Objectives:
1) Be able to broadly describe respiration and its utility for a cell.
2) Know the order of the 3 stages of respiration, what goes into each stage and results.
3) Know some of major limitations/controls on respiration.

Stages in the respiration of glucose
1) Glycolysis
2) TCA cycle
3) Electron transport chain

Glycolysis
A linear metabolic pathway, with 9/10 steps.
Glucose (6carbon), ATP, NAD, Pi, and 9/10 enzymes are required.
Pyruvate (3carbon), ATP, water, and NADH are end products.

The enzyme catalyzing the third step is activated by ADP, and inhibited by ATP and citric acid. This is a metabolic control point.

Question: How many ATP, pyruvate, waters, and NADH result from every glucose that goes through glycolysis?

TCA Cycle
This metabolic pathway includes a cycle.
If oxygen is present pyruvate enters the TCA cycle.
TCA cycle starts with acetyl CoA (2 carbons).
This bonds to a 4 carbon molecule already in the cycle.
There are eight steps in the cycle and eight enzymes to drive the major steps.
Pyruvate, NAD+, ADP, FAD, and over eight enzymes are required.
NADH, FADH₂, CO₂, ATP are direct end products.

The TCA cycle is regulated by product inhibition, reactant availability, and competitive feedback.

Question: How many ATP, CO₂, FADH₂ and NADH result from every glucose that goes through glycolysis?
Electron Transport Chain

Carbon bonds from the glucose no longer utilized.
Energy in FADH₂ and NADH utilized.
ETC occurs in the mitochondria.

Protons and electrons from FADH₂ and NADH are transferred to the ETC.
The protons are released into the intermembrane compartment (creating a gradient).
The electrons are shuffled until transferred to a oxygen and two protons (making water).
The protons come from the matrix (further increasing a proton gradient).
The proton gradient is used to drive the production of ATP (32 ATP/pyruvate).
If O₂ is not present, the ETC stops.

Question: How many ATP are produced for every glucose?
   How many CO₂ molecules are produced?
   How many O₂ are consumed?

Notice:
   1) that the oxygen and carbon dioxide are utilized and produced at different steps,
   2) that the steps producing carbon dioxide also produce NADH,
   3) the production and use of a gradient is a major feature in respiration,
   4) ATP is produced in numerous steps and locations,
   5) the mitochondria’s structure is ideal for its main function (making ATP).