



2022 TRIAL EXAMINATION

BIOLOGY

Form VI

STRUCTURE OF PAPER

SECTION I - 20 marks (pages 3-14)

- Attempt Questions 1- 20
- Allow about 35 minutes for this section

SECTION II – 80 marks (pages 15-34)

- Attempt Questions 21- 32
- Allow about 2 hours and 25 minutes for this section

EXAMINATION

DATE: Thursday 11th August 8.40 AM
 DURATION: 3 hours + 5 minutes reading
 MARKS: 100

CHECKLIST

Each boy should have the following:

- ☐ 1 Examination Paper
- ☐ 1 Multiple-Choice Answer Sheet

GENERAL EXAM INSTRUCTIONS

- 5 minutes reading time and 3 hours working time.
- Write using black pen and draw diagrams using pencil.
- For questions in Section II, show all relevant working for questions involving calculations.
- NESA approved calculators may be used.
- Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.
- WRITE YOUR **CANDIDATE NUMBER** IN THE SPACE PROVIDED AT THE TOP OF EACH SECTION AS INDICATED IN SECTION II.

CLASS NUMBER	1	2	3	4
Class	6BL201	6BL202	6BL203	6BL204
Master Initials	ACR	ZI	ACR	DBD

Authors: ACR, DBD, ZI

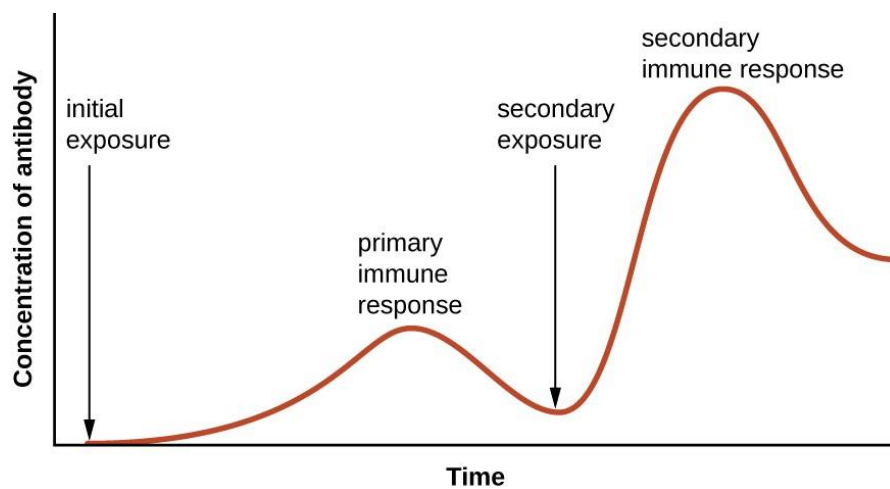
MiC: ACR

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SECTION I: MULTIPLE CHOICE (20 marks)

Attempt ALL Questions
Use the Multiple-Choice Answer Sheet.

- 1 What is the best definition of a *mutagen*?
- (A) A change in the structure of DNA.
 - (B) An agent that causes genetic change.
 - (C) The action or process of nucleotide change.
 - (D) The rearrangement of sections of chromosomes and genes.
- 2 Which of the following cell types initiates the secondary immune response depicted below?



- (A) cytotoxic T cell
- (B) memory B cell
- (C) helper T cell
- (D) suppressor T cell

3 Four ways of being immune are

- 1 having memory cells after an infection
- 2 having memory cells after being injected with dead bacteria
- 3 being injected with antibodies
- 4 receiving antibodies from breast milk

Which row in the table correctly shows the types of immunity?

	natural active	artificial active	natural passive	artificial passive
A	1	2	3	4
B	1	2	4	3
C	2	1	3	4
D	2	1	4	3

4 A pathogen was found to be prokaryotic, contain DNA and have a cell wall.

How would it be classified?

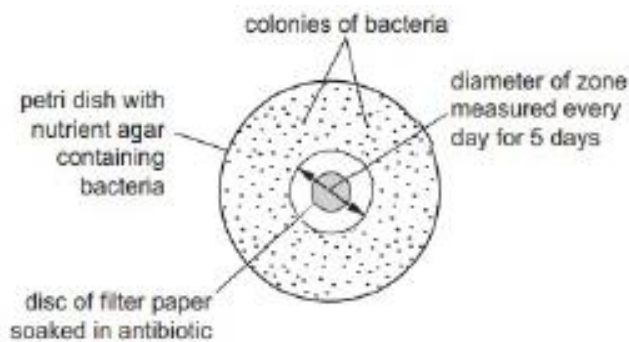
- (A) Virus
- (B) Fungus
- (C) Protozoan
- (D) Bacterium

5 Skin grafting involves the transplantation of healthy skin which can be used to cover damaged skin for example due to burns. A graft of skin tissue received from a different person is usually rejected by the recipient's body.

Which statement about graft rejection is correct?

- (A) The graft is rejected by B-lymphocytes because T-lymphocytes are not stimulated to produce antibodies.
- (B) The graft is rejected by T-lymphocytes because they circulate in the blood and can gather at the graft site.
- (C) The graft is rejected by T-lymphocytes because the graft tissue causes T-lymphocytes to release antibodies.
- (D) The graft is rejected by B-lymphocytes because they make and release antibodies which react with the surface antigens on the graft cells.

- 6 The diagram below shows one way of testing the effect of an antibiotic on bacteria.



The table below shows the results of testing five different types of bacteria using the method above. Zones of less than 13 mm show the presence of resistant bacteria.

Type of bacteria	Diameter of zone with no bacterial growth after 5 days (mm)
1	14.30
2	0.00
3	10.90
4	0.00
5	20.40

Which statement can be supported by this data?

- (A) The antibiotic can be used to treat bacteria types 1 and 3 only.
- (B) All the types of bacteria become resistant to antibiotics over time.
- (C) Type 5 of the bacteria can never become resistant to the antibiotic.
- (D) Only types 2, 3 and 4 of the bacteria show resistance to the antibiotic.

- 7 Which of the following best describes a function of a macrophage?
- (A) They release histamines.
 - (B) They are found in tissues and secrete cytokines in response to infection.
 - (C) They circulate in the blood and produce antigens in response to infection.
 - (D) They can leave the blood and secrete cytotoxins when exposed to damaged cells.
- 8 Which of the following best describes the benefit(s) of artificial insemination of dairy cattle?
- (A) The process creates genetically identical offspring that all produce good milk yield.
 - (B) It decreases genetic diversity by introducing the same genes to different populations on different farms.
 - (C) It enables a large number of cows to be inseminated with sperm from a bull with desirable milk production traits.
 - (D) The process creates genetically modified calves that may produce milk in the future that is safe for human consumption.

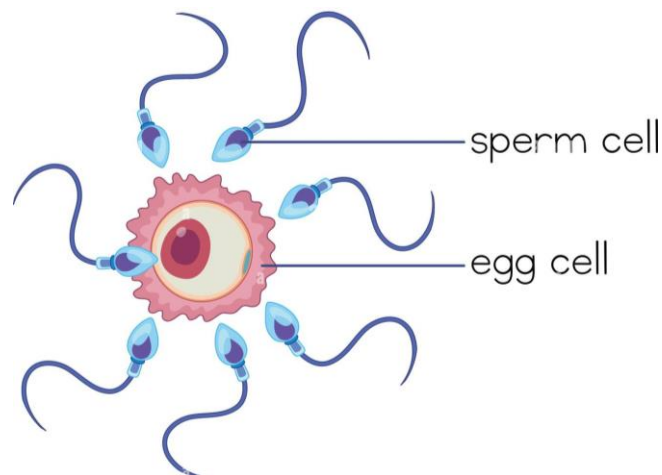
- 9 Which row is the best comparison of the daughter cell produced in each process?

	Mitosis	Meiosis
(A)	• Identical to parent • Identical to each other • Homologous pairs of chromosomes	• Different to parent • Different to each other • Unpaired chromosomes
(B)	• Different to parent • Identical to each other • Homologous pairs of chromosomes	• Identical to parent • Different to each other • Unpaired chromosomes
(C)	• Identical to parent • Different to each other • Unpaired chromosomes	• Different to parent • Identical to each other • Homologous pairs of chromosomes
(D)	• Identical to parent • Identical to each other • Unpaired chromosomes	• Different to parent • Different to each other • Homologous pairs of chromosomes

- 10 Which statement best describes how cloning might be used to assist human health?

- (A) Human clones will mean an individual can 'live' forever.
- (B) Antibiotic resistant bacteria can be used to produce medicines.
- (C) Human organs could be cloned to replace diseased or damaged organs.
- (D) Food from cloned plants and animals can be modified to be healthier for human consumption.

- 11** Which of the following is an example of a physiological adaptation in an endotherm that assists in maintaining homeostasis?
- (A) Animals in cold climates having thick fur coats.
 - (B) A dog moving into the shade to keep cool on a hot day.
 - (C) Surface blood vessels in a human constricting on a cold day.
 - (D) Lizards moving into the sunlight to raise their body temperature.
- 12** The diagram below models the process of fertilisation.



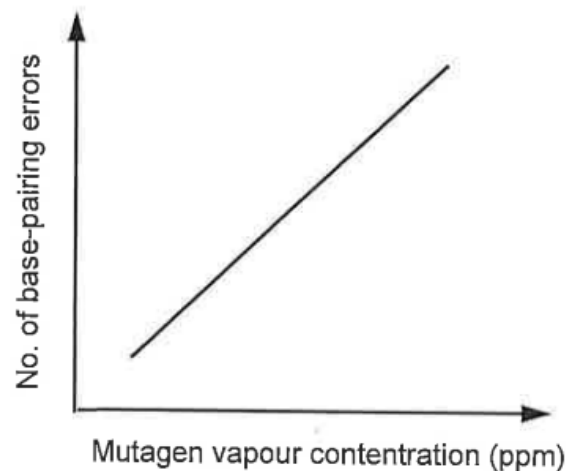
Which of the following is an appropriate evaluation of this model?

- (A) The diagram shows the entry of sperm cells into the egg.
- (B) The diagram has some downfalls, such as the egg is too large.
- (C) The diagram is a very reliable model of fertilisation because it shows all the stages of fertilisation.
- (D) The diagram is good because it depicts fertilisation in a simple way, despite inaccuracies such as the size of cells.

- 13** Grapefruit originated from a cross between an orange and a pomelo.

What is this an example of?

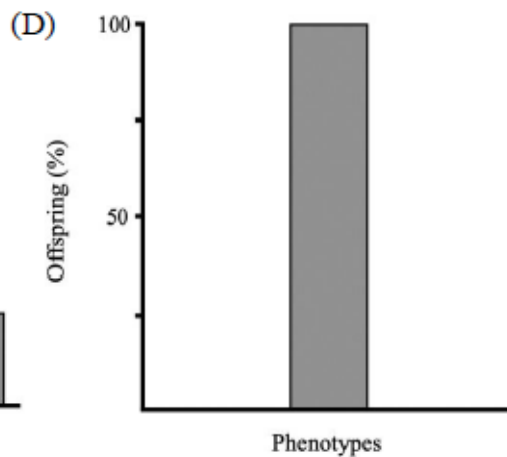
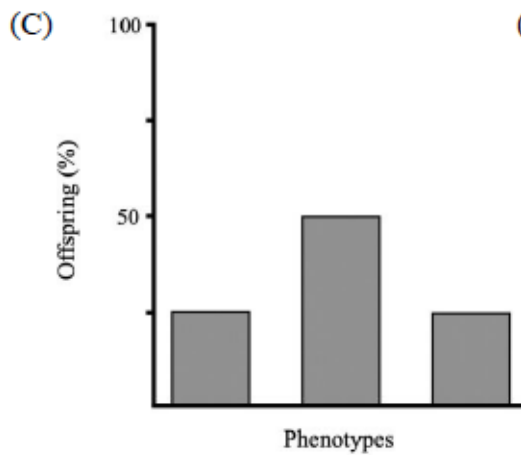
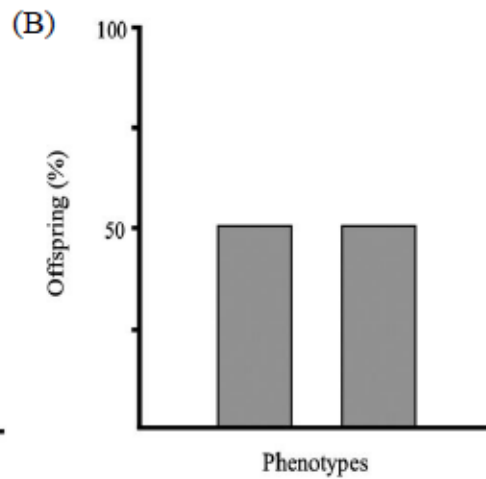
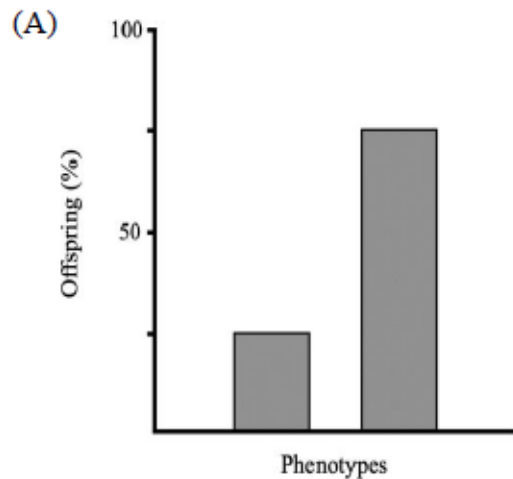
- (A) Cloning
 - (B) Transgenics
 - (C) Selective breeding
 - (D) Artificial insemination
- 14** A chemical mutagen is known to cause significant damage to DNA structure through the disruption of the normal base-pairing process. The graph below shows the relationship between exposure to mutagen vapours and the frequency of base-pairing errors.



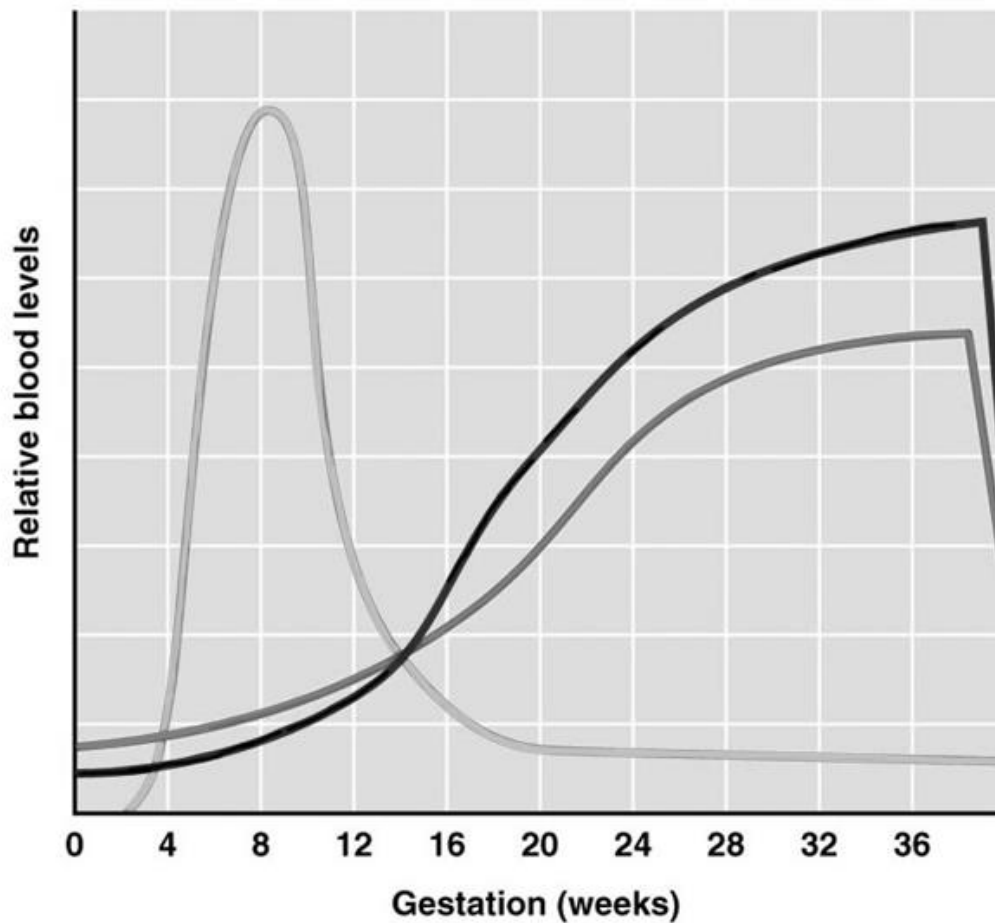
Which of the following statements correctly describes the trend observed?

