

NATIONAL UNIVERSITY OF IRELAND, GALWAY
Ollscoil na hEireann, Gaillimh

Second Science Examination
2001-2002
Semester II

BIOCHEMISTRY 'The Cell Factory' (BI212)

External Examiner: Dr. D. Apps

Time allowed: Three Hours

INSTRUCTIONS:

SECTION A (20 marks)

Answer all questions.

Write answers on examination paper.

SECTION B

Answer 4 questions.

Write answers in answer books.

(20 marks per answer.)

SECTION A

Student number _____

Name _____

Only one answer is correct.

1. The conversion of 1 mol of fructose 1,6-bisphosphate to 2 mol of pyruvate by the glycolytic pathway results in a net formation of:
 - a) 1 mol of NAD^+ and 2 mol of ATP.
 - b) 1 mol of NADH and 1 mol of ATP.
 - c) 2 mol of NADH and 2 mol of ATP.
 - d) 2 mol of NADH and 4 mol of ATP.
 - e) 2 mol of NAD^+ and 4 mol of ATP.
2. During strenuous exercise, the NADH formed in the glyceraldehyde 3-phosphate dehydrogenase reaction in skeletal muscle must be reoxidised to NAD^+ if glycolysis is to continue. The most important reaction involved in the reoxidation of NADH is:
 - a) oxaloacetate \rightarrow malate
 - b) pyruvate \rightarrow lactate
 - c) dihydroxyacetone phosphate \rightarrow glycerol 3-phosphate
 - d) isocitrate \rightarrow α -ketoglutarate
 - e) glucose 6-phosphate \rightarrow fructose 6-phosphate
3. Which combination of cofactors is involved in the conversion of pyruvate to acetyl-CoA?
 - a) NAD^+ , biotin and TPP
 - b) TPP, lipoic acid and NAD^+
 - c) pyridoxyl phosphate, FAD and lipoic acid
 - d) biotin, FAD and TPP
 - e) biotin, NAD^+ and FAD
4. Which of the following cofactors is required for the conversion of succinate to fumarate in the citric acid cycle?
 - a) ATP
 - b) biotin
 - c) FAD
 - d) NAD^+
 - e) NADP^+

5. The antibiotic, antimycin A, inhibits the electron transport chain by interacting with:
- a) the NADH dehydrogenase complex.
 - b) the cytochrome bc_1 complex.
 - c) cytochrome oxidase.
 - d) succinic dehydrogenase.
6. The Photoreactive Centre involved in photosynthesis contains:
- a) one haem molecule.
 - b) a chlorophyll **a** dimer.
 - c) three carotenoid molecules.
 - d) one chlorophyll **b** molecule.
7. Cyclic photophosphorylation in plants is responsible for the synthesis of:
- a) ATP only.
 - b) ATP and NADPH.
 - c) NADPH only.
 - d) ADP and NAD.
8. β -Carotene is the precursor for which vitamin:
- a) Vitamin C
 - b) Vitamin D
 - c) Vitamin K
 - d) Vitamin A
9. The active form of vitamin D is:
- a) cholesterol.
 - b) calcitriol.
 - c) ergosterol.
 - d) testosterone.
10. Which of the following is NOT specifically required in the biosynthesis of fatty acids?
- a) biotin
 - b) acetyl-CoA
 - c) malonyl-CoA
 - d) NADH
 - e) HCO_3^- (CO_2)
11. The enzyme system for adding double bonds to saturated fatty acids requires all of the following EXCEPT:
- a) molecular oxygen (O_2).
 - b) cytochrome b_5 .
 - c) ATP.
 - d) NADPH.
 - e) a mixed-function oxidase.

12. The rate-limiting step in fatty acid synthesis is:

- a) formation of acetyl-CoA from acetate.
- b) the reaction catalysed by acetyl-CoA carboxylase.
- c) condensation of acetyl-CoA and malonyl-CoA.
- d) the reduction of the acetoacetyl group to a β -hydroxybutyryl group.
- e) formation of malonyl-CoA from malonate and coenzyme A.

13. The biosynthesis of triacylglycerols from acetate occurs mainly:

- a) in animals but not in plants.
- b) in plants but not in animals.
- c) in humans after ingestion of excess carbohydrate.
- d) in humans with low carbohydrate intake.

14. The main function of the pentose phosphate pathway is to:

- a) supply energy.
- b) give the cell an alternative pathway should glycolysis fail.
- c) supply NADH.
- d) provide a mechanism for the utilisation of the carbon skeletons of excess amino acids.
- e) supply pentoses and NADPH.

15. In humans, gluconeogenesis:

- a) helps to reduce blood glucose after a carbohydrate-rich meal.
- b) is essential in the conversion of fatty acids to glucose.
- c) can result in the conversion of protein into blood glucose.
- d) requires the enzyme hexokinase.

