



Unit 5 • Life Process: asexual reproduction and vegetative propagation

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. asexual reproduction
2. binary fission
3. budding
4. regeneration
5. spores
6. parthenogenesis
7. rhizome
8. scion

K • 4

Each carries 0.5 mark.

2 Label the diagram

1. nodes
2. new roots
3. stem cutting
4. layering
5. a ball of moist soil in plastic
6. gootee (air layering)

K • 3

Each carries 0.5 mark.

3 Multiple choice

- i. **c. the biological process of producing new individuals of one's own kind** K • 1
Reproduction is any biological process that produces new individuals of the same kind. The other options are too narrow (only some ways) or about something else.
- ii. **b. a broken-off part rebuilds its missing parts and becomes a whole body** U • 1
In regeneration the piece must **rebuild** what it lacks (a head, a tail, an arm), as a planarian or a starfish does.
- iii. **b. both are copies of the parent, with the same genes** U • 1
Asexual reproduction makes **clones**: the same genes as the single parent. There is no "old" cell left over either: the parent has become both of them.
- iv. **a. tuber** A • 1
The potato is a **tuber**: the swollen tip of an underground stem, whose eyes hold buds. A rhizome is a flat underground stem (ginger), a corm a short swollen stem base (taro), and bulbils are fleshy buds (agave).
- v. **c. at least one node, with its bud** A • 1
New shoots and roots grow from the **buds at the nodes**. A piece of cane from between two nodes has no bud, and it just rots.

4 Very short answers

- a. **MARKING SCHEME** K • 1
✓ Sporangia (sporangium).
- b. **MARKING SCHEME** K • 1
✓ Bryophyllum (pattharchatta); begonia is also correct.
- c. **MARKING SCHEME** U • 1
✓ The potato (it has eyes, which are buds at nodes).



5 Short answers

a. MARKING SCHEME

U · 2

- ✓ Asexual reproduction needs only one parent and no gametes.
- ✓ The young grows from a part of that one parent (a split cell, a bud, a piece, a spore), so no male and female gametes, or parents, are needed.

b. MARKING SCHEME

U · 2

- ✓ The grafted plant bears fruit as good as the tree the scion came from.
- ✓ It bears fruit in a few years instead of many, because the scion is already mature (or: the stock can be chosen for strong, disease-resistant roots).

c. MARKING SCHEME

U · 2

- ✓ Any one difference, e.g. in fission the parent splits and no longer exists; in budding a bud grows out and the parent remains.
- ✓ Any second difference, e.g. the new organisms of fission are about the same size; a bud is much smaller than its parent at first; or fission in amoeba, Paramecium; budding in yeast, hydra.

d. MARKING SCHEME

K · 2

- ✓ A small, fleshy bud full of food, formed at a node, a leaf base or in place of a flower, which falls off and grows into a new plant (natural vegetative propagation).
- ✓ Any example: agave (kettuke), githa (air yam), some lilies.

6 Long answers

a. ANSWER

K · 4

The **stock** is the lower part, with roots, usually a year-old seedling cut 20–30 cm above the ground. The **scion** is a twig with a few buds taken from a tree with good fruit. **Process:** the stock and scion are cut so that their ends fit together closely, with their living layers touching. They are joined, tied, and sealed airtight with grafting wax or tape. After a few weeks the cut surfaces heal and the two grow into one plant. **Advantages:** the plant bears fruit as good as the scion's parent; it bears early; the stock can give strong, disease-resistant roots; many good plants can be made from one tree.

MARKING SCHEME

- ✓ Stock: the lower part with roots, a young plant (about a year old) cut 20–30 cm above the ground.
- ✓ Scion: a twig with a few buds from a tree with good fruit.
- ✓ Process: their cut ends are fitted closely so the living layers touch, tied, and sealed airtight with grafting wax or tape; they heal and grow as one plant.
- ✓ Any advantage: fruit as good as the scion's parent; fruits early; strong, disease-resistant roots from the stock; many good plants from one tree.

b. ANSWER

U · 4

Growing new plants in a germ-free lab from a tiny piece of the parent (the explant) on a nutrient jelly (the culture medium). The explant grows into a callus; hormones make it grow shoots and roots (plantlets), which are potted and planted out. Advantage: hundreds of thousands of identical, disease-free plantlets in a few months.

