20. The European corn borer moth, *Ostrinia nubilalis,* is a pest of agriculture. Its larvae develop inside maize stems and eat the contents, weakening the stems so that the plants collapse.

The bacterium *Bacillus thuringiensis* ('Bt') produces a protein that poisons the larvae of moths and butterflies. This protein can be isolated from cultures of Bt and packaged in fluids to be sprayed on the surface of plants.

The gene coding for the toxic protein has also been isolated. It has been incorporated into a genetically modified strain of maize called Bt corn. This makes the plant tissues poisonous to the corn borer moth.

Consider the statement:

'Genetically modified plants and animals should be classed as new species'.

Outline **one** experiment or investigation that would provide evidence to support or contradict the statement.

---

[3]

21. Two species of chimpanzees, the chimpanzee and the bonobo, are the closest living relatives of humans.

Fig. 19.1 is a diagram representing the current classification of chimpanzees and humans within the Family Hominidae.

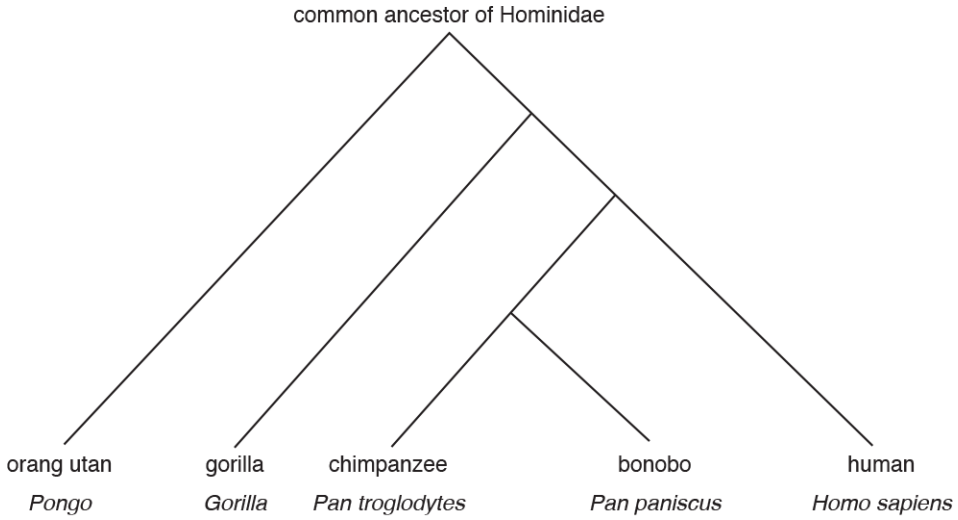


Fig. 19.1

Humans and chimpanzees are currently classified within the same family.

Chimpanzees were once classified separately from humans in the Family Pongidae along with gorillas and orang utans.

Fig. 19.2 shows a human hand and a chimpanzee hand.

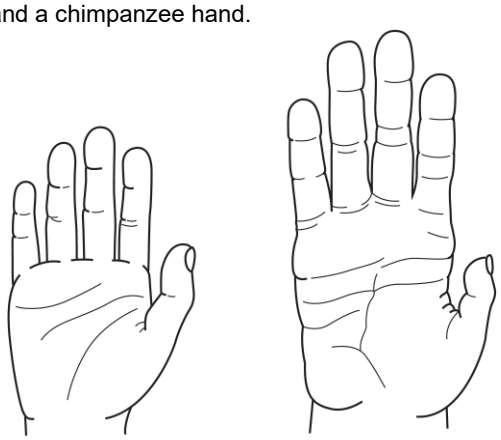


Fig. 19.2

Describe **two** differences between the two images that could have been used to classify humans and chimpanzees in separate families.

---

[2]

22. The Scottish wildcat and European wildcat are both classified in the same species, *Felis silvestris*. Researchers have suggested that both wildcats originated from the same population.

During the Ice Age, the British Isles were connected by ice to mainland Europe.

- After the Ice Age, sea levels rose and the British Isles became isolated from the rest of Europe.
- The isolated population of wildcats in the British Isles developed slightly different characteristics from the mainland population in Europe.
- A subspecies is a group of individuals that is geographically isolated from others of the same species and that is distinguishable from other populations of the same species.
- The Scottish wildcat is now classified as the subspecies *Felis silvestris grampia* and the European wildcat as the subspecies *Felis silvestris silvestris*.

i. Name the genus of the Scottish wildcat.

_____ **[1]**

ii. The information above states that 'the isolated population of wildcats in the British Isles developed slightly different characteristics from the mainland population in Europe'.

What is the term used to describe the differences between the two populations of wildcat?

_____ **[2]**

iii. Suggest why the Scottish wildcat and the European wildcat **cannot** yet be classified as different species.

_____

_____

_____

_____

_____ **[2]**

23. DNA sequencing has allowed scientists to create a strain of *Escherichia coli* bacteria with an entirely artificial genome.

Complete the passage using the most appropriate words.

The creation of an organism with an artificial genome is known as .....

biology. The bacterium created has been classified in the genus .....

However, the classification of this organism is problematic because the basis of classification

is ..... .

[3]

24. The Titicaca water frog, *Telmatobius culeus*, is an aquatic amphibian found in Lake Titicaca in sub-tropical South America. The water frog has an unusual appearance with large folds of skin as shown in Fig. 21.1.

