Biology

Written examination 2 – October/November

Introduction

The examination criteria and description were published in the *VCE Biology Assessment Handbook 2006*. There will be two Biology examinations. Unit 3 will be assessed in Examination 1 (midyear) and Unit 4 will be assessed in Examination 2 (end of year). The duration of each examination will be 90 minutes plus 15 minutes reading time.

The Examination 2 paper will require students to respond to a series of items related to Outcomes 1 and 2 in Unit 4 and the key skills outlined on page 12 of the *VCE Biology Study Design*. Each outcome will be weighted approximately equally on the examination.

Area of study marks allocated	**%**
Heredity	45–55
Change over time	45–55

The examination will assess a representative sample of the key knowledge and skills that underpin the outcomes of Unit 4. While students will not be required to complete practical exercises within the examination, they may be asked to draw on their practical experiences when answering questions.

Structure and format

The structure and format of the examination for the reaccredited *VCE Biology Study Design* (2006–2009) will be the same as in 2005.

The examination paper will be presented in a question and answer book and will have two sections.

Section A will consist of 20–25 multiple-choice questions. Each question will be worth 1 mark. Students will be required to mark their responses on a multiple-choice answer sheet.

Section B will consist of short answer questions and will be worth 50 marks.

Teachers may refer to past examination papers for examples of questions.

Other relevant references

Teachers should refer to the Examination section of the *VCE and VCAL Administrative Handbook 2006*, the *VCE Biology Assessment Handbook*, the VCE Biology Study page on the VCAA website and to the *VCAA Bulletin* for further advice during the year. Assessment Reports on past written examinations may also contain helpful advice.

Sample questions

The following sample questions have been developed with an emphasis on new areas of Unit 4 of the *VCE Biology Study Design*. Each question includes mapping to the relevant key knowledge and the key skills.

These questions are not intended to form the basis of a sample examination paper.

Many of the questions on past papers continue to be relevant to the reaccredited *VCE Biology Study Design*. Some past questions could be extended by the addition of parts that specifically address new areas of the study design.

May 2006

Sample questions – Examination 2

Please note

There may be some overlap in content in the following sample questions. Overlap that gives significant clues to other questions is avoided on examination papers.

Section A – Multiple-choice questions

Question 1

***Key knowledge*: Outcome 1: Principal events in transcription and translation**

***Key skills*: Investigate and enquire scientifically (dot point 3)**

Apply biological understandings (dot point 1)

The haemoglobin of sufferers of the hereditary blood disorder sickle cell anaemia has only one amino acid in one of the peptide chains different to normal haemoglobin.

The peptide sequence involving the differences are

Normal Haemoglobin: threonine – proline – glutamic acid – glutamic acid – lysine

Sickle cell haemoglobin: threonine – proline – valine – glutamic acid – lysine

The codons for these amino acids are

Amino acid	**Codons**
threonine	ACU; ACC; ACA; ACG
proline	CCU; CCC; CCA; CCG
glutamic acid	GAA; GAG
valine	GUU; GUC; GUA; GUG
lysine	AAA; AAG

It is reasonable to conclude that

A. the sickle cell mutation could have arisen from the eighth base in the DNA sequence of the segment being altered from adenine to uracil.

B. the anti-codons involved in translation of the sickle cell haemoglobin could be, in order

UGA – GGG – CAG – CUC – UUC.

C. the altered sequence could have arisen during transcription, when the amino acid valine was brought into the growing peptide chain instead of the amino acid glutamic acid.

D. the DNA sequence of the normal haemoglobin could be, in order

TGA – GGG – CAG – CTT – TTT.

Question 2

***Key knowledge*: Outcome 1: Eukaryote chromosomes, genome, genes; Outcome 2: Evolutionary relationships**

***Key skills*: Investigate and enquire scientifically (dot point 3)**
Apply biological understandings (dot point 1)

The following table shows the genome size, number of genes and chromosome number for a variety of organisms.

