NAME _____

FINAL EXAM
December 17, 2000
Biochemistry I
BI/CH 421/621

I. _____/75

II. _____/27

III. _____/32

IV. _____/66

TOTAL _____/200

I. <u>MULTIPLE CHOICE</u>. (75 points; 3 points each)
Choose the BEST answer to the question by circling the appropriate letter.

1. Which of the following is *not* a reducing sugar?

   A. ribose
   B. glucose
   C. fucose
   D. glyceraldehyde
   E. sucrose

2. What compound allows you to visualize DNA in an agarose gel?

   A. cyanogen bromide
   B. ethidium iodide
   C. Z-DNA
   D. ethidium bromide
   E. Coomassie blue

3. Suppose that you have two bacterial species, one isolated from a hot spring (average temperature, 50 °C) and the other isolated from a glacial lake (average temperature, 4 °C). Which of the following statements about the membrane composition of the "hot" and the "cold" species is probably true?

   A. "Hot" membranes contain more unsaturated fatty acids than "cold."
   B. "Hot" membranes contain longer-chain fatty acids than "cold."
   C. "Cold" membranes contain longer-chain fatty acids than "Hot" membranes.
   D. "Hot" membranes will contain more cholesterol than "cold."

4. In a double-stranded DNA molecule of random sequence, which of the following restriction endonucleases will cut the molecule LEAST often? (In the sequence of bases for each recognition site, N=any base, R=purine, and Y=pyrimidine.)

	<u>Restriction enzyme</u>	<u>Recognition site</u>
A.	*Alu* I	AGCT
B.	*Bgl* I	GCCNNNNNGGC
C.	*Sfi* I	GGCCNNNNNGGCC
D.	*Bsp*M I	ACCTC
E.	*Hin*d II	GTYRAC

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5. Which of the following statements about membrane lipids is true?

   A. Lecithin (phosphatidylcholine), which is used as an emulsifier in margarine and chocolate, is a sphingolipid.
   B. Glycerophospholipids contain fatty acids linked to glycerol through amide bonds.
   C. Some sphingolipids include oligosaccharides in their structure.
   D. Glycerophospholipids are found only in the membranes of plant cells.

6. The macromolecules that serve in the storage and transmission of genetic information are:

   A. carbohydrates.
   B. lipids.
   C. nucleic acids.
   D. proteins.
   E. both A and B.

7. Isolation of a 1000-basepair (bp) plasmid yielded 1.0 mL of a DNA preparation. When an aliquot was diluted 1:100 it had an absorbance of 0.1 at 260 nm. From the concentration in A_{260}/mL and assuming 500 gm/mole-bp, the molar concentraion of your preparation is ____. [recall the conversion factor of 50 μg/O.D.$_{260}$]

   A. 1 mM
   B. 1 nM
   C. 500 mg/mL
   D. 10 mg/mL
   E. 1 μM

8. Which of the following is *not* a fat-soluble vitamin?

   A. A B. C C. D D. E E. K

9. Which of the following amino acid residues is *not* a point of oligosaccharide attachment in glycoproteins?

   A. Thr B. Gly C. Ser D. Asn

10. The shortest □ helix that will span a membrane bilayer has about _____ amino acid residues.

    A. 5 B. 15 C. 50 D. 100 E. 200

11. The reference compound for naming D and L isomers of sugars is:

    A. glucose.
    B. glyceraldehyde.
    C. ribose.
    D. fructose.
    E. sucrose.

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12. Which of the following is true of sphingolipids?

A. Phosphatidylcholine is a typical sphingolipid.
B. They always contain glycerol and fatty acids.
C. They may be charged, but are never amphipathic.
D. Cerebrosides and gangliosides are sphingolipids.

