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CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2012 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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1 (a)

correct order	letter of stage
1	E
2	**H**
3	**A**
4	**J**
5	**C**
6	F
7	**B**
8	**G**
9	**D**
10	**I**

H A J C all above **F ;**
H A J C in correct order **;**

B G D I all below **F ;**
B G D I in correct order **;** [4]

(b) (i) vesicles found **only** in presynaptic neurone /
ACh released **only** from presynaptic neurone or membrane **;**

receptor (proteins) found **only** on postsynaptic membrane **;** [2]

(ii) 1. allows more interconnection of nerve pathways / AW **;**
2. for, memory / AW **;** *ignore learning*
3. allows wider range of responses **;**
4. AVP **;** e.g. summation [2 max]

[Total: 8]

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2 **(a)** 1. 6 penicillin inhibits, enzyme / peptidase ;
2. blocks / alters shape of, active site ;
3. peptidoglycan chains cannot link up / stops cross-links forming ;
4. (so) cell wall weak(er) ;
5. turgor of cell not resisted (by cell wall) /
idea of inability to withstand increased internal pressure ;
6. cell / wall / bacterium, bursts **;** *ignore 'dies' as in question* [4 max]

(b) 1. mRNA produced by transcription ;
2. idea of triplet code ;
3. translated (at ribosome) ;
4. correct ref. to function of tRNA **;** e.g. anticodon / carries amino acid
5. formation of polypeptide ;
6. AVP **;** e.g. ref. tertiary structure / 3D shape / ref. bonds [3 max]

(c) **(i)** *mutant strain 1*
1. very low resistance **or** affected by low concentration of antibiotic ; **A** less resistant
2. gene (for efflux pump) not properly, expressed / switched on ;
3. (so) few pumps (produced) **or** pumps out less antibiotic ;
A pumps not working well [2 max]

mutant strain 2
4. more / x4, resistant **or** tolerates high concentration of antibiotic ;
5. gene (for efflux pump fully), expressed / switched on ;
6. (so) many pumps available **or** pumps out more antibiotic ; [2 max]

(ii) 1. natural selection **;**
2. antibiotic provides selection pressure ;
3. mutant **2** has selective advantage ;
4. in presence of >64 **and** <256 $\mu g\,cm^{-3}$ antibiotic ;
5. **R** dies / mutant strain **2** survives ;
6. mutant **2**, reproduces / increases in number ;
7. (so) passes, resistance / mutation, (to offspring) ; *ignore allele / gene* [4 max]

[Total: 15]

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3 (a) (i) 1. gene isolated ;
2. inserted into plasmid / AW ;
3. correct ref. sticky ends ;
4. plasmid taken up by, *E. coli* / bacterium ; **R** plasmid inserted into bacterium
5. detail **;** e.g. use of restriction enzyme / cDNA produced [3 max]

(ii) 1. marker gene linked to gene for wanted protein ;
2. with promoter ;
3. GFP gene is, transcribed / expressed ;
4. producing GFP which fluoresces ; [3 max]

(b) *disadvantage*
1. may not fluoresce very brightly / may be difficult to detect ;

explanation
2. only a few molecules of GFP produced ;
3. each enzyme molecule produces more fluorescent substance / *idea of* enzymes can be re-used ; [2 max]

[Total: 8]

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4 (a) (i) A ; [1]

(ii) W - spermatogonium ;
X - primary spermatocyte ;
Y - secondary spermatocyte ; [3]

(b) 3 marks for correct labels ;;; [3]

(c) (i) fertility / number of offspring, decreases ;

at 20°C the number of offspring is 280 while at 25°C the number of offspring is 150 / accept difference between figures ; [2]

(ii) smaller reduction in, fertility / number of offspring, in *alg–3* mutants than in *alg–4* mutants ; **ora**

manipulated data quote
either by 24% in *alg–3* **and** 61% in *alg–4*
or by 30 in *alg–3* **and** 135 in *alg–4* ; [2]

(iii) D ; [1]

(iv) *at 20°C*
difference due (only) to lack of (development of) motility (in mutants) / AW ;
R ref to numbers of sperm

at 25°C
difference due to fewer sperm(atids) **and** less (development of) motility ; [2]

[Total: 14]

