To: Stage 2 Biology teachers and students

Late last year the SACE Board made some changes to the Stage 2 Biology Subject Outline. These changes were not available to the authors prior to the publication of the Essentials Workbooks. Most are minor changes, and nothing in our book is wrong, but there are a few areas where a little more information is required. This information is provided in the following pages and we suggest you copy, trim and affix these pages into the back of the Workbook for easy reference.

Any feedback to the publisher from teachers and students using this book will be most welcome and addressed in due course. During the year, the authors will collate and include this additional information in a reprint which will be available for schools to use in 2019.

The Authors

Topic 1

In Chapter 1.4, on or about page 50:

Concentration of the enzyme

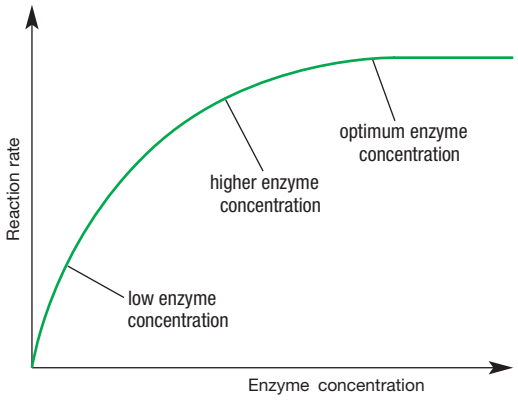
The rate of an enzyme-controlled reaction is affected by: ... the concentration of the enzyme.

The rate of an enzyme controlled reaction is also affected by the concentration of the enzyme.

Figure 1413 (adjacent) illustrates the effect of enzyme concentration on the rate of a reaction.

As the concentration of an enzyme is increased so does the reaction rate as there is ample substrate to bind with the active sites of the enzymes.

When the substrate concentration becomes a limiting factor the addition of more enzyme will not increase the rate of the reaction.



What have you learned?

1. Refer to the adjacent graph to answer the questions that follow.

   a) Describe the pattern of results comparing the different responses observed in A compared to B.

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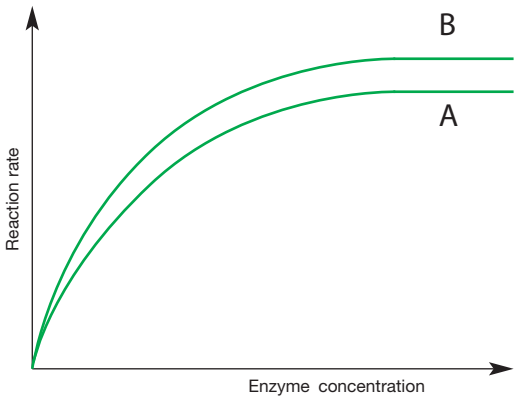

   b) Explain the most likely reason for the flat section (plateau) observed in both graphs.

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   c) Suggest the most likely reason for the differences noted in graph A compared with graph B.

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In Chapter 1.7, on or about page 92.

Electrophoresis and electropherograms

Electrophoresis is used to sequence DNA. The results may be displayed in an electropherogram.

- Describe electrophoresis.
- Interpret electropherograms that illustrate DNA sequences.

Capillary electrophoresis has mostly replaced the use of gel separation techniques but the general principles of electrophoresis still apply:

- DNA fragments move from the negative electrode to the positive electrode.
- Shorter DNA fragments move faster and further through the tube than longer ones.

Frederick Sanger, a British biochemist developed a technique called the chain termination method to sequence the DNA bases in segments of DNA. Currently the process of sequencing DNA is highly automated and carried out by DNA sequencing machines.

