back in its case.

1 Move the reflective mirror while looking through the eyepiece lens and you will be able to see things brightly.

2 Place the slide (the glass with what you want to view) on the stage and hold it down with the clips.

3 Turn the focus knob while watching from the side, and spin until the objective lens and slide are almost touching.

4 Looking through the eyepiece lens, spin the focus knob in the opposite direction from that in 3 to make the slide and objective lens separate. Stop when you can clearly see the image.

### Using a Stereo Microscope

**Eyepiece Lens**

**Objective Lens**

**Diopter Ring**

**Focus Knob**

**Stage**

1 Using in an area with no direct sunlight, place the object to be viewed on the stand.

2 Adjust the eyepiece lens width to fit your eyes, making it so your vision with both eyes open completely overlaps.

3 Looking through your right eye, spin the focus knob until you can see clearly.

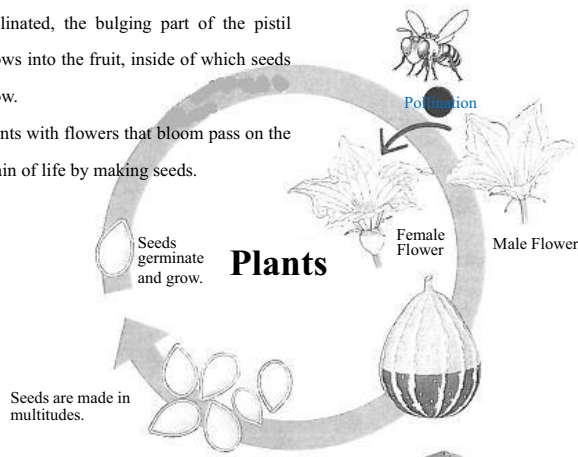
4 Looking through your left eye, spin the diopter ring until you can see clearly, and observe with both eyes.

Outdoor use stereo microscope

There are also microscope attachments that will allow projection onto a monitor.

When a plant's flower blooms and is pollinated, the bulging part of the pistil grows into the fruit, inside of which seeds grow.

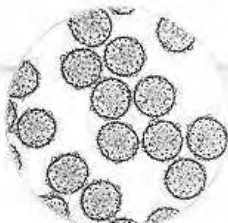
Plants with flowers that bloom pass on the chain of life by making seeds.



Among the things we call "seeds", some are seeds and some are fruit (seed and fruit are unified).

## 2 The Function of Pollen

The powdery substance on the end of the stamen is called *pollen*. The end of the pistil is sticky. If you look at a pumpkin's pistil closely, you will see that there is pollen on it.



So does pollen come out of the pistil too? Or...

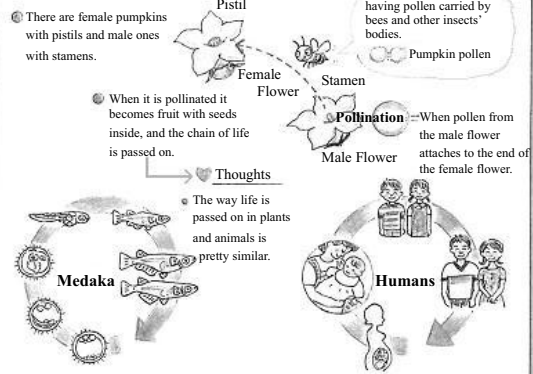
Think about why pollen is on the pumpkin's pistil looking at the pictures below.

End of the pistil on a bud. End of the pistil when flower is blooming.

Once the flower blooms, insects come. With pumpkins...

### Example

#### How Seeds are Made: Passing on the Chain of Life



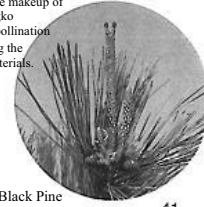
#### Check Did you know?

- What method do farms growing strawberries and other fruit use for pollination? Investigate using the reference materials.



#### Expansion Challenge!

- Investigate the makeup of pine and ginkgo flowers and pollination in detail using the reference materials.



Pollen attaching to the end of the pistil is called *pollination*.

Is there a difference in how fruit is made depending on whether a plant pollinates?

#### Experiment 1 Pollination and Fruit

- Choose a few female buds that look like they will bloom in the next day and arrange them as shown below.
- Continue investigating to see the different changes between female flowers that pollinate and those that do not.

It is easy to injure the bulging part of female flowers, so try not to touch them.

Evening	The Next Morning	After
Cover it with a bag.	Have the ends of the stamen and pistil touch lightly to pollinate, then cover with the bag.	Take the bag off when the flower withers.
Cover it with a bag.	Leave everything as-is.	Take the bag off when the flower withers.

### Appendix

Examples of assessment questions which are used in Kenyan text books

Which one of the following plants is an example of a dicotyledon?

