1999

Biology CAT 3: Written examination

ECIFIC INFORMATION

r each question, an outline answer (or answers) is provided. ch answer is broken into parts to give an indication of the ocation of marks shown on the paper. In some cases, the swer provided is not the only answer that could have been arded marks. Comments on student performance follow the swers for each question.

The average marks quoted are the mean marks awarded for swers over all markings.

uestion 1

–ii. (Average mark 2.16/Available mark 3)

	Phenotype	Allele symbol
	Yellow-green feathers	e.g. B or Y or F
	Pale-blue feathers	e.g. b or y or f

	Offspring	Genotype
	Yellow-green feathers	Bb
	Pale-blue feathers	bb

iii. (1.65/3)

BB	1 or 1/4 or 25% or 0.25	Yellow-green feathers
Bb	2 or 1/2 or 50% or 0.50	Yellow-green feathers
bb	1 or 1/4 or 25% or 0.25	Pale-blue feathers

. (1.77/3)

Autosomal dominant

50% or 1 in 2

50% or 1 in 2

(0.52/2)

isagree, because crossing over will result in recombinant type metes in the male (Da and dA). Hence male will produce four fferent kinds of gametes (DA, da, Da, dA).

Many of the students could correctly assign allelic symbols d identify genotypes in part a. Students who used two letters of alphabet for an allele, e.g. YG for yellow green were more ely to make errors in stating the genotypes.

The most common incorrect answer in part bii. was a ratio 1:2. Some students contradicted themselves by stating that there was a 50 per cent chance (a ratio of 1:2) that a child would be able to produce the amylase enzyme. Answers that contain contradictions cannot be awarded marks.

In part c. students who recognised that the genes were linked could correctly identify that crossing over would most likely occur. Fewer went on to state that four different kinds of gametes could be produced. Some students did not recognise that the genes were linked.

Question 2

a. (1.39/3)

D = Dexter d = normal

Parents: Dd x Dd

Offspring: 1/4 DD, 1/2 Dd Dexter, 1/4 dd normal

DD may be lethal and any offspring with this genotype die, therefore 2 Dexter: 1 normal.

b. (1.01/4)

i. Parents X^EX^e x X^EY

Offspring X^EX^e X^EX^E X^EY X^eY

Therefore male puppy could be affected.

ii. This could be answered in a number of different ways:

A cross of the affected female (could be to unaffected male or epileptic male) carried out where Vitamins A and B are supplied in sufficient quantities.

Result – if there are epileptic offspring then the characteristic is inherited.

or

Pedigree analysis where it was known that all females had adequate Vitamin A and B.

Result – affected female would have affected father if the characteristic were inherited.

or

If the mutation at the locus, on the X chromosome causing epilepsy is known, a probe complementary to the mutant allele could be used.

Result – if hybridisation of the probe is detected to the region on the X chromosome with the gene locus for epilepsy; epilepsy is the result of the X-linked locus.

ci. (0.50/1)
One
cii–iii. (0.83/4)

ii. Z^GZ^s x Z^sW

Z^GZ^s	Z^GW	Z^sZ^s	Z^sW
male silver	female silver	male gold	female gold

iii. Z^sZ^s hh x Z^GW Hh
gold male/soft feathers silver female/hard feathers

Z^GZ^s Hh	Z^GZ^s hh	Z^sW Hh	Z^sW hh
male silver hard	male silver soft	female gold hard	female gold soft

Many students correctly assigned allelic symbols in part a. Fewer went on to state that the parents must be heterozygous and then calculate genotypes of offspring. The unusual ratio presented in the question may have worried some students. By applying genetic principles learnt in class and reading the information given in the question very carefully an explanation should have become evident. The stem of the question contained the fact that no adult homozygous Dexter cattle had been identified. This fact could not be used as an adequate explanation of the 2:1 ratio.

The most common incorrect answer in part bi. was an explanation involving a gene found on an autosome.

Part bii. proved to be a challenging question. This question is a reminder to students that the environment can affect the phenotype of an individual.

