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 questions to be answered	Number of marks	Suggested times (minutes)
A	25	25	25	30
B	6	6	50	60
		Total	**75**	**90**

- 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.

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Phone: 61 + 3 9385 3999 • Fax: 61 + 3 9386 6722 • Email: stav@stav.vic.edu.au Website: http://www.stav.vic.edu.au

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SEMESTER 2

STAV Publishing
2005

BIOLOGY
Unit 4 Trial Examination
MULTIPLE CHOICE ANSWER SHEET

STUDENT NAME:	

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.

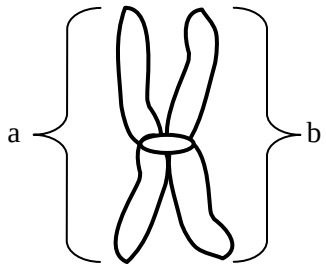
Each question has four possible correct answers. Only **one** answer for each question is correct. Select the answer that you believe is correct and indicate your choice on the Multiple Choice Answer Sheet by crossing the letter that corresponds with your choice of the correct answer.

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.

Question 1

Below is a diagram of a human chromosome from the testis of a man taken at metaphase of the first division of meiosis.



It would be reasonable to state that:

A. a and b are identical chromatids.
B. a and b are one molecule of DNA.
C. a and b may carry some different alleles.
D. a and b will end up in the same sperm cell.

Question 2

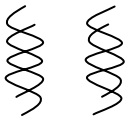
DNA replicates semi-conservatively. Below is a diagram representing the parental DNA molecule.

Which of the diagrams below represents the DNA molecules formed by a semi-conservative method?

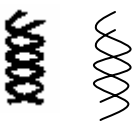
A.

B.

C.



D.



Question 3

A piece of DNA, extracted from the yeast *Candida albicans*, was found to consist of 42% guanine bases. The percentage of bases that are adenine in this piece of DNA would be:

A. 42%
B. 21%
C. 63%
D. 8%

Question 4

The sequence of a gene called the coding sequence is:

A. an intron.
B. an exon.
C. a promoter.
D. a flanking region.

Question 5

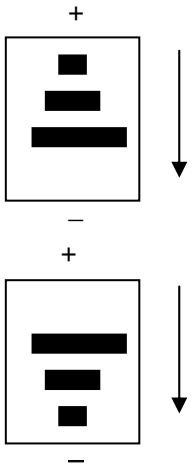
Genetic engineers make use of restriction endonucleases because:

A. they cut DNA at random.
B. they cut DNA at specific sites.
C. they produce DNA of specific lengths.
D. they join pieces of DNA together.

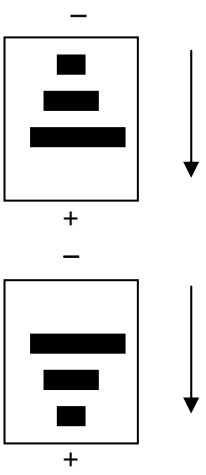
Question 6

Several DNA fragments were separated by electrophoresis. The arrows show the direction of movement of the fragments. Which diagram would best represent the separation?

A.



B.



C.

D.

Question 7

Protein synthesis is a function of living cells and follows a particular sequence of stages. The following list outlines each stage.

1. peptide bonds form between amino acids.
2. ribosomes attach to the mRNA.
3. tRNAs bring amino acids to the ribosome.
4. codons pair up with anticodons.

The correct sequence for these stages would be:

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

Questions 8 and 9 refer to the following information.

In chickens there are two alleles for the gene for feather colour. One allele is for white feathers and the other is for black feathers. When white chickens are crossed with black chickens, the offspring are all slate blue called Blue Andalusian.

Question 8

The type of inheritance demonstrated here is:

A. polygenic inheritance.
B. X linked inheritance.
C. multiple alleles.
D. co-dominance.

Question 9

If slate blue chickens are crossed, the ratio of phenotypes would be expected to be:

