CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2013 series

9700 BIOLOGY

9700/41 Paper 4 (A2 Structured Questions), maximum raw mark 100

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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I	ignore
AVP	Alternative valid point (examples given as guidance)

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Question **Expected Answers**

1 **(a)** **A** – palisade, mesophyll/cell/tissue/layer**;**

B – guard cell**;**

C – (sub-stomatal) air space**;**

[3]

(b) **(i)** 1. through the stoma(ta)**;**

2. by diffusion/description**;**

3. from the, atmosphere/air**;** [max 2]

(ii) ribulose bisphosphate**;**
I RuBP [1]

(iii) reduces/donates hydrogen **;** [2]
A H/hydrogen atoms/H^+ **AND** e^-
R H^+ / H_2

GP to TP **;**
A PGA to PGAL

[Total: 8]

2 **(a)** male mosquitoes do not, bite humans/feed on blood transmit disease
OR
only females, bite humans/feed on blood/transmit disease**;**

I GM male mosquitoes are not infected with the disease [1]

(b) 1. easier to, identify/screen**;**

2. more economical/time saving/labour saving**;**

3. resistance gene(s) can be passed to other bacteria**;**

4. idea of antibiotics no longer effective
OR requiring development of new, antibiotics/treatments**;** [max 2]

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(c) (i) production of tTA causes production of **more** tTA/AW**;** [1]

(ii) 1. promoter, initiates transcription/switches on gene**/**causes gene expression/AW**;**

2. ref. binding of, RNA polymerase/transcription factors**;**

3. otherwise gene has to be inserted near an existing promoter**;**

4. this is difficult to do/this may disrupt expression of existing gene**;**

5. in eukaryotes precise position of promoter important**;** [max 3]

(iii) 1. GM larvae do not die immediately**;**

2. so gives longer time for tTA, production/build up**;**

3. so tTA gets into environment (when GM larvae die) and kills non-GM larvae**;**

4. so (longer-lived larvae) compete with non-GM larvae (for, food/space)**;**

[max 2]

R ref. to larvae breeding

(d) (i) 1. chemical **A** has, similar shape to tTA/complementary shape to binding site**;**

2. so chemical **A** binds to, DNA/binding site, **AND** prevents tTA from binding**;**

3. chemical **A**, binds to/changes shape of, tTA
AND so prevents tTA binding to, DNA/binding site**;**

4. stops positive feedback/small quantity of tTA does not kill**;** [max 2]

5. chemical **A**, binds to/changes shape of/breaks down, tTA, so no longer toxic**;**

(ii) 1. GM males, mated/bred**;**
R with GM females

2. mosquitoes fed chemical **A;**

3. males, identified/separated**;**

4. ref. cloning**;** [max 2]

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(iii) 1. GM males die if they cannot get chemical **A;**

2. (if males mate), their offspring die**;**

3. only mate with, other *A. aegypti*/their own species**;** [max 2]

[Total: 15]

3 **(a)** 1. nutrients added **and** product removed at a steady rate/AW**;**

2. (so) volume kept constant**;**

3. organism kept at, exponential/log, phase of growth**;** [max 2]

(b) 1. (branched fungus tangles together in clumps so) too heavy for bubbles to, lift/stir
OR ref. to blocking**;**

2. difficult to, harvest/get desired texture**;**

3. mutant may be, harmful when eaten/toxic/allergenic**;**

4. mutant may produce, distasteful/coloured, substance**;**

5. mutant may be less productive**;**

6. mutant may have high concentration of RNA (which is difficult to lower)**;**

7. approval for sale only applies to original strain**;** [max 4]

(c) 864 kg**;** [1]

[Total: 7]

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4 (a) (i) 1. ATP is made, in the electron transport chain/by oxidative phosphorylation**;**

2. oxygen is the final electron acceptor**;**

3. in the, inner membrane of the mitochondrion/cristae**;**

4. transfer of electron (between electron carriers) provides energy**;**

5. energy used to pump hydrogen ions (into intermembrane space)**;**

6. creates proton gradient**;**

7. diffusion of hydrogen ions down their electrochemical gradient causes ATP to be synthesised**;**

8. ref. chemiosmosis/ATP synthase/stalked particles**;**

9. idea that if less oxygen (consumed/available) then fewer electrons transferred along the chain**;** [max 4]

(ii) 1. at high temperatures, reactions/enzyme activity/metabolism, faster**;**

2. because, molecules/enzymes/substrates, have more <u>kinetic</u> <u>energy</u>**;**