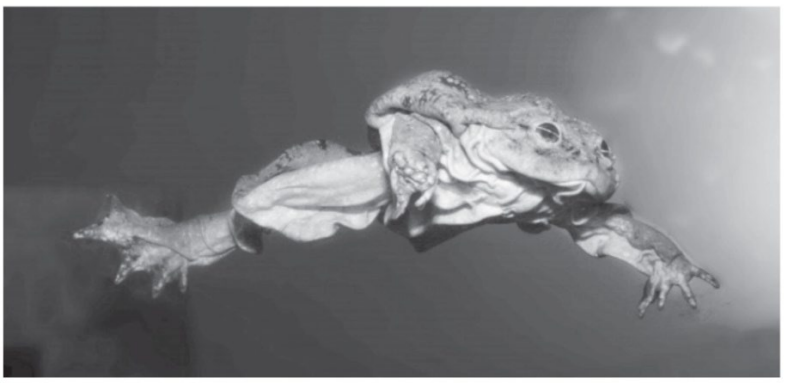


Fig. 21.1

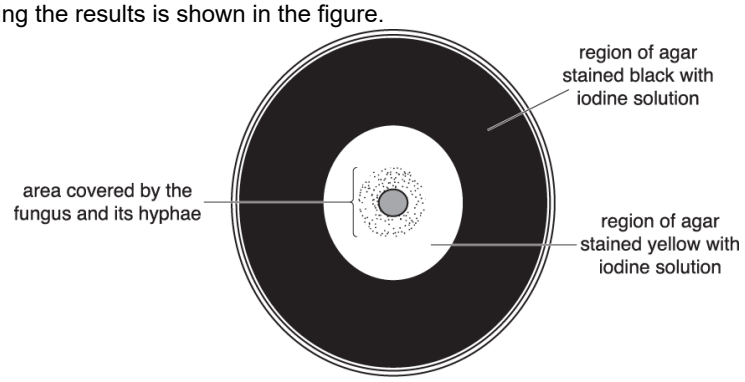
Name the genus of the Titicaca water frog.

_____ **[1]**

25. Fungi produce enzymes to digest complex food substances. Amylase is an enzyme that catalyses the conversion of starch to maltose.

- A sample of the fungus *Amanita citrina* was placed on agar in a petri dish.
- The agar contained starch.
- The dish was incubated until the thread-like hyphae had grown a few centimetres.
- Iodine solution was then poured onto the surface of the agar.

A diagram representing the results is shown in the figure.



i. To which genus does this fungus belong?

_____ **[1]**

ii. The region of yellow staining shown in the figure includes part of the agar where the fungus had not yet grown.

What does this pattern indicate about the action of the fungal enzymes?

_____

_____

_____ **[1]**

26. The Sumatran rhinoceros, *Dicerorhinus sumatrensis*, is a rare member of the family Rhinocerotidae. These rhinoceros are now critically endangered, with only six substantial populations in the wild: four in Sumatra, one in Borneo, and one in the Malay Peninsula.

D. sumatrensis lives in rainforests. Their numbers are difficult to determine but they are estimated to number fewer than 100.

Complete the table below, showing the classification of the Sumatran rhinoceros.

Kingdom	…….
Phylum	Chordata
…….	Mammalia
…….	Perissodactyla
Family	Rhinocerotidae
…….	Dicerorhinus
Species	…….

[2]

27. * The pipistrelle is the most common species of bat in Europe.

Table 5.1 shows information about two distinct populations of pipistrelle.

Population	Mean body mass (g)	Mean wingspan (m)	Range of echolocation call (kHz)	Colour	Habitat
Common pipistrelle	5.5	0.22	52 – 60	medium to dark brown	woodland, hedgerows, grassland, farmland, suburban and urban
Soprano pipistrelle	5.5	0.21	42 – 47	medium to dark brown	wetland, woodland edge, tree lines, hedgerows, suburban gardens and parks

Table 5.1

A researcher made the following claim:

'The common pipistrelle and soprano pipistrelle must be distinct species.'

Evaluate the researcher's claim by using the evidence in **Table 5.1** to support and to challenge the researcher's conclusion.

[6]

28. Domesticated pigs are descended from *Sus scrofa,* sometimes called the 'wild boar'.

i. In **Table 17.1**

- number the levels in the correct sequence and
- complete the name column.

Sequence of levels	Level	Name
……	Order	Artiodactyla
……	Species	……
……	Family	Suidae
1	Kingdom	……
……	Genus	……
……	Phylum	Chordata
……	Class	Mammalia

Table 17.1

[4]

ii. We now have DNA evidence of how organisms are related to each other. This evidence has helped biologists to construct a second classification viewpoint: the Domain system.

Explain what such developments show about the nature of scientific knowledge.

---

[1]

29. The name *Dicerorhinus sumatrensis* is part of the binomial naming system for classifying species.

State an advantage of using this system rather than using the common nameof the species, Sumatran rhinoceros.

---

[1]

30. The malarial pathogen, *Plasmodium*, is a protoctist.

State **two** features of organisms that belong to the Kingdom Protoctista.

1

2

[2]

31(a). Fig. 20.1 shows a transmission electron micrograph of part of a eukaryotic cell.

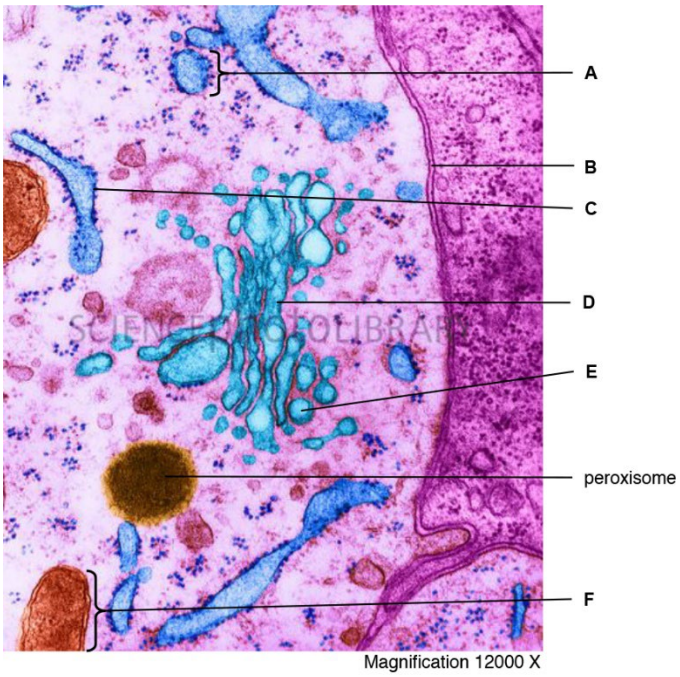


Fig. 20.1

i. Identify **one** feature inside the cell that would also be seen in a prokaryotic cell.

[1]

ii. Identify **two** features of this cell that confirm it is **not** a prokaryotic cell.

In each case state the letter and the name of the feature.

Letter……

Name……

Letter……

Name……**[2]**

(b). The cell shown in **Fig. 20.1** is capable of synthesising and secreting proteins.

Using **only** the letters from **Fig. 20.1**, list the correct sequence of the organelles involved in synthesis and secretion of a protein.