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5 **(a)** transfer of pollen from anther to stigma ;
on the same, flower / plant ; [2]

(b) 1. *idea of* genetic variation ;
2. increased heterozygosity ; **ora**
3. hybrid vigour / decreased inbreeding depression ;
4. able to adapt to changing conditions ;
5. *idea of* some individuals surviving ;
6. AVP ; e.g. reduced risk of expression of harmful recessive alleles [3 max]

(c) **(i)** 1. initially / first 24 mins, exposure time increases, number of seeds produced / (chance of) fertilisation ;
2. then / after 24 or 44 mins, steep decrease in, number of seeds produced / (chance of) fertilisation ;
3. from 120 mins, no seeds produced / no fertilisation ; [2 max]

(ii) 1. plant GM maize some distance away from places that teosinte grows ;
2. estimate how far pollen can travel in 120 minutes ;
3. need more results between 60–120 minutes ; [2 max]

[Total:9]

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6 (a) *allele*
different / alternative, form of a gene ; **A** variety of a gene

one of two or more alternative nucleotide sequences at a single gene locus ; [1 max]

dominant
(allele) that (always) expresses itself in the phenotype when present /
(allele) which influences the phenotype even in the presence of an alternative allele ; [2]

(b) parental genotypes ;
gametes ;
offspring genotypes (in Punnett square) ;;
offspring phenotypes linked to genotypes ;
ratio 9:3:3:1 linked to phenotypes ; [6]

[Total: 8]

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7 (a) *corals*

1. (cells) have no chloroplasts ;
2. (cells) have no, cell walls / large vacuoles ;
3. are heterotrophic / not autotrophic / not photosynthetic ; [2 max]

(b) biotic and abiotic components **or** living and non-living components ;
correct ref. to interaction **;** [2]

(c) (i) Indian Ocean = 22(%)
Pacific Ocean = 9(%) ;
both correct for 1 mark [1]

(ii) any three from

1. named marine pollutant ; e.g. oil / sewage
2. example of climate change ; e.g. sea level rising / change in sea temperature / decrease in oxygen concentration of sea
3. (increasing carbon dioxide) decrease in pH of sea ;
4. intensive fishing ;
5. tourism qualified ;
6. removal of parts of reef ;
7. reclaiming land ; [3 max]

[Total: 8]

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8 **(a)** **X** = crista(e) / inner membrane ;
Y = matrix ; [2]

(b) **(i)** raise chemical PE of glucose / provide activation energy / AW ; [1]

(ii) removes hydrogen / hydrogen carrier / coenzyme ; [1]

(iii) 4 ; **A** net 2 [1]

(iv) dehydrogenation ; **A** oxidation
decarboxylation ;
accept 'oxidative decarboxylation' for two marks [2]

(v) matrix ; [1]

(vi) 1. accepted by NAD ;
2. passed to ETC ;
3. for oxidative phosphorylation ;
4. ref. proton pump / chemiosmosis ; [2 max]

(c) 1. found in all organisms ;
2. loss of phosphate / hydrolysis, leads to, energy release / release of 30.5 kJ (per mole) ;
3. ADP + Pi ⟷ ATP / reversible reaction ;
4. small packets of energy ;
5. small / water soluble, so can move around cell ;
6. (used by cells as) immediate energy donor ;
7. link between energy yielding and energy requiring reactions / AW ;
8. high turnover ;
9. example of use ; e.g. active transport / muscle contraction / Calvin cycle / protein synthesis [5 max]

[Total:15]

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9 (a) **1.** reduction division / (to) halve number of chromosomes / diploid to haploid / AW ;
2. homologous chromosomes pair up / bivalents form ;
3. ref. chiasmata / ref. crossing over ;
4. homologous chromosome pairs / bivalents, line up on equator ;
5. <u>independent</u> <u>assortment</u> ;
6. spindle / microtubules, attached to centromeres ;
7. chromosomes of each pair pulled to opposite poles ;
8. by shortening of, spindle / microtubules ;
9. nuclear envelopes re-form ;
10. cytokinesis / AW ; [6 max]