3. more frequent collisions**;**

4. therefore, respiration/Krebs cycle/electron transport chain/production of reduced NAD, take place at a faster rate**;**

5. idea of increase in rate of anabolic reactions (requiring more ATP)**;** [max 3]

(b) (i) 1. oxygen consumed = oxygen inhaled – oxygen exhaled**;**

2. measure oxygen consumption at rest (x) **and** after exercise stops (y)**;**

3. extra oxygen consumed/oxygen debt = y – x**;**

4. measure mass of lizard**;** [max 2]

(ii) 1. less (oxygen debt)(for *Varanus*)**; ora**

2. difference is greater at higher temperatures**;**

3. any two comparative figures at one temperature including units**;** [3]
A 102.0 cm^3 O_2 kg^{-1} at 30°C and 40°C

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(iii) 1. *Varanus* uses, less anaerobic/more aerobic, respiration (when running)**;**

2. more ATP produced per glucose molecule**;**

3. able to run for long time**;**

4. good chance of catching prey**;** [max 3]

(iv) *assume Varanus throughout*
1. larger surface area, in lungs/for gas exchange**;**

2. more oxygen absorbed into blood (per unit time)/faster rate of gas exchange**;**

3. more oxygen supplied to muscles (so oxygen debt lower)**;** [max 2]

[Total: 17]

5 (a) (indicates that they) have undergone meiosis I**;**

so are, haploid/n **;**
A 23 chromosomes [2]

(b) (i) water moved out of cells**;**

down water potential gradient/into a more concentrated solution/into a lower water potential**;**

(by) osmosis**;** [max 2]

(ii) (**B**) has, higher survival of oocytes after thawing/more successful fertilisations**;**

supporting figures**;**

*these should compare columns 1 or 2 with column 3 or 5 for both **A and B***
raw or manipulated data can be given [2]

(iii) idea of deferring, fertilisation/implantation**;**

idea of preserving oocytes from a woman who may lose her fertility due to medical treatment**;**

idea of fewer rounds of, hormone treatment/oocyte retrieval**;** [max 1]

[Total: 7]

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6 **(a)** **(i)** **A** – calcium ions ; **A** Ca^{2+} **R** calcium/Ca/Ca^{+}

B – sodium ions ; **A** Na^{+} **R** sodium/Na [2]

(ii) exocytosis; [1]

(iii) depolarisation (of post-synaptic membrane)/action potential ; [1]

(iv) 1. splits ACh;

2. into acetate and choline;

3. stops continuous depolarisation of postsynaptic membrane/AW;

4. choline recycled (into presynaptic neurone); [max 3]

(b) binds to/blocks, dopamine receptors (on postsynaptic membrane);

prevents depolarization (of postsynaptic membrane);

reduces **effect** of dopamine;

R reduces amount of dopamine [max 2]

(c) *ref 13 base deletion*
frame shift/alters reading frame (after mutation);

(so) all amino acids different **after** mutation;

3-D shape/tertiary structure, of protein changed;

(whereas) 21 base-pair deletion, loses 7 amino acids/no frame shift;

(whereas) substitution, may change only one amino acid/may be silent; [max 3]

(d) increased chances of, survival/breeding/mating;

provides a selective advantage;

allele passed on (to next generation);

allele increases in frequency over time;

natural selection; [max 3]

[Total: 15]

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7 (a) *sex-linked*
(gene) carried on, one sex chromosome/**X,** and not on, the other/**Y;**

gene
section of DNA/sequence of nucleotides/sequence of bases,
that codes for a (particular) polypeptide**;** [2]

(b)

parental phenotypes	*tortoiseshell female*		*black male*	
parental genotypes	X^BX^O		X^BY**;**	
gametes	X^B	X^O	X^B	**Y;**
offspring genotypes	X^BX^B	X^BY	X^BX^O	X^OY**;**
offspring phenotypes	**black female**	**black male**	**tortoiseshell female**	**orange male;**

[4]

(c) tortoiseshell is heterozygous**;**

males, heterogametic/only one **X** chromosome**;**

(therefore) only one copy of gene/only black or orange allele present**;** [max 2]

[Total: 8]

8 (a) 550(%)**;;**

allow one mark for $\frac{104 - 16}{16}$ *(x 100)* [2]

(b) 1. limiting/density dependent, factors or described**;**

2. reached carrying capacity/AW**;**

3. competition/AW**;**

4. for, food/nesting sites/resources**;**

5. large population attracts predators**;**

6. large population spreads disease more easily**;** [max 4]

