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Student Number

NORTH SYDNEY GIRLS HIGH SCHOOL



2020

Higher School Certificate Trial Examination

Biology

Total Marks – 100

General Instructions

- Reading Time – 5 minutes
- Working Time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- For questions in Section II, show all relevant working in questions involving calculations
- NESA approved calculators may be used
- Write your student number at the top of this booklet and on the multiple choice answer sheet

Section I – 20 Marks

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

Section II – 80 Marks

- Attempt Question 21 – 35
- Allow about 2 hours and 25 minutes for this section

Section I 20 marks

Attempt Question 1-20

Allow about 35 minutes for this section

Use the multiple-choice answer sheet for Questions 1-20.

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

A ☐ B ☒ C ☐ D ☐

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ☐ B ☒ C ☐ D ☒

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word correct and drawing an arrow as follows:

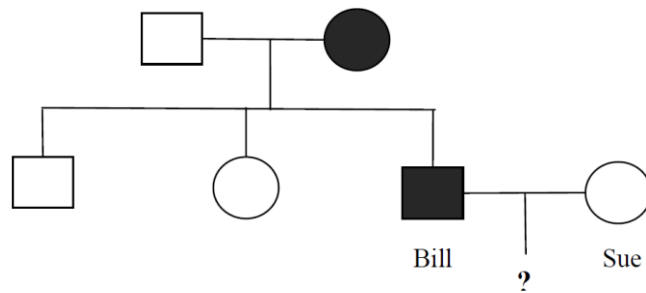
A ☐ B ☒ C ☐ D ☒

correct →

1. What are all the alleles in a population referred to as?

- (A) A gene pool
- (B) A genome
- (C) A genotype
- (D) A loci

2. The pedigree below shows the inheritance of a sex-linked dominant condition in a family.



If Bill and Sue have a daughter, what is the probability that she will have the condition?

- (A) 100%
- (B) 75%
- (C) 50%
- (D) 25%

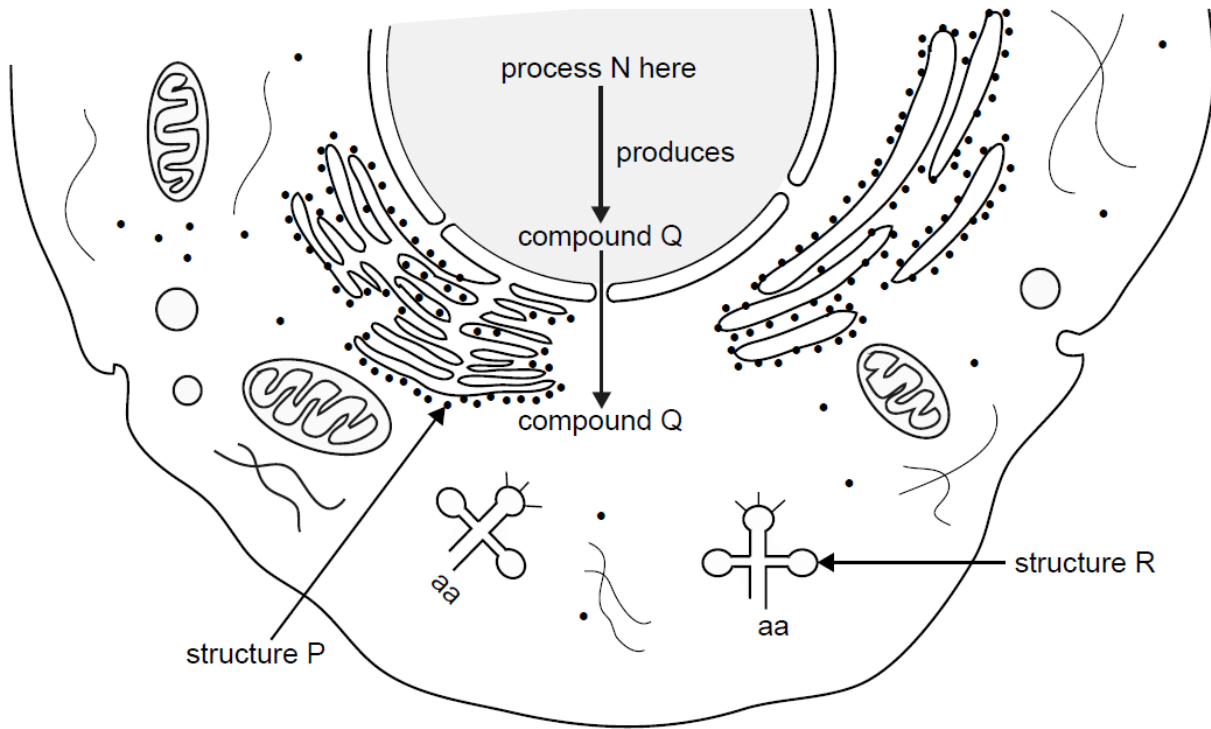
3. The 'crossing over' of chromosomes is one of the processes that can introduce genetic variation into a population. When does crossing over occur?

- (A) Metaphase in Meiosis I
- (B) Metaphase in Meiosis II
- (C) Metaphase in Mitosis
- (D) Anaphase in Meiosis I

4. A student when reading consistently holds the texts at arm's length. This behaviour is most commonly associated with which of the following vision problems?

- (A) astigmatism
- (B) hyperopia
- (C) glaucoma
- (D) myopia

Use the following diagram (not to scale) to answer Questions 5 and 6.



5. Which is the correct name for compound Q?
- (A) RNA
 - (B) mRNA
 - (C) tRNA
 - (D) DNA
6. Structure P is known as
- (A) Endoplasmic Reticulum
 - (B) Ribosome
 - (C) Mitochondria
 - (D) Lysosome
7. Which of the following includes only mutagens?
- (A) Viruses, UV Radiation and Oxygen
 - (B) Bacteria, X-Rays and Nitrogen
 - (C) Uranium, Transposons and UV Radiation
 - (D) Asbestos, Sodium and DDT

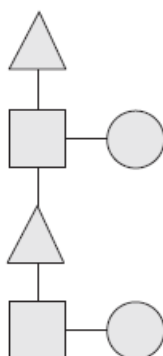
8. When humans exercise, the heart beats faster. Which of the following type of adaptation is this an example of?

- (A) Physiological
- (B) Cardiacal
- (C) Behavioural
- (D) Structural

9. What structure provides a boundary between the outer and the middle ear?

- (A) Pinna
- (B) Ear Ossicles
- (C) Cochlea
- (D) Typanic membrane

10. The diagram shows a model of DNA.



Which key correctly shows the parts of a nucleotide?

(A)	 Sugar	 Base	 Phosphate
(B)	 Base	 Phosphate	 Sugar
(C)	 Phosphate	 Sugar	 Base
(D)	 Sugar	 Phosphate	 Base

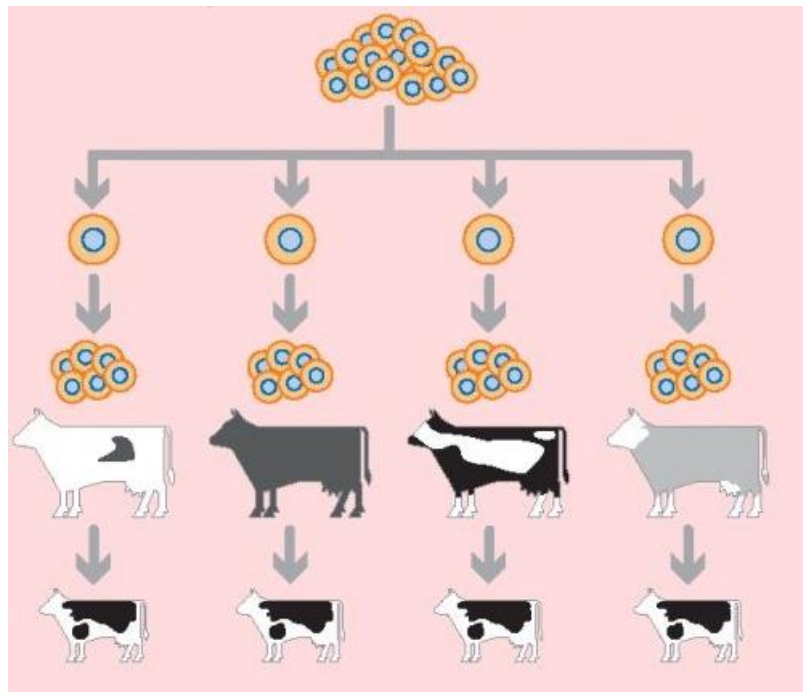
11. Consider the following definition.

“a chemical produced by an organ in the body that is transported to another part of the body where it causes a change in other cells, tissues or organs”

This describes

- (A) A gland
- (B) A hormone
- (C) An effector
- (D) A receptor

12. The following diagram illustrates a biotechnology.

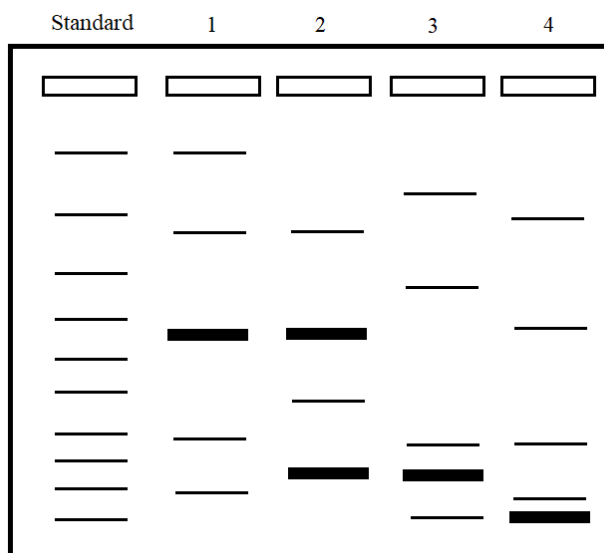


Which process is demonstrated in the diagram?

- (A) Artificial pollination
- (B) Artificial insemination
- (C) Whole organism cloning
- (D) Transgenics

Use the following information to answer questions 13, 14 and 15.

A group of biologists at Taronga Zoo want to mate their endangered penguin with a penguin from another zoo to assist in conservation of the species. They have been sent DNA samples from three possible mates. The results of an electrophoresis gel in which the DNA of Taronga Zoo's penguin (lane 1) was compared to the three possible mates (lanes 2, 3 and 4).



13. Which mate would be most suitable to maintain genetic diversity in the population?

- (A) 2
- (B) 3
- (C) 4
- (D) All mates would produce the same genetic diversity.

