CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2013 series

9700 BIOLOGY

9700/21 Paper 2 (AS Structured Questions), maximum raw mark 60

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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Mark scheme abbreviations:

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

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1 (a) (i) prophase **;**
R prophase I [1]

(iii) two homologous chromosomes shaded **;** [1]

(iii) centriole **; A** centrosome / microtubule organising centre / MTOC

one from
produces spindle / produces spindle fibres **;**
produce / organises, microtubules **;**
disassembles / AW, spindle / spindle fibres / microtubules **;** [max 2]
A one e.g. of role of, spindle fibres / microtubules *if a link to centriole has been made allow if centriole incorrectly named or if not given*

(b) *max 2 if no attempt made at both **X** and **Y***

***X** / cell surface membrane*
1 forms a (cleavage) furrow **; A** 'pinches in' / constricts / AW
2 ref. fusion **;**
3 to divide cell into two **; A** *idea of* formation of two (separate) cells linked to behaviour of (cell surface) membrane**;**

4 ref. to cytokinesis / contractile ring **;**

Y / *nuclear envelope*
5 disassembles / breaks down / AW **;**

6 during prophase / by end of prophase / before metaphase **;**
A by the end of prometaphase

7 re-forms / AW, during telophase (from ER) **;** [max 3]

[Total: 7]

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2 (a) (i) G ; [1]

(ii) B / C ; [1]

(iii) A / F ; [1]

(iv) B ; [1]

(v) D ; [1]

(b) 1 nitrogen and hydrogen / substrates, bind to / AW, active site **;**
2 enzyme-substrate complex (forms) **;**

3 ref. lock and key / induced fit, mechanism **;**

4 activation energy of reaction is lowered **;**
5 example of how activation energy lowered **;**
e.g. strain on (triple) bond of, N_2 / (di)nitrogen
A bond broken between nitrogen (atoms)
nitrogen and hydrogen ions held close together for bond formation
transfer of electrons
alternative pathway

6 product / NH_4^+, leaves active site **;**

7 ATP, required / used / provided from respiration **;**
8 ref. anaerobic conditions for enzyme action **;**

9 suggestion as to use of, vanadium / molybdenum, in active site **;**
e.g. act as cofactor / coenzyme
transfer of, electrons / protons [max 4]

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(c) 1 concentration of all the ions is greater in the root tissue than in the solution **;** ora
A roots

2 comparative data quote **;**

according to these data

3 (so) ions will not diffuse into the root tissue **;**
A if (facilitated) diffusion only, initially / till equilibrium reached

4 (so) active transport **; A** active, uptake / pumping **I** facilitated diffusion

5 use ATP **; A** energy
R ATP energy

6 move ions, against concentration gradient / from low to high concentration**;**
A diffusion gradient

7 use, membrane / integral / intrinsic / transmembrane / transport / carrier, proteins **;**
R channel proteins

8 are specific / have specific binding sites **;**

9 involve, conformational / shape, change **;**

10 comparative data quote to suggest that some ions are pumped more than others **;**
e.g. steepest gradients for K^+ and SO_4^-

11 phospholipid bilayer / hydrophobic core (of cell surface membrane) is impermeable to ions **;**

12 so ions cannot diffuse out / (membrane) proteins only allow inward flow of ions **;**

13 AVP **;** e.g. suggestion of differing numbers of specific membrane proteins to explain observation of mp 10 [max 5]

[Total: 14]

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3 (a) *max 1 if no ref. to TB and COPD or if correct definitions given and ref. to TB/COPD incorrect (TB is an infectious disease, COPD non-infectious)*

TB caused by, a pathogen / *Mycobacterium* / *M. tuberculosis* / *M. Bovis* **;** ora *for* COPD
A microorganism / bacterium / bacteria **I** virus / fungus / protoctist
A infectious disease is caused by a pathogen ora

TB is / COPD is not, transmissible / communicable / can be passed from one organism to another **;** *allow detail of TB transmission e.g. droplet infection* / *in contaminated milk*
A infectious disease is transmissible ora

COPD caused by, damage to / irritation of, lung tissue **;** AW
accept relevant ref. to tobacco smoking [2]

(b) (i) 1 lining / epithelium / wall, is thin / one cell thick / squamous **;**
I thin interstitium
R cell walls of alveoli
R alveoli are one cell thick
R endothelium / membrane

2 (so) short <u>diffusion</u> distance / only <u>diffuse</u> through two cells **;**

3 (collectively / many, so) large surface area for diffusion **;**
R an alveolus has a large surface area
I high SA:V ratio / increase SA

4 surrounded by / many / network of, <u>capillaries</u> **;**
I good blood supply

5 red blood cells are very close to air (in alveoli) **;**

6 (so) maintain, diffusion / concentration / partial pressure, gradient(s) **;**

7 elastin / elastic fibres, allow(s) alveoli to, increase in volume / expand / stretch / stop bursting / recoil **;**
I alveoli are elastic
R contract [max 3]

