# **Classification & evolution**

## Model Answers 1

Level	A Level
Subject	Biology
Exam Board	OCR
Module	Biodiversity, evolution and disease
Торіс	Classification & evolution
Booklet	Model Answers 1

Time allowed:	58 minutes
Score:	/43
Percentage:	/100 AISTRYONLINE
Grade Boundaries:	

A*	А	В	С	D	E
>69%	56%	50%	42%	34%	26%



Which of the following statements about antibiotic resistance is correct?

- A. All antibiotics cause mutations in bacterial DNA.
- B. Antibiotic resistance in bacteria is evidence to support Darwin's theory of evolution by natural selection.
- C. The development of antibiotic resistance in bacteria is an example of genetic drift.
- **D** The development of antibiotic resistance in bacteria is an example of stabilising selection.

[1]

If a random mutation takes place in a bacterium and this gives it resistance to an antibiotic then it will survive at the expense of others. The allele for this mutation will be passed on to the next generation, so over many generations the frequency of this allele in the gene pool will increase.



### **Question 2**

Biologists use both phylogeny and classification to understand how different species are related. Which of the options, **A** to **D**, is a statement about phylogeny?

A. There are 21 species of ladybird in the UK that belong to the sub-family Coccinellinae.

B. Homo sapiens and Pan bonobo share a common ancestor.

C. The lily family, Liliaceae, consists of fifteen genera.

D. The great white shark, *Carcharodon carcharias*, is a member of the class Chondrichthyes.

[1]

Phylogeny is the study of the evolutionary relationships between different species. It uses modern science, such as DNA profiling, to see how closely related they are. If they are closely related then they share a more recent common ancestor



## **Question 3**

The image below shows a European badger, *Meles meles*, which is a member of the family Mustelidae.



The American badger belongs to a different genus within the same family.

Which of the options, A to D, is the correct binomial name for the American badger?

- A. Meles leucurus
- B. mellivora capensis
- C mustelidus Everetti

D Taxidea taxus

[1]

If it's in the same family then the genus name will be different. In the binomial system this is the first word, it must also be written with a capital letter. B and C are not.

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.



<u>CHEMISTRY ONLINE</u> — TUITION — (a) 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.





Describe **two** differences between the two images that could have been used to classify humans and chimpanzees in separate families. [2]

- The chimp has shorter/thinner thumb
- Longer palms
- Thicker wrists
- Thicker fingers

Ignore more creases as this could be for other reasons and make sure to say which species

you are referring to, you can't just say 'They have .....'

(b) Differences between the nucleotide base sequences can be used to estimate the length of time since two species diverged from one another.

The greater the number of differences, the greater the length of time that has elapsed since the two organisms were part of the same species.

Fig. 19.3 shows the line of best fit for the differences in DNA between pairs of primate species plotted against the number of years since the two species diverged from a common ancestor.





(i) Calculate the rate of DNA change using the data in Fig. 19.3.

Give your answer to three significant figures.

[2]

0.177

(ii) The mutation rate in mammals can vary by as much as 20% between species.

**Use Fig. 19.3** to calculate the time since the phylogeny of humans diverged from chimpanzees, and the range over which this estimate may vary.

- 5.25 million years
- The range is between 4.2 and 6.3 million years

read the values off the graph carefully and make sure you include units otherwise

#### you lose a mark!!

(iii)\* Some scientists have suggested that humans and chimpanzees should be reclassified as belonging to the same **genus**.

Evaluate their suggestion using evidence from **Figs. 19.1 to 19.3 and** your own knowledge of the scientific basis for the classification of organisms.

[6]

[2]

- Valid as they diverged quite recently (5.25 million years ago)
- Valid as they occupy the same branch on the (phylogenetic) tree
- Invalid as chimpanzee and bonobo diverged 4 million years before
- Their anatomy is different as seen by the hand diagrams
- Phylogeny is the basis of classification
- Original classification used to use comparative anatomy
- Biochemistry is more accurate than comparative anatomy
- Scientific advances develop over time

This question needs some planning as you have been asked to use all 3 diagrams, so

use them.

