UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2011 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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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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1 **(a)** 36 **;**;
allow one mark for number not rounded up i.e. 35.7
or
allow working of $\frac{X}{7} \times 100$ [2]

(b) 1. reduction in extent of ice sheet **;**
2. reduction in number of, seals / prey / food **or** increased competition for food **;**
3. idea of increased distance to travel to find food **;**
4. loss / destruction, of breeding sites **;**
5. result of named human activity **;** e.g. mining / drilling / killing / building / pollution
6. disease **;** [3 max]

(c) *applies to U. maritimus but accept ora*
1. DNA linear **;**
2. DNA in nucleus **or** has, nuclear membrane / nucleus **;**
3. DNA, associated with protein / in chromosomes **;**
4. ribosome, 22 nm diameter / 80s **;**
5. membrane bound organelles / named organelle **;**
6. no cell wall **;**
7. size up to 40μm **;** [3 max]

[Total: 8]

2 **(a)** **(i)** *any one from* **;**
hot springs
sulphur springs
geysers
geothermals
marine vent
volcanic area
hot desert [1]

(ii) 1. each bacterium grows at a different temperature (range) **;**
2. (the heap) heats up **;**
3. idea of when temperature kills one species of bacterium others are still active
or
as temperature increases process can continue **;**
4. increased oxidation of heap **;**
5. more productive / enables increased yield of gold **;** [3 max]

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(b) (i) 1. *A. ferrooxidans* increases, oxidation of the ore / production of Fe^{3+} ;
2. little difference in effect 0–5 days ;
3. greatest effect after 15 days ;
4. comparative figs for with and without *A. ferrooxidans* on a single day ; [3 max]

(ii) 1. cheaper (than other methods) ;
2. does not require energy input ;
3. does not require other chemicals to be purchased ;
4. does not require specialist equipment ;
5. can be done *in situ* ;
6. less labour needed ;
7. bacteria are self-replicating / AW ;
8. more environmentally friendly than other methods / no harmful emissions / AW ;
9. useful for extraction from, low grade ores / waste ; [3 max]

(c) *must have at least one D mark to score 4 marks*
D1 both strains give similar rate with and without arsenic ions ;
D2 both strains are arsenic-resistant ;
D3 strain 2, more active / higher oxidation rate, (than strain 1) ;
E4 arsenic acts as a selective, agent / pressure ;
E5 mutation / AW, produces resistant bacteria ;
E6 resistant bacteria survive / **ora** ;
E7 resistant allele passed on ;
E8 frequency of allele increases (in population) ; [4 max]

[Total: 14]

3 (a) 1. ref. hormone treatment ;
2. results in, superovulation / many oocytes / many follicles, maturing at same time ;
3. oocytes harvested ;
4. detail of harvesting ;
5. mixed with sample of sperm ;
6. in special medium ;
7. idea of, waiting for three days / wait until 6–8 cell stage ;
8. embryos placed in uterus ;
9. ref. maintenance of endometrium ;
10. sperm / sperm nucleus / sperm DNA, may be injected into oocyte ; [4 max]

(b) *one mark for a ✓ in the correct box*
more than one ✓ in a row = no mark
ignore crosses

DNA – colourless ;
acrosome – colourless ;
mitochondria – green ; [3]

(c) 1. (hydrolytic) enzymes may damage oocyte ;
2. (acrosome contents) affect development of fertilised oocyte ; [1 max]

[Total: 8]

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4 (a)

1.	β cells detect glucose levels	**or**	no detection of blood glucose conc.	;
2.	β cells secrete insulin	**or**	no insulin released	;
3.	when blood glucose concentration rises	**or**	when blood glucose concentration rises	;
4.	(insulin causes) muscle cells / adipose tissue / liver cells	**or**	muscle cells / adipose tissue / liver cells	;
5.	to increase uptake of glucose from blood / increased membrane permeability to glucose	**or**	do not take up excess glucose	;
6.	(insulin causes liver cells) to convert glucose to glycogen	**or**	glucose not converted to glycogen (by liver cells)	;
7.	(insulin causes liver cells) to increase respiration of glucose	**or**	rate of respiration of glucose does not increase	;
8.	(if no β cells) no control of blood glucose levels / AW	**or**	no control of blood glucose levels / AW	;

