

Asexual reproduction and reproduction in plants

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What you need to know

This topic comes up on every paper: one-mark multiple-choice questions on Papers 1 and 2, and longer parts on Papers 3 and 4 built around a flower, a plant that makes plantlets or a germination experiment. Outcomes marked **Extended only** are tested on Papers 2 and 4 only. By the end of this topic you should be able to:

1. **Describe asexual reproduction:** one parent produces offspring that are genetically identical to it.
2. **Spot asexual reproduction** in diagrams, photographs and descriptions (tubers, runners, plantlets, bulbs, cuttings, a bacterium splitting in two, budding).
3. **Extended only:** discuss the advantages and disadvantages of asexual reproduction, both for a wild population and for growing crops.
4. **Describe sexual reproduction:** the nuclei of two gametes fuse to form a zygote, and the offspring are genetically different from each other.
5. **Describe fertilisation** as the fusion of the nuclei of gametes.
6. **Extended only:** state that the nuclei of gametes are haploid and the nucleus of a zygote is diploid.
7. **Extended only:** discuss the advantages and disadvantages of sexual reproduction, for a wild population and for crops.
8. **Identify, and draw**, the parts of an insect-pollinated flower: sepals, petals, stamens (each an anther on a filament), carpels (stigma, style and ovary) and ovules.
9. **State what each of those parts does.**
10. **Identify and describe the anthers and stigmas of a wind-pollinated flower.**
11. **Tell apart the pollen grains** of insect-pollinated and wind-pollinated flowers.
12. **Describe pollination:** the transfer of pollen grains from an anther to a stigma.
13. **State that fertilisation happens** when a pollen nucleus fuses with a nucleus in an ovule.
14. **Describe how insect-pollinated and wind-pollinated flowers are built** for their way of pollination.
15. **Investigate and describe** the conditions seeds need to germinate: water, oxygen and a suitable temperature.
16. **Extended only:** describe self-pollination (pollen to the stigma of the same flower, or another flower on the same plant) and cross-pollination (pollen to a flower on a different plant of the same species).

17. **Extended only:** discuss what self-pollination and cross-pollination do to a population: its variation, its ability to cope with changes in the environment, and how much it relies on pollinators.
18. **Extended only:** describe how the pollen tube grows and enters the ovule, followed by fertilisation. (How the seed then develops, and the endosperm, are not needed.)

Understand it

Two ways to reproduce

Every living thing makes more of its own kind. There are two ways of doing it.

In **asexual reproduction** there is **one parent**. No gametes (sex cells) are made and nothing fuses: the parent's cells simply divide by mitosis and part of the parent becomes a new individual. Because the offspring get an exact copy of the parent's genes, they are **genetically identical** to the parent and to each other. A group of genetically identical organisms is called a clone.

In **sexual reproduction** each parent makes **gametes**. The nucleus of a male gamete fuses with the nucleus of a female gamete; this fusion is **fertilisation**, and the new cell it makes is a **zygote**. The zygote divides again and again to grow into the new organism. Each zygote gets a different mix of genes, so the offspring are **genetically different** from each other and from their parents. That difference is called **variation**.

It is the **nuclei** that fuse in fertilisation: not the whole cells, the cell walls, the membranes or the cytoplasm. The nuclei carry the chromosomes.

Extended only: a gamete's nucleus is **haploid**: it has one set of chromosomes. When two haploid nuclei fuse, the zygote's nucleus has two sets: it is **diploid**. So if a plant's body cells have 24 chromosomes (its diploid number), its pollen nuclei and the female nuclei in its ovules have 12, and the zygote has $12 + 12 = 24$ again. The body cells of offspring made asexually also have 24, because they come from the parent by mitosis.

Asexual reproduction in real life

You must recognise it from pictures and descriptions. The clue is always **one parent, a piece of it growing into a new individual, no flowers or gametes involved**.

- **Bacteria** split into two identical cells (after copying their DNA).
- **Hydra** (a tiny water animal) grows a bud on its side that breaks off as a new animal. Asexual reproduction is not only for plants and bacteria: many animals, such as aphids, use it too.
- **Potato tubers**: swollen underground stems full of stored starch. A tuber planted in spring sprouts into a new plant that is a clone of the parent.
- **Strawberry runners**: side stems grow along the ground and form **plantlets** that root and become new plants.
- **Plantlets** on leaves or on long stalks (the spider plant, the Mexican hat plant).

- **Bulbs** (onions, daffodils, bluebells): a short underground stem with fleshy leaves; new bulbs form beside the old one.
- **Cuttings**: a gardener cuts a shoot and plants it, and it grows roots.

A **seed** is never asexual: it comes from a flower after fertilisation. The same plant can often do both. Strawberries make runners **and** flowers, and a potato plant makes tubers **and** flowers.

Extended: which is better?

Neither way is best everywhere. The key idea is **variation**.

