

Q1.

- 5 (a) (i) air spaces (between cells) / aerenchyma ;
in mesophyll / cortex ;
formed by cell death ; [2 max]
- (ii) provides oxygen ;
for aerobic respiration / because conditions are anaerobic ;
ref. diffusion ;
AVP ; e.g. allows escape of ethene / buoyancy / active transport [2 max]
- (b) (i) internode length increases as water depth increases ;
use of figures ; (2 days) 2 depths + 2 lengths ignore units [2]
- (ii) part of plant is (always) above water ;
access to light ;
access to, air / oxygen / carbon dioxide ;
ref. pollination / flowering ; [2 max]
- (iii) ethene concentration increases up to 30 or 40 cm water depth ;
fluctuation / plateau between 30 or 40 cm to 60 cm water depth ;
comparison between when water level is constant and when water level increases ; [2]
- (c) (i) substance that affects growth / development ; [1]
- (ii) 1. gibberellin causes increase in stem length ;
2. detail of mechanism ; e.g. cell elongation
3. gibberellin has greater effect with ethene present ;
4. more gibberellin could be secreted as water depth increases ;
5. gibberellin could remain constant but have greater effect because more ethene
secreted ;
6. more gibberellin could be transported through plant as water depth increases ;
7. AVP ; [3 max]

[Total: 14]

Q2.

- 3 (a) (i) 1 anthers, versatile / loosely attached / attached at one point (to filaments) ;
2 anthers / stamens / tassels / androecium, on long filaments / hang out (of flower) ;
3 anthers / stamens / tassels / androecium, above leaves ;
4 stigmas / silks, hang out (of flower) ;
5 stigmas, large surface area / hairy / feathery / branched, (to catch pollen) ; [3 max]
- (ii) *advantages*
1 genetic variation / more diverse gene pool / increased gene pool ;
2 increased heterozygosity ;
3 less likely that harmful recessive alleles will be expressed ;
4 hybrid vigour / decreased inbreeding depression ;
5 ability to respond to changing conditions / named example ;
e.g. different environments / pests / disease / increased survival of offspring [3 max]

Q3.

- 4 (a) (i) A pericarp / fruit coat
B scutellum / cotyledon
C plumule / embryo shoot
D radicle / embryo root
0 or 1 = 0 marks, 2 or 3 = 1 mark, 4 = 2 marks ; ; [2]
- (ii) 1 food / starch / nutrients ;
2 for use, during germination / before photosynthesis / before leaves emerge above ground ;
3 to provide glucose for, respiration / ATP production ; *ignore energy*
4 to produce cellulose for cell wall production ;
5 to produce protein for, cell division / growth (of plant) ; R growth of cells [3 max]
- (b) (i) 1 permanently ;
2 binds with / blocks, active site ;
3 binds with, another part of enzyme / allosteric site ;
4 change (shape) of active site ; [2 max]
- (ii) *when acetylcholinesterase is inhibited*
1 acetylcholine remains attached to receptors (on post-synaptic membrane) ;
2 sodium channels on post-synaptic (membrane) remain open ;
3 membrane remains depolarised ;
4 action potentials / nerve impulses, continue to be produced ; [2 max]

- (c) 1 different sequence of, bases / nucleotides, causes different, sequence of amino acids / primary structure ;
- 2 acetylcholinesterase has a different, shape / tertiary structure ;
- 3 acetylcholine can still bind with, active site / acetylcholinesterase / enzyme **or** active site remains functional ;
- 4 (but) pyrethrum / inhibitor, cannot bind with, acetylcholinesterase / enzyme ;
- 5 inhibition is allosteric / AW ; [3 max]

- (d) (i) 1 below 0.5 μg no insects killed in either group ;
- 2 at 0.5 μg hybrid insects killed but resistant insects survived ;
- 3 at 10 μg all insects killed in hybrid group but only 80% killed in resistant group ;
- 4 at 30 μg all insects killed in both groups ;
penalise lack of units once [3 max]

- (ii) 1 resistant and susceptible insects are homozygous ;
- 2 hybrid insect is heterozygous ;
- 3 hybrid insect shows codominance / mutant allele and normal allele both have an effect ;
allow ref to gene here [2 max]

[Total: 17]

Q4.