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(c) 1. not many to begin with;

2. are carnivorous;

3. prey numbers fell;

4. slower reproductive rate;

5. more likely to migrate (to other areas);

[max 2]

[Total: 8]

9 (a) 1. cultural/aesthetic / leisure, reasons;

2. moral/ethical, reasons ; e.g. right to exist/prevent extinction;

3. resource material ; e.g. wood (for building)/fibres for clothes/food for humans/(herbal) medicine

4. (eco)tourism;

5. economic benefits;

6. ref. resource / species, may have use in future/AW;
e.g. medical use

7. maintains, food webs **/** food chains;
A description

8. nutrient cycling;

9. protection against erosion;

10. climate stability;

11. maintains, (large) gene pool**/**genetic variation;

12. scientific research; [max 7]

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(b) *advantages* (max 5)

13. can monitor health of mother;
14. can monitor development of foetus;
15. storage of, sperm/eggs/gametes;
16. artificial insemination;
17. IVF;
18. ref. surrogate mothers;
19. international cooperation;
20. genetic records kept;
21. can prevent extinction/extend range of a species/used in restoring ecosystem;

disadvantages (max 5)

22. unnatural environment;
23. stress in captivity;
24. behavioural changes;
25. reproductive cycles disrupted;
26. may reject selected mate;
27. examples of problems with release ;;
28. difficulty in finding food
    may not integrate into groups
    more susceptible to disease
    very little natural habitat left to release animals into [max 8]

[Total: 15]

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10 (a) 1. *in C3 plants at high temperature*
rubisco combines with oxygen**;**

2. less rubisco to combine with CO_2**;**

3. *in C4 plant such as maize*
idea of spatial separation of light-dependent stage from carbon fixation**;**

4. rubisco/RuBP, in bundle sheath cells**;**

5. kept away from, oxygen/air**;**

6. mesophyll cells, absorb CO_2**;**

7. CO_2 released to combine with RuBP**;**

8. avoid/reduce, photorespiration**;**

9. high optimum temperatures of enzymes involved**;**

10. Calvin cycle can continue**;**

11. AVP **;** e.g. CO_2 reacts with PEP
PEP carboxylase

[max 7]

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(b) 12. light energy absorbed by chlorophyll**;**
A photosystems/pigments

13. electron, excited/raised to higher energy level**;**

14. (electron) emitted by chlorophyll**;**
A photosystems/pigments

15. passes to electron, acceptor/carrier**;**

16. passes along, chain of electron carriers/ETC/Electron Transfer Chain**;**

17. energy released used to pump protons**;**
I ATP production here

18. into thylakoid space**;**

19. thylakoid membrane impermeable to protons**;**

20. proton gradient forms**;**

21. protons move down gradient**;**

22. through/using, ATP synthase/ATP synthetase**;**
R ATPase

23. enzyme rotates**;**

24. ATP produced from ADP and Pi**;**

[max 8]

[Total: 15]

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9700 BIOLOGY

9700/42 Paper 4 (A2 Structured Questions), maximum raw mark 100

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1 (a) (i) *in high light intensity*

1. (as temperature increased) the volume of oxygen released / rate of photosynthesis, increased to a peak **and** then fell**;**

in low light intensity

2. (as temperature increased) the volume of oxygen released / rate of photosynthesis, remained constant **and** then fell**;**

3. supporting figures (two oxygen values at two different temperatures plus units)**;** [3]

(ii) 1. light no longer limiting / temperature now limiting**;**

2. enzymes denatured / described**;**

3. so fewer enzyme-substrate complexes / AW**;**

4. so less photolysis (leads to less oxygen produced)**;** [2 max]

(b) (i) photolysis**;** [1]

(ii) P680**; A** (photosystem) II [1]

(iii) respiration uses oxygen**;** [1]

[Total: 8]

2 (a) (i) 1. easier to, identify / screen**;**

2. more economical / time saving / labour saving / harmless**;**

3. resistance gene(s) can be passed to other bacteria**;**

4. idea of antibiotics no longer effective
or
requiring development of new antibiotics**;** [2 max]

(ii) 1. promoter, initiates transcription / switches on gene /causes gene expression / AW**;**

2. ref. binding of, RNA polymerase / transcription factors**;**

3. otherwise gene has to be inserted near an existing promoter**;**

4. this is difficult to do / this may disrupt expression of existing gene**;**

5. in eukaryotes precise position of promoter important**;**

6. idea that you need a coral promoter to switch on a coral gene**;** [3 max]

