

1. meristematic/pluripotent/totipotent/cambial/undifferentiated, tissue;
sterile conditions;
nutrient medium to encourage, division/mitosis;
produces callus;
subdivided;
different (nutrient) medium to encourage differentiation;
detail of either medium; e.g. *named nutrient or plant growth substance*
grows to plantlet;
hardening medium/sterile soil; max 5

[5]

2. *tissue*
- 1 meristematic ;
 - 2 undifferentiated / totipotent / able to develop into any cell type /
unspecialised ;
 - 3 (cells) can still divide / undergo mitosis ;
 - 4 virus free ; max 2
- sterilising agent*
- 5 aseptic technique ;
 - 6 prevent, growth of / contamination by, bacteria / fungi ;
 - 7 could overwhelm / grow faster than / compete with, plant tissue ;
A AW max 2
- cytokinins, auxins*
- 8 plant growth, **regulator / promoter / hormone** ;
 - 9 cytokinins stimulate, shoot / stem, growth / many branches ;
 - 10 auxins stimulate growth of, root / root hairs ; max 2
- magnesium, nitrate ions, sucrose*
- 11 magnesium for, chlorophyll / photosynthesis ;
 - 12 nitrate (ions) needed for, protein / enzyme / chlorophyll / named chemical ;
 - 13 sucrose converted to, glucose / fructose / monosaccharide ;
 - 14 used in, respiration / release energy ; max 3
- 15 AVP ; e.g. further detail e.g. cytokinins stimulate cell division
no vascular tissue therefore disease free 6 max

QWC – clear well organised using specialist terms ;

1

award QWC mark if three of the following terms are given in correct context

meristematic
undifferentiated
totipotent
mitosis
aseptic
contamination
regulator
promoter
hormone
chlorophyll
photosynthesis
respiration

[7]

3. (a) (i) cow superovulated ;
treated with, hormone / FSH / named proprietary brand ;
washed out of oviduct (A uterus) / collected from ovary ;
detail washing ;
detail collection ; max 3
- (ii) ref to mitochondrial DNA ;
detail ; e.g. circular / self-replicating
mitochondria in cytoplasts fused with darded buffalo cell ; A organelle
embryo has mixture of buffalo and cow mitochondria ;
nuclear / chromosomal, DNA is buffalo ;
ref to bacterial contamination ; max 2
- (iii) for correct phase of cycle ;
ref to synchronisation ;
to prepare uterus for (implantation of) embryo ;
ref to increased thickness of uterine lining ;
ref to increased vascularisation of uterine lining ; max 3
- (b) increases rate of reproduction ;
does not require species' eggs ;
so does not require fertile female ;
does not require female for pregnancy / uses surrogate ;
female not put at risk in, travel / mating / pregnancy ;
successfully formed embryo can be, subdivided / cloned ;
can use adult cells from all existing animals to maintain diversity ; max 4

- (c) sperm bank ;
 oocytes / eggs ; “*gametes*” = 1 mark only
 embryos ;
 tissue ;
 zoo / reserve / game park ;

max 3

[15]

4. (a) (i) produced by asexual reproduction ;
 one parent / no gamete formation ;
genetically identical (to parent) ;
 produced by mitosis ;
- 2 max
- (ii) keeps, desirable characteristics / high productivity / AW ;
 quicker / no germination time ;
 stronger / more likely to survive ;
 mass production / more produced ;
 disease free ;
- 2 max
- (iii) induce seedless fruit ;
 increase fruit size ;
 improve fruit set ;
 avoid need for pollination ;
 AVP ; e.g. weedkiller / inhibits sprouting in potatoes / prevents
 premature fruit drop
- 2 max
- (iv) large surface area ;
 absorbs water ;
 by osmosis / down a water potential gradient ;
 ions / named ion(s) ;
 ions pass through cell surface membrane ;
 protein, channels / carriers ;
 active transport ;
 help to prepare cuttings for transplanting to soil / AW ;
 AVP ;
- 4 max
- (b) sucrose ;
 amino acids ;
 vitamins ;
 ions / named ions ;
 auxins ;
 cytokinins ;
 water ;
 agar ;
- 3 max

- (c) labour intensive ;
sterile conditions ;
special equipment ;
trained staff ;
electricity / power, costs ;
quality control of process ;
AVP ; e.g. set up costs 3 max
- (d) grafting / budding / described ;
layering / described ; 1 max

[17]

