



CATHOLIC SECONDARY SCHOOLS  
ASSOCIATION OF NSW

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Centre Number

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Student Number

DO NOT REMOVE PAPER FROM EXAM ROOM

**2020**  
**TRIAL HIGHER SCHOOL CERTIFICATE**  
**EXAMINATION**

# Biology

Morning Session  
Thursday, 27 August 2020

## General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Use Multiple-Choice Answer Sheet provided
- Draw diagrams using pencil
- NESA-approved calculators may be used
- Write your Centre Number and Student Number on the top of this page

**Total marks – 100**

### Section I

Pages 2-11

**20 marks**

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

### Section II

Pages 12-33

**80 marks**

- Attempt Questions 21-37
- Allow about 2 hours and 25 minutes for this section

## Disclaimer

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**3900-1**

## Section I

20 marks

Attempt Questions 1-20

Allow about 35 minutes for this section

Use the Multiple-Choice Answer Sheet for Questions 1-20.

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- 1 When using showers at a public swimming pool or gym it is advisable to wear footwear to reduce the chance of developing tinea (also called Athlete's foot). This is a condition caused by a fungus which can be passed on from one person to another. When a person with tinea walks barefoot, they leave behind some of the fungal cells. Other people can then pick these up as they walk on the floor.

Tinea is a

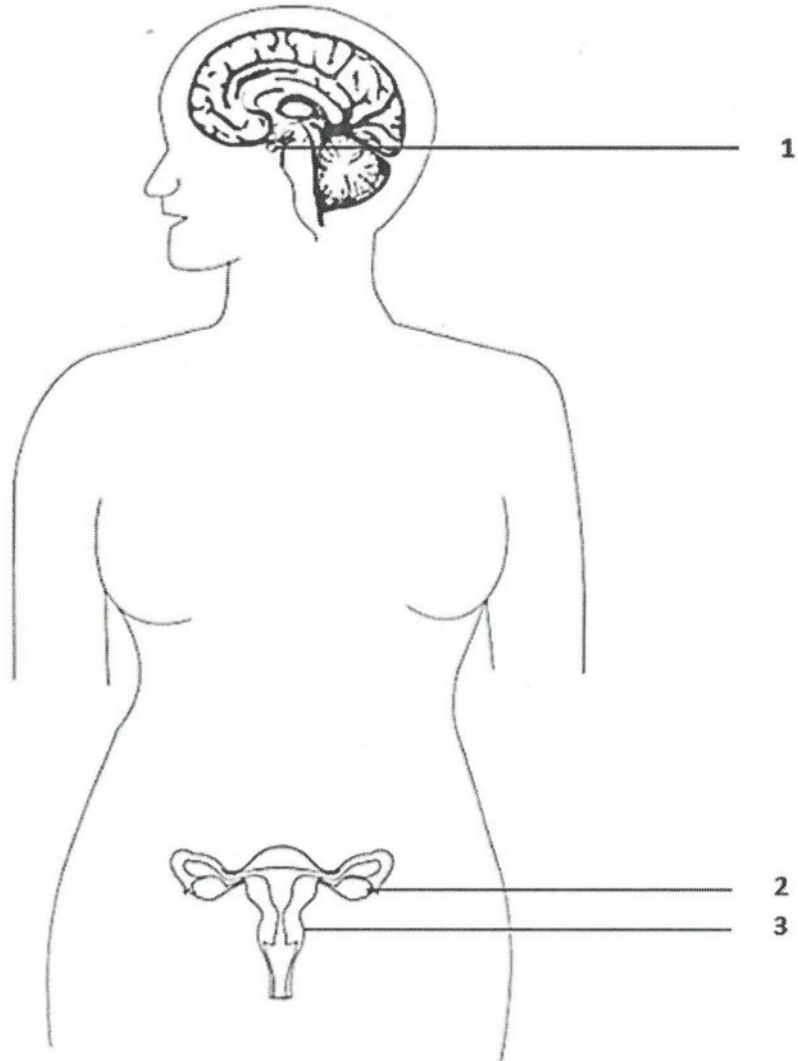
- (A) non-infectious disease.
  - (B) disease that is infectious and is transmitted by a vector.
  - (C) disease that is infectious and is transmitted by direct contact.
  - (D) disease that is infectious and is transmitted by indirect contact.
- 2 When it is extremely cold, some animals tend to shiver. What type of adaptation is this an example of?
- (A) Acquired
  - (B) Structural
  - (C) Behavioural
  - (D) Physiological
- 3 A type of technology used to assist with the effects of hearing loss works by transmitting sound vibrations through the skull. This type of technology is known as a
- (A) cochlear implant.
  - (B) middle ear implant.
  - (C) bone conduction implant.
  - (D) behind-the-ear (BTE) hearing aid.

- 4 Students wanted to compare the number of bacteria in bottled and tap water. They placed a 1 mL sample of tap water on an agar plate and spread the water evenly over the agar. They then repeated the same procedure on another agar plate with the bottled water. Both plates were incubated at 30°C for 48 hours.

In this experiment the dependent variable is the

- (A) type of water (bottled or tap).
  - (B) amount of water on each plate.
  - (C) incubation temperature for each plate.
  - (D) number of bacterial colonies on each plate after 48 hours.
- 5 Which of the following types of electromagnetic radiation can cause mutations?
- (A) UV radiation and X-rays
  - (B) Radio waves and X-rays
  - (C) Radio waves and gamma rays
  - (D) Microwaves and UV radiation
- 6 Scientists observe that the height of one species of tree decreases as the altitude on a mountainside increases. They gather seeds from samples at various altitudes, plant them in a uniform environment and measure the height of the new trees. All the experimental trees grow to approximately the same height. What could the scientists conclude from this experiment?
- (A) The increase in altitude led to genetic variation.
  - (B) The trait observed was due to genetic variation.
  - (C) Variation in height was a result of the environment.
  - (D) Height variation was not related to the environment.

Use the diagram below to answer Question 7.



- 7 Which row of the table has the correct gland that releases oxytocin and target organ for oxytocin.

|     | Gland | Target Organ |
|-----|-------|--------------|
| (A) | 1     | 2            |
| (B) | 1     | 3            |
| (C) | 2     | 1            |
| (D) | 2     | 3            |

- 8 In Iceland the average summer temperature is between 10°C and 13°C and the average winter temperature is between -10°C and 0°C. There is incidence of both malaria and tuberculosis in Iceland but only tuberculosis can be transmitted to others.