- (A) An increased frequency of base-pairing errors leads to increased mutations.
- (B) An increased number of base-pairing errors leads to increased vapour production.
- (C) An increase in mutagen vapour concentration leads to an increase in the frequency of base-pairing errors.
- (D) An increase in mutagen vapour concentration leads to a decrease in the frequency of base-pairing errors.

- 15 Some organisms have genotypes that produce three different phenotypes, for example a red flower crossed with a white flower to produce a pink flower. If two of these pink flowers were crossed, which of the following graphs would correctly represent the offspring of this cross?



- 16 The graph below shows the changes of three hormones during gestation (pregnancy).

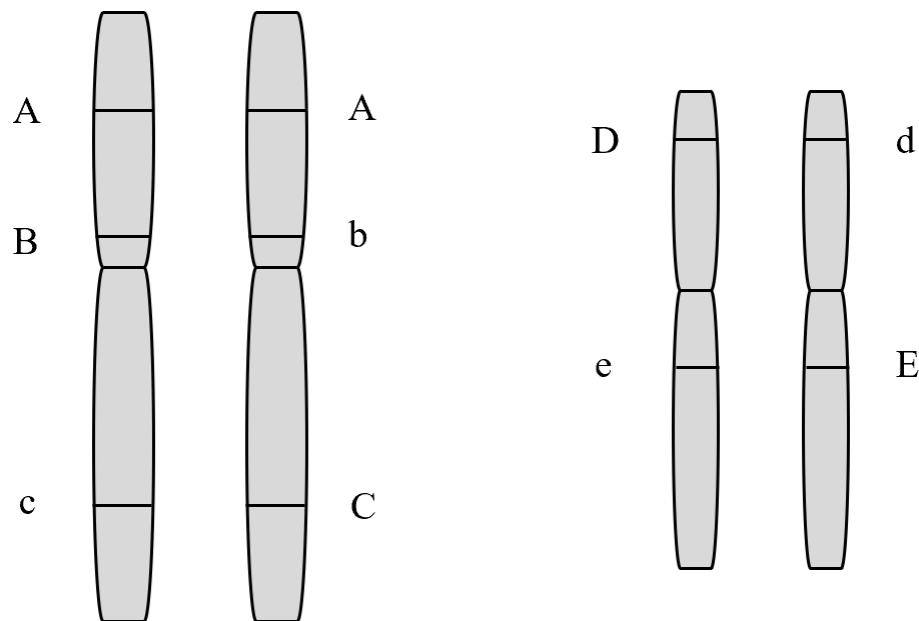


Copyright © 2006 Pearson Education, Inc., publishing as Benjamin Cummings.

Which of the statements below best identifies the changes in hormone levels shown over the gestation period?

- (A) hCG and oestrogen both rise and stay high in concentration from 24 weeks onwards.
- (B) Progesterone levels peak at 8 weeks then drop when the placenta is formed.
- (C) Both oestrogen and progesterone gradually rise in concentration until birth where they both rapidly decline at around 40 weeks.
- (D) hCG, produced by cells surrounding the embryo and then the placenta peaks at around week 36 and can be detected in urine tests.

- 17 Analyse the diagram below which shows two pairs of homologous chromosomes and their allele arrangement.



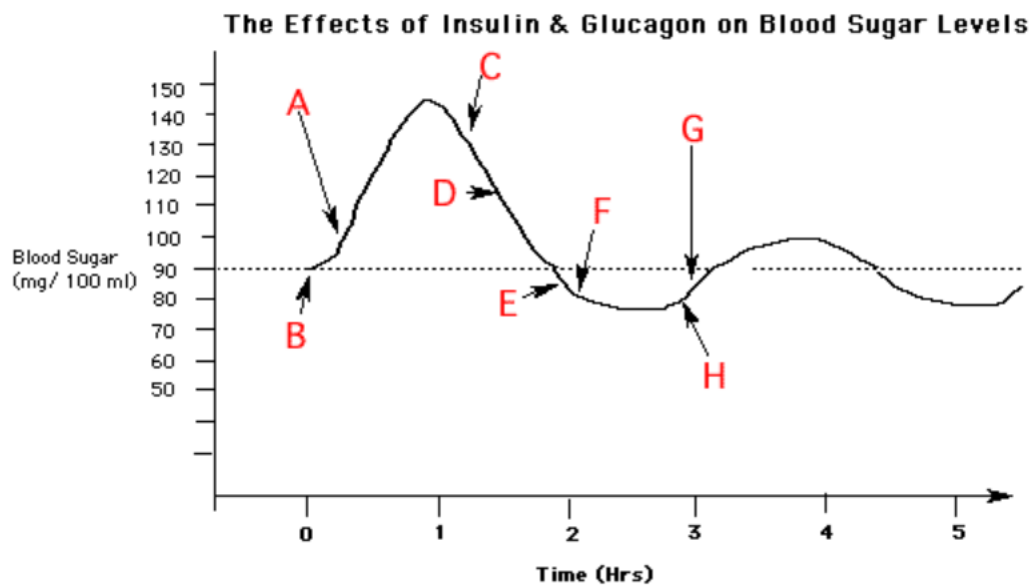
Assuming there is no crossing over, which of the following shows all the possible genotypes for the gametes formed in this organism?

- (A) ABcDe, ABcdE, AbCDe, AbCdE
 - (B) AbCdE, ABCdE, AbCDE, AbCdE
 - (C) ABcDE, ABcdE, AbCDe, AbDdE
 - (D) AbcDE, ABcdE, AbCDe, ABcdE
- 18 Which of the following represents the DNA sequence that codes for the mRNA strand shown below?

5' – CUAACG – 3'

- (A) 3' – GATTGC – 5'
- (B) 3' – GAUUGC – 5'
- (C) 3' – CGUUAG – 5'
- (D) 3' – CGTTAG – 5'

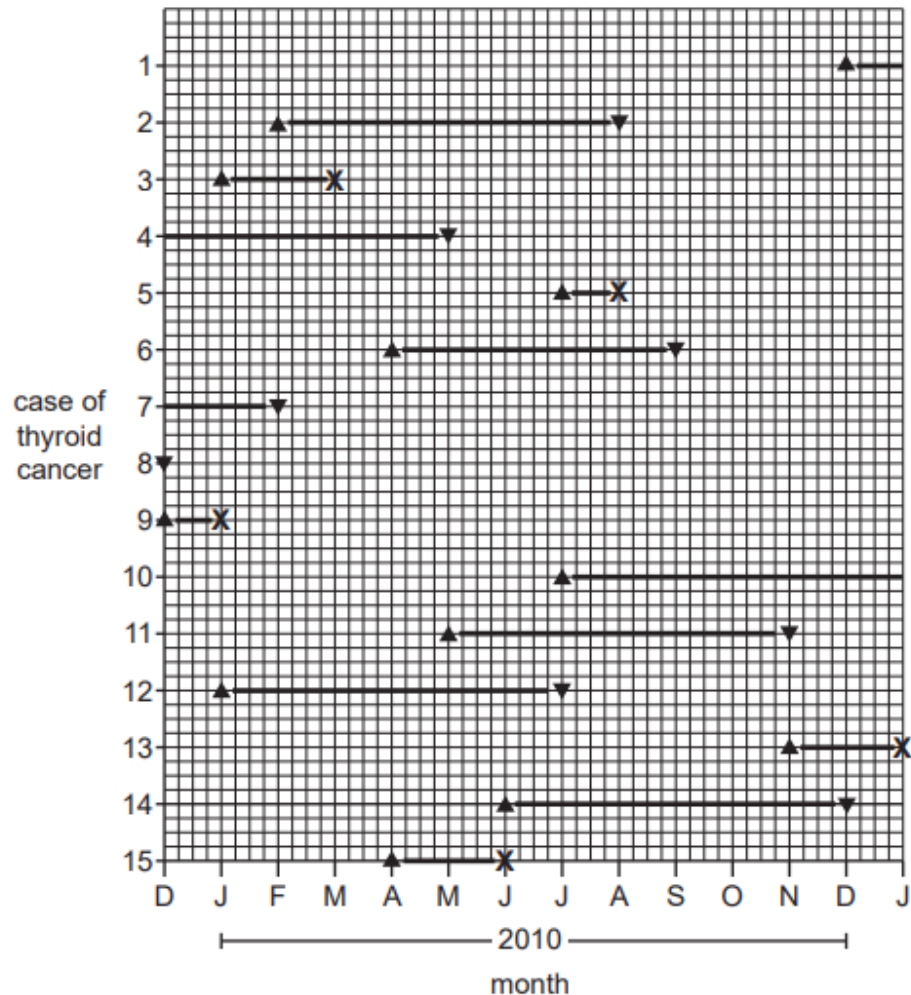
- 19 Analyse the graph below which shows blood glucose regulation.



Which of the following statements is correct?

- (A) Insulin is highest at A.
- (B) Glucagon is highest at H.
- (C) Insulin levels are high whenever the blood glucose levels reach 90mg/mL.
- (D) According to this graph the optimal blood glucose concentration is 140mg/100mL.

- 20 There were 15 cases of thyroid cancer recorded in Iceland between December 2009 and January 2011. The graph below shows, for each case, the month of diagnosis (▲) and month of recovery (▼) or death (X) from the disease.



Iceland has a population of 330 000 people. Which of the options below was the incidence rate (per 100 000) of thyroid cancer from March to October 2010?

- (A) 0.6
- (B) 1.8
- (C) 2.7
- (D) 4.5

SECTION II: SHORT AND LONG ANSWER (80 marks)

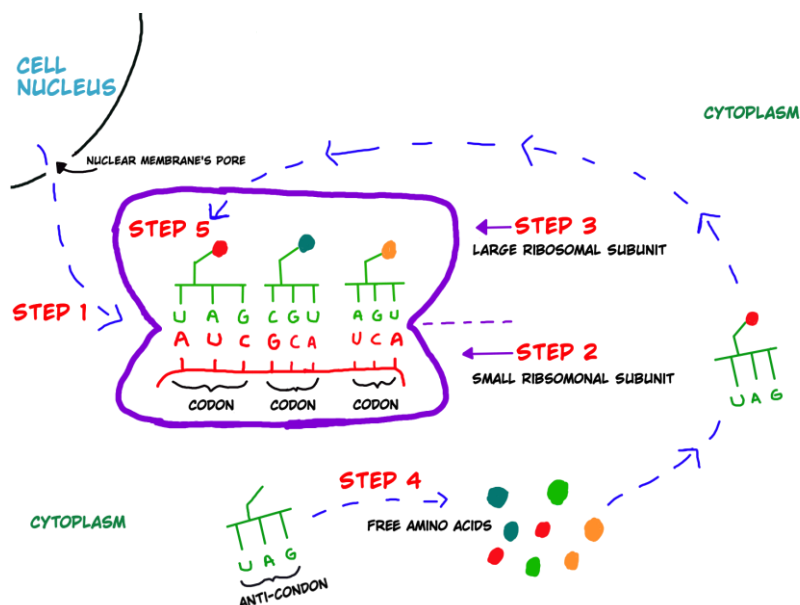
Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

CANDIDATE NUMBER							

Question 21 (3 marks)

Marks

The diagram below shows a stage of polypeptide synthesis.



- (a) Identify the stage of polypeptide synthesis in this diagram.

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- (b) Why is the anti-codon significant in this process?

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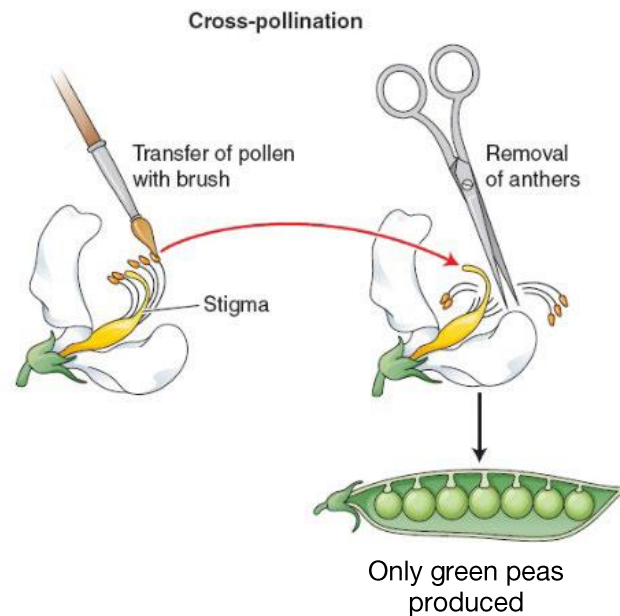
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Question 22 (6 marks)

Marks

The diagram below shows the process of cross pollination in plants, similar to the method Mendel used in his experiments.



- (a) Which step ensures the validity of the cross pollination? Justify your answer.

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Question 22 continued on next page.

Question 22 continued.

Marks

- (b) This species of pea plant, shown on the previous page, has two phenotypes for pea colour, green and yellow. Both parent plants are homozygous. The plant providing the pollen produces yellow peas.

- i. Identify the dominant and recessive phenotype for pea colour in this species.

Dominant:

1

Recessive:.....

- ii. Determine the phenotype and genotype ratios of the offspring produced from crossing two plants grown from the peas in this diagram (on the previous page).

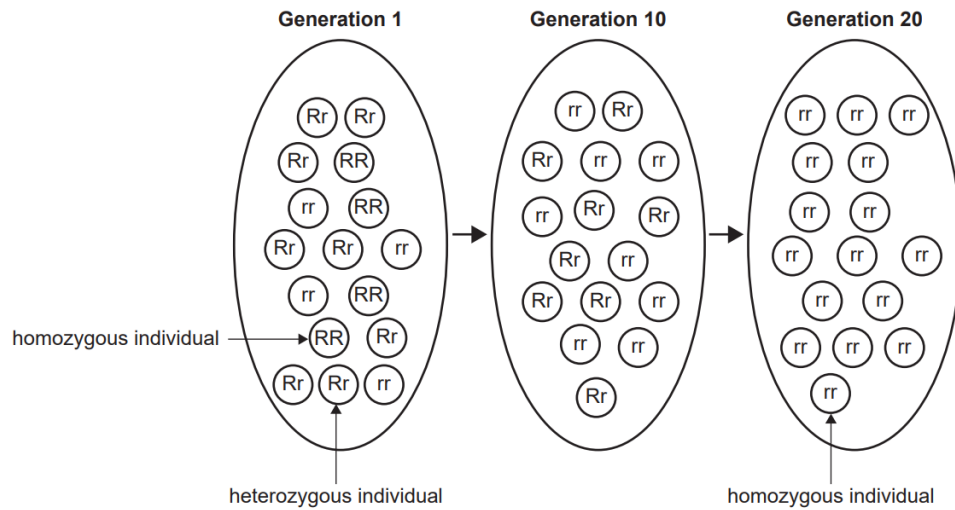
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Question 23 (8 marks)

Marks

The diagram below shows the gene pool of a population over 20 generations.



- (a) Describe how the population has changed over the 20 generations.

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- (b) Explain how the changes you have described in part (a) may have occurred.

