CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2014 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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underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
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I	ignore
AVP	alternative valid point (examples given as guidance)

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1 (a) (i) stroma ; [1]

(ii) lower CO_2 concentration ;

less, carbon fixation / CO_2 combining with RuBP / RuBP converted to GP ;

RuBP reformed from TP ; [max 2]

(iii) 0.01 ;;

A 0.012 **or** 1.8 ÷ 150 **or** $\frac{2.0 - 0.2}{150}$ **or** $\frac{2.0 - 0.2}{350 - 200}$ for 1 mark [2]

(b) less TP ;

(so less) conversion to, (other) carbohydrates / lipids / amino acids / proteins ;
A named examples, e.g. glucose / hexose / cellulose / starch

AVP ; e.g. 1 – (amino acids) used to make proteins for, growth / cell division
e.g. 2 – (carbohydrate / lipid) for respiration for, growth / cell division [max 2]

[Total: 7]

2 (a) *idea of* cross-pollination involves two (parents) / self-pollination one (parent) ;

ref. outbreeding / inbreeding ;

(two parents) have different, genotypes / sets of alleles ;

idea of new combinations of alleles in offspring ; [max 3]

(b) (total) DNA / genome, cut into fragments ;

by restriction enzymes ;

DNA, denatured / made single stranded ;

ref. primers / (modified) PCR ;

ref. dideoxynucleotides / chain termination ;

DNA / Taq, polymerase ;

copies of different lengths produced ;

electrophoresis ; **A** description

detection, of fluorescence / by laser scanner ;

sequence of, bases / nucleotides, read (by computer) ; [max 4]

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(c) cross(-pollinate) them **;** **A** description

(if same species) offspring, are fertile / can themselves produce seeds**;** **ora** [2]

[Total: 9]

3 **(a)** **(i)** AABBCC **;** [1]

(ii) meiosis unsuccessful (in, sterile hybrid / AB) **;**

gametes not formed **;**

bivalents cannot form / chromosomes cannot pair up / chromosomes are not homologous **;**

polyploidy occurs / chromosomes double **;** **A** tetraploid

failure of cell division / all chromosomes in one daughter cell **;** **A** description

chromosomes can now form pairs / gametes can be formed / meiosis can be completed **;** [max 4]

(b) **(i)** in presence of Eβf large number aphids, stop feeding / move **;**

in absence of Eβf, few / no, aphids, stop feeding / move **;**

air in Experiment 1, has other chemicals / not pure Eβf **or** air in Experiment 2 has only Eβf **;**

Eβf concentration in Experiment 2 may be unnaturally high **or** Eβf concentration unknown in Experiment 1 **;**

different volumes of air in Experiment 1 and Experiment 2 **;**

comparative data quote **;**

e.g.

55% versus 84% **or** 54 out of 99 versus 111 out of 132

54.5% versus 0.9% **or** 54 out of 99 versus 1 out of 113

84% versus 0% **or** 111 out of 132 versus 0 out of 106 [max 4]

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(ii) Eβf stops aphids settling **;**

Eβf attracts, predators of aphids / ladybirds **;**

attacked aphids secrete more Eβf **;**

aphids not, eating / taking nutrients from, wheat **;** [max 3]

(iii) gene / Eβf, already in, peppermint / various plant species **;**

Eβf not, toxic / harmful to human health **;**

no new chemical added to human diet **;**

does not kill insects (unlike Bt maize or cotton) **;**

aphids still available for, predators / food web **;** [max 3]

[Total: 15]

4 (a) (i) spermatagonium – 2n
primary spermatocyte – 2n
secondary spermatocyte – n
spermatids – n
spermatozoan – n **;;**

all five correct for two marks
three or four correct for one mark [2]

(ii) (spermatogonium to primary spermatocyte) growth / mitosis **;**

(spermatid to sperm) <u>maturation</u> **;** [2]

