

Student name

BIOLOGY

Unit 4

Trial Examination

QUESTION AND ANSWER BOOK

Total writing time: 1 hour 30 minutes

Structure of book

Section	Number of questions	Number of marks
A	25	25
B	6	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 20 pages with a detachable answer sheet for multiple-choice questions inside the front cover.

Instructions

- Detach the answer sheet for multiple-choice questions during reading time.
- Write your **name** in the space provided above on this page and on the answer sheet for multiple-choice questions.
- All written responses should be in English.

At the end of the examination

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

STAV Publishing

2004

BIOLOGY

Unit 4 Trial Examination

MULTIPLE CHOICE ANSWER SHEET

STUDENT NAME:	
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INSTRUCTIONS: USE PENCIL ONLY

- Write your name in the space provided above.
- Use a **PENCIL** for **ALL** entries.
- If you make a mistake, **ERASE** it – **DO NOT** cross it out.
- Marks will **NOT** be deducted for incorrect answers.
- **NO MARK** will be given if more than **ONE** answer is completed for any question.
- Mark your answer by placing a **CROSS** through the letter of your choice.

1.	A	B	C	D
2.	A	B	C	D
3.	A	B	C	D
4.	A	B	C	D
5.	A	B	C	D
6.	A	B	C	D
7.	A	B	C	D
8.	A	B	C	D
9.	A	B	C	D
10.	A	B	C	D
11.	A	B	C	D
12.	A	B	C	D
13.	A	B	C	D

14.	A	B	C	D
15.	A	B	C	D
16.	A	B	C	D
17.	A	B	C	D
18.	A	B	C	D
19.	A	B	C	D
20.	A	B	C	D
21.	A	B	C	D
22.	A	B	C	D
23.	A	B	C	D
24.	A	B	C	D
25.	A	B	C	D

SECTION A - Multiple Choice Questions**Specific instructions for Section A**

This section consists of 25 questions. You should attempt **all** questions.

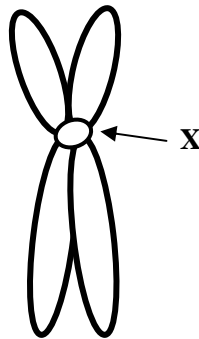
Each question has four possible correct answers. Only **one** answer for each question is correct. Select the answer that you believe is correct and indicate your choice on the Multiple Choice Answer Sheet by crossing the letter that corresponds with your choice of the correct answer.

If you wish to change an answer, erase it and cross your new choice of letter.

Each question is worth **one** mark. **No** mark will be given if more than one answer is completed for any question. Marks will **not** be deducted for incorrect answers.

The following information applies to Questions 1 and 2.

Below is a diagram of a chromosome.

**Question 1**

Region **X** represents:

- A. the locus.
- B. the centriole.
- C. the centromere.
- D. the point of crossing over.

Question 2

The diagram consists of:

- A. two single helices of DNA.
- B. one double DNA helix.
- C. two double helices of DNA.
- D. one single DNA helix.

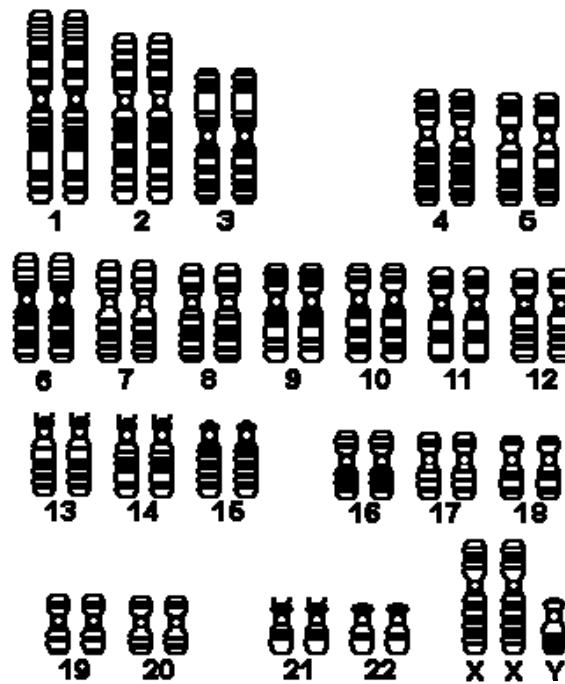
Question 3

A particular gene has two alleles that are co-dominant. The number of phenotypes that can result is:

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

The following information applies to Questions 4, 5 and 6.

