METHODIST LADIES' COLLEGE

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Methodist Ladies' College
Semester 1 Examination, SAMPLE

Question/Answer Booklet

BIOLOGY
ATAR Year 12

Student Name: _____

Teacher Name: _____

Time allowed for this paper
Reading time before commencing work: 10 minutes
Working time for paper: 3 hours

Materials required/recommended for this paper
To be provided by the supervisor
This Question/Answer Booklet
Multiple-choice Answer Sheet

Number of additional answer booklets used (if applicable):	

To be provided by the candidate
Standard items: pens (blue/black preferred), pencils (including colours), sharpener, correction fluid/tape, eraser, ruler, highlighters
Special items: non-programmable calculators approved for use in the WACE examinations

Important note to candidates
No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of total exam	Mark
Section One: Multiple-choice	30	30	40	30	30	
Section Two: Short response	6	6	90	100	50	
Section Three: Extended answer Part A	3	2	50	40	20	
Part B	3	2				
				Total	100	

Instructions to candidates

1. The rules for the conduct of ATAR course examinations are detailed in the 2016 Year 12 Information Handbook. Sitting this examination implies that you agree to abide by these rules.

2. Answer the questions according to the following instructions.

   Section One: Answer **all** questions on the separate Multiple-choice Answer Sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through the square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answer. No marks will be given if more than one answer is completed for any question.

   Sections Two and Three: Write your answers in this Question/Answer Booklet. Wherever possible, confine your answers to the line spaces provided. Use a black or blue pen for this section. Only graphs and diagrams may be drawn in pencil.

3. You must be careful to confine your responses to the specific questions asked and to follow any instruction that are specific to a particular questions.

4. Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
   - Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
   - Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the questions that you are continuing to answer at the top of the page.

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Section One: Multiple-choice 30% (30 Marks)

Suggested time: 40 minutes

This section has **30** questions. Answer **all** questions on the separate Multiple-choice Answer Sheet provided. For each question shade the box to indicate your answer. Use only a blue or black pen to shade the boxes.
If you make a mistake, place a cross through that square, do not erase or use correction fluid, and shade your new answer. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

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1. Organisms can transmit their genes to the next generation through all the following processes except one. This one is:

   a) binary fission
   b) meiosis
   c) mitosis
   d) mutation

2. DNA profiles used as evidence in criminal trials look something like supermarket bar codes. The pattern of bars in a DNA profile shows

   a) the presence of various-size fragments of DNA
   b) the order of genes along particular chromosomes
   c) the order of bases in a particular gene
   d) the presence of dominant or recessive alleles for particular traits

3. Putting a human gene into the plasmids of bacteria has enabled scientists to

   a) insert the corrected gene into patients who have certain genetic disorders
   b) match DNA found at a crime scene to a suspect's DNA
   c) use bacteria as "factories" for protein products such as insulin
   d) use these bacteria to mass-produce mRNA for certain genes

4. Genetic engineers insert genetic markers into plasmids containing genes of interest so that

   a) they will be able to work out the sequence of the plasmid genome
   b) they will know which bacteria have taken up the plasmid
   c) the gene of interest will be automatically expressed once the bacteria take it up
   d) the chances that the bacteria will take up the plasmid are greatly increased

See next page

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5. The theory of natural selection involves which of the following principles?

    a) Species evolve because individuals respond to environmental change.

    b) There is competition between individuals for survival.

    c) The physically strongest organisms are the ones most likely to survive.

    d) Since species become extinct, the number of species in existence will decrease over time.

The next three questions refer to the following information:

A biologist is investigating the effect of different chemicals to see whether they cause mutations in plant cells undergoing mitosis. She eventually hopes to cause mutations in the rose gene for flower colour in the hope of making a truly blue rose. She tests compounds X, Y and Z on tissue cultures of rose bud cells, and then allows the buds to develop.

6. Given the description of this investigation, which statement best represents the hypothesis being tested?

    a) Roses will mutate faster in the presence of chemicals than without.

    b) X will cause more mutations in rose bud cells than Y, Z, or no compounds.

    c) More blue genes will be created in the presence of X than Y or Z.

    d) More rose cells undergoing mitosis will turn blue than non-dividing cells

7. Which of the following changes would improve the reliability of the investigation results?

    a) Using as many possible different species of plant related to roses

    b) Growing the plants in a range of different temperatures to see which is best

    c) Using many different samples of the same tissue culture

    d) Including X rays as well as chemicals to increase the likelihood of mutations

8. A control group for this experiment would be

    a) Testing a range of cells from different parts of the rose plant

    b) Using the same concentrations of chemicals on another type of plant

    c) Repeating the experiment again later to see if the results are the same

    d) Growing tissue cultures of rose bud cells with no added chemicals

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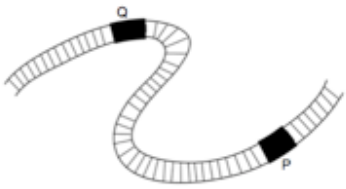
9. The genome of a small virus is depicted below, showing the positions of cutting sites (P and Q) for two restriction enzymes.