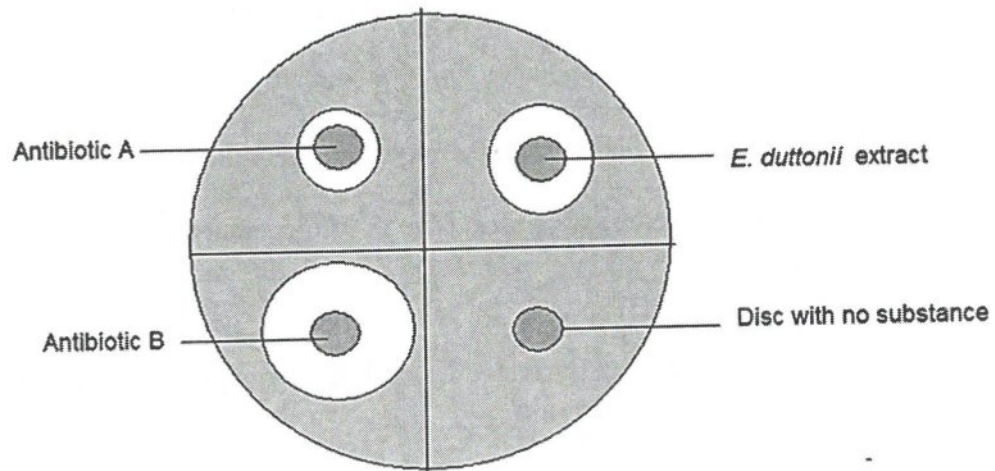
Which of the following is the most likely reason why only tuberculosis can be transmitted to others?

- (A) Migrants and visitors can carry the diseases with them.
  - (B) Mosquitoes that carry malaria can only breed in warmer climates.
  - (C) Vaccines can be used to treat people with tuberculosis but not malaria.
  - (D) Tuberculosis bacteria cannot survive in sub-tropical and tropical areas.
- 9 Which of the following can introduce new alleles into a population's gene pool?
- (A) Mutation and gene flow
  - (B) Genetic drift and gene flow
  - (C) Mutation and natural selection
  - (D) Genetic drift and natural selection
- 10 A sequence of double-stranded DNA that codes for a polypeptide contains 180 nucleotides in total.

What is the maximum number of amino acids in a polypeptide that can be synthesised by coding from a single strand of this DNA sequence?

- (A) 30
- (B) 60
- (C) 90
- (D) 180

- 11 *Eremophila duttonii*, (*E. duttonii*) also known as Harlequin fuchsia bush is a plant used in traditional Australian Aboriginal medicine. A scientist used a spreader to cover agar plates evenly with 0.5 mL of *E. coli* broth and placed discs soaked in various substances as shown in the diagram on each quarter of the agar plate. The experiment was repeated multiple times and produced consistent results. Results of the investigation are shown in the diagram below.



- Bacteria have grown where the plate is shaded (grey area)
- No bacteria have grown in areas that are not shaded (clear white area)

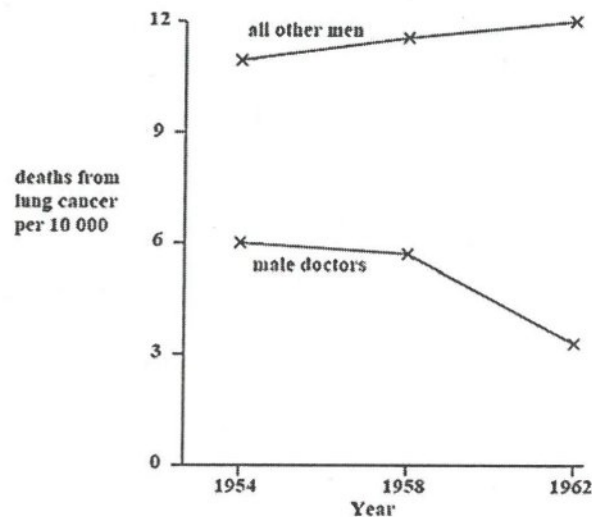
It can be concluded from this experiment that *E. duttonii* extract is

- (A) ineffective for bacterial infections.
- (B) an effective treatment for all bacterial infections.
- (C) more effective at inhibiting the growth of *E. coli* than Antibiotic A.
- (D) more effective at inhibiting the growth of *E. coli* than Antibiotic B.
- 12 Somatic cells are any cells of a living organism other than germ-line cells. Germ-line cells are the sex cells, sperm cells and egg cells. Which statement below is most accurate?
- (A) Somatic mutations do not result in phenotypic changes in cells.
- (B) Germ-line mutations result in cancers, while somatic mutations do not.
- (C) Mutations that occur in somatic cells are not inherited by successive generations.
- (D) Mutations that occur in germ-line cells will always be inherited by successive generations.

13 A type of canola has been genetically modified to be resistant to a weed killer called glyphosate. Which of the following is NOT a concern raised by this type of genetic modification?

- (A) A higher yield of canola crop.
- (B) Increased use of glyphosate by farmers.
- (C) Reduction in genetic diversity in canola plants.
- (D) Reduction in biodiversity in the fields where this type of canola is grown.

14 Between 1954 and 1958 a study was published among doctors that linked cigarette smoking with death from lung cancer. The outcome suggested that between one-third and half of all cigarette smokers would die because of their smoking. The graph below shows deaths from lung cancer among male doctors and all other men in England and Wales between 1954 and 1962.



Which statements best describe and provide a possible explanation for the changes in number of deaths from lung cancer between 1954 and 1962?

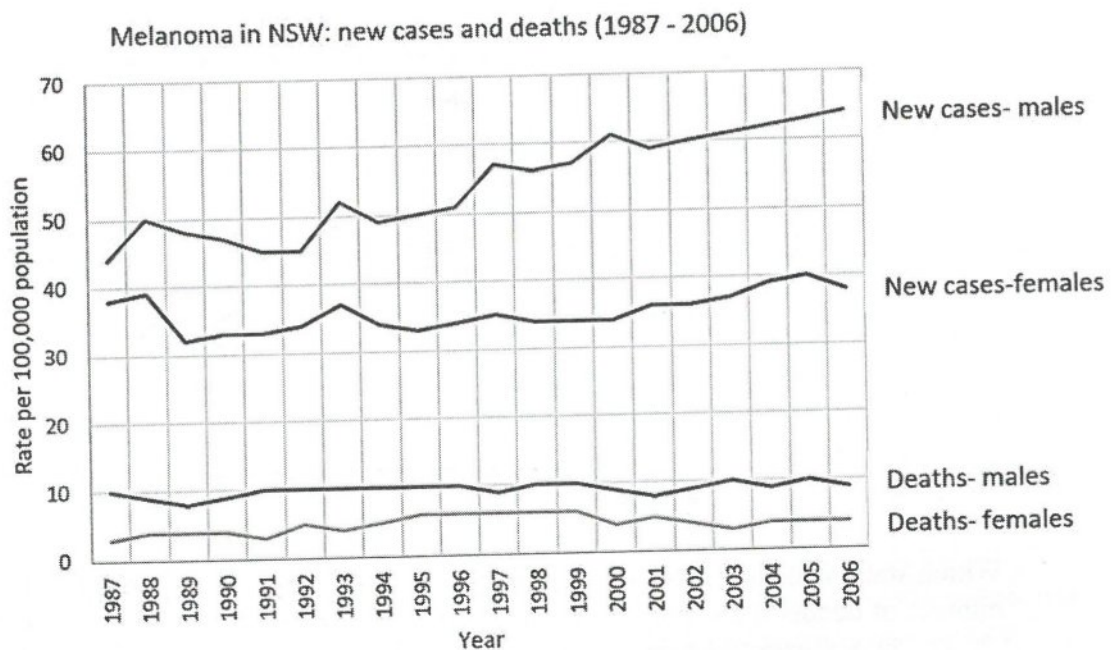
1. Fewer male doctors gave up smoking than other men.
2. More male doctors gave up smoking cigarettes than other men.
3. Male doctors were more at risk of dying from lung cancer than other men.
4. Male doctors had a lower risk of dying from lung cancer than other men.