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(ii) *allow microorganisms or named type of microorganism or infectious agent for pathogens*

1 recognise, non-self / foreign, antigens, (on pathogen) **;**

2 receptors (on macrophage) bind antigens (on pathogen) **;**

3 (or), pathogen / AW, adheres / 'sticks', to (cell surface) membrane **;**

4 infolding of (macrophage cell surface) membrane around / engulf / phagocytosis of, pathogen **;** **R** engulf antigen

5 vacuole / vesicle / phagosome, forms **;**

6 ref. to lysosomes **;**

7 hydrolytic / digestive / named, enzymes **;**
e.g. lysozyme / protease / nuclease
A pathogen broken down by enzymes

8 hydrolysis of named compound(s) **;**

9 ref. to destroying / killing, pathogen **;**

10 ref. to antigen presentation **;**
accept idea even though does not occur in alveoli [max 4]

(c) 1 emphysema **;**
2 (alveolar walls broken down so) less surface area for, gas exchange / diffusion **;**
A impaired / AW, gas exchange / diffusion
3 difficulty in breathing / restriction in air flow / shortness of breath wheezing / rapid breathing **;**

4 blood is less well oxygenated / less oxygen reaches, tissues / muscles **;**

5 any two other, signs / symptoms **;;**
6 e.g. lethargy / tiredness / fatigue **/** constraints on mobility or activity
wheezing
persistent / AW, coughing
chest tightness **;** **R** chest pain
more prone to / frequent, chest / respiratory, infections
A more frequent colds / influenza ('flu)
weight loss
swollen, ankles / feet
increase in thickness of, right ventricle / right side of heart
increase in blood pressure in pulmonary artery [max 3]

[Total: 12]

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4 **(a)** 1 mitochondrion **;** **A** mitochondria
A outer mitochondrial membrane

2 produces / synthesises / AW, ATP **;** **A** release / supply, ATP / energy
R produces energy
R ATP energy

or
for outer mitochondrial membrane allows exit of (synthesised) ATP to cell

3 example of use of ATP in liver cells **;**
e.g. for synthesis of, cholesterol / glycogen / protein / biological molecules / polymers / AW
intracellular movement of vesicles
exocytosis / endocytosis / bulk transport
active transport [3]

(b) **(i)** lipoproteins are soluble **;**
cholesterol is not water-soluble **;**
cholesterol surrounded by / lipoproteins have, phospholipid heads / proteins, that are hydrophilic **;** AW
allows transport in blood **;** [max 1]

(ii) *cholesterol needed for*
making / components of, membranes **;**
membrane stability **;**
regulating the fluidity of, membranes / phospholipid bilayer **;**
production of, steroid hormones / named steroid hormone **;**
AVP **;** e.g. helps prevent entry of, ions / polar molecules [max 2]

(c) vesicles travel to cell surface membrane **;** **A** travels through cytoplasm towards space between cells
exocytosis **;**
vesicle / membrane, fusion (with cell surface membrane) **;**
contents / cholesterol, released **;** [max 2]

(d) glycosylation / adding sugar molecules to proteins / making glycoproteins **;**
A modifying proteins
phosphorylating proteins **;**
cutting / folding, proteins **;**
assembly of polypeptides into proteins (with quaternary structure) **;**
AVP **;** e.g. lipid synthesis
ref. lysosome formation [max 1]

[Total: 9]

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5 (a) (i) GTG ;

ACU ;

leu ; [3]

(ii) primary structure ; [1]

(b) 1 mutation ;
2 base substitution / T→ A in template strand of DNA / AW ;

transcription
3 DNA has CAC as 6th triplet ;
4 (so) mRNA has GUG as (6th) codon ;
allow one mark for altered mRNA codon *if no marks gained for mps 3 and 4*

translation
5 different tRNA involved / tRNA specific to val and not glu ;
6 anticodon on tRNA has CAC (with valine) ;
7 tRNA brings, incorrect amino acid / val, to ribosome ;
8 further detail ; e.g. incorrect amino acid incorporated into growing polypeptide chain [max 5]

[Total: 9]

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6 (a) *niche*
functional role / function / role / AW, of a species within an ecosystem **;**
A population / organism, *for species*
accept description

community
all populations of all species / all organisms / AW, living in a (particular) area / AW, (at the same time) **;** [2]

(b) 1 changing / increasing / decreasing, numbers of sea otters has (large) effect on the rest of the ecosystem **;**

effect on kelp
2 prey on sea urchins, which, graze / feed on, kelp **;**
3 if, no / few, otters numbers of urchins increase, so kelp decreases **;** ora
4 sea urchins have no other predator **;**

role of kelp
5 kelp, is a producer / initial input of energy into ecosystem **;**
6 so less kelp means less energy available for the ecosystem **;**
7 kelp provides habitats for many other species **;**
8 loss of kelp (significantly), changes structure of ecosystem / ref. to 'deforestation' **;**

effect on other organisms
9 decrease in numbers (of sea otters) leads (initially) to increase in numbers of their prey / named organism from Fig. 6.1**;** ora
10 *for any one example* ref. to consequence / knock-on effect **;**
11 AVP **;** e.g. ref. to effect on, energy flow through ecosystem / regulation of populations within the ecosystem / community structure [max 4]