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Question 23 continued on next page.

Question 23 continued.

Marks

- (c) Calculate the allele frequency for the two alleles present in generation 10.

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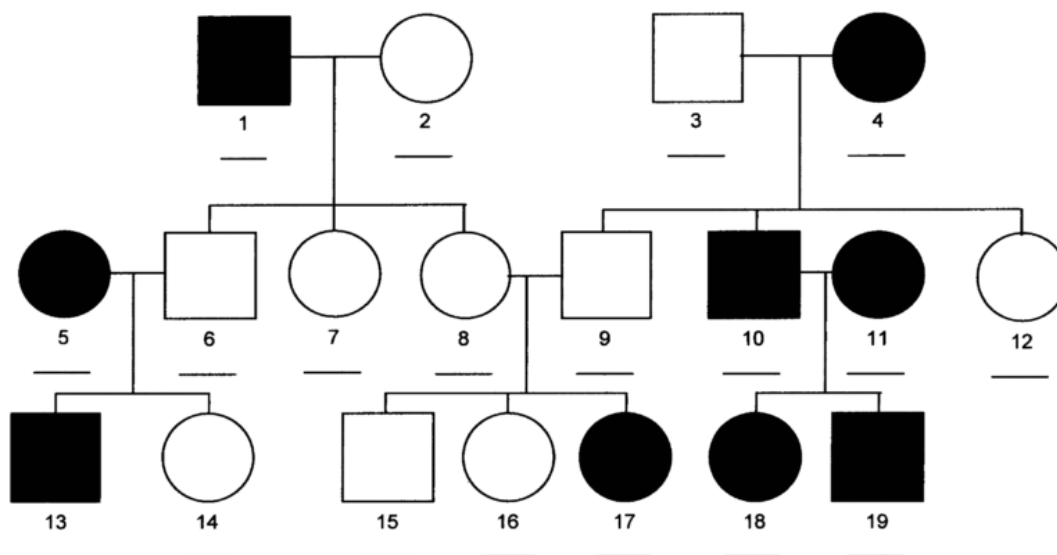
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Question 24 (6 marks)

Marks

Analyse the pedigree below showing a genetic condition expressed in a family.



- (a) Determine the pattern of inheritance shown in this pedigree and identify the genotypes of individuals 1 and 16. Use the letter 'A' or 'a' to represent alleles.

Inheritance pattern:

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Genotype Individual 1:

Genotype Individual 16:

- (b) If individual 16 has a child with an affected partner (who has the genetic condition), what are the chances this child will be affected? Show any relevant working.

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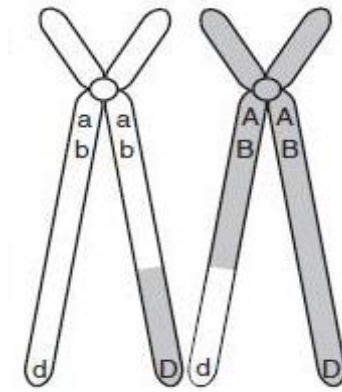
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Question 25 (3 marks)

Marks

The diagram below shows the result of crossing over during meiosis.



- (a) Identify the genotype of the parent cell.

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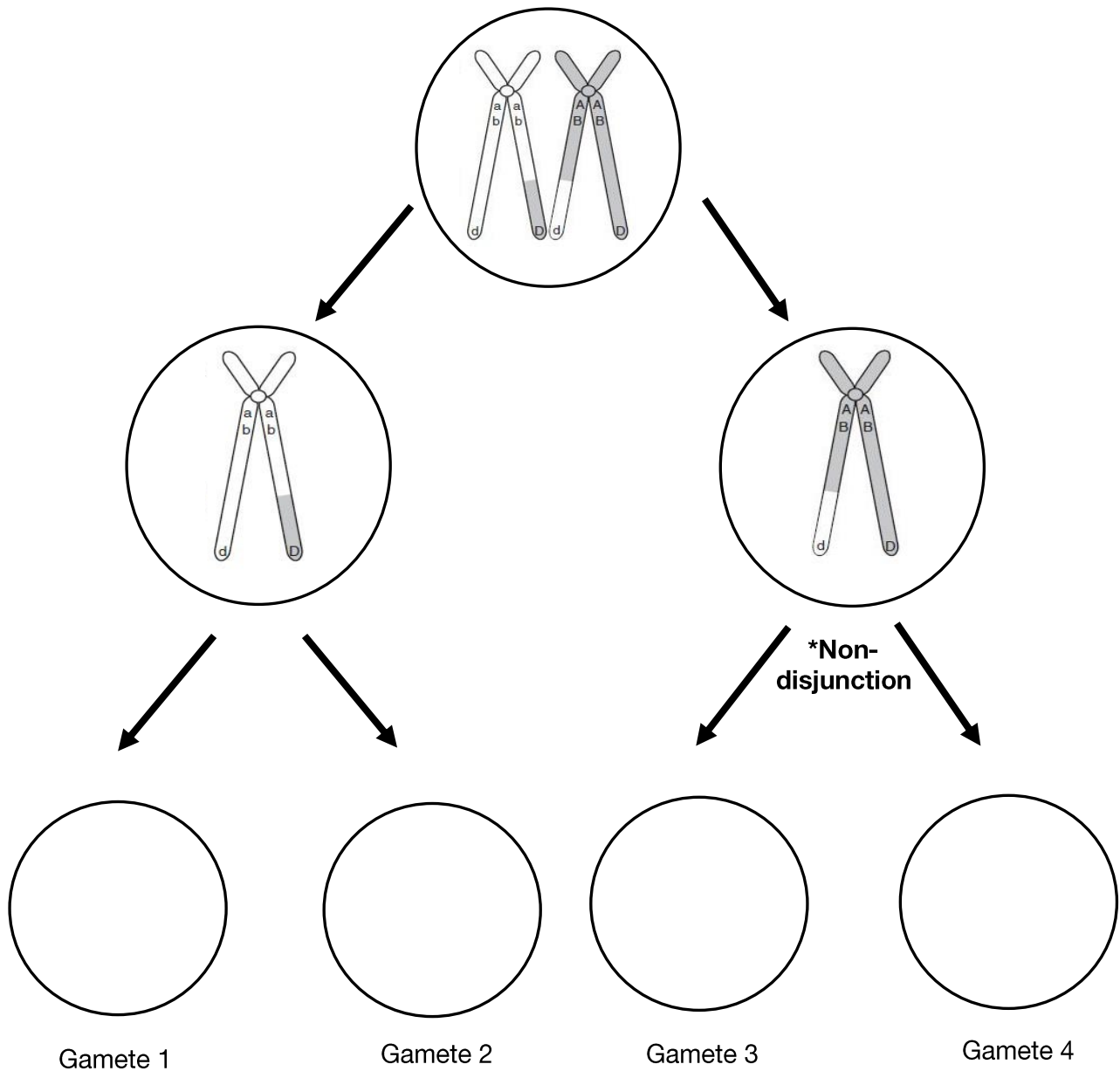
Question 25 continued on next page.

Question 25 continued.

Marks

- (b) The diagram below shows some steps in the process of meiosis involving the recombinants shown on the previous page. Complete the diagram below by filling in the possible allele combinations in the gametes that would result.

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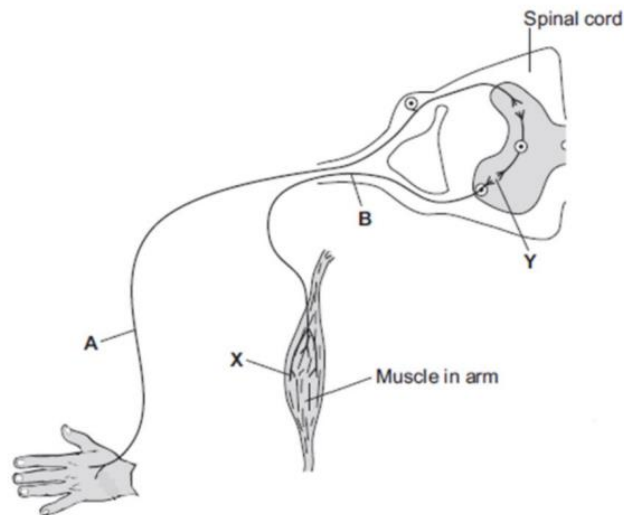
Answer the questions in the spaces provided.
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CANDIDATE NUMBER							

Question 26 (3 marks)

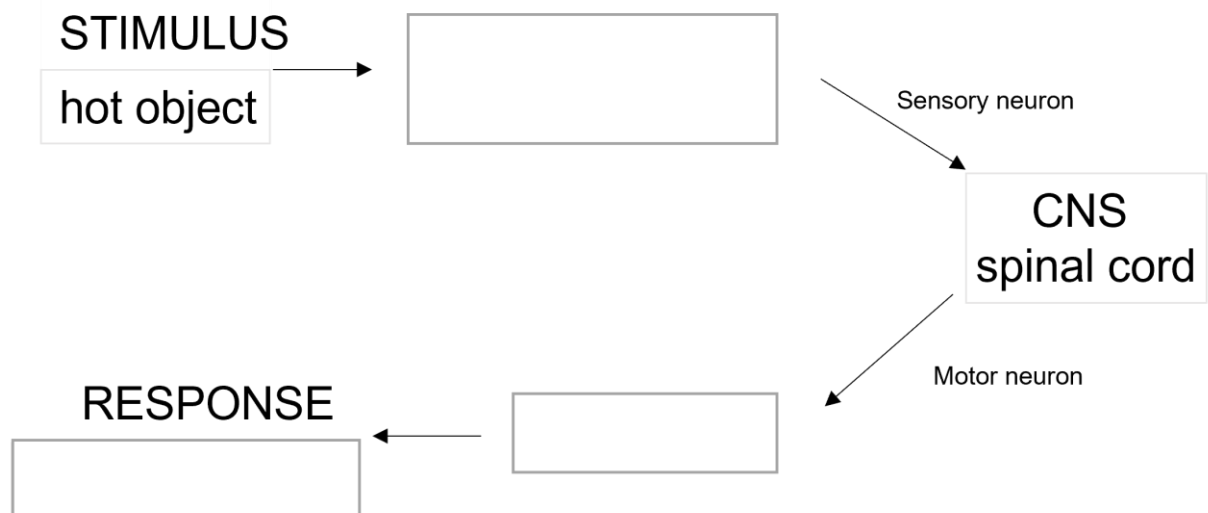
Marks

The diagram below shows the neurons and parts of the body involved in a response to touching a hot object.



Fill in the three blank boxes on the flow chart below which outlines the stimulus-response pathway for the above scenario.

3



Question 27 (4 marks)**Marks**

DNA has both coding and non-coding segments, which vary in terms of biological function. The difference in function also means that the location of genetic mutations can change the impact on the function of the cell.

Complete the table below to distinguish between coding and non-coding DNA.

4

	Coding DNA	Non-coding DNA
Biological function		
Give an example of how biological function can be impacted by a mutation		

Question 28 (13 marks)

Marks

Prostate cancer is the most commonly diagnosed cancer in Australian men.

Prostate Specific Antigen (PSA) is a protein secreted within the prostate gland. The normal function of this protein is as a component of semen. It is coded for by the *KLK3* gene on chromosome 19. PSA is normally very high in men who are developing prostate cancer.

- (a) Using a flow diagram, describe how the *KLK3* gene produces PSA.

4

- (b) In a recent article it was stated that 11.8% of men who have metastatic (ie. spreading) prostate cancer also have germ-line mutations in certain repair genes (Prichard et al, 2016). This is significantly more than in the general male population.

- i. What is meant by germ-line mutations?

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Question 28 continued on next page.

Question 28 continued.

Marks

- ii. Explain why the effect of germ-line mutations on organisms are more severe than somatic mutations.

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- (c) Explain how mutations of genes which repair DNA might cause metastatic prostate cancer.

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- (d) Recent research has suggested that a diet high in processed meats correlates to a higher incidence of prostate cancer. Assess whether consuming processed meats has any scientific basis in causing prostate cancer.

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Question 29 (8 marks)

Marks

Genetic technologies such as DNA sequencing and DNA profiling can be used to determine inheritance patterns in a population.

Compare the results obtained from these two technologies and discuss how they can be used to predict inheritance patterns and the spread of diseases.

8

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Question 29 continued on next page.

Question 29 continued.

Marks

This image shows a full page of a handwriting practice worksheet. It consists of approximately 20 horizontal dashed lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

CANDIDATE NUMBER							

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Question 30 (3 marks)

Marks

Cosmetics companies seek Kakadu Plum, or gubinge, found in north-western Australia, for its antioxidant- and nutrient-rich properties. For example, the cosmetics company Red Earth, was using Kakadu Plum products to hand out on Qantas flights. The patenting of cloned animals, genetically modified crops and genetic materials such as the breast cancer gene is well publicised, but you can also patent natural products.

Discuss the patenting of ingredients taken from Aboriginal Australian cultural and intellectual property.

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Question 31 (8 marks)

When a person is bitten by a venomous snake, the snake injects a toxin into the person. Antivenom is injected as treatment. This treatment is an example of passive immunity.

- (a) Outline how the treatment with antivenom works and explain why it is essential to use passive immunity, rather than active immunity.

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Question 31 continued on next page.

Question 31 continued.

Marks

- (b) A mixture of venoms from several snakes of the same species is used to make antivenom. Suggest why this makes a more effective antivenom.

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- (c) Antivenom is made by the vaccination of animals. Each animal is initially injected with a small volume of venom. Two weeks later, the animals are injected with a larger volume of venom following which the purification of antibodies from the animal's blood plasma takes place. Use your knowledge of the humoral immune response to explain this vaccination programme.

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Question 32 (15 marks)**Marks**

Zika is a RNA virus, which can be spread by the *Aedes* mosquito. Most people infected with the Zika virus experience no or very mild symptoms. An outbreak in South America was accompanied by an increase in the number of babies being born with microcephaly (a significantly smaller head and abnormal brain development). The incubation period for the Zika virus is estimated to range between 3 and 12 days. The symptoms, are similar to other mosquito-borne diseases such as malaria and include: fever, rash, muscular pain, joint pain and headaches.

In 2016, concern was expressed by athletes travelling to the Olympics in Brazil regarding possible infection with Zika. The World Health Organisation concluded that the risk of transmission was relatively low. The advice given to anyone travelling to the Olympics was:

- use insect repellent and wear loose clothing that covers the body
- keep windows closed at night and sleep under a mosquito net
- avoid areas with poor sanitation and stagnant water.

(a) Identify the method of transmission of the Zika virus.

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(b) Outline how the preventative methods described above would help reduce the chance of infection with Zika.

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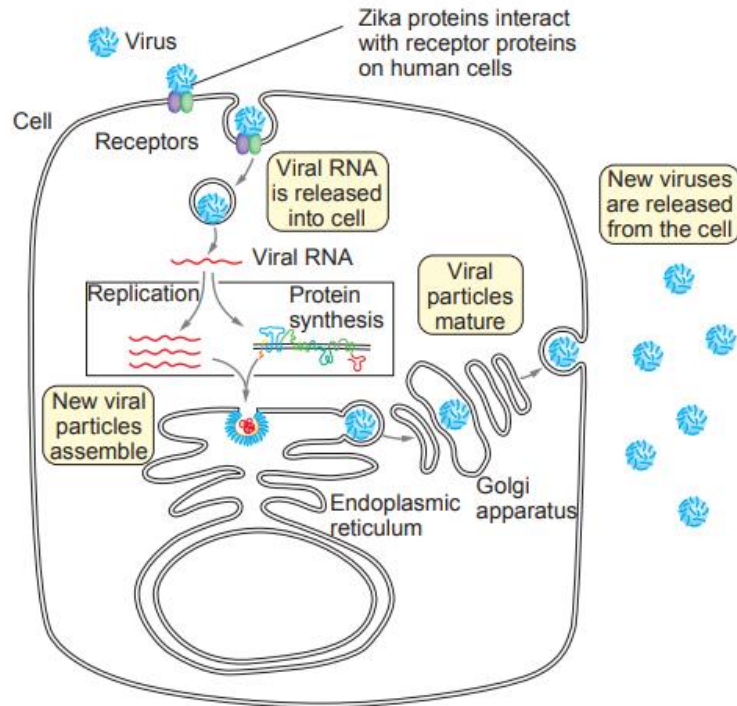
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Question 32 continued on next page.

