

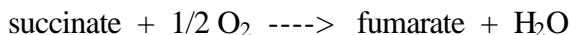
This exam consists of six pages. Make sure you have one of each. For questions indicating a choice, answer only one of the choices. (If you answer both, you need to indicate which answer is to be counted, otherwise the first one will be graded.) A seventh page contains the genetic code. You may tear that page off and use it for scratch work.

Good luck, and have a nice Christmas.

Page	Points
1	_____
2	_____
3	_____
4	_____
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6	_____
Total	_____

Answer question 1 or 2

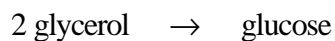
- (12) 1. Mitochondria can oxidize succinate to fumarate by catalyzing the following overall reaction:



- (a) Calculate ΔG° for this reaction ($F = 96.5 \text{ kJ/volt}$)
($E'_{\circ} \text{ succinate/fumarate} = 0.031 \text{ volt}$; $E'_{\circ} \text{ H}_2\text{O/O}_2 = 0.82 \text{ volt}$)
- (b) Give the intermediate re-dox carriers which participate in this reaction in the order in which the electrons are passed (not just the complexes, but the components of the complexes).
- (c) Explain the reasoning by which one concludes that this process is coupled to the formation of 1.5 moles of ATP.
- (12) 2. ATP synthesis in chloroplasts has many similarities to that in mitochondrial complex III. Compare and contrast these two systems by drawing diagrams of the mitochondrial inner membrane and the thylakoid membrane showing the **identity**, **location** and **orientation** of the following components in each: a quinone, cytochromes, a peripheral membrane protein, the ATP synthase. How does the nature of the proton motive force differ in the two systems?

Answer 3 or 4

- (12) 3. Calculate the number of ATP's that can be obtained from oxidation of stearic acid (C_{18:0}) to acetoacetate in the liver. Consider that NADH and CoQH₂ are reoxidized by the electron transport chain. Sketch the overall pathway, showing where ATP, NADH and CoQH₂ would be used or produced. Why wouldn't acetoacetate be further oxidized in the liver?
- (12) 4. The liver cannot synthesize glucose from fatty acids, but it can make some glucose from fat by metabolizing glycerol. Glycerol released from adipose tissue when fats are hydrolyzed can be taken up by liver and converted to glycerol-3-phosphate by the enzyme **glycerokinase**. Show the overall pathway by which the following reaction can occur, giving all intermediates involved (names or structures), and summarize the overall stoichiometry (i.e. net production or utilization of NADH, CoQH₂, ATP, and GTP).



Answer 5 or 6

- (9) 5. Bacteria have three distinct DNA polymerases, Pol I, Pol II, and Pol III. Describe the role of each in DNA synthesis.
- (9) 6. 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 7 or 8.

- (12) 7. Cyclic AMP has been called "an ancient hunger signal". Explain how this concept applies to its action in both bacteria and animals.
- (12) 8. Explain how epinephrine **stimulates** the breakdown of glucose (glycolysis) in muscle. (Note: I am not talking about breakdown of glycogen, but of glucose). Identify the glycolytic enzyme stimulated, the compound causing the stimulation, and all the signaling intermediates involved in producing this compound.

Answer question 9 or 10

- (12) 9. 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 in prokaryotes**
- (12) 10. 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**.

Answer 11 or 12

- (11) 11. Draw the structure of guanine and cytosine, and indicate the source of **each C and N atom** in the structure. (For example, N might be from glutamine, C from CO₂, etc.)
- (11) 12. Give the pathway by which acetyl-CoA is converted to isopentenyl pyrophosphate, showing the structures of each intermediate. How many ATP's are required for this conversion?

Answer question 13 or 14

- (12) 13. 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.
- (12) 14. Metabolism of amino acids begins with the action of transaminases.
- (a) Give the overall reaction catalyzed by a transaminase.
 - (b) What prosthetic group is involved?
 - (c) Give the structure of the intermediate formed between this prosthetic group and the amino acid.
 - (d) How does the nitrogen atom ultimately get converted to ammonia?

Answer 15 or 16

- (8) 15. In prokaryotes, translation begins before transcription is completed. Compare transcription and translation with respect to:
- (a) Identification of the "start" position.
 - (b) Direction of synthesis.
 - (c) Source of energy driving the polymerization.
 - (d) Identification of the termination point.
- (8) 16. Explain how "proofreading" is accomplished in:
- (a) Synthesis of DNA.
 - (b) Synthesis of aminoacyl tRNA.
 - (c) peptide bond formation in protein synthesis.

Answer 17, 18 and 19

- (6) 17. Circle the following mutations which could result from a single base substitution. Give a codon change that could be responsible for the mutation. (The genetic code table is on the last page).

Glu ---> Val

Ile ---> Terminate (Stop)

Arg ---> Pro

Cys ---> Gly

Leu ---> His

Phe ---> Tyr

- (6) 18. The following sequence from the middle of a m-RNA could encode three different polypeptide sequences. What are they?

5'-GCCUACUGACGACUAA-3'

The Genetic Code (mRNA)

Second position

		Second position				
		U	C	A	G	
First position	U	UUU Phe	UCU Ser	UAU Tyr	UGU Cys	U
		UUC Phe	UCC Ser	UAC Tyr	UGC Cys	C
		UUA Leu	UCA Ser	UAA Stop	UGA Stop	A
		UUG Leu	UCG Ser	UAG Stop	UGG Trp	G
	C	CUU Leu	CCU Pro	CAU His	CGU Arg	U
		CUC Leu	CCC Pro	CAC His	CGC Arg	C
		CUA Leu	CCA Pro	CAA Gln	CGA Arg	A
		CUG Leu	CCG Pro	CAG Gln	CGG Arg	G
	A	AUU Ile	ACU Thr	AAU Asn	AGU Ser	U
		AUC Ile	ACC Thr	AAC Asn	AGC Ser	C
		AUA Ile	ACA Thr	AAA Lys	AGA Arg	A
		AUG Met	ACG Thr	AAG Lys	AGG Arg	G
	G	GUU Val	GCU Ala	GAU Asp	GGU Gly	U
		GUC Val	GCC Ala	GAC Asp	GGC Gly	C
		GUA Val	GCA Ala	GAA Glu	GGA Gly	A
		GUG Val	GCG Ala	GAG Glu	GGG Gly	G

Third position