

TRIALS FOR TEACHERS

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ASSESSMENT GUIDE

VCE BIOLOGY – TRIAL EXAMINATION

UNIT 4 – OCTOBER 2006

INSTRUCTIONS

Reading Time - 15 minutes
Writing time - 1 hour 30 minutes

ANSWER ALL THE QUESTIONS

SECTION A **25 Questions 25 marks** **Suggested Time: 30 minutes**

Answer the multiple choice questions on the answer sheet provided.

SECTION B **8 Questions 50 marks** **Suggested time: 60 minutes**

Answer the short answer questions in this booklet.

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MULTIPLE CHOICE

Question 1:

The cell cycle

Answer: B varies in length in different cells

The cell cycle is a continuous process, where specialized cells tend not to divide and growth occurs prior to replication.

Question 2:

All cells have a predetermined life span, they get old and die. This is known as

Answer: B apoptosis

Apoplast is the network of cell walls & intercellular spaces within a plant body, apoplexy is form of a stroke and apophysis is a projection from a bone or organ.

Question 3:

After a prokaryotic cell has grown to a certain optimum size, the cytoplasm undergoes cleavage into roughly equal halves. This asexual process is known as;

Answer: C binary fission

Binary fission is division of a cell into two without mitosis, ie nuclear division.

Question 4:

The phenotype of an organism can be modified by external environmental factors. Which of the following factors are **NOT** sources of environmentally induced variation?

Answer: A mutations

Mutations are a form of genetic variation.

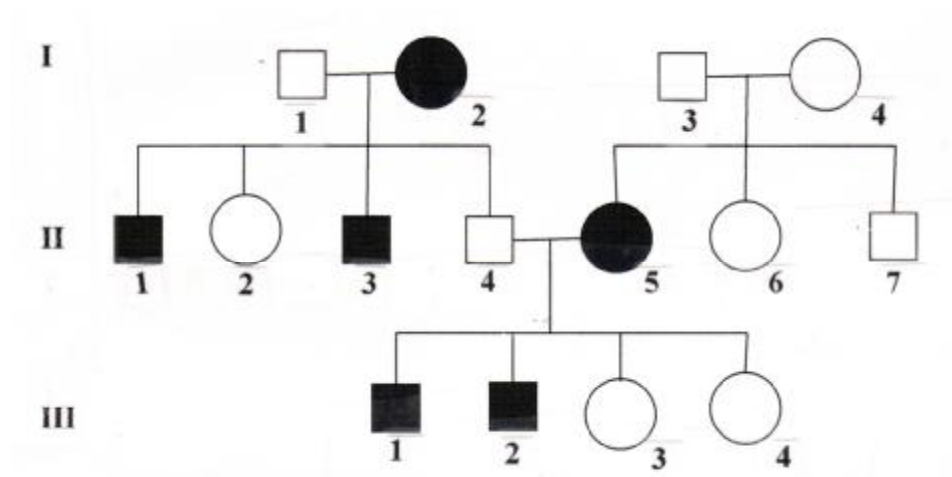
Question 5:

DNA and RNA are very similar compounds; they differ in three important ways. Which of the following is **incorrect**?

Answer: D RNA is found only on the nucleus

RNA can be found in the cytoplasm.

The following pedigree relates to Questions 6, 7 and 8



Pedigree showing the incidence of deafness in a particular family. (Affected individuals are shaded.)

Question 6

It is reasonable to conclude from the above pedigree that deafness in this family is inherited as;

Answer: B autosomal recessive

Two unaffected parents can have an affected child.

Question 7

It is also reasonable to conclude from the above pedigree that the genotype of individual

Answer: D III-2 is homozygous

I-2 is (dd), II-3 is (dd) and II-7 is (D?) – cannot tell from this pedigree.

