

Interactive Example Candidate Responses

Paper 4 (May/June 2016), Question 4

Cambridge International AS & A Level Biology 9700

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- 4 Maize is an important food crop that has been improved both by selective breeding and by genetic modification.

(a) Outline how selective breeding has been used to improve maize.

Maize with desirable characteristics such as high yield of kernel ~~are~~ ^{by humans} are selected to be bred with others with desirable characteristics. Their alleles are passed on to their offspring. This process is repeated over many generations to produce a species with improved features. However, inbreeding as such may lead to inbreeding depression ~~and loss~~ due to increased homozygosity. Therefore it is important to ~~be~~ ^{breed} maize with other types / relatives to increase hybrid vigour, and increase genetic diversity.

[4]

Your
Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

Q4	Mark scheme
(a)	<p>1 best / desirable, plants crossed ; A cross-pollinated R cross with other (maize) species</p> <p>2 repeatedly / every generation ;</p> <p>3 detail of cross-pollination ; e.g. ref. to male tassels and female silks</p> <p>4 example of desirable characteristic ; A more kernels / big kernels / high yield / ref. to kernel colour / fast-growing / cold-tolerant</p> <p>5 hybridisation / two inbred (named) lines crossed / F1 hybrids formed ; A description, e.g. cross two, homozygous parents / parents from two purebred lines</p> <p>6 gives more, vigorous / uniform, plants ; A heterosis</p> <p>7 ref. to dwarf maize / mutant alleles for gibberellin (synthesis) ;</p> <p style="text-align: right;">[max 4]</p>
(b)	<p>1 discontinuous ;</p> <p>max 2 for mp2–6</p> <p>2 one gene / single locus / monogenic, inheritance ; A monohybrid</p> <p>3 two alleles ;</p> <p>4 dominant and recessive ;</p> <p>5 1:1 ratio purple to yellow ; A 50% purple, 50% yellow</p> <p>6 test cross / $Aa \times aa$;</p> <p style="text-align: right;">[max 3]</p>
(c)(i)	<p>1 as, Bt crops / area, increases the number of resistant, pests / species, increases ; A the more (the area of) Bt crops grown, the more (the) resistant species</p> <p>2 figures quote ; (2 years, area with units once)</p> <p>3 figures quote ; (2 years, no. resistant pest species)</p> <p>4 mutation(s) (in pest species) ;</p> <p>5 chance / random / spontaneous (mutations) ;</p> <p>6 pests evolve resistance / natural selection for resistant pests ;</p> <p>7 AVP ; e.g. plateau in resistance, 2002–2005 / 2009–2011 first 6 years / 1996–2001, no resistant species</p> <p style="text-align: right;">[max 4]</p>
(c)(ii)	<p>social</p> <p>increased yield / more food / cheaper food / AW ;</p> <p>environmental</p> <p>decreased insecticide use / few hazards to humans / Bt only targets pest</p> <p>species ; A no / less pesticide used R herbicide</p> <p style="text-align: right;">[2]</p> <p style="text-align: right;">[Total: 13]</p>

- (b) Fig. 4.1 shows part of a maize cob. The cob is made up of many individual seeds called kernels. Each kernel results from a separate fertilisation of a male and a female gamete. Some kernels are yellow and some are purple.

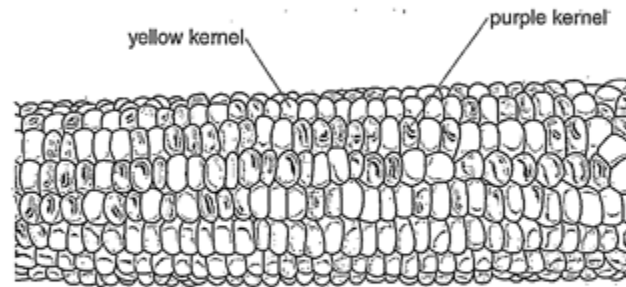


Fig. 4.1

Name the type of variation shown in Fig. 4.1. Suggest a genetic explanation for this pattern of variation in colour.

type of variation Phenotypic variation
 explanation Difference in colour is due to genotypic variation and
 different alleles giving different phenotypes (colour of kernel in
 this case) (one from male one from female gamete)

 [3]