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(b) (i) 1. DNA fragmented by, restriction enzyme(s) / endonuclease(s)**;**

2. loaded (into wells) at, negative end / cathode end, (of gel)**;**

3. ref. buffer / electrolyte**;**

4. phosphate groups of DNA give negative charge**;**

5. (negatively charged) DNA attracted to, anode / positive electrode**;**

6. separation due to, electric field / PD / potential difference**;**

7. short pieces / smaller mass, move further (in unit time) / move faster**; ora**

8. ref. impedance of gel / AW**;** [4 max]

(ii) 1. idea of comparison of position with reference DNA**;**

2. ref. staining / fluorescence in UV**;**

3. by use of <u>DNA</u> <u>probe</u>**;**

4. ref. single-stranded / complementary base pairing**;** [2 max]

(c) 1. allows estimate of numbers of each type;

2. to check success (of release of sterile males);

3. if sterile males wrongly identified as wild;

4. there will be a waste of resources, e.g. pesticides;

5. if wild males wrongly identified as sterile males;

6. a potential infestation may be missed;

7. AVP**;** e.g. to determine which moths to (re)release [2 max]

(d) 1. that DsRed is not toxic to predators of the moth;

2. that DsRed does not persist in the environment;

3. that the gene cannot pass to other organisms;

4. does not alter, food web / ecosystem, (in harmful way); [2 max]

[Total: 15]

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3 (a) 1. nutrients added **and** product removed at a steady rate / AW;

2. (so) volume / named condition, kept, constant / at an optimum;

3. organism kept at, exponential / log, phase of growth; [2 max]

(b) (i) 1. at, low / 7.0, (carbon concentration) higher temperature causes increases in, growth / dry mass**;**

2. at, high / 14.0, (carbon concentration) higher temperature causes little or no change in, growth / dry mass**;**

3. comparative figures plus units**;** [3]

(ii) *carbon or nitrogen source*

1. to produce, amino acids / proteins / enzymes**;**

2. to produce, nucleic acids / nucleotides / ATP / purines / pyrimidines / named N-base**;**

3. chitin / building block, for cell wall**;**

carbon only

4. used in respiration;

5. to produce, carbohydrates / sugar / polysaccharide / glycogen / lipids**;** [3 max]

[Total: 8]

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4 (a) (i) inner membrane / crista(e); [1]

(ii) 1. (electron comes from) hydrogen (atom); **R** H^+ / H_2

2. (from) reduced NAD / reduced FAD;

3. (from) dehydrogenation / oxidation, reactions;

4. (from substances in) Krebs cycle / link reaction / glycolysis;

5. in, matrix of mitochondrion / cytoplasm; [max 3]

(iii) 1. final electron acceptor / accepts electron from last carrier;

2. so carrier can be reduced again;

3. so electrons can keep flowing (along ETC) / so ETC can continue to work;

4. (oxygen) combines with H^+ to form water; [2 max]

(b) (i) 1. (when pump stops working), resting potential not maintained
or
pump usually maintains the resting potential;

2. (during resting potential) membrane polarised
or
positive charge outside (neurone) / negative charge inside (neurone) / -70mV inside neurone relative to outside / potential difference across membrane;

3. (when pump stops working), ions (only) move by diffusion;

4. Na^+ **into** the neurone;

5. outward diffusion of K^+ is limited / K^+ stay in neurone;

6. ref. non voltage-gated channels;

7. (eventually) inside of the neurone, becomes less negative / contains (relatively) more positive ions
or
there is a reduced potential difference across the membrane; [max 4]

(ii) 1. voltage gated (calcium) channels open;

2. (calcium ions move in) by diffusion / move down their concentration gradient; [2]

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(c) (i) 1. Na^+ / K^+, cannot move through membrane;

2. so potential across membrane maintained even when pump stops / so membrane depolarisation does not happen;

3. calcium ions cannot enter cell;

4. so, (destructive) enzymes not activated; [max 2]

(ii) 1. gene (for protein channels), expressed less / switched off;

2. transcription, reduced / stopped;

3. AVP; e.g. reduced aerobic respiration / less ATP, for transcription [max 2]

[Total: 16]

5 (a) correct ref. to woman being given hormones;

ref. to one suitable hormone, e.g. FSH / gonadotrophin / LH / GnRH agonist; [2]

(b) 1. <u>capacitation</u>;

2. able to undergo acrosome reaction;

3. able to swim (more vigorously); [max 2]

(c) (i) 1. fewer IVF cycles needed;

2. no need to transfer more than one embryo to the uterus;