The length of the DNA fragment obtained when using each restriction enzyme alone is shown in the table below:

Cutting site	Restriction enzyme used	Length of DNA fragments obtained (kB)
Q	**EcoR1**	**3, 7**
P	**BamH1**	**8, 2**

If both EcoR1 and BamH1 are used **together** on this same viral DNA section, the length of fragments obtained would be

a) 3, 8, 5, 2

b) 7, 2, 1

c) 3, 5, 2

d) 3, 7, 8, 2

10. Modern zoos keep detailed breeding and DNA profile records of their animals. Sometimes animals will be transported around the world to breed. Zoos do this to

a) ensure that only the few fittest animals of each species breed together.

b) minimise breeding of closely related animals.

c) compensate for the lack of natural selection in captive animals.

d) prevent predators killing captive animals.

11. Which of the following statements about gene flow is true?

a) Gene flow occurs only as a result of immigration.

b) Allele frequency in a population will not change as a result of gene flow.

c) Gene flow increases the mutation rate in a population.

d) Gene flow can cause new alleles to enter the gene pool.

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12. A soil bacterium (*Agrobacterium tumefaciens*) infects roses and fruit trees, stunting their growth. A similar bacterium *(A. radiobacter*) was genetically modified to include a plasmid gene coding for an antibiotic lethal to *A. tumefaciens*. *A. radiobacter* has a gene which gives it resistance to this antibiotic. A transfer gene located on the plasmid enables the plasmid to insert itself into other bacteria. Suspensions of genetically modified bacteria are applied to the soil around plants to prevent stunting of growth.

For this treatment to be successful in preventing damage to the growth of the roses and fruit trees, genetic modification of *A. radiobacter* would need to include:

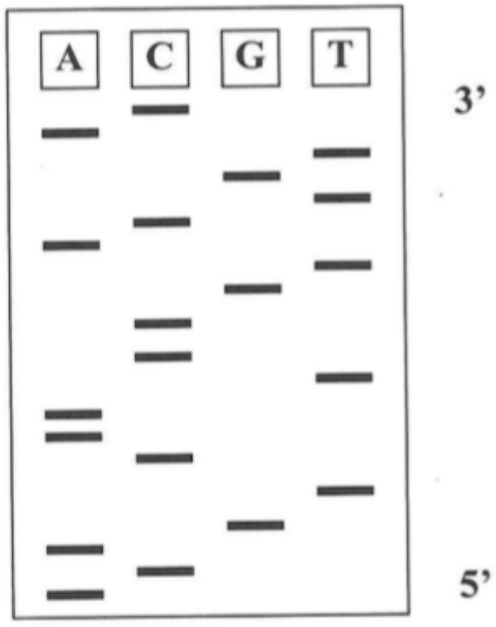
a) removal of all plasmids.

b) removal of the antibiotic gene.

c) destruction of the antibiotic resistance gene.

d) removal of the plasmid transfer gene.

13. A sample of DNA was sequenced using radioactively labelled nitrogen bases. The fragments produced were then run on a gel and exposed to X-ray film. The following diagram shows part of the exposed X-ray film



The DNA sequence, 5" – 3" , determined from this X-ray image is

a) A A A A A A C C C C C C G G G T T T T T

b) A C G T A C A A T C C T A C G T A C G T

c) A C A G T C A A T C C G T A C T G T A C

d) C A T G T C A T G C C T A A C T G A C A

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14. The so-called sticky ends of a plasmid or bacterial chromosome are

a) paired bases produced by DNA polymerase
b) the result of reverse transcription
c) unpaired bases produced by DNA polymerase
d) unpaired bases produced by a restriction enzyme

15. A single dose of a pesticide kills 99.9% of snails in a pond, but the survivors increase in numbers and soon the population returns to its original level. Which of the following statements about this situation is most likely to be true?

a) The new population would lose a smaller percentage of snails if exposed to the pesticide.
b) The pesticide caused a mutation in some snails that helped them survive.
c) Snails in the new population will all be more susceptible to the pesticide because they have already been exposed to it.
d) If the pesticide is given to the new population, over time the population will adapt.

16. Which of the following is NOT an example of a selection pressure operating in a population?

a) Pollution turning trees dark in a forest containing peppered moths.
b) A herbicide used on weeds on a farm.
c) An antibiotic used on a bacterial population.
d) A mutation for drought resistance in plants growing next to a river.

17. A rooster with blue feathers is mated with a hen of the same phenotype. Among their offspring, 15 chicks are blue, 7 are black and 8 are white. What is the simplest explanation for the inheritance of these colours in chickens?

a) Black and white feather colours show incomplete dominance.
b) Both the black and white alleles are recessive to the blue allele
c) The blue allele is a result of a mutation in the parents
d) Blue feather colour is a result of the effects of the environment.

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18. In the Holstein Friesian breed of cattle, black coat colour is dominant to red coat colour and is considered a desirable feature of the breed. The alleles for coat colour are autosomal. For a particular bull to have breeding value it must be homozygous for black coat colour.

Which of the following matings would be the best way to determine whether a bull is homozygous for black coat?