Then the classic 'Use your own knowledge of the scientific basis for the

classification...'

In other words what have you revised and understood about phylogeny and

classification.

(iv) One type of gene is known as a homeobox gene.

The base sequences of homeobox genes in humans and chimpanzees are almost identical.

What conclusions about the evolutionary relationship between humans and chimpanzees can be drawn from this piece of evidence? [1]

Not much as there are very few differences between base sequences of

any animal as they are highly conserved. Any change or mutation tends to

have disastrous effects

[Total: 13]



### **Question 5**

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.

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

- They both have the same selection pressure
- Both had the same selective advantage
- Both occupy similar niches
- Alleles for these characteristics are more likely to be passed to the next generation

Note the question asks 'Why' they have both evolved wings. 'Evolved' should also give you

some direction here too

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

[1]

[3]

Birds are active during the day when visibility is good so echolocation would not give

any advantage



(b)\* The pipistrelle is the most common species of bat in Europe.

Table 5.1	shows	information	n about two	distinct	populations	of pipistrelle.
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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]

To challenge the researcher's conclusion

- They have the same body mass
- They are the same colour

so could be the same species

• Their wing spans are the same

Both arguments

- Their habitats overlap
- Their wing spans are similar
- This could indicate a difference but it's not significant
- To support the hypothesis
- Echolocation ranges do not overlap
- Echolocation is controlled by a genetic basis
- This suggests they are genetically different

The answer to this question lies entirely in the table. Some values are the same, some are

slightly different, some are completely different. However small the differences, they are



Six major groups of organisms are listed below:

animals	bacteria	plants
archaea	fungi	protoctists

(a) A teacher constructed a **dichotomous key** to help her students distinguish between each of these groups.

The key consisted of a series of questions with 'yes' or 'no' answers.

(i) The first question is shown in the box below. Complete the key by choosing the correct answer from the groups of organisms listed.



Fungi are the only group of organisms whose cell walls are made of chitin.

Bacterial cell walls are made of peptidoglycan, whereas plants and some

protoctists have walls made out of cellulose.

(ii) Write a question in the box below to distinguish plants and protoctists from the remaining groups of organisms.



[1]

Plants have cellulose cell walls and chloroplasts, some plant-like protoctists

also do, but no other group have these.

(iii) Write a question in the box below to distinguish the archaea and bacteria from animals.



[1]

Archaea and bacteria are all prokaryotic, have no membrane-bound organelles, 70S ribosomes and are always unicellular. Animals always have a nucleus, membrane- bound organelles such a mitochondria and are multicellular.

(b) (i) Fig. 6.1 is a diagram representing the taxonomic hierarchy of organisms within the animal kingdom.





State the level of taxonomic group represented by the letters **Q**, **R**, **S** and **T**. [2]

- Q phylum , R class
- S order , T family

Diagram to show taxonomic hierarchy:



(ii) Fig. 6.2 shows a diagram representing the phylogenies of some groups of organisms.



Fig. 6.2

The letter 'A' on Fig.6.2 represents a group of organisms called slime moulds.

With reference to Fig. 6.2, discuss the **classification** of slime moulds and include the range of evidence on which this classification might be based. [3]

Slime moulds can be classified as:

- eukaryotes
- This can be classified on the basis of genetics / amino acid sequences
- As genetics/ amino acid sequences are distinct from other kingdoms
- Slime mould genetics / amino acid sequences are less similar to protoctists and more similar to plants / fungi

Classification is based on genetic and amino acid sequences and how similar they are to one another. The more similar, the more closely related the organisms, due to the fact that there are fewer mutations.

(iii) State three reasons why the three-domain classification system is now used in preference to the five-kingdom system. [3]

The three domain system in now used instead of the five kingdom system because:

- 3 domains fits phylogeny better
- there are key differences between prokaryotes and eukaryotes
- eukaryotes all have a nucleus and membrane-bound organelles
- there are key differences between bacteria and archaea
- bacteria and archaea have different flagella / enzymes / DNA replication / RNA

The three domain system is based on molecular evidence. It saw that there were important differences between bacteria and archaea (which were originally grouped together). Despite being prokaryotic, archaea share many other features that are more similar to eukaryotes.

