Fig. 1.1 is a flow diagram showing the main stages involved in making cheese. The starting material is milk, which contains the protein, casein.

(a) (i) Explain why making cheese can be described as a biotechnological process.
(ii) Suggest two benefits of the pasteurisation stage.

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(b) (i) Rennin is a protein that can be obtained from the stomach lining of calves. It is used in the cheese-making process in the ratio one part rennin to 10 000 parts milk.

Suggest what type of protein rennin is and explain how a very small quantity of rennin is able to convert a large quantity of milk.

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(ii) Rennin could, in theory, be immobilised for use in cheese-making.

List two potential advantages of this.

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________________________________________________________________________________________________________________________________________
________________________________________________________________________________________________________________________________________
________________________________________________________________________________________________________________________________________
(c) Rennin can now be made by genetically modified microorganisms.

Outline the process by which bacteria can be genetically modified to produce rennin.

In your answer, you should make clear how the steps in the process are sequenced.
(a) The fruit fly, *Drosophila melanogaster*, the zebra fish, *Danio rerio*, and the mouse, *Mus musculus*, have all been used by scientists to find out more about how genes control development in all animals, including humans. They are described as 'model organisms'.

(i) Suggest why information gained from studying such model organisms can be applied to humans.
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(ii) Suggest two characteristics that researchers should look for when choosing an organism for research into how genes control development.
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(b) Fig. 3.1 and Fig. 3.2, on the insert, show the heads of two *Drosophila* fruit flies.

Fig. 3.1 shows a normal wild type fly.

Fig. 3.2 shows a mutant fly.

(i) Name the type of microscope used to take the two pictures.
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
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[2]
(ii) State one significant difference between the two heads.

_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________

[1]

(iii) Name the type of gene which, if mutated, gives rise to dramatic changes in body plan.

_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________

[1]

(c) Describe how the information coded on genes is used to synthesise polypeptides and how these polypeptides control the physical development of an organism.

In your answer, you should consider both the synthesis of polypeptides and their roles.

_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________

[8]

[Total: 16]
Fig. 4.1 shows a junction between two neurones where the neurotransmitter is dopamine.

Fig. 4.2 shows a neuromuscular junction.

(a) Complete Table 4.1 below to compare the structure and function of the dopamine synapse and the neuromuscular junction.

<table>
<thead>
<tr>
<th></th>
<th>similarity</th>
<th>difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>structure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>function</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(b) The sequence of events at a dopamine synapse is given below:
• dopamine molecules bind to the protein receptors on the postsynaptic membrane and trigger a response
• dopamine leaves the receptors and moves back into the presynaptic neurone
• some dopamine is repackaged into vesicles
• some dopamine is broken down by the enzyme monoamine oxidase (MAO).

Table 4.2 summarises the action of some drugs that affect dopamine synapses.

<table>
<thead>
<tr>
<th>drug</th>
<th>action at synapse</th>
</tr>
</thead>
<tbody>
<tr>
<td>phenothiazine</td>
<td>binds to and blocks dopamine receptors</td>
</tr>
<tr>
<td>phentolzine</td>
<td>acts as an inhibitor of MAO</td>
</tr>
<tr>
<td>amphetamine</td>
<td>binds to and activates the dopamine receptor and</td>
</tr>
<tr>
<td></td>
<td>causes release of stored dopamine from vesicles</td>
</tr>
</tbody>
</table>

(i) Use the information in Table 4.2 to suggest which drug molecule could have a shape that differs from that of the dopamine molecule. Give a reason for your answer.

(ii) Schizophrenia is a condition in which there is a higher than usual level of dopamine in certain areas of the brain.
Suggest why phenothiazine is used to treat schizophrenia.

(c) DRD4 is a dopamine receptor in humans. The DRD4 receptor gene has a large number of alleles, of which a single individual can only have two.