---**[3]**

32. The table shows the characteristics of five species from the five different kingdoms.

species	organisation	nucleus	cell wall	nutrient source
Solanum tuberosum	multicellular	yes	yes	autotroph
Yersinia pestis	unicellular	no	yes	heterotroph
Cantharellus pallens	unicellular	yes	yes	saprotroph
Ministeria vibrans	unicellular	yes	no	heterotroph
Ailuropoda melanoleuca	multicellular	yes	no	heterotroph

i. Name the genus of the protoctist in the table.

---**[2]**

ii. Use the information in the table to determine the kingdom and cell wall molecule for *S. tuberosum* and *C. pallens*. Write your answers in the table below.

species	kingdom	cell wall molecule
S. tuberosum		
C. pallens		

[2]

iii. Describe how the genetic material is arranged in organisms in the same kingdom as *Y. pestis*.

---**[1]**

33. Many algal species are unicellular organisms. Some occur in colonies of more than one cell.

Fig. 21.2 shows a typical algal cell.

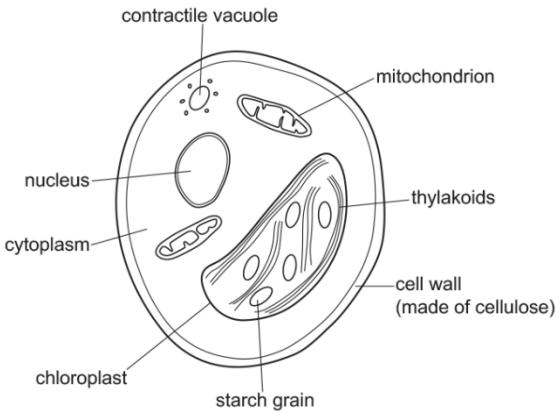


Fig. 21.2

i. At various times, algae have been classified in different kingdoms.

Using the information given above, draw a conclusion about which kingdom is the most appropriate in which to classify algae.

In your answer explain why other kingdoms are not appropriate choices.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ **[4]**

ii. Suggest one piece of evidence not given above that could be used to provide strong support for the classification of algae in a particular kingdom.

_____ **[1]**

34(a). In 1990, Carl Woese suggested a new top level taxon to the current system of classification of living organisms, which he termed a domain. He used his results from studying RNA to organise organisms into three distinct groups.

i. Name the cell component that appears in organisms of all three domains that Woese suggested.

_____ **[1]**

ii. One of the domains he suggested is called Eukarya.

Name the other **two** domains.

1

_____

2

_____ **[2]**

iii. State **two** defining features of all members of the domain Eukarya.

_____

_____ **[2]**

(b). Woese carried out a detailed study of RNA molecules in order to draw his conclusions.

Suggest **two** ways in which the scientific community are likely to have validated Woese's research.

_____

_____ **[2]**

35. Which of the following options, **A** to **D**, lists the three domains of life?

A. Archaea, Bacteria and Eukaryota
B. Bacteria, Prokaryota and Eukaryota
C. Prokaryotae, Protoctista and Eukaryota
D. Protoctista, Plantaea and Animalia

Your answer ☐

[1]

36. Evolution is the change of species over time. Natural selection is the mechanism by which this change occurs.

Fig. 1.1 shows two species of trilobites, a group of arthropods that became extinct about 240 million years ago. Species **A** is 20 million years older than species **B**.

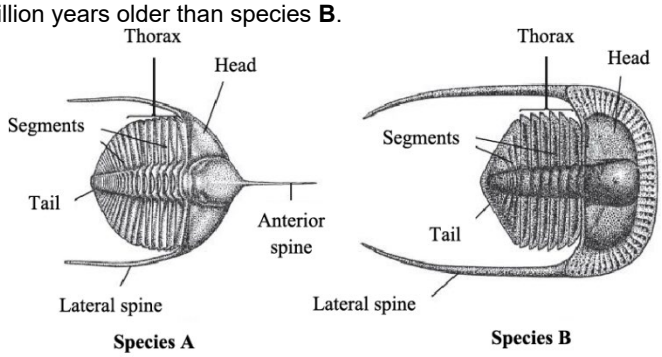


Fig 1.1

i. Explain how scientists are able to estimate the age of extinct organisms, such as species **A** and species **B**.

---

[2]

ii. Identify two features **visible** in both species that suggest that species **A** and species **B** evolved from a relatively close common ancestor.

1 .....

2 .....

[1]

iii. A student used Fig. 1.1 to make a number of observations comparing species **A** and **B**.

One such observation was "species **B** had longer lateral spines than species **A**".

Explain why this is not a valid observation to make on the basis of Fig. 1.1.

---

[2]

iv. Fig. 1.2 shows two modern arthropods.

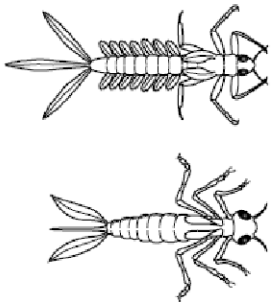


Fig. 1.2

Modern species **C** and **D** live in water. The trilobite species, **A** and **B** also lived in water.

Identify and briefly explain an adaptation present in all four species, **A**, **B**, **C** and **D**, that would be advantageous for an organism that lives in water.

Adaptation ……

Explanation ……

[1]

37(a). Squid are an order of aquatic animals. Many species of squid show a reflex response to changes in their body position.

- A sensory receptor called a statocyst detects changes in the body position of the squid in their aquatic environment.
- The reflex response corrects the squid's body position.

i. Describe the components and events involved in a reflex arc.

---

[3]

ii. Suggest one benefit to the squid of the reflex response described above.

---

[1]

iii. A statocyst sensory receptor is shown in Fig. 2.1.

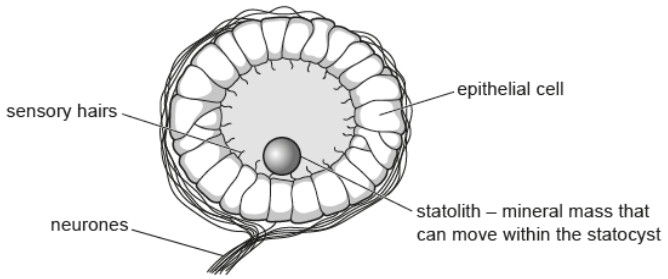


Fig. 2.1

What can you conclude from Fig. 2.1 about the mechanism by which a statocyst acts as a transducer?

