VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2006

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

									Letter
Figures									
Words									

BIOLOGY

Written examination 2

Monday 30 October 2006

Reading time: 9.00 am to 9.15 am (15 minutes)
Writing time: 9.15 am to 10.45 am (1 hour 30 minutes)

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	25	25	25
B	8	8	50
			Total 75

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- No calculator is allowed in this examination.

Materials supplied

- Question and answer book of 23 pages.
- Answer sheet for multiple-choice questions.

Instructions

- Write your **student number** in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- All written responses must be in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.
Choose the response that is **correct** for the question.
A correct answer scores 1, an incorrect answer scores 0.
Marks will **not** be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.

Question 1

In eukaryotic organisms genes are

A. composed of DNA.
B. alternative forms of an allele.
C. composed of DNA and protein.
D. the same length as a chromosome.

Question 2

In prokaryotic organisms

A. translation occurs at the ribosome.
B. transcription occurs in the nucleus.
C. chromosomes are usually linear.
D. DNA is only found in plasmids.

Use the following information to answer Questions 3 and 4.

In lentils the seed coat pattern is determined by a gene with three alleles. The phenotypes are marbled, spotted and clear.

Four crosses were repeated many times. The crosses and the outcomes of these crosses are shown in the table below.

Cross	Parents	Offspring phenotype and ratio
1	marbled x marbled	3 marbled : 1 clear
2	spotted x clear	1 spotted : 1 clear
3	marbled x marbled	3 marbled : 1 spotted
4	clear x clear	all clear

Question 3

The number of different genotypes possible at the locus for seed coat pattern is

A. 3
B. 4
C. 5
D. 6

Question 4

From the data it is possible to conclude that

A. spotted is recessive to clear.

B. all of the clear offspring are heterozygous.

C. two thirds of the marbled offspring in cross 3 are heterozygous.

D. the marbled parents in cross 1 have the same genotype as the marbled parents in cross 3.

Question 5

In bees, females are diploid and males are haploid.

This means that male bees

A. produce gametes with half the haploid number of chromosomes.

B. produce gametes by meiosis.

C. produce gametes by mitosis.

D. do not produce gametes.

Question 6

In the Australian human population, when collecting data about the frequency of different phenotypes at the ABO blood group locus, it is possible to group all members of the population into four phenotypic classes.

This is an example of

A. hybridisation.

B. continuous variation.

C. polygenic inheritance.

D. discontinuous variation.

Question 7

A fisherman was surprised to catch a fish which had no scales (nude). To investigate the origin of this phenotype the nude fish was mated several times to fish with scales and the result of each cross was recorded. In the crosses of nude with scaled, a third phenotype appeared, which was later called linear. The linear phenotype has only a single line of scales down one side of the body.

The outcomes of these crosses are shown in the table.

Cross	Parents	Offspring phenotype and ratio
1	scaled x nude	all offspring linear
2	linear x linear	1 scaled : 2 linear : 1 nude

From the data it can be concluded that

A. there is incomplete dominance between the nude and scaled phenotype.

B. the environment is the reason for the loss of scales in the nude fish.

C. all of the linear fish are homozygous.

D. the nude fish are heterozygous.

Question 8

In guinea pigs two genes have the following alleles.

Gene 1:	hair length	Gene 2:	hair type
	S : long hair		**W** : straight hair
	s : short hair		**w** : wavy hair

A breeder carried out the cross **SSWW** × **ssww** and obtained a number of **SsWw** offspring.

The breeder then carried out many test crosses involving these offspring to find out if the two genes were on the same chromosome.

If the genes were on the same chromosome, close to each other, you could reasonably expect the offspring from the test crosses to include

A. more with long, wavy hair than short, wavy hair.

B. more with short, straight hair than short, wavy hair.

C. approximately equal numbers of long, straight hair and long, wavy hair.

D. approximately equal numbers of long, straight hair and short, wavy hair.

Question 9

For humans, the term nuclear genome refers to all the genes in

A. an autosome.

B. an X chromosome.

C. a Y chromosome.

D. a set of autosomes plus the sex chromosomes.

Question 10

All the alleles in a population are referred to as the

A. phenotypic family.

B. proteome.

C. gene pool.

D. genotype.

Question 11

Amplification of DNA in the polymerase chain reaction requires

A. nucleotides of uracil.

B. DNA polymerase.

C. amino acids.

D. ribose sugar.

Question 12

In the Australian sheep blowfly, the length of the wing is a polygenic trait.

