University-Level Respiration (Detailed 10 Pages)

Chapter 1: Advanced Cellular Respiration

Cellular respiration is a multi-step biochemical pathway converting glucose into ATP through controlled oxidation. It integrates glycolysis, pyruvate oxidation, Krebs cycle, and oxidative phosphorylation. Each step is enzyme-regulated and tightly controlled by feedback mechanisms.

Glycolysis consists of energy investment and payoff phases. Key regulatory enzymes include hexokinase, phosphofructokinase-1 (rate-limiting), and pyruvate kinase. NAD+ acts as an electron carrier forming NADH.

The Krebs cycle in the mitochondrial matrix generates reducing equivalents (NADH, FADH2). These feed into the electron transport chain where redox reactions establish a proton gradient across the inner mitochondrial membrane according to the chemiosmotic theory proposed by Peter Mitchell.

ATP synthase utilizes proton motive force to synthesize ATP via rotational catalysis. Respiratory control ratio measures coupling efficiency. Uncouplers such as DNP disrupt ATP production.

Regulation occurs via allosteric modulation, covalent modification, and substrate availability. Mitochondrial disorders impair ATP synthesis. Comparative respiration studies reveal differences between prokaryotes and eukaryotes and adaptations in extreme environments.

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