---

[3]

(b). Lobsters and sea cucumbers also have statocysts. From this information, the student concluded:

'I think this means squids, lobsters and sea cucumbers evolved from a recent common ancestor and are probably classified in the same phylum.'

Evaluate the extent to which the information about lobsters and sea cucumbers supports the student's conclusion.

---

[2]

38. Explain how a specific molecule is used to show that two different species have evolved from a recent common ancestor.

_____

_____

_____

_____

_____ **[2]**

39(a). Termites are highly social insects. They are thought to have evolved from earlier forms of insect at least 150 million years ago, in the Jurassic geological period. They are related to cockroaches.

i. How might scientists a century ago have known that termites evolved in the Jurassic geological period?

_____

_____ **[1]**

ii. What new source of evidence might help today's scientists to find out how closely related termites are to cockroaches?

_____

_____ **[1]**

(b). Fig. 5.1 shows a termite mound, the nest of approximately one million individuals. The photograph was taken in Queensland Australia, about 3000 kilometres south of the equator.

i. **Fig. 5.1** shows that the interior of the termite mound is full of interconnecting chambers. At the top of the mound some of these chambers open to the air outside.

Fig. 5.1

Worker termites spend all their time working in brood chambers low in the mound, where eggs and larvae develop.

ii. Explain how carbon dioxide produced in the respiring body cells of worker termites is removed to the air outside the termite mound.

_____

_____

_____

_____

_____

_____ **[4]**

iii. In Africa, closer to the equator, the mounds built by some species of termite are blade-shaped, with the long axis pointing North–South. **Fig. 5.2** shows an example of a termite mound in Africa.

Suggest why the African termites need to build mounds in this shape and orientation.

Fig. 5.2

_____

_____

_____ **[2]**

40. The cheetah, *Acinonyx jubatus*, is a member of the cat family, Felidae.

Cheetahs display less intraspecific variation than other members of the family Felidae.

The population of cheetahs has been declining for the past 100 years and is estimated to be between 6000 and 7000.

Within the remaining cheetah population, intraspecific genetic diversity is very low.

One isolated population of cheetahs in Iran has fewer than 100 individuals.

i. State one way in which genetic diversity can be measured.

_____

_____ **[1]**

ii. It is thought that the modern cheetah population has low genetic diversity because the population, relatively recently, experienced a genetic bottleneck.
Explain why a genetic bottleneck can lead to low genetic diversity.

_____

_____

_____

_____

_____

_____ **[2]**

iii. Scientists are concerned about genetic drift in the remaining cheetah populations.
Explain why genetic drift is likely to be of particular concern in the population of 100 cheetahs in Iran.

_____

_____

_____

_____

_____

_____ **[2]**

41(a). In disruptive selection, extreme phenotypes are selected for and average phenotypes selected against. The *G. fortis* all live in the same location. If disruptive selection is occurring in the *G. fortis* population, it is possible that speciation might occur.

i. Name the type of speciation that occurs when two populations live in the same location.

_____ **[1]**

ii. Suggest how *G. fortis* with large beaks could become reproductively isolated from *G. fortis* with small beaks despite living in the same location.

_____

_____ **[1]**

iii. Comparing anatomy between species such as beak size in finches can be used to provide evidence to support the theory of evolution by natural selection.

Describe how DNA can be used to provide evidence to support the theory of evolution by natural selection.

_____

_____

_____

_____

_____ **[2]**

(b). Alfred Russel Wallace is another important figure in the understanding of evolution.

Outline the way in which Wallace contributed to the acceptance of Darwin's theory of natural selection by the wider scientific community.

_____

_____

_____

_____

_____ **[2]**

42(a). Explain how biological molecules can provide evidence that species have evolved.

You should refer to different types of molecule in your answer.

_____

_____

_____

_____

_____

_____

_____

_____ **[4]**

(b). In his book 'On the Origin of Species', Charles Darwin made the following four observations.

E Offspring generally appear similar to their parents.
F No two individuals are identical.
G Organisms have the ability to produce large numbers of offspring.
H Populations in nature tend to remain relatively stable.

From these observations he made a number of deductions, listed in the table below.

The deductions are supported by one **or more** of the observations (**E**, **F**, **G** or **H**).

In the table, indicate which of the above observations contributed to each deduction.

You may use each letter (**E**, **F**, **G**, or **H**) once, more than once, or not at all.

Deduction	Supporting observation(s)
Characteristics are passed on to the next generation.	
There is a struggle for existence.	
Individuals with beneficial characteristics are among the few who survive.	

[3]

43(a). The downy birch tree, *Betula pubescens*, produces varying numbers of leaf hairs.

These hairs are between 200 μm and 500 μm long in response to different environmental conditions.

A group of students investigated the relationship between the distance of different trees from a river and the mean leaf hair density.

Table 25 shows the results of their investigation.

Distance from river (m)	Rank of distance	Mean leaf hair density (number mm^{-2})	Rank of hair density	Difference in ranks *(d)*	Difference squared (d^2)
9.1	4	33.1			
13.7	1	34.8			
5.5	7	11.3			
0.3	10	3.4			
5.4	8	27.3			
11.5	3	30.3			
1.7	9	6.3			
6.0	6	22.9			
11.9	2	5.7			
6.8	5	23.2			

Table 25

i. Complete Table 25 by calculating the difference between the ranks and then squaring the difference.

[Answer on Table 25] **[2]**

ii. Use the formula below to calculate Spearman's rank correlation coefficient for this data.

$$r_s = 1 - \frac{6\Sigma d^2}{n(n^2-1)}$$

[2]

(b). The students concluded that there is a positive correlation between distance of the tree from the river and mean leaf hair density.

i. Suggest reasons for this positive correlation.

[2]

ii. For this investigation, the students randomly selected leaves from ten downy birch trees at varying distances from the river.

Suggest **three** ways in which the students could improve the validity of their sampling method.

1

2

3

[3]

(c). Another group of students repeated this investigation and calculated r_s = 0.589. The critical value of r_s at the 5% level for 9 degrees of freedom is 0.600.