14. How will the cross in Question 13 affect allele frequency in the population?

- (A) Decrease in allele frequency
- (B) Increase in allele frequency
- (C) No change in allele frequency
- (D) New alleles will be introduced

15. Gel Electrophoresis allows DNA fragments to be separated in order for the differences between samples to be visualized. The fragment that travels the farthest in a gel sample must be:

- (A) The largest
- (B) The smallest
- (C) The most positive
- (D) The most negative

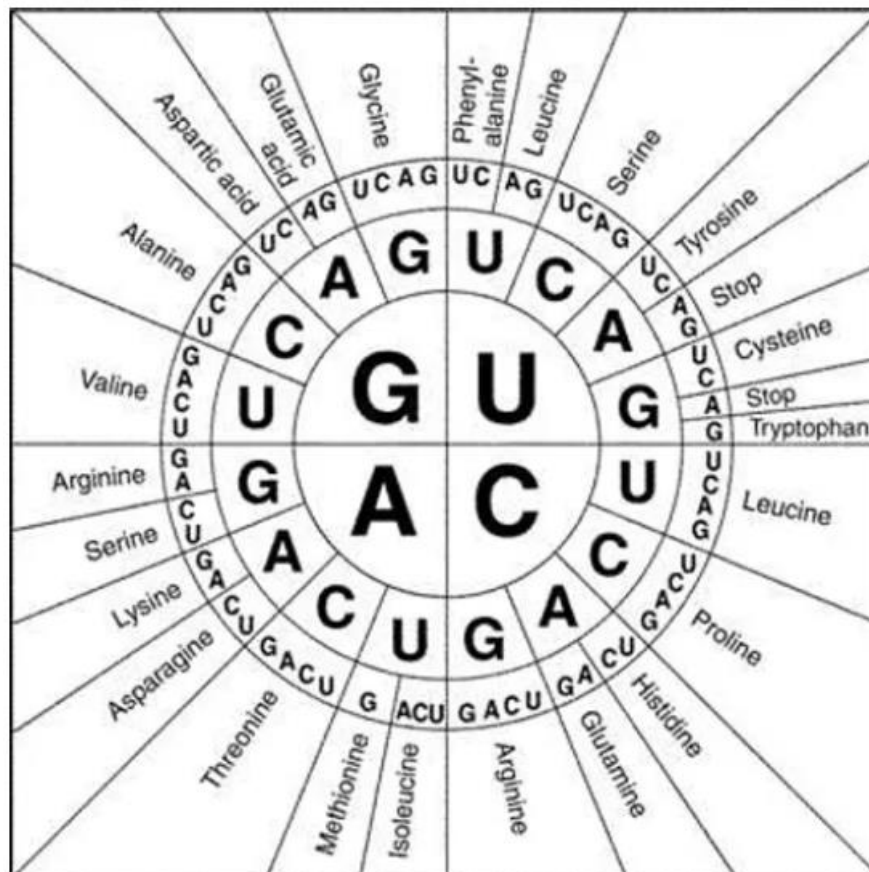
16. Which of the following statements is **incorrect** for homologous chromosomes?

- (A) Homologous chromosomes always carry the same genes
- (B) Homologous chromosomes can always exchange genetic information
- (C) Homologous chromosomes are always from different parents
- (D) Homologous chromosomes always carry the same alleles

17. A student wanted to examine a section of DNA

5'	A	T	C	A	T	G	T	A	C
3'	T	A	G	T	A	C	A	T	G

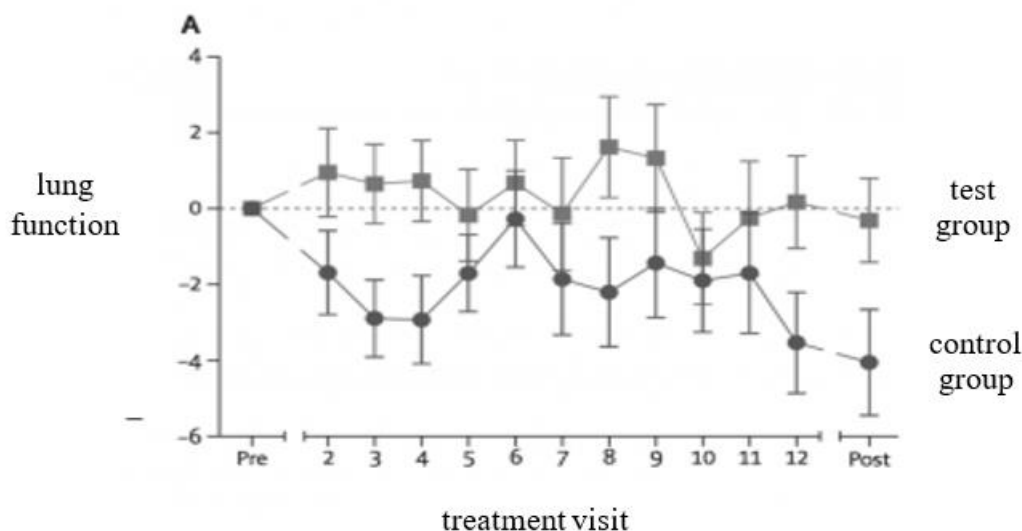
Use the mRNA wheel to identify the amino acid coded for by the second codon.



- (A) Methionine
- (B) Tyrosine
- (C) Isoleucine
- (D) Serine

Use the following information to answer Questions 18 and 19.

The graph below shows the average change in lung function for cystic fibrosis sufferers undergoing different treatments. 150 individuals with cystic fibrosis were separated into two groups, a test group and a control group. Patients did not know which group they were in. The test group received a new form of gene therapy treatment and the control group were treated with a placebo (a treatment which doesn't contain the gene).



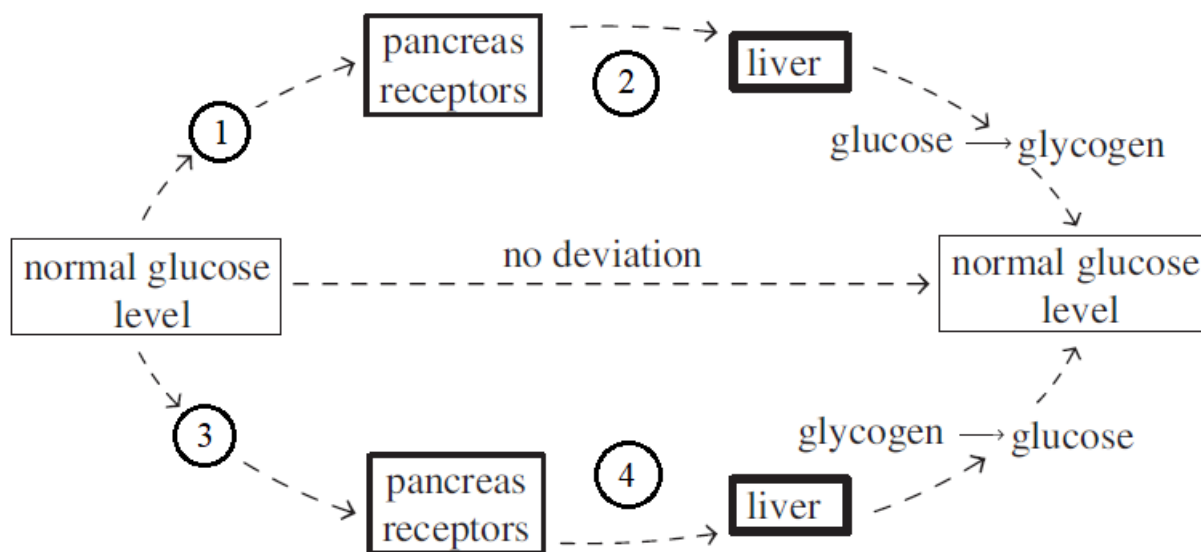
18. What is the dependent variable in this investigation?

- (A) The type of treatment
- (B) Initial lung function
- (C) Composition of both groups
- (D) Change in lung function

19. Which of the following statements is a valid conclusion from this graph?

- (A) Placebos work just as well as gene therapy
- (B) There was no benefit to gene therapy
- (C) The gene therapy helped to maintain lung function
- (D) The control group experienced a steady decrease in lung function

20. A student produced the following diagram to represent a negative feedback loop controlling the level of glucose in the bloodstream of a healthy human. The diagram has some missing information.



Which option correctly matches the numbers to the missing information?

	1	2	3	4
(A)	Glucose increases	Insulin produced	Glucose decreases	Glucagon produced
(B)	Glucose decreases	Glucagon produced	Glucose increases	Insulin produced
(C)	Glucose increases	Glucagon produced	Glucose decreases	Insulin produced
(D)	Glucose decreases	Insulin produced	Glucose increases	Glucagon produced

End of Section I

Section II 80 Marks

Attempt Questions 21- 35

Allow about 2 hours and 25 minutes for this section

Answer the questions in the space provided.

Question 21 (3 marks)

The back of the leopard frog (*Rana pipiens*) can be either patterned or non-patterned. Several patterned **3**
frogs were allowed to breed and they produced 75 patterned offspring and 25 non-patterned offspring.
Which phenotype, patterned or non-patterned, would be dominant? Explain your answer with use of a
Punnett square.

Question 22 (3 marks)

The joining of male and female gametes for fertilisation to occur can be done in one of two ways: internally or externally.

3

Complete the following table to compare and contrast internal and external fertilisation.

Characteristics	Differences		Similarity
	External fertilisation	Internal fertilisation	
Chance of fertilisation			
Environment for zygote			

3

3

[illegible]

Question 24 (2 marks)

Below is a diagram of the leaves of a eucalyptus (gum) tree. These trees typically exist in dry habitats so 2
it is important they have strategies to conserve water.



Describe two adaptations associated with eucalyptus leaves that help the tree conserve water.

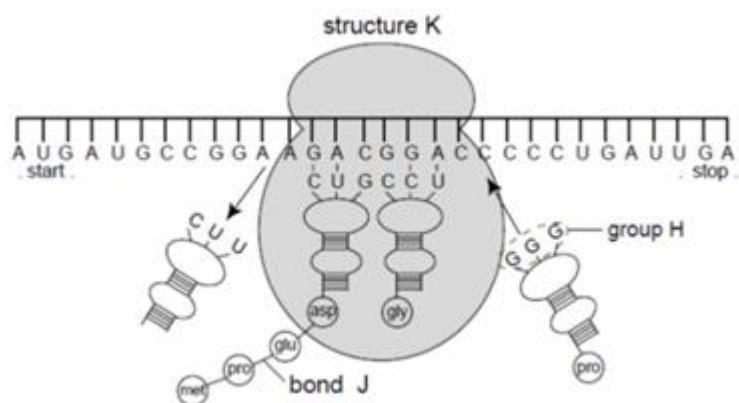
Question 25 (3 marks)

Identify the cause and effect of a named nutritional disease you have studied.

3

Question 26 (3 marks)

The diagram below shows a structure involved in protein synthesis.

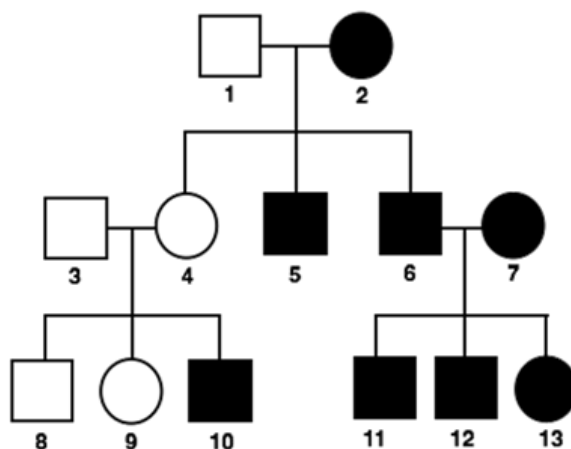


Explain the stage of protein synthesis that involves structure K.

3

Question 27 (3 marks)

The pedigree below shows a family tree that includes individuals affected by a hereditary disorder. Individual I-2 suffers from the disorder, but her husband I-1 does not.



- a) Is the hereditary disorder most likely to be autosomal dominant or autosomal recessive? Explain your answer with reference to the family tree.

