

STUDENT:

TEACHER:

CSE TEST – OCTOBER 2009

YEAR 12 – BIOLOGY

Written test 2

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

Section	Number of questions	Number of questions to be answered	Number of marks	Suggested time (minutes)
A	25	25	25	30
B	7	7	50	60
Total			75	90

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

Materials

- Question and answer book of 22 pages.
- Detachable answer sheet for multiple choice questions. You may remove this during reading time.

Instructions

- Write your **name** in the space provided above **and** on the multiple choice answer sheet.
- All written responses must be in English.

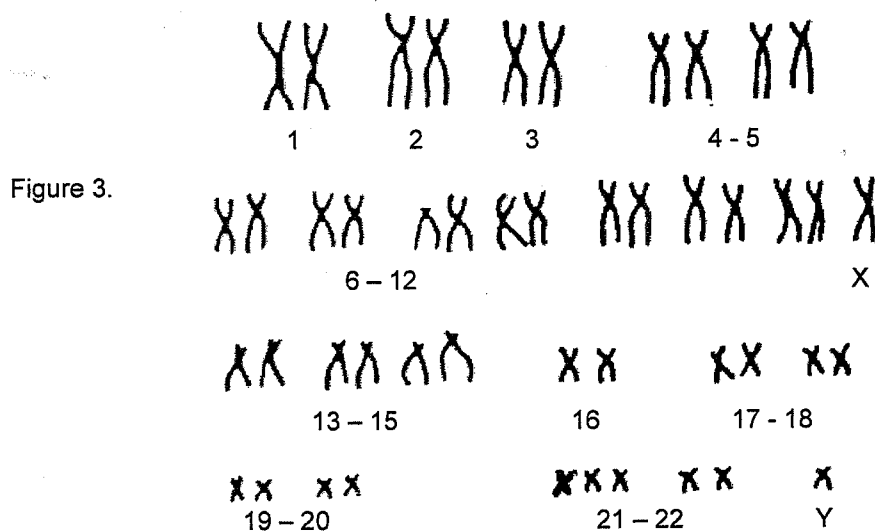
At the end of the examination

- 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 other electronic communication devices into the test room.

Information for Questions 3 and 4

The following is a karyotype of a boy with Down's syndrome caused by the presence of an extra chromosome 21.



Question 3

In this karyotype the number of homologous pairs of chromosomes is

- A. 46
- B. 21
- C. 22
- D. 23

Question 4

This condition shown in Figure 3 arises from non-disjunction during cell division. Which of the following is correct?

	Type of cell division	Stage when error occurs	Type of cell resulting from cell division
A.	Mitosis	Metaphase	Somatic
B.	Meiosis	Metaphase I	Somatic
C.	Mitosis	Anaphase	Gamete
D.	Meiosis	Anaphase II	Gamete

Question 5

In certain varieties of wheat, *Triticum vulgare*, the colour of the grain is controlled by three genes. Each gene has two alleles and the resulting phenotypes range from dark red through five shades of pink to white.

This is an example of

- A. polygenic inheritance
- B. multiple alleles
- C. discontinuous variation
- D. codominance

Information for Questions 8 and 9

In corn, the allele for coloured kernel (C) is dominant to colourless (c) and that for full kernel (F) is dominant to shrunken kernel (f). A cross was carried out (as shown in the following diagram) in which coloured full kernel plants of genotype CcFf were crossed with colourless plants with shrunken kernels.

When:

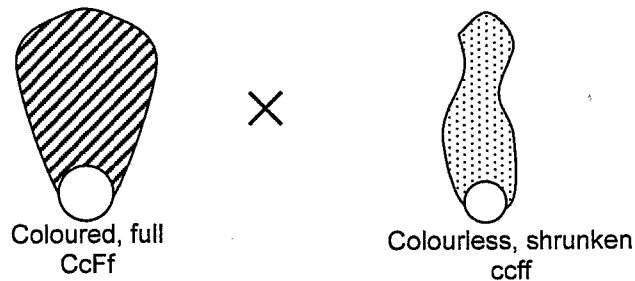


Figure 4

The following results were obtained:

Results:

Coloured Full	Coloured Shrunken	Colourless Full	Colourless Shrunken
47%	5%	3%	45%

Question 8

The proportions obtained in the results

- A. could be predicted by Mendel's Law of Independent Assortment.
- B. suggest no crossing-over occurred during meiosis.
- C. suggest the two gene loci are on the same chromosome.
- D. suggest the two gene loci are inherited independently.

