Unit 5 · Applied Biology

ANSWER KEY · FOR TEACHERS

Full marks 42

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. short tandem repeats
2. gel electrophoresis
3. clone
4. mitosis
5. restriction enzymes
6. DNA ligase
7. plasmid
8. allograft

K · 4

Each carries 0.5 mark.

2 Label the diagram

1. insulin gene
2. sticky ends
3. insulin
4. plasmid

K · 2

Each carries 0.5 mark.

3 Multiple choice

i. **b.** smallest — K · 1

All DNA pieces are negatively charged and move towards the positive electrode; the gel's mesh holds back big pieces more, so the smallest travel farthest.

ii. **c.** the animal whose body cell gave the nucleus — U · 1

The chromosomes are in the nucleus, and the nucleus came from the body cell. The egg donor gives only the egg's cytoplasm, with its mitochondria and their small amount of DNA; the surrogate mother only carries the embryo. That is why Dolly had a white face like the Finn Dorset ewe.

iii. **c.** potato plants grown from the tubers of one plant — U · 1

Plants grown from the tubers of one plant come from mitosis alone and have its genes exactly. A calf, non-identical twins and a mule all come from sexual reproduction.

iv. **c.** 1975 — K · 1

It was agreed in 1972 and came into force on 26 March 1975. The 1925 Geneva Protocol banned only the use of such weapons; 2016 is when Nepal ratified the convention.

v. **b.** external iliac artery, in the pelvis — A · 1

The new kidney is placed low, in the iliac fossa, so its artery is joined to the nearby external iliac artery (the artery to the leg) and its vein to the external iliac vein. Its ureter goes to the bladder. The old kidneys and their vessels are left where they are.

4 Very short answers

a. MARKING SCHEME — K · 1

✓ About 99.9%.

b. MARKING SCHEME — U · 1

✓ The positive electrode, because DNA is negatively charged.

c. MARKING SCHEME — K · 1

✓ The use of chemical and biological weapons in war.

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d. MARKING SCHEME K · 1

✓ Crossmatch.

5 Short answers

a. MARKING SCHEME U · 2

✓ DNA is in the nucleus, and human red blood cells have no nucleus.

✓ A drop of blood also has white blood cells, which have a nucleus, and their DNA is tested.

b. MARKING SCHEME U · 2

✓ Once released they can't be controlled: they spread with wind, water and people, and strike civilians and the attacker's own side (any one such reason).

✓ Almost every country agreed in the Biological Weapons Convention of 1972 not to develop, produce or stockpile them, and their use is a war crime.

c. MARKING SCHEME A · 2

✓ The new kidney carries the donor's HLA markers, which the recipient's immune system attacks as foreign (rejection).

✓ Immunosuppressants keep this attack down, so they are needed for as long as the kidney works.

6 Long answers

a. MARKING SCHEME U · 4

✓ Clones are made by mitosis alone, with no meiosis or fertilization, so every clone has the parent's genes exactly (variation only from rare mutations).

✓ Good effects: desired qualities kept exactly; uniform crops; fast, disease-free multiplication (any two).

✓ Bad effects: one disease or pest can destroy all of them (the Gros Michel banana); they can't adapt to new conditions (either, with the reason that all have the same genes).

✓ Harmful genes are kept too, or local varieties are lost; the harm is reduced by several varieties, gene banks or new breeding (any one).

b. ANSWER A · 4

Claims: they were considered cheap compared with nuclear weapons; an attack was thought to be hard to detect at first, and it might be hard to tell who caused it; it was claimed they would harm people without destroying buildings, roads and factories (any two).

Why they are banned: they can't be controlled once released and can strike the attacker's own soldiers and people; they strike civilians, with children, the old and the sick hit hardest; their effects are unpredictable; their use is a war crime under international law (any two). These far outweigh anything claimed for them, and the claims are reasons they were sought, not reasons for anyone to make or use them.

MARKING SCHEME

✓ One claim, written as a claim (e.g. they were considered cheap compared with nuclear weapons).

