

**1. A** (25 pts). Starting from succinate and pyruvate write out the sequence of reactions required to metabolize 1 mole of pyruvate and make 3 moles of carbon dioxide. Provide a **balanced** equation for each reaction giving the **chemical structures** of each of the metabolites (names for reduced credit) and the names of the responsible enzymes. Use the conventional acronyms for cofactors and prosthetic groups. Do NOT give the detailed mechanism for the individual enzymes.0

**1. B** (10 pts). In separate experiments fresh pigeon flight muscle is incubated with the following compounds radio-labeled as indicated. Indicate what metabolic **events** must occur before the radio-label is found in carbon dioxide.

- $^{14}\text{C}$  carboxyl-labeled pyruvate.
- $^{14}\text{C}$  methyl-labeled pyruvate
- $^{14}\text{C}$  carboxyl-labeled succinate.
- $^{14}\text{C}$  malate-labeled in the secondary alcohol.
- $^{14}\text{C}$  malonate-labeled in the methylene group.

2). What are anaplerotic reactions? Provide one example (using balanced equations) from mammals and a second from plants. What processes (metabolic or otherwise) make anaplerotic reactions necessary? Give 3 examples.

3. Match the items in the two columns using a notation like: **a**⇒**1**. Do not assume that all entries on the right must be used up.

- |  |                             |
|--|-----------------------------|
| a) Can transfer 1 or 2 electrons: <b>a</b> ⇒                 | 1) $\text{NAD}^+$           |
| b) Introduces $\text{CO}_2$ into a CoA ester: <b>b</b> ⇒     | 2) Coenzyme $\text{B}_{12}$ |
| c) Can transfer a 2 carbon fragment: <b>c</b> ⇒              | 3) Thiamin pyrophosphate    |
| d) Interchanges substituents on adjacent carbons: <b>d</b> ⇒ | 4) Lipoic acid              |
| e) Transfers a hydride ion: <b>e</b> ⇒                       | 5) FAD                      |
| f) Reacts with oxygen: <b>f</b> ⇒                            | 6) Coenzyme A               |

Which of the entries in the right hand column are:

Cosubstrates?  
Prosthetic Groups?

**4)** (a) What is the physical reason that the melting point of octadecanoic acid (18:0) is  $63^\circ\text{C}$  and octadecenoic acid (18:1) is  $16^\circ\text{C}$ ?

(b) What is the structure (at pH 7) of phosphatidic acid that contains the above two fatty acids Write out the structure in full except that the **alkyl** side-chain of each fatty acid can be replaced by its name or number.

(c) Provide a simple test to establish whether-or-not a protein is an integral membrane protein.

(d) An integral protein is known to form a transmembrane pore. How would you determine whether this pore is constructed from helices or from beta sheets.

(e) What is the difference between primary and secondary active transport?

(f) Bacteria accumulate lactose by lactose+H<sup>+</sup> symport and acetate by acetate+H<sup>+</sup> symport. For the same magnitude of proton motive force across the membrane will lactose and acetate be concentrated to the same extent? Explain!.

(g) To what extent are the adrenaline receptor and acetyl choline receptor similar? To what extent are they different (ignoring the fact that they undoubtedly have different protein structures)?

5.) The proton-motive force ( $P$ ) across the mitochondrial membrane is typically -200 millivolts; about 75% is due to  $\Delta\psi$  and 25% due to  $\Delta\text{pH}$ .

What would be the value of the proton-motive force following treatment of mitochondria with:

- 1) Valinomycin
- 2) Gramicidin.
- 3) Dinitrophenol (DNP)
- 4) Tetraphenylphosphonium (TPP<sup>+</sup>)
- 5) 5,5-dimethyl-2,4-oxazolidinedione (DMO).

(Explain your responses.)

Some bacteria use a “sodium motive” force with the same magnitude and relative composition for  $\Delta\psi$  and  $\text{pNa}$  as given above for  $P$ . What would the value of this force after treatment of the bacteria with:

(Explain your responses).

- 1) Valinomycin
- 2) Gramicidin.
- 3) Dinitrophenol (DNP)
- 4) Tetraphenylborate (TPB<sup>-</sup>)
- 5) 5,5-dimethyl-2,4-oxazolidinedione (DMO).