Your
Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

Q4	Mark scheme
(a)	<p>1 best / desirable, plants crossed ; A cross-pollinated R cross with other (maize) species</p> <p>2 repeatedly / every generation ;</p> <p>3 detail of cross-pollination ; e.g. ref. to male tassels and female silks</p> <p>4 example of desirable characteristic ; A more kernels / big kernels / high yield / ref. to kernel colour / fast-growing / cold-tolerant</p> <p>5 hybridisation / two inbred (named) lines crossed / F1 hybrids formed ; A description, e.g. cross two, homozygous parents / parents from two purebred lines</p> <p>6 gives more, vigorous / uniform, plants ; A heterosis</p> <p>7 ref. to dwarf maize / mutant alleles for gibberellin (synthesis) ;</p> <p>[max 4]</p>
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- (c) Maize and other crops have been genetically modified since 1996 to produce the Bt toxin to kill insect pests.

Fig. 4.2 shows the area of Bt crops grown (plotted points) and the number of insect pest species in which resistance to Bt has been reported (bars).

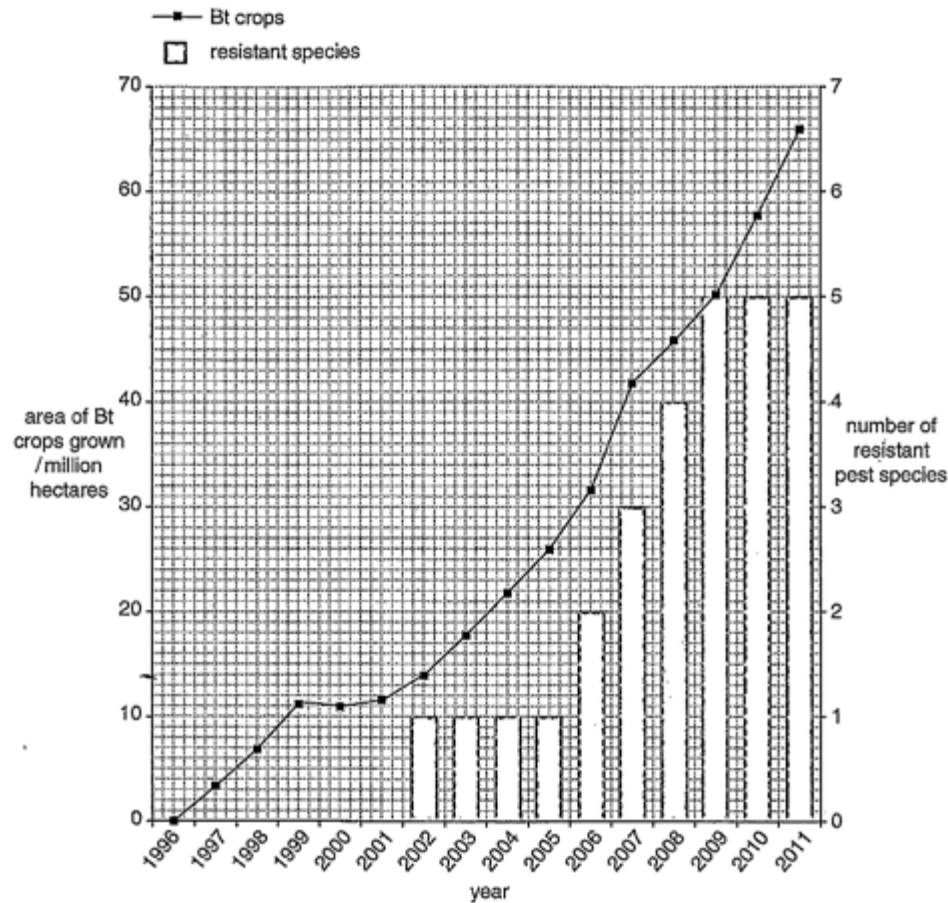


Fig. 4.2

Your
Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

Q4	Mark scheme
(a)	<p>1 best / desirable, plants crossed ; A cross-pollinated R cross with other (maize) species</p> <p>2 repeatedly / every generation ;</p> <p>3 detail of cross-pollination ; e.g. ref. to male tassels and female silks</p> <p>4 example of desirable characteristic ; A more kernels / big kernels / high yield / ref. to kernel colour / fast-growing / cold-tolerant</p> <p>5 hybridisation / two inbred (named) lines crossed / F1 hybrids formed ; A description, e.g. cross two, homozygous parents / parents from two purebred lines</p> <p>6 gives more, vigorous / uniform, plants ; A heterosis</p> <p>7 ref. to dwarf maize / mutant alleles for gibberellin (synthesis) ;</p> <p>[max 4]</p>
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- (i) Describe and suggest an explanation for the relationship between the area of Bt crops grown and the number of resistant pest species.