A. 1 white : 1 black
B. 1 white : 2 blue : 1 black
C. 3 white : 1 black
D. all blue.

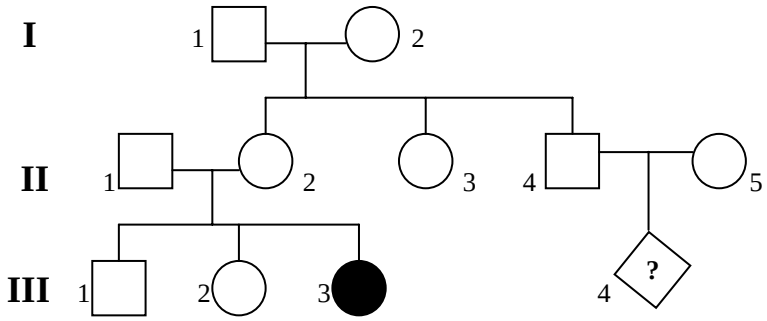
Question 10

X-linked traits in humans involves:

A. genes that are on autosomes.
B. genes that are on X chromosomes and can only be inherited by males.
C. genes that are on X chromosomes and therefore only females can be carriers.
D. genes that are on Y chromosomes and can only be inherited by males.

Questions 11, 12 and 13 refer to the following information.

The pedigree below shows a family with the condition cystic fibrosis.



Question 11

The probability that individual **I** 2 is a carrier is:

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

Question 12

DNA analysis showed that **I** 2 is homozygous normal. What is the probability of **I** 1 being a carrier?

A. 50%
B. 100%
C. 75%
D. 25%

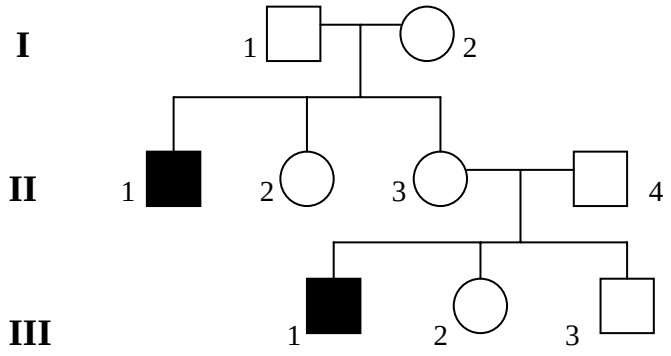
Question 13

Individual **II** 5's father suffered from cystic fibrosis. The probability of the unborn child **III** 4 having cystic fibrosis would be:

A. 1/2
B. 1/4
C. 1/8
D. 1/16

Question 14

Duchennes Muscular Dystrophy is due to a recessive allele on the X chromosome. The following pedigree shows the occurrence of this condition in a particular family.



D = allele for normal muscles
d = allele for Duchennes Muscular Dystrophy

The genotypes of individuals **I** 1, **II** 3 and **III** 1 respectively are:

A. X^DY, X^DX^d, X^dY
B. X^DY, X^DX^D, X^dY
C. X^DY, X^dX^d, X^dY
D. X^dY, X^DX^d, X^DY

Question 15

The relative location of 4 linked genes, W, X, Y and Z can be mapped using crossing over frequencies according to the table below.

Genes	Frequency of crossovers
X and Y	10%
Z and Y	19%
W and Y	12%
W and Z	7%
W and X	2%
Z and X	9%

The relative positions of these four genes on the chromosome can best be represented by:

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

Question 16

In some hospitals there now exists strains of bacteria that show resistance to different antibiotics. The evolution of these bacteria is a demonstration of:

A. natural selection.
B. random mating.
C. misuse of antibiotics.
D. physical isolation.

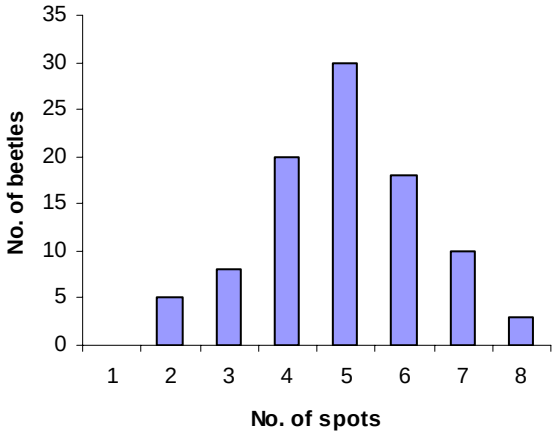
Question 17

The shell of turtles possibly evolved from the scales of ancestral reptiles over time. It would be reasonable to state that:

A. There would be no intermediate forms, as this type of evolution involves one mutation and one step.
B. All the intermediate forms showing shell development would die out quickly as they are incomplete.
C. All the intermediate forms showing shell development had to be advantaged in their environments.
D. All intermediate forms showing shell development would be the same species as they are the ancestors of modern turtles.