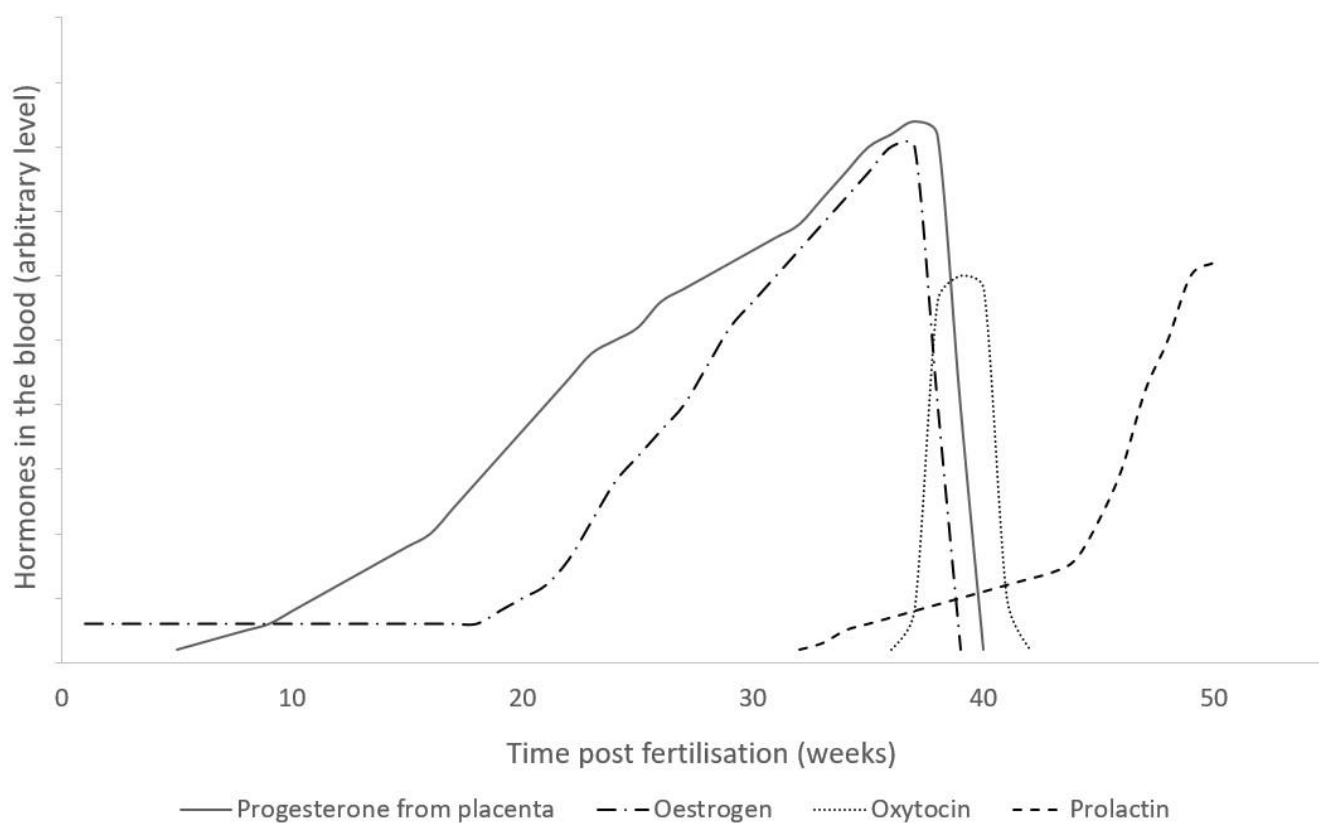
2

- b) What is the genotype of individual II-4?

1

Question 28 (5 marks)

The following graph shows changes in hormones in blood post fertilisation.



- a) Explain why progesterone from the placenta was not produced until 5 weeks post fertilisation.

2

Question 28 continues over the page

- b) For ONE other hormone from the graph, describe its function with specific reference to the graph. 3

Question 29 (4 marks)

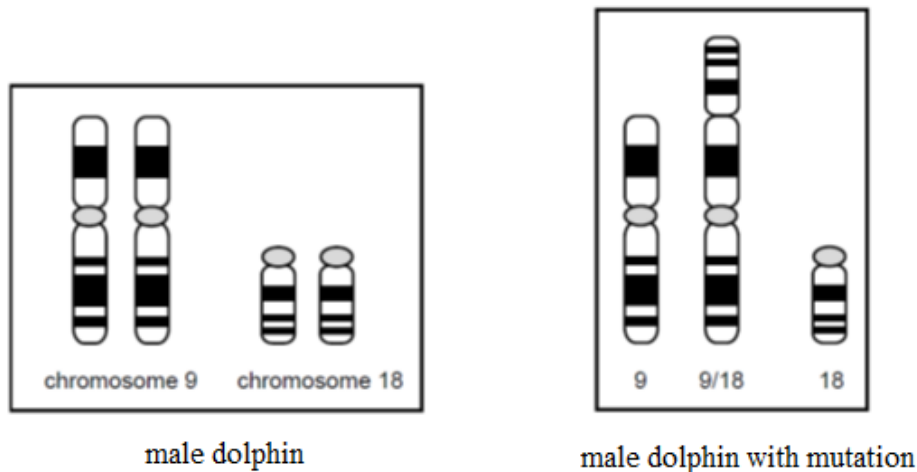
With the aid of a specific example, assess the impact of the process of artificial pollination on the composition and continuity of a population. 4

Question 30 (12 marks)

The dolphin, *Delphinus delphis*, has a diploid number of 44.

Genetic ‘accidents’ can occur to chromosomes. One type of accident is when one chromosome becomes permanently attached to another. A scientist observed a mutation involving chromosomes 9 and 18 in somatic cells of a male dolphin. The diagram below shows chromosomes 9 and 18 in a normal male dolphin and their arrangement in the dolphin carrying the mutation.

Note that the centromere has been lost in the mutation.



- a) How many chromosomes would a gamete of a normal dolphin contain?

1

- b) Identify this type of mutation.

1

- c) Compare and contrast chromosomal mutations and point mutations.

3

Question 30 continues over the page.

- d) In this case, the male dolphin with the mutation has a normal phenotype. The dolphin with the mutation has only 43 chromosomes in each somatic cell. Explain why it still has a normal phenotype. 2

- e) The male dolphin with the mutation is mated to a female dolphin. Complete the following diagram to show how chromosome 9 and 18 could be distributed during meiosis. 2

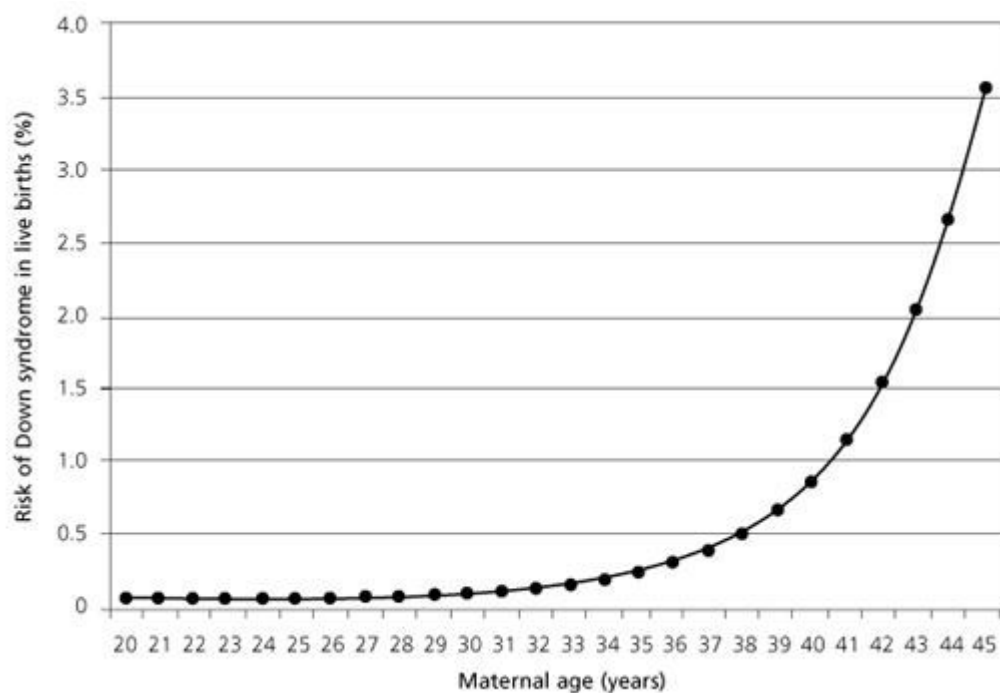


- f) One of the sperm produced will not produce viable offspring when fertilising an egg. Identify which sperm would not produce offspring and provide a reason. 2

- g) The male dolphin with the mutation is mated with a normal female. Identify the likelihood that the offspring would have the mutation. 1

Question 31 (4 marks)

The graph below shows the percentages of Down syndrome babies against the age of the mother.



a) Identify the independent variable in this study

1

b) What can you conclude from the shape of this graph?

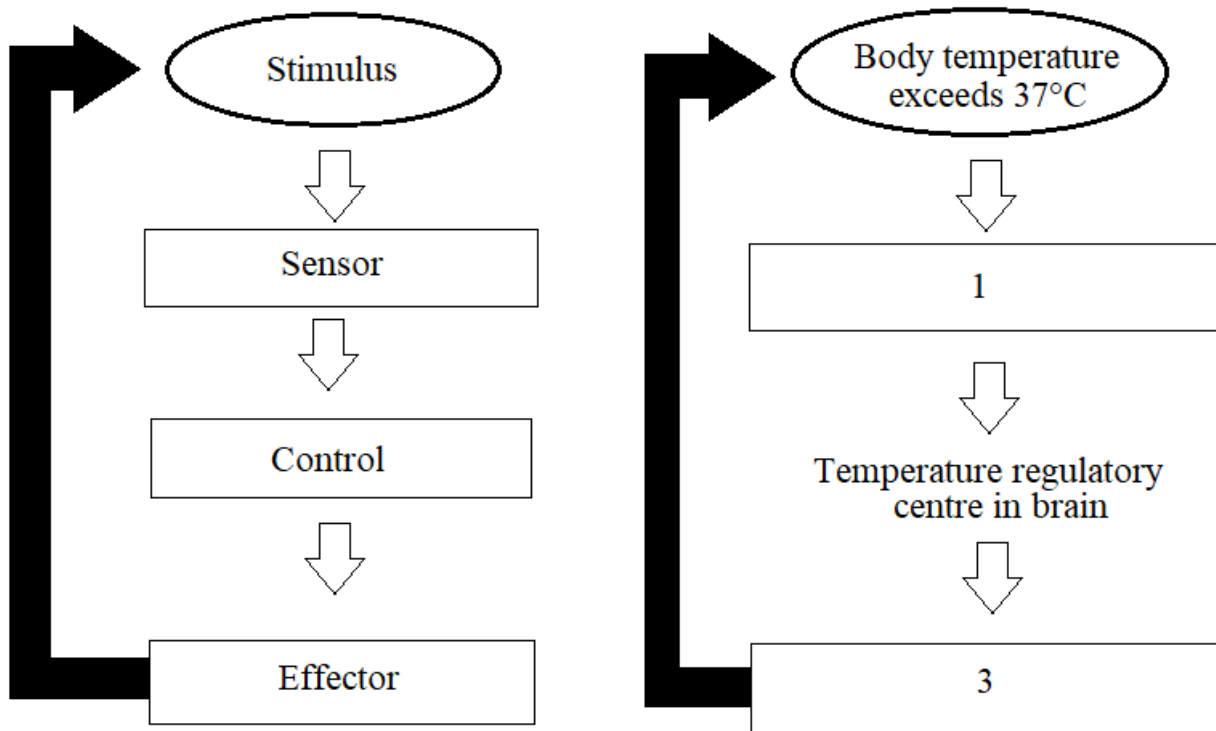
2

c) What is the probability of a 38 yr old mother having a Down Syndrome child?

1

Question 32 (3 marks)

The diagrams below describe processes that occur in the human body which help the body remain in balance.



- a) Identify the term used to describe the maintenance of the internal environment in response to external changes.

