

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.

- 1 A pharmaceutical company is planning to develop a new medication based on Aboriginal knowledge of bush medicine.

What should the company do first?

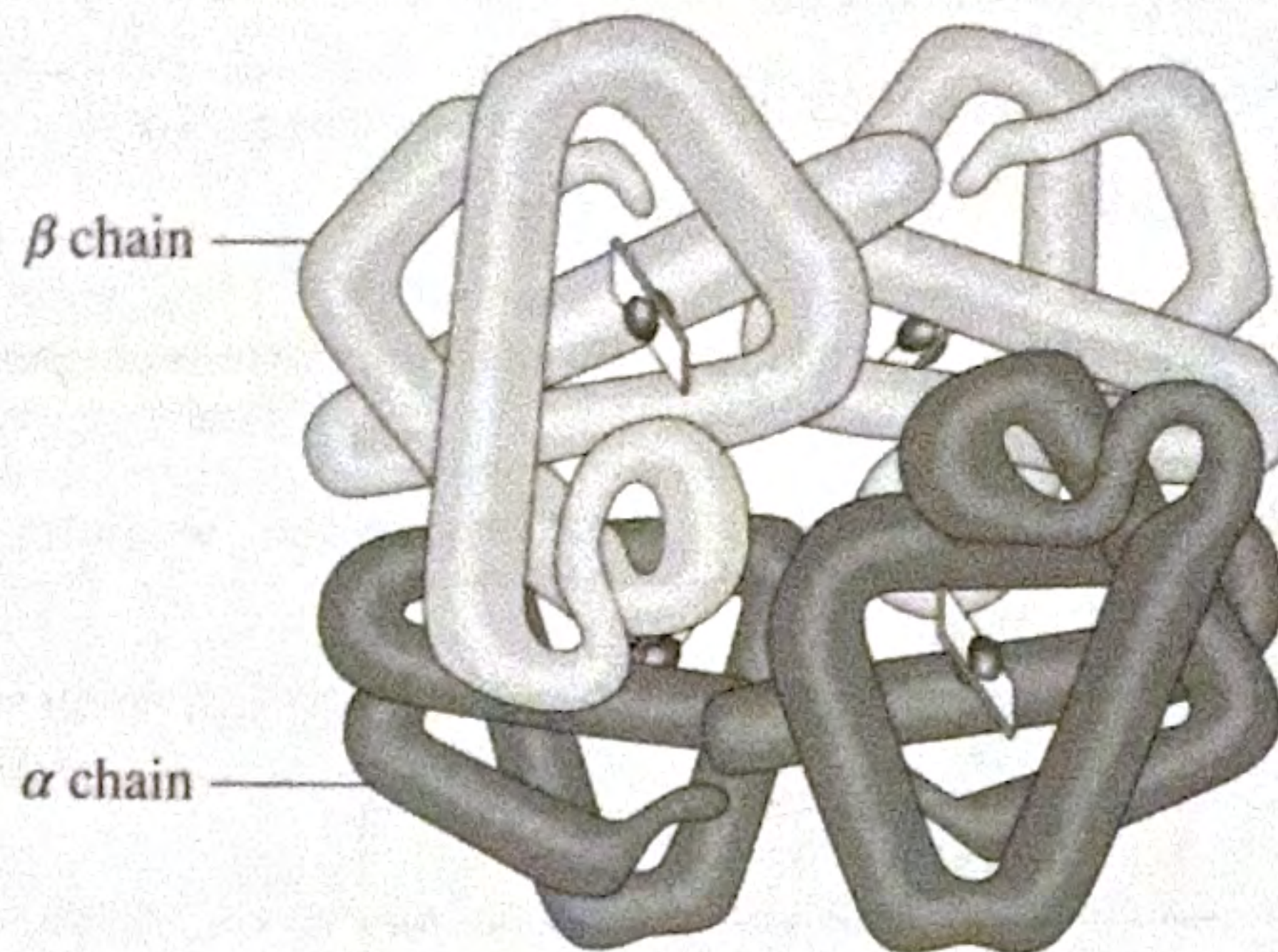
- A. Extract the plant compound and begin medical trials
 - B. Immediately patent the plant compound internationally
 - C. Publish the bush medicine knowledge for global access
 - ☒ D. Consult with Aboriginal knowledge holders and follow cultural protocols
- 2 Which of the following correctly identifies a cause of a non-infectious disease?
- A. Transmission of influenza virus through sneezing
 - ☒ B. Exposure to high levels of silica dust leading to lung disease
 - C. Spread of bacteria through contaminated food causing food poisoning
 - D. Transmission of *Plasmodium* parasites by *Anopheles* mosquito causing malaria

- 3 A new treatment for Huntington's disease involves infusing a modified virus directly into the affected regions of the brain. The virus carries a short genetic sequence of RNA.

What is this new treatment an example of?

- A. Organ transplant
- ☒ B. Genetic engineering
- C. Improved antibiotics
- D. Improved hygiene practices

- 4 The diagram shows the structure of the protein haemoglobin, which plays a crucial role in transporting oxygen to the tissues.



What type of protein structure is haemoglobin?

- A. Primary
 - B. Secondary
 - C. Tertiary
 - ☒ D. Quaternary
- 5 How do somatic mutations differ to germ-line mutations?
- A. Somatic mutations are beneficial, while germ-line mutations are harmful.
 - B. Somatic mutations occur in gametes, while germ-line mutations occur in body cells.
 - C. Somatic mutations always cause cancer, while germ-line mutations always cause genetic disorders.
 - ☒ D. Somatic mutations affect only the individual, while germ-line mutations can be inherited by offspring.

- 6 Newcastle disease is a viral disease that affects chickens. A population study was conducted on a poultry farm, and the following data was collected.

