Acknowledgments

SECTION 1

Page 4 'Courtship and Mating Behaviour of the Twelve-wired Bird of Paradise *Seleucidis melanoleuca*', pp. 133–140, Clifford B. Frith & Bruce M. Beehler, *Emu,* Vol. 97, 1997.

Page 6 Picture of wolves from The Wolf Education and Research Center: www.wolfcenter.org/Hertel/html/packs.htm

Page 7 Wolf drawings from *Year 13 Biology Study Guide,* p. 401, Martin Hanson, ESA Publications Ltd, 2001.

SECTION 2

Page 10 Drawing adapted from 'Quantitative genetic evidence that the timing of vegetative phase change in *Eucalyptus globulus* ssp. *globulus* is an adaptive trait', p. 562, *Australian Journal of Botany,* Vol. 48, 2000.

Page 11 Map from Max-Planck Institute for Plant Breeding Research: www.mpiz-koeln.mpg.de/pr/garten/schau/SecalecerealeL./Rye.html

Page 14 Origin of Modern Human diagrams adapted from *Year 13 Biology 2002: Student Resource and Activity Manual,* p. 272, Biozone International, 2001.

STDNT

(Supervisor's use only)

208

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

University Entrance, Bursaries and Scholarships Examination

BIOLOGY: 2002

QUESTION BOOKLET

9.30 am Thursday 21 November 2002
Time allowed: Three hours
(Total marks: 200)

Write your answers in the appropriate spaces in ANSWER BOOKLET 208/1.

This examination is divided into four sections. Answer **ALL** questions in Sections 1 to 3 and only **ONE** essay in Section 4.

Allocation of marks and suggested times you should allow for answering each question are as follows:

Section 1:	Animal Behaviour and Plant Responses (page 2)	50 marks:	45 minutes
Section 2:	Genetics and Evolution (page 8)	90 marks:	80 minutes
Section 3:	Techniques and Processes in Molecular Biotechnology (page 15)	20 marks:	20 minutes
Section 4:	Contemporary Biological Issues – Essay (page 18)	40 marks:	35 minutes

Check that this booklet has all of pages 2–19 in the correct order and that none of these pages is blank.

YOU MAY KEEP THIS QUESTION BOOKLET AT THE END OF THE EXAMINATION.

SECTION 1: ANIMAL BEHAVIOUR AND PLANT RESPONSES

(50 marks: 45 minutes)

Instructions: Answer all parts of all questions in this section. The space allocated in the Answer Booklet is a guide to the length and, in some cases, the format of the answers that are required.

QUESTION ONE (13 marks)

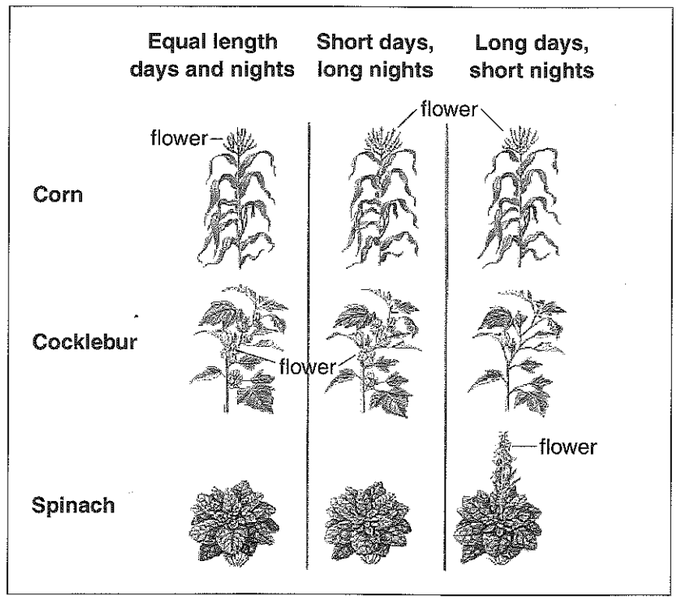
The changing length of day and night regulates the onset of flowering in many plants.

(a) Give the term that describes the regulation of activity in plants and animals by day and night length. (1 mark)

(b) Describe TWO advantages of having the time of flowering regulated by an environmental factor. (2 marks)

(c) Name ONE process in plants, other than flowering, controlled by the length of day and night. (1 mark)

Study the information in the diagram below, and then answer (d)–(g).



(d) Is spinach a short-day **or** long-day **or** day-neutral plant? (1 mark)

(e) Describe the environmental factor that initiates flowering in short-day plants. (1 mark)

(f) Explain how cocklebur, a short-day plant, can flower when day and night length are equal. (2 marks)

(g) In which TWO months from the list below would you expect cocklebur to flower in New Zealand?

