

## 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  $\mu\text{g}$  no insects killed in either group ;
- 2 at 0.5  $\mu\text{g}$  hybrid insects killed but resistant insects survived ;
- 3 at 10  $\mu\text{g}$  all insects killed in hybrid group but only 80% killed in resistant group ;
- 4 at 30  $\mu\text{g}$  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 O<sub>2</sub> cannot reach bundle sheath cells ;  
 3 light independent stage/Calvin cycle **or** RuBP, in bundle sheath cells ;  
 4 ref. malate shunt ;  
 5 maintains high CO<sub>2</sub> concentration (in bundle sheath cells) ;  
 6 PEP carboxylase, has high optimum temperature/has higher affinity for CO<sub>2</sub>/doesn't accept O<sub>2</sub> ;  
 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 CO<sub>2</sub> uptake at higher light intensity ; **ora**  
 2 comparative figures ; *using columns 1 and 2*  
 3 CO<sub>2</sub> 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. CO<sub>2</sub> / malate, delivered to bundle sheath cells ;  
 6. from mesophyll (cells) ;  
 7. (so) CO<sub>2</sub> concentration in bundle sheath cells always high ; [4 max]
- (c) (i) 1. CO<sub>2</sub> concentration (in bundle sheath cells) is always high ;  
 2. CO<sub>2</sub> 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 *ctrl* genes ;
  2. only difference was the source of the *psy* genes ;
  3. if *ctrl* 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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<b>Page 8</b>	<b>Mark Scheme: Teachers' version</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>GCE AS/A LEVEL – May/June 2012</b>	<b>9700</b>	<b>42</b>

- (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 / CO<sub>2</sub> 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. CO<sub>2</sub> / 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. CO<sub>2</sub> accumulation / maintains higher CO<sub>2</sub> 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 CO<sub>2</sub> / uptake of O<sub>2</sub> ;  
6. avoids photorespiration / competition between CO<sub>2</sub> and O<sub>2</sub> 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.**

<b>4</b>	<b>(a)</b>		AABBCC ;	[1]
	<b>(b)</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]
	<b>(c)</b>	1	unable to, breed / reproduce ;	[2 max]
		2	to produce fertile offspring ;	
		3	reproductively isolated ;	
	<b>(d)</b>	1	species split into two <u>populations</u> by (geographical) barrier ;	[3 max]
		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 ;	
				<b>[Total: 9]</b>

**Q13.**

<b>4</b>	<b>(a)</b>	<p><b>(i)</b></p> <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;"> <thead> <tr> <th style="text-align: left;">feature</th> <th style="text-align: left;">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										
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										

		<p><b>(ii)</b></p> <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]
		<p><b>(b)</b></p> <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 O<sub>2</sub> / maintains high CO<sub>2</sub> 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]
			<b>[Total: 10]</b>

**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]**

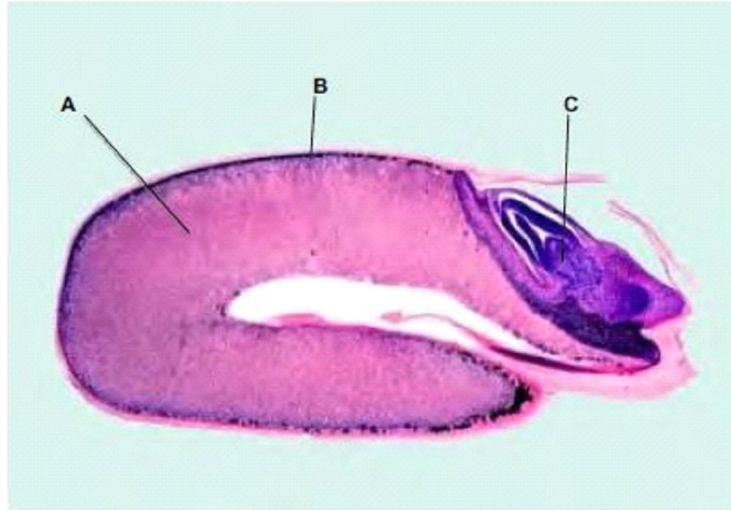
**Q18.**



- 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 60–120 minutes ; [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 $\beta$ f large number aphids, stop feeding /move ;  
 in absence of E $\beta$ f, few / no, aphids, stop feeding /move ;  
 air in Experiment 1, has other chemicals / not pure E $\beta$ f **or** air in Experiment 2  
 has only E $\beta$ f ;  
 E $\beta$ f concentration in Experiment 2 may be unnaturally high **or** E $\beta$ 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 $\beta$ f stops aphids settling ;  
 E $\beta$ f attracts, predators of aphids /ladybirds ;  
 attacked aphids secrete more E $\beta$ f ;  
 aphids not, eating /taking nutrients from, wheat ; [max 3]
- (iii) gene/ E $\beta$ f, already in, peppermint/ various plant species ;  
 E $\beta$ 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  $\mu\text{m}$  (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/  
 $\beta$  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*<sup>TM</sup> [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]





