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ST BENEDICT'S COLLEGE

SUBJECT	LIFE SCIENCES PAPER 1	DATE	17 JULY 2024
GRADE	12	MARKS	200
EXAMINER	MRS S. STEGMANN MRS B. ZAJAC	MODERATOR	MRS S. STEGMANN MRS B. ZAJAC
NAME		DURATION	3 HOURS
CLASS			

INSTRUCTIONS:

1. This paper consists of 34 pages- 31 pages of questions and 3 pages of additional writing space. Please check that your question paper is complete.
2. Answer all questions on the question paper.
3. Write in blue or black pen only.
4. Read all questions carefully and answer in as much detail as possible.
5. All diagrams should have a clear heading.
6. Any calculations need to be rounded off to TWO decimal places unless stated otherwise.
7. It is in your own interest to write legibly and to present your work neatly.

QUESTION	POSSIBLE MARK	MARK ACHIEVED
1	80	
2	40	
3	40	
4	40	
TOTAL: 200		

Question 1:

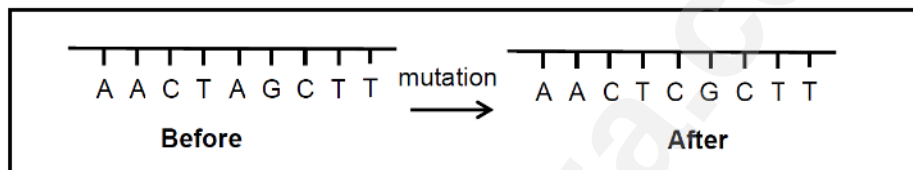
- 1.1. Select the name/ or term in Column II which best matches the description in Column I. Write the letter of the matching name/term in the appropriate space provided between the brackets. Each letter may only be used once. [10]

<u>Column I</u>	<u>Column II</u>
[] Imaginary line dividing the Malay archipelago into two different ecological regions.	A transitional fossils
[] Flightless birds found in South America	B vestigial organs
[] Study of the distribution of organisms in space and time.	C archipelago
[] Molecule that contains the genetic code.	D natural selection
[] A group or chain of islands.	E rheas
[] The use and disuse of body parts.	F Lamarck
[] The most easily believable historical evidence for evolution.	G biogeography
[] Mixture of traits.	H macroevolution
[] Mechanism of evolution.	I DNA
[] Evolution within a species.	J Wallace's line
	K Darwin
	L microevolution

- 1.2. Various possibilities are suggested as answers to the following questions. Indicate the correct answer by writing the correct letter from the corresponding question in the space provided in the table below: [10]

1.2.1.	1.2.2.	1.2.3.	1.2.4.	1.2.5.	1.2.6.

Question 1.2.1. and 1.2.2. refer to the diagram below showing a piece of DNA before and after a mutation.



1.2.1. The mutation...

- A. will result in an extra chromosome.
- B. will produce the same protein if a different amino acid is coded for.
- C. will produce a different protein if a different amino acid is coded for.
- D. is the result of an extra chromosome.

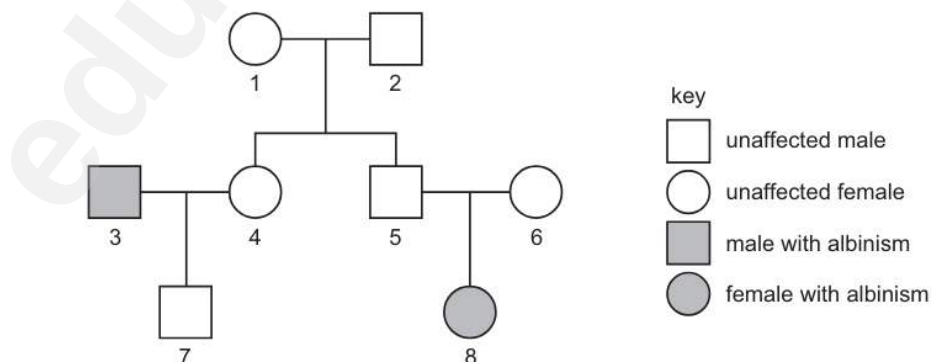
(1)

1.2.2. Which one of the following best describes the mutation?

- A. More than one nitrogenous base was changed.
- B. Adenine was changed to cytosine.
- C. Adenine was changed to thymine.
- D. Cytosine was changed to adenine.

(1)

1.2.3. The diagram below shows the inheritance of albinism in one family. Albinism is an inherited condition caused by a recessive allele.



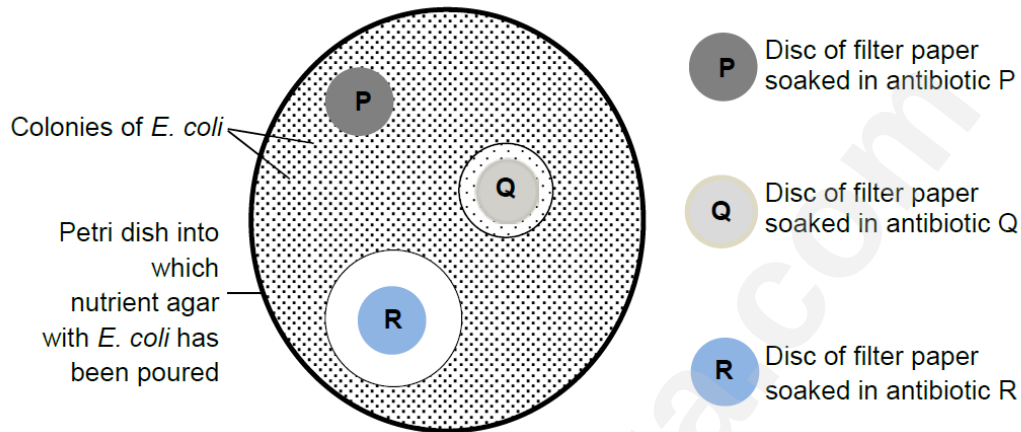
Which individuals must be heterozygous for this condition?

- A. 1 and 2
- B. 4 and 7
- C. 5, 6 and 7
- D. 5 and 6 only

(2)

Questions 1.2.4. and 1.2.5. refer to the diagram below.

1.2.4. The diagram below shows the effects of antibiotics P, Q and R on the bacterium *E. coli*.



What can you deduce about the response of *E. coli* to the effects of the antibiotics?

	Completely resistant	Not completely resistant	Not resistant
A	P	Q	R
B	Q	P	R
C	R	Q	P
D	P	R	Q

(2)

1.2.5. A suitable control in this experiment would be:

- A. Soak a disc of filter paper with a mixture of P, Q and R and place it on the same set of apparatus.
- B. Set up an identical petri dish and average the results
- C. Soak a disc of filter paper with distilled water and place it on the same set of apparatus.
- D. This experiment does not need a control.