Question 8

The chance that a fourth child of I-3 and I-4 is a carrier is

Answer: C Two in three

Mating between I-3 (Dd) and I-4 (Dd) would produce 25% (DD), 50% (Dd) and 25% (dd). As (dd) would be deaf then 2 out of 3 would be carriers.

Question 9

Crossing over can involve chromatids from one chromosome exchanging fragments of chromatids from another chromosome to create hybrid chromatids. This process

Answer: B can only occur during the first phase of meiosis

Question 10

Which of the following pedigrees is **NOT** consistent with the inheritance of a recessive characteristic controlled by a gene on the X chromosome? (*Shaded individuals show the trait.*)

Answer: C

Mother cannot pass to daughter if father does not have trait. His X chromosome does not carry the disorder.

Question 11

Below is a diagram showing an original sequence of DNA and the same length of DNA after it has undergone a mutation.

Original DNA strand: CCG TGG TAA TTT CTT
Mutated DNA strand: CCG TGG TAC TTT CTT

Name the type of mutation the original sequence of DNA has undergone.

Answer: A substitution

Nucleotide A has been substituted for nucleotide C in the 3rd codon..

Question 12

In guinea pigs, black hair (B) is dominant over white hair (b) and short hair (S) is dominant over long hair (s). A dihybrid cross was performed between a pure breeding white short hair guinea pig and a pure breeding black long hair guinea pig. The offspring of this cross were then mated and the ratio of the phenotypes of their offspring were

Answer: C: 9 : 3 : 3 : 1

Question 13

A large population with plenty of genetic diversity goes through a period where the population diminishes to a very low number of individuals. These individuals survive and reproduce to build up the species again but have lost much of their genetic diversity. This type of event is known as

Answer: B Population bottleneck

Question 14

By comparing fossils in different layers of rock strata (sedimentary rocks), it is possible to determine the relative ages of the fossils. Which of the following rock strata contains the oldest fossils?

Answer: A

Layers of sedimentary rock are arranged in the order they were deposited with the most recent layers near the surface.

Question 15

An index fossil can be used to date rock in which it is found. A useful feature of an index fossil is:

Answer: A An index fossil should be abundant.

An index fossil should only live a short time and in a wide geographic distribution.

Question 16

Australia and Antarctica were part of which supercontinent?

Answer: A Gondwana

Question 17

A bat and a butterfly have wings with which they fly. These wings have a similar function but a very different construction. They are

Answer: D analogous structures

Analogous structures have same function but different structure

Question 18

Episodes of mass extinction have occurred over the last 500 million years. Which of the following is **NOT** a possible cause of mass extinction?

Answer: C predation

Predation is not large scale, would not cause large scale extinction

Question 19

“Ancestral giraffes with short necks tended to stretch their necks to reach tree foliage that served as a major part of their food source. This frequent neck stretching caused their offspring to have slightly longer necks. As these offspring also stretched their necks, the next generation had still longer necks. And so, as a result of neck stretching to reach higher and higher foliage, each generation had slightly longer necks than the preceding generation.” This theory was put forward by;

Answer: C John Baptiste de Lamarck

Lamarck believed in the inheritance of acquired characteristics.

Question 20

Mitochondria were once free living organisms that became incorporated into eukaryotic cells bringing their DNA with them. Mitochondrial DNA has been used extensively in evolutionary studies because

Answer: B It does not recombine

mtDNA mutates at a steady rate and can therefore be traced quite readily.

Question 21

Consider the following table of percentage divergence of nucleotide sequences in a rapidly evolving psuedogene in four primate species.

DNA from ↓ compared with DNA from →	Human	Chimpanzee	Gorilla	Orangutan
Human	-	1.56	1.69	3.30
Chimpanzee	1.56	-	1.82	3.42
Gorilla	1.69	1.82	-	3.39
Orangutan	3.30	3.42	3.39	-

From the above data on DNA comparison it is reasonable to conclude;

Answer: C Chimpanzees and Humans are the most closely related species

Chimpanzees and humans have the smallest divergence of 1.56

Question 22

Humans have shown extensive adaptation and have migrated into more habitats than any other primate species. This is most likely due to

Answer: B large brain

A large brain has been attributed to the most useful adaptive advantage of humans.