(c) 1 (determine) energy content of consumed kelp, absorbed / that can be used, by sea urchins **;** AW
2 (determine) energy content of kelp consumed by sea urchins **;**

allow other reasonable suggestions for mps 1 and 2

3 *idea of* comparing energy contents and expressing as a, percentage / proportion / ratio **;**
A equation *or* worded e.g. mp 1 divided by mp 2

4 (calculated as) per unit, area / volume, per unit time **;**
A example e.g.(J) m^{-3} $year^{-1}$ [max 3]

[Total: 9]

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1 **(a)** 1.4 mm ; ;
two marks for the correct answer
A 1.3 / 1.34 / 1.37 / 1.43 / 1.46 / 1.5

tolerance on measurement of 49 mm = ± 2 mm (i.e. 47 to 51 mm)

*if answer not given or incorrect allow one mark for correct measurement and correct use of formula (measurement divided by the magnification of 35 **or** showing the rearranged formula)* [2]

(b) 1 large / wide, lumen (relative to thickness of wall) ;
A artery narrow lumen

2 irregular shape ; AW
A flattened / oval / not round(ed) (shape) ;
A artery, round(ed) / regular (shape)
I ref. to (vein) not spherical / artery spherical

3 thin / AW, tunica media / middle layer / (smooth) muscle and elastic layer
or
(proportionately) less, elastic / (smooth) muscle, in, tunica media / middle layer ;

4 (relatively) thin, tunica externa / tunica adventicia / outer layer / fibrous coat / fibrous layer ;
R small(er)

5 tunica intima / tunica interna / inner layer / endothelium, smooth / not 'crinkly' / not wavy / AW ;

alt *if mp 3 not awarded, award 1 mark only for*
thin (smooth) muscle layer / less (smooth) muscle
thin elastic layer / less elastic tissue [max 3]

(c) **(i)** short distance for diffusion (of molecules / ions / named) ;
A reduced distance / thin / short pathway / AW

increased rate / AW, of diffusion (of molecules / ions / named) ;
A fast(er) / (more) efficient
I easy / better [max 1]

(ii) 1 small size allows contact with (many body) cells / AW ;
A *idea of* extending into small spaces

2 red blood cell, close to, (body) cells / tissue for (efficient), diffusion / AW ;
A in contact with / close to, capillary wall / endothelium, for diffusion

3 red blood cells / blood flow, slow(s) down / *idea of* more time,
for (efficient) diffusion / cells to obtain sufficient nutrients / AW ;
treat ref. to lower pressure as neutral

4 (plasma / blood, containing), glucose / nutrients / named nutrient / oxygen,
close to / AW, body cells ; [max 1]

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(d) (i) *(produce genetically identical daughter epithelial cells for)*

1 (for tissue) repair ;
R cell repair

2 *idea of* replacing, dead / destroyed / damaged / worn-out / AW, cells ;
A replacement of cells, unqualified *if mp 1 gained*

3 ref. protection of, underlying tissue / muscle and elastic layer / tunica media / AW ;

4 meiosis produces, haploid cells / cells with n chromosomes / cells with one set of chromosomes ;
A cells with half the number of chromosomes

5 meiosis for gamete formation ;
A sex cells
R meiosis in gametes [max 2]

(ii) *ignore ref. to 23/46 chromosomes*

(mitosis to), maintain genetic stability / produce genetically identical cells / produce clones ora
or
meiosis produces genetically different cells ;

(mitosis), ensures cells retain function / cells function as tissue / AW ;
(mitosis) maintains chromosome number ;
A maintains, diploid number / 2n
meiosis produces, haploid cells / cells with n chromosomes / cells with one
A cells with half the number of chromosomes
meiosis for gamete formation ;
A sex cells
R meiosis in gametes [max 2]

(e) *ignore labels*
max 1 if nuclear, membrane / envelope, shown
no marks if chromosomes with two chromatids drawn

1 four separate, chromatids / daughter chromosomes, shown in each half ;

2 all centromeres leading
A 'V' shapes if centromere not obvious *(point of V towards pole)*
or
all centromeres attached to spindle fibres ; [2]

[Total: 13]

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2 (a)

Keratin and chitin have structural functions cellulose ; collagen ; *allow <u>only one</u> incorrect molecule to be listed for max 1*	*Keratin is a fibrous protein* collagen ; *no marks if other molecules given*
The monomers of chitin have β-1,4 linkages between them cellulose ; *no marks if other molecules given*	*Keratin and chitin contain nitrogen* collagen / haemoglobin ; *1st mark* mRNA ; *2nd mark* *allow <u>only one</u> incorrect molecule to be listed for max 1*

