TONGA GOVERNMENT
MINISTRY OF EDUCATION AND TRAINING

Tonga National Form Seven Certificate
2014

BIOLOGY

QUESTION AND ANSWER BOOKLET

Time Allowed: 3 Hours

INSTRUCTIONS

Write your Student Personal Identification Number (SPIN) on the top right hand corner of this page and on the last page. Answer ALL QUESTIONS. Write your answers in the appropriate spaces provided in this Booklet. If you need more space for answers, ask the supervisor for extra paper. Write your SPIN on all extra sheet used and number the question clearly. Attach the extra sheets at the appropriate places in this Booklet.

| QUESTION ONE: Intraspecific Competition | 4 marks | 5 min |
| QUESTION TWO: Animal Timing Behavior | 10 marks | 11 min |
| QUESTION THREE: Animal Orientation Behavior | 12 marks | 15 min |
| QUESTION FOUR: Interspecific Competition | 11 marks | 13 min |
| QUESTION FIVE: DNA and Protein Synthesis | 18 marks | 22 min |
| QUESTION SIX: Mutation | 12 marks | 14 min |
| QUESTION SEVEN: Gene –gene Interaction | 13 marks | 15 min |
| QUESTION EIGHT: Gene Linkage and Inheritance | 9 marks | 11 min |
| QUESTION NINE: Trisomy in Human Autosome | 9 marks | 11 min |
| QUESTION TEN: Speciation | 11 marks | 13 min |
| QUESTION ELEVEN: Pattern Of Evolution | 14 marks | 17 min |
| QUESTION TWELVE: Natural Selection | 11 marks | 13 min |
| QUESTION THIRTEEN: PCR and DNA Profiling | 16 marks | 20 min |

TOTAL MARKS 150MARKS

Check that this Booklet contains page 2 – 31 in the correct order and that page 30 is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION

TOTAL MARKS 150
QUESTION 1: INTRASPECIFIC COMPETITIONS (4 MARKS)

1. a) Define intraspecific competition.

___________________________________________________________________________________
___________________________________________________________________________________ (1 mark)

The takahe is a native New Zealand bird, which is highly endangered. It is confined to a small area of alpine grasslands in the Fiordland area. It is a stocky, flightless bird which feeds on the native tussock grasses of its habitat. During the summer months, male takahe establishes and maintains territories. They mate for life.

The diagram below represent the summer territories of takahe in the same Fiordland valley during 1967 and 1980. Territories held by unmated males are marked with a black spot.

b) Discuss the strategies shown by the Takahe to enhance reproductive success, so promoting the survival of the species.

___________________________________________________________________________________
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___________________________________________________________________________________ (3 marks)
QUESTION 2: ANIMAL TIMING BEHAVIOUR (10 MARKS)

1. Internal Timing Systems are often called Biological Clock. These internal Rhythms will continue even in the absence of environmental cues (although with a slightly different period than that observed in the natural environment).

   a) Describe the function of biological clocks in each of the diagrams below labeled A-D.

<table>
<thead>
<tr>
<th>DIAGRAM</th>
<th>FUNCTION OF BIOLOGICAL CLOCKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
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<tr>
<td>B</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
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</tbody>
</table>

   (4 marks)

P.2
b) Name the organisms, and describe two examples of activities where preparation for environmental events is required for A and B in the diagrams on page 3.

i) Organism A __________
   Activity __________

ii) Organism B __________
    Activity __________ (2 marks)

c) Using a named animal, describe a social activity that requires synchronization.
___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________
(1 mark)

d) Describe an orientation behavior that requires time compensation.
___________________________________________________________________________________
___________________________________________________________________________________
(1 mark)

2. a) Describe the purpose of a Zeitgeber.
___________________________________________________________________________________
___________________________________________________________________________________
(1 mark)

b) Describe a common Zeitgeber in animals.
___________________________________________________________________________________
___________________________________________________________________________________
(1 mark)
QUESTION 3: ANIMAL ORIENTATION BEHAVIOUR (12 MARKS)

1. Kokako (Callaeas cinerea) is an endangered species that inhabits the native forest canopy. Gliding flight is uncommon and it gets around mainly by running and hopping along branches or gliding between trees. It’s diets consists of insects, berries and leaves.

   The diagram below shows the daily rhythm displayed by Kokako and Kiwi.

![Diagram of Kokako and Kiwi daily rhythm]

   a) Describe the type of rhythm and activity pattern displayed by Kokako.

   ____________________________________________________________
   ____________________________________________________________

   (1 mark)

   b) Describe the type of rhythm and activity pattern displayed by Kiwi.