- 4 (a) (i) J – epidermis/epidermal cell ;
K – mesophyll (cell) ;
L – bundle sheath (cell) ; [3]
- (ii) 1 mesophyll cells tightly packed/AW ;
2 so O₂ cannot reach bundle sheath cells ;
3 light independent stage/Calvin cycle **or** RuBP, in bundle sheath cells ;
4 ref. malate shunt ;
5 maintains high CO₂ concentration (in bundle sheath cells) ;
6 PEP carboxylase, has high optimum temperature/has higher affinity for CO₂/doesn't accept O₂ ;
7 (PEP carboxylase) not denatured ;
8 photorespiration is avoided ; [4 max]
- (b) 1 reduces water loss/AW ;
2 wax does not melt ;
3 shiny surface reflects radiation ; [2 max]
- (c) (i) greater reduction in sorghum than in soybean ;
use of comparative figures ; e.g. sorghum 5.5 to 1.2 **or** by 4.3
soybean 5.2 to 1.6 **or** by 3.6 [2]
- (ii) *reject 'no' for all points*
- 1 less surface area ;
2 less absorption of light ;
3 less, photophosphorylation / light dependent reaction ;
4 less chemiosmosis ;
5 (due to) smaller thylakoid space **or** reduced proton gradient ;
6 less ATP (produced) ;
7 less reduced NADP (produced) ;
8 light-independent reaction / Calvin cycle, slows down ;
9 less carbon dioxide, fixed / combined with PEP ; R uptake [4 max]
- [Total: 15]

Q5.

- 4 (a) 1 can be grown in many different environments/AW ;
2 (grains) contain variety of nutrients ; **A** list of 3+ nutrients
3 detail of nutrient content ; e.g. high in calcium/vitamin B/protein
4 (grains) have high, energy/fibre, content ;
5 (grains) store well ; [3 max]
- (b) (i) endosperm ; [1]
(ii) 1 both rise and then fall ;
2 sorghum (enzyme) has higher activity (at all temperatures) ;
3 sorghum (enzyme) has higher maximum activity ;
4 sorghum (enzyme) has higher optimum temperature ; **A** 70° and 60°
5 comparative figures to illustrate points 2 or 3 ; [3 max]
- (iii) 1 (rice) tertiary structure/active site, of amylase is altered more by high temperature ;
2 (therefore) fewer ES/enzyme-substrate complexes formed/AW ;
3 high temperatures affect H bonds (more than other bonds) ;
4 amylase in rice may have more H bonds ; **ora**
5 correct ref. to other named bond ; [3 max]
- (c) (i) 1 higher CO₂ uptake at higher light intensity ; **ora**
2 comparative figures ; *using columns 1 and 2*
3 CO₂ used in, Calvin cycle/light independent reaction ;
4 photophosphorylation/light dependent stage provides, ATP/reduced NADP ;
5 for use in, Calvin cycle/light independent reaction ;
6 light is a limiting factor ; [3 max]
- (ii) 1 survive better at low light intensities ;
2 comparative figures ; *using columns 1 and 6* [2]
- [Total: 15]

Q6.

- 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. enzyme-substrate complexes can form ;
6. so more protein is digested to amino acids ; [3 max]
- [Total: 8]

Q7.

- 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. CO₂ / malate, delivered to bundle sheath cells ;
6. from mesophyll (cells) ;
7. (so) CO₂ concentration in bundle sheath cells always high ; [4 max]
- (c) (i) 1. CO₂ concentration (in bundle sheath cells) is always high ;
2. CO₂ 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]

Q8.

- 4 (a) 1. anthers, outside flower / exposed, to allow wind to carry pollen away ;
2. long / flexible, filaments to allow wind to dislodge pollen ; **A** versatile anthers
3. no / small, petals to allow, anthers/ pollen, to be exposed to the wind ;
4. anthers large to produce large quantities of pollen ; [2 max]
- (b) 1. (genetic) mutation / random changes (in corn borer) ;
2. caterpillars / corn borers, with mutation, more likely to survive / have selective advantage ;
3. (adults with this mutation) likely to breed ;
4. mutated gene / resistance alleles, passed on to next generation ;
5. increase in frequency of allele for resistance ; [3 max]
- (c) \bar{r} ; [1]
- (d) 1. when (non resistant) borers from outside breed with resistant borers, many offspring will not be resistant ;
2. because (many) offspring will be, Rr / heterozygous ;
3. detail, e.g. results of rr x RR **and** rr x Rr ; [2 max]
- (e) (i) 1. much mixing ;
2. more marked females recaptured than marked males, showing more mixing of males ; **ora**
3. high percentage of recaptured borers were unmarked ;
4. unmarked borers come from different fields ;
5. ref. considerable variation between results for different trials ;
6. use of data from shaded columns ; [3 max]
-
- (ii) 1. (HDR strategy needs) mating between borers from *Bt* fields with borers from outside ;
2. (results show) marked females had mated with marked males / only some marked females had mated with unmarked males ;
3. use of figures relating to above point ;
4. (this means that) many females mated with males from the same field ;
5. (so) many females from a *Bt* field would mate with males from *Bt* field ;

6. their offspring would all be, resistant / rr ;
7. ref. this reduces the effectiveness of the HDR strategy / fewer heterozygotes ; [4 max]

[Total: 15]

Q9.