(b) *accept alternative symbols for alleles throughout*
11. frequency of sickle cell anaemia is highest in areas where malaria is common ;
12. sickle cell anaemia red blood cells cannot carry oxygen very well / AW ;
A sickling blocks capillaries
13. homozygous H^S / H^SH^S, have sickle cell anaemia / may die ;
14. homozygous H^N / H^NH^N, have normal, Hb / red blood cells ;
15. heterozygotes, have sickle cell trait
or
(sickle cell trait) red blood cells not (severely) affected ;
16. malaria parasite / *Plasmodium*, affects red blood cells ;
17. malaria lethal ;
18. sickle cell trait people / heterozygotes, less likely to suffer from (severe effects of) malaria ;
19. have selective advantage ;
20. pass on both H^N and H^S ;
21. malaria selects against, homozygous H^N / H^NH^N ;
22. sickle cell anaemia selects against, homozygous H^S / H^S H^S ;
23. *idea that* sickle cell <u>allele</u> is maintained within population
because of sickle cell trait individuals ; [9 max]

[Total: 15]

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10 (a) 1. chlorophyll a is primary pigment ;
2. carotenoids / chlorophyll b, is accessory pigment ;
3. arranged in, light harvesting clusters / photosystems ; **A** antenna complex
4. on, grana / thylakoids ;
5. ref. PI and PII ; **A** P700 and P680
6. primary pigment / chlorophyll a, in reaction centre ;
7. accessory pigments / carotenoids / chlorophyll b, surround primary pigment ;
8. light energy absorbed by, accessory pigments / carotenoids / chlorophyll b ;
9. (energy) passed on to, primary pigment / chlorophyll a / reaction centre ;
10. chlorophyll a and b absorb light in red and blue/violet region ;
11. carotenoids absorb light in blue/violet region ;
12. ref. absorption spectrum peaks ;
13. diagram of absorption spectrum ;
14. different combinations of pigments (in different plants) give different spectra ; [8 max]

(b) 15. IAA / plant growth regulator / plant growth substance / plant hormone ;
16. synthesised in, growing tips / apical buds / meristems ;
17. moves by, diffusion / active transport ;
18. from cell to cell ;
19. also, mass flow / in phloem ;
20. stimulates <u>cell</u> elongation ; **R** cell enlargement
21. inhibits, side / lateral, buds / growth ; **A** inhibits branching
22. plant grows, upwards / taller **or** allows stem to grow up to light (instead of sprouting) ; **A** stem elongates
23. auxin not solely responsible for apical dominance **or** there is interaction between auxin and other plant growth regulators ;
24. ref. *idea of* concentration gradient down shoot so effect of dominance decreases ;
25. AVP **;** e.g. role of ABA and lateral bud inhibition / cytokinins antagonistic to IAA / gibberellins enhance IAA *also mp 23* [7 max]

[Total: 15]

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

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1 **(a)** **A** - mitochondrion ;
B - post-synaptic membrane ;
C - myelin sheath / Schwann cell ; [3]

(b) 1 produces ATP ; (1)
R produces energy
any two from
2 (for) ACh production ;
3 (for) vesicle formation ;
4 (for) vesicle movement ;
5 (for) exocytosis / described ;
6 (for) functioning of ion pumps ;
R calcium ions (2 max) [3 max]

(c) 1 fits into (membrane) <u>receptors</u> ;
2 not broken down (by enzymes) ;
3 (so) <u>action</u> <u>potentials</u> generated for a long time (in post-synaptic neurone) ;
ignore ref to increased frequency of action potentials
4 AVP ; e.g. causes release of other transmitters / stimulant and depressant / variable response [2 max]

[Total: 8]

2 **(a)** 1 ref. sticky ends ;
2 GATC and CTAG ;
3 <u>complementary</u> bases (pairing) ;
4 A to T **and** C to G ;
5 H-bonds (to sticky ends of plasmid) ;
6 (gaps in) sugar-phosphate backbones sealed by (DNA) ligase ;
7 AVP ; e.g. formation of phosphodiester bonds / ref. terminal transferase [4 max]

(b) **(i)** 1 *idea of* identifying bacteria that, are transformed / have taken up plasmid / have taken up ampicillin resistance gene ;
2 these bacteria have survived ;
3 these bacteria may contain pBR322 or recombinant plasmid / plasmids taken up may not contain human insulin gene ;
4 other bacteria have been killed ; [3 max]

