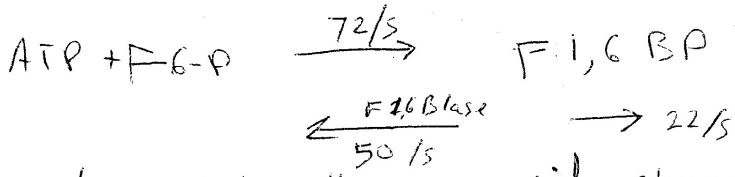
Chem. 454-Sp. 2006
Write concise, but clear answers EXAM 1
65 PTS.

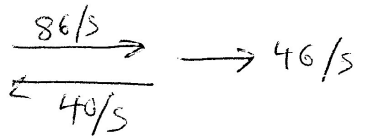
NAME KEY

1. Help two scientists, Dr. Lilac Arug and Dr. Chuck Roast, settle a dispute. Dr. Arug says that her research shows that under typical cell conditions the fructose 1,6-bis phophatase enzyme catalyzes its reaction at a turnover rate of 50 molecules/second and phosphfructokinase proceeds at a pace of 72 molecules/second for a *flux* toward glucose breakdown of 22/second. Dr. Roast says this is crazy because the cell would be wasting about 50 ATPs /second. He says that surely the fructose 1,6-bis phophatase must be shut off completely by some effector while phosphfructokinase goes on at 22/second.

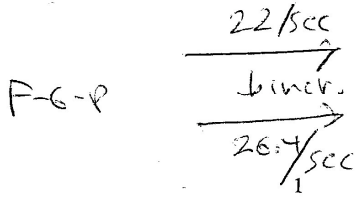
Explain politely to Dr. Roast why this seemingly futile process is beneficial and what the consequences of his method of enzyme regulation would be (use a numerical example). (8) PFK-1



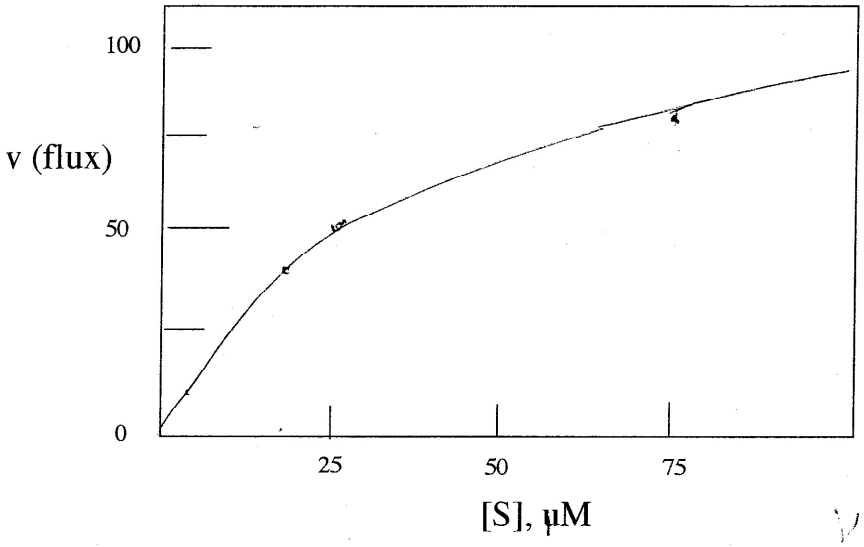
Dr. Arug's model allows rapid changes in flux when needed. For example, a 20% increase in forward rxn. + decr. in backward rxn produces over 100% incr in flux.



Dr. Roast's model of PFK would show only a 20% incr. in flux if the forward rxn. were accelerated by 20%.



2. a. Sketch in a curve for the substrate concentration, [S] versus flux in an M-M enzyme catalyzed reaction with a V_{max} of 100 (µmol/minute) and a K_m of 25 µM. Draw as accurately as you can (use calculations to give you a few points).(8)



e.g.

$$v = \frac{V_{max}[S]}{K_m + [S]}$$

$$50 = \frac{100[25]}{25+25}$$

$$75 = \frac{100[75]}{25+75}$$

b. What [S] would sustain a rate of 40% of Vmax?

$0.40 \times 100 = 40$ nmol/min $= v$

$$40 = \frac{100[S]}{25+[S]}$$

$40[S] + 1000 = 100[S]$

$1000 = 60[S]$ $\quad [S] = 16.7$ nM

c. What [S] would sustain a rate of 10% of Vmax?

$$10 = \frac{100[S]}{25+[S]}$$

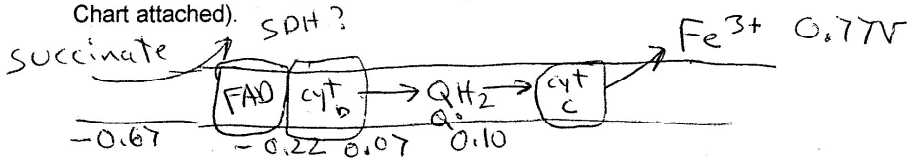
$250 + 10[S] = 100[S]$

$250 = 90[S]$

$[S] = 2.8$ nM

3. A newly isolated soil bacterium grows without oxygen but requires Fe^{3+} ion in the growth medium. Succinate suffices as a carbon source, but neither hexoses nor pyruvate can be utilized. The bacteria require riboflavin as a growth supplement. Neither niacin nor thiamine is required, and neither substance nor compounds derived from them can be found in the cells. The electron carriers found in the bacteria are cytochrome b, cytochrome c, FAD, and coenzyme Q (ubiquinone) .(10)

a. Propose a reasonable electron transport chain that takes into account these observations including the Fe^{3+} ion requirement (and see Reduction Potential Chart attached).



b. Which other observations help explain why the bacteria cannot use hexose sugars or pyruvate.