Question 9

The genotype of the coloured, full kernel plants used in the cross in Figure 4 should be written as

- A. $\frac{Cc}{Ff}$
- B. $\frac{CF}{cf}$
- C. $\frac{Cf}{cF}$
- D. $\frac{CC}{ff}$

Question 10

In birds, sex is determined in the opposite way to that in humans - males have ZZ sex chromosomes and females have ZW sex chromosomes. For a trait inherited as a sex-linked recessive

- A. a male bird with the trait could not pass the allele of the gene to his male offspring.
- B. affected female birds must have an affected mother.
- C. the female offspring of affected male birds must be carriers.
- D. the trait may skip a generation and be passed on from a grandfather bird to his grandson offspring.

Question 15

Figure 4 shows the two-dimensional shape of a molecule of transfer-RNA.

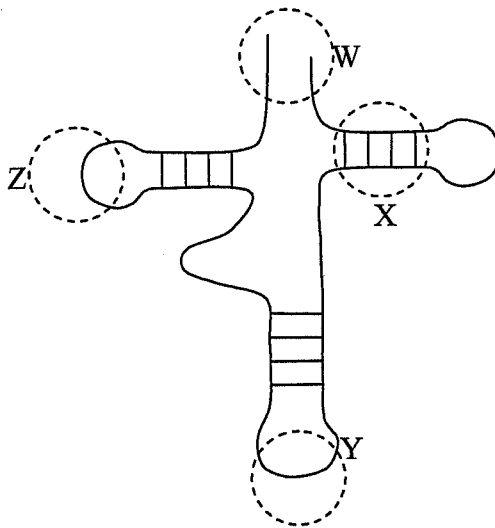


Figure 4

Which of the following is correct for transfer-RNA?

- A. Area W is the attachment site for any three of the 20 different amino acids.
- B. Area X shows peptide bonding between the two strands.
- C. Area Y is the anticodon which is unique to each t-RNA type.
- D. Area Z is circular plasmid RNA.

Question 16

Fossils of crocodiles very similar to those living today are found in Cretaceous rocks 80 million years old. Modern crocodiles are 'living fossils', remnants of the age of dinosaurs. The best explanation of why they exist virtually unchanged is that

- A. their habitat has not changed markedly.
- B. they are well adapted and need not change.
- C. they live for so long that natural selection does not act on them.
- D. dinosaurs stopped evolving 60 million years ago and most died out.

Question 17

Of all the millions of fossils that have been collected, the greatest number came from rocks that were originally formed in lakes or shallow seas.

This is probably because

- A. life existed on land for a very long time before migrating to the sea.
- B. marine life is far more varied than terrestrial life.
- C. most marine organisms have hard shells which fossilise readily.
- D. burial of dead organisms takes place faster in water than on land.

Information for Questions 22 and 23

Nucleotide sequencing has been carried out on mitochondrial DNA, chloroplast DNA and nuclear DNA of various organisms. The sequence of bases in a piece of DNA can be used to discover the relationships of organisms to one another.