They concluded that their results showed a weak positive correlation between leaf hair density and distance of the tree from the river.

Evaluate the conclusion of this group of students.

---**[2]**

(d). State the **pattern** of variation shown by leaf hair density.

---**[1]**

44. Fig. 2.1 shows a naked mole rat, *Heterocephalus glaber*.

Fig. 2.1

The naked mole rat is a mammal. However, it has several features that are unusual for mammals.

Fig. 2.3 shows the relationship between body mass and lifespan in a range of mammal species.

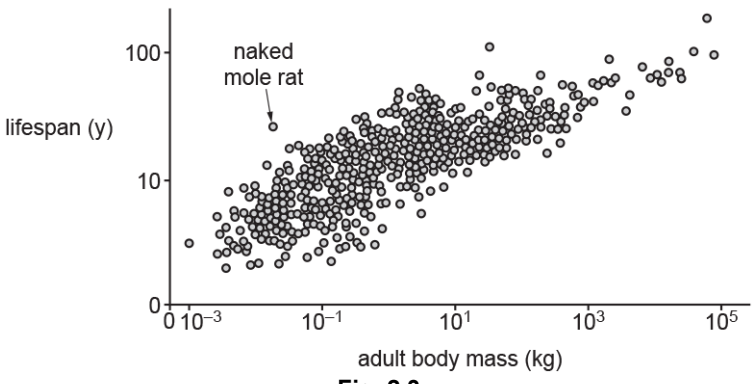


Fig. 2.3

i. Describe the relationship between body mass and lifespan shown in Fig. 2.3.

_____

_____ **[1]**

ii. What conclusion can you draw from Fig. 2.3 about the lifespan of naked mole rats in comparison to other mammals?

_____

_____

_____ **[1]**

45. The cheetah, *Acinonyx jubatus*, is a member of the cat family, Felidae.

Cheetahs display less intraspecific variation than other members of the family Felidae.

Fig. 20.1 shows the mean body length of a population of cheetahs from southern Africa.

The error bars on Fig. 20.1 show the standard deviation of mean body length.

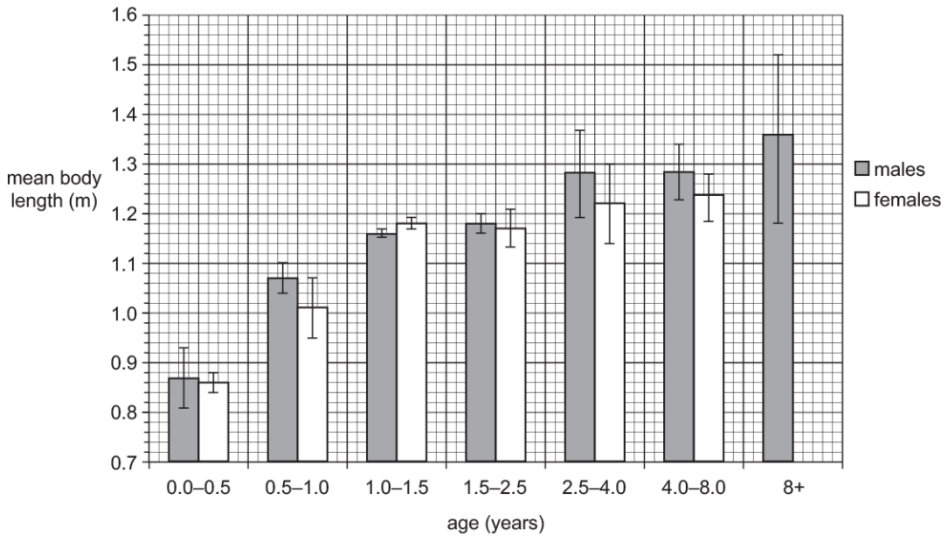


Fig. 20.1

i. At between 2.5 and 4 years old, the mean length of female cheetahs is less than that of males.

Calculate how much shorter than males female cheetahs are.

Show your working. Express your answer as a percentage to **two significant figures**.

Answer ..... % **[2]**

ii. Using only Fig. 20.1 and your answer to (i), what can be concluded about the **significance** of the difference between the length of male and female cheetahs aged between 2.5 and 4 years?

Explain your answer.

_____

_____

_____

_____ **[2]**

iii. A student looked at Fig. 20.1 and wrote:

"The longest male cheetah that was measured was 1.52 m long".

Explain whether the information in Fig. 20.1 supports the student's answer.

_____

_____

_____

_____

_____ **[1]**

iv. State the likely causes of variation in body length in cheetahs.

_____

_____

_____

_____

_____ **[2]**

46(a). As an extension to the field work the student decided to investigate the effect of soil moisture on the germination of buttercup seeds.

The student planted *R. bulbosus* seeds into five pots and maintained the soil moisture in each pot at a different level (0%, 20%, 40%, 60% and 80%). This was repeated with seeds of *R. repens*. After four weeks the student counted the number of plants that had germinated in each pot.

Table 16 shows the results of the student's investigation.

Soil moisture (%)	Number of seedlings germinated	
	R. bulbosus	*R. repens*
0	0	0
20	23	8
40	46	15
60	16	42
80	4	33

Table 16

i. State **two** factors that should be controlled as part of this investigation.

