UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2010 question paper

for the guidance of teachers

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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International Examinations

1 **(a)** $\frac{(275 - 90)}{10}$ or $\frac{185}{10}$ or $\frac{1705}{10}$ for 1 mark

18.5 **;;** **A** 19 **R** 18 [2]

(b) 1 avoid disturbance to, nest sites/nesting females **;** **R** ref. to mating

2 protect, nest sites/young, from predators **;**

3 avoid sea pollution **;**

4 example of pollution **;** e.g. do not throw rubbish into sea / avoid discharge from boats/light pollution (beaches)

5 take care when fishing (with nets) **;**

6 stop hunting of adults **;** **A** trading ban on turtle products

7 captive breeding programmes/AW **;**

8 conservation areas/zoos **;**

9 education/ecotourism **;** [5 max]

[Total: 7]

2 **(a)** 1 hamster injected with, antigen/CD40 **;**

2 B cells/plasma cells, with ability to make antibody taken **;**

3 from spleen **;**

4 (B cells/plasma cells) fused with, tumour/cancer/myeloma, cell **;**

5 use of, fusogen/PEG **;**

6 (hybrid) cells cultured/AW **;** **R** use of fermenter

7 check cells for mAb production **;**

8 (antibody making) cells mass produced/AW **;** **A** use of fermenter [4 max]

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(b) (i) *accept mouse survival for heart survival*

1 in **A**, 100% hearts survive 10 days **or** no heart survives 20 days **;**

2 in **D**, 100% hearts survive, 80 days/to end of investigation **;**

3 in **B**, 100% hearts survive 30 days **or** 10% hearts survive, 80 days/to end of investigation **;**

4 in **C**, 100% hearts survive 30 days **or** 75% hearts survive, 80 days/to end of investigation **;**

penalise once for no mention of percentage in mps 2, 3 and 4 [4]

(ii) 1 in **D**, both pathways/CD28 and CD40, blocked **;**

2 so T-cells cannot be cloned/no immune response **;**

3 in **B**, CD40 pathway is not blocked/only CD28 is blocked **;**

4 so T cells can still be cloned/immune response triggered **;** [2 max]

(c) 1 carry blood to, cardiac/heart, muscle/tissue/cells **;**

2 supply oxygen **;**

3 supply, nutrient/named nutrient **;**

4 for, energy release/respiration **;** **R** produce energy [3 max]

(d) *two of the following:*

1 diagnosis of, disease/named disease **;** e.g. gonorrhoea/HIV

2 treatment of disease **;** e.g. directing drugs to cancerous cells **A** <u>auto</u>immune disease but **not** tissue or blood typing

3 pregnancy testing/drug testing **;**

4 (passive) vaccine production **;** [2 max]

[Total: 15]

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3 **(a)** **E** – spermatogonium/germinal epithelial cell **;**
F – secondary spermatocyte **;**
G – spermatid **;** **R** spermatozoa
H – Sertoli cell/nurse cell **;** [4]

(b) *Accept identification of cells from diagram.*

1 cell **E** mitosis **;**

2 (**E** / spermatogonia) increases in size/AW **;**

3 becomes a primary spermatocyte **;**

4 (primary spermatocyte) meiosis **I ;**

5 forms secondary spermatocyte(s) **;**

6 2n to n/diploid to haploid/halving chromosome number **;** [4 max]

[Total: 8]

4 **(a)** **(i)** **J** – epidermis/epidermal cell **;**
K – mesophyll (cell) **;**
L – bundle sheath (cell) **;** [3]

(ii) 1 mesophyll cells tightly packed/AW **;**

2 so O_2 cannot reach bundle sheath cells **;**

3 light independent stage/Calvin cycle **or** RuBP, in bundle sheath cells **;**

4 ref. malate shunt **;**

5 maintains high CO_2 concentration (in bundle sheath cells) **;**

6 PEP carboxylase, has high optimum temperature/has higher affinity for CO_2 /doesn't accept O_2 **;**

7 (PEP carboxylase) not denatured **;**

8 photorespiration is avoided **;** [4 max]

(b) 1 reduces water loss/AW **;**

2 wax does not melt **;**

3 shiny surface reflects radiation **;** [2 max]

