

Chapter 17 – Reproduction in Flowering Plants

Subject content

Content

- Asexual Reproduction
- Sexual Reproduction in Plants

Learning outcomes

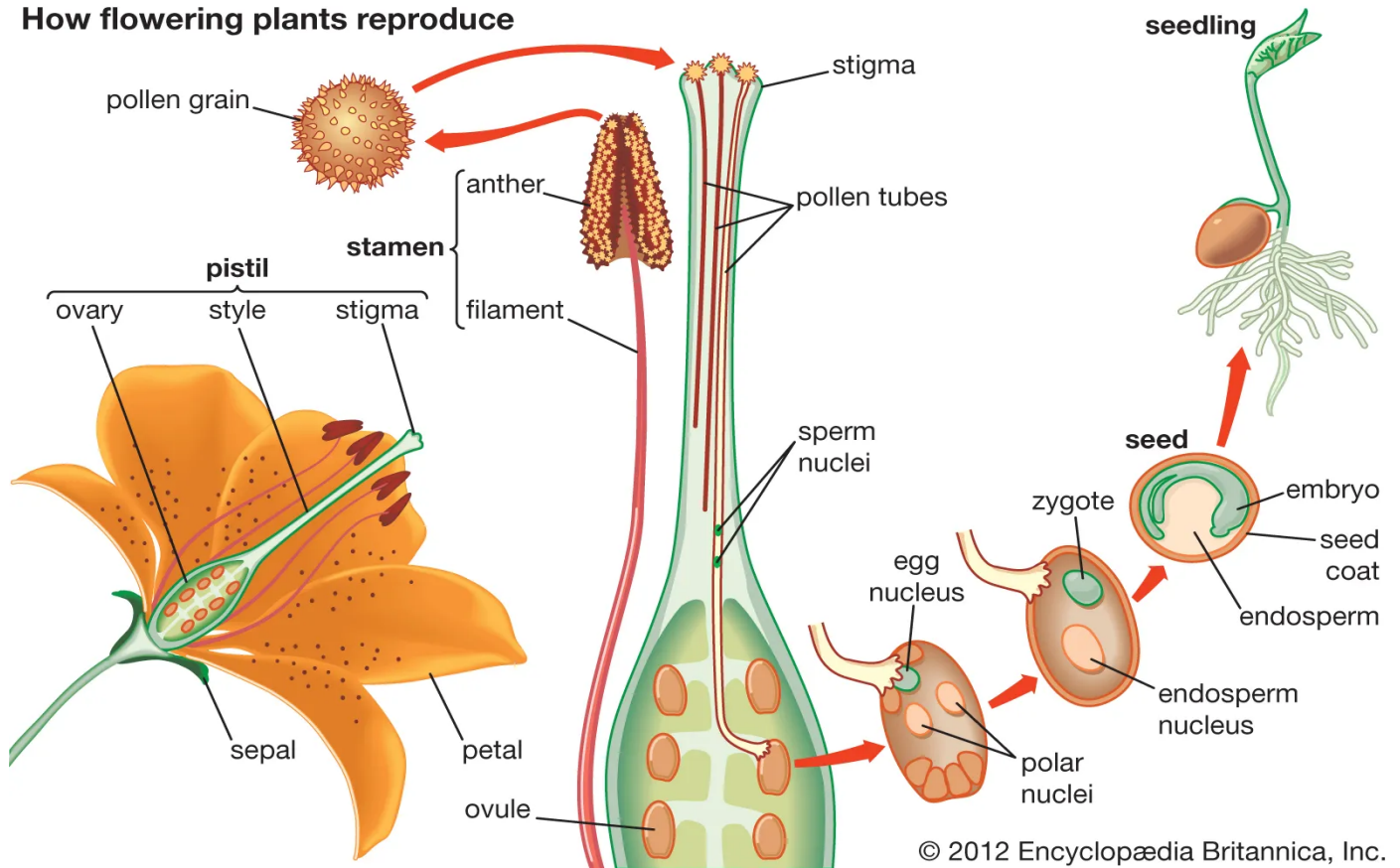
- define asexual reproduction as the process resulting in the production of genetically identical offspring from one parent
- define sexual reproduction as the process involving the fusion of nuclei to form a zygote and the production of genetically dissimilar offspring
- identify and draw, using a hand lens if necessary, the sepals, petals, stamens and carpels of one, locally available, named, insect-pollinated, dicotyledonous flower, and examine the pollen grains using a microscope
- state the functions of the sepals, petals, anthers and carpels
- use a hand lens to identify and describe the stamens and stigmas of one, locally available, named, wind-pollinated flower, and examine the pollen grains using a microscope
- outline the process of pollination and distinguish between self-pollination and cross-pollination
- compare, using fresh specimens, an insect-pollinated and a wind-pollinated flower
- describe the growth of the pollen tube and its entry into the ovule followed by fertilisation (production of endosperm and details of development are not required)

Use the knowledge gained in this section in new situations or to solve related problems.

