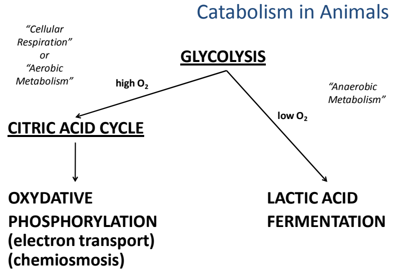
Slide 1

Catabolism in Animals



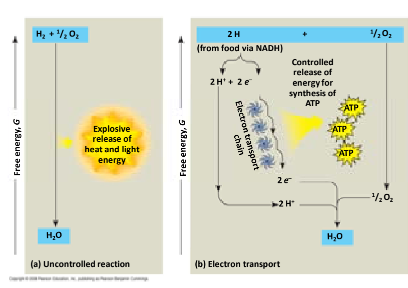
Slide 2

Oxidative Phosphorylation: Electron transport - Chemiosmosis - ATP synthesis

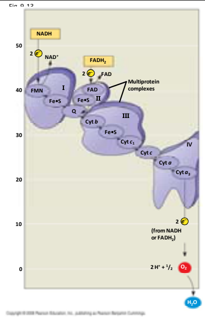
- Glycolysis and the citric acid cycle supply:
  - 10 NADH and 2 $FADH_2$
  - extracted from each glucose molecule burned
- These two electron carriers donate electrons to the electron transport chain (ETC)

Slide 3

Fig. 9-5



Slide 4



- The electron transport chain (made mostly of multi-protein components) is in the cristae of the mitochondrion
- The carriers alternate reduced and oxidized states as they accept and donate electrons
- Electrons drop in free energy as they go down the chain and are finally passed to O_2, forming H_2O
- H+ are released from carriers as they move into chain

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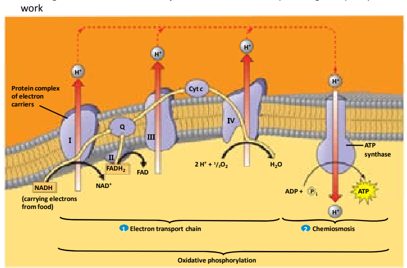
- Electrons are passed through a number of proteins including **cytochromes** (each with an iron atom) to O_2
- The electron transport chain generates <u>no ATP</u>
- It simply uses the energy to push the freed hydrogen ions H+ out of the mitochondrial matrix into the intermembrane space

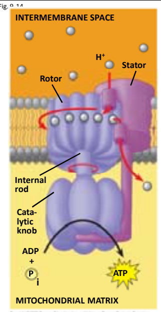
Slide 6

- The energy stored in a H^+ gradient across a membrane couples the redox reactions of the electron transport chain to ATP synthesis
- The H^+ gradient is referred to as a **proton-motive force**, emphasizing its capacity to do work



Slide 7

Fig. 9-14



Chemiosmosis - the use of E in a H^+ gradient to drive cellular work

1. Electron transfer in the ETC causes proteins to pump H^+ from the mitochondrial matrix to the intermembrane space

- H^+ then moves back across the membrane, passing through channels in **ATP synthase**
- ATP synthase uses the exergonic flow of H^+ to drive phosphorylation of ATP

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Oxidative Phosphorylation: Electron transport - Chemiosmosis - ATP synthesis

- Glycolysis and the citric acid cycle supply:
  - 10 NADH and 2 $FADH_2$
  - extracted from each glucose molecule burned
- NADH carries enough energy to make 3 ATP
- FADH2 carries enough energy to make 2 ATP
- Enough for 34 ATP from each glucose

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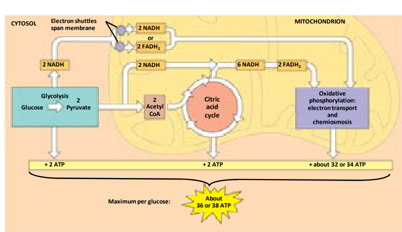
Fig. 9-17

Flow of energy during cellular respiration:

glucose → NADH → electron transport chain → proton-motive force → ATP

~ 40% of energy in glucose is transferred to ATP



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Other Catabolic Pathways

- **Fermentation** is a partial degradation of sugars that occurs (with/without) O_2
  - Alcohol fermentation – *Saccharomyces cerevisiae*
  - Lactic acid fermentation – *Lactobacillus acidophilus*
  - Acetic acid fermentation – *Escherichia coli*
- **Anaerobic respiration** is similar to aerobic respiration but consumes compounds other than O_2
  - Sulfate-reducing bacteria and archaea