As area of Bt crops grown increased, numbers of resistant pest species also increased. From 1996 to 2001 there were no resistant species but as the area of Bt crops grown increased from 0 to 14 million acres, the one species appeared in 2002. The Bt crops then act as a selection pressure - mutation may have occurred and an insect became resistant to the toxin giving it a selective advantage to survive while others with no resistance died. It reproduced passing its resistant allele to offspring. Allele frequency changes & and more of the species have resistance. More Bt crops grown result in greater selection pressure so more species evolve to have resistance. [4]

- (ii) Suggest one social advantage and one environmental advantage of growing this Bt maize.

social advantage: there is higher yield of maize so more food supply for humans and economic benefit
environmental advantage: to decrease reduce number of harmful pests by killing them. [2]

[Total: 13]

Your
Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

Q4	Mark scheme
(a)	<p>1 best / desirable, plants crossed ; A cross-pollinated R cross with other (maize) species</p> <p>2 repeatedly / every generation ;</p> <p>3 detail of cross-pollination ; e.g. ref. to male tassels and female silks</p> <p>4 example of desirable characteristic ; A more kernels / big kernels / high yield / ref. to kernel colour / fast-growing / cold-tolerant</p> <p>5 hybridisation / two inbred (named) lines crossed / F1 hybrids formed ; A description, e.g. cross two, homozygous parents / parents from two purebred lines</p> <p>6 gives more, vigorous / uniform, plants ; A heterosis</p> <p>7 ref. to dwarf maize / mutant alleles for gibberellin (synthesis) ; [max 4]</p>
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- 4 Maize is an important food crop that has been improved both by selective breeding and by genetic modification.

(a) Outline how selective breeding has been used to improve maize.

maize that has short stems are produce a high yield of seeds were selected. Artificial selection; then those with ~~desir~~ desirable traits were breed together. This new generation now possess possess an allele that has a selective advantage over other maize population. Those artificially selected (by humans) are allowed to breed together to pass on the allele to next generations. This improved maize end harvesting short stemmed maize costs less money. [4] Now always.

Your
Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

Q4	Mark scheme
(a)	<p>1 best / desirable, plants crossed ; A cross-pollinated R cross with other (maize) species</p> <p>2 repeatedly / every generation ;</p> <p>3 detail of cross-pollination ; e.g. ref. to male tassels and female silks</p> <p>4 example of desirable characteristic ; A more kernels / big kernels / high yield / ref. to kernel colour / fast-growing / cold-tolerant</p> <p>5 hybridisation / two inbred (named) lines crossed / F1 hybrids formed ; A description, e.g. cross two, homozygous parents / parents from two purebred lines</p> <p>6 gives more, vigorous / uniform, plants ; A heterosis</p> <p>7 ref. to dwarf maize / mutant alleles for gibberellin (synthesis) ; [max 4]</p>
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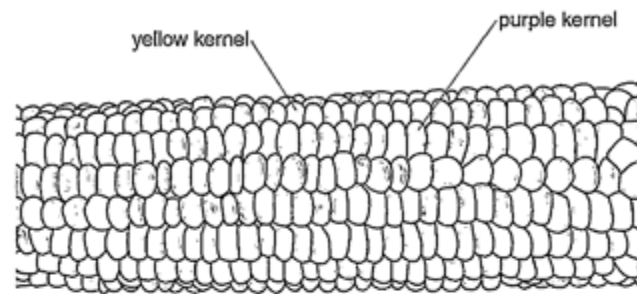


Fig. 4.1

Name the type of variation shown in Fig. 4.1. Suggest a genetic explanation for this pattern of variation in colour.

type of variation Discontinuous Variation
 explanation When each fertilisation of each kernel separately makes them independent of each other. As there are different alleles of the colour genes that are carried by males and female gametes. The random fertilisation is a reason for such variation to appear.
Also independent assortment of chromosomes during fertilisation plays a role in such variation to appear. [3]