(i) Explain why one individual can only have two of the different alleles of the DRD4 gene.
(ii) Name a technique that would reveal differences in the lengths of the different forms of the DRD4 receptor gene.

(d) Three alleles of DRD4 have the following alterations:

• a single base-pair substitution
• a 21 base-pair deletion
• a 13 base-pair deletion.

Suggest which of the three mutations will have the most serious consequences for the structure of the protein receptor. Give a reason for your choice.

(e) One allele of DRD4 has been found more frequently amongst individuals whose personality is described as "novelty-seeking" and whose behaviour tends to be exploratory and impulsive.

Suggest how this particular allele of the DRD4 receptor could have become common in the human population.

[Total: 18]
(a) Plant responses to environmental changes are co-ordinated by plant growth substances (plant hormones).

Explain why plants need to be able to respond to their environment.
The following investigation was carried out into the effects of plant growth substances on germination:

- a large number of lettuce seeds was divided into eight equal batches
- each batch of seeds was placed on moist filter paper in a Petri dish and given a different treatment.

The different treatments are shown in Table 6.1. Each tick represents one of the eight batches of seeds.

<table>
<thead>
<tr>
<th>treatment</th>
<th>concentration of gibberellin (mol dm⁻³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>A water</td>
<td>✓</td>
</tr>
<tr>
<td>B abscisic acid</td>
<td>✓</td>
</tr>
</tbody>
</table>

The batches of seeds were left to germinate at 25°C in identical conditions and the percentage germination was calculated.

Fig. 6.1 shows the results of this investigation.

(i) Describe, with reference to Fig. 6.1, the effects of the plant growth substances on the germination of lettuce seeds.

(ii) Explain why all the lettuce seeds were kept at 25°C.
(iii) State three variables, other than temperature, that needed to be controlled in the investigation.

(c) State two commercial uses of plant growth substances.
Knowledge of the nitrogen cycle can be used to make decisions about management of farmland.

A farmer uses her grass meadow to raise sheep. In a separate field she grows cabbages.

(a) Fig. 1.1 shows part of the nitrogen cycle. The four boxes on the bottom line of the diagram refer to substances in the soil.

(i) Briefly describe the steps that must occur for plant protein to be converted to animal protein in the farmer’s sheep, as shown by arrow A on Fig. 1.1.

(ii) List the processes which contribute to B in the meadow where sheep are raised.
(iii) Name the bacteria that carry out processes C and D, and explain the significance of these bacteria for the growth of plants.

(iv) Use the letters on Fig. 1.1 to explain why the soil nitrate concentration will decrease in the cabbage field if it is used to grow repeated crops of cabbages year after year.

(v) The farmer does not wish to use inorganic fertiliser to replace the nitrate in the soil of the cabbage field. She wishes to make use of process F.

Suggest a crop she could plant that would allow process F to occur and explain how this would add nitrate to the soil.
(b) The sheep on this farm belong to a rare breed called Greyface Dartmoor. The Rare Breeds Survival Trust (RBST) gives advice on looking after these sheep and keep records to monitor the breeding of these sheep, in order to maintain a healthy population.

Why is the continued existence of rare breeds of farm animals desirable?
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(c) North Ronaldsay sheep are listed as ‘endangered’ by the Rare Breeds Survival Trust. These sheep were raised on a small Scottish Island where they were kept along the seashore for most of the year. The sheep developed an unusual metabolism that allowed them to survive by eating seaweed. They are, however, susceptible to copper poisoning when fed on grass.

(i) State the two essential steps that must have occurred for a breed to develop a distinctive metabolism, such as the ability to eat mainly seaweed.
_____________________________________________________________________________________________________
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(ii) Suggest what particular problems make the North Ronaldsay breed one of the most endangered sheep breeds in the United Kingdom.
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[Total: 20]
This question is about the evolution, genetics, behaviour and physiology of cats.

Fig. 1.1 (on the insert) shows a Scottish wildcat, *Felis sylvestris*.

