BIOSCI 1820
MIDTERM EXAM
SPRING 2002

I. Short Answer

A. Lactate produced in the muscle under anaerobic conditions is transported through the blood to the liver, where it reacts with lactate dehydrogenase and proceeds through gluconeogenesis; the resulting glucose is released back into the bloodstream. What is the name of this cycle?

B. Even through gluconeogenesis in the liver should be favorable ($\Delta G'^{o} < 0$), the $\Delta G'$ of the reaction is even more negative after a period of intense exercise when the levels of lactate produced in the body may be quite high. Why is this so?

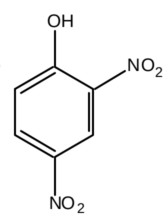
C. Why does the glucose produced from gluconeogenesis in the liver not "turn around" and get directed right back into the glycolytic pathway?

D. Under anaerobic conditions, yeast will grow to a high density only if there is a very high concentration of sugar, whereas under aerobic conditions, they can achieve the same density with much less sugar. What is the (i) name and (ii) physiological basis of this effect?

E. During glycolysis, fructose-1,6-bisphosphate activates another enzyme in the glycolytic pathway. What is the (i) name of this enzyme and (ii) what is the name given to this type of activation?

F. Enzymes such as hexokinase and citrate synthase undergo a large conformational change to exclude water from their active site. What is the term used to describe this conformational change?

G. The structure of the following molecule belongs to a class of factors known as what?



II. Draw the structures of the reactants and products of the reaction catalyzed by glyceraldehyde-3-phosphate dehydrogenase.

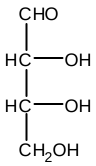
Using the following table, calculate the E'° for this reaction.

Oxidant	Reductant	n	E'_0, V
Acetate + CO_2 + $2H^+$	Pyruvate + H_2O	2	−0.70
Succinate + CO_2 + $2H^+$	α-Ketoglutarate + H_2O	2	−0.67
Acetate + $3H^+$	Acetaldehyde + H_2O	2	−0.60
O_2	O_2^-	1	−0.45
Ferredoxin (oxidized)	Ferredoxin (reduced)	1	−0.43
$2H^+$	H_2	2	−0.42
Acetoacetate + $2H^+$	β-Hydroxybutyrate	2	−0.35
Pyruvate + CO_2 + H^+	Malate	2	−0.33
NAD^+ + H^+	NADH	2	−0.32
$NADP^+$ + H^+	NADPH	2	−0.32
FMN (enzyme-bound) + $2H^+$	$FMNH_2$ (enzyme-bound)	2	−0.30
Lipoate (oxidized) + $2H^+$	Lipoate (reduced)	2	−0.29
1,3-Bisphosphoglycerate + $2H^+$	Glyceraldehyde-3-phosphate + P_i	2	−0.29
Glutathione (oxidized) + $2H^+$	2 Glutathione (reduced)	2	−0.23
FAD + $2H^+$	$FADH_2$	2	−0.22
Acetaldehyde + $2H^+$	Ethanol	2	−0.20
Pyruvate + $2H^+$	Lactate	2	−0.19
Oxaloacetate + $2H^+$	Malate	2	−0.17
α-Ketoglutarate + $\overset{+}{N}H_4$ + $2H^+$	Glutamate + H_2O	2	−0.14

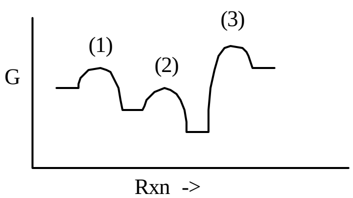
Methylene blue (oxidized) + $2H^+$	Methylene blue (reduced)	2	0.01
Fumarate + $2H^+$	Succinate	2	0.03
CoQ + $2H^+$	$CoQH_2$	2	0.04
Cytochrome *b* (+3)	Cytochrome *b* (+2)	1	0.07
Dehydroascorbate + $2H^+$	Ascorbate	2	0.08
Cytochrome c_1 (+3)	Cytochrome c_1 (+2)	1	0.23
Cytochrome *c* (+3)	Cytochrome *c* (+2)	1	0.25
Cytochrome *a* (+3)	Cytochrome *a* (+2)	1	0.29
$\frac{1}{2}O_2 + H_2O$	H_2O_2	2	0.30
Ferricyanide	Ferrocyanide	2	0.36
Nitrate + $2H^+$	Nitrite + H_2O	1	0.42
Cytochrome a_3 (+3)	Cytochrome a_3 (+2)	1	0.55
Fe (+3)	Fe (+2)	1	0.77
$\frac{1}{2}O_2 + 2H^+$	H_2O	2	0.82

Note: E_0' is the standard reduction potential at pH 7 and 25°C, *n* is the number of electrons transferred, and each potential is for the partial reaction written as follows: Oxidant + ne^- ⟶ reductant.

