MARKER CODE

Student Personal Identification Number

South Pacific Form Seven Certificate

BIOLOGY

2016

QUESTION and ANSWER BOOKLET

Time allowed: Two and a half hours

INSTRUCTIONS

Write your **Student Personal Identification Number (SPIN)** in the space provided on the top right hand corner of this page.

Answer **ALL QUESTIONS**. Write your answers in the spaces provided in this booklet.

If you need more space for answers, ask the Supervisor for extra paper. Write your SPIN on all extra sheets used and clearly number the questions. Attach the extra sheets at the appropriate places in this booklet.

Major Learning Outcomes (Achievement Standards)	Skill Level Band			Weight/ Time
	1 *Basic*	2 *Proficient*	3 *Advanced*	
BioA: Describe, explain and discuss biological concepts and processes relating animal behaviour to biotic and abiotic environmental factors AND explain and discuss how the behaviour contributes to the organism's survival.	11 items	2 items	1 item	18% 38 min
BioC: Describe, explain and discuss biological concepts and processes relating to gene expression.	12 items	3 items	2 items	24% 52 min
BioD: Describe, explain and discuss biotechnology applications and the human needs and demands for the applications.	2 items	1 item	1 item	7% 15 min
BioF: Describe, explain and discuss processes and patterns of evolution.	9 items	3 items	2 items	21% 45 min
Total	34 items	9 items	6 items	70% 150 min

Check that this booklet contains pages 2-23 in the correct order and that none of these pages is blank.

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

SECTION A: Animal Behaviour

Assessor's use only

A1

A slater *(Porcellio scaber)* turns rapidly when exposed to hot dry conditions, but slows down as the temperature drops.

https://museumvictoria.com.au/pages/639/image001.jpg

Name this behaviour and describe the importance of this behaviour for the slater.

Skill Level 1	
Basic	
Weak	
NR	

A2

Monarch butterflies from North America migrate to warmer climates of Mexico over winter, where they breed in the mountain hillsides of oyamel forests. The next generation of Monarch butterflies migrate north again as the summer season approaches.

Should the migratory behaviour of the Monarch butterfly be described as innate or learned behaviour? Give a reason for your choice.

Skill Level 1	
Basic	
Weak	
NR	

A3

Monarch butterflies use a combination of air currents and thermals to travel long distances, as they migrate. Monarch butterflies only travel during the day and need to find a roost at night.

Suggest **two** methods of navigation that Monarch butterflies are likely to use to locate their over-wintering habitat as they migrate.

Skill Level 1	
Basic	
Weak	
NR	

Assessor's use only

A4 Maggots feed off live and rotting animal flesh.

A student recorded how far a maggot moved away from a light source in 20 seconds. The student investigated this behaviour when the maggot was placed at four different starting distances from the light source. A fresh maggot was used for each trial. The results are shown below.

http://www.budgetpestcontrolpgh.com

Distance of lamp from maggot (cm)	Distance maggot moves away in 20 s (cm)			Mean (Average) (cm)
	Trial 1	Trial 2	Trial 3	
20	1.2	1.3	1.2	1.2
15	2.6	2.3	2.3	2.4
10	3.8	3.2	3.4	3.5
5	4.1	4.2	4.1	4.1

State the behaviour the maggots appear to be showing ***and*** explain the adaptive advantages this behaviour provides the maggot.

Skill Level 2	
Proficient	
Basic	
Weak	
NR	

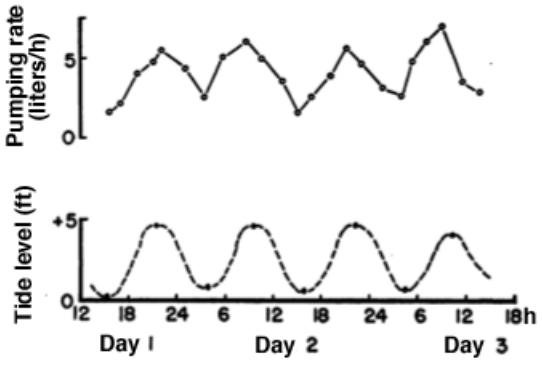
A5 Research using the desert ant *Cataglyphis* has shown that when the ant leaves its nest to go foraging, it counts the steps and keeps a record of how many steps it is away from home at any given time. In addition, it also records changes in direction.

State the behaviour shown by *Cataglyphis* ***and*** describe an advantage for this behaviour for this particular ant species in its habitat.

