

Student Name: _____

BIOLOGY

Unit 4 – Written examination 2



2007 Trial Examination

Reading Time: 15 minutes
Writing Time: 1 hour and 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A	25	25	25
B	5	5	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 permitted in this examination.

Materials supplied

- Question and answer book of 20 pages.

Instructions

- Print your name in the space provided on the top of this page.
- All written responses must be in English.

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

SECTION A- Multiple-choice questions

Instructions for Section A

Answer **all** questions.

Choose the response that is **correct** for the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks are **not** deducted for incorrect answers.

If more than 1 answer is completed for any question, no mark will be given.

Question 1

The cell cycle is the sequence of events that occur between one cell division and the next. It consists of several stages. Which stage do eukaryotic cells spend the most time in?

- A. Interphase
- B. Prophase
- C. Metaphase
- D. anaphase

Question 2

The diagram below shows a replicated chromosome taken from a cell during metaphase of meiosis 1. It consists of 2 chromatids joined by a centromere.



It would be reasonable to conclude:

- A. both chromatids will end up in the same daughter cell
- B. both chromatids have different bases
- C. each chromatid consists of a single DNA molecule
- D. each chromatid consists of a single RNA molecule

Question 3

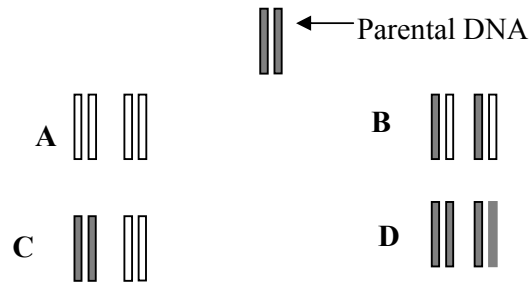
The number of chromosomes normally found in the nucleus of a human muscle cell after cell division would be:

- A. 23
- B. 46
- C. 69
- D. 92

SECTION A - continued

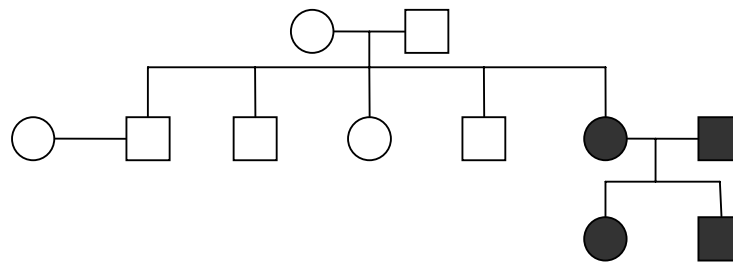
Question 4

The replication of DNA is semi-conservative. The diagram below shows a parental DNA molecule and four diagrams of replicated DNA. Identify which of these diagrams correctly shows semiconservative replication of DNA.



The following information relates to Questions 5 and 6.

The pedigree chart below shows the inheritance pattern for black hair dysplasia in dogs across 3 generations.



Question 5

Based on this pedigree chart, the mode of inheritance for this condition is most likely to be:

- A. autosomal dominant
- B. X-linked recessive
- C. X-linked dominant
- D. autosomal recessive

Question 6

Which of the following conclusions can be made from the data in the pedigree chart?

- A. both dogs in the parental generation are homozygous
- B. at least one of the dogs in the parental generation are homozygous
- C. both dogs in the parental generation are heterozygous
- D. one of the dogs in the parental generation is homozygous, the other is heterozygous

SECTION A – continued
TURN OVER

Question 7

A species of chickens have two alleles for feather colour. One allele is for the inheritance of black feathers and the other for the inheritance of white feathers. If a pure-breeding white chicken is crossed with a pure-breeding black chicken all of the F1 generation are charcoal grey and referred to as Andalusian Blue chickens. This type of inheritance is:

- A. polygenic
- B. autosomal recessive
- C. intermediate inheritance
- D. X linked recessive

Use the following information to answer Questions 8 and 9.

In pea plants, one gene controls seed colour, while another gene controls the shape of the seed. The two genes are not linked. The alleles for these two genes are as follows:

G – Green seed R – Round seed
g – Yellow seed r – Wrinkled seed

Question 8

A geneticist carried out the following cross:

GgRR x Ggrr

The chance of producing a plant from this cross which is heterozygous for both traits is:

- A. 1/2
- B. 1/4
- C. 1/16
- D. 9/16

Question 9

The biologist then carried out a test cross with the heterozygote offspring. The ratio of phenotypes from this cross would be:

- A. 9:3:3:1
- B. 1:2:1
- C. 3:1
- D. 1:1:1:1

SECTION A - continued

Question 10

All of the organelles were removed from the cytoplasm of a plant cell and tested for the presence of DNA. The results are shown below.