1

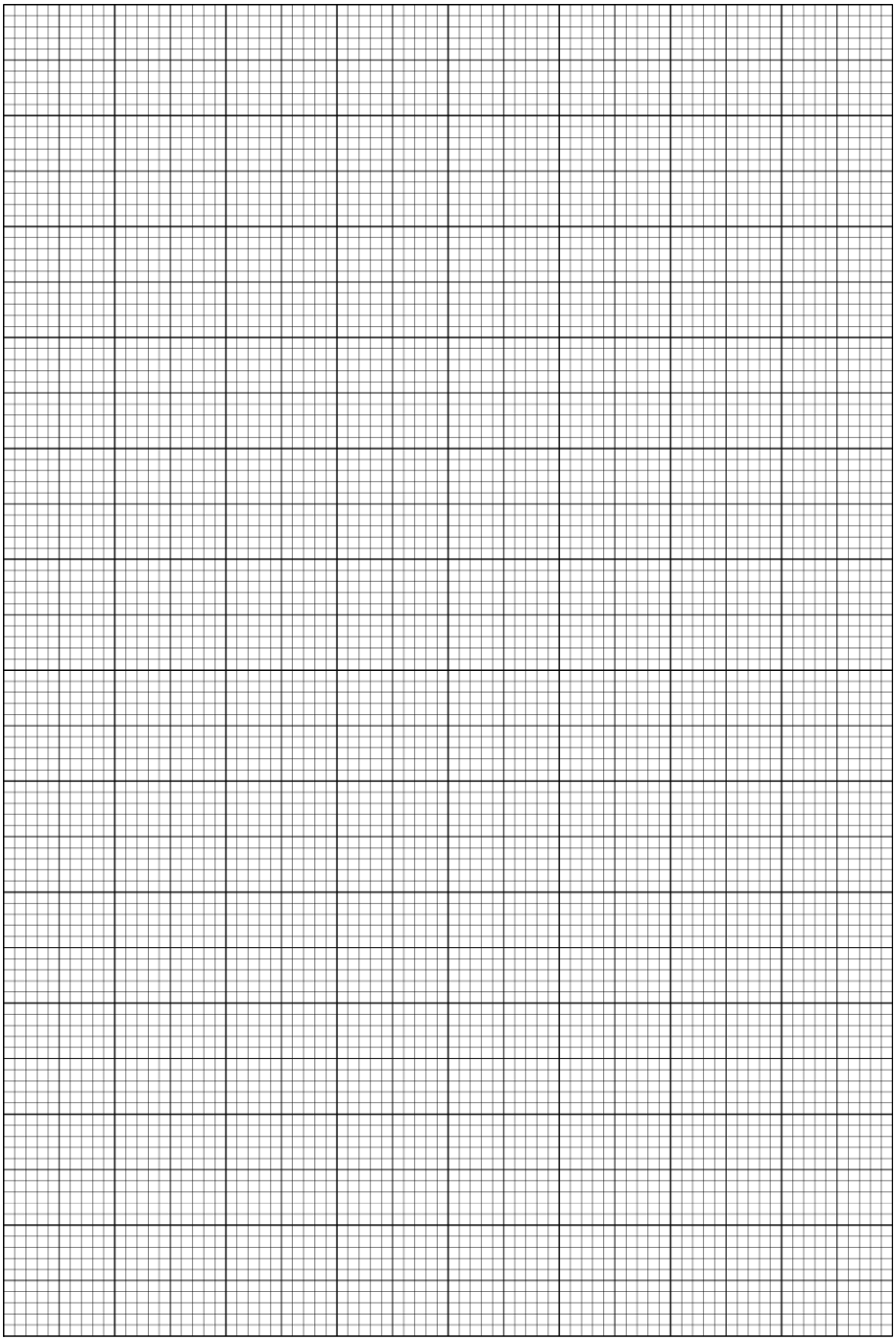
2

---

[2]

ii. Use the grid provided on page 13 to plot the results of this investigation.

[4]



(b). The student used Spearman's rank correlation to show that germination is correlated to soil moisture in *R. repens*.

The value of Spearman's rank correlation coefficient (r_s) is calculated using the formula:

$$r_s = 1 - \frac{6\Sigma d^2}{n(n^2 - 1)}$$

where d is the difference in rank within each pair and n is the number of pairs.

i. Use the following table to calculate the value of Σd^2.

Soil moisture (%)	Rank (R1)	Number of seedlings germinated	Rank (R2)	d (R1–R2)	d^2
0	1	0	1	0	0
20	2	8	2	0	0
40	3	15	3	0	0
60	4				
80	5				
				Σd^2	

[2]

ii. Use your value of Σd^2 to calculate the value of r_s.

r_s = ... **[2]**

iii. The critical value at p = 0.05 is 1.0.

What can the student conclude about the correlation between soil moisture and germination in *R. repens*?

---**[1]**

47. * Read the following five statements.

Mutations preventing lactose intolerance have occurred in humans at various times in the prehistoric past, and in all human races.

The domestication of large lactating mammals like goats and cattle arose in Europe and parts of Africa 5 000 to 10 000 years ago.

The lowest levels of lactose intolerance are found in areas that European populations colonised, like North America.

The ability of agricultural populations to digest the milk, as well as the meat, of animals, is advantageous. It adds to their general nutrition.

Until recent times the Australian aborigines had been isolated on their island continent for around 50 000 years.

Suggest how the lactose intolerance phenotype came to be present in only 5% of a population like the Europeans, but came to be present in 97% of the Australian aborigines. Use the information given above and knowledge of Darwin's theory of evolution by natural selection.

_____

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_____

_____

_____

_____

_____ **[9]**

48. State **two responses** that some plants use to defend themselves from herbivory.

_____

_____

_____

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_____ **[2]**

49. Tigers, *Panthera tigris*, are predatory mammals. They have evolved striped patterns on their fur (as shown below and in Fig. 3.1a **on the insert**), which provide camouflage in their habitats.

Fig. 3.1a

i. Adaptations can be divided into three types.

State the type of adaptation represented by the tiger's stripes.

_____ **[1]**

ii. Describe and explain how a tiger with striped fur may have evolved from a non-striped ancestor.

In your answer you should discuss the different types of genes that might be involved in the creation of the striped pattern in the tiger's fur.

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_____ **[6]**

50. Madagascar is a large island off the coast of Africa that once formed part of the mainland.

The fossa, *Cryptoprocta ferox* is the top predator on Madagascar.

The fossa shares many physical similarities with cats but it is not a member of the family Felidae. It is related to the mongoose.

The mongoose is a much smaller mammal that lives on the African mainland.

Fig. 20.2 shows a fossa and a mongoose.