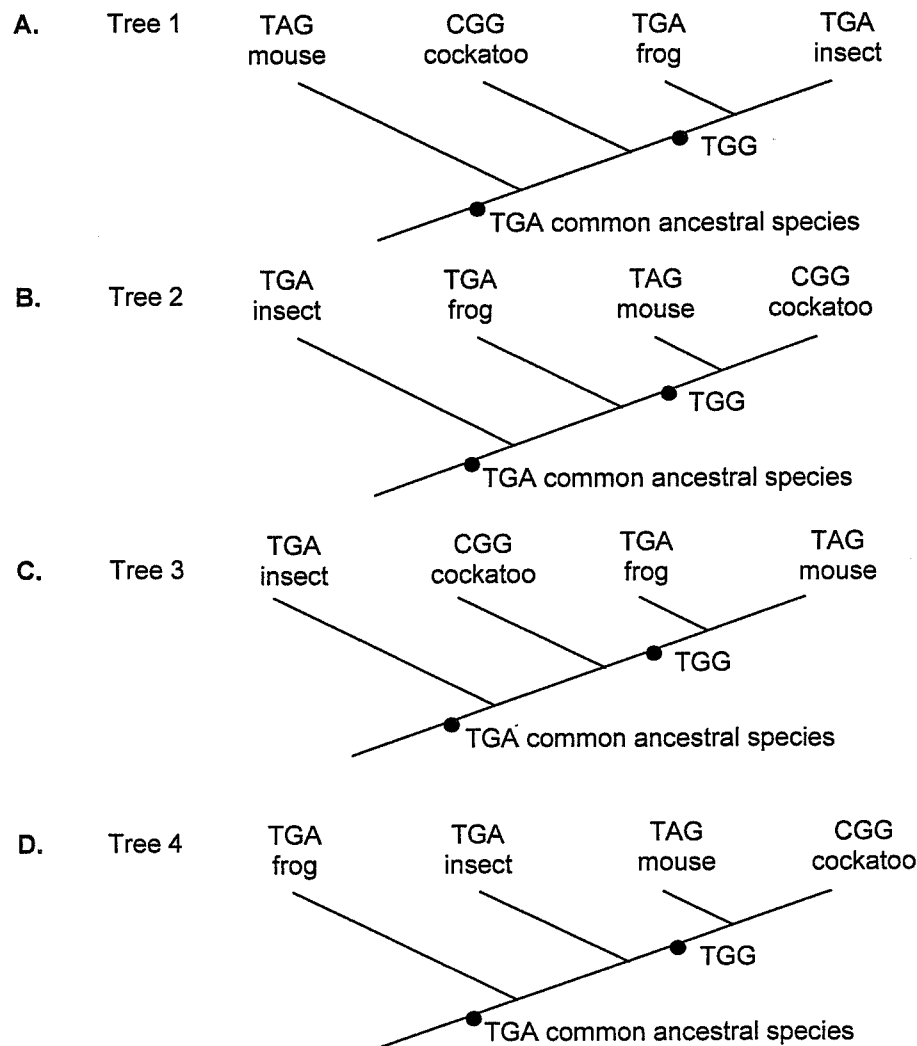
Question 22

Mitochondrial DNA is an important tool for tracing the evolutionary history of a species as it

- A. is structurally different to nuclear DNA because it is single – stranded.
- B. is inherited from the father only so that all offspring receive just one kind of mtDNA.
- C. is passed down from parent to offspring with different combinations of genes resulting from recombination that occurs during meiosis.
- D. undergoes mutation over time and can be used to study populations that have been separated for long periods and so they accumulate different mutations in their mtDNA.

Question 23

Nucleotide sequencing was used to determine three nucleotide positions in the 28 S ribosomal gene of three vertebrates - mouse, cockatoo and frog; and one invertebrate - an insect. This information was then used to determine the phylogenetic tree to show the evolutionary relationships of the four organisms. The phylogenetic tree that best fits the DNA data is



SECTION B – Short answer questions

Instructions for Section B

Answer this section in **pen**.

Answer all questions in the spaces provided.

Question 1

In mice, black colour (B) is dominant to white (b). At a different locus, an allele of another gene (A) produces a band of yellow just below each hair tip in mice with black hair. This gives them a frosted silvery appearance called agouti. Expression of the allele (a) results in a solid coat (no band on the hair).

- a. What is the meaning of the term locus?

1 mark

- b. The alleles of these two gene loci are inherited independently. On the following diagram mark with an X, and put the letters for the alleles in the correct positions on the chromosomes, for a mouse that is heterozygous at both gene loci (B and A).