Modern domestic cats evolved from a wild ancestor of similar appearance to the Scottish wildcat.

Fig. 1.2 (also on the insert) shows a breed of domestic cat, *Felis cattus*. This breed is called the Colourpoint Persian cat.

(a) State two phenotypic differences between the Scottish wildcat in Fig. 1.1 and the Colourpoint Persian cat in Fig. 1.2.

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(b) Name the process that:

(i) has given rise to the modern domestic cat from its wild ancestor

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(ii) has given rise to coat colour variation in cats.

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[2] [1] [1]
(c) In Colourpoint Persian cats, interaction between two genes, \(B/b\) and \(D/d\), causes the colour of the face, ears, paws and tail.

The dominant allele, \(B\), gives a dark brown colour, known as ‘seal’. The recessive allele, \(b\), gives a light brown colour, known as ‘chocolate’.

The dominant allele, \(D\), has no effect on coat colour. However, the presence of two copies of the recessive allele, \(d\), changes the colour ‘seal’ to a colour known as ‘blue’, and ‘chocolate’ to a colour known as ‘lilac’.

(i) State the name given to this type of genetic interaction.

(ii) Suggest the possible **genotypes** of a ‘seal’ Colourpoint Persian cat.

(iii) A ‘lilac’ Colourpoint Persian cat is homozygous at both the \(B/b\) and the \(D/d\) gene locus. What is meant by the terms **homozygous** and **gene locus**?

homozygous

gene locus
A cross was carried out between a ‘seal’ cat and a ‘lilac’ Colourpoint Persian cat. A Punnett square of the expected genotypes of the offspring of this cross is shown in Table 1.1.

**Table 1.1**

<table>
<thead>
<tr>
<th>gametes</th>
<th>BD</th>
<th>Bd</th>
<th>bD</th>
<th>bd</th>
</tr>
</thead>
<tbody>
<tr>
<td>bd</td>
<td>BbD</td>
<td>Bbd</td>
<td>bbD</td>
<td>bbdd</td>
</tr>
</tbody>
</table>

Use Table 1.1 to state the **phenotypes** of the offspring and to predict the **phenotypic ratio**.

**phenotypes**

_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
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_____________________________________________________________________________________________________

**phenotypic ratio**

_____________________________________________________________________________________________________
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(d) Breeders of Colourpoint Persian cats are advised to be present at the birth of the kittens. In this breed, the mother cat may not perform essential maternal behaviour such as licking the newborn kitten to free it from its amniotic sac (the membrane surrounding it at birth).

Wildcat mothers, even when they are first-time mothers, perform this behaviour naturally.

(i) State the type of behaviour shown by these wildcat mothers.

**Give one** characteristic of this type of behaviour.

**type of behaviour**

_____________________________________________________________________________________________________
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**characteristic**

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[2]
(ii) Over time, the frequency of domestic cat mothers who perform essential maternal behaviour, such as licking the newborn kitten, has decreased.

Suggest and explain a reason for this change in frequency over time.

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[2]

(e) Breeding pedigree cats, such as Colourpoint Persian cats, may involve crossing closely related individuals in order to obtain desirable characteristics.

Physiological problems are more common in pedigree animals than in wild animals.

(i) Suggest why physiological problems are more common in pedigree animals.

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[2]

(ii) An example of a physiological problem in Colourpoint Persian cats is that some of them cannot digest lactose sugar in milk. These cats can be fed lactose-reduced milk which is made by a biotechnological process using immobilised lactase enzyme.

State two methods of immobilising an enzyme.

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[2]

[Total: 21]
Fig. 2.1 is an electron micrograph showing a longitudinal section of contracted striated muscle.
(a) (i) Using Fig. 2.1, identify T, U and V.

(ii) Using Fig. 2.1, name the structure between positions X and Y.

(iii) Explain why glycogen granules are present in striated muscle.
(iv) Calculate the actual distance between positions X and Y on Fig. 2.1.

