3.1 Genes & Chromosomes

Question Paper

Course	DP IB Biology
Section	3. Genetics
Topic	3.1 Genes & Chromosomes
Difficulty	Medium

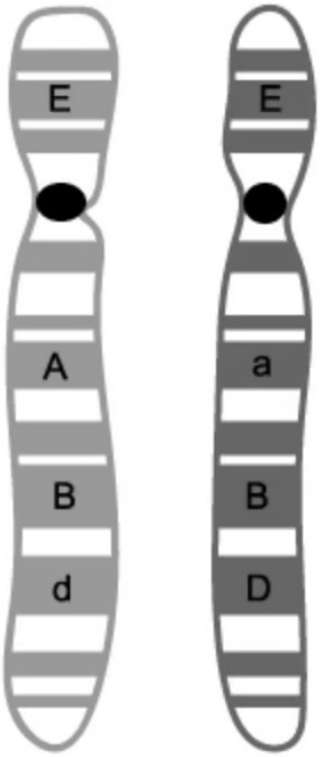
Time allowed: 60

Score: /47

Percentage: /100

Question 1a

a) The diagram shows one pair of homologous chromosomes.



i) Label the diagram to identify the following:

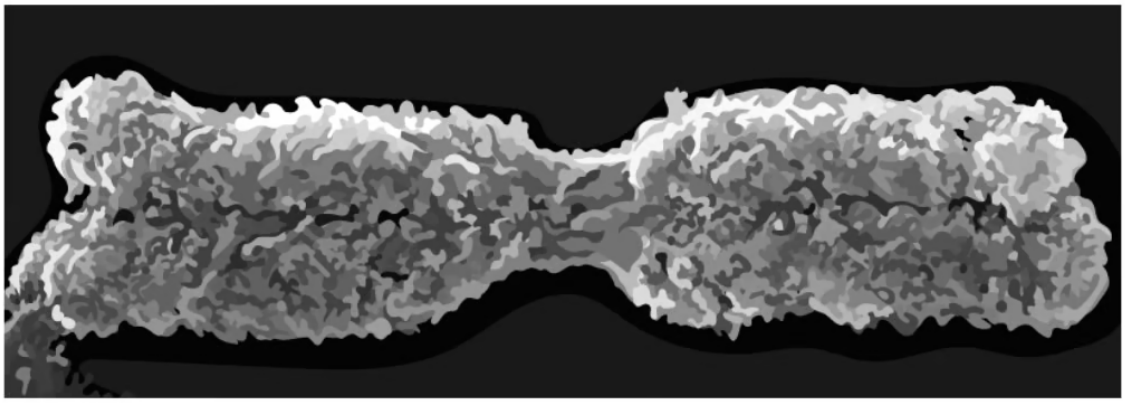
- Locus
- Centromere

ii) Draw a circle around a section of chromosome that contains a recessive allele.

[3 marks]

Question 1b

b) Outline the process which leads to the production of a chromosome with the appearance as shown in the image below, when viewed with an electron microscope.



[2 marks]

Question 1c

c) In meiosis, homologous chromosomes pair up during metaphase 1.

Explain why these homologous chromosomes are similar but not identical.

[3 marks]

Question 2a

a) The following base sequences represent sections of two different alleles of the gene which determines an individual's ability to roll their tongue.

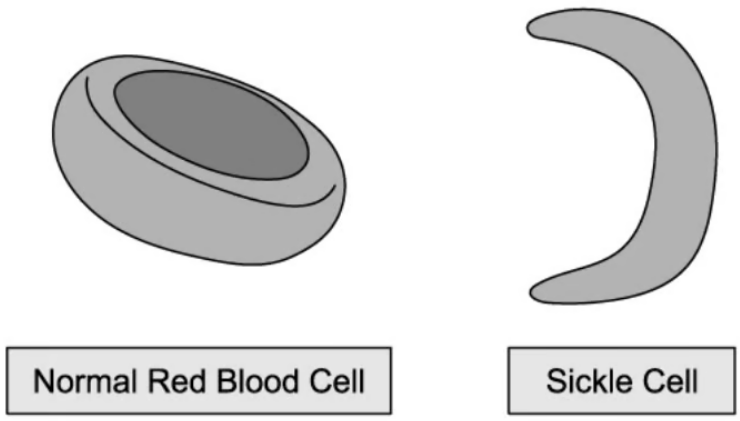
Allele A (tongue roller): GCCGTAAC
Allele B (non-tongue roller): GCGCTTAC

Outline why two different alleles result in different expressions of a gene.

