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NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2020
FORMERLY MAY/JUNE

LIFE SCIENCES: PAPER I

Time: 3 hours

200 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 13 pages and a yellow Answer Booklet of 14 pages (i–xiv). Please check that your question paper is complete. Detach the yellow Answer Booklet from the middle of the question paper. Remember to write your examination number in the blocks provided.
 2. This question paper consists of four questions.
 3. Question 1 must be answered in the yellow Answer Booklet provided. Questions 2, 3 and 4 must be answered in your Answer Book.
 4. Read the questions carefully.
 5. Start **each question** on a **new** page.
 6. Number the answers exactly as the questions are numbered.
 7. Use the total marks that can be awarded for each question as an indication of the detail required.
 8. It is in your own interest to write legibly and to present your work neatly.
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QUESTION 2

2.1 Read the extract below and answer the questions that follow.

Night-time pollinators affected by artificial light

An investigation was conducted by scientists to show how artificially lighting a field at night affects the plants' ability to make seeds.

They noticed that the flowers of cabbage thistles in fields that were lit during the night had a decrease of 62% in visits from pollinating insects compared to flowers in dark areas. They also noted that night-lit plants produced 13% less seeds overall than the plants in naturally dark places.

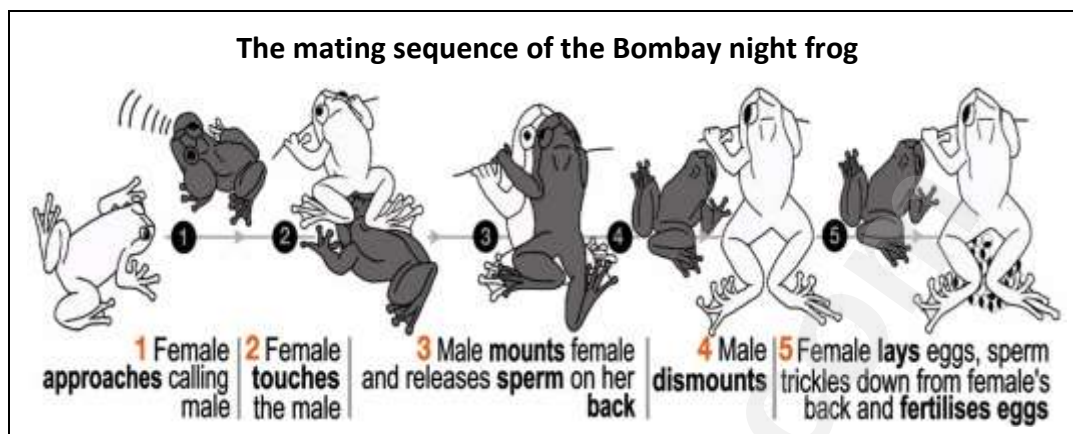
Cabbage thistle

[Source: <<http://www.luontoportti.com>>]

[Adapted: < <https://www.sciencenews.org>>]

- 2.1.1 Provide a definition for *pollination*. (2)
- 2.1.2 Explain the link between pollination and successful seed production. (3)
- 2.1.3 Provide a suitable hypothesis for this study. (3)
- 2.1.4 State TWO variables that would need to be controlled in this study. (2)
- 2.1.5 Explain how the scientists would ensure that their results are reliable. (2)
- 2.1.6 Suggest what the implications of this study are, particularly around urban areas. (2)

- 2.2 The diagram below shows the mating sequence of the Bombay night frog. Use the information provided in the diagram and your own knowledge to answer the questions that follow.