Show your working. **Give your answer to the nearest 0.1 of a micrometre (μm).**

Answer = .................................................. μm
(b) Fig. 2.2 below shows the arrangement of thick and thin filaments in striated muscle.

State what happens to the lengths of the following when muscle contracts:

**A band**

**H zone**

**I band**
(c) During strenuous exercise, the concentration of hydrogen ions in muscle tissue increases. A high concentration of hydrogen ions reduces the ability of calcium ions to bind to proteins in the myofibrils. This reduces the force with which a muscle can contract.

Use this information and your own knowledge of the proteins in muscle cells to explain how an increased concentration of hydrogen ions leads to a reduction in the force of contraction of a muscle.

*In your answer you should make clear the link between the increased concentration of hydrogen ions and the reduction in the force of contraction of a muscle.*
Peat bogs are large areas of waterlogged land that support a specialised community of plants. Peat bogs take thousands of years to form.

Fig. 5.1 lists the main stages in the formation of a peat bog.

---

(a) (i) Name the process summarised in Fig. 5.1 that changes a lake community into a peat bog community.

---

[1]
Using Fig. 5.1, list two abiotic factors that play a role in determining what species of plant can grow in an area.

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\[2\]

(b) Most of the minerals in a peat bog are held within the living plants at all times, not in the soil.

• Plants like bog cotton and bog asphodel recycle the minerals they contain.
• The leaves of these plants turn orange as the chlorophyll within them is broken down.
• Minerals such as magnesium ions are transported from the leaves to the plants’ roots for storage.

Describe one similarity and two differences in mineral recycling in a peat bog and in a deciduous forest.

similarity
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
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_____________________________________________________________________________________________________

differences
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\[3\]
(c) In Ireland in 2002, two well-preserved Iron Age human bodies were found in peat bogs. Despite having been dead for over two thousand years, the bodies had not decomposed. They still had skin, hair and muscle.

Suggest why these bodies had not decomposed.

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[2]

(d) Suggest two reasons why the large scale removal of peat from bogs for use in gardens is discouraged by conservation groups.

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[2]

[Total: 10]
(a) Great tits, *Parus major*, are birds that form male-female pairs. The male of each pair then establishes an area of territory, which he defends against other great tits by singing and threat displays.

The birds build a nest within the territory in which the eggs are laid and young chicks are reared. Weasels, *Mustela nivalis*, are predators which eat eggs and young chicks.

Fig. 6.1 shows how the territory size of great tits affects the risk of nest predation by weasels.

Fig. 6.1

(i) Describe the relationship shown in Fig. 6.1.

(ii) Suggest and explain what effect weasels may have on the population size of the great tit.
The ochre starfish, *Pisaster ochraceus*, is a starfish that lives on rocky intertidal shores. It is the top predator in its habitat.

Fig. 6.2 shows part of the food web for this starfish.

![Food web diagram](image)

An experiment was carried out in which all the starfish were removed from an 8 m × 2 m area of the shore. In an equivalent area of the same size, the starfish were not removed.

The population sizes of the other organisms in the food web were monitored at intervals. It was found that in the area in which starfish were removed:

- chitons and limpets disappeared
- anemones, sponges and nudibranchs decreased in abundance.

(i) Explain why two areas of the same size were monitored.

(ii) Using Fig. 6.2, explain why the chitons and limpets disappeared in the area from which starfish were removed.
(iii) Using Fig. 6.2, suggest the sequence of events that led to the decrease in abundance in nudibranchs in the area from which starfish were removed.

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[2]
[Total: 9]
(a) Genetic modification of organisms uses a “toolkit” that includes:

- enzymes that cut DNA
- enzymes that join sections of DNA together
- vectors that introduce DNA into new host cells.

Some of the enzymes and vectors that are important in genetic modification are given an identifying letter in Table 4.1.