MARKING SCHEME

- ✓ Growing new plants in a lab from a tiny piece of the parent (explant) on a nutrient jelly (culture medium), kept germ-free.
- ✓ The explant grows into a callus.
- ✓ Hormones make the callus grow shoots and roots (plantlets), which are moved into pots and planted out.
- ✓ Any advantage: hundreds of thousands of identical, disease-free plantlets from a small piece, in a short time; or plants without seeds (banana) can be grown.



7 Numerical problems

a. ANSWER

A · 2

2 hours = 120 minutes = $120 \div 20 = 6$ generations. Number = $2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^6 = 64$ bacteria.

MARKING SCHEME

- ✓ $120 \div 20 = 6$ generations (doubling 6 times).
- ✓ $2^6 = 64$ bacteria.

b. ANSWER

A · 2

Multiple fission: $16 \times 16 = 256$ cells. Binary fission: $2 \times 2 = 4$ cells.

MARKING SCHEME

- ✓ $16 \times 16 = 256$ cells.
- ✓ $2 \times 2 = 4$ cells by binary fission.

8 Think

ANSWER

HA · 2

No. It is regeneration as repair: the lizard grows back a lost part, but the dropped tail doesn't grow into a new lizard, so no new individual is made. In reproduction by regeneration (planaria), each piece grows into a whole new body.

MARKING SCHEME

- ✓ No, it is regeneration as repair (of a lost part).
- ✓ The tail doesn't grow into a new lizard, so the number of individuals doesn't increase.

9 Activity: Grow a rose from a cutting (Activity 5.4)

(not marked)

WHAT STUDENTS SHOULD FIND

After a week or two the buds above the soil swell and open into small leaves. A cutting pulled up gently at the end has new white roots growing from the buried node. Cuttings without a node in the soil, or that dried out, don't grow.

See it at Science Playground

Exhibits and plants at the center, Bhaktapur, that go with this unit. Book a class visit at science-playground.com/booking.

- **Miracle Leaf** (garden): Look for tiny plantlets along the leaf's edge: each can root and become a new plant.
- **The Bamboo Horse** (exhibit): The sculpture is a bamboo rhizome: the underground stem that sends up new shoots.
- **Taro (Pindalu)** (garden): Pindalu grows again from its underground corm, so farmers plant corms, not seeds.
- **Jade Plant** (garden): A single jade leaf pressed into soil grows roots and a new plant: a leaf cutting.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	16	13	6	2	37





Unit 5 • Life Process: sexual reproduction in plants and animals

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. sexual reproduction
2. zygote
3. bisexual
4. pollination
5. autogamy
6. anemophily
7. ornithophily
8. double fertilization

K • 4

Each carries 0.5 mark.

2 Label the diagram

- | | |
|-------------|-----------|
| 1. petal | 5. stigma |
| 2. anther | 6. style |
| 3. filament | 7. ovary |
| 4. sepal | 8. ovule |

K • 4

Each carries 0.5 mark.

3 Multiple choice

- i. c. in the ovule

K • 1

The egg cell is inside the ovule, and the pollen tube enters the ovule and releases the male gametes there. "In the ovary" is not wrong, since the ovules are inside the ovary, but the ovule is the exact place, so it is the best answer.

- ii. d. entomophily

U • 1

Flies are insects, and pollination by insects is entomophily. (Ornithophily is pollination by birds.)

- iii. c. by the wind

A • 1

Nothing about it attracts animals; instead it sends out clouds of light pollen and catches some with its feathery stigmas. That is anemophily, as in maize and rice.