✓ A second claim, written as a claim (e.g. they were thought hard to detect at first).

✓ One reason, e.g. they can't be controlled and can strike the attacker's own side.

✓ A second reason, e.g. they strike civilians, or are banned by the Biological Weapons Convention and their use is a war crime.

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c. **ANSWER** A · 4

i. The white-faced Finn Dorset ewe, whose udder cell gave the nucleus.
ii. So that the egg held only the adult's chromosomes, and the lamb would be a clone of that adult.
iii. It made the udder cell and the empty egg fuse into one cell, and it started that cell dividing, as a fertilized egg does.
iv. From the egg, given by a Scottish Blackface ewe. A clone's mitochondria come from the egg, not from the nucleus donor.

MARKING SCHEME

✓ i. The Finn Dorset ewe (the udder cell's nucleus).
✓ ii. So that the egg's only chromosomes are those of the adult being copied.
✓ iii. It fused the two cells and started the new cell dividing.
✓ iv. From the egg, given by the Scottish Blackface ewe.

7 Numerical problems

a. **ANSWER** A · 2

$$\frac{1}{5} \times \frac{1}{10} \times \frac{1}{12} \times \frac{1}{20} = \frac{1}{12000}$$

1 in 12,000. In a city of a million people, about 1,000,000 ÷ 12,000 ≈ 83 people would match by chance, so four places are far too few for a court: that is why laboratories test 15 to 24.

MARKING SCHEME

✓ The chances multiplied, because the places are inherited independently.
✓ 1 in 12,000.

b. **ANSWER** A · 2

Embryos: 29 ÷ 277 × 100% = **10.5%**.
Lambs from embryos: 1 ÷ 29 × 100% = **3.4%**.
Overall, 1 lamb from 277 fusions is only 0.36%.

MARKING SCHEME

✓ 29 ÷ 277 × 100% = 10.5% became embryos.
✓ 1 ÷ 29 × 100% = 3.4% of the embryos became a lamb.

c. **ANSWER** A · 2

4 hours = 240 minutes, so the number of doublings = 240 ÷ 20 = 12.
Number of bacteria = 2^{12} = **4,096**. After 10 hours (30 doublings) there would be over a billion: that is why bacteria make a medicine so cheaply in a fermenter.

MARKING SCHEME

✓ 240 ÷ 20 = 12 doublings.
✓ 2^{12} = 4,096 bacteria.

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8 Think

ANSWER HA · 3

For: farmers would lose less of their harvest and spend less on pesticides, which also harm their health; more food could be grown on the same land.
Caution: the gene could spread to Nepal's many local maize varieties and the wild plants around fields, which are a treasure of genetic variety; the pest could become resistant if the crop is grown everywhere; farmers might have to buy seed every year from one company.
To test first: whether the crop is safe to eat and to feed to animals; whether it harms useful insects such as bees; how well it grows in Nepal's own conditions; and how far its pollen travels to other maize. There is no single right answer: the point is to weigh the evidence on both sides.

MARKING SCHEME

- ✓ Two reasons for allowing it, e.g. farmers lose less of their harvest; less is spent on pesticides, which harm their health.
- ✓ Two reasons for caution, e.g. the gene could spread to local maize and wild plants; the pest could become resistant; farmers might have to buy seed every year from one company.
- ✓ What to test first, e.g. whether it is safe to eat, whether it harms useful insects, how well it grows in Nepal, how far its pollen travels.

9 Activity: Organ transplantation in Nepal (Practical 10)

(not marked)

WHAT STUDENTS SHOULD FIND

Kidney transplants at the Shahid Dharmabhakta National Transplant Centre in Bhaktapur and at several hospitals in Kathmandu; liver transplants at the Bhaktapur center; corneal transplants at eye hospitals with eye banks. The law lets a living person give an organ only to a close family member, to prevent the buying and selling of organs, and since its amendment of 2073 BS (2016) also allows organs from brain-dead donors. Problems: cost, too few donors, beliefs about the body after death. The numbers change from year to year, so accept any with a reliable source and a date.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	11	11	17	3	**42**

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