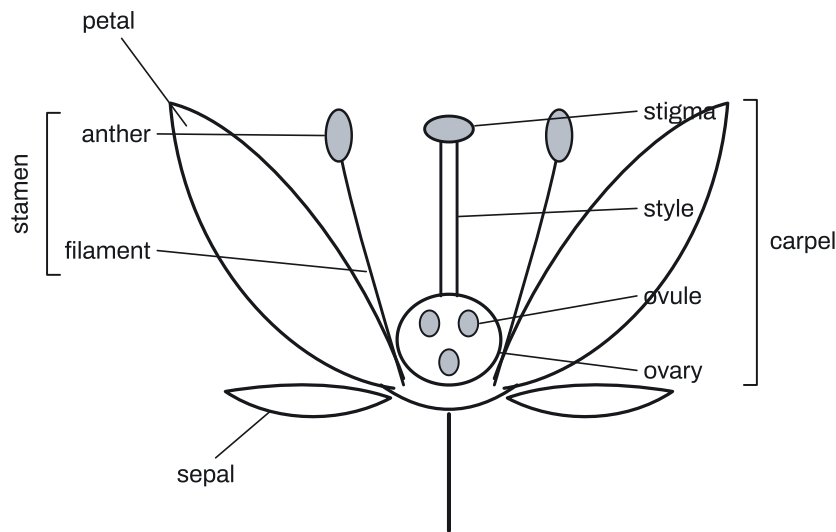
	Asexual	Sexual
Parents	One: no mate or pollinator needed	Usually two, or a pollinator to carry pollen
Speed	Fast; many offspring quickly	Slower
Energy	Less: no flowers, nectar or huge amounts of pollen	More
Offspring	Genetically identical (no variation)	Genetically different (variation)
Good in	A stable environment the parent already suits	A changing environment
Big risk	One new disease or change in climate can kill every plant, because none is resistant	Pollination or finding a mate may fail

In the wild: asexual reproduction lets a well-suited plant spread fast across a good patch, but the clones all compete for the same light, water and ions, and a new disease can wipe out the whole population. Sexual reproduction gives variation, so some individuals may survive a new disease or a change in climate, and the species can adapt over time (natural selection).

In crop production: a farmer who has a plant with good features (large, sweet fruit, high yield) can clone it by cuttings or tubers, and every plant keeps those features and ripens at the same time. The danger is that the whole crop has the same genes, so a new disease can destroy all of it. Sexual reproduction produces variation, which plant breeders need to make new varieties (for example, ones resistant to a disease), but the offspring are less predictable.

The parts of a flower

Flowers are the sexual reproductive organs of flowering plants. Learn the parts on a flower pollinated by insects, and learn to draw them.



Part	What it does
Sepal	Protects the flower while it is a bud
Petal	Large and coloured (often scented, with nectar at its base) to attract insects
Anther	Makes pollen grains, which contain the male nuclei
Filament	Holds the anther up in the right place
Stamen	The male part: anther + filament
Stigma	Receives pollen (sticky in insect-pollinated flowers)
Style	Holds the stigma up; the pollen tube grows down through it
Ovary	Contains the ovules; becomes the fruit after fertilisation
Ovule	Contains the female nucleus (female gamete); fertilisation happens here; becomes the seed
Carpel	The female part: stigma + style + ovary

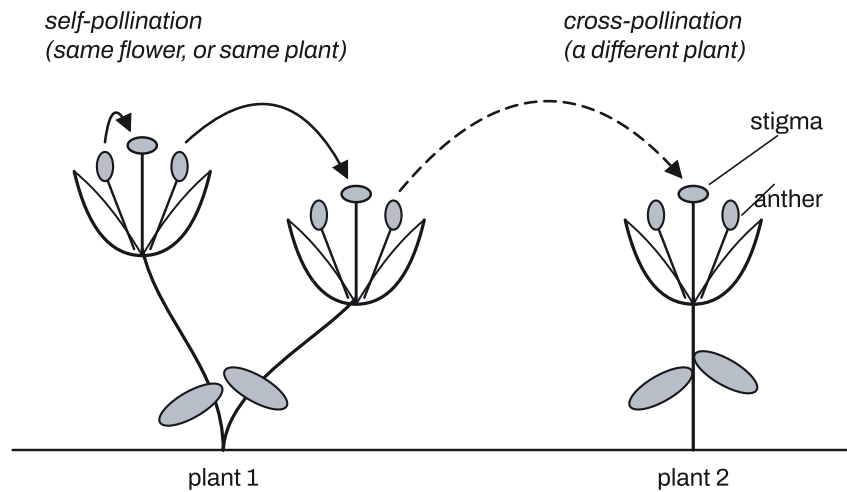
A **nectary** at the base of the petals makes **nectar**, a sugary liquid that insects feed on.

Pollination

Pollination is the transfer of pollen grains **from an anther to a stigma**. It is not fertilisation: it only gets the pollen to the right place. Insects and wind are the two usual carriers.

Extended only: there are two kinds.

- **Self-pollination:** pollen goes to the stigma of the **same flower**, or of **another flower on the same plant**.
- **Cross-pollination:** pollen goes to the stigma of a flower on a **different plant of the same species**.