13. Which of the following types of enzyme inhibitors changes the K_M, while having no effect on the V_{max}?

A. Irreversible
B. Noncompetitive
C. Competitive
D. Uncompetitive
E. Suicide

14. Which of the following monosaccharides is *not* a carboxylic acid?

A. glucuronate
B. glucose
C. gluconate
D. muramic acid

15. Which of these is a general feature of the lipid bilayer in all biological membranes?

A. Polar, but uncharged, compounds readily diffuse across the bilayer.
B. Individual lipid molecules are free to diffuse laterally in the surface of the bilayer.
C. Individual lipid molecules in one face (monolayer) of the bilayer readily diffuse (flip-flop) to the other monolayer.
D. The bilayer is stabilized by covalent bonds between neighboring phospholipid molecules.

16. When two carbohydrates are epimers:

A. they rotate plane-polarized light in the same direction.
B. they differ in length by one carbon.
C. one is an aldose, the other a ketose.
D. one is a pyranose, the other a furanose.
E. they differ only in the configuration around one carbon atom.

17. Heterotrophs re-cycle carbon in the biosphere by _____.

A. breathing in carbon dioxide and making sugar
B. breathing in oxygen and breathing out carbon dioxide
C. ingesting reduced carbon compounds and breathing out carbon dioxide
D. ingesting sugar and breathing in carbon monoxide

18. From the abbreviated name of the compound Gal(□1□ 4)Glc, we know that:

A. the glucose residue is the □ anomer.
B. the galactose residue is at the reducing end.
C. C-4 of glucose is joined to C-1 of galactose by a glycosidic bond.
D. the compound is dextrorotatory.
E. the glucose is in its pyranose form.

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19. For the reaction A⇌B, $\Delta G^{\circ\prime}$ = -14 kcal/mol. The reaction is started with 10 mmol of A; no B is initially present. After 24 hours, analysis reveals the presence of 2 mmol of B, 8 mmol of A. Which is the most likely explanation?

A. A and B have reached equilibrium concentrations.
B. Formation of B is thermodynamically unfavorable.
C. The result described is impossible, given the fact that $\Delta G^{\circ\prime}$ is -14 kcal/mol.
D. B formation is kinetically slow; equilibrium has not been reached by 24 hours.
E. An enzyme has shifted the equilibrium toward A.

20. Stereoisomers that are non-superimposable, complete, mirror images of each other are known as:

A. enantiomers.
B. diastereoisomers.
C. chiral compounds.
D. anomers.
E. cis-trans isomers.

21. An *E. coli* mutant lacking in DNA polymerase I (*polA*) activity would be defective in DNA ____.

A. exonucleolytic activity
B. transcription
C. replication & repair
D. unwinding
E. recombination

22. Which of the following is true for both prokaryotic and eukaryotic gene expression?

A. After transcription, a 3'-polyA tail and a 5'-cap are added to mRNA.
B. Translation of mRNA can begin before transcription is complete.
C. RNA polymerase may recognize a promoter region upstream from the start of transcription.
D. mRNA is synthesized in the 3'- to 5'-direction.
E. The mRNA is always colinear to the gene from which it was copied.

23. During a typical day each ATP molecule in your body is phosphorylated and dephosphorylated _____.

A. causing multiple mutations in DNA
B. twice
C. over a thousand times
D. 10,000 times
E. which is mainly to release heat to keep you warm

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24. When erythrocyte membranes are treated extensively with trypsin, most membrane proteins are broken down into small peptides, but a few proteins are completely resistant to trypsin action. A reasonable explanation for this observation is that trypsin-resistant proteins:

A. contain no Lys or Arg residues.
B. contain no Met residues.
C. move from the outside surface of the membrane to the inside surface in the presence of trypsin--thus avoiding degradation.
D. are integral proteins, buried in the lipid bilayer.

