Q1.

Read the following passage.

The wall gecko is a medium-sized lizard. In an isolated habitat of southern Italy, the wall gecko shows phenotypic diversity. Scientists investigated whether disruptive selection was leading to sympatric speciation in the wall gecko.

Pale geckos live only on walls and are nocturnal (active at night). Dark geckos live mainly on the dark trunks of olive trees and are diurnal (active during the day). These diurnal geckos can change skin colour when occupying different surfaces during the day.

Comparison of mitochondrial genes indicated that the diurnal geckos formed a distinct genetic group. This comparison also confirmed that all the geckos in the habitat were of the same species.

The scientists used the mark-release-recapture method to estimate the size of the population of geckos in the habitat.

Use the information in the passage and your own knowledge to answer the following questions.

(a) The wall gecko shows phenotypic diversity (lines 1–2).

Suggest **two** factors that have resulted in this phenotypic diversity.

1 _____

_____

_____

2 _____

_____

_____

(2)

(b) The ability of diurnal geckos to change skin colour (lines 7–8) is advantageous.

Explain why.

(2)

(c) The scientists concluded that it was probable that disruptive selection was leading to sympatric speciation in the wall gecko.

Use the information in the passage to evaluate this conclusion.

(5)

(d) Explain how comparison of mitochondrial genes could indicate that the nocturnal geckos formed a distinct genetic group (lines 9–10).

In your answer, explain how new techniques enable the comparison of genes to be completed rapidly.

(3)

(e) Describe and explain **two** precautions required to ensure that the estimate of the size of the population of geckos was valid (lines 12–13).

Do **not** include sample size as one of the required precautions.

In your answer, include the formula to estimate the size of the population using the mark-release-recapture method.

Precaution 1

Precaution 2

Formula

(3)

(Total 15 marks)

Q2.

Leigh syndrome (LS) is a rare, recessive, inherited condition.

LS is caused by a mutation in any one of more than 75 different genes coding for proteins involved in oxidative phosphorylation.

In 80% of people with LS, these mutations occur in nuclear DNA. In 20% of people with LS, these mutations occur in mitochondrial DNA (mtDNA).

15% of the nuclear DNA mutations that cause LS occur in the *SURF1* gene. A mutated *SURF1* gene codes for a shorter polypeptide than a non-mutated *SURF1* gene.

(a) Name **one** type of *SURF1* gene mutation and explain how this mutation could lead to production of a shorter polypeptide.

Type of mutation _____

Explanation _____

_____

_____

_____

(2)

Globally, the frequency of LS is 1 in 40 000

In the Faroe Islands, which are 18 isolated islands, the frequency of LS is 1 in 1700

(b) The population of the Faroe Islands is 49 053

Estimate the number of people in the Faroe Islands with LS caused by a mutation in the *SURF1* gene.

Use information in this question.

Give your answer to the nearest whole number.

Show your working.

Answer _____ people

(3)

(c) The frequency of LS is higher in the Faroe Islands than globally.

Suggest and explain **one** reason why.

(2)

(d) LS usually causes death within the first three years of life.

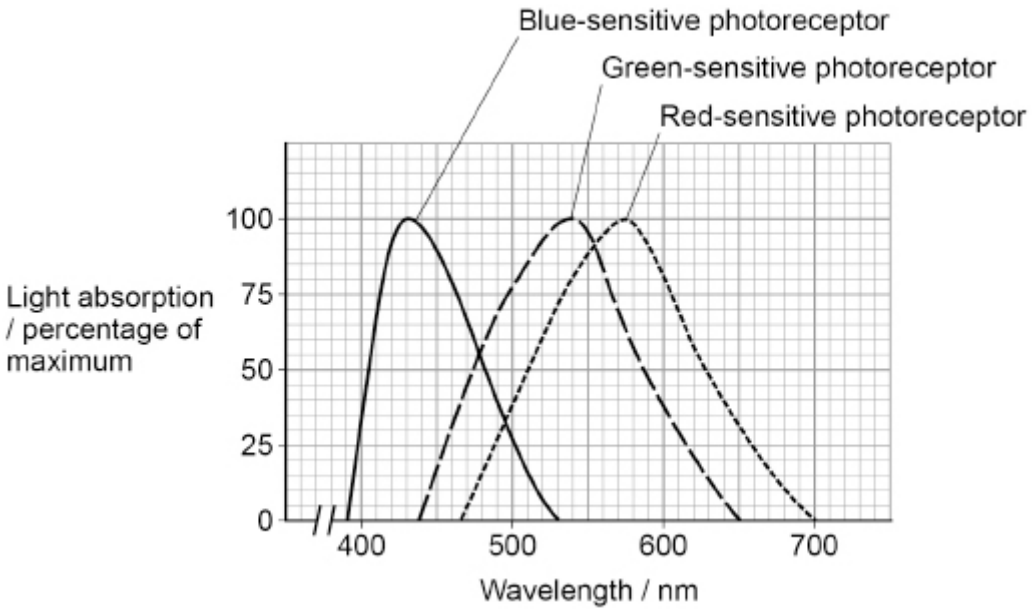
Using all the information in this question, evaluate whether all people should be genetically screened for LS.

(3)

(Total 10 marks)

Q3.

(a) The figure below shows the wavelengths of light absorbed by three types of photoreceptor found in the human retina.



Use the figure and your knowledge of colour vision to explain how an orange colour is seen at 600 nm

(3)

(b) Which of the following statements is associated with high sensitivity to light in the retina?

Tick ✓ **one** box.

