DATE: December 5, 1996

PAPER NO.: 210/221

DEPARTMENT & COURSE NO.: 2.277/60.277

EXAMINATION: Elements of Biochemistry I

Final EXAMINATION

PAGE NO. 1 of 7

TIME: 2 HOURS

EXAMINERS: Drs. F. Hruska & A. Scoot

INSTRUCTIONS

1. You must mark the answer sheet with pencil (not pen).
2. Put your name and enter your student number on the answer sheet.
3. The examination consists of multiple choice questions. Choose the answer that you think is correct and record your choice on the answer sheet. There is only **ONE CORRECT** answer.
4. This exam will count for 60% of your final mark.
5. There is a blank page at the end of the exam for rough work.

LAB SECTION (Questions 1 to 10)

1. The R-group carboxyl of glutamate has a pKa of 4.2. What percentage of this group will be protonated at a pH of 4.7?

   (a) 50%   (b) 32%   (c) 100%   (d) 24%
   (e) cannot be determined.

2. The absorption spectrum of a compound can best be used

   (a) to determine its concentration.
   (b) to identify the compound.
   (c) to follow the course of a reaction
   (d) to estimate its pKa
   (e) to do none of the above.

3. What information can be determined from a Lineweaver-Burke plot of enzymatic data giving the following values: $1/v$ is 0 (zero) when $1/[s]$ is $-2.5 \times 10^2 M$?

   (a) V_{MAX} is $1.25 \times 10^2 M/min$
   (b) K_M is 0.004M
   (c) K_M is $-4.0 \times 10^{-3} M$
   (d) K_M is $-2.5 \times 10^2 M$
   (e) nothing can be determined.

4. A graph drawn from the results of the experiment performed to measure the effect of pH on the activity of alkaline phosphatase would be expected to show the following relationship:

   (a) hyperbolic
   (b) linear
   (c) sigmoidal
   (d) bell-shaped
   (e) Michaelis-Menten

5. What is reduced in the reaction between glucose and copper ion?

   (a) glucose
   (b) copper
   (c) both
   (d) neither

6.   Which of the following statements describes Seliwanoff's test?

    (i)   It is used to detect ketoses
    (ii)   It requires heat and HCL
    (iii)   A furfural intermediate is formed
    (iv)   It requires orcinol and ferric ions
    (v)   Red condensation products are formed

    (a)   (ii), (iii) and (iv)   (b)   (ii), (iii), (iv), and (v)
    (c)   (i), (ii), (iii) and (v)   (d)   (i), (ii), (iii) and (iv)
    (e)   all of the above

    For questions 7 and 8 please refer to the following:

    The chemical tests listed below are used to distinguish between different carbohydrates.
    (i)   Barfoed's test   (ii)   Benedict's test
    (iii)   Bial's test   (iv)   Molisch test
    (v)   Seliwanoff's test

7.   Which of the test(s) could be used to distinguish between ribose and glucose?

    (a)   (iii)   (b)   (i)   (c)   (ii) and (iii)
    (d)   (v)   (e)   (iv) and (v)

8.   Which of the test(s) would be best to distinguish between glucose and maltose?

    (a)   (v)   (b)   (iv)   (c)   (iii)
    (d)   (ii)   (e)   (i)

9.   True (a) or False (b): Solutions of DNA when heated show an increase in viscosity.

10.   Which of the following statements describe the role of sodium dodecyl sulfate (SDS) in the
        isolation of DNA from salmon nuclei:

    (i)   it disrupts the nuclei
    (ii)   it frees the DNA from nucleoproteins
    (iii)   it precipitates the protein
    (iv)   it precipitates the DNA
    (v)   it denatures the DNase present in the nuclei

    (a)   (i), (ii) and (v)
    (b)   (i) and (ii)
    (c)   (iii)
    (d)   (iv)
    (e)   all of the above.

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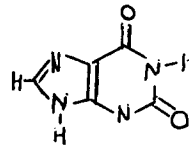EXAMINATION: Elements of Biochemistry   EXAMINER: Drs. F. Hruska & A. Scoot

PART B

11. The name of the molecule shown is:
    A) uracil B) thymidine C) guanine D) cytosine
    E) adenine   F) none of the above.

12. Which of these statements about the sugar units in RNA is correct?
    A) They are aldopentoses.   B) They are joined to the N1 atom of a purine base or the N9 atom
    of a pyrimidine base.   C) They are in a pyranose ring form.   D) When part of an RNA chain,
    they undergo interconversion between their chain and ring forms.   E) All of these statements are
    incorrect.