<table>
<thead>
<tr>
<th>enzymes</th>
<th>vectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>A reverse transcriptase</td>
<td>J plasmid</td>
</tr>
<tr>
<td>B DNA polymerase</td>
<td>K virus</td>
</tr>
<tr>
<td>C DNA ligase</td>
<td>L Agrobacterium tumefaciens</td>
</tr>
<tr>
<td>D restriction endonuclease</td>
<td>M BAC</td>
</tr>
<tr>
<td>E RNA polymerase</td>
<td>N bacteriophage</td>
</tr>
</tbody>
</table>

Select one correct letter from Table 4.1 to fit each of the following statements.

An enzyme that cuts DNA

An enzyme that joins sections of DNA together

A vector to introduce foreign DNA into bacteria

A vector to introduce foreign DNA into plant cells

A vector to introduce foreign DNA into animal cells

(b) Discuss the potential benefits to mankind and the ethical concerns raised by the following examples of genetically modified organisms:

- rice modified for increased vitamin A content (‘Golden Rice™’)
- humans having somatic gene therapy treatment for a genetic disease.

In your answer you should give a balanced account of the benefits and concerns for each example of genetic modification.
A long-term breeding experiment to investigate the genetic basis of tame (friendly) behaviour was carried out in a population of silver foxes. The foxes were bred each year and the resulting young foxes assessed each month between the ages of 1 and 8 months to see how tame they were.

Table 6.1 shows how the foxes were put into categories according to their tameness.

![Table 6.1](image)

The tamest 5% of the male foxes and the tamest 20% of the female foxes in each generation were used for breeding to produce the next generation. This was repeated for over forty generations.

(a) (i) State the name given to the process in which only a certain percentage of adult foxes were chosen by humans to breed in each generation.

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(ii) Suggest why 20% of the female foxes were used for breeding but only 5% of the male foxes.

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_____________________________________________________________________________________________________

(b) Table 6.2 shows the number of foxes in the elite tameness class during the long-term experiment.
Discuss what the results shown in Table 6.2 suggest about the causes of the variation in tameness behaviour in silver foxes.

Table 6.2

<table>
<thead>
<tr>
<th>number of generations</th>
<th>foxes in elite class (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>20</td>
<td>35</td>
</tr>
<tr>
<td>35</td>
<td>75</td>
</tr>
</tbody>
</table>

As tameness increased in the silver fox population over the years, it was noticed that other phenotypic traits also became more common.

Table 6.3 compares the frequency of these traits in a control group of silver foxes that had not been used in this long-term breeding experiment and in the tame population of foxes.

Table 6.3

<table>
<thead>
<tr>
<th>phenotypic trait</th>
<th>animals showing trait (per 100000)</th>
<th>percentage increase in trait</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>control population</td>
<td>tame population</td>
</tr>
<tr>
<td>white patch of fur on head</td>
<td>710</td>
<td>12400</td>
</tr>
<tr>
<td>floppy ears</td>
<td>170</td>
<td>230</td>
</tr>
<tr>
<td>short tail</td>
<td>2</td>
<td>140</td>
</tr>
<tr>
<td>curly tail</td>
<td>830</td>
<td>9400</td>
</tr>
</tbody>
</table>

Students were asked to suggest a variety of genetic hypotheses to explain why these traits become more common in tame foxes. Their suggestions were:

- linkage
- epistasis
- inbreeding
- genetic drift

Select one hypothesis from the list and explain how it could account for the data in Table 6.3.
(d) Similar changes in tameness, colour and body shape are believed to have occurred in the 11 000 year period during which the grey wolf species, *Canis lupus*, evolved into the domesticated dog species, *Canis familiaris*.

Suggest how different types of isolating mechanism allowed dogs to evolve separately to wolves.

(e) Interbreeding between members of the wolf species and some dogs has been reported. However, there are some large breeds of dogs that cannot breed successfully with small dog breeds.