This means that

A. there is a small number of clearly defined phenotypes.

B. wing length is controlled by one gene with many alleles.

C. the wing length phenotype shows continuous variation.

D. the phenotype is controlled by many genes on the same chromosome.

Question 13

Achondroplasia is an autosomal dominant trait in humans that results in a form of dwarfism. In some cases a child with achondroplasia is born to parents who have normal height.

The most likely reason for the appearance of the child with achondroplasia is that

A. the parents are carriers and the child has inherited the mutant allele from each parent.

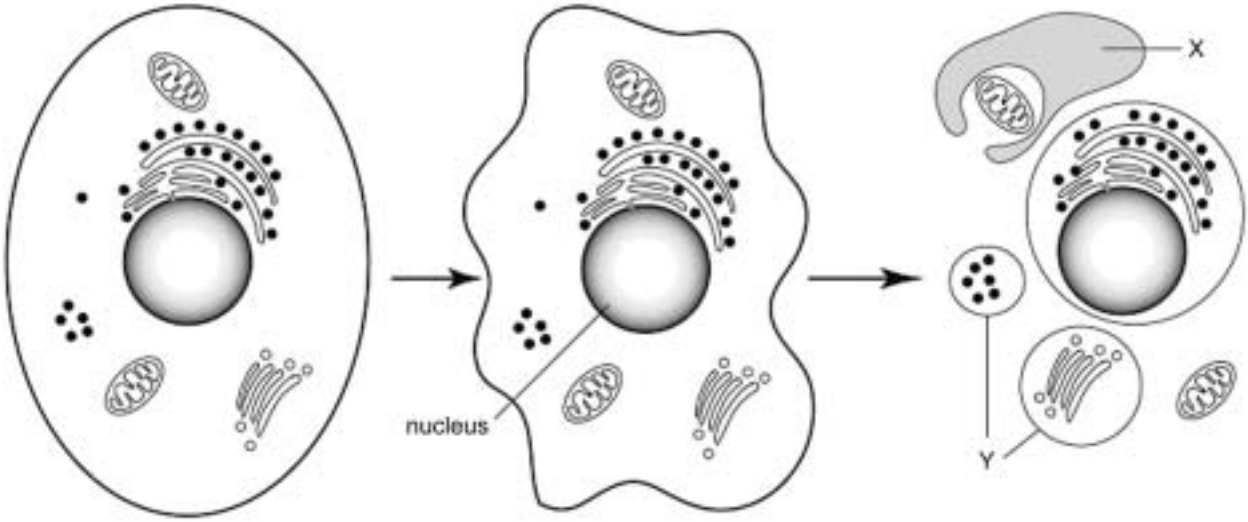
B. a mutation has occurred in a gamete of either the mother or the father.

C. a mutation has occurred in a somatic cell of one of the parents.

D. a mutation has occurred in the tissues of the child.

Use the following information to answer Questions 14 and 15.

The following diagram outlines a process that occurs in multicellular organisms.



Question 14

This process is called

A. mitosis.

B. necrosis.

C. apoptosis.

D. binary fission.

Question 15

The process shown in the diagram above

A. is initiated only within the cell itself.

B. involves the total destruction of structures Y.

C. is under the control of a single enzyme.

D. involves the destruction of parts by phagocytes such as X.

Question 16

The founder effect and bottleneck are examples of

A. gene flow.

B. speciation.

C. genetic drift.

D. selection pressures.

Question 17

The shark (a fish) and the dolphin (a mammal) are an example of

A. convergent evolution.

B. allopatric speciation.

C. divergent evolution.

D. species radiation.

Question 18

During a volcanic eruption molten material called magma comes out of the volcano, cools and solidifies on the surface of the earth forming basalt. Volcanic ash, also from the eruption, is deposited near the basalt and may contain well-preserved fossils.