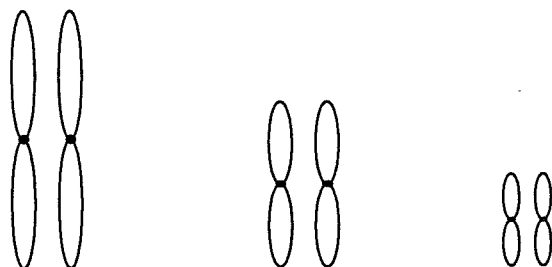


Figure 6

1 mark

- c. If mice that are heterozygous at both gene loci are crossed, what is the expected phenotypic ratio of their offspring? Show all working in the space provided.

3 marks

Question 2

In a recent article it was reported that 'health may soon be just a matter of a bar code'. American researchers are developing a technique which will make it possible to read an individual's entire genetic makeup in record time. It will make it possible to determine the six billion letters that form an individual's biological blueprint in less than an hour!

- a. i. What is the 'bar code' of an individual called?

1 mark

- ii. There are six billion letters that form an individual's biological blueprint. Draw and label one of the subunits that make up their genetic material.

2 marks

The technique proposed involves extracting the genetic material from an individual's cells and then treating it in various steps to produce a pattern which will identify the letters and their positions.

The stages of the treatment involve the following steps:

- b. i. Heating the extracted genetic material. Why is this done?

1 mark

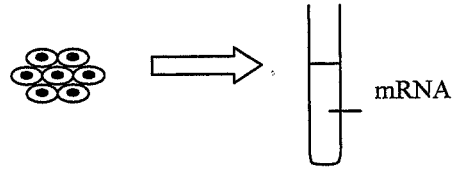
- ii. Cutting the genetic material into segments of varying lengths using a particular chemical. What is this chemical called and where will it cut the genetic material?

2 marks

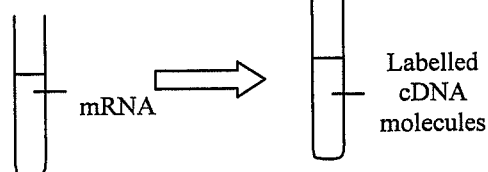
Question 3

A new technique of DNA Microarray Assay can be used to test thousands of genes simultaneously to determine which ones are expressed in a particular tissue. The technique involves the following steps:

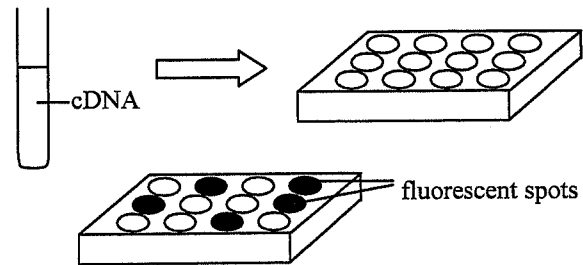
1. Isolate messenger RNA (mRNA) from cells.



2. Make copy DNA (cDNA) from mRNA using fluorescent-labelled nucleotides.



3. Apply cDNA to a microarray (a microscope slide on which copies of single-stranded DNA of the organism's genes are fixed in individual spots). cDNA hybridizes with any complementary DNA.



4. Rinse off excess cDNA and examine for fluorescent spots – each spot represents a gene expressed in the tissue.

Figure 7

- a. How is cDNA made from mRNA? Name any special chemicals needed for the process to occur.

2 marks

- b. Why is single-stranded cDNA used in this Microarray Assay technique instead of double stranded DNA?

1 mark

The species concept is often explained in terms of the allele frequencies in the different populations of one species compared to the allele frequencies in the population of a different species. The terms used include gene pool and gene flow.

- b. Draw and label a concept map for several different populations of one species and one population of a different species to show the relationship between these two terms.

2 marks

Recent studies of the blood proteins of ringtail possums from populations along the eastern coast show similarities that support the view that the populations are not different enough to be called different species.

- c. i. In these studies, what differences could be detected?