- 50 chickens were living with the disease.
- 500 new cases were diagnosed during the year.
- 200 chickens died from the disease during the year.

Which row of the table correctly matches the data with the epidemiological term?

	<i>Prevalence</i>	<i>Incidence</i>	<i>Mortality</i>
A.	500	50	200
B.	200	50	500
C.	50	500	200
D.	50	200	500

- 7 Why were the results of Pasteur's swan-neck flask experiment significant for explaining the cause and transmission of disease?

- A. They showed that bacteria are transmitted only through direct contact.
- B. They proved that microorganisms arise spontaneously from non-living matter.
- C. They helped establish a link between a specific microorganism and a particular disease.
- D. They proved that microorganisms could only grow if exposed to air containing microbes.

- 8 A team of biologists observed that a grizzly bear survived through a particularly harsh winter. They recorded several features that helped the bear maintain a stable internal environment despite freezing temperatures.

Which row of the table correctly matches each grizzly bear feature with its adaptation type?

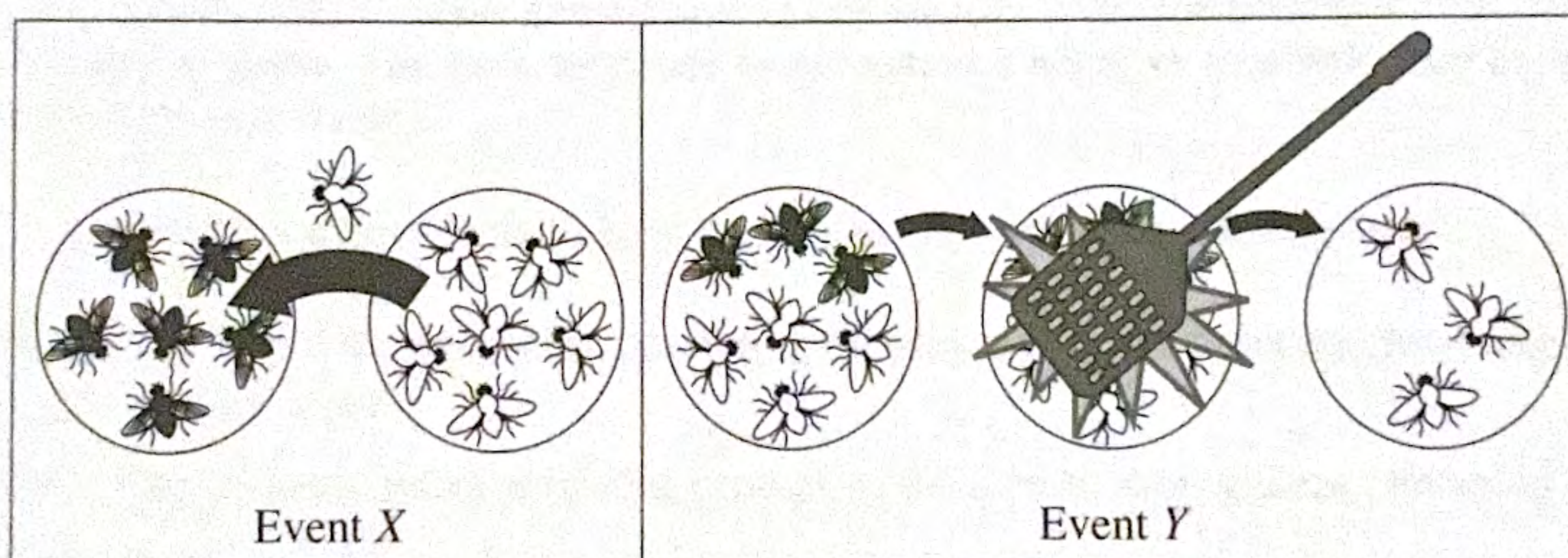
	<i>Structural</i>	<i>Behavioural</i>	<i>Physiological</i>
A.	Thick fur	Hibernation	Shivering
B.	Hibernation	Shivering	Thick fur
C.	Hibernation	Thick fur	Shivering
D.	Thick fur	Shivering	Hibernation

- 9 A localised tissue infection occurred in an animal. The following table presents quantitative data on the changes measured at the site of infection within the first 60 minutes of pathogen exposure.

Measurement	0 minutes (before infection)	60 minutes (after infection)
White blood cell count in tissue	4000 cells/mm ³	15 000 cells/mm ³
Capillary permeability	Low	High (increased $\times 5$)
Local histamine concentration	0.5 g/mL	20.0 g/mL

Which statement best describes the relationship between the observed changes and the role of histamine?

- A. Histamine caused an increase in capillary permeability allowing the movement of white blood cells into the infected tissue.
- B. The decrease in white blood cell count chemically triggered the release of histamine to initiate the adaptive immune response.
- C. Increased capillary permeability diluted the concentration of histamine, reducing the severity of the inflammatory response.
- D. The high local histamine concentration is a response that chemically slowed down blood flow by increasing capillary permeability.
- 10 The images model two events which contribute to evolution.



Which row of the table correctly identifies the event being modelled in X and Y?