November **January** **March** **May** (2 marks)

Poinsettia is a short-day plant with a critical day length of around 13 hours.

(h) Write the **letter** of the 24-hour cycle from the table below that will **prevent** flowering in poinsettia.

A	10 hours light/14 hours dark
B	4 hours light/20 hours dark
C	6 hours light/4 hours dark/light flash/14 hours dark
D	8 hours light/8 hours dark/8 hours light
E	2 hours light/20 hours dark/2 hours light

(1 mark)

Poinsettia plants were put in a glasshouse under conditions of short days and long nights.

(i) Explain what will happen to the flowering if the day period is interrupted with a few minutes of darkness. (2 marks)

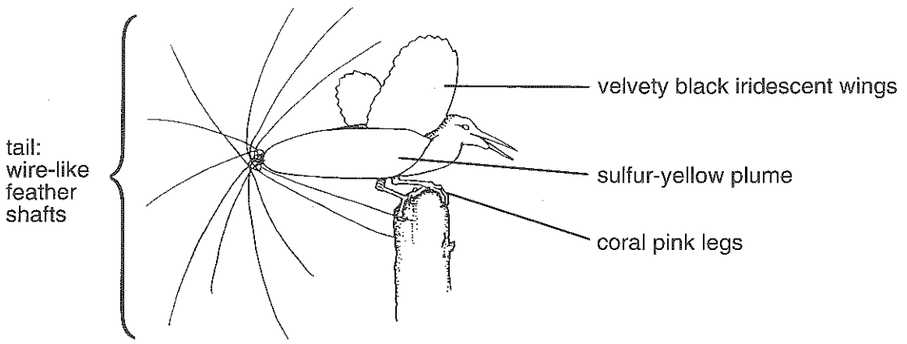
QUESTION TWO (12 marks)

The Twelve-wired Bird of Paradise is a territorial bird. For most of the year, the male bird does not allow other birds, including females, into his territory. The males use song to mark their territory and warn off other birds. The songs from birds occupying neighbouring territories will often be slightly different.

(a) Suggest ONE reason why the male Twelve-wired Bird of Paradise defends his territory. (1 mark)

(b) Explain why neighbouring birds have different songs. (2 marks)

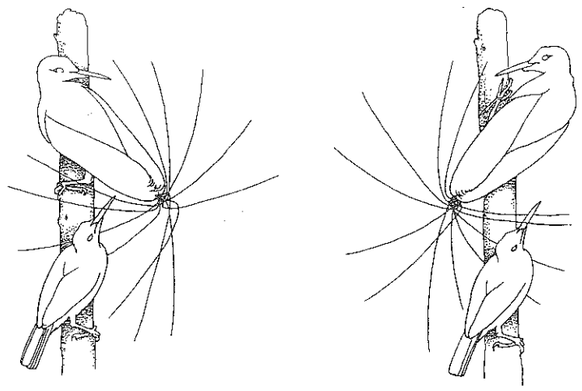
The Twelve-wired Bird of Paradise is a **sexually dimorphic** species. Below is a drawing of a male Twelve-wired Bird of Paradise. The female is predominantly brown with patches of black.



(c) Define **sexually dimorphic.** (1 mark)

(d) Females of many bird species often select the most colourful males as mates. What does this suggest about the suitability of such males as mates? (2 marks)

The male Twelve-wired Bird of Paradise performs an elaborate courtship display, part of which is shown below. Here the male is rhythmically swaying his body and brushing his 12 plume wires across the female below him.



(e) Describe TWO purposes of courtship behaviour. (2 marks)

The Twelve-wired Bird of Paradise finds a new mate each season, whereas the albatross mates for life.

(f) Explain how each bird **species** benefits from its mating strategy. (4 marks)

QUESTION THREE (11 marks)

The flower buds of the sunflower change the direction in which they are orientated during the day.

(a) Describe the environmental factor the flower buds are responding to. (2 marks)

Biologists have difficulty deciding if this response is a phototropic or photonastic response.

(b) Explain why the movement of the sunflower could be classified as **either** phototropic **or** photonastic. (3 marks)

One of the earliest studies of biological timing was done with honeybees in France and the United States of America. If this experiment is repeated under New Zealand conditions, the bees are first trained by supplying a sugar solution in the same place at the same time each day. Following this initial training, there are three experiments:

Experiment 1 – no sugar solution is supplied.

Experiment 2 – sugar solution is supplied at a different time.

Experiment 3 – the bees are moved to another time zone, eg Perth, four hours behind New Zealand.

The following table shows the results of such experiments.