Skill Level 1	
Basic	
Weak	
NR	

Assessor's use only

A6 Research on the mussel *Mytilus californianus* revealed the following rhythm when pumping seawater through its gill filaments.



http://www.asnailsodyssey.com/IMAGES/MUSSEL/Rao1954Fig2.gif

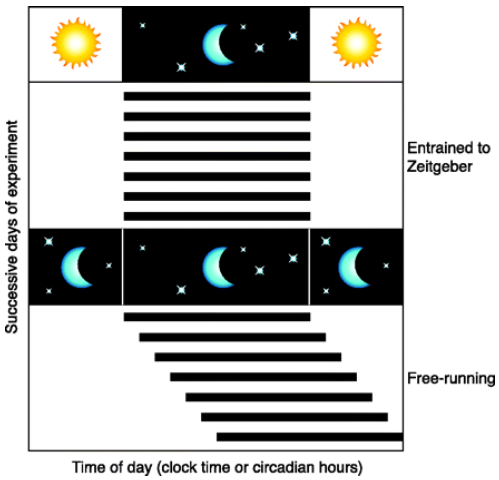
The rhythm was found to be independent of temperature and was shown to continue in the laboratory in both constant darkness and continuous light for a 4-week period.

Discuss this rhythm of the *Mytilus californianus* mussels. In your answer you must; (i) Describe the type of cycle shown by the mussels. Support your answer using data from the graph; (ii) Define the term *endogenous* and (iii) Explain from the information given, why the pumping cycle rhythm shown by *Mytilus californianus* is endogenous and why this rhythm has adaptive advantages for the mussels

Skill Level 3	
Advanced	
Proficient	
Basic	
Weak	
NR	

Assessor's use only

A7 The actogram shows the effect on an animal's circadian rhythm when it is moved from a light-dark routine to a routine of constant darkness.



http://d6igaq6njxgjh.cloudfront.net/content/physrev/90/3/1063/F2.medium.gif

Describe the terms *entrainment* and *free-running* as shown in the actogram.

Entrainment: _____

_____

Free-running: _____

_____

_____

Skill Level 1	
Basic	
Weak	
NR	

A8 The Fijian crested iguana, *Brachylophus vitiensis,* is classed as a critically endangered species. A single population exists on the island of Yadua Taba within natural and regenerating forests.

Two factors influencing the survival of the Fijian crested iguana on Yadua Taba are the removal of grazing **feral goats** and the removal of **invasive plant species**.

Describe why these factors are important in the protection of the Fijian crested iguana population on Yadua Taba.

_____

_____

_____

_____

_____

_____

_____

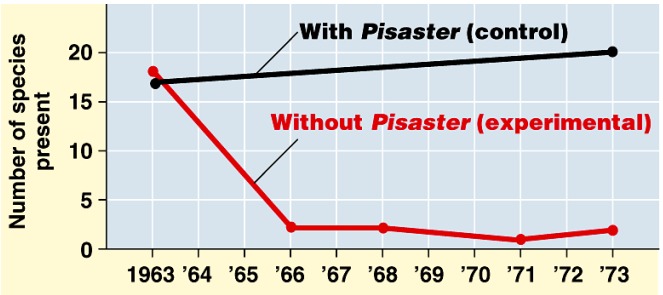
Skill Level 1	
Basic	
Weak	
NR	

Assessor's use only

A9

The sea star, *Pisaster ochraceous,* and the mussel, *Mytilus californicus,* are two of at least twenty commonly found species that co-exist on the rocky shoreline of coastal Catalina Island (USA). The sea star *Pisaster ochraceous* is an important predator.

The numbers of sea star were reduced by removal from experimental areas of the shoreline over a ten-year period, which allowed the mussel populations in the experimental areas to expand into new habitats.
The effects on species diversity over the ten-year period are shown in the graph below.



http://www.hammiverse.com/lectures/53/images/1-5.png

Explain the role of the sea star, *Pisaster ochraceous,* in the intertidal community.

Skill Level 2	
Proficient	
Basic	
Weak	
NR	

A10

An ecological study of the population of Fijian crested iguana, *Brachylophus vitiensis,* on the island of Yadua Taba found a very high population density. Larger males and females hold high quality territories, but their home ranges frequently overlap with others.

Define the difference between territory and home range.