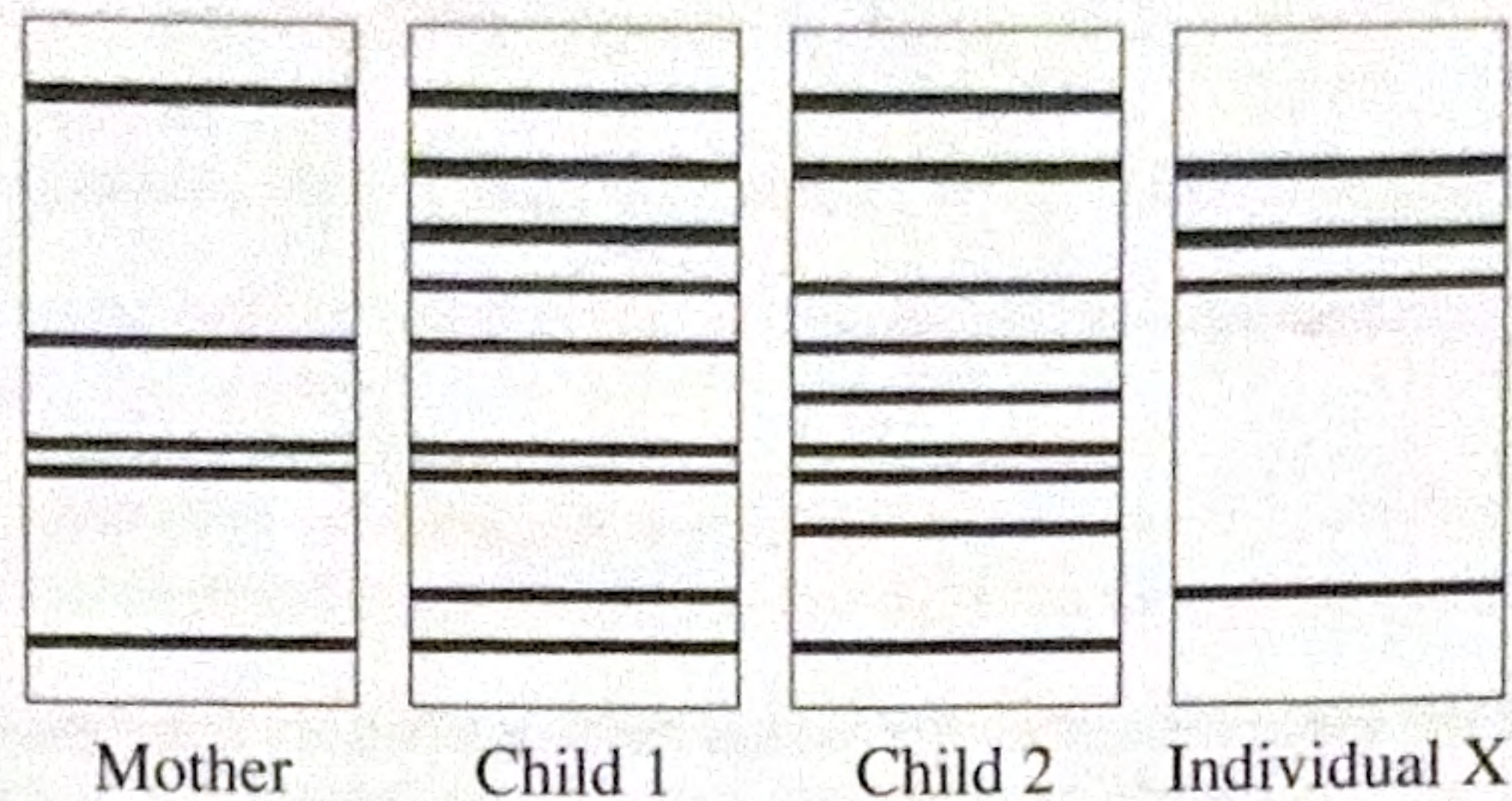
	Event X	Event Y
A.	Selective breeding	Gene flow
B.	Gene flow	Genetic drift
C.	Genetic drift	Natural selection
D.	Natural selection	Selective breeding

- 11 Which of the following describes a benefit of artificial insemination?
- A. Identical organisms can be cloned quickly.
 - B. A population develops full immunity to all diseases.
 - ☒ C. Favourable trait frequency is increased within a population.
 - D. The introduction of transgenic genes into an organism results in favourable characteristics.
- 12 A student investigates how endothermic animals maintain homeostasis during a sudden increase in environmental temperature.

Which of the following best explains how both the nervous and endocrine systems are required to coordinate an effective response?

- A. Vasodilation is triggered by hormones, while thermoreceptors in the skin trigger sweating.
- ☒ B. Nerve impulses cause vasodilation of blood vessels, while hormones reduce metabolic activity.
- C. Nerve impulses cause vasoconstriction of blood vessels, while hormones act only on nearby sweat glands for short-term cooling.
- D. Thermoreceptors are stimulated by a decrease in temperature, while sweat glands produce slower, long-term changes in body temperature.

- 13 Technology is used to determine inheritance patterns and develop DNA profiles such as the ones shown for four different individuals.