The surrounding basalt can be useful to date fossils in the strata formed by the ash because

A. eruption dates of volcanoes are known from historical data.

B. organic remains are baked and preserved in the basalt.

C. radioactive elements within the basalt can be accurately dated.

D. the basalt may contain an index fossil.

Question 19

There is little fossil evidence of the earliest forms of life because the organisms

A. decayed quickly in the oxygen-rich atmosphere.

B. did not have hard parts which would fossilise easily.

C. evolved so quickly that they left few remains.

D. lived in water and were not preserved.

Question 20

One section of a polypeptide has the amino acid sequence

Ala – Cys – Lys – Ile – Asn

The codons for these amino acids are

Ala	GCA	GCC	GCG	GCU
Cys	UGC	UGU		
Lys	AAA	AAG		
Ile	AUU	AUC	AUA	
Asn	AAC	AAU		

The sequence of DNA coding for this section of the polypeptide could be

A. CGTACGTTTTATTTG
B. CGTTCGTTTTATTTG
C. CGTACTTTTTACTTG
D. CGAACATTCTATTTT

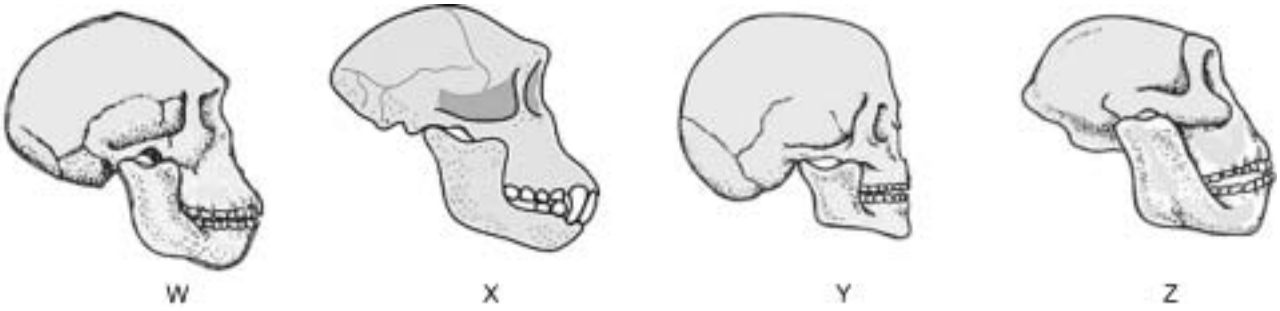
Question 21

Hominids are believed to have evolved in Africa because

A. the oldest hominid fossils have been found in Africa.
B. the most hominid fossils have been found in Africa.
C. monkey fossils were found in Africa.
D. Africa is the oldest continent.

Question 22

Consider the following diagrams of skulls.



The skull most likely to be that of a chimpanzee is

A. W
B. X
C. Y
D. Z

Question 23

There is evidence that *Homo sapiens* and *Homo neanderthalensis* coexisted in Europe more than 30 000 years ago. Both of these species left signs of cultural evolution from this period.

An example of evidence which would show that cultural evolution was occurring in these groups at this time is

A. drawings and carvings on rocks.

B. animal remains close to a *Homo* skeleton.

C. male and female skeletons in the same area.

D. *Homo sapiens* and *Homo neanderthalensis* skeletons in the same area.

Question 24

The following statements (not in correct order) summarise the steps in natural selection.