Your
Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

Q4	Mark scheme
(a)	<p>1 best / desirable, plants crossed ; A cross-pollinated R cross with other (maize) species</p> <p>2 repeatedly / every generation ;</p> <p>3 detail of cross-pollination ; e.g. ref. to male tassels and female silks</p> <p>4 example of desirable characteristic ; A more kernels / big kernels / high yield / ref. to kernel colour / fast-growing / cold-tolerant</p> <p>5 hybridisation / two inbred (named) lines crossed / F1 hybrids formed ; A description, e.g. cross two, homozygous parents / parents from two purebred lines</p> <p>6 gives more, vigorous / uniform, plants ; A heterosis</p> <p>7 ref. to dwarf maize / mutant alleles for gibberellin (synthesis) ;</p> <p style="text-align: right;">[max 4]</p>
(b)	<p>1 <u>discontinuous</u> ; max 2 for mp2-6</p> <p>2 one gene / single locus / monogenic, inheritance ; A monohybrid</p> <p>3 two alleles ;</p> <p>4 dominant and recessive ;</p> <p>5 1:1 ratio purple to yellow ; A 50% purple, 50% yellow</p> <p>6 test cross / $Aa \times aa$;</p> <p style="text-align: right;">[max 3]</p>
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(c) Maize and other crops have been genetically modified since 1996 to produce the Bt toxin to kill insect pests.

Fig. 4.2 shows the area of Bt crops grown (plotted points) and the number of insect pest species in which resistance to Bt has been reported (bars).