[max 5]

(b) (i) 47.5 ˚C ; [1]

(ii) *accept activity for relative activity throughout*
accept manipulated data quotes and penalise once for, incorrect / no, units

Fig. 2.2 (relative activity of enzyme at different temperatures)

1 as temperature increases, activity increases up to, optimum / 47.5 ˚C (*allow ecf from* **(i)**, then decreases ;
A peaks (*for increase then decrease)*

2 activity increases from 30 ˚C to 47.5 ˚C, then decreases to 70 ˚C ; *also mp 1*
or
increase <u>or</u> decrease, described with comparative data (*activity and temperature compared with another activity and temperature*)

3 at higher temperatures (compared to most others) enzyme still active ;

4 high optimum temperature (compared to most other enzymes) ;

Fig. 2.3 (stability over time for enzyme maintained at different temperatures)

5 enzyme becomes less stable over time ;
A activity decreases over time
A description if at least two temperatures described

6 data quote to support ; *activity at two times for any one temperature*
if time 0 or 'start', then assume 100% relative activity
if 100%, assume time 0

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7 (over the time period) the lower the temperature, the more stable the enzyme ; ora
A enzyme has higher activity at the lower temperatures
A stated temperatures (at least two) to illustrate the point
e.g. 28 ˚C higher activity than 40 ˚C throughout
A 28 ˚C, highest activity / enzyme most stable (throughout)

8 data quote to support ; *temperatures and (relative) activity (with one time)*

discussion points

9 AVP ; ;

10 *e.g. Fig 2.2*
reason for increasing activity up to optimum / decrease after optimum
e.g. ref. collisions, kinetic energy increase e.g. denaturation at 60–70 ˚C
R denaturation at 50 ˚C (but **A** denaturation begins)
suggested reason for higher optimum temperature e.g. more bonds

Fig. 2.3
(suggests that) more molecules become, denatured / inactive, as time progresses
greater stability / higher activity, at 40 ˚C than 37 ˚C between 40–50 hours

Fig. 2.2 and 2.3
optimum temperature for activity not most stable temperature
steep decrease in stability at 60 ˚C in a short time as (nearly complete) denaturation occurs *allow once only*
commercial application e.g. if hydrolysis occurs over a longer time period, better to use a lower temperature than optimum [max 5]

[Total: 11]

3 (a) 1 large (size / volume / organism) ;
A multicellular / many cells
A larger

2 (so) small(er) / low, surface area : volume ;
as size increases, SA:V decreases = 2 marks

3 diffusion (alone), not enough / too slow (to supply needs) ;

4 explanation ; e.g. surface too far from, centre / AW, of plant
distances too far to supply required, nutrients / substances
requires, supplies in bulk / mass flow

5 (so require) xylem and phloem, qualified ;
e.g. transport in different directions
xylem transports water (and mineral ions) and phloem transports, assimilates / photosynthates / sugars / amino acids [max 3]

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(b) (i) *cell **A*** = companion cell
A companion ;
*cell **B*** = (phloem) sieve tube element
A sieve tube, sieve tube cell [1]

(ii) *allow ecf from* **(i)** *for incorrect names of cells*
*cell **A** / companion cell*

1 mitochondria for, aerobic respiration / oxidative phosphorylation / ATP, production / AW ;
R ATP energy
A release / supply, ATP / energy (for the cell)
treat as neutral cell B also has mitochondria

2 RER / many ribosomes, for, polypeptide / protein, production ;
if mps 1 and 2 not given, one mark for mitochondria and, ribosomes / RER

3 ref. nucleus and, genes coding for (required) proteins / synthesis of ribosomes
or
nucleolus synthesises ribosomes ;
*cell **B** / sieve tube element*

4 (at least) one main structural feature ;
R hollow
peripheral cytoplasm / AW e.g. pushed against walls
no nucleus / no RER / no vacuole / no Golgi / few organelles / reduced ER / few mitochondria
R no organelles

5 (to) minimise / reduce, resistance to (mass) flow ; AW
e.g. uninterrupted flow / more efficient transport of sucrose

6 (so) maximum volume transported (/unit time) ;
A *idea of*

7 sieve plates, qualified ; e.g. stop bulging
allow mass flow / reduce barrier to flow
become plugged with, P-protein / callose, to prevent losses / after damage

8 no plasmodesmata (*as on Fig. 3.1*) to maintain pressure
or
plasmodesmata (*not shown*) for diffusion of sucrose into sieve tube / AW ; [max 5]