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(c) (i) greater reduction in sorghum than in soybean **;**
use of comparative figures **;** e.g. sorghum 5.5 to 1.2 **or** by 4.3
soybean 5.2 to 1.6 **or** by 3.6 [2]

(ii) *reject 'no' for all points*

1 less surface area **;**

2 less absorption of light **;**

3 less, photophosphorylation / light dependent reaction **;**

4 less chemiosmosis **;**

5 (due to) smaller thylakoid space **or** reduced proton gradient **;**

6 less ATP (produced) **;**

7 less reduced NADP (produced) **;**

8 light-independent reaction / Calvin cycle, slows down **;**

9 less carbon dioxide, fixed / combined with PEP **;** **R** uptake [4 max]

[Total: 15]

5 (a) *(A.) porcatus* **;** [1]

(b) 1 *A. brunneus, A. smaragdinus and A. carolinensis* have smaller differences with *A. porcatus* (than with others)/AW **;**

2 therefore more closely related to *A. porcatus* (than to each other) **;**

3 use of figures **;**

4 AVP **;** e.g. comment about figures for *A. brunneus* with *A. smaragdinus*/
ref. different times of separation [3 max]

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(c) 1 allopatric speciation ;

2 (lizard populations) separated by water ;

3 geographical/physical, barrier ;

4 no, breeding/gene flow, between populations ;

5 mutations occur ;

6 different selection pressures/different (environmental) conditions ;

7 genetic change ; e.g. different alleles selected for/change in allele frequency/ change in gene pool/advantageous alleles passed **on** ;

8 (can result in) different chromosome numbers ;

9 genetic drift ;

10 ultimately, reproductively isolated/cannot interbreed ; [4 max]

[Total: 8]

6 **(a)** change in, DNA/base sequence ;
produces different allele ;
ref. different, protein/polypeptide, produced ; [2 max]

(b) 1 – X^rX^r ;
3 – X^rY ;
9 – X^RX^r ;
10 – X^RY ; [4]

(c) *answers must refer to phosphate ions*

1 altered shape/non-functional/no, carrier protein ;

2 less/no, reabsorption of phosphate ions (into blood) ;

3 from, glomerular filtrate/lumen of/proximal convoluted tubule ;

4 more/all, phosphate ions excreted ;

5 low phosphate ion concentration in, blood/bones ; **R** no phosphate ion conc [2 max]

[Total: 8]

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7 (a) (i) glycolysis ; [1]

(ii) cytoplasm/cytosol ; [1]

(iii) 4 ; **A** 4 – 2 = 2 [1]

(b) (i) inner membrane/cristae/stalked particles ; [1]

(ii) 1 reduced, NAD/FAD ;

2 dehydrogenase enzymes ;

3 release hydrogen ; **A** H **R** H_2/H^+

4 hydrogen splits into proton and electron ;

5 electrons flow down, ETC/AW ;

6 energy released ;

7 protons pumped (across inner membrane/from matrix) ;

8 into intermembrane space ;

9 proton gradient ;

10 protons pass through, ATP synthase/stalked particle ;

11 oxygen final, hydrogen/proton, acceptor ; [5 max]

(c) (i) nuclei **and** ribosomes ; [1]

(ii) 1 glycolysis, does not occur in mitochondrion/only occurs in cytosol or cytoplasm ;

2 pyruvate produced in glycolysis ;

3 pyruvate can enter mitochondrion/glucose cannot enter mitochondrion ;

4 carbon dioxide produced/decarboxylation, in, Krebs/link reaction ; [3 max]

(iii) 1 cyanide, inhibits cytochrome oxidase is a non-competitive inhibitor ;

2 reduced NAD not oxidised/AW ;

3 Krebs cycle stops ;

4 alternative H acceptor needed/pyruvate is H acceptor/pyruvate is reduced ; **R** H^+

5 lactate produced in cytoplasm ;

6 by anaerobic respiration ; [3 max]

[Total: 16]

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8 (a) (i) 1 parents, heterozygous/carriers ;

2 CF allele recessive ;

3 CF child homozygous recessive ; [2 max]

(ii) 1 thick/sticky/dehydrated, mucus produced ;

2 mucus not moved effectively by cilia/mucus accumulates ; **R** mucus blocks airway

3 reduced gaseous exchange/longer diffusion pathway ;

4 difficulty in breathing/AW ;

5 infections/(mucus) traps bacteria ;