- (A) 1 and 2
- (B) 1 and 3
- (C) 2 and 3
- (D) 2 and 4

- 15 Which row of the table has the correct aim and strategy for the prevention of a non-infectious disease?

|     | AIM  | STRATEGY   |
|-----|--|--|
| (A) | To reduce the incidence of lung cancer.    | Cigarettes are sold in plain packaging with graphic health warnings.                               |
| (B) | To reduce the incidence of ovarian cancer. | A pink bus where women can have free mammograms travels around Australia and visits country towns. |
| (C) | To reduce the incidence of bowel cancer.   | When Australians reach the age of 50, they receive a bowel cancer testing kit in the mail.         |
| (D) | To reduce the incidence of measles.        | Free measles vaccination program.  |

- 16 Use the graph below to answer Question 16.



What can be concluded from the graph?

- (A) For females, the prevalence of melanoma was lower in 2006 than in 2005, but the mortality rate was higher in 2006 than in 2005.
- (B) For males, the incidence of melanoma increased between 2003 and 2006, but the mortality rate remained relatively constant.
- (C) In 2006, the incidence of melanoma in males was double the incidence of melanoma in females.
- (D) In 2006, the prevalence of melanoma in females was low due to greater awareness about the causes of melanoma.



- 17 Single nucleotide polymorphisms (SNP) are genetic markers that are currently used to identify disease susceptibility in individuals. Statins are drugs used to lower blood cholesterol levels. Due to genetic variation, some people who take statins to reduce cholesterol levels and prevent heart attacks end up with a new problem: a type of muscular damage called myopathy.

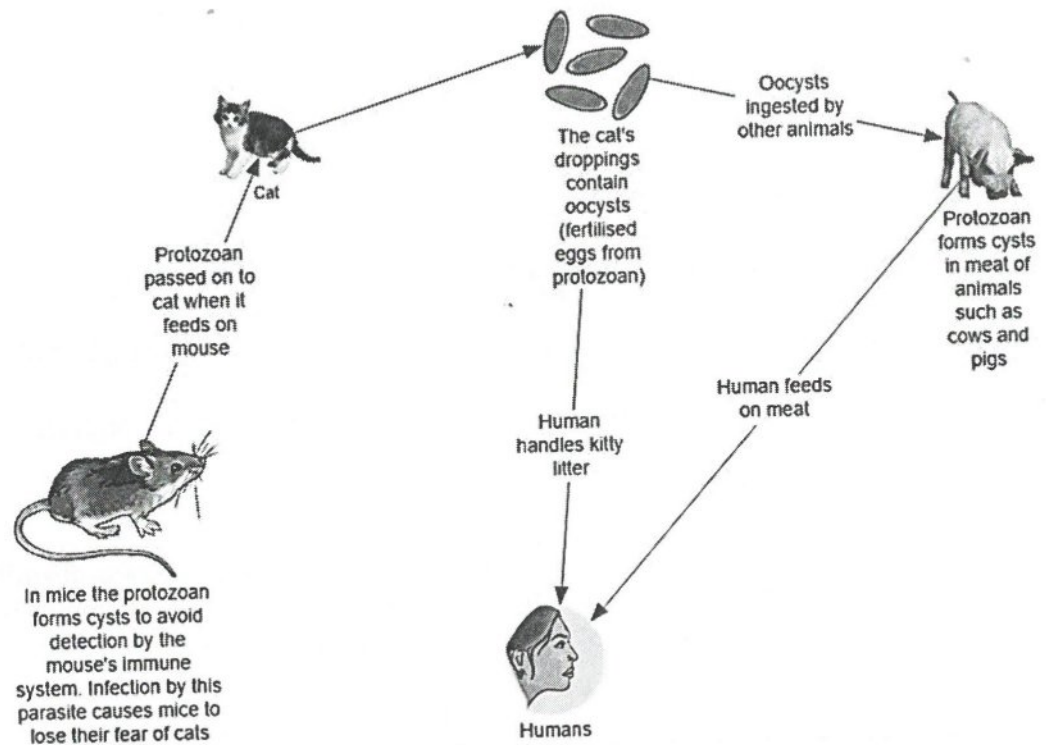
In the future, SNP profiles will allow doctors to

- (A) use statins to treat illnesses other than high cholesterol.
  - (B) predict in advance which patients will respond well to statins.
  - (C) increase the dosage of statins needed to treat patients with high cholesterol levels.
  - (D) decrease the dosage of statins needed to treat patients with high cholesterol levels.
- 18 Severe Combined Immune Deficiency (SCID) is a group of rare disorders caused by mutations in genes involved with the development and function of lymphocytes. An infant has been diagnosed with the SCID disorder. Testing has revealed that their T lymphocytes do not function properly.

Which of the following statements is correct?

- (A) The infant will be able to fight bacterial but not viral infections.
- (B) A bone marrow transplant could provide a cure for the infant's condition.
- (C) The infant will need regular injections of antibodies throughout their life.
- (D) The infant is unlikely to display any symptoms of SCID while breastfed, because their mother's milk contains antibodies.