[4 max]

(b) (i) 1. (yes) more people with infection have CFRD than those without infection **;**
2. use of 'with CFRD' comparative figs **;**
either *using number of people* – 44 / 52 / 96 (**no** infection)
against 106 / 121 / 227 (with infection)
or *using* FEV_1 *values* – 71.1 / 53.6 / 124.7 (**no** infection)
against 49.0 / 42.0 / 91.0 (**with** infection)
or 28.5% males against 35.8% females (**no** infection)
or 38.9% males against 50.05% females (**with** infection)
3. AVP **;** e.g. we do not know how the sample was chosen (so this may not be a valid conclusion) [2 max]

(ii) $\frac{2.2}{71.4} \times 100$ **;** = 3.08 / 3.1 **;**
or
$\frac{2.2}{73.6} \times 100$ **;** = 2.99 / 3.0 **;** [2]

(iii) 1. more lung damage in females (with CFRD) than in males **;**
2. females (with CFRD) have lower FEV_1 than males **;**
3. use of figures **;** e.g. males FEV_1 49 whereas female FEV_1 42
or female FEV_1 1.16 times lower than male FEV_1 [3]

(c) 1. CFTR protein acts as chloride channel (in cell membranes) **;**
with CF
2. faulty (CFTR) gene **;**
3. faulty / non-functional, (CFTR) protein produced **;**
4. chloride ions not able to move out (of cell) **;**
5. by active transport **;**
6. so less water passes out (of cell) **;**
7. down water potential gradient **;** **A** by osmosis
8. mucus secreted contains less water **;** [4 max]

[Total: 15]

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5 **(a)** 1. (either feature) reduces water loss by, transpiration / evaporation **;**
2. reduction in, number of stomata / surface area, (for, transpiration / evaporation) **;**
3. rolling leaves traps moist air **;**
4. idea of reduced, diffusion / water potential, gradient (between leaf and trapped air) **;**

[3 max]

(b) **(i)** cooked protein more digestible than raw protein **;**
use of figures **;** *accept any **named** comparison between cooked and raw* [2]

(ii) *cooked*
1. cooking breaks cross-links (in kaffirin) **; A** bonds
2. ref. to named bond **;** e.g. hydrogen / ionic / disulphide / covalent
3. tertiary / 3D / quaternary, structure disrupted / AW **;**
4. protease can now bind, more / easier, with polypeptides **;**
5. <u>enzyme-substrate complexes</u> can form **;**
6. so more protein is digested to amino acids **;** [3 max]

[Total: 8]

6 **(a)** enzyme acts on only one substrate **;**
shape of active site is complementary to substrate **;**
AVP **;** e.g. substrate held by temporary bonds / ES complex [2 max]

(b) symbols (must be of same letter) **;**
parental genotypes **and** gametes **;**
offspring genotypes **and** phenotypes **linked ;** [3]

(c) 1. insulates axon (membrane) **;**
2. depolarisation occurs only at nodes (of Ranvier) / AW **;**
3. <u>local circuits</u> **;**
4. saltatory conduction / AW **;**
5. speeds transmission of, action potential / impulse **;**
6. AVP **;** e.g. speed increases up to 50 times / 100ms^{-1} [3 max]

[Total: 8]

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7 **(a)** active transport **;**
ribose **;**
water **;**
hydrolysis **;** **A** dephosphorylation
heat **;** [5]

(b) **(i)** (converted to) glycogen / lipid **;**
(used in) glycolysis / respiration **;** [1 max]

(ii) *anaerobic*
1. less ATP / only 2 ATP **;**
2. per mol glucose **;**
3. lactate still contains energy / only glycolysis involved / stages other than glycolysis not involved **;**
4. not sustainable / cannot go on indefinitely / AW **;** [2 max]

(iii)

process	precise location
glycolysis	cytoplasm / cytosol **;**
link reaction	mitochondrial matrix **;**
Krebs cycle	mitochondrial matrix **;**
oxidative phosphorylation	inner mitochondrial membrane / cristae **;**