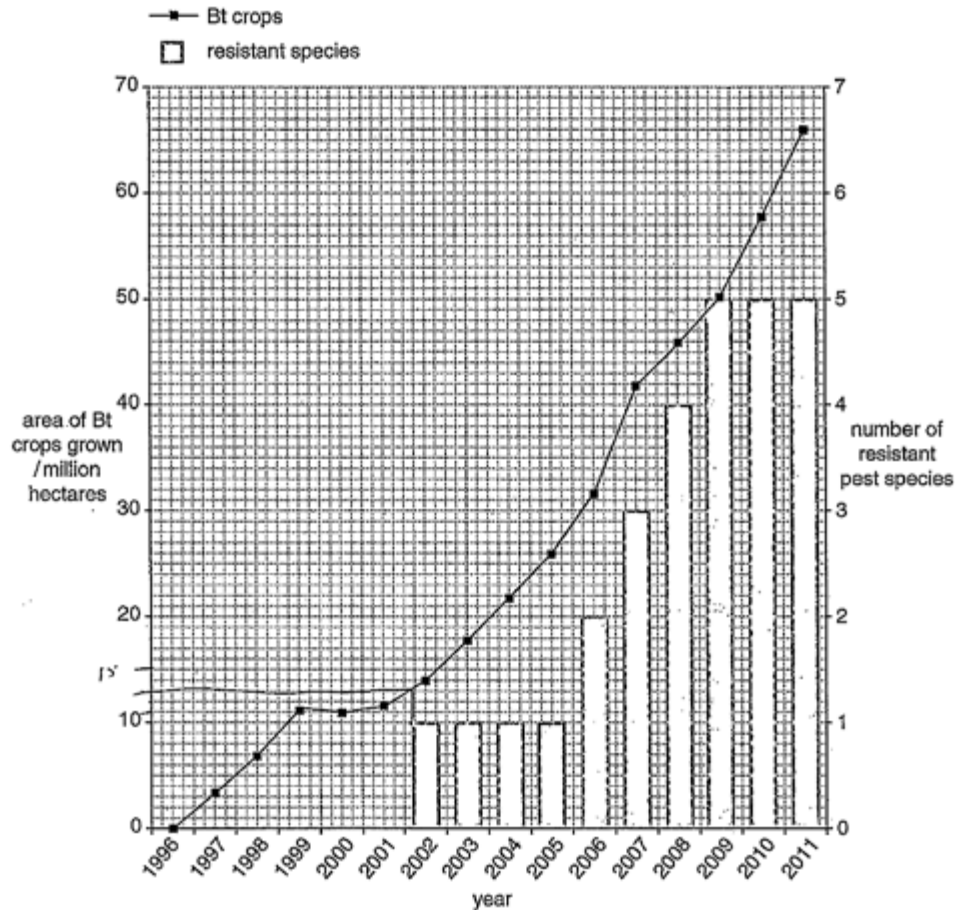


Fig. 4.2

Your
Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

Q4	Mark scheme
(a)	<p>1 best / desirable, plants crossed ; A cross-pollinated R cross with other (maize) species</p> <p>2 repeatedly / every generation ;</p> <p>3 detail of cross-pollination ; e.g. ref. to male tassels and female silks</p> <p>4 example of desirable characteristic ; A more kernels / big kernels / high yield / ref. to kernel colour / fast-growing / cold-tolerant</p> <p>5 hybridisation / two inbred (named) lines crossed / F1 hybrids formed ; A description, e.g. cross two, homozygous parents / parents from two purebred lines</p> <p>6 gives more, vigorous / uniform, plants ; A heterosis</p> <p>7 ref. to dwarf maize / mutant alleles for gibberellin (synthesis) ;</p> <p>[max 4]</p>
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- (i) Describe and suggest an explanation for the relationship between the area of Bt crops grown and the number of resistant pest species.

As area of Bt crops grown increases from 1996 till 2002, there was no effect, and no resistant strain of insect pests was formed, but furthermore as the area of Bt crops starts to increase from 13 million hectares till 66, the number of resistant pest species started to appear. During 2002 till 2005, number of resistant pests were constant at 1, but started increasing from 2006 till 2009, then again becomes constant from 2009 till 2011 at 5 pest species.

Increasing the selection pressure put on insects, those insects with selective advantages survive only and reproduce, increasing in number and reproducing. (ii) Suggest one social advantage and one environmental advantage of growing this Bt maize.

social advantage number of ~~maize~~ maize production increases, ~~more~~
environmental advantage number of pests killed increases, so less damage to plants.

[Total: 13]

Your
Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

Q4	Mark scheme
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- 4 Maize is an important food crop that has been improved both by selective breeding and by genetic modification.

(a) Outline how selective breeding has been used to improve maize.

a Maize is outbreeded with other species of maize to give taller and more yield of the maize that has allele that can be best adapted to the environment if it was bred with same species less yield will be give and shorter ones.