The following diagram represents a photograph of the chromosomes of an individual. The individual suffers from a genetic disorder.



Question 4

The diagram represents:

- A. a karyotype.
- B. a DNA fingerprint.
- C. a cladogram.
- D. a gene map.

Question 5

From the diagram it is possible to conclude that:

- A. the individual is female.
- B. there are 44 autosomes.
- C. each pair of chromosomes has identical alleles.
- D. there are 2 sex chromosomes.

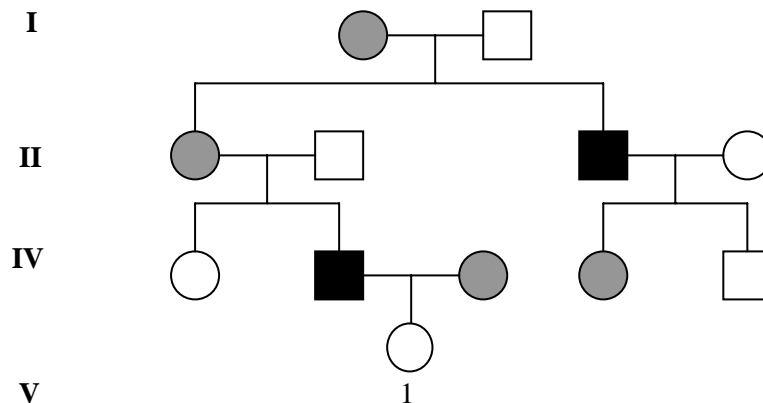
Question 6

The genetic disorder depicted:

- A. has resulted from non-disjunction during meiosis in either parent.
- B. has resulted from non-disjunction during meiosis in the mother only.
- C. has resulted from non-disjunction during meiosis in the father only.
- D. has resulted from hybridization during gamete formation.

Question 7

Consider the following pedigree for colourblindness. Grey indicates a carrier of the condition.



The probability that individual V 1 is colourblind is:

- A. 0
- B. 0.25
- C. 0.5
- D. 0.75

Question 8

In the vinegar fly, *Drosophila*, two dominant genetic conditions, curly wings and plum eye colour, are linked. Linked genes:

- A. are next to each other on a chromosome.
- B. never show crossing over.
- C. are on the same chromosome.
- D. have multiple alleles that are inherited together.

Question 9

Incontinentia Pigmenti is a dominant X-linked disorder, a symptom of which is excessive deposits of melanin (normal skin pigment) in the skin. A woman with Incontinentia Pigmenti, had a father with the disease, and a mother who didn't. In terms of probability:

- A. there is 100% chance that her sons will inherit the condition.
- B. there is 100% chance her sons and daughters will all inherit the condition.
- C. there is 100% chance her daughters will inherit the condition but a 0% chance that her sons will.
- D. there is a 50% chance her daughters will inherit the condition and a 50% chance that her sons will.

Question 10

A test cross is one that involves:

- A. crossing an individual with a homozygous recessive individual for the trait under consideration.
- B. testing to see if an individual is homozygous recessive or heterozygous for the trait under consideration.
- C. crossing an individual that is heterozygous with a homozygous dominant individual.
- D. testing individuals that do not follow Mendelian genetic patterns.

Question 11

In squash plants, the trait for white fruit (W) is dominant to the alternative allele (w) for yellow fruit, and the trait for disc shaped fruit (D) is dominant to the alternative allele (d) for spherical fruit. These genes are on different chromosomes. In a particular cross of squash plants, the probability of an offspring being white is 0.5 and the probability of the fruit being disc shaped is 0.75.