## The Three-Domain System

TABLE 10.1 S	ome Characteristics of	Archaea, Bacteria, ar	nd Eukarya	
	Archaea	Bacteria	Eukarya	
				No.
	Methanosarci	na E. co	Dli An	noeba
Cell Type	Prokaryotic	Prokaryotic	Eukaryotic	
Cell Wall	Varies in compositi contains no peptid	ion; Contains peptid oglycan	loglycan Varies in cor contains carl	nposition; bohydrates
Membrane Lipid	Composed of bran carbon chains atta glycerol by ether li	iched Composed of st ched to carbon chains of nkage glycerol by este	raight Composed of attached to carbon chair r linkage glycerol by e	of straight ns attached to ester linkage
First Amino Acid Protein Synthesi	in Methionine	Formylmethionin	ne Methionine	
Antibiotic Sensitivity	No	Yes	No	
rRNA Loop*	Lacking	Present	Lacking	
Common Arm of	tRNA <sup>†</sup> Lacking	Present	Present	

\*Binds to ribosomal protein; found in all bacteria. \*A sequence of bases in IRNA found in all eukaryotes and bacteria: guanine-thymine-pseudouridine-cytosine-guanine.

Table 10.1

[Total: 11]

# <u>CHEMISTRY ONLINE</u> — TUITION —

The leaves of flowering plants have the ability to develop differently, depending on environmental conditions such as the amount of sun or shade a leaf receives.

A student carried out an investigation into sun and shade leaves from different parts of the same plant. Her observations and results are shown in Table 6.1.

T	abl	le (	6.'	1	

type of leaf	numl	ber of leaves studied	mean no. of stomata per mm <sup>2</sup> on lower surface	mean thickness of leaf (μm)	cuticle
sun		55	170	208	thick
shade		8	92	93	thin

(a) Calculate the percentage difference in the **mean thickness** of the sun leaves compared to the shade leaves.

Show your working.

[2]

• The sun leaves have a mean thickness of 208  $\mu$ m which is (208 – 93) = 115  $\mu$ m greater

than the shade leaves

• This is 115 ÷ 93 x 100 = 124%

Remember the percentage is the difference between the two divided by the one you're

comparing it two. In this case it's the shade leaves

(b) Suggest and explain one benefit of the greater **mean number** of stomata per mm<sup>2</sup> on the lower surfaces of the sun leaves.

[2]

- The sun leaves have more stomata on the underside which allows more gas exchange
- More CO<sub>2</sub> is allowed into the leaf for photosynthesis
- CO<sub>2</sub> is needed for Calvin cycle so it will be less likely to be a limiting factor
- If it is in sunshine then there will be plenty of reduced NADP and ATP
- ATP and reduced NADP are needed to convert GP to TP
- TP can then be built up into sugars and other assimilates

You must be prepared to include the biochemistry of photosynthesis without being asked directly. Sometimes the clue will be about increased temperature and photosynthesis, in this case it's about carbon dioxide. You must reference Calvin cycle and productivity.

(c) Describe two ways in which the student could improve her investigation.

[2]

- The student didn't do as many shade leaves so sample more of those or sample a lot more leaves from sun and shade to make it more reliable
- The student should have measured the actual thickness of the cuticle
- The range of results or standard deviation should have been recorded
- The size of the leaves should have been measured
- Light intensity where the leaves were taken from
- Repeats should have been performed to give reliability

Exam tip: Accu	Exam tip: Accuracy, reliability, validity.		
Accuracy	= use narrower intervals between the independent variable		
Reliability	= at least 3 repeats to identify anomalies, calculate a mean or do a statistical test such as standard deviation		
Validity	= have all the control variables been taken into account?		

[Total: 6]