16. Glycogenin:

- a) is the gene that encodes glycogen synthase.
- b) is the primer on which new glycogen chains are initiated.
- c) is the enzyme responsible for forming branches in glycogen.
- d) regulates the synthesis of glycogen.
- e) catalyses the conversion of starch into glycogen.

17. Glycogen is converted to monosaccharide units by:

- a) glycogenase.
- b) glycogen phosphorylase.
- c) glycogen synthase.
- d) glucokinase.

18. Which of these amino acids is BOTH ketogenic AND glucogenic:

- a) valine
- b) histidine
- c) arginine
- d) isoleucine
- e) serine

19. Transamination reactions are catalysed by a family of enzymes, all of which require _____ as a coenzyme.

In the first step of a transamination, the coenzyme in the aldehyde form condenses with the _____ group of an amino acid via a _____ linkage.

20. The human genetic disease phenylketonuria (PKU) can result from:

- a) inability to synthesise phenylalanine.
- b) inability to catabolize ketone bodies.
- c) inability to convert phenylalanine to tyrosine.
- d) production of enzymes containing no phenylalanine.
- e) deficiency of protein in the diet.

21. Which one of the following statements correctly describes the pathway by which purine nucleotides are synthesized?

- a) The first enzyme in the pathway is aspartate transcarbamoylase.
- b) The purine rings are first synthesised, then condensed with ribose phosphate.
- c) The pathway occurs in plants and bacteria, not in animals.
- d) Inosinate is the purine nucleotide that is the precursor of both adenylylate and guanylate.
- e) The nitrogen in the purine base that is bonded to ribose in the nucleotide is derived originally from glycine.

22. Precursors for the biosynthesis of the pyrimidine ring include:

- a) glutamate, NH_3 , and CO_2 .
- b) glycine, glutamine, CO_2 and aspartate.
- c) glycine and succinyl-CoA
- d) carbamoyl phosphate and aspartate.

23. Which of the following statements about metabolism in the mammalian liver is FALSE?

- a) The enzymatic complement of liver tissue changes in response to changes in the diet.
- b) The presence of glucose 6-phosphatase makes liver able to release glucose into the bloodstream.
- c) Most plasma lipoproteins are synthesised in the liver.
- d) The liver synthesises most of the urea produced in the body.
- e) Under certain conditions, most of the functions of the liver can be performed by other organs.

24. The largest energy store in a well-nourished human is:

- a) muscle glycogen.
- b) liver glycogen.
- c) blood glucose.
- d) triacylglycerols in adipose tissue.
- e) total ATP in all tissues.

25. When blood glucose is abnormally low, the pancreas releases:

- a) insulin.
- b) glucagon.
- c) epinephrine.
- d) trypsin.
- e) glucose.

26. Long-term maintenance of body weight is regulated by the hormone:

- a) testosterone.
- b) hypothalmin.
- c) adiposin.
- d) leptin.
- e) obesin.

27. Restriction enzymes:

- a) are very specific proteases that cleave polypeptides.
- b) are very specific ribonucleases that degrade RNA.
- c) are sequence specific DNA endonucleases.
- d) catalyse the addition of a specific amino acid to a tRNA.
- e) act at the membrane to restrict the passage of certain molecules into the cell.

28. Which component of a Sanger DNA sequencing reaction is required for chain termination?

- a) DNA template
- b) oligonucleotide primer
- c) deoxynucleoside triphosphates
- d) dideoxynucleoside triphosphates
- e) DNA polymerase

29. The polymerase chain reaction (PCR) reaction mixture does NOT contain:

- a) oligonucleotide primers.
- b) DNA containing the sequence to be amplified.
- c) heat-stable DNA polymerase.
- d) all four deoxynucleoside triphosphates.
- e) DNA ligase.

30. A restriction fragment length polymorphism (RFLP) is a:

- a) variation in DNA base sequences.
- b) protein.
- c) genetic disease.
- d) plasmid vector for cloning DNA.
- e) bacteriophage vector for cloning DNA.

SECTION B

Answer 4 questions.

1. Outline the reactions of glycolysis and gluconeogenesis and describe how they are regulated.
2. Give an account of oxidative phosphorylation and describe the role of ATP synthase.
3. Outline schematically the 'dark reactions of photosynthesis' and explain how the light phase is important for the biosynthesis of plant carbohydrate.
4. Outline the main steps in glycogen breakdown and synthesis. Explain in detail how glycogen metabolism is regulated in mammalian cells.
5. Describe fatty acid biosynthesis in cells, including the intracellular location and regulation of the pathway.
6. Write an essay on the detoxification of ammonia, with emphasis on the urea cycle.
7. Describe how the concentration of glucose in the blood is hormonally regulated and explain the molecular basis for diabetes.
8. Describe the polymerase chain reaction and outline some of its applications.