THE UNIVERSITY OF MANITOBA

DATE: December 19, 1998 — Final EXAMINATION

PAPER NO.: 700/702 — PAGE NO.: 1 of 11

DEPARTMENT & COURSE NO.: 2.277/60.277 — Time: 2 HOURS

EXAMINATION: Elem. of Biochemistry I — EXAMINER: Drs. Eze & Scoot

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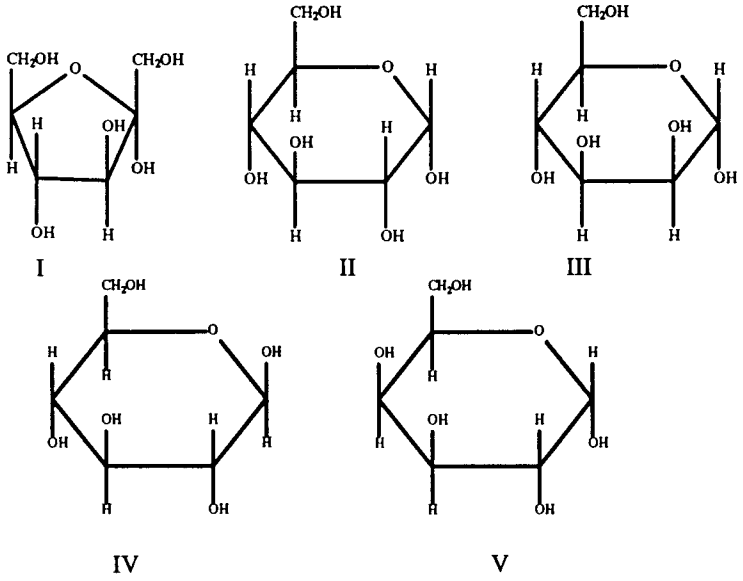
1. **You must mark your answer sheet with a pencil (not a pen). Do NOT erase answers.**
2. **Put your NAME on the answer sheet.**
3. **Enter your STUDENT NUMBER on subject line underneath your name on the answer sheet.**
4. **The examination, worth 60% of your final grade, consists of multiple choice questions. Choose the answer that you think is best and record your choice on the answer sheet. There is only ONE CORRECT answer.**
5. **At the end of the exam is blank paper for rough work.**

Structures I, II, III, IV & V for Question 1.



1. Identify the only false statement among A, B, C, D & E below regarding structures I, II, III, IV & V _____ .

A) II is α-D-glucopyranose, and I is α-D-fructofuranose.
B) II is an epimer of both III and V.
C) I is a ketohexose, and V is α-D-galactopyranose.
D) IV is α-D-glucopyranose, and III is not a reducing sugar.
E) III is α-D-mannopyranose, and all I, II, III, IV & V are reducing sugars.

2. An aqueous solution of pure β-D-glucose initially has a specific optical rotation (α_D^{20}) of +19°. On standing at 20°C, the optical rotation of this solution gradually increases to an equilibrium value. This phenomenon is _____ .

A) Mutarotation, and the equilibrium value of α_D^{20} is +19°
B) Lateral rotation, and the equilibrium value of α_D^{20} is +52°
C) Flip-flop, and the equilibrium value of α_D^{20} is -52°
D) Mutarotation, and equilibrium value of α_D^{20} is +10°
E) Mutarotation, and the equilibrium value of α_D^{20} is +52°

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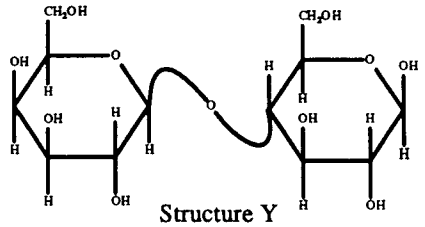
Structure Y for Questions 3 & 4



Structure Y

3. Structure Y is a _____
   - A) disaccharide named lactose
   - B) monosaccharide named lactose
   - C) trisaccharide named galactose
   - D) disaccharide named maltose
   - E) dipeptide named sucrose

4. The only false statement (out of A, B, C, D & E) below concerning Y is _____ .
   - A) Y is a reducing sugar because it has one free anomeric carbon atom.
   - B) Y is not a reducing sugar because all its anomeric carbon atoms are involved in glycosidic bonds.
   - C) Y has a β(1→4) glycosidic linkage and has β-configuration on its free anomeric carbon.
   - D) On hydrolysis, one mole of Y will yield one mole each of glucose and galactose
   - E) Y does not contain a furanose ring in its structure.