- A. napier grass
- B. sugarcane
- C. pawpaw
- D. wheat

In which of the following seeds is food stored in the cotyledon?

- A. maize
- B. rice
- C. barley
- D. bean

(Longhorn; Understanding Science, Pupil's Book 6 P.32)

Which of the following correctly lists the parts that make up the female part of a flower?

- A. Anther, stigma, ovary.
- B. Stigma, style, ovary.
- C. Filament, anther.
- D. Ovary, stigma, filament.

Which of the following correctly describes pollination in flowers?

- A. Pollen grains are transferred from anthers to the stigma.
- B. Pollen grains are transferred from the stigma to the anthers.
- C. Ovules are transferred from the ovary to the stigma.
- D. Pollen grains fuse with ovules.

(Oxford; Science in Action 6 P.25)

Complete the table below

PART OF A FLOWER	FUNCTION
(a) Stalk	
(b) Sepals	
(c) Ovary	
(d) Ovules	
(e) Style	
(f) Stigma	
(g) Filament	
(h) Anther	
(i) Petals	

(JKF; Primary Science Education Foundation Science 6 P.31)

The Science teacher in a Standard six class in one of the schools in Zim asked the class to write down the necessary conditions for a maize seed to germinate. Zippo gave the following answers:

- i. soil.
- ii. air
- iii. sunlight
- iv. warmth
- v. water

The correct answer Zippo should have given was

- A ii, iv, v
- B ii, iii, i
- C i, ii, iii
- D iii, iv, v

The main difference between cross-pollination and self-pollination is that cross-pollination.

- A involves one single flower
- B involves two separate flowers
- C has an insect as the pollinating agent
- D has wind as the pollinating agent

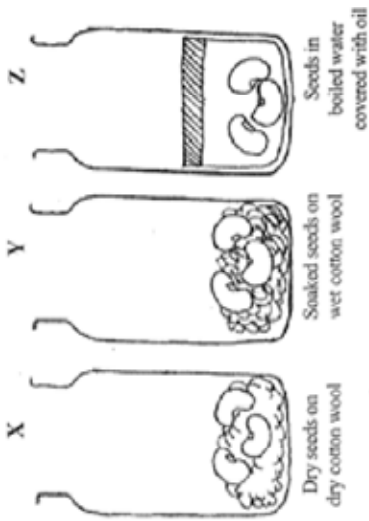
(Macmillan; Macmillan Primary Science, Pupil's book 6 P.45)

Mark + characteristics of insect-pollinated flower

- Produce a large amount of light and powdery pollen grains which can easily be carried by the wind.
- Have large hairy or feathery stigmas. The stigmas hang outside the flower and trap any pollen grains that may be 'floating' in the air.
- Are usually large in size.
- Have brightly coloured petals that 'attract' insects.
- Have a strong nice smell (scent).
- Produce nectar. Many insects feed on nectar and therefore visit these flowers.
- Have anthers which are not very large. These anthers are firmly attached to the filament.
- Produce a small amount of heavy and sticky pollen grains which can stick firmly to the bodies of visiting insects.
- Have flat and sticky stigmas that are found inside the flowers. Any pollen grains deposited by an insect stick on the stigma.

K.L.B; Primary Science Pupils' Book for Standard Six P.26)

Standard Six pupils placed seeds in containers as shown below and left them for a week.



- (a) Explain what they observed in X.
- (b) Explain what they observed in Y.
- (c) Explain what they observed in Z.

(JKF; Primary Science Education Foundation Science 6 P.32)

### Appendix

Examples of materials which are used in Kenyan text books

#### Parts of flower

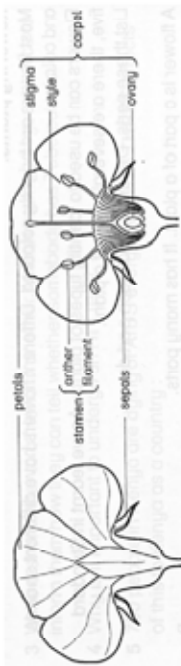
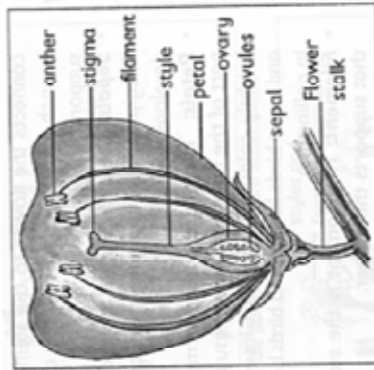


Figure 3.1 Parts of a flower

(Macmillan; Macmillan Primary Science, Pupil's book 6 P.32)



Parts of a flower

(Longhorn; Understanding Science, Pupil's Book 6 P.21)