Times that sugar solution is available and bees are foraging

	During initial training	Experiment 1 – No sugar solution	Experiment 2 – Sugar solution at a different time	Experiment 3 – Bees in Perth
Sugar solution available	10:00am–11:30am	–	1:30pm–3:30pm	10:00am–11:30am
Bees foraging (collecting food)	10:00am–11:30am	10:00am–11:30am	10:00am–11:30am	6:00am–7:30am

(c) What do these results suggest about the control of timing for bee foraging activity? (1 mark)

Different flowers produce nectar at different times of the day.

(d) Explain why the timing of foraging behaviour is important to the bees. (2 marks)

(e) The activity of a bee foraging for nectar is a circadian process. Explain what **circadian** means. (1 mark)

After a few days of exposure to the Perth daylight, the bees will start foraging at the times the sugar solution is available.

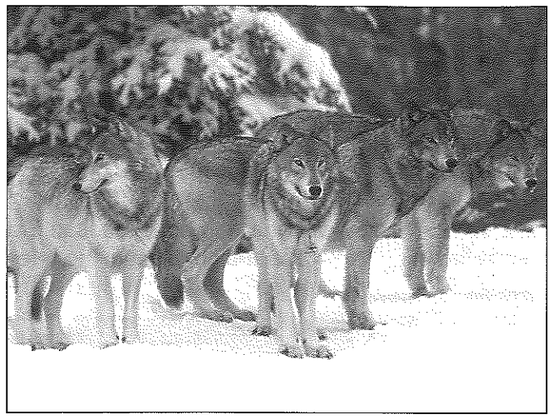
(f) What is the name given to this process? (1 mark)

(g) Describe the role of sunlight in this process. (1 mark)

(Turn over

QUESTION FOUR (14 marks)

Wolves are found in the wild only in northern Europe, Canada and the northern states of the United States of America. They are very social animals, living in family packs of up to 20 wolves.



The pack is well organised with a dominant animal, generally a male, as the alpha wolf. Next is the beta wolf who acts as the disciplinarian to reinforce the alpha's decisions. The omega wolf is the lowest-ranking member of the pack. The other wolves rank between the beta and omega wolves.

(a) Name the term that describes the social structure seen in wolf packs. (1 mark)

Wolves are often seen grooming each other and taking part in play fights.

(b) Describe how the following behaviours are important in maintaining the social structure of the pack:

(i) grooming

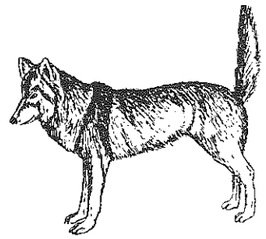
(ii) play fighting.

(4 marks)

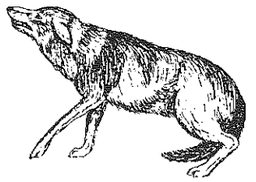
Young males will often leave the pack to find a mate and form a new pack.

(c) Explain how this benefits the wolf species. (2 marks)

The drawings below show two behaviours commonly seen in wolves.



A



B

(d) Give the letter of the behaviour that would be associated with the omega wolf. (1 mark)

(e) Explain why the omega wolf would display this behaviour. (2 marks)

The omega wolf is the last to get access to food and may be chased away from areas favoured by the dominant wolves. Despite this, the omega wolf remains within the pack.

(f) Describe TWO advantages to the omega wolf of remaining within, rather than leaving, the pack. (2 marks)

Wolf packs in Europe are generally much smaller than those in Canada.

(g) Suggest why pack sizes are smaller in Europe. (2 marks)

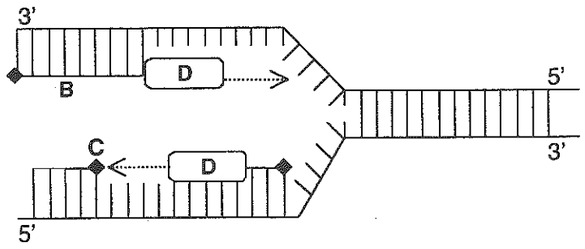
SECTION 2: GENETICS AND EVOLUTION

(90 marks: 80 minutes)

Instructions: Answer all parts of all questions in this section. The space allocated in the Answer Booklet is a guide to the length and, in some cases, the format of the answers that are required.

QUESTION ONE (16 marks)

Below is a diagrammatic representation of a biochemical process.



(a) Name the process represented by this diagram. (1 mark)

(b) Describe the function of structure **D**. (2 marks)

(c) Describe the significance that the 3' and 5' ends have in this process. (2 marks)

(d) Compare and contrast the ways in which strands **B** and **C** are formed. (4 marks)

(e) Explain why the process represented in the diagram above is necessary for the growth of living organisms. (3 marks)

Scientists are able to make synthetic mRNA by joining together nucleotides. If they use nucleotides with only one base, uracil, the resulting polypeptide consists only of the amino acid, phenylalanine. However, by using **two** bases, uracil and guanine, it is possible to code for **six** different amino acids. This is shown in the table below.