3. so less chance of problems from multiple embryos;

4. less chance of miscarriage; [max 2]

(ii) 1. need to wait (at least 7.8 hours) before transferring embryo to uterus;

2. may be difficult to keep embryos in ideal conditions during this time period;

3. embryos destroyed; [2 max]

[Total: 8]

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6 (a) (i) 17.9;;

allow $\frac{125}{700}$ *(× 100) or 17.8 for one mark* [2]

(ii) *fluid can pass through glomerular capillaries because* (max 3)
1. fenestrations in capillary endothelium; **A** hole / pores / gaps
2. basement membrane acts as a filter;
3. no substances >68 000 MM can get through;
4. no cells can get through**;**

fluid can pass through podocytes because
5. have, projections / AW;
6. gaps (between projections); **A** filtration slits [4 max]

(b) (i) microvilli; [1]

(ii) 1. produce ATP / provide energy;
2. for active transport of Na^+;
3. **out** (of cell); [max 2]

(iii) *mark first two answers*
any named ion / mineral ions;

vitamins;

amino acids;

glucose;

some urea; [max 2]

[Total: 11]

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7 (a) $\mathbf{W^R}$ = allele for warfarin resistance
$\mathbf{W^S}$ **=** allele for warfarin susceptibility

parental phenotypes	resistant male		resistant female	
parental genotypes	$\mathbf{W^R W^S}$		$\mathbf{W^R W^S}$	
gametes	$\mathbf{W^R}$	$\mathbf{W^S}$	$\mathbf{W^R}$	$\mathbf{W^S}$;
offspring genotypes	$\mathbf{W^R W^R}$	$\mathbf{W^R W^S}$	$\mathbf{W^R W^S}$	$\mathbf{W^S W^S}$;
offspring phenotypes	**resistant**	**resistant**	**resistant**	**susceptible ;**

[3]

(b) not enough Vitamin K found (in the wild) / require too much Vitamin K; [1]

(c) competitive / reversible;

as the concentration of inhibitor increases, the rate of the (inhibited) reaction decreases
or
as dose of warfarin increases, the rate at which blood clots decreases; **ora** [2]

(d) 1. different, codon / triplet;

2. stop codon;

3. different amino acid;

4. different, primary / secondary / tertiary / 3D, structure;

5. shortened, polypeptide / protein;

6. change in function of protein; [3 max]

[Total: 9]

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8 (a) 1. allopatric speciation;

2. fish populations isolated;

3. geographical / physical / land, barrier;

4. no, breeding / allele flow / gene flow, between populations;

5. mutations occur;

6. different selection pressures / different (environmental) conditions;

7. advantageous alleles selected for / advantageous alleles passed on**;**

8. change in, allele frequency / gene pool;

9. (can result in) different chromosome numbers;

10. genetic drift;

11. ultimately, reproductively isolated / cannot interbreed; [5 max]

(b) 1. conditions remain the same within the pool;

2. best adapted fish (to conditions in pool) survive;

3. extreme phenotypes, selected against / do not survive; [2 max]

(c) 1. numbers of all species increase initially;

2. due to more, breeding space / food;

3. competition between (four) species**;**

4. (possible) reduction in numbers within, some / all, species;

5. not all species (may) survive;

6. different species, restricted to different areas / occupy different niches;

7. interbreeding / hybridisation;

8. AVP; e.g. ref. new selection pressure [3 max]

[Total: 10]

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9 (a) 1. DNA not surrounded by nuclear membrane / no nucleus;

2. (prokaryote) DNA is circular;

3. DNA not associated with histones; **A** naked DNA

4. plasmids (may) be present;

5. no (double) membrane-bound organelles; **A** no, mitochondria / chloroplasts

6. no, ER / Golgi; **A** ribosomes not attached to membranes

7. ribosomes,70S / 18 nm / smaller (than eukaryotic cells);

8. cell wall made of, peptidoglycan / murein / amino sugars / AW;

9. (usually) unicellular;

10. 0.5 to 5.0 μm diameter; **A** any value between 0.5 and 5.0 as long as μm is used

11. AVP; (may) have, flagella / pili / capsule / slime layer [8 max

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(b) 12. ores (may) contain metal sulfides;

13. example; e.g. iron / copper / zinc / cobalt / lead

14. insoluble in water so difficult to extract;

15. bacteria oxidise metal sulfide;

16. to soluble sulfate;

17. <u>bioleaching</u>;

18. example of bacteria; e.g. *A.ferrooxidans*

19. bacteria need to survive in acidic conditions;

