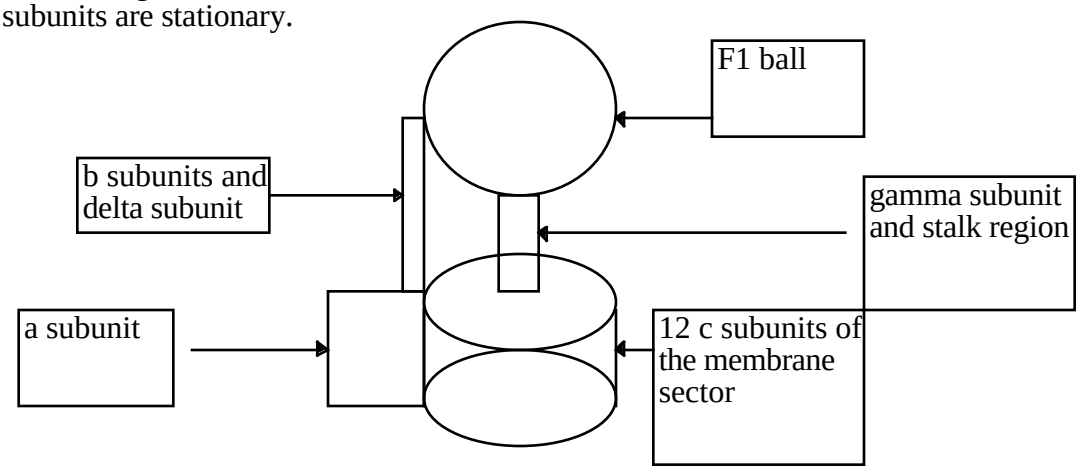
Key to oxphos exam questions Nov. 4, 1998

1. The electrons can enter from complex II (succinate dehydrogenase) or the electron transfer flavoprotein dehydrogenase (ETF QO) or the glycerol phosphate shuttle that uses a cytosolic glycerolphosphate dehydrogenase and a mitochondrial membrane bound version. All three of these pathways converge on ubiquinone as the electron carrier to complex III.

2. NADH is an obligatory 2 electron donor. Fe in iron sulfur clusters or in cytochromes can only accept 1 electron at a time. Therefore, an intermediate flavin is required that can accept two electrons and donate one at a time to Fe.

3. Cytochrome c oxidase has many channels in its structure. There is an oxygen channel to allow O2 to enter the active site. This channel comes from the lipid bilayer, not from the aqueous phase. There are at least two different pathways for protons to enter from the matrix. One pathway is needed for chemical protons that react with O2 and another pathway is needed for the protons that are pumped across the membrane. These two pathways have to be independent, or the pumped protons will be exposed to the active site and could interfere with the reaction there. The product H2O must also be released, so there must be a water channel. This is probably different from the O2 channel.

4. The ball of F1 is fixed relative to the a and b subunits in the membrane by an interaction with the delta subunit. This forms the stator of the molecular motor. The gamma subunit and the proteins of the stalk plus the 12 c subunits of E. coli are coupled to each other to form the rotor. gamma, the stalk and the c subunits turn, while the F1 ball, the a, b and delta subunits are stationary.



5. The elevator model of proton movement postulates a broken channel for protons in the a subunit. The protons move half way through the membrane in the first part of the channel. Then they move onto the required carboxyl group of the c subunit and the rotor turns 1/12th of a circle. The proton is then able to leave and enter the other half of the broken channel and exit to the matrix side of the membrane. The proton gradient is responsible for forcing the rotor to turn.

6. The experiments that show the ATP synthase is a molecular motor that turns are of three types. 1) cysteine crosslinking experiments that lock the protein together so it cannot turn. 2). The visualization of movement by a fluorescent actin fiber attached to gamma by avidin streptavidin or 3) periodic changes in fluorescence caused by a tryptophan being quenched as it passed by a fluorescence energy transfer partner. See the notes for details on these.