1. Some individuals are better suited to a particular environment.

2. Over time there is an increase in particular characteristics in the population.

3. There is variation within a population, some of which is genetic.

4. Individuals better suited to the environment are more successful at survival and reproduction.

The order of statements which best describe natural selection are

A. 1, 3, 2, 4

B. 3, 1, 4, 2

C. 2, 3, 1, 4

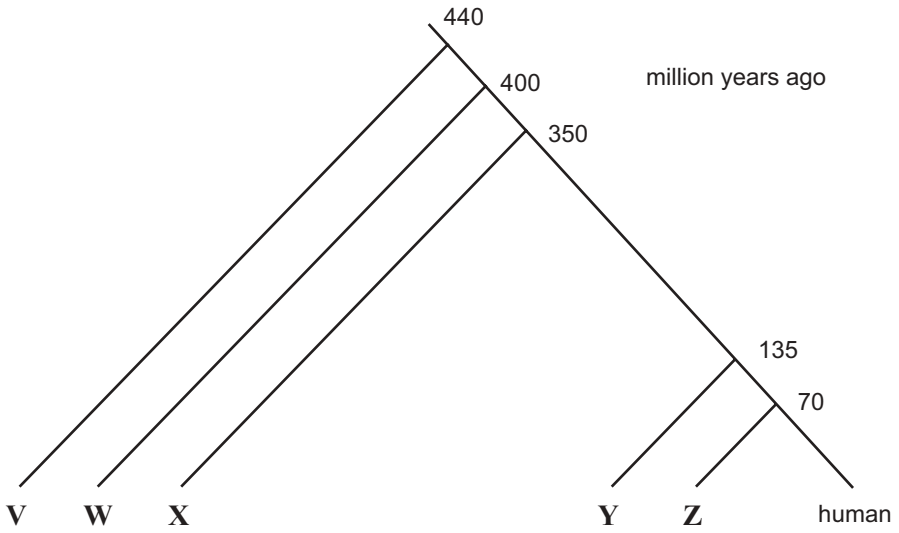
D. 1, 2, 4, 3

Question 25

Comparisons of the amino acid sequences of the α-globin polypeptide have been made between humans and a number of other vertebrates. The number of differences is shown in the table below.

Organism	**shark**	**kangaroo**	**carp**	**cow**	**newt**
amino acid differences in α-globin compared to human	79	27	68	17	62

An evolutionary relationship between these vertebrates was determined and illustrated in the figure below.



Based on the information provided, the correct placement of each animal on the figure to show the evolutionary relationship is

A. **V** = cow, **W** = kangaroo, **X** = newt, **Y** = carp, **Z** = shark

B. **V** = shark, **W** = carp, **X** = newt, **Y** = kangaroo, **Z** = cow

C. **V** = carp, **W** = shark, **X** = kangaroo , **Y** = newt, **Z** = cow

D. **V** = kangaroo, **W** = cow, **X** = newt, **Y** = shark, **Z** = carp

END OF SECTION A
TURN OVER

SECTION B – Short answer questions

Instructions for Section B

Answer this section in pen.

Answer **all** questions in the spaces provided.

Question 1

In humans the presence of a dimple in the chin is dominant.

The first child of a couple, each with a dimple, does not have a dimple but their second child does have a dimple.

a. Use alleles **D** and **d** to show the genotype corresponding to the phenotype of the parents and the child without a dimple.

genotype of parents _____

genotype of child without a dimple _____

1 mark

A plant has two phenotypes, herbicide resistant and herbicide sensitive. A farmer wanted to establish the pattern of inheritance for this trait and performed the following crosses.

Cross	Parents	F_1 (offspring)
1	sensitive x sensitive	all sensitive
2	resistant x resistant	38 resistant and 12 sensitive
3	resistant x sensitive	12 resistant and 14 sensitive
4	resistant x resistant	all resistant

Assume this trait is the result of one gene with two alleles.

b. i. Which one of the crosses, on its own, allows you to conclude which is the dominant phenotype?

_____

ii. Explain your choice in **b.i**.

_____

_____

_____

_____

1 + 1 = 2 marks

c. Use appropriate allelic symbols to show the genotypes of the parents and offspring of cross 3.

2 marks

Coat colour in mice is under the control of a single gene with two alleles. Many crosses between yellow-coated mice and mice with grey coats gave the following results. The mice with grey coats were known to be homozygous.

Parental cross	yellow x grey
First generation	50% yellow : 50% grey

Many crosses were carried out between the first generation yellow mice.

d. What genotypic ratio and phenotypic ratio would we expect to see in the offspring of the cross between the first generation yellow mice? Make sure you indicate the allelic symbols you are using for this gene locus.

2 marks

Scientists performed this cross many times and the result they observed was always a ratio of 2 yellow to 1 grey mouse.

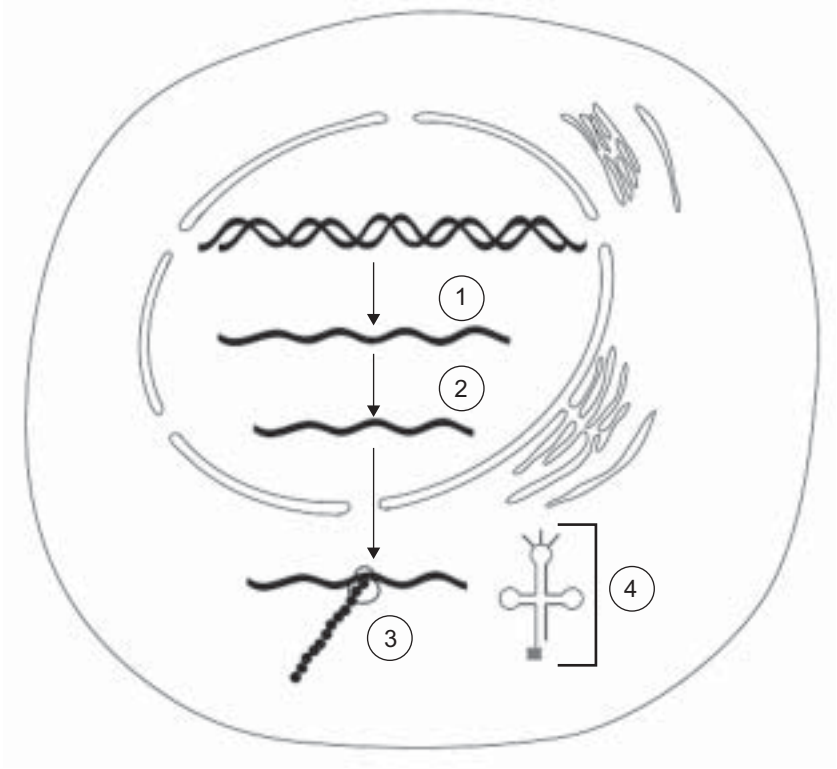
e. How can this result be explained?

