InkBiology

ANSWER BOOK

Cloning in plants and animals

Cell cycles, reproduction and development · Unit B06

OCR A 6.2.1 · Edexcel A 8.18 · Edexcel B 2.3 iii

15 questions · 51 marks

NAVY EDITION

Every question in this book has a code beside its number.
Type inklearning.co.uk/q/ followed by the code to open that question online.

inklearning.co.uk/biology/ · youtube.com/@InkPhysics

SECTION A · Short, 1 to 2 marks

A1 CPAC-Q7 **B1** any one of runner or stolon, rhizome, stem tuber, bulb or leaf plantlet, with a correct plant such as strawberry, couch grass, potato, onion or Kalanchoe. **B1** a second correct structure from that list, with a correct plant named for it. [2]

A2 CPAC-Q15 **B1** the first mammal cloned from an adult cell was a sheep, born in 1996. **B1** success rates have improved in the decades since but remain low. [2]

SECTION B · Standard, 3 to 5 marks

B1 CPAC-Q2 **B1** an explant, a small piece of tissue such as a shoot tip or a node, is cut from the chosen parent plant. **B1** the surface of the explant is sterilised, because any bacteria or fungal spores on it would outgrow the plant tissue on the medium. **B1** the explant is placed on sterile nutrient medium containing sugar, mineral ions and plant hormones, and its cells divide to form a callus of undifferentiated cells. **B1** the callus is divided repeatedly, and the ratio of cytokinin to auxin in the medium is used to make the pieces grow shoots and then roots. **B1** the plantlets are acclimatised, being moved gradually from the sterile medium to compost at high humidity; every division has been mitosis, so all the plants are genetically identical to the parent. [5]

B2 CPAC-Q8 **B1** advantage: micropropagation produces very large numbers of genetically identical plants quickly, at any time of year, from a single valuable parent. **B1** advantage: it produces uniform plants that mature together, which suits a commercial grower supplying a market that wants a standard size and timing. **B1** disadvantage: the sterile facilities, culture media and skilled labour needed make it far more costly per plant than growing from seed. **B1** disadvantage: not every species forms a callus and regenerates successfully, so the technique does not work for every crop, and a contamination discovered late costs the whole batch. **A1** on balance, micropropagation is justified commercially where uniformity, speed or freedom from disease outweigh its higher cost, for example in high-value ornamentals or virus-free seed stock, but not for a low-value crop that grows easily from seed. [5]

B3 CPAC-Q3 **B1** an egg cell is taken from a donor female and enucleated, its nucleus being removed and its cytoplasm left intact. **B1** a somatic cell, such as a skin or mammary gland cell, is taken from the animal to be cloned, and it or its nucleus is placed next to the enucleated egg. **B1** the two are fused using a pulse of electricity, which also stimulates the reconstructed cell to begin dividing, and factors in the egg cytoplasm reprogramme the transferred nucleus. **B1** the cell divides by mitosis, the embryo is cultured to the blastocyst stage and is implanted into a surrogate mother that carries the pregnancy. [4]

B4 CPAC-Q4 **M1** 12 weeks allows three rounds of division, one every 4 weeks. **M1** 1 multiplied by 8 three times, which is 8^3. **A1** 512 calluses are present after 12 weeks. [3]

B5 CPAC-Q5 **B1** the micropropagated plants are clones, produced by mitosis from one parent, so they are genetically identical to one another. **B1** there is therefore no variation between them in resistance to the pathogen, whereas plants grown from seed carry new combinations of alleles produced by meiosis and fertilisation. **A1** a strain able to infect one plant can infect every plant in the field, so the whole crop can be lost, and no resistant individuals survive to be selected or bred from. [3]

B6 CPAC-Q6 **B1** only the nuclear DNA comes from the donor animal, because only the nucleus was transferred. **B1** the mitochondria, and so the mitochondrial DNA, came with the cytoplasm of the egg cell and belong to the egg donor. **B1** the reprogramming of the transferred nucleus is not perfect, so the pattern of gene expression differs, and the calf develops in a different uterus and grows up in different conditions, which affect the phenotype. [3]