Nucleotide sequence in mRNA	Amino acids coded for
UUUUUUUUUUUUUUUUUU	phenylalanine
UUUGUGUUGUGUUGGGGU	phenylalanine, valine, cysteine, leucine, tryptophan, glycine

(f) For the amino acid **phenylalanine**, give the:

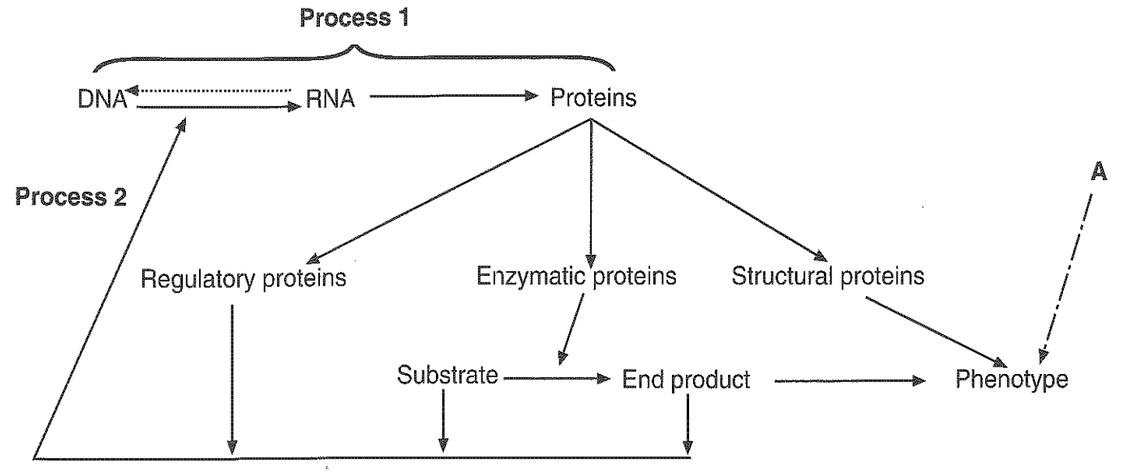
(i) corresponding DNA base sequence

(ii) tRNA anticodon. (2 marks)

(g) Explain how the information in the **table** supports the idea of a triplet code. (2 marks)

QUESTION TWO (8 marks)

The following diagram illustrates the relationship between DNA and the phenotype of an organism.



(a) Give the name of **Process 1**. (1 mark)

(b) Describe the function of:

(i) enzymatic proteins

(ii) regulatory proteins. (2 marks)

(c) Describe what is happening in **Process 2**. (2 marks)

Letter **A** represents factors external to the cell or organism that can influence the phenotype.

(d) Use the information in the diagram above to summarise the processes that contribute to the phenotype of an organism. (3 marks)

QUESTION THREE (11 marks)

Phenylketonuria (PKU) is a recessively inherited disorder caused by a genetic mutation. Sufferers lack the ability to synthesise an enzyme to convert the amino acid phenylalanine into tyrosine.

(a) Name ONE mutagen. (1 mark)

(b) Describe how a gene mutation can result in the production of an **ineffective** enzyme. (2 marks)

(c) Explain why a base deletion mutation may have a greater effect on **enzyme function** than a base substitution mutation. (4 marks)

Most mutation effects are only to the organism in which the mutation occurs and do not spread into the gene pool.

(d) Describe what needs to happen for a mutation to spread throughout a population. (4 marks)

(Turn over

QUESTION FOUR (7 marks)

In a common garden plant, two genes, Y and R, affect flower colour. Neither gene is completely dominant and the two interact with each other to produce seven different flower colours:

YYRR = crimson	YyRR = magenta
YYRr = orange-red	YyRr = magenta-rose
YYrr = yellow	Yyrr = pale yellow
yyRR, yyRr, and yyrr = white	

A crimson-flowered plant is crossed with a white-flowered plant (yyrr) and the offspring are allowed to cross breed.

(a) Give the **phenotype ratio** of:

(i) the F1 generation (1 mark)

(ii) the F2 generation. (4 marks)

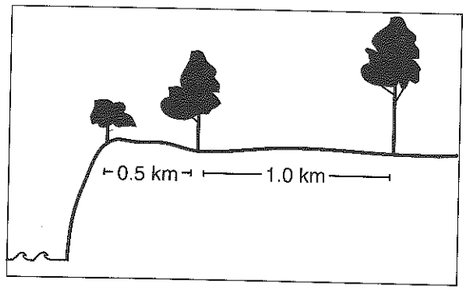
(b) There are **two** types of gene-gene interaction involved in the control of flower colour in this example. Name each type of interaction. (2 marks)

QUESTION FIVE (9 marks)

Eucalyptus globulus is a member of the Australian Eucalypt family. Like many plants, it displays considerable intraspecific variation.