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(c)

	transport system in mammals	*transport system in plants*
1	arteries, veins, capillaries **A** delivery to cells by arteries and capillaries	xylem and phloem ; **A** vascular bundle
2	heart / pump	no heart / no pump / (xylem and phloem) have different mechanisms for (mass) flow ; **A** transpiration pull in xylem / pressure gradients in phloem
3	double circulation	no double circulation / xylem unidirectional flow / phloem source to sink / AW ; **R** single circulation
4	closed circulation	not closed circulation / pits / plasmodesmata ; **A** open
5	one (circulatory) system / water and organic molecules transported in same vessels / AW	two (separate) systems / water transport in separate vessels to organic molecules ;
6	(all) living cells	living and dead cells ; **A** dead cells in xylem
7	transports, (respiratory) gases / oxygen / carbon dioxide	respiratory gases not transported ;
8	transports glucose *accept within correct list*	(phloem) transports sucrose ; *accept within correct list*
9	faster rate of flow	slower rate of flow ;
10	rate of flow controlled by, nervous system control of heart / action of heart / vasoconstriction and vasodilation / AW *accept ref. endocrine system*	rate of flow, not controlled by nervous system / (in xylem) controlled by external factors / (in xylem) controlled by transpiration rate ;
11	components include blood cells	cells not transported / AW ;
12 13 14	AVP ;;; homeostasis involved / concentration of dissolved substances controlled ref. to defence e.g. immune system e.g. blood clotting organ-based valves present	no homeostasis / AW ; no equivalent to immune system callose formation ; tissue-based ; no valves ;

[max 4]

[Total: 13]

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4 (a) (i) *penalise once if the term genetic material is used instead of DNA*

1 no nuclear envelope / no (true) nucleus ;
A no nuclear membrane
A no nucleus envelope
A DNA free in cytoplasm ora
A DNA as nucleoid

2 DNA, loop / circular ;
A DNA not linear

3 DNA, not in chromosomes / DNA not associated with, histones / proteins ;
A naked DNA

4 no nucleolus ;

5 (presence of) plasmids ;

6 (only) have, 70S / small / 18–20 nm, ribosomes ;

7 presence of, capsule / slime layer ;

8 ref. small (cell) size / less than 5 μm / (only) 1 μm ;
A ora for eukaryotes [max 3]

(ii) *plant cell*
cellulose ; *treat as neutral ref. to microfibrils / fibres*

bacterial cell
murein / peptidoglycan ;
A peptoglycan / polysaccharide and amino acid [2]

(b) 1 cell contents shrink / cytoplasm shrinks ; AW
R cell shrinks *unless clear that the cell wall remains, intact / same size*

2 cell (surface) membrane / plasma membrane, peels away / AW, from cell wall ;
A plasmolysis occurs **/** cell becomes flaccid

3 (movement of) water out by osmosis ;
4 down water potential gradient / from high to low water potential / to lower water potential /from less negative to more negative water potential ;
A ψ for water potential [max 3]

(c) 1 (mutation involves) change in sequence of, bases / nucleotides (of DNA);
A (mutation leads to) altered, mRNA / codons
A change leads to new alleles
(genes code for, polypeptides / proteins, so)

2 different, protein structures / proteins, possible / synthesised ;
A different, primary / tertiary / 3-D, structure

3 (so) range of / different, functions possible / AW ; [max 2]

[Total: 10]

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5 (a) *max 2 if no examples from passage given*
population

1 all individuals / all organisms / AW, of,
Trichophilus welckeri
three-toed sloths / *Bradypus variegatus*
one / a, species of roundworm
one / a, species of insect *any one* ;
one / a, species of saprotrophic fungi
one / a, species of algae
A one (particular), species **/** kind / type
I e.g. the roundworms etc.
treat as neutral same organisms

2 *idea of* in, an (specified) area / AW ; e.g. place / habitat e.g. (sloths) in the, forest / trees (at one time)in central / south America
in the sloth's fur / on the sloth

3 at the same time ; *allow once only*

4 (named organisms) share same gene pool / ref. isolated from other populations (of the same species) ;
community

5 all populations of all species / all organisms / AW, living in a (particular) area / AW ;

6 examples ; all the organisms living on the sloths fur
or
roundworms, insects, fungi, algae, on sloth's fur/ in same area
in second example do not need ref. to fur or area if mp 5 given

7 at, the same / one, time ; *allow once only* [max 4]

(b) 1 has biotic and abiotic components / biological and physical components ;
A living and non-living components

2 described by use of examples from text ; e.g. water and organisms
A fur as an abiotic factor