Definition

Term	Definition
Asexual reproduction	Production of genetically identical offspring from 1 parent
Sexual reproduction	Production of genetically dissimilar offspring from 2 parents Fusion of nuclei of male + female gamete to form zygote
Pollination	Transfer of pollen grains from anther → stigma
Self-pollination	Transfer of pollen grains from anther → stigma of same / different flower on same plant
Cross-pollination	Transfer of pollen grains from one plant to stigma of a flower in another plant of same species

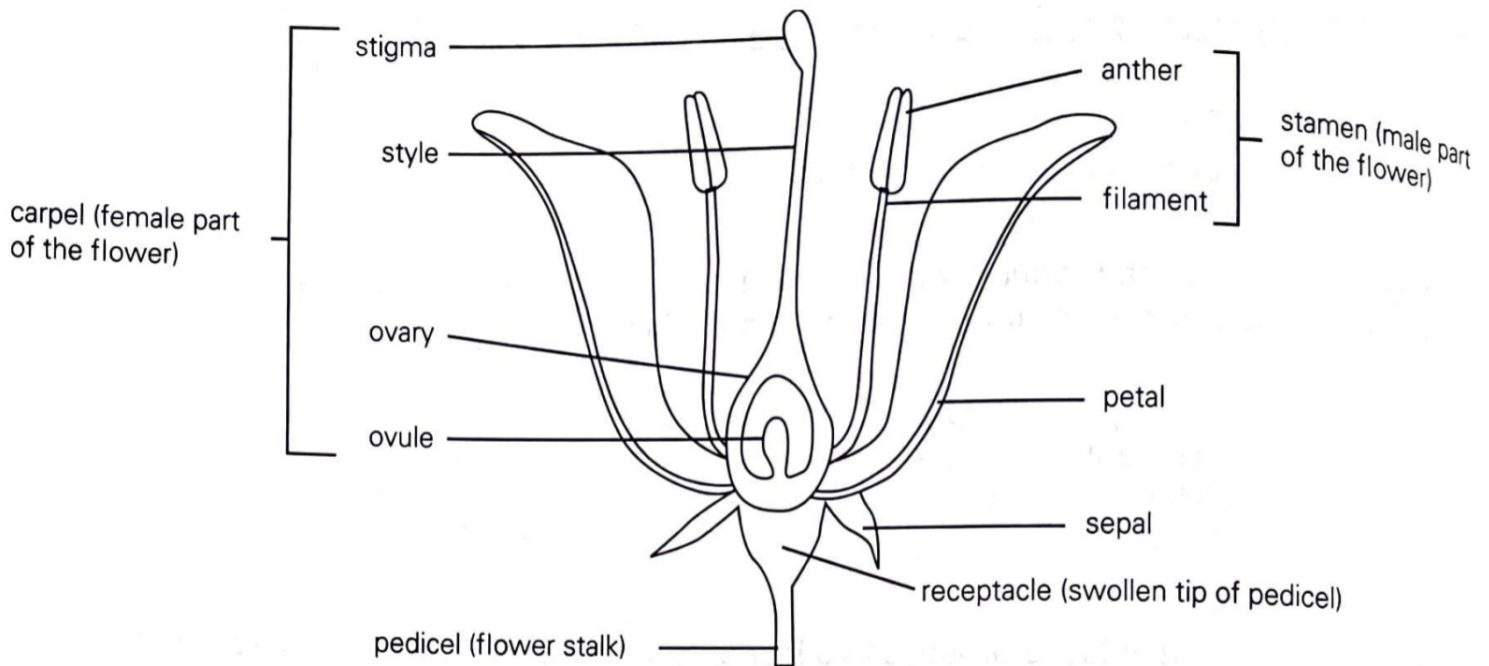
How flowering plants reproduce



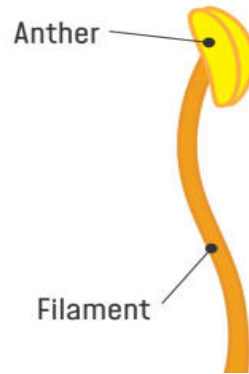
17.1 Asexual and Sexual Reproduction

Aspect	Asexual reproduction	Sexual reproduction
Parent required	1	2
Fusion of gametes	✗	✓
Offspring	Genetically identical to parent	Genetically dissimilar to parents
Speed	Relatively faster	Slower
Qualities / traits passed on	All	From both parents
Genetic variation	No genetic variation → X well adapted to changes in envt	Greater genetic variation → better adapted to changes in envt

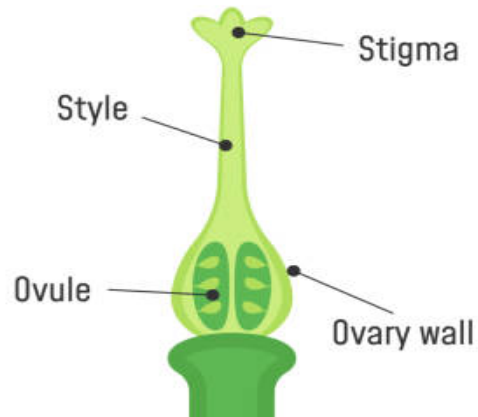
17.2 The Floral Structure



Part	Function	Description
1. Sepal	<ul style="list-style-type: none"> Enclose petals + reproductive organs → protect during bud stage 	<ul style="list-style-type: none"> Modified leaf Green (may be coloured) Outermost layer Collectively make up calyx
2. Petal	<ul style="list-style-type: none"> Brightly-coloured: attract insect pollinators Landing platform for insects 	<ul style="list-style-type: none"> Modified leaf Collectively make up corolla
3. Stamen	<ul style="list-style-type: none"> Male reproductive organ 	
4. Carpel	<ul style="list-style-type: none"> Female reproductive organ 	