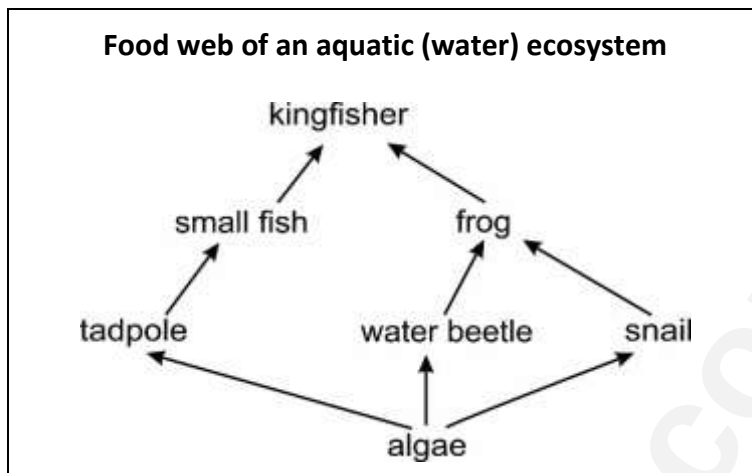
[Adapted: <<https://phys.org>>]

- 2.2.1 State whether the following statements regarding the Bombay night frog are TRUE (T) or FALSE (F). Write A to E underneath each other in your Answer Book and T or F next to each letter.

- A Internal fertilisation takes place.
- B Bombay night frogs are viviparous.
- C There is no physical contact between the sexes during egg laying.
- D Courtship involves calling a mate.
- E Amniotic eggs are laid by the frogs. (5)

- 2.2.2 Bombay night frogs are a typical r-strategy species. Sketch a survivorship graph that would represent this species. (3)

2.2.3 Study the diagram of the food web below and answer the questions that follow.



[Source: < <https://www.smart4k.co>>]

- (a) How do frogs and their tadpole offspring avoid intraspecific competition? (1)
- (b) About 41% of frogs are threatened with extinction. Explain TWO effects that the removal of the adult frog species in the diagram would have on the food web. (4)

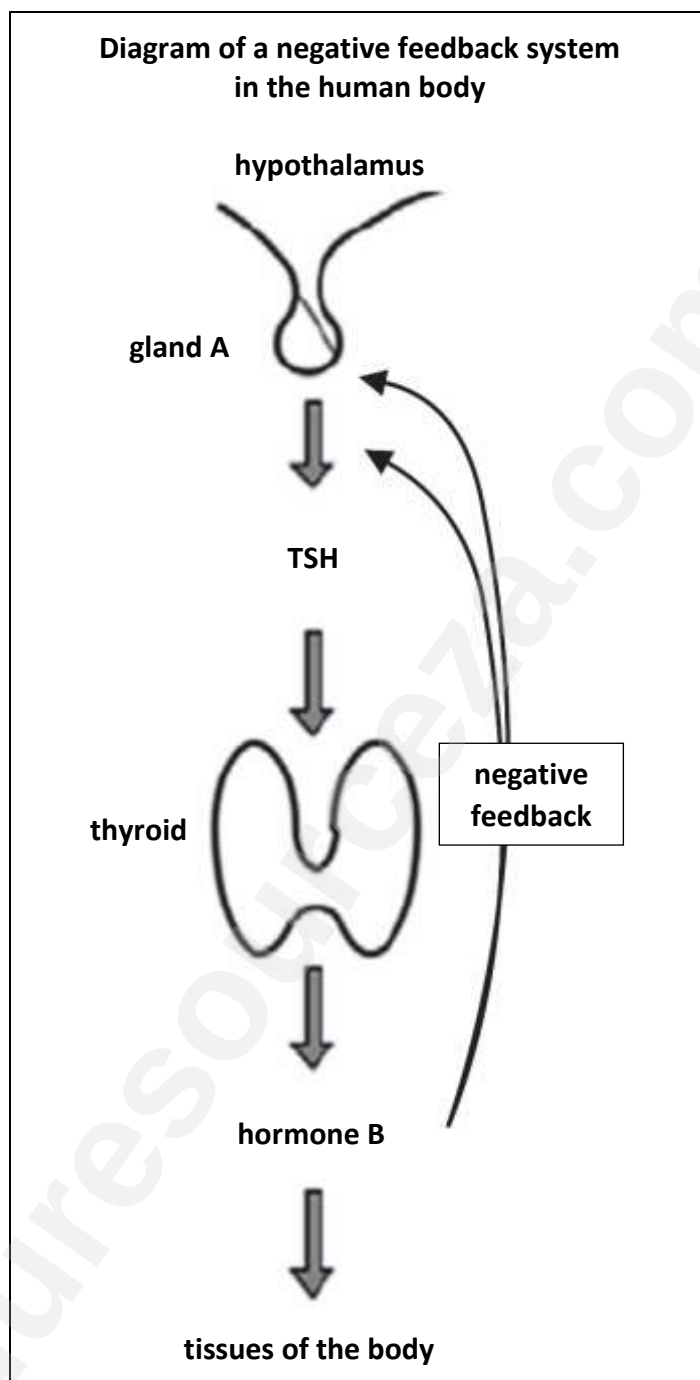
2.3 The image below depicts the fight or flight response.