6 lungs are scarred ; [2 max]

(b) (i) 1 alters genotype ;

2 insert, dominant/normal, allele ; **R** gene

3 into, affected/appropriate, cells ;

4 use of vector/named vector ;

5 ref. recombinant DNA ; [2 max]

(ii) *advantage*

1 treats cause not symptoms ;

2 no, physiotherapy/antibiotics/etc, needed ;

3 less time consuming than others treatments ; max 1

disadvantage

4 effects only last for a few days (at present)/low uptake by target cells ;

5 only target lung cells (at present) ;

6 side effects ; max 1 [2 max]

[Total: 8]

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9 **(a)** 1 closely packed to absorb maximum light ;

2 vertical/at right angles to surface of leaf to reduce number of cross walls ;

3 large vacuole pushes chloroplasts to edge of cell ;

4 chloroplasts at edge short diffusion path for carbon dioxide ;

5 chloroplasts at edge to absorb maximum light ;

6 large number of chloroplasts to absorb maximum light ;

7 cylindrical cells **or** air spaces to circulate gases/provide a reservoir of CO_2 ;

8 large surface area for diffusion of gases ;

9 moist cell surfaces for diffusion of gases ;

10 cell walls thin for maximum light penetration/diffusion of gases ;

11 chloroplasts can move towards light ;

12 chloroplasts can move away from high light intensity to avoid damage ; [8 max]

(b) 13 Calvin cycle/stroma ;

14 carbon dioxide fixed by RuBP ;

15 rubisco ;

16 2 molecules of GP formed ; **A** PGA

17 (GP) forms TP ; **A** GALP/PGAL

18 use of ATP ;

19 use of, reduced NADP/NADPH ;

20 from light dependent stage ;

21 some TP forms, hexose/sucrose/starch/cellulose/glycerol ;

22 some TP converted to acetyl CoA ;

23 some TP used to regenerate RuBP ;

24 using ATP ;

allow either mp 18 or mp 24

marks can be awarded on a diagram [7 max]

[Total: 15]

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10 (a) 1 renal/Bowman's, capsule ;

2 ref. podocytes ;

3 (proximal convoluted tubule/distal convoluted tubule/capsule) in cortex ;

4 proximal convoluted tubule ;

5 loop of Henle ;

6 (loop) in medulla ;

7 distal convoluted tubule ;

8 afferent arteriole ;

9 glomerulus ;

10 efferent arteriole ;

11 capillary network around/proximal convoluted tubule/loop/distal convoluted tubule ;

12 collecting duct ;

accept points on a labelled diagram [7 max]

(b) 13 endothelium of, blood capillaries/glomerulus ;

14 more/large, gaps between endothelial cells ;

15 podocytes ;

16 large gaps between podocytes/filtration slits ;

17 basement membrane, selective barrier/acts as a filter ;

18 prevents, large protein/RMM > 68 000, passing through ;

19 no cells pass through ;

20 named molecule which is filtered ; e.g. urea/water/glucose/uric acid/creatinine/ $Na^+/K^+/Cl^-$;

21 high, blood/hydrostatic, pressure in glomerulus ;

22 afferent arteriole wider than efferent arteriole ;

23 lower pressure in, renal/Bowman's, capsule ;

24 fluid forced into capsule/ultrafiltration ; [8 max]

[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)** 1 more nests in, areas of low salinity/less salty areas **;** **ora**

2 comment about result for salinity 16-20 not following trend **;**

3 2 paired figs with units **;** *linked to 1* [3]

(b) **(i)** $\frac{(31 - 8)}{8} \times 100$

287.5/288 **;;**

allow one mark for suitable working if incorrect answer [2]

(ii) *any two from*

1 (ensure) low salinity or more freshwater **;**

2 nest sites protected **;**

3 education/ecotourism **;**

4 assisted breeding **;**

5 ban on hunting **;**

6 preventing pollution **;** [2 max]

[Total: 7]

2 **(a)** 1 receptor or binding site not, complementary/specific, to FSH **;**

2 FSH has shorter β chain than LH **; ora**

3 FSH has different, primary structure/sequence of amino acids **;**

4 FSH has different, tertiary structure/3D shape **;** [3 max]

(b) **(i)** follicle (cells) **;** **A** granulosa (cells) [1]

(ii) corpus luteal (cells) **;** **A** granulosa (cells) [1]

