1)

1	(a)	(i)	A = plasma / cell surface, membrane ; B = DNA / chromosome / chromatin / genetic material ;	2	DO NOT CREDIT membrane, cell membrane DO NOT CREDIT chromosomes (do not accept plural) CREDIT loop of / circle of, DNA DO NOT CREDIT plasmid, RNA ACCEPT nucleoid
1	(a)	(ii)	production of ATP ; aerobic respiration ;	max 1	ACCEPT named stages of aerobic respiration e.g. Krebs cycle, oxidative phosphorylation, ETC, chemiosmosis, link reaction, substrate level phosphorylation DO NOT CREDIT glycolysis, ATP *for* respiration DO NOT CREDIT *produce* energy (in form of ATP) IGNORE provide / release energy unqualified
1	(a)	(iii)	protein synthesis / translation ; photosynthesis / described ;	2	ACCEPT production / creation, of proteins / polypeptides, assembly of proteins from amino acids IGNORE autotrophic nutrition DO NOT CREDIT absorption of light unqualified
1	(b)		large surface area to volume ratio ; small so demand for, O_2 / CO_2, is low ; *idea of:* diffusion (alone) is adequate to meet needs ;	2	ACCEPT large SA:Vol or large SA/Vol ACCEPT small Vol:SA ratio or small Vol/SA DO NOT CREDIT large surface area alone IGNORE gases alone, nutrients ACCEPT *idea of* : body SA large enough to meet needs by diffusion ACCEPT idea of : diffusion distance short
1	(c)		cell / tissue — function in the lungs recoil OR return to original, size / shape OR to help expel air OR prevents alveoli bursting ; waft / wave / move / AW, mucus ; secrete / release / produce, mucus ; constrict the airway / AW ;	4	IGNORE stretch / expand ACCEPT ref to lungs, alveoli, airways recoiling etc DO NOT CREDIT ref trachea / bronchi recoiling ACCEPT transport / remove, mucus DO NOT CREDIT dirt particles without ref to mucus DO NOT CREDIT excrete mucus ACCEPT narrows lumen OR controls, airflow / diameter, of airways DO NOT CREDIT ref to alveoli OR greater airflow

2)

(a)	(i)	osmosis ;	1	
	(ii)	2 = symplast (pathway) ; 3 = apoplast (pathway) ;	2	ACCEPT symplastic ACCEPT apoplastic
	(iii)	S ;	1	

(b)		*This is a QWC question* 1 water moves into xylem down **water potential** gradient ; 2 **root pressure** / high (**hydrostatic**) **pressure** at bottom of xylem ; 3 water vapour loss / **transpiration** / **evaporation**, at leaves / top of plant ; 4 (creating) low (hydrostatic) pressure at top of xylem ; 5 water, under **tension** / pulled up (in a continuous column) ; 6 **cohesion** between water molecules / described ; 7 **adhesion** of water molecules to xylem / described ; 8 **capillary action** / described ; 9 water moves up (xylem / stem) by **mass flow** ; 10 from high(er) (hydrostatic) pressure to low(er) (hydrostatic) pressure / down (hydrostatic) pressure gradient ;	max 4	ACCEPT ψ for water potential ACCEPT water moves from high ψ to low ψ IGNORE drawn for pulled up ACCEPT ref to xylem being very narrow so water rises
		QWC (three terms used in correct context and spelt correctly) ;	1	Any **three** terms from the following : water potential, hydrostatic pressure, transpiration / evaporation, cohesion / cohesive, adhesion / adhesive, tension, root pressure, capillary action / capillarity, mass flow

(c)

xylem vessel	phloem sieve tube element	
present	absent	;
present	absent	;
(water and), minerals / ions / salts	products of photosynthesis / sucrose / assimilates / amino acids / minerals / ions / salts / plant 'hormones'	;
(only) up stem / towards leaves	both directions / up and down / from source to sink	;