(2)

1.2.6. The length of double-stranded DNA contains 90 nucleotides and codes for polypeptide X. What is the maximum length of polypeptide X?

- A. 20 amino acids
- B. 30 amino acids
- C. 90 amino acids
- D. 15 amino acids

(2)

- 1.3. Indicate whether each of the statements in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B**, or **NONE** of the items in COLUMN II. Write your answer in the answer column.

	COLUMN I	COLUMN II	ANSWER
1.3.1.	Has no effect on population size.	A: immigration B: emigration	
1.3.2.	A small portion of the population is counted and then used to work out the size of the whole population.	A: census B: simple sampling	
1.3.3.	Competition between cows and goats for grass.	A: intra-specific B: inter-specific	
1.3.4.	A change in the composition of species in a habitat that has never been inhabited by organisms before.	A: primary succession B: secondary succession	
1.3.5.	The mature community of plants that remains relatively stable with few, if any, changes over time.	A: pioneer B: climax	
1.3.6.	Density-dependent population parameter.	A: flood B: increase in temperature	

[6]

- 1.4. A researcher observed a few different species of organisms in an area of 100m². His results are below.

	Quadrat 1 (2m ²)	Quadrat 2 (2m ²)	Quadrat 3 (2m ²)	Average
Lichens	15	6	20	
Mosses	5	5	4	
Dandelions	3	6	8	

- 1.4.1. Name the method used above and state whether it is a direct or indirect method of counting the fish population. (2)

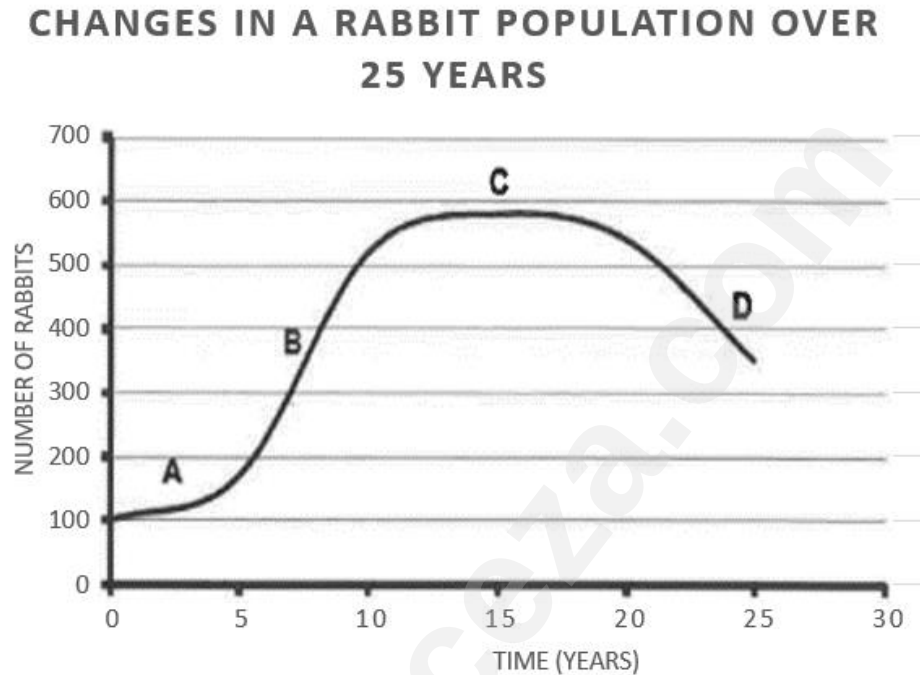
- 1.4.2. Complete the last column **in the table**. (3)

- 1.4.3. Estimate the total number of lichens found in the area. Show all working below. (3)

[8]

1.5. Rabbits are herbivores that are found in many habitats.

The graph below shows the changes in a rabbit population over 25 years.



1.5.1. Which part of the curve (**A**, **B**, **C** or **D**) show the following the best:

(i) The years in which the death rate was equal to the birth rate.

(ii) The years in which the birth rate was slightly higher than the death rate.

(iii) The years in which the birth rate was much higher than the death rate.

(3)

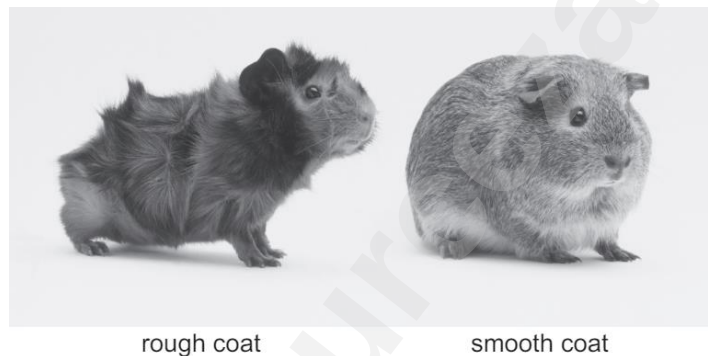
1.5.2. Provide a reason for your answer to 1.5.1. (i).

(2)

1.5.3. How would the trend in the graph change if a population of sheep was introduced into the area during the 10th year. (3)

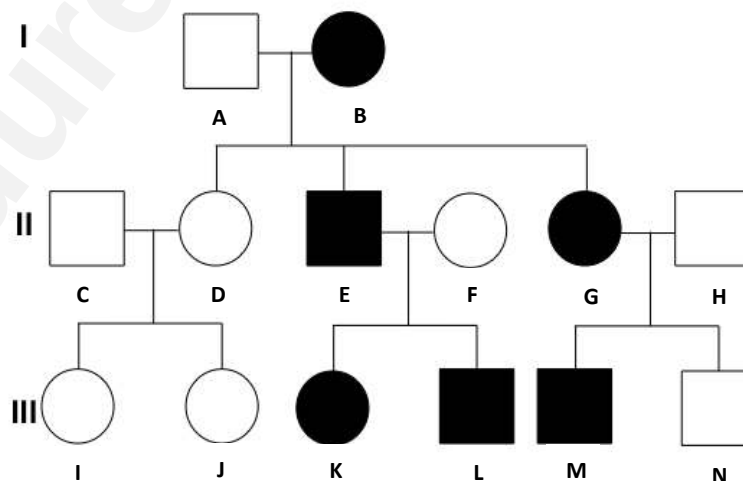
1.5.4. On the graph on the previous page draw in the line that represents any predator of the rabbit. (2)
[10]

1.6. Below is picture of a guinea pig with a rough coat and a guinea pig with a smooth coat.



The allele for rough coat is dominant and is represented by the letter **R**
The allele for smooth coat is recessive and is represented by the letter **r**.