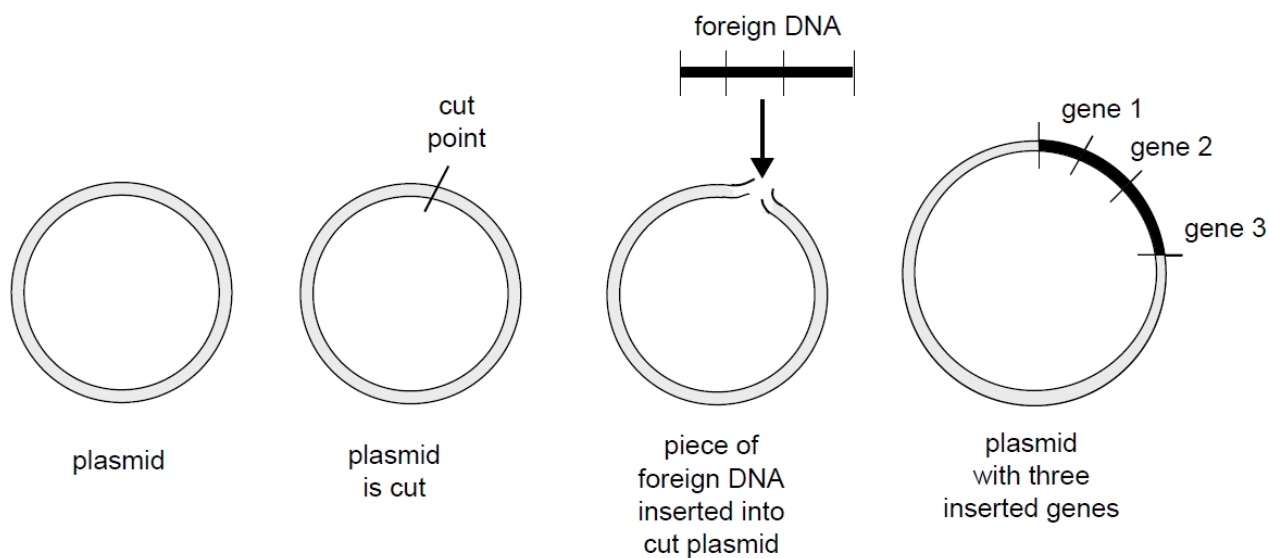
1

- b) The right-hand diagram above describes the body's response to an increase in the temperature of the air to 40°C, resulting in an increase in body temperature. Complete boxes 1 and 3 by identifying relevant parts of the body and specific locations.

2

Question 33 (13 marks)

Genes can be cloned in various ways. One method is given in the diagram below.



a) Identify and describe this process and how it can be used to clone a gene.

3

b) Another method of gene cloning is the Polymerase Chain Reaction (PCR) process. Contrast PCR with the process described in a).

3

Question 33 continues over the page.

7

- c) Bacteria containing plasmids can be used in a variety of settings with plants and animals. For example, some plants are resistant to attack by insects or resistant to particular herbicides. A particular species of tomato plant was genetically engineered to contain a gene which makes it resistant to some pests. Such plants are referred to as GM (genetically modified) plants. Discuss the social, economic and cultural considerations surrounding the use of GM plants, with reference to this tomato plant and another example of a GM plant.

[illegible]

5

5

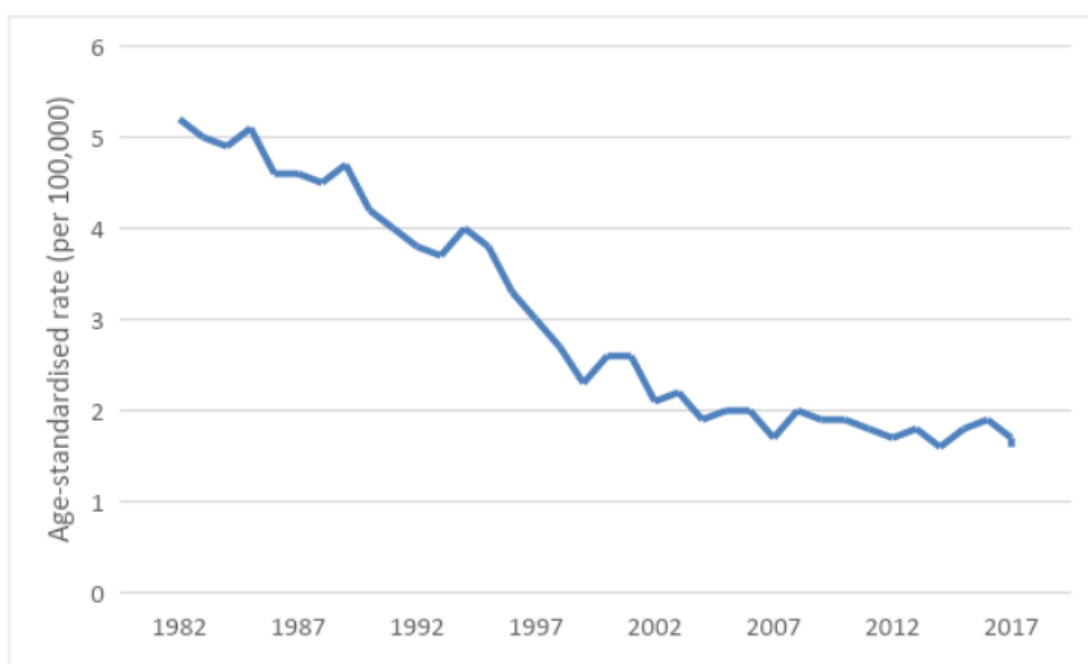


Question 35 (14 marks)

Cervical cancer is defined as cancer of the cervical cells. It normally develops between the ages of 20 to 50. Early signs can be detected through the pap smear process, in which a cell sample is taken from the cervix to identify any abnormalities that could indicate the development of cervical cancer. Pap smears became widely used in Australia in the mid-1980s. In 2007, a vaccination program was introduced in which Australian girls aged between 12-15 receive a series of vaccinations against the human papillomavirus. Human papillomavirus is associated with a range of conditions including cervical cancer.

- a) The following graph shows the age standardised incidence of cervical cancer for women in Australia from 1982 to 2017.

2



Explain the trend in the graph between 1982 and 2002.

Question 35 continues over the page.

- c) Technologies, such as genetic engineering, are providing new avenues for disease prevention. Assess the effectiveness of these two technologies as a prevention method for cervical cancer. In your answer, include reference to the information and data provided throughout Question 35.

[illegible]

END OF PAPER

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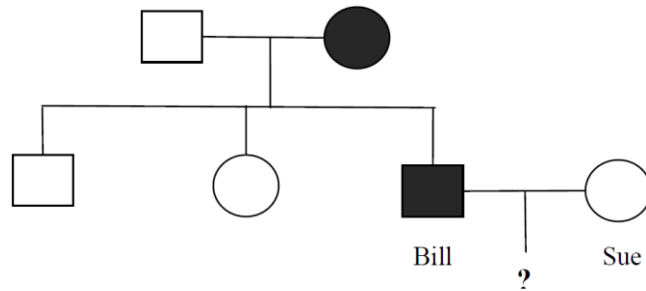
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correct →

1. What are all the alleles in a population referred to as?

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2. The pedigree below shows the inheritance of a sex-linked dominant condition in a family.



If Bill and Sue have a daughter, what is the probability that she will have the condition?

- (A) **100%**
- (B) 75%
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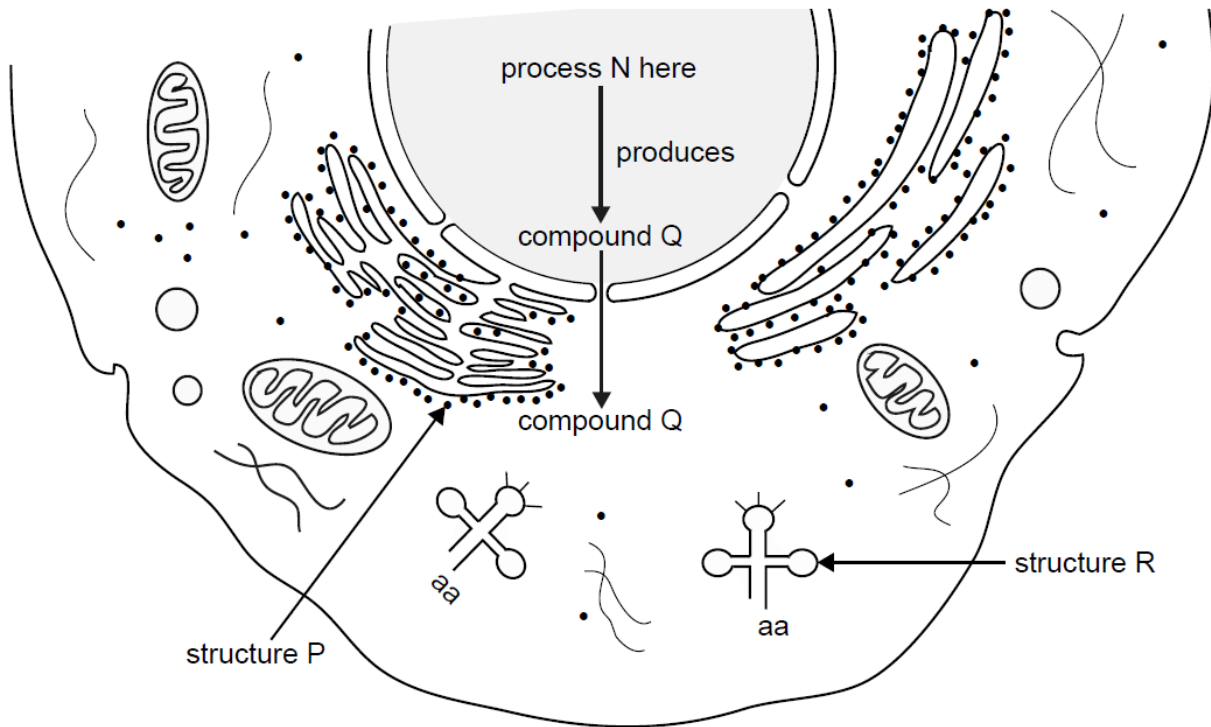
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4. A student when reading consistently holds the texts at arm's length. This behaviour is most commonly associated with which of the following vision problems?

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Use the following diagram (not to scale) to answer Questions 5 and 6.



5. Which is the correct name for compound Q?
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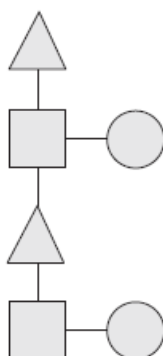
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- (A) Pinna
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10. The diagram shows a model of DNA.



Which key correctly shows the parts of a nucleotide?

(A)	 Sugar	 Base	 Phosphate
(B)	 Base	 Phosphate	 Sugar
(C)	 Phosphate	 Sugar	 Base
(D)	 Sugar	 Phosphate	 Base

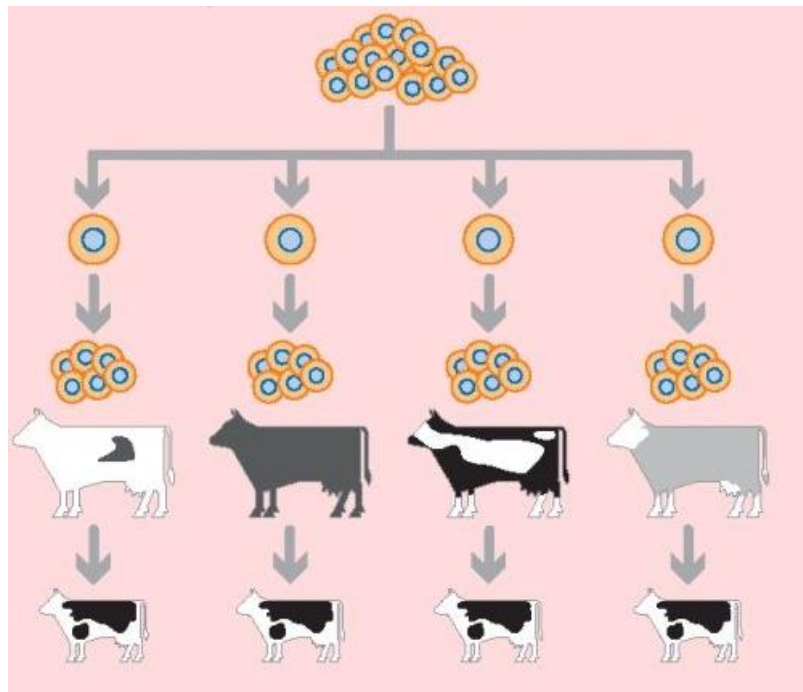
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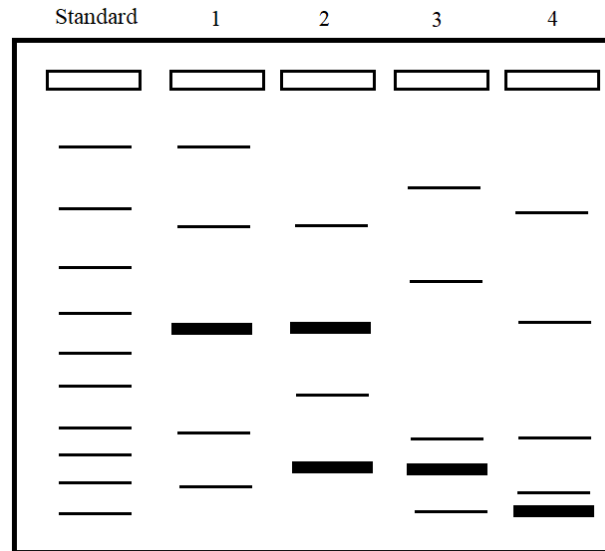


Which process is demonstrated in the diagram?