Identify the only false statement among A to E in each of Questions 5 & 6 below:

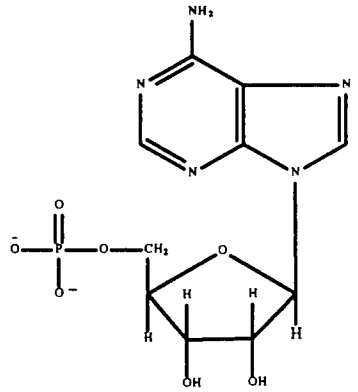
5.
   - A) Amylose is a linear polymer of glucose in α(1→ 4) glycosidic linkage.
   - B) Amylopectin consists of glucose residues in both α(1 → 4) and α(1 → 6) linkages.
   - C) Cellulose is a linear polymer of glucose in β(1→4) linkages only.
   - D) Glycogen is a polymer of glucose residues in β(1→4) linkages only.
   - E) The frequency of branching is higher in glycogen than in amylopectin.

6.
   - A) Denaturation temperature (T_m) of DNA increases as G-C content increases over A-T in DNA.
   - B) DNA random coil resulting from denaturation shows higher UV absorption than duplex DNA.
   - C) The increased UV absorption of the random coil is called hyperchromic effect.
   - D) The increased UV absorption of the random coil is called hypochromic effect.
   - E) The increased UV absorption is due to the decreased base stacking in the random coil.

7. In DNA, G-C base pairs are more stable than A-T base pairs because there are _____.
   - A) 3 hydrogen bonds (H-bonds) in G-C and only 2 in A-T base pairs.
   - B) 2 H-bonds in G-C and 3 in A-T base pairs.
   - C) 2 H-bonds in G-C and 4 in A-T base pairs
   - D) 3 H-bonds in G-C and 5 in A-T base pairs
   - E) 2 H-bonds in G-C and 5 in A-T base pairs

Questions 8 and 9 refer to the structure Z

8. Z is _____.
   - A) Uridine 5'-monophosphate
   - B) Adenosine 5'-monophosphate
   - C) Cytidine 5'-monophosphate
   - D) Deoxyadenosine 5'-monophosphate
   - E) Guanosine 5'-monophosphate.



Structure Z

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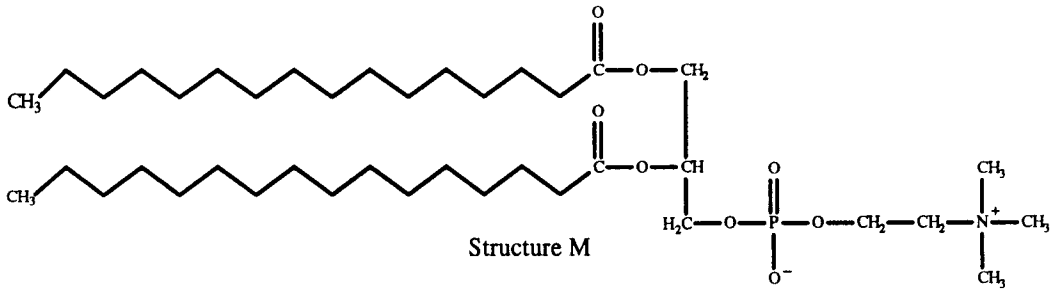
9. Z is a _____ .

A) nucleoside B) pyrimidine base C) purine base D) nucleotide E) sugar

10. RNA is more easily hydrolyzed than DNA under alkaline conditions in the test tube because of four reasons out of A to E below. Identify the only incorrect statement _____.

A) The pentose in RNA is ribose
B) The pentose in DNA is deoxyribose
C) The 2' OH of ribose in RNA participates in the hydrolysis mechanism.
D) The pentose in DNA lacks a 2' OH
E) DNA contains fructose in its backbone

Refer to structure M for questions 11 & 12 below:



Structure M

11. Structure M is a _____ .

A) phospholipid, named dipalmitoyl phosphatidylcholine.
B) phospholipid, named dipalmitoyl phosphatidyl ethanolamine.
C) sphingolipid, named sphingomyelin
D) neutral lipid, named distearoyl phosphatidylethanolamine
E) fatty acid, named 1-stearoyl-2-oleoylphosphatidylserine.

