PRIMARY EXAMINATION

Cell Biology and Biochemistry

Tuesday 30 November 2004
Time allowed: Two hours

INSTRUCTIONS TO CANDIDATES
There are five sections in this paper. Each section is worth 30 marks, and should take about 30 minutes to complete. Candidates are required to complete the compulsory Section 1 and THREE of the other four sections. If a candidate attempts more than three of the four optional sections, only the first three sections will be marked.

TURN THE PAGE OVER FOR SECTION 1.

SECTION 1

This section is compulsory and must be completed by all candidates.

1. Match the vitamin listed in column A with the description of its main function listed in column B. If, for example, you think that Vitamin A is a precursor for FAD and FMN, write in your answer booklet "Vitamin A- 1".

Column A	**Column B**
Vitamin A	1. Precursor for FAD and FMN
Thiamin	2. B-group vitamin that is involved in a variety of methylation reactions, including reactions in the pathways that lead to the production of purines and pyrimidines
Niacin	
Folate	
Vitamin C	3. Fat soluble vitamin, regulates growth and differentiation of epithelial cells
Vitamin D	
Vitamin K	4. Precursor for NAD^+ and $NADP^+$
Vitamin E	5. Important in the production of the active form of a number of clotting factors
Riboflavin	
Vitamin B_{12}	6. A vitamin that has hormone-like properties, because it is able to regulate the transcription of genes involved in calcium homeostasis.
	7. A B-group vitamin, which is a cofactor for an enzyme that catalyses the transfer of a methyl group from methyl tetrahydrofolate to homocysteine.
	8. A water soluble vitamin that is important in the synthesis of collagen.
	9. A fat soluble vitamin that is able to stably bind a single electron, thereby neutralising oxygen radicals
	10. Important for the synthesis of neurotransmitters, including GABA and acetyl choline

10 marks

TURN THE PAGE OVER FOR SECTION 1

SECTION 1 (CONTINUE)

2. A 22 year old female patient presents with pale oral mucosa, angular stomatitis and glossitis. List three nutritional deficiencies that could account for these observations.

3 marks

3. You obtain a brief dietary history from this patient. What would you look for to try to determine whether a nutritional deficiency could account for these signs? Explain your reasoning.

5 marks

4. The patient subsequently has a blood test that reveals a macrocytic anaemia. How does this information help you decide what is wrong with your patient? In your answer, you should discuss how a macrocytic anaemia may arise as a result of a nutritional deficiency.

6 marks

5. Why would you be concerned if your patient told you that she was 2 months pregnant? In your answer, you should discuss the molecular mechanisms that underlie any possible detrimental effect on the foetus of the mother's poor nutritional status.

6 marks

Total for Section 1 = 30 marks

TURN THE PAGE OVER FOR SECTION 2

SECTION 2

6. The absence of trophic factors, such as growth factors can induce a cell to undergo apoposis.

   a. Draw a simple diagram to show how interactions between Bcl and Bax lead to the release of cytochome C from the mitochondria in apoptosis.

   5 marks

   b. How does *p53* regulate Bcl and Bax?

   4 marks

7. Cytochrome C triggers the activation of caspases. List at least three processes that are activated by caspases.

   6 marks

8. List the five main phases of mitosis and briefly describe the main features of each phase.

   15 marks

Total for Section 2 = 30 marks

TURN THE PAGE OVER FOR SECTION 3

SECTION 3

9. Match the hormone listed in column A with the description of its properties, listed in column B. More than one description may fit a hormone. If you think that the binding of insulin to its receptor triggers the exchange of GDP for GTP on ras, write "1-Insulin" in your answer booklet.

Column A	**Column B**
Glucagon	1. The binding of this hormone to its receptor triggers the exchange of GDP for GTP on ras.
Insulin	2. The hormone binds to its receptor, the hormone-receptor complex translocates to the nucleus and activates the transcription of target genes.
Testosterone	3. Binds to a receptor that has seven-membrane spanning domains
	4. The receptor for this hormone is a tyrosine kinase
	5. Activates adenylate cyclase to increase the concentration of cAMP.
	6. This hormone stimulates the translocation of the glucose transporter GLUT 4 to the plasma membrane of muscle and adipose tissue cells.
	7. This hormone is lipid soluble and does not require its receptor to be located in the plasma membrane. Instead, the receptor is intracellular.

14 marks

10. Glucagon opposes many of the short-term effects of insulin. Describe how glucagon is able to exert a counter-regulatory effect on insulin. This question may be best answered with a simple diagram.

6 marks

11. Describe how acetyl choline, acting on endothelial cells that line blood vessels triggers a process that leads to the relaxation of smooth muscle cells in blood vessels, resulting in vessel dilatation.

10 marks

Total for Section 3 = 30 marks

TURN THE PAGE OVER FOR SECTION 4

SECTION 4

12. Fill in the following table to compare the main features of type 1 and type 2 diabetes.

	Type 1	**Type 2**
Age of onset		
Over/under weight?		
Insulin present?		
Presence of hyperglycaemia		
Presence of ketoacidosis		
Treated with insulin?		

6 marks

13. a. Explain how poor glycaemic control in a diabetic patient can lead to the production of advanced glycation endproducts (AGEs).

b. How do these compounds contribute to the onset of peripheral neuropathy in poorly controlled diabetic patients?

6 marks

14. Explain how the activation of the polyol pathway and the subsequent conversion of glucose to sorbitol can lead to:

a. Blindness

b. Impaired immune function

6 marks

TURN THE PAGE OVER FOR SECTION 4 AND 5

SECTION 4 (CONTIUNE)

15. a. Why does diabetes increase the likelihood that a patient will develop periodontal disease?

    b. Why does the presence of periodontal disease often induce a deterioration in glycaemic control in a diabetic patient?

6 marks

16. The progression to full-blown type 2 diabetes typically takes many years. Outline the various stages of the disease progression.

6 marks

Total for Section 4 = 30 marks

SECTION 5

17. a. Draw a diagram to illustrate a typical eukaryotic gene, showing the promoter region, the start codon, the initiation site and the likely location of transcription factor binding sites.

    b. How do transcription factors work to increase the rate at which a gene is transcribed to mRNA?

10 marks

18. Describe five (5) mechanisms by which the final concentration of a protein in a cell can be regulated.

10 marks

19. Outline how gene arrays may be used to detect changes in gene expression in a cancer cell line, compared to normal cells.

10 marks

Total for Section 5 = 30 marks

End of paper