**Pollination**



Fig. 3.2: Flowers in male and female plants  
(KLB; Primary Science Pupil's Book for Standard Six P.23)

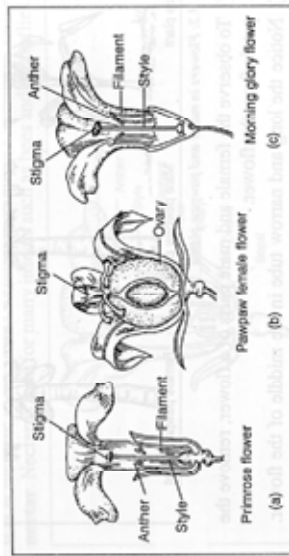


Fig. 3.3: (a), (b) and (c): Male and female parts of various flowers  
(KLB; Primary Science Pupil's Book for Standard Six P.24)

**Agents of pollination**

**Insects**



Figure 3.7: A bee looking for nectar

(Oxford; Science in Action 6 P.20)



Figure 3.8: A bird looking for nectar

(Oxford; Science in Action 6 P.20)



Figure 3.9: Animals grazing

(Oxford; Science in Action 6 P.21)



Figure 3.6: Wind pollination in maize

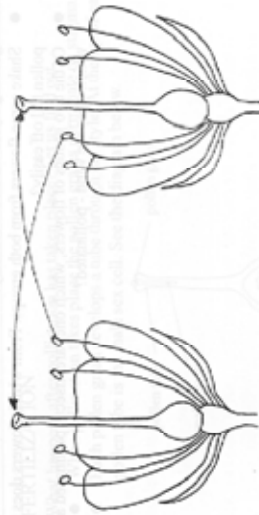
(Oxford; Science in Action 6 P.20)





**Wind pollination**

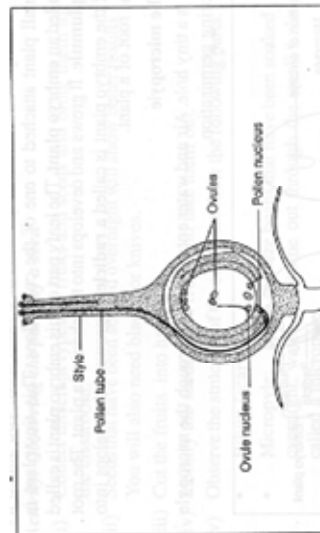
(Longhorn, Understanding Science, Pupil's Book 6 P.25)



*Cross - Pollination*

(JKF; Primary Science Education Foundation Science 6 P.23)

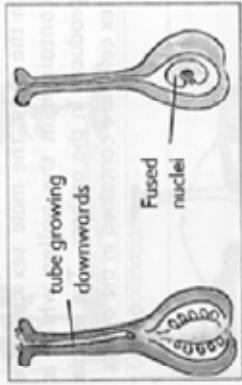
**Fertilization**



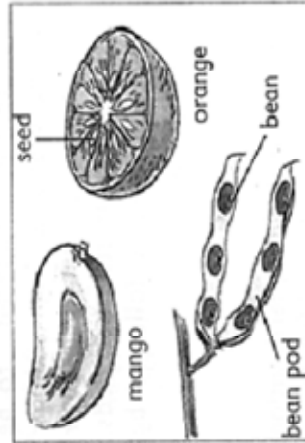
*Fig. 3.4: Fertilisation in a flowering plant*

(KLB; Primary Science Pupil's Book for Standard Six P.27)

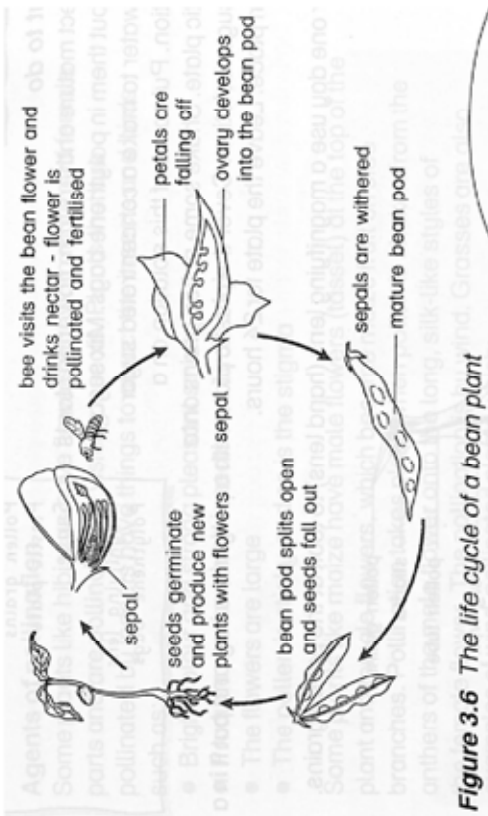
Once the nucleus of the male sex cell fuses with the nucleus of the female sex cell **fertilisation** has taken place.