In sequencing DNA the strands are tagged at the last nucleotide by a specifically coloured molecule. It is the colour of the tag, detected using a laser that indicates the nucleotide at the end of the DNA fragment. Refer to *Figure 1714*

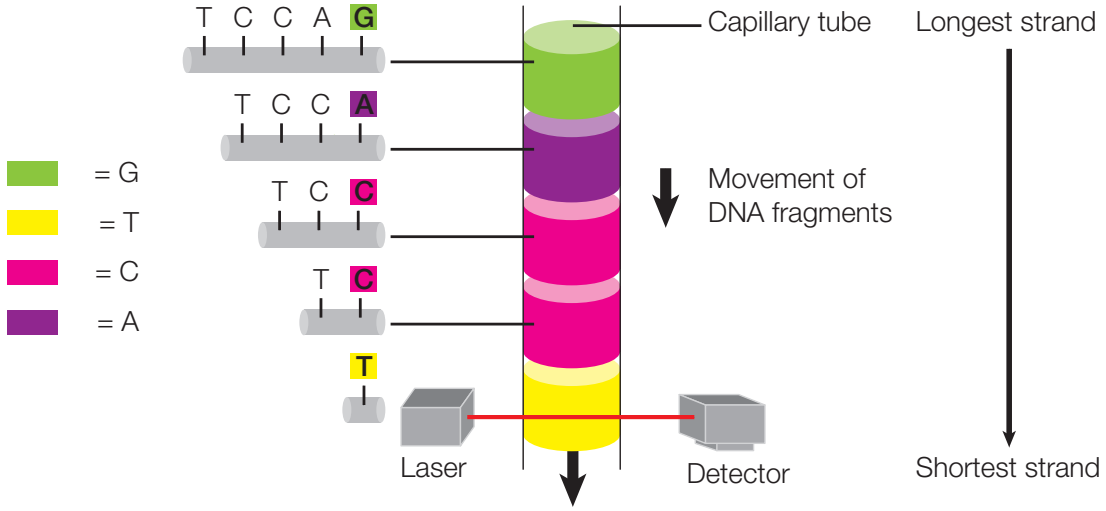

Figure 1714 The principle of electrophoresis

The graph produced is called an electropherogram where each peak signifies a specific DNA nucleotide in the DNA sequence. Refer to an example shown in *Figure 1715*.

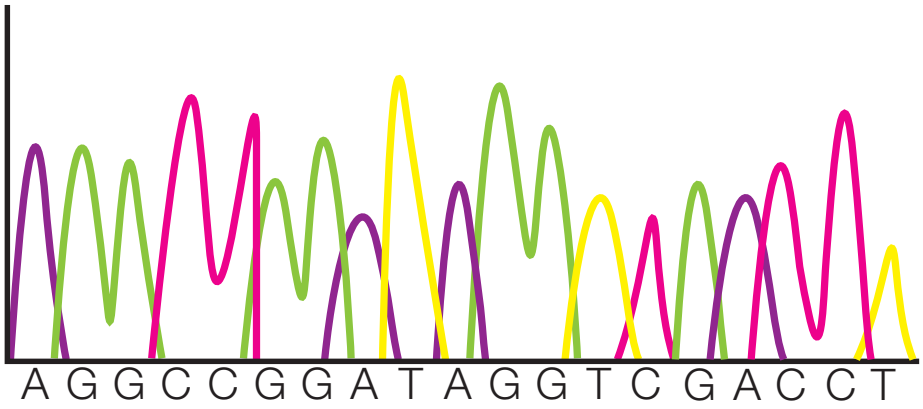

Figure 1715 An example of an electropherogram

In Chapter 1.7, on or about page 93.

DNA profiles and electropherograms

The results of electrophoresis can be used to construct DNA profiles. They may be displayed in an electropherogram or in a table of data.

- Interpret electropherograms and tables of data that illustrate DNA profiles.

Humans have about 99.9% of their DNA in common, which means they are very similar in the order, number and type of DNA bases. At several locations, however, these base pairs are different and it is these differences that enable scientists to distinguish between the DNA of different people. The variable regions that are used are called short tandem repeats(STR's) and these are known as markers that are found in specific locations known as loci – they are usually around 2-5 base pairs long – eg GATA.