   ____________________________________________________________
   ____________________________________________________________

   (1 mark)
c) Describe the possible selection pressures that may have determined these rhythms in:

i) Kokako:

________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________

(1 mark)

ii) Brown Kiwi

________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________

(1 mark)

2. Distinguish between diurnal, nocturnal, and crepuscular activity. Identify how each activity is linked to the daily rhythm.

________________________________________________________________________________
________________________________________________________________________________
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(2 marks)
3. The diagrams below show the record of spontaneous activity of two species of cockroaches over several days. The dark phase is shaded.

![Graphs showing cockroach activity](image)

**Celatoblatta subcorticaria**

**Celatoblatta undulivitta**

- **Key:** 
  - Dark
  - Light

a) Describe ONE similarity and ONE difference in the activities of the two species of cockroaches.

___________________________________________________________________________________
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(4 marks)
4. The diagram below shows homing in Salmon.

a) Describe the mechanism used by Salmon to return to the stream where they hatched.

______________________________________________________________________________________
______________________________________________________________________________________
______________________________________________________________________________________

(1 mark)

b) Study the map shown above, and discuss the evidence indicating that the method of Navigation is not foolproof.

______________________________________________________________________________________
______________________________________________________________________________________
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(1 mark)
QUESTION 4:  INTERSPECIFIC COMPETITION  (11 MARKS)

The diagram below shows the distribution of ecologically similar damsel fish over a coral reef at Heron Island, Queensland, Australia. The habitat and resource requirement of these species overlap considerably.

**a)** Describe TWO ways in which species can avoid directly competing for the same resources in their habitat.

(i) _____________________________________________________________________

__________________________________________________________________________

(ii) _____________________________________________________________________

__________________________________________________________________________

(2 marks)

**b)** Explain why **intraspecific** competition is more intense than **interspecific** competition.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

(2 marks)

**c)** Describe the mechanism by which interspecific competition for resources can be minimized

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

(2 marks)
d) During their breeding season, some types of animals spend large amounts of time and energy on courtship behavior. Some courtship behavior of the wandering albatross (Diomedea exulans) is shown below.

**Courtship behaviour in the wandering albatross**

i) Besides visual displays, name **TWO** other forms of behavior that may have evolved with courtship.

___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________

(2 marks)

ii) Describe the **THREE** distinct ways in which courtship behavior may increase the chances of successful mating to produce viable offspring.

___________________________________________________________________________________
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(3 marks)
1. The diagram below represents DNA Replication involving a number of large molecules. Some of these molecules have been labeled with the letters P, Q, R, S.

a) Describe the role of the molecule labeled Q, in the diagram.

___________________________________________________________________________________
___________________________________________________________________________________

(1 mark)

b) Explain why the process going from a → b is proceeding in opposite direction on each of the two sides of molecule P.

___________________________________________________________________________________
___________________________________________________________________________________

(1 mark)

c) Explain why the replication of DNA is described as being semi-conservative.

___________________________________________________________________________________
___________________________________________________________________________________

(1 mark)
d) Discuss the significance of accurate DNA replication.

___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________
(2 marks)

2. a) Select ONE Nucleic acid from the list that matches with each nucleic acid to which descriptions below.

(i) __________ is a double helical molecule
(ii) __________ transport amino acids
(iii) __________ is a component of ribosomes. 

DNA, mRNA, tRNA, rRNA

(3 marks)

b) (i) Complete the following missing bases, on the molecules below that involve in protein synthesis.

G T ___ A C ___ T ___ A G C A ___ ___ C
___ ___ T ___ ___ G ___ C ___ ___ ___ ___ A A ___ DNA
G ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ mRNA
___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ tRNA

(2 marks)
Use the genetic code **fig 11.11** to answer the following questions.

<table>
<thead>
<tr>
<th>First base of codon (5’ end)</th>
<th>Second base of codon</th>
<th>Third base of codon (3’ end)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>phe</td>
<td>U</td>
</tr>
<tr>
<td>phe</td>
<td>ser</td>
<td>C</td>
</tr>
<tr>
<td>leu</td>
<td>ser</td>
<td>A</td>
</tr>
<tr>
<td>leu</td>
<td>ser</td>
<td>G</td>
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<tr>
<td>C</td>
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<td>U</td>
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<tr>
<td>leu</td>
<td>pro</td>
<td>C</td>
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<td>leu</td>
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<td>A</td>
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<td>leu</td>
<td>pro</td>
<td>G</td>
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<tr>
<td>A</td>
<td>Ile</td>
<td>U</td>
</tr>
<tr>
<td>Ile</td>
<td>thr</td>
<td>C</td>
</tr>
<tr>
<td>Ile</td>
<td>thr</td>
<td>A</td>
</tr>
<tr>
<td>met + START</td>
<td>thr</td>
<td>G</td>
</tr>
<tr>
<td>G</td>
<td>val</td>
<td>U</td>
</tr>
<tr>
<td>val</td>
<td>ala</td>
<td>C</td>
</tr>
<tr>
<td>val</td>
<td>ala</td>
<td>A</td>
</tr>
<tr>
<td>val</td>
<td>ala</td>
<td>G</td>
</tr>
</tbody>
</table>