Skill Level 1	
Basic	
Weak	
NR	

A11

Polygyny is a mating system that is commonly found in mammals, where dominant males control access to females and are highly territorial.

Describe **one** benefit of polygynous mating behaviour to the reproductive group.

Skill Level 1	
Basic	
Weak	
NR	

Assessor's use only

A12 Mammals and birds are animals known for their usually high levels of parental care. This type of care has advantages and disadvantages for the family unit.

Describe **one** advantage to animals that exhibit a high level of parental care.

Advantage:_____

Skill Level 1	
Basic	
Weak	
NR	

A13 Gannets nesting on cliff tops at Muriwai, near Auckland, New Zealand form dense, orderly colonies. Despite the crowded conditions, the gannets return regularly to breed at the colony site.

Apart from gaining some protection from predators by nesting in large numbers, describe **one other** possible advantages of this kind of cooperative breeding behaviour.

Skill Level 1	
Basic	
Weak	
NR	

A14 Bottlenose dolphins establish and maintain dominance by biting, chasing, jaw-clapping, and smacking their tails on the water.

http://ambientbluecreative.com/animals

State the type of interaction that is occurring between the bottlenose dolphins and describe **one** reason why bottlenose dolphins display these types of behaviour.

Skill Level 1	
Basic	
Weak	
NR	

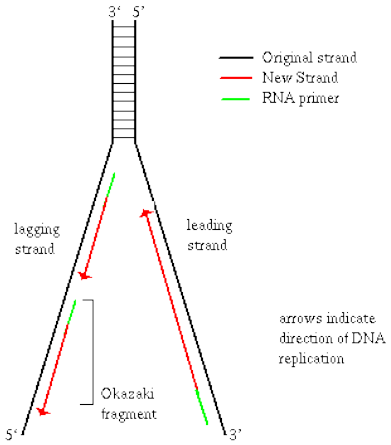
SECTION B: Gene Expression.

Assessor's use only

B1 The diagram represents the replication of a DNA molecule.

http://www.austincc.edu/emeyerth/fork.gif

Define the terms 3' and 5' as shown in the diagram.



Skill Level 1	
Basic	
Weak	
NR	

B2 Use the diagram above to describe the meaning of Okazaki fragments.

Skill Level 1	
Basic	
Weak	
NR	

B3 Use the diagram from question B1 to answer the following:

What causes the complementary strands of the DNA molecule to run anti-parallel to each other?

Skill Level 1	
Basic	
Weak	
NR	

B4 During protein synthesis, the DNA molecule provides the coding for the manufacture of a RNA molecule.

What will be the order of nucleotides in the mRNA molecule produced by this section of a template strand of DNA?

ACGGTGCACGAGATT

Skill Level 1	
Basic	
Weak	
NR	

Assessor's use only

B5 Use the codon table to answer the following questions.

(wikimedia.org/wikipedia/commons/2/21/06_chart_pu3.png)

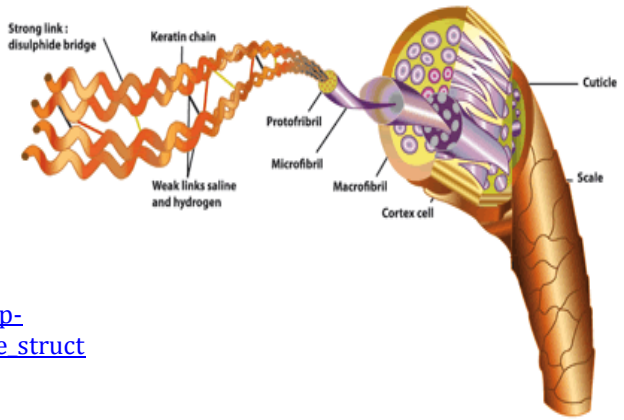
First letter	Second letter: U	Second letter: C	Second letter: A	Second letter: G	Third letter
U	UUU Phe, UUC Phe, UUA Leu, UUG Leu	UCU Ser, UCC Ser, UCA Ser, UCG Ser	UAU Tyr, UAC Tyr, UAA Stop, UAG Stop	UGU Cys, UGC Cys, UGA Stop, UGG Trp	U, C, A, G
C	CUU Leu, CUC Leu, CUA Leu, CUG Leu	CCU Pro, CCC Pro, CCA Pro, CCG Pro	CAU His, CAC His, CAA Gln, CAG Gln	CGU Arg, CGC Arg, CGA Arg, CGG Arg	U, C, A, G
A	AUU Ile, AUC Ile, AUA Ile, AUG Met	ACU Thr, ACC Thr, ACA Thr, ACG Thr	AAU Asn, AAC Asn, AAA Lys, AAG Lys	AGU Ser, AGC Ser, AGA Arg, AGG Arg	U, C, A, G
G	GUU Val, GUC Val, GUA Val, GUG Val	GCU Ala, GCC Ala, GCA Ala, GCG Ala	GAU Asp, GAC Asp, GAA Glu, GAG Glu	GGU Gly, GGC Gly, GGA Gly, GGG Gly	U, C, A, G