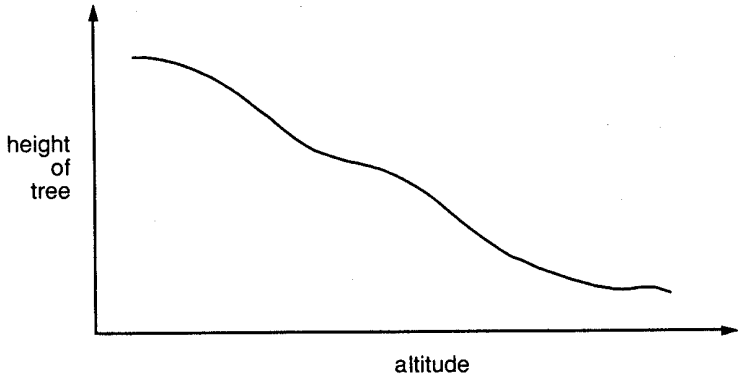
a) mate the bull with 10 red cows and check the colour of the offspring.

b) mate the bull with 10 black cows known to be heterozygous for coat colour and check the colour of the offspring.

c) mate the bull with 10 cows of random coat colour and check the colour of the offspring.

d) mate the bull's mother and father again and check the colour of their offspring.

19. The following graph shows the relationship between the average height of *Eucalyptus pauciflora* and altitude in a natural ecosystem in a mountain region near Canberra, Australia.



Which of the following statements best accounts for this relationship?

a) mutations have been produced in the trees by the high altitudes.

b) all of the trees at high altitudes are much older than those at low altitudes.

c) different alleles for height are favoured at different altitudes.

d) natural selection has been operating to form several species.

20. If eighteen percent (18%) of the nucleotide bases in a sample of human DNA are guanine (G), what is the percentage of adenine (A) bases?

a) 18

b) 32

c) 36

d) 64

See next page

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Questions 21 and 22 refer to the information below.

21. Two breeding pairs of endangered flightless birds, similar to kiwis, are used to start a new colony. Each bird is heterozygous (Dd) for a gene that is harmful in the homozygous recessive form. Individuals who are dd do not survive.
What is the allele frequency of d in this initial population?

a) 1

b) 0.50

c) 0.25

d) 0.125

22. After the pairs have bred for several generations, assuming no new mutations, and considering the individuals who will survive, the allele frequency of d will be closest to:

a) 0

b) 0.25

c) 0.33

d) 0.50

23. Which of the following statements is the best description of a genome? A genome is

a) the total DNA complement of an individual.

b) the letters representing an individual's phenotype.

c) the smallest unit of function in a chromosome.

d) a sequence of nucleotides that codes for a protein.

24. A zoologist wondered if a cricket was making chirping noises by rubbing its wings rather than its legs. Using a stereomicroscope, she could see small notches on the underside of its wings.

To investigate this idea, which of the following would she do first?

a) Consult scientific publications to find out what data have been collected by other biologists about the topic and what interpretations they have made.

b) Investigate the behaviour of crickets with wings removed.

c) Publish her suggestion as a new theory in a scientific paper.

d) Try a number of ways of testing crickets, and discard the results that do not support her hypothesis.

See next page

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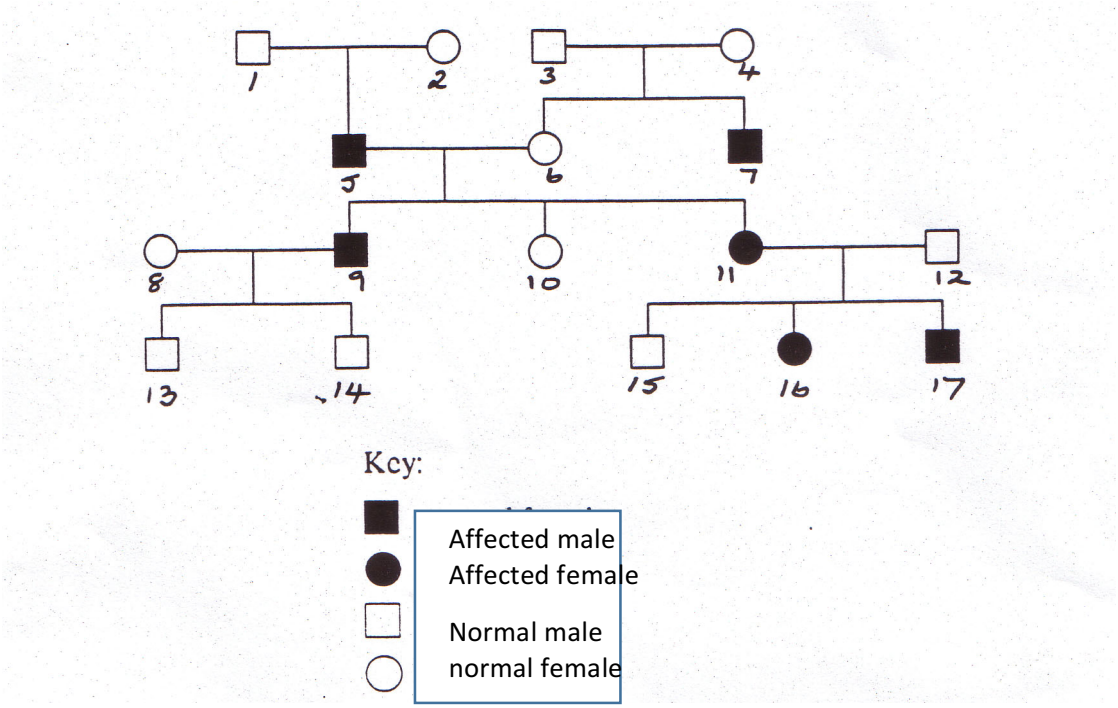
Questions 25, 26 and 27 are based on the pedigree chart shown below. A rare condition is suspected to be inherited. The diagram shows the pedigree of a family affected by the condition.