Question 23

Which of the following is an example of cultural evolution?

Answer: D Religious rituals and burials

Other alternatives are all structural evolution

Question 24

Modern technology now allows scientists to manipulate the genetic complements of an organism. Which of the following is **NOT** a gene manipulation technique?

Answer: B DNA sequencing

DNA sequencing only establishes the order of bases in DNA

Question 25

Which of the following correctly identifies a stage of mitosis?

Answer: D chromatids separate along the mitotic spindle during anaphase

Cytokinesis is the division of cytoplasm, the mitotic spindle forms during metaphase and during early prophase the DNA condenses into chromosomes.

SECTION B – Short-answer questions

Question 1

A normal zebra finch is brightly colored but there are also two distinct forms of albino finch. One form, though almost totally white, has a slight brown tinge near its eyes (Strain A). The other is a classic albino (Strain B). If the two forms of albino finches are crossed, the offspring are normal wild types; they have slate grey bodies and colorful markings.

- a. Name the study of a mating between two organisms where two pairs of contrasting characters are followed.

Dihybrid cross

1 mark

The failure of the normal pigmentation system in zebra finches can occur at two known points; the pigment protein can be defective which is the problem with stain B; or the control mechanisms that turn on pigment production and control the amount made can be defective, which is the problem for strain A.

- b. Use allelic symbols Q and q for pigment production and R and r for defective proteins.
- i. What are the genotypes of the two varieties of purebred albino zebra finches? (Indicate in your answer which genotype matches which phenotype.)

Brown Tinge (RRqq) and Pure Albino (rrQQ)

- ii. If the above two zebra finches mate, what is the genotype and phenotype of their F₁ offspring?

Wild Type – Grey/colorful (RrQq)

1 + 1 = 2 marks

A mating occurred between a female albino zebra finch (qqRr) and a normal male colorful finch (QqRr).

- c. What are the gametes produced by each parent?

Female (qR) and (qr); Male (Qr) and (qr)

1 mark

- d. Draw a punnet square to represent the possible zygotes formed by different combinations of gametes coming together at fertilization.

	<i>qR</i>	<i>qR</i>	<i>qr</i>	<i>qr</i>
<i>QR</i>	<i>QqRR</i>	<i>QqRR</i>	<i>QqRr</i>	<i>QqRr</i>
<i>Qr</i>	<i>QqRr</i>	<i>QqRr</i>	<i>Qqrr</i>	<i>Qqrr</i>
<i>qR</i>	<i>qqRR</i>	<i>qqRR</i>	<i>qqRr</i>	<i>qqRr</i>
<i>qr</i>	<i>qqRr</i>	<i>qqRr</i>	<i>qqrr</i>	<i>qqrr</i>

2 marks

- e. What is the phenotypic ratio of the offspring in (d)?

Normal coloring Zebra Finch (3/8); Brown tinge Zebra Finch (3/8); Pure albino Zebra Finch (2/8)

1 mark
Total 7 marks

Question 2

New cells are constantly being produced in organisms. As cells reproduce, it is critical that the genetic material is also reproduced so that any new cells produced have the same amount and kind of genetic material as the parent cell.

- a. Briefly explain the purpose of DNA replication.

It is a necessary step for cell division, both mitosis and meiosis. The whole chromosome is essentially replicated ready for cell division.

1 mark

- b. DNA replication involves many stages that are controlled by enzymes. One such enzyme is *helicase*. Describe the role of *helicase* in DNA replication.

Helicase splits and unwinds the two stranded DNA molecule.

1 mark

- c. Meiosis is a specialized form of cell division. Label the following statements as *true* or *false*.

