



ANSWER BOOK

Continuous and discontinuous variation

Evolution and speciation · Unit B19

OCR A 4.2.2 · Edexcel A 3.14, 3.15, 8.19 · CAIE 17.1

13 questions · 40 marks

NAVY EDITION

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SECTION A · Short, 1 to 2 marks

A1 **B1** variation in which the individuals of a population fall into a small number of distinct categories, with no intermediates between them. **B1** ABO blood group, or another correct example such as the ability to roll the tongue. [2]
VCD-Q4

A2 **B1** the 90 snails from one wood show intraspecific variation, because all the individuals measured belong to the same species. **B1** the comparison of two species shows interspecific variation, because the measurements come from members of different species. [2]
VCD-Q5

A3 **B1** six genotypes are possible: $I^A I^A$, $I^A I^O$, $I^B I^B$, $I^B I^O$, $I^A I^B$ and $I^O I^O$. **B1** these six genotypes give four phenotypes, groups A, B, AB and O, because I^A and I^B are codominant with each other and both are dominant to I^O , so two different genotypes give group A and two give group B. [2]
VCD-Q15

SECTION B · Standard, 3 to 5 marks

B1 identical twins have the same genotype, so any difference in phenotype between two of them must have come from the conditions they grew in rather than from their alleles. **B1** comparing pairs reared apart with pairs reared together changes the environment while the genotype is held constant, which is as close to a controlled experiment as human inheritance allows. **B1** against it: identical twins separated in infancy are rare, so the samples are very small and a few unusual pairs can move the result a long way. **B1** against it: twins placed for adoption are often placed in homes of a similar kind, and every pair shared a uterus before they were separated, so the two environments differ less than the phrase 'reared apart' suggests. **B1** a judgement: the design is the strongest human evidence that a characteristic has a genetic component, but any figure it yields applies to that population and to the range of environments actually sampled, so it is an estimate rather than a fixed proportion. [5]
VCD-Q6

B2 **B1** continuous variation is controlled by many genes acting together, called polygenes, whereas discontinuous variation is controlled by one gene or very few. **B1** the environment changes a continuous characteristic a great deal, whereas it has little or no effect on a discontinuous one. **B1** a continuous characteristic spreads over an unbroken range with no gaps, whereas a discontinuous one falls into separate classes. **B1** continuous data are drawn as a histogram with the bars touching, whereas discontinuous data are drawn as a bar chart with the bars separated. [4]
VCD-Q1

- B3** **M1** each additional gene adds two more possible contributing alleles, so the number of classes follows the pattern $(2 \times \text{number of genes}) + 1$. **A1** for three genes: $(2 \times 3) + 1 = 7$ classes. **M1** apply the same pattern to six genes: $(2 \times 6) + 1$. **A1** = **13** classes, closer together than for three genes and easier for environmental variation to blur into an apparently continuous spread. [4]
VCD-Q9
- B4** **B1** each extra gene adds two more possible contributing alleles, so the number of phenotype classes increases. **B1** the difference between one class and the next therefore becomes smaller, until it is smaller than the differences that can be measured. **B1** environmental variation then shifts individuals across those small gaps, so no separate classes remain and the distribution is unbroken. [3]
VCD-Q2
- B5** **B1** the cuttings are clones, so all of them have the same genotype and any difference between them cannot be genetic. **B1** the difference in flower colour is therefore environmental variation, caused here by the difference in soil pH and the availability of ions that follows from it. **B1** the phenotype is produced by the genotype developing in a particular environment, and this environmental difference is not passed to any offspring because the alleles are unchanged. [3]
VCD-Q3
- B6** **B1** the allele the rabbit carries codes for an enzyme in the pigment pathway that is only active at low temperature, so pigment is made only where the skin is cool. **B1** binding ice to the shaved patch lowers the local skin temperature below the point at which the enzyme works, even though the genotype at that patch is unchanged. **B1** the fur that regrows under the ice pack will be black, because the local environmental condition, low temperature, rather than a different genotype, determines whether the enzyme is active and pigment is made. [3]
VCD-Q10
- B7** **B1** the height difference is environmental variation caused by the difference in nitrogen availability, not genetic variation, because the two plants share the same genotype. **B1** the phenotype reached is produced by the genotype developing under a particular set of conditions, and the conditions differ here while the genotype does not. **B1** grown together in the same well-fertilised soil, the height difference would disappear or become much smaller, because the environmental cause of the original difference would no longer apply and offspring inherit alleles, not the environmentally produced phenotype of a parent. [3]
VCD-Q11

- B8** **B1** height is controlled by many genes, called polygenes, each contributing a small additive amount to the total, so there is a genetic basis to height in the same sense that there is for a discontinuous characteristic such as blood group. **B1** evidence for the genetic component is that, across a range of adequate diets, taller parents tend to have taller children on average, which would not be expected if height had no genetic basis. **B1** the environment adds further variation on top of the genetic component, and only within the range the genotype permits, so height is controlled by both genes and environment together rather than by environment alone. [3]
VCD-Q12
- B9** **B1** the fruit-size difference between the two clones is environmental variation, because the two plants are genetically identical, so the difference cannot be caused by different alleles and must be caused by the difference in growing conditions. **B1** the height variation among the 50 unrelated plants is at least partly genetic variation, because the plants have different genotypes but were grown in the same conditions, so the difference cannot be attributed to environment alone. **B1** the logic in each case is the same: holding the genotype constant while the environment varies isolates environmental variation, and holding the environment constant while the genotype varies isolates genetic variation. [3]
VCD-Q13
- B10** **B1** seed coat colour is discontinuous, controlled by a single gene, so there is no genotype lying between the possible genotypes and therefore no phenotype lying between the two colour classes for environmental conditions to shift an individual across. **B1** seed mass is continuous, controlled by many genes, called polygenes, each contributing a small additive amount, giving many closely spaced classes with very small gaps between them. **B1** environmental conditions such as water availability can shift an individual's value within the range set by its genotype, and because the classes for a polygenic characteristic are so close together this shift is enough to move individuals across the small gaps between them, an effect too small to matter for a characteristic with only a few widely separated genotype classes. [3]
VCD-Q14

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