25. Which is the most likely explanation of the way the condition is inherited?

a) X-linked recessive allele.

b) X-linked dominant allele.

c) autosomal recessive allele.

d) autosomal dominant allele.

26. From the information given in the pedigree above, which of the following must be true?

a) Individual 1 is heterozygous for the trait.

b) Individual 8 is heterozygous for the trait.

c) Individual 10 is homozygous normal.

d) None of the individuals shown is homozygous for the trait.

27. If individuals 11 and 12 produce another offspring, which of the following is the probability that the offspring will show the trait?

a) 1.0

b) 0.5

c) 0.25

d) 0

See next page

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28. Which technique can copy, or clone, a piece of DNA ?

a) recombinant DNA

b) gel electrophoresis

c) DNA sequencing

d) polymerase chain reaction

29. In a scientific experiment, it is important to consider how a sample of organisms is selected for testing. Which of the following best explains good sample selection?

a) Selection of a large sample by some random method will help to minimise the effects of individual variation on the results.

b) Selection of a large sample will ensure the results are more accurate.

c) Random selection of a small sample minimises the effects of individual error on the results.

d) Choosing the organisms in the sample to prove the hypothesis true will give more reliable results.

30. The table below shows the measured body temperature of four different organisms exposed to two different environmental temperatures, A and B.

Organism	External Temperature ^{0}C A	Body Temperature ^{0}C A	External Temperature ^{0}C B	Body Temperature ^{0}C B
mouse	20	37.1	41	37.4
cockroach	20	20.8	41	40.8
chicken	20	41.0	41	40.8
fish	20	21.5	41	40.5

Which of the following can be concluded from these data?

a) All organisms' body temperature will rise as external temperature rises

b) The body temperature of a cockroach, chicken, and fish rises with external temperature

c) A mouse and a chicken can maintain a relatively constant body temperature

d) Cockroaches and chickens regulate their body temperature most similarly

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Section Two: Short Answer 100 Marks

This section has **six (6)** questions. Answer **all** questions. Write your answers in the space provided in this Question/Answer Booklet. Wherever possible, confine your answers to the line spaces provided. Use a blue or black pen (**not** pencil) for this section.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

- Planning: If you use spare pages for planning, indicate this clearly at the top of the page.
- Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time for this section is 90 minutes.

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Question 31 15 marks

A newly discovered island, Lee'fee, in the Pacific Ocean is densely populated with a single species of palm trees. An experiment is conducted to find out the closest related palm tree from neighbouring islands. Sequences of six different sections of DNA are compared between palm trees on Lee'fee and palm trees from four nearby islands.

a. Give a suitable hypothesis for this experiment. (2 marks)

b. i. Briefly describe the independent variable. (1 mark)

ii. Briefly describe the dependent variable. (1 mark)

c. Give two variables that should be controlled in this experiment. (2 marks)

See next page

Table 31 below shows the results of the sequencing of the DNA sections of palm trees from Island Lee'fee and the four nearby islands; Moala, Labeka, Vava'u and Ha'ano.

d. Complete the table with the number of differences in DNA sequence between Lee'fee and the other islands. (4 marks)

Island	DNA coding strand loci 1 2 3 4 5 6	Number of differences compared to Island Lee'fee
Lee'fee	CATG TTAG TGCA GCGC CATG AACC	0
Moala	CATG TTAG TGCA GCGC CATG AACC	
Labeka	CATG TTGG TGCA GCGC CATG AACT	
Vava'u	CATG TTGG TGCA GCGT CATG AACT	
Ha'ano	CATG TTGG TGCA GCGC CATG AACT	

Table 31. Number of differences in DNA sequence between palm trees on Lee'fee and nearby islands .

e. Create a phylogenetic tree to represent these results. (4 marks)

f. Write a conclusion for this experiment (1 mark)

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Question 32 **21 marks**

Data from experiments are often graphed to show relationships more clearly.
Sometimes line graphs are used, and at other times column graphs.

a) Give the type of graph you would use to display the following data, and justify your choice.

(i) The number of mutations in DNA exposed to different intensities of X rays.

What type of graph would you use? (circle ONE): LINE or COLUMN

Reason:

(1 mark)

(ii) Average daily water requirement of different marsupial species.

What type of graph would you use? (circle ONE): LINE or COLUMN

Reason:

(1 mark)

Weeds are a problem in many agricultural pastures. In WA weeds are usually annuals, meaning they complete their life cycle in one season, produce seeds and die. The seeds germinate when wet. Some germinate the very next year; others remain dormant and germinate one or two or more years later.

Researchers set up an experiment to compare the dormancy of two species of annual weeds.

Their procedure was as follows.

1. Two separate square metre plots were prepared outdoors.
2. Two grams of weed seed R was sown in plot R; two grams of weed seed L was sown in plot L.
3. Each year the number of seeds germinated in each plot was counted.
4. The seedlings were then removed so no new seeds were produced in the plot.

The results of the experiment are shown below.