12. At pH7, M has a net charge of _____ .

A) +1 B) -2 C) zero D) +3 E) -3

13. Arrange the following four fatty acids in the order of increasing melting points _____ .

1) Oleic acid 2) stearic acid 3) linoleic acid 4) Palmitic acid

A) 3, 1, 4, 2 B) 2, 4, 1, 3 C) 3, 1, 2, 4 D) 1, 3, 4, 2

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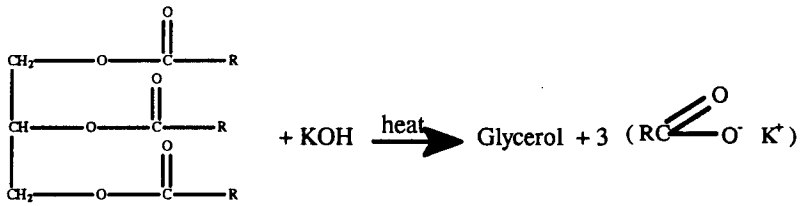
Identify the only false statement among A to E in each of Questions 14 & 15:

14.



A) This is a saponification reaction.
B) This reaction yields K^+ salts of fatty acids.
C) K^+ salts of long chain fatty acids are soaps.
D) Long chain fatty acyl anions are amphipathic.
E) The backbone of triacylglycerols is sphingosine.

15. The human ABO blood group antigen _____

A) is a sphingolipid B) contains galactose C) contains cholesterol
D) contains glucose E) contains ceramide

16. β-Carotene is the precursor of _____.

A) Vitamin A B) Vitamin B_6 C) Vitamin C
D) Vitamin D_3 E) Vitamin E

17. Identify the only false statement regarding biological membranes, among A to E below:

A) Integral membrane proteins are embedded in the lipid bilayer core of the membrane.
B) Peripheral membrane proteins can be extracted by mild aqueous treatment.
C) Integral membrane proteins can only be extracted by agents that destabilize hydrophobic interactions.
D) Cholesterol is embedded in the lipid bilayer of some membranes
E) Carbohydrates are buried in the hydrophobic core of the lipid bilayer of membranes.

For Questions 18 and 19, refer to the reaction:

Fructose-6-phosphate +ATP → X + ADP

18. The glycolytic enzyme catalyzing the phosphorylation of Fructose-6-phosphate is _____.

A) Hexokinase B) Aldolase C) Aspartate transcarbamoylase
D) Phosphofructokinase-1 E) Fructose-6-phosphatase

19. The product X is _____.

A) Aspartate B) Xylulose C) Fructose-1,6-bisphosphate
D) Sucrose E) Fructose

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For Questions 20 -24, refer to the following reactions (i), (ii) and (iii):

(i) Ga3P + NAD^+ + Pi ⇌ 1,3BPG + NADH + H^+ $\Delta G_{(i)}^{01}$ = +6.3 kJ/mol

(ii) 1,3BPG + ADP ⇌ 3PGA + ATP $\Delta G_{(ii)}^{01}$ = -18.5kJ/mol

(iii) net: Ga3P + NAD^+ + ADP + Pi ⇌ 3PGA + NADH + H^+ + ATP $\Delta G_{(iii)}^{01}$ = ?

Ga3P = Glyceraldehyde-3-phosphate, ; 1,3BPG = 1,3-bisphosphoglycerate; 3PGA = 3-phosphoglycerate

20. $\Delta G_{(iii)}^{01}$ for reaction (iii), the net reaction, is _____ kJ/mol

A) -18.5 B) +6.3 C) -12.2 D) -24.8 E) +24.8

21. Reaction (ii) [ΔG^{o1} = -18.5 kJ/mol] in glycolysis is an example of energy conservation by _ .

A) oxidative phosphorylation B) aldol reaction C) fatty acid oxidation
D) substrate level phosphorylation E) amino acid metabolism