- 4 (a) 1. ref. to vitamin A deficiency in, developing countries / named part of the world ;
2. rice, is a staple food / forms a major part of diet (in those countries) ;
 3. increases vitamin A (in diet) ;
 4. ref. prevention of blindness or reduces susceptibility to, diarrhoea, respiratory infections, measles ; ora [2 max]
- (b) (desaturases, are not limiting production because) phytoene does not accumulate ;
(so) desaturases are, functioning normally / converting phytoene to other compounds ;
or
GGDP, present in large amounts / accumulates / remains high ;
(so) phytoene synthase is, limiting / reducing conversion to phytoene ; [2]
- (c) (i) restriction (enzymes) ; [1]
- (ii) 1. (promoter required) to ensure expression of the (introduced) genes / AW ;
2. (suitable promoter) might not be present in the rice cells ;
 3. (suitable promoter) might not be in the correct position relative to the introduced genes ; [2 max]
- (iii) yes (no mark)
1. all rice cells contain the same *cr1* genes ;
 2. only difference was the source of the *psy* genes ;
 3. if *cr1* limiting there would be no difference in the carotene in each group ; [2 max]

- (d)
1. different base sequences (in the *psy* genes from different sources) ;
 2. so different amino acid sequences, in the enzyme / in phytoene synthase ;
 3. so different tertiary structure ;
 4. could affect interaction with other components, e.g. cofactors ;
 5. AVP ; e.g. refs to different protein synthesising machinery in the cells

ignore refs to active site and ability to bind with GGDP – must be able to do that as it does it in daffodils [2 max]

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Page 8	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2012	9700	42

- (e)
1. GM seed could be difficult for farmers in developing countries to obtain ;
 2. high cost of buying (new) GM seed / cannot use own seed ;
 3. may not grow well in all conditions (as other traits not selected for) ;
 4. too expensive for, people to buy / farmers to sell ;
 5. might reduce efforts to relieve poverty ;

[3 max]

[Total: 14]

Q10.

- 5 (a) (i) as temperature increases, rate / CO₂ used, increases then decreases ;
2 paired figs / peak at 18°C ; [2]
- (ii) 1. (rises due to) increased kinetic energy of molecules ;
2. increased number of collisions / increase in enzyme activity ;
3. enzymes become (partly) denatured above, 18°C / optimum ;
4. (affects) rate of, light independent reaction / Calvin cycle / dark stage ;
5. stoma close as temperature rises ;
6. because of increased transpiration rate ;
7. which decreases carbon dioxide availability ;
8. more carbon dioxide available as temperature increases ;
9. faster diffusion rate ;
10. CO₂ / light / other factor, becomes limiting ; [2 max]
- (b) (i) 1. maize has greater rate of photosynthesis (at all temperatures) / ora ;
2. optimum for maize is 23°C while optimum for wheat is 18°C ;
3. steeper increase for maize as temperature increases to optimum / ora ;
4. 2 paired figs (comparing wheat and maize) ; [2 max]
- (ii) 1. bundle sheath cells (surround, vascular bundle / vein) ;
2. CO₂ accumulation / maintains higher CO₂ concentration than air outside ;
3. light-independent stage takes place here ;
4. (bundle sheath cells) kept away from air spaces (by mesophyll cells) ;
5. limits, loss of CO₂ / uptake of O₂ ;
6. avoids photorespiration / competition between CO₂ and O₂ for, RuBP / rubisco ;
7. plasmodesmata between bundle sheath cells and mesophyll ;
8. relevant comment on stomata ; [3 max]
- (iii) lamellae / membranes, needed for light dependent reaction ;
as less chlorophyll to absorb light / less surface area exposed to light ; [2]
- (c) (i) endosperm ; [1]
- (ii) 1. total of oil and starch lower in maize than in sorghum / ora ;
2. 66.9% and 73.9% dry mass / ora ;

3. maize contains less energy than sorghum / ora ;
4. but overall not much difference in energy ;

(because)
5. oil provides more energy than starch (per unit mass) ;
6. maize has more oil but not enough to outweigh the greater starch content in sorghum / AW ; [3 max]

[Total: 15]

Q11.

- 3 (a) 1 very extensive root system / roots go very deep ;
2 small surface area of leaves ; **R** narrow leaves
3 leaves roll / presence of hinge cells ; **A** bulliform
4 leaves / stalks, have waxy covering / thick cuticle ;
5 high silica content ;
6 stomata, reduced in number / in sunken pits ;
7 idea of supporting tissue ; e.g. sclerenchyma [max 2]
- (b) (i) 1. (ABA concentration) increases from day 3 / 4 to day 7 then decreases
(to day 8 / 9 / 10) **or** peaks at day 7 ;
2. comparative figs (2 ABA concentrations at 2 days) ; *ignore units*
e.g. 1 at day 4 and 10 at day 7
3. as water potential decreases concentration of ABA increases / **ora** ;
4. no response until water potential drops below -600 to -800 kPa ; [max 3]
- (ii) fall in water potential causes, stomatal resistance to increase / closure of
stomata ; **A** **ora**

increase in ABA concentration causes, stomatal resistance to increase /
closure of stomata ; **A** **ora**

detail of mechanism ; e.g. turgor of guard cells / proton pump / flow of K^+ [max 2]
- (c) stomatal closure reduces water loss ; **R** stops / prevents
by transpiration / (by diffusion of) water vapour from leaves ; [2]

[Total: 9]

Q12.