[4]

Your
Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

Q4	Mark scheme
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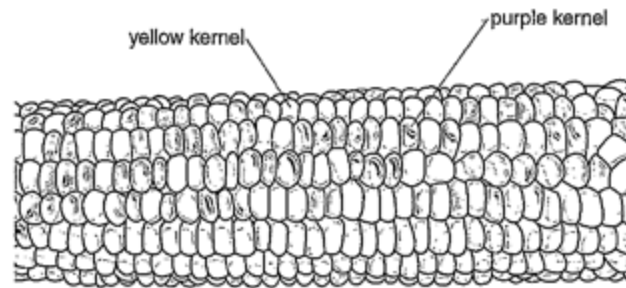


Fig. 4.1

Name the type of variation shown in Fig. 4.1. Suggest a genetic explanation for this pattern of variation in colour.

type of variationdiscontinuous variation.....
 explanation it is only influenced by gene
 and there is no intermediates.
 different alleles of this gene has a great
 effect on the phenotype.

[3]

Your
Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

Q4	Mark scheme
(a)	<p>1 best / desirable, plants crossed ; A cross-pollinated R cross with other (maize) species</p> <p>2 repeatedly / every generation ;</p> <p>3 detail of cross-pollination ; e.g. ref. to male tassels and female silks</p> <p>4 example of desirable characteristic ; A more kernels / big kernels / high yield / ref. to kernel colour / fast-growing / cold-tolerant</p> <p>5 hybridisation / two inbred (named) lines crossed / F1 hybrids formed ; A description, e.g. cross two, homozygous parents / parents from two purebred lines</p> <p>6 gives more, vigorous / uniform, plants ; A heterosis</p> <p>7 ref. to dwarf maize / mutant alleles for gibberellin (synthesis) ;</p> <p>[max 4]</p>
(b)	<p>1 discontinuous ;</p> <p>max 2 for mp2-6</p> <p>2 one gene / single locus / monogenic, inheritance ; A monohybrid</p> <p>3 two alleles ;</p> <p>4 dominant and recessive ;</p> <p>5 1:1 ratio purple to yellow ; A 50% purple, 50% yellow</p> <p>6 test cross / Aa × aa ;</p> <p>[max 3]</p>
(c)(i)	<p>1 as, Bt crops / area, increases the number of resistant, pests / species, increases ; A the more (the area of) Bt crops grown, the more (the) resistant species</p> <p>2 figures quote ; (2 years, area with units once)</p> <p>3 figures quote ; (2 years, no. resistant pest species)</p> <p>4 mutation(s) (in pest species) ;</p> <p>5 chance / random / spontaneous (mutations) ;</p> <p>6 pests evolve resistance / natural selection for resistant pests ;</p> <p>7 AVP ; e.g. plateau in resistance, 2002–2005 / 2009–2011 first 6 years / 1996–2001, no resistant species</p> <p>[max 4]</p>
(c)(ii)	<p>social</p> <p>increased yield / more food / cheaper food / AW ;</p> <p>environmental</p> <p>decreased insecticide use / few hazards to humans / Bt only targets pest</p> <p>species ; A no / less pesticide used R herbicide</p> <p>[2]</p> <p>[Total: 13]</p>