(c) 1 (binding to a receptor), acts as a signal to the cells/stimulates cells **;**

2 to, start/increase, synthesis of hormone **;** **A** cells start to divide

3 oestrogen secreted **;** **A** mature follicle formed (oestrogen),

4 stimulates thickening of endometrium/inhibits FSH (production) **;** [3 max]

[Total: 8]

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3 (a) 1 penicillin inhibits enzyme **;** *ignore name of enzyme*

2 peptidoglycan chains cannot link up/stops cross-links forming **;**

3 cell wall becomes weaker/AW **;**

4 turgor of cell not resisted (by cell wall)/AW **;**

5 cell/wall, bursts **;** [3 max]

(b) (i) **B** has, an outer membrane/channel proteins **;**
B has thinner (peptidoglycan) wall **;** *accept* ***ora*** *for* ***A*** [2]

(ii) 1 penicillin V can reach the, wall/(cell surface) membrane, of **A ; ora**

2 outer membrane of **B** stops penicillin V getting through **; ora**

3 penicillin V cannot get through pores of outer membrane of **B ;** [2 max]

(iii) can penetrate outer membrane **;**
through pores/directly through as non-polar **;** [2]

(c) *batch culture*

1 set up and allowed to proceed **;**

2 nutrients not added or products removed, (during fermentation) **;**

3 air allowed in/waste gas allowed out **;**

4 at end of each process, product harvested/fermenter cleaned out **;** *max 2*

continuous culture

5 nutrients added (all the time) **;**

6 products removed (all the time) **;**

7 no down time/AW **;** *max 2* [3 max]

(d) 1 *(Penicillium*/fungus), does not make penicillin all the time/penicillin is made in the later stages of growth **;**

2 when beginning to run out of nutrients **;**

3 (penicillin) is a secondary metabolite **;**

4 continuous culture has no yield of penicillin **;**

5 continuous culture, never reaches stationary phase of growth/always exponential growth **;**
[3 max]

[Total: 15]

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4 **(a)** 1 can be grown in many different environments/AW **;**

2 (grains) contain variety of nutrients **;** **A** list of 3+ nutrients

3 detail of nutrient content **;** e.g. high in calcium/vitamin B/protein

4 (grains) have high, energy/fibre, content **;**

5 (grains) store well **;** [3 max]

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

(ii) 1 both rise and then fall **;**

2 sorghum (enzyme) has higher activity (at all temperatures) **;**

3 sorghum (enzyme) has higher maximum activity **;**

4 sorghum (enzyme) has higher optimum temperature **;** **A** 70° and 60°

5 comparative figures to illustrate points 2 or 3 **;** [3 max]

(iii) 1 (rice) tertiary structure/active site, of amylase is altered more by high temperature **;**

2 (therefore) fewer ES/enzyme-substrate complexes formed/AW **;**

3 high temperatures affect H bonds (more than other bonds) **;**

4 amylase in rice may have more H bonds **;** **ora**

5 correct ref. to other named bond **;** [3 max]

(c) **(i)** 1 higher CO_2 uptake at higher light intensity **;** **ora**

2 comparative figures **;** *using columns 1 and 2*

3 CO_2 used in, Calvin cycle/light independent reaction **;**

4 photophosphorylation/light dependent stage provides, ATP/reduced NADP **;**

5 for use in, Calvin cycle/light independent reaction **;**

6 light is a limiting factor **;** [3 max]

(ii) 1 survive better at low light intensities **;**

2 comparative figures **;** *using columns 1 and 6* [2]

[Total: 15]

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5 **(a)** divergence values less for *persimilis* than for *pseudoobscura* (at all DNA regions) **;** **ora** use of figures **;** [2]

(b) 1 some regions of DNA more prone to mutation than others **;**

2 mutation in some regions likely to be fatal (so not seen in populations) **;**

3 there tends to be less divergence if DNA is part of an important gene/**ora** **;**

4 detail **;** e.g. causes change in essential protein [2 max]

(c) 1 allopatric speciation **;**

2 geographical/physical, barrier **;**

3 no, breeding/gene flow, between populations **;**

4 mutations occur **;**

5 different selection pressures/different (environmental) conditions **;**

6 genetic change **;** e.g. different alleles selected for/change in allele frequency/change in gene pool/advantageous alleles passed on **;**