Organism	Genome size (bp) (approximately)	Number of genes (approximately)	Chromosome number
E coli bacterium	4 369 000	4 289	N = 1
baker's yeast	12 069 000	6 200	2N = 32
Amoeba	290 000 000 000	data not available	500–1000 (possibly polyploid)
rodent	3 399 900 000	data not available	2N = 64
Rhesus monkey	3 399 900 000	data not available	2N = 42
vinegar or fruit fly	137 000 000	14 000	2N = 8
humans	3 200 000 000	30 000	2N = 46

From this data it is possible to conclude that

A. there is more non-coding DNA in humans than in the bacterium.

B. as chromosome number increases, so do the number of genes.

C. the rodent and the monkey will have the same number of genes.

D. the genome size relates to the evolutionary position of an organism.

Question 3

***Key knowledge*: Outcome 1: Apoptosis**

***Key skills*: Apply biological understandings (dot point 1)**
Communicate biological information and understandings (dot point 1)

Apoptosis is often called programmed cell death.

Apoptosis

A. occurs equally in all tissues.

B. involves damaged cells only.

C. occurs only in cells of ageing organisms.

D. involves a dying cell sending signals to phagocytes.

Question 4

***Key knowledge*: Outcome 1: DNA sequencing; Outcome 2: evidence of evolution, evolutionary relationships, hominid evolution**

***Key skills*: Apply biological understanding (dot point 1)**

Communicate biological information and understandings (dot point 1)

The following table shows a section of the mitochondrial DNA (mtDNA) sequence for a modern human. To this human sequence, the mtDNA sequence of a chimpanzee and three examples of Neanderthals is compared. The letter x means that the DNA base was the same as the human sequence.

Organism	**Section of mtDNA sequence**
Modern human	AATTCCCCGACTGCAATTCACGCACCATCCT
Chimpanzee	xxxxxxTxATTxxxxxACTGAAAxxxxGxxx
Neanderthal 1	GGxCTTTTATTCxTCCCTGTAAGTATGCTxC
Neanderthal 2	GGxxxxxxATTCxTCCCCTGTAAGTATGCTx
Neanderthal 3	xCxxxxxxATTxATCCCCTGTAAxTATGCTT

From the data in the table it is possible to conclude that

A. there are more differences between the DNA sequence of chimpanzee and modern human than between Neanderthal 1 and modern human.

B. there are more differences between the DNA sequences of Neanderthal 2 and 3 than between chimpanzee and modern human.

C. there are fewer differences between the DNA sequences of Neanderthal 2 and 3 than between Neanderthal 1 and 2.

D. based on sequence similarity, chimpanzee is more closely related to Neanderthal 1 than to modern human.

Question 5

***Key knowledge*: Outcome 1: Variation; discontinuous variation: Patterns of inheritance in sexually reproducing organisms; multiple alleles**

***Key skills*: Apply biological understanding (dot point 1)**

Communicate biological information and understandings (dot point 1)

When a trait such as milk production in cattle has a continuous distribution of phenotypes it is most likely the result of

A. multiple alleles.

B. codominance.

C. polygenes.

D. mutation.

Question 6

***Key knowledge*: Outcome 1: Patterns of inheritance; Outcome 2: Evolutionary relationships; mitichondrial DNA**

***Key skills*: Apply biological understanding (dot point 1)**
Communicate biological information and understandings (dot point 1)

Scientists wishing to examine the evolution of human mtDNA examined the mtDNA from various persons.

It is reasonable to predict that the greatest similarities in mtDNA sequences would be found in

A. two people, both from one indigenous population.

B. two people from the same family, one a father and the second his daughter.

C. two people from the same family, one a boy and the second his maternal grandmother.

D. two people from different populations, but where members of one population migrated to give rise to the second population.

