July 18, 1999

ID number _____

Biochemistry Cumulative Exam

Consider this one a "freebie." The 50 questions on this exam came straight out of Zubay's *Biochemistry* textbook. Any self-respecting biochemist should be able to answer them (with some thought). Therefore, at least 75% of the questions must be answered correctly to pass this exam. No books, notes, or references of any kind may be used on this exam; it has been designed to test what you know. (If you do not pass it, then at least you will know what areas you need to review.)

Good luck,
K. Redding

answered correctly: _____

answered incorrectly: _____

Grade: _____

1. Each of the following subcellular structures contains DNA EXCEPT

   A. the nucleus.
   B. ribosomes.
   C. chloroplasts.
   D. mitochondria.

2. In plant and animal cells, the three-dimensional integrity of the cell is maintained, in part, by an internal network of filaments called

   A. the cell wall.
   B. the Golgi apparatus.
   C. the cytoskeleton.
   D. the endoplasmic reticulum.

3. Of the following, which are prokaryotes?

   A. viruses
   B. bacteria
   C. yeast
   D. plant cells

4. G° for the conversion of glycerol-3-phosphate to glycerol + P_i is -2.2 kcal/mole. Thus, you can conclude that

   A. this reaction will occur spontaneously.
   B. this reaction may or may not occur spontaneously, depending on the actual concentrations of reactants and products.
   C. this reaction will only occur spontaneously if it is coupled to another reaction that has a more favorable G°.
   D. this reaction is so strongly favorable that it could be coupled to drive an otherwise unfavorable cell reaction.

5. In most biochemical reactions, ΔPV is

   A. negligible
   B. positive
   C. negative
   D. dependent on ΔE

6. According to the Second Law of Thermodymnamics,

   A. the total entropy change in any reaction that occurs spontaneously must be greater than 0.
   B. the total entropy change in any reaction that occurs spontaneously must be less than 0.
   C. the total entropy of the universe remains constant.
   D. the total entropy of the universe is always decreasing.

7. Which of the following is true?

   A. Liquid and solid water have the same number of hydrogen bonds per molecule of water
   B. Liquid water has more hydrogen bonds per molecule than does solid water
   C. Solid water has more hydrogen bonds per molecule than does liquid water
   D. Hydrogen bonding is a major factor in the structure of gaseous water
   E. None is true

8. What is the pH of an aqueous solution that has a $[OH^-]$ of 3.45×10^{-5} M?

   A. 3.47
   B. 4.47
   C. 5.53
   D. 9.54
   E. none of the above

9. A peptide was found to have a molecular mass of about 650 and upon hydrolysis produced Ala, Cys, Lys, Phe, and Val in a 1:1:1:1:1 ratio. The peptide upon treatment with Sanger's reagent produced DNP-Cys and exposure to carboxypeptidase produced valine. Chymotrypsin treatment of the peptide produced a dipeptide that contained sulfur and has a UV absorbance, and a tripeptide. Exposure of the peptide to trypsin produced a dipeptide and a tripeptide. Deduce the sequence of the peptide.

   A. Val-Ala-Lys-Phe-Cys
   B. Cys-Lys-Phe-Ala-Val
   C. Cys-Ala-Lys-Phe-Val
   D. Cys-Phe-Lys-Ala-Val
   E. Val-Phe-Lys-Ala-Cys

10. Which amino acid has an R-group pKa closest to physiological pH?

    A. lysine
    B. histidine
    C. glutamate
    D. arginine
    E. aspartate

11. Which is true regarding the orientation of the R-groups in beta structures?

    A. In the parallel beta sheet structures the amino acid R-groups are all on the same side of the sheet.
    B. In the antiparallel beta sheet structure the R-groups on alternate strands are on the same side of the sheet.
    C. In parallel and antiparallel sheets consecutive R-groups on each peptide strand alternate sides of the sheet.
    D. Because of the free rotation around the alpha carbon, the R-groups can seek the least crowded region and are not restricted to a specific side of the sheet.
    E. a and b

12. A reagent commonly employed to cleave disulfide bonds in proteins is

    A. 2,4-dinitrofluorobenzene
    B. urea
    C. 2-mercaptoethanol
    D. phenylisothiocyanate
    E. cyanogen bromide

13. With respect to a relaxed muscle, which of the following is true?

A. the number of actin-myosin cross-bridges is maximized and the muscle is shortened
B. the number of actin-myosin cross bridges is maximized and the muscle is stretched
C. the number of actin-myosin cross bridges is minimized and the muscle is shortened
D. the number of actin-myosin cross bridges is minimized and the muscle is stretched
E. none of the above

14. Which of the following does not describe hemoglobin?

A. Hemoglobin is an oxygen transport protein.
B. Hemoglobin is an allosteric protein.
C. Hemoglobin has quaternary structure.
D. Copper ions are important in hemoglobin's ability to bind oxygen.
E. Hemoglobin is composed, in part, of an iron containing heme group.