[Source: < <https://medium.com>>]

- 2.3.1 Which hormone in humans would be released in this situation? (1)
- 2.3.2 Name the gland that secretes this hormone. (1)
- 2.3.3 State TWO effects this hormone would have on the body and explain why each effect would be beneficial for the fight or flight response. (4)

2.4 The diagram below shows a negative feedback system in the human body.



[Adapted: <<https://www.researchgate.net>>]

2.4.1 Identify gland A. (1)

2.4.2 Identify hormone B. (1)

2.4.3 State TWO functions of hormone B. (2)

2.4.4 A patient was diagnosed with a condition where the negative feedback system as seen in the diagram did not work. The patient had normal TSH levels but very high levels of hormone B. Explain clearly why hormone B levels were so high.

(3)
[40]

QUESTION 3

- 3.1 Read the article below and use this information and your own knowledge to answer the questions that follow.

Marfan syndrome

Marfan syndrome is a connective tissue disorder that can affect the heart, blood vessels, eyes and skeleton. People with Marfan syndrome are usually tall and thin with abnormally long arms, legs, fingers and toes. The damage caused by Marfan syndrome can be mild or severe. Some Marfan features – for example, enlargement of the aorta (expansion of the main blood vessel that carries blood away from the heart to the rest of the body) can be life-threatening. This condition is inherited in an autosomal dominant pattern.

The diagram illustrates a person with Marfan syndrome. Labels point to various features: 'eye problems' at the eyes, 'long arms, legs and fingers' on the limbs, 'shortened torso' on the upper body, 'heart problems', 'lung problems', and 'sunken chest' on the chest area. A 'tall, thin body frame' is indicated by a vertical line. An inset shows an 'enlarged blood vessel' (aorta) next to a heart diagram. A watermark 'eduresourceza.com' is visible across the diagram.

[Adapted: <<http://www.study.pk.com>>]

[Adapted: <<https://ghr.nlm.nih.gov> & <https://www.mayoclinic.org>>]

- 3.1.1 Explain your understanding of *autosomal dominant inheritance*. (2)
- 3.1.2 A man with Marfan syndrome, who is heterozygous for the condition, wishes to have children with a woman who does not have the disease. Use the key **R** for a gene coding for Marfan syndrome and **r** for a normal gene.
- (a) Provide the genotypes of both the man and woman using the key provided above. (2)
 - (b) Use a genetic cross/Punnett square to determine the ratio of the possible phenotypes of the offspring. (4)
 - (c) The couple are advised to go and see a genetic counsellor before having children. Suggest TWO reasons why this is a good idea. (2)
- 3.1.3 At least 25% of Marfan syndrome cases result from a spontaneous mutation that occurs in people with no history of the disorder in their family.
- (a) Provide a definition for the term *mutation*. (1)
 - (b) Explain why there might be cases of Marfan syndrome where there is no history of the disorder in the family. (2)

- 3.2 Read the text below and use this information and your own knowledge to answer the questions that follow.

