

MOLECULAR CELL PHYSIOLOGY - Cellular Respiration

- I. Overview
 - A. Photosynthesis (energy & CO₂ fixation) - chloroplasts
 - B. Respiratory metabolism
 - 1. Glycolysis - cytoplasm
 - 2. Krebs (Citric acid cycle) - mitochondrion
 - 3. Electron transport and oxidative phosphorylation - mitochondrion
- II. Glycolysis [glucose and fructose from Calvin cycle (photosynthesis)]
 - A. Glucose - glucose-6-p - fructose-6-p - fructose 1,6-dp - PGAL (=DHAP) - 1,3-dp-glycerate - 3-p-glycerate - 2-p-glycerate - phosphoenolpyruvate - pyruvate
 - B. Initial step(s) - energy requiring (2 ATP)
 - C. Subsequent steps
 - 1. Two - substrate-level phosphorylations (4 ATP)
 - 2. One - reduction of NAD to NADH (2 NADH)
 - D. Yield - 2 ATP & 2 NADH
 - E. Final product - 2 pyruvates
- III. Alternatives after glycolysis
 - A. Lactic acid - 2 ATP (no NADH) ... intense muscle activity (little O₂ available)
 - B. Ethanol - 2 ATP (no NADH) ... fermentation
 - C. Krebs Cycle - (2 ATP) and oxidative phosphorylation (32 ATP)
- IV. Krebs Cycle - mitochondrial matrix
 - A. [pyruvate - acetyl CoA] - citrate - isocitrate - alpha-ketoglutarate - succinyl CoA - succinate - fumarate - malate - oxaloacetate - w/acetyl CoA - citrate
 - B. Initial step(s) - pyruvate converted to acetyl CoA [CO₂ emission and NADH production] - acetyl CoA combines with oxaloacetate (4 carbon) to form citrate (6 carbon)
 - C. Subsequent steps
 - 1. Cycle (two trips) - 2 GTP (2 ATP), 8 NADH, and 2 FADH₂
 - D. Final product - 6 CO₂
- V. Electron transport system - three sites in inner mitochondrial membrane
 - A. NADH-CoQ reductase
 - B. CoQ cytochrome c reductase
 - C. Cytochrome oxidase
- VI. Oxidative phosphorylation - across inner mitochondrial membrane
 - A. Convert NADH & FADH₂ to ATP
 - 1. NADH (glycolysis) = 2 ATP - 4 ATP
 - 2. NADH (Krebs) = 3 ATP - 24 ATP
 - 3. FADH₂ (Krebs) = 2 ATP - 4 ATP
 - B. How is it done? H⁺ gradient (opposite of chloroplast)
 - 1. NADH & FADH₂ give up H⁺ to outer compartment (High outside)
 - 2. H⁺ is then pumped back in and ATP is produced
 - C. Net yield of ATP
 - 1. From oxidative phosphorylation - 32 ATP
 - 2. Substrate level phosphorylation - 4 ATP
 - 3. TOTAL..... 36 ATP