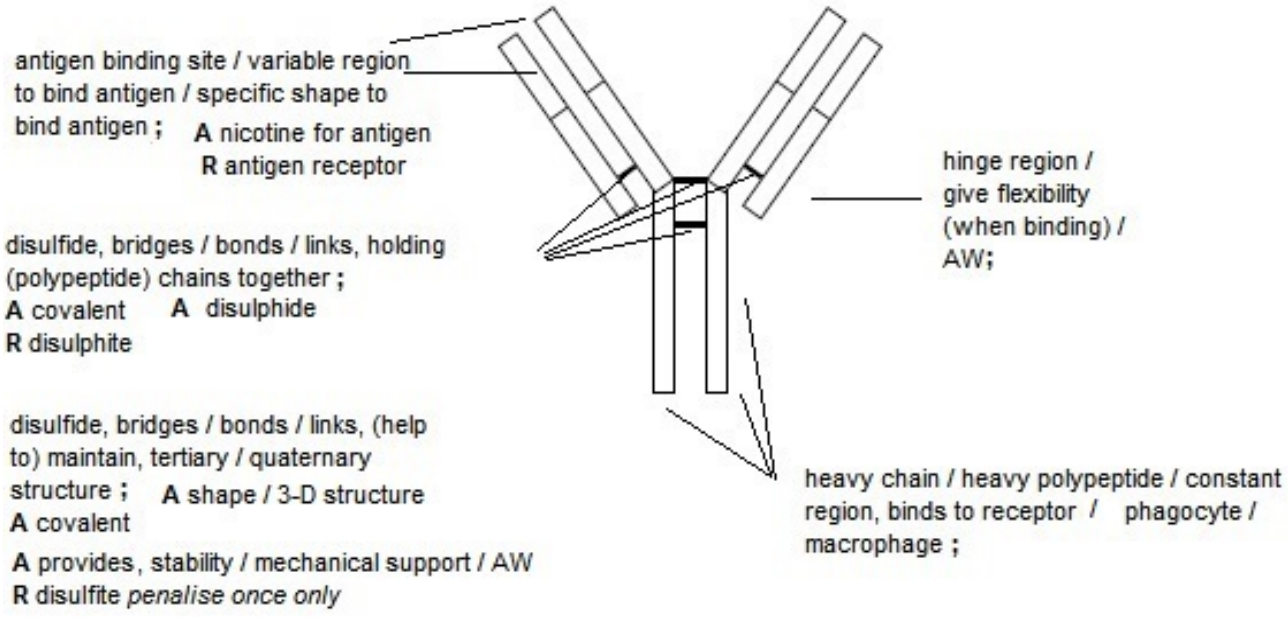
3 ref. energy flow / nutrient cycling ;
A described e.g. food web, algae as producers, fungi as decomposers
A food chains *look for at least one link*

4 ref. interactions / functional entity ; AW e.g. self-contained / self-sustaining / inter-relationships [max 3]

[Total: 7]

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6 **(a)** *labels to correct areas, mark to max 3*



AVP ; e.g.
light and heavy polypeptide chain, ref. forming variable region / different primary structure(s) giving different shapes ;
heavy / polypeptide, chain constant region gives antibody class ; AW [max 3]

(b) **1** increases heart rate ;
A heart, pumps / beats faster

2 increased blood pressure **/** hypertension ;

3 damage to, endothelial / arterial, lining ;
A damage to, tunica intima / lining of veins

4 (so) contributes to plaque / atheroma ;
A atherosclerosis

5 vasoconstriction
or
constricts / reduces diameter of, arterioles / blood vessels ;
A more resistance to blood flow *must be in context*

6 reduced blood flow to extremities / AW ; [max 3]

[Total: 6]

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

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Cambridge is publishing the mark schemes for the October/November 2013 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

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Mark scheme abbreviations:

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

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1 (a) (i) variable region / antigen binding site ; **A** antigen binding region
A light, polypeptide / chain **R** antigen receptor [1]

(ii) disulfide ; **I** bridge
A disulphide **R** disulfite / covalent [1]

(iii) two or more / more than one , polypeptide(s) / tertiary structure(s) ;
R any specific number of polypeptide on its own
R more than one type of polypeptide / many polypeptides
R more than two / several, polypeptides
I ref to prosthetic group [1]

(b) 1 antigen recognised as / AW, non-self / foreign ;
accept once for macrophage, B-lymphocyte or T-lymphocyte
A non-self / foreign, antigen leads to immune response
2 *idea of* phagocytosis leading to antigen presentation ;
3 antigen (on pathogen or APC) binding to, receptor / membrane, of B-cell(s) / B-lymphocyte(s) ; **A** clonal selection of B-lymphocytes occurs
4 (helper) T-cell / T-lymphocyte, activate B-cells ; **I** killer T-cells
A release cytokines to stimulate B-cells
5 B-cells / B-lymphocytes, divide by mitosis ; **A** replicates / proliferates by mitosis
A clonal expansion of B-cells
6 plasma cells, formed / AW ;
7 plasma cells / B-cells / B-lymphocytes, produce / secrete / AW, antibody / immunoglobulin / Ig ; [max 4]

(c) *parasite / Plasmodium / pathogen / protoctist / protist / protozoan must be mentioned at least once somewhere in the answer to gain any marks*
e.g. 'malaria / disease has many antigens' = 0

if malaria is caused by a virus / bacterium penalise once only

1 (malarial) parasite / pathogen / *Plasmodium*, (is eukaryotic) has many genes ;
A has greater genetic complexity cf smallpox / AW
2 different (malarial) parasite, species / strains / AW, have different antigens ;
R 'strands'
3 (malarial) parasite has different antigens in different stages of its life cycle ;
4 (malarial) parasite / *Plasmodium*, switches antigens / idea of antigens changing during infection / different genes coding for antigens switching on / AW ;
R 'active sites' of antigens changing
R 'antigens mutate'
5 parasite / antigen / stages of the life cycle, inside (host / liver / red blood) cells ; [max 2]