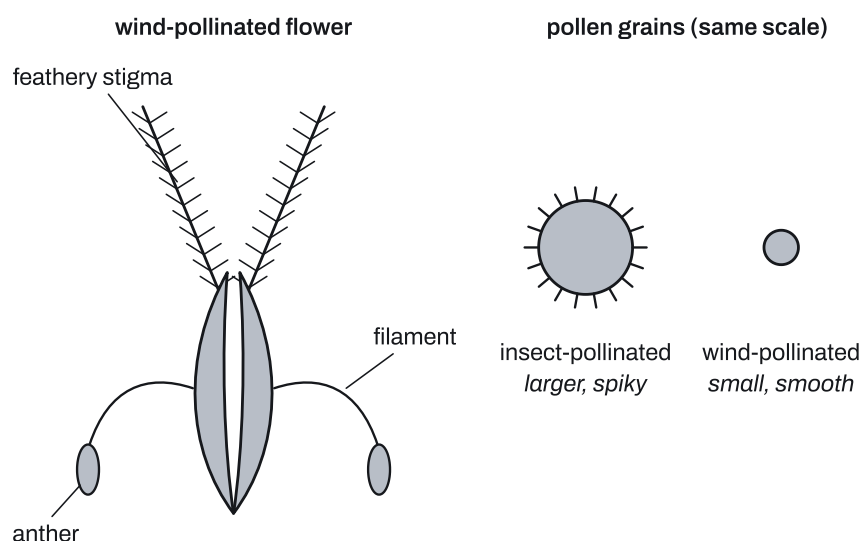
Self-pollination is still **sexual** reproduction: pollen nuclei and ovule nuclei (made by meiosis, so haploid) fuse at fertilisation and form a zygote, and the offspring are not identical. But both sets of genes come from one plant, so there is **much less variation** than with cross-pollination.

Extended only: effects on a population.

- **Self-pollination** doesn't rely on pollinators, works for an isolated plant, wastes less pollen and makes fertilisation more certain. It keeps a well-suited plant's features. But the population has little variation, so it is less able to adapt when the environment changes or a new disease arrives, and harmful inherited conditions are more likely to show; in the worst case the population could die out.
- **Cross-pollination** gives more variation, so the population can respond to changes in the environment. But it **relies on pollinators** (or the wind), so if pollinating insects become scarce, fewer seeds are made; and the plant must spend more energy on large amounts of pollen, petals, scent and nectar.

Insect-pollinated and wind-pollinated flowers

A flower's structure matches the way its pollen travels.

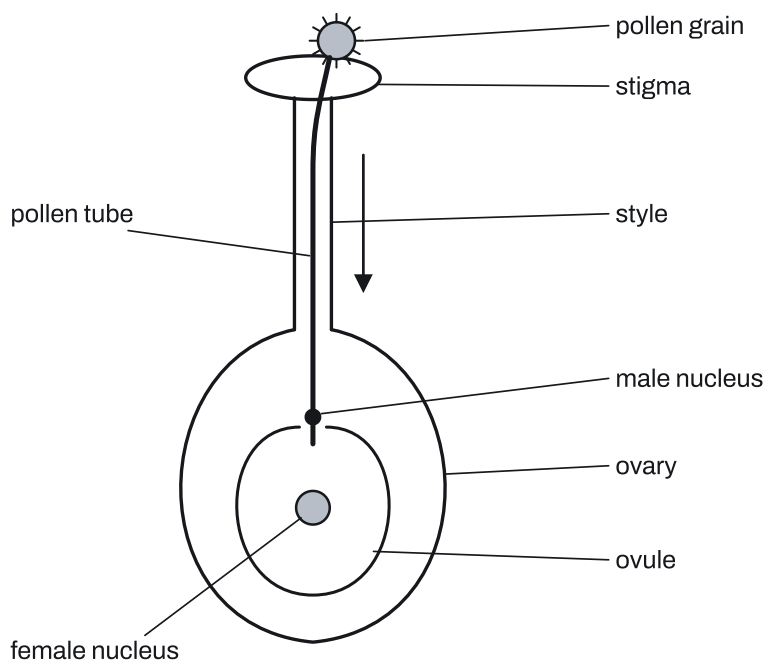


Feature	Insect-pollinated	Wind-pollinated
Petals	Large, brightly coloured, sometimes with guide lines	Small and dull green, or none
Scent and nectar	Present	Absent
Anthers	Inside the flower, so the insect brushes against them	Hang outside the flower on long filaments, so the wind shakes pollen out
Stigmas	Inside the flower; small and sticky	Outside the flower; large and feathery, a big surface to catch pollen from the air
Pollen grains	Larger, heavier, sticky or spiky (hooks onto the insect's body)	Smaller, lighter and smooth (carried far on the wind)
Amount of pollen	Smaller amounts	Huge amounts: wind carries pollen at random, so most never lands on a stigma

An insect visiting for nectar or pollen picks up pollen from the anthers on its body and leaves some on the sticky stigma of the next flower it visits.

From pollination to fertilisation

A pollen grain on a stigma still has to get its nucleus to the female nucleus inside an ovule.



1. **Pollination:** a pollen grain lands on the stigma.
2. **Extended only:** the pollen grain grows a **pollen tube**. It grows down through the **style** (making enzymes that digest a path through the tissue) into the **ovary** and enters an **ovule** (through a small hole, the micropyle).

3. **Extended only:** the **male (pollen) nucleus** moves down the tube. The pollen grain itself stays on the stigma.
4. **Fertilisation:** the pollen nucleus fuses with the female nucleus in the ovule, making a **diploid zygote** (the diploid part is Extended). Fertilisation happens **in the ovule**.
5. The ovule then becomes a seed and the ovary becomes a fruit.

So the order is always **pollination** → **pollen tube grows** → **fertilisation**, and the tube passes **stigma** → **style** → **ovary** → **ovule**.