The diagram below shows the inheritance of coat texture in some guinea pigs.



Shaded individuals have a smooth coat.

○ Female □ Male

1.6.1. What type of diagram is shown above? (1)

1.6.2. How many guinea pig have smooth coats? (1)

1.6.3. State the letter of a guinea pig that has a homozygous dominant genotype. (1)

1.6.4. Give the genotype of guinea pig F. (1)

1.6.5. Give the phenotype of guinea pig M. (2)

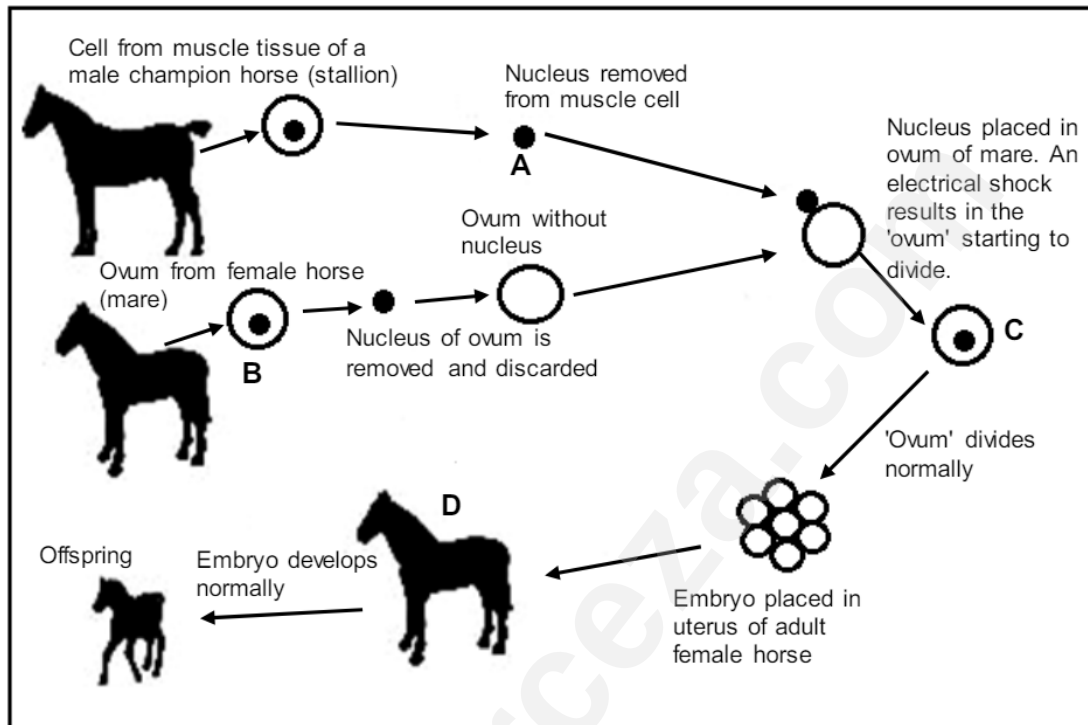
1.6.6. Complete the Punnett square below for guinea pigs E and F.
Give the ratio of the F1 genotypes and phenotypes. (5)

F1 genotype: _____

F1 phenotype: _____

[11]

1.7. The diagram below shows a genetic engineering process. A donor cell was taken from the muscle cell of a male champion horse (stallion) to create a new offspring.



[Adapted from www.biologyreference.com]

1.7.1. Name the:

(i) Genetic engineering process shown in the diagram above. (1)

(ii) Process that produced ovum B. (1)

1.7.2. Why is the donor cell extracted from a champion horse? (2)

1.7.3. A somatic cell in a horse contains 64 chromosomes.

How many chromosomes would there be in:

(i) Structure A

(ii) Ovum B

(iii) A muscle cell in organism D

(3)

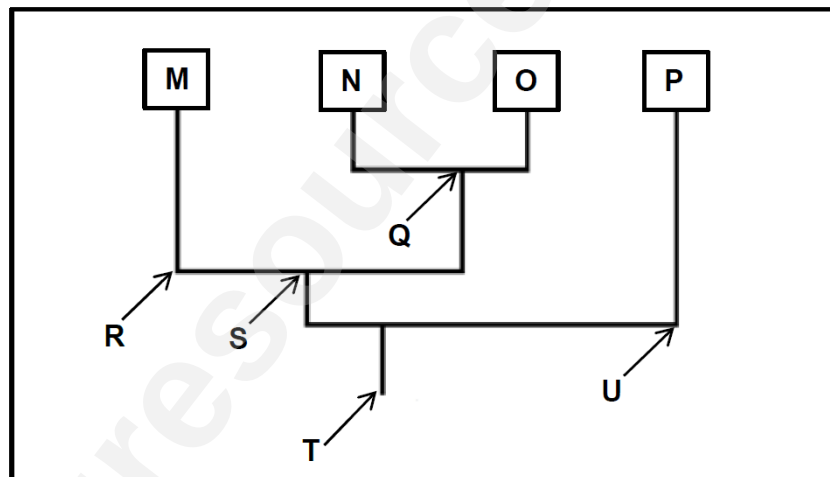
1.7.4. Why can 'ovum' C not be considered a gamete?

(2)

[9]

- 1.8. Trilobites are an extinct group of marine arthropods. Many of their fossils have been discovered. They had a tough exoskeleton and they are thought to be closely related to three other phyla of extinct arthropods, namely helmetids, tegopeltids and naraoids. The tegopeltids and helmetids are the two most closely related phyla and are more closely related to trilobites than to naraoids.

Study the diagram below, which illustrates the possible evolutionary relationships among the four phyla, represented by the letters M, N, O and P.