1 mark

Total 8 marks

Question 2

The following diagram outlines events associated with the production of a polypeptide chain in a eukaryotic cell.



a. What is the name of the process at step 1?

_____

1 mark

b. **i.** Name the product of step 1.

_____

ii. Outline what occurs at step 2.

_____

_____

_____

_____

1 + 1 = 2 marks

c. Name the event that occurs at structure 3.

_____

1 mark

d. **i.** Name the structure at 4.

_____

ii. Outline the function of the structure you named in **d.i.**

_____

_____

_____

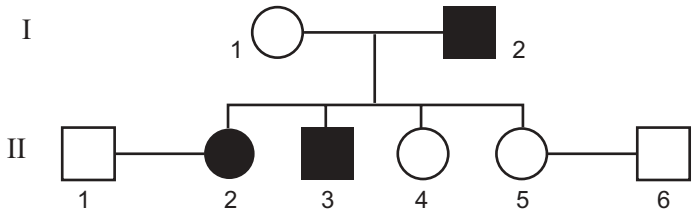
_____

1 + 1 = 2 marks

Total 6 marks

Question 3

Haemophilia is an X-linked recessive condition. The following pedigree shows a portion of a family in which some members have haemophilia. Those on the pedigree with haemophilia are shaded.



a. Use appropriate allele symbols from $\mathbf{X^H}$, $\mathbf{X^h}$ and **Y** to indicate the genotype of each of the following individuals.

I1 _____ and I2 _____

1 mark

b. The couple II1 and II2 have a son. What is the probability that the child has haemophilia?

_____

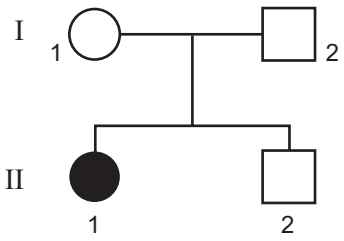
1 mark

c. The couple II5 and II6 have a son. What is the probability that the child has haemophilia?

_____

1 mark

The following pedigree is of a family in which one member (shaded) has an autosomal recessive condition. The alleles of the gene locus involved are **G** and **g**.



d. Give a possible genotype for each of the four members of the family.

I1 _____

I2 _____

II1 _____

II2 _____

2 marks

Total 5 marks

Question 4

a. Describe the appearance of a bacterial plasmid.

1 mark

A bacterial plasmid was modified in the laboratory so that it contained a gene for an enzyme which provided resistance to the antibiotic tetracycline.

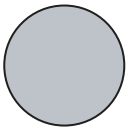
Bacterial cells, which in their natural environment were sensitive to the antibiotic tetracycline, were mixed with the modified plasmid. The bacterial cells were treated so that they could take up the plasmid.

b. What is the name of the process in which a bacterial cell takes up a plasmid and expresses the genes of the plasmid?

1 mark

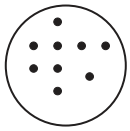
The outcome of an experiment is shown below.

A
bacterial cells only, spread on agar



B
bacterial cells only, spread on agar with tetracycline

C
bacterial cells exposed to the plasmid, spread on agar with tetracycline



With respect to the growth of bacteria the results of plates A and C are shown. On plate A there is a continuous growth of bacteria over the surface of the agar. On plate C the colonies are distinguishable from each other.

c. i. What result would you expect on plate B with respect to the growth of the bacteria?

ii. Explain your answer to **c.i.**

1 + 1 = 2 marks

d. Explain why there is a difference in the way the bacteria have grown on plates A and C.