(iii) *any 1 from*

provide nutrients for sperm(atid) **;**

protect sperm from attack from immune system **;**

regulation of, sperm production / FSH **;**

AVP **;** e.g. removes excess cytoplasm during sperm maturation /
guides sperm to centre of tubule [max 1]

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(b) FSH ;

(hormone) given to stimulate follicle development ;

GnRH agonists / GnRH receptor antagonists ;

to prevent, LH surge / ovulation ;

human chorionic gonadotrophin ;

(hormone) given to stimulate maturation of oocytes ;

(mature oocytes) collected from ovaries (just before ovulation) ;

ref. use of, fine tube / needle / ultrasound ; [max 4]

(c) (i) FSH (alone) / FSH + testosterone, increases development (of spermatids into, spermatozoa / elongated cells) ;

testosterone (alone) has very little effect ;

FSH + testosterone causes greatest increase of development ;

use of, comparative / manipulated, figures ; [4]

(ii) (reduction is very small so) may be, insignificant / random / due to chance ;

(some cells) may have died ; [max 1]

(iii) temperature, similar to testes / in range 30 °C to 35 °C / lower than core ;

spermatozoa production, will not proceed at 37 °C / at high temperature ; [2]

[Total: 16]

5 (a) random / spontaneous ;

mutation ;

base / nucleotide / triplet, change / substitution ; **R** addition / deletion [max 2]

(b) (i) as altitude increases frequency of $\mathbf{A^0}$ increases ; **ora** for $\mathbf{A^1}$

$\mathbf{A^0}$ more frequent at high altitudes / $\mathbf{A^1}$ more frequent at low altitudes / intermediate frequency of either allele at intermediate altitude ; [2]

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(ii) *idea of* (pre-existing) genetic variation in deer mouse population **;**

at high altitude mice with, glycine / $\mathbf{A^0}$, more likely to survive / have selective advantage **; ora**

mice (with $\mathbf{A^0}$) reproduce (at high altitude) **; ora**

and pass on the $\mathbf{A^0}$ allele **; ora**

partial pressure / concentration, of O_2 acts as a selection pressure **;**

ref. to disadvantage of haemoglobin with very high affinity at low altitude **;**

as less able to unload oxygen (in respiring tissues) **;** [max 4]

[Total:8]

6 (a) channels **; I** voltage-gated

depolarised **; A** positive inside

receptor / generator **;**

threshold **;**

frequency **; A** number per second / rate **R** speed [5]

(b) action potential stimulates neighbouring area of membrane **; AW**

Na^+, moves sideways / attracted to areas at resting potential **; A** local circuit

causes, Na^+ ion channels to open / 2^{nd} depolarisation **;**

(transmission) in one direction due to, hyperpolarisation / refractory period **;**

myelin sheath / Schwann cell **;**

sheath insulates, axon / dendron / neurone **;**

depolarisation / action potential, only at nodes of Ranvier / unmyelinated part **; ora**

saltatory conduction / action potential 'jumps' from node to node **;** [max 5]

[Total:10]

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7 **(a)** centromere ; [1]

(b) *idea that* different genes, are present / missing **; R** alleles

different, proteins / poypeptides, produced / missing **;** [2]

(c) XY **;**

X X_1 X Y **;**

XX XX_1 **;**

normal Turner's **;** [4]

[Total:7]

8 **(a)** (DNA for) transcription / codes for mRNA **;**

(ribosomes for) translation **;**

synthesis of, respiratory enzymes / named enzyme / inner membrane proteins **;** [max 3]

(b)

correct order	letter of stage
1	**V**
2	**S**
3	**U**
4	**W**
5	**R**
6	**Q**
7	**X**
8	**T**

S U W all above **R ;**
S U W in correct order **;**

Q X T all below **R ;**
Q X T in correct order **;** [4]

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(c) hydrolysis / dephosphorylation / exothermic / exergonic **;** [1]