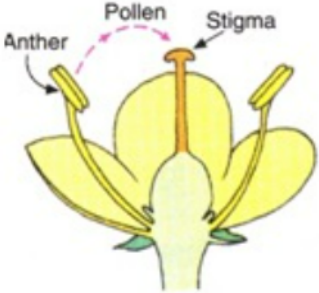
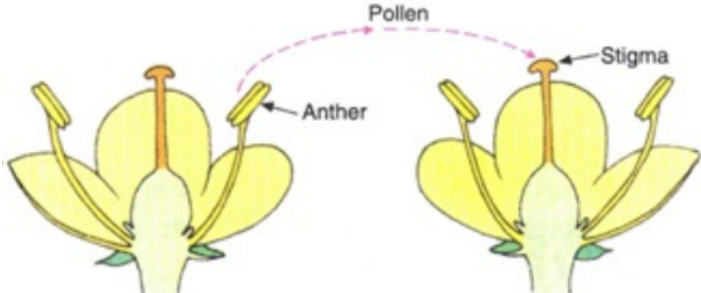
Stamen

Stamen part	Function	Description
1. Filament	<ul style="list-style-type: none"> • Phloem: sucrose + amino acids → anther • Xylem: water + dissolved mineral salts → anther 	<ul style="list-style-type: none"> • Stalk that bears anther • Contain vascular bundle
2. Anther	<ul style="list-style-type: none"> • Pollen sacs produce pollen grains • Split open → release pollen grains 	<ul style="list-style-type: none"> • 2 lobes (each 2 pollen sacs)
3. Pollen grain	<ul style="list-style-type: none"> • Sexual reproduction 	Contain 2 haploid nuclei 1) generative nucleus: divide → 2 male gametes 2) pollen tube nucleus

Carpel

Carpel part	Function	Description
1. Stigma	<ul style="list-style-type: none"> • Receive pollen grains • Secrete sugary fluid → stimulate pollen grain germination 	<ul style="list-style-type: none"> • Sticky, swollen tip of style
2. Style	<ul style="list-style-type: none"> • Hold stigma in suitable position to receive pollen grains 	<ul style="list-style-type: none"> • Stalk joining stigma & ovary
3. Ovary	<ul style="list-style-type: none"> • Sexual reproduction 	<ul style="list-style-type: none"> • Hollow base of carpel • Contain ovules: contain ovum (haploid egg cell)

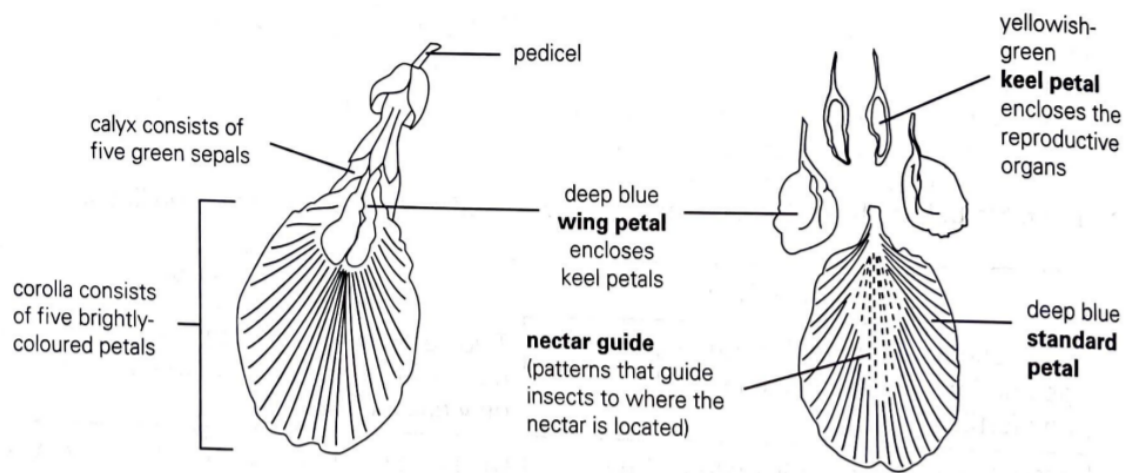
17.3 Self-Pollination and Cross-Pollination

Self-pollination	Cross-pollination
<u>same</u> plant	<u>another</u> plant
	
Flower features favouring	
<ol style="list-style-type: none"> 1. Bisexual 2. Anther & stigma mature at same time 3. Stigma: directly below anther 	<ol style="list-style-type: none"> 1. Dioecious (bear male / female flowers) 2. Anther & stigma mature at diff times 3. Stigma: some distance away from anther
Characteristics	
1 parent plant required	2 parent plants required
Offspring inherit genetic material from 1 parent <ul style="list-style-type: none"> • genetically similar → inherit beneficial qualities of parent • less genetic variation → X adapt to changes in envt → lower chance of survival 	Offspring inherit genetic material from 2 parents <ul style="list-style-type: none"> • inherit combination of best qualities of both parents • greater genetic variation → better adapt to changes in envt → higher chance of survival
✗ depend on external factors → more likely to occur	✓ depend on external factors → less likely to occur
Pollen grains travel short distance → less pollen + energy wasted	Pollen grains travel long distance → more energy + pollen wasted

17.4 Insect Pollination and Wind Pollination

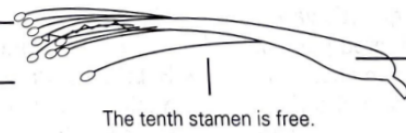
Insect-pollinated flower – Clitoria flower

Figure



Androecium (male reproductive organ): 10 stamens

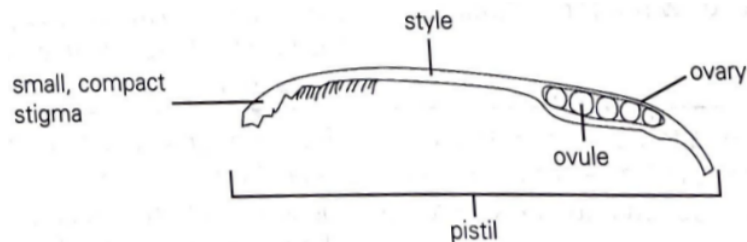
The filaments of nine of the stamens are fused to form the hollow **stamen trough**, which encloses the pistil.