After fertilisation the ovule develops into a seed while the ovary develops into a fruit.



(Longhorn; Understanding Science, Pupil's Book 6 P.26)



**Figure 3.6** The life cycle of a bean plant

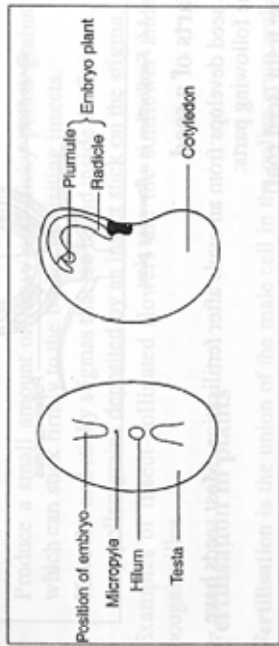
(Macmillan; Macmillan Primary Science, Pupil's book 6 P.38)

**4. Parts of seed**

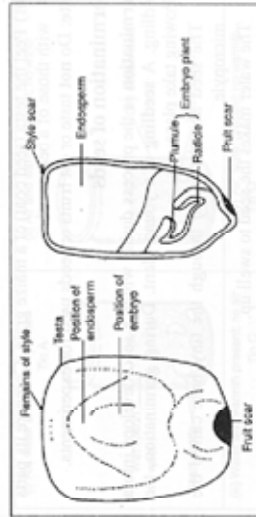
- Draw the soaked seed and label as shown.
- Cut the soaked mature seed along the dotted line as shown below.
- Observe one half.
- How many parts can you see?
- Draw one half.
- We can now label the mature seed.

- Draw the seed and show testa, scar and micropyle.
- Cut open another seed along the dotted line as shown.
- How many parts can you see?
- Draw the seed.
- We can label the parts of the seed as shown below.

(JKF; Primary Science Education Foundation Science 6 P.27-28)



**Fig. 3.5:** The parts of a bean seed, a dicot  
(KLB; Primary Science Pupil's Book for Standard Six P.28)



**Fig. 3.6:** The parts of a maize seed, a monocot  
(KLB; Primary Science Pupil's Book for Standard Six P.29)

### Germination

Put four seeds in the tin.  
Pour a thin layer of oil on top of the water in tin 4. This will stop oil from dissolving in the water.

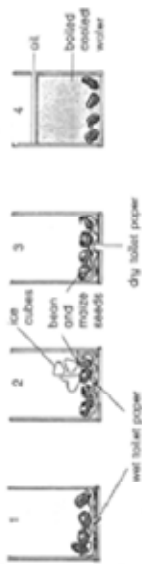


Figure 3.9 How to set up the tins

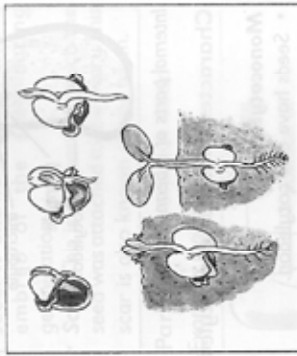
Leave the tins for 10 days. Keep the paper in tins 1 and 2 wet by adding some drops of water.  
Draw what you observe in each tin after 10 days.



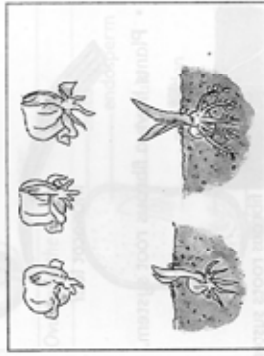
Figure 3.10 What happens to the seeds in each tin?

(Macmillan; Macmillan Primary Science, Pupil's book 6 P.41)

### Characteristics of monocotyledon and dicotyledon plants



Dicot seed germinating



Monocot seed germinating

(Longhorn; Understanding Science, Pupil's Book 6 P.28)

<p><b>Monocotyledons</b></p> <ul style="list-style-type: none"> <li>• Seeds have one cotyledon.</li> <li>• Food is stored in the endosperm.</li> <li>• Leaves have parallel veins.</li> </ul> <p>monocot leaf</p> <p>Plants have a fibrous root system.</p> <p>fibrous roots system</p>	<p><b>Dicotyledons</b></p> <ul style="list-style-type: none"> <li>• Seeds have two cotyledons.</li> <li>• Food stored in the cotyledons in the seed</li> <li>• Leaves have branched or a network of veins.</li> </ul> <p>dicot leaf</p> <p>Plants have a taproot system.</p> <p>tap root system</p>
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(Longhorn; Understanding Science, Pupil's Book 6 P.27)