Organelle	DNA
A	Absent
B	Present
C	Absent
D	Present

Which of the following deductions is most likely to be correct?

- A. The results for B and D are contaminated.
- B. Organelle A is the nucleus
- C. Organelle D is a mitochondrion
- D. Organelle C is a chloroplast

Question 11

Several cells were taken from a plant and the amount of DNA in each was assessed. The results are shown below.

Cell	Amount of DNA (arbitrary units)
A	4.75
B	2.48
C	4.92
D	4.87

Which of these cells is most likely to be the nucleus from a pollen grain?

- A. Cell A
- B. Cell B
- C. Cell C
- D. Cell D

Question 12

Which of the following triplets could not be found on a DNA molecule?

- A. TCG
- B. CAG
- C. CCG
- D. CGU

SECTION A – continued
TURN OVER

Question 13

A sequence of three nucleotides in a triplet provides the code for a particular amino acid. Combinations of three of the letters A, C, G and T are used to represent triplets in DNA, e.g. CGA, TGA, and TGG. Each letter represents:

- A. each of the different three parts of the nucleotide – one a sugar, one a phosphate and one a nitrogenous base
- B. each of the different nitrogenous bases that can be found in a nucleotide
- C. each of the different phosphates that can be found in a nucleotide
- D. each of the different types of sugars that can be found in a nucleotide

Question 14

The genetic code is described as redundant because:

- A. there is more than one codon for most of the amino acids
- B. almost all organisms follow the same code for building proteins
- C. there are both start and stop codons
- D. DNA always contains the same 4 bases

Question 15

A man is born with the karyotype 47, XYY. The most likely explanation for this is:

- A. non-disjunction during meiosis in his father
- B. non-disjunction during mitosis in his father
- C. non-disjunction during meiosis in his mother
- D. non-disjunction during mitosis in his mother

Question 16

Protein synthesis occurs in stages. Some of these stages are listed below:

1. mRNA is read by a ribosome
2. DNA is used as a template to produce mRNA
3. peptide bonds form between amino acids in the growing polypeptide chain
4. tRNA brings amino acids from the cytosol to the ribosome.

The order these stages occur in is:

- A. 1,2,3,4
- B. 1,3,2,4
- C. 2,1,4,3
- D. 2,4,1,3

SECTION A - continued

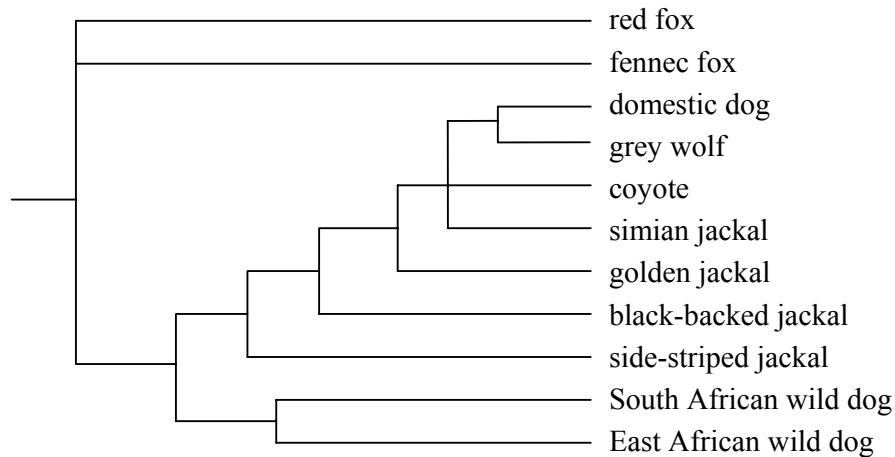
Question 17

The process of locating a particular sequence of DNA on a specific chromosome involves the use of:

- A. probes
- B. primers
- C. plasmids
- D. promoters

Question 18

The phylogenetic tree below shows the evolutionary history of some members of the dog family.