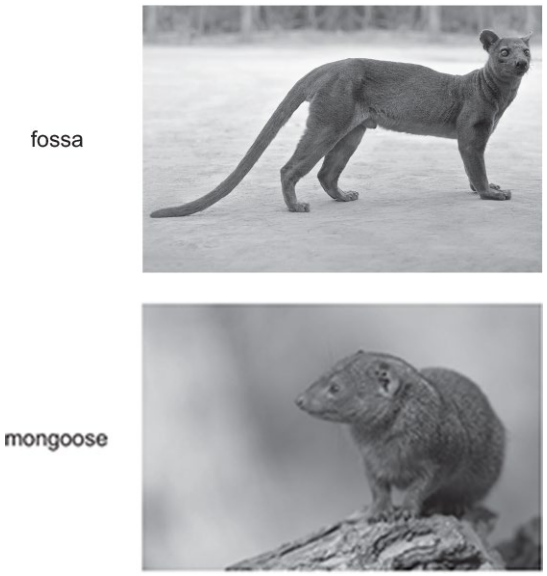

Fig. 20.2

i. The mongoose is a smaller mammal and also has proportionally longer fur. State **one** other difference, **visible in Fig. 20.2**, between a fossa and a mongoose.

_____

_____ **[1]**

ii. When the island of Madagascar became separated from the African continent, there were no members of the cat family, Felidae, on the island.
Outline how a fossa could have evolved from a much smaller, mongoose-like ancestor.

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[4]

iii. Islands, such as Madagascar, often have species that are different from those on the nearest land mass because they are reproductively isolated.
State **three** other conditions that must be present in order for speciation to occur.

1

2

3
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[3]

51. Sago pondweed is an underwater plant that grows in many regions of the world.

Sago pondweed has evolved many adaptations to its aquatic environment. Three such adaptations are described below.

Explain the advantage of each adaptation.

Adaptation 1: No waxy cuticle

Advantage

Adaptation 2: Stem tissue that contains air spaces

Advantage

Adaptation 3: A thin, flexible stem

Advantage

---

[3]

52. Mosses are small plants that live in damp conditions.

The life cycle of many mosses involves two stages: a gametophyte and a sporophyte.

The gametophyte contains haploid cells and produces sperms and eggs.

The sporophyte contains diploid cells and produces spores which can be spread easily through the air.

The spores germinate and grow into a gametophyte.

Fig. 19.2 shows the life cycle of the moss *Funaria*.

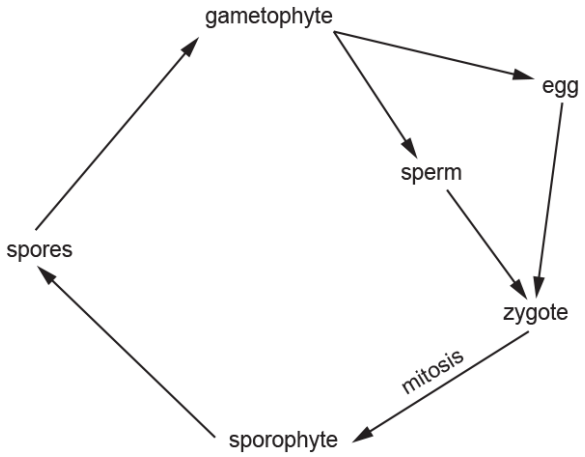

Fig. 19.2

i. The zygote grows into the sporophyte by mitosis.

The haploid gametophyte of one species of *Funaria* contains 28 chromosomes.

A single DNA molecule contains two strands.

Calculate the number of strands of DNA present in the nucleus of the zygote immediately before mitosis.

number of strands = ... **[1]**

ii. Mark an **X** on **Fig. 19.2** at the point at which meiosis occurs.

Answer on **Fig. 19.2**

[1]

iii. A diagram of a moss sperm is shown in Fig. 19.3.

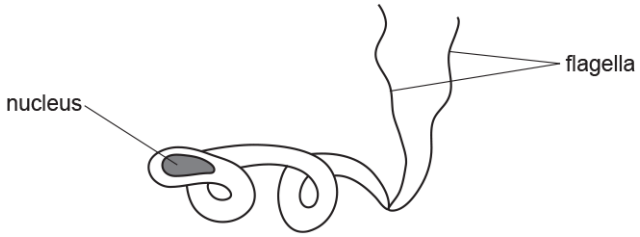

Fig. 19.3

The flagella allow the sperm to move towards an egg.

Suggest and explain another adaptation that is likely to be present in these sperm cells.

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_____

_____

_____

_____

_____ **[2]**

53. Female silver-washed fritillary butterflies, *Argynnis paphia*, are usually an orange-brown colour. However, a deep olive-green colour can be seen in some females, largely in the south of England.

i. What is the term given to this type of biodiversity?

_____ **[1]**

ii. Give one possible benefit to the species of this type of biodiversity.

_____

_____ **[1]**

54. Halophytes are plants that have the ability to live in soils with a very low water potential. In the UK these plants form part of salt marsh communities.

Suggest **and** explain how the root hairs of halophytes are able to absorb water by osmosis from the soil of the salt marsh.

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_____

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_____ **[2]**

55. Fig. 22.1 shows a transverse section of the stem of a typical pondweed viewed using a × 10 objective lens. Part of a graticule is shown below the stem. The markings on the graticule are 0.1 mm apart.

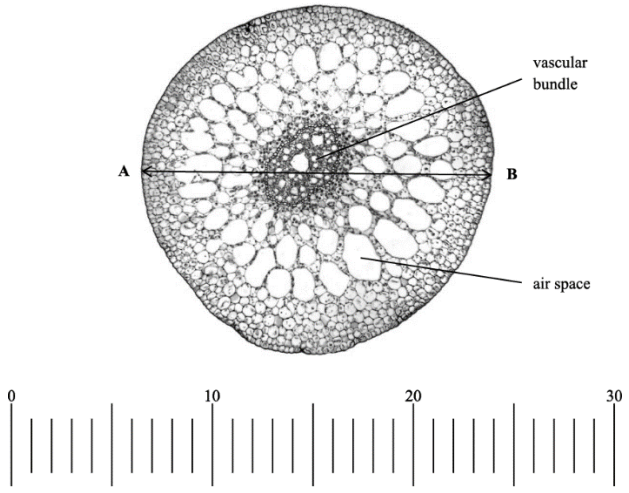

Fig. 22.1

i. Measure the width of the stem between points **A** and **B**.
Give your answer to the nearest 0.1 mm.

Answer …… **[1]**

ii. Calculate the magnification of the image in **Fig. 22.1**.

Answer …… **[2]**

iii. The thin stem and thin cell walls do not provide much support for the leaf. Suggest how the leaf is supported.