Question 32 continued.

Marks

- (c) The diagram below shows how the Zika virus replicates inside a human cell.



- i. With reference to the diagram, suggest why viruses are difficult to treat with drugs.

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Question 32 continued on next page.

Question 32 continued.

Marks

- ii. Outline why it may be difficult to develop an effective vaccine against the Zika virus.

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- iii. Evaluate the effectiveness of vaccination programmes, public health campaigns, pharmaceuticals, and genetic engineering in the prevention of epidemics such as Zika.

8

This image shows a full page of a handwriting practice worksheet. It consists of multiple rows of horizontal dashed lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no margins or additional markings.

END OF PAPER

This image shows a full page of a handwriting practice worksheet. It consists of approximately 20 horizontal rows. Each row is defined by two parallel dashed lines, creating a series of uniform gaps for letter height. The lines are evenly spaced across the entire page, providing a guide for consistent letter formation. There is no text or other markings on the page.

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2022 TRIAL EXAMINATION BIOLOGY Form VI

STRUCTURE OF PAPER

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Attempt Questions 1- 20

Allow about 35 minutes for this section

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5 minutes reading time and 3 hours working time.

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For questions in Section II, show all relevant working for questions involving calculations.

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Class	6BL201	6BL202	6BL203	6BL204
Master Initials	ACR	ZI	ACR	DBD

Authors: ACR, DBD, ZI

MiC: ACR

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SECTION I: MULTIPLE CHOICE (20 marks)

Attempt ALL Questions
Use the Multiple-Choice Answer Sheet.

1 What is the best definition of a *mutagen*?

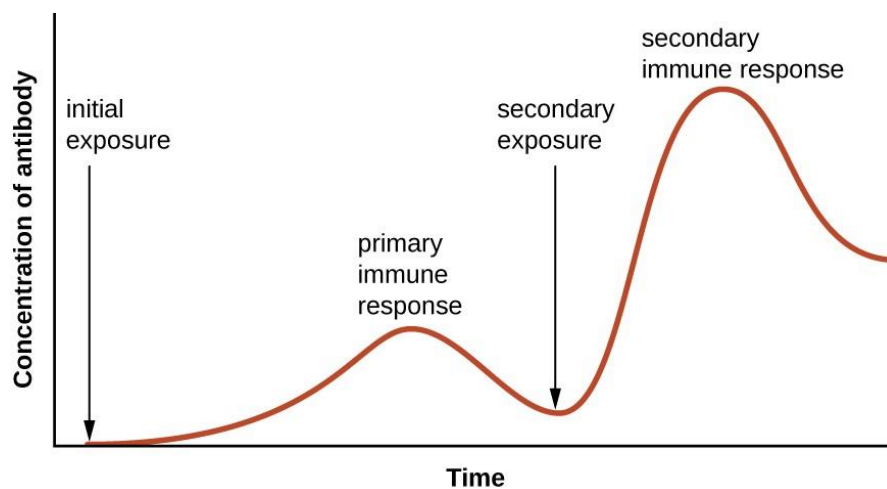
A change in the structure of DNA.

An agent that causes genetic change.

The action or process of nucleotide change.

The rearrangement of sections of chromosomes and genes.

2 Which of the following cell types initiates the secondary immune response depicted below?



cytotoxic T cell

memory B cell

helper T cell

suppressor T cell

3 Four ways of being immune are

- 1** having memory cells after an infection
- 2** having memory cells after being injected with dead bacteria
- 3** being injected with antibodies
- 4** receiving antibodies from breast milk

Which row in the table correctly shows the types of immunity?

	natural active	artificial active	natural passive	artificial passive
A	1	2	3	4
B	1	2	4	3
C	2	1	3	4
D	2	1	4	3

4 A pathogen was found to be prokaryotic, contain DNA and have a cell wall.

How would it be classified?

Virus

Fungus

Protozoan

Bacterium

5 Skin grafting involves the transplantation of healthy skin which can be used to cover damaged skin for example due to burns. A graft of skin tissue received from a different person is usually rejected by the recipient's body.

Which statement about graft rejection is correct?

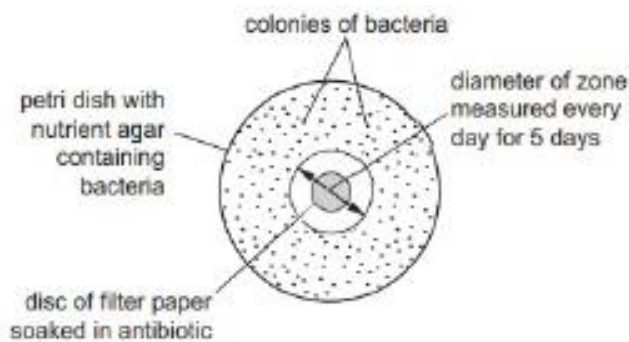
The graft is rejected by B-lymphocytes because T-lymphocytes are not stimulated to produce antibodies.

The graft is rejected by T-lymphocytes because they circulate in the blood and can gather at the graft site.

The graft is rejected by T-lymphocytes because the graft tissue causes T-lymphocytes to release antibodies.

The graft is rejected by B-lymphocytes because they make and release antibodies which react with the surface antigens on the graft cells.

- 6 The diagram below shows one way of testing the effect of an antibiotic on bacteria.



The table below shows the results of testing five different types of bacteria using the method above. Zones of less than 13 mm show the presence of resistant bacteria.

Type of bacteria	Diameter of zone with no bacterial growth after 5 days (mm)
1	14.30
2	0.00
3	10.90
4	0.00
5	20.40

Which statement can be supported by this data?

The antibiotic can be used to treat bacteria types 1 and 3 only.

All the types of bacteria become resistant to antibiotics over time.

Type 5 of the bacteria can never become resistant to the antibiotic.

Only types 2, 3 and 4 of the bacteria show resistance to the antibiotic.

7 Which of the following best describes a function of a macrophage?

They release histamines.

They are found in tissues and secrete cytokines in response to infection.

They circulate in the blood and produce antigens in response to infection.

They can leave the blood and secrete cytotoxins when exposed to damaged cells.

8 Which of the following best describes the benefit(s) of artificial insemination of dairy cattle?

The process creates genetically identical offspring that all produce good milk yield.

It decreases genetic diversity by introducing the same genes to different populations on different farms.

It enables a large number of cows to be inseminated with sperm from a bull with desirable milk production traits.

The process creates genetically modified calves that may produce milk in the future that is safe for human consumption.

- 9 Which row is the best comparison of the daughter cell produced in each process?

	Mitosis	Meiosis
(A)	• Identical to parent • Identical to each other • Homologous pairs of chromosomes	• Different to parent • Different to each other • Unpaired chromosomes
(B)	• Different to parent • Identical to each other • Homologous pairs of chromosomes	• Identical to parent • Different to each other • Unpaired chromosomes
(C)	• Identical to parent • Different to each other • Unpaired chromosomes	• Different to parent • Identical to each other • Homologous pairs of chromosomes
(D)	• Identical to parent • Identical to each other • Unpaired chromosomes	• Different to parent • Different to each other • Homologous pairs of chromosomes

- 10 Which statement best describes how cloning might be used to assist human health?

Human clones will mean an individual can 'live' forever.

Antibiotic resistant bacteria can be used to produce medicines.

Human organs could be cloned to replace diseased or damaged organs.

Food from cloned plants and animals can be modified to be healthier for human consumption.

- 11** Which of the following is an example of a physiological adaptation in an endotherm that assists in maintaining homeostasis?

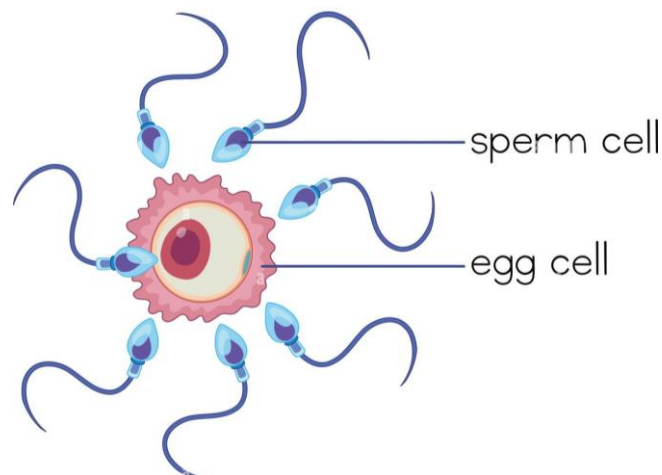
Animals in cold climates having thick fur coats.

A dog moving into the shade to keep cool on a hot day.

Surface blood vessels in a human constricting on a cold day.

Lizards moving into the sunlight to raise their body temperature.

- 12** The diagram below models the process of fertilisation.



Which of the following is an appropriate evaluation of this model?

The diagram shows the entry of sperm cells into the egg.

The diagram has some downfalls, such as the egg is too large.

The diagram is a very reliable model of fertilisation because it shows all the stages of fertilisation.

The diagram is good because it depicts fertilisation in a simple way, despite inaccuracies such as the size of cells.

- 13** Grapefruit originated from a cross between an orange and a pomelo.

What is this an example of?

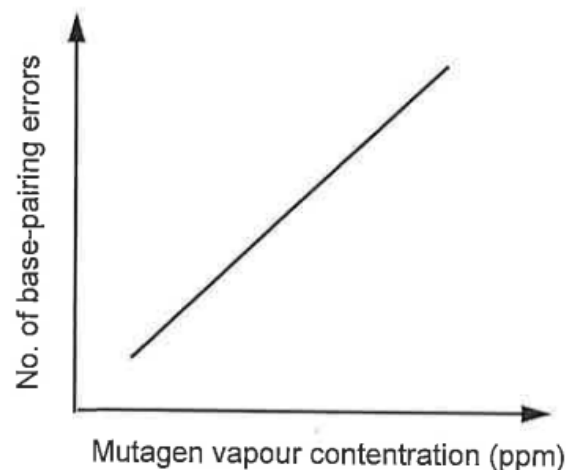
Cloning

Transgenics

Selective breeding

Artificial insemination

- 14** A chemical mutagen is known to cause significant damage to DNA structure through the disruption of the normal base-pairing process. The graph below shows the relationship between exposure to mutagen vapours and the frequency of base-pairing errors.



Which of the following statements correctly describes the trend observed?

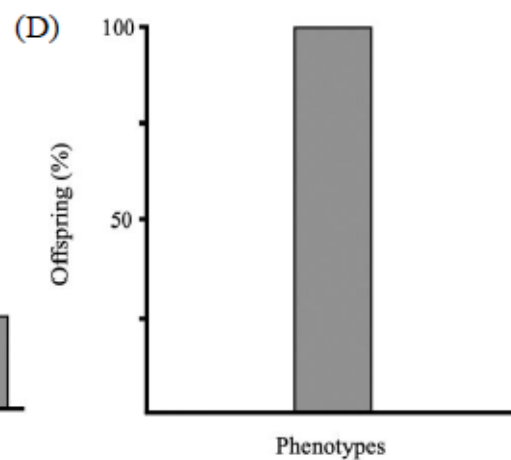
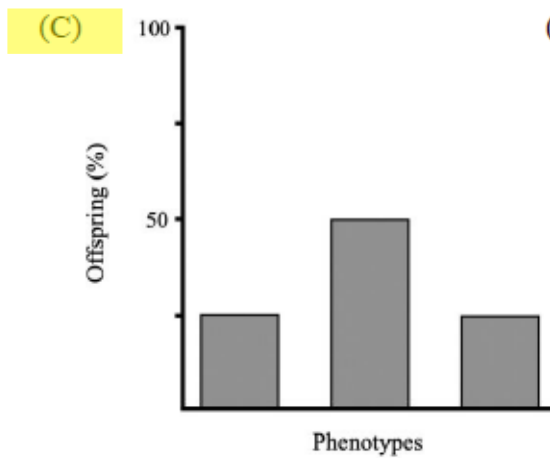
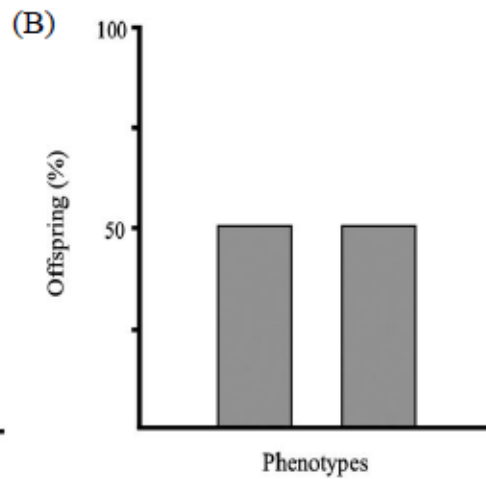
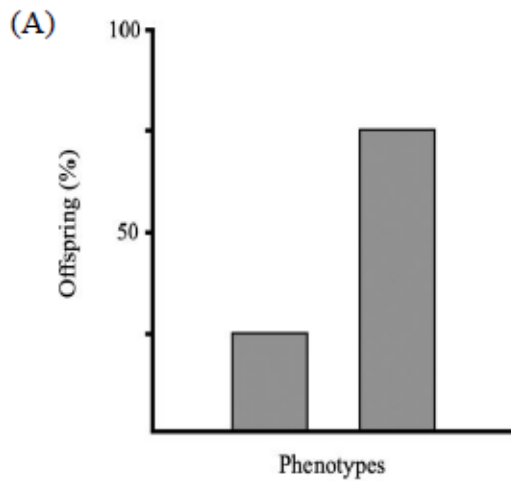
An increased frequency of base-pairing errors leads to increased mutations.

An increased number of base-pairing errors leads to increased vapour production.

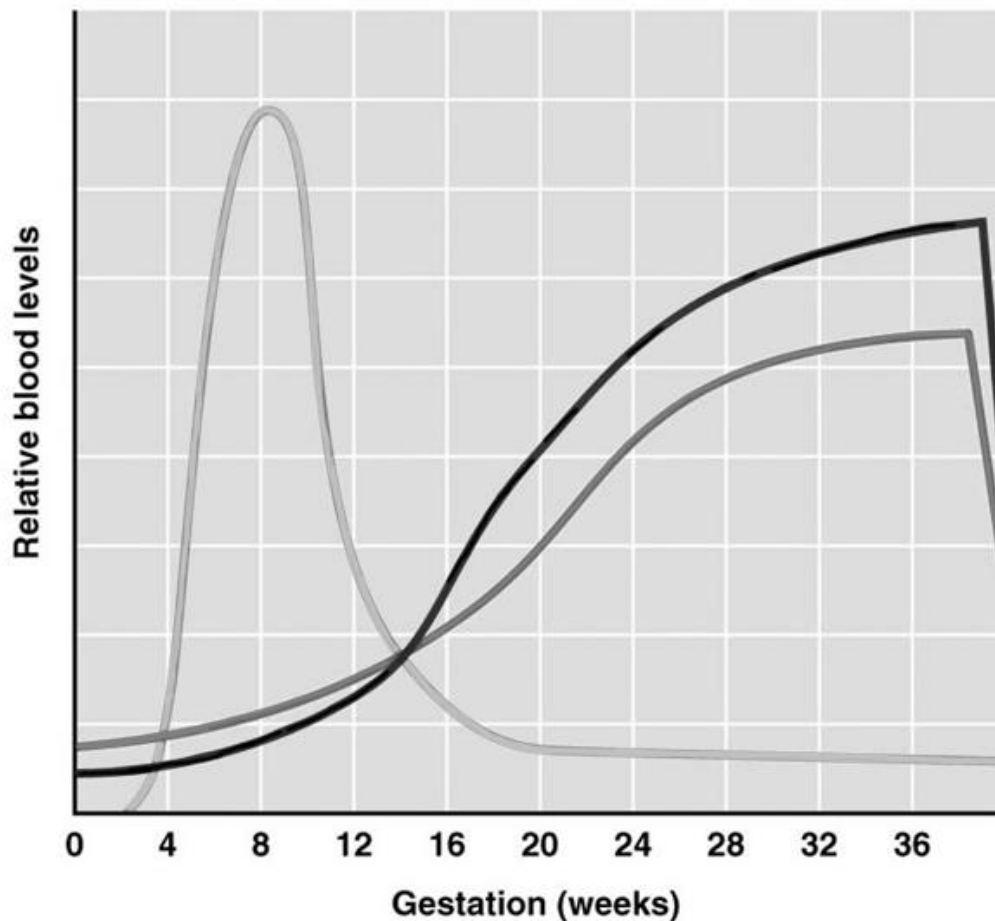
An increase in mutagen vapour concentration leads to an increase in the frequency of base-pairing errors.