B7 CPAC-Q9 **B1** a piece of stem is cut from the parent plant just below a node, and the lower leaves are removed. **B1** the cut end is dipped in rooting powder containing auxin, and the cutting is pushed into moist compost and kept humid. **A1** cells near the cut divide and roots develop, producing a new plant genetically identical to the parent because every division has been mitosis. [3]

B8 CPAC-Q10 **B1** a cutting needs only a knife and rooting powder, and is cheap, whereas micropropagation needs sterile facilities, culture media and trained staff, and is far more costly per plant. **B1** one parent plant yields at most a few dozen cuttings in a season, whereas micropropagation can produce thousands of genetically identical plantlets, repeatedly, from one parent. **A1** micropropagation can also be started from meristem tissue to give stock free of a virus the parent carries, which taking cuttings cannot do because a cutting carries the parent's vascular tissue and any virus in it. [3]

B9 CPAC-Q11 **B1** viruses spread through a plant in its vascular tissue, and the cells at the very tip of the shoot meristem have no vascular tissue supplying them yet. **B1** those cells are therefore often free of a virus that has infected the rest of the plant, even though the rest of the plant is infected. **A1** an explant taken from just the tip can give rise to a whole population of virus-free plants, which is worth the slower start because no other propagation method can clear the virus. [3]

B10 CPAC-Q12 **B1** the twins are genetically identical to each other because both arose from the same zygote by mitosis, which produces genetically identical daughter cells. **B1** they are not clones of either parent because the zygote they came from was produced by fertilisation, combining alleles from both parents in a new combination. **A1** that combination of alleles is not identical to either parent's genotype, so neither twin is a clone of the mother or of the father. [3]

B11 CPAC-Q13 **B1** embryo splitting copies an embryo produced by fertilising two chosen parents, so it copies a new genotype whose phenotype is not yet known, whereas nuclear transfer copies an adult animal whose phenotype has already proved itself. **B1** in embryo splitting the resulting calves' qualities can only be estimated from both parents, whereas in nuclear transfer every calf carries the same nuclear DNA as the donor animal, so the genotype behind its known qualities is copied exactly. **A1** embryo splitting is the more established technique with a higher success rate, whereas nuclear transfer has a lower success rate and a greater welfare cost, since many reconstructed pregnancies fail or produce unhealthy offspring. [3]

B12 CPAC-Q14 **B1** coat colour pattern in a calico or tortoiseshell cat depends on which of the two X chromosomes is inactivated in each patch of skin. **B1** X-inactivation is settled at random early in the development of each individual embryo, independently of the sequence of the DNA itself. **A1** the donor cat and the clone therefore have different patterns of X-inactivation, even though their nuclear DNA sequence is identical, so their coat patterns differ. [3]

SECTION C · Long, 6 marks or more

C1 CPAC-Q1 **B1** for: the two share every step until the blastocyst stage, and in therapeutic cloning the embryo is never implanted, so no animal or person is born and the welfare problems of reproductive cloning do not arise. **B1** for: the stem cells carry the patient's own nuclear DNA and so the patient's own antigens, so they are not rejected by the patient's immune system. **B1** for: the cells obtained are pluripotent, so a far wider range of tissues can be produced from them than from adult stem cells taken from the patient. **B1** against: a human embryo is created and then destroyed, which some hold to be the ending of a human life whatever the benefit to the patient. **B1** against: human egg cells are needed in quantity, and collecting them requires hormone treatment and a procedure that carries a risk to the donor; success rates are also low. **A1** a judgement is stated and supported by the points made, for example that induced pluripotent cells now offer patient-matched pluripotent cells with no egg and no embryo; credit either conclusion where the reasoning leads to it. [6]

THIS BOOK ONLINE

Scan the code, or type the address, to open the questions in this book online:

inklearning.co.uk/biology/practise/questions/cloning-in-plants-and-animals/