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Fermentation

- Fermentation does not generate ATP directly
- Instead it makes glycolysis run as a cycle
  - Fermentation involves reactions that regenerate NAD^+, which can be reused by glycolysis
  - Two common types are alcohol fermentation and lactic acid fermentation

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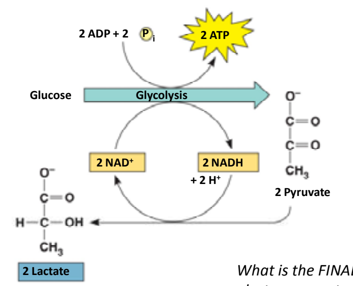
Fig. 9-18b



(b) Lactic acid fermentation

What is the FINAL electron acceptor?

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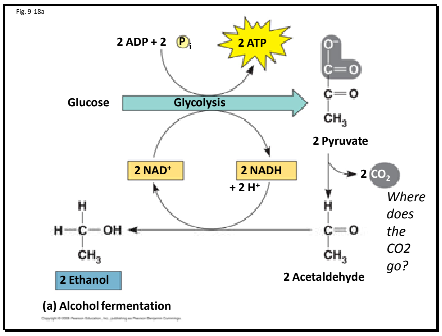

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Fermentation and Aerobic Respiration Compared

- Both processes use glycolysis to oxidize glucose and other organic fuels to pyruvate
- Final electron acceptors: an organic molecule (such as pyruvate or acetaldehyde) in fermentation and O_2 in cellular respiration
- Cellular respiration produces ~38 ATP per glucose molecule
- Glycolysis/fermentation produces 2 ATP per glucose molecule

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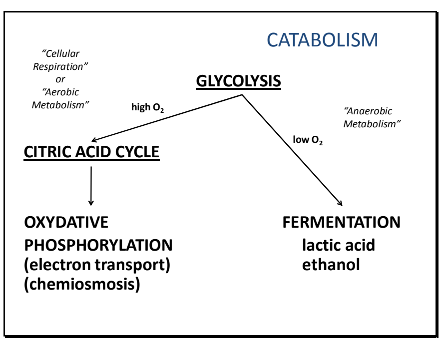

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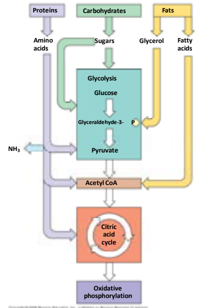
Fig. 9-20



Slide 17

Biosynthesis (Anabolic Pathways)

- The body uses small molecules to build other substances
- These small molecules may come directly from food, from glycolysis, or from the citric acid cycle

Slide 18

Regulation of Cellular Respiration via Feedback Mechanisms

- Feedback inhibition is the most common mechanism for control
- If ATP concentration begins to drop, respiration speeds up; when there is plenty of ATP, respiration slows down
- Control of catabolism is based mainly on regulating the activity of enzymes at strategic points in the catabolic pathway

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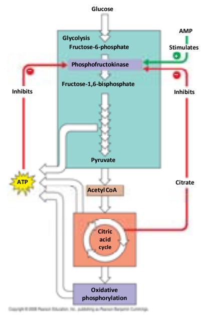
Fig. 9-21



Slide 20

Practice Questions

1. “Glucose + Fructose ------> Sucrose” is an example of which type of reaction?
   a. catabolism
   b. anabolism

2. Does the equation above generate or use energy?

3. What is the name of the high-energy, recyclable molecule in which energy is stored?

4. In glycolysis, glucose is broken down. Is glucose oxidized or reduced?

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Practice Questions

5. Are the following oxidized/reduced forms?
   NAD^+
   NADPH
   FAD
6. Are the above molecules:
   inorganic cofactors?
   organic coenzymes?
7. What is the primary function of the above molecules in cellular respiration?

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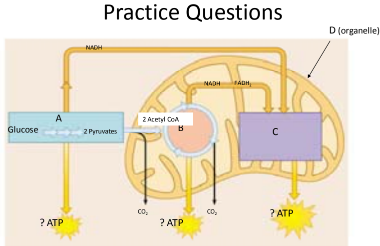
Practice Questions



Name the stages of cellular respiration (A, B, C)
Name the organelle (D); Where does each stage occur?
How many ATP are generated at each stage?
What type of phosphorylation occurs at each stage to generate ATP?