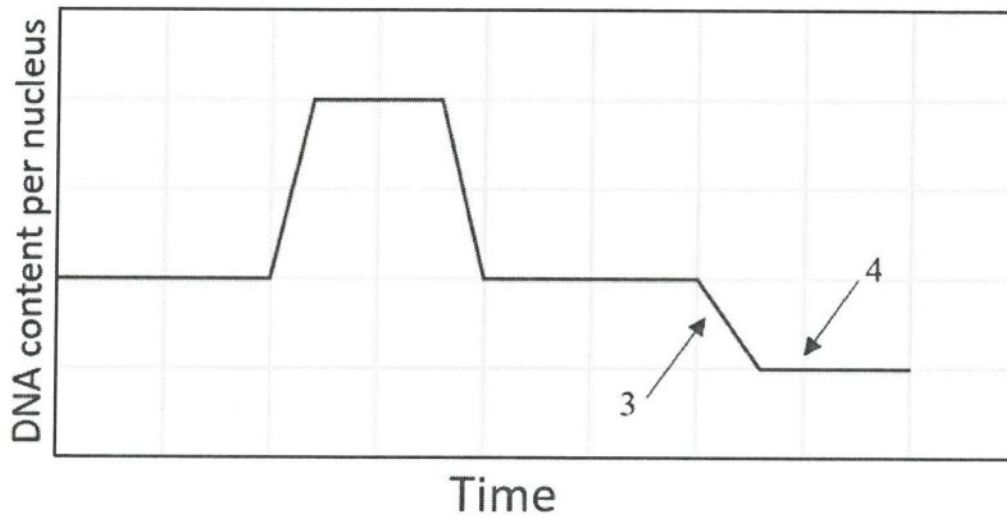
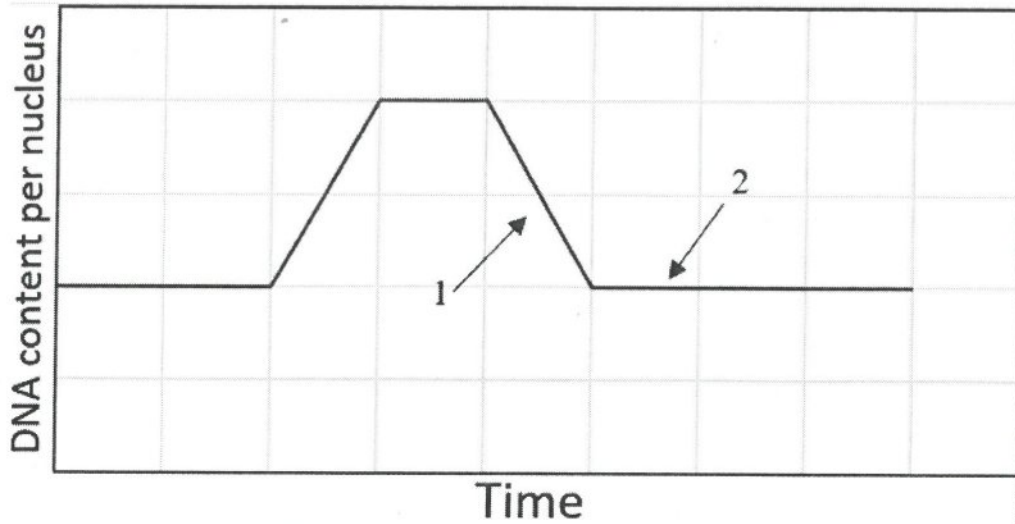
- 19 The diagram below shows part of the life cycle for *Toxoplasma gondii*, a protozoan responsible for the disease toxoplasmosis.



With reference to the information in the diagram above, which of these statements is correct?

- (A) Humans handling kitty litter transmit oocysts to pigs.
- (B) Humans can be infected with *Toxoplasma gondii* by a cat bite.
- (C) Infection with *Toxoplasma gondii* causes mice to be less fearful of cats.
- (D) Infection with *Toxoplasma gondii* causes pigs' droppings to contain oocysts.

- 20 Refer to the following graphs that illustrate DNA content in a eukaryotic cell over time for two different types of cell division.



Which stage(s) correspond to a haploid cell with only one sister chromatid per chromosome?

- (A) 1 and 3
- (B) 2 and 4
- (C) 2 only
- (D) 4 only

## Section II

80 marks

Attempt Questions 21-37

Allow about 2 hours and 25 minutes for this section

- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- Show all relevant working in questions involving calculations.
- Extra writing space is provided on pages 34 and 35. If you use this space, clearly indicate which question you are answering.

### Question 21 (2 marks)

Describe a feature of fertilisation in a named mammal.

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### Question 22 (4 marks)

Complete the table below by providing a possible outcome and explanation for that outcome when a mutation occurs in a 'coding' and 'non-coding' DNA segment.

| Mutation                  | Possible outcome for the organism | Explanation |
|---------------------------|-----------------------------------|-------------|
| Coding segment of DNA     |                                   |             |
| Non-coding segment of DNA |                                   |             |

**Question 23** (2 marks)

A quick and easy test to detect kidney disease involves dipping a strip that tests for the presence of albumin, a large protein, in a sample of the patient's urine. Outline why the presence of albumin in urine may indicate a problem with kidney function.

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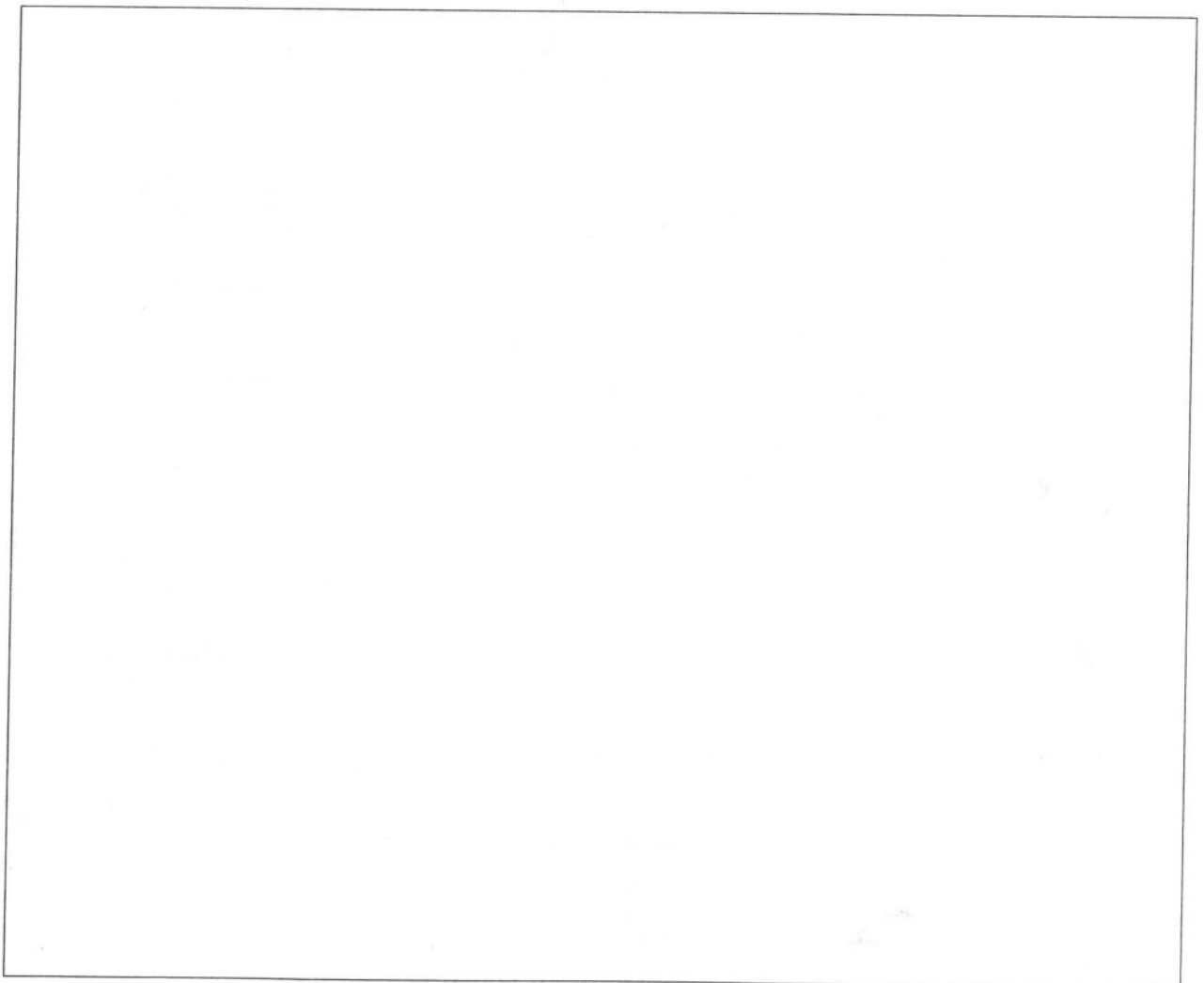
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**Question 24** (4 marks)