According to the tree, the two least-related species are:

- A. the black-backed jackal and the golden jackal
- B. the East African wild dog and the South African wild dog
- C. the grey wolf and the domestic dog
- D. the domestic dog and the simian jackal

Question 19

There has been found to be a comparatively high degree of polydactyly (having extra fingers) and dwarfism in the Amish population. Amish people are descended from a small group of people of Swiss German origin who immigrated to America during the 18th century. This is an example of:

- A. genetic conservation
- B. natural selection
- C. gene flow
- D. the founder effect

**SECTION A – continued
TURN OVER**

Question 20

The half-life of radioactive elements can be used to determine the age of fossils. Uranium-235 has a half life of approximately 700 million years. If the rock surrounding a fossil was found to have $1/64^{\text{th}}$ of the original amount of uranium-235, then it could be concluded that the age of the fossil is approximately:

- A. 700 million years
- B. 10 million years
- C. 42000 million years
- D. 25000 million years

Question 21

Immunology can be used to indirectly estimate the extent of phylogeny between different species.

A scientist wishes to establish the extent of similarity between humans and several other primates. A sample of human blood is injected into a rabbit, which then produces antibodies to human serum. The antibodies were then extracted and placed into several test tubes.

Blood samples were taken from the species being compared and reacted with the antibodies. If the antibodies recognise the proteins in the samples, they will form a complex with the protein antigens and precipitate out of the solution.

The chart below identifies which serum each test tube holds and the percentage similarity of the species genome to the human genome.

Test Tube	Organism	% Genome similarity
A	Western Gorilla	98.0
B	Bonobo	98.6
C	Orang Utan	94.8
D	Gibbon	92.3

Use this information to establish which test tube would contain the greatest amount of precipitate.

- A. Tube A
- B. Tube B
- C. Tube C
- D. Tube D

Question 22

Dolphins and sharks live in a similar environment and appear to be similar species. Dolphins are mammals and sharks are fish. Both species have a similarly streamlined shape and fin structure. These similar structures are an example of:

- A. analogous structures
- B. homologous structures
- C. speciation
- D. genetic drift

SECTION A - continued

Question 23

An increasing degree of bipedalism in hominid species has been accompanied by significant anatomical changes. Which of the following is an example of skeletal changes that would indicate an individual was bipedal?

- A. decreased carrying angle of the thigh bone
- B. a straight spine column
- C. a lack of supraorbital brow ridges
- D. foramen magnum is further forward

Question 24

Homo floresiensis is the name given to a new species in the Homo genus. In 2003, bones were discovered in Ling Bua Cave, Flores. Scientists often search for fossils and remains in caves as they have been proven to be a good source of fossils and other remains in the past. Which of the following reasons does not explain why caves are a good site to search for fossils?

- A. remains in caves are not subjected to weather
- B. remains in caves are more protected from scavengers
- C. caves are humid promoting rapid bacterial decay
- D. sedimentation is rapid, covering the remains

Question 25

Outcomes of cultural evolution in the genus Homo include the following, with the exception of:

- A. the first use of shaped stone objects as tools
- B. the cultivation of crops
- C. the use of written language
- D. the herding of animals.

**END OF SECTION A
TURN OVER**

SECTION B- Short-answer questions

Instructions for Section B
Answer all questions in the spaces provided.

Question 1

Chondrodystrophy is an autosomal recessive condition in turkeys. It is governed by a single gene with 2 alleles.

Affected embryos die approximately 16 days after fertilisation so they do not survive long enough to hatch.

- a. Write appropriate symbols for both alleles.

1 mark

- b. Two turkeys that are heterozygous for the condition are crossed. Show all of your working to determine the phenotypic and genotypic ratios of the offspring.

3 marks

SECTION B - Question 1- continued

A farmer wishes to establish a flock of turkeys that will not inherit the allele for chondrodystrophy, but is worried that his prize gobbler (male turkey) carries the recessive allele.

- c. A test cross is usually performed to determine if an individual is homozygous or heterozygous. Explain why a normal test cross could not be done in this case.

2 marks

- d. It is still possible to attempt a genetic cross to establish the genotype of the gobbler. Identify the genotype of the hen the farmer would need to use and explain why the hen would need to have that genotype.

2 marks

- e. The gobbler and hen were mated and the hen laid 18 eggs, which the farmer placed into an incubator. What results would support the farmer's suspicion that the gobbler is heterozygous? Explain your answer.