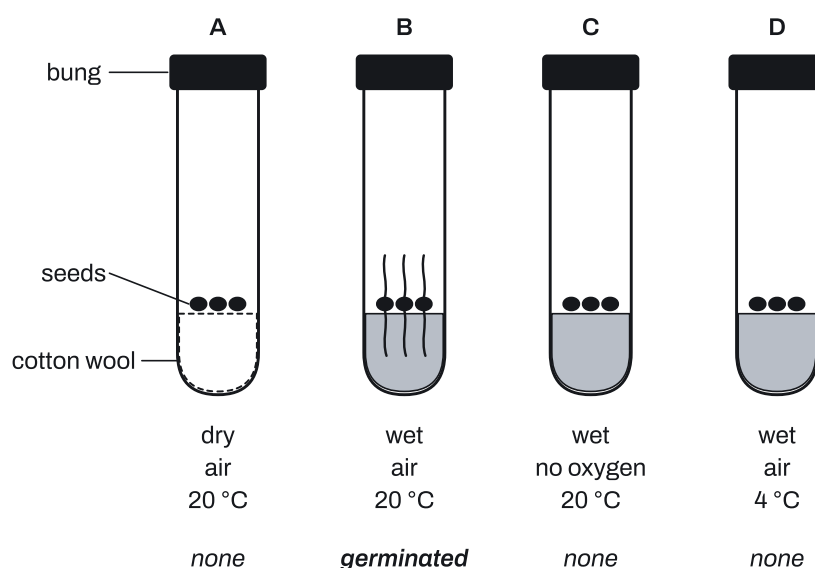
Germination

A seed is a dormant embryo plant with a food store. **Germination** is the start of its growth: the seed takes up water, swells, and a root and then a shoot grow out. A seed needs three things to germinate:

- **Water:** it activates the enzymes in the seed, which break down the stored food (starch to sugars) into small soluble molecules that can move to the growing root and shoot; it also swells the seed to split its coat.
- **Oxygen:** for aerobic respiration, which releases the energy for growth.
- **A suitable temperature:** enzymes work fastest near their best temperature. Too cold and they work very slowly, so germination is slow or doesn't happen; too hot (such as boiling) and the enzymes are denatured and the embryo is killed.

A seed does **not** need light, carbon dioxide, soil, mineral ions or chlorophyll to germinate: it isn't photosynthesising yet, because it lives on its food store. Seeds are stored **cold and dry** (as in a seed bank) so that they don't germinate.

You investigate this by giving seeds every condition except one, and checking which set germinates:



Compare tubes that differ in **one** condition only: A and B show that water is needed, B and C that oxygen is needed, B and D that a suitable temperature is needed. Keep everything else the same (the type and number of seeds, the volume of water, the time), and use several seeds in each tube, because some seeds are dead

and never germinate.

Key facts and formulas

There is no formula list in the IGCSE Biology exam. Everything below must be learnt.

Formula	Status
Asexual: one parent, no gametes, offspring genetically identical (to the parent and each other)	Learn it
Sexual: nuclei of two gametes fuse to form a zygote; offspring genetically different	Learn it
Fertilisation: fusion of the nuclei of two gametes; in a plant, pollen nucleus + nucleus in the ovule	Learn it
Extended: gamete nuclei haploid (one set), zygote nucleus diploid (two sets): $n + n = 2n$	Learn it
Stamen = anther + filament; carpel = stigma + style + ovary (containing ovules)	Learn it
Pollination: pollen from anther to stigma	Learn it
Extended: self: same flower or same plant; cross: different plant, same species	Learn it
Insect: large coloured petals, scent, nectar, anthers and sticky stigma inside, larger sticky or spiky pollen	Learn it
Wind: small or no petals, anthers hanging outside, large feathery stigmas outside, small light smooth pollen in huge amounts	Learn it
Extended: pollen tube: stigma → style → ovary → ovule; male nucleus moves down the tube	Learn it
Germination needs water, oxygen and a suitable temperature (not light, not carbon dioxide)	Learn it
Actual size = $\frac{\text{measured length}}{\text{measured scale bar}} \times \text{scale bar value}$; percentage change = $\frac{\text{change}}{\text{original}} \times 100$	Learn it

How to do it

We tagged 132 questions for this topic (2021–2025, Papers 1–4; 129 different, since a few multiple-choice questions appear on more than one paper). 17 of them mix types, so the counts add up to 161.

Question type	Questions
Recognise asexual reproduction	35
Describe sexual reproduction and fertilisation	23
State and test the conditions for seed germination	20
Name, label and give the functions of flower parts	18
Define self- and cross-pollination and show them on a diagram	18
Compare insect- and wind-pollinated flowers and pollen	16
Advantages and disadvantages of asexual and sexual reproduction, and of self- and cross-pollination	15
Describe the events from pollination to fertilisation	12
Handle data in a reproduction context	4

Most are one-mark multiple choice. On Papers 3 and 4 they are parts of a longer question, often built on a flower diagram, a photograph of a plant making plantlets, or test-tubes of seeds.

1. Recognise asexual reproduction (35 questions)

1. **The definition**, word for word in meaning: the production of **genetically identical** offspring from **one parent**.
2. **To spot it**, ask: is there one parent? Are there no gametes, flowers or seeds involved? If yes, it is asexual.