4	(a)	AABBCC ;	[1]
	(b)	<i>if doubling of chromosomes has not occurred</i> 1 chromosomes would not be able to pair ; 2 because chromosomes in the two sets are not homologous ; 3 during, prophase 1 / meiosis 1; 4 (therefore) gametes cannot be produced ;	[3 max]
	(c)	1 unable to, breed / reproduce ; 2 to produce fertile offspring ; 3 reproductively isolated ;	[2 max]
	(d)	1 species split into two <u>populations</u> by (geographical) barrier ; 2 different, selection pressures / (environmental) conditions, (on the two populations) ; 3 different features, selected / advantageous ; 4 change in, gene pools / allele frequencies ; 5 (over time) become unable to interbreed ;	[3 max]
			[Total: 9]

Q13.

4	(a)	(i)	<p>1. yield for sorghum is <u>greater</u> than yield for wheat (in any soil type) ;</p> <p>2. yield for wheat is <u>better</u> in HWC soil / little difference in yield for sorgham ;</p> <p>3. paired figs ; <i>only award if linked correctly to mp 1 or mp2</i></p> <p>4. sorghum is adapted to live in arid environment / AW ;</p> <p>5. and 6. <i>any two of the following</i> ; ;</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 50%;">feature</th> <th style="width: 50%;">function</th> </tr> </thead> <tbody> <tr> <td>extensive / deep, root system</td> <td>maximises water absorption</td> </tr> <tr> <td>curled leaves / leaves small surface area / wazy leaves / bulliform leaf cells / hinged leaf cells / reduced stomata numbers / stomata in pits</td> <td>reduces water loss</td> </tr> <tr> <td>high silica content / more sclerenchyma / more strengthening tissue</td> <td>reduces wilting</td> </tr> </tbody> </table>	feature	function	extensive / deep, root system	maximises water absorption	curled leaves / leaves small surface area / wazy leaves / bulliform leaf cells / hinged leaf cells / reduced stomata numbers / stomata in pits	reduces water loss	high silica content / more sclerenchyma / more strengthening tissue	reduces wilting	[4 max]
feature	function											
extensive / deep, root system	maximises water absorption											
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high silica content / more sclerenchyma / more strengthening tissue	reduces wilting											

		(ii)	<p>number of <u>seeds</u> sown ;</p> <p>density of <u>seeds</u> sown / area of plot ;</p> <p>minerals / fertilisers ;</p> <p>wind / shelter ;</p> <p>soil pH;</p>	[2 max]
		(b)	<p>1. ref. bundle sheath cells;</p> <p>2. light independent stage occurs / RuBP found (in bundle sheath cells) ;</p> <p>3. RuBP / rubisco, kept away from, air / oxygen ;</p> <p>4. <u>by</u> mesophyll cells ;</p> <p>5. limits uptake of O₂ / maintains high CO₂ concentration (in bundle sheath cells) ;</p> <p>6. enzymes / PEP carboxylase, have high optimum temperature ;</p> <p>7. approx 45°C ;</p> <p>8. not denatured ;</p>	[4 max]
				[Total: 10]

Q14.

- 5 (a) 1 oxygen availability low (when soil is flooded) ;
2 plants carry out anaerobic respiration ;
3 ethanol produced ;
4 roots can continue to respire ; [2 max]
- (b) (i) (store of) nutrients ; **A** named nutrient *ignore food / water / fibre*
for, germination / growth of embryo ; [2]
- (ii) protein in aleurone layer ;
which is removed in white rice ; *ora* [2]
- (iii) endosperm makes up a greater proportion of the total mass in white rice ;
or
brown rice has more, lipid / fibre / protein, than white rice so less
carbohydrates per gram ; [1 max]
- (iv) 1 cheap source of food ;
2 high, energy value / fibre content ;
3 high in carbohydrate ;
4 contain wide range of nutrients **or** three named nutrients ;
5 cereal grains store well ;
6 because they contain very little water ; [2 max]
- [Total: 9]**

Q15.