(a) Define **intraspecific.** (1 mark)

One population of *E. globulus* grows over a 1.5 km range from an exposed coastal cliff top to sheltered, open forest. At the coastal end, mature trees are 3–4 m tall and start flowering when they are about 1 m high. In the forest, mature trees are 25 m tall and start flowering when they are 3–4 m high. This variation is an example of a cline.



(b) Suggest TWO experiments that could be carried out to establish whether this cline is caused by environmental **or** genetic variation. (4 marks)

Analysis of this population of *E. globulus* showed that the cline is due to genetic variation. This genetic variation, however, is not enough for speciation to have occurred.

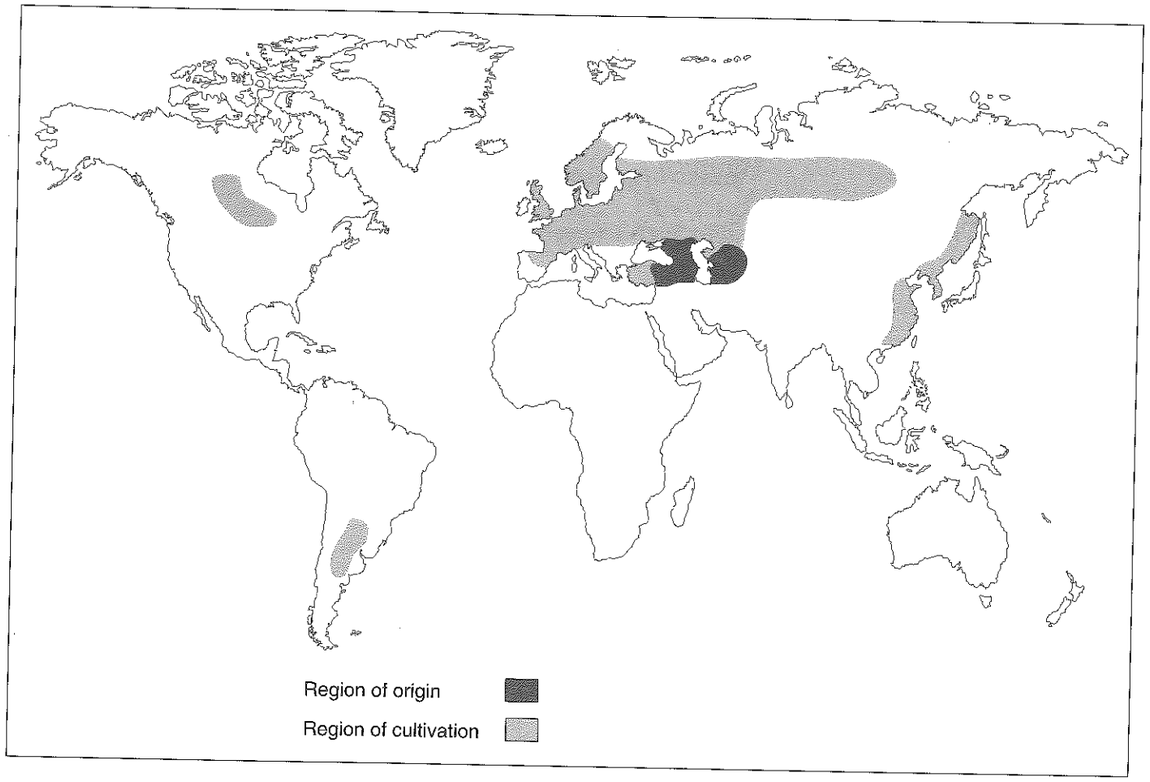
(c) Define **speciation.** (1 mark)

(d) Suggest why speciation has **not** occurred in this population. (1 mark)

(e) Identify TWO environmental selection pressures that could have resulted in the variation in tree height and flowering shown in this cline. (2 marks)

QUESTION SIX (9 marks)

Rye (*Secale cereale*) came to Europe from its origin in Asia Minor as a contaminant in the seeds of wheat and barley. In most of Europe, rye was regarded as a weed in the wheat crop because of its poor yield and grain quality. However, in the northern regions of Europe, under the **selection pressures** of cold, dry winters and poor soil, rye outcompeted the wheat and became the main cereal crop.



(a) Define **selection pressures.** (3 marks)

(b) Discuss the biological significance of the following statement: 'Individual organisms cannot adapt, only populations can'. (3 marks)

Artificial breeding between wheat (4N) and rye (2N) has resulted in a new hybrid cereal: triticale.