[Total: 9]

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2 **(a)** 1 nitrogen, converted / reduced / fixed, to, ammonium / ammonia (in root nodules) ;
A correct equation $N_2 \left(+ 6e^- + 8H^+\right) \rightarrow (2)NH_4^+ / (2)NH_3$
R if nitrogen fixation is said to happen in the soil
I nitrogen fixation is carried out by leguminous plant
2 (catalysed by) nitrogenase ; *accept if part of equation*
3 ATP, hydrolysed / AW ; *accept if part of equation*
4 ref. to anaerobic conditions ;
5 ammonia (converted) to amino acids to protein (in plants) ;
6 plant protein, digested / hydrolysed / broken down, by animals (into amino acids and absorbed) ;
7 amino acids used to synthesise (animal) protein ; [max 5]

(b) UAC ; [1]

(c) mRNA, less stable / broken down sooner / used only for a short time / does not last long / is temporary / has short (half-) life ; **I** 'used up'
tRNA is re-used (for a longer time); no ora
unless correct ref. to mRNA 'shelf life' [max1]

(d) 1 translation (*in correct context*) / genetic code used to make a sequence of amino acids / AW ;
2 attach / assemble around / moves along / AW, mRNA ;
A ref. to bind mRNA / mRNA 'lies within' the ribosome
R mRNA enters ribosome
3 tRNA(s) carrying amino acid(s), bind to / AW, mRNA ;
A provides two sites for tRNAs carrying amino acids to bind to mRNA
4 binding / pairing / AW, between anticodon on tRNA to codon on mRNA ;
5 (catalyse) formation of peptide bond (to form polypeptide) ;
6 any further detail of translation ;
e.g. peptidyl transferase
ribosome moves along one codon at a time
start codon is AUG
stop codon *in context*
correct roles of P and A sites [max 3]

[Total: 10]

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3 (a) (i) **R** *if more than one stage given*
A = prophase ; **I** early / late
B = interphase ; [2]

(ii) *no ecf from* **(a)(i)**
I *information about other phases*
1 chromatin / chromosomes / chromatids, condense / become visible ;
A described e.g. coiling, supercoiling, shorten, thicken
2 each chromosome is two (sister) chromatids joined together (at a centromere) ;
R 'two chromatids, join together / pair up'
3 nucleolus disappears ;
4 nuclear envelope, disassembles / breaks down / AW ;
5 centrioles / centrosomes, move to poles ;
A MTOC / microtubule organising centre
R 'ends' / 'sides'
6 ref to spindle ; e.g. spindle (fibres) start to form
centrioles organise microtubules (to form spindle fibres)
microtubules assemble [max 4]

(b) 6 ;;

if answer not given or incorrect allow one mark for correct measurement and correct use of formula

distance between **P** and **Q** is 30 mm, conversion to micrometres = 30 × 1000

either (magnification) $= \frac{30000}{5000}$

or $5000 = \frac{30 \times 100}{\text{actualsize}}$

look carefully for correct use of standard form
allow a tolerance of ± 2 mm (28–32 mm, i.e. 28 000–32 000 in formula) [2]

(c) **I** *general references to LM v EM*
A ora *for electron microscope*

1 living cells can be viewed (with light microscope) ;
2 can watch the cell cycle happen (in real time / time lapse) / AW ;
3 all chromosomes can be seen (at once) ;
4 can see, whole chromosomes / all the stages of mitosis or cell cycle ;
5 do not need take sections to see mitosis ;
6 dyes / stains, can be used ; **I** ref. to natural colours of specimens
A ref. to fluorescence microscopy [max 3]

[Total: 11]

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4 (a) **W** right atrium labelled in lumen / wall ;
X tricuspid valve labelled ; **A** valve flap / chordae tendinae *see encircled area on diagram*
Y aorta labelled ; [3]



(b) *needs to be a sequence, not events in the cardiac cycle e.g.* ***I*** *valves*

aorta, body (tissues / blood vessels) / capillaries / systemic circulation, vena cava ;
A body cells
right atrium and right ventricle ;
pulmonary artery (to lungs) ; **R** if blood comes from left ventricle [3]

(c) *max 2 for structural features*
I *fast diffusion, efficient diffusion, reduces diffusion distance*
mps 4, 6, 8 and 10 – can be awarded if related structure is not given but is implied

