Preparation for class on October 28 in BSCI 2520-01

Please read Chapter 18, sections 1 and 2, using the following questions to guide your thinking. In class, you'll have a chance to confirm these answers and to check your understanding with some additional questions/problems.

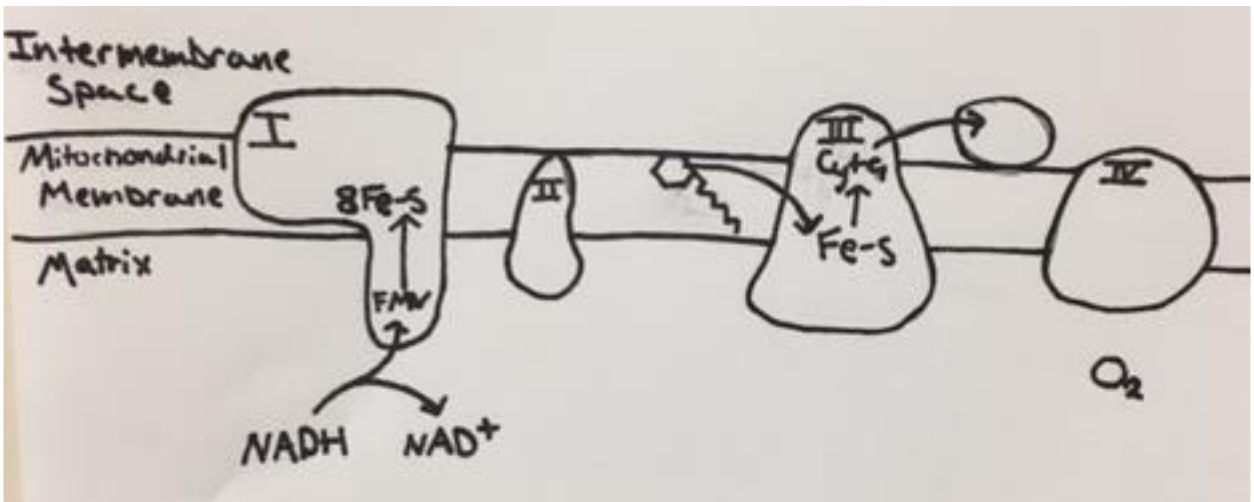
Part 1

Choosing one of the templates below, draw or diagram the path that electrons from NADH follow in the electron transport chain.

Template 1:

NADH → FMN → 8 Fe-S clusters → → Fe-S → cyto c_1 → → → → → O_2

Template 2:



1. In thermodynamic terms, why do electrons follow this path?

2. Do you think it would be possible to substitute an Fe-S cluster for the FMN in complex 1? Why or why not?

3. Figure 18-8 in your text shows a circular path for the electrons in Complex 3, but in the templates above, we have omitted it. Do the templates accurately (if incompletely) describe the path of electrons from NADH? If so, how can this be true? If not, why not?

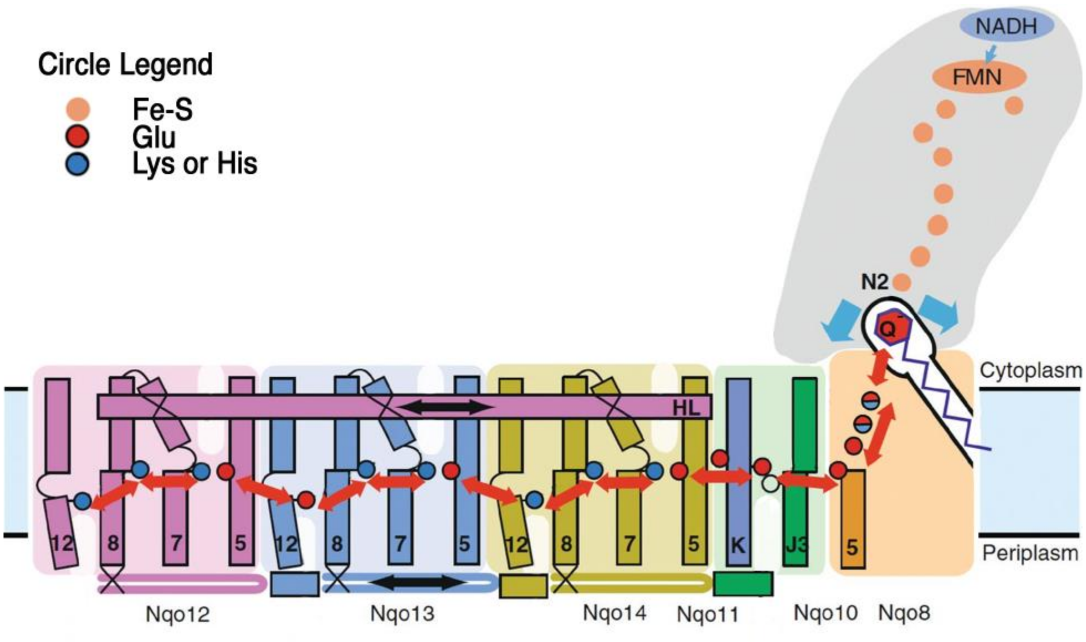
4. Which parts of the pathway do electrons from $FADH_2$ use? I encourage you to underline, circle, or somehow indicate on the template you used above.

5. How is the electron transport chain intimately linked to the citric acid cycle?

Part 2

In complexes 1, 3, and 4, electron transport is coupled to H^+ pumping across a membrane (the inner mitochondrial membrane in eukaryotes, the plasma membrane in prokaryotes). We are going to consider the mechanism of proton pumping and its relationship to electron flow in Complexes 1 and 3.

While answering the questions about Complex 1, it will help you to carefully reread section 18-2C. Consider the diagram of Complex 1 shown below.



Rozbeh Baradaran, John M. Berrisford, Gurdeep S. Minhas & Leonid A. Sazanov Nature 494, 443–448 (28 February 2013) doi:10.1038/nature11871

1. Label the path of electron flow in the diagram.
2. Note that the electrons are passing to Coenzyme Q (aka ubiquinone). Draw the reduced form of CoQ here.

3. It's thought that the CoQ binding pocket of Complex 1 is so snug that H_2O and H^+ are excluded. Draw the structure of reduced CoQ when H^+ are not available.

4. You can see that the reduction of CoQ in the environment of Complex 1 converts a neutral molecule to a molecule with two negative charges. This change in charge produces a conformational change that propagates across the complex and results in the opening of four proton translocation channels. Label those channels in the diagram above.

5. When the H^+ enter the channel, they do not flow across the membrane in the way we are used to with Na^+ or K^+ channels. Instead, they associate with an amino acid. For example, in the H^+ channel at the far left in the diagram, the H^+ that enters the channel converts lysine from the neutral (--NH_3) to the charged (--NH_4^+) form. How, then, is a proton translocated across the membrane at each of the channels you labeled?

6. What is the name for this mechanism of proton translocation?

While answering the questions about Complex 3, it will help you to carefully reread section 18-2E OR to watch the animation shown here: www.wiley.com/college/sc/voet/guided_exploration/index.html (Requires Flash. I love this animation and think it helps with understanding of the Q cycle. The text is fine, though.)

1. In words, write a summary of the Q cycle.

2. What about the structure of Coenzyme Q makes it an ideal electron carrier for this process?

3. How are protons “pumped” during the Q cycle? Why do we call it “pumping”?

4. What is the purpose of the Q cycle?