- (A) Artificial pollination
- (B) Artificial insemination
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13. Which mate would be most suitable to maintain genetic diversity in the population?

- (A) 2
- (B) 3**
- (C) 4
- (D) All mates would produce the same genetic diversity.

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- (A) Decrease in allele frequency**
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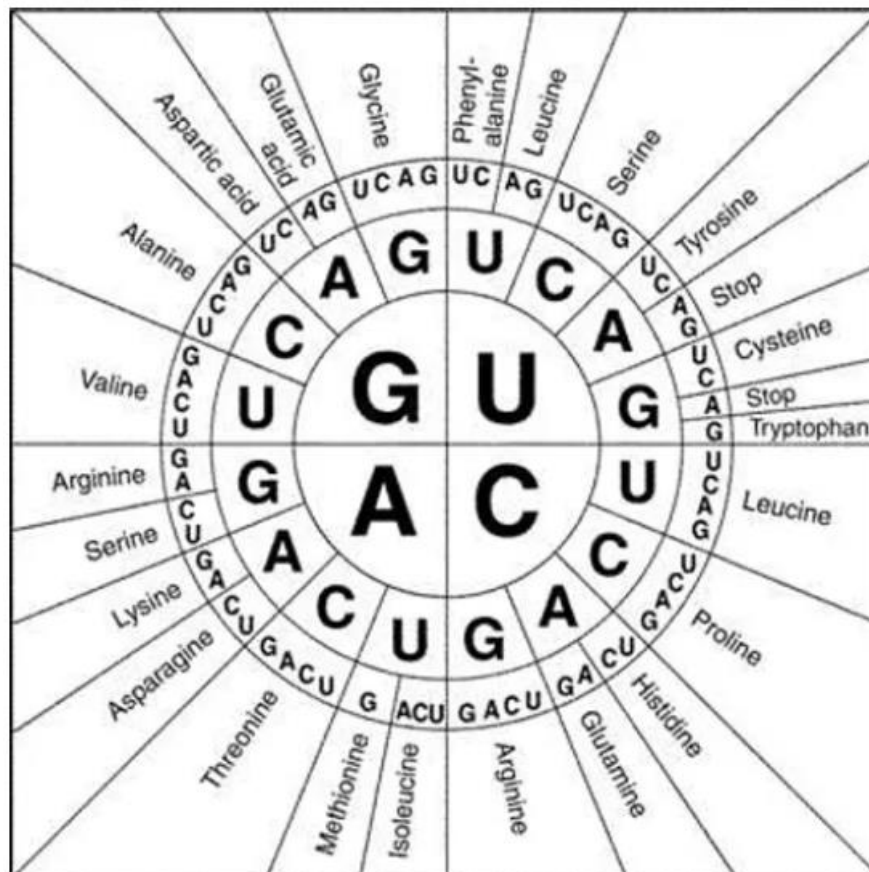
16. Which of the following statements is **incorrect** for homologous chromosomes?

- (A) Homologous chromosomes always carry the same genes
- (B) Homologous chromosomes can always exchange genetic information
- (C) Homologous chromosomes are always from different parents
- (D) **Homologous chromosomes always carry the same alleles**

17. A student wanted to examine a section of DNA

5'	A	T	C	A	T	G	T	A	C
3'	T	A	G	T	A	C	A	T	G

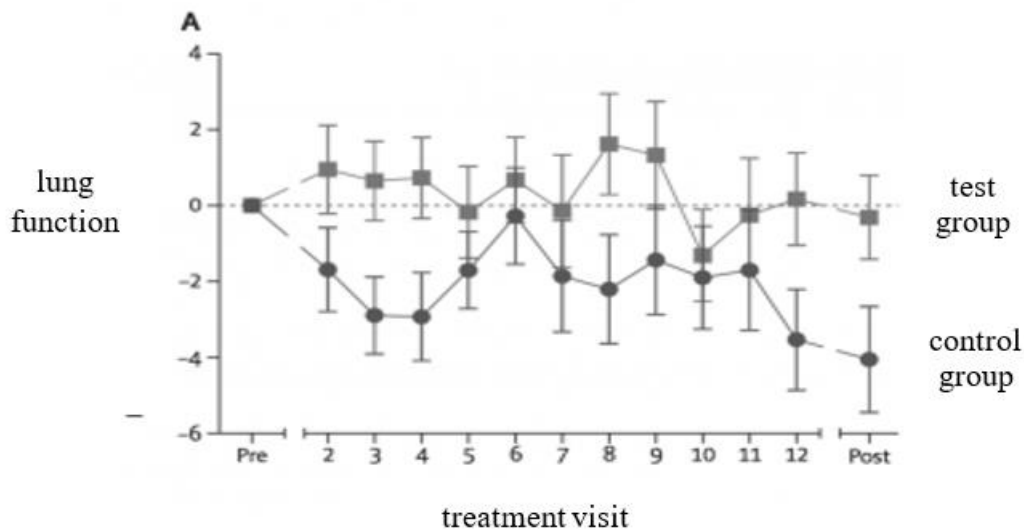
Use the mRNA wheel to identify the amino acid coded for by the second codon.



- (A) **Methionine**
- (B) Tyrosine
- (C) Isoleucine
- (D) Serine

Use the following information to answer Questions 18 and 19.

The graph below shows the average change in lung function for cystic fibrosis sufferers undergoing different treatments. 150 individuals with cystic fibrosis were separated into two groups, a test group and a control group. Patients did not know which group they were in. The test group received a new form of gene therapy treatment and the control group were treated with a placebo (a treatment which doesn't contain the gene).



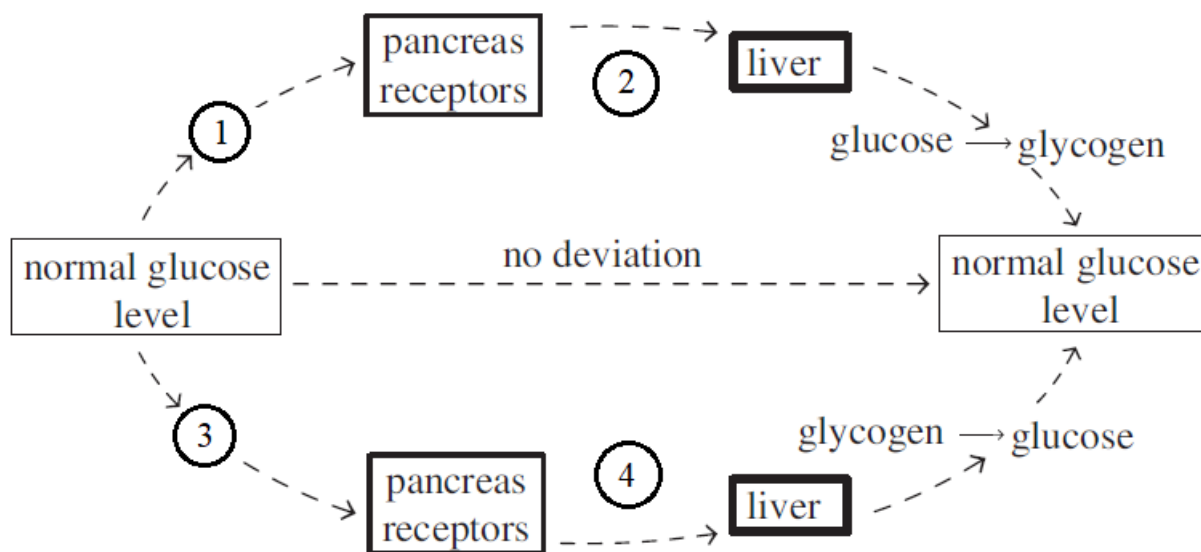
18. What is the dependent variable in this investigation?

- (A) The type of treatment
- (B) Initial lung function
- (C) Composition of both groups
- (D) Change in lung function**

19. Which of the following statements is a valid conclusion from this graph?

- (A) Placebos work just as well as gene therapy
- (B) There was no benefit to gene therapy
- (C) The gene therapy helped to maintain lung function**
- (D) The control group experienced a steady decrease in lung function

20. A student produced the following diagram to represent a negative feedback loop controlling the level of glucose in the bloodstream of a healthy human. The diagram has some missing information.



Which option correctly matches the numbers to the missing information?

	1	2	3	4
(A)	Glucose increases	Insulin produced	Glucose decreases	Glucagon produced
(B)	Glucose decreases	Glucagon produced	Glucose increases	Insulin produced
(C)	Glucose increases	Glucagon produced	Glucose decreases	Insulin produced
(D)	Glucose decreases	Insulin produced	Glucose increases	Glucagon produced

End of Section I

Section II 80 Marks

Attempt Questions 21- 35

Allow about 2 hours and 25 minutes for this section

Answer the questions in the space provided.

Question 21 (3 marks)

The back of the leopard frog (*Rana pipiens*) can be either patterned or non-patterned. Several patterned frogs were allowed to breed and they produced 75 patterned offspring and 25 non-patterned offspring. Which phenotype, patterned or non-patterned, would be dominant? Explain your answer with use of a Punnett square. 3

- Patterned frogs would be dominant
- Explanation that only frogs who were heterozygous for patterned back could produce offspring in a 3 to 1 ratio of patterned to non-patterned
- Relevant punnet square – monohybrid cross showing the 3 to 1 ratio

Note: the better answers considered non-patterned being dominant. Therefore patterned would have to be homozygous recessive with Punnett square showing 100% of offspring being patterned and therefore not correct.

Question 22 (3 marks)

The joining of male and female gametes for fertilisation to occur can be done in one of two ways: internally or externally. 3

Complete the following table to compare and contrast internal and external fertilisation.