A mutation leads to a single substitution of the 6th nucleotide of the DNA template strand ACGGTGCACGAGATT. It changes from G to A.

Describe the effect this has on the polypeptide strand that is coded for ***and*** explain your answer.

Skill Level 2	
Proficient	
Basic	
Weak	
NR	

B6 The diagram shows the formation of keratin, which is found in human hair. The protein structure of keratin helps to determine if the hair is straight or curly.



www.hairtransplantmentor.com/wp-content/uploads/2015/03/keratine_structure_en.png

Using the diagram, discuss how the primary keratin structure forms a secondary coiled structure and then how the secondary structure contributes to curly hair.

Continue: _____

_____

_____

_____

_____

_____

_____

_____

Skill Level 3	
Advanced	
Proficient	
Basic	
Weak	
NR	

B7 Down's Syndrome is a genetic condition that occurs as a result of a child inheriting an additional chromosome 21, resulting in 47 chromosomes instead of the normal 46. This condition is an example of aneuploidy.

About 4% of Down's Syndrome cases result from a rare event where a chromosome 21 attaches itself to another chromosome, often chromosome 14, in one of the parents.

Where this type of mutation happens, there is a 1 in 2 chance that the child will have Down's Syndrome.

Explain how this would happen.

_____

_____

_____

_____

_____

_____

_____

Skill Level 2	
Proficient	
Basic	
Weak	
NR	

B8 Polyploidy is a chromosome mutation that is common in plants but rare in animals.

Describe the type of change in chromosome number when a plant undergoes polyploidy.

_____

_____

_____

Skill Level 1	
Basic	
Weak	
NR	

Assessor's use only

B9	A woman with blood group A has a child with blood group O. The paternity of the child is not known. One possible father has blood group AB and another has blood group A. Construct genetic diagrams in the space below to show which one of these men could definitely **not** be the father of the child. _____ _____	**Skill Level 1** Basic ☐ Weak ☐ NR ☐
B10	When two alleles of a gene are dominant and recessive, crossing heterozygotes gives a 3:1 ratio of phenotypes in the offspring. Describe the ratio of phenotypes in the offspring when the two alleles are co-dominant. You may use a diagram. _____ _____ _____ _____	**Skill Level 1** Basic ☐ Weak ☐ NR ☐
B11	On an exposed coastal walkway, two different plant species, A and B, were found to be growing horizontally along the ground. One of each plant type was transferred to an inland greenhouse where conditions were provided for maximum growth. Species A continued to grow horizontally along the ground, whereas Species B changed its growing pattern and grew upright. Identify the **cause** of the horizontal growth pattern for each species when growing in the coastal habitat. Species A: _____ _____ Species B: _____ _____	**Skill Level 1** Basic ☐ Weak ☐ NR ☐

Assessor's use only

B12 Two varieties of pea plant, each of which was pure-breeding for white flowers were crossed. This produced an F_1 generation in which all offspring had purple flowers.

Two F_1 plants were crossed to create the F_2 generation. In this generation, a total of 364 purple-flowered plants and 286 white-flowered plants were produced.

a) Describe this type of gene interaction. You may give the ratio or name it.

_____

b) Using the letters A and B to represent the flower colour genes, show the genotypes of the F_1 generation flowers and show how the F_1 gene combinations can produce this F_2 phenotype ratio.

Genotypes: _____

F_2 Phenotypes: _____

Skill Level 3	
Advanced	
Proficient	
Basic	
Weak	
NR	

B13 In maize the alleles for yellow colour (C) and smoothness (S) are dominant over the alleles for colourless (c) and wrinkled (s).
A test cross was carried out, where the dihybrid CcSs maize variety was crossed with the homozygous recessive (ccss).
In the table below are the expected outcomes and the actual outcomes, given in percentages, from the test cross.