Which of the following most probably represent the parental genotypes?

- A. WwDd x WwDd
- B. WwDd x wwDd
- C. WwDd x wwdd
- D. WWdD x wwDd

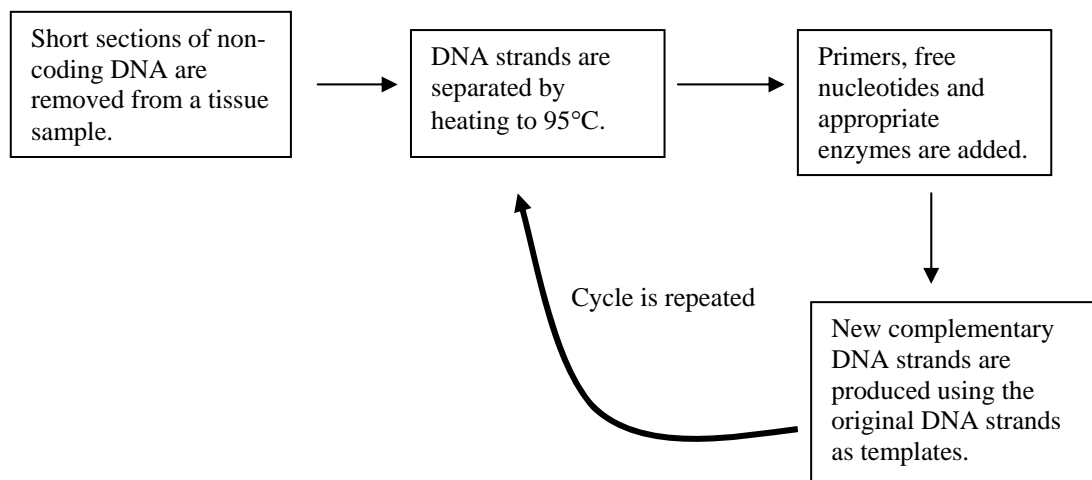
Question 12

RNA is a nucleic acid that occurs in 3 types: ribosomal RNA, transfer RNA, and messenger RNA. It is reasonable to conclude that:

- A. transfer RNA functions in transcription.
- B. messenger RNA is produced on ribosomes.
- C. DNA codes for messenger RNA but not transfer RNA or ribosomal RNA.
- D. ribosomal RNA functions in translation.

Question 13

The flow chart below shows the steps involved in a single cycle of a laboratory technique used to increase the amount of DNA for analysis in genetic fingerprinting.



The name of the laboratory technique described above is:

- A. DNA fingerprinting.
- B. polymerase chain reaction.
- C. DNA copying.
- D. DNA sequencing.

Question 14

The coding sequence of part of a gene has the DNA sequence:

GCAAATCATAAT

The sequence is read from left to right. The anticodon of the transfer RNA for the last amino acid would be:

- A. AAU
- B. UAA
- C. TAA
- D. AAT

Question 15

A population is in Hardy-Weinberg equilibrium for a trait controlled by one gene consisting of 2 alleles. If the frequency of the recessive allele is 0.8, the frequency for the dominant allele would be:

- A. 0.2
- B. 0.4
- C. 0.6
- D. 0.8

Question 16

The wings of a butterfly and the wings of a bird are:

- A. analogous structures because they have a common evolutionary origin.
- B. homologous structures because they have a common evolutionary origin.
- C. homologous structures because they perform a similar function
- D. analogous structures because they perform a similar function.

Question 17

Natural selection is a process that:

- A. adapts individuals to environmental conditions.
- B. acts on species rather than individuals.
- C. always results in organisms becoming extinct.
- D. often results in gradual phenotypic changes in a species over a long period of time.