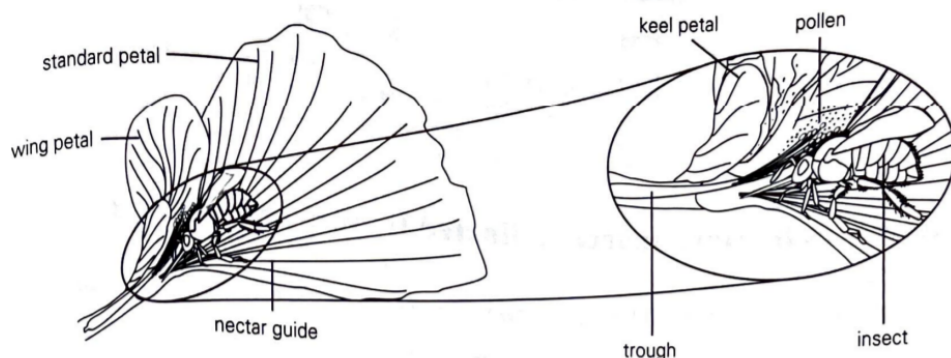
The tenth stamen is free.

Nectar collects at the bottom of the trough, and can only be reached by an insect with a long **proboscis** (tubular mouth), such as a bee.

Pistil (female reproductive organ): 1 carpel

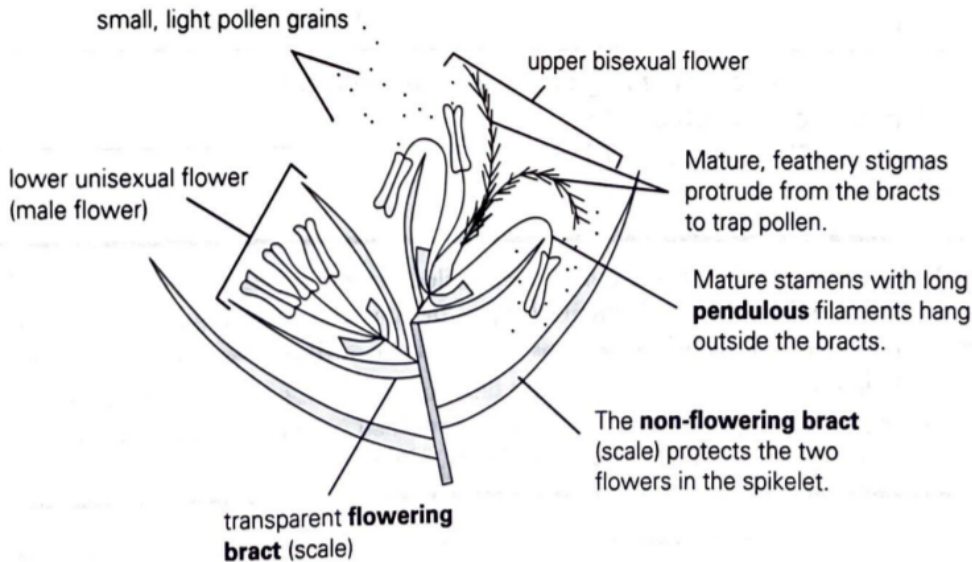


Procedure / adaptations

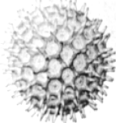



1. Insect land on standard petal → follow nectar guide into flower
2. Insect force its way b/w wing petals, more in to collect nectar
3. Insect back: push keel petal upwards → expose stigma + anther
4. Insect hairy back: brush against anther → pollen grains picked up
brush against stigma → pollen grains (from another flower) transferred
5. Insect leave: keel petal spring back → enclose stigma + anther

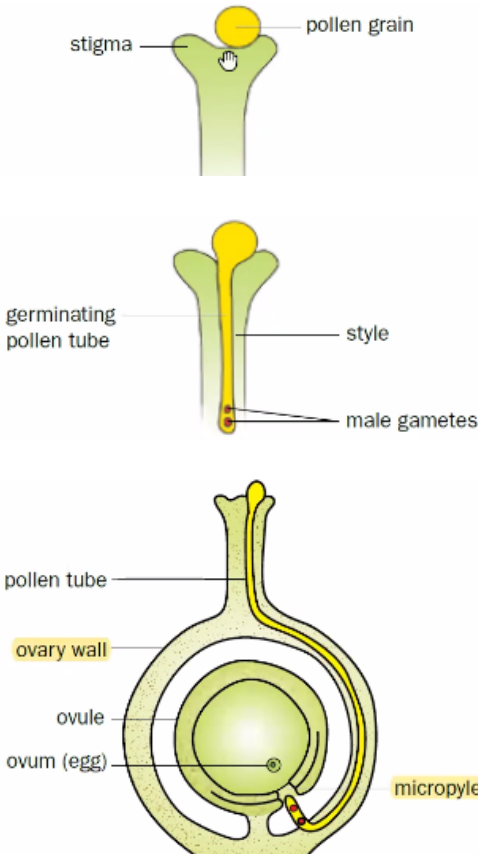
Wind-pollinated flower – *Ischaemum muticum*