2 marks

Total 6 marks

Question 5

'CC' for Carbon Copy is the name of the first cloned kitten born in 2001. The nucleus of a cat's egg cell was removed. It was replaced by a nucleus from a somatic cell of a donor female cat. Once development commenced the egg cell was transferred into a surrogate female.

a. What is meant by the term cloning?

1 mark

The diploid number of a cat is 38.

b. **i.** How many chromosomes would have been in the nucleus that was removed from the egg cell?

ii. Is CC male or female? Explain.

1 + 1 = 2 marks

To determine if CC was in fact a true clone, studies were made of specific variable regions in the DNA of the donor, CC and surrogate.

The results are shown in the table.

DNA variable region	Donor DNA (size in base pairs)	CC DNA (size in base pairs)	Surrogate DNA (size in base pairs)
1	164/164	164/164	166/166
2	222/222	222/222	218/218
3	196/198	196/198	194/200
4	154/160	154/160	160/162

c. For each region of DNA there are two values, for example, 164/164. Suggest a reason for this.

1 mark

d. In the case of DNA variable region 4 in the donor DNA, why are the pairs of values different?

1 mark

e. From the data it was concluded that CC was a true clone. Explain the evidence in the table that supports this claim.

1 mark

Total 6 marks

Question 6

Cabbage (*Brassica oleracea*) and radish (*Raphanus sativus*) both have a diploid number of 18. However they do not naturally hybridise with each other.

a. How many chromosomes would be expected in the gametes of the cabbage?

_____

1 mark

In the laboratory, the two species can be forced to mate and produce offspring. The offspring are sterile.

b. **i.** What would be the diploid number of the hybrid?

_____

ii. Explain why the hybrid of the cabbage and radish is sterile.

_____

_____

_____

_____

1 + 1 = 2 marks

An occasional spontaneous event produces a doubling of each chromosome set in the hybrid. The new plants are able to grow and produce fertile offspring.

c. What term is used to describe cells with more than two sets of chromosomes?

_____

1 mark

d. Explain, with reference to the events of meiosis, why the new plants are fertile.

_____

_____

_____

_____

1 mark

Selective breeding has been used to improve the milk yield of cattle herds in Australia.

e. Identify a key difference between selective breeding and random mating in a herd of cattle.

1 mark

f. What is the impact of selective breeding on genetic variability in a herd of cattle?

1 mark

The quality and yield of milk in cattle has been improved by artificial insemination in which semen from a selected bull is used.

g. Explain how the use of artificial insemination may intervene in the evolutionary process.

1 mark

Total 8 marks

Question 7

Organisms can regulate the expression of their genes in a number of ways.

a. Suggest why an organism regulates the expression of its genes.

1 mark

One example in bacteria is the regulation of the expression of a gene which produces an enzyme (enzyme X) involved in the metabolism of the amino acid tryptophan. Enzyme X is only produced when tryptophan is in high concentration. This gene regulation involves several genes. Two of the genes include a gene for the production of enzyme X and an operator gene. If a protein, called a repressor protein, binds to the operator gene, transcription of the gene for enzyme X is stopped. If no repressor protein is bound to the operator, transcription of the gene for enzyme X occurs. A summary of this regulation is shown in Figure 1.