Question 18

The evolutionary evidence provided by fossils is:

- A. behavioural
- B. structural
- C. functional
- D. genetic

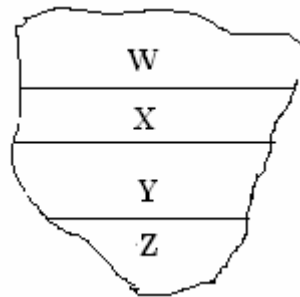
Question 19

The sequence of events contributing to speciation is best outlined as:

- A. geographical barrier → genetic mutations → reproductive isolation.
- B. genetic mutations → geographical barrier → reproductive isolation.
- C. reproductive isolation → geographical barrier → genetic mutations.
- D. geographical barrier → reproductive isolation → genetic mutations.

Question 20

The letters in the following diagram represent various layers of sedimentary rocks.

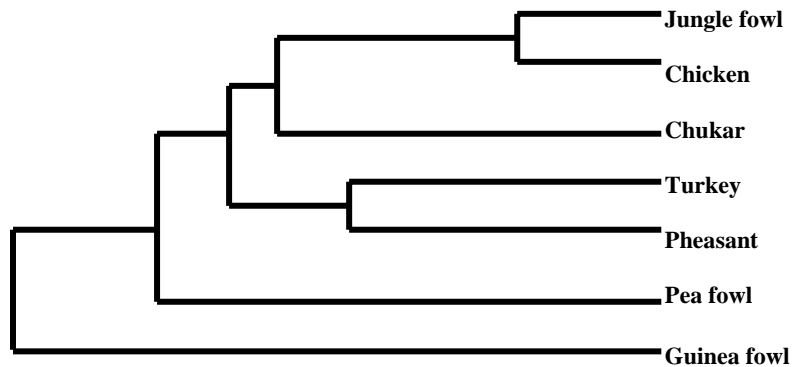


Which of the following can be deduced from the diagram?

- A. Fossils in layer **Z** evolved from fossils in layer **Y**.
- B. Fossils in layer **Z** are younger than fossils in layer **X**.
- C. Fossils in layer **W** evolved from fossils in layer **Z**.
- D. Fossils in layer **X** are younger than fossils in layer **Y**.

Question 21

In studying the evolution of modern chickens, scientists used electrophoretic analysis of 3 regions of the chicken's nuclear genome: those containing structural genes for lysosome c, those for three "alpha-like" globulins, and those for four "beta-like" globulins. The same parts of the genome were measured for other members of this group of birds known as phasianoids. The diagram below shows the relationship between members of this group of birds based on this evidence.



From the diagram it can be said that:

- A. the Jungle fowl and the Guinea fowl have the most recent common ancestor.
- B. the Pea fowl and the Guinea fowl are the most closely related.
- C. the Guinea fowl is the most evolutionary distant from the other birds.
- D. the modern day chicken evolved from the Chukar.

Question 22

The sugar glider, *Petaurus breviceps*, an Australian marsupial possum, is very similar in appearance to the flying squirrel, *Glaucomys sabrinus*, of North America, a placental mammal, even though they are not related. They are similar in size and have long, bushy tails and skin folds that allow them to glide through the air. This is an example of:

- A. divergent evolution as they are not related.
- B. local adaptation, as the climates are different in Australia and North America.
- C. convergent evolution as they have been subjected to similar selection pressures.
- D. parallel evolution as they evolved at a similar time.

Question 23

In Australia nearly all of the endemic snakes are poisonous. This is because:

- A. the dry arid habitat of Australia has selected out poisonous snakes.
- B. the evolutionary history of Australia would have involved colonisation by ancestral snakes that were poisonous.
- C. geographical barriers in Australia are especially prominent, leading to convergence among unrelated snake species on the use of venom to capture prey.
- D. poisonous snakes were inadvertently introduced by aborigines.

Question 24

Bipedalism is a characteristic of the genus *Homo*. Bipedalism probably evolved because:

- A. bipedal locomotion is more energy efficient than quadrupedal movement when long distances are to be covered.
- B. bipedal motion is less energy efficient than quadrupedal motion, but it frees the hands for carrying offspring.
- C. bipedal locomotion enabled early humans to outrun quadrupedal predators.
- D. bipedal locomotion evolved so as to enable early humans to use tools.