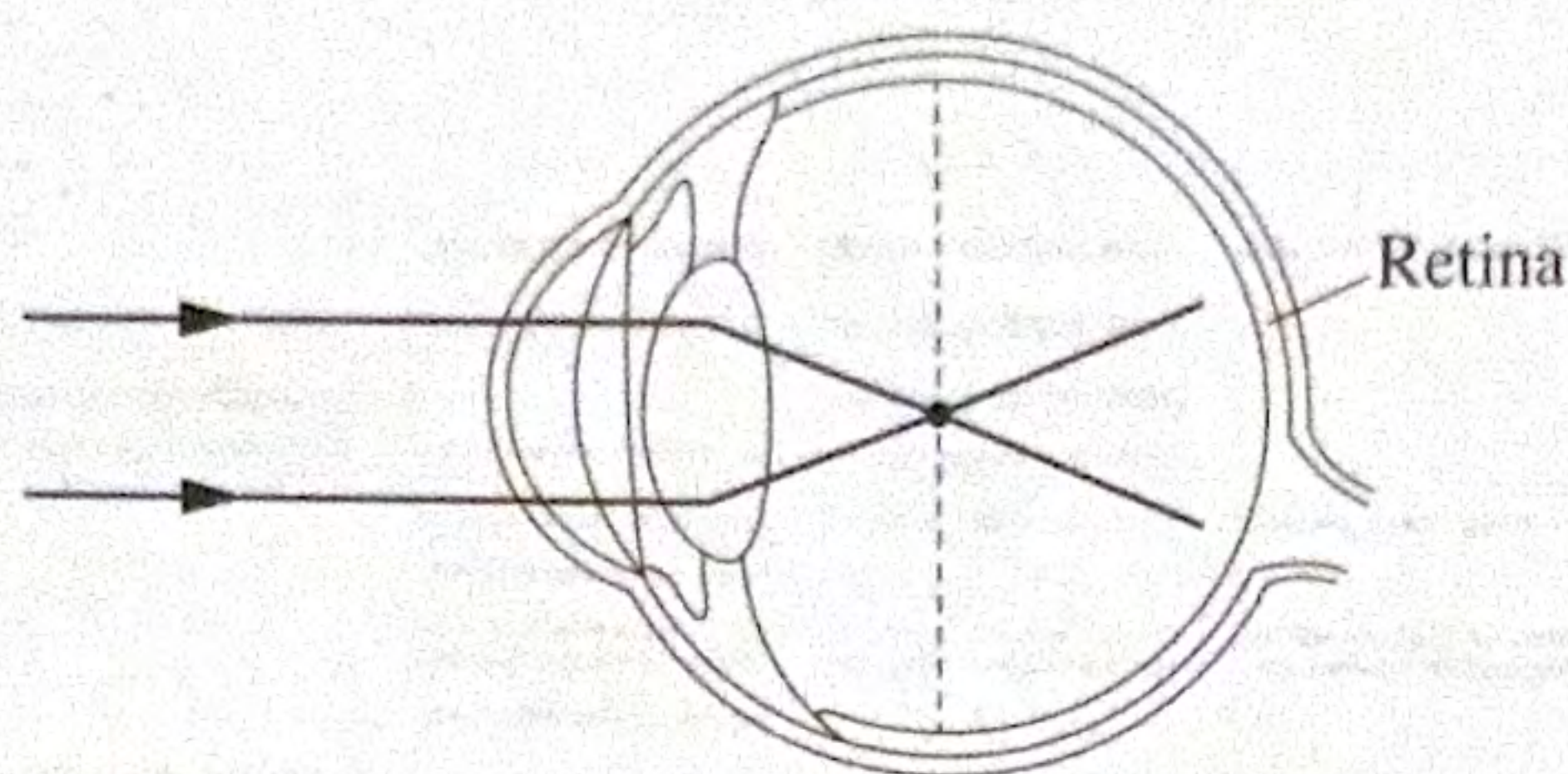
Based on the DNA profiles shown, which statement regarding Individual X is correct?

- A. Individual X cannot be the father of Child 1, because Child 1 possesses a band that is present in neither the Mother nor Individual X.
 - B. Individual X cannot be the father of Child 2, because Child 2 has four distinct bands that are not shared with the Mother's profile.
 - ☒ C. Individual X is the father of Child 1, because every band in Child 1's profile can be matched to a band in either the Mother or Individual X.
 - D. Individual X is the father of Child 2, because Child 2 shares the lowest molecular weight (furthest migrating) band exclusively with Individual X.
- 14 The human body's blood glucose level rises sharply after consuming a large amount of carbohydrates. The body responds by activating a negative feedback loop to restore blood glucose levels.

Which statement best explains how the human body maintains homeostasis?

- A. The liver releases insulin, prompting the pancreas to store glucose, lowering blood glucose levels.
- ☒ B. The pancreas releases insulin, prompting the liver to store glucose, lowering blood glucose levels.
- C. The liver releases glucagon, promoting the pancreas to store glucose, lowering blood glucose levels.
- D. The pancreas releases glucagon, prompting the liver to store glucose, lowering blood glucose levels.

- 15 The diagram shows a common visual disorder.



Which row of the table identifies the visual disorder and its appropriate lens type?

	<i>Disorder</i>	<i>Spectacle lens type</i>
A.	Myopia	Concave (diverging)
B.	Myopia	Convex (converging)
C.	Hyperopia	Concave (diverging)
D.	Hyperopia	Convex (converging)

- 16 An epidemiological study was conducted to investigate the relationship between smoking and asthma.

- Method: followed 5000 participants each from urban and rural areas over a 10 year period.
- Data for the 10 year period:

<i>Region</i>	<i>Number of new asthma cases (per 100 000)</i>	<i>Prevalence of asthma (per 100 000)</i>	<i>Deaths due to asthma (per 100 000)</i>	<i>Population of smokers (%)</i>
Urban areas	310	2600	50	7
Rural areas	180	1300	65	20

Which of the following options would improve the validity of this epidemiological study?

- A. Collect data on asthma prevalence and mortality rates only
- B. Reduce the study duration so that data can be collected and analysed more efficiently
- C. Include participants from a broader range of regions, socioeconomic backgrounds and air quality
- D. Increase the proportion of participants from urban areas to better reflect the regions with higher asthma prevalence reported in the study