20. mixture of bacteria required (in bioheap);

21. (in order to) survive a wide range of temperatures / range of bacteria with different temperature optima;

22. advantage;

23 e.g. low grade ores / spoil heaps, can be exploited
can get metal from industrial waste
does not produce sulfur dioxide
can be done in situ
low energy demand
less (heavy) machinery
not labour intensive
relatively cheaper (than other mining methods)

24. AVP; e.g. ref. gold / uranium [7 max]

[Total: 15]

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10 (a) *ignore references to function*
accept from diagram

1. 3 – 10 μm (diameter);
2. double membrane;
3. ground substance / stroma;
4. contains enzymes / named enzyme, e.g. rubisco;
5. also, sugars / lipids / starch;
6. 70S / AW, ribosomes;
7. circular DNA;
8. internal membrane system **/** fluid-filled sacs / thylakoids; **A** flattened sacs
9. grana are stacks of thylakoids;
10. (grana) membranes hold, photosynthetic pigments / ATP synthase / ETC; [7 max]

(b) 11. ethene (in plant);
12. stimulates production of gibberellin;
13. gibberellin stimulates, cell division / cell elongation / increase in stem length**;**
14. leaves / flowers, above water;
15. (so) photosynthesis can occur;
16. (so) sexual reproduction / pollination, can occur;
17. aerenchyma / description;
18. assists gas diffusion (within plant);
19. air can be trapped by specialised underwater leaves;
20. (submerged parts of plant) carry out anaerobic respiration;
21. produce ethanol;
22. can tolerate high concentrations of ethanol;
23. produce a lot of ethanol dehydrogenase; [8 max]

[Total: 15]

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This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
R	reject
A	accept (for answers correctly cued by the question, or by extra guidance)
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants excepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
AVP	Alternative valid point (examples given as guidance)

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Question **Expected Answers**

1 **(a)** **A** – palisade, mesophyll/cell/tissue/layer**;**

B – guard cell**;**

C – (sub-stomatal) air space**;**

[3]

(b) **(i)** 1. through the stoma(ta)**;**

2. by diffusion/description**;**

3. from the, atmosphere/air**;** [max 2]

(ii) ribulose bisphosphate**;**
I RuBP [1]

(iii) reduces/donates hydrogen **;** [2]
A H/hydrogen atoms/H^+ **AND** e^-
R H^+ / H_2

GP to TP **;**
A PGA to PGAL

[Total: 8]

2 **(a)** male mosquitoes do not, bite humans/feed on blood transmit disease
OR
only females, bite humans/feed on blood/transmit disease**;**

I GM male mosquitoes are not infected with the disease [1]

(b) 1. easier to, identify/screen**;**

2. more economical/time saving/labour saving**;**

3. resistance gene(s) can be passed to other bacteria**;**

4. idea of antibiotics no longer effective
OR requiring development of new, antibiotics/treatments**;** [max 2]

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(c) (i) production of tTA causes production of **more** tTA/AW**;** [1]

(ii) 1. promoter, initiates transcription/switches on gene**/**causes gene expression/AW**;**

2. ref. binding of, RNA polymerase/transcription factors**;**

3. otherwise gene has to be inserted near an existing promoter**;**

4. this is difficult to do/this may disrupt expression of existing gene**;**

5. in eukaryotes precise position of promoter important**;** [max 3]

(iii) 1. GM larvae do not die immediately**;**

2. so gives longer time for tTA, production/build up**;**

3. so tTA gets into environment (when GM larvae die) and kills non-GM larvae**;**

4. so (longer-lived larvae) compete with non-GM larvae (for, food/space)**;**

[max 2]

R ref. to larvae breeding

(d) (i) 1. chemical **A** has, similar shape to tTA/complementary shape to binding site**;**

2. so chemical **A** binds to, DNA/binding site, **AND** prevents tTA from binding**;**

3. chemical **A**, binds to/changes shape of, tTA
AND so prevents tTA binding to, DNA/binding site**;**

4. stops positive feedback/small quantity of tTA does not kill**;** [max 2]

5. chemical **A**, binds to/changes shape of/breaks down, tTA, so no longer toxic**;**

(ii) 1. GM males, mated/bred**;**
R with GM females

2. mosquitoes fed chemical **A;**

3. males, identified/separated**;**

4. ref. cloning**;** [max 2]

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(iii) 1. GM males die if they cannot get chemical **A;**

2. (if males mate), their offspring die**;**

3. only mate with, other *A. aegypti*/their own species**;** [max 2]

