

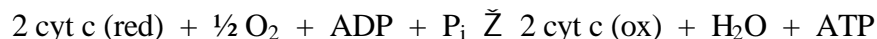
Answer question 1 or 2 (11 points)

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1	_____
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Total	_____

1. Diagram the **thylakoid membrane**, identifying the space on each side of it. On your diagram place, in proper orientation, the following:

CF₁, CF₀, plastocyanin, pigment system I, pigment system II, cytochrome b/f complex, direction of proton movement by the cytochrome complex, site of O₂ production, site of NADPH production, Rubisco, and ferredoxin

2. Mitochondria or submitochondrial particles can carry out the following coupled reaction:



- (a) Calculate the overall ΔG° for this coupled process. (E_o' for $\text{cyt } c_{(\text{ox})}/\text{cyt } c_{(\text{red})}$ is +0.25 V, E_o' for $\frac{1}{2} \text{ O}_2/\text{H}_2\text{O}$ is +0.82 V, $R = 8.314 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$, $F = 96.5 \text{ kJ}\cdot\text{mol}^{-1}\text{V}^{-1}$, $T = 298 \text{ K}$)
- (b) Diagram the orientation of the two complexes in the inner mitochondrial membrane that carry out this coupled reaction, illustrating in the diagram how the coupling occurs.
- (c) Explain how the proposed coupling leads to the proposed stoichiometry in the equation (1 ATP made per two cyt c's reduced).
- (d) What effect would **cyanide**, **dinitrophenol**, and **oligomycin** each have on the overall reaction?

Answer question 3 or 4 (11 points)

3. The **Calvin Benson Cycle** converts CO₂ into carbohydrate. The pathway requires NADPH and ATP and involves an enzyme found in the pentose phosphate pathway. Identify the following steps of the cycle by giving the reactants and products of each reaction:
- (a) The step fixing CO₂.
 - (b) The two steps requiring ATP.
 - (c) The step requiring NADPH.
 - (d) A step catalyzed by the enzyme **transketolase**.
4. The **urea cycle** converts amino acid nitrogen into urea in the liver. Show the pathway by which nitrogen from two glutamate molecules can be converted into urea, identifying all intermediates by name or structure, and showing the cellular location (mitochondria or cytoplasm) of each step.

Answer question 5 or 6 (9 points)

5. Identify the enzyme catalyzing the **regulatory step** for each of the following pathways, and the substance(s) that activate or inhibit the enzyme.
- (a) **cholesterol biosynthesis** (b) **fatty acid biosynthesis** (c) **pyrimidine biosynthesis**
6. In each of the following tissues, the **absence** of a particular enzyme normally found in other tissues has a consequence on the metabolism in the tissue. For each, identify the missing enzyme and explain how its lack affects the tissue.
- (a) **muscle** (b) **liver** (c) **adipose tissue**

Answer question 7 or 8 (8 points)

7. Propionyl-CoA is a product of catabolism of both odd chain fatty acids and several amino acids. Explain how it is converted to a TCA cycle intermediate, showing all the intermediates in the conversion, and identifying the enzymes involved and their prosthetic groups.
8. Compare eukaryotic fatty acid oxidation with fatty acid synthesis, giving at least five ways in which the two pathways differ from each other.

Answer question 9 or 10 (8 points)

9. There are two HMG-CoA synthase enzymes, one in mitochondria and one in the cytoplasm. Give the reaction catalyzed by this enzyme, including all reactants and products, and the metabolic role of each enzyme.
10. There are two carbamoyl phosphate synthases, one in mitochondria and one in the cytoplasm. Give the reaction catalyzed by each of them, including all reactants and products, and the metabolic role of each enzyme.

Answer question 11 or 12 (8 points)

11. Both the **Cori cycle** and the **alanine cycle** involve metabolic interaction between muscle and liver. Diagram this interaction for both cycles, and explain the functional purpose of each.
12. IMP is a branch intermediate in the synthesis of AMP and GMP, and each conversion involves two enzymatic steps. Give the reaction steps by which each of these conversions occur, including the **structure** of IMP, AMP, GMP and all nucleotide intermediates, and indicating the other reactants and products of each step.

Answer question 13 or 14 (8 points)

13. Describe an Okasaki fragment. When and where is it made, what is its structure, and what happens to it? (Use a diagram to clarify your answer).
14. Cyclic AMP has been called "an ancient hunger signal". Explain how this concept applies to its action in both bacteria and animals.

Answer question 15 or 16 (8 points)

15. Explain how the starting point for transcription of a gene is recognized in (a) prokaryotes and (b) eukaryotes.
16. Explain how the starting point for translation of a message is recognized in (a) prokaryotes and (b) eukaryotes.

Answer question 17 or 18 (9 points)

17. Bacteria have three distinct DNA polymerases, Pol I, Pol II, and Pol III. Describe the role of each in DNA synthesis.
18. Eukaryotic cells have three distinct RNA polymerases, RNA Pol I (or A), RNA Pol II (or B) and RNA Pol III (or C). Describe the function of each, and the sensitivity of each to α -amanitin.

Answer question 19 or 20 (8 points)

19. Identify the **G proteins** that are involved in protein synthesis, describing the function of each.
20. Describe the post-transcriptional modification of eukaryotic messenger RNA.

Answer questions 21 and 22 (6 points each)

- 21 Circle the following mutations which could result from a single base substitution. Give a codon change that could be responsible for the mutation.

Thr GluGly Terminate (stop)Met LysAla ValHis ThrCys Ser

22. The following sequence from the **middle** of a m-RNA could encode three different polypeptide sequences. What are they?

5'-GACUACUGCGGCUAAGUCGCAA-3'