IDX G10 Biology H

Study Guide Issue S1 M2

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9.1 Cellular Respiration: An Overview

- a calorie: amount of energy needed to raise 1 degree celsius of 1 gram of water
- a Calorie: kilocalorie(1000 calorie), used on food label
- energy obtained from food
- cellular respiration: releases energy by breaking down food in prescence of oxygen
  - $6\ O_2 + C_6H_{12}O_6 \text{-->} 6\ CO_2 + 6\ H_2O$ + Energy

- Glycolysis
  - cytoplasm, only a small amount of ATP produced
  - 90% of glucose's energy locked in the chemical bonds of pyruvic acid
- Krebs Cycle
  - matrix of mitochondrian
  - a little more ATP is generated from pyruvic acid
- Electron transport chain
  - inner mitochondrial membrane
  - produces great amount of ATP by using O_2 as the final electron acceptor
- Aerobic: requrie oxygen, Krebs Cycle and electron transport chain
- Anaerobic: not requrie oxygen, glycolysis

9.2 Process of Cellular Respiration

Glycolysis: process in which 1 molecule of glycolysis is split into two, producing 2 molecules of pyruvic acid, a 3 carbon compound

- happen in cytosol--the aqueous part of cytoplasm
- ATP Production
  - 2ATP-->2ADP
  - 4ADP-->4ATP
  - net gain of 2 ATP

- NADH production
  - electron carrier NAD^+ -->NADH
  - help pass energy from glucose to other pathways
- glycolysis does not require oxygen. Supply chemical energy when oxygen is not available
- product: 2 pyruvic acid enters krebs cycle
- Overall: glucose+2NAD^++2ATP-->2 pyruvate + 2 NADH + 4ATP
- Formation of Acetyl-CoA
  - 2 pyruvates are transported to the mitochondria matrix
  - pyruvate is converted into acetyl-CoA, which enters the Krebs Cycle
  - electrons released from pyruvate are transferred to NAD^+, which becomes NADH
  - NADH shuttles electrons to ETC

Krebs Cycle(Citric Acid Cycle)

- mitochondrial matrix
- product: carbon dioxide from organic immediate, ATP, NADH carrying electrons, $FADH_2$ carrying electrons
- Acetyl-CoA combines with oxaloacetate to form citrate
- harvest high energy electrons from carbon bond--electrons captured by NAD^+, FAD
- citric acid-CO_2-->5C compound-CO_2-->4C compound
- a total of 3 carbon dioxide molecules are released in one cycle
- citrate + NAD^+ -->4C compound +CO_2+NADH
- 5C compound+ NAD+ --> 4C compund + CO2+NADH
- 4C compound + FAD +NAD^+ +ADP+P_i --> OXAL + $FADH_2$+NADH+ATP
- for each pyruvate, 1 ATP produced

Oxidative Phosphorylation

- happen in inner membrane of mitochondria in eukaryote
- electrons extracted in glycolysis and krebs cycle are transferred by NADH and FADH2 to the ETC
- ETC transfers electron in a series of oxidation reduction reaction

    - energy released and pump hydrogen ions agaisnt the concentration gradient, from matrix into intermembrane space
    - Oxygen is the final electron acceptor and is reduced into water molecule
    - folding of inner membrane increases the surface area for ETC to happen on, allowing more ATP synthesis
- As hydrogen ions are pumped, an electrochemical gradient of hydrogen ions established
    - higher concentration(more positively charged) in the intermembrane space than matrix
- during the chemiosmosis, hydrogen ions flow from intermembrane space back to the matrix through ATP synthase, moving down the electrochemical gradient. The movement provide energy to form ATP

Conclusion

- 38% of energy by 1 glucose from 36(38)ATP
- 62% of glucose's energy is released as heat to keep warm
- net 2 ATP from glycolysis
- krebs cycle: 2 pyruvate--> 8NADH + $2FADH_2$ + 2ATP + $6CO_2$
- electron transport: 10NADH + $2FADH_2$ --> $10NAD^+$+2FAD+32 or 34 ATP
- for prokaryotes, the ETC locates on cell membrane(hydrogen ions pumped from cytoplasm to outside)

9.3 Cellular Energies: Fermentation

- fermentation: release energy from food molecules in absence of oxygen--allow glycolysis to continue supply of ATP
- Alcoholic fermentation
    - produce ethyl alcohol and carbon dioxide
    - in cytoplasm of yeast and some microorganisms
    - glucose-->2ATP + 2Alcohol + 2 CO_2
    - two steps: glycolysis, alcoholic fermentation
        - glucose + 2 NAD^+ + 2ATP-->2 pyruvate+ 2NADH + 4ATP
        - 2 pyruvic acid + 2NADH --> 2 Alcohol + $2CO_2$ +$2NAD^+$

- Lactic acid fermentation
  - lactic acid as waste
  - 2 pyruvic acid + 2NADH-->2 lactic acid + $2NAD^+$
  - produced during rapid exercise where there is not enough oxygen and thus not enough ATP produced
- both kinds of fermentation regenerate NAD^+ so that glycolysis can continue
- muscles use stored ATP, lactic acid fermentation, cellular respiration
- Quick energy
  - stored ATP: contained by cell from glycolysis and cellular respiration, only for a few seconds of intense activity
  - lactic acid fermentation: after stored ATP used up, enough ATP to last 90s
- Long term energy
  - cellular respiration--release energy slower than fermentation
  - use energy stored in muscle--glycogen(only for 15-20min)
  - after 15-20min, body break down other stored molecules(eg. fats)