2 marks

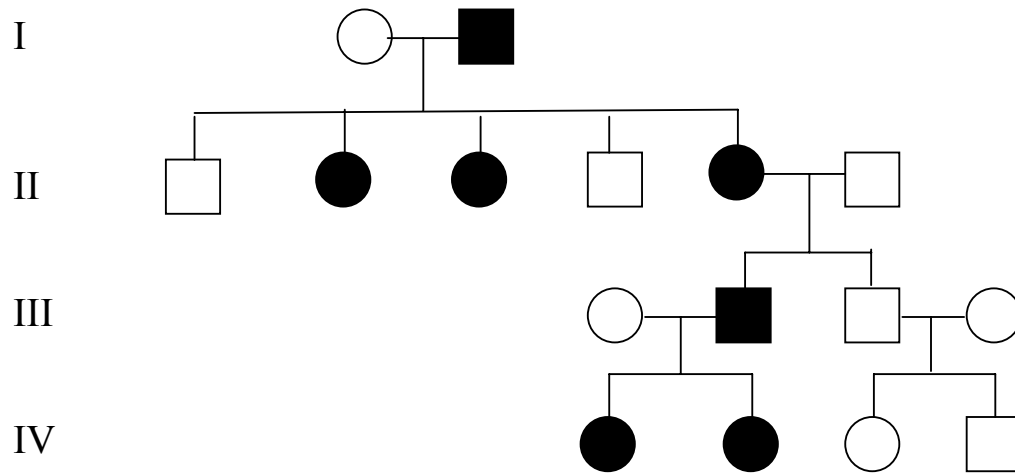
Total 10 marks

SECTION B – continued

TURN OVER

Question 2

The pedigree chart below shows the pattern of inheritance for vitamin D-resistant rickets in a family over four generations.



- a. Identify the mode of inheritance for this condition. Use the data from the pedigree chart to support your answer.

2 marks

- b. Explain why individual III-2 is affected, while his brother, individual III-3 is unaffected.

2 marks

SECTION B-Question 2-continued

- c. If individual IV-1 marries an unaffected male, what is the chance that they will have an affected son?

1 mark

- d. What is the chance that this couple will have an affected daughter?

1 mark
Total 6 marks

SECTION B-continued
TURN OVER

Question 3

Thalassaemia is a genetically inherited condition that usually appears in infancy or early childhood. The inheritance of this condition is controlled by a single gene.

A person with this condition lacks the ability to produce normal haemoglobin. It is often also characterised by severe anaemia, bone deformity and enlargement of essential organs including the heart, liver and spleen.

The table below shows the anticodons that are responsible for transporting a specific amino acid from the cytosol to the ribosome.

Amino Acid	tRNA code
(ala)	CGG
(thr)	UGA
(leu)	GAC
(trp)	ACC
(gly)	CCG
(lys)	UUC
(val)	CAG
(asn)	UUG
(his)	GUG
Stop	AUU
Stop	AUC

The following table shows the DNA, mRNA and amino acid sequences for a person affected by thalassaemia.

DNA	TGA	CGG	GAC	ACC	CCG	ATC
mRNA	ACU	GCC	CUG	UGG	GGC	UAG
Amino Acid	Thr	Ala	Leu	Trp	Gly	Stop

- a. The table below shows the amino acid sequence of a person unaffected by thalassaemia. Use the anticodon table provided to assist you to ascertain the tRNA, mRNA and DNA sequence of the unaffected individual.

DNA							
mRNA							
tRNA							
Amino Acid	Thr	Ala	Leu	Trp	Gly	Lys	Val

3 marks

SECTION B-Question 3-continued

- b. Use the information to establish the type of mutation that causes thalassaemia and explain your answer.

2 marks

A scientist wishes to compare both proteins, so they decide to cut a copy of each gene and amplify it prior to cloning the genes.

- c. Identify the process of artificial DNA amplification.

1 mark

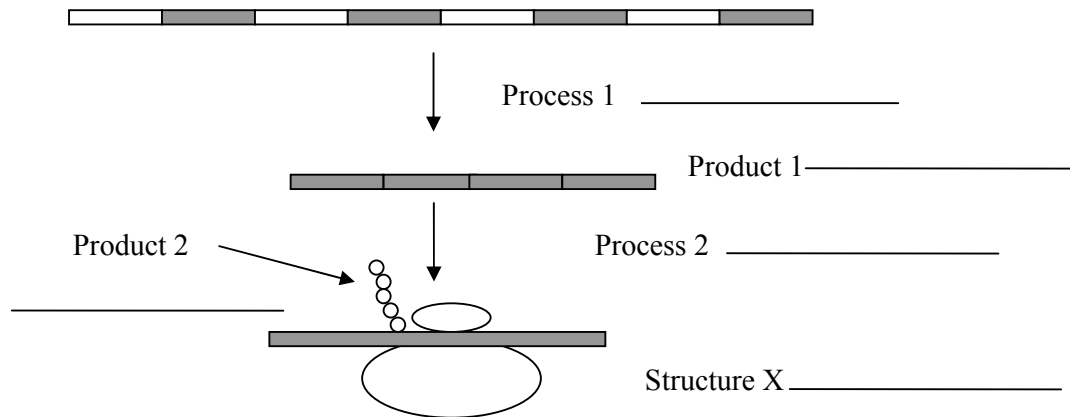
- d. The genes of interest and the plasmids they will be inserted into are cut with “molecular shears”. What is the correct term for these “molecular shears”?