_____

_____

_____ **[2]**

56. Bats are the only mammals that have wings. Many species of bat hunt flying insects at night. Bats are able to use echolocation (sound waves) in order to help them find their prey in the dark.

i. Explain why bats and birds, despite not being closely related, have both evolved wings.

_____

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_____

_____ **[3]**

ii. Suggest why the vast majority of bird species have not evolved the ability to echolocate.

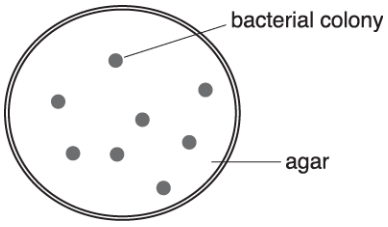
_____

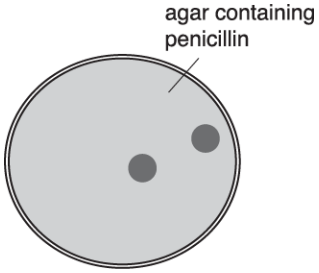
_____ **[1]**

57. An experiment was carried out to investigate the resistance of a species of bacterium to the antibiotic penicillin.

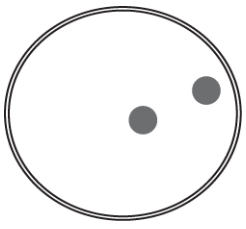
Bacteria were allowed to grow into colonies on an agar plate.

A cloth was placed onto the bacteria and then the pattern of bacterial colonies was transferred to an agar plate that contained penicillin.





Only two colonies survived and continued to grow on the agar that contained penicillin.
The bacteria in these colonies possessed a mutation that gave them resistance to the penicillin.



The original plate was flooded with a solution containing penicillin and the same two colonies continued to grow.

i. A student made the following suggestion:

> I think that the colonies on the agar containing penicillin that survived and grew did so because those bacteria evolved resistance.
> They evolved resistance as a result of being exposed to the penicillin.

Another student commented:

> But some of the bacteria in the population were already resistant, so they can't have evolved resistance because they were exposed to the penicillin.

What evidence indicates that the penicillin-resistant bacteria already existed in the population?

_____

_____

_____ **[1]**

ii. Name the process that increases the proportion of penicillin-resistant bacteria in the population.

_____ **[1]**

58. DNA codes for proteins within the cell. Some regions of DNA are described as non-coding.

i. Explain why some regions of DNA can be described as 'non-coding'.

_____

_____

_____

_____

_____ **[2]**

ii. Non-coding regions of DNA show more variation than coding regions. This makes non-coding regions useful in DNA profiling.

Suggest why non-coding regions of DNA show more variation.

_____

_____ **[1]**

59. * In the 1970s, a group of scientists studied beak sizes in one species of finch on Daphne Island, one of the Galapagos Islands. The study lasted three years. The results are shown in **Fig. 20.2**.

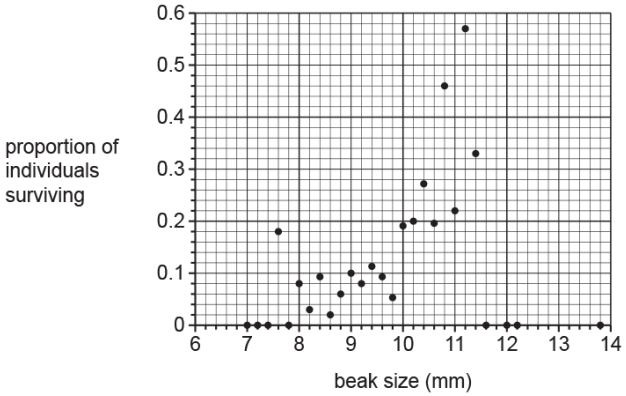


Fig. 20.2

The results suggested that stabilising selection was occurring within this population of finches.

With reference to **Fig. 20.2**, explain the effect of stabilising selection on beak size on Daphne Island.

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_____ **[6]**

60. Crude oil contains hydrocarbons.

Crude oil is often spilled from ships into the sea causing great damage to wildlife. The chemicals in crude oil are harmful to many species and do not break down quickly in the environment.

Some bacteria can break down the hydrocarbons in crude oil. These bacteria have been used by conservationists at sites where oil has been spilled.

Bacteria that are able to digest and metabolise the hydrocarbons in crude oil are more common in areas, such as around the coast of Alaska and the Gulf of Mexico, where oil spillages are common.

Suggest an explanation for this observation.

_____

_____

_____ **[1]**

61.

a. It takes time for an effective vaccine to be prepared in quantity for a new strain of bacterium.

List two vulnerable groups of people for whom you would advise doctors to prescribe antibiotics although they are **not** yet showing symptoms of the new disease.

_____

_____ **[2]**

b. Discuss the implications of the over-use of antibiotics when people do not show symptoms.

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_____ **[4]**

62. One role of the Office for National Statistics (ONS) is to collate data about the causes of death in England and Wales. Deaths involving *Staphylococcus aureus* and MRSA statistics have been produced by the ONS for each year since 1993.

S. aureus can be mentioned on a death certificate and *S. aureus* may also be specified as being methicillin resistant (MRSA).

The table shows the data for the years 1993 to 2012.

Year	Number of death certificates mentioning *S. aureus*		
	***S. aureus* not specified as resistant**	***S. aureus* specified as MRSA**	**Total**
1993	379	51	430
1994	358	90	448
1995	409	198	607
1996	445	298	743
1997	395	386	781
1998	451	409	860
1999	484	480	964
2000	476	666	1036
2001	473	731	1204
2002	421	794	1215
2003	448	968	1516
2004	461	1138	1599
2005	450	1649	2099
2006	498	1652	2150
2007	459	1593	2052
2008	270	1230	1500
2009	472	781	1253
2010	475	485	960
2011	274	364	638
2012	265	292	557

i. Calculate the percentage increase in the number of death certificates that mention MRSA from 1993 to the year when the numbers reach a peak.

Show your working and give your answer to **three significant figures**.

Answer =…… % **[2]**

ii. The proportion of death certificates that mention MRSA in 1993 is 12%.

Compare this figure with the proportion of death certificates that mention MRSA in 2012.

_____

_____

_____

_____

_____ **[2]**

iii. What can you conclude from these data about the deaths involving S. aureus and MRSA since 2007?

_____

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_____ **[2]**