Question 18

The following graph shows the number of spots on the wing cases of a species of beetle.



The number of spots is genetically determined. The graph suggests that the genetic control of spot numbers is due to:

A. two alleles and one gene – spots being dominant to no spots.
B. polygenetic inheritance with more than one gene.
C. two alleles and one gene – no spots dominant to spots.
D. more than two genes that are linked.

Question 19

Which of the following characteristics are **both** homologous **and** analogous?

A. The wings of a bat and the wings of a butterfly.
B. The wings of a bat and the wings of a bird.
C. The wings of a bat and the flipper of a whale.
D. The eye of an octopus and the eye of a human.

Question 20

A mutation that sometimes occurs in the DNA molecule causes a frame shift. This mutation:

A. can only occur in a non-coding area of DNA.
B. causes a protein to form that is shorter than normal.
C. is due to a deletion or insertion of a nitrogen base in the DNA molecule.
D. results in a stop codon being inserted.

Question 21

Chance alone can cause significant changes in gene frequencies in small populations. This describes the effect of:

A. genetic drift.
B. Hardy-Weinberg equilibrium.
C. natural selection.
D. gene flow.

Question 22

One strand of a DNA molecule consists of the sequence:

3’ CATTAGTAC 5’

The complementary sequence of the other strand would be:

A. 3’ CATTAGTAC 5’
B. 3’ GTAATCATG 5’
C. 5’ GUAAUGUAG 3’
D. 5’ GTAATCATG 3’

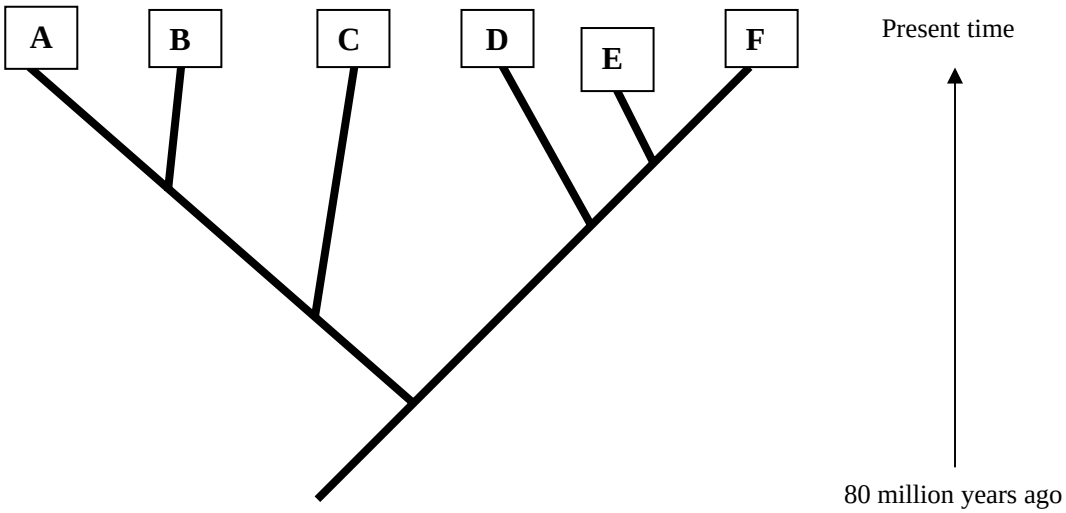
Question 23

Porcupines (animals with long sharp spines) have evolved independently in both Africa (the old world porcupines) and South America (the new world porcupines). More than 70 million years ago, before the land masses of Africa and South America separated, these current porcupines shared a common ancestor resembling a large fuzzy rat. The current porcupines are remarkably similar in all their body features. This is an example of:

A. divergent evolution.
B. convergent evolution.
C. parallel evolution.
D. analogous evolution.

Question 24

The following diagram shows evolutionary relationships between different species.



The two species that have the oldest common ancestor are:

A. D and F
B. B and C
C. C and F
D. A and C

Question 25

Excavations by archeologists uncovered a series of layers containing the fossil remains of organisms that existed in that particular area over the past 500,000 years. It can be inferred that:

A. fossils found in the same sedimentary layer are the same age.
B. fossils found in the top sedimentary layer are the oldest.
C. fossils found in the bottom layer gave rise to the species in the top layer.
D. fossils found in the top layers are of present day organisms.