1 many alveoli ;
2 large surface area ; **I** high SA:V ratio / increase SA
3 many capillaries / network of capillaries ; **I** good blood supply
4 (so) maintain, diffusion / concentration / partial pressure, gradient(s) ;
5 lining / epithelium / wall, of, alveoli / gas exchange surface, is thin / one cell thick / squamous ; **I** thin interstitium
R 'cell walls of' **R** lungs **R** alveoli are one cell thick **R** endothelium / membrane
6 (so) short diffusion distance / only diffuse through two cells ;
7 ref. to, elastin / elastic fibres ; **I** alveoli are elastic
8 (so) allows alveoli to, increase in volume / expand / stretch / stop bursting / recoil ;
R contract
9 (alveolar type II cells secrete) surfactant ;
10 (so) reduces surface tension ; [max 4]

[Total: 10]

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5 (a) *mark both parts together to a maximum of four marks*

1 (polymer / polysaccharide of) β-glucose ; *allow glucose if β given for bond*
2 (1-4, β) glycosidic, bonds / linkages ; **A** glucosidic
R if 1-6 also given
3 ref. to (β) glucose units, linked at 180° to each other / alternately orientated / AW ;
4 many –OH groups projecting out (in different directions) ;
5 unbranched (polymer) / straight chain / linear ;
6 many hydrogen bonds between molecules ;
7 (straight chain allows) molecules lie parallel to each other ;
8 (form) microfibrils ;
9 many microfibrils form (cellulose) fibres ;
10 ref. to fibres at angles / criss-cross / AW ;
11 (cellulose) cell wall is permeable ;
A *idea* of many gaps, in wall / between fibres, allowing passage of water / (named) substances
12 ref. to strength to, prevent cell bursting / withstanding (turgor) pressure / AW ; [max 4]

(b) (i) *data quote may help to decide if mp2 is matched*
units must be used at least once in the answer to award mp3

1 as retention time increases percentage of cell wall material digested increases / positive correlation ;
A 'time for digestion' / reverse relationship
R directly proportional
2 results scattered / not all animals fit the pattern / varying percentages for the same retention time ; *not just a data quote*
3 data quote with units (% and h) using both axes ;
e.g. (highest percentage) 65% at 78 hours
(lowest percentage) 35.5 ± 0.5%, 35 hours
4 no retention time shorter than 35 hours and none longer than 88 hours ;
A lowest / shortest and highest / longest
A reverse relationship **A** 'time for digestion'
5 none of the (24) herbivores can digest the cell wall material completely ;
A no more than 65% is digested
not just a data quote [max 3]

(ii) more digestion means that there is more energy available to the animal ;
ora = undigested material means less energy to the animal

2 more digested material means more energy for, secondary consumers / carnivores / next trophic level / for the food chain ; ora

3 more digested material means more trophic levels ; ora

4 more undigested material provides more energy to decomposers / AW ;

5 AVP ; e.g. ref. to (named) animal productivity
A secondary, production / productivity [max 2]

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(c) *one mark per line*

similarities

use, membrane / integral / intrinsic / transmembrane / transport / carrier, proteins ;
R channel proteins
are specific / have specific binding site ;
involve conformational / shape, change of protein ;
(movement of (named)), ions / polar molecules / water soluble molecules / hydrophilic molecules / lipid insoluble molecules ;
I large molecules **A** charged
(movement) across membranes / into *or* out of the cell ; [max 2]

*differences **A** ora*

facilitated diffusion is (movement from), high(er) to low(er) concentration /
down concentration gradient ; ora **A** diffusion gradient
I 'along a concentration gradient'
facilitated diffusion, is passive process / does not require energy *and / or* ATP (from the cell) ;
R ATP energy
R the cell makes energy for active transport [max 2]

[Total: 13]

6 **(a)** *look at any labelling on the diagram*

cell contents / cytoplasm / not hollow ; **I** ref. to any organelles (not visible)
A xylem vessels are hollow
thin walls ;
A no, thickened walls / lignified walls / lignin
A xylem vessels have, thick walls / lignin
sieve plates / end walls / cross walls ;
A end walls not broken down
A xylem vessels have no end walls
R 'end' unqualified
I end plates / cell plates
no pits ; **A** xylem vessels have pits [max 2]
***I** ref. to companion cells*

(b) dissolved in, water / sap ; **A** in solution
mass flow ;
down (hydrostatic) pressure gradient / moves from high(er) to low(er) pressure (potential) ;
A symbol – ψ_p
AVP ; e.g. from source to sink
loading by, companion / transfer cells, requires ATP / is active ;
I ATP required for mass flow [max 2]

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(c) *answers may be general or in the context of phloem transport*

active site (with shape) complementary to substrate ;
A description in terms of lock and key (either way round)
I structure
induced fit / described ;
substrate binds to active site / enzyme-substrate complex forms / ESC forms ;
ref. to specificity of enzymes ;
activation energy of reaction is lowered ;
example of how activation energy lowered ;
e.g. reactants held close together for bond formation
transfer of electrons
strain on bonds
alternative pathway
holding the substrate in such a way that the bonds needed to be broken are exposed
product released from, enzyme / active site ;
A enzyme can be used again / enzyme unchanged at end of reaction [max 3]

[Total: 7]

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