1 mark

- ii. Explain another modern method of biochemical analysis which could be used to determine if ringtail possums are one or several different species.

2 marks

Total: 6 marks

Question 6

Madagascar, the world's fourth largest island, is located off the southeastern coast of Africa, as shown on the following map.

Together with the tiny Comoro islands it is the world's only present-day native habitat to lemurs. They are small primates known as "prosimians" resembling ancient primates. They have no prehensile tail, but they do have long, wet noses; good vision; and opposable thumbs and big toes.

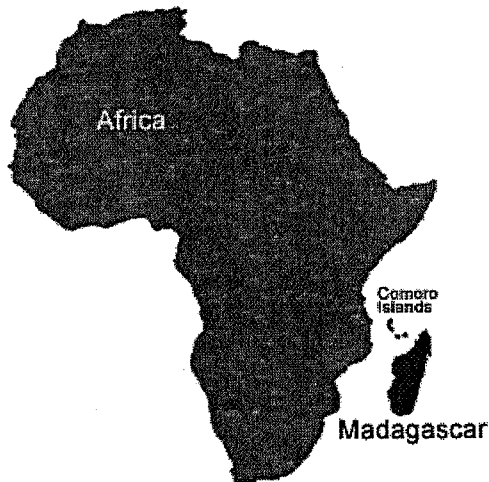


Figure 9



Figure 10

The first lemur-like primates in the fossil record appeared roughly 60 million years ago in mainland Africa. Now living lemurs only exist on the isolated islands of Madagascar and Comoro.

- a. Suggest how these islands became isolated from the mainland.

1 mark

In the past much of the island of Madagascar was covered by forest but up to 80% has now been destroyed. The terrain on the island of Madagascar is extremely diverse, ranging from coastal beaches to grasslands, deserts and mountains. Today 33 different species of lemurs are found on the island.

- b. i. What type of evolution has resulted in this diverse group of lemurs?

1 mark

The upper primates reduced the number of lemur species quickly and drastically by at least fifteen species. Currently all lemur species are endangered.

- d. Suggest two reasons why the number of lemur species has declined since the arrival of these upper primates.

1.

2.

2 marks

Total: 11 marks

Question 7

Scientists may soon be 'tooth-making fairies' as whole teeth may be the first complex organs regenerated from stem cells. Stem cells will be harvested from the dental pulp inside the tooth. People would be encouraged to 'bank' their wisdom and baby teeth in the same way as umbilical cord blood is stored.

- a. What are stem cells?

1 mark

- b. Why would people want to 'bank' their baby and wisdom teeth?

1 mark

One difficulty in regenerating whole teeth is that adult stem cells from dental pulp cannot make the outer layer of tooth enamel. Embryonic stem cells would need to be used as they have the potential to generate all cell types in the body.

- c. What term is used for stem cells that can give rise to all cell types?

1 mark

CSE TEST – OCTOBER 2009

YEAR 12 – BIOLOGY

Written test 2

ANSWERS & SOLUTIONS BOOK

SECTION A – Multiple choice questions (25 marks)

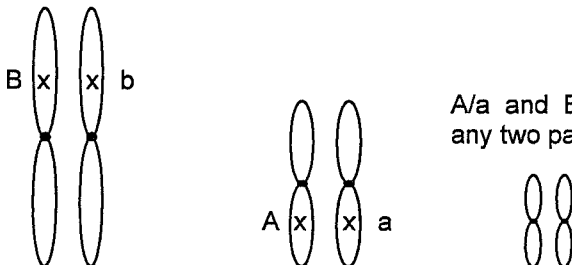
1	A	6	C	11	B	16	A	21	B
2	D	7	A	12	D	17	D	22	D
3	B	8	C	13	C	18	C	23	B
4	D	9	B	14	B	19	A	24	B
5	A	10	D	15	C	20	D	25	C

SECTION B – Short Answer Questions (50 marks)

Question 1 (9 marks)

- a. The locus is the position of a gene on a chromosome 1 mark

b.



A/a and B/b alleles can be on any two pairs of chromosomes.

