**Stage 2 Biology**

The following examination-style questions are suitable for assessing evidence of learning in **Topic 1.** They do not constitute a complete test.

* 1. One chromosome is distinguishable from another because it
     1. is made of DNA.
     2. has specific genes.
     3. contains nucleotide bases.
     4. codes for amino acids.
  2. A genetic condition in which individuals cannot break down the sugars sucrose and maltose is due to the absence of the enzyme sucrase-isomaltase (SI). The SI gene codes for SI.

Which one of the following statements explains the absence of SI in individuals with this genetic condition?

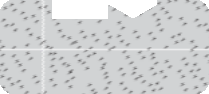
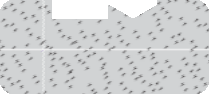
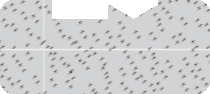
* + 1. A mutation in the SI gene.
    2. A mutation in the tRNA molecule that codes for SI.
    3. A mutation in the mRNA molecule translated from the SI gene.
    4. A mutation in SI.

*When answering the next two questions, refer to the following diagram, which shows the breakdown of sucrose by the enzyme sucrase to produce fructose and glucose:*

**B**

**C**

**A**



* 1. Which one of the following combinations identifies A, B, and C?

|  |  |  |  |
| --- | --- | --- | --- |
|  | **A** | **B** | **C** |
| J. | sucrase | active site | sucrose |
| K. | sucrose | sucrase | active site |
| L. | active site | sucrose | sucrase |
| M. | sucrase | sucrose | active site |

* 1. Which one of the following statements describes why the interaction between sucrase and sucrose lowers the input of energy required to initiate the breakdown of sucrose?
     1. The induced fit between sucrase and sucrose puts pressure on the bonds within sucrose.
     2. Increasing the concentration of sucrose increases the number of reactions with sucrase.
     3. The induced fit between sucrase and sucrose puts pressure on the bonds within sucrase.
     4. Decreasing the concentration of fructose and glucose results in more free sucrase molecules.
  2. The DNA in a single cell of the bacterium Escherichia coli contains about 4.6 million base pairs, which make up about 4400 different genes.

Which one of the following statements best explains the number of genes in an E. coli cell?

* + 1. There are about 4400 different enzymes in the cell.
    2. The cell produces thousands of different proteins.
    3. There are at least two copies of each gene in each chromosome pair.
    4. There are about 1000 base pairs in a gene.
  1. Human beings have two genes for the protein haemoglobin-β, which carries oxygen around the body.

1. Sickle-cell anaemia occurs in people who have two genes for abnormal haemoglobin-β.

At a hospital in Paris, doctors used a treatment to reverse the effects of sickle-cell anaemia in a teenager. They removed bone marrow from the teenager and added the genes for normal haemoglobin-β to the bone marrow cells. The modified bone marrow was then put back into the teenager.

The teenager has now been free of disease for 15 months.

1. State the name of the process that resulted in the gene for abnormal haemoglobin-β.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1 mark)

1. Describe how the gene for normal haemoglobin-β can be located within fragments of DNA from healthy bone marrow cells.

(2 marks)

1. Describe one method that doctors may have used to transfer the gene for normal haemoglobin-β into the teenager’s bone marrow cells.

(2 marks)

1. The genes for normal and abnormal haemoglobin-β can be removed from bone marrow cells and cut into fragments, which can be separated using electrophoresis.

*Refer to the following diagram, which shows the separated DNA fragments for three individuals (***A***,* **B** *and* **C***). The size of the DNA fragments in base pairs (bp) are shown on the left of the diagram:*

Size (bp)

38

25

20

18

8

Individual

**A B C**

Individual **A** has two genes for normal haemoglobin-β.

Individual **B** has one gene for normal haemoglobin-β and one gene for abnormal haemoglobin-β.

Individual **C** has two genes for abnormal haemoglobin-β.

1. Use the information in the diagram to determine the minimum number of sites at which the gene for abnormal haemoglobin-β was cut.

(1 mark)

(ii) On the left of the diagram, draw an arrow to indicate the direction of movement of the DNA fragments during electrophoresis. (1 mark)

1. The amount of DNA in a sample is not always enough for profiling.

State the name of the method that is used to overcome this problem.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1 mark)

* 1. Some people lack the enzyme sucrase and so cannot break down the sugar sucrose.
     1. Sucraid® Oral Solution contains the enzyme sacrosidase, which can be taken as a substitute for sucrase. The following warning is displayed on the label.

**NEVER HEAT SUCRAID® OR PUT IT IN WARM OR HOT BEVERAGES OR INFANT FORMULA.**

*Source:* Sucraid® — Information for patients, viewed 11 October 2017, [www.sucraid.net/](http://www.sucraid.net/)

Explain why sacrosidase should not be heated.

(3 marks)

* + 1. Describe the process that occurs in the nucleus of a cell and initiates the production of sucrase.

(3 marks)

* 1. Many plants synthesise amino acids in a metabolic process that involves several consecutive steps.

Glyphosate is a widely used weedkiller that prevents an enzyme from functioning properly in one of these steps, and this results in the death of the plant.

Explain how a chemical such as glyphosate can prevent an enzyme from functioning properly.

(6 marks)