- 4 (a) 1 water lost by, evaporation / transpiration ;
2 no water uptake (by roots) ; [2]
- (b) (i) 1 as water potential increases, oxygen uptake increases ;
must be stated
2 levels off (at 5 kPa / at 225 au) ;
3 figures ; *two water potential plus two oxygen uptake figures plus kPa* [2 max]
- (ii) 1 succinate converted to oxaloacetate ;
2 dehydrogenation / oxidation ;
3 NAD, is reduced / accepts hydrogen ;
4 (hydrogens move to) ETC ;
5 hydrogen splits into protons and electrons ;
6 electrons pass along ETC ;
7 $\text{ADP} + \text{P}_i \longrightarrow \text{ATP}$;
8 oxygen, receives protons and electrons / is final electron acceptor, to form water ; [4 max]
- (c) (i) 1 water leaves mitochondrion ; **A** other named organelle
2 by osmosis / down water potential gradient ;
3 idea mechanical disruption to membranes ;
4 membranes made of phospholipid (bilayer) ;
5 hydrophilic heads / glycoproteins / glycolipids, form fewer hydrogen bonds with water ;
6 reduces, stability / fluidity (of membrane) ;
7 ref. (proteins with) hydrophilic channels ; [3 max]

- (ii) 1 inner membrane (of mitochondrion) / cristae, site of ETC ;
2 fewer carriers held in position ;
3 fewer electrons pass along ETC ;
4 less ATP produced / less energy released ;
5 less oxygen required to act as electron acceptor ;
6 protons can move freely through the damaged inner membrane ;
7 proton gradient not formed ;
- accept ora for less damaged membranes for marking points 2-7* [3 max]

- (d) 1 extensive / deep, roots ;
2 leaves have small surface area ;
3 leaves, are curled / are waxy / have bulliform cells / have hinged cells ;
4 reduced stomata numbers / stomata in pits ; [2 max]

[Total: 16]

Q16.

- 4 (a) 1. low oxygen (in water) results in anaerobic respiration ;
2. (anaerobic respiration) produces alcohol ;
3. rice tolerant to alcohol ;
4. (because rice has) high levels of, alcohol dehydrogenase / enzyme that breaks down alcohol ;
5. presence of, aerenchyma / described ;
6. allows, oxygen / air, to reach roots (from aerial tissues) ; [3 max]
- (b) (i) 1. (immersion in water) stimulates production of ethene ;
2. (concentration of) ethene produced increased with time (after submergence) ;
3. very little difference in ethene production between T65 and C9285 ;
4. use of figures ; 2 values of ethene **plus** 2 values of time for **either** T65 **or** C9285 [2 max]

- (ii) 1. in T65 ethene does not affect internode elongation **but** in C9285 ethene promotes internode elongation ;
2. in C9285, greater concentrations of ethene cause greater elongation ;
3. use of comparative figures to support mark point 1 **or** mark point 2 ; *both units at least once* [2 max]
- (c) 1. SK genes present in C9285 / SK genes not present in T65 ;
2. **increased** production of GA in C9285 / little or no increased production of GA in T65 ;
3. GA stimulates, stem elongation / AW ;
4. AVP ; e.g. T65 has no receptors for ethene [3 max]
- (d) (i) SK2 more important ; **ora**
O. nivara has mutated SK2 and does not have deepwater response
or
O. glumaepatula has SK2 but not SK1 and does have deepwater response ; [2]
- (ii) 1. (addition / insertion), of a, base / nucleotide, to DNA / to a gene ;
2. changes a, sequence of three bases / triplet / codon ; *ignore ref. to frame shift*
3. (triplet) no longer codes for an amino acid ; [2 max]
- (iii) 1. breed deepwater variety with (high-yielding) non-deepwater variety ;
2. identify / select, offspring with **both** deepwater response and high yield ;
3. breed selected offspring (with **both** deepwater response and high yield) ;
4. continue for many generations ; [3 max]
- [Total: 17]

Q17.

- 4 (a) (i) 1. anthers, versatile / loosely attached / attached at one point (to filaments) ;
2. anthers / stamens / tassels / androecium, on long filaments / hang out (of, plant / flower) ;
3. anthers / stamens / tassels / androecium, above leaves / high up ;
4. stigmas / silks, hang out (of, plant / flower) ;
5. stigmas / silks, large surface area / hairy / feathery / long, (to catch pollen) ;
6. no / small, petals allow access to wind / AW ; *ignore references to pollen* [3 max]