- (c) Maize and other crops have been genetically modified since 1996 to produce the Bt toxin to kill insect pests.

Fig. 4.2 shows the area of Bt crops grown (plotted points) and the number of insect pest species in which resistance to Bt has been reported (bars).

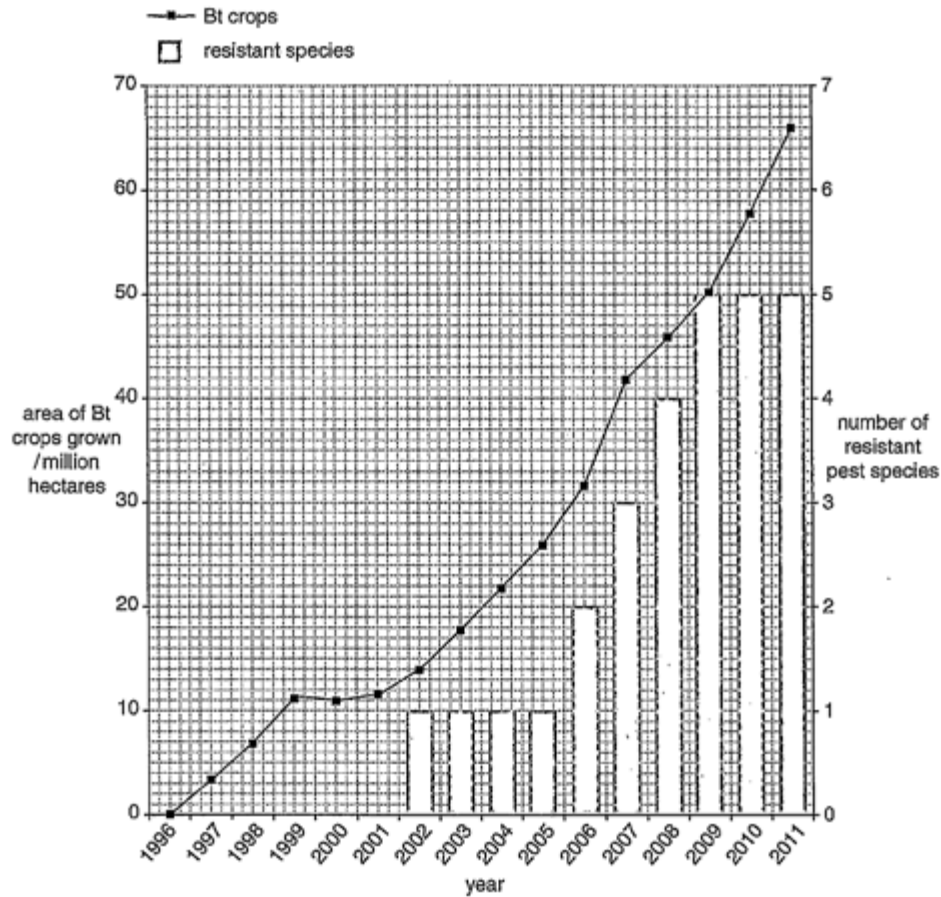


Fig. 4.2

Your
Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

Q4	Mark scheme
(a)	<p>1 best / desirable, plants crossed ; A cross-pollinated R cross with other (maize) species</p> <p>2 repeatedly / every generation ;</p> <p>3 detail of cross-pollination ; e.g. ref. to male tassels and female silks</p> <p>4 example of desirable characteristic ; A more kernels / big kernels / high yield / ref. to kernel colour / fast-growing / cold-tolerant</p> <p>5 hybridisation / two inbred (named) lines crossed / F1 hybrids formed ; A description, e.g. cross two, homozygous parents / parents from two purebred lines</p> <p>6 gives more, vigorous / uniform, plants ; A heterosis</p> <p>7 ref. to dwarf maize / mutant alleles for gibberellin (synthesis) ;</p> <p>[max 4]</p>
(b)	<p>1 discontinuous ;</p> <p>max 2 for mp2-6</p> <p>2 one gene / single locus / monogenic, inheritance ; A monohybrid</p> <p>3 two alleles ;</p> <p>4 dominant and recessive ;</p> <p>5 1:1 ratio purple to yellow ; A 50% purple, 50% yellow</p> <p>6 test cross / Aa × aa ;</p> <p>[max 3]</p>
(c)(i)	<p>1 as, Bt crops / area, increases the number of resistant, pests / species, increases ; A the more (the area of) Bt crops grown, the more (the) resistant species</p> <p>2 figures quote ; (2 years, area with units once)</p> <p>3 figures quote ; (2 years, no. resistant pest species)</p> <p>4 mutation(s) (in pest species) ;</p> <p>5 chance / random / spontaneous (mutations) ;</p> <p>6 pests evolve resistance / natural selection for resistant pests ;</p> <p>7 AVP ; e.g. plateau in resistance, 2002–2005 / 2009–2011 first 6 years / 1996–2001, no resistant species</p> <p>[max 4]</p>
(c)(ii)	<p>social</p> <p>increased yield / more food / cheaper food / AW ;</p> <p>environmental</p> <p>decreased insecticide use / few hazards to humans / Bt only targets pest species ; A no / less pesticide used R herbicide</p> <p>[2]</p> <p>[Total: 13]</p>

- (i) Describe and suggest an explanation for the relationship between the area of Bt crops grown and the number of resistant pest species.

number of resistant pest species is
discontinuous variation as no intermediate
and as the years increase the more the
resistant pest.
the are of Bt crops grow increase
within the year and it between
to top extremes

[4]

- (ii) Suggest one social advantage and one environmental advantage of growing this Bt maize.

social advantage more variety of food

environmental advantage symbiosis

[2]

[Total: 13]

Your
Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

Q4	Mark scheme
(a)	<p>1 best / desirable, plants crossed ; A cross-pollinated R cross with other (maize) species</p> <p>2 repeatedly / every generation ;</p> <p>3 detail of cross-pollination ; e.g. ref. to male tassels and female silks</p> <p>4 example of desirable characteristic ; A more kernels / big kernels / high yield / ref. to kernel colour / fast-growing / cold-tolerant</p> <p>5 hybridisation / two inbred (named) lines crossed / F1 hybrids formed ; A description, e.g. cross two, homozygous parents / parents from two purebred lines</p> <p>6 gives more, vigorous / uniform, plants ; A heterosis</p> <p>7 ref. to dwarf maize / mutant alleles for gibberellin (synthesis) ;</p> <p>[max 4]</p>
(b)	<p>1 discontinuous ;</p> <p>max 2 for mp2-6</p> <p>2 one gene / single locus / monogenic, inheritance ; A monohybrid</p> <p>3 two alleles ;</p> <p>4 dominant and recessive ;</p> <p>5 1:1 ratio purple to yellow ; A 50% purple, 50% yellow</p> <p>6 test cross / $Aa \times aa$;</p> <p>[max 3]</p>
(c)(i)	<p>1 as, Bt crops / area, increases the number of resistant, pests / species, increases ; A the more (the area of) Bt crops grown, the more (the) resistant species</p> <p>2 figures quote ; (2 years, area with units once)</p> <p>3 figures quote ; (2 years, no. resistant pest species)</p> <p>4 mutation(s) (in pest species) ;</p> <p>5 chance / random / spontaneous (mutations) ;</p> <p>6 pests evolve resistance / natural selection for resistant pests ;</p> <p>7 AVP ; e.g. plateau in resistance, 2002-2005 / 2009-2011 first 6 years / 1996-2001, no resistant species</p> <p>[max 4]</p>
(c)(ii)	<p>social</p> <p>increased yield / more food / cheaper food / AW ;</p> <p>environmental</p> <p>decreased insecticide use / few hazards to humans / Bt only targets pest species ; A no / less pesticide used R herbicide</p> <p>[2]</p> <p>[Total: 13]</p>

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