Figure	 <p>The diagram illustrates the structure of a wind-pollinated flower of <i>Ischaemum muticum</i>. It shows a cross-section of the flower with the following labeled parts:</p> <ul style="list-style-type: none"> small, light pollen grains: Shown as small dots being dispersed by wind. upper bisexual flower: The main flower structure at the top. lower unisexual flower (male flower): A smaller flower structure below the main one. transparent flowering bract (scale): A protective scale-like structure. Mature, feathery stigmas protrude from the bracts to trap pollen.: The female reproductive parts are shown protruding from the bracts. Mature stamens with long pendulous filaments hang outside the bracts.: The male reproductive parts have long, hanging filaments. The non-flowering bract (scale) protects the two flowers in the spikelet.: A protective scale for the entire flower cluster.
Procedure / adaptations	<ol style="list-style-type: none"> 1. Long filament: hold anther outside flower → exposed to wind <ul style="list-style-type: none"> • sway in wind → pollen shaken free + dispersed by wind 2. Large feathery stigma: large surface area <ul style="list-style-type: none"> • receive pollen floating around in wind

Differences

Feature	Insect-pollinated flower	Wind-pollinated flower
Petals	<ul style="list-style-type: none"> Large, brightly coloured and conspicuous to attract insects Nectar guides present 	<ul style="list-style-type: none"> Absent or very small, dull dull colour Nectar guide absent
Stigmas	<ul style="list-style-type: none"> Small and <u>sticky</u> (insect rub pollen grains against them) Held within flower 	<ul style="list-style-type: none"> Large and <u>feathery</u> (larger surface area to catch pollen grains) Hang outside flower
Stamens	<ul style="list-style-type: none"> Not pendulous (X hang outside flower) 	<ul style="list-style-type: none"> Protrude out of flower Long filament – hold anthers outside flower Pendulous anther
Pollen	<ul style="list-style-type: none"> <u>Less</u> produced (insects are more reliable pollinators) <u>Larger</u> + <u>heavy</u> + sticky / hooks / spikes → cling onto insect body 	<ul style="list-style-type: none"> <u>More</u> produced <u>Small</u> + <u>light</u> → easily blown about by wind 
Nectar	Present	Absent
Scent	Fragrant / rotting meat	Absent

17.5 Fertilisation

Stage	Process
	<ul style="list-style-type: none"> • <u>Mature</u> pollen grain land on <u>mature</u> stigma • Sugary fluid secreted by mature stigma → stimulate <u>germination</u> of pollen grain → <u>pollen tube grow out</u> from pollen grain • Pollen tube secrete enzymes → digest surrounding tissue of stigma & style → grow down style into ovary • Pollen tube enter ovary through micropyle • Within ovule: tip of pollen tube absorb sap → burst → release 2 male gametes • Fertilisation: nuclei of 1 male gamete fuse with 1 ovum → zygote • Zygote undergo mitosis repeatedly + develop → embryo of seed

Post fertilisation

- Stamen, petal: wither and fall off
- Sepal, stigma, style: persist, enlarge and modified → help in fruit dispersal
- Ovary → fruit
- Ovule → seed
- Ovary wall → flesh of fruit

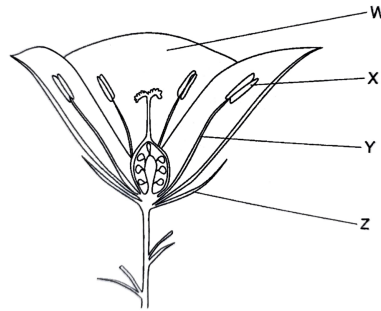
Typical questions**Multiple choice questions**

- 1 Which characteristics does a wind-pollinated flower have? (2011 P1 Q27)
- A anthers with short filaments
 - B nectaries producing nectar
 - C short, unbranched stigmas
 - D small, smooth pollen grains**
- 2 After fertilisation, which structure develops into the seed of a flowering plant? (2011 P1 Q28)
- A carpel
 - B ovule**
 - C ovum
 - D receptacle
- 3 Which statement about reproduction in plants is correct? (2012 P1 Q27)
- A All the adult offspring formed by asexual reproduction have identical phenotypes.
 - B Asexual reproduction only occurs in plants.
 - C Offspring formed after cross-pollination contain genetic material from two individuals.**
 - D Sexual reproduction always produces gametes by the fusion of zygotes.
- 4 Flowering plants use different methods to ensure that their flowers are pollinated successfully. Some of these methods are listed.
1. Plant 1 has flowers in which the female parts ripen before the male parts.
 2. Plant 2 has separate male and female flowers.
 3. Plant 3 has separate male and female plants.
 4. Plant 4 has flowers in which the same parts ripen before the female parts.
 5. Plant 5 has flowers in which the male and female parts ripen at the same time.

Which method(s) make it more likely that cross-pollination will take place? (2012 P1 Q28)

- A 1, 2, 3 and 4 only**
- B 1 and 4 only
- C 2 and 3 only
- D 5 only

- 5 The diagram shows a section through a flower.

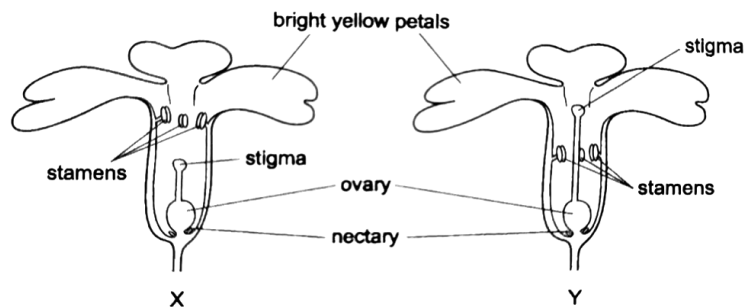


What are the functions of the parts labelled W, X, Y and Z?