A single photoreceptor connecting to one neurone and spatial summation	☐
A single photoreceptor connecting to one neurone and temporal summation	☐
Several photoreceptors connecting to one neurone and spatial summation	☐
Several photoreceptors connecting to one neurone and temporal summation	☐

(1)

(c) Variation in flower colour is considered one of the factors involved in the evolution of the following two species of monkeyflower.

- *Erythranthe lewisii* (Great Purple Monkeyflower), which has pink flowers, is mostly found at higher altitudes (1600 to 3000 metres) and attracts bumblebees.
- *Erythranthe cardinalis* (Scarlet Monkeyflower), which has red flowers, is mostly found at lower altitudes (up to 2000 metres) and attracts hummingbirds.

Bumblebees and hummingbirds are important in the pollination of flowers. Pollination involves the transfer of male gametes to female gametes.

Explain the different processes that may have been involved in the evolution of these two species of monkeyflower. Use the information provided to justify your answer.

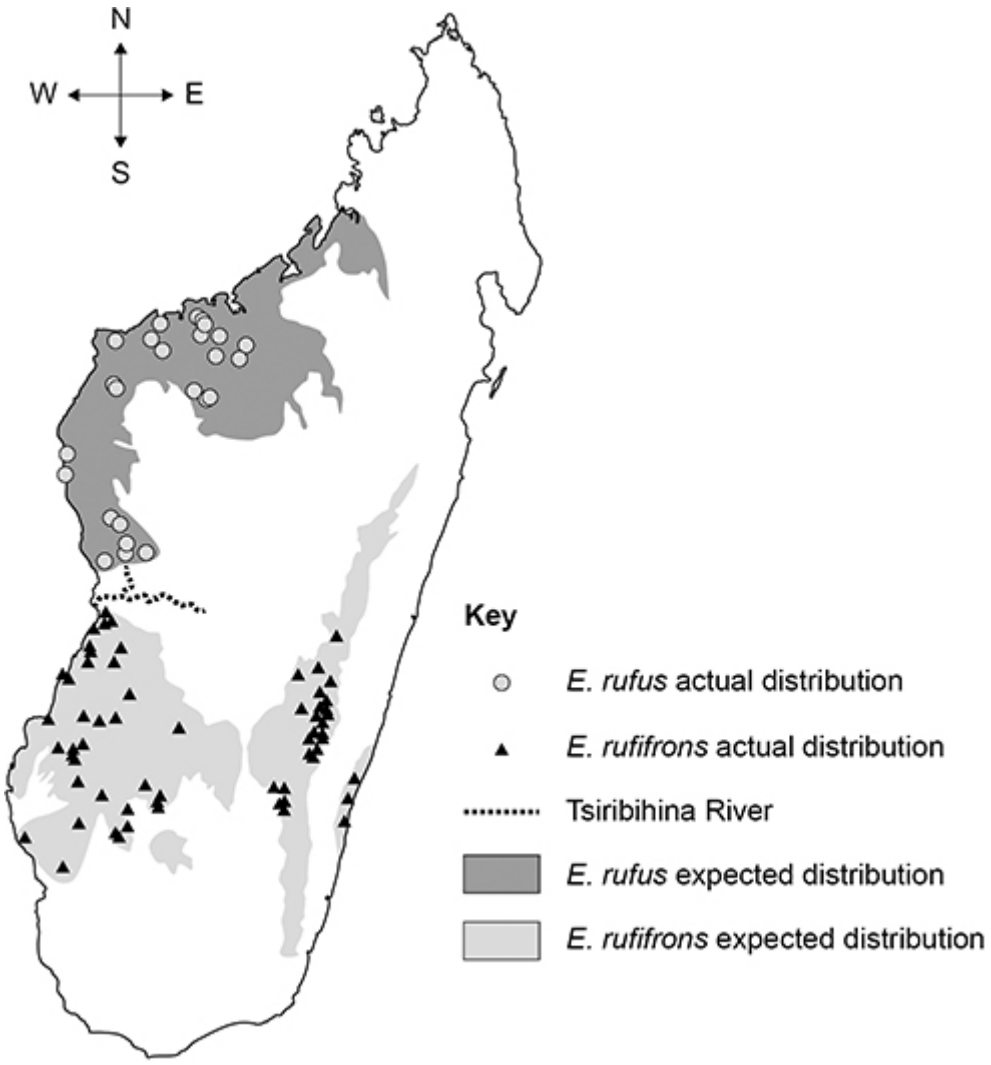
(5)

(Total 9 marks)

Q4.

Lemurs are small mammals. Lemurs live in trees and feed on leaves and fruit. Scientists used a computer program to predict the expected distribution of two species of lemur, *Eulemur rufus* and *Eulemur rufifrons,* on the island of Madagascar. These predictions were based on the environmental needs of each species.
Then, the scientists determined the actual distribution of these two species of lemur on the island of Madagascar.

The diagram below shows the scientists' results.



(a) Using the diagram above, give **three** conclusions you can make about the distribution of these lemur species.

1 _____

_____

2 _____

_____

3 _____

_____

(3)

(b) Using all the information, suggest how speciation happened to produce two species of lemur.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

The scientists used the mark-release-recapture method to determine the number of lemurs in one area of forest. They captured, marked and released a first sample of 30 lemurs. A week later, they captured a second sample of 25 lemurs from the same area of forest. The scientists calculated that there were 250 lemurs in that area of forest.

(c) Suggest **one** precaution needed when marking the lemurs to make sure the estimate of the number of lemurs is valid.

_____

_____

_____

(1)

(d) Using the information provided, calculate how many lemurs in the second sample were marked.

Answer _____

(1)

(Total 10 marks)