[4]

(iv)
1. cannot pass through phospholipid bilayer **;**
2. too big to fit through (glucose's) protein channel **;**
3. no specific transport protein **;**
4. AVP **;** e.g. used up as soon as it is made [2 max]

(v) oxygen debt **;** [1]

[Total:15]

8 **(a)** *north island*
1. fewer / less abundant, hedgehogs allow increase (in both lapwing and redshank) **;**
2. breeding pair figs for either bird for 1983 and 2000 **or**
% change in population over that time for either bird **;**

south island
3. presence of hedgehogs causes decrease (in both lapwing and redshank) **;**
4. breeding pair figs for either bird for 1983 and 2000 **or**
% change in population over that time for either bird **;** [3 max]

(b) 1. (oystercatchers have) less competition **;**
2. hedgehogs mostly eat lapwing and redshank eggs / hedgehogs don't eat oystercatcher eggs **;**
3. (oystercatcher) eggs are, too large / camouflaged / inaccessible / distasteful
or
oystercatchers defend their, nests / eggs **;** [2 max]

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(c) 1. idea of geographical isolation ;
2. no interbreeding / gene flow, between <u>populations</u> ;
3. mutations occur ;
4. different, selection pressures / environmental conditions ;
5. genetic change / AW ;
6. genetic drift ;
7. (eventually) reproductive isolation ;
8. <u>allopatric</u> speciation ; [4 max]

[Total: 9]

9 (a) *endocrine*
1. hormones ;
2. chemical messengers ; **A** chemicals that transfer information
3. ductless glands / (released) into blood ;
4. target, organs / cells ;
5. ref. receptors on cell membranes ;
6. example of named hormone and effect ;

nervous
7. impulses/ action potentials ; **R** electrical, signals / current
8. along, axon / neurones / nerve fibres ; **R** nerves **R** across
9. synapse (with target) / neuromuscular junction ;
10. ref. receptor / sensory neurones ;
11. ref. effector / motor neurones ;

differences – endocrine
12. slow effect / ora ;
13. long lasting effect / ora ;
14. widespread effect / ora ;
15. AVP ; e.g. extra detail of synapse / hormone changes triggered within cells [8 max]

(b) 16. IAA / plant growth regulator ; **R** plant hormone
17. synthesised in, growing tips / apical buds / meristems ; **R** root tip
18. moves by diffusion ;
19. moves by active transport ;
20. from cell to cell ;
21. also, mass flow / in phloem ;
22. stimulates cell elongation ; **R** cell enlargement
23. inhibits, side / lateral, buds / growth ; **A** inhibits branching
24. plant grows, upwards / taller ; **A** stem elongates
25. auxin not solely responsible or interaction between auxin and other plant growth regulators ;
26. AVP ; e.g. role of ABA and lateral bud inhibition
27. AVP ; e.g. cytokinins antagonistic to IAA / gibberellins enhance IAA [7 max]

[Total: 15]

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10 (a) 1. photosystem I (PI) **and** photosystem II (PII) involved **;**
2. light harvesting clusters **;**
3. light absorbed by accessory pigments **;**
4. primary pigment is chlorophyll a **;**
5. energy passed to, primary pigment / chlorophyll a **;**
6. electrons, excited / raised to higher energy level **;**
7. (electrons) taken up by electron acceptor **;**
8. (electrons) pass down electron carrier chain *(to produce ATP)* **;**
9. PII has (water splitting) enzyme **;**
10. water split into protons, electrons and oxygen **;** **A** equation
11. photolysis **;**
12. electrons from PII pass to PI / electrons from water pass to PII **;**
13. to replace those lost **;** *give either in relation to PI or PII*
14. protons and electrons combine with NADP *(to produce reduced NADP)* **;**

can award these marking points from a diagram [9 max]

(b) 15. RuBP combines with carbon dioxide **;**
16. rubisco **;**
17. forms unstable 6C compound **;**
18. produces two molecules of, GP / PGA **;**
19. GP / PGA, converted to TP **;**
20. by reduced NADP and ATP **;**
21. from light dependent stage **;**
22. TP used to regenerate RuBP **;**
23. using ATP **;**
24. TP can form, hexose / fatty acids / acetyl CoA [6 max]

