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|-----|--|---|--------|--|
| 1. | (a) | (i) 12 chromatids shown as 6 pairs either side of the equator of cell; spindle shown; | 2 | |
| | | (ii) cell with one chromosome from each homologous pair; | 1 | |
| | (b) | (i) mutation; | 1 | |
| | | (ii) environmental factors; | 1 | |
| | (c) | crossing over;
random assortment of chromosomes; | 2 | |
| 2. | (a) | (i) A; | 3 | |
| | | (ii) D; | | |
| | | (iii) E; | | |
| | (b) | acetic orcein / feulgen / other suitable stain; | 1 | |
| | (c) | short duration of interphase /
whole cycle only takes 3 hours 20 mins / short time; | 1 | |
| (d) | replication of DNA;
ATP production;
synthesis of proteins/spindle/replication of centrioles; | max 2 | [7] | |
| 3. | (a) | asexual / vegetative; | 1 | |
| | (b) | all potatoes have 'favoured characteristics';
large numbers can be produced quickly/food store leads to rapid initial growth | 2 | |
| | (c) | similar genes/genotypes little variation;
reduced gene pool means that if one is susceptible, most will be; | 2 | |
| 4. | (a) | DCBEA; | 1 | |
| | (b) | A - pulled/moved to poles;
C - coiling/condensing/shortening; | 1
1 | |

- (c) (i) separation of cells;
(ii) formation of a single cell/thin layer; 2 [5]
5. (a) (i) nuclear membrane disappears (once only);
chromosomes become shorter / condense /coiling;
arranged on equator;
spindle formation (once only);
centromeres attach to spindle;
accept reference to centrioles (once only) max 2
- (ii) nuclear membrane disappears (once only);
spindle formation (once only);
accept reference to centrioles (once only)
centromeres divide;
chromatids pulled apart;
role of spindle fibres;
chromatids moved to opposite poles max 2
- (b) uncoiling / elongation;
(DNA) replication;
formation of another chromatid max 2 [6]
6. (a) daughter plants have identical genetic information to parents / are clones
OR seed production leads to variation;
therefore fruit likely identical /daughter plants or fruits have desired
characteristics;
asexual reproduction quicker /seeds take longer to produce new plants max 3
- (b) cells of mammal embryo separated;
before differentiation;
after further multiplication;
‘ball of cells’ implanted in uterus
OR
nucleus removed;
from fertilised egg;
‘somatic’ nucleus inserted into egg;
egg implanted into uterus max 2 [5]

7. (a) (Allow *labelled* features on diagrams)
- (i) Chromosomes or chromatids on equator / in middle of cell;
Of spindle (once); No nuclear membrane (once only).
- (ii) Chromatids moving towards poles / centrioles;
of spindle (once);
Two centromeres per chromosome/ centromeres are being pulled;
No nuclear membrane (once only). 3
- (b) (i) T 8
U 16 2
- (ii) (No)
Both derived by mitosis / clones;
From same cell;
U has two of each allele, but these are identical. 2
- (iii) 24 1
- [8]**
8. (a) (i) Metaphase; 1
- (ii) Centromeres divide;
Chromatids separate / pulled apart;
By spindle fibres; 2 max
- (iii) Three chromosomes;
One of each homologous pair; 2
- (b) 7.6 is replicated DNA / chromatids joined together / late
interphase / prophase / metaphase / before cell division;
3.8 contains single chromatids / DNA is not replicated /
telophase / early interphase; 2
- [7]**
9. (a) 30, 31, 61; 1
- (b) chromatids did not separate/ chromosomes move to one pole;
centromeres did not divide;
spindle did not form/spindle was not active;
daughter cells did not separate/cytokinesis did not occur; 2 max

	(c) vegetative propagation/asexual reproduction/cloning/runners /tubers/bulbs/corns/grafting/micropropagation/tissue culture; by mitosis;	2	
			[5]
10.	(a) prophase;	1	
	(b) uncoiling/elongation (of chromosomes); formation of nuclear membranes/two nuclei formed; loss of spindle; new cell membranes formed/two cells formed;	2 max	
	(c) one mark for chromatid correctly labelled; one mark for centromere correctly labelled;	2	
	(d) 6;	1	
			[6]
11.	(a) 6; 6 12	2	
	(b) (i) between male and female aphids and gametes;	1	
	(ii) when gametes fuse or at fertilisation diploid number is restored/ chromosome number maintained; produces variation;	1 max	
	(c) asexual reproduction quick; so rapid increase in population; in favourable conditions; energy resources not used in producing males/economical use of energy resources;	2 max	
	(d) only eggs survive winter; variation introduced; sexual reproduction can occur;	1 max	
			[7]

12. (a) prophase – coil up/spiralise/condense;
(allow shorter/contract/become visible)
metaphase – move to equator or centre of cell / attach to spindle;
(reject if reference to pairing)
anaphase – chromatids separate/centromeres divide;
(reject chromosomes move to poles without further explanation)
telophase – uncoil; (allow lengthen/becomes less visible) 4
(allow labelled diagrams)

(b)