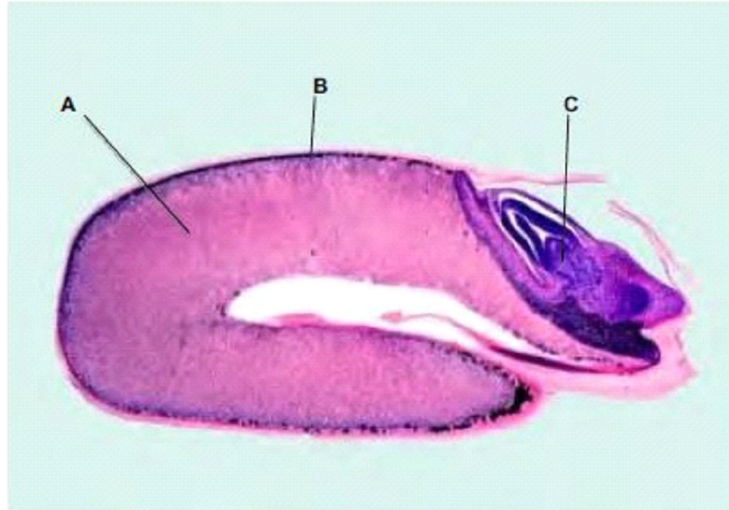
- (ii) 1. increased genetic variation / increased heterozygosity / more diverse gene pool / increased gene pool ;
2. reduced inbreeding / prevents inbreeding depression ;
3. less likely that harmful recessive alleles will be expressed ;
4. hybrid vigour ;
5. ability to respond to named change in conditions ; e.g. climate / disease / pests [2 max]
- (b) (i) *must be comparative statements*
1. maize has greater rate of photosynthesis (at all temperatures) / ora ;
2. optimum for maize is at 23°C while optimum for wheat is at 17.5°C ;
or
highest rate for maize is 39 units while highest rate for wheat is 26 units ;
3. after 17.5°C increase for maize while decrease for wheat ; [2 max]
- (ii) 1. maize is C4 ;
2. PEP carboxylase more efficient at higher temperatures (than rubisco) ;
3. photorespiration occurring in wheat ; **ora**
4. oxygen, instead of carbon dioxide, combines with RuBP ;
5. less fixation of carbon dioxide ;
6. Calvin cycle slows down ;
7. AVP ; e.g. detail of krantz anatomy **R** ref. denaturation [3 max]
- (c) (i) 1. protein in aleurone layer ;
2. which is removed in white rice ; **A** outer layer(s) removed
3. ref. different species ; [2 max]
- (ii) 1. wheat has more iron / comparative figs ;
2. ref. haemoglobin ;
3. low haemoglobin linked to anaemia ; [2 max]
- [Total: 14]

Q18.

- 5 (a) transfer of pollen from anther to stigma ;
on the same, flower / plant ; [2]
- (b) 1. *idea of genetic variation* ;
2. increased heterozygosity ; **ora**
3. hybrid vigour / decreased inbreeding depression ;
4. able to adapt to changing conditions ;
5. *idea of some individuals surviving* ;
6. AVP ; e.g. reduced risk of expression of harmful recessive alleles [3 max]
- (c) (i) 1. initially / first 24 mins, exposure time increases, number of seeds produced /
(chance of) fertilisation ;
2. then / after 24 or 44 mins, steep decrease in, number of seeds produced /
(chance of) fertilisation ;
3. from 120mins, no seeds produced / no fertilisation ; [2 max]
- (ii) 1. plant GM maize some distance away from places that teosinte grows ;
2. estimate how far pollen can travel in 120 minutes ;
3. need more results between 60–120minutes ; [2 max]
- [Total:9]

Q19.

4 (a)



[3]

- (b) 1 protein higher in whole grain flour **because** protein is in aleurone layer ;
 2 parts containing protein / aleurone layer, not removed (as in white flour) ;
 3 dietary fibre higher in whole grain flour **because** (most) fibre is in, pericarp / testa ;
 4 pericarp / testa, has not been removed (as in white flour) ;
 5 carbohydrate content lower in whole grain flour **because** outer parts not removed ;
 accept **ora** throughout [3 max]

- (c) (i) starch must be digested (to glucose) before it is absorbed / digestion of starch takes time ; [1]

- (ii) 1 amylose has 1–4 bonds / amylopectin has 1–4 bonds plus 1–6 bonds ;
 2 amylose, digested / broken down to glucose / acted on by amylase, more slowly ;
 3 because fewer sites for enzyme to work on / AW ;
 accept **ora** for mp2 and mp3 [2 max]

- (d) (i) 1 increasing intake (of whole cereal grains) decreases risk (of developing type II diabetes) ;
 2 use of figures supporting this relationship ;
 3 not all values fit the trend / reference to this not being a linear effect ;
 4 reference to higher risk at 19.0 – 24.5 intake ; [3 max]

- (ii) 1 idea that the risk of 1.00 for each food group is not the same risk ;
 2 no info on size of servings / no indications that same units used for each group ;
 3 intervals of range of intake not consistent – different intervals may give different results ;
 [2 max]

- (iii) 1 fruits contain, sugars / glucose / fructose ;
 2 sugar has a high GI ; [2]

[Total: 16]

Q20.