(d) anaerobic respiration **;**

substrate level phosphorylation (in glycolysis)**;**

at triose phosphate ⟶ pyruvate step **;**

(net) gain of 2ATP (per glucose) **;** **A** 2 used and 4 produced

pyruvate, reduced / gains hydrogens (from reduced NAD) **;**

forming lactate **;**

NAD regenerated / $NADH_2$ re-oxidised **;**

this allows glycolysis to continue **;**

I ethanol pathway [max 5]

[Total:13]

9 **(a)** *similarities*
eukaryotic (cells) **;**

detail of eukaryotic cell **;;** e.g. nucleus / linear DNA / chromosomes associated with histones / (named) membrane-bound organelles / 80S ribosomes

differences
single-celled **or** colonial / multicellular **;**

autotrophic **or** heterotrophic **;**

motile **or** unable to move **;**

cell wall **or** no cell wall **;**

vacuole **or** no vacuole **;**

different life cycles **;** [max 7]

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(b) fall in numbers ;

danger of becoming extinct ;

ref. (IUCN / International Union for Conservation of Nature) / red list ;

one mark for idea, additional mark if qualified with point specific to named example
e.g.
habitat destruction ;
detail ;

climate change ;
detail ; e.g. rise in temperature

increase in disease ;
detail ;

increase in, predators / grazers ;
detail ;

decrease in food ;
detail ;

named pollutant and habitat affected ;
detail ;

hunting / killing / poaching / removal (plant) ;
detail ; e.g. trade in animal parts, selling rare plants

increased competition ;
detail ;

lack of human education ;
detail ;

disturbance to breeding sites ;
detail ; [max 8]

[Total:15]

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10 (a) bacteria walls made of peptidoglycans **;**

bacteria secrete autolysins **;**

make holes in cell wall / **AW ;**

to allow wall to stretch during growth / **AW ;**

(glycoprotein) peptidases form cross-links (between peptidoglycans) **;**

(penicillin) inhibits (glycoprotein) peptidases **;**

cross-links (between peptidoglycans) do not form **;**

cell wall weakened **;**

bacteria take in water by osmosis **;**

increased turgor pressure causes cell to burst **; AW**

AVP **;** e.g. competitive inhibition [max 8]

(b) ref. bioleaching **;**

Acidithiobacillus / A. ferrooxidans **; A** *Thiobacillus / T. ferrooxidans*

low grade ores / (mine) waste **;**

two metals **;** e.g. copper, zinc, cobalt, uranium, lead, nickel, gold, silver **I** iron

insoluble ore turned into soluble products **;**

ore piled up **;**

acidic conditions created / pH low(ered) / pH 1.5 – 3 **;**

different bacteria at different temperatures **;**

chemoautotrophic **; A** description

oxidation (reactions) **;**

sulfide / S^{2-} to sulfate / SO_4^{2-} **;** (direct oxidation of ore)

Fe^{2+} / ferrous → Fe^{3+} / ferric **;**

Fe^{3+} oxidise other ores **;**

product, drains / leaches / is washed, into pool **;**

metal displaced by adding scrap iron **;** [max 7]

[Total:15]

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CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2014 series

9700 BIOLOGY

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

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1 **(a)** transport proteins – **Y ;**

pigments – **X ;** [2]

(b) *DNA*
codes for, proteins / polypeptides / enzymes **;**

one example of protein or enzyme **;**
e.g. rubisco / electron acceptor / ATP synthase / transport

ref. transcription / mRNA **;** [max 2]

(c)

factor	stage	✓or ×
carbon dioxide concentration	Calvin cycle	✓
	photolysis	×
light intensity	Calvin cycle	×
	photolysis	✓
temperature	Calvin cycle	✓
	photolysis	×

;;;

all 6 correct = 3 marks
4 or 5 correct = 2 marks
2 or 3 correct = 1 mark [3]

[Total:7]