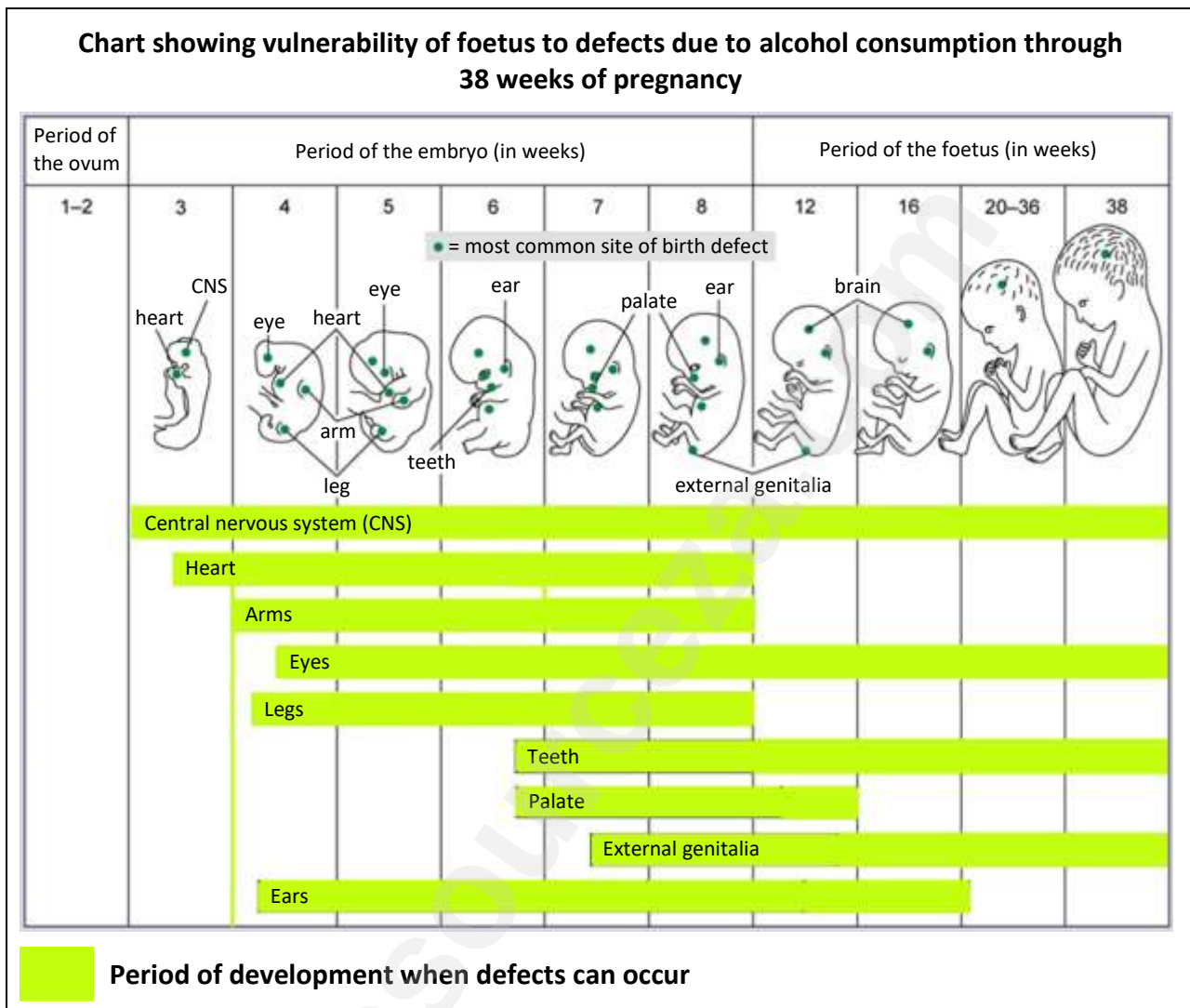
Using CRISPR to edit embryos carrying the gene for Marfan syndrome

For the first time, scientists used a CRISPR genome-editing technique to edit a disease mutation in viable human embryos. Researchers from China used a variation of CRISPR known as a base editor to correct a single amino acid that causes Marfan syndrome. The researchers describe their work as "proof of principle" (this indicates that it has practical potential). They did not detect any off-target effects of CRISPR or unwanted insertions or deletions in the genomes of the seven modified embryos. The embryos were not allowed to develop further.