- iv. a. lizard

U • 1

Reptiles such as lizards mate, and fertilization happens inside the female; she lays shelled eggs. Frogs, toads and rohu fertilize their eggs in water.

- v. b. anther, pollen grain, stigma, germination of the pollen

U • 1

The anther makes the pollen grain, which is carried to the stigma, where it germinates into a pollen tube.

4 Very short answers

- a. MARKING SCHEME

K • 1

✓ The middle piece.

- b. MARKING SCHEME

K • 1

✓ The seed.



- c. MARKING SCHEME U · 1
✓ Once one sperm enters, the egg's outer layer changes and keeps the others out.

5 Short answers

- a. MARKING SCHEME U · 2
✓ Pollen can't move by itself; for cross-pollination something must carry it from an anther to a stigma of another flower (wind, water, insects, birds).
✓ Without them most flowers would get no pollen, so no fertilization, fruits or seeds would follow.
- b. MARKING SCHEME U · 2
✓ The sperms have to swim to the eggs, which needs water.
✓ The eggs have no shell and would dry up and die in air.
- c. MARKING SCHEME U · 2
✓ Any one difference, e.g. pollination is the transfer of pollen from an anther to a stigma; fertilization is the fusion of a male and a female gamete.
✓ Any second difference, e.g. pollination happens at the stigma; fertilization inside the ovule; or pollination comes first, fertilization follows.
- d. MARKING SCHEME K · 2
✓ The making of gametes (sex cells) in the reproductive organs.
✓ In animals, sperms are made in the testes and ova in the ovaries.

6 Long answers

- a. ANSWER U · 4

In flowering plants, **two** fusions happen in each ovule; this is double fertilization. A pollen grain on the stigma grows a pollen tube down the style. Two male gametes form in it. The tube enters the ovule through the micropyle and releases them.

1. One male gamete fuses with the **egg cell** → **zygote** → embryo.
2. The other fuses with the **two polar nuclei** (secondary nucleus) → **endosperm nucleus** → endosperm, the food for the embryo.

Then the ovule becomes the seed and the ovary becomes the fruit.

MARKING SCHEME

- ✓ In flowering plants two fusions happen in each ovule; this is double fertilization.
- ✓ A pollen grain on the stigma grows a pollen tube down the style, with two male gametes, and enters the ovule through the micropyle.
- ✓ One male gamete fuses with the egg cell to form the zygote, which grows into the embryo.
- ✓ The other fuses with the two polar nuclei (secondary nucleus) to form the endosperm nucleus, which grows into the endosperm.



Self-pollination	Cross-pollination
Pollen reaches a stigma on the same plant.	Pollen reaches a stigma on a different plant of the same species.
Often no agent is needed.	An agent (wind, water, insect, bird) is always needed.
Flowers small, dull, without scent or nectar; anthers and stigma ripen together.	Flowers often bright, scented, with nectar (or feathery stigmas); anthers and stigma often ripen at different times.
No new characters; the line slowly weakens. e.g. pea, wheat	New combinations of characters; healthier young. e.g. mustard, maize

MARKING SCHEME

- ✓ Self: pollen reaches a stigma on the same plant; cross: on a different plant of the same species.
- ✓ Self: often no agent is needed; cross: an agent (wind, water, insect, bird) is always needed.
- ✓ Self: flowers small, dull, without scent or nectar, anthers and stigma ripen together; cross: flowers often bright, scented, with nectar (or feathery stigmas), anthers and stigma often ripen at different times.
- ✓ Self: no new characters, the line slowly weakens (e.g. pea, wheat); cross: new combinations, healthier young (e.g. mustard, maize). Any one difference per point.

7 Numerical problems

a. ANSWER

A • 2

Time = distance ÷ speed = 24 cm ÷ 1 cm per hour = 24 hours = 1 day.

MARKING SCHEME

- ✓ 24 cm ÷ 1 cm/h = 24 hours.
- ✓ 24 hours = 1 day.

b. ANSWER

A • 2

10 mm ÷ 0.1 mm = 100 ova.