22. Reaction (ii) ΔG^{o1} = -18.5 kJ/mol is an _____ Reaction

A) exothermic B) endothermic C) exergonic D) endergonic E) anaphylactic

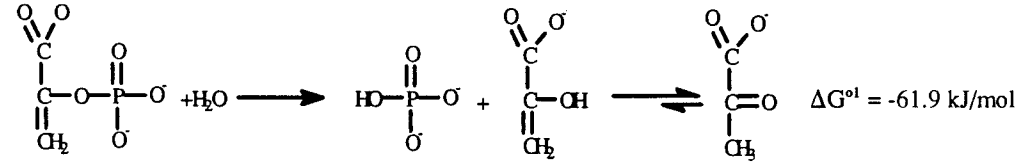
23. The enzyme catalyzing formation of 1,3 BPG from Ga3P [reaction (i)] is _____

A) phosphohexose isomerase B) phosphoglucose isomerase
C)glyceraldehyde-3-phosphate dehydrogenase D) aldolase E) triosephosphate isomerase

24. The enzyme catalyzing formation of ATP from ADP and 1,3 BPG [reaction (ii)] is _____

A) phosphoglycerate kinase B) hexokinase C) aldolase
D) phosphofructokinase E) enolase

25. Phosphoenolpyruvate (PEP) is a high energy compound because on hydrolysis it liberates large amounts of free energy



Identify the only false statement among A to E below regarding this hydrolysis:

A) The direct product of hydrolysis is enol pyruvate.
B) Enol pyruvate tautomerizes to more stable keto pyruvate.
C) The other product HPO_4^{2-} is stabilized by resonance.
D) Tautomerism to keto pyruvate liberates free energy.
E) None of the above is actually the case.

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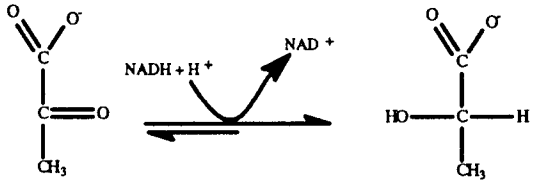
26. During alcohol fermentation, baker's yeast breaks down one mole of glucose to _____

A) One mole of ethanol, plus one mole NADH, plus one mole CO_2.
B) Two moles ethanol, plus two moles CO_2.
C) Two moles ethanol, plus two moles $FADH_2$
D) Two moles ethanol, plus one mole NADH, plus 1 mole CO_2.
E) Two moles ethanol, plus two moles NADH, plus 2 moles CO_2

For Questions 27, 28 and 29, refer to the reaction:



M N

27. A) M is aspartate, and N is citrate.
B) M is acetate, and N is serine.
C) M is propionate, and N is acetaldehyde.
D) M is malonate, and N is alanine.
E) M is pyruvate, and N is lactate.

28. This reaction (M → N) is the last step in _____

A) anaerobic breakdown of glucose in actively exercising vertebrate skeletal muscle cell.
B) alcoholic fermentation in brewer's yeast.
C) aerobic respiration in liver mitochondria.
D) anaerobic respiration in baker's yeast.
E) no metabolic pathway.

29. The enzyme catalyzing reaction M → N is _____

A) alcohol dehydrogenase B) glucokinase C) lactate dehydrogenase
D) pyruvate decarboxylase E) monoamine oxidase

30. The pyruvate dehydrogenase enzyme complex catalyzes _____

A) Oxidative decarboxylation of α-ketoglutarate to succinyl CoA.
B) Oxidative decarboxylation of pyruvate to form acetyl CoA.
C) Dehydration of 2-phosphoglycerate to phosphoenol pyruvate.
D) Hydrolysis of short peptides to amino acids.
E) Hydrolysis of oligopeptides to shorter peptides.

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31. For the reaction

Succinate Fumarate

The catalyzing enzyme is _____

A) fumarase B) succinate dehydrogenase C) alcohol dehydrogenase
D) not the only membrane-bound enzyme of the citric acid cycle
E) none of A to D

32. One of the following statements about eukaryotic cells is false. The false statement is _____.

A) Reactions of the citric acid cycle occur in the mitochondrial matrix.
B) All the enzymes of the glycolytic pathway are in the cytosol.
C) Oxidative electron transport is associated with the inner membrane of mitochondria.
D) Malate dehydrogenase oxidizes L-malate to oxaloacetate in the citric acid cycle.
E) The oxidative electron transport chain functions under anaerobic conditions.