[3 marks]

Question 2b

b) Sickle cell anemia is a genetic disorder with symptoms such as dizziness, a rapid heart rate and fatigue. It is caused by an allele that leads to altered haemoglobin proteins. These altered proteins undergo aggregation (sticking together), an event which changes the shape of red blood cells. This can be seen in the image below.



Suggest how sickled red blood cells may result in the symptoms noted above.

[3 marks]

Question 2c

c) Explain why the shape of white blood cells is not affected by sickle cell anaemia.

[1 mark]

Question 2d

d) Mutations such as the one seen in sickle cell patients are usually caused by an error during DNA replication.

Identify the enzyme that is responsible for catalysing the process of DNA replication..

[1 mark]

Question 3a

a) Outline the developments in technology which have enabled the successful sequencing of the genome in the Human Genome Project.

[2 marks]

Question 3b

b) Suggest **two** medical applications of genome projects like the Human Genome Project.

[2 marks]

Question 3c

c) It was decided that all data generated for the Human Genome Project would be made publicly available so that access would be free for everyone.

Suggest **one** advantage and **one** disadvantage of making scientific data publicly available.

[2 marks]

Question 3d

d) When carrying out the genome project the DNA from individuals was obtained via blood samples.

Identify, with a reason, which cell type the DNA is obtained from when using a blood sample.

[2 marks]

Question 4a

a) The human genome is approximately 3 billion, or 3 000 000 000, base pairs long. A DNA sequencing machine allows for 5.5 x 10^8 base pairs to be sequenced per hour.

Using this information calculate the number of days it would take to sequence 1500 genomes of hospital patients using this machine. Give your answer to the nearest day.

[2 marks]

Question 4b

b) The table below shows part of the DNA base sequence coding for β-haemoglobin and two mutations of this sequence detected in a sickle cell sufferer.

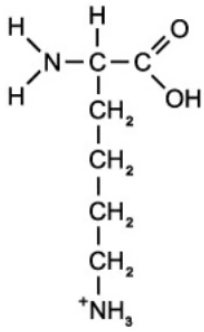
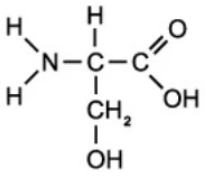
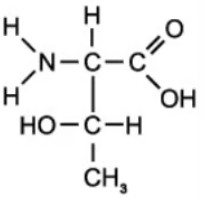
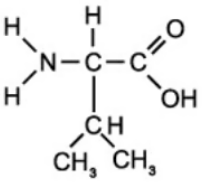
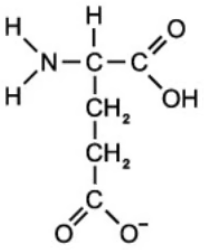
DNA base sequence coding for β-haemoglobin												
mRNA sequence for β-haemoglobin	A	C	U	C	C	U	G	A	G	G	A	G
DNA base sequence with mutation 1												
mRNA base sequence with mutation 1	A	C	U	C	C	U	G	U	G	G	A	G
DNA base sequence with mutation 2												
mRNA base sequence with mutation 2	A	C	U	C	C	U	G	A	A	G	A	G

Complete the table with the DNA sequences that will undergo transcription to produce β-haemoglobin, mutated protein **1**, and mutated protein **2**.

[3 marks]

Question 4c

c) The table below shows some examples of amino acids, their structures, and the mRNA codons that code for them.