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

The colour of the cotyledon leaf in soybeans is under genetic control as outlined below.

The homozygous genotype C^GC^G produces dark green cotyledon leaves.

The heterozygous genotype C^GC^Y produces light green cotyledon leaves.

The homozygous genotype C^YC^Y produces yellow leaves due to almost no green pigment.

a What substance is responsible for the green colour in the leaf?

_____

(1 mark)

b Would plants of genotype C^YC^Y survive to maturity? Explain your answer.

_____

_____

(2 marks)

c What type of inheritance is demonstrated by the gene for colour of cotyledon leaves in the soybean? Explain your answer.

_____

_____

_____

(2 marks)

d A cross was performed between parent plants known to be C^GC^G and C^GC^Y. What colour(s) would the F_1 generation be and in what ratio? Show your working.

_____

_____

_____

_____

(2 marks)

e A second cross was then performed involving all the genotypes of the F_1 generation above.

What would be the genotypes of the mature, viable F_2 generation and the ratios of the expected phenotypes? Show your working.

_____

_____

_____

_____

_____

_____

_____

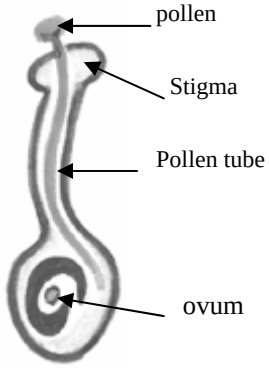
_____

(3 marks)

Total 10 marks

Question 2

Many adaptations of flowering plants reduce the possibility of inbreeding by various mechanisms. Normally, if pollen lands on the stigma of a flower of the same species it grows a pollen tube down the style so that the male gamete can reach the female ovum and fertilise it, as shown in the diagram below.



a Why is it advantageous for a plant to avoid inbreeding?

_____

_____

(1 mark)

In clover, *Trifolium pratense*, one mechanism employed to avoid inbreeding is genetically based. Clover possesses a self-incompatibility gene, a single gene "S", for which there are several alleles S^1, S^2, S^3, S^4. If pollen lands on the stigma of a flower with an allele that is the same as the pollen, then the pollen will fail to grow a pollen tube down the style and fertilization of the ovum will not take place.

b How many of these alleles would be present in the somatic cells of the stigma of a clover plant?

_____

(1 mark)

c How many of these alleles would be present in a pollen grain of clover?

_____

(1 mark)

Pollen from a plant of genotype S^1S^2 with respect to the self-incompatibility gene is placed on the stigma of a plant of genotype S^2S^3.

d What would be the genotype(s) of any offspring?

_____

(1 mark)

e What would be the expected genetic ratio of any offspring?

_____

(1 mark)

Total 5 marks

Question 3

Tay-Sachs disease is an autosomal recessive genetic disorder resulting from a mutation in the hexosaminidase enzyme that is responsible for the breakdown of certain fatty substances in the brain and nerve cells. Babies born with this condition do not produce effective hexosaminidase and the fatty substances accumulate in their brain cells, irreversibly destroying them. One type of mutation resulting in this condition is a change in amino acid number 180 as shown below.

	Amino acid 180 codon
Normal Hexosaminidase	UAC
Tay-Sachs	UAG

a What do the letters C and G stand for?

_____

(1 mark)

b Is the codon UAG part of the DNA molecule? Explain your answer.

_____

_____

(2 marks)

The Genetic Code for mRNA codons to amino acids.

First Base Letter	Second base letter: U	Second base letter: C	Second base letter: A	Second base letter: G	Third Base Letter
U	Phenylalanine Phenylalanine Leucine Leucine	Serine Serine Serine Serine	Tyrosine Tyrosine ***Stop*** ***Stop***	Cysteine Cysteine ***Stop*** 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**

c Use the table above to show the translation products of each of the codons above.

Normal codon_____

Tay-Sachs codon _____

(2 marks)

d As a result of this mutation, what is the outcome for the polypeptide being translated?