[Total: 15]

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1 **(a)** 1. pools drying up **;**
2. pools, affected by the sea / more salty **;**
3. disease / parasite, (causing high death rate) **;**
4. changes to sand dunes **;** e.g. by humans or natural causes
5. increase in predators **;**
6. decrease in food **;**
7. named pollution **;** e.g. acid rain affecting pH of pools
8. named human activity **;** e.g. taking toads / road kill / food for humans
9. increased competition **;** [3 max]

(b) 616 or 617 **;;**
allow one mark for working if incorrect answer [2]

(c) **(i)** idea of feeding on other organisms **;**
to obtain organic compounds **;** [2]

(ii) animalia **and** fungi **;** [1]

(d) people more interested in vertebrates
or
vertebrates, larger / more visible **;** [1]

[Total: 9]

2 **(a)** 1. (solutions of) alginate and enzyme mixed **;**
2. droplets (of mixture) into calcium chloride (solution) **;**
3. to produce beads **;** [2 max]

(b) 1. idea of easier purification of product **;**
2. enzyme, can be reused / is not lost / has longer shelf life **;**
3. allows continuous culture **;**
4. cheaper **;** 2 max

(c) *description*
1. immobilised papain more active / papain in solution less active, at higher temperatures **;**
2. idea of difference above 30°C **;**
3. comparative figs **;** e.g. values of activity for **both** at any **one** temperature above 30°C

explanation
4. (inert support) protects enzyme **;** **A** beads
5. tertiary structure / 3D structure / active site, (of the enzyme) is stabilised **;**
6. less denaturation **;**
7. <u>H bonds</u>, vibrate less / less easily broken **;**

accept ora for mp4–mp7 [4 max]

[Total: 8]

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3 (a) **A** – germinal epithelium ;
B – theca / wall of follicle ;
C – follicle cells / granulosa cells / corona radiata ;
D – oocyte ; **R** ovum / egg [4]

(b) 1. (progesterone / oestrogen), reduce the production of, FSH / LH ;
2. negative feedback ;
3. to, hypothalamus / anterior pituitary ;
4. idea of lack of FSH prevents maturation of follicle ;
5. lack of LH prevents ovulation ;
6. cervical mucus, thick / hostile to sperm ;
7. thin uterine lining prevents implantation ; [4 max]

(c) (i) 1. blocking gene means no, ZP3 / receptor (for sperm) ;
2. because no, transcription / translation / protein synthesis ;
3. sperm (head) has complementary shape to, ZP3 / receptor ;
4. fertilisation cannot occur ;
5. because sperm cannot bind (to oocyte) ; [3 max]

(ii) 1. idea of giving unwanted side effects ;
2. example ; *any one from*
nausea
mood swings
high blood pressure
risk of blood clots
headaches
weight gain
increased risk of breast cancer
3. to maintain natural hormone balance
or
because pill may reduce subsequent fertility ; [2 max]

(iii) 1. only oocytes affected / no other cells affected ;
2. ref. unknown / undesirable, effects elsewhere in the body ; [2]

[Total:15]

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4 (a) (i)
1. hybrid vigour ;
2. increased heterozygosity / decreased homozygosity ;
3. increases gene pool / AW ;
4. harmful recessive alleles less likely to be expressed / reduces inbreeding depression ;
5. increased yield ;
6. other named useful characteristic ; e.g. disease resistance / more nutritious [3 max]

(ii) high cost (of seed) / farmers must buy new seed each year ; [1]

(b) (i)
1. stomata closed ;
2. to reduce transpiration / to avoid too much loss of water ;
3. so carbon dioxide cannot enter the leaf ;
4. so carbon dioxide concentration (in leaf / in chloroplast) becomes very low ; [3 max]

(ii)
1. RuBP / rubisco / Calvin cycle, present in bundle sheath cells ;
2. which are tightly packed ;
3. which are not in contact with air (spaces) ;
4. so are not exposed to oxygen ;
5. CO_2 / malate, delivered to bundle sheath cells ;
6. from mesophyll (cells) ;
7. (so) CO_2 concentration in bundle sheath cells always high ; [4 max]