7 genetic drift **;**

8 (ultimately) cannot interbreed/reproductively isolated **;** [4 max]

[Total: 8]

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6 **(a)** 1 allele/gene, found on **X** chromosome **;**

2 females have two copies of, allele/gene **;**

3 males have only one copy of, allele/gene **;** [2 max]

(b) *key to symbols*

recessive allele **X^a** (= allele for CI)

dominant allele **X^A** (= allele for normal iris) ;

cross 1
parental phenotypes male with CI/cleft iris **and** normal female **;**

gametes **X^a or Y** **all X^A ;**

offspring genotypes **X^AX^a** **X^AY ;**

offspring phenotypes **normal female** **normal male ;**

.....

or

……..……..

cross 2
parental phenotypes male with CI/cleft iris **and** normal female **;**

gametes **X^a or Y** **X^A or X^a ;**

offspring genotypes **X^AX^a** **X^AY** **X^aX^a** **X^aY ;**

offspring phenotypes **normal female** **normal male** **cleft iris/CI female** **cleft iris/CI male ;** [5]

offspring phenotypes must be linked to genotypes

(c) 1 in 4/25%/0.25 **;** **R** ratios [1]

[Total: 8]

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7 (a) (i) removal of, carbon dioxide/carboxyl group ;
removal of hydrogen ; [2]

(ii) **P** and **Q** ; [1]

(b) (i) 3 ; [1]

(ii) 1 inner mitochondrial membrane/cristae ;

2 dehydrogenase enzymes ;

3 release hydrogen ;

4 hydrogen splits into protons and electrons ;

5 electrons flow down, ETC/Electron Transfer Chain/AW ;

6 energy released ;

7 protons pumped across (inner membrane) ;

8 into intermembrane space ;

9 proton gradient ;

10 protons pass through, ATP synthase/stalked particles ;

11 ATP formed ; *linked to 10*

12 oxygen (final), hydrogen/proton and electron, acceptor ; *max 4* [5 max]

(c) 1 pyruvate converted to ethanal ;

2 ethanal reduced ;

3 by reduced NAD ;

4 NAD, oxidised/regenerated ;

5 allows glycolysis to continue ;

6 ethanal dehydrogenase ;

7 ethanol formed ;

8 prevents H^+ from lowering pH ; [4 max]

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(d) 1 no, decarboxylation/carbon dioxide removed ; **A** ora

2 single step ;

3 lactate dehydrogenase ;

4 reversible ; [3 max]

[Total: 16]

8 **(a)** **(i)** 1 change in, genetic material/DNA, (in cell) ;

2 (therefore) change product of cell ;

3 during protein synthesis ; [2 max]

(ii) 1 identification of transformed, cells/organisms ;

2 avoid use of antibiotics ;

3 easy to detect ;

4 no known ill effect on GM organism ; [2 max]

(b) **(i)** 1 reduces deficiency disease/AW ;

2 better quality food ;

3 assistance to developing nations/AW ;

4 cheap seed ; e.g. for golden rice [2 max]

(ii) 1 high cost of GM seed ;

2 too much power held by multinational companies ;

3 change to ecosystem ; e.g. hybridisation

4 GM crops may be difficult to sell ;

5 GM plant varieties may be genetically unstable ;

6 no long term studies done on effects on human health ;

7 reduction in biodiversity/outcompetes natural variety or species ; [2 max]

[Total: 8]

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9 **(a)** 1 arranged in light harvesting, clusters/system **;**

2 primary pigments/chlorophyll a **;**

3 at reaction centre **;**

4 P700/P1, absorbs at 700(nm) **;**

5 P680/P11, absorbs at 680(nm) **;**

6 accessory pigments/chlorophyll b/carotenoids, surround, primary pigment/reaction centre/ chlorophyll a **;**

7 pass <u>energy</u> to, primary pigment/reaction centre/chlorophyll a **;**

8 P700 / PI, involved in cyclic photophosphorylation **;**

9 (light absorbed results in) electron excited/AW **;**

10 emitted from, chlorophyll/photosystem **;**

11 flows along, chain of electron carriers/ETC **;**

12 ATP synthesis **;**

13 electron returns to, P700/P1 **;** [8 max]