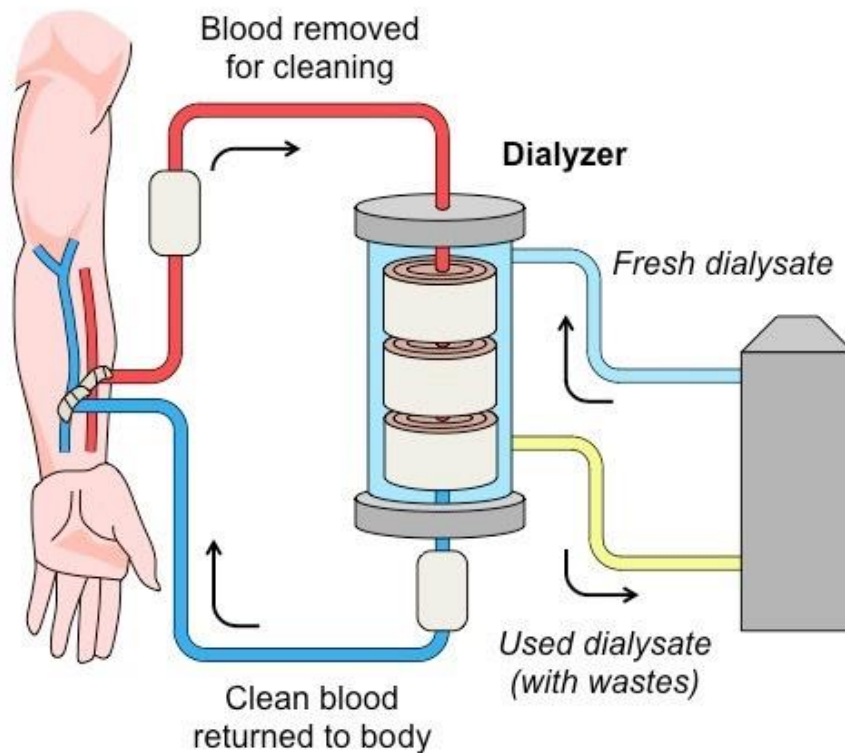
Characteristics	Differences		Similarity
	External fertilisation	Internal fertilisation	
Chance of fertilisation	lower	higher	Fusion of gametes must occur in order to produce zygote
Environment for zygote	Zygote develops in a harsh and continually changing environment with no protection from predators	Zygote develops inside the female. It is therefore protected from the harsh external environment with a constant source of nutrients	Fertilisation occurs in a moist environment (not aquatic)

½ mark per box

Question 23 (3 marks)

The diagram below shows blood from a human passing through an artificial kidney.

3



Evaluate the effectiveness of the dialysis machine compared to normal kidney function for filtering blood.

- 1 mark for description of normal kidney function with reference to materials removed (and returned) and/or reference to diffusion process
- 1 mark for description of dialysis with specific reference to the function of the dialysate
- 1 mark evaluation of effectiveness/ comparative statement which must relate to specific differences

Sample Answer

The human body has 2 kidneys whose role is to filter out waste products from the blood. The kidneys use a combination of passive and active diffusion to remove the waste products such as urea and have the ability to return water and salts to the bloodstream. Failure of both kidneys would lead to a build up of these toxic substances and death.

The process of dialysis allows the blood to be filtered outside the body. The key component of dialysis is the dialysate which is especially designed to match specific components of the bodies chemistry. It consists of a semipermeable membrane which allows small molecules and ions to pass through but not larger bodies such as blood cells. It contains no urea, so the urea in the blood passively diffuses out. Replacement of this solution with fresh dialysate maintains this important process. The dialysate contains glucose so no net loss of this important compound occurs.

Dialysis machines are a highly effective means of cleaning the blood for people with poorly functioning kidneys. They do however cause issues relating to maintaining blood volumes and patients often suffer from low blood pressure and dizziness. The risk of infections is also a possibility.

Note: answers that discussed efficiency and convenience did not earn marks.

Question 24 (2 marks)

Below is a diagram of the leaves of a eucalyptus (gum) tree. These trees typically exist in dry habitats so it is important they have strategies to conserve water. 2



Describe two adaptations associated with eucalyptus leaves that help the tree conserve water.

- 1 mark per correct description
- Vertical leaves, waxy cuticles

Note: ensure you describe two different adaptations in these type of questions. Example leaf shape and orientation overlap and may not earn 2 marks

Question 25 (3 marks)

Identify the cause and effect of a named nutritional disease you have studied. 3

- 1 for name
- 1 for cause
- 1 for effect

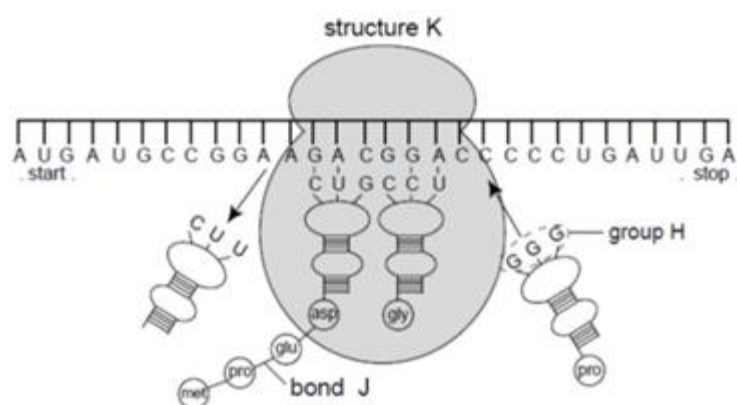
Sample Answer

Scurvy is a disease caused by a lack of vitamin C in the diet. Symptoms include bleeding and swollen gums, loose teeth and bruising.

Note when listing symptoms, choose ones which are specific to that disease not general ones like lack of energy, headaches etc.

Question 26 (3 marks)

The diagram below shows a structure involved in protein synthesis.



Explain the stage of protein synthesis that involves structure K.

3

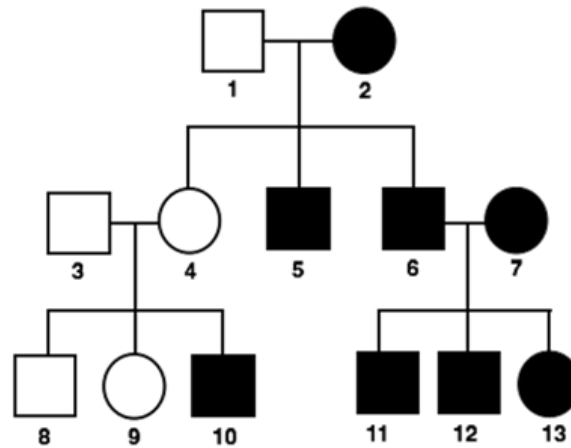
3 marks	Correctly identifies structure K AND Accurately explains translation with explicit reference to stop/start codons and tRNA.
2 marks	Correctly identifies structure K AND Provides an accurate description of translation OR Accurately explains translation with explicit reference to stop/start codons and tRNA.
1 mark	Correctly identifies structure K OR Provides an some relevant information about translation

Sample answer:

Structure K is a ribosome. Ribosomes 'read' mRNA that has exited the nucleus in order to produce a polypeptide chain. This is the translation stage of protein synthesis. Once a ribosome has assembled around an RNA strand, it reads the mRNA in base triplets or codons, beginning with the start codon. Each codon has a complementary anti-codon on a tRNA molecule. Each anti-codon is associated with a specific amino acid, which will be carried to the ribosome by the associated tRNA molecule. As each codon is read, an amino acid is added to a growing polypeptide chain through peptide bonding catalysed by the ribosome. The tRNA molecules sequentially detach and can be reused later. Translation ceases at the stop codon.

Question 27 (3 marks)

The pedigree below shows a family tree that includes individuals affected by a hereditary disorder. Individual I-2 suffers from the disorder, but her husband I-1 does not.



a) Is the hereditary disorder most likely to be autosomal dominant or autosomal recessive? Explain your answer with reference to the family tree.

2

- Recessive
- 3 and 4 have 10 which has the trait despite neither parent possessing it. Only possible for a recessive trait.

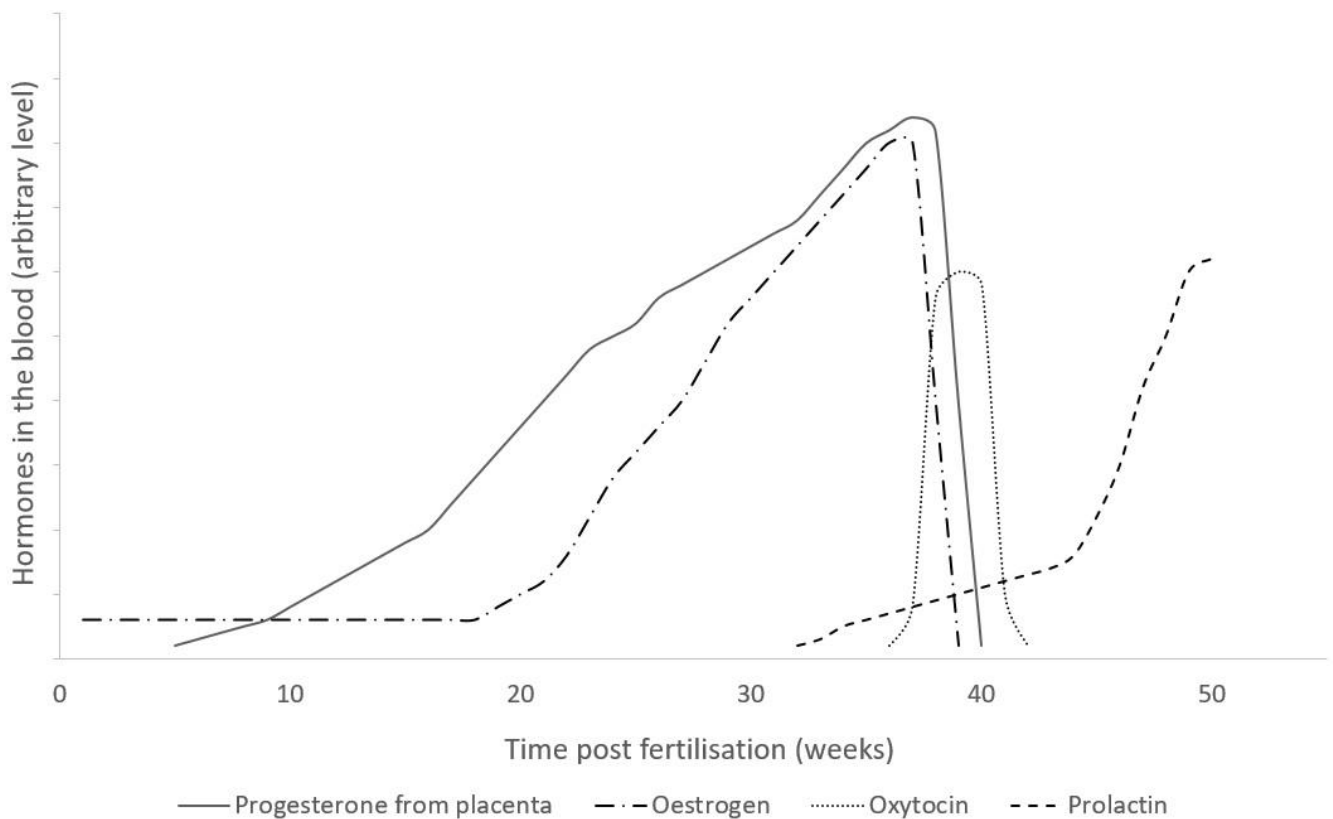
b) What is the genotype of individual II-4?

Heterozygous

1

Question 28 (5 marks)

The following graph shows changes in hormones in blood post fertilisation.



a) Explain why progesterone from the placenta was not produced until 5 weeks post fertilisation. 2

- 1 mark – placenta does not form until 5 weeks after fertilisation
- 2 marks – link to question/explanation!

The placenta is not formed until approx. 5 weeks post fertilisation. Until this point, progesterone, which is responsible for maintaining the pregnancy, is produced from the corpus luteum.

b) For ONE other hormone from the graph, describe its function with specific reference to the graph.

- 1 mark – function
- 2 marks – 2 references to different places on the graph

Question 29 (4 marks)

With the aid of a specific example, assess the impact of the process of artificial pollination on the composition and continuity of a population.