One mark per row
Both statements must be correct to achieve mark

DO NOT CREDIT ticks and crosses

Read whole list – if any suggestion is wrong then do not award mark
XYLEM
DO NOT CREDIT 'nutrients' OR 'water' alone
PHLOEM
ACCEPT 'sugar' in place of sucrose
IGNORE unspecified 'solutes'
DO NOT CREDIT glucose

ACCEPT arrows ↑ (xylem) ↓↑ (phloem)
DO NOT CREDIT 'all directions'
IGNORE ref to pits / lateral movement

3)

(a)		a single value between 67 and 80 ; ;	max 2	two marks for correct answer If answer incorrect, allow one mark for appropriate working i.e. 60 divided by time from trace selected by candidate
(b)		heart rate, slower / lower / reduced / 60 – 63 beats per minute ; rest period / diastole longer ; ventricle takes longer to contract / ventricular systole longer ;	max 2	*Mark first point on each numbered line* **ACCEPT** length of one beat is longer **DO NOT CREDIT** 'slows heart's activity' **ACCEPT** T wave elongated / increases from 0.24s to 0.32s / increases by 0.1 s **IGNORE** name of chamber **ACCEPT** R wave slightly elongated / increases from 0.07s to 0.12s / increases by 0.05 s
(c)		SAN, is pacemaker / initiates heart beat ; (SAN sends) impulse / wave of excitation, over atria (walls) ; AVN delays impulse ; (AVN) sends impulse down, septum / bundle of His / Purkyne fibres ;	max 3	**ACCEPT** *starts*, wave of excitation / action potential / electrical impulse **IGNORE** 'sends out' (wave) **IGNORE** *through / to,* the atrium **DO NOT CREDIT** signal / message for impulse, **allow ecf** **DO NOT CREDIT** pulse **IGNORE** delays contraction **ACCEPT** Purkinje

4)

(a)		placing, living things / organisms / named organisms, into, groups / categories / taxa / named taxonomic groups ; based on / AW, similarity / difference ;	2	**ACCEPT** 'grouping living things' Look for the idea of similar organisms being placed in the same group or different organisms being placed in different groups
(b)	(i)			**ACCEPT suitable examples for mps 1 to 4**
	1	morphology / anatomy / (observable / physical) features / appearance / AW ;		*1* **CREDIT** cell features e.g. nucleus / membrane-bound organelles / cell wall / prokaryotic-eukaryotic features / unicellular
	2	biochemistry / cytochrome C ;		*2* **CREDIT** component of cell wall
	3	genes / DNA / genetics / RNA ;		*3* **IGNORE** chromosomes
	4	behaviour / physiology / embryology ;		*4* **ACCEPT** 'how they feed' / nutrition / 'how they reproduce'
	5	idea of shared, evolutionary past / phylogeny ;	3 max	*5* **ACCEPT** 'how closely related' **IGNORE** refs to interbreeding / fertile offspring
(b)	(ii)	T S R W U Q ; ; ;	3	**Mark the order of letters** (ignoring the dotted lines) All 6 in correct order = 3 marks If any incorrect, then credit T S in order at beginning = 1 mark U Q in order at end = 1 mark R before W anywhere in the sequence = 1 mark
(c)				**ACCEPT phonetic spellings throughout** **ACCEPT** alternative terms for names of kingdoms and domains throughout (e.g. plants / plantae)
	1	3 domains **AND** 5 kingdoms ;		
	2	domains are, bacteria / eubacteria, **AND**, archaea / archaebacteria, **AND**, eukarya / eukaryotes ;		*2* **ACCEPT** 'eukaryota'
	3	kingdoms are prokaryotes **AND** protoctists **AND** fungi **AND** plants **AND** animals ;		*3* **DO NOT CREDIT** protists / protozoa
	4	eukaryotes split into different kingdoms / all eukaryotes are in the same domain ;		
	5	all prokaryotes are in the same kingdom / prokaryotes split into different domains ;		
	6	domain classification based on, rRNA / ribosomes / RNA polymerase / protein synthesis / enzymes / flagella / membrane structure ;	4 max	*6* **IGNORE** RNA unqualified **DO NOT CREDIT** other forms of RNA **ACCEPT** any detail of protein synthesis