1.8.1. What type of diagram is displayed above?

(1)

1.8.2. What structural feature of trilobites improved the chances of fossilisation?

(1)

1.8.3. Give only the LETTER of the most recent common ancestor for phyla:

(i) M and O: _____

(ii) M, N, O and P: _____

(2)

1.8.4. Which of the extinct arthropods are represented by phylum:

(i) M: _____

(ii) N: _____

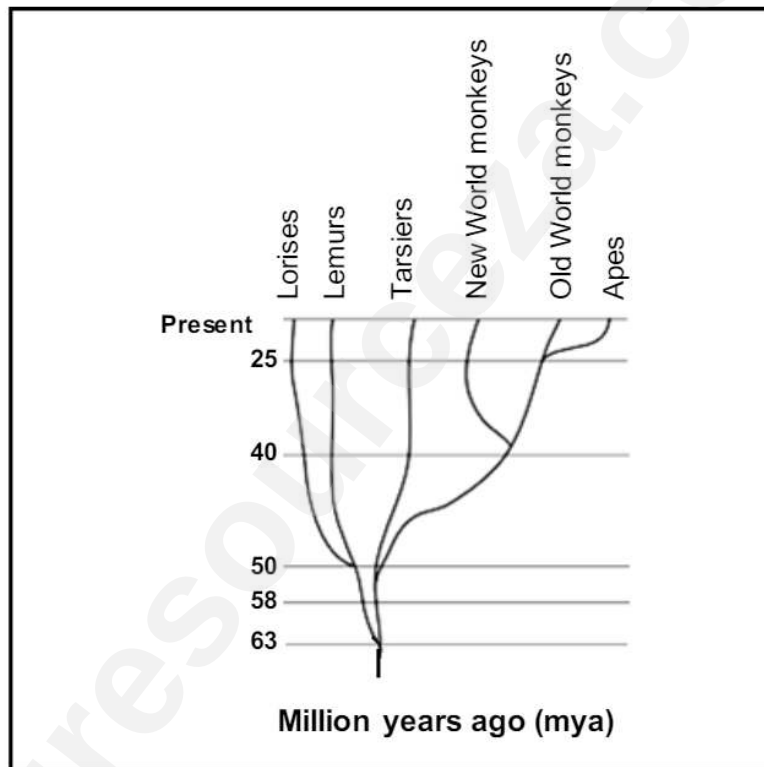
(iii) O: _____

(iv) P: _____

(4)

[8]

1.9. The diagram below shows possible evolutionary relationships among primates.



[Source: <http://dl0.creation.com/articles>]

1.9.1. How many million years ago did the:

(i) Apes appear on Earth?

(ii) Common ancestor evolve to form the Tarsiers and Lemurs?

(iii) The first speciation event occur?

(3)

1.9.2. Which TWO species share the most recent common ancestor? (2)

1.9.3. Which species is most closely related to the Lemur? (1)

1.9.4. Which TWO species share the most distant common ancestor? (2)

[8]

Total Question 1: 80 marks

Question 2

2.1. Read the information below and then answer the questions that follow.

Neltumius arizonensis is a weevil that lives in seeds such as beans or peas.



Female weevils carefully cement each egg to the outside of a seed. The eggs hatch and the larvae burrow down into the seed where they feed on the seed contents.



The larvae mature after a few weeks. Jack conducted an investigation into population growth of this weevil species. He put 10g of bean seeds into a closed container with five male weevils and five female weevils. He counted the adult weevils every 20 days for a period of 200 days and recorded his results in a table.

Time in days	0	20	40	60	80	100	120	140	160	180	200
Number of weevils	10	16	80	125	120	115	125	140	145	100	90

2.1.1. Identify between which two consecutive counts the greatest increase in the population occurred.

(2)

2.1.2. Calculate the rate of increase per day over the period mentioned in 2.1.1. Show all working out. (3)

2.1.3. Suggest THREE reasons why the population did not continue to increase. (3)

2.1.4. Suggest what would eventually happen to this population. (1)

2.1.5. The weevils were kept in a closed container. The weevils can be described as part of a closed population.
Explain what this means and how it would affect the population. (2)

2.1.6. Predict how the population growth of the weevils could have been different if 120g of seeds had been used. (3)

2.1.7. Weevils cause great damage to the seed and grain industries.
Explain the consequences of a weevil infestation to farmers. (2)

2.2. A biologist wanted to study the abundance of fish in a seagrass bed and the adjacent sand flatbed in Shark Bay in Western Australia. The biologist used the mark-recapture method to estimate the number of fish that were found during the day and night in the seagrass and the sand flatbed.

2.2.1. List TWO precautions with regards to the actual capturing and marking of the fish that need to be taken into consideration when performing this technique and explain why each precaution is taken. (4)

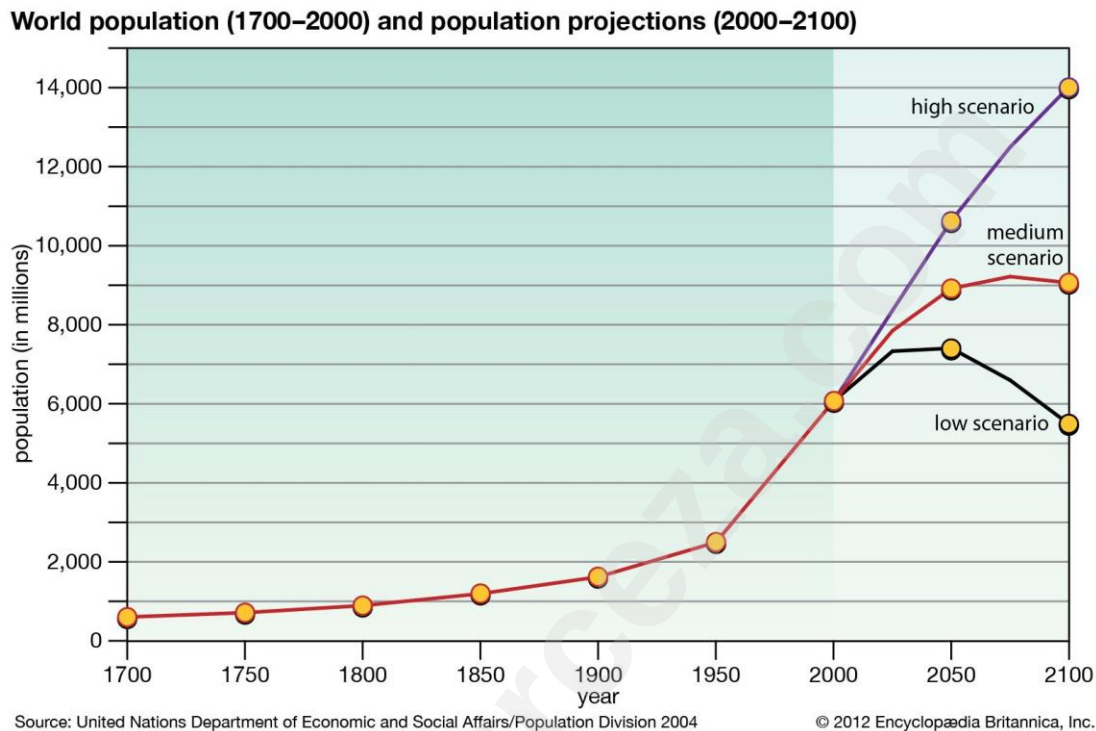
2.2.2. The biologist caught 66 fish which he marked. In the second catch he caught 75 fish and of those he saw that 18 were marked.