[Total: 15]

3 **(a)** 1. nutrients added **and** product removed at a steady rate/AW**;**

2. (so) volume kept constant**;**

3. organism kept at, exponential/log, phase of growth**;** [max 2]

(b) 1. (branched fungus tangles together in clumps so) too heavy for bubbles to, lift/stir
OR ref. to blocking**;**

2. difficult to, harvest/get desired texture**;**

3. mutant may be, harmful when eaten/toxic/allergenic**;**

4. mutant may produce, distasteful/coloured, substance**;**

5. mutant may be less productive**;**

6. mutant may have high concentration of RNA (which is difficult to lower)**;**

7. approval for sale only applies to original strain**;** [max 4]

(c) 864 kg**;** [1]

[Total: 7]

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4 (a) (i) 1. ATP is made, in the electron transport chain/by oxidative phosphorylation**;**

2. oxygen is the final electron acceptor**;**

3. in the, inner membrane of the mitochondrion/cristae**;**

4. transfer of electron (between electron carriers) provides energy**;**

5. energy used to pump hydrogen ions (into intermembrane space)**;**

6. creates proton gradient**;**

7. diffusion of hydrogen ions down their electrochemical gradient causes ATP to be synthesised**;**

8. ref. chemiosmosis/ATP synthase/stalked particles**;**

9. idea that if less oxygen (consumed/available) then fewer electrons transferred along the chain**;** [max 4]

(ii) 1. at high temperatures, reactions/enzyme activity/metabolism, faster**;**

2. because, molecules/enzymes/substrates, have more <u>kinetic</u> <u>energy</u>**;**

3. more frequent collisions**;**

4. therefore, respiration/Krebs cycle/electron transport chain/production of reduced NAD, take place at a faster rate**;**

5. idea of increase in rate of anabolic reactions (requiring more ATP)**;** [max 3]

(b) (i) 1. oxygen consumed = oxygen inhaled – oxygen exhaled**;**

2. measure oxygen consumption at rest (x) **and** after exercise stops (y)**;**

3. extra oxygen consumed/oxygen debt = y – x**;**

4. measure mass of lizard**;** [max 2]

(ii) 1. less (oxygen debt)(for *Varanus*)**; ora**

2. difference is greater at higher temperatures**;**

3. any two comparative figures at one temperature including units**;** [3]
A 102.0 cm^3 O_2 kg^{-1} at 30°C and 40°C

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(iii) 1. *Varanus* uses, less anaerobic/more aerobic, respiration (when running)**;**

2. more ATP produced per glucose molecule**;**

3. able to run for long time**;**

4. good chance of catching prey**;** [max 3]

(iv) *assume Varanus throughout*
1. larger surface area, in lungs/for gas exchange**;**

2. more oxygen absorbed into blood (per unit time)/faster rate of gas exchange**;**

3. more oxygen supplied to muscles (so oxygen debt lower)**;** [max 2]

[Total: 17]

5 (a) (indicates that they) have undergone meiosis I**;**

so are, haploid/n **;**
A 23 chromosomes [2]

(b) (i) water moved out of cells**;**

down water potential gradient/into a more concentrated solution/into a lower water potential**;**

(by) osmosis**;** [max 2]

(ii) (**B**) has, higher survival of oocytes after thawing/more successful fertilisations**;**

supporting figures**;**

*these should compare columns 1 or 2 with column 3 or 5 for both **A and B***
raw or manipulated data can be given [2]

(iii) idea of deferring, fertilisation/implantation**;**

idea of preserving oocytes from a woman who may lose her fertility due to medical treatment**;**

idea of fewer rounds of, hormone treatment/oocyte retrieval**;** [max 1]

[Total: 7]

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6 **(a)** **(i)** **A** – calcium ions ; **A** Ca^{2+} **R** calcium/Ca/Ca^{+}

B – sodium ions ; **A** Na^{+} **R** sodium/Na [2]

(ii) exocytosis; [1]

(iii) depolarisation (of post-synaptic membrane)/action potential ; [1]

(iv) 1. splits ACh;

2. into acetate and choline;

3. stops continuous depolarisation of postsynaptic membrane/AW;

4. choline recycled (into presynaptic neurone); [max 3]

(b) binds to/blocks, dopamine receptors (on postsynaptic membrane);

prevents depolarization (of postsynaptic membrane);

reduces **effect** of dopamine;

R reduces amount of dopamine [max 2]

(c) *ref 13 base deletion*
frame shift/alters reading frame (after mutation);

(so) all amino acids different **after** mutation;