1 mark

- e. What term is used to describe plasmids that have foreign DNA spliced into them?

1 mark

- f. The diagram below shows the stages that occur from the gene to the polypeptide product. Complete the labels on the diagram.



3 marks

SECTION B-Question 3-continued
TURN OVER

g. What do the white areas on the DNA represent?

1 mark

The plasmids containing each type of gene were kept separate from each other during the entire process and were designated Group A and Group B.

The Group A plasmids produced a polypeptide 287 amino acids long and the Group B plasmids produced a polypeptide 351 amino acids long.

h. Which group of plasmids contained the gene taken from a person with thalassaemia? Justify your answer.

2 marks

i. Gel electrophoresis is a technique that allows proteins and other substances to be separated. In the space below draw and label a diagram showing the separation of proteins produced by the Group A plasmids and the Group B plasmids.

2 marks
Total 16 marks

SECTION B-continued

Question 4

The pictures below are of 2 different animals. The animal on the left is the spiny anteater; *Tachyglossus aculeatus*. It is found in Australia and Papua New Guinea. The spiny anteater is a marsupial which grows to about 30cm in length and is covered with course fur and spines. The animal on the right is the giant anteater *Myrmecophaga tridactyla*. It is found in the northern areas of South America and in Central America. It is a mammal that grows six to eight feet in length and is covered with short fur.



a. What term would be used to describe the evolution of these 2 organisms?

_____ 1 mark

b. These two organisms have many structural features in common. Identify two of them.

_____ 2 marks

c. Would these features be analogous or homologous? Explain your answer.

_____ 2 marks

**SECTION B-Question 4-continued
TURN OVER**

- d. The extent of genetic similarity between these 2 species can be determined using mitochondrial DNA. Explain why mitochondrial DNA is used to establish ancestry rather than nuclear DNA.

2 marks

Hawthorn trees grow throughout North America and they produce a small fruit which is eaten by a small fly larva called a hawthorn maggot fly. Originally these flies were specialist feeders, but in 1864 there was a blight on the hawthorn fruit and apple growers discovered maggots of the hawthorn maggot fly had started feeding on apples. Over the past 143 years, increasing numbers of hawthorn maggot flies have developed the ability to eat apples as well as hawthorn fruit.

- e. Explain how the frequency of the ability to eat apples in addition to hawthorn fruit led to an increase in the population of fruit flies.

3 marks

Total 10 marks

SECTION B-continued

Question 5

Remains of the hominids Neanderthals and Cro Magnon have both been located in Europe. Current information indicates that these two groups co-existed for approximately 10,000 to 15,000 years. Some time within the past 40,000 years, Neanderthals disappeared from Europe.

Mitochondrial DNA has been obtained from both species and compared with that of modern humans. It has been found that Neanderthal DNA has approximately 25 differences compared to modern human DNA, whereas there is no difference between Cro Magnon DNA and modern human DNA.

- a. What does this information imply about the degree of relationship between modern humans, Cro Magnons and Neanderthals?

2 marks

When comparing the mitochondrial DNA between Cro Magnons and Neanderthals, it has been determined that the last mitochondrial split occurred approximately 500,000 years ago. In comparison, the last known mitochondrial split in domestic dogs occurred approximately 1 million years ago.

- b. At an excavation in Europe, a skeleton was located that had features that could be traced to both species. Given the information above is it possible that this individual was a hybrid? Explain your answer.

2 marks

- c. Early humans gathered into comparatively large groups and there is evidence of social interactions between groups. What advantages would social interactions have conferred?

1 mark

**SECTION B-Question 5-continued
TURN OVER**

One of the theories of the origin of modern humans is the “Out of Africa” theory which makes the assumption that modern man evolved in Africa only, and then spread out throughout the rest of the world, replacing older populations as they progressed. Skeletons of a variety of hominids have been found throughout the world.

- d. Provide one way in which the age and distribution of these skeletal remains could be used to support the “Out of Africa” theory.

1 mark

- e. Advances in science and technology have contributed to human’s ability to control evolution of humans and of other species. List and explain one way in which scientific, medical or technological advances have allowed humans to intervene in evolution of the human species.

2 marks

Total 8 marks

END OF QUESTION AND ANSWER BOOK