Unit 13 · Biotechnology

ANSWER KEY · FOR TEACHERS

Full marks 32

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. totipotency
2. explant
3. callus
4. hardening
5. emasculation
6. restriction enzymes
7. DNA ligase
8. plasmids
9. transgenic
10. green manure

Each carries 0.5 mark. K · 5

2 Label the diagram

1. promoter switch: when and where
2. new gene code for the protein
3. terminator signal: stop here
4. marker gene lets only changed cells live

Each carries 0.5 mark. K · 2

3 Multiple choice

i. **c.** white K · 1

White (industrial) biotechnology uses living things to make industrial products: enzymes, biofuels, bioplastics. Red is medical, green agricultural, blue marine and aquatic.

ii. **b.** so that its own pollen can't self-pollinate it U · 1

Emasculation, removing the **anthers** before they shed pollen, stops the flower **pollinating itself**. Then bagging keeps out other stray pollen, so the only pollen to reach the stigma is the one the breeder puts there.

iii. **c.** meristem culture U · 1

Meristem culture: the tiny tip of a shoot's apical meristem is usually free of viruses, which spread into it slowly, so plants grown from it are clean. Anther culture gives haploids, protoplast culture somatic hybrids, and suspension culture is used to make chemicals.

iv. **c.** the crystals become toxic only in an insect's alkaline gut, which also has the receptors the toxin binds to A · 1

Bt's crystal proteins dissolve and are activated only in the **alkaline gut** of particular insect larvae, and the toxin acts by binding to **receptors on their gut wall**. A human stomach is **acid** and has no such receptors, so the protein is simply digested.

v. **b.** access A · 1

The food is **available** in the district, but these families lack the income to obtain it: they lack **access**. Utilization is about using food well (safe, nutritious, a healthy body), and stability about all three lasting over time.

4 Short answers

a. MARKING SCHEME K · 2

✓ *Rhizobium*, symbiotic, in legume root nodules.

✓ *Azotobacter* or *Anabaena*, free-living.

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b. MARKING SCHEME U · 2

✓ Hazard: the thing that can cause harm, with an example.
✓ Risk: the likelihood of harm, which depends on exposure.

c. MARKING SCHEME A · 2

✓ Wheat: pure line selection, as it is self-pollinated.
✓ Sugarcane: clonal selection, as it is propagated vegetatively.

d. MARKING SCHEME U · 3

✓ A first use (e.g. insulin).
✓ A second (e.g. hepatitis B vaccine).
✓ A third (e.g. gene therapy).

5 Long answers

a. ANSWER U · 4

Hybridization is the deliberate crossing of two genetically different parents to bring the desirable genes of both into one offspring.

1. **Selection of parents** with the qualities wanted.
2. **Emasculation**: the anthers of the female parent's flower are removed before they shed pollen.
3. **Bagging**: the flower is covered so no stray pollen reaches it.
4. **Collection of pollen** from the male parent, and **cross-pollination**: it is dusted on the stigma; the flower is bagged again and **tagged**.
5. **Collection of the seeds** (the F_1 hybrids), and **selection** of the best over several generations.

MARKING SCHEME

✓ Definition: crossing two different parents to combine their good genes.
✓ Selection of parents and emasculation.
✓ Bagging, pollen collection and cross-pollination with tagging.
✓ Collection of F_1 seeds and selection over generations.

b. ANSWER U · 4

1. **DNA extraction**: the DNA is taken out of the organism with the gene wanted.
2. **Gene cloning**: the one gene is separated and copied thousands of times.
3. **Gene design**: a **promoter**, a terminator and a **marker gene** are joined to it so it works in the plant.
4. **Transformation**: the gene is put into plant cells (gene gun, *Agrobacterium*, microfibers, electroporation); cells picked out by the marker are regenerated into **transgenic plants**.
5. **Backcross breeding**: the transgenic plant is crossed with a high-yielding variety to give a useful variety carrying the gene.

MARKING SCHEME

✓ DNA extraction and gene cloning.
✓ Gene design (promoter, marker).
✓ Transformation, with a method, and regeneration.
✓ Backcross breeding into a good variety.

6 Think

ANSWER HA · 3

Azospirillum fixes **nitrogen** only; biofertilizers **don't supply potassium** or most other nutrients, act **slowly**, and **can't alone** supply enough for a high-yielding crop, so the yield may fall.
Better: use the biofertilizer **with** manure (compost, FYM) and a **reduced** dose of the fertilizers still needed, kept as living cultures (away from heat, before expiry).

MARKING SCHEME

✓ It supplies nitrogen only, not potassium or other nutrients.
✓ It acts slowly and can't alone meet a high-yielding crop's needs, so yield may fall.
✓ Advice: combine with manure and a reduced chemical dose.

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7 Activity: Find the nitrogen factories

(not marked)

WHAT STUDENTS SHOULD FIND

Many small round or finger-shaped **nodules**; a working one is **pink or red inside**, colored by leghemoglobin. They hold *Rhizobium*, which **fixes nitrogen** from the air for the plant in exchange for sugar.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	10	15	4	3	**32**

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