Question 25

Genetic similarities amongst some vertebrates can be estimated by the degree of DNA hybridisation. Below is a table of comparisons of different animals and the percentage differences in part of their DNA sequence.

Animals Compared	% Difference in DNA Sequence
Human - Chimpanzee	1.6
Human - Gibbon	3.5
Human – Rhesus monkey	5.5
House mouse – Norway rat	20.0
Cow - Sheep	7.5
Cow - Pig	20.0

From the data above it can be concluded that:

- A.** the human is more closely related to the gibbon than to the rhesus monkey.
- B.** the rhesus monkey and the gibbon are more closely related than the human and the chimpanzee.
- C.** the difference in DNA sequence between the house mouse and the Norway rat is identical to the difference in DNA sequence between the cow and the pig.
- D.** the chimpanzee and the gibbon will differ by 5.1% in DNA sequence.

END OF SECTION A

SECTION B - Short Answer Questions

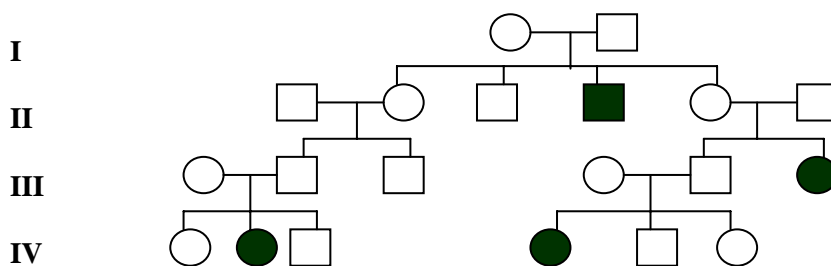
Specific instructions for Section B

This section consists of 6 questions. There are 50 marks in total for this section. Write your responses in the spaces provided. You should attempt **all** questions. Please write your responses in **blue or black ink**.

Question 1

Changes in the Beta globin gene that codes for the beta chains of haemoglobin are responsible for a series of conditions known as beta thalassaemia syndromes.

The following pedigree shows the inheritance of one of the beta thalassaemia syndromes.



a Is this condition dominant or recessive?

(1 mark)

b Give evidence from the pedigree to support your answer to **a** above.

(1 mark)

The following represents part of the mRNA for normal haemoglobin and below that is the mRNA that results in a form of Beta thalassaemia.

Normal Beta globin	Codon number	36	37	38	39	40	41.....146
	Codon	CCU	UGG	ACC	CAG	AGG	UUC.....UAG
Beta thalassaemia	Codon	CCU	UGG	ACC	UAG	AGG	UUCUAG

c What type of mutation is shown above?

(1 mark)

Use the table below to show the translation products of each mRNA shown on the previous page.

The Genetic Code for mRNA codons to amino acids.

		Second base letter				
		U	C	A	G	
F i r s t B a s e L e t t e r	U	Phenylalanine Phenylalanine Leucine Leucine	Serine Serine Serine Serine	Tyrosine Tyrosine <i>Stop</i> <i>Stop</i>	Cysteine Cysteine <i>Stop</i> Tryptophan	U C A G
	C	Leucine Leucine Leucine Leucine	Proline Proline Proline Proline	Histamine Histamine Glutamine Glutamine	Arginine Arginine Arginine Arginine	U C A G
	A	Isoleucine Isoleucine Isoleucine Methionine	Threonine Threonine Threonine Threonine	Asparagine Asparagine Lysine Lysine	Serine Serine Arginine Arginine	U C A G
	G	Valine Valine Valine Valine	Alanine Alanine Alanine Alanine	Aspartic acid Aspartic acid Glutamic acid Glutamic acid	Glycine Glycine Glycine Glycine	U C A G

d Normal haemoglobin _____

Beta thalassaemia _____

(2 marks)

e Why would this mutation result in such a severe case of beta thalassaemia?