The STR's are highly variable between people and this enables forensic scientists to establish which DNA belongs to which person. The length of an STR varies between individuals and are signified by a number. For example '11' implies that the allele has 11 repeating units whereas '13' implies 13 of the repeating units. Each person inherits one of the alleles from each parent.

Again using electrophoresis DNA fragments are separated by size and the information is shown by a graph called an electropherogram. See ***Figure 1716***

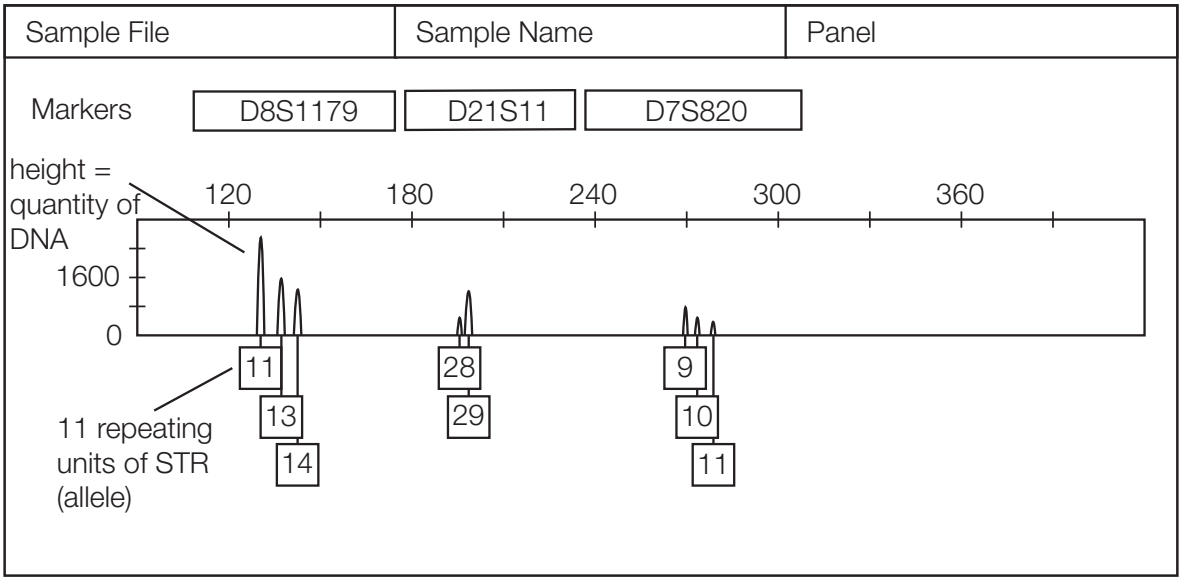

Figure 1716 Another example of an electropherogram

This type of data can also be displayed in a data table; an example is shown below.

In the example below there are 3 sets of data shown at 3 markers. One set of data is from evidence taken at the scene of a crime, the next DNA is from the suspect and the last is from the victim.

The numbers in the table represent the numbers of the repeating STR found at the allele position. Typically forensic scientists examine 13- 15 specific markers in determining someone's genetic profile.

	DNA evidence at crime scene				**Suspects DNA**				**Victims DNA**			
	Allele				**Allele**				**Allele**			
Marker	1	2	3	4	1	2	3	4	1	2	3	4
D8S1179	11	13	14	-	11	14	-	-	11	13	-	-
D21S11	28	29	-	-	29	-	-	-	28	29	-	-
D7S820	9	10	11	-	9	-	-		10	11	-	-

What have you learned?

1. Using capillary electrophoresis, DNA fragments can be separated by their molecular weight (size). A DNA sequence can be worked out using this technique and a laser to detect bases marked with fluorescent dyes.

   a) State 2 factors that may affect the rate at which molecules move through the capillary.