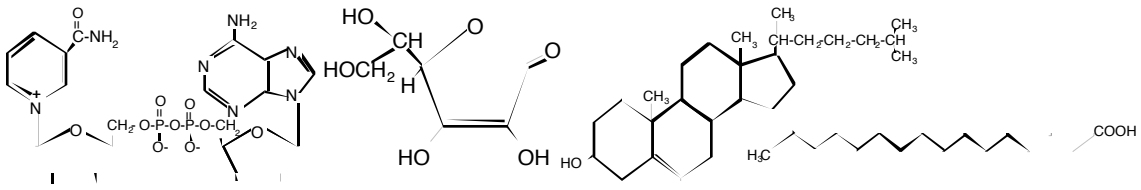
25. The reaction of two amino acids to form a dipeptide is a(n):

A. cleavage.
B. condensation.
C. group transfer.
D. oxidation-reduction.
E. rearrangement.

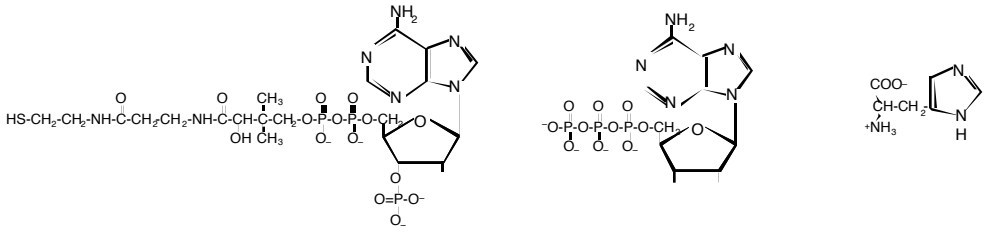
II. <u>STRUCTURES</u>: INDENTIFICATION & FUNCTION (23 points)

26. Draw the structure of the repeating basic unit of (a) amylose and (b) cellulose. (6 pts)

27. Identify the following structures by putting the name in the blank below the structure (abbreviations acceptable). For a), e), and f), use an arrow to identify the <u>functional</u> atom or group for each molecule. (17 pts)



a)_____ b)_____ c)_____ d)_____



e)_____ f)_____ g)_____

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III. MATCHING. (32 points)

28. Match these molecules to their biological roles.

____1.	carbohydrate storage in animal liver	A.	proteoglycan
____2.	extracellular matrix of animal tissues	B.	starch
____3.	blood clotting factor inhibitor	C.	chitin
____4.	carbohydrate storage in plants	D.	cellulose
____5.	polyanionic acid-sugar that forms main stalk of proteoglycans	E.	glycogen
____6.	structural component of plant cell walls	F.	hyaluronic acid
____7.	disaccharide	G.	lactose
____8.	exoskeleton of insects	H.	heparin

IV. SHORT ANSWER. (66 points)
Give a **brief** answer as directed to each problem or question below.

29. The four peptides below resulted from fragmenting a larger polypeptide, which itself was generated from a larger protein. Each of the four fragments was separated and sequenced by Edman degradation.
a) Determine the sequence of the original polypeptide (show reasoning).
b) What was likely used to generate each of these four fragments? c) What was likely used to generate the larger polypeptide? (12 pts)

Fragment 1 IAGKPM(homoserine-lactone)
Fragment 2 GRAHHDRIPAGF
Fragment 3 QCVYGR
Fragment 4 IPAGFAYIAGK

30. Differentiate between configuration and conformation. (6 pts)

31. A chemist working in a pharmaceutical lab synthesized a new drug as a racemic mixture. Why is it important that she separate the two enantiomers and test each for its biological activity? (5 pts)

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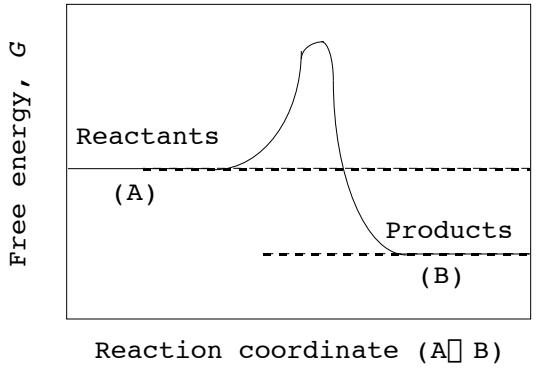
32. Recently a re-evaluation of x-ray crystallographic structures of myoglobin and hemoglobin has revealed that CO binds adequately in a perpendiclar position to the heme, not forced into a "bent" unfavorable conformation as described in your textbook. Recall that it was previously thought that the distal His acts as a steric hinderance to carbon monoxide and this helps hemoglobin counteract the higher affinity CO has for the free heme as compared to O_2. From what you know about molecular forces and binding sites in proteins, propose an alternate explanation for why the binding of O_2 relative to CO might be favored in hemoglobin compared to the free heme (and thus why we don't all die from CO poisoning). (10 pts)