13. True (A) or False (B): Barbiturates are members of the pyrimidine family of molecules.

14. In developing their model for the structure of DNA, Watson and Crick did NOT make use of:
    A) x-ray diffraction patterns.   B) Chargaff's Rules.   C) Knowledge of the tautomeric
    structures of the purines and pyrimidines.   D) incorporation of ^{15}N into DNA.
    E) Molecular models.

15. Double helical DNA isolated from marine crab contains 3 mole % of guanine. The mole % of
    thymine is: A) 3%   B) 22%   C) 28% D)47%   E) 53%

16. For the reaction A $\rightleftharpoons$ B, $\Delta G° = -15$ kcal/mol. The reaction is started with 10 mmol of A; no
    B is initially present. After 24 hours, analysis reveals the presence of 5 mmol of B and 5 mmol
    of A. Which is the most likely explanation of the observations?
    A) A and B have reached equilibrium concentrations.
    B) The formation of B is thermodynamically unfavorable.
    C) The analysis described is impossible, given the fact that $\Delta G° = -15$ kcal/mol.
    D) Equilibrium has not been reached after 24 hours.
    E) The formation of B is extragonic.

17. The following reaction is catalyzed by the enzyme phosphoglucomutase (PGM) and has a $\Delta G°$
    = +1.8 kcal/mole at 25°C. (R = 1.987 cal/mol•K)

    Glucose-6-phosphate (G6P) $\rightleftharpoons$ glucose-1-phosphate (G1P)
    The equilibrium constant for this reaction is
    A) 1.76×10^{-16} B) 9.12×10^{-4} C) 4.77×10^{-2}
    D) 21.0   E) 1.10×10^{-3} F) 5.68×10^{15}

18. Use the information in Question 17 to solve this problem. If PGM is added to a solution (T =
    25°C) that contains initially 0.1 M G6P but no G1P, the solution quickly reaches equilibrium.
    Which answer best approximates the equilibrium concentrations of G6P and G1P?
    A) [G6P] = 0.095 M; [G1P] = 0.0045 M   B) [G6P] = 0.075 M; [G1P] = 0.025 M
    C) [G6P] = 0.055 M; [G1P] = 0.045 M   D) [G6P] = 0.020 M; [G1P] = 0.080 M
    E) [G6P] = 0.010 M; [G1P] = 0.090 M

19. Which one of the following is NEITHER a substrate NOR a product of the reaction catalyzed by glyceraldehyde-3-phosphate dehydrogenase?

A) Pi   B) 1,3-bisphosphoglycerate   C) NAD+   D) NADH   E) ADP

F) Each of these is either a substrate or a product.

20. During glycolysis, which of the following are products of the reaction catalyzed by phosphoglycerate mutase?

1) 2-phosphoglycerate   2) 3-phosphoglycerate   3) Pi   4) ADP   5) ATP

A) only 1.   B) only 2.   C) 1 & 3   D) 2 & 4   E) 1 & 5   F) 2 & 3

21. Which of the following enzymes catalyzes a reaction that yields a high energy phosphate bond?

A) aldolase   B) phosphoglucose isomerase   C) enolase   D) pyruvate decarboxylase

E) lactate dehydrogenase   F) pyruvate dehydrogenase

22. True (A) or False (B): The molecule below is the structure of X in the following reaction catalyzed by aldolase:

fructose-1,6-bisphosphate ---> glyceraldehyde-3-phosphate + X

$$CH_2-O-P \overset{O}{\underset{O^-}{\overset{\diagup}{\diagdown}}} O^-$$
$$H-C-OH$$
$$CH_2-OH$$

23. The NADH formed during anaerobic glycolysis is eventually oxidised by the action of which enzyme?

A) aldolase   B) glyceraldehyde-3-phosphate dehydrogenase   C) pyruvate dehydrogenase

D) lactate dehydrogenase   E) pyruvate decarboxylase

24. Which of the following best describes the products of the anaerobic glycolysis of one mole of glucose?

A) 2 lactic acid, 2 ATP   B) 2 lactic acid, 8 ATP   C) 1 lactic acid, 2 ATP, 3 CO_2

D) 2 lactic acid, 2 ATP, 2 NADH, 2 H+   E) 2 pyruvate, 2 ATP, 2 CO_2

25. The initial electron acceptor in the fermentation of glucose to ethanol is NAD+. The final electron acceptor in this pathway is:

A) pyruvate   B) acetate   C) acetaldehyde   D) ethanol   E) NADH

26. An intermediate of the Krebs Cycle was shown by chemical analysis to have exactly 5 carbon atoms and 5 oxygen atoms? The molecule is: .