(b) 14 <u>photolysis</u> (of water) **;**

15 releases H^+ **;** ***R*** *H/hydrogen atoms*

16 by, P680/PII **;**

17 e^- released **;**

18 by, P700/PI **;**

19 both combine with NADP **;**

(reduced NADP)

20 reduces, GP **;** **A** PGA

21 to TP **;** **A** PGAL / GALP

22 ATP used **;**

23 NADP, regenerated/oxidised **;** [7 max]

[Total: 15]

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10 (a) 1 nucleus in cell body ;

2 (long) dendron ; **R** plural

3 (shorter) axon ;

4 many mitochondria (in cell body) ;

5 many RER/nissl's granules, (in cell body) ;

6 synaptic knobs ;

7 detail of synaptic knob ;

8 (terminal) dendrites ;

9 Schwann cells ;

10 detail of myelin sheath ;

11 nodes of Ranvier ;

accept points on labelled diagram [7 max]

(b) 12 Na^+ channels open ; **A** sodium channels

13 Na^+ enter cell ; **R** enter membrane

14 inside becomes, less negative/positive/+40mV **or** membrane depolarised ;

15 Na^+ channels close ; **A** sodium channels

16 K^+ channels open ; **A** potassium channels

17 K^+ move out (of cell) ; **R** of membrane

18 inside becomes negative **or** membrane repolarised ; **A** negative figure
max 5

19 local circuits/description ;

20 (myelin sheath/Schwann cells) insulate axon/does not allow movement of ions ;

21 action potential/depolarisation, only at nodes (of Ranvier)/gaps ;

22 saltatory conduction/AW ;

23 one-way transmission ;

24 AVP ; e.g. hyperpolarisation/refractory period [8 max]

[Total: 15]

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1 **(a)** 1 more nests in, areas of low salinity/less salty areas **;** **ora**

2 comment about result for salinity 16-20 not following trend **;**

3 2 paired figs with units **;** *linked to 1* [3]

(b) **(i)** $\frac{(31 - 8)}{8} \times 100$

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(ii) *any two from*

1 (ensure) low salinity or more freshwater **;**

2 nest sites protected **;**

3 education/ecotourism **;**

4 assisted breeding **;**

5 ban on hunting **;**

6 preventing pollution **;** [2 max]

[Total: 7]

2 **(a)** 1 receptor or binding site not, complementary/specific, to FSH **;**

2 FSH has shorter β chain than LH **; ora**

3 FSH has different, primary structure/sequence of amino acids **;**

4 FSH has different, tertiary structure/3D shape **;** [3 max]

(b) **(i)** follicle (cells) **;** **A** granulosa (cells) [1]

(ii) corpus luteal (cells) **;** **A** granulosa (cells) [1]

(c) 1 (binding to a receptor), acts as a signal to the cells/stimulates cells **;**

2 to, start/increase, synthesis of hormone **;** **A** cells start to divide

3 oestrogen secreted **;** **A** mature follicle formed (oestrogen),

4 stimulates thickening of endometrium/inhibits FSH (production) **;** [3 max]

[Total: 8]

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3 **(a)** 1 penicillin inhibits enzyme **;** *ignore name of enzyme*

2 peptidoglycan chains cannot link up/stops cross-links forming **;**

3 cell wall becomes weaker/AW **;**

4 turgor of cell not resisted (by cell wall)/AW **;**

5 cell/wall, bursts **;** [3 max]

(b) **(i)** **B** has, an outer membrane/channel proteins **;**
B has thinner (peptidoglycan) wall **;** *accept* ***ora*** *for* ***A*** [2]

(ii) 1 penicillin V can reach the, wall/(cell surface) membrane, of **A** **;** **ora**

2 outer membrane of **B** stops penicillin V getting through **;** **ora**

3 penicillin V cannot get through pores of outer membrane of **B** **;** [2 max]

(iii) can penetrate outer membrane **;**
through pores/directly through as non-polar **;** [2]

(c) *batch culture*

1 set up and allowed to proceed **;**

2 nutrients not added or products removed, (during fermentation) **;**

3 air allowed in/waste gas allowed out **;**

4 at end of each process, product harvested/fermenter cleaned out **;** *max 2*

continuous culture

5 nutrients added (all the time) **;**

6 products removed (all the time) **;**

7 no down time/AW **;** *max 2* [3 max]