(c) Describe the likely purpose of the breeding programme that produced triticale. (2 marks)

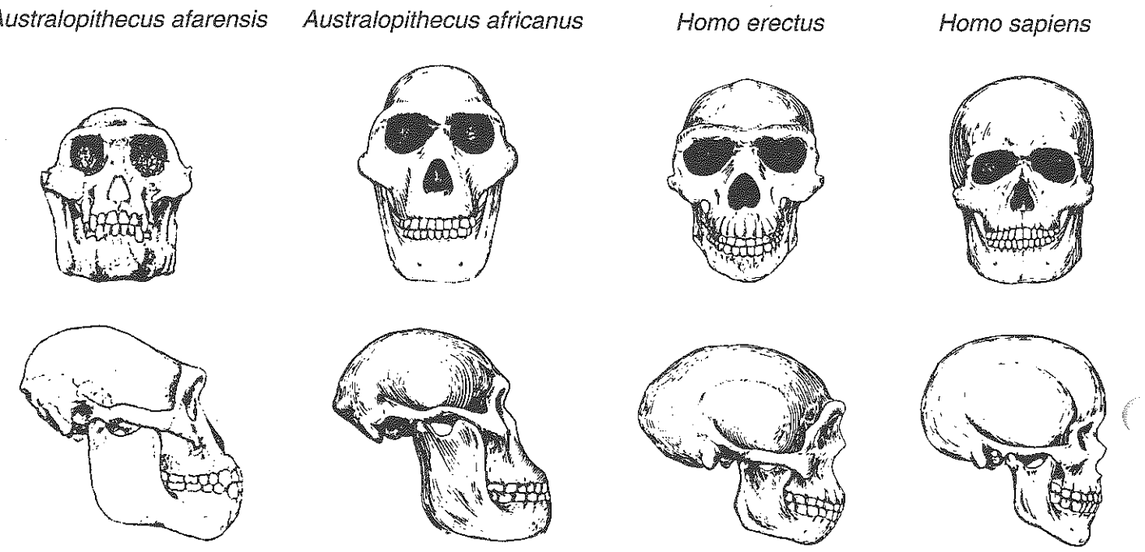
The initial hybrids produced were sterile, because they were 3N.

(d) Describe what needed to be done to produce a fertile plant from the sterile hybrid. (1 mark)

(Turn over

QUESTION SEVEN (14 marks)

Study the hominid skulls shown below.



Not drawn to scale

(a) Describe TWO changes to the skull that have occurred in the evolution of modern humans. (2 marks)

(b) For each change, suggest ONE reason why it has occurred. (4 marks)

(c) Discuss the importance of diet in the evolution of the brain. (2 marks)

Cultural evolution of humans led to major improvements in the quality and quantity of food.

(d) For THREE specific cultural developments, describe how each contributed to improvement in the quality and quantity of food. (6 marks)

QUESTION EIGHT (16 marks)

In 2001, the discovery of fossils belonging to a new species of hominid, *Orrorin tugenensis,* was announced. The dating of these fossils indicates a likely time range of 5.7–6.1 million years ago.

(a) Describe how a paleoanthropologist would estimate the age of hominid fossils like *Orrorin tugenensis.* (2 marks)

(b) Give the name of the hominid **genus** that *Orrorin tugenensis* is likely to be most closely related to. (1 mark)

Initial analysis suggests that *Orrorin tugenensis* was bipedal.

(c) For each of the following skeletal structures, describe TWO characteristics that could indicate bipedalism:

(i) skull

(ii) knee

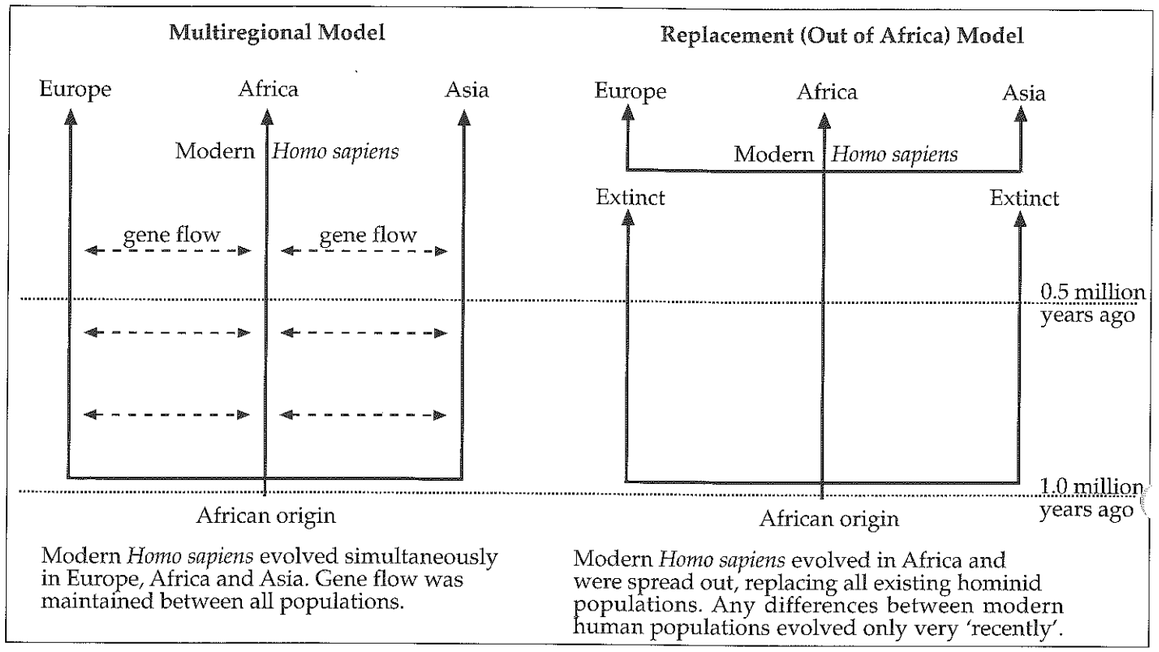
(iii) foot. (6 marks)