[Adapted: <<http://www.sciencemag.org>>]

- 3.2.1 Explain what is meant by the following terms/phrases:
- (a) *genome* (2)
 - (b) *unwanted insertions or deletions* (2)
- 3.2.2 Do you think scientists should be allowed to use gene-editing tools such as CRISPR on human embryos? Explain TWO reasons in support of your answer. (4)

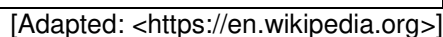
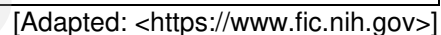
3.3 Answer the questions below using the following chart and your own knowledge.



[Adapted from: <<https://www.ontarioprenataleducation.ca>>]

- 3.3.1 Differentiate between an embryo and a foetus. (2)
- 3.3.2 Which part of the foetus is most vulnerable to defects due to alcohol consumption? (1)
- 3.3.3 During which period of time are the arms most likely to suffer from abnormalities due to the consumption of alcohol? (2)
- 3.3.4 Name the organ where alcohol can pass from the maternal bloodstream into the bloodstream of the baby. (1)
- 3.3.5 A woman can legally get an abortion in South Africa up to 20 weeks of her pregnancy. Use the information in the chart above to suggest why getting an abortion at 20 weeks may not be advisable. (2)

(3)



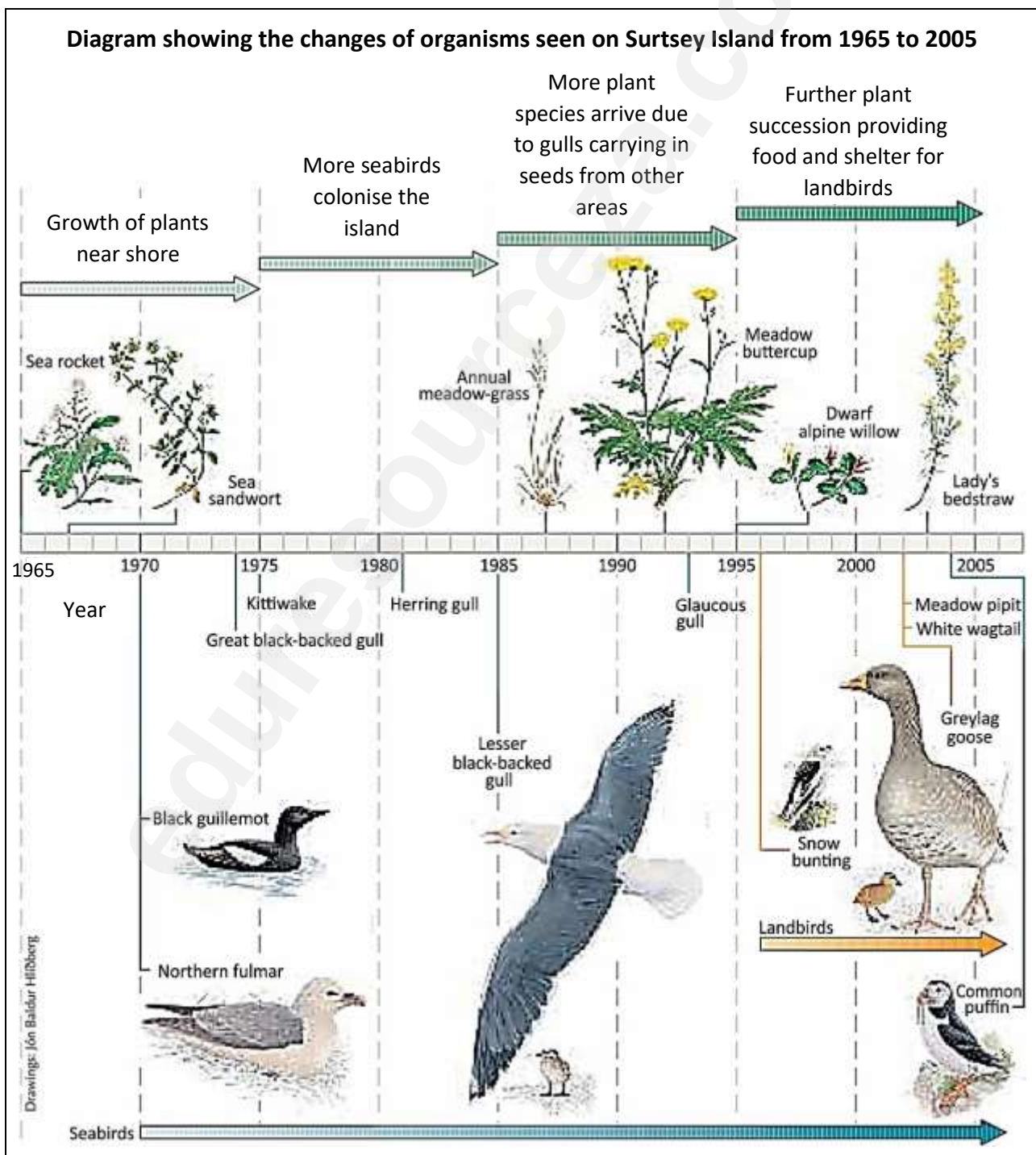
(6)