(d) 1 *(Penicillium*/fungus), does not make penicillin all the time/penicillin is made in the later stages of growth **;**

2 when beginning to run out of nutrients **;**

3 (penicillin) is a secondary metabolite **;**

4 continuous culture has no yield of penicillin **;**

5 continuous culture, never reaches stationary phase of growth/always exponential growth **;**
[3 max]

[Total: 15]

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4 **(a)** 1 can be grown in many different environments/AW **;**

2 (grains) contain variety of nutrients **;** **A** list of 3+ nutrients

3 detail of nutrient content **;** e.g. high in calcium/vitamin B/protein

4 (grains) have high, energy/fibre, content **;**

5 (grains) store well **;** [3 max]

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

(ii) 1 both rise and then fall **;**

2 sorghum (enzyme) has higher activity (at all temperatures) **;**

3 sorghum (enzyme) has higher maximum activity **;**

4 sorghum (enzyme) has higher optimum temperature **;** **A** 70° and 60°

5 comparative figures to illustrate points 2 or 3 **;** [3 max]

(iii) 1 (rice) tertiary structure/active site, of amylase is altered more by high temperature **;**

2 (therefore) fewer ES/enzyme-substrate complexes formed/AW **;**

3 high temperatures affect H bonds (more than other bonds) **;**

4 amylase in rice may have more H bonds **;** **ora**

5 correct ref. to other named bond **;** [3 max]

(c) **(i)** 1 higher CO_2 uptake at higher light intensity **;** **ora**

2 comparative figures **;** *using columns 1 and 2*

3 CO_2 used in, Calvin cycle/light independent reaction **;**

4 photophosphorylation/light dependent stage provides, ATP/reduced NADP **;**

5 for use in, Calvin cycle/light independent reaction **;**

6 light is a limiting factor **;** [3 max]

(ii) 1 survive better at low light intensities **;**

2 comparative figures **;** *using columns 1 and 6* [2]

[Total: 15]

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5 **(a)** divergence values less for *persimilis* than for *pseudoobscura* (at all DNA regions) **;** **ora** use of figures **;** [2]

(b) 1 some regions of DNA more prone to mutation than others **;**

2 mutation in some regions likely to be fatal (so not seen in populations) **;**

3 there tends to be less divergence if DNA is part of an important gene/**ora** **;**

4 detail **;** e.g. causes change in essential protein [2 max]

(c) 1 allopatric speciation **;**

2 geographical/physical, barrier **;**

3 no, breeding/gene flow, between populations **;**

4 mutations occur **;**

5 different selection pressures/different (environmental) conditions **;**

6 genetic change **;** e.g. different alleles selected for/change in allele frequency/change in gene pool/advantageous alleles passed on **;**

7 genetic drift **;**

8 (ultimately) cannot interbreed/reproductively isolated **;** [4 max]

[Total: 8]

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6 (a) 1 allele/gene, found on **X** chromosome **;**

2 females have two copies of, allele/gene **;**

3 males have only one copy of, allele/gene **;** [2 max]

(b) *key to symbols*

recessive allele **X^a** (= allele for CI)

dominant allele **X^A** (= allele for normal iris) ;

cross 1
parental phenotypes male with CI/cleft iris **and** normal female **;**

gametes **X^a or Y** **all X^A ;**

offspring genotypes **X^AX^a** **X^AY ;**

offspring phenotypes **normal female** **normal male ;**

.....
or
……..……..

cross 2
parental phenotypes male with CI/cleft iris **and** normal female **;**

gametes **X^a or Y** **X^A or X^a ;**

offspring genotypes **X^AX^a** **X^AY** **X^aX^a** **X^aY ;**

offspring phenotypes **normal female** **normal male** **cleft iris/CI female** **cleft iris/CI male ;** [5]

offspring phenotypes must be linked to genotypes

(c) 1 in 4/25%/0.25 **; R** ratios [1]

[Total: 8]

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7 (a) (i) removal of, carbon dioxide/carboxyl group ;
removal of hydrogen ; [2]

(ii) **P** and **Q** ; [1]

(b) (i) 3 ; [1]

(ii) 1 inner mitochondrial membrane/cristae ;

2 dehydrogenase enzymes ;

3 release hydrogen ;

4 hydrogen splits into protons and electrons ;

5 electrons flow down, ETC/Electron Transfer Chain/AW ;