In part ci. students needed to recognise that the female chicken would have one Z and one W chromosome in each somatic cell. Therefore there is only one allele for feather colour in each somatic cell. Fifty per cent of responses were correct. Students who had most success in part ciii. considered the two loci independently. More responses correctly identified the genotypes for feather hardness than feather colour.

Question 3

ai. (0.61/1)
Pedigree A
aii. (0.31/2)
Inheritance of one whorl could be autosomal recessive so that parents would be I–1 Aa x I–2 aa or autosomal dominant so that the parents would be I–1 aa x I–2 Aa.
bi. (0.45/2)
Two parents with single whorl have a child with two whorls.
If the one whorl trait were recessive all parents would both be ww and all offspring would be ww and have one whorl.
bii. (0.19/1)
An affected father II–1 has unaffected daughters II–4 and II–5.

Although the majority of responses were correct in part ai., relatively few students could give an adequate explanation in part aii. Common incorrect responses referred to dominant/recessive without any mention of autosomal/X-linked patterns. Assigning genotypes to the individuals in pedigree A made it easier for some students to explain how the pedigree could fit more than one pattern of inheritance.

A common incorrect answer given to part bii. was 'equal number of males and females express the trait'.

Question 4

a–b. (1.20/3)
a. 3 bases found in mRNA
b. Any one of:
- GCA
- GCG
- GCT
- GCC.

c. (1.88/4)
i. Translation
ii. mRNA attaches to the ribosome
anticodon on tRNA pairs in a complementary way with co on mRNA, amino acid attached to tRNA, adjacent amino acids are joined by peptide bonds to form a polypeptide/ protein.

d–f. (1.00/3)
d. A G in the proline triplet has replaced the C in the DNA of the arginine triplet.
or
There has been a substitution of a C (in arginine) by a G (i proline).
e. The sequence of a gene that is translated or left behind afte RNA processing
or
The sequences of a gene in the final RNA transcript.
or
The sequence in mRNA that codes for the polypeptide.
or
The coding regions of a gene.
or
The sequences of a gene that are translated.
f. The sugar, base and phosphate which make up the unit of DNA/RNA.

g. (1.56/3)
i. Guanine
ii. A deletion will mean the reading frame will be out of sequence when read in threes (or there has been a frameshi so that all amino acids after the deletion could be different a stop codon may result and shorten the polypeptide.

Many responses to part a. lacked sufficient information. Th question was worth 2 marks and at least two separate points we required for the award of full marks. Some definitions included incorrect statements. The most common incorrect statements included 'a set of three bases found in DNA' or 'a set of three bases that make up an amino acid'.

Part b. was completed successfully by most students.

When students are required to list steps in a process they should use the number of marks allocated to the question as a guide to the depth of the answer required. In part cii. some students incorrectly described transcription instead of translatic This occurred in a few cases even when the correct process had been identified in part ci.

The most common incorrect response given in part d. described the change that would have occurred in RNA and not DNA. Students need to be reminded to read the question carefu and check over their responses to see that it does answer the question being posed.

Parts f. and gi. were generally well answered.

Students could recognise that there may be some alteration the amino acid sequence in the polypeptide produced. Many the went on to discuss how this would effect the functioning of the protein. This was not required in the answer to part gii.

Question 5

a. (1.43/2)

A – rabbit B – tuna

b. (0.50/2)

No, the genetic code is degenerate (redundant) – an amino acid may have several different codons therefore the same amino acid sequence can result from a different mRNA and hence DNA sequence.

c. (1.64/4)

i–ii. Two of the following:

fossils: can indicate intermediate forms and common ancestors; relative age of fossils when an organism lived relative to another, homologous structures indicating common ancestor

and/or

morphology/comparative anatomy: can identify common ancestors via homologous structures; relationships via similarities or differences

and/or

embryological development: allows comparison between organisms during development which may indicate common ancestor

and/or

karyotyping: look for similarities and differences to establish how closely related organisms are to each other.

d. (0.38/2)

Similar genetic background or a common ancestor the same selective forces/pressures are acting on this variation of branch number so that they have become more similar over time

e. (1.11/2)

i. Convergent evolution

ii. Distantly related lineages come to resemble each other over time; same selective forces acting, in this case adapted to living in dry environments.

f. (0.59/2)

Analogous – structures with similar function (as a result of convergence), not related by a recent common ancestor.