4

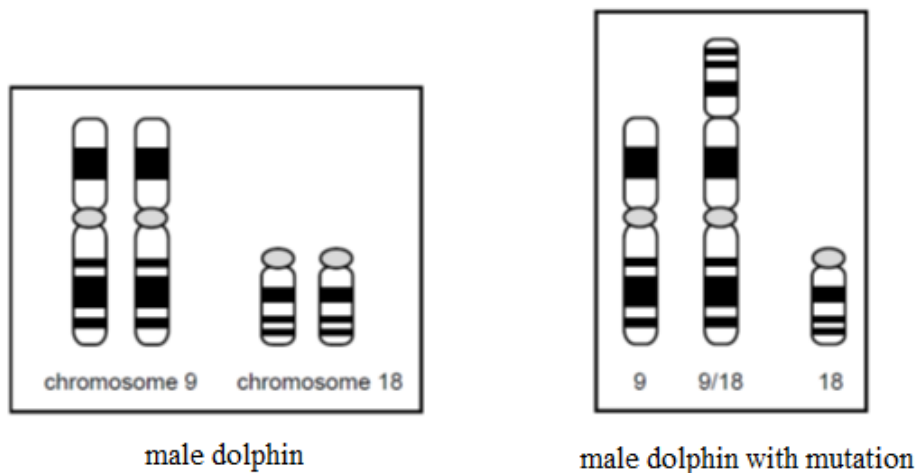
- Description of artificial pollination
- Related to correct example
- Correct assessment of composition effect
- Correct assessment of continuity effect

Question 30 (12 marks)

The dolphin, *Delphinus delphis*, has a diploid number of 44.

Genetic ‘accidents’ can occur to chromosomes. One type of accident is when one chromosome becomes permanently attached to another. A scientist observed a mutation involving chromosomes 9 and 18 in somatic cells of a male dolphin. The diagram below shows chromosomes 9 and 18 in a normal male dolphin and their arrangement in the dolphin carrying the mutation.

Note that the centromere has been lost in the mutation.



a) How many chromosomes would a gamete of a normal dolphin contain?

1

22

b) Identify this type of mutation.

1

translocation

Question 30 continues over the page.

c) Compare and contrast chromosomal mutations and point mutations.

3

- Need 3 points of comparison
- Must include at least one similarity and one difference

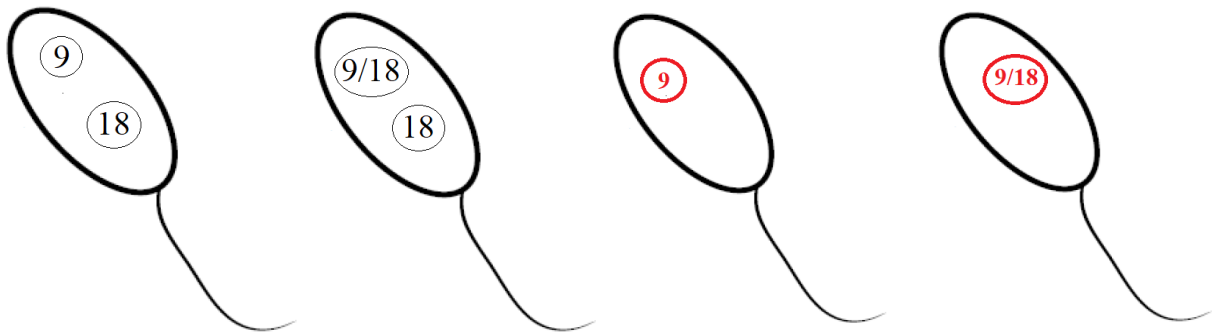
d) In this case, the male dolphin with the mutation has a normal phenotype. The dolphin with the mutation has only 43 chromosomes in each somatic cell. Explain why it still has a normal phenotype.

2

- 1 mark all genetic information still present in genome
- 1 mark therefore normal proteins etc still produced hence normal phenotype

e) The male dolphin with the mutation is mated to a female dolphin. Complete the following diagram to show how chromosome 9 and 18 could be distributed during meiosis.

2



f) One of the sperm produced will not produce viable offspring when fertilising an egg. Identify which sperm would not produce offspring and provide a reason.

2

1 mark for a correct choice

1 mark for valid reason

9 chromosome only

Incomplete genetic info ie: not all proteins produced

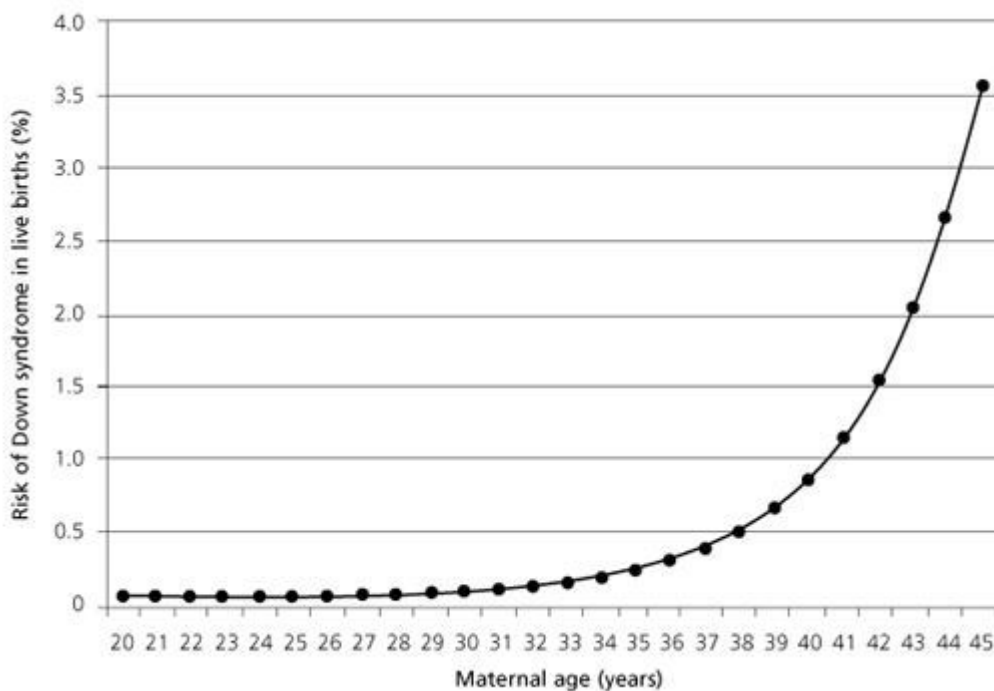
1

g) The male dolphin with the mutation is mated with a normal female. Identify the likelihood that the offspring would have the mutation.

2/3 or 66%

Question 31 (4 marks)

The graph below shows the percentages of Down syndrome babies against the age of the mother.



a) Identify the independent variable in this study

1

Maternal age

b) What can you conclude from the shape of this graph?

1 mark risk of down syndrome in babies increases with maternal age

1 mark – exponential increase OR data from graph

2

c) What is the probability of a 38 yr old mother having a Down Syndrome child?

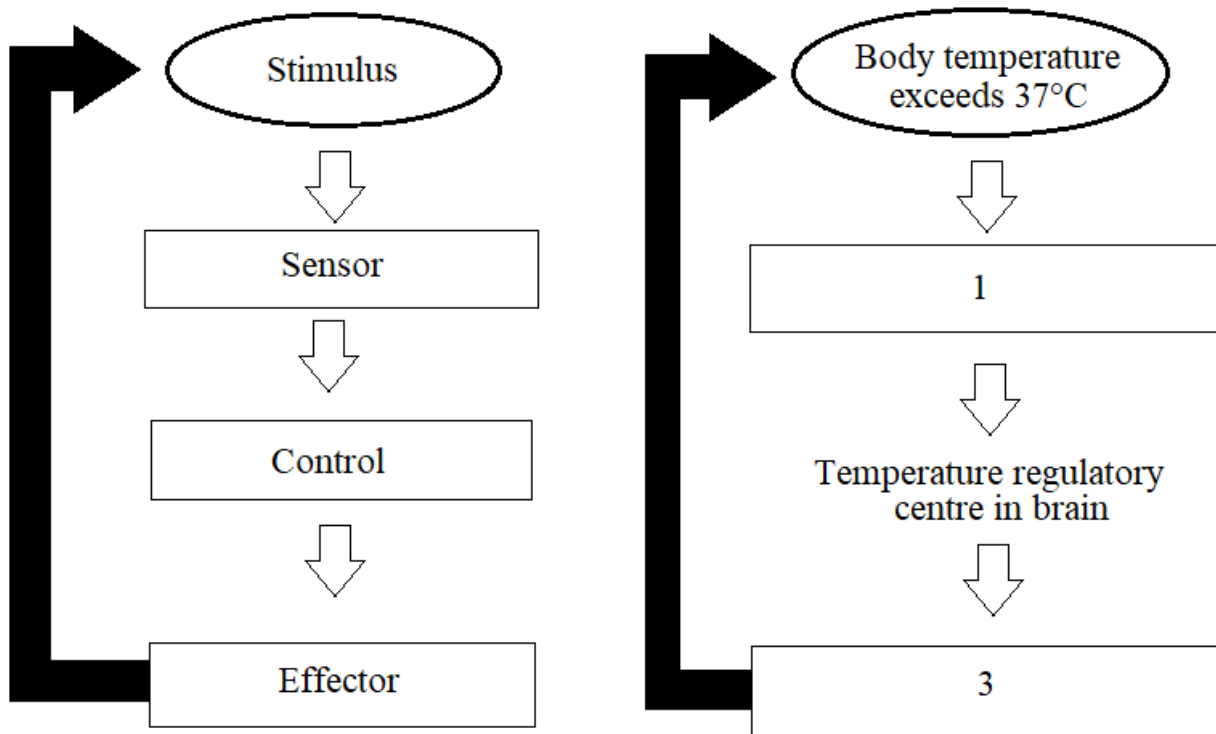
0.5%

Note: Dots on graph correspond to numbers on Y scale. The marks on the axis are irrelevant here

1

Question 32 (3 marks)

The diagrams below describe processes that occur in the human body which help the body remain in balance.



- a) Identify the term used to describe the maintenance of the internal environment in response to external changes.

1

homeostasis

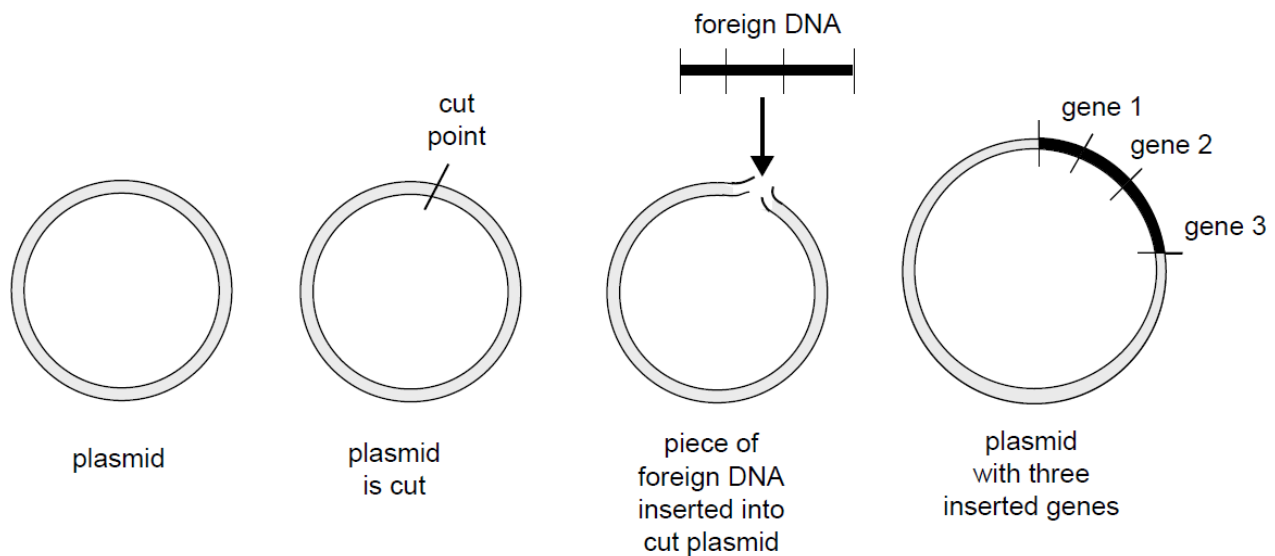
- b) The right-hand diagram above describes the body's response to an increase in the temperature of the air to 40°C, resulting in an increase in body temperature. Complete boxes 1 and 3 by identifying relevant parts of the body and specific locations.