- 7 (a) 1 *idea of genetic variation* ;
2 increased heterozygosity / decreased homozygosity ;
3 hybrid vigour / decreased inbreeding depression ;
4 able to adapt to changing conditions ;
5 *idea of some individuals surviving* ;
6 AVP ; e.g. reduced risk of expression of harmful recessive alleles [3 max]
- (b) (i) *most affected*
almond, because, 100% / all / only, pollinated by honey bee ;
least affected
orange, because only 25% pollinated by honey bee / 75% pollinated by other methods [2]
- (ii) *any three from*
1 parasites / mites / viruses / bacteria ;
A disease
2 detail of climate change ; e.g. temperature change
3 pollution qualified ; e.g. increased use of pesticides / increased sulfur dioxide concentration in air
4 inbreeding ;
5 competition for food / food shortage ;
6 increase in predator numbers ;
7 AVP ; e.g. ref. killer bees / plant monoculture provides limited nutrition [3 max]
- [Total: 8]

Q21.

- 5 (a) 1. no change between 1860 and 1930 ;
2. ref. to increases from 1930 to 2010 ;
3. use of figures including units ; [3]
- (b) 1. single-cross hybrids have homozygous parents ;
2. each has inherited the same alleles ;
3. (so) they are uniformly heterozygous ;
4. double-cross hybrids have heterozygous parents ;
5. each has inherited different combinations of alleles
or
(mixture of) homozygous dominant, homozygous recessive and heterozygous hybrids ;
[max 3]
- (c) (i) 1. the greater the inbreeding coefficient, the lower the yield ;
2. in each site in each year ;
3. use of figures ; [max 2]
- (ii) 1. the yield differs, at different sites / in different years ;
2. for the same inbreeding coefficient ;
3. use of figures ;
4. named environmental factor ; e.g. rainfall / temperature / mineral content of soil
[max 2]
- [Total: 10]**

Q22.

- 5 (a) (i) 1. greater in teosinte (than in maize) ;
2. greater at 9 loci / less at 1 locus / except at locus 7 ;
3. greatest difference at locus 10 ;
4. use of comparative figures ; [max 2]
- (ii) 1. artificial selection / selective breeding ;
2. humans carry out selection ;
3. of plants with desirable traits ;
4. not all alleles selected (in cultivated varieties) ;
5. increased homozygosity ;
6. *idea that* greater variety of alleles are needed to survive in the wild environment ; [max 3]
- (iii) 1. wild plants have greater variety of, alleles / base sequences ;
2. could be useful for future breeding ;
3. example of use ; e.g. to cope with climate change / drought [max 2]
- (b) 1. to avoid inbreeding depression ;
2. hybrids have, higher yields / hybrid vigour ;
3. avoids expression of harmful recessive alleles ;
4. ref. to genetic uniformity ;
5. (which) results in easier, cultivation / harvest / etc ; [max 3]

[Total: 10]

Q23.

- 8 (a) (i) general description of the trend ;
steepest / fastest, increase between 1996 and 1999 ;
comparative data quote either for Bt cotton or HT cotton ;
e.g. Bt cotton increased from 16% (in 1996) to 75% in 2013
or
HT cotton increased from 2% (in 1996) to 82% in 2013
ref. most cotton is modified to be both Bt and HT ; [max 3]
- (ii) *Agrobacterium tumefaciens* / Ti plasmid / pGreen plasmid ; [1]
- (iii) to check whether gene transfer was successful ;
to see which parts of plant expressed new genes ;
GUS marker easy to, use / track / see (compared to antibiotic resistance markers) ; [max 2]
- (b) (i) number (of glyphosate-resistant weed species) only increased after 1995 / 1996 ;
this was when, GM crops resistant to herbicide / HT crops, were introduced ; [2]
- (ii) no triazine-resistance genes existed in crops but weeds developed triazine resistance ;
idea that triazine resistance in weeds pre-dates, gene technology / genetic modification ; [max 1]
- (iii) spontaneous / random, mutation ;
weeds without, allele / mutation, die ; ora
when / so long as, (named) herbicide (still) applied ;
new allele / mutation, selected for / gives selective advantage ; ora
survivors, breed / reproduce / pass on, allele / mutation ; ora
frequency of, new allele / mutation, increases ; [max 4]
- (c) any suitable suggestions, such as:
1. the damage done by the insect pests surveyed ;
 2. the number of reports of resistance for each species ;
 3. the proportion of populations with the highest percentage of resistant individuals ;
 4. the effect on the crops concerned of pest resistance at the levels given (<1%, etc.) ;
e.g. the losses in yield
 5. the geographical spread of the insect pest species that show resistance ;
 6. AVP ;
 7. AVP ;
- [max 2]

[Total: 15]

Q24.