Homologous – similar underlying structure but not necessarily function – indicate common inheritance.

Part a. was well answered by most students.

Many students failed to recognise that an amino acid may have several different codons in part b. Some incorrect answers tried to discuss differences in terms of mutations.

In part c. many students could correctly identify types of evidence but could not discuss how the evidence is used to determine an evolutionary relationship.

Many answers to part d. correctly stated that there must be the same selective pressures acting on the graptolites but failed to mention the similar genetic background.

The correct answer was often given to part ei. but the explanation given was insufficient.

Part f. was straightforward but not well answered by many students, with most responses reflecting a poor understanding of the two terms.

Question 6

a–b. (1.26/3)

ai. Tetraploid

aii. One of:

non separation/non disjunction of chromosomes at first mitosis of zygote to give 2 x 12 =24 chromosomes in future cells.

or

non separation/non disjunction during meiosis/gamete formation.

or

fertilisation between two diploid gametes.

b. Homologous pair.

c. (0.23/2)

Would expect offspring to be triploid, one haploid set of chromosomes from normal and a diploid set from polyploid parents.

Would not expect triploid to produce viable gametes hence disagree with student.

Many students correctly answered part ai. The most common incorrect answer was hexaploid.

In part aii. a statement 'when producing a gamete its parental plant may not have carried out meiosis correctly' cannot be awarded marks. A more detailed answer is required with terminology being used that is reasonable to expect from a Year 12 Biology student.

Students recognised that the offspring would be triploid in part c. but could not go on to explain whether the offspring could reproduce sexually.

Question 7

a–b. (0.96/2)

a. One of:

- original specimen partially eaten by predators or decomposed
- body of original specimen broken up and spread by action of water
- fossil parts spread by rock movement over time.

b. Heel bone adapted for movement on two legs.

c. (0.97/2)

Any two of:

Little Foot has:

- more prominent brow ridges
- smaller braincase/cranium
- less prominent chin
- backward pointing foramen magnum
- relatively long arms
- stronger jaws
- larger prominent teeth
- outward-angled hip joint
- smaller adult size
- big toe for grasping
- less curvature of the spine.

d. (0.94/2)

Any two of:

- evolved into a different species
- became extinct due to competition from another species
- became extinct due to changes in climate.

The most common incorrect answer given to part b. was '4 foot bones'.

Students who made comparative statements were more likely to be awarded marks in part c. An example of an answer awarded full marks was 'Little Foot's adult skeleton is very small in height while modern adult humans are taller'.

In part d. students tended to repeat themselves and not give two different reasons.

Question 8

a–b. (1.33/4)

a.

Proposals	Evidence
Coelodonta evolved somewhere in northeastern Asia from an earlier form, Dicerorhinus.	Similarities between *Dicerorhinus* and *Coelodonta* or a transition fossil. Dating shows *Dicerorhinus* fossils older than *Coelodonta.*
Coelodonta became extinct at the end of the most recent ice age, about 10 000 years ago.	All fossil remains of *Coelodonta* are older than 10 000 years.

b. Carbon dating
or
Thermoluminescence

c. (0.53/1)
Existence of prehistoric land bridge between the mainland and islands enabled populations to spread to suitable habitats.

d. (0.15/1)
Habitat loss due to human populations.

e. (0.81/2)
Any two of:

- inbreeding leading to homozygosity and expression of deleterious combinations of alleles
- low existing genetic variation
- may be an aging population and unlikely to breed
- may not have females of reproductive age
- difficulty breeding in captivity.

In part a. students often only gave one answer for evidence to the first proposal when two were required.

The majority of students could correctly answer part c. and suggest in part e. one problem that may be encountered if a breeding program were to be established.