5)

(a)		young / elderly / HIV infected / malnourished / post-operative / on immunosuppressants / leukaemia / undergoing cancer treatment / anorexics ; immature / compromised / weak / AW, immune system ;	2	**IGNORE** prompt lines and mark the answer as a whole **ACCEPT** AW for young / elderly etc **IGNORE** 'ill' or 'unfit' **IGNORE** any reference to populations e.g. those living in vicinity of outbreak **ACCEPT** description **ACCEPT** no immunity
(b)	(i)			**DO NOT CREDIT** 'mould' – penalise once only
	1	bacteria / (bacterial) cells, divide / increase in number / multiply / reproduce / proliferate / replicate ;		*1* **IGNORE** 'growth' **DO NOT CREDIT** 'mitosis'
	2	(secrete) enzymes / named enzyme ;		*2* **DO NOT CREDIT** excrete Answer should **not** imply intracellular enzymes
	3	food, digested / broken down ;		
	4a	protein / named protein / polypeptides → peptides / amino acids OR		
	4b	fat / triglycerides → fatty acids OR		*4b* **IGNORE** cholesterol
	4c	starch / amylose / glycogen → glucose / sugar ;		*4c* **ACCEPT** other correct carbohydrate breakdown
	5	production / release / excretion / secretion, of, toxins / named toxin / waste products ;		
	6	(causes) change in, appearance / smell / texture / taste ;	3 max	*6* **CREDIT** suitable example e.g. 'goes mushy'
(b)	(ii)			Idea of 'more' is needed for all marking points but it can be stated once and linked to more than one point. • e.g. 'more bacteria secreting enzymes' = mp 2 and 4 **ACCEPT** converse argument throughout **ACCEPT** 'fungi' / 'mould' in place of bacteria as question stem does not specify
	1	bacteria, reproduce / AW, more rapidly / faster ;		*1* **IGNORE** 'grow' **IGNORE** 'more easily' or 'effectively' **DO NOT CREDIT** if the candidate thinks there is no reproduction at 5°C
	2	(so) more bacteria present ;		
	3	more, toxins / waste, produced / released / AW ;		
	4	more enzymes, secreted / AW ;		*4* **DO NOT CREDIT** excreted
	5	enzyme, action faster / works better / more effective, at higher temperatures ;		*5* **IGNORE** optimum
	6	(substrate and enzymes have) more kinetic energy ;		
	7	more, enzyme-substrate complexes / ESC / (successful) collisions between substrate and active site ;	3 max	