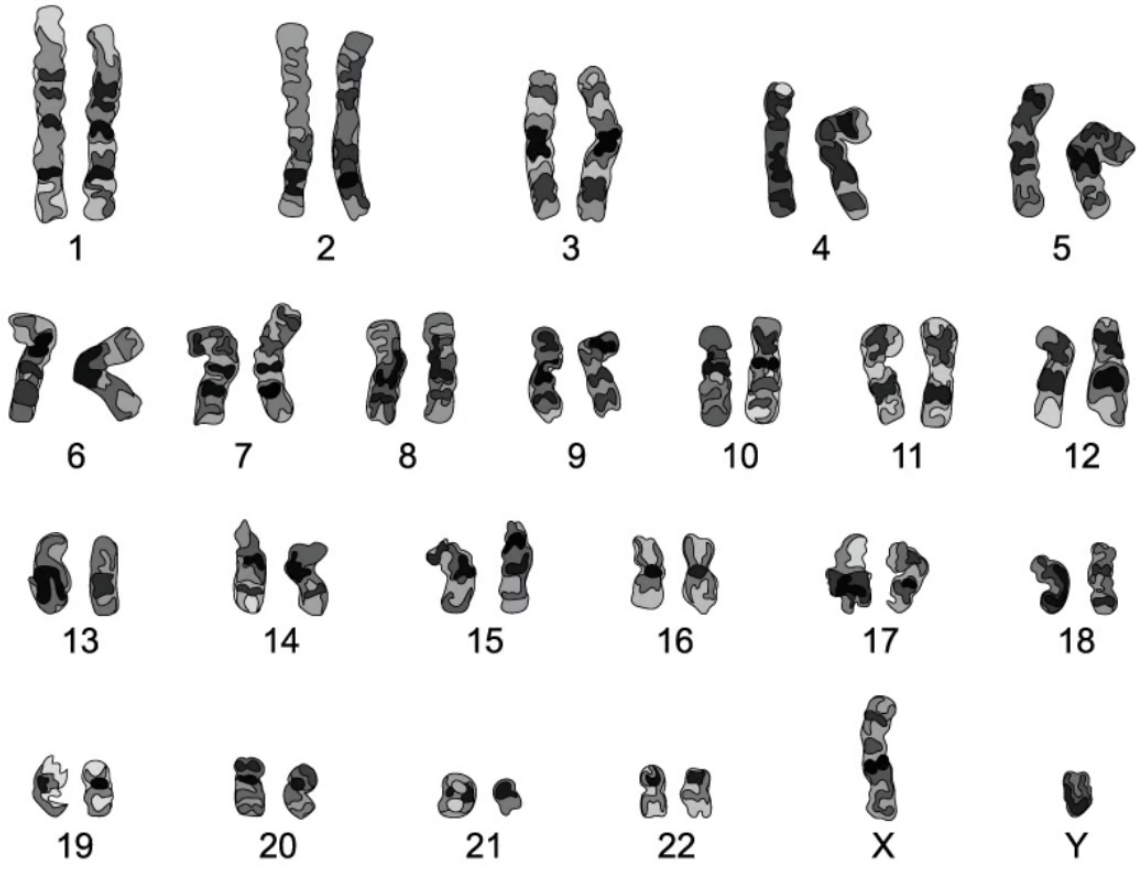
Amino Acid	 Lys	 Ser	 Thr	 Val	 Glu
mRNA codons	AAA AAG	AGU AGC	ACU ACG ACA ACC	GUU GUG GUC GUA	GAA GAG

Suggest why mutation **2** from part (b) is of no concern to the scientists studying this patient's DNA.

[2 marks]

Question 4d

d) A karyogram, such as the one shown in the image below, can be used to detect some Mutations.



State why this karyogram could not be used to detect sickle cell anaemia.

[1 mark]

Question 5a

One mark is available for clarity of communication throughout this question.

a) Outline how a mutation leads to the development of Down syndrome.

[3 marks]

Question 5b

b) Distinguish between prokaryotic and eukaryotic DNA.

[5 marks]

Question 5c

c) Outline the technique developed by John Cairns to measure the length of DNA, and how his methods contributed to further discoveries about DNA.

[7 marks]