

Objectives  
Unit on Mitochondria  
Medical Cell Biology  
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## Study Guide

Read Cooper sections listed in Course schedule

Use the excellent diagrams to show how the different mitochondrial systems are interrelated and also how proteins enter mitochondria. Study the section on mitochondrial diseases and understand how they are inherited. Finally, correlate your learning with the biochemical lectures during these weeks to fully understand the chemiosmotic theory.

### Objectives and Lecture Outline:

#### Lecture 1. Mitochondrial Architecture:

1. Describe the substructure of mitochondria. Be able to correlate a change in structure with a change in function.
2. Locate each of the major sets of enzymes/functional groups: Krebs's Cycle, Electron transport chain, ATP synthetase, hydrogen pumps and describe their significance.
3. Be able to specify exactly where and on what structures ATP is synthesized.
4. How and where is electron transport coupled to the production of ATP.
5. Describe how the Proton gradient (Hydrogen ion gradient) affects the delivery of pyruvate, ATP, ADP, inorganic phosphate to their respective end points.
6. Define how mitochondria replicate and the function of mitochondrial DNA, RNA, ribosomes. Categorize the proteins produced.
7. Explain the significance of an abnormal increase in number of mitochondria and/or cristae in cells which have defective mitochondrial proteins.

#### Lecture 2. Mitochondrial Import and Genetics

1. Describe general functions for TOM and TIM proteins in mitochondria.
2. List the major steps involved in protein entry into mitochondria (preparation, binding, guiding, entry, final steps in matrix).
3. Describe how the electron transport chain facilitates the following:
  - a. ATP synthesis
  - b. ATP/ADP transporter
  - c. Entry of proteins
4. Define the steps used by the cell to destroy old mitochondria.
5. Describe the Mitochondrial DNA code, including spacer molecules.

6. Distinguish nuclear inheritance of mitochondrial proteins from maternal inheritance of mitochondrial proteins. How may this be used to trace ancestry?

### **Competencies**

Given the origin of a specific mitochondrial protein, be able to trace its route into mitochondria and be able to predict the outcome of a genetic defect in the protein.

Describe multiple examples where mitochondria functions are integrated and thus facilitate one another.

Be able to explain mitochondrial heredity to a patient and, if there is a defect, why there is variability in severity of the disease in a given family.

### **Sample questions:**

- 1) Your patient has a genetic defect in a mitochondrial Krebs's cycle protein encoded by nuclear DNA. The defect is not in or near the signaling sequence, however it prevents the protein from being folded into its proper 3-dimensional structure. At what point in its route to its destination will the defect be a problem:
  - a. Chaperone interaction in the matrix
  - b. Chaperone interaction in the cytoplasm
  - c. Binding to TOM proteins
  - d. Transport through the General Import pore
  - e. Binding to TIM proteins

Answer: B

- 2) The hydrogen pumps on the electron transport chain directly or indirectly facilitate the following:
  - a. Chaperone binding to proteins in the cytoplasm
  - b. Transport through the general import pore
  - c. ADP/ATP Exchange
  - d. Production of ATP
  - e. All of the above

Answer: E