Variations you will meet:

- **"Which is an example?"** A bacterium dividing in two; a tuber, runner, bulb or plantlet growing into a new plant; a cutting; Hydra budding. Not a bird laying eggs, a mammal giving birth, or a plant making seeds or fruit.
- **"Which row is correct?"** One parent; offspring identical to the parent **and** to each other; no fusion of gametes; mitosis (not meiosis, fertilisation or pollination).
- **Compare genotypes**: a shoot growing from a tuber has the same genes as the tuber **and** the parent plant.
- **Tick statements** about a plant making plantlets: only one parent; offspring genetically identical to each other; the reproduction is asexual. "Gametes are produced" and "pollination happens first" are wrong.
- **Name the structure** a plant uses: tuber (potato), runner (strawberry), bulb, plantlet.
- **Some organisms do both**: the question may show a life cycle with both asexual and sexual stages. The stage with a fertilised egg or gametes is sexual.
- **Extended, bacteria**: the DNA (the loop of DNA) is copied, then the cell divides into two genetically identical daughter cells.

2. Describe sexual reproduction and fertilisation (23 questions)

1. **Sexual reproduction:** the nuclei of two gametes fuse (fertilisation) to form a zygote; the offspring are genetically different.
2. **Fertilisation** is the fusion of the gametes' **nuclei**. The product is a **zygote**.

Variations you will meet:

- **"Which parts fuse?"** Nuclei (not cell walls, membranes or cytoplasm). **"What is a fertilised cell called?"** A zygote (not an embryo or a gamete).
- **"What process is shown?"** Two gametes joining to make a zygote is fertilisation. A pollen nucleus fusing with a nucleus in an ovule is fertilisation, not pollination.
- **Compare asexual and sexual** in a table or a list, one point per mark, each a direct comparison: one parent / two parents; no gametes / gametes; no fertilisation / fertilisation; genetically identical / genetically different offspring; fast / slow. Say **"genetically identical"**, not just "identical".
- **Terms used only for plants:** ovule, filament, pollen, stigma. "Male gamete", "female gamete", "ovary", "fertilisation" and "haploid" are used for animals too.
- **Extended: haploid and diploid.** Gametes (pollen nuclei, egg nuclei) are haploid; the zygote is diploid. If the diploid number is 24, body cells (stem, leaf, root) have 24 and a pollen nucleus has 12.
- **Extended: the sequence** reproductive organs → (meiosis) → gametes → (fertilisation) → zygote → (mitosis) → embryo.
- **Extended: "Explain why self-pollination is sexual reproduction."** It involves gametes (pollen and ovules) made by meiosis, so haploid; fertilisation (fusion of nuclei) forms a zygote; the offspring show genetic variation.

3. State and test the conditions for seed germination (20 questions)

1. **Learn the three:** water, oxygen, a suitable temperature.
2. **In an experiment,** find the tube that has all three: that is where seeds germinate. For each other tube, name the one condition it lacks.
3. **Explain** (Extended, and when a question asks why): water activates enzymes to break down food stores; oxygen is for aerobic respiration to release energy for growth; a suitable temperature lets the enzymes work quickly.

Variations you will meet:

- **"Which tube germinates, and why?"** Give the letter and **both** or **all** the reasons that apply, such as "tube D: it has oxygen and it has water". Use the information given: if every tube is at a suitable temperature, temperature is not the answer.
- **Only carbon dioxide in a tube** means **no oxygen**, so no germination. Carbon dioxide is not needed.
- **Light and dark:** seeds in the dark germinate too, so light is not needed (it is needed later, for photosynthesis in the seedling).

- **A warmer temperature within the range:** germination is **faster** (more seeds germinate in the same time).
A cold tube: slow or none.
- **Boiled seeds:** they don't germinate, because the heat killed the embryo (denatured its enzymes).
- **Storage:** cold and dry conditions prevent germination.
- **A table of germination temperature ranges:** the largest range is the biggest (highest – lowest); a species germinates at a temperature only if it lies within its range.
- **"Which condition do germination and photosynthesis both need?"** Water (or a suitable temperature).
- **Planning** a temperature investigation: several temperatures (for example 0 °C to 40 °C), the same number and type of seeds, the same volume of water, count how many germinate each day, and repeat.

4. Name, label and give the functions of flower parts (18 questions)

1. **Name** the part from its position: outside at the base (sepal), large and coloured (petal), on a stalk around the centre (anther on a filament), top of the centre column (stigma), the column (style), the swollen base (ovary), the small bodies inside it (ovules).
2. **State the function** from the table in "Understand it".

Variations you will meet:

- **Label lines** must touch the exact structure: the filament, not the anther; the ovule, not the ovary. Put a cross or letter exactly where asked (for example on the ovule for the site of fertilisation, inside the ovary).
- **Group the parts:** "which parts make up the stamen?" anther and filament; "which are in a carpel?" stigma, style and ovary (with its ovules).
- **"Which structure produces pollen?"** The anther. **"Which receives pollen?"** The stigma.
- **Structures found in both plants and animals:** the ovary (not a sepal, stamen or cornea).
- **Complete a table** of name and function for three letters: one mark per row, so both name and function must be right.