ii) Suppose the first base G from the left is deleted from mRNA segment. What will be the amino acid sequence produced?

iii) Why would it be incorrect to say that the organism produced is a mutant?

iv) Explain why can’t a codon consist of fewer than three bases?

(1 mark)

(1 mark)

(1 mark)
3. In studies involving synthesis of DNA, why should radioactive thymine be more suitable for use as a radioactive tracer than radioactive cytosine, guanine or adenine?

___________________________________________________________________________________
___________________________________________________________________________________

(1 mark)

4. Write True or False. Explain your answer.
   i) A mutation is a change in the genetic code.

___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________

(2 marks)

   ii) A change in a triplet may not result in a change in protein structure.

___________________________________________________________________________________

(1 mark)

   iii) The tertiary structure of a protein depends indirectly on the DNA base sequence.

___________________________________________________________________________________

(1 mark)
QUESTION 6: MUTATION (12 MARKS)

1. a) For each of the chromosome mutation illustrated below, write the original gene sequence and the new gene sequence after the mutation has occurred and type of mutation occurred in i) to iv).

<table>
<thead>
<tr>
<th>Type of mutation</th>
<th>Original sequence</th>
<th>Mutated Sequence</th>
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</thead>
<tbody>
<tr>
<td>i)</td>
<td></td>
<td></td>
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<tr>
<td>ii)</td>
<td></td>
<td></td>
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<td>iii)</td>
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<tr>
<td>iv)</td>
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</tbody>
</table>

b) State which of the above type of block mutation in a) above is likely to be the least damaging to organism. Give a reason for your answer.

___________________________________________________________________________________
___________________________________________________________________________________

(2 marks)
2. The examples below illustrate block mutations in human chromosome. Individuals with these karyotype could produce faulty gametes and also gametes either missing or with extra genetic material.

![Chromosome images]

a) The photograph above was taken by the cytogenetic department at Vaiola hospital in Tongatapu.
Using the diagram and the explanations on the diagram as a guide, draw arrows to show the movement of chromosome segments on the photographs. (3 marks)

b) Identify the kind of chromosome rearrangement shown in each photo. Give a reason for your answer.

(i) Chromosome 15

(ii) Chromosome 1 and 10

(iii) Chromosome 14 and 21

(3 marks)
QUESTION 7: GENE-GENE INTERACTION (13 MARKS)

1. a) Complete the diagram below, to show the resulting gametes, genotypes and sex of the offspring in the WZ type where females are WZ and male is ZZ.

   ![Diagram showing gametes, genotypes, and sex determination in WZ type] (2 marks)

b) Explain what determines the sex of the offspring at the moment of conception in human.

___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________

(1 mark)

c) Discuss the modes of sex determination in animals emphasizing the differences between them.

___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________

(3 marks)
2. The fruit of the squash plants come in three colors – white, green and yellow. The dominant allele of a gene for no color (white) is epistatic to a gene for a specific color (at a second locus) if it is present in the dominant form (W). In order for squash to be green or yellow, the color gene must be homozygous recessive. At the locus codes for yellow color while g codes for green.

If white heterozygous parents are crossed:

a) Name this type of gene interaction.

__________________________________________________________________________ (1 mark)

b) Give genotypes of white heterozygous parents

__________________________________________________________________________

__________________________________________________________________________ (1 mark)

c) What might be the genotypes of these squash colors?

(i) white ____________________

(ii) yellow: __________________

(iii) Green: ___________________ (3 marks)

d) Draw a punnet square for a cross between white heterozygous parents. Give the F₁ phenotypic ratio of the offspring.

\[ \begin{array}{|c|c|}
\hline
|   |   |
\hline
| W | W |
\hline
| G | G |
\hline
\end{array} \]

(2 marks)
QUESTION 8: GENE LINKAGE AND INHERITANCE (9 MARKS)

1. A woman with Gene Linkage from Matuku Island has a family history with the disease rickets, went to Dr ‘Akau’ola to obtain genetic counselling. In this case, the husband is normal and the wife is affected. The wife’s father was not affected by this disease. They wanted to determine what are their chances of having a child born with this condition. They would also like to know what probabilities of having an affected boy are or affected girl.