III. Draw the (A) enantiomeric and (B) diastereomeric forms of the following sugar:



IV. The following depicts an energy diagram of a reaction catalyzed by an enzyme that we have discussed:

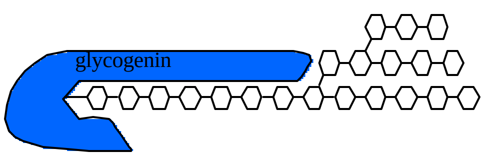


A. Which step is rate limiting?

B. Which enzyme that we discussed does this diagram most closely resemble?

C. Ignoring the 3rd step, if reactions 1 and 2 describe a short biosynthetic pathway (A + B making product C), how might you drive the process in reverse? That is, what "tricks" are used in living systems to make this happen? Give 2 examples.

V. The following is a representation of a short glycogen polymer:

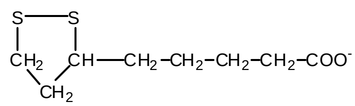


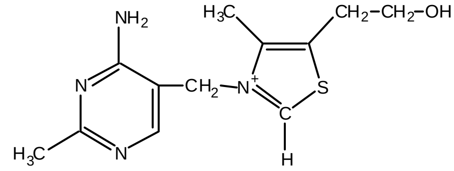
Draw the structure of the product when glycogen phosphorylase acts on this polymer:

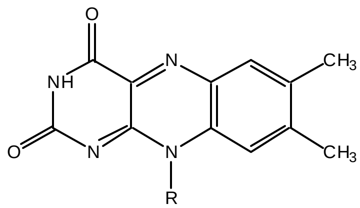
How many of these products can be formed before the action of de-branching enzyme?

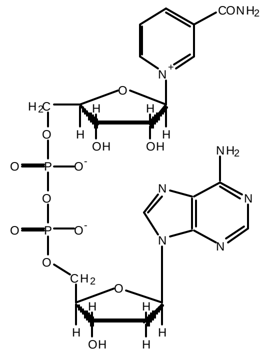
Assuming that de-branching enzyme is not active, what is the theoretical maximum number of ATPs that can be generated under aerobic conditions from the action of phosphorylase on this polymer?

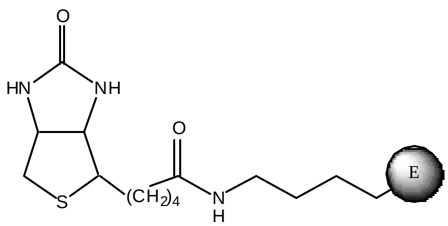
VI. What are the names of the following co-factors?











Which of these (A-E) is NOT a co-factor in the reaction catalyzed by pyruvate dehydrogenase?

VII. A molecule of radioactive pyruvate is fed into mitochondria that are actively respiring and performing the Krebs cycle. The radioactive label in the pyruvate is the carbon on the CH_3 group. Draw the structure of isocitrate that would derive from and first be produced upon addition of the radioactive pyruvate, and indicate which carbon(s) would be radiolabeled.

VIII. Will glycogen synthesis (A) INCREASE or (B) DECREASE under the following conditions?

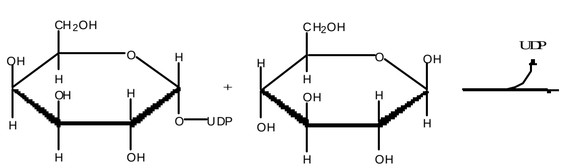
_____ The activity of Protein Kinase A (also known as cAMP-dependant kinase) is increased

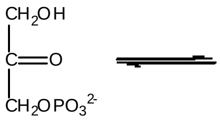
_____ There is an increase in the circulating concentration of epinephrine

_____ A mutant form of the α subunit of the G protein involved in this pathway is present in cells that can bind, but cannot hydrolyze the GTP

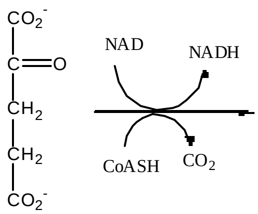
_____ Protein phosphatatse inhibitor becomes dephosphorylated

IX. Draw the structures of the products of the following reactions:

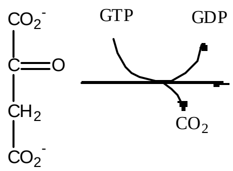




CH2OH
C=O
CH2OPO3 2-



CO2 -
C=O
CH2
CH2
CO2 -
NAD
NADH
CoASH
CO2



CO2 -
C=O
CH2
CO2 -
GTP
GDP
CO2