An increase in mutagen vapour concentration leads to a decrease in the frequency of base-pairing errors.

- 15 Some organisms have genotypes that produce three different phenotypes, for example a red flower crossed with a white flower to produce a pink flower. If two of these pink flowers were crossed, which of the following graphs would correctly represent the offspring of this cross?



- 16 The graph below shows the changes of three hormones during gestation (pregnancy).



Copyright © 2006 Pearson Education, Inc., publishing as Benjamin Cummings.

Which of the statements below best identifies the changes in hormone levels shown over the gestation period?

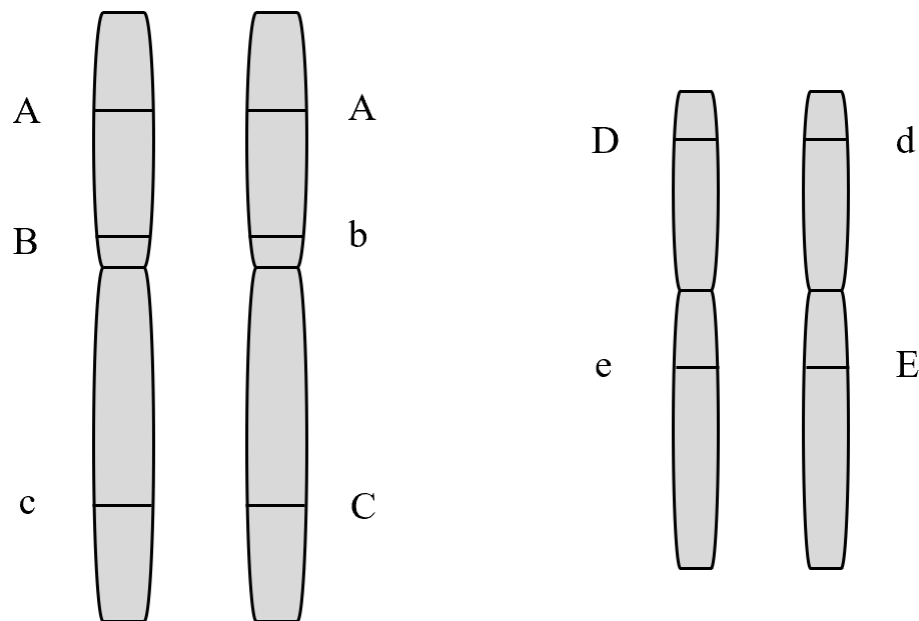
hCG and oestrogen both rise and stay high in concentration from 24 weeks onwards.

Progesterone levels peak at 8 weeks then drop when the placenta is formed.

Both oestrogen and progesterone gradually rise in concentration until birth where they both rapidly decline at around 40 weeks.

hCG, produced by cells surrounding the embryo and then the placenta peaks at around week 36 and can be detected in urine tests.

- 17 Analyse the diagram below which shows two pairs of homologous chromosomes and their allele arrangement.



Assuming there is no crossing over, which of the following shows all the possible genotypes for the gametes formed in this organism?

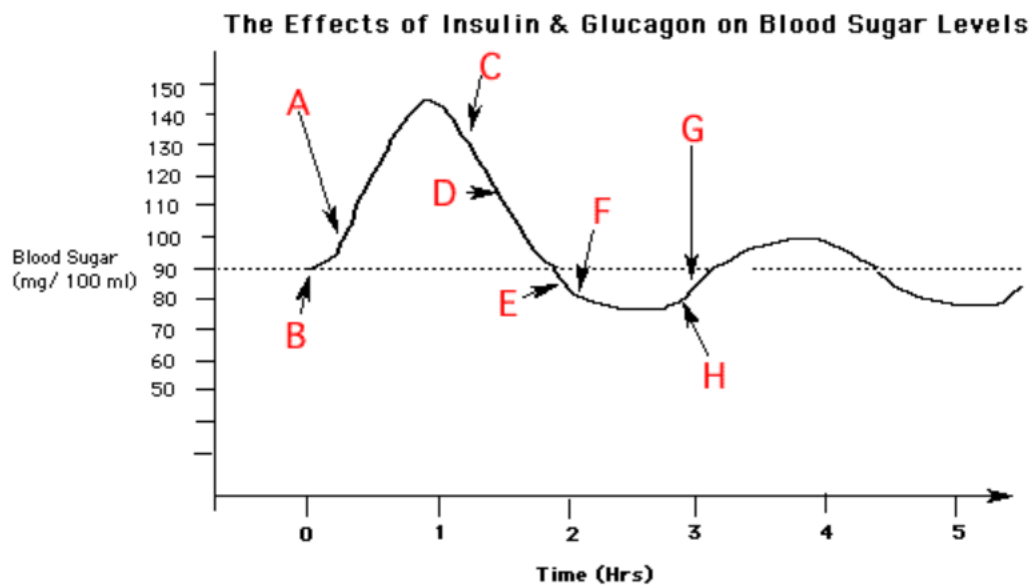
- ABcDe, ABcdE, AbCDe, AbCdE
- AbCdE, ABCdE, AbCDE, AbCdE
- ABcDE, ABcdE, AbCDe, AbDdE
- AbcDE, ABcdE, AbCDe, ABcdE

- 18 Which of the following represents the DNA sequence that codes for the mRNA strand shown below?

5' – CUAACG – 3'

- 3' – GATTGC – 5'
- 3' – GAUUGC – 5'
- 3' – CGUUAG – 5'
- 3' – CGTTAG – 5'

19 Analyse the graph below which shows blood glucose regulation.



Which of the following statements is correct?

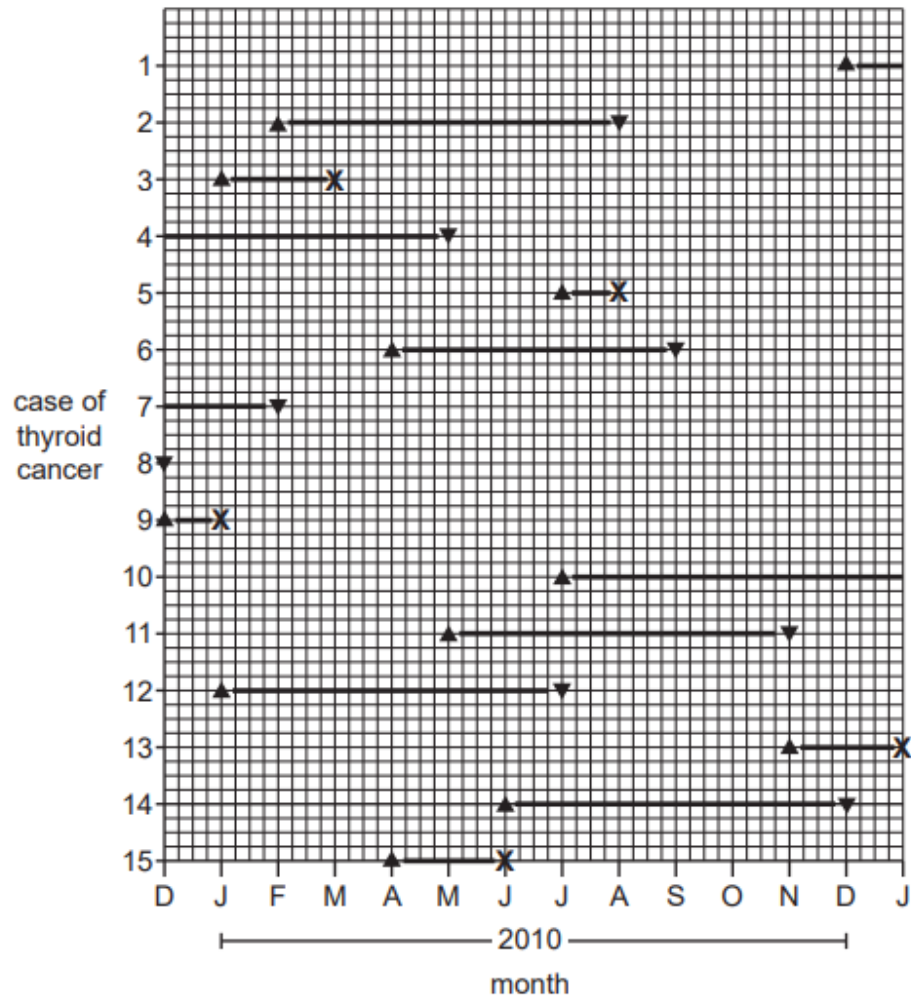
Insulin is highest at A.

Glucagon is highest at H.

Insulin levels are high whenever the blood glucose levels reach 90mg/mL.

According to this graph the optimal blood glucose concentration is 140mg/100mL.

- 20 There were 15 cases of thyroid cancer recorded in Iceland between December 2009 and January 2011. The graph below shows, for each case, the month of diagnosis (▲) and month of recovery (▼) or death (X) from the disease.



Iceland has a population of 330 000 people. Which of the options below was the incidence rate (per 100 000) of thyroid cancer from March to October 2010?

- 0.6
- 1.8
- 2.7
- 4.5

SECTION II: SHORT AND LONG ANSWER (80 marks)

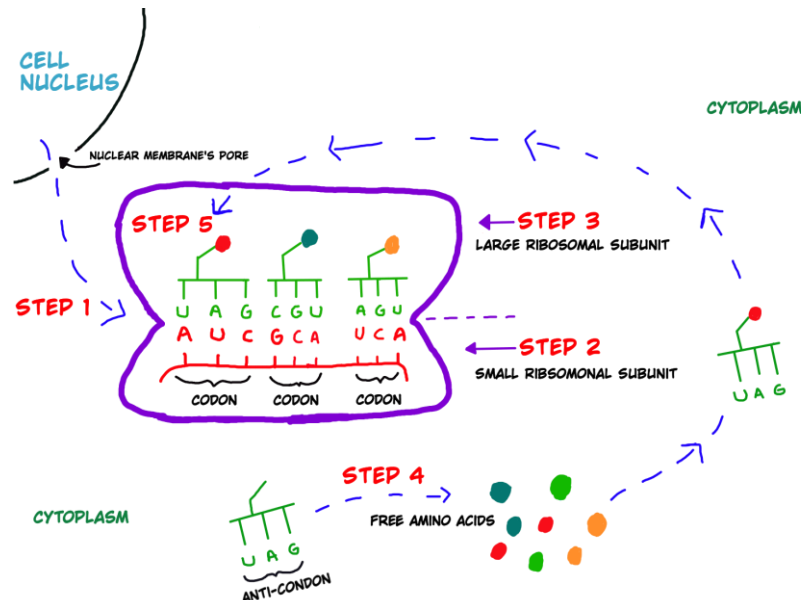
Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

CANDIDATE NUMBER							

Question 21 (3 marks)

Marks

The diagram below shows a stage of polypeptide synthesis.



Identify the stage of polypeptide synthesis in this diagram.

Translation 1

Why is the anti-codon significant in this process?

2 – correctly relates the structure of the anti-codon to its significance in polypeptide synthesis

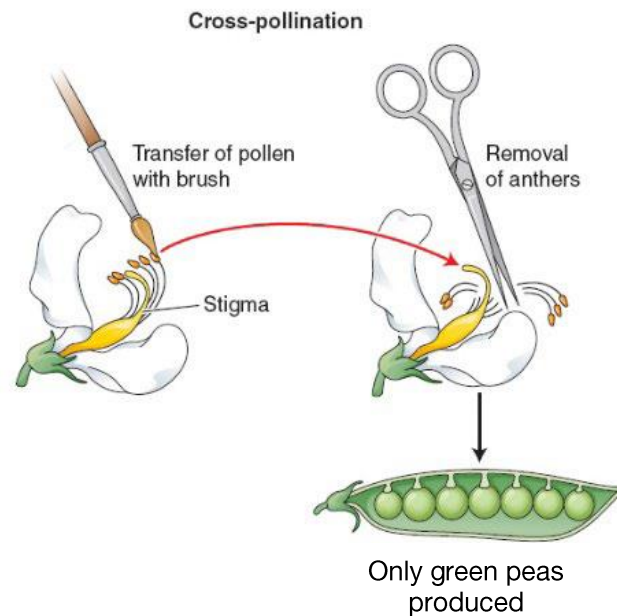
1 – gives some relevant information about anti-codon structure OR polypeptide synthesis

Eg: The triplet of bases on the anti-codon are complementary to those on the mRNA. This means that the amino acids, attached to the anti-codon (tRNA) are joined in the correct order to form a functional protein.

Question 22 (6 marks)

Marks

The diagram below shows the process of cross pollination in plants, similar to the method Mendel used in his experiments.



Which step ensures the validity of the cross pollination? Justify your answer.

2 – correct step identified and appropriately justified

1- correct step identified and/or an attempt at a justification is made.

Eg: Removal of the anthers prevents self-pollination ensuring that only the transferred pollen fertilises the ova.

Question 22 continued on next page.

Question 22 continued.

Marks

This species of pea plant, shown on the previous page, has two phenotypes for pea colour, green and yellow. Both parent plants are homozygous. The plant providing the pollen produces yellow peas.

Identify the dominant and recessive **phenotype for pea colour** in this species.

Dominant: green

Recessive: yellow BOTH correct for 1

Determine the phenotype and genotype ratios of the offspring produced from crossing two plants grown from the peas in this diagram (on the previous page).

.....

3

3 – correctly identifies parents and crosses them accurately to determine the correct genotype and phenotype ratio of the offspring

2 – shows the genotypes and phenotypes from an appropriate cross OR correctly identifies the parent genotype and crosses them to obtain a correct genotype or phenotype ratio of the offspring

1- makes some attempt to determine a genotype or phenotype

Markers comments: ALWAYS show a punnett square, clearly, even if not asked for!

Always link the genotype to phenotype eg: GG and Gg are green; gg is yellow.

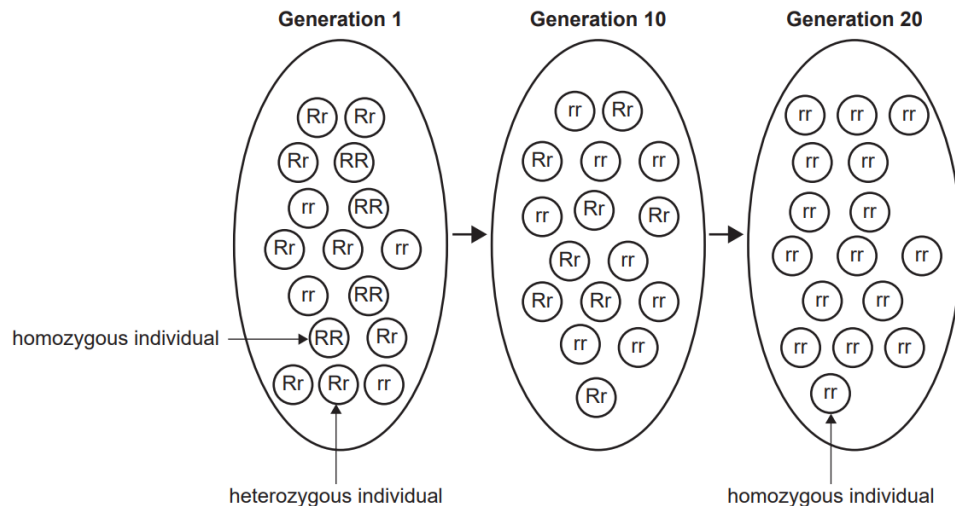
This question is about understanding that genotype ratio is different to phenotype b/c the parent plants (from the **seeds aka PEAS, produced** in the diagram) are heterozygous.