No thiamine means no PDH and hence Pyruvate can't be used. No Niacin means no NADH and so no glycolysis could occur (G-APDH).

c. Why is riboflavin required?

It is the precursor to FAD.

d. What is ΔG° for two electrons transferred through your proposed electron transport chain? How many ATP (theoretically) could be synthesized per succinate fed into the system?

$\Delta G^{o\prime} = -n\ F\ \Delta E\ (0.77 - -0.67)$

$= -2 \cdot 23{,}000 \cdot 1.44$

$\hat{=} -66{,}000$ cal/mol

$-66.$ kcal/mol pair e^- / 7.5 kcal/mol ATP

$= 8.8$ mol ATP/pair e^-

Multiple choice (+3)

C 4. Approximately how many ATP can be synthesized per extramitochondrial NADH? Assume the glycerol phosphate shuttle is working.

a. 1
b. 2
c. 1.5
d. 2.5
e. 3.5

d 5. Which of the following completes the sentence correctly? Uncouplers such as dinitrophenol (DNP), uncouple electron transport from phosphorylation by

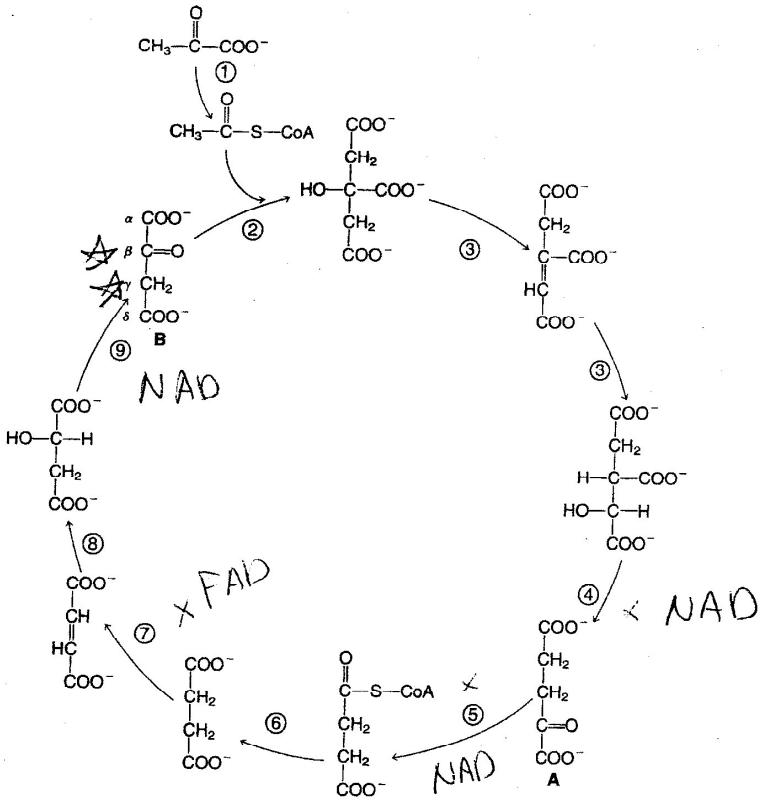
a. inhibition of cytochrome reductase
b. dissociating the Fo and F1 ATP synthase units
c. blocking electron transport
d. dissipating the proton gradient
e. blocking the ATP-ADP exchanger

C 6. Which of the following is a product of the reaction of superoxide dismutase?

a. O_2-
b. H_2O
c. H_2O_2
d. O_2
e. H_3O+

b, d, e 7. Which of the following statements about the Cori cycle and its physiologic consequences are correct?(may be more than one answer)

a. it involves the synthesis of glucose in muscle
b. it involves the release of lactate by muscle
c. it involves lactate synthesis in the liver
d. it involves ATP synthesis in muscle
e. it involves the release of glucose by the liver



8. For the pathway above (answer with numbers or letters)(14)

a. Draw a **STAR** ☆ by the methyl group of acetyl CoA. Pretend this is labeled with ^{14}C. Put star(s) by the carbon(s) if any, that you would expect to be labeled in Oxaloacetate. (C2 + C3)

b. Which steps are decarboxylations? (4) (5)

c. Which step(s) require NAD+ ? (4) (5) (9)

d. Which step(s) require FAD+ ? (7)

e. Which two steps are inhibited by ATP and NADH ? (4) (5) (1)

f. Which step uses a ***prochiral*** substrate? (3)

g. Which intermediate can be replenished by anapleurotic reactions? (B) (A)

Oxaloacetate
malate
α-kg would be acceptable

9. What is the effect of ***increasing the concentration*** of each of the following metabolites on the net rate of glycolysis (increase,decrease) ? *Briefly* explain the why for each answer.(12)

a. Glucose-6-phosphate

Should ↑ the pathway since it's a substrate. (but may inhibit hexokinase)

b. Fructose 1,6,-bisphosphate

Should ↑ since it is the Flux controlling substrate.

c. Citrate

Inhibits PFK-1 (and stimulates F1,6 B Phosphatase) so it will ↓ decrease activity.

d. Fructose 2,6-bisphosphate

Stimulates PFK-1 so it will ↑ rate.