_____

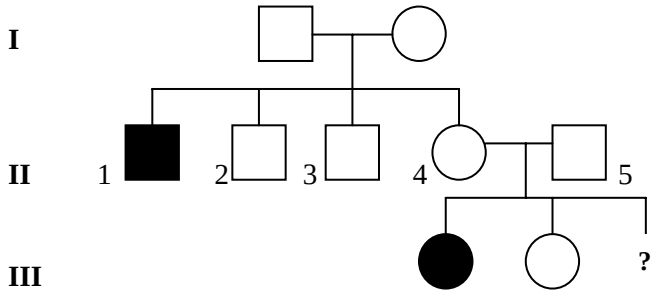
_____

(1 mark)

Total 6 marks

Question 4

The pedigree below shows the occurrence of a condition called Congenital Adrenal Hyperplasia (CAH) a disease characterized by adrenal glands that are unable to provide hormones known as corticosteroids. The condition is due to various mutations of the 21-hydroxylase gene, situated on chromosome 6. Below is a typical pedigree for the inheritance of this condition.



a What is the mode of inheritance of this condition? Explain your answer.

_____

_____

_____

(2 marks)

In conditions such as CAH, where there are many different mutations in the gene causing the disease, direct analysis, i.e. testing for the presence of the actual gene for diagnosis, is impossible. Indirect analysis is possible if the position of the gene on the chromosome is known and there is a linked marker that can be tested for, which is polymorphic in the population.

b What is a polymorphic, linked marker?

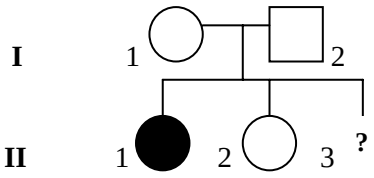
_____

_____

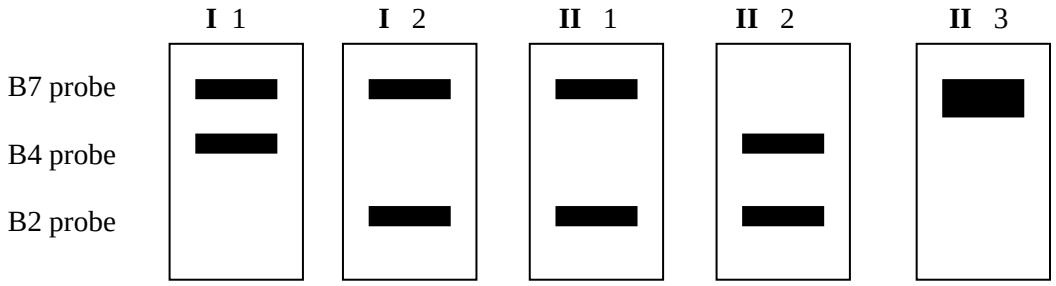
_____

(2 marks)

The gene 21-hydroxylase is adjacent to the major histocompatibility antigens (HLA) gene. The HLA can be used as a marker for the CAH gene. The family that is part of the above pedigree and is represented below is expecting a third child. They already have one child with the CAH condition and are anxious to know if the unborn child also has inherited the defective alleles.



In this family there are three different alleles for the HLA gene. B7, B4 and B2. The diagram below shows the electrophoresis and probe results for the family when their DNA is probed for these HLA alleles.



c Using the results above, would you expect the unborn child to have the condition CAH? Explain your answer.

_____

_____

_____

_____

_____

_____

(3 marks)

This type of indirect diagnosis is less than 100% accurate, especially if the marker is not very close to the disease gene.

d Why is it important, in this type of indirect analysis, to use a marker that is as close to the disease gene as possible? Explain your answer.

_____

_____

_____

_____

_____

_____

(3 marks)

Total 10 marks

Question 5

The origins of the dingo (*Canis lupus dingo)* has been investigated using mitochondrial DNA (mtDNA) analysis. It is now believed that the dingo was introduced by settlers from Indonesia about 5000 years ago and was in fact an early domesticated dog. The entire Australian population of dingoes stems from very few dogs, maybe just one pregnant female.

a What term is given to the establishment of a population from only a few individuals?

_____

(1 mark)

b How does the establishment of such a population influence genetic diversity?

_____

_____

(1 mark)

The dingo has been blamed for a series of extinctions of marsupial carnivores including the *Thylacine* from the Australian mainland. The dingo never inhabited Tasmania. The *Thylacine* in Tasmania was exterminated by European settlers.

c What does this observation suggest about the separation of Tasmania from mainland Australia?

_____

_____

(1 mark)

d Suggest a possible reason that explains how the dingo could have contributed to the extinction of the *Thylacine* on the mainland.