(ii) 1 (*Bam*HI) breaks the tetracycline resistance gene ;
2 (inserting human insulin gene) makes tetracycline resistance gene inactive ;
3 colonies that are ampicillin-resistant but **not** tetracycline-resistant have taken up recombinant plasmid / insulin gene ;
4 colonies that survive on, tetracycline / both ampicillin and tetracycline / plate **T**, have not taken up the recombinant plasmid / insulin gene ; [3 max]

(iii) *Answer on Fig. 2.2*
left hand colony on plate **A** ; [1]

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(c) (i) 1 plasmids (easily) transferred between bacteria ;
2 (bacteria of), same species / different species ;
3 bacteria can acquire antibiotic resistance / renders antibiotic useless / AW ; [2 max]

(ii) *mark for gene and mark for how product detected*
1 gene for β galactosidase ;
2 blue colour from X-gal medium ;
or
3 gene for β glucuronidase (GUS) ;
4 produces product that is easily stained blue ;
or
5 gene for, GFP / other fluorescent product ;
R fluorescent / fluorescence, gene
6 fluorescence detected when present ;
or
7 other gene ;
8 how detected ; [2 max]

[Total: 15]

3 (a) 1 globular ;
2 ref. tertiary structure / 3D shape ;
3 active site (because enzyme) ;
4 outer amino acids with hydrophobic R groups (because in membrane) / AW ; [2 max]

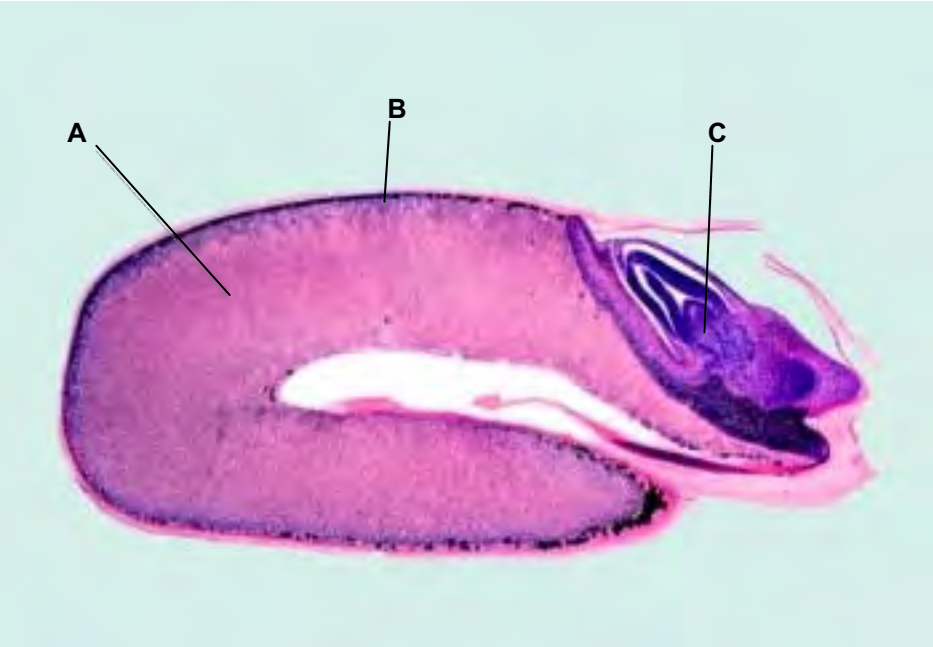
(b) 1 (penicillin) binds, rarely / briefly, with PBP2a ;
ignore doesn't bind well
2 (so) most PBP2a molecules not blocked ;
3 (so) cell wall / cross links, can still be made (in presence of penicillin) ;
4 penicillin is competitive inhibitor (of PBP) ;
5 (so) reduces PBP enzyme activity ; [3 max]

(c) 1 viruses have no (peptidoglycan) wall ;
2 viruses have no, transpeptidase / glycoprotein peptidase ;
3 viruses, have no cell structure / are not cells ;
4 viruses have no metabolism ; [2 max]

[Total: 7]

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4 (a)



[3]