MARKING SCHEME

- ✓ 1 cm changed to 10 mm and divided by 0.1 mm.
- ✓ 100 ova.

8 Think

ANSWER

HA • 2

Apple flowers are pollinated by insects. Without bees, little pollen would reach their stigmas, so there would be no fertilization, and few apples would form. The farmers carry the pollen themselves, doing the bees' work.

MARKING SCHEME

- ✓ Apple flowers need insects (bees) to carry pollen to the stigma (cross-pollination).
- ✓ Without pollination there is no fertilization, so few or no fruits form; the brush carries the pollen instead.

9 Activity: Pollen under the microscope (Activity 5.6)

(not marked)

WHAT STUDENTS SHOULD FIND

Each kind of flower has its own pollen. Mustard: tiny, pale yellow, rounded grains with a net-like surface. Hibiscus: large, round grains covered in spikes. Lily: large, bean-shaped, orange-brown grains. The grains are far too small to see one by one without the microscope.



See it at Science Playground

Exhibits and plants at the center, Bhaktapur, that go with this unit. Book a class visit at science-playground.com/booking.

- **Hibiscus** (garden): Find the long column of stamens sticking out, with the five-lobed stigma at its tip.
- **A Giant Pumpkin** (exhibit): Pumpkin vines have separate male and female flowers; only pollinated ones become fruit.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	13	18	5	2	38





Unit 5 • Life Process: seeds, their dispersal and germination

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. ovule
2. dispersal
3. micropyle
4. dormancy
5. germination
6. epigeal
7. hypogeal
8. seedling

K • 4

Each carries 0.5 mark.

2 Label the diagram

- | | |
|--------------|--------------------------|
| 1. radicle | 5. scutellum (cotyledon) |
| 2. cotyledon | 6. tegmen |
| 3. hilum | 7. plumule |
| 4. testa | 8. endosperm |

K • 4

Each carries 0.5 mark.

3 Multiple choice

- i. a. by air (wind) K • 1
Khar, like kans and other grasses, has tiny, light seeds with hairs, carried by the wind.
- ii. b. to produce a new plant U • 1
A seed carries an embryo that grows into a new plant. Storing food and keeping the kind going are true too, but they serve this main job.
- iii. d. the cotyledons (in a seed like the bean) come up and become the first green leaves U • 1
In a bean, the cotyledons are lifted above the soil and turn green (epigeal germination). The radicle, not the endosperm, becomes the root; the cotyledons are already in the seed; nothing grows from the seed coat.
- iv. c. because moisture would start germination and let molds rot them A • 1
Water ends dormancy: damp seeds start to germinate in the store (and die without soil), and fungi and bacteria grow on damp seeds. Dry seeds stay dormant and alive for a long time.
- v. a. it keeps the seed alive and able to germinate later K • 1
During dormancy the seed rests, using almost no food, so it stays alive until conditions are good for germination.

4 Very short answers

- a. MARKING SCHEME K • 1
✓ The radicle.
- b. MARKING SCHEME K • 1
✓ Any two of lotus, water lily, coconut, mangroves, cattail (both needed).
- c. MARKING SCHEME U • 1
✓ Polishing removes the embryo and the outer layers.



5 Short answers

a. MARKING SCHEME

U • 2

- ✓ A dry seed is dormant: with almost no water its cells can't carry out their chemical reactions.
- ✓ Soaked, it absorbs water, the coat softens and enzymes become active, so the stored food is used and the embryo starts to grow.

b. MARKING SCHEME

U • 2

- ✓ Small seeds are small and light, each wrapped in fine, silky cotton.
- ✓ The cotton gives a lot of surface for little weight, so the seed floats in the air and the wind carries it far.

c. MARKING SCHEME

K • 2

- ✓ Any one difference, e.g. the plumule grows into the shoot system; the radicle into the root system.
- ✓ Any second difference, e.g. the plumule grows upwards, the radicle downwards; or the radicle comes out first.

d. MARKING SCHEME

U • 2

- ✓ Air gives the seed oxygen, which the cells of the embryo use in respiration to break down stored food and release energy for growth.
- ✓ Without enough oxygen (waterlogged soil, under water) a seed can't germinate, and often rots.