2 **(a)** presence of C base in DNA (code) changes amino acid (in myostatin) **;**

myostatin in CC horses, is inactive / not produced **; ora for TT**

in CC horses muscle, differentiation / growth, has not been slowed **; ora for TT** [max 2]

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(b) CC genotype does best in short races ;

data quote ; e.g. 75% winners at 1.0 km ;

TT genotype does better in longer races ;

data quote ; e.g. about 60% of winners at 2.6 km

CT genotype has some winners at all distances ;

CT does best at 1.8 km ; [max 4]

(c) (i) by humans ;

individuals with desired features chosen to breed / AW / named example ; [2]

(ii) can choose parents genotypes to breed ;

CC for racing short distances / TT for racing long distances / CT as all-rounders ;

ref. need to keep all three genotypes in population ; [max 2]

[Total:10]

3 (a) (i) idea of sugars unable to pass through phospholipid bilayer ;

hydrophilic / polar / not lipid-soluble / water soluble ;

large ; [max 2]

(ii) forms bonds with hydrophilic heads (of phospholipids) ;

hydrophobic parts of SWEET ;

bond with, fatty acid chains / hydrophobic tails, (of phospholipids) ;

ref. hydrogen bonding / ionic bonds / hydrophobic interactions ; [max 3]

(b) (i) (SWEET) <u>gene</u> cannot be switched on ;

no SWEET (protein) produced ;

no, glucose / sugar, secreted (into intercellular spaces) ;

(so) Xoo / bacteria, do not multiply / numbers remain low ;

(small numbers of Xoo / bacteria) so no disease ; [max 3]

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(ii) allele is recessive **;**

idea of not expressed when dominant allele present **;**

ref. promoter **;** e.g. normal promoter must be inactivated or removed / must transfer mutated promoter [max 2]

(iii) prevents <u>diffusion</u> of air (from leaves to roots) **;**

ref. aerenchyma **;**

roots respire anaerobically **;**

(so) less ATP produced (for growth) **;**

bacteria use of oxygen **;**

more ethanol produced may be beyond tolerance / **AW ;** [max 4]

[Total:14]

4 (a) details of electrophoresis **;;**

any 2 from
DNA cut by, restriction enzyme(s) / endonuclease(s)

loaded (into wells) at, negative end / cathode end, (of gel)

ref. buffer / electrolyte

(negatively charged) DNA attracted to, anode / positive electrode

separation due to, electric field / potential difference

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

fluorescent / radioactive, DNA probes

compare, DNA sequences / bands, (of male lizard and hatchling) **;** [3]

(b) (i) *body length*
no relationship (between body length and number of offspring) **;**

small / intermediate, body length produce more offspring **;**

sprint speed
lizards with greater sprint speed sire more offspring **;**

use of two paired figures from Fig. 4.3 to support relationship **;** [4]

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(ii) lizards with longer (hind) legs will tend to have more offspring ;

so will have a greater chance of passing on their alleles ;

(over time) the frequency of alleles (for long hind leg) will increase ;

so mean hind leg length will increase ;

directional selection ; [max 3]

(c) no, breeding / allele flow / gene flow, between (lizard) populations ;

different selection pressures / different (environmental) conditions ;

mutations occur ;

advantageous alleles, selected for / passed on ;

change in, allele frequency / gene pool ;

genetic drift ;

(eventually) unable to interbreed ;

allopatric speciation ; [max 5]

[Total:15]

5 (a) anterior pituitary ; [1]

(b) (i) early follicle development not dependent on FSH ;

with no FSH / no FSH receptors, follicle development stops ; **ora**

with no FSH / no FSH receptors, Graafian / ovarian, follicle does not develop ; **ora**

with no FSH / no FSH receptors, there is no ovulation ;

no corpora lutea because these form, from Graafian follicle / after ovulation ; [max 4]