15. Which of the following would allow you to determine the isoelectric point of a protein?

A. protein quaternary structure
B. protein solubility as a function of pH
C. protein size
D. protein shape
E. protein tertiary structure

16. A mixture of urease (pI = 5.1, mol. wt. 482,700), catalase (pI = 5.6, mol. wt. 247,500), lactoglobin (pI 5.2, mol. wt. 37,100) and hemoglobin (pI 6.9, mol. wt. 64,500) were applied in a pH 6.5 buffer to a DEAE-cellulose chromatography column and eluted with the same buffer. What was their order of elution?

A. urease, lactoglobin, catalase, hemoglobin
B. hemoglobin, catalase, lactoglobin, urease
C. urease, catalase, hemoglobin, lactoglobin
D. lactoglobin, hemoglobin, catalase, urease
E. cannot be determined from the information given

17. The K_m is:

A. The time for half of the substrate to be converted to product.
B. The time for all of the substrate to be converted to product.
C. The [S] that gives half of the maximum reaction rate.
D. The [S] that gives the maximum reaction rate.
E. The [P] that is produced when the enzyme is saturated with the substrate.

18. An holoenzyme is

A. a coenzyme
B. an enzyme with its cofactor
C. an enzyme lacking its cofactor
D. an allosteric enzyme
E. a cofactor

19. Some non-serine proteases contain

A. Fe^{3+} B. Mg^{2+} C. Co^{2+} D. Mn^{2+} E. Zn^{2+}

20. Under physiological conditions, which of the following processes is not an important method for regulating the activity of enzymes?

A. Phosphorylation.
B. Temperature changes.
C. Adenyl addition.
D. Disulfide reduction.
E. Partial proteolysis.

21. Which of the following will probably not affect the rate at which an intermediate in a metabolic pathway is utilized by the appropriate enzyme?

A. formation of a multienzyme complex involving the enzymes of the pathway
B. increasing availability of the substrate for the first enzyme in the pathway
C. a decrease in the concentration of the product of the last enzyme in the pathway
D. addition of water to the organism's growth medium
E. increase the temperature from 30° C to 37° C

22. The conversion of glucose to maltose

A. an equilibrium
B. a hydrolysis reaction
C. an dehydration process
D. an epimerization
E. a mirror image

23. The use of nucleotides such as GTP in a metabolic reaction is energetically equivalent to the use of ATP. This is because the GDP that is produced is rephosphorylated to GTP at the expense of ATP by which of the following enzymes?

A. adenylate kinase
B. ATPase
C. GTPase
D. nucleoside diphosphate kinase
E. phosphorylase a

24. Which of the following intermediates is a substrate for the only membrane-associated enzymatic activity in the TCA cycle?

A. citrate
B. fumarate
C. oxaloacetate
D. pyruvate
E. succinate

25. The ultimate acceptor of the electrons removed by oxidative decarboxylation in the TCA cycle is

A. NAD^+ B. $NADP^+$ C. FAD D. ATP E. O_2

26. Which of the following is the hydrophobic electron carrier which is mobile within the membrane?

A. ubiquinone
B. complex II
C. cytochrome a
D. cytochrome b
E. cytochrome c

27. Electrons from complex I are transferred directly to which of the following electron transport components?

A. complex Ia
B. complex II
C. complex III
D. cytochrome c
E. ubiquinone

28. If an antenna chlorophyll absorbs energy from a photon, which is the desired pathway for de-excitation?

A. fluorescence
B. resonance energy transfer
C. donation of the excited electron
D. return to the lower energy level with loss of energy as heat

29. The electrons transferred in the light reactions of photosynthesis end up in which molecule?

A. NADPH
B. $FADH_2$
C. water
D. oxygen
E. carbon monoxide

30. Which of the following is true concerning the peptide portion of peptidoglycans?

A. contain only amide bonds analogous to those in proteins
B. contain ester linkages
C. contain amide bonds involving the epsilon amino group of lysine
D. contain amide bonds involving the gamma carboxyl group of glutamate
E. c and d

31. Which of the following describes the most abundant energy storage polysaccharide in nature?

A. α(1,4) heteropolymer
B. β(1,4) heteropolymer
C. α(1,4) homopolymer
D. β(1,4) homopolymer
E. β(1,6) homopolymer

32. The biological role of cholesterol is which of the following?

A. to help reseal arteries which have developed leaks
B. to make membranes more fluid
C. to transfer light to P700 in photosynthesis
D. to transfer electrons to chytochrome c
E. to cause membranes to fluoresce

33. When cells of *E. coli* are placed in a solution with both D-glucose and lactose, the cells will preferentially transport and utilize the D-glucose until its concentration is depleted and then will start to import and catabolize the lactose. This phenomenon is called "diauxie." What is a likely reason for this phenomenon?