(i) Calculate the estimated number of fish. Show all working out. (3)

(ii) In this study the biologist used the same sampling methods each time.
Explain why this is important. (2)

[9]

2.3. The graph below shows Human population growth according to the United Nations under three different birth rate scenarios from 1700 to 2100.



2.3.1. Define the following terms:

(i) Carrying capacity: (2)

(ii) Population: (2)

2.3.2. The human population has already exceeded the carrying capacity of the earth, yet humans have been able to artificially elevate the carrying capacity of earth to ensure their high population growth rate. However, this has had detrimental impacts on the natural environment which is causing a lowering of the earth's carrying capacity for all species.

(i) In what year will the human population in the medium birth rate scenario reach the carrying capacity? (1)

- (ii) List TWO human activities between 1900 and 2018 that has enabled our species to increase the carrying capacity of the earth. (2)

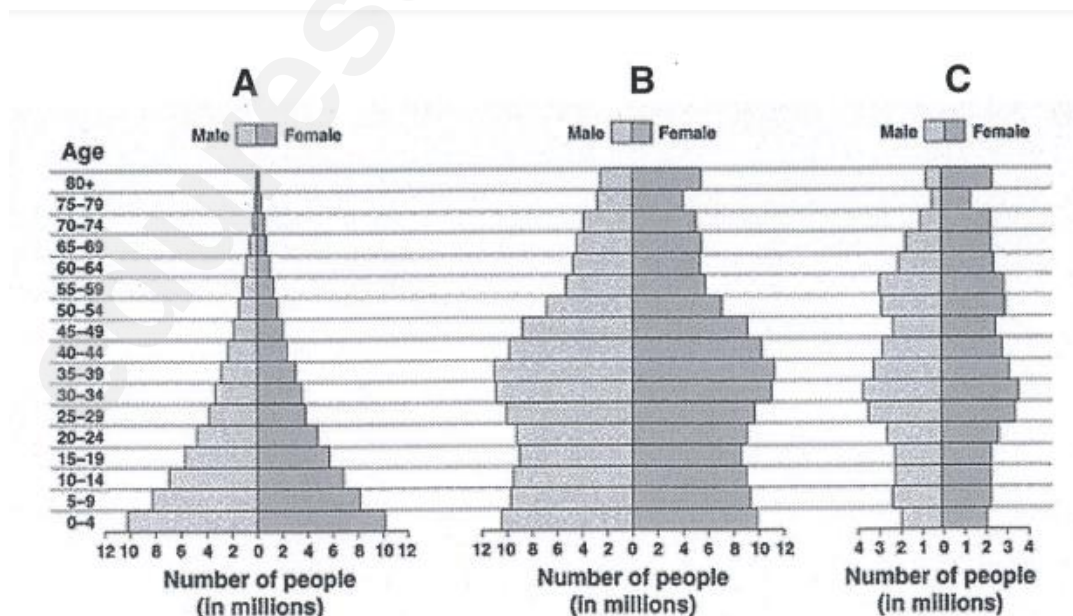
- (iii) Describe ONE human activity and its impact on the natural environment. (2)

2.3.3. Give the correct term for the following statement:

- "The sum of all the environmental factors that inhibit further increase in a population" (1)

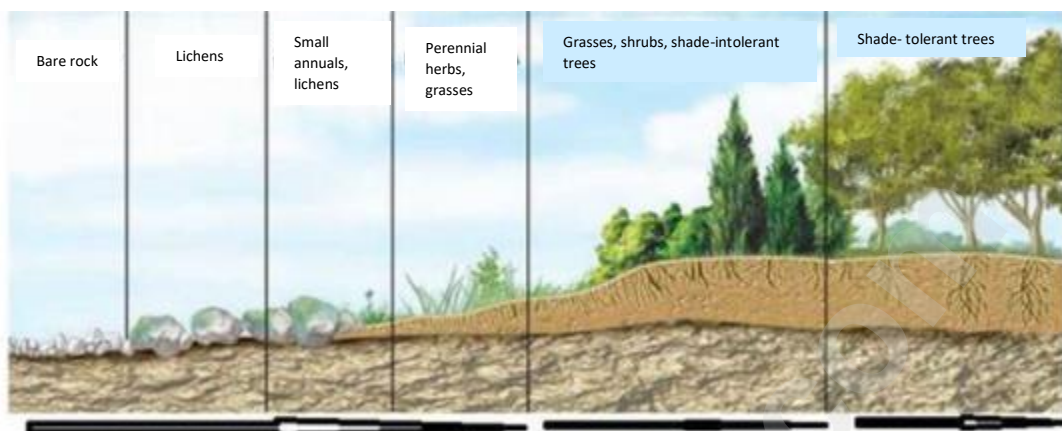
2.3.4. Which of the human population pyramids below (A, B or C) will apply to the low birth rate scenario?

- Give a reason for your answer. (2)



[12]

2.4. Study the diagram below and answer the questions that follow.



2.4.1. Name the **precise** process taking place.

(1)

2.4.2. Explain your answer in 2.4.1.

(2)

[3]

Total Question 2: 40 marks

Question 3

3.1. Read the following description of Y- linked alleles.

Rarely, sex-linked genes may be found on the Y chromosome so only males are affected, although there are no absolute examples of Y-linked inheritance. Hairy ears are thought to be determined by a sex-linked allele found on the Y chromosome but this has not been confirmed. This trait is common in certain populations, such as in India, Pakistan and Israel. If the gene is found only on the Y chromosome, then it should only be found in men and must be inherited by all their sons, who inherit the Y chromosome from their father and the X chromosome from their mothers. A study of hairy ears in Israel showed that 76% of sons inherited the trait from their fathers and none of the daughters. This does seem to confirm that this is a Y- linked gene, but not all the sons inherited the hairy ears.
It is possible that this is where one gene is inhibited or suppressed by another.