5. (a) mRNA and its complementary RNA bind together ;
hydrogen bonding ;
A to U and C to G ; **R** 'T'
double stranded RNA / duplex RNA ;
cannot bind to ribosome ;
tRNA cannot bind ;
cannot be translated / AW ;
ref to, RNA interference / RNAi ; 4 max
- (b) (i) theobromine content, reduced / approximately halved ;
no significant difference between short and long lengths of RNA ;
caffeine content reduced ;
to half by short lengths of RNA ; **A** figures
to about a third by long lengths of RNA ; **A** figures 3 max
- (ii) (re caffeine) greater chance of pairing longer length with mRNA ;
AVP ; 1
- (iii) explant of meristematic / cambium / totipotent / pluripotent, cells
/ tissue ;
explant (surface) sterilised / sterile nutrient ;
appropriate hormone to stimulate, mitosis / division ;
callus formed ;
subdivided ;
appropriate hormone to stimulate differentiation ;
plantlet formed ;
hardening medium / sterile soil 4 max

- (iv) genetically identical ;
 genotype does not affect result ;
 easily genetically engineered ;
 plants derived from it identically genetically engineered / AW ;
 large numbers easily obtained ;
 early stages compact ;
 so easily kept in identical conditions ;

3 max

[15]

6. *any three acceptable e.g.*

- disease / virus, free ;
 genetically identical / clone ;
 maintain, favourable characteristics / advantageous phenotypes ;
 faster method ;
 produces many plants ;
 allows long-term storage of plant tissue ;
 easily genetically manipulated / example of genetic manipulation ;
 easier exchange between countries as no quarantine ;
 enables optimal production of useful secondary products (e.g. codeine from poppy) ;
 no external environmental influences ;
 no influence of seasonal variation ;
 AVP ; e.g. use for, sterile / infertile, plants,
 AVP ; named example of advantageous phenotype e.g. grow more vigorously
 use for rare or endangered plants
 relevant example of genetic manipulation

3 max

[3]

7. (a) (i) gradual process / AW ;
 to improve traits ;
 to achieve homozygosity / AW ;
 best in each generation interbred ;
 ref to artificial selection ;
 ref to several traits involved / may be, additive / polygenic ;
- (ii) ref to mitosis ;
 chromosomes replicated ;
 failure of, spindle / cell division ;
 colchicine / other method ;
- (iii) self-pollination prevented ;
 pollination by foreign pollen prevented ;
 pollen transfer ;
 practical detail ;
- (iv) $3n$;
 meiosis fails ;
 ref to, synapsis / homologous pairs ;
- (b) (i) sterile explant ;
 sterile nutrient medium ;

max 2

max 2

max 2

max 2

ref to plant growth regulators ;
callus ;
 subdivided ;
 medium with different plant growth regulators ;
 plantlets / embryoids ;
 hardening medium / sterile soil ;
 AVP ; e.g. appropriate plant growth regulators

max 5

(ii) callus can be divided ;
 large numbers of identical plants ; **A** clone
 in short time ;
 bulk up sterile hybrid ;
 bulk up master hybrid lines ;
 no need for making more 4n ;

max 2

[15]

8. (a) odd number of sets of chromosomes / AW ;
 homologous pairs not formed ; **A** ref to difficulties in pairing
 during meiosis ; *allow point if reference made to causing problems
 during meiosis*
 does not form seeds ;

max 2

(b) ref to, sterile conditions / aseptic techniques ;
 (small) piece of plant tissue removed ; **A** take cuttings
 ref to named tissue ; e.g. meristem, axillary / (apical) buds
 explant ;
or
 leaf removed ;
 enzymes / cellulases / pectinases, to remove cell wall ;
 protoplasts formed ;
 growth on nutrient medium ;
 plant growth regulators / named growth regulator ; **R** hormones
 rooting ;
 incubation in light ;
 plantlets ;
 subdivide ;
 handling, medium / sterile soil ;
 AVP ;
 AVP ; e.g. remove wax from leaves
 callus culture / mass of undifferentiated cells forms
 ref. auxin to cytokinin ratio
 Murashige and Skoog (M & S) medium
 further detail of culture method / aseptic technique

max 5

(c) *max 4 for either*

advantages

many plants ;
genetically identical ;
(so) all have desired, characteristics / genotypes / phenotypes ;
no need for (artificial) selection ;
can be obtained in short space of time / AW ;
easy to, transport / store ; **A** ref to space saving
easy to genetically engineer ;
disease / virus, free ;

disadvantages

genetically identical, qualified in terms of disadvantage ;
susceptible to disease ;
loss in genetic diversity (as cloned plants are grown exclusively) ;
farmers have to buy plants from suppliers / AW ;
ref to economic problems for developing countries ; e.g. start up costs
patented property ;

AVP ;

AVP ; e.g. no quarantine required, ref. to cost qualified, not labour intensive
(advantages), genetically unstable (disadvantage)

max 5

[12]