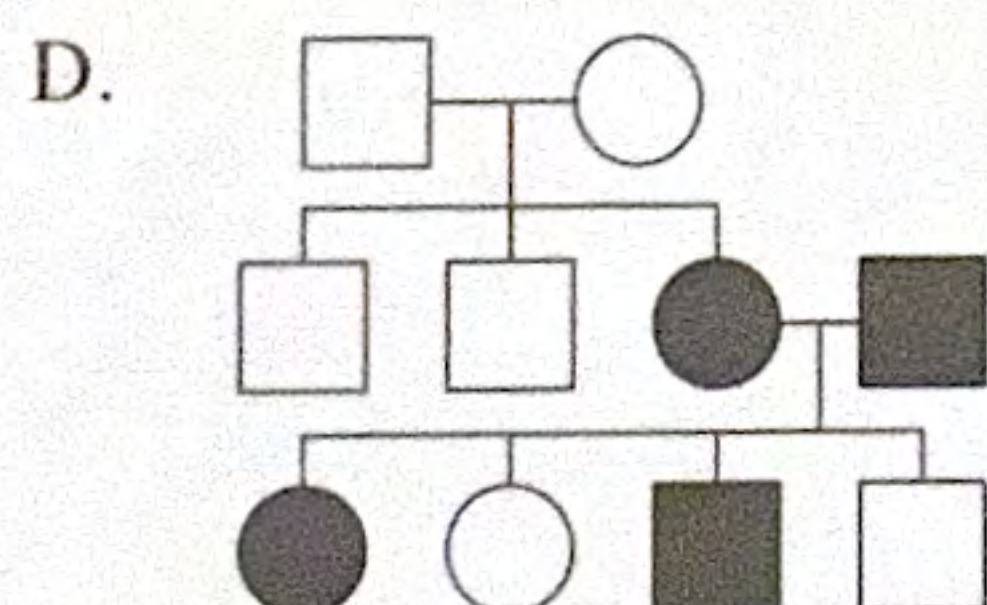
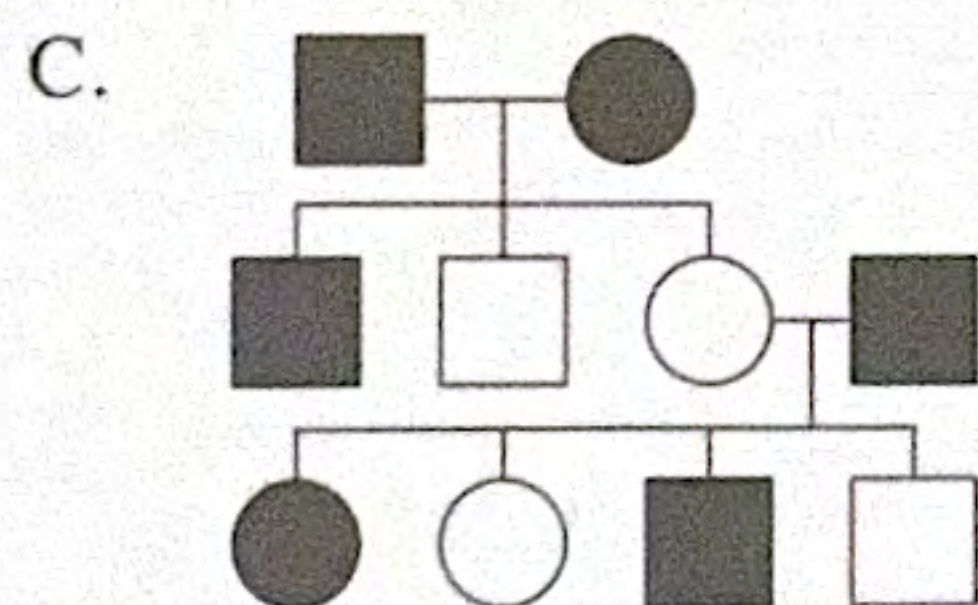
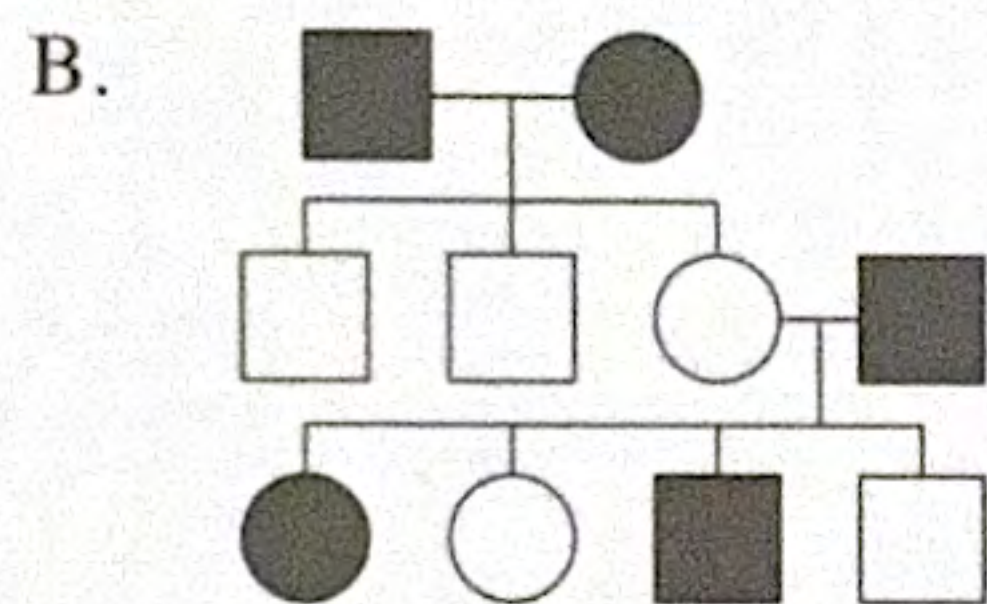
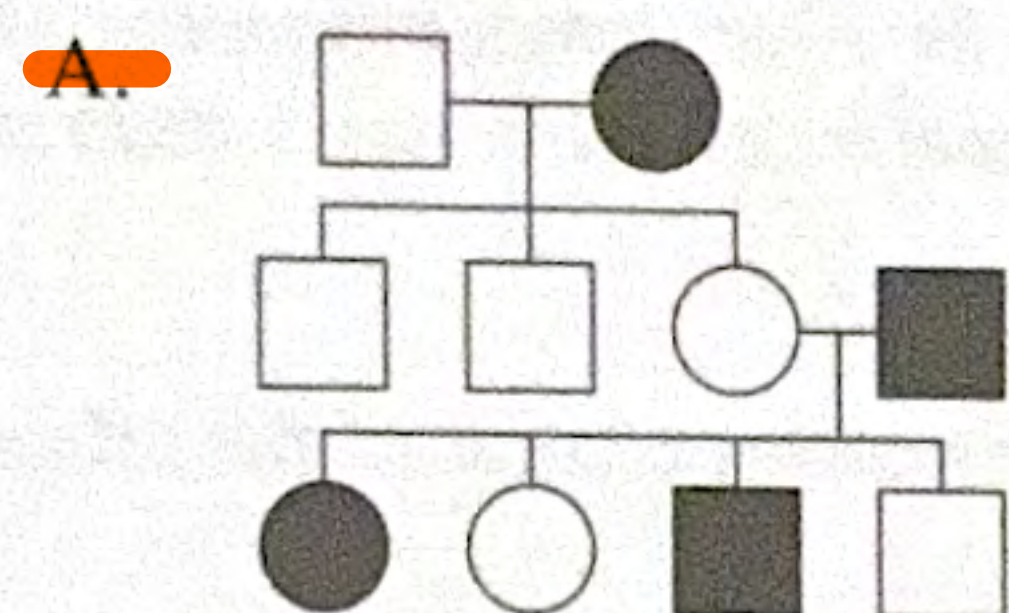
- 17 Non-disjunction during meiosis can result in offspring with an abnormal chromosome number.