33. Draw the structures of the following functional groups,pH 7.0: (8 pts)
(a) hydroxyl (b) carboxylate (c) amino (d) phosphoryl

34. (a) On the reaction coordinate diagram shown below, label the transition state and the overall free-energy change (ΔG) for the uncatalyzed reaction A ⇌ B. (b) Is this an exergonic ($-\Delta G$) or endergonic ($+\Delta G$) reaction? (c) Draw a second curve showing the energetics of the reaction if it were enzyme-catalyzed. (8 pts)



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35. (a) List FOUR types of noncovalent interactions that are important in providing stability to the three-dimensional structures of macromolecules. (b) Why is it important that these interactions be noncovalent, rather than covalent, bonds? (11 pts)

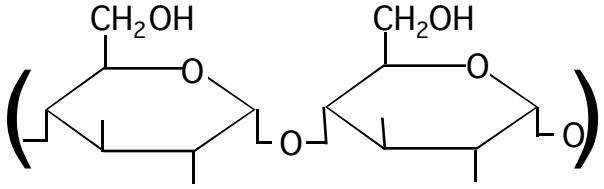
36. You are given a solution containing an enzyme that converts B into A. Describe what you would do to determine the specific activity of this enzyme solution. (6 pts)

Answer Key for Final 2000

No. on Test	Correct Answer
1	E
2	D
3	B
4	C
5	C
6	C
7	E
8	B
9	B
10	C
11	B
12	D
13	C
14	B
15	B
16	E
17	C
18	C
19	D
20	A
21	C
22	C
23	C
24	D
25	B

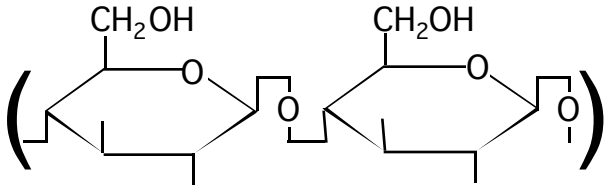
26

(a) The structure of amylose:



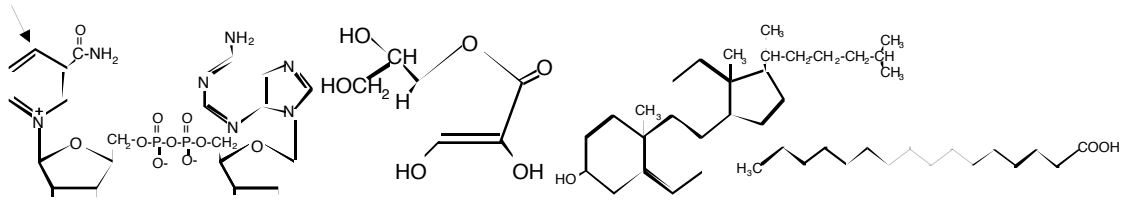
The repeating unit is α-D-glucose linked to α-D-glucose; the glycosidic bond is therefore (α1→4)

(b) Cellulose has the same structure as amylose, except that the repeating units are β-D-glucose, and the glycosidic bond is (β1→4):