5. Define self- and cross-pollination and show them on a diagram (18 questions)

1. **Pollination** (Core): pollen from an **anther** to a **stigma**. Not to the ovary, style or ovule, and never stigma to anther.
2. **Extended:** self: same flower or another flower on the same plant; cross: a flower on a different plant of the same species.

Variations you will meet:

- **"Where is pollen found just after pollination?"** On the anthers and on the stigma.
- **Arrows on a diagram:** an arrow from an anther to the stigma of the same flower, or to another flower on the same plant, is self; to a flower on a different plant is cross. The cross arrow gives more variation.
- **Extended: draw the arrows yourself:** one from an anther to the stigma of the same flower labelled "self-pollination", one from an anther to the stigma of the flower on the other plant labelled "cross-pollination", and label the anther and the stigma.

- **Two varieties grown near each other** (such as sweet and hot peppers): insects carry pollen from one variety's anthers to the other's stigmas (cross-pollination), so the offspring show features of both.
- **Bags over flowers** stop unwanted pollen from reaching the stigma, so a breeder controls which plants are crossed.

6. Compare insect- and wind-pollinated flowers and pollen (16 questions)

1. **Decide the type** from what you can see: large petals, anthers and stigma hidden inside means insect; anthers and stigmas hanging outside, no big petals means wind.
2. **Justify** with features you can **see** in the picture, one per mark, using the table in "Understand it".

Variations you will meet:

- **"State three features that attract insects"**: scent, nectar, large colourful petals (pollen as food and guide lines also score).
- **"How is pollen adapted for insects?"** Larger, sticky or spiky, so it sticks to the insect.
- **Pollen of wind-pollinated flowers**: small, light, smooth, made in huge amounts. Compare **pollen with pollen**, not flower with flower, and use comparative words (lighter, smaller).
- **Extended: "Explain why wind-pollinated plants make so much pollen."** The wind carries it in random directions, so most is lost and never reaches a stigma; lots of pollen increases the chance that some does.
- **Extended: "How is the stigma adapted?"** Large and feathery (a big surface area to catch pollen), hanging outside the flower.
- **A photo question**: only name features that are visible. "Large petals" scores; "colourful" can't be seen on a black-and-white photo.

7. Advantages and disadvantages of asexual and sexual reproduction, and of self- and cross-pollination (15 questions, Extended)

1. **Read which one the question asks about**, and whether it wants advantages, disadvantages or both, and whether it is about the wild or about crops.
2. **Write separate points**, labelled "advantage" and "disadvantage", as many as the marks.

Points that score:

- **Asexual, advantages**: fast; only one parent (no mate, no pollinators, no gametes or fertilisation needed); less energy; offspring suit the same environment as the parent; for crops, good features are kept in every plant.
- **Asexual, disadvantages**: no genetic variation; less able to survive a change in the environment (such as climate change); a new disease can spread through and kill the whole population or crop; offspring grow close together and compete.
- **Sexual (and cross-pollination), advantages**: genetic variation, so some may survive a new disease or change; the species can adapt (natural selection); new varieties can be bred.

- **Sexual, disadvantages:** slower; needs two parents or a pollinator; more energy (flowers, nectar, lots of pollen); good features of a crop may be lost in the offspring.
- **Reasons a plant might self-pollinate:** no pollinators about; the plant is isolated; less pollen and energy needed; a better chance of pollination and fertilisation; keeps the features of a well-adapted plant.
- **Effects of only self-pollinating:** less variation; less able to adapt to changes in the environment; less resistant to disease (a disease spreads quickly); more chance of an inherited disease; the risk of extinction.

"Reasons for self-pollination" and "effects of self-pollination" are different questions: examiners report students giving one when asked for the other.

8. Describe the events from pollination to fertilisation (12 questions)

1. Pollen from the **anther** lands on the **stigma** (pollination).
2. A **pollen tube** grows from the pollen grain (it makes enzymes to digest its way).
3. The tube grows **down the style** into the **ovary** and **into the ovule** (through the micropyle).
4. The **male (pollen) nucleus** travels **down the tube**.
5. It **fuses** with the **female nucleus** in the ovule: **fertilisation**.
6. A **zygote** forms (diploid, from two haploid nuclei).

Variations you will meet:

- **Multiple-choice order:** pollination → growth of pollen tube → fertilisation, and stigma → style → ovary → ovule for the tube.
- **"Where does fertilisation happen?"** In the ovule (inside the ovary). **"Which part can contain a pollen tube?"** The style.
- **"Name part X"** on a carpel with a tube growing from a pollen grain: the pollen tube.
- **"Has this flower been pollinated or fertilised?"** Pollen on the stigma means pollinated; a pollen tube reaching an ovule means fertilisation is about to happen or has happened.
- **Long answers (3–5 marks):** one step per mark, in order, with the right words: "pollen **nucleus**" moves down the tube (not "the pollen grain"), and it goes into an **ovule** (not an "ovum").

9. Handle data in a reproduction context (4 questions)

1. **Actual size from a scale bar:** measure the object and the scale bar on the page in the same units (mm), then actual size = $\frac{\text{object}}{\text{scale bar}} \times \text{the scale bar's value}$. Give the unit.
2. **Percentage change:** $\frac{\text{new} - \text{original}}{\text{original}} \times 100$.
3. **A graph:** read values off carefully, including where the line is steepest (the fastest change).