Question 7

***Key knowledge*: Outcome 2: Natural selection; Patterns of evolution; Development of evolutionary theory**

***Key skills*: Apply biological understanding (dot point 1)**
Communicate biological information and understandings (dot point 1)

A plant population that reproduces annually exists on a remote oceanic island. Two flower-colour variants are present, red and blue. Flower colour is known to be a monogenic trait. The frequencies of the two flower colours were observed and it was noted the proportion of plants with blue flowers steadily declined in each of ten generations.

From this data, it may reasonably be concluded that

A. migration of red-flowered plants into the population was the most likely cause of the observed change.

B. blue-flowered plants had a lower genetic fitness than the red-flowered plants.

C. the increased frequency of red-flowered plants was a result of genetic drift.

D. mutation was producing more red-flowered plants in each generation.

Question 8

***Key knowledge*: Outcome 2: Evidence of evolution**

***Key skills*: Apply biological understanding (dot point 1)**
Communicate biological information and understandings (dot point 1)

In order to examine the evolutionary relationship between two fossil species, a number of procedures were considered.

It can reasonably be concluded that valid data would be obtained from a study of the

A. fossil structures in order to identify changes in DNA sequences.

B. biogeographical distribution of modern species in order to identify homologous structures.

C. relative ages of the fossils in order to identify which was a possible ancestral species of the other.

D. comparative anatomy of modern species in order to identify the percentage of DNA hybridisation.

Question 9

***Key knowledge*: Outcome 2: Human intervention in evolutionary processes – application of gene technologies**

***Key skills*: Apply biological understanding (dot points 2 and 3)**
Communicate biological information and understandings (dot points 2 and 3)

Gene therapy involves delivering a new gene into a patient with a genetic disorder to replace a faulty or missing gene. The new allele enables the patient to produce a functional protein.

A biology class uses an online discussion forum to express views and share issues associated with gene therapy. Four views are listed below.

The view best based on valid biological understandings is that

A. it is unfair to offer hope for a cure to individuals with genetic disorders because plasmids that are found in viruses are not easily taken up by human cells.

B. gene therapy is not a safe application because the viral vector will reproduce out of the target cells and cause the patients to suffer an infectious disease.

C. the safety of the patient is at risk from gene therapy because the inserted gene may disrupt the existing DNA and consequently the expression of the existing alleles.

D. gene therapy is a beneficial application because the cured patients will be able to pass the functional genes in their affected tissues on to their children.

Question 10

***Key knowledge*: Outcome 1: One gene locus, codominance**

***Key skills*: Apply biological understanding (dot point 1)**
Communicate biological information and understandings (dot point 1)

A classroom activity involved students setting up a simulation of natural selection using paper cut-out beetles. The beetles were black (B^1B^1), red (B^1B^2) or white (B^2B^2). One group of students used 54 beetles in their original population, 18 of each phenotype. To model the effects of natural selection they removed all white beetles, on the basis that white beetles could show poor fitness in a darkened environment, because they would be more visible to preying birds. These students calculated allele frequencies after the predation by birds.

Considering the allele frequencies in the original population and the population after the simulated selection, it is reasonable to claim that

A. there would be no change in allele frequencies as a result of selection.

B. the frequency of allele $\mathbf{B}^1$ would be greater after selection.

C. the frequency of allele $\mathbf{B}^2$ would be greater after selection.

D. the frequencies of the two alleles would be identical after selection.

Question 11

***Key knowledge*: Outcome 2: Patterns of evolution**

***Key skills*: Apply biological understanding (dot point 1)**

Communicate biological information and understandings (dot point 1)

Sharks and dolphins share similar features but also have essential differences.