(2 marks)

Total 7 marks

Question 2

In Cocker Spaniels the trait for black coat colour (B) is dominant to the alternative allele for red coat colour (b) and the trait for solid pattern (S) is dominant to the alternative allele for spotted pattern (s). These two genes are on different chromosomes that undergo independent assortment. A solid black male is mated with a solid red female and this produces a litter of six pups shown in the table below.

Pup	Phenotype
1	Solid black
2	Solid black
3	Solid red
4	Solid red
5	Black and white
6	Red and white

- a** What does the term independent assortment mean? Include a diagram in your answer.

(3 marks)

- b** Using the alleles given, what is the genotype of the parents?
Give reasons for your answer.

Genotype of the father _____

Genotype of the mother _____

(2 marks)

Explanation _____

(3 marks)

- c** Indicate which of the pup(s) above numbered 1-6, have genotypes that can be determined. Give a reason for your selection.

Pup(s) _____
(1 mark)

Reason _____

(1 mark)

- d** Give the genotype of the pup(s) you selected for your answer to **c** above by completing the table below.

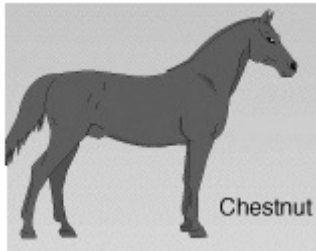
Pup number(s)	Genotype(s)

(1 mark)

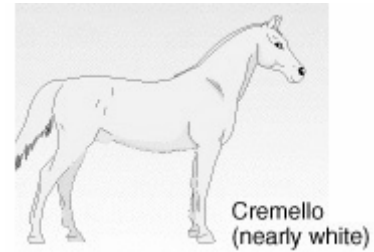
Total 11 marks

Question 3

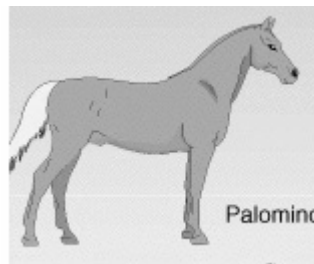
Coat colour in horses involves interaction of different genes. One gene, the Cream gene, is known as a dilution gene, because its phenotypic action is to dilute the body colour by lightening hairs with red pigment (called pheomelanin). The cream gene has two alleles C and C^r . A horse carrying the chestnut gene and also homozygous for the Cream gene C^rC^r will be almost white, called Cremello. A horse carrying the chestnut gene and homozygous for the alternative Cream allele CC , will retain the reddish brown colour as these alleles are not able to “dilute” the action of the chestnut gene. A horse carrying the chestnut gene and heterozygous for the Cream gene, CC^r will be a golden colour, called palomino.



genotype: Chestnut gene plus CC
phenotype: reddish brown



genotype: Chestnut gene plus C^rC^r
phenotype: nearly white



genotype: Chestnut gene plus CC^r
phenotype: golden

- a** What type of inheritance is demonstrated by the Cream gene? Explain your answer.

(2 marks)

- b** What is meant by the term “to breed true?”

(1 mark)

- c If two palomino horses were crossed, what phenotypes would you expect in the offspring and in what ratios. Show your working.

(2 marks)

- d What percentage of the non-palomino offspring calculated in c above would breed true?

(1 mark)

A horse breeder wanted to breed only palomino horses.

- e What kind of cross would best produce palominos most efficiently? Explain your answer.

(2 marks)

Total 8 marks

Question 4

The DNA in some regions of human chromosomes is made up of base sequences that are repeated. The number of repeats varies between individuals. These are called VNTRs (*varied number of tandem repeats*). These VNTRs can be used to identify criminals, paternity cases and other family relationships as they are passed from parent to child like other alleles. When an investigation is carried out, the area of DNA containing the VNTRs is first cut using specific restriction enzymes.

- a Where do restriction enzymes come from?