(b) 1 protein higher in whole grain flour **because** protein is in aleurone layer ;
2 parts containing protein / aleurone layer, not removed (as in white flour) ;
3 dietary fibre higher in whole grain flour **because** (most) fibre is in, pericarp / testa ;
4 pericarp / testa, has not been removed (as in white flour) ;
5 carbohydrate content lower in whole grain flour **because** outer parts not removed ;
*accept **ora** throughout* [3 max]

(c) (i) starch must be digested (to glucose) before it is absorbed / digestion of starch takes time ; [1]

(ii) 1 amylose has 1–4 bonds / amylopectin has 1–4 bonds plus 1–6 bonds ;
2 amylose, digested / broken down to glucose / acted on by amylase, more slowly ;
3 because fewer sites for enzyme to work on / AW ;
*accept **ora** for mp2 and mp3* [2 max]

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(d) (i) 1 increasing intake (of whole cereal grains) decreases risk (of developing type II diabetes) ;
2 use of figures supporting this relationship ;
3 not all values fit the trend / reference to this not being a linear effect ;
4 reference to higher risk at 19.0 – 24.5 intake ; [3 max]

(ii) 1 idea that the risk of 1.00 for each food group is not the same risk ;
2 no info on size of servings / no indications that same units used for each group ;
3 intervals of range of intake not consistent – different intervals may give different results ; [2 max]

(iii) 1 fruits contain, sugars / glucose / fructose ;
2 sugar has a high GI ; [2]

[Total: 16]

5 (a) 1 ref. to suitable container e.g. dish
or
ref. suitable medium ;
2 ref. to addition of, sperm / semen, to <u>oocytes</u> ; [2]
A ICSI

(b) *advantage*
better chance of survival / more certain of getting a good-quality embryo / better chance of implantation ;
disadvantage
may be difficult to keep embryos alive for this time / embryos may become less viable / less chance of implantation ; [2]
only allow one mark for ref. to implantation

(c) (i) 1 higher % of pregnancies than the other methods ;
2 2. 35.1 % versus 22 .1 % **or** 35.1 % versus 34.6 % ;
3 little difference in the success rate of single top quality embryo transfer compared to multiple embryo transfer ;
4 multiple embryos increases risk of problems during pregnancy / birth ; [3 max]

(ii) 1 could lead to selection of features desired by parents / society
or less chance of a child being born with features seen as undesirable ;
2 ref. to discarding other embryos ; [1 max]

[Total: 8]

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6 (a) (i) *accept answers in a genetic diagram where genotypes are linked to phenotypes*
1 agouti allele / C^a, dominant to black allele / C^b ; **ora**
2 black parents homozygous recessive ;
3 agouti parents heterozygous **or** homozygous ; [2 max]

(ii) *accept answers in a genetic diagram where genotypes are linked to phenotypes*
1 yellow allele / C^y, dominant to, black allele / C^b ;
2 ref. to modified 3:1 ;
3 (homozygous) genotype $C^y C^y$, lethal / does not survive ; [2 max]

(iii) *accept answers in a genetic diagram where genotypes are linked to phenotypes*
1 yellow allele / C^y, dominant to **all** others ;
2 agouti / C^a **or** black and tan / C^{bt}, allele, dominant to black allele ;
A black allele recessive to all other alleles
3 yellow mice all heterozygous (must be stated) ; [2 max]

(b) 1 cross (black and tan mouse) with, black mouse / homozygous recessive mouse / $C^b C^b$;
2 if **all** offspring black and tan then parent, $C^{bt} C^{bt}$ / homozygous ;
3 if some offspring are black (and some are black and tan) then parent, $C^{bt}C^*$ / heterozygous ; [2 max]

[Total: 8]

7 (a) 1 *idea of* genetic variation ;
2 increased heterozygosity / decreased homozygosity ;
3 hybrid vigour / decreased inbreeding depression ;
4 able to adapt to <u>changing</u> conditions ;
5 *idea of* some individuals surviving ;
6 AVP ; e.g. reduced risk of expression of <u>harmful recessive alleles</u> [3 max]

(b) (i) *most affected*
almond, because, 100% / all / only, pollinated by honey bee **;**
least affected
orange, because only 25% pollinated by honey bee / 75% pollinated by other methods [2]