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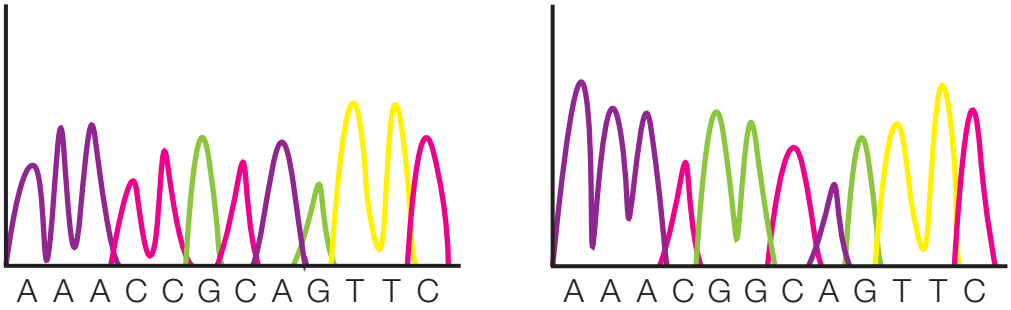
   b) Compare the DNA sequences shown below in the 2 electropherograms.



   (i) State the change which has occurred from sequence 1 (left) compared with sequence 2 (right).

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   (ii) Using your knowledge from earlier in this Topic, suggest what possible impact this might have on the polypeptide produced when this sequence is transcribed and translated.

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2. The results of electropherograms are used to construct DNA profiles and thus are key in forensic science. Refer to ***Figure 1416*** and the table to answer the questions that follow.

   a) State the importance of STR's in the production of a DNA profile of an individual.

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   b) Explain why each individual has 2 alleles for each marker shown.

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   c) Explain, giving reasons which marker does not provide strong support as to whether the suspect might be guilty.

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   d) Explain how the other 2 markers do provide evidence to support the fact that the suspect may have been at the scene of the crime.

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Topic 2

There are no significant changes in the SACE Subject Outline.

Topic 3

There is some significant re-arrangement, but very little change to the SACE Subject Outline, except for the addition of this minor point in **Chapter 3.2, on or about pages 310, 311**:

Control of carbon dioxide levels in the blood

Explain how the nervous and endocrine systems work independently or together to: ...

- monitor pH in the brain to maintain a constant carbon dioxide level

Carbon dioxide diffuses out of the blood and into the brain fluid where it reacts with water to form bicarbonate ions (HCO_3^-) and hydrogen ions (H^+) (***see below)***, the concentration of which, is detected as a change of pH.

$$CO_2 + H_2O \rightleftharpoons HCO_3^- + H^+$$

Topic 4

In Chapter 4.3 on p391: 'Hybrid unviability' is now 'hybrid inviability', otherwise no significant changes.

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Suggested answers

Enzymes (in Chapter 1.4)

1. With reference to the graphs:
   a) Both reactions increase rapidly as enzyme concentration increases until a maximum rate of reaction is reached; this is represented by the 'plateau' region of the graph. Reaction B occurs more quickly than A and plateaus at a higher rate of reaction.
   b) The substrate concentration is likely to be a limiting factor. There is ample enzyme concentration but insufficient substrate for the reaction to go faster.
   c) A likely reason is that more substrate was added in reaction B.

Electropherograms (in Chapter 1.7)

1. Regarding electrophoresis:
   a) Other than fragment size, factors include charge, temperature, gel consistency.
   b) Comparing the 2 electropherograms:
      (i) The 5th nucleotide from the left is C in sequence 1 but G in sequence 2.
      (ii) A codon has been altered and when it is translated it may lead to a different amino acid being inserted at this position in the polypeptide.
2. With reference to ***Figure 1416*** and the table:
   a) 'STR' stands for 'short tandem repeats' of bases in an individual's DNA sequence. It is known that these vary significantly between people and therefore can be used to identify them.
   b) One allele comes from each parent.
   c) In marker D21S11: The evidence contained the alleles 28 and 29, so also did the victims DNA. The suspect did not contribute a new marker at this site. However, note more of DNA at allele 29.
   d) In markers D8S1179 and D7S820: In each case the suspects DNA STRs were the alleles 14 and 9 respectively, this was also present at the evidence at the crime scene but not present in the victims DNA. This suggests that the suspect was at the crime scene.