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(ii) sperm development better when FSH present **;**

with FSH receptors
more sperm produced **; ora**

sperm more active **; ora**

males have increased fertility **; ora**

without FSH receptors
some sperm produced **;** [max 3]

[Total:8]

6 (a) (i) tendency of water molecules to move from one region to another **/** potential energy of water / ability of water to do work **;** [1]

(ii) (water potential) becomes, lower / more negative **;** [1]

(iii) posterior pituitary **;** [1]

(iv) for **one** mark **;**
any 2 from
urine
sweat
water vapour (from exhaled air)
faeces
bleeding
tears [max 1]

(b) affects collecting duct, (cells / wall) **;** **A** distal convoluted tubule cells

binds to receptors on cell surface membranes **;**

activates series of enzyme controlled reactions **;**

(phosphorylase causes), vesicles / aquaporins, to move to cell surface membrane (on lumen side) **;**

vesicles / aquaporins, fuse with cell surface membrane **;**

cells / wall, more permeable to water **;**

water moves out of lumen (of collecting duct) **;**

down water potential gradient **;** [max 5]

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(c) produce, a lot of urine / dilute urine **;**

dehydration / thirsty **;**

cramps / loss of salts **;** [max 2]

[Total:11]

7 **(a)** symbols and key **;** e.g. A = NF allele and a = normal allele

parental genotypes **and** gametes **;** e.g. parental genotypes Aa x aa
gametes A a x a a

offspring genotypes **and** phenotypes **linked ;** e.g. Aa has NF and aa is unaffected [3]

(b) spontaneous / random / chance **;**

mutation of, gene / allele **;**

AVP **;** e.g. named mutagen / detail of mutation / in oocyte / in sperm [max 2]

(c) compresses nerve **;**

damages, myelin sheaths / Schwann cells **;**

prevents, setting up of local circuits / saltatory conduction **;**

stops Na^+ / K^+ pumps from working **;**

blocks blood supply**;**

qualified **;** e.g. effect on, oxygen supply / glucose supply / ATP production

AVP **;** e.g. may stop ion channels opening [max 3]

[Total:8]

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8 (a) (i) receptors / hypothalamus, detect change in blood temperature **;**

brain **;**

(receptor / brain) sends impulses to effector **;**

effector carries out response / example of response **;**

blood temperature returns to normal **;**

negative feedback **;** [max 4]

(ii) larger SA : V ratio **;**

lose (relatively) more heat **;**

ref. more mitochondria to release heat energy **;**

cannot carry out behavioural actions to get warm **;**

infants cannot shiver **;** [max 2]

(b) (i) **A** – ATP synthase / ATP synthetase / stalked particles **; R** ATPase

B – inner membrane / crista **; I** phospholipid bilayer [2]

(ii) arrow going down from intermembrane space to matrix **;** [1]

(iii) 1 **and** 3 **;** [1]

(iv) water **;** [1]

(v) fatty acids **; A** lipid / fat / triglycerides [1]

[Total:12]

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9 (a) multicellular ;

differentiated cells ;

(most) have, vascular tissue / xylem and phloem ;

eukaryotic (cells) ;

ref. meristems ;

(most) are not motile ;

motile gametes **only** in mosses and ferns ;

autotrophic nutrition / photosynthesis ;

cells have:
chloroplasts ;

large / central, vacuole ;

walls made of cellulose ; [max 8]

(b) place in zoos ;

protected against, disease / predation ;

captive breeding programme ;

ref. assisted reproduction / cloning / sperm banks ;

released into wild ;

ref. national parks / reserves ;

rangers patrol parks ;

human access restricted ;

controlled agriculture ;

controlled industry ;

visitor centres / education ;

habitat / breeding sites, protected ;

banning sale of protected animals or their products ;

banning hunting ; [max 7]

[Total:15]

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10 (a) use *Penicillium* (in batch fermenter) ;

(main) nutrients added at start ;

penicillin only produced, after growth phase / when running out of nutrients ;