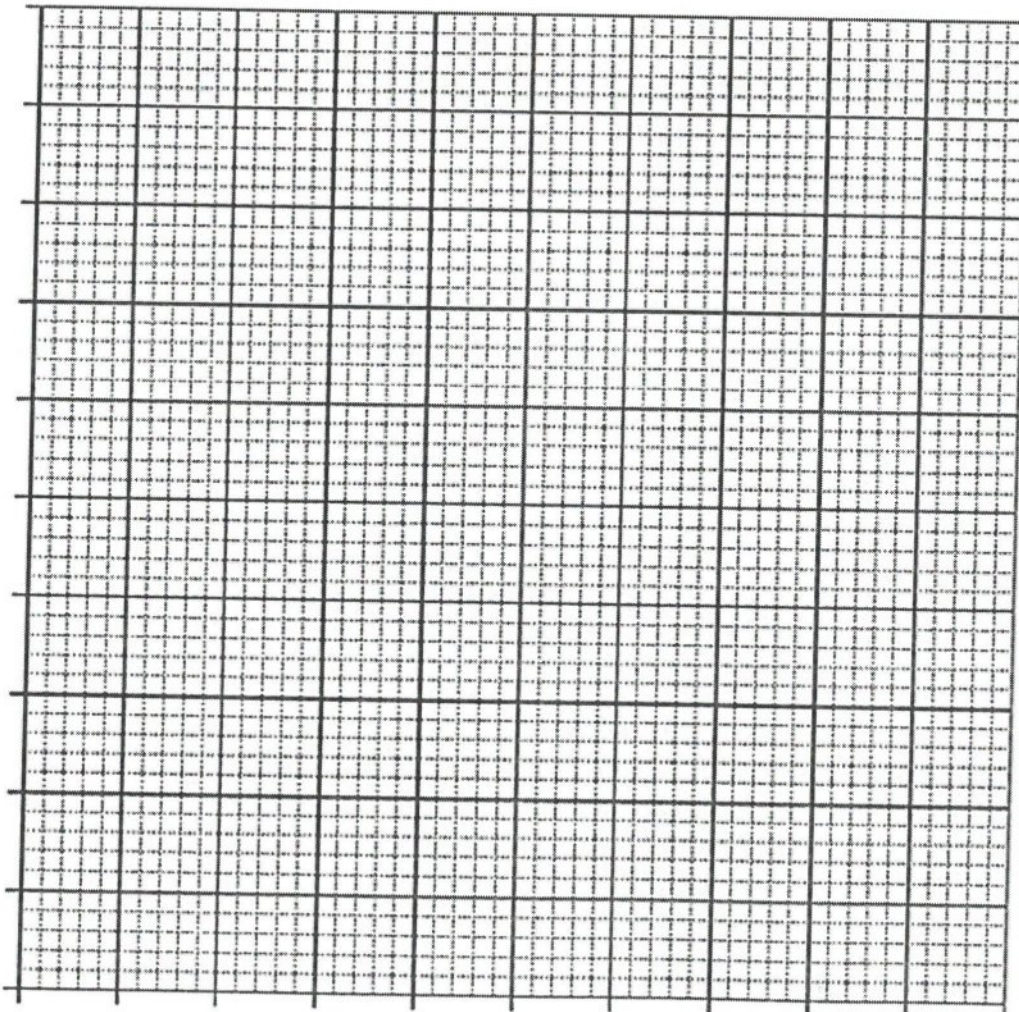
A farmer noticed that his poultry were losing their appetite and were suffering from diarrhoea. He suspected that this was due to a bacterial infection. Draw a flowchart to show how Koch's postulates could be used to prove that the disease in these poultry is caused by a bacterial infection.



**Question 25** (3 marks)

A patient's blood antibody concentration was measured over a period of time after a vaccination and the information tabulated below. Draw an appropriate graph in the space provided using the information in the table.

| Time (days) | Antibody Concentration (mg/mL) |
|-------------|--------------------------------|
| 0           | 0                              |
| 10          | 1.25                           |
| 20          | 2                              |
| 25          | 2                              |
| 30          | 1.75                           |
| 40          | 0.25                           |



**Question 26 (7 marks)**

- (a) Explain how knowledge of plant reproduction has led to the development of ONE named reproductive technology in agriculture. 3

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- (b) Evaluate the potential benefits of genetic technologies for society using named examples. 4

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**Question 27** (3 marks)

Mitochondrial DNA sequencing was carried out on tissue collected from koalas from different regions of NSW. The results were used to produce the table below. Koalas of a particular haplotype have the same set of alleles for particular genes that tend to be inherited together, indicating that they are related.

| <b>Site</b>    | <b>Number of koalas tested</b> | <b>Number of haplotypes identified in koalas tested</b> |
|----------------|--------------------------------|---|
| Ballina        | 37                             | 2   |
| Port Macquarie | 142                            | 3   |
| Pine Creek     | 50                             | 1   |
| Campbelltown   | 24                             | 4   |
| Tyagarah       | 17                             | 1   |
| Maitland       | 7                              | 1   |

What conclusions can be drawn from the data in the table?

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**Question 28** (3 marks)

During your Biology course you investigated the response of a named Australian plant to a pathogen. Using the example you investigated, explain how a specific response to an infection increases the plant's chance of survival.