There are currently two theories that account for the origin and dispersal of modern *Homo sapiens.* Both models agree that hominids first left Africa around 1–2 million years ago.

(d) Give the scientific name of the hominid species that first migrated out of Africa. (1 mark)

(e) Explain how the ice ages aided in the dispersal of hominids across the world. (2 marks)

The models below present some information about the origin of modern humans.



(f) Identify the statements below that support each model. Write the corresponding letter in the correct column of the table in the Answer Booklet.

A	The oldest *Homo sapiens* fossils have only been found in Africa. They are dated to 80 000–120 000 years old.
B	The oldest *Homo sapiens* fossils found outside Africa are thought to be 60 000 years old. They were found in Australia.
C	Asian fossils show a clear transition from older hominid to modern *Homo sapiens.*
D	Analysis of mitochondrial DNA shows a high degree of similarity between all modern human populations. The differences are likely to have occurred during the last 150 000–200 000 years.

(4 marks)

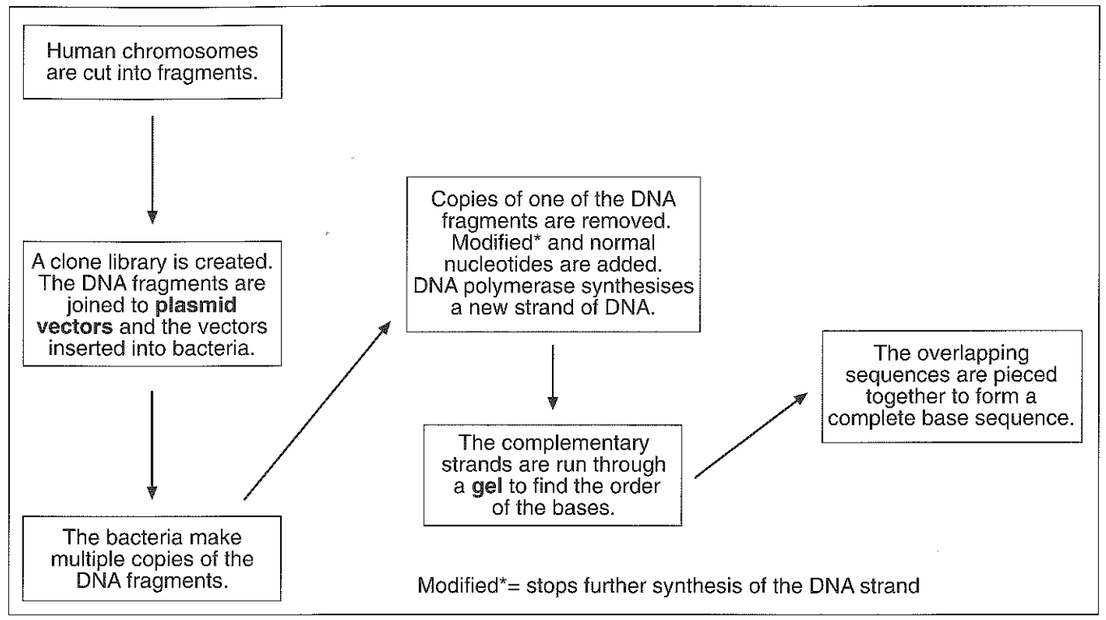
SECTION 3: TECHNIQUES AND PROCESSES IN MOLECULAR BIOTECHNOLOGY

(20 marks: 20 minutes)

Instructions: Answer all parts of all questions in this section. The space allocated in the Answer Booklet is a guide to the length and, in some cases, the format of the answers that are required.