3.1.1. What is an allele? (1)

3.1.2. Give an example of an X-linked disease passed on from mothers to their sons. (1)

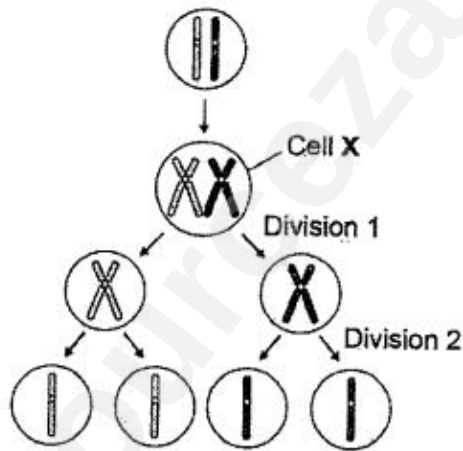
3.1.3. Using your example from question 3.1.2. show, by means of a genetic cross, what would happen if a carrier woman married a normal man and produced offspring. (5)

3.1.4. Explain why sons will always inherit the hairy allele from their father. (2)

3.1.5. Suggest why females would be unaffected by sex-linked genes found on the Y chromosome. (1)

[10]

3.2. The diagram below shows the process of meiosis. The circles represent cells and the structures within each cell represent chromosomes



3.2.1. Describe and explain the appearance of **one** of the chromosomes in cell X. (2)

3.2.2. Describe what has taken place during division 1 in the diagram. (2)

3.2.3. Identify one event that has occurred during division 2 but not during division 1. (1)

3.2.4. Name TWO ways in which meiosis produces genetic variation in offspring.

(2)

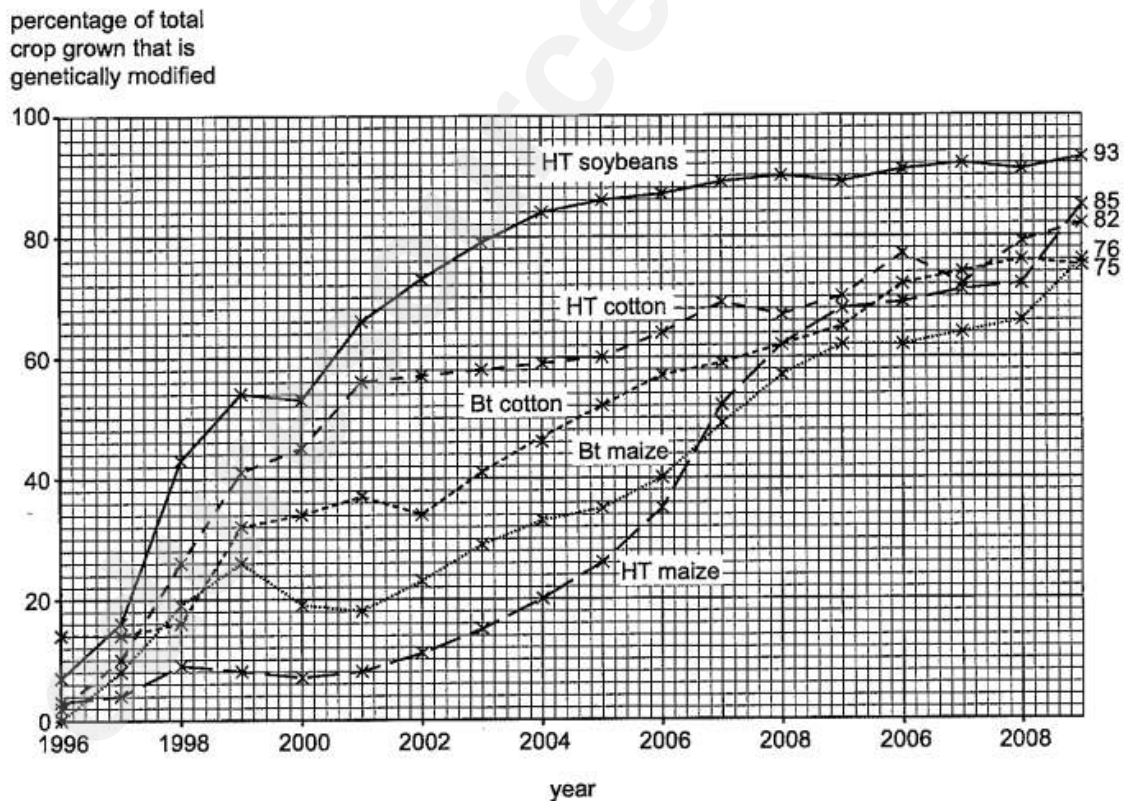
3.2.5. What is the importance of genetic variation in organisms?

(2)

[9]

3.3. The graph below shows the proportion of cotton, maize and soybeans grown in the USA that are genetically modified in two different ways.

- HT crops are modified to be resistant to the herbicide glyphosate
- Bt crops are modified to express the Bt toxin which kills insect pests.



3.3.1. Provide an aim for this study.

(2)

3.3.2. Name the independent variable in this investigation. (1)

3.3.3. Give a suitable heading for the graph. (2)

3.3.4. With reference to the graph, describe the change in the percentage of genetically modified cotton grown in the USA since 1996. Use data from the graph in your answer. (2)

3.3.5. Crops such as maize and cotton are genetically modified to produce Bt toxins to protect them insect pests. When these GM crops first became available it was predicted that insect pests would develop resistance to these toxins.

A survey was conducted in 2005 and 2011 to determine the extent of Bt resistance in insect pest species.

The level of resistance in each species was classified according to the highest percentage of resistant individuals recorded in any population anywhere in the world. Three levels of resistance were used:

- <1%
- 1-6%
- >50%

There were no reports of populations of insect pests having between 6% and 50% of resistant individuals.

The results of the survey are shown in the table below:

Year	Total number of insect pest species surveyed	Number of insect pest species susceptible to Bt toxins	Number of insect pest species with reported levels of resistance		
			<1%	1-6%	>50%
2005	9	8	0	0	1
2011	13	4	3	1	5

(i) What do the results show in the survey? (2)

- (ii) Suggest one other piece of information that is needed to assess the significance of the results of the survey. (1)

[10]

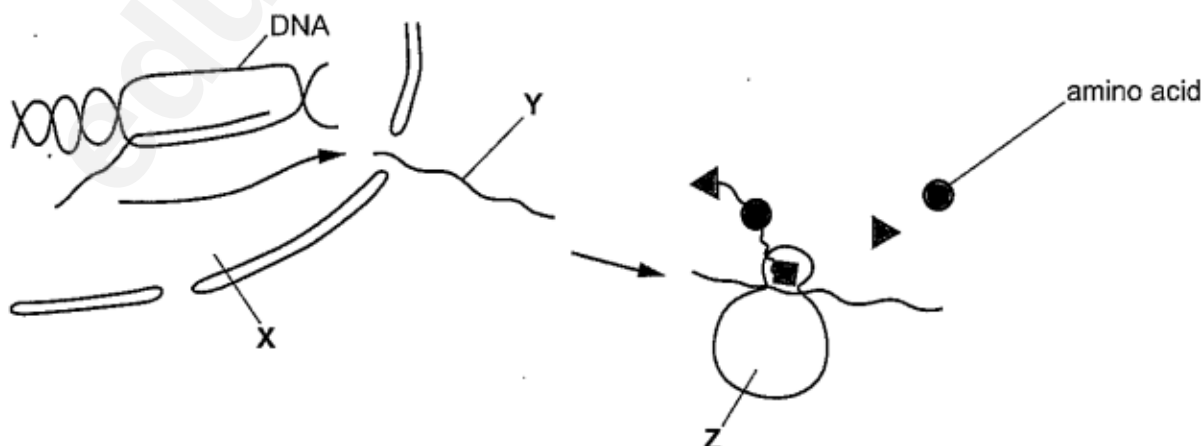
3.4. The names of bases present in RNA and DNA nucleotides can be abbreviated using a single letter. These are shown in the table below.