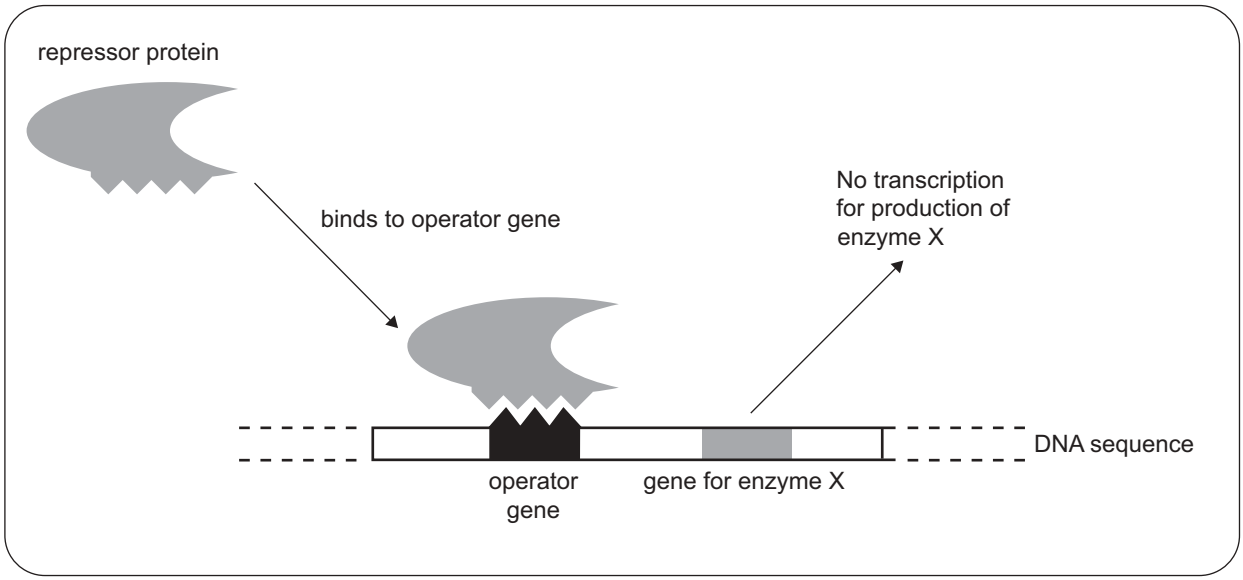


Figure 1

b. The gene coding for enzyme X is not transcribed when the repressor protein binds to the operator gene. What enzyme is prevented from functioning during this binding?

1 mark

When tryptophan binds to the repressor protein, the repressor protein can no longer bind to the operator gene. (See Figure 2.)

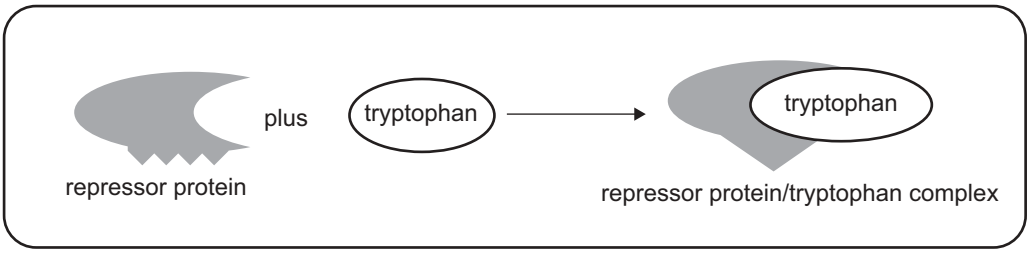


Figure 2

c. When tryptophan binds to the repressor protein what will happen to the production of enzyme X?

_____

1 mark

d. Based on Figure 2, suggest how tryptophan prevents repressor protein function.

_____

_____

_____

_____

1 mark

Total 4 marks

Question 8

The Isthmus of Panama is a narrow strip of land that joins North and South America.

The land bridge formed approximately 3 million years ago.

Snapping shrimps, genus *Alpheus*, can be found on either side of the land bridge. The two groups are phenotypically similar. However when the males and females from either side of the land bridge were brought together they snapped aggressively at each other and would not mate. They are now considered to be two different species.

a. Why is the inability to mate sufficient evidence to call the two groups different species?

1 mark

b. What type of speciation has occurred in the snapping shrimp?

1 mark

c. Explain how the differences between the shrimp on either side of the land bridge could have arisen.

2 marks

Thylacinus cyanocephalus (Tasmanian tiger) was the largest living marsupial carnivore in Australia at the time of European settlement. The thylacine is believed to have become extinct on 7 September 1936 when the last captive thylacine died in the Hobart Zoo.

There are thylacine fossils found in Tasmania and mainland Australia, but when Europeans arrived in Australia living thylacines were only found in Tasmania.

d. Suggest why thylacines were not found in mainland Australia at the time of European settlement.

1 mark

Since 1936 there have been many reported sightings of thylacines in Tasmania and along the southern coast of Victoria.

e. Explain why scientists still believe thylacines are extinct.

1 mark

The dingo is a eutherian mammal and the thylacine is a marsupial mammal. Scientists regard these two carnivores as an example of convergent evolution.

f. Explain why scientists would regard the thylacine and the dingo as an example of convergent evolution.

1 mark

Total 7 marks

END OF QUESTION AND ANSWER BOOK