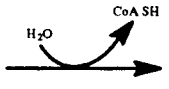
33. Complex I of the oxidative electron transport chain of the mitochondrial inner membrane catalyzes the reaction _____.

A) $NADH + H^+ + CoQ \rightleftharpoons NAD^+ + CoQH_2$
B) $FADH_2 + CoQ \rightleftharpoons FAD + CoQH_2$
C) $Succinate + FAD \rightleftharpoons Fumarate + FADH_2$
D) $Fumarate + H_2O \rightleftharpoons L\text{-malate}$
E) None of A to D

34. In tightly coupled mitochondria, electron transport can be uncoupled from ATP synthesis by _____

A) 2,4-dinitrophenol (DNP), but not thermogenin. B) either DNP or thermogenin.
C) neither DNP nor thermogenin. D) thermogenin, but not DNP E) none of A to D

35. The reaction:



Oxaloacetate + Acetyl CoA Citrate

is the first step in _____

A) glycolysis B) amino acid deamination C) fatty acid β oxidation
D) citric acid cycle E) anaerobic glucose breakdown

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36. Complete breakdown of each mole of acetyl CoA to CO_2 in the citric acid cycle produces GTP (or ATP) by substrate level phosphorylation, as well as NADH and $FADH_2$. The correct yield of GTP (or ATP), NADH, $FADH_2$ & CO_2 per mole of acetyl CoA is as given in _____

	GTP (or ATP)	NADH	$FADH_2$	CO_2
A)	3	1	2	2
B)	1	2	2	2
C)	1	5	1	2
D)	2	3	1	2
E)	1	3	1	2

37. Given that $E^{0\prime} = -0.320$ volt for $NAD^+/NADH$ couple, and +0.816 volt for $\frac{1}{2}O_2/H_2O$

couple, the standard free energy change ($\Delta G^{0\prime}$) associated with the reoxidation of NADH by oxygen in the oxidative electron transport chain of inner mitochondrial membrane is about _____ kJ/mol.

A) -100 B) -220 C) +220 D) +100 E) +10

38. The net ATP yield (in moles) from the complete oxidation of one mole of glucose through glycolysis, citric acid cycle and oxidative electron transport chain in the liver cell is _____

A) 28 B) 48 C) 38 D) 18 E) 8

39. In isolated tightly coupled rat heart mitochondria, addition of ADP + Pi followed by an oxidizable substrate (eg., succinate) triggers both oxygen consumption and ATP synthesis. On addition of an inhibitor of electron transport (eg. Cyanide), _____

A) both ATP synthesis and oxygen consumption are enhanced.
B) both ATP synthesis and oxygen consumption stop.
C) ATP synthesis stops but oxygen consumption continues.
D) ATP synthesis continues but O_2 consumption stops.
E) None of A to D

40. In tightly coupled mitochondria, electron transport to oxygen in the inner membrane leads to net proton pumping from the matrix to the intermembrane space establishing a proton gradient. ATP is synthesized when the protons _____

A) flow down the gradient through the membrane-bound F_oF_1 ATP synthase back into matrix.
B) leak into the cytosol through the outer membrane.
C) flow through complex I back into the matrix.
D) flow through complex II back into the matrix
E) flow through complex III back into the matrix.

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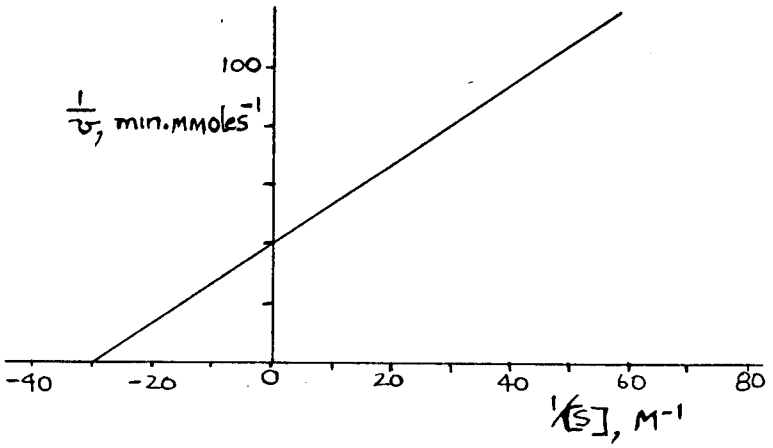
LAB SECTION (QUESTIONS 41 TO 50)

For questions 41 to 44 please refer to the following:

An investigation into the kinetics of alkaline phosphatase yielded data from which the Lineweaver-Burk plot shown below was derived.