(penicillin) is a secondary metabolite ;

fermentation is stopped ;

penicillin is harvested ;

fermenter is cleaned out / ref. sterility ;

new culture of *Penicillium* is put in and started again ;

ref. fed batch culture ;

carbohydrate / named nutrient, added regularly ;

keeps fermentation going longer / produces more penicillin ;

detail of fermenter ;; e.g. paddle to mix nutrients / sterilising steam inlet / set at pH 6.5 / aeration / kept at 27 °C [max 8]

(b) *batch*
easy to set up culture ;

can continue with minimal attention / AW ;

environmental conditions easy to control ;

fermenter can be used for different process afterwards ;

only waste one batch if contaminated ;

less chance of blockage in fermenter ;

continuous
no / less, down time / AW ;

small vessels can be used ;

productivity high ;

cost effective ;

downstream processing easier ;

good for using immobilised enzymes ; [max 7]

[Total:15]

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1 (a) (i) stroma ; [1]

(ii) lower CO_2 concentration ;

less, carbon fixation / CO_2 combining with RuBP / RuBP converted to GP ;

RuBP reformed from TP ; [max 2]

(iii) 0.01 ;;

A 0.012 **or** 1.8 ÷ 150 **or** $\frac{2.0 - 0.2}{150}$ **or** $\frac{2.0 - 0.2}{350 - 200}$ for 1 mark [2]

(b) less TP ;

(so less) conversion to, (other) carbohydrates / lipids / amino acids / proteins ;
A named examples, e.g. glucose / hexose / cellulose / starch

AVP ; e.g. 1 – (amino acids) used to make proteins for, growth / cell division
e.g. 2 – (carbohydrate / lipid) for respiration for, growth / cell division [max 2]

[Total: 7]

2 (a) *idea of* cross-pollination involves two (parents) / self-pollination one (parent) ;

ref. outbreeding / inbreeding ;

(two parents) have different, genotypes / sets of alleles ;

idea of new combinations of alleles in offspring ; [max 3]

(b) (total) DNA / genome, cut into fragments ;

by restriction enzymes ;

DNA, denatured / made single stranded ;

ref. primers / (modified) PCR ;

ref. dideoxynucleotides / chain termination ;

DNA / Taq, polymerase ;

copies of different lengths produced ;

electrophoresis ; **A** description

detection, of fluorescence / by laser scanner ;

sequence of, bases / nucleotides, read (by computer) ; [max 4]

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(c) cross(-pollinate) them **;** **A** description

(if same species) offspring, are fertile / can themselves produce seeds**;** **ora** [2]

[Total: 9]

3 **(a)** **(i)** AABBCC **;** [1]

(ii) meiosis unsuccessful (in, sterile hybrid / AB) **;**

gametes not formed **;**

bivalents cannot form / chromosomes cannot pair up / chromosomes are not homologous **;**

polyploidy occurs / chromosomes double **;** **A** tetraploid

failure of cell division / all chromosomes in one daughter cell **;** **A** description

chromosomes can now form pairs / gametes can be formed / meiosis can be completed **;** [max 4]

(b) **(i)** in presence of Eβf large number aphids, stop feeding / move **;**

in absence of Eβf, few / no, aphids, stop feeding / move **;**

air in Experiment 1, has other chemicals / not pure Eβf **or** air in Experiment 2 has only Eβf **;**

Eβf concentration in Experiment 2 may be unnaturally high **or** Eβf concentration unknown in Experiment 1 **;**

different volumes of air in Experiment 1 and Experiment 2 **;**

comparative data quote **;**

e.g.