A) citrate   B) isocitrate   C) α-ketoglutarate   D) malate   E) oxaloacetate

27. Which compound is NEITHER a substrate NOR a product of the reaction catalyzed by the enzyme isocitrate dehydrogenase?

A) isocitrate   B) coenzyme A   C) CO_2 D) NADH

E) Each of these is either a substrate or a product

28. In the Kreb's Cycle, malate is formed by the _____?_____ of fumarate.

A) oxidation   B) reduction   C) carboxylation   D) decarboxylation

E) hydration   F) dehydration

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29. In the Krebs Cycle, a coenzyme derivative of riboflavin is required for the step that brings about the oxidation of:
    A) isocitrate   B) succinate   C) oxaloacetate   D) malate   E) fumarate

30. The enzyme reaction in the Krebs Cycle that produces __?_ involves an "oxidative decarboxylation".
    A) isocitrate   B) malate   C) succinyl-CoA   D) oxaloacetate
    E) fumarate   F) succinate

31. Which of the following intermediates of the Krebs Cycle is the product of an enzyme reaction that involves a "substrate level phosphorylation"?
    A) malate   B) fumarate   C) succinyl coenzyme A   D) α-ketoglutarate
    E) None of these.

32. The enzyme __?_ catalyzes the formation of oxaloacetate in the Citric Acid Cycle.
    A) citrate synthase   B) malonate dehydrogenase   C) aconitase   D) fumarase
    E) none of these enzymes.

33. The conversion __?_ involves an "anaplerotic reaction".
    A) pyruvate to oxaloacetate   B) threonine to isoleucine   C) $ATP + H_2O \rightarrow ADP + Pi$
    D) α-D-glucopyranose to β-D-glucopyranose   E) citrate to isocitrate

34. The structure below is a part of __?_ .
    A) NAD+   B) FAD   C) coenzyme A
    D) lipoic acid   E) thiamine pyrophosphate

35. The enzyme that converts pyruvate to acetaldehyde during alcohol fermentation in yeast requires a coenzyme derived from the vitamin:
    A) niacin   B) riboflavin   C) thiamin   D) pantothenate   E) biotin.

36. Niacin is a vitamin whose active coenzyme usually participates with which type of enzyme?
    A) hydrolase   B) flavoprotein   C) kinase   D) dehydrogenase   E) carboxypeptidase

37. A molecule of coenzyme-A contains several units, one of which is:
    A) guanine   B) niacin   C) pantothenic acid   D) ubiquinone   E) vitamin A

38. Which of the following conversions involves a total of 5 different B vitamins?
    A) pyruvate + $CO_2 \rightarrow$ oxaloacetate   B) citrate to isocitrate   C) isocitrate to α-ketoglutarate.
    D) acetaldehyde to ethanol.   E) pyruvate to acetyl-CoA.

39. __?_ electrons are needed for the reduction of a molecule of oxygen gas (O_2) to water.
    A) 1   B) 2   C) 4   D) 6   E) 8.

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40. Which of the following statements about coenzyme Q is incorrect?

    A) It is an electron carrier.   B) Its biological activity involves an interconversion between its quinone and hydroquinone forms.   C) It transports electrons from complexes I and II to complex III of the electron transport system.   D) It has a long polar chain of isoprene units. E) It is located in the inner membrane of the mitochondrion.

41. What is the $\Delta G°$ for a pair of electrons which flow from a point at -0.35 volts to a point at $+1.25$ volts? (Faraday's constant is 23.06 kcals/volt)

    A) -73.8 kcal   B) -41.5 kcal   C) -36.9 kcal   D) $+36.9$ kcals   E) $+73.8$ kcal

42. Which of the following statements about cytochrome-c is incorrect?

    A) It is a membrane-bound protein.

    B) It is involved in electron transport in the mitochondrion.

    C) It has a heme prosthetic group that is similar to that of hemoglobin

    D) Its prosthetic group contains an iron atom.

    E) Its prosthetic group contains a copper atom.

43. Which of the following best describes the chemiosmotic gradient that drives ATP synthesis in the mitochondrion?

    A) a difference in concentration of electrons on opposite sides of the inner mitochondrial membrane.