2

- 1: thermoreceptor in skin
- 3: relevant effector

Question 33 (13 marks)

Genes can be cloned in various ways. One method is given in the diagram below.



a) Identify and describe this process and how it can be used to clone a gene.

3

1 mark – recombinant DNA/plasmid

1 mark – description

1 mark – link to gene replication

Both the plasmid and the gene of interest are cut using the same restriction enzymes. The two are combined and DNA ligase is used to fuse the backbone. The Recombinant plasmid is re-inserted into a bacterial cell where it will replicate independent to the cell.

b) Another method of gene cloning is the Polymerase Chain Reaction (PCR) process. Contrast PCR with the process described in a).

3

Description with 2 explicit differences OR

3 explicit differences

Could include: cycling temperatures, inside cells vs outside cells, PCR just copying, recombinant DNA edits plasmid genetic code whereas PCR doesn't

Question 33 continues over the page.

- c) Bacteria containing plasmids can be used in a variety of settings with plants and animals. For example, some plants are resistant to attack by insects or resistant to particular herbicides. A particular species of tomato plant was genetically engineered to contain a gene which makes it resistant to some pests. Such plants are referred to as GM (genetically modified) plants. Discuss the social, economic and cultural considerations surrounding the use of GM plants, with reference to this tomato plant and another example of a GM plant.

- 2 marks social (code S1/S2)
- 2 marks economic (code E1/E2)
- 2 marks cultural (code C1/C2)

Each has an appropriate consideration WITH reference to either tomato or student example

- 1 mark correct example (code GM)
- Need to have at either 2 correct points for each category OR a comprehensive and detailed discussion of one point with explicit reference to examples.

Things you could talk about

Social

- Inequality based on location and access
- Long term health effects such as antibiotic resistance of bacteria due to exposure to antibiotic compounds in plants, triggering allergies, long term toxicity, changes to nutritional value of food products?
- Benefit of use (Golden Rice)

Economic

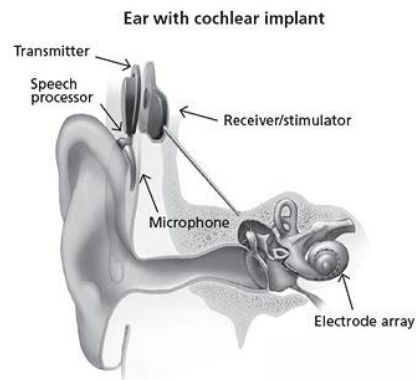
- Cost of patents to grow and use
- Save money on pesticides/higher guarantee of yield (BT Cotton)
- Consistency of product

Cultural

- Religious beliefs against use of animal products
- "Tampering with nature"
- Customs of the area

Question 34 (5 marks)

Two individuals are both receiving advice from the same doctor about treatment for their hearing loss. 5
One patient has been recommended a hearing aid and the other patient a cochlear implant. With reference to your understanding of the structure and function of the ear, explain why two different technologies are being recommended by the same doctor for different individuals.



- 1 mark each for CORRECT description of technology: hearing aid and cochlear
- 1 mark each for CORRECTLY linking to type of damage
- 1 mark for explicitly answering stem: the two individuals have different types of hearing loss, so different technologies are necessary to assist.

Sample answer:

Different treatments may be suitable for different types of hearing loss based on the cause of the problem.

A hearing aid consists of an external microphone which picks up sound, a processor that converts the sound into electrical signals in order to amplify it, and a microphone/emitter which directs this now louder sound into the ear canal. Hearing aids are typically used to treat hearing loss that can be rectified by amplification alone. This could be mild conductive hearing loss or minor stiffening of stereocilia in the inner ear.

A cochlear implant consists of an external microphone which picks up sound, a transmitter that sends the sound as a radio signal to a receiver implanted in the ear, and an electrode array that directly stimulates the auditory nerve with that signal. The cochlear implant is used to treat damage in which some part of the ear has entirely (or almost entirely) lost function. This could be profound conductive hearing loss or a malfunctioning cochlea/organ of corti.

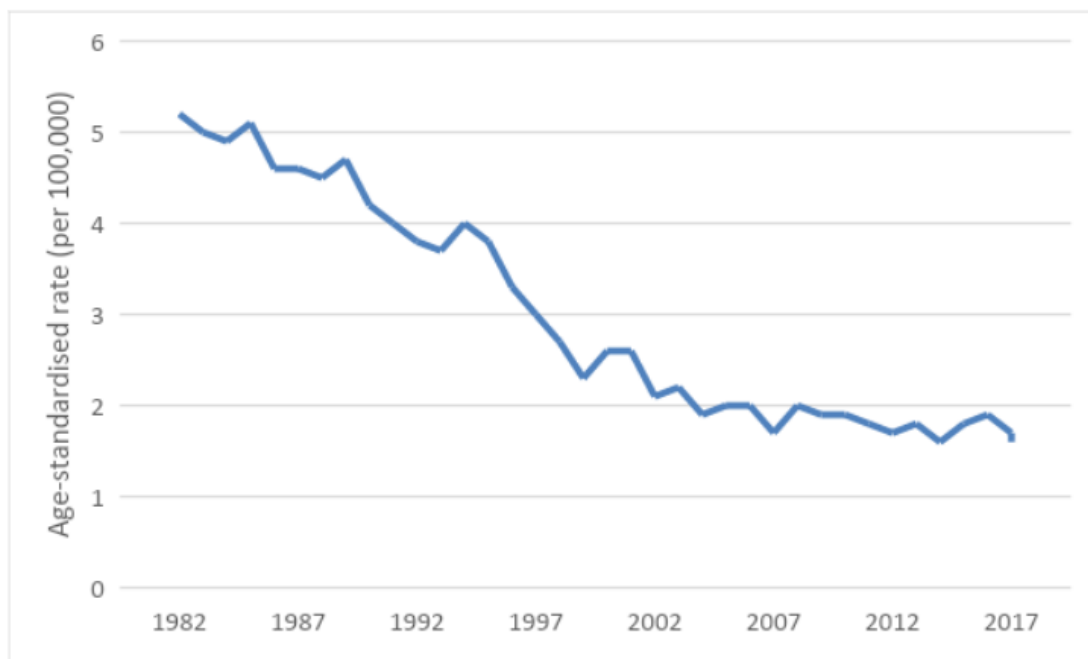
Hence, the same doctor would prescribe two different treatments based on the cause of each patient's hearing loss.

Question 35 (14 marks)

Cervical cancer is defined as cancer of the cervical cells. It normally develops between the ages of 20 to 50. Early signs can be detected through the pap smear process, in which a cell sample is taken from the cervix to identify any abnormalities that could indicate the development of cervical cancer. Pap smears became widely used in Australia in the mid-1980s. In 2007, a vaccination program was introduced in which Australian girls aged between 12-15 receive a series of vaccinations against the human papillomavirus. Human papillomavirus is associated with a range of conditions including cervical cancer.

- a) The following graph shows the age standardised incidence of cervical cancer for women in Australia from 1982 to 2017.

2



Explain the trend in the graph between 1982 and 2002.

- Decrease in rate
- Pap smears allow early detection of abnormalities → prevention.

It was NOT sufficient to say “early detection of CANCER” as a diagnosis of cervical cancer would contribute to a steady or an increased incidence, not a decrease.

Question 35 continues over the page.

b) The following table shows the incidence of cervical cancer in Australia by age bracket from 2005 to 2014.

4

Year	Incidence per 1000 women screened by age			
	<20	20-24	25-29	30-34
2005	10	17	15	9
2006	11	16	15	9
2007	10	18	16	10
2008	12	21	17	12
2009	8	18	18	11
2010	6	17	17	12
2011	5	15	18	13
2012	6	15	18	13
2013	5	14	17	14
2014	4	12	15	14

Describe each of the trends shown in the table.

1 mark per trend

- <20: decreasing
- 20-24: decreasing
- 25-29: no significant change
- 30-34: increasing

NOTE: numerous students quoted incidence decrease of “6000” between 2005-2014 for <20 year olds. Similar issue was students instead quoting “6”. It is incidence PER THOUSAND. This incurred a deduction in either part b) or part c), but not in both.

Question 35 continues over the page.

- c) Technologies, such as genetic engineering, are providing new avenues for disease prevention. Assess the effectiveness of these two technologies as a prevention method for cervical cancer. In your answer, include reference to the information and data provided throughout Question 35.

8

This question required you to **USE THE DATA PROVIDED** to make an assessment of “these two technologies” – ie: the technologies referenced in part a) and part b); pap smears and the HPC vaccine. The question also refers to genetic engineering – hence it is necessary to include genetic engineering in your answer.

Good answers relied on the data and engaged with complexity. Less good answers brain dumped or repeated info from earlier parts of the question.

- DV - Description of vaccine (how is this genetic engineering?)
- PSD - Decrease in incidence 82-02 due to pap smear (technology) use
- VID - Decreases in incidence 05-14 in under 24s due to vaccine introduction
- PSAS - Pap smears only decrease rate to a point; no further reduction after this
- INC - Increase in 30-34 possibly due to increased detection OR changed behaviours – accepted acknowledgement of increase
- OLD - Older people do not see benefit of vaccine because they weren't in school vaccination programs (only introduced in 2007) -- also accepted the reverse eg: the <24 numbers are referred to as these individuals are those who received the vaccination as teenagers.
- ACK – Acknowledge that more data needs to be collected to assess efficacy of vaccine in preventing cases for >25 year olds. (This is NOT the same as “the vaccine is not effective in older people.”)
- VAS - Assessment statement for vaccine: effective.

Sample answer:

Pap smears and the HPV vaccination have both contributed to a decrease in the incidence of cervical cancer. The HPV vaccine is an example of genetic engineering, where only a single component of the virus' complex protein coat is used to stimulate a protective immune response.

It can be seen in the graph that the age standardised incidence decreased noticeably between 1982 – 2002. This is likely due to the widespread introduction of the pap smear in Australia which allowed detection of abnormalities in cervical cells, providing medical practitioners with the opportunity to prevent progression into actual cancer. However after 2002 there is no further significant decrease. It follows that pap smears are an effective prevention method, but only to a point; additional measures are necessary to reduce incidence below approximately 1.6 cases per 100,000.

It is apparent in the table that incidence trends vary by age group between 2005-2014. Women under the age of 24 experienced a significant decrease in incidence; however, women between 25-29 years old experienced essentially no change in overall incidence trend, and women between 30-34 years old experienced an increase. It is likely that the decrease in incidence in women under 24 is due to the school HPV vaccination program which began in 2007. Women young enough to receive the vaccination would only be represented in the 25-29 age group in the last few years of the data collection period, and hence have little impact on the data. Women in the 30-34 age group are extremely unlikely to be vaccinated, since they left school before the introduction of the school-based program. The increasing incidence trend in this group could be due to changed behaviours or improved diagnosis sensitivity; it is unlikely to be related to the vaccine.

The HPV vaccine therefore shows great promise as a means of further reducing the incidence of cervical cancer. In order to see further reduction in the age-standardised rate, data from the cohort that received the early vaccination rounds would need to be collected as they age. Once this data has been collected, a definitive judgement could be made on the efficacy of the vaccine across all age groups.

END OF PAPER