Which statement describes non-disjunction during meiosis?

- A. Non-disjunction during meiosis I occurs when sister chromatids fail to separate.
- B. Non-disjunction during meiosis II occurs when homologous chromosomes fail to separate.
- C. Non-disjunction during meiosis I produces two gametes with the normal chromosome number and two gametes with an abnormal chromosome number.
- D. Non-disjunction during meiosis II produces two gametes with the normal chromosome number and two gametes with an abnormal chromosome number.**

- 18 A geneticist is studying a newly discovered disorder. They determine that the trait is inherited in an autosomal recessive pattern.

Which of the following pedigrees correctly represents the inheritance of the disorder?



KEY

	Affected male
	Affected female
	Unaffected male
	Unaffected female

- 19 Which row of the table correctly identifies the definition of the types of immunity and their examples?

	<i>Active immunity</i>	<i>Passive immunity</i>
A.	Immune system makes its own antibodies eg antibodies made after a vaccination	Receives antibodies from another organism eg antibodies made after an infection
B.	Receives antibodies from another organism eg horse antibodies injected into a person	Immune system makes its own antibodies eg antibodies made after an infection
~~C.~~	Immune system makes its own antibodies eg antibodies made after an infection	Receives antibodies from another organism eg antibodies passed on from mother to baby via placenta
D.	Receives antibodies from another organism eg antibodies passed on from mother to baby via placenta	Immune system makes its own antibodies eg horse antibodies injected into a person

- 20 In humans, a sex-linked recessive condition known as Agammaglobulinemia (XLA) results in a deficiency in B cells and antibodies. An unaffected male has a child with a carrier female.

Which of the following options correctly identifies the genotype ratios of the offspring?

- A. $2 X^A X^a : 2 X^a Y$
 B. $2 X^A X^A : 2 X^A Y$
 C. $1 X^A X^a : 1 X^a X^a : 1 X^A Y : 1 X^a Y$
~~D.~~ $1 X^A X^A : 1 X^A X^a : 1 X^A Y : 1 X^a Y$

Question 21 (4 marks)

[REDACTED]

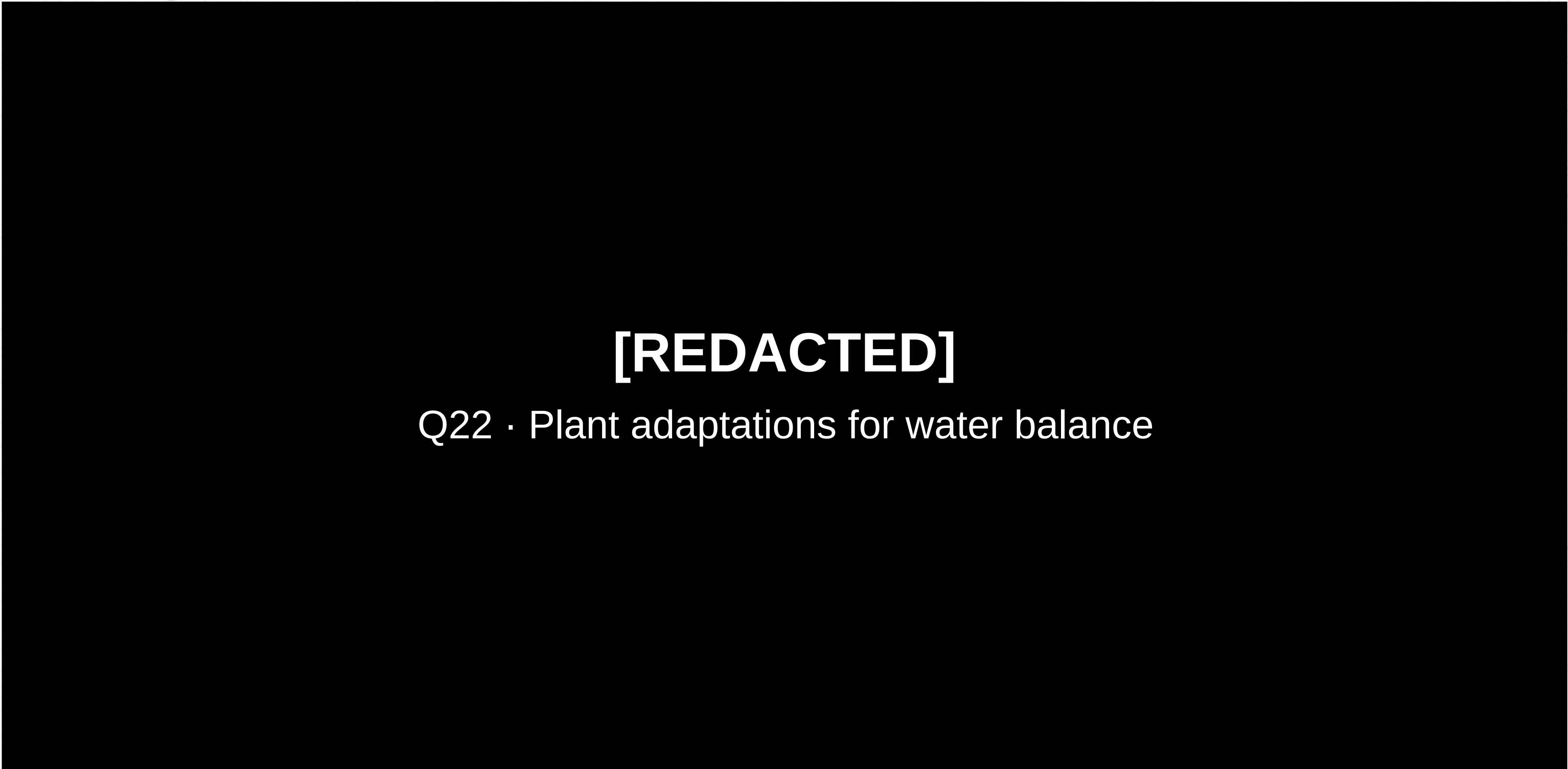
Q21(a) · DNA in prokaryotes vs eukaryotes