1 mark

- c. Parents: AaBb x AaBb
Gametes: AB, Ab, aB, ab AB, Ab, aB, ab

	AB	Ab	aB	ab
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb

Offspring phenotypic ratio – 9 agouti: 3 black: 4 white

Parents and gametes (1 mark)

Cross – working (1 mark)

Ratio answer (1 mark) 3 marks

- d. i. AABB, AaBB, AABb, AaBb 2 marks
- d. ii. Use a test cross (1 mark)
Cross the agouti – coloured mouse (A.B.) with a homozygous recessive mouse (aabb) (1 mark) 2 marks

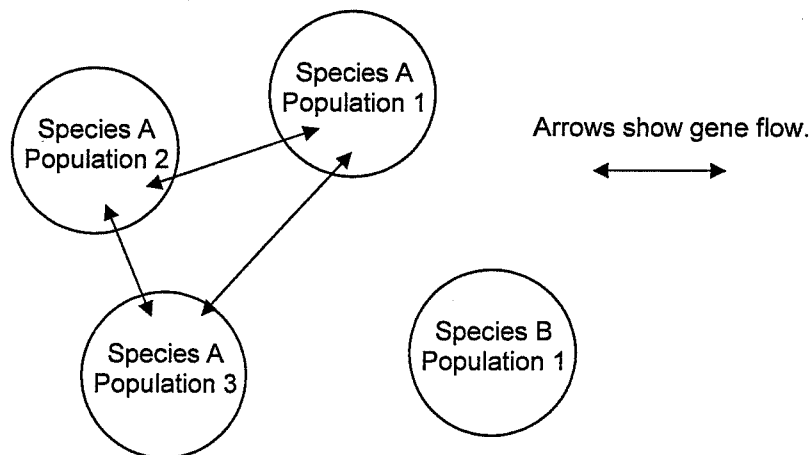
Question 3 (6 marks)

- a. Reverse transcriptase is the enzyme needed to initiate cDNA formation. (1 mark)
Using single-stranded mRNA as a template, DNA nucleotides, and the reverse transcriptase enzyme, single-stranded cDNA can be synthesised. (1 mark) **2 marks**
- b. The spots on the microarray slide contain single-stranded DNA from the organism. Therefore single-stranded cDNA must be added so it will hybridize/pair up with it. **1 mark**
- c. Gene expression involves the activation of a particular gene (1 mark)
resulting in the synthesis of a specific polypeptide or protein (via transcription and translation) (1 mark) **2 marks**
- d. Beneficial for early detection of cancer, the tissue it is affecting and the degree of its activity.
or
To understand what might be the trigger to make these breast cancer genes "turn on"/be activated.
or
Any other reasonable suggestion. **1 mark**

Question 4 (6 marks)

- a. A species is a group of similar organisms that can interbreed under natural conditions and produce viable fertile offspring. **1 mark**

b.



Students must indicate three gene pools of the same species in three different locations with gene flow occurring between them. (1 mark)

A separate gene pool for a different species must be shown with no gene flow with the other three species. (1 mark)

2 marks

- c. i. Differences in the amino acid sequences of the blood proteins. **1 mark**
- c. ii. DNA hybridization. (½ mark)
Heat and separate the DNA of two different types of possums. Mix the single-stranded DNA obtained together and determine the percentage of base-pairing. (1 mark)
The greater the percentage of hybridization, the closer the genetic relationship of the two types of possum. (½ mark) **2 marks**

Question 7 (4 marks)

- a. Undifferentiated or precursor cells that can specialise to become specific cell types. **1 mark**
- b. The pulp from these baby and wisdom teeth could be used to obtain stem cells that could be used in the future to generate teeth to replace lost or damaged teeth with no rejection problems. **1 mark**
- c. Totipotent. **1 mark**
- d. Many people believe that embryos are living and therefore destruction of them is death of a potential person.
or
Issue of therapeutic cloning where embryos are created solely for obtaining stem cells and are then destroyed.
or
Any other reasonable suggestion. **1 mark**

END OF SOLUTIONS