Differences		Similarities	
Sharks	**Dolphins**	**Sharks**	**Dolphins**
breathe with gills	breathe with lungs	well developed fin	
fish	mammals	streamlined body	
		aquatic animals	

The information in the table suggests

A. fish evolved from mammals.

B. evidence for convergent evolution.

C. sharks and dolphins are geographically isolated.

D. sharks act as a selective pressure on the dolphin.

Question 12

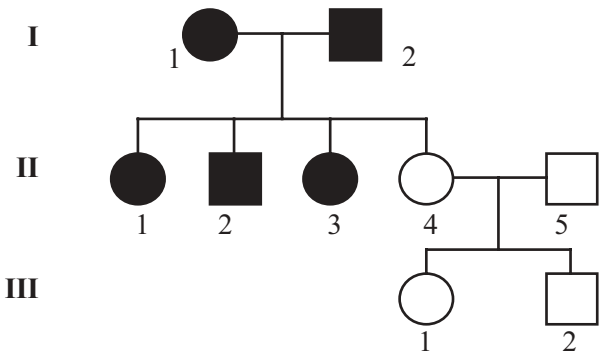
***Key knowledge*: Outcome 1: Patterns of inheritance; pedigree analysis**

***Key skills*: Investigate and inquire scientifically (dot point 3)**

Apply biological understanding (dot points 1 and 3)

Communicate biological information and understandings (dot point 1)

The following pedigree shows the inheritance of a trait in a family. Shaded individuals have the trait.



From the data in the pedigree you could reasonably conclude that

A. the trait is inherited as an autosomal recessive.

B. one of the parents of individual **I1** must have had the trait.

C. all gametes produced by individual **II2** will contain the allele for the trait.

D. individual **II4** has a one in two chance of producing a gamete containing the allele for the trait.

Section B – Short-answer questions

Question 1

***Key knowledge*: Outcome 1: Molecular genetics; Tools and techniques**

***Key skills*: Investigate and inquire scientifically (dot point 3)**
Apply biological understanding (dot point 1)
Communicate biological information and understandings (dot points 1 and 3)

A plasmid often used in the transfer of DNA from one organism to another is called *pGlo*. This plasmid was designed in a laboratory and has a gene which provides resistance to the antibiotic, ampicillin. The product of the gene breaks down ampicillin in the medium on which the bacteria grow.

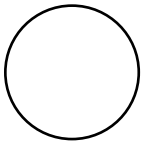
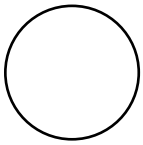
a. What type of compound is likely to be the end product of this gene?

_____

1 mark

Bacteria sensitive to ampicillin can be treated in such a way that they 'take up' this plasmid.

An experiment was carried out with untreated bacteria and bacteria exposed to the plasmid (treated).

	Spread with untreated bacteria	**Spread with treated bacteria**
Agar only 	**A** _____	**B** _____
Agar and ampicillin 	**C** _____	**D** _____

b. Complete the table above by writing in the space provided alongside A, B, C and D whether you would expect **growth** of bacteria or **no growth** of bacteria.

2 marks

c. Choose any **two** of A, B, C or D and explain the reason for your choice of growth or no growth.

_____

_____

_____

_____

_____

2 marks

In this plasmid, another DNA sequence produces a protein called GFP (green fluorescent protein) that results in the bacteria fluorescing under UV light. A third gene is present in the plasmid which regulates the expression of GFP.

d. Why is it important that genes are regulated?

_____

_____

1 mark

It is known that this regulatory gene produces a compound which influences the function of the enzyme which is involved in the transcription of the GFP gene.

e. What is the template for transcription?

_____

1 mark

f. In a bacterial cell, where does transcription take place?

_____

1 mark

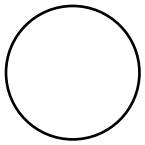
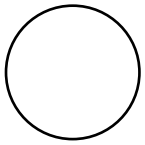
g. What is the enzyme involved in transcription?

_____

1 mark

The regulatory gene is switched on and allows transcription of GFP, when arabinose sugar is present in the agar.

An experiment was carried where arabinose was added to some of the agar plates, along with ampicillin.

	Spread with untreated bacteria
Agar only 	**E** _____
Agar and ampicillin 	**F** _____

h. Complete the table at **E** and **F** by predicting whether the bacteria

- grow or do not grow and
- fluoresce or do not fluoresce.