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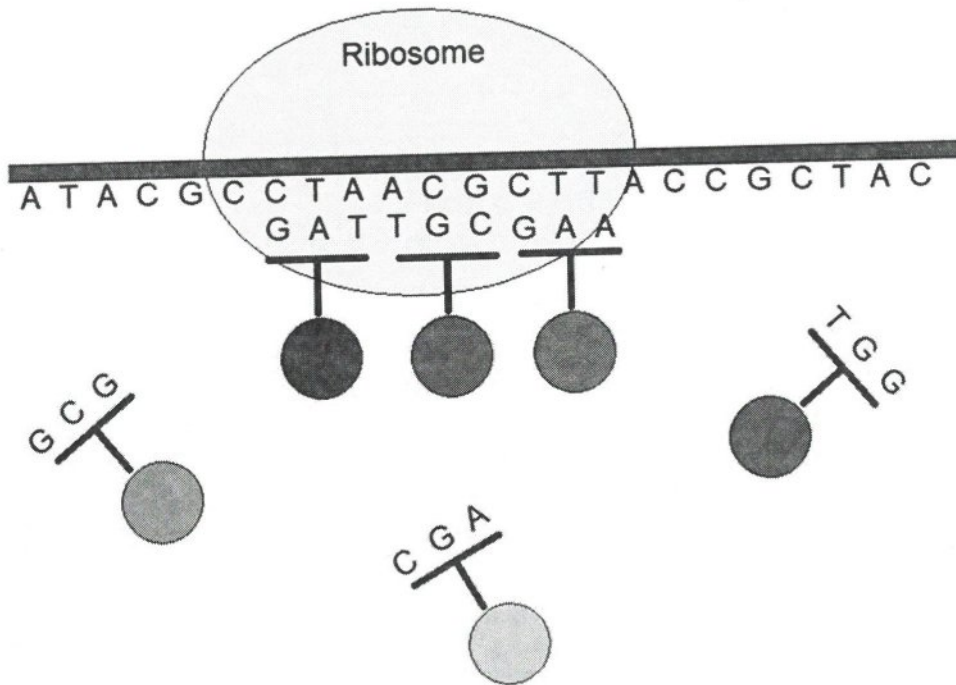
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**Question 29** (4 marks)

A model of polypeptide synthesis is shown below.



Evaluate the accuracy and effectiveness of the model in explaining the process of polypeptide synthesis.

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**Question 30** (6 marks)

- (a) The chart below shows which amino acids are coded for different combinations of mRNA nucleotides. 4

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

Sickle cell anaemia is a genetic disease caused by a mutated version of the gene that helps make haemoglobin - a protein that carries oxygen in red blood cells. Sickle cell anaemia is a result of a point mutation as shown below.

mRNA sequence for normal haemoglobin is as follows:

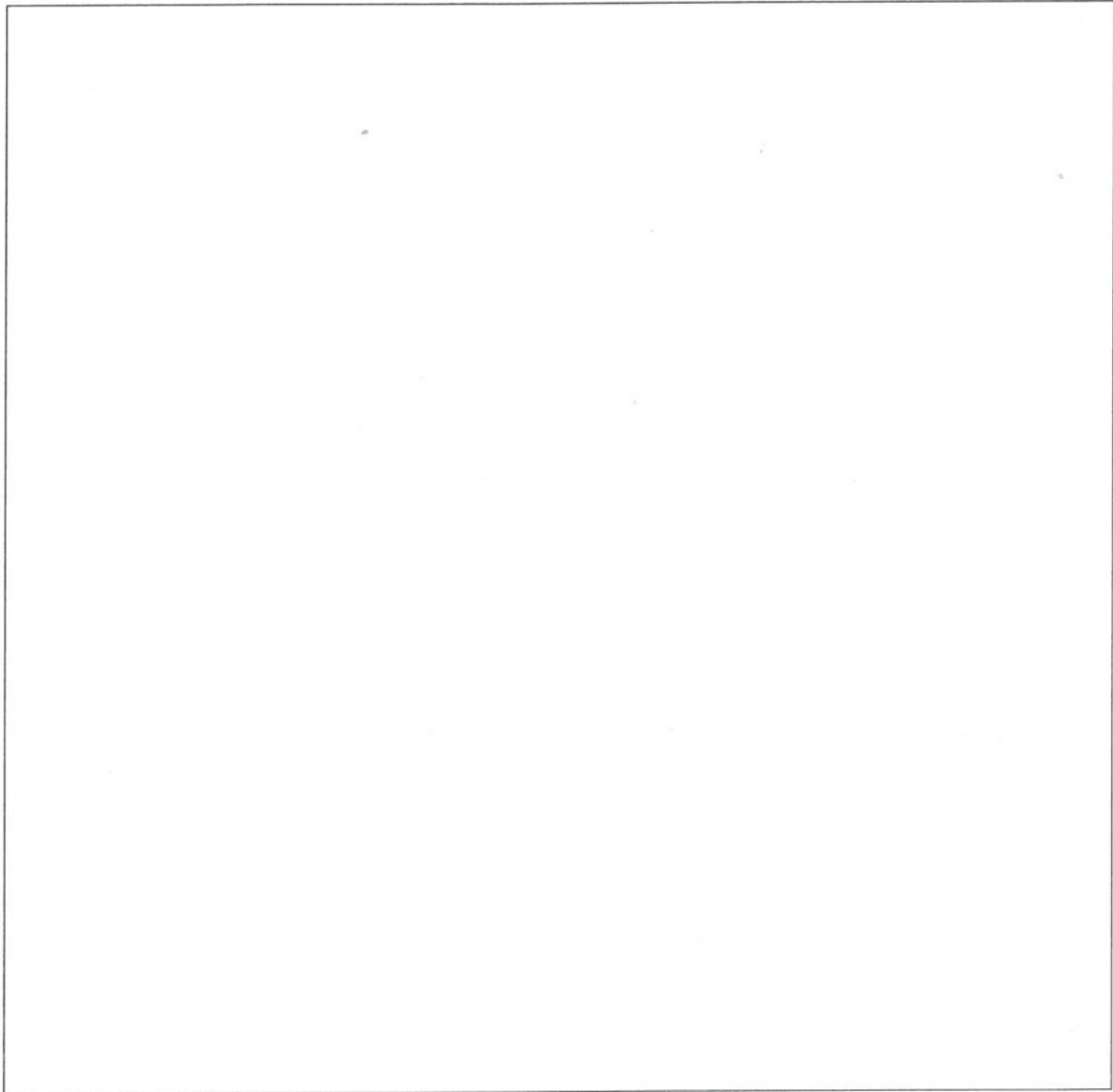
AUG GUG CAC CUG ACU CCU GAG GAG AAG UCU GCC GUU ACU

mRNA sequence with a point mutation causing sickle cell haemoglobin is as follows:

AUG GUG CAC CUG ACU CCU GUG GAG AAG UCU GCC GUU ACU

Draw labelled diagrams to explain the effects of TWO other types of point mutations (different from the point mutation that causes sickle cell anaemia) using the following DNA sequence:

AAAATACGT



(b) Describe the effects of a named genetic disease caused by a chromosomal mutation.