(b)	(iii)	max 2 for 2 distinct methods max 2 for 2 **correctly linked** explanations Only credit the explanation mark if the method mark has been awarded.		Where more than one method is given, mark first on line and assume explanation linked with that **DO NOT CREDIT** chilling or freezing (as in question)
	M1 E1	salting ; lack of water due to, osmosis / low water potential (outside cell) ;		*M1* **IGNORE** drying *E1* **ALLOW** low Ψ / high solute potential
	M2 E2	sugar ; lack of water due to, osmosis / low water potential (outside cell) ;		*M2* **IGNORE** drying *E2* **ALLOW** low Ψ / high solute potential
	M3 E3	(air / freeze) drying ; *idea that* enzymes cannot mobilise / intracellular transport impaired / reactions have no medium in which to occur / (microbes) cannot move ;		
	M4 E4	pickling / (use of) vinegar ; (low pH) denatures / changes tertiary structure of / changes 3D shape of, enzymes / proteins **OR** substrate no longer fits active site / active site shape changes / prevents ESC ;		*E4* **DO NOT CREDIT** high pH
	M5 E5	heat treatment / cooking ; denatures / changes tertiary structure of / changes 3D shape of, enzymes / proteins **OR** substrate no longer fits active site / active site shape changes / prevents ESC ;		*M5* **ACCEPT** pasteurising **IGNORE** canning for this mp *E5, E 6 & E7* **ACCEPT** 'kills bacteria' or 'kills microbes' as a reason supporting heat treatment, irradiation or smoking **only once**
	M6 E6	irradiation / UV / gamma rays / X-rays / ionising radiation ; destroys / damages / changes / mutates, DNA / genes / genetic material ;		*M6* **CREDIT** radiation if correctly qualified in explanation
	M7 E7	smoking ; (so exposed to) antibacterial / named antibacterial, chemical(s) ;		*M7* **CREDIT** addition of, sulphites / sodium benzoate / alcohol
	M8 E8	vacuum packing / canning / bottling ; microorganisms cannot respire aerobically ;		*E8* **IGNORE** 'denaturing' as a consequence of canning / bottling
			4	

(c)		**This is a QWC question** **Ignore sections and mark as continuous prose**		Assume candidate is talking about mycoprotein unless otherwise stated. **CREDIT** ora for beef throughout. **IGNORE** use of figures alone when awarding mps **1**, 3, 6, 7, 9 – look for **descriptive statement**, e.g. • '12 g of protein' = no mark • 'only 12 g protein' = 1 mark (mp 9)
	1 2	low(er) / less, energy (than beef) ; useful for, slimming / weight control / AW ;		*2* **ACCEPT** preventing obesity **ACCEPT** 'less energy to burn off *during exercise*' **DO NOT CREDIT** 'burn off' unqualified
	3 4 5	low(er) / less, (total) fat ; (very) low / (much) less, saturated fat ; lower, cholesterol **OR** lower risk of, (coronary) heart disease / CHD / cardio-vascular diseases / heart attack / cardiac arrest / myocardial infarction / MI / angina / atherosclerosis / atheroma / stroke / hypertension ;		
	6	contains carbohydrate / AW ;		*6* **ACCEPT** 'more carbohydrate than beef' **IGNORE** 'carbs'
	7 8	low(er) / less, iron content ; (increased risk of) anaemia / fewer RBCs / less haemoglobin / reduced oxygen carrying capacity of blood ;		*8* **IGNORE** answers phrased in terms of role of iron alone e.g. 'haemoglobin contains iron' = 0 Answers must show consequence of deficiency e.g. 'less haemoglobin' = 1
	9	low(er) / less, protein ;		
	10 11	(mycoprotein provides) more balanced diet ; need larger intake to meet requirements / AW ;	7 max	
		QWC – award for 2 clear references to the table ;	1	Award for 2 sets of comparative figures (stated or calculated) with units – 'content per 100g' not needed **IGNORE** vague terms like 'about' as long as figs are correct

6)

(a)	(i)	mucus traps, bacteria / microbes / pathogens / microorganisms / viruses / spores ; cilia, sweep / move / waft, mucus / bacteria / pathogens / microorganisms / viruses / spore, upwards / AW ;	2	For both marking points **ACCEPT** ora for what would happen if they didn't work **IGNORE** ref to dirt / dust / etc **ACCEPT** answers that imply out of airways e.g. to the throat / coughed / swallowed