For example, a crop disease that spread from 800 to 2000 hectares increased by $\frac{2000 - 800}{800} \times 100 = 150\%$.

A pollen grain is roughly 0.01 to 0.1 mm across. An answer such as "3 cm" is too big to be a pollen grain: check it.

Worked examples

The bold codes show where marks are earned, as in Cambridge mark schemes. The number is how many marks.

- **M1** method mark: for a correct method, even if the numbers slip.
 - **A1** accuracy mark: for a correct answer; it needs the M mark before it.
 - **B1** mark for a correct result on its own, with no method needed.
-

Example 1

Core. Look at the half-flower in the first diagram in "Understand it".

(a) State the function of the anther, the sepal and the stigma. **[3]**

(b) Name the two structures that make up a stamen. **[1]**

(c) Describe pollination. **[2]**

(d) State the name of the part where fertilisation takes place, and which parts of the gametes fuse. **[2]**

(e) State three features you would expect to see on this flower if it were pollinated by insects. **[3]**

(a) Anther: makes pollen **B1**. Sepal: protects the flower when it is a bud **B1**. Stigma: receives pollen (it is sticky and pollen sticks to it) **B1**.

(b) Anther and filament **B1** (both needed).

(c) The transfer of pollen grains **B1** from an anther to a stigma **B1**.

(d) The ovule **B1**; their nuclei fuse **B1**.

(e) Any three: large, brightly coloured petals **B1**; a scent **B1**; nectar (nectaries) **B1**; anthers and stigma inside the flower; a sticky stigma.

Example 2

Core, with an Extended part. A student set up the four tubes in the last diagram in "Understand it". Each tube had 20 seeds of the same kind. After five days she counted the seeds that had germinated.

Tube	A	B	C	D
Conditions	dry, air, 20 °C	wet, air, 20 °C	wet, no oxygen, 20 °C	wet, air, 4 °C
Seeds germinated	0	18	0	0

- (a) Calculate the percentage of seeds that germinated in tube B. **[1]**
- (b) Using the results, state three conditions needed for germination, and name the two tubes that show each one. **[3]**
- (c) State one condition, not tested here, that seeds do not need to germinate. **[1]**
- (d) Predict the result if tube B were kept at 25 °C instead of 20 °C, and explain your prediction. **[2]**
- (e) **Extended:** explain why the seeds need oxygen, and why none germinated in tube D. **[3]**
- (f) Suggest why 20 seeds were used in each tube, not one. **[1]**
- (a) $\frac{18}{20} \times 100 = 90\%$ **B1.**
- (b) Water: tubes A and B **B1.** Oxygen: tubes B and C **B1.** A suitable temperature: tubes B and D **B1.**
- (c) Light (or carbon dioxide, or soil) **B1.**
- (d) The seeds would germinate faster (more would germinate in five days) **B1,** because 25 °C is closer to the best temperature for the seeds' enzymes **B1.**
- (e) Oxygen is used in aerobic respiration **B1,** which releases energy for growth **B1.** At 4 °C the enzymes in the seeds work too slowly, so the seeds did not germinate in five days **B1.**
- (f) Some seeds may be dead and never germinate, so using many seeds makes the results more reliable **B1.**

Example 3

Extended. A farmer grows a maize crop. Maize flowers are wind-pollinated. The male flowers are at the top of the plant, well above the leaves.

- (a) Describe two ways in which the anthers and stigmas of a wind-pollinated flower differ from those of an insect-pollinated flower. **[2]**
- (b) Explain why a maize plant makes very large numbers of pollen grains. **[2]**
- (c) Describe the events after pollination that lead to fertilisation. **[4]**
- (d) Describe cross-pollination. **[2]**
- (e) Another farmer grows bananas, which are produced by asexual reproduction from pieces of the parent plant. Discuss the advantages and disadvantages of asexual reproduction for this crop. **[4]**

- (a) The anthers hang outside the flower on long filaments **B1**; the stigmas are large and feathery and outside the flower **B1**.
- (b) Pollen is carried randomly by the wind, so most is lost and never reaches a stigma **B1**; making lots increases the chance that some lands on a stigma **B1**.
- (c) A pollen tube grows from the pollen grain **B1**, down through the style into the ovary and into the ovule **B1**. The male nucleus travels down the pollen tube **B1** and fuses with the female nucleus in the ovule (fertilisation), forming a zygote **B1**.
- (d) The transfer of pollen from the anther of one flower to the stigma of a flower **B1** on a different plant of the same species **B1**.
- (e) Advantages: every plant keeps the parent's good features (such as sweet fruit and high yield) **B1**; it is fast and needs no pollination **B1**. Disadvantages: there is no genetic variation **B1**, so a new disease could infect and destroy the whole crop, as no plant is resistant **B1**.

Example 4

Extended. A plant has a diploid number of 20.

- (a) State the number of chromosomes in the nucleus of: a leaf cell; a pollen grain's male nucleus; a zygote; a cell of a plantlet formed on a runner. **[2]**
- (b) A photograph shows a spiky pollen grain 45 mm long. The 0.05 mm scale bar on the photograph is 30 mm long. Calculate the actual length of the pollen grain. Give your answer in mm. **[2]**
- (c) Using your answer to (b) and its surface, state whether this pollen grain is more likely to be from an insect-pollinated or a wind-pollinated flower. Give a reason. **[1]**
- (d) A disease of a clone-grown crop spread from 250 hectares in one year to 900 hectares five years later. Calculate the percentage increase. **[2]**

(a) Leaf cell 20; male nucleus 10 **B1**; zygote 20; plantlet cell 20 **B1**.