See next page

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	Number per m^2	
Years elapsed	**Weed R**	**Weed L**
1	610	380
2	320	100
3	200	38
4	140	Missing data
5	Missing data	10

Table 32. Germination of weed seeds of different types.

(b) Describe the dependent variable for this experiment. (1 mark)

(c) On the grid provided, plot a graph of the data shown above. (5 marks)

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If you wish to have a second attempt at this item, the grid is repeated at the end of the examination booklet. Indicate if you have used the second grid and cancel the working on the grid above.

(d) Give a possible hypothesis for this experiment. (2 marks)

(e) (i) Clearly showing working on the graph, predict the readings for the following

Weed R, Year 5 _____

Weed L, Year 4 _____

(2 marks)

(ii) In which of the predictions above do you have the greatest confidence? Explain.

(2 marks)

(f) This experiment was designed to see which of the weed species would still be a problem after a drought. In severe drought years, weed seeds may germinate but die before they produce seed. The year after a drought, weed growth depends on dormant seeds that are at least 2 years old.

Explain from the data which of Weed R or L will be the most significant problem for farmers after drought.

(2 marks)

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(g) After the experiment was finished, one researcher suggested that the size of the seeds may have influenced the results. She noted that Weed L seeds are twice as heavy as Weed R seeds.

i. How could this have affected the results? (2 marks)

ii. What could be done to control for this difference in seed weight? (1 mark)

Iii. Describe and explain ONE other specific suggestion to make this investigation more reliable.

(2 marks)

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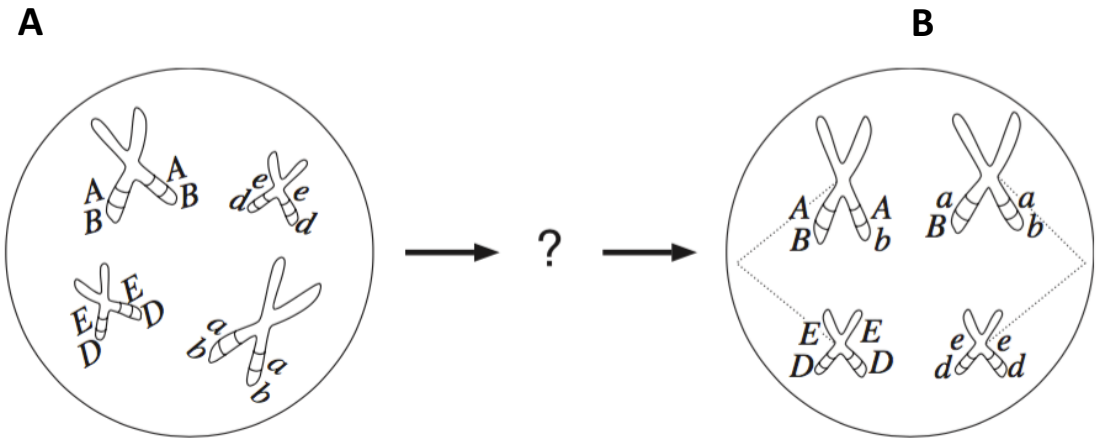
Question 33. **19 marks**

a) Explain the difference between the terms **allele** and **gene**. [2 marks]

See next page

b) The diagram below shows two steps, A and B, of the process of meiosis occurring in a cell with four chromosomes.



i. Describe two key behaviours of the chromosomes that produce step B from A. [2 marks]

ii. List FOUR possible combinations of alleles that would be found in the gametes resulting from this process. [2 marks]

iii. Explain ONE advantage of the process of meiosis to the species. [2 marks]

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c) Claire and Nick have two children: a colour blind boy, Jack, who is 8 and a girl, Kate, who is 10 years old. Both of the babies' grandfathers are red-green colour-blind, both grandmothers have normal vision. Nick and Claire have normal vision. Colour blindness is a recessive sex-linked genetic disorder.
Construct a family pedigree to show the inheritance of colour blindness. Include all mentioned individuals and a key, and use all the normal conventions in labelling. [4 marks]

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i. Give the genotypes of Claire and Nick for red-green colour blindness. Explain your reasoning by reference to the pedigree and information given. (4 marks)

ii. Claire and Nick find they are pregnant again. What is the chance of their next child being colour blind? Justify your answer by showing all working. (3 marks)

See next page

Question 34. **12 marks**

In pea plants, a single gene determines if the pods are green or yellow. One of these characteristics is dominant, while the other is recessive. A plant geneticist wanted to determine which characteristic is dominant. Accordingly, she carried out crosses between different plants A, B, C, and D. The results of these crosses are shown below.

Table 32: Pod colour of parent pea plants and F1 (first) generation

Parent crosses	F1 generation
A (green) x B (green)	all green
A (green) x D (yellow	all green
B (green) x C (green)	77 green : 23 yellow
B (green) x D (yellow)	102 green : 98 yellow

a) Which pod colour is dominant? Explain briefly how you can determine this from the data.

(2 marks)

b) Using the results above as examples, demonstrate why crossing a green pod parent plant with a yellow pod plant can give differing results in the F1 generation.

(4 marks)

c) What is the genotype of plant C? Explain your answer.