DNA in prokaryotes are located in the nucleoid whereas eukaryotic
DNA is primarily in the nucleus

[REDACTED] Q21(b) · DNA replication

DNA polymerase allows for the synthesis of the new DNA strand
by adding nucleotides for DNA to be replicated

Question 22 (4 marks)



[REDACTED]

Q22 · Plant adaptations for water balance

Stomatas sunk in pits allows for moist air to be trapped over the stomata as a result humid saturated air above the stomates reduce the evaporation rate.

Waxy cuticle makes the leaf water tight and reflects sunlight reducing the heat as therefore lowers evaporation rate.

Question 23 (3 marks)

[REDACTED] Q23 · Hearing loss technology

Name of technology: Bone conduction implants

Bone conduction implants work by detecting sound waves via a microphone and relaying it to a sound processor that converts the waves into vibrations. These vibrations travel through the skull and vibrate the cochlea fluid stimulating the cochlear hairs in order to hear sound.

Please turn over

[REDACTED]

Q24(a) · Classifying pathogens

- X Protein
- Y Nucleic acid
- Z Bacteria

[REDACTED] Q24(b) · Plant response to a pathogen

Myrtle rust fungus can cause damage to the red river gum tree. The red river gum tree can use apoptosis around the surrounding infected tissue.

.....
.....

[REDACTED]

Q25 · Confirming the cause of a disease

- To confirm the bacterium caused the deaths, use Koch’s postulates:
1. Collect samples from several dead lizards and isolate the suspected bacterium.
 2. Grow the bacterium in a pure culture.
 3. Inoculate healthy lizards with the cultured bacterium; use an uninfected control group given sterile solution. Keep other conditions the same.
 4. Check whether the inoculated lizards develop the same disease and symptoms, while controls remain healthy.
 5. Re-isolate the same bacterium from the newly diseased lizards. This supports that the bacterium caused the deaths.

Please turn over

Question 26 (11 marks)

[REDACTED]

Q26(a) · Cloning techniques

Technique 1 is somatic-cell nuclear transfer (whole-organism cloning): a donor nucleus is placed into an egg cell whose nucleus has been removed, and the embryo develops into a genetically similar organism. Technique 2 is gene cloning: a desired gene is inserted into vector DNA (such as a plasmid) to make recombinant DNA, which is put into a host cell to copy the gene. Both produce genetic copies, but technique 1 copies an organism's nuclear genome, whereas technique 2 copies a particular gene or DNA fragment.

Question 26 continues on page 21

– 20 –

[REDACTED]

Q26(b) · Public attitudes to GM food

Social factors may influence public attitudes towards super salmon due to concerns about food safety and animal welfare. Consumers may fear unknown long-term health effects of consuming genetically modified organisms (GMOs), reducing acceptance. However, scientific evidence demonstrating that super salmon is safe for human consumption may increase public confidence and acceptance.

Economic factors may increase acceptance because super salmon grow to market size faster, increasing production efficiency and supply. This may reduce production costs and retail prices, making salmon more affordable and accessible. However, additional costs associated with regulation, containment and labelling may increase prices and reduce the economic benefits for producers and consumers.

Cultural factors, including religious beliefs and ethical values, may influence acceptance of super salmon. Some individuals may oppose genetic modification because they believe it interferes with nature or conflicts with religious beliefs about altering living organisms. Others may accept the technology because it improves food production and availability.

Overall, public attitudes towards super salmon will vary depending on perceptions of food safety, economic benefits, animal welfare and cultural values.

End of Question 26

Question 27 (7 marks)

[REDACTED]

Q27 · Hormone data in pregnancy

[REDACTED]

Q27(a) · Graphing hormone levels

Question 27 continues on page 23

– 22 –

[REDACTED] Q27(b) · Roles of pregnancy hormones

hCG rises early in pregnancy and peaks at about week 10, then falls; it helps maintain the corpus luteum early in pregnancy. Progesterone increases and remains high, maintaining the uterine lining and inhibiting uterine contractions to support the pregnancy. Oxytocin stays low for most of pregnancy but rises around labour and stimulates uterine contractions. Contractions promote further oxytocin release (positive feedback), strengthening contractions during birth.