Variation and diversity of offspring is narrowed.	<i>False</i>
Each daughter cell contains the haploid number of chromosomes.	<i>True</i>
Meiosis takes place in the reproductive organs of living things.	<i>True</i>
One cell division completes the process of meiosis.	<i>False</i>
Asexually reproducing organisms reproduce by meiotic division of cells.	<i>False</i>
Gametes are the output of this process.	<i>True</i>

3 marks
Total 5 marks

Question 3

A group of Year 12 Biologists are to visit the CSIRO to undertake some experiments relating to DNA manipulation and modification. The first experiment is to insert a plasmid into *E.coli* then select and amplify those cells which have taken up the plasmid.

a.

i. What is a plasmid?

A small circular piece of DNA that is found in bacteria and is able to replicate independently of the cells chromosomes, in the cytoplasm.

ii. Gene cloning is a process of making large quantities of a desired piece of DNA, for example a hormone. How would you clone a gene for a specific hormone using a recombinant DNA plasmid? Space has been provided for you to include a diagram.

Plasmid DNA and foreign DNA are both cut with the same restriction enzyme so as to produce matching sticky ends. These sticky ends (restriction site) are attracted by base pairing (and weak hydrogen bonds). The two fragments are then joined permanently by DNA ligase.

The diagram should show the stages outlined above.

1 + 2 = 3 marks

b. Name the method you would use to amplify the recombinant DNA plasmid.

PCR

1 mark

The second experiment the students must undertake is to separate fragments of a plasmid which has been cut using restriction enzymes. They will be using gel electrophoresis.

d. Name two factors that gel electrophoresis would use to separate large molecules.

Size of fragment AND electric charge of fragment

2 marks

e. Describe one situation where only a small amount of DNA may be available for sampling and would need to be amplified.

Crime scene OR from bones or fossils OR small amount of DNA from extinct organism OR another appropriate response.

1 mark

Total 10 marks

Question 4

Below is a DNA sequence from the beginning of a gene coding for an enzyme involved in the process of cellular respiration. It represents a synthesized DNA sample.

A	T	G	C	C	G	T	G	G	A	T	A	T	T	T	C	T	T	T	T	A	T	A	T	A	A	A	T	A	G
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

a.

i. What do the letters **A** and **C** stand for?

A = adenosine and C = cytosine

ii. Convert the above synthesized DNA sample into the complementary sequence of the sample DNA.

T	A	C	G	G	C	A	C	C	T	A	T	A	A	A	G	A	A	A	A	T	A	T	A	T	T	T	A	T	C
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

1 + 1 = 2 marks

b.

i. The sample DNA now undergoes a process by which the code is rewritten into a mRNA molecule. Name this process.

Transcription

ii. Complete the mRNA sequence.

A	U	G	C	C	G	U	G	G	A	U	A	U	U	U	C	U	U	U	U	A	U	A	U	A	A	A	U	A	G
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

1 + 1 = 2 marks

Consider the following genetic code table.

		U		C		A		G			
F I R S T L E T T E R	U	UUU	phe	UCU	ser	UAU	tyr	UGU	cys	U	T H I R D L E T T E R
		UUC		UCC		UAC		UGC		C	
		UUA	leu	UCA		UAA	stop	UGA	stop	A	
		UUG		UCG		UAG	stop	UGG	trp	G	
	C	CUU	leu	CCU	pro	CAU	his	CGU	arg	U	
		CUC		CCC		CAC		CGC		C	
		CUA		CCA		CAA	gin	CGA		A	
		CUG		CCG		CAG		CGG		G	
	A	AUU	ile	ACU	thr	AAU	asn	AGU	ser	U	
		AUC		ACC		AAC		AGC		C	
		AUA		ACA		AAA	lys	AGA	arg	A	
		AUG	met	ACG		AAG		AGG		G	
	G	GUU	val	GCU	ala	GAU	his	GGU	gly	U	
		GUC		GCC		GAC		GGC		C	
		GUA		GCA		GAA	gin	GGA		A	
		GUG		GCG		GAG		GGG		G	

c. Determine the amino acid sequence of the above mRNA sequence by using the genetic code table.