(2 marks)

See next page

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In another experiment, 100 seeds of a different pea species are sown in a single garden bed. While the plants are growing, the gardener notices that a group of 15 plants in one part of the garden bed is not growing as tall as the rest of the plants. There is no dwarf form of this pea species.

d) What is a likely reason for the difference in the average height of the two groups? Suggest ONE factor that could be responsible. (1 mark)

e) Briefly describe specific factors you would vary, measure and control in an experiment to determine whether the factor you stated in d) could result in differences between pea plants.

vary

measure

control (list several factors)

(3 marks)

Question 35. **14 marks**

The Ice Ages separated two areas of Australian rainforest in Queensland: one in the Atherton tablelands, the other in the Daintree. A dry, mountainous region, called the Black Mountain Barrier, separated the two regions. The forests are now connected again.

a) Suggest how the Black Mountain Barrier could act to separate organisms from the two areas of rainforest.

(2 marks)

See next page

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Scientists have compared sequences of a gene called cytochrome b. This gene is found in mitochondria and mutates at a consistently rapid rate. When the gene sequences differ by more than 10%, the two populations are considered two different species.

Table 35. Results of percentage differences in cytochrome b genes between 2 populations of selected animals on each side of the Black Mountain Barrier.

Animals studied		Percentage differences in cytochrome b genes between populations from either side of the Black Mountain Barrier
Birds	Robins	1.4%
	Chowchillas	2.5%
	Large billed scrub wren	0.2%
Lizard	Prickly skink	6.0%

b) i. Which of these animals from Table 3 is the closest to becoming separate species?

(1 mark)

ii. If the populations became separate species, What type of evolution would this represent?

(1 mark)

c) Give a simple hypothesis to explain the smaller % gene difference between populations of the three bird species compared to the two skink populations.

(1 mark)

d) Explain the processes that could lead populations of skinks to diversify into different species.

See next page

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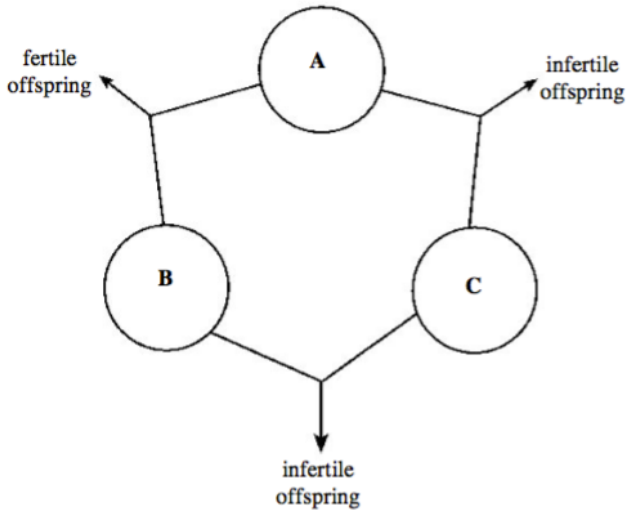
(6 marks)

e) The diagram below shows the fertility of the offspring produced when three populations of skinks, A, B and C, interbreed.



How many species of skinks are represented in the diagram? Explain your answer. [2 marks]

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The robins and chowchilla require warm moist conditions yet the large billed scrub wren is more tolerant and able to live in drier eucalypt forests.

f) Use this information to explain the difference between the two populations of scrub wrens compared to the differences between other birds. (2 marks)

There is another species of scrub wren which shows no difference in the cytochrome b genes between the populations either side of the Black Mountain Barrier. This species is less tolerant of dry conditions and is found only in true rainforests. One theory proposed to explain the remarkable similarities was only <u>one</u> of the two original populations survived the last ice age.

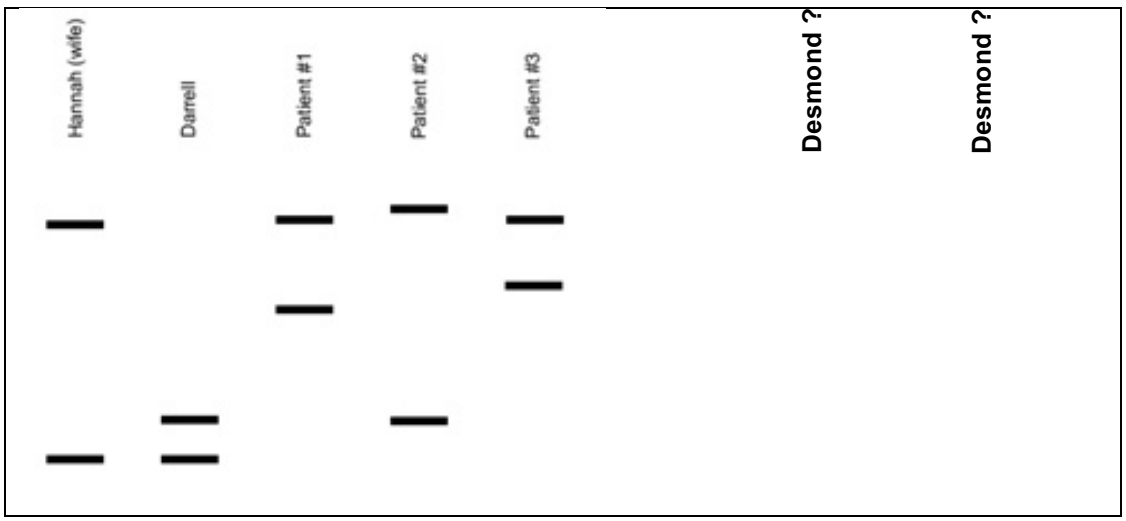
g. How could it be possible then, that today there are populations of this species of scrub wren on either side of the Black Mountain Barrier? Suggest a possible explanation.