6 energy released ;

7 protons pumped across (inner membrane) ;

8 into intermembrane space ;

9 proton gradient ;

10 protons pass through, ATP synthase/stalked particles ;

11 ATP formed ; *linked to 10*

12 oxygen (final), hydrogen/proton and electron, acceptor ; *max 4* [5 max]

(c) 1 pyruvate converted to ethanal ;

2 ethanal reduced ;

3 by reduced NAD ;

4 NAD, oxidised/regenerated ;

5 allows glycolysis to continue ;

6 ethanal dehydrogenase ;

7 ethanol formed ;

8 prevents H^+ from lowering pH ; [4 max]

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(d) 1 no, decarboxylation/carbon dioxide removed ; **A** ora

2 single step ;

3 lactate dehydrogenase ;

4 reversible ; [3 max]

[Total: 16]

8 **(a)** **(i)** 1 change in, genetic material/DNA, (in cell) ;

2 (therefore) change product of cell ;

3 during protein synthesis ; [2 max]

(ii) 1 identification of transformed, cells/organisms ;

2 avoid use of antibiotics ;

3 easy to detect ;

4 no known ill effect on GM organism ; [2 max]

(b) **(i)** 1 reduces deficiency disease/AW ;

2 better quality food ;

3 assistance to developing nations/AW ;

4 cheap seed ; e.g. for golden rice [2 max]

(ii) 1 high cost of GM seed ;

2 too much power held by multinational companies ;

3 change to ecosystem ; e.g. hybridisation

4 GM crops may be difficult to sell ;

5 GM plant varieties may be genetically unstable ;

6 no long term studies done on effects on human health ;

7 reduction in biodiversity/outcompetes natural variety or species ; [2 max]

[Total: 8]

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9 **(a)** 1 arranged in light harvesting, clusters/system **;**

2 primary pigments/chlorophyll a **;**

3 at reaction centre **;**

4 P700/P1, absorbs at 700(nm) **;**

5 P680/P11, absorbs at 680(nm) **;**

6 accessory pigments/chlorophyll b/carotenoids, surround, primary pigment/reaction centre/ chlorophyll a **;**

7 pass <u>energy</u> to, primary pigment/reaction centre/chlorophyll a **;**

8 P700 / PI, involved in cyclic photophosphorylation **;**

9 (light absorbed results in) electron excited/AW **;**

10 emitted from, chlorophyll/photosystem **;**

11 flows along, chain of electron carriers/ETC **;**

12 ATP synthesis **;**

13 electron returns to, P700/P1 **;** [8 max]

(b) 14 <u>photolysis</u> (of water) **;**

15 releases H^+ **;** ***R*** *H/hydrogen atoms*

16 by, P680/PII **;**

17 e^- released **;**

18 by, P700/PI **;**

19 both combine with NADP **;**

(reduced NADP)

20 reduces, GP **;** **A** PGA

21 to TP **;** **A** PGAL / GALP

22 ATP used **;**

23 NADP, regenerated/oxidised **;** [7 max]

[Total: 15]

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10 (a) 1 nucleus in cell body ;

2 (long) dendron ; **R** plural

3 (shorter) axon ;

4 many mitochondria (in cell body) ;

5 many RER/nissl's granules, (in cell body) ;

6 synaptic knobs ;

7 detail of synaptic knob ;

8 (terminal) dendrites ;

9 Schwann cells ;

10 detail of myelin sheath ;

11 nodes of Ranvier ;

accept points on labelled diagram [7 max]

(b) 12 Na^+ channels open ; **A** sodium channels

13 Na^+ enter cell ; **R** enter membrane

14 inside becomes, less negative/positive/+40mV **or** membrane depolarised ;

15 Na^+ channels close ; **A** sodium channels

16 K^+ channels open ; **A** potassium channels

17 K^+ move out (of cell) ; **R** of membrane

18 inside becomes negative **or** membrane repolarised ; **A** negative figure
max 5

19 local circuits/description ;

20 (myelin sheath/Schwann cells) insulate axon/does not allow movement of ions ;

21 action potential/depolarisation, only at nodes (of Ranvier)/gaps ;

22 saltatory conduction/AW ;

23 one-way transmission ;

24 AVP ; e.g. hyperpolarisation/refractory period [8 max]

[Total: 15]

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