3.4.1. Complete the table:

Base	Name of base	Purine or pyrimidine	Present in RNA, DNA or both
A			
C			
G			
T			
U			

(5)

3.4.2. The following diagram shows the stages involved in protein synthesis.



- (i) State the names of the parts labeled X, Y and Z.

X- _____

Y- _____

Z- _____

(3)

- (ii) By what process is structure Y formed?

(1)

- (iii) Which enzyme catalyzes the process mentioned in (ii)?

(1)

- (iv) What determines the sequence of the amino acids in the protein that is produced?

(1)

[11]

Total Question 3: 40 Marks

Question 4

4.1. On his voyage on the HMS Beagle, Darwin collected many fossil specimens such as those of the extinct vertebrates known as glyptodonts. He noted that they had many traits in common with modern living armadillos. For example:

- Armadillos are now found only in places where glyptodonts once lived
- Both have bony helmets and shells made of bony scales
- Both were/are herbivores

The extinct glyptodonts had a mass of 2 000 kilograms (about the size of a small car), and were much larger than living armadillos, which are cat-sized.

Figure 1

Biological illustrations of an armadillo and a glyptodont drawn to scale

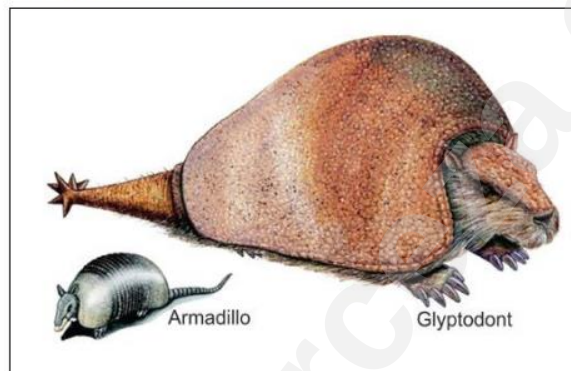
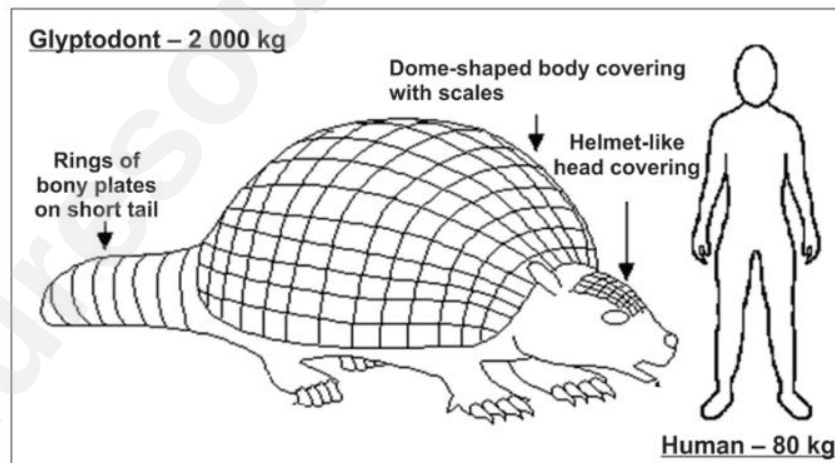


Figure 2

A glyptodont and a human drawn to scale



[Adapted from: <www.Zoomschool.com>]

4.1.1. What could the function of the bony shells of the large glyptodonts have been? (1)

4.1.2. Use the information in Figure 2 above to calculate how much greater the glyptodont was in mass than the average human. Show your working. (2)

4.1.3. Darwin used similarities between living and extinct organisms to formulate his theory of 'modification by descent'.

What is the scientific term for 'modification by descent'? (1)

4.1.4. Many people do not accept Darwin's theories. They may point out the fact that there is no direct visible evidence linking living armadillos and extinct glyptodonts, making it unlikely that an earlier species can give rise to modern species.

Use the information provided to give TWO well explained scientific reasons why scientists believe that glyptodonts are the ancestors of modern armadillos. (4)

4.1.5. Suggest and explain a possible reason for the glyptodonts becoming extinct. (2)

[10]

4.2. The survival of organisms in an ever changing environment is dependent on a high degree of variation among the individuals of a species.

Choose ONE of the following and explain how it is responsible for variation within a species.

1. Random assortment
2. Crossing over
3. Gene mutations

[3]

- 4.3. A group of university students planned to research the evolutionary effects of noise pollution on frogs. They had read about a study done on the Galapagos finches which showed that evolution can occur far more quickly than originally believed- within only 10 to 20 years, rather than hundreds to thousands of years.

Frogs are particularly vulnerable to environmental changes. A local newspaper reported that the mating calls of a species of frog had recently become much louder. Residents in the area claimed that since a major highway had been built near their local dam in 2000, the frogs' mating calls at night were much louder and the frogs were much larger than before. The students determined that the average level of peak time traffic noise before the highway was built was 56 decibels.

They worked on the following hypothesis:

Environmental conditions such as noise pollution can cause frogs to grow bigger so that they can call more loudly to attract mates.