MET	PRO	TRP	ILE	PHE	LEU	LEU	TYR	LYS	STOP
-----	-----	-----	-----	-----	-----	-----	-----	-----	------

1 mark

d. What is an anticodon and where is it located?

The anticodon is the site of the 3-base sequence that recognizes and matches up with the codon on the mRNA molecule. It is located on the tRNA molecule.

2 marks

Total 7 marks

Question 5

The Tamar wallaby, *Macropus eugenii*, lives today in regions in the south west corner of Western Australia, on a few islands and in a small area of South Australia. During the day they rest and at night travel to feed in open grassy areas up to 1 km away from the protective thickets in which they sleep.

a. Describe one way that will cause some animals will move on to new environments, away from their original habitats.

Competition, either interspecific or intraspecific AND compete for identical resources and/or mates..

1 mark

b. Another species of *Macropus*, is a form of desert wallaby. It is also nocturnal but does not have access to open grassy areas. Describe the process of speciation and outline how it may have occurred with respect to *Macropus*.

Speciation is the process of one parent population becoming two different subspecies. This may occur by the formation of physical barriers or geographical 'islands' caused by inhospitable regions surrounding the species.

2 marks

b. Isolated populations may be subjected to quite different selection pressures. Define the term selection pressure and give an example.

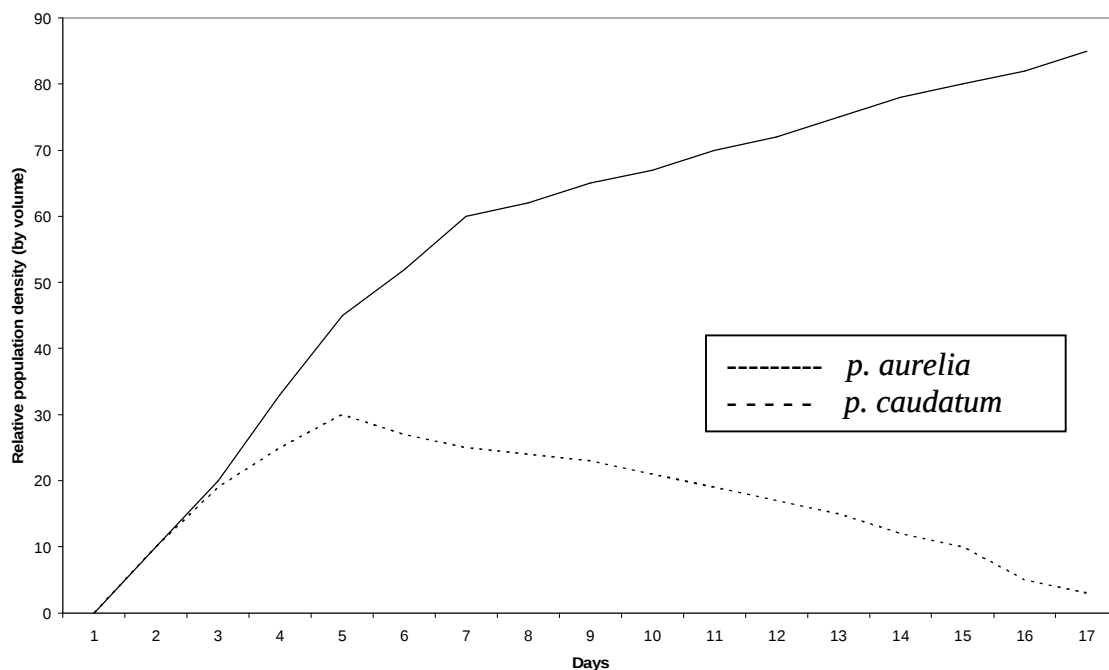
A selection pressure is a factor that can influence/favour the survival of an individual, population or species. Many specific examples, such as water conservation.