Use the symbols below to complete diagram and determine the probabilities stated below. (Expressed as a proportion or percentage)

<table>
<thead>
<tr>
<th>Allele types</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_R =$ affected by rickets</td>
</tr>
<tr>
<td>$X =$ normal</td>
</tr>
</tbody>
</table>

a) Complete the diagram to show the possible genotypes of the children from a cross between an affected wife whose father was normal and a normal husband.

b) Determine the probability that the couple might have:

(i) affected children __________________
(ii) an affected girl __________________
(iii) an affected boy __________________ (3 marks)

c) Using examples other than those above, discuss the role of sex linkage in the inheritance of genetic disorders.

___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________ (3 marks)
QUESTION 9: TRISOMY IN HUMAN AUTOSOMES. (9 MARKS)

1. a) Study the three Karyotype photographs (A-C) above. Identify three chromosomes that cause Down Syndrome by placing a circle around them, on the diagram above. (3 marks)

   b) Identify the Karyotype and the chromosomes trisonic, for the following syndromes.

   - Down Syndrome: Karyotype ________ Chromosome ________________
   - Edward Syndrome: Karyotype ________ Chromosome ________________
   - Patau Syndrome: Karyotype ________ Chromosome ________________

   (3 marks)

2. Describe the characteristics of the phenotype of a Down Syndrome person.

   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

   (2 marks)

3. Explain why the presence of an extra chromosome has such a profound effect on the development of phenotype.

   ________________________________________________________________
   ________________________________________________________________

   (1 mark)
QUESTION 10: SPECIATION (11 MARKS)

1. a) Define Speciation.

___________________________________________________________________________________

(1 mark)

b) Explain why allopatric speciation would be less likely to occur on an island close to the mainland than on a more isolated island of the same size.

___________________________________________________________________________________

(1 mark)

2. Normal watermelon plants are diploid \(2n = 22\) but breeders have produced tetraploid \(4n = 22\) watermelons. If tetraploid plants are hybridized with their diploid relatives, they produce triploid \(3n = 33\) seeds. These offspring can produce triploid seedless watermelons and can further be propagated by cutting. Are the diploid and tetraploid watermelon plants different species? Explain.

___________________________________________________________________________________

(1 mark)

3. Madagascar is a large island off the east coast of Africa, and was once part of the mainland. The baobab tree is believed to have originated in Africa with only one species on the mainland but six species on Madagascar. Suggest why there are more species on Madagascar island than in continental Africa.

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(4 marks)
4. The diagram shows the distribution of two species of tree frog, Hyla *ewigi* and *H. verreriuxi*, in South East Australia. Oscillographs (sound traces) of the male mating calls are also shown.

a) Describe what is meant by the terms *allopatric* and *sympatric*.

__________________________________________________________________________________

__________________________________________________________________________________

__________________________________________________________________________________

(1 mark)

b) Suggest an evolutionary explanation for the mating calls of the two species which are similar in areas where only one of the two species is present, but markedly different in areas where both species live.

__________________________________________________________________________________

__________________________________________________________________________________

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(2 marks)

c) Describe ONE key difference between *allopatric* and *sympatric* species.

__________________________________________________________________________________

__________________________________________________________________________________

__________________________________________________________________________________

(1 mark)
QUESTION 11: PATTERN OF EVOLUTION (14 MARKS)

1. Evolution may cause related species to become different (diverge), or as shown in Diagram A unrelated species to become similar (converge) as shown in Diagram B.

From the diagram shown below answer the following questions:

![Diagram A](image1.png)  
![Diagram B](image2.png)

In the hypothetical example of divergent evolution illustrated in Diagram A, left.

a) Explain the type of evolution that produces species B from species D.

__________________________________________________________________________  
__________________________________________________________________________  
(1 mark)

b) Describe the type of evolution that produces species P and H from species B:

__________________________________________________________________________  
__________________________________________________________________________  
(1 mark)
c) Name all species that evolved from a:

common ancestor D___________________________
common ancestor B___________________________  (2 marks)

d) Explain why species B, P and H all have a physical trait that is not found in species D or W.

___________________________________________________________________________________
___________________________________________________________________________________  (1 mark)

2. a) Explain the difference between divergence and adaptive radiation.

___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________

(2 marks)

b) Discuss the differences between Parallel Evolution and Convergent Evolution.