	CS	Cs	cS	cs
cs	CcSs	Ccss	ccSs	ccss
expected %	25	25	25	25
actual %	48.5	1.5	1.5	48.5

Why are the actual results different from the expected outcome in this case?

_____

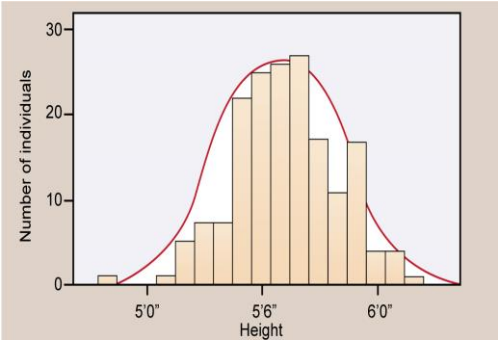
_____

_____

Skill Level 1	
Basic	
Weak	
NR	

Assessor's use only

B14 The heights of a group of 160 students was measured and a histogram was produced from the results, as shown.



Does this represent an example of polygenic inheritance or pleiotropic inheritance?

_____

Give a reason for your answer.

_____

_____

_____

_____

Skill Level 1	
Basic	
Weak	
NR	

B15 Point colouration is a phenotype found in Siamese cats and other animals, resulting from a mutation of an enzyme that affects melanin production.

Darker pigment appears at the extremities of the body, which becomes even darker in winter.

Describe the type of gene interaction that causes this effect and the factor that controls it.

_____

_____

_____

Skill Level 1	
Basic	
Weak	
NR	

B16 Red-green colour blindness is a recessive sex-linked gene.
In the space below, demonstrate why red-green colour blindness is a phenotype that is expressed in males and rarely in females, **but** a trait that is carried by females. You may use a punnet square.

_____

_____

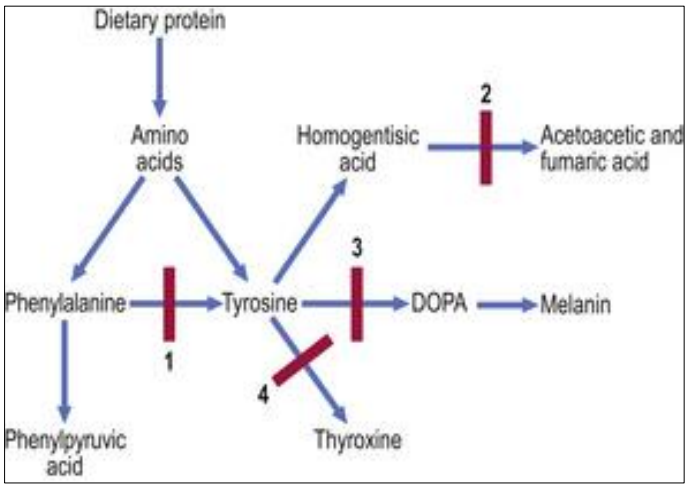
_____

_____

Skill Level 1	
Basic	
Weak	
NR	

Assessor's use only

B17 The metabolism of the essential amino acid phenylalanine is shown below, in simplified form.



Key to enzymes:

1. phenylalanine hydroxylase
2. homogentistic acid oxidase
3. tyrosinase
4. thyroxine forming enzymes (thyroid)

Phenylketonuria (PKU) is a condition that affects approximately 1 in 1000 newborn infants. If left untreated it can lead to loss of skin pigment, fits and slowed mental development.

Explain how PKU is caused **and** how it can be treated.

Skill Level 2	
Proficient	
Basic	
Weak	
NR	

SECTION C Biotechnology Applications.

Assessor's use only

C1 A section of the DNA strands from a bacterial plasmid used to take up an isolated gene are shown below, before being cut with restriction enzymes.

The restriction enzymes to be used and their cutting sites are also shown. Only one of the enzymes cuts within this sequence.

```
G A C C G A C G T C G G T T        Bam1     C↓CTAG  G
C T G G C T G C A G C C A A                  G   GATC↑C

                                   Pst1     G↓ACGT   C
                                            C   TGCA↑G
```

In the space below, draw the two strands after cutting and label the DNA sequences that form the sticky ends.

Skill Level 1	
Basic	
Weak	
NR	

C2 DNA profiling can be used to identify short repeating sequences of non-coding DNA, called short tandem repeats, or STRs.