Use this information and your own knowledge to explain the problems of classifying wolves and different dog breeds according to:

- the biological species concept

and

- the phylogenetic species concept.
Four different eye pigments in the fruit fly, *Drosophila melanogaster*, are made from the amino acid tryptophan. A simplified metabolic pathway of pigment production is shown in Fig. 2.1.

Three different gene loci control the pathway. Each locus has two alleles. These alleles are V or v, C or c and B or b, as shown in Fig. 2.1.

(a) (i) Using the information in Fig. 2.1, deduce the phenotypes of flies with the following genotypes:

<table>
<thead>
<tr>
<th>genotype</th>
<th>phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>VvCcBb</td>
<td></td>
</tr>
</tbody>
</table>
(ii) State the term that is applied to this type of gene interaction.

(iii) Explain how the products coded for by the genes interact to give the different pigments.

(b) A mutation in another gene at another locus in Drosophila gives rise to white-eyed flies. The red eye allele of this gene (\(R\)) is known to be dominant to the white eye allele (\(r\)).

A student crossed a red-eyed fly with a white-eyed fly, expecting to get an F1 generation of red-eyed flies. In fact, the results were as shown in Table 2.1.

<table>
<thead>
<tr>
<th>phenotype of fly</th>
<th>number of offspring</th>
</tr>
</thead>
<tbody>
<tr>
<td>red-eyed female</td>
<td>27</td>
</tr>
<tr>
<td>red-eyed male</td>
<td>0</td>
</tr>
<tr>
<td>white-eyed female</td>
<td>0</td>
</tr>
<tr>
<td>white-eyed male</td>
<td>23</td>
</tr>
</tbody>
</table>

(i) The student first suggested that the reason for there being red-eyed and white-eyed flies in the offspring was that the red-eyed parent was heterozygous.

Explain why this cannot be the correct explanation for the results shown in Table 2.1.
(ii) In *Drosophila*, the males are the heterogametic sex, possessing two different sex chromosomes, X and Y.

Draw a genetic diagram to show how the results shown in Table 2.1 could have been produced.

Parental genotypes .................................................................

Gametes .................................................................

\[ F_1 \text{ genotypes} \] .................................................................

[3]
The chi-squared ($\chi^2$) test can be used to analyse the results in Table 2.1.

The expected ratio of red-eyed females to white-eyed males is 1:1.

Use Table 2.2 to calculate a value for chi-squared ($\chi^2$).

\[ \chi^2 = \sum \frac{(O - E)^2}{E} \]

Key to symbols:
- $\Sigma$ = 'sum of...'
- df = degrees of freedom
- n = number of classes
- O = observed value
- E = expected value

### Table 2.2

<table>
<thead>
<tr>
<th>phenotype of fly</th>
<th>O</th>
<th>E</th>
<th>O - E</th>
<th>$(O - E)^2$</th>
<th>$\frac{(O - E)^2}{E}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>red-eyed female</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>white-eyed male</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2 = \ldots$  

Use your calculated value of $\chi^2$ and the table of probabilities shown in Table 2.3 to test the significance of the difference between the observed and expected results.

State your conclusion in the space below.

Conclusion
This question is about types of muscle and how the nervous system and hormones control their activity.

(a) There are three types of muscle within the human body. These differ in their cellular structure and in their function.

Complete Table 2.1 to show how each type of muscle differs from the other two types.

Table 2.1

<table>
<thead>
<tr>
<th></th>
<th>voluntary (skeletal) muscle</th>
<th>involuntary (smooth) muscle</th>
<th>cardiac muscle</th>
</tr>
</thead>
<tbody>
<tr>
<td>cellular structure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>function</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) The human thorax is the area between the base of the neck and the base of the rib cage. All three types of muscle can be found within this area.

For each type of muscle, identify where in the thorax this type of muscle may be found.

voluntary

involuntary

cardiac
(c) Fig. 2.1 shows a vertical section through the human brain.