(2013 P1 Q28)

	W	X	Y	Z
A	attracts insects	makes pollen	supports anther	protects other flower parts
B	makes pollen	supports anther	protects other flower parts	attracts insects
C	protects other flower parts	attracts insects	makes pollen	supports anther
D	supports anther	protects other flower parts	attracts insects	makes pollen

- 6 The diagrams show sections through two types of flower found on plants of the same species.



Which row gives the method by which these types of flower can be pollinated?

(2015 P1 Q28)

	type of pollination possible in flower type X	type of pollination possible in flower type Y
A	insect	wind
B	self	insect
C	wind	self
D	wind	wind

7 Which row describes asexual reproduction?

(2016 P1 Q27)

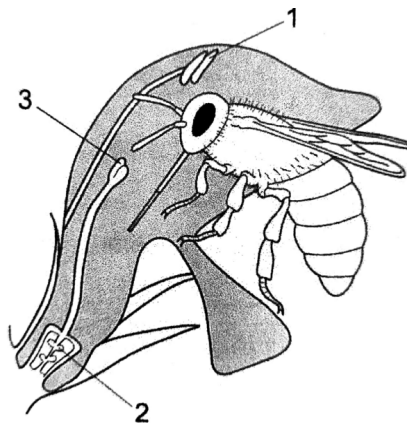
	formed from a single parent	involves fertilisation	involved meiosis
A	yes	yes	no
B	yes	no	no
C	no	yes	yes
D	no	no	yes

8 Which characteristic does an insect-pollinated flower have?

(2016 P1 Q28)

- A** anthers on long filaments
- B** light, smooth pollen grains
- C** small, dull petals
- D** sticky stigmas inside flowers

9 The diagram shows an insect entering a flower.



The insect's role is to move material from which numbered part of the flower to which other part?

(2017 P1 Q27)

	from	to
A	1	2
B	1	3
C	3	1
D	3	2

10 Which features are found in a wind-pollinated flower?

(2017 P1 Q28)

	stamens	petals	nectary	stigma
A	long and hanging	absent or small	absent	feathery
B	long and hanging	large	absent	feathery
C	short and erect	absent or small	present	sticky
D	short and erect	large	present	sticky

11 Some female insects are able to produce offspring that have developed from unfertilised eggs. Which row describes the type of reproduction and the genetic variation of the offspring?

(2017 P1 Q29)

	type of reproduction	genetics of offspring
A	asexual	genetically different
B	asexual	genetically identical
C	sexual	genetically different
D	sexual	genetically identical

12 Which features of pollen grains indicate that they are produced by wind-pollinated flowers?

(2018 P1 Q27)

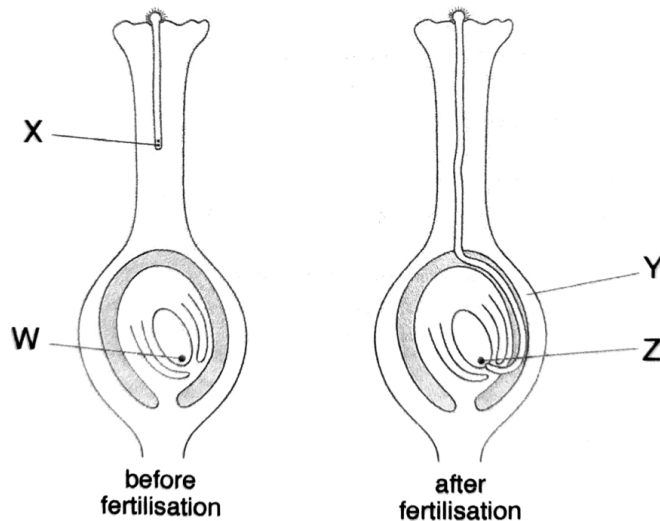
	relative mass of pollen grain	surface of pollen grain
A	heavy	rough and sticky
B	heavy	smooth and dry
C	light	rough and sticky
D	light	smooth and dry

13 When can self-pollination **never** occur?

(2018 P1 Q29)

- A** if the anthers are found below the stigma
- B** if the female and male flowers are on separate plants
- C** if the flowers have no petals
- D** if the pollen grains are carried by wind or water

14 The diagram shows a pollinated carpel, before and after fertilisation.



Which labelled structures are diploid and which are haploid?

(2019 P1 Q28)

	W	X	Y	Z
A	diploid	diploid	haploid	diploid
B	diploid	haploid	haploid	haploid
C	haploid	diploid	diploid	haploid
D	haploid	haploid	diploid	diploid

Structured questions

1 How is sexual reproduction advantageous over asexual reproduction?

[3]

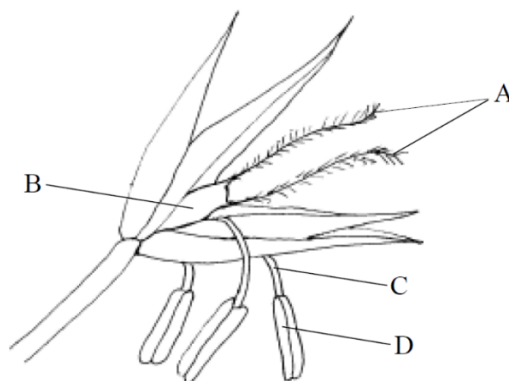
- Offspring produced have different genetic make-up from their parents (greater genetic variation).
- This provides a means of survival of the species under unfavourable conditions,
- enables some of the offspring to adapt to changes in environment.