The total assay volume was 5 mL and the assay time 10 min. A 1.0 mL volume of enzyme solution was added to each assay tube. The concentration of the enzyme solution was 5 x 10^{-7} M.

41. What are the values for K_m and V_{max} for this enzyme under these conditions?

A) K_m = 30 M V_{max} = 40 mmoles/min
B) K_m = 40 mmoles/min V_{max} = 30 M
C) K_m = 0.033 M V_{max} = 0.050 mmoles/min
D) K_m = 0.033M V_{max} = 0.025 mmoles/min
E) Cannot be determined

42. If the assay time was reduced to 5 min how would this affect the values of K_m and V_{max}?

A) K_m halved V_{max} halved
B) K_m unchanged V_{max} halved
C) K_m unchanged V_{max} unchanged
D) K_m halved V_{max} unchanged
E) K_m doubled V_{max} halved

43. If the enzyme concentration used in the assay was doubled how would this affect the values of K_m and V_{max}?

A) K_m doubled V_{max} doubled
B) K_m unchanged V_{max} doubled
C) K_m unchanged V_{max} unchanged
D) K_m doubled V_{max} unchanged
E) K_m halved V_{max} doubled

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44. V_{max} for an enzyme-catalysed reaction:

A) generally increases when pH increases
B) is twice the rate observed when the concentration of substrate is equal to the K_m
C) is only influenced by the amount of substrate supplied and no other assay condition
D) increases in the presence of an inhibitor
E) only occurs when half the enzyme is present as the ES complex

45. Three chemical tests, Barfoed's, Bial's and Seliwanoff's, were performed in the order listed on the following carbohydrate solutions; fructose, galactose, ribose and sucrose. Each test led to the identification of one of the carbohydrates which could then be eliminated. Which one of the four carbohydrates remained after this process of elimination?

A) Fructose
B) Galactose
C) Ribose
D) Sucrose
E) Cannot be determined

46. Which of the following statements describe Benedict's test?

1) It is used to distinguish between monosaccharides and disaccharides
2) The reagent contains copper acetate
3) The assay conditions are acidic
4) The copper ion is oxidised
5) A furfural intermediate is formed

A) All of the above
B) 1, 2, 3 and 4
C) 2 and 3 and 4
D) 2 and 3
E) None of the above

47. Which of the following statements describe Bial's test?

1) It is used to detect ketoses
2) It requires heat and HCl
3) A furfural intermediate is formed
4) It requires orcinol and ferric ions
5) Red condensation products are formed

A) All of the above
B) 1, 2, 3 and 4
C) 1 and 5
D) 2, 3 and 4
E) 2 and 3

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48. When double-stranded DNA is heated, which change does not occur?

A) The absorption of UV light increases
B) The covalent bond between the base and the pentose breaks
C) The hydrogen bonds between A and T break
D) The viscosity of the solution decreases
E) The helical structure unwinds

49. When DNA was isolated from Salmon sperm one of the steps separated the DNA from RNA. Which one of the following statements relates to this step?

A) It is achieved because DNA is double-stranded whereas RNA is single-stranded
B) It is achieved using iso-pentyl alcohol- ethyl acetate
C) It requires the presence of citrate ions
D) DNA is precipitated by ethanol whereas RNA remains in solution
E) DNA is disrupted by SDS and forms sticky fibres whereas RNA forms a flocculent precipitate.

50. Which of the following statements about the T_m for DNA are true?

1) It is the temperature where half the DNA is single stranded and half is double stranded.
2) It is the temperature at the midpoint of DNA denaturation.
3) It is the midpoint of the transition temperature range for the DNA.
4) It is the melting temperature of DNA.
5) Its value depends upon the base composition of the DNA.

A) 4 B) 2 & 3 C) 1, 2 & 3 D) 1, 2, 3 & 4 E) 1, 2, 3, 4 & 5

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

Question Number	277 Midterm			277 Final		
	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

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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