    B) a difference in concentration of ADP on opposite sides of the inner mitochondrial membrane.

    C) a difference in oxygen concentration on opposite sides of the inner mitochondrial membrane.

    D) a high H^+ concentration in the intermembrane space and a low H^+ concentration in the mitochondrial matrix.

    E) a high pH in the intermembrane space and a low pH in the mitochondrial matrix.

44. What is the net increase in high-energy phosphate bonds when one mole of phosphoenolpyruvate (PEP) is completely metabolized under aerobic conditions?

    A) 10   B) 12   C) 14   D) 16   E) 18

45. How many of the high-energy (P~O) bonds generated during the aerobic oxidation of one molecule of glucose are formed by "Substrate Level Phosphorylation"?

    A) 2   B) 4   C) 6   D) 32   E) 34   F) 36

46. The name of molecule with the formula $CH_3(CH_2)_4CH=CHCH_2CH=CH(CH_2)_7COOH$:

    A) α-linoleic   B) oleic acid   C) palmitic acid   D) palmitoleic acid   E) stearic acid

47. The short-hand form for the fatty acid that is expected to melt at the lowest temperature is:

    A) 18:0   B) 16:0   C) 16:1   D) 14:0   E) 14:1

48. How many grams of triolein can be completely hydrogenated by 100 grams of hydrogen gas (H_2). Triolein is a simple triacylglycerol. (Atomic weights: H = 1; C = 12; O = 16)

    A) 14,733   B) 14,880   C) 15,044   D) 15,211   E) 15,380   F) 15,551

49. Which of the following BEST describes a sphingomyelin molecule?

    A) contains a sphingosine residue

    B) contains a sphingosine and one fatty acid residue

    C) contains sphingosine and two fatty acid residues

    D) contains sphingosine, two fatty acid residues and a phosphate residue

    E) contains sphingosine, two fatty acid residues, a phosphate residue, and choline.

50. Which of the following statements about biological membranes is incorrect?

    A) Membranes lipids are generally amphipathic molecules.

    B) In weight percent, lipids are always present to a greater extent than proteins.

    C) Cholesterol is an example of a steroid.

    D) Cholesterol is an important component of the membrane of human red blood cells.

    E) The Fluid Mosaic Model states that lipid molecules are free to move about, but tend to remain in one layer of the lipid bilayer.

    F) All of these statements are correct.

Answers for 2.277/60.277 Exams 96/97, 97/98 and 98/99

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	96/97	97/98	98/99	96/97	97/98	98/99
1.	B	E	D	D	E	D
2.	B	C	B	B	E	E
3.	C	C	A	B	A	A
4.	F	E	A	D	C	B
5.	A	C	C	B	B	D
6.	G	B	B	C	E	D
7.	G	B	B	A	D	A
8.	C	B	B	E	A	B
9.	D	A	C	B	B	D
10.	B	D	D	A	B	E
11.	F	D	A	F	A	A
12.	C	C	B	A	B	C
13.	B	B	B	A	C	A
14.	H	E	A	D	D	E
15.	D	E	A	D	B	C
16.	D	D	C	D	C	A
17.	F	A	A	C	A	E
18.	E	E	A	A	E	D
19.	B	B	D	E	A	C
20.	B	E	E	A	D	C
21.	F	B	B	C	D	D
22.	C	E	D	B	D	C
23.	A	A	A	D	C	C
24.	B	A	E	A	E	A
25.	A	C	B	C	E	E

Question Number	277 Midterm			277 Final		
	96/97	97/98	98/99	96/97	97/98	98/99
26.	C	B	A	C	A	B
27.	D	C	A	B	C	E
28.	E	D	A	E	E	A
29.	D	D	A	B	C	C
30.	B	B	C	C	A	B
31.	D	C	A	E	C	B
32.	E	E	B	E	E	E
33.	B	E	B	A	B	A
34.	B	A	A	B	E	B
35.	E	B	B	C	D	D
36.	D	B	B	D	A	E
37.	E	A	A	C	A	B
38.	A	C	A	E	B	C
39.	C	C	C	C	E	B
40.	C	B	B	D	B	A
41.	B	B	A	A	D	D
42.	A	C	C	E	B	C
43.	B	A	B	D	E	B
44.	D	B	C	D	A	B
45.	C	C	E	C	A	B
46.	B	B	A	A	B	E
47.	D	A	D	E	E	D
48.	D	D	B	A	C	B
49.	C	A	E	B	A	A
50.	A	B	E	B	B	E