3-D shape/tertiary structure, of protein changed;

(whereas) 21 base-pair deletion, loses 7 amino acids/no frame shift;

(whereas) substitution, may change only one amino acid/may be silent; [max 3]

(d) increased chances of, survival/breeding/mating;

provides a selective advantage;

allele passed on (to next generation);

allele increases in frequency over time;

natural selection; [max 3]

[Total: 15]

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7 (a) *sex-linked*
(gene) carried on, one sex chromosome/**X,** and not on, the other/**Y;**

gene
section of DNA/sequence of nucleotides/sequence of bases,
that codes for a (particular) polypeptide**;** [2]

(b)

parental phenotypes	*tortoiseshell female*		*black male*	
parental genotypes	X^BX^O		X^BY**;**	
gametes	X^B	X^O	X^B	**Y;**
offspring genotypes	X^BX^B	X^BY	X^BX^O	X^OY**;**
offspring phenotypes	**black female**	**black male**	**tortoiseshell female**	**orange male;**

[4]

(c) tortoiseshell is heterozygous**;**

males, heterogametic/only one **X** chromosome**;**

(therefore) only one copy of gene/only black or orange allele present**;** [max 2]

[Total: 8]

8 (a) 550(%)**;;**

allow one mark for $\frac{104 - 16}{16}$ *(x 100)* [2]

(b) 1. limiting/density dependent, factors or described**;**

2. reached carrying capacity/AW**;**

3. competition/AW**;**

4. for, food/nesting sites/resources**;**

5. large population attracts predators**;**

6. large population spreads disease more easily**;** [max 4]

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(c) 1. not many to begin with;

2. are carnivorous;

3. prey numbers fell;

4. slower reproductive rate;

5. more likely to migrate (to other areas);

[max 2]

[Total: 8]

9 (a) 1. cultural/aesthetic / leisure, reasons;

2. moral/ethical, reasons ; e.g. right to exist/prevent extinction;

3. resource material ; e.g. wood (for building)/fibres for clothes/food for humans/(herbal) medicine

4. (eco)tourism;

5. economic benefits;

6. ref. resource / species, may have use in future/AW;
e.g. medical use

7. maintains, food webs **/** food chains;
A description

8. nutrient cycling;

9. protection against erosion;

10. climate stability;

11. maintains, (large) gene pool**/**genetic variation;

12. scientific research; [max 7]

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(b) *advantages* (max 5)

13. can monitor health of mother;
14. can monitor development of foetus;
15. storage of, sperm/eggs/gametes;
16. artificial insemination;
17. IVF;
18. ref. surrogate mothers;
19. international cooperation;
20. genetic records kept;
21. can prevent extinction/extend range of a species/used in restoring ecosystem;

disadvantages (max 5)

22. unnatural environment;
23. stress in captivity;
24. behavioural changes;
25. reproductive cycles disrupted;
26. may reject selected mate;
27. examples of problems with release ;;
28. difficulty in finding food
    may not integrate into groups
    more susceptible to disease
    very little natural habitat left to release animals into [max 8]

[Total: 15]

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10 (a) 1. *in C3 plants at high temperature*
rubisco combines with oxygen**;**

2. less rubisco to combine with CO_2**;**

3. *in C4 plant such as maize*
idea of spatial separation of light-dependent stage from carbon fixation**;**

4. rubisco/RuBP, in bundle sheath cells**;**

5. kept away from, oxygen/air**;**

6. mesophyll cells, absorb CO_2**;**

7. CO_2 released to combine with RuBP**;**

8. avoid/reduce, photorespiration**;**

9. high optimum temperatures of enzymes involved**;**

10. Calvin cycle can continue**;**

11. AVP **;** e.g. CO_2 reacts with PEP
PEP carboxylase

[max 7]

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(b) 12. light energy absorbed by chlorophyll**;**
A photosystems/pigments

13. electron, excited/raised to higher energy level**;**

14. (electron) emitted by chlorophyll**;**
A photosystems/pigments

15. passes to electron, acceptor/carrier**;**

16. passes along, chain of electron carriers/ETC/Electron Transfer Chain**;**

17. energy released used to pump protons**;**
I ATP production here

18. into thylakoid space**;**

19. thylakoid membrane impermeable to protons**;**

20. proton gradient forms**;**

21. protons move down gradient**;**

22. through/using, ATP synthase/ATP synthetase**;**
R ATPase

23. enzyme rotates**;**

24. ATP produced from ADP and Pi**;**

[max 8]

[Total: 15]

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