A. D-glucose is a competitive inhibitor of the lactose transport system
B. the lactose transport system is not produced until the glucose is consumed
C. carbohydrates cannot be transported until glucose catabolism produces ATP in the cells
D. the cell membrane contains an antiport system which pumps lactose out while transporting D-glucose into the cell

34. The conversion of acetoacetate to acetone

A. might be non-enzymatic
B. is facilitated by a resonance stabilized carbanion
C. changes one ketone body into another
D. occurs in the mitochondria
E. all of the above

35. Dietary fats (triglycerides) are imported into the body by which tissues?

A. adipose tissue
B. intestine
C. liver
D. pancreas
E. skin

36. In *E. coli* the last common intermediate for the synthesis of phosphatidylethanolamine and phosphatidylglygerol is

A. diacylglycerol
B. CDP-diacylglycerol
C. phosphatidylserine
D. phosphatidic acid

37. During the formation of glycocholate, cholic acid, CoASH, and ATP form cholyl-CoA, AMP, and pyrophosphate. What reaction intermediate would you expect in this process?

A. cholyl phosphate
B. cholyl adenylate
C. cholyl pyrophosphate
D. cholyl group bound to a protein by a thioester linkage

38. In animals, HMG-CoA is synthesized

A. in the cytosol and mitochondrial matrix
B. on the endoplasmic reticulum and plasma membrane
C. in the Golgi apparatus primarily
D. on the endoplasmic reticulum and outer mitochondrial membrane
E. on the plasma membrane

39. Although only one amino acid is synthesized by the histidine pathway, the pathway is connected to another pathway responsible for the synthesis of

A. pyrimidine nucleotides
B. coenzyme A
C. flavonoids
D. Purine nucleotides
E. heme

40. Which of the following amino acids does not play an important role in the active site of serine proteases?

A. Lysine
B. Serine
C. Histidine
D. Aspartate
E. None of the above

41. The protein thioredoxin is involved in which of the following processes?

A. The reduction of cysteine residues.
B. The phosphorylation of cysteine residues.
C. The oxidation of cystine residues.
D. The reduction of cystine residues.
E. The deamination of cystine residues.

42. Vitamin B_{12} contains which of the following metals?

A. magnesium
B. copper
C. cobalt
D. chromium
E. zinc

43. Which of the following processes does not describe the action of NAD^+?

A. It is an oxidizing agent.
B. It is a hydride ion acceptor.
C. It is a reducing agent.
D. It is an electron acceptor.
E. It is a water soluble substrate.

44. Regulated enzymes frequently exhibit a higher-order response to substrate concentration than non-regulated enzymes, which are commonly first-order. If enzyme "G" is first-order and enzyme "N" is fourth-order,

A. enzyme N will be more sensitive to changes in substrate concentration than enzyme G.
B. enzyme G is said to be cooperative.
C. a graph of velocity versus substrate concentration for enzyme G will have the shape of a parabola.
D. enzyme G will require energy from ATP to produce a product, but not enzyme N.

45. A β-D-aldopentofuranose has how many chiral carbons?

A. 0 B. 2 C. 3 D. 4 E. 5

46. Which of the following conversions is catalyzed by the enzyme 3-phosphoglycerate kinase?

A. glycerate-2-phosphate to phosphoenol pyruvate
B. glycerate-3-phosphate to glycerate-2-phosphate
C. glycerate-1,3-bisphosphate to glycerate-3-phosphate
D. glyceraldehyde-3-phosphate to dihydroxyacetone phosphate

47. Lipid components of membranes do not readily move from one side of a bilayer to the other.

A. true B. false

48. Phosphatidylinositol

A. only functions as an intermediate in the biosynthesis of of phosphatidylinositol-4 phosphate in eukaryotes
B. does not occur in the membranes of eukaryotes
C. constitutes about 5 % of the phospholipids in prokaryotes
D. may be converted to two phosphatidylinositol derivatives that yield cellular second messengers in animal cells

49. How many molecules of δ-aminolevulinate are required to make one molecule of porphyrin?

A. 2
B. 4
C. 6
D. 8
E. none of these

50. The nucleotide, dGTP, consists of

A. guanine, ribose, and three phosphoryl groups
B. GMP plus two phosphoryl groups
C. guanine, 2-deoxyribose, and three phosphoryl groups
D. guanosine, 2-deoxyribose, and three phosphoryl groups

Answer Sheet for Test “Cume 7/99”, 7/16/99

No. in Q-Bank	No. on Test	Correct Answer
1	29	1	B
1	3	2	C
1	4	3	B
2	29	4	B
2	3	5	A
2	4	6	A
3	24	7	C
3	2	8	D
4	21	9	D
4	2	10	B
5	21	11	C
5	2	12	C
6	22	13	D
6	2	14	D
7	20	15	B
7	2	16	B
8	26	17	C
8	2	18	B
9	24	19	E
10	16	20	B
12	11	21	D
13	17	22	C
14	18	23	D
15	14	24	E
15	17	25	E
16	15	26	A
16	19	27	E
17	14	28	B
17	18	29	A
18	33	30	E
18	4	31	C
19	4	32	B
20	3	33	B
21	34	34	E
21	4	35	B
22	4	36	B
23	27	37	B
23	3	38	A
24	25	39	D
9	6	40	A
10	12	41	D
11	16	42	C
11	11	43	C
12	8	44	A
13	10	45	D
14	8	46	C
19	28	47	A
22	11	48	D
25	24	49	D
26	6	50	C