Get into the habit of using the SAME letter (capital for dominant and lower case for recessive) when doing standard mendelian crosses.

NEVER use X and Y unless doing sex-linked crosses.

Question 23 (8 marks)**Marks**

The diagram below shows the gene pool of a population over 20 generations.



Describe how the population has changed over the 20 generations.

2- correctly describes the changes in gene pool from generation 1 to generation 20

1 – makes some reference to the gene pool in generation 1 or 20.

Eg: the appearance of R and r is about equal in generation 1. By generation 20, the R allele has disappeared from the population leaving on r alleles present.

Explain how the changes you have described in part (a) may have occurred.

3 – provide a valid reason and explains this as a factor causing the change/s identified in part (a)

2 – describes a factor that could change the gene pool

1 – makes some reference to a factor that can change gene pools.

Eg: If R is responsible for a trait that is not favourable in this environment, individuals with that trait will not survive. Those with rr will be better suited, survive and pass on their alleles. Over time (20 gen's) the R allele will be selected against and disappear.

Marker comment: explain means you need to describe the factor and also say HOW it will lead to the change in gene pool. Many boys only described a factor but didn't relate it to the gene pool in the question.

Question 23 continued on next page.

Question 23 continued.

Marks

Calculate the **allele** frequency for the two alleles present in generation 10.

3 – correctly calculates the FREQUENCY of R and r alleles

2 – calculates two frequencies

1 – attempts to calculate a frequency

Eg: $R = 8/32 = 0.25$ or 25%

$r = 24/32$ (or $1 - 0.25$) = 0.75 or 75%

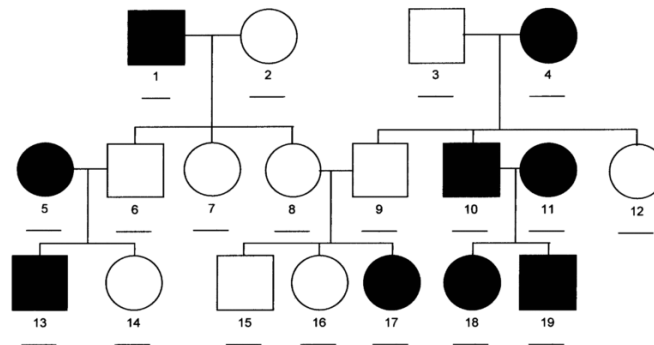
Marker comments: lots of boys calculated the frequency of the genotype Rr and rr not the allele frequency R and r.

Some boys didn't give a frequency, but gave a ratio.... be careful with what the question is asking vs what you usually do!

Question 24 (6 marks)

Marks

Analyse the pedigree below showing a genetic condition expressed in a family.



Determine the pattern of inheritance shown in this pedigree and identify the genotypes of individuals 1 and 16. Use the letter 'A' or 'a' to represent alleles.

Inheritance pattern: autosomal recessive NB: CoE applied below if this incorrect

3

Genotype Individual 1: aa

Genotype Individual 16: Aa or AA – both needed for 1 mark

If individual 16 has a child with an affected partner (who has the genetic condition), what are the chances this child will be affected? Show any relevant working.

3 – correctly uses appropriate working to determine the chances of a child, from 16 (both genotype possibilities considered) and an affected partner, being affected.

2 – Identifies a chance of being affected and shows appropriate working

1 – makes an attempt to determine the chance of being affected.

Eg: if 16 is Aa, partner is aa then 2 in 8 (25%) chance; if 16 AA and partner aa then 0 chance of being affected.

	A	a			A	A
a	Aa	aa		a	Aa	Aa
a	Aa	aa		a	Aa	Aa

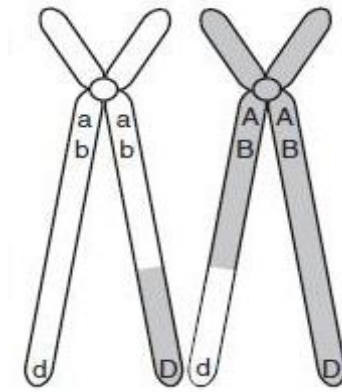
Marker comments: PUNETT SQUARES ARE ESSENTIAL HERE = “show working” is not an invitation it is an instruction to be followed!

Many boys made their process VERY complicated, look at the marks available! 2 punetts plus a probability/chance determination = 3 marks

Question 25 (3 marks)

Marks

The diagram below shows the result of crossing over during meiosis.



Identify the genotype of the parent cell.

Aa Bb Dd 1

Marker comment: many boys missed the info in the stem (highlighted) when answering this question.

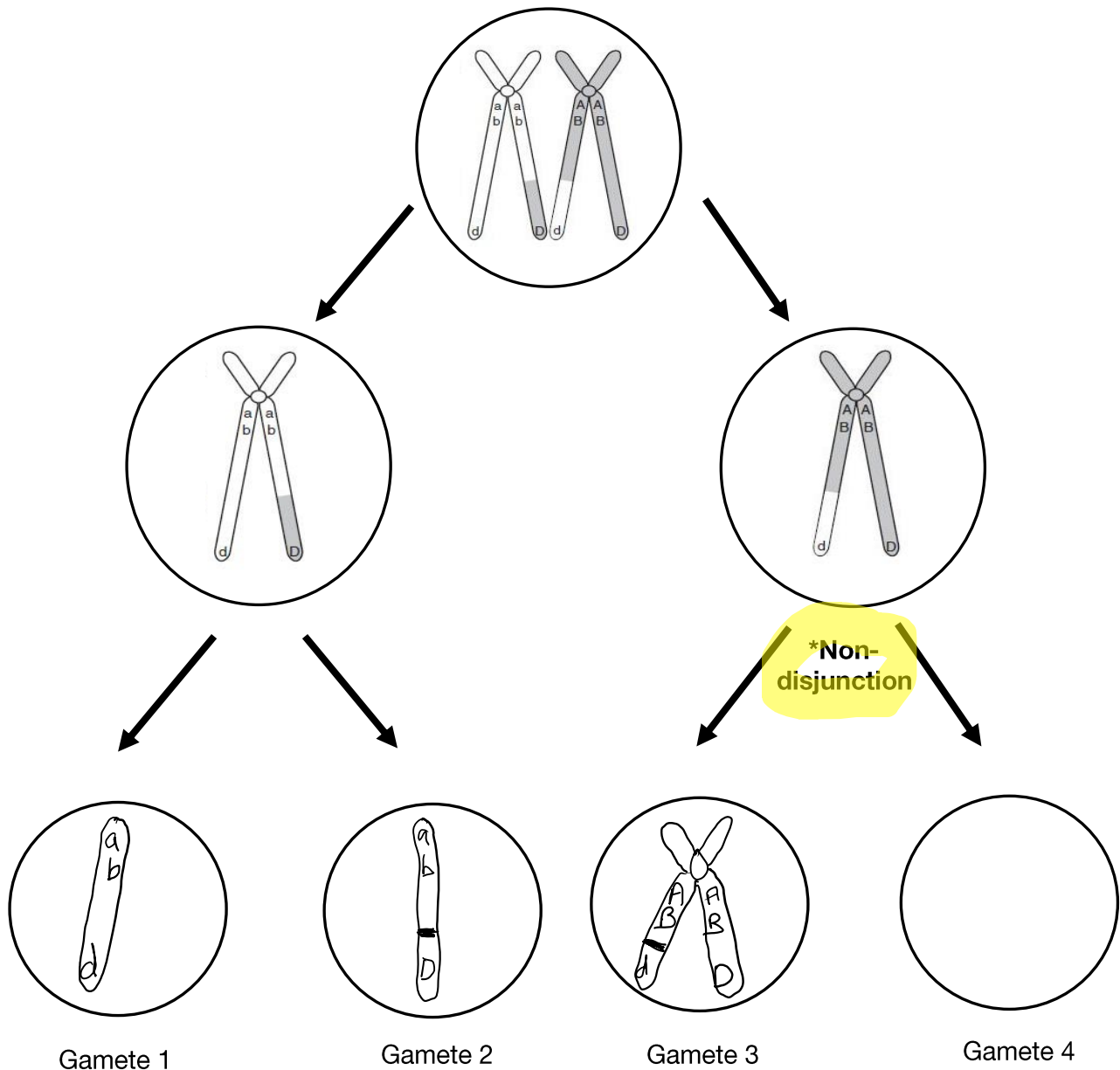
Question 25 continued on next page.

Question 25 continued.

Marks

The diagram below shows some steps in the process of meiosis involving the recombinants shown on the previous page. Complete the diagram below by filling in the possible allele combinations in the gametes that would result.

2



2 – correctly completes the diagram (all four gametes)

1 – correctly completes 2 or 3 of the gametes

Marker comments: many boys missed the non-disjunction statement or don't understand the term.

If a gamete is left 'empty' don't write anything in it (not even "no genetic material")

You don't need to shade the whole chromatid but it is a good idea to show the crossed-over section (see gamete 2 and 3)

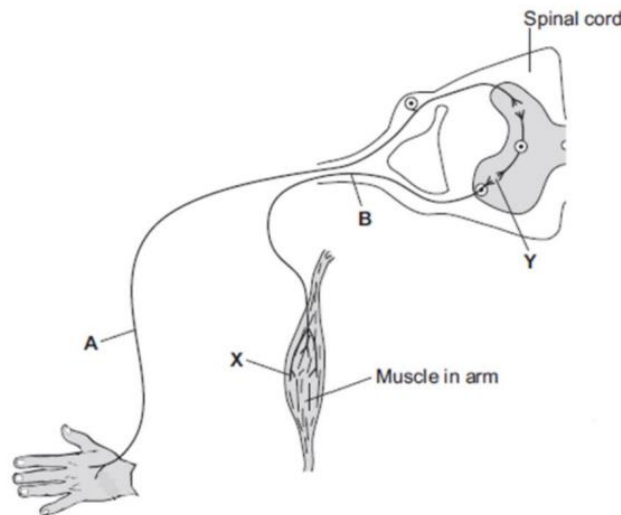
Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

CANDIDATE NUMBER							

Question 26 (3 marks)

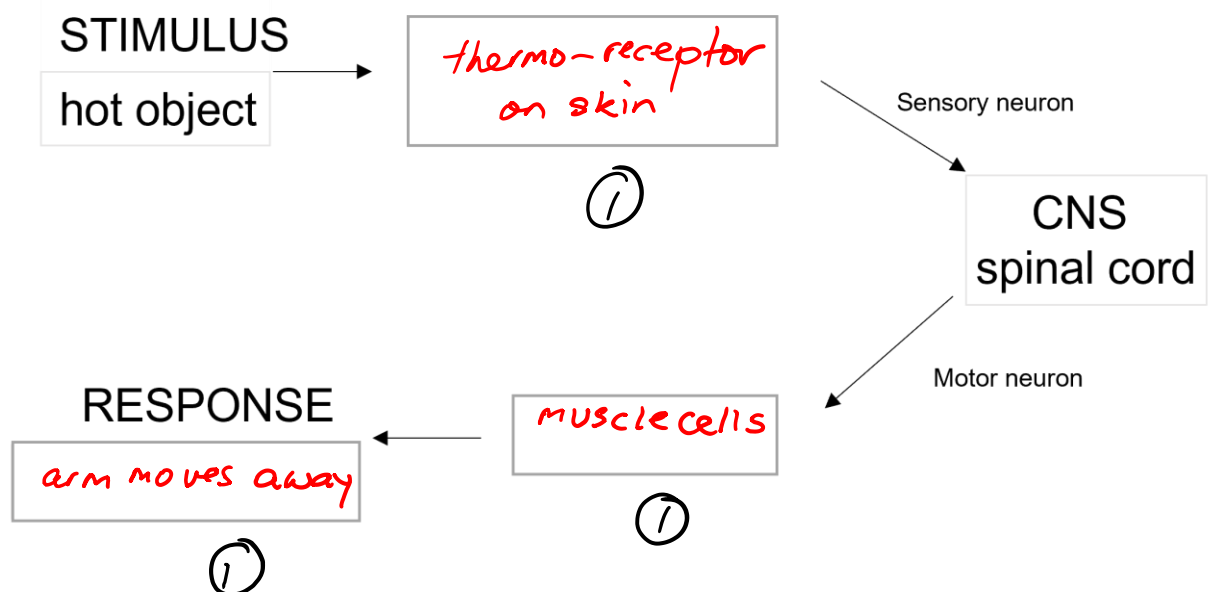
Marks

The diagram below shows the neurons and parts of the body involved in a response to touching a hot object.



Fill in the three blank boxes on the flow chart below which outlines the stimulus-response pathway for the above scenario.

3



Question 27 (4 marks)**Marks**

DNA has both coding and non-coding segments, which vary in terms of biological function. The difference in function also means that the location of genetic mutations can change the impact on the function of the cell.

Complete the table below to distinguish between coding and non-coding DNA.

4

	Coding DNA	Non-coding DNA
Biological function	Protein synthesis	-Regulation of gene expression -structural for example chromosome, centromere, rRNA
Give an example of how biological function can be impacted by a mutation	Disfunctional protein made, leading to disease	-Turns genes on and off at the wrong times -centromeres, potentially chromosomes cannot separate Leading to disease

Question 27 (4 marks)

Mark

DNA has both coding and non-coding segments, which vary in terms of biological function. The difference in function also means that the location of genetic mutations can change the impact on the function of the cell.

Complete the table below to distinguish between coding and non-coding DNA.

4

	Coding DNA	Non-coding DNA
Biological function	Codes for proteins through process of transcription during polypeptide synthesis.	Affects gene expression, only so can cause some genes to show while others don't.
Give an example of how biological function can be impacted by a mutation	Interrupts the Alters the code Can cause a nucleotide base to alter - e.g. deletion will effectively remove the base and thus the amino acid produced from this strand could either have altered function, be completely useless or not be affected at all. Additionally, if a base is altered and it forms a premature stop codon for an amino acid, (nonsense) the protein produced will be non functional.	Impacts gene expression, causing a gene to not express itself and or cause a gene that did not previously express itself. Eg a deletion mutation of a gene base could cause the gene to stop expressing itself completely.

4

Question 27 (4 marks)

Mark

DNA has both coding and non-coding segments, which vary in terms of biological function. The difference in function also means that the location of genetic mutations can change the impact on the function of the cell.

Complete the table below to distinguish between coding and non-coding DNA.

	Coding DNA (transcribe)	Non-coding DNA molecules
Biological function	* Produce mRNA in order to produce polypeptides / proteins. ✓	- Produce RNA RNA like tRNA molecules. - Produce q-satellite regions base for chromosomal segregation (kinetochore binding). * Don't produce mRNA and hence don't produce proteins or polypeptides.
Give an example of how biological function can be impacted by a mutation	Possible * Production of a substitution missense mutation which can produce a new, undesirable protein that may lead to an adaptation or lack of cellular function like a cancer. ✓	* A mutation in q-satellite DNA can result in improper kinetochore binding to the centromere of a chromosome and hence an increased likelihood in non-disjunction resulting in aneuploid cells. ✓

4

4

V. good

Question 27 (4 marks)

Mark

DNA has both coding and non-coding segments, which vary in terms of biological function. The difference in function also means that the location of genetic mutations can change the impact on the function of the cell.