QUESTION 4

- 4.1 Surtsey Island, off the southern coast of Iceland, formed between 1963 and 1967 as a result of volcanic activity. In its earliest years, bacteria and fungi soon appeared on the island. Scientists have been studying the succession of plants and animals on the island. The diagram below shows the timeline of some of the organisms that were seen on the island from 1965 to 2005.

The first row in the diagram shows the changes in plant succession.

The second row shows the colonisation of the island by some seabirds and then the arrival of landbirds in 1996.



[Source: <<http://www.surtsey.is>>]

- 4.1.1 Explain why the changes seen on Surtsey Island are an example of primary succession and NOT an example of secondary succession. (2)
- 4.1.2 Suggest why there were mainly seabirds seen on the island rather than terrestrial (land) birds until 1995. (1)
- 4.1.3 Suggest a reason to explain why, after a dense seagull population began to form on Surtsey Island in 1986, numerous new plant species colonised the island. (2)
- 4.1.4 The number of breeding pairs of the lesser black-backed gull was recorded between 1970 and 2015. The data that was collected is shown in the table below.

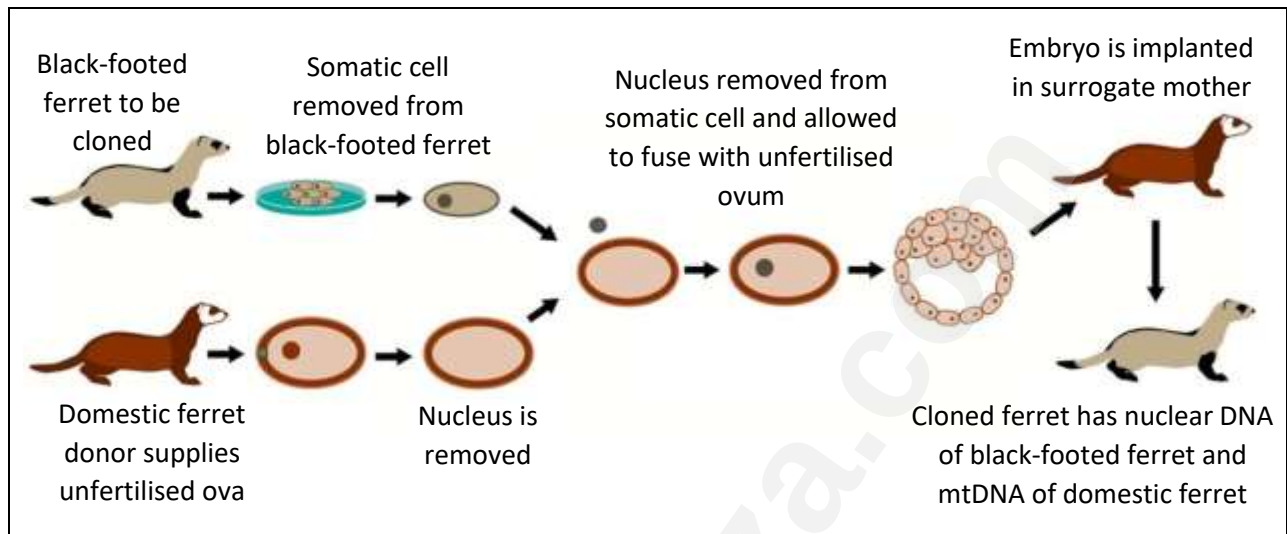
Table showing the breeding pairs of the lesser black-backed gull between 1970 and 2015

Year	Number of breeding pairs
1970	10
1980	40
1985	240
1990	280
2003	290
2011	280
2015	283

[Adapted: <<http://www.surtsey.is>>]

- (a) State four parameters that have an effect on the population size of the lesser black-backed gulls. (4)
- (b) According to the table, between which years did environmental resistance limit the population size of the lesser black-backed gulls. (2)
- (c) State THREE ways in which environmental resistance may limit population size. (3)
- 4.1.5 The island was declared a nature reserve in 1965 and access to the island by people is very restricted. Explain ONE benefit to the island of limiting the number of people who visit. (2)