(c) (i)
1. CO_2 concentration (in bundle sheath cells) is always high ;
2. CO_2 not limiting ;
3. another factor / light intensity / temperature, limiting ;
4. no photorespiration ; [2 max]

(ii)
1. idea of change in temperature ;
2. affects, light independent / light dependent, stage (of photosynthesis) ;

or

3. idea of change in light intensity ;
4. affects light dependent stage (of photosynthesis) ; [2]

[Total: 15]

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5 **(a)** 1. higher yields / more crop survives **;**
2. less need to use pesticides / crop pest-resistant **;**
3. (reduced pesticide use) may benefit other organisms in the same environment **;**
4. less risk of harm to humans, from spray drift / from pesticide residues on food **;**
ignore refs to cost [2 max]

(b) (eating Bt maize) reduces growth rate **;**
0.6 compared to 0.7 / difference of 0.1 **;** [2]

(c) 1. experiments done in laboratory and not in the ecosystem / AW **;**
2. predicts what could happen if Bt toxin conc. increases in the future **;**
3. may not (normally) feed on pollen **;** [2 max]

(d) 1. such results likely to have a negative effect on public perception (of GM crops) / AW **;**
2. might reduce work for researchers in this area **;**
3. might reduce income of companies (producing GM crops) **;**
4. increased use of pesticides **;** [1 max]

6 **(a)** **(i)** decarboxylation **;** [1]

(ii) dehydrogenation / oxidation **;** [1]

(iii) substrate level phosphorylation **;** [1]

(b) **K** – reduced NAD **;** **A** NADH etc.
L – oxaloacetate **;** [2]

(c) 1. hydrogens split into protons and electrons **;**
2. electrons pass along ETC **;**
3. energy released used to pump protons **;**
4. (from matrix) to intermembrane space **;**
5. inner membrane impermeable to protons **;**
6. proton gradient forms **;**
7. protons move down gradient **;**
8. through ATP, synthase / ATP synthetase **;** **R** ATPase
9. enzyme rotates **;**
10. ATP produced **;** [5 max]

[Total: 10]

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7 (a)

nuclear division	letter of stage
meiosis I	B
	E
	J
	H
	F
	D
meiosis II	G
	I
	C
	A

E J H F all in meiosis I ;
E J H F in correct order ;
G I C A all in meiosis II ;
G I C A in correct order ; [4]

(b)
1. chiasma / crossing over ;
2. between <u>non-sister</u> chromatids ;
3. homologous chromosomes / bivalents ; *in correct context of mp1 or mp8*
4. in prophase I ;
5. exchange of genetic material / AW ;
6. linkage groups broken ;
7. new combination of <u>alleles</u> ;
8. <u>independent</u> assortment ; **R** random assortment
9. in metaphase I ;
10. detail of independent assortment ;
11. AVP ; e.g. possible mutation [5 max]

[Total: 9]

8 reproductive ;
constant / stable / AW ;
variation ;
alleles ;
gene ; [5]

[Total: 5]

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9 (a) *gene mutation*

1. spontaneous / random, change **;**
2. in, base sequence / nucleotide sequence / mRNA code / codon **;**
3. example **;** e.g. addition / insertion / substitution / deletion / inversion

triplet code

4. (sequence of) three (DNA nucleotide) bases **;**
5. complementary to mRNA codon **;**
6. codes for a specific amino acid **;** 4 max

(b)

parental phenotypes	man without HD	woman with HD
parental genotypes	**tt**	**Tt**
gametes	**all t**	**T or t ;**
offspring genotypes	**Tt**	**tt**
offspring phenotypes	**Huntington's disease**	**normal ;**

probability of first child having D **50% / 0.50 / 1 in 2 ;** [3]

[Total: 7]

10 (a)