2 What are the commercial advantages of asexual reproduction?

[3]

- Asexual reproduction produces large numbers of offspring.
- Offspring are generated quickly (compared to growing from seeds).
- All of offspring have known characteristics (such as flavour, appearance, yield and disease resistance).

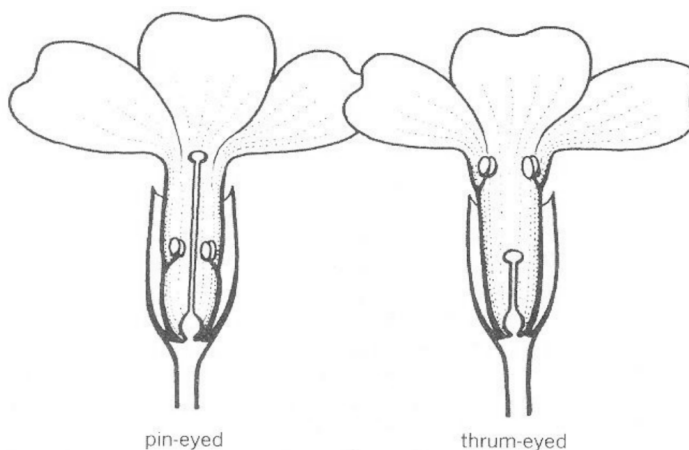
- 3 The figure below shows a flower of a typical member of the grass family.



State and explain three features shown in the figure above that suggest that the flower is wind pollinated. [3]

Feature	Explanation
1. feathery stigmas	give a large surface area (to catch pollen)
2. large hanging anthers	release much pollen (into wind)
3. other floral parts / petals / bracts reduced in size	allow free access of wind to male and female parts

- 4 The diagram shows two types of primrose flower. These types of flower are often found growing close together. Any one primrose plant, however, only has one type of flower.



- (a) Describe the difference in the arrangement of the anthers and stigma in the pin-eyed and thrum-eyed primrose. [2]

	Pin-eyed primrose	Thrum-eyed primrose
Stigma	long extends to outside corolla tube	short protected within corolla tube
Anthers	below stigma	above stigma

- (b)** Primroses are pollinated by insects, which reach into the bottom of the flower to get nectar. Which part of the insect's body would pick up pollen in
- (i)** a pin-eyed primrose? the insect's head
- (ii)** a thrum-eyed primrose? the back of the insect's body
- (c)** Which part of the insect's body would touch the stigma in
- (i)** a pin-eyed primrose? the back of the insect's body
- (ii)** a thrum-eyed primrose? the insect's head
- (d)** State two features which are characteristic of insect-pollinated flowers (your answer must be confined to observations of the flowers in the above diagram).
1. Large, conspicuous petals for the insects to use as landing platforms.
 2. Relatively small anthers that are not pendulous and protected within the flower where insects will touch / brush against them.
 3. Stigmas are usually more compact with smaller surface area, not feathery and positioned inside the flower (not protruding).
- (e)** Explain how this will help to ensure that cross-pollination takes place.
- The complementary positions of the anthers and stigmas in the two types of flowers promote cross-pollination because each plant only has one type of flower.
 - A thrum-eyed flower will be pollinated by a pin-eyed flower pollen and a pin-eyed flower will be pollinated by a thrum-eyed flower pollen.
 - An insect would pick up pollen on different parts of its body and can only pollinate the other flower type.

[When the insect visits a pin-eyed flower, the pollen of thrum-eyed flowers on its back will stick on the stigma. When it visits a thrum-eyed flower, the pollen of pin-eyed flowers on its head will settle on the stigma.]

- (f)** Self-pollination does sometime occur in primroses. Would you expect it to occur more often in pin-eyed or thrum-eyed flowers? Explain your answer.

Thrum-eyed primrose

Anthers are positioned above the stigma. When the anthers ripen and burst, the large and heavy pollens fall downwards onto the stigma.

(g) Why is cross-pollination usually preferable to self-pollination?

Cross-pollination involves two flowers on different plants of the same species.

- Since there are more genetic variability between two plants, the offspring produced may have even greater genetic variability with valuable qualities from both parents.
- The seeds produced are abundant and tend to be more viable, possessing genetic variability which increases the chance of survival of the species during environmental changes.

5 Explain the difference between the offspring of sexual reproduction and asexual reproduction in plants. [4]

Sexual reproduction:

- offspring from sexual reproduction are genetically dissimilar
- as they are produced from the fusion of gametes produced by meiosis from two different parents

Asexual reproduction:

- offspring from asexual reproduction are genetically identical
- as they are produced via mitosis from one parent

6 Suggest, with reasons, the level of genetic variation of offspring from asexual reproduction, self-pollination and cross-pollination. [5]

- Offspring from **asexual reproduction** are genetically identical to their parent plants, as asexual reproduction does not involve fusion of gametes
- Offspring from **self-pollination** show less genetic variation compared to those from cross-pollination, as those produced from self pollination involves fusion of gametes from one parent
- Offspring from **cross-pollination** involves fusion of gametes from two parents

7 Define the term *asexual reproduction*.

[2]

(2014 P2 A6a / 2017 P2 A5a)

- Asexual reproduction is a method of reproduction that only requires one parent to produce offspring.
- Offspring is genetically identical to the parent and inherit the genes of that parent only.