2 marks

i. Explain your answers to part **h**.

2 marks

Question 2

***Key knowledge*: Outcome 1: Apoptosis**

***Key skills*: Apply biological understanding (dot point 1)**
Communicate biological information and understandings (dot points 1 and 3)

Apoptosis can occur in healthy cells.

a. What is apoptosis?

1 mark

b. **i.** Name one situation in which a healthy cell dies because of apoptosis.

ii. Explain why such an event is of benefit to an organism.

1 + 2 = 3 marks

c. Outline the series of events that occur during apoptosis of a cell.

3 marks

Question 3

***Key knowledge*: Outcome 2: Interrelationships between biological, cultural and technological evolution: human intervention in evolutionary relationships, selective breeding.**

***Key skills*: Apply biological understanding (dot points 1 and 2)**
Communicate biological information and understandings (dot points 1, 2 and 3)

Selective breeding has been used to improve sheep flocks in Australia.

a. Identify **two** key differences between selective breeding and random mating in a sheep flock.

2 marks

b. What is the impact of selective breeding on genetic variability in a sheep flock?

1 mark

Question 4

***Key knowledge*: Outcome 2: Change in populations; natural selection as a mechanism of evolution; patterns of evolution**

***Key skills*: Apply biological understanding (dot points 1 and 2)**

Communicate biological information and understandings (dot points 1, 2 and 3)

Two separate populations of greenish warblers, *Phylloscopus trochiloides*, coexist in Siberia. One group of birds has a single bar on each wing, while the other has two bars. They do not recognise each others' mating songs and because of this they do not interbreed.

a. What distinguishing behavioural feature marks the two groups of birds as separate species?

1 mark

b. Describe a likely sequence of events that has resulted in the two groups of greenish warblers becoming two species that exist in the same habitat.

4 marks

Question 5

***Key knowledge*: Outcome 1: Cell reproduction; gamete production: Patterns of inheritance; two gene loci, dihybrid cross**

***Key skills*: Apply biological understanding (dot points 1 and 2)**
Communicate biological information and understandings (dot points 1, 2 and 3)

In guinea pigs, black (**B**) is dominant to white (**b**) and long hair (**L**) is dominant to short hair (**l**). A guinea pig breeder specialises in breeding and selling purebred animals showing the dominant traits for colour and hair length. Alison wishes to introduce unrelated animals into her stock and looks for new animals. Another breeder, Tom, offers Allison a black, long-hair guinea pig and assures her that it will breed true to form because the animal is homozygous dominant for the traits.

Alison decides to check the genotype of Tom's guinea pig by carrying out a test cross.

a. What is a test cross?

_____

1 mark

The first test cross resulted in two black, long-haired offspring.

b. Explain whether this result supports Tom's claim about the genotype of his guinea pig.

_____

_____

1 mark

c. What further action would you expect Alison to take after seeing the result of the initial test cross?

_____

_____

1 mark

Alison was interested in finding out whether the genes for hair colour and hair length are on the same chromosome.

d. **i.** What experiment would Alison need to carry out to gain informative results that would assist her to answer this question?

ii. What results from the experiment performed in part **d.i.** would support Alison concluding that the genes were on the same chromosome?

iii. What results from the experiment performed in part **d.i.** would support Alison concluding that the genes were on different chromosomes?

2 + 2 + 2 = 6 marks

Question 6

***Key knowledge*: Outcome 2: Human intervention in evolutionary processes**

***Key skills*: Apply biological understanding (dot points 1 and 2)**
Communicate biological information and understandings (dot points 1, 2 and 3)

There may be negative effects associated with selective breeding.

a. Outline one risk associated with this type of breeding.

1 mark

Captive breeding is one way that numbers of an endangered species can be increased. One opinion related to captive breeding is that 'we might save the species but we can never replace the population'.

b. In what ways is this opinion related to genetic diversity?

2 marks