

University of Canterbury

# Mid Year Examination and Test Period 2008

Prescription Number(s):	BCHM 201
Paper Title:	Biochemistry 1

Time Allowed: 2.5 HOURS

Number of pages: SEVEN

Answer **FIVE** questions out of six

All questions are of equal value

**TURN OVER**



## 1. (a) (8 marks)

Deduce the structure of the disaccharide trehalose, given the following experimental information:

- (i) Acid hydrolysis of trehalose gives glucose only.
- (ii) Trehalose is hydrolysed by  $\alpha$ -glucosidase, but not by  $\beta$ -glucosidase.
- (iii) Trehalose does not reduce  $\text{Cu}^{2+}$  to  $\text{Cu}^+$ .

Describe the nature of the linkage in trehalose (in the style of, e.g.,  $\beta$ -1,3).

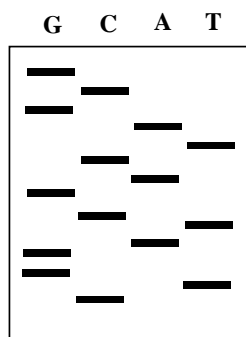
## (b) (6 marks)

Draw the structure of a typical naturally occurring fatty acid that contains 18 carbon atoms and 3 double bonds, with the first double bond occurring at position 9.

Explain why a triglyceride ester derived from this fatty acid would have a mp  $\approx 5^\circ\text{C}$ , whereas an analogous triglyceride ester incorporating the same size fatty acid but without any double bonds would have a mp  $\approx 30^\circ\text{C}$ .

## (c) (6 marks)

Deduce the sequence of bases ( $5' \rightarrow 3'$ ) in the fragment of ssDNA that yielded the following autoradiograph when the chain termination protocols were applied to the fragment and followed by gel electrophoresis.



2. (a) (8 marks)

Outline the steps required to determine the sequence of a large peptide by chemical methods.

(b) (12 marks)

A hexapeptide was found to contain the amino acids Ala, Leu, Lys, Met and Phe. Determine the sequence of this peptide given the following information:

- (i) One cycle of the Edman degradation yielded the phenylthiohydantoin (PTH) derivative of Leu.
- (ii) Trypsin had no effect on the peptide.
- (iii) Reaction of the peptide with chymotrypsin yielded a dipeptide, a tripeptide and Lys. One cycle of the Edman degradation on the tripeptide yielded PTH-Ala.
- (iv) Treatment of the hexapeptide with CNBr yielded a tetrapeptide and a dipeptide, both of which had absorptions at 280 nm in their UV spectra.

Show your reasoning in your answer.

3. (20 marks)

The three-dimensional structure of a globular protein is usually dominated by the presence of secondary structural features arising from the interplay of various types of weak bonds/interactions.

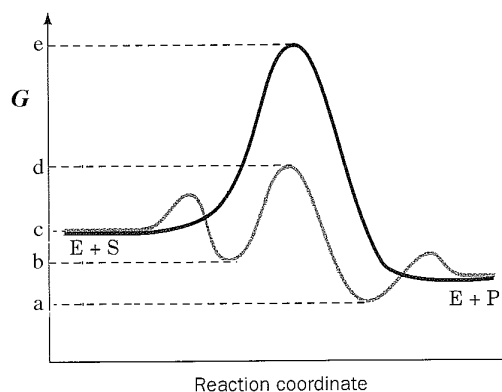
Discuss the nature and origins of these weak bonds/interactions.

Describe the secondary structural features that have been observed in protein structures, showing how the weak bonds/interactions discussed above participate in stabilizing these structural features.

4. (a) (8 marks)

The following graph represents the reaction pathways for the reaction  $S \rightarrow P$  in the presence and the absence of an enzyme E.

- (i) Identify the two points on the graph, the difference between which represents the activation energy for the enzyme-catalysed reaction.
- (ii) Identify the two points on the graph, the difference between which represents the activation energy for the uncatalysed reaction.
- (iii) Identify the two points on the graph, the difference between which represents the binding energy for S to E.
- (iv) It is said that the binding of S to E must be favorable, but not too favorable. Comment on why this should be so, and discuss some of the factors that contribute to the destabilization of the ES complex.



(b) (12 marks)

Determine the type of inhibition of an enzyme for which the following initial rate data were obtained in the presence and absence of a fixed concentration of an inhibitor I. (If you use any graph paper, put your name on the paper and hand it in with your answer book.)

[S] (mM)	$v_0$ (mM min <sup>-1</sup> )	$v_0(+I)$ (mM min <sup>-1</sup> )
1	1.3	0.8
2	2.0	1.2
4	2.8	1.7
8	3.6	2.2
12	4.0	2.4

**TURN OVER**

5. (a) A patient presented with an unusual case history, consistent with defects in oxygen transport. A blood sample was taken from the patient and the haemoglobin extracted and purified from the red blood cells.

(i) (5 marks)

One possibility was that the patient's haemoglobin had a different amino acid composition from normal haemoglobin. Describe methods you could have used to establish whether or not this was the case.

(ii) (10 marks)

Detailed analysis failed to distinguish any difference between normal haemoglobin and haemoglobin from the patient. Subsequently, an analysis of the blood serum established that the levels of 2,3-bisphosphoglycerate (2,3-BPG) in the patient were abnormally low. Explain how a low concentration of this molecule in the blood might lead to defective oxygen transport.

(b) (5 marks)

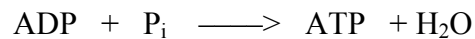
Another patient presented with similar symptoms, but in this case the analysis of amino acid composition of the haemoglobin and other indicators were consistent with the occurrence of sickle cell anaemia. Describe how a difference in amino acid composition leads to the abnormal behaviour of the haemoglobin in this condition.

6. (a) (7 marks)

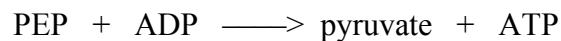
The coenzyme ATP plays a central role in the transfer of energy in cellular processes through its ability to readily transfer a phosphate group to another molecule. Describe the reasons why ATP is so able to release one of its phosphate groups.

(b) (7 marks)

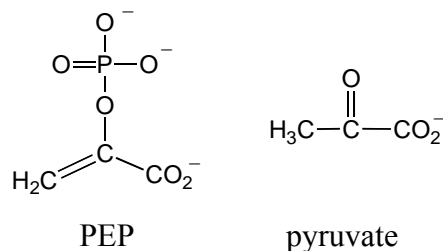
The free energy for the process



under cellular conditions is  $\Delta G = +55 \text{ kJ mol}^{-1}$ . Explain how this apparently unfavorable conversion can be made to occur with the involvement of phosphoenolpyruvate (PEP) so that the overall process of

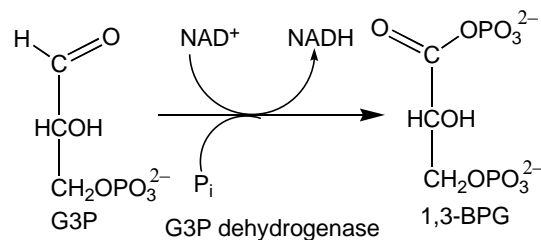


has  $\Delta G = -23 \text{ kJ mol}^{-1}$ .



(c) (6 marks)

Use suitable diagrams to show how the following conversion of glyceraldehyde-3-phosphate (G3P) to 1,3-bisphosphoglycerate (1,3-BPG), mediated by the enzyme G3P dehydrogenase and the coenzyme  $\text{NAD}^+$ , occurs.



**END OF PAPER**