DNA samples used for profiling are usually too small for profiling.

Briefly describe how a DNA sample can be made large enough for analysing.

_____

_____

_____

Skill Level 1	
Basic	
Weak	
NR	

C3 Transgenesis is an important biotechnology application that is used for reliable and plentiful supplies of medically important proteins.

Two techniques used in the application of transgenesis involve the use of pronuclear ('micro') injection and viral vectors.

Explain the important differences between these two techniques.

_____

_____

_____

_____

_____

_____

_____

_____

Skill Level 2	
Proficient	
Basic	
Weak	
NR	

Assessor's use only

C4

Beta-carotene is needed by the human body to produce vitamin A, which is involved in many functions, including vision, immunity, foetal development, and skin health.
Rice does not contain beta-carotene in its edible endosperm, but genetic engineering can be used to introduce **two** genes to produce a metabolic pathway that expresses beta-carotene in the endosperm of rice.
The gene for **phytoene synthase** (PSY) found in daffodil plants can synthesise a colourless carotene. The gene for the enzyme **carotene desaturase** (CRT1), found in soil bacteria, can catalyse multiple steps in the production of beta-carotene.

Discuss how genetic engineering could be used to modify rice plants so that they produce beta-carotene. In your answer, describe a suitable vector for this process and justify your choice. Give detailed explanations of the processes involved.

Skill Level 3	
Advanced	
Proficient	
Basic	
Weak	
NR	

SECTION D Processes and Patterns of Evolution.

Assessor's use only

D1 The diagram represents homologous chromosomes, on which there are matching alleles.

The diagram also shows that each chromosome is made up of several genes, labelled A to I.

http://nevinerk.weebly.com/uploads/5/2/9/9/5299320/1815752.gif

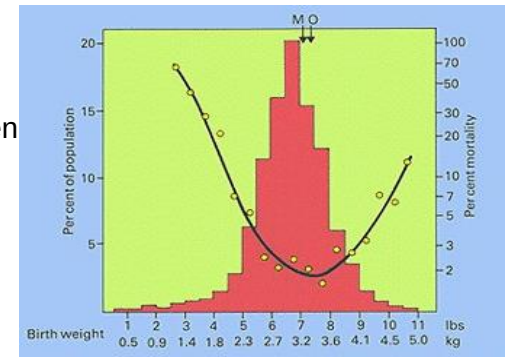
Describe how the genes D and C, on the same chromosome, may become separated.

Skill Level 1	
Basic	
Weak	
NR	

D2 Describe **one** way that sexual reproduction provides advantages over asexual reproduction in the long term.

Skill Level 1	
Basic	
Weak	
NR	

D3 The histogram shows the distribution of mass at birth of children born in a hospital over a 12-year period. The line graph shows the percentage death rate of children by 4 weeks of age, compared to mass at birth. 'O' is the optimal birth rate and 'M' is the mean birth mass.



Describe what this information says about natural selection in human babies.

Skill Level 1	
Basic	
Weak	
NR	

Assessor's use only

D4	Define the term *fitness* when applied to a population of organisms **and** describe **one** effect *fitness* is likely to have on the population gene pool. _____ _____ _____ _____ _____ _____ _____	**Skill Level 1** Basic ☐ Weak ☐ NR ☐
D5	Explain why a dominant allele for an unfavourable condition is likely to disappear from a population faster than a recessive allele for an unfavourable condition. _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____	**Skill Level 2** Proficient ☐ Basic ☐ Weak ☐ NR ☐

Assessor's use only

D6	Compare and contrast *natural selection* and *artificial selection.* In your answer you should define **both** terms and consider: • selection agents and selection pressures • selection outcomes.	

Skill Level 3	
Advanced	
Proficient	
Basic	
Weak	
NR	

Assessor's use only

D7

The Hawaiian Islands are 3000 Km from the nearest continent. Formed relatively recently, the islands have patches of forest separated by wide lava flows. High mountains cause climate variation.

There are more than 8000 species of fruit fly on the islands, showing a wide diversity in phenotypes.

Genetic analysis show that they are all related to a single species that may have arrived on the islands around 8 million years ago.

Hawaiian Islands
(http://www.hawaiicity.com/travel/hotel%20pictures/map2c.GIF)

Discuss how such a large number of fruit fly species might have evolved on Hawaii.

