

Bioengineering

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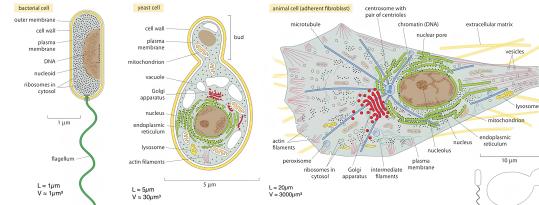
Tera	T	10^{12}	Kilo	k	10^3	Nano	n	10^{-9}
Giga	G	10^9	Milli	m	10^{-3}	Piko	p	10^{-12}
Mega	M	10^6	Mikro	μ	10^{-6}	Femto	f	10^{-15}

Orientation of the cell

Central Dogma of Molecular Biology



Cells:



nucleus: houses DNA for EK
nucleolus: produces ribosomes/rRNA
mitochondria: cellular respiration (prod. ATP)
ribosome: produces proteins from mRNA transcripts

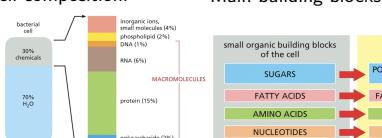
RER, SER and Golgi: involved in protein/lipid synthesis/processing

cytoskeleton: structure to cell, transport mol. in the cell or to enable the cell to move (cell migration)

centrosome: organizes microtubules during cell division allows the mother cell to split into 2 cells

Building Blocks

Cell composition:



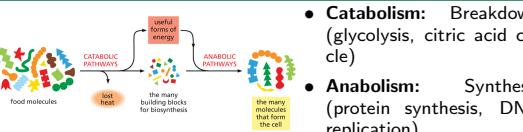
Main building blocks:

- Lipids (fatty acids):** long-term energy storage, cell membrane structure, signaling molecules.
- Proteins (amino acids):** perform most of the cell's functions, including catalyzing reactions, signaling, and structural support. amino group NH_2 , carboxyl group COOH
- Nucleic acids (nucleotides):** store and transmit genetic information (DNA, RNA), carry energy
- Carbohydrates (Sugars):** short-term energy storages and for structural support.

Enzymes (aka catalysts)

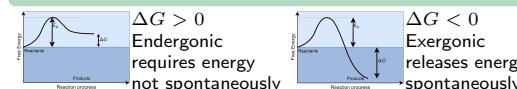
- Accelerate reaction by lowering the activation energy
- Are not consumed in the reaction
- Are specific to the reaction they catalyze
- Do not change the equilibrium point of the reaction.

Energy and Metabolism



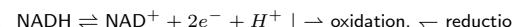
- Catabolism:** Breakdown (glycolysis, citric acid cycle)
- Anabolism:** Synthesis (protein synthesis, DNA replication)

Free Energy

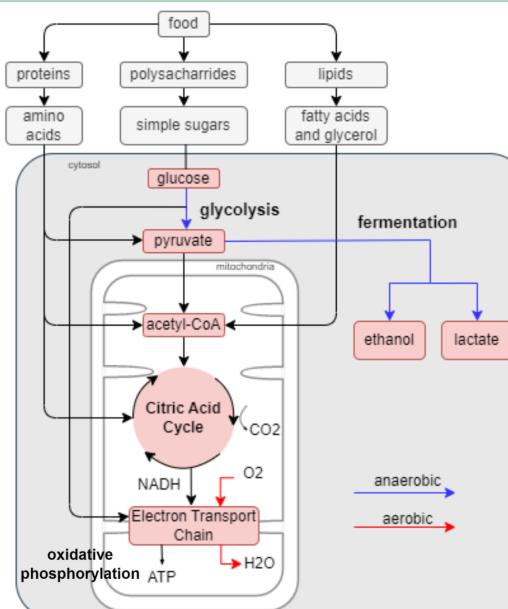


Redox

Oxidation loss of e^- ($H^+ + e^-$) | Oxidation of glucose
 Reduction gain of e^- ($H^+ + e^-$) | Reduction of pyruvate



Glucose Metabolism



Bounds

$$\text{Covalent} \longleftrightarrow 100k_B T$$

$$\text{Ionic} \longleftrightarrow 1 - 10k_B T$$

$$\text{Hydrogen} \longleftrightarrow 1k_B T$$

$$\text{Van der Waals} \longleftrightarrow 0.1k_B T$$

$$\text{Electrostatic} \longleftrightarrow 0.1k_B T$$

K_D : Equilibrium const.; indicates the ratio of free & bound units

k_{off} : Dissociation rate constant; inverse of time protein dissociates from the ligand

k_{on} : Association rate constant, speed of the reaction

$$K_D = \frac{k_{off}}{k_{on}}$$

Biosynthesis

Transport and Exchange

Cell sensing and signaling

Growth and Differentiation

Bioprocess

Cell and tissue architecture

Woundhealing and Tissue Engineering

Microphysiological Systems and Immune Engineering

Foodprocessing

Drug Delivery