QUESTION ONE (11 marks)

Below is a flow chart showing a simplified overview of the processes involved in sequencing the human genome.



(a) What is a **genome**? (1 mark)

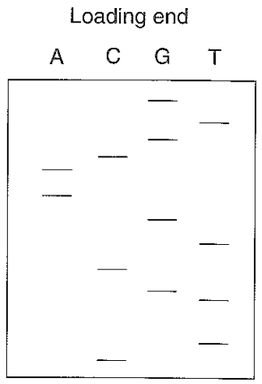
(b) Describe the use of each of the following in the sequencing of a genome:

(i) plasmid vectors

(ii) gel electrophoresis. (4 marks)

(c) Describe TWO properties of restriction enzymes that make them such a valuable tool in genome analysis. (2 marks)

Below is a graphic representation of part of a gel after the DNA fragments have been run through it.



(d) State the sequence of bases found in this fragment of DNA. (2 marks)

(e) Describe TWO benefits that could result from sequencing the human genome. (2 marks)

QUESTION TWO (9 marks)

New Zealand scientists have produced transgenic animals that produce particular human proteins. Producing a transgenic animal is more complex than producing transgenic bacteria or plants.

(a) Give ONE reason why the following organisms are easier to genetically modify than animals:

(i) bacteria

(ii) plants. (2 marks)

(b) Explain why bacteria cannot be used to produce these particular human proteins. (1 mark)

(c) Describe how the gene coding for the human protein is inserted into the animal. (2 marks)

(d) Match the recombinant DNA tool in the table below with the letter of its use.

Recombinant DNA Tool		Use	
1.	DNA ligase	A	Production of DNA from mRNA
2.	Taq DNA polymerase	B	Joins DNA at the sticky ends
3.	Reverse transcriptase	C	Makes multiple copies of a fragment of DNA
4.	PCR	D	Creates complementary strands of DNA in PCR

(4 marks)

SECTION 4: CONTEMPORARY BIOLOGICAL ISSUES – ESSAY

(40 marks: 35 minutes)

INSTRUCTIONS

1. *Write an essay on ONE of the topics listed below.*
2. *Each topic has **two** options. Choose ONE option only.*
3. *In your essay, you should include **social**, **ethical** and **biological** aspects when discussing implications of the issue.*
4. *You should write about 500 words in total (2–3 pages). The space in your Answer Booklet is more than adequate and should not be exceeded.*
5. *A space has been provided in your Answer Booklet to plan your essay. This plan will NOT be marked.*
6. *Marks will be awarded for:*
   - *presenting an essay that answers the question* *(30 marks)*
   - *communicating knowledge and ideas logically and clearly.* *(10 marks)*

(Total = 40 marks)

LIST OF TOPICS

Topic 1: Biological Control

Option 1

Write a submission in support of more research into biological control methods for pests or weeds. Using a New Zealand* example to support your case, describe the biological control methods used to control the named pest or weed. Discuss the benefits and the implications for the New Zealand* environment of choosing biological control methods.

OR:

Option 2

Write a submission on the problems associated with methods of biological control of pests or weeds. Using a New Zealand* example, describe the biological control methods that have been used to control a named weed or pest. Discuss the implications for the New Zealand* environment of using biological control methods and the reasons why the biological control methods will never eradicate the pest or weed.

OR:

Topic 2: Biodiversity in Aquatic Environments in New Zealand*

Option 1

Write a submission to support existing conservation measures or the implementation of new conservation measures in aquatic environments, with reference to at least one named aquatic environment in New Zealand*. Describe the conservation measures that are being or could be used. Discuss the implications of these measures for the conservation of biological diversity of indigenous species in this environment.

OR:

Option 2

Write a submission that supports the reduction of conservation measures in aquatic environments, with reference to at least one named aquatic environment in New Zealand*. Discuss the implications of these measures that justify their reduction. Include an explanation of why some conservation measures are still needed to conserve the biological diversity of indigenous species in this environment.

OR:

Topic 3: Genetically Modified Organisms

Option 1

Write a submission supporting an increase in research into genetically modified organisms in New Zealand*. In your submission, describe the methods used in plant crop or farm animal genetic modification. Discuss the potential benefits of genetic modification. Highlight any potential implications and describe how these might be overcome. Support your position with reference to relevant New Zealand* or international examples where possible.

OR:

Option 2

Write a submission supporting the moratorium on the release of genetically modified organisms into the field in New Zealand*. Include a description of the methods used in plant crop or farm animal genetic modification. Discuss the potential advantages and disadvantages of having New Zealand* free of genetically modified organisms. Support your position with reference to relevant New Zealand* or international examples where possible.

* Candidates who attend a Pacific Island school may write their essay with reference to their own country.