1. (photosynthetic pigments) arranged in light harvesting clusters **;**
2. primary pigments / chlorophyll a **;**
3. at reaction centre **;**
4. P700 / PI, absorbs light at 700nm **;**
5. accessory pigments / chlorophyll b / carotenoids **;**
6. surround, primary pigment / reaction centre / chlorophyll a **;**
7. absorb light **;**
8. pass energy to, primary pigment / reaction centre / chlorophyll a **;**
9. (light absorbed results in) electron excited / AW **;**
10. emitted from, chlorophyll / primary pigment / reaction centre **;**
11. passes to electron, acceptor / carrier **;**
12. (electron) passes along, chain of electron carriers / ETC **;**
13. ATP (synthesis) **;**
14. electron returns to, P700 / PI **;** [8 max]

(b)

15. photolysis of water **;**
16. releases H^+ **;** **R** H / hydrogen atoms
17. by, P680 / PII **;**
18. e^- released from, P700 / PI **;**
19. e^- (from PI) and H^+ combine with NADP **;**
20. used in Calvin cycle **;**
21. reduces, GP / PGA **;**
22. to TP **;**
23. ATP used (during reduction of GP) **;**
24. NADP, regenerated / oxidised **;** [7 max]

[Total: 15]

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11 (a) *accept ABA for abscisic acid*

1. stress hormone ;
2. plant secretes ABA in, high temperatures / dry conditions ;
3. ABA binds to receptors ;
4. on plasma membranes of guard cells ;
5. inhibits proton pump / H^+ not pumped out of cell ;
6. high H^+ conc / positive charge, inside cell ;
7. K^+ diffuses out of cell ;
8. water potential of cell increases ; **A** increase in solute potential
9. water moves out of cell by <u>osmosis</u> ;
10. volume of guard cells decreases ;
11. guard cells become flaccid ;
12. response very fast ; [8 max]

(b) 13. (barley) seed is, dormant / metabolically inactive ;
14. seed absorbs water ;
15. embryo produces gibberellin ;
16. gibberellin stimulates aleurone layer ;
17. to produce amylase ;
18. amylase hydrolyses starch ;
19. in endosperm ;
20. to maltose / glucose ;
21. embryo uses sugars for respiration ;
22. energy used for growth ;
23. gibberellins affect, gene / transcription of mRNA, coding for amylase ; [7 max]

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1 **(a)** 1. pools drying up **;**
2. pools, affected by the sea / more salty **;**
3. disease / parasite, (causing high death rate) **;**
4. changes to sand dunes **;** e.g. by humans or natural causes
5. increase in predators **;**
6. decrease in food **;**
7. named pollution **;** e.g. acid rain affecting pH of pools
8. named human activity **;** e.g. taking toads / road kill / food for humans
9. increased competition **;** [3 max]

(b) 616 or 617 **;;**
allow one mark for working if incorrect answer [2]

(c) **(i)** idea of feeding on other organisms **;**
to obtain organic compounds **;** [2]

(ii) animalia **and** fungi **;** [1]

(d) people more interested in vertebrates
or
vertebrates, larger / more visible **;** [1]

[Total: 9]

2 **(a)** 1. (solutions of) alginate and enzyme mixed **;**
2. droplets (of mixture) into calcium chloride (solution) **;**
3. to produce beads **;** [2 max]

(b) 1. idea of easier purification of product **;**
2. enzyme, can be reused / is not lost / has longer shelf life **;**
3. allows continuous culture **;**
4. cheaper **;** 2 max

(c) *description*
1. immobilised papain more active / papain in solution less active, at higher temperatures **;**
2. idea of difference above 30°C **;**
3. comparative figs **;** e.g. values of activity for **both** at any **one** temperature above 30°C

explanation
4. (inert support) protects enzyme **;** **A** beads
5. tertiary structure / 3D structure / active site, (of the enzyme) is stabilised **;**
6. less denaturation **;**
7. <u>H bonds</u>, vibrate less / less easily broken **;**

accept ora for mp4–mp7 [4 max]

[Total: 8]

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3 (a) **A** – germinal epithelium ;
B – theca / wall of follicle ;
C – follicle cells / granulosa cells / corona radiata ;
D – oocyte ; **R** ovum / egg [4]