Mitosis	Meiosis
chromosome number remains same / cells produced diploid	chromosome number halved / cells produced haploid
cells produced identical / no variation in cells produced	cells produced not identical / variation in cells produced
only one division/2 cells produced	two divisions / 4 cells produced
somatic/ body cell formation/ used in AR/growth	used in gamete formation / reproductive cell formation / occurs in gonads/named gonad (reject occurs <u>in</u> gametes)

Accept

no pairing of chromosomes	pairing of chromosomes
no chiasma/crossing over	chiasma/crossing over (may occur)

2 max

[6]

13. (a) DNA/chromosomes/genetic information in nucleus;
divides by mitosis; (reject asexual reproduction) 2
- (b) body cell has full number of chromosomes/diploid;
gamete has only half number of chromosomes/haploid;
require complete genome to form new individual; 1 max
- (c) (i) desired characteristic/qualities kept / exact/known features produced;
produces more of an endangered species;
(ignore genetically identical) 1 max
- (ii) possible development of side effects / early death / named side effect;
high cost due to low chance of success/technology required;
no possibility of adaptation ;
consequence of lack of variation (e.g. all susceptible to same disease);
long term effect not known; 1 max
(ignore ethical issues / genetic diseases)

[5]

14. (a) (i) A anaphase; 1
(ii) (C) B,A,D; 1
(iii) (original) chromosome/DNA has been replicated;
each chromosome consists of two chromatids/
chromatids attached at centromere;
(accept reference to condensed state of chromosomes) 2
- (b) (i) it has doubled/now 8; 1
(ii) chromosome/DNA replication but no separation
/anaphase/cell division; 1
- [6]**
15. (a) (i) prophase;
chromosomes thickening/becoming visible; 2
(ii) anaphase;
chromatids/chromosomes moving to opposite poles/
ends of spindles; 2
- (b) DNA replication;
synthesis or proteins/build-up of energy stores/growth/increase in
cytoplasm;
replication of organelles/named example; 2 max
- [6]**
16. (a) (i) 8 'chromatids' each side;
spindle drawn; 2
(ii) 4 chromosomes;
1 from each homologous pair; 2
- (b) produces haploid cells / chromosome number halved;
fertilisation;
maintains the diploid / chromosome number (in next generation); 2 max
- [6]**
17. (a) genetically identical cells/individuals; 1
(b) mitosis; 1

- (c) no differentiation at this stage / same genes being expressed; 1
- (d) brown - genes/DNA/genetic 'information' from the nucleus (expressed); 1
- (e) embryo cell diploid, egg cell haploid;
contain different alleles/forms of the colour gene; 2
- (f) damage to nucleus / cells during transfer; 1
- [7]**
- 18.** (a) (i) anaphase; 1
- (ii) sister / identical chromatids (separate);
move to opposite poles / ends / sides; 2
- (b) (i) interphase; 1
- (ii) ATP production / protein synthesis / replication of centrioles; 1
- (iii) 1.2; 1
- (c) short duration of interphase; 1
- [7]**
- 19.** (a) mitosis;
genetically/ genes /genotype identical; 2
- (reject same genes)*
- (ignore references to asexual reproduction)*
- (b) (different)
environmental conditions/named environmental factor/mutation; 1
- (c) dispersal / prevent overcrowding / competition / colonise ;
increased number of (proven) offspring; *(not quicker)* 2
- [5]**
- 20.** (a) 1 two strands therefore semi-conservative replication (possible);
- 2 base pairing/hydrogen bonds holds strands together
- 3 hydrogen bonds weak/easily broken, allow strands to separate;
- 4 bases (sequence) (exposed so) act as template /can be copied;
- 5 A with T, C with G / complementary copy;
- 6 DNA one parent and one new strand; 4 max
- (b) 1 chromosomes shorten/thicken/supercoiling;
- 2 chromosomes (each) two identical chromatids/strands/copies

- (due to replication);
- 3 chromosomes/chromatids move to equator/middle of the spindle/cell;
- 4 attach to individual spindle fibres;
- 5 spindle fibres contract / centromeres divide / repel;
- 6 (sister) chromatids/chromosomes (separate)
move to opposite poles/ends of the spindle;
- 7 each pole/end receives all genetic information/
identical copies of each chromosome;
- 8 nuclear envelope forms around each group of chromosomes/
chromatids/at each pole; 7 max
- (c) cancer cells killed, normal body cells survive;
cancer cells low oxygen (as blood supply cannot satisfy demand); 2
- [13]**
21. (a) produced by mitosis;
genetically identical; 2
(accept identical genes/ same genotype/WNA/genetic information)(reject same genes, same genetic code)
- (b) cells lost ability to control development / no longer totipotent /
cells have differentiated/become specialised; 1
- (c) (many) offspring with favourable characteristics / high meat/milk yield;
pedigree embryos into non-pedigree mothers / not risking pedigree
mothers / rare breeds
conserved;
sex/gender selection; 2 max
- [5]**
22. (a) (i) (D) B E A C; 1
(ii) metaphase; 1
- (b) interphase/S phase; 1
- (c) (i) 0.06×100 ;
6(%); 2
(correct answer 2 marks)

(ii) more(cancer cells) killed, cancer cells divide more (often) (so are more likely to be killed, more susceptible); 1

(iii) longer time to recover;
reduced rate of mitosis / divide more slowly/increased doubling time; 2

[8]