(1 mark)

- b What is meant by “specific” restriction enzymes?

(1 mark)

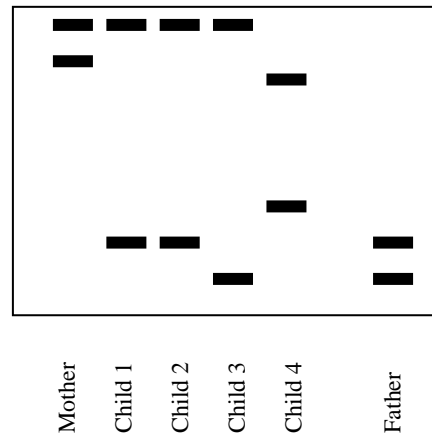
After treatment with the restriction enzyme the DNA is run on an electrophoresis gel and treated with an appropriate radioactive probe.

- c What is an “appropriate” DNA probe? Explain your answer.

(2 marks)

A family of refugees has three children and was given asylum. Later, another boy arrived and claimed to be the fourth child of the family. The authorities asked for a DNA analysis to establish if this relationship was true. The diagram below shows a VNTR region analysed using a probe.

DNA profile with probe



d Are the mother and the father the biological parents of this fourth child? Explain your answer.

(2 marks)

Total 6 marks

Question 5

In the East African Lakes; Tanganyika, Malawi and Victoria, there exists a diversity of fish known as cichlids or mouth brooders. The cichlids are spiny-rayed fresh water fish that come in a vast array of colours, forms and habitats. They are indigenous to warm rivers and lakes in Africa, Madagascar, Southern India, Sri Lanka and South and Central America.



- a** Explain how these fish are found in all these countries as well as the East African Lakes?

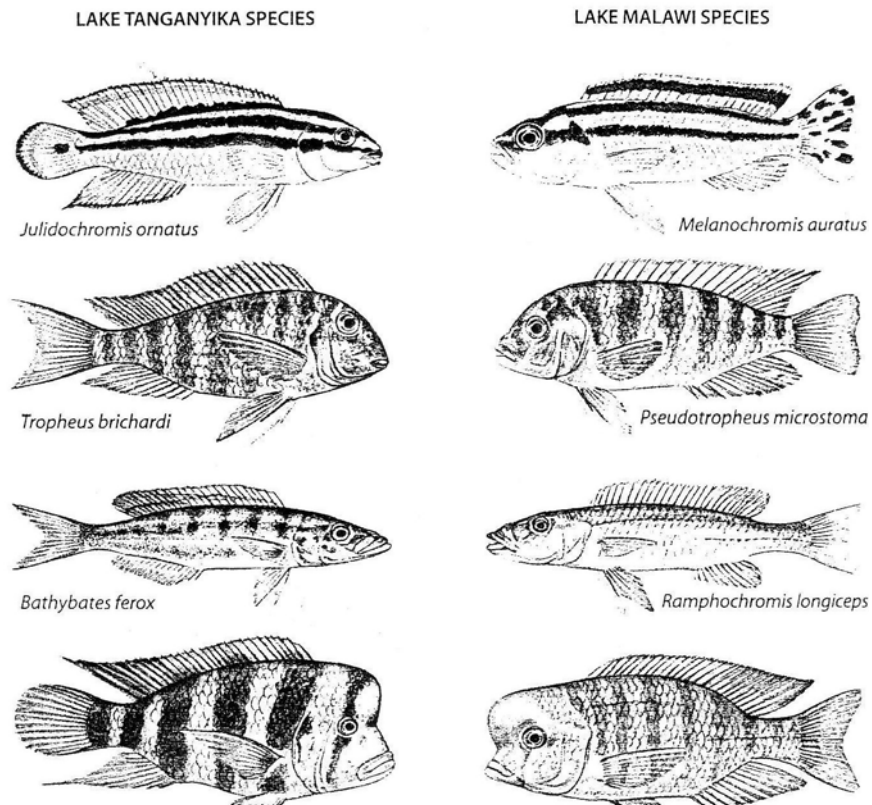
(2 marks)

The cichlids are also known as mouth brooders because the female carries the fertilised eggs and the newly hatched young in her mouth. These cichlids lay fewer eggs than other fish.