- 3 (a) (i) AABBC ; [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 E β f large number aphids, stop feeding /move ;
in absence of E β f, few / no, aphids, stop feeding /move ;
air in Experiment 1, has other chemicals / not pure E β f **or** air in Experiment 2
has only E β f ;
E β f concentration in Experiment 2 may be unnaturally high **or** E β f
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]
- (ii) E β f stops aphids settling ;
E β f attracts, predators of aphids /ladybirds ;
attacked aphids secrete more E β f ;
aphids not, eating /taking nutrients from, wheat ; [max 3]
- (iii) gene/ E β f, already in, peppermint /various plant species ;
E β f 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]

Section_B

1.

10 (a) *ignore references to function
accept from diagram*

1. 3 – 10 μm (diameter);
2. double membrane;
3. ground substance / stroma;
4. contains enzymes / named enzyme, e.g. rubisco;
5. also, sugars / lipids / starch;
6. 70S / AW, ribosomes;
7. circular DNA;
8. internal membrane system / fluid-filled sacs / thylakoids; **A** flattened sacs
9. grana are stacks of thylakoids;
10. (grana) membranes hold, photosynthetic pigments / ATP synthase / ETC; [7 max]

(b) 11. ethene (in plant);

12. stimulates production of gibberellin;
13. gibberellin stimulates, cell division / cell elongation / increase in stem length;
14. leaves / flowers, above water;
15. (so) photosynthesis can occur;
16. (so) sexual reproduction / pollination, can occur;
17. aerenchyma / description;
18. assists gas diffusion (within plant);
19. air can be trapped by specialised underwater leaves;
20. (submerged parts of plant) carry out anaerobic respiration;
21. produce ethanol;
22. can tolerate high concentrations of ethanol;
23. produce a lot of ethanol dehydrogenase; [8 max]

[Total: 15]

2.

- 9 (a) 1 high, carbohydrate /starch, content ; **A** 70–80%
2 source of, energy/ATP ;
3 protein provides amino acids ;
4 for growth ;
5 low in fat ; **A** 2–4%
6 contains essential fatty acids ;
7 source of, vitamin B/vitamin E ;
8 deficient in, vitamin A/vitamin D/ vitamin C ;
9 *ref. to Golden Rice and vitamin A ; A ref. to other valid examples*
10 wide range /AW, of minerals ;
11 named mineral plus use in human body ; e.g. calcium for bone development
12 high in fibre ;
13 for peristalsis/ prevents constipation ;
14 easily, dried/ stored ;
15 AVP ; e.g. staple diet for much of the world /named staple crop and location
16 AVP ; e.g. different parts of grain have different nutrients /*ref. to processing grain* [max 8]
- (b) 1 seed is, dormant/ metabolically inactive ;
2 water enters seed ;
3 embryo, produces/releases, gibberellin ;
4 gibberellin stimulates aleurone layer ;
5 (by) affecting, gene coding /transcription of mRNA, for amylase ;
6 to produce amylase ;
7 amylase hydrolyses starch ;
8 in endosperm ;
9 to, maltose /glucose ;
10 embryo uses sugars for respiration ;
11 energy/ATP, used for growth ; [max 7]

[Total: 15]

3.

- 9 (a) 1 vitamin A found in aleurone layer of rice (seeds) ;
2 white rice does not contain, aleurone layer/vitamin A/carotenoids/
 β carotene ;
3 genes coding for vitamin A production extracted ;
4 from, bacteria/*Erwinia uredovora*/*Pantoea ananatis* ;
5 (and) daffodils/maize ;
6 inserted into plasmids/plasmid used as a vector ;
7 promoters added ;
8 plasmids put into *Agrobacterium tumefaciens* ;
9 *Agrobacterium tumefaciens* mixed with rice embryos ;
10 (some embryos) take up bacteria and vitamin A gene ; A gene gun
11 grow into adult plants ;
12 produce seeds with, vitamin A/carotene ;
13 in endosperm ;
14 AVP ; e.g. *ref. to Golden Rice*TM [max 8]
- (b) 1 GM seed could be difficult for farmers in developing countries to obtain ;
2 high cost of (buying) GM seed/cannot use own seed ;
3 too expensive for, people to buy/farmers to sell ;
4 might reduce efforts to relieve poverty ;
5 may not grow well in all conditions (as other traits not selected for) ;
6 *ref. to possible, allergic reactions in humans/toxicity of more herbicide left
after use/adverse effects on the immune system* ;
7 under-developed countries becoming more dependent on other countries ;
8 cross-pollination with, wild plants/organic crops ;
9 new more resistant weeds/"superweeds" ;
10 *ref. to loss of traditional varieties* ;
11 loss of genetic diversity ;
12 harm to other species ; e.g. effect on rest of food chain [max 7]

[Total: 15]

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