(1 mark)

Question 36. **19 marks**

a) DNA can be collected and used for paternity tests. Darrell knew his biological father was a sperm donor. After contacting the clinic, Darrell was told three men had donated sperm at the time he was conceived. The DNA of his mother, Hannah, as well as the three possible fathers and his own DNA were tested and the results are given below.

Fig 36. DNA fingerprints of Hannah, Darrell, and 3 possible fathers.



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i. Which patient is Darrell's father? How do you know? (2 marks)

ii. Hannah has another son, **Desmond**. If Patient #3 is Desmond's father, draw in **two** possible DNA fingerprints for **Desmond** in the boxes in Fig 36 above. (2 marks)

iii. Name the process used to obtain results such as these. _____ (1 mark)

b) Mutations sometimes occur in genes or chromosomes. Using as an example the section of DNA below, draw and label the effect of two different types of mutations.

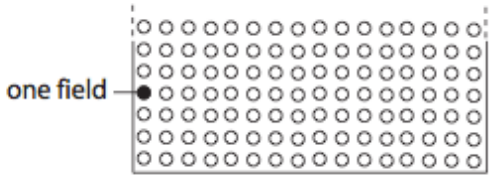
T C A C C A T G T

i. Result 1: Type of mutation: _____

ii. Result 2: Type of mutation: _____ (2 marks)

During what cell processes are mutations most likely to occur in a cell? (2 marks)

c) DNA microarray technology has been used to survey the *p53* gene because a mutation of this gene is present in about 60% of all cancers. The position of a mutation in the *p53* gene of a patient, Patient **X**, who has breast cancer, can be determined.



The steps in the screening procedure are outlined below.

Step 1: Treat a normal allele of *p53* to break it down into base sequences.

Step 2: Each segment must be tested, one nucleotide at a time.

Step 3: The normal sequence is found

See next page

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Step 4: Sections from the original sequence are manufactured so that all possible mutant sequences are formed.

Step 5: Each different sequence is placed into a field.

Step 6: Two solutions are added to each of the fields. These solutions contain:

Solution I Complementary normal strand, labelled with green fluorescent dye

Solution II Complementary strand from DNA of person with breast cancer, labelled with red fluorescent dye.

Step 7: Allow time for hybridisation of strands, then wash the DNA chip to remove excess dyes.

Step 8: Examine fields under UV light to distinguish colours remaining. Interpret results.

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The results for Patient **X** are shown below.

	GTCC**G**TGTT normal	GTCC**T**TGTT mutant	GTCC**A**TGTT mutant	GTCC**C**TGTT mutant
Colour observed after hybridisation and washing	**green**	**No colour appears (black)**	**red**	**No colour appears (black)**

i. Describe what is placed in each field of a microarray chip. (1 mark)

ii. What does hybridisation, in Step 7 above, mean? (1 mark)

iii. Explain the reason for the three different colours appearing in the DNA microarray after it was washed with DNA strands from Patient X. (3 marks)

See next page

d) A US company has recently released what is believed to be the first designer transgenic pet. The 'Glofish' is derived from the zebra fish, which is normally silver with black stripes. The fish are genetically modified by adding a gene found in a sea coral into zebra fish eggs. The fish hatching from genetically modified eggs are red in colour and glow or fluoresce under ultraviolet light.
Although the added gene is from a different species, it is expressed in the same way in both the sea coral and transgenic zebra fish.

i. What feature of the genetic code makes it possible for a gene to be transferred from one species to another and to be expressed in the second species? [1 mark]

ii. What steps are required, within the zebra fish cells, for the sea coral gene to be expressed? [2 marks]

iii. Predict the chance of survival of a Glofish if it were released into the natural environment of the zebra fish. Explain your answer [2 marks]

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Section Three: Extended answer **20% (40 Marks)**

Section Three consists of two parts.

Part A mainly tests your **knowledge** of syllabus content. **Part B** mainly tests **how you apply** your understanding of biological principles.

Answers may be presented in different ways provided they communicate your ideas effectively. You may choose to:

- present a clearly labelled diagram;
- write notes beside a clear diagram;
- write lists of points, with sentences which link them;
- write concisely worded sentences;

Use black or blue pen or ballpoint for written answers and pencil for diagrams. Crossing out of incorrect material is acceptable and preferred to using correction fluid.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
- Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time for this section is 50 minutes

Part A **Answer any two (2) questions from Questions 37 to 39** **(20 marks)**

Indicate the questions you will answer by ticking the box next to the question. Write your answers on pages XXXX. Do not re-write the question, just put the number of the question you are answering at the top of the page. Use a NEW PAGE for your second question. Then turn to page XX for Part B.

☐ **Question 37.** **(10 marks)**

Explain how the structure of a DNA molecule permits

(i) its accurate replication and
(ii) storage of genetic information

☐ **Question 38.** **(10 marks)**

Outline examples of molecular, fossil, and anatomical evidence for evolution, including how each line of evidence shows relatedness between species.