6 Long answers

a. ANSWER

U • 4

The seed absorbs water through its micropyle and swells, and its coat softens and splits. Enzymes break down the food stored in the cotyledons, which is used, with oxygen, for energy and growth. The radicle comes out first and grows down into the root, with root hairs. The hypocotyl grows into a hook and pulls the cotyledons out of the soil, where they turn green, and the plumule grows up into the stem and the first leaves. The young plant is now a seedling (epigeal germination).

MARKING SCHEME

- ✓ The seed absorbs water through its micropyle and swells; the seed coat softens and splits.
- ✓ The stored food in the cotyledons is broken down, with oxygen, for energy and growth.
- ✓ The radicle comes out first and grows down into the root.
- ✓ The hypocotyl grows into a hook and pulls the cotyledons above the soil, where they turn green, and the plumule grows into the stem and first leaves (epigeal germination).



b. ANSWER

A • 4

- i. To **cover the seeds with soil**, which keeps them moist and warm, gives them air in the loose soil, and saves them from birds.
- ii. The dry part lacked **water**. Without enough moisture, the seeds couldn't absorb water, their dormancy didn't break, and they did not germinate (or germinated late).
- iii. **Irrigate** the field evenly (or sow just after rain), soak the seeds for a day before sowing, keep the soil loose and moist but not waterlogged, sow at the right time and depth, and use good seeds.

MARKING SCHEME

- ✓ i. To cover the seeds with soil, which keeps them moist and warm, gives them air and saves them from birds.
- ✓ ii. The dry part lacked water, so the seeds couldn't absorb water and their dormancy didn't break.
- ✓ iii. Irrigate the field evenly (or sow just after rain).
- ✓ iii. Any other good step: soak the seeds for a day before sowing; keep the soil loose and moist but not waterlogged; sow at the right time and depth; use good seeds.

7 Numerical problems**a. ANSWER**

A • 2

Percentage = $42 \div 50 \times 100\% = 84\%$.

MARKING SCHEME

- ✓ $42 \div 50 \times 100\%$.
- ✓ 84%.

b. ANSWER

A • 2

18 kg = 18,000 g. Number = $18,000 \times 1,000,000 = 18,000,000,000$ (18 billion, 1.8×10^{10}) orchid seeds.

MARKING SCHEME

- ✓ 18 kg changed to 18,000 g.
- ✓ $18,000 \times 1,000,000 = 18,000,000,000$ (1.8×10^{10}) seeds.

8 Think**ANSWER**

HA • 2

A germinating seed needs oxygen for respiration, to release energy from its stored food. Under water it gets only the little oxygen dissolved in the water, which is not enough, so it swells but doesn't grow, and may rot.

MARKING SCHEME

- ✓ A germinating seed needs oxygen (air) for respiration, to get energy for growth.
- ✓ Under water it gets too little oxygen (only what dissolves in water), so it can't germinate.

9 Activity: Watch seeds germinate (Activity 5.12)

(not marked)

WHAT STUDENTS SHOULD FIND

Day 1–2: the seeds swell and a white radicle pokes out. Day 2–3: fine root hairs, and the hypocotyl lifts the two small cotyledons, still inside the seed coat. Day 4–5: the coat falls off, and the cotyledons open and turn green. The radicle always comes out first.

See it at Science Playground

Exhibits and plants at the center, Bhaktapur, that go with this unit. Book a class visit at science-playground.com/booking.

- **Flying Paper Shapes** (exhibit): Drop the folded paper shapes: the spinners fall slowly, as a maple seed does in the wind.



- **Balsam (garden):** A ripe balsam pod bursts at a touch and flings its seeds away: dispersal by bursting pods.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	14	13	9	2	38