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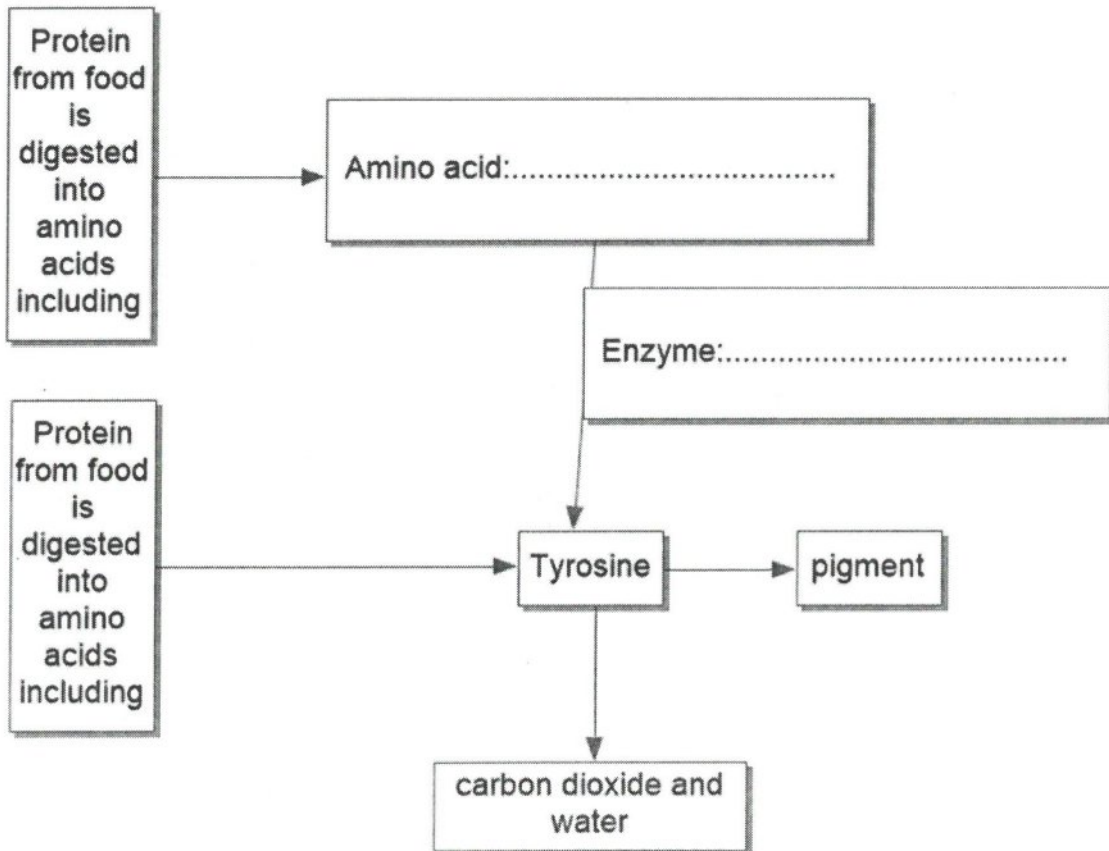
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**Question 31** (6 marks)

Phenylketonuria (PKU) is an autosomal disorder in which an affected individual is unable to metabolise the amino acid phenylalanine. The gene involved with the production of the enzyme phenylalanine hydroxylase, which is needed to break down phenylalanine, is non-functional.

- (a) Use the information given above to complete the metabolic pathway that shows the action of the enzyme by filling in the TWO empty boxes. 2

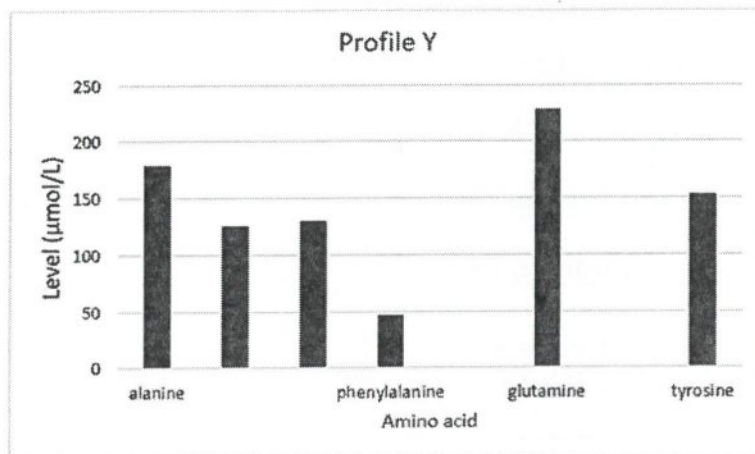
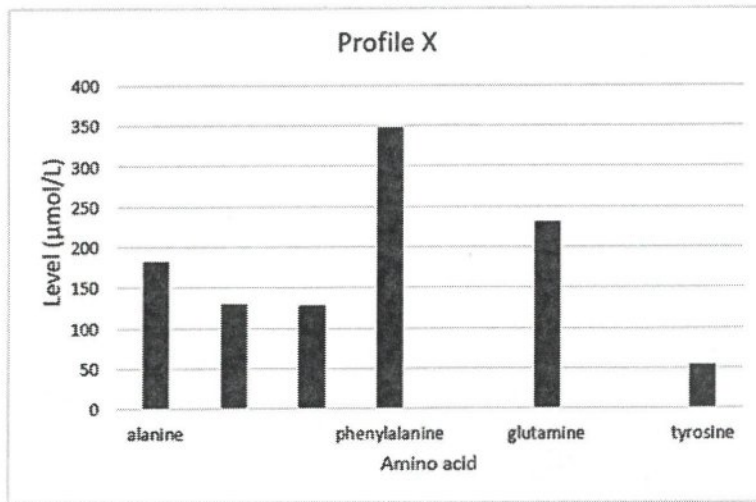


- (b) Predict a possible treatment/management strategy for a baby who tests positive for PKU. 1

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In a test for PKU, blood is taken from a baby very soon after birth. The sample of blood is examined by a machine that gives a visual profile of the amino acids present in the blood. Two examples of profiles, X and Y, are shown below one of which is from a baby with PKU. Only some of the amino acids are shown.



- (c) Which profile comes from a baby with PKU? Use data provided in the profiles to give reasons for your answer.

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**Question 32** (5 marks)

Tuberculosis (TB) is a disease that is spread from one person to another through the air. The World Health Organisation (WHO) collects data on TB from its six different regions and uses these figures to estimate:

- the total number of people with the disease in each region
- the number of deaths from TB.