☐ **Question 39.** **(10 marks)**

a) Explain the steps in protein synthesis in a cell. Use labelled diagrams as the basis of your answer.
b) Why are proteins important to cell functioning?

See next page

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Part B

Answer any two (2) questions from questions 40 to 42 **(20 marks)**

Indicate the questions you will answer by ticking the box next to the question. Write your answers on pages XXX. Do not re-write the question, just put the number of the question you are answering at the top of the page. Use a NEW PAGE for your second question.

☐ **Question 40** **(10 marks)**

A small population of finches, the Palmer finches, exist on an isolated island in the Pacific Ocean. Populations of similar birds in other islands have alleles for white or yellow rings around eyes, but Palmer finches have yellow rings around their eyes. Male Palmer finches perform an elaborate courtship dance before mating, including puffing out a large red membrane on their throat. Only males have this red membrane. However, both male and female Palmer finches are mostly dark brown in colour, similar to the volcanic rocks on which they nest on the island.

Use examples from this information to suggest how natural selection, sexual selection and genetic drift could each have played a role in the evolution of Palmer finch characteristics.

☐ **Question 41** **(10 marks)**

The terms polygene and multiple alleles both appear to refer to multiple copies of genes. Suppose three closely related species of plant A, B and C all have flower colours in shades of white to red. The species differ only in the inheritance responsible for petal colour. In A it is controlled by polygenes, in B by multiple alleles and in C by a simple dominant/recessive inheritance pattern.

a) Explain the meaning of each term: polygene, multiple alleles, and dominant/recessive
b) Apply your explanation to a description of the pattern of flower colour phenotypes you would expect in each species. Simple diagrams or graphs may be used in your answer.

☐ **Question 42** **(10 marks)**

By 2030, the human population of Western Australia will have grown exponentially. Climate change, urbanisation and changes in land use will pose many challenges. Governments will struggle to provide food, conserve species and protect natural environments. Transgenic organisms have been engineered in the hope they will enable better use of farming land and reduce the pressure on conservation reserves.

Present biological arguments for and against the development and use of transgenic organisms. Include examples of current applications where applicable.
Use a table to present your answer.

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ADDITIONAL WORKING SPACE Question number_____

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Marker's use only:

	QUESTION	TOTAL	MARK
Section One	1 - 30	60	/60
Section Two	31	15	
	32	21	
	33	19	
	34	12	
	35	14	
	36	19	/100
Section Three	37 38 39	20	
	40 41 42	20	
			/40
TOTAL		**200**	

[5 marks]

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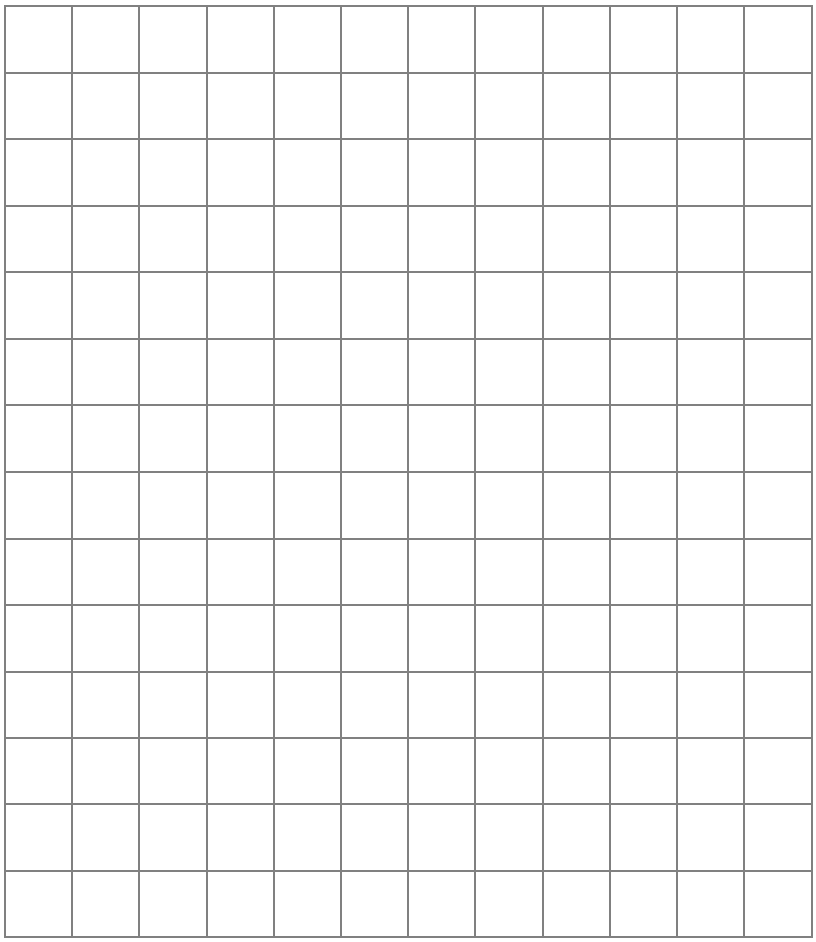
If you use this grid, clearly cancel the working on the grid on p15.

Question 32 (c) On the grid provided, plot a graph of the data shown. (5 marks)



[5 marks]

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