- 4.1.6 Explain ONE reason why the quadrat method would not be suitable for calculating the population size of the common puffin. (2)

4.2 Scientists are investigating the possibility of cloning the critically endangered black-footed ferret (*Mustela nigripes*) using the process of interspecies somatic cell nuclear transfer (SCNT). The diagram below shows the process of SCNT.



[Adapted: <<https://academic.oup.com/>>]

4.2.1 Explain what is meant by the following terms:

- (a) somatic cell (1)
- (b) cloning (1)
- (c) surrogate (1)
- (d) interspecies (1)

4.2.2 Discuss ONE benefit of SCNT to the population of black-footed ferrets. (2)

4.2.3 Explain why the cloned ferret has the nuclear DNA of the black-footed ferret and the mitochondrial DNA of the domestic ferret. (3)

4.2.4 The table below shows examples of reproductive cloning using SCNT on endangered wildlife and the success rate of each.

Endangered species	Related species for donated ovum	Number of engineered embryos implanted	Number of initial pregnancies	Numbers of actual live births	Numbers that survived after birth
Coyote (wild dog found in North America) $2n = 78$	Domestic dog $2n = 78$	22	6	5	5
Grey wolf $2n = 78$	Domestic dog $2n = 78$	17	4	4	2
African wild cat $2n = 38$	Domestic cat $2n = 38$	25	20	17	2

- (a) What is the diploid chromosome number of the domestic dog? (1)
- (b) Calculate the percentage of implanted embryos of coyotes that resulted in live births. (3)
- (c) Use data from the table and/or your own knowledge to evaluate whether it would be worthwhile for scientists to invest time and money in cloning the black-footed ferrets. (3)

4.3 The Human Genome Project (HGP) was an international, collaborative research program.

4.3.1 What was the purpose of the HGP? (2)

4.3.2 The HGP has been viewed as an extremely important scientific collaboration due to its many positive benefits. Do you agree with this statement? Support your answer with TWO well explained reasons. (4)

[40]

Total: 200 marks