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**Contents: chapter 9**

**CHEMICAL ENERGY AND FOOD**

- All organisms make energy by breaking down food
- Unit: calorie
- 1 calorie = amount of energy needed to raise the water 1 degree
- 1 Calorie = 1000 calorie
- Carbohydrates & protein: 4000 calorie
- Fat: 9000 calorie

**OVERVIEW OF CELLULAR RESPIRATION**

- The controlled release of energy from food molecules in cells to form ATP in the release of oxygen
- Stages: glycolysis -> krebs cycle -> ETC

**ELECTRON CARRIERS**

- A compound that can accept a pair of high energy electrons and transfer them, along with most of their energy to another molecule
- $\text{NAD}^+ + 2\text{e}^- + \text{H}^+ \rightarrow \text{NADH}$
- $\text{FAD}^+ + 2\text{e}^- + \text{H}^+ \rightarrow \text{FADH}$

**GLYCOLYSIS**

- Total net yield: 2 pyruvic acid + 2ATP + 2NADH
- Use 2 ATP to produce 2ATP, net production: 2 ATP
- Advantage: fast, anaerobic

## THE KREBS CYCLE

- Stage 1: citric acid production
  - $2 \text{ pyruvic acid} \rightarrow 2 \text{ acetyl CoA} + 2\text{NADH} + 2\text{CO}_2$
  - $2 \text{ Acetyl CoA} \rightarrow 2 \text{ citric acid}$
- Stage 2: energy extraction
  - $2 \text{ citric acid} \rightarrow 6\text{NADH} + 2\text{FADH}_2 + 4\text{CO}_2 + 2\text{ATP}$
- Total net yield:  $2\text{pyruvic acid} \rightarrow 2\text{ATP} + 8\text{NADH} + 6\text{FADH}_2 + 6\text{CO}_2$

## ETC AND ATP SYNTHESIS

- use high energy electron carried by NADH and FADH<sub>2</sub> from glycolysis and krebs cycle to form ATP
- This process is called chemiosmosis - the cell uses the potential energy from charge difference built up as a result of electron transport
- high energy electrons released by NADH and FADH<sub>2</sub> are passed along electron transport chain, As e<sup>-</sup> transport down the ETC, their energy is used to pump H<sup>+</sup> across the inner membrane, H<sup>+</sup> diffuse back across inner membrane through ATP synthase and cause it to rotate. The rotation of ATP synthase cause ADP and P to form ATP
- Total net yield: release 32 or 34 ATP. (NADH = 3ATP, FADH<sub>2</sub> = 2ATP)

## ALCOHOLIC FERMENTATION

- Step 1:  $\text{glucose} + 2\text{NAD}^+ \rightarrow 2 \text{ pyruvic acid} + 2\text{ATP} + 2\text{NADH}$
- Step 2:  $2 \text{ pyruvic acid} + 2\text{NADH} \rightarrow 2 \text{ alcohol} + 2\text{CO}_2 + 2\text{NAD}^+$
- Help produce bread, beer, and wine

## LACTIC ACID FERMENTATION

- Step 1:  $\text{glucose} + 2\text{NAD}^+ \rightarrow 2 \text{ pyruvic acid} + 2\text{ATP} + 2\text{NADH}$
- Step 2:  $2 \text{ pyruvic acid} + 2\text{NADH} \rightarrow 2 \text{ NAD}^+ + 2\text{lactic acid}$
- In bacteria (cheese, yogurt)

## OXYGEN DEBT

- Cells require extra O<sub>2</sub> to break down the lactic acid (by-product) built