55% versus 84% **or** 54 out of 99 versus 111 out of 132

54.5% versus 0.9% **or** 54 out of 99 versus 1 out of 113

84% versus 0% **or** 111 out of 132 versus 0 out of 106 [max 4]

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(ii) Eβf stops aphids settling **;**

Eβf attracts, predators of aphids / ladybirds **;**

attacked aphids secrete more Eβf **;**

aphids not, eating / taking nutrients from, wheat **;** [max 3]

(iii) gene / Eβf, already in, peppermint / various plant species **;**

Eβf not, toxic / harmful to human health **;**

no new chemical added to human diet **;**

does not kill insects (unlike Bt maize or cotton) **;**

aphids still available for, predators / food web **;** [max 3]

[Total: 15]

4 (a) (i) spermatagonium – 2n
primary spermatocyte – 2n
secondary spermatocyte – n
spermatids – n
spermatozoan – n **;;**

all five correct for two marks
three or four correct for one mark [2]

(ii) (spermatogonium to primary spermatocyte) growth / mitosis **;**

(spermatid to sperm) <u>maturation</u> **;** [2]

(iii) *any 1 from*

provide nutrients for sperm(atid) **;**

protect sperm from attack from immune system **;**

regulation of, sperm production / FSH **;**

AVP **;** e.g. removes excess cytoplasm during sperm maturation /
guides sperm to centre of tubule [max 1]

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(b) FSH ;

(hormone) given to stimulate follicle development ;

GnRH agonists / GnRH receptor antagonists ;

to prevent, LH surge / ovulation ;

human chorionic gonadotrophin ;

(hormone) given to stimulate maturation of oocytes ;

(mature oocytes) collected from ovaries (just before ovulation) ;

ref. use of, fine tube / needle / ultrasound ; [max 4]

(c) (i) FSH (alone) / FSH + testosterone, increases development (of spermatids into, spermatozoa / elongated cells) ;

testosterone (alone) has very little effect ;

FSH + testosterone causes greatest increase of development ;

use of, comparative / manipulated, figures ; [4]

(ii) (reduction is very small so) may be, insignificant / random / due to chance ;

(some cells) may have died ; [max 1]

(iii) temperature, similar to testes / in range 30 °C to 35 °C / lower than core ;

spermatozoa production, will not proceed at 37 °C / at high temperature ; [2]

[Total: 16]

5 (a) random / spontaneous ;

mutation ;

base / nucleotide / triplet, change / substitution ; **R** addition / deletion [max 2]

(b) (i) as altitude increases frequency of $\mathbf{A^0}$ increases ; **ora** for $\mathbf{A^1}$

$\mathbf{A^0}$ more frequent at high altitudes / $\mathbf{A^1}$ more frequent at low altitudes / intermediate frequency of either allele at intermediate altitude ; [2]

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(ii) *idea of* (pre-existing) genetic variation in deer mouse population **;**

at high altitude mice with, glycine / $\mathbf{A^0}$, more likely to survive / have selective advantage **; ora**

mice (with $\mathbf{A^0}$) reproduce (at high altitude) **; ora**

and pass on the $\mathbf{A^0}$ allele **; ora**

partial pressure / concentration, of O_2 acts as a selection pressure **;**

ref. to disadvantage of haemoglobin with very high affinity at low altitude **;**

as less able to unload oxygen (in respiring tissues) **;** [max 4]

[Total:8]

6 (a) channels **; I** voltage-gated

depolarised **; A** positive inside

receptor / generator **;**

threshold **;**

frequency **; A** number per second / rate **R** speed [5]

(b) action potential stimulates neighbouring area of membrane **; AW**

Na^+, moves sideways / attracted to areas at resting potential **; A** local circuit

causes, Na^+ ion channels to open / 2^{nd} depolarisation **;**

(transmission) in one direction due to, hyperpolarisation / refractory period **;**

myelin sheath / Schwann cell **;**

sheath insulates, axon / dendron / neurone **;**

depolarisation / action potential, only at nodes of Ranvier / unmyelinated part **; ora**

saltatory conduction / action potential 'jumps' from node to node **;** [max 5]

[Total:10]

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7 **(a)** centromere **;** [1]