(b) 1. (progesterone / oestrogen), reduce the production of, FSH / LH ;
2. negative feedback ;
3. to, hypothalamus / anterior pituitary ;
4. idea of lack of FSH prevents maturation of follicle ;
5. lack of LH prevents ovulation ;
6. cervical mucus, thick / hostile to sperm ;
7. thin uterine lining prevents implantation ; [4 max]

(c) (i) 1. blocking gene means no, ZP3 / receptor (for sperm) ;
2. because no, transcription / translation / protein synthesis ;
3. sperm (head) has complementary shape to, ZP3 / receptor ;
4. fertilisation cannot occur ;
5. because sperm cannot bind (to oocyte) ; [3 max]

(ii) 1. idea of giving unwanted side effects ;
2. example ; *any one from*
nausea
mood swings
high blood pressure
risk of blood clots
headaches
weight gain
increased risk of breast cancer
3. to maintain natural hormone balance
or
because pill may reduce subsequent fertility ; [2 max]

(iii) 1. only oocytes affected / no other cells affected ;
2. ref. unknown / undesirable, effects elsewhere in the body ; [2]

[Total:15]

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4 (a) (i)
1. hybrid vigour ;
2. increased heterozygosity / decreased homozygosity ;
3. increases gene pool / AW ;
4. harmful recessive alleles less likely to be expressed / reduces inbreeding depression ;
5. increased yield ;
6. other named useful characteristic ; e.g. disease resistance / more nutritious [3 max]

(ii) high cost (of seed) / farmers must buy new seed each year ; [1]

(b) (i)
1. stomata closed ;
2. to reduce transpiration / to avoid too much loss of water ;
3. so carbon dioxide cannot enter the leaf ;
4. so carbon dioxide concentration (in leaf / in chloroplast) becomes very low ; [3 max]

(ii)
1. RuBP / rubisco / Calvin cycle, present in bundle sheath cells ;
2. which are tightly packed ;
3. which are not in contact with air (spaces) ;
4. so are not exposed to oxygen ;
5. CO_2 / malate, delivered to bundle sheath cells ;
6. from mesophyll (cells) ;
7. (so) CO_2 concentration in bundle sheath cells always high ; [4 max]

(c) (i)
1. CO_2 concentration (in bundle sheath cells) is always high ;
2. CO_2 not limiting ;
3. another factor / light intensity / temperature, limiting ;
4. no photorespiration ; [2 max]

(ii)
1. idea of change in temperature ;
2. affects, light independent / light dependent, stage (of photosynthesis) ;

or

3. idea of change in light intensity ;
4. affects light dependent stage (of photosynthesis) ; [2]

[Total: 15]

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5 **(a)** 1. higher yields / more crop survives **;**
2. less need to use pesticides / crop pest-resistant **;**
3. (reduced pesticide use) may benefit other organisms in the same environment **;**
4. less risk of harm to humans, from spray drift / from pesticide residues on food **;**
ignore refs to cost [2 max]

(b) (eating Bt maize) reduces growth rate **;**
0.6 compared to 0.7 / difference of 0.1 **;** [2]

(c) 1. experiments done in laboratory and not in the ecosystem / AW **;**
2. predicts what could happen if Bt toxin conc. increases in the future **;**
3. may not (normally) feed on pollen **;** [2 max]

(d) 1. such results likely to have a negative effect on public perception (of GM crops) / AW **;**
2. might reduce work for researchers in this area **;**
3. might reduce income of companies (producing GM crops) **;**
4. increased use of pesticides **;** [1 max]

6 **(a)** **(i)** decarboxylation **;** [1]

(ii) dehydrogenation / oxidation **;** [1]

(iii) substrate level phosphorylation **;** [1]

(b) **K** – reduced NAD **;** **A** NADH etc.
L – oxaloacetate **;** [2]

(c) 1. hydrogens split into protons and electrons **;**
2. electrons pass along ETC **;**
3. energy released used to pump protons **;**
4. (from matrix) to intermembrane space **;**
5. inner membrane impermeable to protons **;**
6. proton gradient forms **;**
7. protons move down gradient **;**
8. through ATP, synthase / ATP synthetase **;** **R** ATPase
9. enzyme rotates **;**
10. ATP produced **;** [5 max]