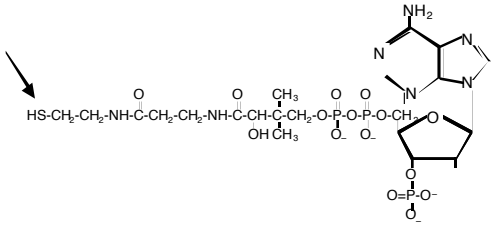


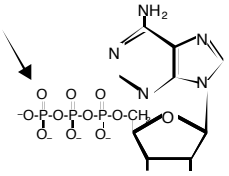
No. on Test | Correct Answer

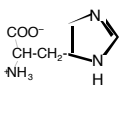
27



a) NAD+ b) Vitamin C c) cholesterol d) Palmitic acid







e) Coenzyme A f) ATP g) histidine

28

E
A
H
B
F
D
G
C

29

a) QCVYGR
GRAHHDRIPAGF
IPAGFAYIAGK
IAGKPM
QCVYGRAHHDRIPAGFAYIAGKPM

b) Fragments 1 & 2; chymotrypsin
Fragments 3 & 4; trypsin

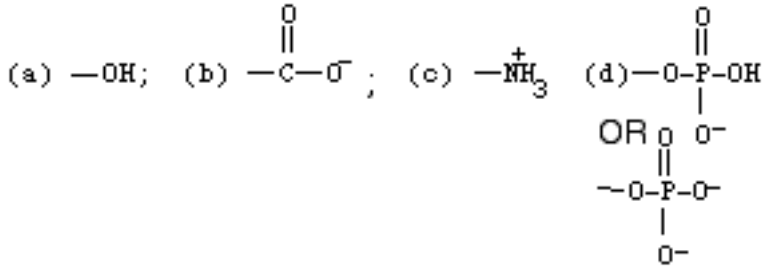
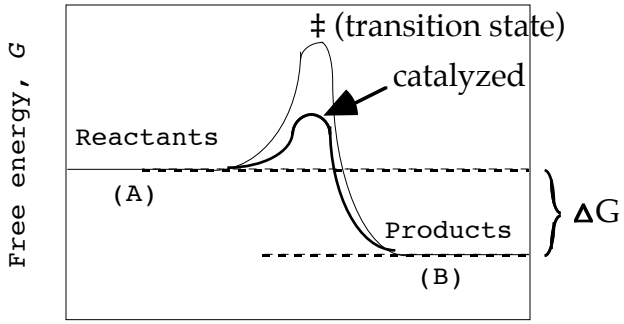
c) CNBr, cyanogen bromide

30

Configuration denotes the spatial arrangement of a molecule that is determined by the presence of either double bonds, around which there is no freedom of rotation, or chiral centers, which give rise to stereoisomers. Conformation refers to the spatial arrangement of substituent groups that are free to assume different positions in space, without breaking any bonds, because of the freedom of bond rotation.

31

Biomolecules are stereospecific. Therefore, each of the two enantiomers of the drug may have very different effects on an organism. One may be beneficial, the other toxic; or one enantiomer may be ineffective and its presence would reduce the efficacy of the other enantiomer.

No. on Test	Correct Answer
32	electrostatic interactions between O_2 and the distal His that are not available to CO due to its perpedicular conformation. Also, interactions with other parts of the protein, due to binding of O_2 in a different conformation (bent). Also, could mention the difference in electronegativity of the O_2 vs. CO.
33	
34	(a, c)  (b) exergonic reaction; G(products) is smaller than G(reactants), so $G_P - G_S = -\Delta G$
35	(a) Noncovalent interactions include 1. hydrogen bonds, 2. ionic interactions between charged groups, 3. van der Waals interactions, and 4. hydrophobic interactions. (b) Because noncovalent interactions are weak, they can form, break, and re-form with less energy input than can covalent bonds. This is important to maintain the flexibility needed in macromolecules. -
36	First, you must assay the <u>activity</u> of the enzyme. Add a known volume of the enzyme solution (say, 0.01 ml) to a solution of its substrate B and measure the <u>initial rate</u> at which product A is formed, expressed as μmol/ml of enzyme solution/min. Then, measure the <u>total protein</u> concentration, expressed as mg/ml. Finally, <u>divide</u> the enzyme activity (μmol/min/ml) by the protein concentration (mg/ml); the quotient is the specific activity (μmol/min/mg or Units/mg). The units of measure are important here!