Complete the table below to distinguish between coding and non-coding DNA.

4

	Coding DNA	Non-coding DNA
Biological function	Responsible for genes which code for proteins which have a variety of functions, e.g., as enzymes, or to increase structural integrity.	Responsible for things like preventing coding DNA being removed during replication (telomeres) or structural support by forming centromeres.
Give an example of how biological function can be impacted by a mutation	If a frameshift mutation occurred the DNA code would be distorted, and the protein produced by polypeptide synthesis would be structurally damaged and hence non-functional. For example, the enzymes used by lysosomes may be non-functional, preventing cellular digestion.	If a point mutation occurred in the telomeres there would be no negative impact as the telomeres exist only to be destroyed during replication, and their genetic code has no significant impact. If a STR section responsible for forming centromeres had a mutation preventing it from properly functioning as a structural support, then homologous chromosomes could not be bonded by the centromeres, affecting processes like mitosis and meiosis where homologous chromosomes are split into daughter cells.

Question 28 (13 marks)

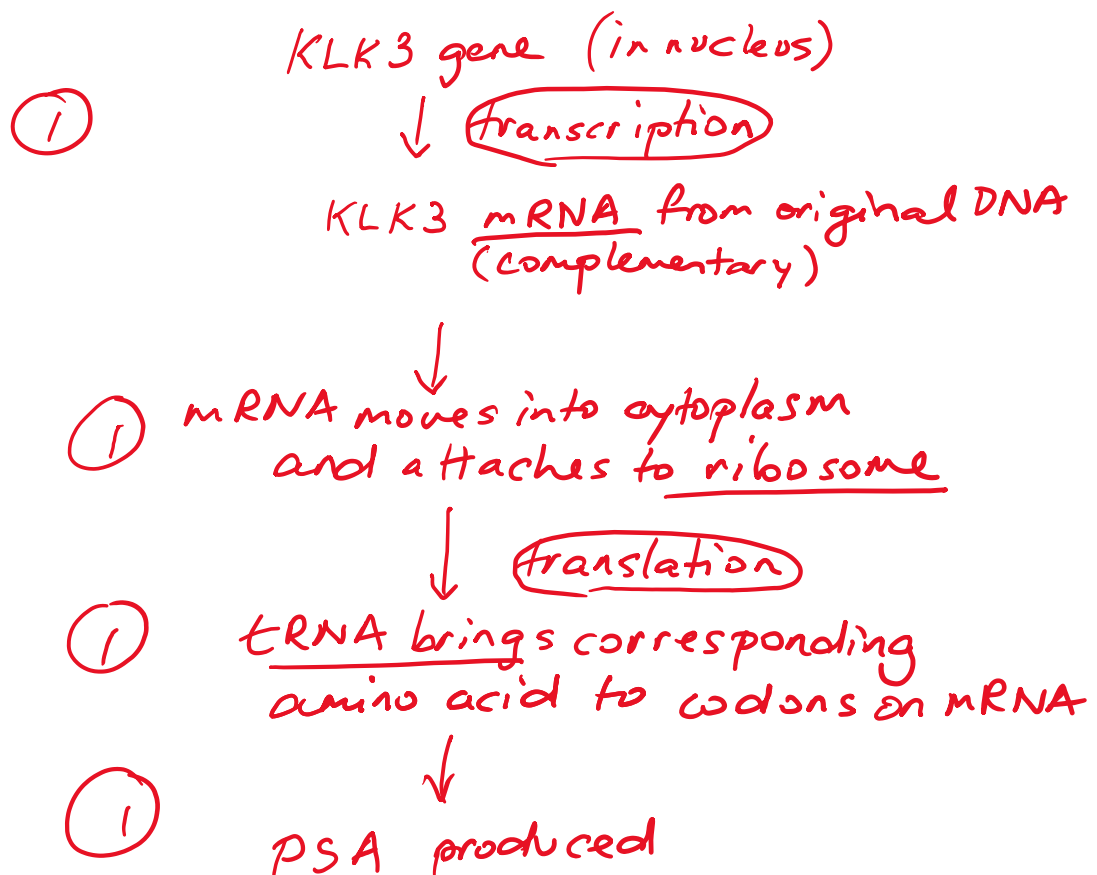
Marks

Prostate cancer is the most commonly diagnosed cancer in Australian men.

Prostate Specific Antigen (PSA) is a protein secreted within the prostate gland. The normal function of this protein is as a component of semen. It is coded for by the *KLK3* gene on chromosome 19. PSA is normally very high in men who are developing prostate cancer.

Using a flow diagram, describe how the *KLK3* gene produces PSA.

4



In a recent article it was stated that 11.8% of men who have metastatic (ie. spreading) prostate cancer also have germ-line mutations in certain repair genes (Prichard et al, 2016). This is significantly more than in the general male population.

What is meant by germ-line mutations?

1

A mutation occurring in a germ cell which will become a gamete, which can be then be inherited

Question 28 continued on next page.

Question 28 continued.

Marks

Explain why the effect of germ-line mutations on organisms are more severe than somatic mutations.

- **3**
- 1 mark – germ-line mutations are more severe than somatic mutations, as the mutation is potentially passed on to every offspring (multiple organisms in population affected)
- 1 mark – the zygote carrying the mutation will undergo mitosis producing every cell in the body with the mutation present
- 1 mark- on the other hand, for somatic mutations one original cell with the mutation will produce only a patch of cells which are affected (only within organism)

Explain how mutations of genes which repair DNA might cause metastatic prostate cancer.

- **2**
- 1 mark – errors in DNA repair genes can lead to failure to repair mistakes in DNA replication
- 1 mark – this allows mutations to accumulate in a cell in the prostate and will result in uncontrollable cell proliferation – cancer

Recent research has suggested that **a diet high in processed meats** correlates to a higher incidence of prostate cancer. Assess whether consuming processed meats **has any scientific basis** in causing prostate cancer.

- **3**
- 1 mark – processed meats are high in carcinogens/mutagens
- 1 mark – there are chemicals which can cause mutations in the DNA in cells which are exposed to them
- 1 mark – a diet high in processed meats means that these chemicals can potentially accumulate in the prostate gland, increasing the chances of mutations occurring
- Therefore, there is strong scientific basis in causing prostate cancer

Question 29 (8 marks)**Marks**

Genetic technologies such as DNA sequencing and DNA profiling can be used to determine inheritance patterns in a population.

Compare the results obtained from these two technologies and discuss how they can be used to predict inheritance patterns and the spread of diseases.

8

Criteria	Marks
- Discusses, with the effective use of examples, how the results of both technologies can be used to predict inheritance patterns AND the spread of diseases - Compares results obtained from DNA sequencing and DNA profiling - Describes how results for both technologies are obtained - Communicates logically and succinctly with precise biological terms	8
- Discusses how the results of both technologies can be used to predict inheritance patterns AND the spread of disease/s - Compares results obtained from DNA sequencing and DNA profiling - Describes how results for both technologies are obtained - Communicates logically and succinctly with precise biological terms	6-7
- Outlines the two technologies and states how they can be used to predict inheritance patterns and the spread of disease - Missing effective use of examples to support discussion of the two technologies	4-5
- Outlines some inheritance patterns and the spread of disease OR - Describes how results for technologies are obtained - Missing details links between outlined technologies and inheritance patterns and spread of disease	2-3
Provides any relevant information	1

Possible points for discussion:

(2 marks)

DNA profiling – STRs of a locus, microsatellites, use of PCR, restriction enzyme, electrophoresis, unique banding pattern, paternity testing, forensic, inexpensive

(2 marks)

DNA sequencing – determining the exact nucleotide sequence, whole genome or specific DNA fragment, PCR, labelled fluorescent markers attached, used to study genomes, new alleles, diseased genes, medical diagnoses, biotech, bioinformatics, more expensive

(2 marks)

DNA profiling

- can collect data on a wide scale, and track specific markers through populations, migrations, evolution
- which people are more predisposed to certain diseases (non-infectious and infectious) - limited to risk factors of diseases
- examples of sickle cell anaemia and correlation with malaria, elephants in Africa

(2marks)

DNA sequencing

- determine mutations
- sequence the genetic material of pathogens and track which serotypes are spreading through population, eg. Flu, Covid
- predict which viral/bacterial strains are most numerous in outbreaks in the population and design vaccines to them (most boys missed this point)
- cancer genes and likelihood of getting cancers, eg BRCA for breast cancer (tumour suppressor genes), mutations tracked through a population

Note: The very good responses incorporated appropriate examples to support their argument to predict inheritance patterns and spread of diseases

Question 29 continued on next page.

Def both techniques

Explain use of each in det'g inher. patts. + spread of diseases

Question 29 (8 marks)

Mark

Genetic technologies such as DNA sequencing and DNA profiling can be used to determine inheritance patterns in a population.

Compare the results obtained from these two technologies and discuss how they can be used to predict inheritance patterns and the spread of diseases.

DNA sequencing is the process of cataloguing a full list of the DNA base pairs present in an organism, or at least in one gene thereof. DNA profiling is the process of sequencing short-tandem repeats only, which are correlated to inheritance.

8

DNA sequencing is extremely useful for understanding the roles of different genes, and thus for predicting how organisms will respond to stimuli, as well as for learning how mutations act on organisms. For instance, the sequencing of a single gene that the p53 gene enables the recognition and understanding of the mutations therein that are associated with cancer development. By understanding this, we can predict the development of cancers throughout a population. Additionally, widespread DNA sequencing of whole populations has led to the understanding of haplotypes, groups of genes on a chromosome with a series of SNPs (single-nucleotide polymorphisms, i.e. single base-pair mutations present in $\geq 1\%$ of population) inherited together on a chromosome as a block, which has enabled the prediction of inheritance patterns in humans. Through further sequencing, the genetic diversity of populations can be determined, and then their resistance to disease. If there is high genetic diversity, then the population is more likely to possess an allele

Question 29 continued on next page.

combination that confers resistance, then it may be better able to adapt, ~~to the~~ and we can hence predict the spread of disease. The converse would be predictable for a population with low genetic diversity, which might motivate the inception of captive breeding programs to increase it and help preserve the population.

By contrast, DNA profiling is used primarily for determining the inheritance of patterns of small groups. It targets STRs, producing a summary of band ~~length~~ DNA strand lengths for the organism profiled. Usually, STRs vary over time with generations, with strong similarity between those of parents and children, thus allowing the prediction of a child's parents, for example, as in paternity testing. This knowledge of inheritance patterns at a more targeted level can also enable an understanding of the inheritance of non-infectious diseases, such as Huntington's chorea, which arises from having over 30 copies of a certain STR. Thus, the later development of this disease can be predicted in infancy with DNA profiling. Notably, DNA profiling is far faster, and less costly, than DNA sequencing, and hence it is more widely applicable in the everyday needs of inheritance pattern prediction (e.g. paternity tests).

sickle cell?

Hence, both DNA sequencing and DNA profiling can be used to predict inheritance patterns ~~for~~ in populations — sequencing at a large-scale and profiling at a smaller-scale. From this information, the spread of non-infectious genetic diseases ^{within a population} can also be predicted.

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

CANDIDATE NUMBER							

Question 30 (3 marks)

Marks

Cosmetics companies seek Kakadu Plum, or gubinge, found in north-western Australia, for its antioxidant- and nutrient-rich properties. For example, the cosmetics company Red Earth, was using Kakadu Plum products to hand out on Qantas flights. The patenting of cloned animals, genetically modified crops and genetic materials such as the breast cancer gene is well publicised, but you can also patent natural products.

Discuss the patenting of ingredients taken from Aboriginal Australian cultural and intellectual property.

.....

3

Discuss means - Identify issues and provide points for and/or against.

Any 3 points eg:

Arguments against eg Aboriginal Australian intellectual property not being credited / Lack of recognition of aboriginal rights and protection of native species / Use of thousands of years of practice and knowledge by Aboriginals that ingredients have been discovered – should be protected / Large companies exploiting intellectual property for profits

Arguments for eg – ingredients can create benefits for wider population and should be shared / companies are already using these products

See sample answer

Question 31 (8 marks)

When a person is bitten by a venomous snake, the snake injects a toxin into the person. Antivenom is injected as treatment. This treatment is an example of passive immunity.

Outline how the treatment with antivenom works and explain why it is essential to use passive immunity, rather than active immunity.

.....

3

1 – passive immunity is providing antibodies which bind to toxin

1 – Active immunity would be too slow (need to state time effect)

1 – Explanation – Because active immunity would take time to produce the required B-plasma cells to secrete the antibodies to stop the venom and this delay might result in death of the individual.

See sample answer

Question 30 (3 marks)

Mark

Cosmetics companies seek Kakadu Plum, or gubinge, found in north-western Australia, for its antioxidant- and nutrient-rich properties. For example, the cosmetics company Red Earth, was using Kakadu Plum products to hand out on Qantas flights. The patenting of cloned animals, genetically modified crops and genetic materials such as the breast cancer gene is well publicised, but you can also patent natural products.

Discuss the patenting of ingredients taken from Aboriginal Australian cultural and intellectual property.

The patenting of ingredients taken from Aboriginal Australian culture and property has interfered with their land and stolen their traditional methods. ~~This is~~ significant. By patenting their native ingredients, they are unable to ~~to~~ sell and distribute their ingredients and methods. This has taken away significant financial benefits and recognition, while also undermining the importance and value of their land and cultural and spiritual processes.

3

3

Question 31 continued.

Marks

A mixture of venoms from several snakes of the same species is used to make antivenom. Suggest why this makes a more effective antivenom.

..... **2**

1 – different antigens / different snakes produce different venom (due to genetic diversity)

1 – Different antibodies are needed to combat different types of antigen / in case you don't know which species of snake individual has been bitten by.

Sample answer

The antivenom would be effective against antigens from multiple venoms and so the different antibodies provided will be able to bind with the different antigens.

Antivenom is made by the vaccination of animals. Each animal is initially injected with a small volume of venom. Two weeks later, the animals are injected with a larger volume of venom following which the purification of antibodies from the animal's blood plasma takes place. Use your knowledge of the humoral immune response to explain this vaccination programme.

..... **3**

1 – stimulation / cloning of B-plasma cells (or outline of T-Helper cell interaction to stimulate B-plasma cells)

1 – relate to B-memory (or T-memory) cells being produced

1 – second dose would stimulate a higher concentration of antibodies and a quicker response

/ first dose has to be smaller so that the animal is not killed

No marks can be awarded for repeating/copying information from the question stem.

Sample answer

The program stimulated production of B-plasma cells after the first small dose of venom is given, which is reduced so it will not cause harm to the animal. The antigens present in the venom will stimulate the cloning of B-plasma cells to produce specific antibodies to these antigens alongside the creation of B-memory cells. The second dose will result in a faster and bigger production of antibodies and so the animal will not be harmed by the increased dosage.

Question 30 (3 marks)

Mark

Cosmetics companies seek Kakadu Plum, or gubinge, found in north-western Australia, for its antioxidant- and nutrient-rich properties. For example, the cosmetics company Red Earth, was using Kakadu Plum products to hand out on Qantas flights. The patenting of cloned animals, genetically modified crops and genetic materials such as the breast cancer gene is well publicised, but you can also patent natural products.

Discuss the patenting of ingredients taken from Aboriginal Australian cultural and intellectual property.

Patenting ingredients from Aboriginal Australian cultural and intellectual property is highly important. One reason for this is that the cultural and intellectual knowledge about these ingredients such as the Kakadu plum and gubinge are part of the identity and history of indigenous cultures. meanwhile, patenting ensures the protection and preservation of these cultures' intellectual and cultural property. As well as this, patenting is important as it shows respect to indigenous property, it may encourage further sharing of knowledge and collaboration to develop new socially beneficial medicinal products.