**Fig. 2.1**

Use Fig. 2.1 to state the letter (B to E) of the part of the brain that would be involved in the following:

- adjusting the rate of contraction of cardiac muscle
- clapping the hands together
- automatically correcting balance when riding a bicycle

(d) Movement disorders are conditions in which people lose the ability to control their body movements.

Scientists have discovered that inserting electrodes to stimulate parts of the brain can help to cure some movement disorders. This discovery has resulted from experimental work with monkeys, which has made the research controversial.

Suggest why monkeys rather than other laboratory animals, such as rats, were used for this work and comment on whether their use in this way is justified or not.

(e) The 'fight or flight' response to threatening environmental stimuli is coordinated by the nervous and endocrine
Describe and explain how the activation of the ‘fight or flight’ response affects voluntary, involuntary and cardiac muscle.

In your answer, for each type of muscle, you should give a named structure in which it is found and explain how the nervous and endocrine systems affect its response.
(a) State the term used to describe:

(i) a directional growth response of a plant

(ii) a signalling molecule that enables plants to respond to environmental change

(iii) plants that lose their leaves seasonally

(iv) the process of managing an ecosystem sustainably to protect biodiversity

(v) organisms that return inorganic minerals from the bodies of dead organisms to the abiotic environment
(vi) the conversion of nitrogen gas to ammonium compounds in the soil.

(b) Describe briefly one example of each of the following types of animal behaviour:

(i) habituation

(ii) operant conditioning

(iii) social behaviour in primates and its importance.

[Total: 15]
Sarawak is an area of tropical rainforest in south-east Asia. Logging has been allowed in 60% of the forest.

A study was carried out into the effects of logging on the diversity of mammal species living in the forest. An area of rainforest was sampled before logging, immediately after logging and then again two years and four years after logging.

Before logging began, there were 29 mammal species and four years after logging there were 26 mammal species.

Table 5.1 shows the population densities of six groups of mammals before and after logging. Where numbers were too small to measure the density, the species was recorded as “present”.

### Table 5.1

<table>
<thead>
<tr>
<th>mammal</th>
<th>mean number of animals per km²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>before logging</td>
</tr>
<tr>
<td>marbled cat</td>
<td>present</td>
</tr>
<tr>
<td>oriental small-clawed otter</td>
<td>present</td>
</tr>
<tr>
<td>giant squirrel</td>
<td>5</td>
</tr>
<tr>
<td>small squirrel</td>
<td>16</td>
</tr>
<tr>
<td>tree shrew</td>
<td>10</td>
</tr>
<tr>
<td>barking deer</td>
<td>3</td>
</tr>
</tbody>
</table>

(a) Marbled cats and otters are carnivores, while squirrels, shrews and deer are herbivores.

Use the information provided to choose the best word(s) or terms to complete the following passage.

The rainforest [dynamic set of interactions] is a dynamic set of interactions between populations of organisms and the [abiotic environment]. Energy flows from [consumers such as squirrels] to higher [consumers such as cats and otters] at higher [levels]. The activities of decomposers contribute to the energy lost from the [component of the rainforest] but decomposers allow energy to be recycled.

(b) (i) Table 5.1 shows that the number of small squirrels increases initially, but then decreases. Explain, using your knowledge of factors affecting population growth, why the small squirrel population in this rainforest does not increase in size indefinitely.

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_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________

[6]

[4]
(ii) Describe, using the information provided, how species richness and species evenness change in the rainforest by comparing the situation before logging and four years after logging.

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_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________

[2]

(c) (i) Suggest why marbled cats and oriental small-clawed otters became extinct in this area but other mammals did not.

_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________

[1]

(ii) Outline three reasons for conserving biological resources, such as the rainforest in Sarawak.

1

_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________

[3]
(d) Timber is produced sustainably in the United Kingdom.

Describe **and** explain the benefits of **two** management practices used in sustainable timber production in a temperate country.

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[4]

[Total: 20]