

Interactive Example Candidate Responses

Paper 4 (May/June 2016), Question 3

Cambridge International AS & A Level

Biology 9700

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- 3 Malaria is a serious and often fatal infectious disease caused by *Plasmodium*. Drugs such as chloroquine are widely used to decrease the risk of getting malaria and also to treat people who have become infected. However, in many parts of the world, *Plasmodium* populations have become resistant to chloroquine.

Sequencing the genome of *Plasmodium* and the application of bioinformatics has provided several new targets for the development of anti-malarial drugs.

- (a) (i) Define the term *bioinformatics*.

the biological data, sequences of DNA stored in
2 computer software base 3D structures of proteins and
be stored.

[2]

- (ii) Outline how sequencing the genome of *Plasmodium* and the use of bioinformatics can suggest new targets for anti-malarial drugs.

the DNA sequence of *Plasmodium* could be stored on the
computer ~~not first~~ to find the proteins that it
synthesises and make ^{3D} models of ~~the~~ ^{or enzymes} an inhibition that
could ~~no longer~~ block the active site of the enzymes ^{on the active site}
and make making its effect harmless. Or binding
previously stored ~~of~~ substances that have the same shape as
the active site. 3D structures of the enzyme made
could be displayed on the computer

[3]

Your
Mark

3(a)(i)

3(a)(ii)

3(b)(i)

3(b)(ii)

Q3	Mark scheme
(a)(i)	<p>database(s) ; computer (programs) / software ; analysis of, data / biological information / sequences ; A compare, genes / genomes [max 1]</p>
(a)(ii)	<p>1 identify / recognise, gene(s) ; A find where genes are 2 predict, primary structure / amino acid sequences, of proteins ; 3 predict 3D structure of proteins ; A tertiary 4 identify / predict, functions of proteins (from 3D structure) ; 5 ref. to drug to, bind with / block activity of / disrupt structure of, protein / enzyme ; A drug specific to protein / denature, protein / enzyme 6 drug prevents, transcription / expression, (of gene) ; I gene editing [max 3]</p>
(b)(i)	<p>cheaper ; A more economic(al) faster / can try many different drugs in a short period of time ; A time-saving can try out changes to, model / drug structure, to see if more effective ; no need for, laboratories / equipment ; I uses less labour (initially) no need for tests on, animals / humans ; A fewer ethical issues [max 3]</p>
(b)(ii)	<p>functionality / to test that drug, actually works / is effective ; A cannot assume predictions are correct / efficiency safety ; A ref. to clinical trials / side effects dosage ; A theoretical modelling will not give information on doses [max 2] [Total: 10]</p>

Your
Mark

3(a)(i)

3(a)(ii)

3(b)(i)

3(b)(ii)

- (b) In parts of the world where *Plasmodium* is resistant to chloroquine, one of the most effective anti-malarial drugs currently in use is artemisinin. Artemisinin works by binding to an enzyme in *Plasmodium* called PfATP6, acting as an inhibitor.

A substance called curcumin, which has long been used as a spice and yellow food colouring in India and other countries, is also known to act against chloroquine-resistant *Plasmodium*. A group of researchers predicted that curcumin acts by binding to the same enzyme as artemisinin.

In order to test this hypothesis, and to try to find similar substances that might work even better than curcumin, the researchers used theoretical modelling to:

look at the chemical structures of various molecules with a similar structure to curcumin (curcumin analogues)

generate a three-dimensional model of the structure of the enzyme PfATP6

investigate whether each curcumin analogue could bind to PfATP6.

The researchers predicted that several of the curcumin analogues would bind more strongly than curcumin to PfATP6.

- (i) Suggest advantages of using theoretical models in this research, rather than testing possible drugs in the laboratory.

So not to waste lab animals or materials in the lab if it does not work. To minimise the risk of the curcumin analogue released into the world if it takes a longer time to try many different drugs instead of less efficient. You can minimise the amount of drugs needed to be tested.

[3]

- (ii) Suggest why theoretical modelling cannot completely replace laboratory trials in the search for new drugs.

Because something that works in theory might not always work in real life, drugs will affect many people so the chances of it working must be above 99.1% it might have side effects that are not shown or be counter.

[2]

[Total:10]

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Sequencing the genome of *Plasmodium* and the application of bioinformatics has provided several new targets for the development of anti-malarial drugs.

- (a) (i) Define the term *bioinformatics*.

The organizing, processing, analysing of
biochemical information of an organism
into computer systems.

[2]

- (ii) Outline how sequencing the genome of *Plasmodium* and the use of bioinformatics can suggest new targets for anti-malarial drugs.

e.g. the genes that are responsible for the
resistant strain can be determined by comparing
the genome of resistance *Plasmodium*
with the genome of a regular *Plasmodium*
that were stored in bioinformatics. New
alleles are distinguished and an anti-malarial
drug for the resistant base sequence may
be developed.

[3]

Your
Mark

3(a)(i)

3(a)(ii)

3(b)(i)

3(b)(ii)

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- (b) In parts of the world where *Plasmodium* is resistant to chloroquine, one of the most effective anti-malarial drugs currently in use is artemisinin. Artemisinin works by binding to an enzyme in *Plasmodium* called PfATP6, acting as an inhibitor.

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In order to test this hypothesis, and to try to find similar substances that might work even better than curcumin, the researchers used theoretical modelling to:

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- investigate whether each curcumin analogue could bind to PfATP6.

The researchers predicted that several of the curcumin analogues would bind more strongly than curcumin to PfATP6.

- (i) Suggest advantages of using theoretical models in this research, rather than testing possible drugs in the laboratory.

testing possible drugs in the laboratory may form
a different strains of resistance Plasmodium.
testing possible drugs in the laboratory may have
a different outcome or result than if tested outside
the laboratory. Using theoretical models are is
more safer and cheaper too.

[3]

- (ii) Suggest why theoretical modelling cannot completely replace laboratory trials in the search for new drugs.

The effect of new drugs on people living organisms
is important to see, in order to observe
if any side effects might show. To test if
also to test and see the strength of drugs
(test whether they are effective or not).

[2]

[Total: 10]

Your
Mark

3(a)(i)

3(a)(ii)

3(b)(i)

3(b)(ii)

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- (a) (i) Define the term *bioinformatics*.

at Altering and changing factors in the environment to change the behaviour of a cell.

[2]

- (ii) Outline how sequencing the genome of *Plasmodium* and the use of bioinformatics can suggest new targets for anti-malarial drugs.

Sequencing the genome of plasmodium to work it and only switch on in environments where humans are vulnerable. When a mosquito is taking a meal, the plasmodium can be sequenced to not be suitable to enter the blood stream because of size or of a chemical reaction.

[3]

Your
Mark

3(a)(i)

3(a)(ii)

3(b)(i)

3(b)(ii)

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- (i) Suggest advantages of using theoretical models in this research, rather than testing possible drugs in the laboratory.

Saves time and money to firstly use theoretical models and deduce which molecules would bond to PfATP6. It is also safer to use models instead of handling with Plasmodium and to trying to extract the enzyme

[3]

- (ii) Suggest why theoretical modelling cannot completely replace laboratory trials in the search for new drugs.

In order to be 100% sure the drug works and that it has no side effects, it needs to be used in laboratory trials to make sure nothing has been missed and to gain further information on the efficiency of the drug

[Total:10]

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