3

Question 31 (8 marks)

When a person is bitten by a venomous snake, the snake injects a toxin into the person. Antivenom is injected as treatment. This treatment is an example of passive immunity.

- (a) Outline how the treatment with antivenom works and explain why it is essential to use passive immunity, rather than active immunity.

Antivenom is essentially pre-prepared antibodies being injected into the body which bind to the antigens of the venom, neutralising their ability to cause damage and making them more easily identified for destruction.

Passive immunity in this case, is where injected the active immunity as passive allows for a much faster destruction of the venom, where as it would take time for active immunity (such as memory cells) to produce antibodies.

Question 31 continued on next page.

This is important as in this case, the person has already been bitten, and needs immediate treatment, rather than the slower response of active immunity.

3

Question 32 (15 marks)**Marks**

Zika is a RNA virus, which can be spread by the *Aedes* mosquito. Most people infected with the Zika virus experience no or very mild symptoms. An outbreak in South America was accompanied by an increase in the number of babies being born with microcephaly (a significantly smaller head and abnormal brain development). The incubation period for the Zika virus is estimated to range between 3 and 12 days. The symptoms, are similar to other mosquito-borne diseases such as malaria and include: fever, rash, muscular pain, joint pain and headaches.

In 2016, concern was expressed by athletes travelling to the Olympics in Brazil regarding possible infection with Zika. The World Health Organisation concluded that the risk of transmission was relatively low. The advice given to anyone travelling to the Olympics was:

- use insect repellent and wear loose clothing that covers the body
- keep windows closed at night and sleep under a mosquito net
- avoid areas with poor sanitation and stagnant water.

Identify the method of transmission of the Zika virus.

Vector / mosquito

1

Outline how the preventative methods described above would help reduce the chance of infection with Zika.

.....

2

1 mark for each method linked to how it prevents transmission of the virus.

Eg Mosquito nets prevent the mosquitoes from biting individuals and transmitting the virus into bodily fluids of person

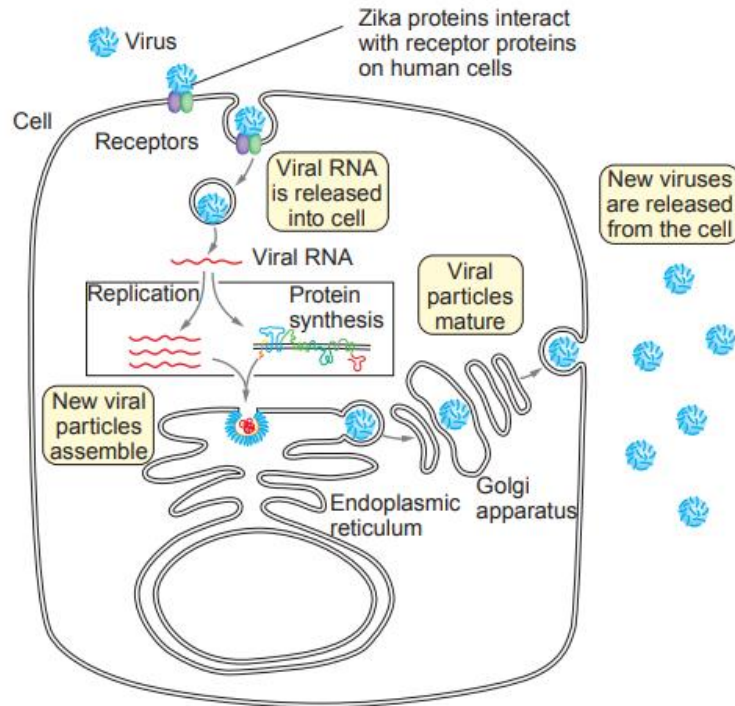
Many did not state how the pathogen was being prevented from gaining entry into the body by breaking the skin barrier

Question 32 continued on next page.

Question 32 continued.

Marks

The diagram below shows how the Zika virus replicates inside a human cell.



With reference to the diagram, suggest why viruses are difficult to treat with drugs.

2

Any two points from following eg

viruses are not cellular so there are no metabolic pathways to attack with drugs / Drugs would interfere with the host cell metabolism or damage host cells / viruses enter the host's cells and so drugs cannot target the virus inside the cell / drugs would have to disrupt essential cell processes.

See the following sample responses:

Viruses are just nucleic acid encased by a selection of proteins - therefore, as they are non-living, it is hard to interfere with their replication process as they utilise the machinery of our own cells. Two years

2

Question 32 continued on next page.

that if we target their replication such as by interfering with protein translation, we will also interfere with our own cells resulting in ~~our~~ our own cellular death - hence, such drugs will not work as they will damage the organism rather than just the virus.

Unlike Bacteria, ~~that~~ viruses like Zika do not replicate on their own but rather use host ^{protein} cells. This means drugs would have to

2

target and kill human cells to get rid of the virus. This is very difficult to do because the virus uses the host's own systems

(replication, protein synthesis, glycolysis etc.) to replicate itself. Either drugs could be killing healthy human cells or are not able to target the virus in any

Question 32 continued on next page. meaningful way. This makes

it hard to treat with drugs compared to other pathogens.

Question 32 continued on next page.

Question 32 continued.**Marks**

Outline why it may be difficult to develop an effective vaccine against the Zika virus.

2

.....

Outline means - Sketch in general terms; indicate the main features of:

Any 2 of the following main features:

Viruses have high mutation rates / high antigenic variation / problems with funding issues since vaccines need to be constantly made / difficult to develop vaccine to target virus directly or virus infected cells.

Evaluate the effectiveness of vaccination programmes, public health campaigns, pharmaceuticals, and genetic engineering in the prevention of epidemics such as Zika.

8

Criteria	Marks
- Describes all 4 prevention measures and how they prevent epidemics in terms of reduction of transmission - Compares advantages and disadvantages of each prevention measure to help make judgement - Makes a judgement of each measure in terms of effectiveness using supporting evidence and relates to prevention of epidemics - Communicates logically and succinctly with precise biological terms	8
Describes all 4 prevention measures and how they prevent epidemics in terms of reduction of transmission Missing full evaluation of advantages and disadvantages of a measure / or missing a judgement of each measure in terms of effectiveness using supporting evidence and relates to prevention of epidemics	6-7
Outlines all 4 prevention measures and how they prevent epidemics in terms of reduction of transmission Missing full evaluation of advantages and disadvantages of one or two measures / or missing a judgement of a measure in terms of effectiveness	4-5
Outlines all some prevention measures and how they prevent epidemics in terms of reduction of transmission Missing evaluations of advantages and disadvantages of some measures / or missing a judgement of a measure in terms of effectiveness	2-3
Provides any relevant information	1

NB – common error was to describe the effectiveness of a vaccine rather than a vaccination programme. Vaccination programme needed to include comment on

effectiveness related to mass immunisation / herd immunity and needing it to be on a very large / global scale.

Better answers included egs of when these measures have proven effective – eg eradication of smallpox thanks to mass immunisation and world-wide vaccination program by WHO.

* Please indicate in the examination if you have continued your answer on a separate answer booklet.

See sample responses:

- ii. Outline why it may be difficult to develop an effective vaccine against the Zika virus.

Effective vaccines depend on specific antigens on the surface of the pathogen. Zika however uses its surface proteins to gain access to cells, and spends most of its life cycle replicating inside and hijacking host cells, which will not display its changes to their MHC complexes which alert the immune system to pathogenic invasion. Thus the vaccine

← Cont. in writing booklet

- iii. Evaluate the effectiveness of vaccination programmes, public health campaigns, pharmaceuticals, and genetic engineering in the prevention of epidemics such as Zika.

Epidemics are localised outbreaks of specific infectious diseases. The effectiveness of the methods listed above have ~~very~~ very significantly however, and are contingent on the pathogen responsible for the disease and the powers of the local government and willingness of the community. Vaccination programs can be extremely effective in preventing pandemics by producing immunity in those who have received the vaccine. Vaccines work by introducing an attenuated copy of the pathogen (e.g., influenza virus) to the body. Thus the pathogen has the antigens, but not its viral code, meaning the body can undergo a response to and neutralising the antigens through the production of antibodies by B-plasma cells without having to combat the spread of the pathogen or compensate for all the cells it destroys. Additionally, vaccines allow for memory B-cells to be produced, which on a 2nd infection will stimulate the cloning of B-plasma cells to rapidly produce antibodies capable of neutralising pathogens by surrounding them and thus preventing their access to host cells. This is the 2nd ~~infection~~ infection, the first one by the actual pathogen. The body combats the pathogen so quickly that no symptoms arise.

Thus widespread vaccination programs can be highly effective in preventing endemic epidemics by preventing infection in local populations. The success of widespread vaccination programs is evidenced ^{goodly} by the success of the smallpox vaccination program which eliminated smallpox in 1978, a disease that was causing 2.5 million deaths a year only a decade earlier. Equally, vaccines of widespread can lead to herd immunity, as a high enough proportion of the population is immune to the disease, preventing its replication/reproduction and transmission, preventing epidemics. The effectiveness of vaccination programs in delivering the aforementioned benefits is contingent on the programs being well-communicated to the public and being well-subscribed to. If the level of vaccinations in a population are low, then herd immunity cannot be established. This is preventing the emergence of an epidemic, as seen in the US' response to COVID-19. ^{good} Additionally, vaccines only work on specific pathogens like the influenza virus. Malaria caused by Plasmodium falciparum ^{malaria} or a protozoa is capable of changing its antigens, preventing a sustained antibody response to effectively neutralise it. Similarly, pathogens like influenza virus can mutate, meaning that vaccines need to be regularly produced and disseminated. Public health campaigns are also important in preventing the emergence of epidemics by communicating key information to the population. As a case study, the outbreak of SARS (Severe Acute Respiratory Syndrome) in China in 2002 led to widespread health campaigns notifying the population to look out for fevers - a key symptom.

END OF PAPER

Cont. in writing booklet

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

20)c) functional, and thus able to correct mutations in the DNA. Thus the cancerous cells may not be checked for the mutations using their cancerous properties, allowing them to spread rapidly (thus making them metastatic.)
 by replicating ~~uninhibited~~ with the mutation

30) However, there ~~has~~ been ~~no~~ recognition of the medicinal properties of the plant as arising from Aboriginal Australian intellectual property (an ingredient in the smoke bush was found to help ~~with~~ treat HIV, hence the company patents). Furthermore, the patents limit the access of Aboriginal Australians to the plant which holds cultural significance ^{for them}, infringing on their cultural property as well.

30)b) ensures that regardless of the snake, the person will not be killed as all possible ~~antivenoms~~ for all possible venoms are within the serum making the antivenom more effective.

32)c)i) produced will be unable to stop the Zika viral particles replicating inside the cells, even if it can neutralise the viruses ~~once~~ they are outside the cells. Thus the effectiveness of this vaccine is thoroughly reduced, as it has limited ability to stop the spread of the ^{Zika} virus within the host once it is inside.

Planning for Q 32)(c)iii)

Effectiveness for all methods → use small pox as example

1. Vaccination programs $\Rightarrow$ can be effective if widespread, well communicated and well subscribed to by producing herd immunity. (also need to describe how vaccines work)
 $\hookrightarrow$ caveat: only work on specific pathogens, these pathogens can mutate, and some pathogens, e.g., malaria, cannot be vaccinated against altogether $\checkmark$
2. Public health $\Rightarrow$ important, e.g., SARS in 2002 clearly for monitoring of fevers led to $\downarrow$ in lag between symptoms and isolation $\Rightarrow$ $\downarrow$ transmission
3. Pharmaceuticals, e.g., antivirals/antibacterials $\Rightarrow$ less effective, contingent on funding, distribution and use
4. Genetic engineering $\Rightarrow$ bring in 24 $\Rightarrow$ make mos. infertile $\downarrow$ decrease vector pop. $\Rightarrow$ $\downarrow$ transmission

Q 32)(c)iii) cont.) Thus with increased consciousness of the symptoms, people were noticing symptoms earlier and isolating quicker, reducing the period of time that they were infectious in the community, limiting transmission $\checkmark$. Thus public health campaigns can be responsible for decreasing transmission so that an epidemic does not emerge. However, the effectiveness of these campaigns is contingent on the ability of the local government to communicate important messages and the willingness of the public to act in accordance with these guidelines. Additionally, the public health campaign will not in of itself prevent deaths or illness.

Pharmaceuticals such as antivirals and antimicrobials are less effective in stopping preventing epidemics as they are contingent on funding, distribution and use. Antimicrobial treatments for instance are not well-funded by pharmaceutical companies due to the lack of economic return from the poorer countries where malaria has a high prevalence (i.e., Sub-Saharan Africa). Thus the drugs are often largely ineffective against the disease, preventing the ability to prevent transmission, and thus failing to prevent the emergence of epidemics. Similarly, antiviral medications are only useful when taken early in the infectious period, so if they are their distribution and use is not timely they are effectively useless in preventing epidemics.

Genetic engineering has the potential great potential to prevent epidemics through vector control. CRISPR technology for instance can be used to reduce the *Aedes* mosquito which transmits Zika or the *Anopheles* mosquito which transmits the protozoan responsible for malaria, reducing their population. Thus with decreased vector populations, the transmission of viruses like Zika to ~~humans~~ humans could be reduced, ensuring that epidemics are prevented altogether. However, these genetic engineering technologies like CRISPR have limitations in their costliness to deploy and thus limited access for a less economically developed countries such as those in Sub-Saharan Africa which actually require the technologies for vector control. Thus the effectiveness of these technologies is contingent on support and research from more economically developed countries.

Thus preventing epidemics like Zika can be achieved through methods such as wide-spread vaccination campaigns, public health campaigns, appropriate use of pharmaceuticals and genetic engineering.

Epidemics are more likely to be prevented by the combination of methods, so that the weaknesses and strengths of each particular method (as described) overlap. For instance running vaccination programs with public health campaigns to ensure they are well proscribed too. Thus epidemics through the combination of these methods can be prevented. For the most part be prevented, ^{or} in the case of more advanced pathogens like HIV, the severity of the epidemic thoroughly reduced.

* which is resistant to vaccines

✓ good

8

Question 32 continued.

Mark

- ii. Outline why it may be difficult to develop an effective vaccine against the Zika virus.

1. ~~These~~ Viruses, such as the Zika virus, mutate ~~very~~ commonly and thus the development of a vaccine ~~can~~ combatting ~~of~~ the specific Zika virus antigens at one point in time may be futile after a mutation in the future.

2

- iii. Evaluate the effectiveness of vaccination programmes, public health campaigns, pharmaceuticals, and genetic engineering in the prevention of epidemics such as Zika.

(exacerbated by more being different strains of the virus)

Overall, ~~vaccination~~ for public health campaigns ~~are~~ and genetic engineering are effective in preventing epidemics such as Zika whilst ~~are~~ vaccination programmes and pharmaceuticals, whilst ~~reducing~~ the severity of epidemics such as Zika, they are not as effective as public health and genetic engineering.

8

Public health campaigns prevent epidemics such as Zika through raising awareness and ^{thus effectively} ~~discouraging~~ practices that prevent infection. This effectiveness is evident in the AIDS epidemic where ~~in~~ the campaign 'AIDS: Don't Die of Ignorance' increased use of contraception, and safe sex and testing rates with 84% of ~~more~~ HIV positive individuals now aware they have the disease - thus preventing further spread by ~~ensuring~~ they don't infect others.

(referring to the outbreak of disease in a region)

8

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

32(ciii)

Similarly, antivirals such as Tamiflu reduce the severity and duration of disease (eg, Tamiflu reducing influenza illness period by up to 2-3 days), constantly mutating diseases and the difficulty in targeting viruses without harming host cells makes its use hinder its effectiveness in preventing epidemics.

Thus, public health programs and genetic engineering ~~have been~~ are effective in preventing epidemics such as Zika ~~was~~, whilst vaccination programs and pharmaceuticals ~~have overall~~ are overall ineffective despite helping ~~attenuate some~~ of prevention epidemics to some extent.