(a)	(ii)	*stage A* 1 phagocyte, attaches / binds / AW, to bacterium / pathogen ; 2 receptor (on phagocyte), attaches to / binds to / recognises / AW, antigen (on bacterium) ; *stage B* 3 bacterium, engulfed / enters by endocytosis / enters by phagocytosis / AW ; 4 (formation of) phagosome / phagocytic vacuole ; *stage C* 5 lysosomes, fuse with / join with / move towards (phagosome) ; 6 release / secrete, enzymes / lysins / named enzyme / hydrogen peroxide / free radicals (into phagosome) ; *stage C/D* 7 bacterium, digested / broken down / hydrolysed ; 8 (to) amino acid / sugar / glucose / fatty acid / glycerol ; *stage D* 9 absorbed / AW, into, cytoplasm / cytosol ; 10 by, (facilitated / simple) diffusion / active transport ;	6 max	**IGNORE** stage letters and look for correct sequence **DO NOT CREDIT** steps that are biologically out of sequence, e.g. mp6 before mp5. Penalise once only. **ACCEPT** 'bacteria' throughout *2* **CREDIT** PAMP / antibody marker / complement marker, as AW for antigen *3* **DO NOT CREDIT** 'eaten' **IGNORE** pseudopodia or any other structure *5* **DO NOT CREDIT** 'binds with' *7* **DO NOT CREDIT** destroyed (as in the question) **IGNORE** refs to antigen presentation as this happens after the stage shown in the diagram
(b)	(i)	plasma (cell) ;	1	**ACCEPT** B lymphocyte **ACCEPT** effector cell **DO NOT CREDIT** lymphocyte unqualified

(b)	(ii)	**This is a QWC question** 1 Y-shaped molecule / light and heavy chains / disulfide bonds / 4 polypeptide chains ; 2 constant region ; 3 marker for / binds to, phagocytes / AW ; 4 variable region ; 5 (antibody) specificity ; 6 (has) complementary shape to antigen (on pathogen) ; 7 hinge (region) ; 8 allows flexibility ; 9 more than one variable region : 10 allows, agglutination / description of agglutination or attachment to more than one, pathogen / antigen ; 11 neutralisation / blocking pathogen's binding sites ;	6 max	**CREDIT** a correctly labelled diagram that is clearly an antibody **CON** if diagram and text are contradictory MPs 3, 5, 6, 8, 10 are stand alone but **DO NOT CREDIT** if context is clearly incorrect. e.g. 'constant region gives specificity' **AWARD** mp 2 but not mp 5 *3* **ACCEPT** ref to opsonisation 'Complimentary shape to specific antigen' = 2 marks (mps 5 & 6) *8* **IGNORE** 'movement' unqualified *9* **DO NOT CREDIT** from diagram unless more than one is explicitly labelled or clearly keyed (e.g. by shading) *11* **ACCEPT** ref. to antitoxin
		QWC – award when 2 marks are given in any two of the grouped sections ;	1	2 marks had been awarded from 2 of the following groups of marks (4 marks in total) mps 2 & 3 mps 4 & 5/6 mps 7 & 8 mps 9 & 10

(b)	(iii)	*type of immunity* *artificial active* ☐ *artificial passive* ☐ *natural active* ☐ *natural passive* ✔ ;		**DO NOT CREDIT** if more than 1 box is ticked **DO NOT CREDIT** a cross **DO NOT CREDIT** a tick that has been crossed out and is a 'hybrid' tick

7)

(a)	1 2 3 4 5 6 7 8	biodiversity (of heathland) ; rare / endangered, species / plants / animals / fungi / organisms / named organism ; rarity of (this) habitat ; example of current *legal* status ; (likely) reduction in size of, habitat / ecosystem / heathland ; effect of reduced size on viability (of whole ecosystem) ; effect on, movement / spread, of, species / named species / plants / animals ; a method of minimizing impact / AW / named example ;	3 max	*4* e.g. National Park / SSSI / protected species / National Nature Reserves / NNR / other *legal* example *5* **IGNORE** 'habitat destruction' alone. Must refer to extent or size of destruction. 7 **CREDIT** effect on wildlife corridors Answers could refer to limiting species spread or introduction of species *8* e.g. 'toad tunnels' / relocation of population 'build toad tunnels so that the toads can still move between the two areas of heathland' = 2 marks (mps 7 and 8)
(b)	(i) 1 2 3 4 5	*idea of* (collect in) different / wider, area ; (collect at) different, times of day / times of year / weather conditions ; use of named, collecting / identifying, technique ; method of ensuring that individuals not counted again ; mark-release-recapture / capture-recapture, technique ;	3 max	*1* **ALLOW** several transects e.g. another path *3* e.g. (sweep) net / photographs / feeding stations **IGNORE** pooter (as could only catch larvae) / light trap / use of key / single transect *4* This mark refers to an initial or the only sample – it is **not** linked to mp 5 *5* **CREDIT** count marked individuals in 2nd sample / population = no. in 1st sample x no. in 2nd sample / no. retrapped in 2nd sample