(b) $\frac{45}{30} \times 0.05$ **M1** = 0.075 mm **A1**.

(c) Insect-pollinated: the grain is spiky (and fairly large), so it sticks to an insect's body **B1**.

(d) $\frac{900 - 250}{250} \times 100$ **M1** = 260% **A1**.

Common mistakes

- **Mixing up pollination and fertilisation.** Pollination moves pollen from anther to stigma; fertilisation is the fusion of nuclei, in the ovule, later. Examiners see students describing fertilisation when asked for pollination, and choosing "pollination" for the fusion of nuclei.
- **Pollination "to the ovary" or "from the stigma".** It is always **anther** → **stigma**.

- **Saying the pollen grain travels down the tube.** The grain stays on the stigma; the **pollen (male) nucleus** moves down the tube. And the female structures are **ovules**, not "ova".
- **Thinking self-pollination happens only within one flower.** Pollen to another flower on the **same plant** is self-pollination too.
- **Thinking self-pollination is asexual**, or gives identical offspring. It involves gametes and fertilisation, so it is sexual and gives some variation.
- **Believing asexual reproduction happens only in plants and bacteria, and sexual only in animals.** Many animals reproduce asexually, and flowering plants reproduce sexually.
- **Writing "offspring are identical" or "different"** without "genetically". Say **genetically** identical.
- **Giving carbon dioxide or light as germination needs**, or leaving out oxygen. The seed respire; it doesn't photosynthesise. Examiners report it again and again.
- **Writing just "temperature" or "warmth"** for germination. Write "a **suitable** temperature".
- **Ignoring the experiment.** If every tube is at a suitable temperature, the answer is water or oxygen, not temperature.
- **Saying boiling helps seeds germinate.** It kills the embryo and denatures its enzymes.
- **Mixing up the anther and filament, or the stigma and style**, on a labelled diagram; or putting the X for fertilisation outside the ovary.
- **Describing the flower when asked about the pollen**, or the other way round. Pollen is light and smooth; the stigma is feathery.
- **Scale-bar answers with no unit** or impossible sizes, and using a magnification formula when a scale bar is given.

How to get the marks

- **"State" or "name"**: a word or short phrase: "anther", "zygote", "oxygen".
- **"Describe"** a process: the steps in order, one fact per mark, with the proper words (anther, stigma, pollen tube, style, ovule, male nucleus, fuse, zygote).
- **"Explain"**: give the reason as well: oxygen **for aerobic respiration to release energy**; lots of pollen **because the wind carries it at random**.
- **"Discuss"** (Extended): both advantages **and** disadvantages, clearly labelled; for "in the wild" or "for crops", link each point to that setting.
- **"Suggest"**: apply the ideas to the new plant or set-up; more than one answer can be right.
- **"Using the information in Fig. ..."**: only use features that you can see or that the question gives.
- **Comparisons**: each point is a direct contrast in one sentence ("one parent, but two in sexual reproduction"; "wind pollen is lighter").
- **Label lines** touch the exact structure; label only what is asked.
- **Tick** only as many boxes as asked: an extra tick cancels a mark.
- **Calculations**: show the working and give the unit.
- **Use the marks as a guide**: three marks usually means three separate points.

Quick check

1. Name the part of a flower that: (a) makes pollen; (b) receives pollen; (c) holds the anther up; (d) protects the flower in bud.
2. Which of these are asexual reproduction? A potato tuber sprouting into a new plant; a sunflower making seeds; a bacterium dividing into two; a strawberry runner forming a new plant; a pea flower pollinating itself and making seeds.
3. Some seeds were kept dry in a fridge for a year and did not germinate. Give two reasons.
4. **Extended:** a plant has a diploid number of 16. How many chromosomes are in (a) a root cell, (b) the male nucleus in a pollen grain, (c) a zygote?
5. A 0.05 mm scale bar on a photograph is 25 mm long. A pollen grain on the same photograph is 40 mm long. Calculate its actual length.

Answers

1. (a) Anther; (b) stigma; (c) filament; (d) sepal.
2. The potato tuber, the bacterium and the strawberry runner. The sunflower and the pea make seeds after fertilisation, which is sexual reproduction (the pea's self-pollination is still sexual).
3. They had no water, and the temperature was too low (not suitable). (They did have oxygen.)
4. (a) 16; (b) 8; (c) 16.
5. $\frac{40}{25} \times 0.05 = 0.08 \text{ mm}.$

Past questions to try

- **0610/32/F/M/25 Q4:** plantlets on a leaf, naming flower parts, predicting insect pollination and a pollen grain's length from a scale bar (Core).
- **0610/32/M/J/25 Q2:** a germination temperature table and a test-tube investigation (Core).
- **0610/41/O/N/25 Q4:** features that attract insects, labelling a flower and the events from pollen release to the zygote (Extended).
- **0610/41/M/J/25 Q3:** the pollen tube, and the reasons for and effects of self-pollination (Extended).