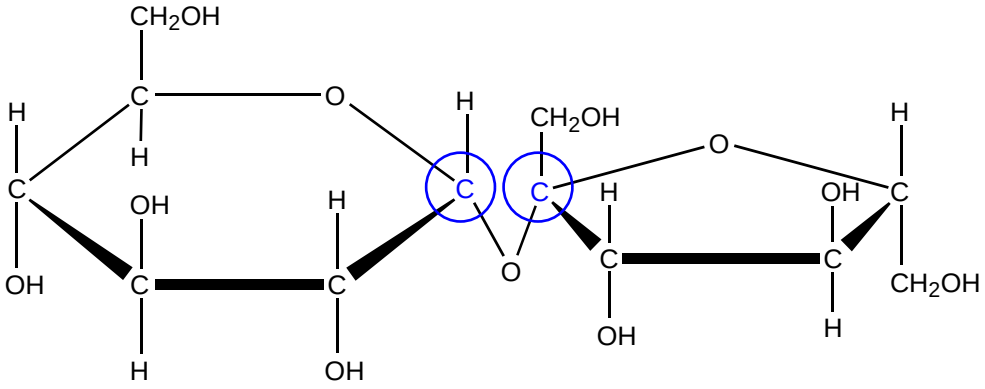
Code: _____ **Score:**_____

Please provide short answers to the following 25 questions.

1. Sucrose is referred to as a non-reducing sugar. In the structure below, circle the atoms that were the original reducing anomeric carbons in the monosaccharide units.



2. Which enzyme traps glucose within muscle cells and which enzyme prepares glucose for release from liver cells?

   hexokinase and glucose-6-phosphatase

3. Which two peptide hormones participate in the regulation of carbohydrate metabolism?

   insulin and glucagon

4. Which insulin-independent GLUT transporter is utilized by liver parenchymal cells?

   GLUT2

5. Which electron transport complex catalyzes the four-electron reduction of O_2 to H_2O?

   complex IV (cytochrome *c* oxidase)

6. Substrate-level phosphorylation reactions result in the synthesis of ATP and which two glycolytic intermediates?

   3-phosphoglycerate and pyruvate

7. Which protein binds to and is activated by cyclic AMP?

   protein kinase A (cAMP-dependent protein kinase)

8. List two enzymes of glycolysis that must be by-passed during gluconeogenesis.

   pyruvate kinase, phosphofructokinase and hexokinase

9. What is the net ATP yield during the complete oxidation of glucose to 6 CO_2 and 6 H_2O? Use traditional ratios for NADH and $FADH_2$.

38 molecules of ATP

10. What does the free energy of the pyruvate dehydrogenase reaction (ΔG° = –8 kcal mol^{-1}) suggest about the conversion of acetyl-CoA to pyruvate?

The conversion of acetyl-CoA to pyruvate will not occur.

11. Which pathway leads to the oxidation of glucose by the use of coenzyme $NADP^+$?

pentose phosphate pathway

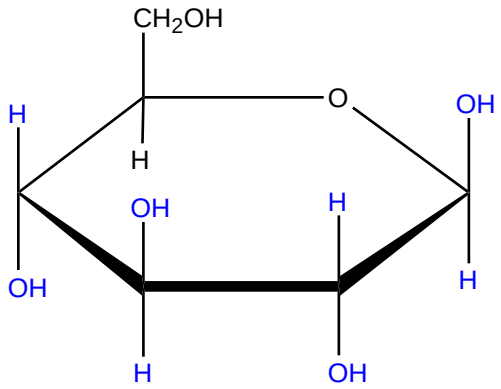
12. How does the structure of glycogen differ from that of α-amylose?

Glycogen is a branched polymer while α-amylose is a linear polymer.

13. List two mitochondrial metabolite transporters.

monocarboxylate, dicarboxylate, tricarboxylate (malate-citrate), phosphate, adenine nucleotide, aspartate-glutamate, and malate-α-ketoglutarate transporter

14. Fill in the missing functional groups on the structure below to complete the β anomer of D-glucopyranose.



15. Calculate the free energy for ATP hydrolysis given the information below.

glucose + ATP → glucose-6-phosphate + ADP $\Delta G^{o'}$ = -4.0 kcal mol^{-1}
glucose-6-phosphate + H_2O → glucose + P_i $\Delta G^{o'}$ = -3.3 kcal mol^{-1}

adding the two equations gives ATP + H_2O → ADP + P_i

$\Delta G^{\circ\prime}$ = [-4.0 + (-3.3)] kcal mol^{-1} = -7.3 kcal mol^{-1}

16. List two amino acids involved in glycopeptide bonds.

asparagine, serine, threonine, and 5-hydroxylysine

17. What is the difference between the reaction of glycogen phosphorylase with glycogen and that of α-amylase with glycogen?

Glycogen phosphorylase uses inorganic phosphate (P_i) to cleave α-1,4-glycosidic bonds while α-amylase uses water (H_2O) to cleave α-1,4-glycosidic bonds.

18. Which one citric acid cycle enzyme is associated with the inner mitochondrial membrane?

succinate dehydrogenase (complex II)

19. Which ion is pumped across the inner mitochondrial membrane to establish the gradient that drives the synthesis of ATP?

H^+ (proton)

20. List the substrate and product of the reaction catalyzed by the citric acid cycle enzyme aconitase.

citrate and isocitrate

21. List the metal ion and its oxidation states that are found in the redox centers of cytochromes associated with the electron transport chain?

Fe^{2+} and Fe^{3+}

22. List two glycosaminoglycans.

hyaluronate, chondroitin sulfate, dermatan sulfate, heparin, heparan sulfate, and keratan sulfate

23. Galactosemia is best treated by removing which sugar from the diet.

lactose (galactose)

24. Which coenzyme is used by the transketolase found in the pentose phosphate pathway?

thiamine pyrophosphate

25. Calculate the minimum potential difference ($\Delta\varepsilon_o'$) needed to produce sufficient energy for the synthesis of one mole of ATP. Assume a two-electron transfer.

$$ATP + H_2O \Leftrightarrow ADP + P_i + H^+ \qquad \Delta G^\circ = -7.3 \text{ kcal mol}^{-1}$$

$$\Delta G^\circ = -nF\,\Delta\varepsilon_o' \text{ where } F = 23 \text{ kcal V}^{-1} \text{ mol}^{-1}$$

$\Delta\varepsilon_o' = -\Delta G^\circ/nF = -(-7.3 \text{ kcal mol}^{-1})/[(2)(23 \text{ kcal V}^{-1} \text{ mol}^{-1})] = 0.16 \text{ V}$