The table below shows the estimated incidence of TB and the number of deaths from TB in each of the six regions in 2017. The mortality rate is the number of deaths as a percentage of the number of cases.

| WHO region            | Some major countries in the region | Incidence | Number of deaths from TB | Mortality rate |
|-----------------------|------------------------------------|-----------|--------------------------|----------------|
| Africa                | Nigeria, Kenya                     | 70 000    | 9 270                    | 13.24          |
| The Americas          | USA, Brazil                        | 821       | 45                       | 5.48           |
| Eastern Mediterranean | Lebanon, UAE                       | 7 660     | 733                      | 9.56           |
| Europe                | UK, Italy                          | 1 150     | 87                       |                |
| South-East Asia       | India, Thailand                    | 44 900    | 2 090                    | 4.65           |
| Western Pacific       | Australia, New Zealand             | 18 000    | 309                      | 1.71           |

- (a) Complete the table in the space below by calculating the mortality rate for Europe. Enter your result in the table.

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Question 32 continues on page 25

- (b) Use the information in the table above to outline reasons why the mortality rate varies across the different regions. 3

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- (c) Suggest a reason why there was a high incidence of TB in some of the WHO regions in 2017. 1

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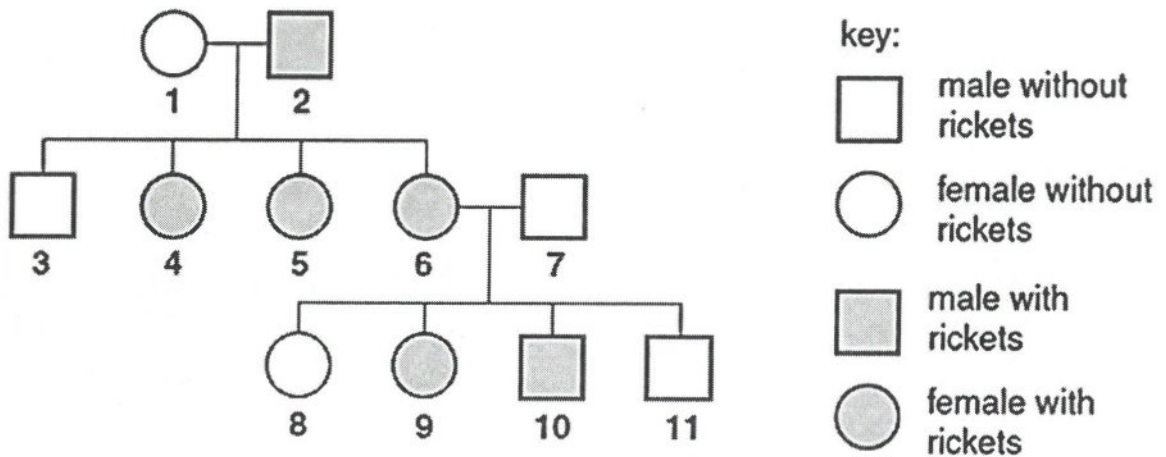
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**Question 33** (4 marks)

Rickets is a bone disorder that affects infants and young children. It involves the softening and weakening of bones. It is usually caused by a lack of vitamin D, calcium ions or phosphate ions. A rare form of rickets that cannot be treated with vitamin D supplement therapy is caused by a mutant allele on the X chromosome.

The figure below shows a pedigree chart for a family that has a history of this condition.



- (a) State the genotypes of Individuals 3 and 9. 1

3: .....

9: .....

- (b) Explain why all daughters of Individuals 1 and 2 have the disease. 3

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**Question 34** (5 marks)

E-cigarettes carry a nicotine-containing liquid which is heated into a vapour and breathed in. The nicotine satisfies the cravings associated with a smoking addiction. These e-cigarettes have been in use for the past 10 years. Research shows an increase in e-cigarette use among young people in recent years. While studies have established a link between smoking cigarettes containing tobacco and lung cancer, much remains to be determined about the long-term effect of vaping using e-cigarettes on the lungs.

Describe the main characteristics of an epidemiological study that you could perform to investigate whether vaping using e-cigarettes causes lung disease. Include a hypothesis for your study.

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**Question 35** (8 marks)

- (a) Feather colour in chickens is an autosomal inherited characteristic. The gene for feather colour has two alleles, black ( $C^B$ ) and splashed-white ( $C^W$ ). When a chicken with black feathers is mated with a chicken with splashed-white feathers, all the offspring have grey feathers. Identify the type of inheritance of feather colour in chickens. Justify your answer.

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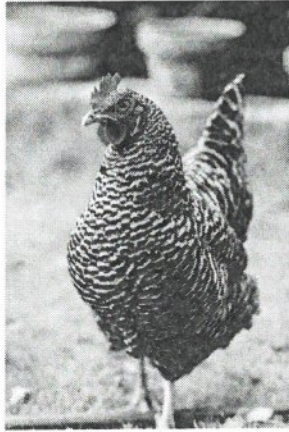
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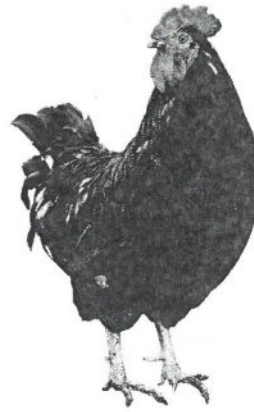
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**Question 35 continues on page 29**

- (b) Male chickens have two Z chromosomes (ZZ) while the females have one Z chromosome and one W chromosome (ZW). Barred feathers (stripes on feathers) in chickens is a sex-linked inherited characteristic. The gene for barred feathers is carried on the Z chromosome. The allele for barred feathers,  $Z^A$ , is dominant over the allele for non-barred feathers,  $Z^a$ .



Barred feathers (stripes on feathers)



Non-barred feathers

A male chicken with non-barred feathers was crossed with a female chicken with barred feathers. All male offspring were barred, and the females were non-barred. Using the symbols given above draw a Punnett square to determine the genotypes of the offspring of this cross.

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Question 35 continues on page 30

- (c) Suggest how a farmer could selectively breed chickens to determine the genotype of an adult male chicken with barred feathers.

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**Question 36** (7 marks)

Cattle farmers are exploring the advantage of IVF (In Vitro Fertilisation) over artificial insemination. IVF is a process in which eggs retrieved from the ovary of a female are fertilised by sperm in a laboratory to produce viable embryos. These embryos are then transferred to a female's uterus to grow until birth. Currently, eggs from older 14-month-old sexually mature cows are used for IVF. Bethany Finger is a scientist who is exploring how farmers can use eggs from juvenile cows to maximise the number of offspring produced on a farm. She is working on a technique to collect eggs from a juvenile cow as young as three months old.

Evaluate the process of IVF over artificial insemination in agriculture and describe the economic benefits that IVF could provide over artificial insemination for the agricultural industry.

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