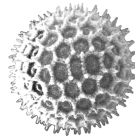
8 (2015 P2 A2)

(a) Define the term *sexual reproduction*.

[3]

- Sexual reproduction is a method of reproduction that requires two parents to produce offspring. The nucleus of male gamete fuses with the nucleus of the female gamete to form a zygote.
- The offspring receives genes from both parents and are more genetically varied.
- Some of the offspring produced are more adaptable to sudden changes in the environment, thus they have a higher survival rate than the offspring produced by asexual reproduction.

(b) The figure shows a pollen grain from the plant of Morning Glory, *Ipomoea purpurea*.



This pollen grain is dispersed by animals.

Explain how this pollen grain is adapted for dispersal.

[2]

- 1) The pollen grain has a rough and spiky surface so that it can cling easily onto the body of animals for dispersal.
- 2) It has a sticky surface so that it can stick to the body of animals and travel further away from the parent plant.

(c) The figure shows a germinated pollen grain from a plant of *Lilium sp.*



(i) Name the part labelled A.

[1]

Pollen tube

(ii) Describe **and** explain how the tip of part A reaches the female nucleus inside the flower. [3]

- When a pollen grain lands on a stigma, it germinates in response to the sugary fluid secreted by the mature stigma.
- A pollen tube grows out from the pollen grain and secretes enzymes to digest the surrounding tissue of the stigma and style.
- It grows downwards towards the ovary and enters the ovule through the micropyle.
- The pollen tube then releases the two male gametes in it into the ovule.
- The nucleus of one of the male gametes meets and fuses with the female nucleus of the ovum to form a zygote, hence fertilisation occurs.

9 (2013 P2 B10 EITHER)

(a) Distinguish between sexual and asexual reproduction. [4]

Sexual reproduction	Asexual reproduction
<ul style="list-style-type: none"> • Two parents are needed to produce offspring • Offspring are genetically dissimilar from the parents • Offspring produced is more genetically varied due to random pollination and fertilisation. Offspring are more able to adapt to sudden changes in environment, thus they have higher survival rate • Offspring develop from seeds, thus they take a longer time to grow into new plants 	<ul style="list-style-type: none"> • Only one parent is needed to produce offspring • Offspring are genetically identical to the parent • Offspring produced is less genetically varied. Offspring are less able to adapt to sudden changes in environment, thus they have lower survival rate • Offspring develop from a small piece of the existing parent plant, thus they take a shorter time to grow into new plants

(b) Define the term pollination.

[2]

- Pollination is the transfer of pollen grains from the anther of a flower of a plant to the stigma of a flower or another flower, of the same plant or another plant of the same species, by wind or insects.
- Male gametes of a plant are found in pollen grains while the female gametes of a plant are found in ovaries. Pollination is needed to bring the male gamete to the female gamete so that fertilisation can occur.

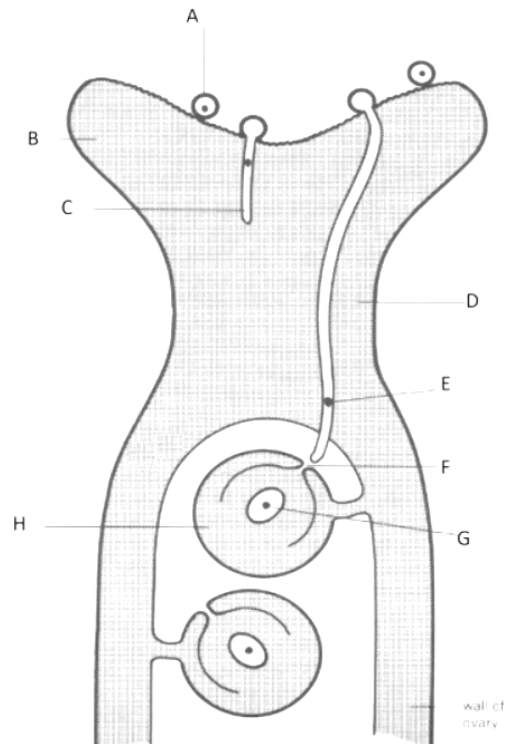
(c) State two differences between wind-pollinated and insect-pollinated flowers.

Give a reason for each difference.

[4]

	Wind-pollinated flowers	Insect-pollinated flowers
Colour	<ul style="list-style-type: none"> • Small, dull in colour and without petals 	<ul style="list-style-type: none"> • Large with brightly-coloured petals • Attract insects that help carry pollen grains to pollinate insect-pollinated flowers
Stigma	<ul style="list-style-type: none"> • Large, feathery and protrude out of the flowers • Larger exposed surface area increases chances of wind-pollinated flowers catching pollen grains carried by the wind 	<ul style="list-style-type: none"> • Small and do not protrude out of the flowers

- 10** Describe how fertilisation occurs after the pollen is deposited. In your answer, identify structures A to H. [6]



1. Pollen grain (A) lands on mature stigma (B) of the same species of plant, the sugary fluid secreted by mature stigma stimulates germination of pollen grain.
2. Pollen grain germinates a pollen tube (C) that grows down the style (D) towards the ovary by releasing enzymes to digest surrounding tissues of the style.
3. At the ovary end of the pollen tube, male gamete (E) enters ovule (H) through micropyle (F).
4. Tip of pollen tube bursts to release male gamete. Nucleus of male gamete fuses with nucleus of female gamete, hence fertilisation occurs.