(b) *idea that* different genes, are present / missing **; R** alleles

different, proteins / poypeptides, produced / missing **;** [2]

(c) XY **;**

X X_1 X Y **;**

XX XX_1 **;**

normal Turner's **;** [4]

[Total:7]

8 **(a)** (DNA for) transcription / codes for mRNA **;**

(ribosomes for) translation **;**

synthesis of, respiratory enzymes / named enzyme / inner membrane proteins **;** [max 3]

(b)

correct order	letter of stage
1	**V**
2	**S**
3	**U**
4	**W**
5	**R**
6	**Q**
7	**X**
8	**T**

S U W all above **R ;**
S U W in correct order **;**

Q X T all below **R ;**
Q X T in correct order **;** [4]

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(c) hydrolysis / dephosphorylation / exothermic / exergonic ; [1]

(d) anaerobic respiration ;

substrate level phosphorylation (in glycolysis);

at triose phosphate ⟶ pyruvate step ;

(net) gain of 2ATP (per glucose) ; **A** 2 used and 4 produced

pyruvate, reduced / gains hydrogens (from reduced NAD) ;

forming lactate ;

NAD regenerated / $NADH_2$ re-oxidised ;

this allows glycolysis to continue ;

I ethanol pathway [max 5]

[Total:13]

9 **(a)** *similarities*
eukaryotic (cells) ;

detail of eukaryotic cell ;; e.g. nucleus / linear DNA / chromosomes associated with histones / (named) membrane-bound organelles / 80S ribosomes

differences
single-celled **or** colonial / multicellular ;

autotrophic **or** heterotrophic ;

motile **or** unable to move ;

cell wall **or** no cell wall ;

vacuole **or** no vacuole ;

different life cycles ; [max 7]

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(b) fall in numbers ;

danger of becoming extinct ;

ref. (IUCN / International Union for Conservation of Nature) / red list ;

one mark for idea, additional mark if qualified with point specific to named example
e.g.
habitat destruction ;
detail ;

climate change ;
detail ; e.g. rise in temperature

increase in disease ;
detail ;

increase in, predators / grazers ;
detail ;

decrease in food ;
detail ;

named pollutant and habitat affected ;
detail ;

hunting / killing / poaching / removal (plant) ;
detail ; e.g. trade in animal parts, selling rare plants

increased competition ;
detail ;

lack of human education ;
detail ;

disturbance to breeding sites ;
detail ; [max 8]

[Total:15]

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10 (a) bacteria walls made of peptidoglycans **;**

bacteria secrete autolysins **;**

make holes in cell wall / **AW ;**

to allow wall to stretch during growth / **AW ;**

(glycoprotein) peptidases form cross-links (between peptidoglycans) **;**

(penicillin) inhibits (glycoprotein) peptidases **;**

cross-links (between peptidoglycans) do not form **;**

cell wall weakened **;**

bacteria take in water by osmosis **;**

increased turgor pressure causes cell to burst **; AW**

AVP **;** e.g. competitive inhibition [max 8]

(b) ref. bioleaching **;**

Acidithiobacillus / A. ferrooxidans **; A** *Thiobacillus / T. ferrooxidans*

low grade ores / (mine) waste **;**

two metals **;** e.g. copper, zinc, cobalt, uranium, lead, nickel, gold, silver **I** iron

insoluble ore turned into soluble products **;**

ore piled up **;**

acidic conditions created / pH low(ered) / pH 1.5 – 3 **;**

different bacteria at different temperatures **;**

chemoautotrophic **; A** description

oxidation (reactions) **;**

sulfide / S^{2-} to sulfate / SO_4^{2-} **;** (direct oxidation of ore)

Fe^{2+} / ferrous → Fe^{3+} / ferric **;**

Fe^{3+} oxidise other ores **;**

product, drains / leaches / is washed, into pool **;**

metal displaced by adding scrap iron **;** [max 7]

[Total:15]

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