

Introduction to Metabolism

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Key concepts, terminology, and pathways for a foundational understanding

1. What Is Metabolism?

Aspect	Description
Definition	The sum of all chemical reactions that occur in living cells to maintain life.
Purpose	- Obtain energy from nutrients - Synthesize macromolecules (proteins, lipids, nucleic acids, carbohydrates) - Eliminate waste products
Two Major Categories	Catabolism – breakdown of complex molecules ? release energy. Anabolism – synthesis of complex molecules ? consume energy.
Energy Currency	Adenosine triphosphate (ATP) is the primary energy?transfer molecule.

2. General Principles

Principle	Explanation
Enzyme Catalysis	Metabolic reactions are accelerated by enzymes (biological catalysts). Each enzyme is specific for a substrate and a reaction.
Thermodynamics	• ΔG° (standard free?energy change) predicts spontaneity. • Coupled reactions link an unfavorable process (positive ΔG) to a favorable one (negative ΔG), usually via ATP hydrolysis. • Allosteric control – effectors bind away from the active site to modulate activity.
Regulation	• Covalent modification – phosphorylation, acetylation, etc. • Gene expression – long?term control of enzyme levels.
Compartmentalization	Eukaryotic cells separate pathways into organelles (e.g., glycolysis in cytosol, ??oxidation in mitochondria).

3. Central Metabolic Pathways

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Pathway	Location	Primary Function	Key Products
Glycolysis	Cytosol	Breaks glucose (6?C) ? pyruvate (3?C)	2 ATP (net), 2 NADH, pyruvate
Gluconeogenesis	Cytosol & mitochondria	Synthesizes glucose from non?carbohydrate precursors	Glucose
Citric Acid Cycle (TCA/Krebs)	Mitochondrial matrix	Oxidizes acetyl?CoA ? CO?, captures high? energy electrons	3 NADH, 1 FADH?, 1 GTP per acetyl?CoA
Oxidative Phosphorylation (ETC & ATP synthase)	Inner mitochondrial membrane	Uses electrons from NADH/FADH? to generate ATP	~30?34 ATP per glucose
??Oxidation	Mitochondrial matrix (also peroxisomes)	Fatty?acid breakdown ? acetyl?CoA	Acetyl?CoA, NADH, FADH?
Pentose Phosphate Pathway (PPP)	Cytosol	Produces NADPH & ribose?5?phosphate	NADPH, ribose?5?P
Amino?acid catabolism	Cytosol & mitochondria	Deaminates amino acids ? ??keto acids, NH? keto?acids for TCA entry	(urea cycle)
Urea Cycle	Liver mitochondria & cytosol	Converts toxic ammonia ? urea for excretion	Urea, fumarate

4. Energy Yield from Glucose (Aerobic)

Step ATP (or equivalent)