2 marks

Total 5 marks

Question 6

When a few individuals of either species of *paramecium* are introduced into a tank alone they multiply until they reach a limiting density. The graph below shows what occurs when individuals of both species are introduced together.



a. Describe what has occurred in both populations of *paramecium* in the first three days.

Both populations of paramecium have increased steadily at the same rate until day 3 when p. caudatum's rate of reproduction slows down.

1 mark

b. Discuss what has occurred to the population of *p. aurelia* compared to *p. caudatum* over the three week experiment.

p. aurelia has increased for the duration and therefore must be more efficient under these conditions. It has driven *p. caudatum* to almost extinction in 3 weeks.

2 marks

Total 3 marks

Question 7

Accurate diagnostic tools are increasingly being used to detect genetic diseases, such as Huntington's Disease, in embryos. Genetic screening for inherited diseases and the associated approved termination of affected fetuses will affect the human gene pool.

a. As a result of medical advances for the sufferers of genetic diseases, some are living to adulthood and thus reproducing. In what way will the gene pool be affected by

i. genetic screening

Alleles that are deleterious to humans (but occur naturally) are being removed from the gene pool thus enhancing the gene pool.

ii. longer life span for sufferers of genetic diseases

Alleles that are deleterious to humans (but occur naturally) are being kept in the gene pool and possibly propagated if these sufferers reproduced.

1 + 1 = 2 marks

Current research in Australia is looking at ways to control the differentiation of stem cells and their possible applications to the general population.

b. What are stem cells?

Unspecialized cells that have the potential to develop into many different kinds of cells.

1 mark

The research has both commercial and therapeutic possibilities. Once cells are grown they can be transplanted into people who need them.

c. Give a specific example of the possible use of stem cells.

*Examples are numerous but may include;
Engineering a living skin for burns victim
Pancreas (insulin producing cells) for diabetic
Heart tissue for cardiac patient
Spinal cord tissue for paralyzed accident victims.*

1 mark

Total 4 marks

Question 8

The African rhinoceros has been slaughtered over many years for its horns. It appears, however that a change in the phenotype of the rhinoceros may be allowing for its long term survival. In 1920, only 1 percent of rhinoceros were born without horns, but recent surveys show that 13.6 percent of females and 8.3 percent of males are now hornless. It is unknown what effect the lack of horns will have on the rhinoceros.

- a. How did the absence of horns originate? Define this term.

Mutation : a random change in the amount or sequence of genetic information 1 mark

- b. Name the process which has allowed the increase in frequency of the hornless rhinoceros.

Natural selection 1 mark

- c. Explain how this process had lead to this change in the rhinoceros population.

- *Some rhinoceros born without horns, variation in horn length.*
- *Rhinoceros with horns are more likely to be killed by poachers*
- *Those rhinoceros with horns are less likely to pass their genes on to their offspring*
- *The rhinoceros without horns are more likely to survive, reproduce and pass on their genes to their offspring*
- *Over time the frequency of hornless rhinoceros has increased.* 3 marks

- d. A rhinoceros would generally be expected to show a slower evolutionary change over time than a mouse. Explain.

Change over time is related to the time taken for each generation and mouse generations are shorter than rhinoceros generations. 1 mark

- e. The change in the rhinoceros has occurred at a faster rate than that which would normally be expected. Why has there been such a rapid change in the rhinoceros?

Very strong selection pressure 1 mark

- f. Name and describe one mechanism which allows the shuffling of existing genetic information.

- *Random/independent assortment – homologous chromosomes may line up in any combination on the spindle during meiosis*
- *Crossing over/recombination – random exchange of material between non sister chromatids*
- *Sexual reproduction/random fusion of gametes – gametes are from different sources and therefore contain different genetic material.*

2 marks

Total 9 marks