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End of Question 27

Please turn over

[REDACTED]

Q28 · Protein synthesis

Translation is the process by which the genetic code in mRNA is used to synthesise a polypeptide (protein). The mRNA is transported from the nucleus to a ribosome, where it is read in groups of three bases called codons. Each codon is complementary to an anticodon on a tRNA molecule, which carries a specific amino acid. The tRNA binds to the complementary codon on the mRNA, delivering its amino acid to the ribosome. The ribosome joins adjacent amino acids together by forming peptide bonds, producing a growing polypeptide chain. This process continues as the ribosome moves along the mRNA until it encounters a stop codon, signalling the termination of translation and the release of the polypeptide.

Question 29 (4 marks)

[REDACTED]

Q29 · Testing water for microbes

Use a safe, controlled comparison. Collect equal volumes of stormwater and drinking water in separate sterile, labelled containers. Using aseptic technique, spread the same measured volume of each sample onto identical nutrient-agar plates; include a negative-control plate with sterile water. Prepare replicate plates, seal them, and incubate all plates at the same suitable temperature and for the same time. Count and compare colony numbers. More colonies in stormwater would indicate a higher microbial load. Wear PPE and do not open plates after incubation. Autoclave all the plates after use.

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Question 30 (7 marks)

[REDACTED]

Q30 · Dialysis

.....
Dialysis can keep a person with kidney failure alive by removing urea and excess.....
salts/water from the blood by diffusion across a selectively permeable membrane.....
into dialysing fluid. It is not a complete replacement for healthy kidneys: treatment..
must be repeated for several hours, restricts daily life and diet, and can cause.....
infection or low blood pressure. Some substances may not be removed as effectively..
as by functioning kidneys. Therefore dialysis is effective for managing kidney failure
and can prolong life, but it is burdensome and does not cure the damaged kidneys; a
transplant may be a longer-term option for suitable patients. The diagram shows.....

Question 30 continues on page 27

Question 30 (continued)

blood and dialysing solution separated by a selectively permeable membrane.
Small waste molecules such as urea and excess salts diffuse down their
concentration gradients into the dialysing solution, while blood cells and
large proteins remain in the blood. Fresh dialysing fluid maintains the
gradient. Dialysis therefore removes wastes that would otherwise accumulate,
but it requires access to the blood vessels and repeated sessions, with risks
such as infection. It manages rather than cures kidney failure.

End of Question 30

Please turn over

Question 31 (6 marks)

[REDACTED]

Q31(a) · Preventing disease exposure

Prevent exposure by keeping horse feed and water covered and stored securely so bats cannot contaminate them with urine or saliva. Remove feed contaminated by bats and prevent horses from accessing areas beneath bat roosts where possible.

[REDACTED] Q31(b) · Evaluating quarantine

The statement is only partly correct. Quarantine can limit spread from an infected horse to other horses and people, so it is useful after a case is detected. However, Hendra virus is associated with bats and horses are exposed when feed or water is contaminated by bat urine or saliva. Quarantine does not prevent the initial exposure and may not stop new cases if other horses continue to access contaminated feed. Prevention also requires reducing bat access to feed and water, monitoring horses and using appropriate biosecurity.

Question 32 (5 marks)

[REDACTED]
Q32(a) · Multiple alleles

..... Multiple alleles is when there are more than 2 alleles contributing to each
..... phenotype

[REDACTED]
Q32(b) · Inheritance cross

	r ^h	r ^h	
R	Rr ^h	Rr ^h	1 : 1 Brown : Chinchilla
r ^{ch}	r ^{ch} r ^h	r ^{ch} r ^h	1 : 1 Rr ^h : r ^{ch} r ^h

Question 33 (5 marks)

[REDACTED]

Q33 · Reproductive technologies in conservation

Artificial insemination can improve long-term survival by introducing sperm from unrelated males, increasing gene flow and genetic diversity in isolated koala populations. Greater diversity makes it more likely that some koalas can resist disease or adapt to environmental change. Its benefit depends on choosing genetically different males; repeatedly using sperm from a few males could reduce diversity or increase inbreeding. It also requires expertise and does not by itself protect habitat.

Artificial pollination of important food plants may increase seed or fruit production and improve food availability, supporting koala health and reproduction. However, it does not directly increase genetic diversity in koalas, and the benefit may be temporary if habitat loss and fragmentation continue. Both approaches can help, but they work best alongside habitat protection and connecting populations.

Question 34 (5 marks)

[REDACTED]

Q34 · Cancer screening program

The program appears to have contributed to a decline in bowel-cancer rates, but the graph alone cannot prove it caused the decline. After the NBCSP began in 2006, the male age-standardised rate falls from roughly 80 per 100,000 to about 50 by 2023, and the female rate falls from about 55 to around 35. The downward trends are consistent with screening and early detection helping reduce disease burden. However, rates were already changing and other factors (such as treatment, lifestyle and diagnostic changes) may also contribute. Screening may also initially increase detection. Overall, the data suggest the program may be effective, but more evidence is needed to attribute the decline solely to it.

Question 35 (4 marks)

[REDACTED] Q35 · Non-coding DNA mutations

Mutations in the noncoding DNA can cause changes in phenotype however it is not guaranteed. Mutations in the promoter site can change if a gene is expressed resulting in no protein. Mutations in introns can result in misfolded proteins as a result of insertion and deletions causing frameshifts. However substitution mutation can be silent.

End of paper