(ii) *any three from*
1 parasites / mites / viruses / bacteria ;
A disease
2 detail of climate change ; e.g. temperature change
3 pollution qualified ; e.g. increased use of pesticides / increased sulfur dioxide concentration in air
4 inbreeding ;
5 competition for food / food shortage ;
6 increase in predator numbers ;
7 AVP ; e.g. ref. killer bees / plant monoculture provides limited nutrition [3 max]

[Total: 8]

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8 **(a)** **(i)** cytoplasm / cytosol ; [1]

(ii) 1 NAD regenerated ;
2 so glycolysis can continue ;
3 to produce ATP ; [2 max]

(iii) lactate dehydrogenase ; [1]

(iv) *reaction* - condensation / polymerisation ;
bond - glycosidic ; [2]

(b) *in yeast*
1 decarboxylation / CO_2 removed ;
2 ethanal (as intermediate step) ;
3 ethanol produced ;
4 two steps (from pyruvate) ;
5 ethanol dehydrogenase ;
6 not a reversible reaction / ethanol cannot be converted back to pyruvate ;
7 *idea of* process less energy efficient ;
*allow **ora** for mp1, mp4, mp5, mp6 and mp7* [4 max]

(c) **(i)** carbon dioxide produced divided by oxygen consumed ;
volume / number of moles (of both gases) ; [2]

(ii) carbohydrate = 1.0 ;
lipid = 0.7 ; [2]

(iii) increase / go above one / infinity ; [1]

[Total: 15]

9 **(a)** 1 occur during meiosis I ;
crossing over
2 between non-sister chromatids ;
3 of, (a pair of) homologous chromosomes / a bivalent ;
4 in prophase 1 ;
5 at chiasma(ta) ;
6 exchange of genetic material / AW ;
***R** genes unqualified*
7 linkage groups broken / AW ;
8 new combination of alleles (within each chromosome) ;
independent assortment
9 of homologous chromosomes pairs / bivalents ;
10 each pair lines up independently of others ;
11 line up on equator ;
12 (during) metaphase 1 ;
13 results in gametes that are genetically unique / AW ; [9 max]

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(b)

	artificial selection		*natural selection*
14	selection (pressure by) humans	**or**	environmental selection pressure ;
15	genetic diversity lowered	**or**	genetic diversity remains high ;
16	inbreeding common	**or**	outbreeding common ;
17	loss of vigour / inbreeding depression	**or**	increased vigour / less chance of inbreeding depression ;
18	increased homozygosity / decreased heterozygosity	**or**	decreased homozygosity / increased heterozygosity ;
19	no isolation mechanisms operating	**or**	isolation mechanisms do operate ;
20	(usually) faster	**or**	(usually) slower ;
21	selected feature for human benefit	**or**	selected feature for organism's benefit ;
22	not for, survival / evolution	**or**	promotes, survival / evolution ;

[6 max]

[Total: 15]

10 (a) 1 PII absorbs light ;
2 enzyme (in PII) involved ;
3 to break down water / AW ;
4 $2H_2O \longrightarrow 4H^+ + 4e^- + O_2$;
5 <u>oxygen</u> is produced ;
6 used by cells for (aerobic) respiration ;
7 or released (out of plant) through stomata ;
8 protons used to reduce NADP ;
9 with electrons from PI ;
10 reduced NADP used in, light independent stage / Calvin cycle ;
11 to convert GP to TP ;
12 electrons also used in ETC ;
13 to release energy for photophosphorylation ;
14 to produce ATP ;
15 electrons (from PII) go to PI ;
16 ref. re-stabilise PI ; [10 max]

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(b) 16 gibberellin is a, plant growth regulator / plant hormone / plant growth substance ;
17 stimulates cell division ;
18 stimulates cell elongation ;
19 detail of cell elongation ; e.g. changes plasticity of cell wall
20 plant grows tall ;
21 apply gibberellin to dwarf plants and they grow taller / gibberellin promotes bolting of some rosette plants ;
22 ref. inactive and active forms ;
23 dwarf plants, lack active form / have inactive form, of gibberellin ;
24 (dominant) allele causes synthesis of enzyme ;
25 (enzyme) catalyses the production of the active form of gibberellin ;
26 recessive allele only inactive form of gibberellin formed / dominant allele results in active form of gibberellins ;
27 AVP ; e.g. ref. to different forms of gibberellins / there is interaction between / gibberellin and other plant growth regulators [5 max]

[Total: 15]

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