[Total: 10]

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7 (a)

nuclear division	letter of stage
meiosis I	B
	E
	J
	H
	F
	D
meiosis II	G
	I
	C
	A

E J H F all in meiosis I ;
E J H F in correct order ;
G I C A all in meiosis II ;
G I C A in correct order ; [4]

(b) 1. chiasma / crossing over ;
2. between <u>non-sister</u> chromatids ;
3. homologous chromosomes / bivalents ; *in correct context of mp1 or mp8*
4. in prophase I ;
5. exchange of genetic material / AW ;
6. linkage groups broken ;
7. new combination of <u>alleles</u> ;
8. <u>independent</u> assortment ; **R** random assortment
9. in metaphase I ;
10. detail of independent assortment ;
11. AVP ; e.g. possible mutation [5 max]

[Total: 9]

8 reproductive ;
constant / stable / AW ;
variation ;
alleles ;
gene ; [5]

[Total: 5]

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9 (a) *gene mutation*

1. spontaneous / random, change **;**
2. in, base sequence / nucleotide sequence / mRNA code / codon **;**
3. example **;** e.g. addition / insertion / substitution / deletion / inversion

triplet code

4. (sequence of) three (DNA nucleotide) bases **;**
5. complementary to mRNA codon **;**
6. codes for a specific amino acid **;** 4 max

(b)

parental phenotypes	man without HD	woman with HD
parental genotypes	**tt**	**Tt**
gametes	**all t**	**T or t ;**
offspring genotypes	**Tt**	**tt**
offspring phenotypes	**Huntington's disease**	**normal ;**

probability of first child having D **50% / 0.50 / 1 in 2 ;** [3]

[Total: 7]

10 (a)

1. (photosynthetic pigments) arranged in light harvesting clusters **;**
2. primary pigments / chlorophyll a **;**
3. at reaction centre **;**
4. P700 / PI, absorbs light at 700nm **;**
5. accessory pigments / chlorophyll b / carotenoids **;**
6. surround, primary pigment / reaction centre / chlorophyll a **;**
7. absorb light **;**
8. pass energy to, primary pigment / reaction centre / chlorophyll a **;**
9. (light absorbed results in) electron excited / AW **;**
10. emitted from, chlorophyll / primary pigment / reaction centre **;**
11. passes to electron, acceptor / carrier **;**
12. (electron) passes along, chain of electron carriers / ETC **;**
13. ATP (synthesis) **;**
14. electron returns to, P700 / PI **;** [8 max]

(b)

15. photolysis of water **;**
16. releases H^+ **;** **R** H / hydrogen atoms
17. by, P680 / PII **;**
18. e^- released from, P700 / PI **;**
19. e^- (from PI) and H^+ combine with NADP **;**
20. used in Calvin cycle **;**
21. reduces, GP / PGA **;**
22. to TP **;**
23. ATP used (during reduction of GP) **;**
24. NADP, regenerated / oxidised **;** [7 max]

[Total: 15]

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11 (a) *accept ABA for abscisic acid*

1. stress hormone ;
2. plant secretes ABA in, high temperatures / dry conditions ;
3. ABA binds to receptors ;
4. on plasma membranes of guard cells ;
5. inhibits proton pump / H^+ not pumped out of cell ;
6. high H^+ conc / positive charge, inside cell ;
7. K^+ diffuses out of cell ;
8. water potential of cell increases ; **A** increase in solute potential
9. water moves out of cell by <u>osmosis</u> ;
10. volume of guard cells decreases ;
11. guard cells become flaccid ;
12. response very fast ; [8 max]

(b)

13. (barley) seed is, dormant / metabolically inactive ;
14. seed absorbs water ;
15. embryo produces gibberellin ;
16. gibberellin stimulates aleurone layer ;
17. to produce amylase ;
18. amylase hydrolyses starch ;
19. in endosperm ;
20. to maltose / glucose ;
21. embryo uses sugars for respiration ;
22. energy used for growth ;
23. gibberellins affect, gene / transcription of mRNA, coding for amylase ; [7 max]

[Total: 15]

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