(b)	(ii)	<table><tr><th>species</th><th>n</th><th>n/N</th><th>$(n/N)^2$</th></tr><tr><td>Grayling (*Hipparchia semele*)</td><td></td><td></td><td></td></tr><tr><td>Large Heath (*Coenonympha tullia*)</td><td></td><td>0.3548</td><td></td></tr><tr><td>Gatekeeper (*Pyronia tythonus*)</td><td></td><td></td><td></td></tr><tr><td>Green Hairstreak (*Callophrys rubi*)</td><td></td><td></td><td></td></tr><tr><td>Silver-studded Blue (*Plebeius argus*)</td><td></td><td></td><td></td></tr><tr><td>Small Heath (*Coenonympha phamhylus*)</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td>Sum (Σ)</td><td>0.31633 OR 0.31217</td></tr><tr><td></td><td></td><td>1 - Σ</td><td>D = 0.68367 OR 0.68783</td></tr></table>	3	Original table on question paper had incorrect figure in $(n/N)^2$ column for Grayling row. Answers for mps 2 & 3 take this into account. **ACCEPT** ecf from incorrect answer for Σ (whether decimal places or rounding)
(b)	(iii) 1 2	many species present / high species richness / all species evenly represented / high species evenness / high biodiversity ; (so) should not be developed / development should be modified / development should be reconsidered / should be conserved / AW ;	2	**IGNORE** refs to relative robustness of habitat *1* **ACCEPT** 'types of butterfly' as AW for species **IGNORE** 'individuals' or 'organisms' *2* **DO NOT CREDIT** ref to 'planning' alone (as given in question) 2 **IGNORE** responses that imply uncertainty about the development. e.g. 'could' 'might' 'may'

<table>
<tr>
<td>(c)</td>
<td>(i)</td>
<td>
<table>
<tr><th>species</th><th>letter</th></tr>
<tr><td>Grayling
(Hipparchia semele)</td><td>A ;</td></tr>
<tr><td>Large Heath
(Coenonympha tullia)</td><td>D ;</td></tr>
<tr><td>Gatekeeper
(Pyronia tythonus)</td><td>F ;</td></tr>
<tr><td>Green Hairstreak
(Callophrys rubi)</td><td>B ;</td></tr>
<tr><td>Silver-studded Blue
(Plebeius argus)</td><td>C ;</td></tr>
<tr><td>Small Heath
(Coenonympha phamhylus)</td><td>E</td></tr>
</table>
</td>
<td>5</td>
<td>DO NOT CREDIT if more than one letter given against any individual species</td>
</tr>
<tr>
<td>(c)</td>
<td>(ii)
1

2

3</td>
<td>(is) same <u>genus</u> ;

have, features / characteristics / appearance / behaviour / biochemistry / physiology / anatomy / genes / genetic makeup / DNA, that are, similar / in common ;

(share a) common, ancestor / phylogeny ;</td>
<td>2 max</td>
<td>1 DO NOT CREDIT vague statements like ‘could be in the same genus’
IGNORE Coenonympha

2 IGNORE ‘similar’ on its own
DO NOT CREDIT ‘same’
IGNORE specific examples (e.g. orange wings / large spot)

3 ACCEPT closely related ;</td>
</tr>
</table>