Skill Level 3	
Advanced	
Proficient	
Basic	
Weak	
NR	

Assessor's use only

D8

A male zebra (2N = 44) and a female donkey (2N = 62) are able to mate and produce a hybrid offspring called a "zebronkey".
However the zebronkey offspring are sterile.

Describe this type of reproductive isolating mechanism **and** give a biological reason why it has occurred.

Skill Level 1	
Basic	
Weak	
NR	

D9

The courtship behaviour of empid flies involves elaborate displays and presentation of items of prey. The sexual organs of empid flies are also like a "lock and key" so that physical reproduction is specific.

Describe the features of empid fly reproduction that ensure that it is species specific.

Empid flies mating.
(https://lh6.googleusercontent.com/-cpsZTH1DZ4k/TuogQg6RYRI/AAAAAAAQIk/qKlaoIcSGfE/s800/Empid-flies-20100426b.JPG)

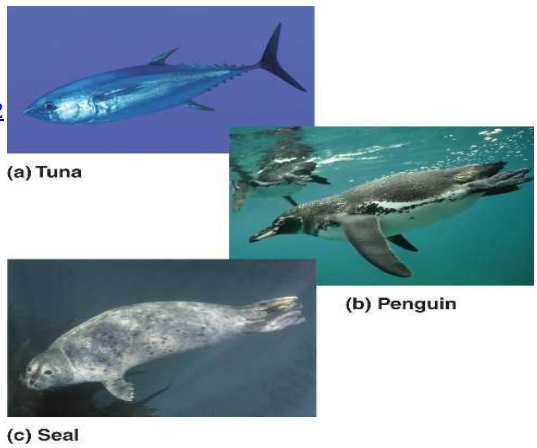
Skill Level 1	
Basic	
Weak	
NR	

D10

The species shown are examples of convergent evolution.

http://bio1152.nicerweb.com/Locked/media/ch40/40_02ConvergentEvolution.jpg

Describe why these animals illustrate convergent evolution **and** give **one** possible selection pressure that has led to their evolutionary convergence.



Skill Level 1	
Basic	
Weak	
NR	

Assessor's use only

D11

The Fatu Hiva Monarch lives on the remote island of Fatu Hiva, 1500 Km from Tahiti.

The Monarch is a critically endangered bird species, currently numbering 25 adults and perhaps only 5 fertile pairs.

http://ibc.lynxeds.com/files/pictures/Pomarea_whitneyi_M_3.Imagen_fija004.jpg

The population has increased slowly, with 2 chicks in 2012, 6 chicks in 2013 and 8 chicks in 2014.

Explain why, as the population recovers slowly, it will remain critically endangered and at risk of extinction.

Skill Level 2	
Proficient	
Basic	
Weak	
NR	

D12

A species of cycad palm, *Cycas seemanni*, is found existing in small populations on islands in Fiji, New Caledonia and Vanuatu.

A study showed that this species of cycad palm shows low genetic variation **within** each island population, but the genetic variation **between** island populations of *C. seemanni* is very high.

http://www.endemia.nc/images/dynamique/imgflore3231_46790e.jpg

Despite being wind-pollinated, *Cycas seemanni* palms produce relatively heavy pollen and large seeds that tend to fall straight down to the ground.

Explain how these properties concerning reproduction might be contributing to the pattern of genetic variation seen both within and between the *Cycas seemanni* populations and suggest what might be happening to the island populations of *Cycas seemanni* in terms of evolution.

Explanation:

Suggestion:

Skill Level 2	
Proficient	
Basic	
Weak	
NR	

Assessor's use only

D13

Lake Masoko is a small volcanic crater lake, only 700 m wide, located in southern Tanzania.
Scientists have studied two distinct populations of Cichlid fish found in this small lake. One population is found near the lakeshores, whilst the other population is found in the deeper areas of the lake.
Whole genome sequences show small but significant differences in the genomes of each population.

Scientists believe this species of Cichlid is undergoing evolutionary changes.

From the information given state the type of evolutionary change occurring and describe the evidence for this change.

Skill Level 1	
Basic	
Weak	
NR	

D14

Scientists' investigations have found no single factor that fully explains the evolutionary changes in Lake Masoko's Cichlid fish populations, but genetic variation has led to external colour changes and minor shape changes, hormone signalling changes and changes in low light intensity vision among the Cichlids.

Describe at least **two** ways that natural selection might be working on the Cichlid populations in Lake Masoko.

Skill Level 1	
Basic	
Weak	
NR	