_____

_____

(1 mark)

Researchers analysed mtDNA sequences in 211 dingoes, and compared them with a worldwide sample of 676 dogs *(Canis lupus familiaris)* and wolves *(Canis lupus).* All dingo mtDNA types either belonged to, or showed great similarity to, a type called A29. This matched a type of domestic dog that lived in the Indonesian Archipelago. Mitochondrial DNA undergoes mutations at a faster rate than nuclear DNA. Evidence from this study suggests that dingoes have been isolated for at least 3500 years.

e Explain how the examination of mtDNA allows the establishment of this time-line.

_____

_____

_____

_____

(2 marks)

f What other scientific information, besides DNA analysis, could be useful in establishing that dingo came from Asian domestic dogs?

_____

_____

(1 mark)

The dingo is not an endangered species as such, however 80% of dingoes are thought to be hybrids, having bred with feral domestic dogs introduced by European settlers. Both the dingo and current domestic dogs have descended from the grey wolf, *Canis lupus.*

g How is the dingo able to successfully interbreed with feral domestic dogs?

_____

_____

_____

(2 marks)

Total 9 marks

Question 6

In 2004 a group of Australian and Indonesian scientists published their discovery of the bones of a possible species of tiny human that grew no bigger than a modern three-year old child. These tiny hominins lived on a remote, hot and humid island, the island of Flores, in the Indonesian Archipelago, from 95,000 to 18,000 years ago. They occupied the island with pygmy elephants (stegadons) and giant komodo dragons (lizards). Scientists believe that these skeletons (they have now found 7 individuals) are from a new species of human that they have named *Homo floresiensis.*

a Name **two** features of these individuals that would place them in the genus Homo.

Feature one: _____

Feature two: _____

(2 marks)

Homo floresiensis had slightly longer arms than other hominins.

b What type of behaviour can be inferred from the possession of long arms?

_____

_____

(1 mark)

The bones found were not fossilized.

c What is the difference between fossilized bones and normal bones?

_____

_____

(1 mark)

d Give one reason, from a scientific point of view, why the finding of these bones is better than finding fossilized bones.

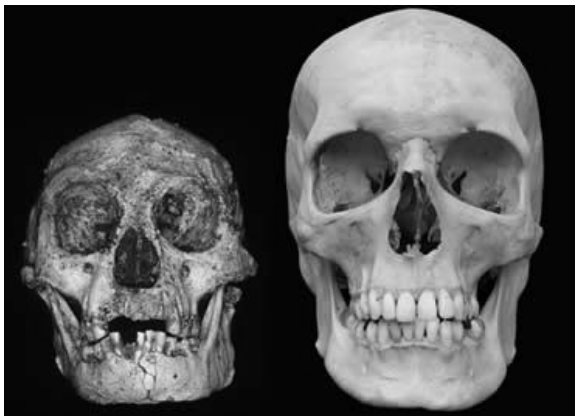
_____

_____

(1 mark)

Although smaller, the general form of *Homo floresiensis* most closely resembles *Homo erectus*, a species of hominin that populated Asia and Africa 1.8 to 2 million years ago. Below is a comparison of brain size and height between *Homo erectus, Homo floresiensis* and *Homo sapiens.*

	Brain size (cm^3)	Height (m)
Homo erectus	650 – 1250	1.55 – 1.78
Homo floresiensis	380	1
Homo sapiens	1400 – 1500	1.65 – 1.82



H. floresiensis *H. sapiens*

e Explain how the climatic conditions on Flores Island would favour those individuals with smaller bodies.

_____

_____

_____

(2 marks)

One theory put forward is that *Homo floresiensis* evolved from normal sized *Homo erectus* that arrived on the island about 840,000 years ago. It is well documented that dwarfing of mammals occurs on islands.

f Suggest a reason for the phenomenon of dwarfing of mammals isolated on islands. Explain your answer.

_____

_____

_____

_____

_____

(2 marks)

Scientists found an array of stone tools with the skeletons of *Homo floresiensis*. Also present in the same cave were the remains of stegadons. Although these stegadons are small compared with modern elephants, they were still around 1000 kg in weight.

g What can be inferred from this information about the hunting practices of *Homo floresiensis*?

_____

_____

(1 mark)

Total 10 marks

END OF EXAMINATION

Acknowledgements:
Question 2 diagram sourced from:
Sci Art: The New Millenium, Compact Disc, Cambridge University Press
Question 6 diagrams sourced from the following website:
http://abcnews.go.com/technology/story?id=198867&page=1