- b** Why would these cichlids lay fewer eggs than other fish?

(1 mark)

The cichlids in Lake Tanganyika are genetically diverse coming from 11 ancestral species. Some cichlids left Lake Tanganyika and by entering the river system found their way to Lake Victoria and Lake Malawi. Below is a set of diagrams showing some of the different species of cichlids in the two lakes.



Studies of mitochondrial DNA show that the cichlids in Lake Malawi are more closely related to one another than to the cichlids in Lake Tanganyika even though they differ in appearance.

- c** Name the process that has resulted in any two “pairs” of cichlids from the different lakes looking so much alike.

(1 mark)

The total population of mouth brooding species is often quite small. Small populations are prone to genetic drift.

- d** What is genetic drift?

(1 mark)

Lake Victoria dried up completely 14,000 years ago. Only a small fraction of the cichlids could have survived.

e How would this help explain the close relationship of the cichlids in Lake Victoria?

f In population genetics, what is the term given to describe the situation in **e** above? (1 mark)

(1 mark)

Lake Tanganyika has in the past experienced a series of successive drops in water levels - as much as 2000 feet - resulting in small, isolated pockets of water. Later the water level rose, joining up the isolated pockets. Scientists believe that this situation has contributed to the appearance of the different types of cichlids.

g Outline the steps by which these different cichlids could have come about in this lake.

(4 marks)

Total 11 marks

Question 6

In 1997, scientists succeeded in extracting mitochondrial DNA from a Neanderthal fossil found in 1856 in the Neander valley in Germany. Since then scientists have extracted mitochondrial DNA from other Neanderthals found in Europe. They have found that these different Neanderthals showed very little genetic diversity.

a What is mitochondrial DNA?

(1 mark)

Mitochondrial DNA is particularly interesting because most scientists believe that it is inherited from the maternal line.

b Explain why mitochondrial DNA is used instead of nuclear DNA?

(2 marks)

Mitochondrial DNA undergo mutations and as a result human mitochondrial DNA has been slowly diverging from the mitochondrial DNA of previous generations.

c How can the mitochondrial DNA be used as an evolutionary biological clock?

(1 mark)

After extracting the mitochondrial DNA, scientists used the technique of PCR on the sample.

d What was the purpose of the PCR procedure?

(1 mark)

Cro Magnon man invaded the eastern edge of the Neanderthals range in Western Asia around 45,000 years ago. Within 10,000 to 15,000 years ago Cro Magnons had spread to Western Europe and Neanderthals became extinct. Scientists have debated whether Neanderthals or the Cro Magnon man was the ancestor of modern humans. Examination of the mitochondrial DNA from 60 living humans, 4 Neanderthals and 3 Cro Magnons using 360 base pairs was performed. The results are tabled below.

	Comparison to modern humans
Neanderthal	23 – 28 base pairs different
Cro Magnon	No discernable difference

e What do these results suggest about the ancestry of modern man? Explain your answer.

(2 marks)

Total 7 marks

END OF EXAMINATION

Sources of diagrams, illustrations, photographs

Figure number or title	Author/illustrator	Date of publication	Title	Publisher	Page number(s)
Section A Q4	Website below				
Section B Q3	J.W Evans	1977	The Horse	W. H Freeman & Co	
Section B Q5 (map)	Web site below				
Section B Q5 (fish)	Melanie L.J Stiassny and Alex Meyer	Feb 1999	Cichlids of the Rift Lakes	Scientific American	p.48

Web address	Date accessed
http://med.b.med.utah.edu/WebPath/TUTORIAL/PRENATAL/PRENO.43.html	April 2004
http://www.cichlid-forum.com/articles/lakes_east_africa.php	