Method:

- The loudness of the mating calls at night was recorded
- The recorded frogs were caught and weighed
- Occasionally they were unable to catch the frogs in the dark and estimated their masses

The following results were presented to their supervisor after only 6 years of investigation:

Years	2006	2007	2008	2009	2010	2011
Average level of peak time traffic noise in decibels (dB)	60,1	62,4	62,8	64,2	64,4	64,9
Average loudness of mating calls in decibels (dB)	63,8	64,5	65,2	66,1	65,8	66,4
Average mass in grams (g)	122	125	130	128	129	132

- 4.3.1. The learners' hypothesis is incorrect. Rewrite it in the correct scientific format. (2)

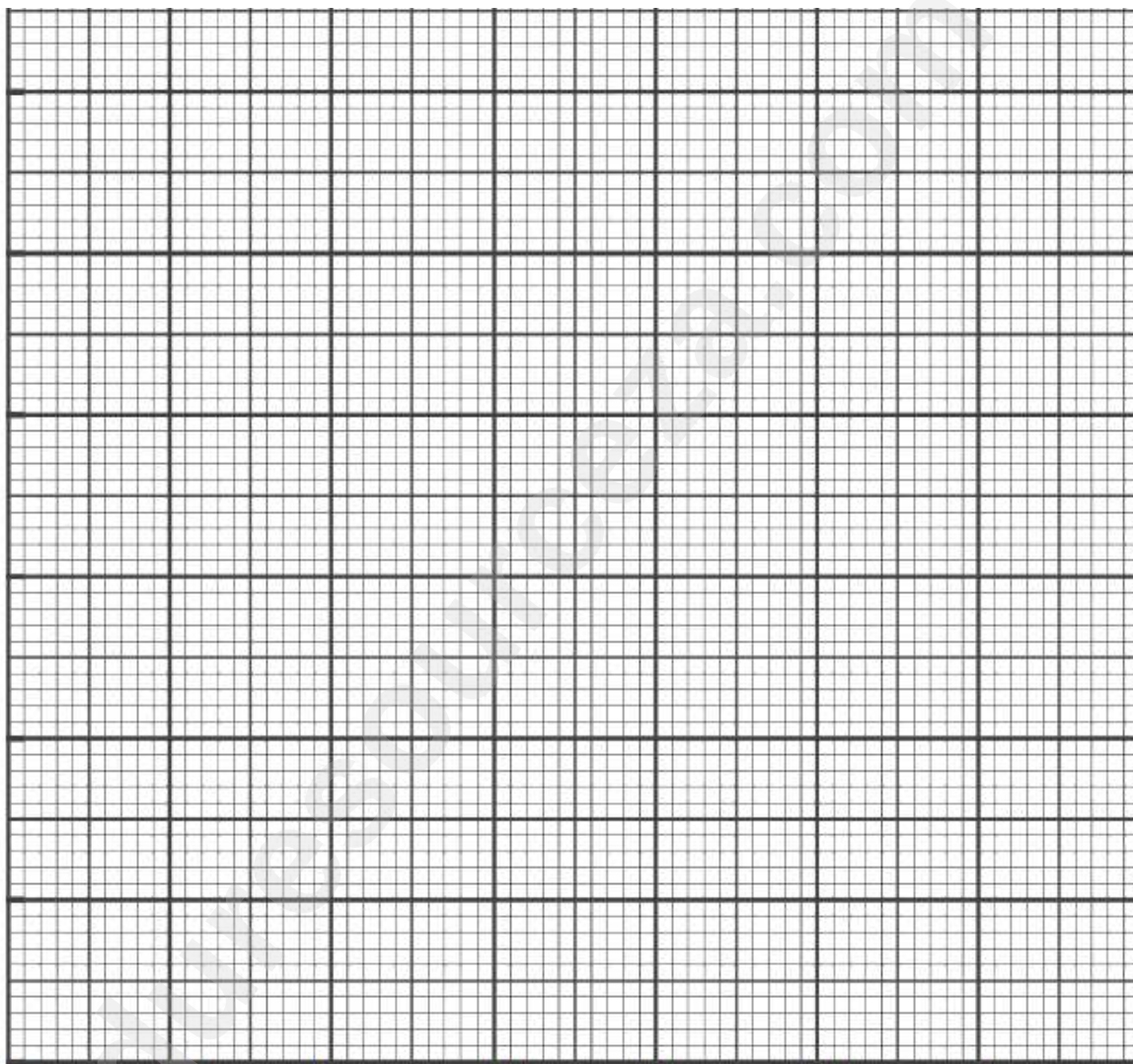
4.3.2. Explain TWO ways in which the learners did not conduct their research well and suggest a way that they could correct each. (4)

4.3.3. What was the selection pressure on the frogs that the students were investigating? (1)

4.3.4. Why were the students concerned about the frogs' mating calls not being loud enough? (3)

4.3.5. Do you think the learners should continue with this investigation? Give a reason for your answer. (2)

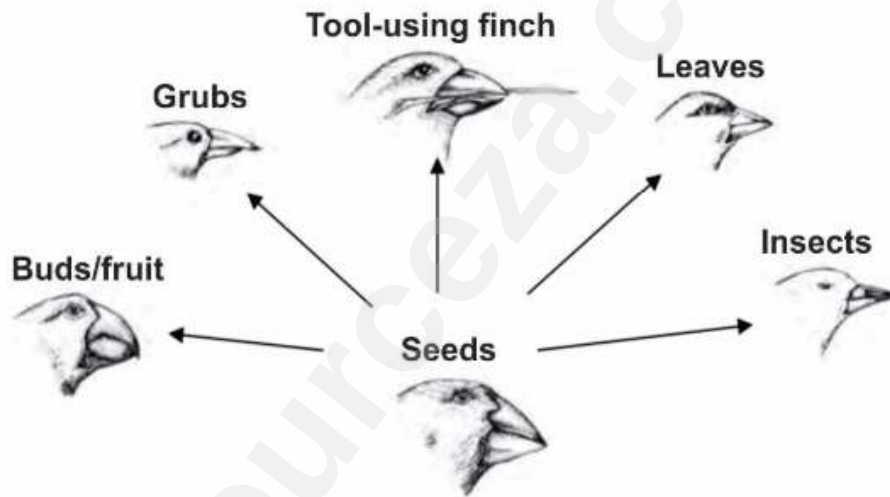
4.3.6. Plot the average mass of the frogs over the investigation on the grid **on the next page**. (6)



- 4.4. Read the following source and use the information and your own knowledge to answer the questions that follow.

The Galapagos finches are all dark coloured with similar body proportions. The various species differ from one another by body size, beak size and beak shape. Each species lives in a specific niche. All species of Galapagos finches have evolved and diversified from one ancestral species that colonized the Galapagos Islands. Each species of finch occupies a specific niche in the Galapagos Islands, which reduces competition amongst them.

Some of these different finches and their food sources



- 4.4.1. Define 'speciation'. (1)

- 4.4.2. How would a biologist determine if two finch birds belonged to the same species? (2)

- 4.4.3. Are the finches on the islands an example of convergent or divergent evolution?
Give a reason for your answer. (2)

4.4.4. Why are islands like the Galapagos Islands suitable places for speciation to occur? (2)

4.4.5. The evidence above is a form of Biogeographical evidence.
Name TWO other lines of evidence for the theory of evolution. (2)

[9]

Total Question 4: 40 marks

TOTAL: 200 MARKS