___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________

(2 marks)

3. Early taxonomists originally classified the New Zealand grey Warbler bird into the same family as Warblers found in the Northern Hemisphere. As a result of recent DNA analysis the New Zealand grey Warbler has been reclassified into a genetically unrelated group.

Explain the pattern of evolution that is demonstrated in this example.

___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________

(2 marks)
4. Seabirds such as albatross molly mawk, titi and petrel have undergone adaptive radiation from an ancestral species to become the many hundreds of different species of seabird species seen today. One major characteristics of this group is the amount of time they spend out at sea, only returning to land to breed.

Discuss how adaptive radiation may have occurred in this group of birds.

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(3 marks)
QUESTION 12 : NATURAL SELECTION (11 MARKS)

In 1940’s and 1950’s, coal burning was still high around industrial centers of Manchester and Liverpool in England. During this time, the melanic form of the moth was still very dominant. In the rural areas further South and West of these industrial centers, the grey or speckled forms increased dramatically.

The diagram below shows the Frequency of melanic peppered moth related to reduced air pollution.

Use the diagram above to answer the following questions.

1. a) The populations of peppered moth in England have undergone changes in the frequency of an obvious phenotypic character over the last 150 years. Describe the phenotypic character that changed in its frequency.

___________________________________________________________________________________
___________________________________________________________________________________

(1 mark)

b) Identify the (proposed) selective agent for phenotypic change in Boston.

___________________________________________________________________________________
___________________________________________________________________________________

(1 mark)

c) Describe how the **selective pressure** on the light coloured morph has changed with the changing environmental conditions over the last 150 years.

___________________________________________________________________________________
___________________________________________________________________________________

___________________________________________________________________________________

(3 marks)
2. The industrial centers for England in 1950 were located around London, Birmingham, Liverpool, Manchester, and Leeds, Glasgow in Scotland also had a large industrial base.
   a) Comment on how the relative frequencies of the two forms of peppered moth were affected by the geographic location of industrial regions.

   ____________________________________________________
   ____________________________________________________
   ____________________________________________________
   ____________________________________________________
   ____________________________________________________

   (1 mark)

   The level of summer smoke pollution dropped around Manchester and Liverpool between 1960 and 1985.
   b) State how much the pollution dropped by.

   ____________________________________________________
   ____________________________________________________
   ____________________________________________________

   (1 mark)

   c) Describe how the frequency of the darker melanin form responded to this reduced pollution.

   ____________________________________________________
   ____________________________________________________
   ____________________________________________________

   (1 mark)

3. In the example of the peppered moths, state whether the selection pressure is disruptive, stabilizing or directional.

   ____________________________________________________
   ____________________________________________________
   ____________________________________________________

   (1 mark)

4. Outline the difference between natural and artificial selection.

   ____________________________________________________

   (1 mark)

5. Discuss the statement “The environment directs natural selection”.

   ____________________________________________________
   ____________________________________________________
   ____________________________________________________

   (1 mark)
QUESTION 13: PCR AND DNA PROFILING (16 MARKS)

1. Malau birds or the megapodes are an endangered species of Niuafo'ou. One of the biggest killer of Megapodes are cats. The dead Malau was sent to Scientists in hope that DNA could be extracted from the cat's saliva on the feathers of the Malau to create a DNA PROFILE.

The technique of PCR shown below is likely to be used on any DNA found in the cat’s saliva.

A

F

C

E

B

D
a) Arrange the 6 steps in the diagram for PCR process in the correct order, from the start to the end.

___________________________________________________________________________________
(1 mark)

b) Give a brief description of each step you have identified in a) above.

___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________
(5 marks)

2. Outline TWO advantages of Polymerase Chain Reaction.

___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________
(2 marks)

3. DNA produced from PCR will be subjected to the technique of gel electrophoresis.
   a) Give the purpose of gel electrophoresis.

___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________
(2 marks)

   b) Explain how gel electrophoresis works to achieve this purpose.

___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________
(2 marks)

   c) Explain how the resulting DNA profile may be used to identify the killer cat.

___________________________________________________________________________________
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(4 marks)
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# Tonga National Form Seven Certificate 2014
## BIOLOGY
(for marker use only)

<table>
<thead>
<tr>
<th>QUESTIONS</th>
<th>MARK</th>
<th>CHECK MARKER</th>
<th>TOTAL</th>
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<tbody>
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<td>ONE</td>
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<td>THIRTEEN</td>
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<td><strong>TOTAL MARKS</strong></td>
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<td><strong>150</strong></td>
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