Objectives
To define metabolism.
To define and explain the significance of phosphorylation.
To briefly outline the steps of cellular respiration.
To explain the significance of ATP to drive energetic needs of cells.
To identify the importance of anaerobic metabolism.

Metabolism
Collectively all the chemical reactions that take place within a cell.
Metabolic reactions in the cell allow for:
- production of energy
- synthesis of new molecules
- growth and reproduction

Metabolic Reaction Types
Catabolism – the breaking down of molecules to provide energy.
Anabolism – the building up of more complex molecules from simpler molecules e.g. protein synthesis.

Types of Energy
I. Kinetic – Energy related to work/movement.
III. Chemical – (Energy of molecules)

Where does energy come from in biological systems in the cell?
The rearrangement of electrons involved with bonding between atoms.
Electronegativity – strength of electron attraction to nucleus. Energy released when it changes orbitals. E.g. Oxygen

Energy Yield
Fats have high energy bonds C=O and can provide the most energy. Per unit wt.
Carbohydrates are the body’s preferred energy source and easier to metabolize.
- Said to be “readily available”
- Requires enzymes in cells to catabolize it.
Biological Energy Capture

The energy of bonding electrons is slowly extracted and used by first capturing the energy of electrons, and then transporting these to the mitochondria — the power generator for the cell.

Cellular Respiration

The series of reactions that occur in the mitochondria that break down the end products of glycolysis into carbon dioxide and water, while capturing large amounts of energy as ATP.

i.e. Break down of high energy molecules to extract their energy.

Oxidation of Glucose

\[ C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O + 6CO_2 + 36 \text{ ATP} + \text{heat} \]

Summary of Cellular Respiration

I. **Glycolysis** → breaking of glucose in 2 pyruvate molecules (anaerobic process in cytosol)

II. **Kreb cycle** → aerobic process that occurs in mitochondria generates CO2

Ends with reduced co-enzymes.

III. **Electron Transport** → H+ ions transported through mitochondrial membranes, coupled to production of 32-34 ATP.

What is ATP?

Adenosine Tri-Phosphate

An energy carrier molecule.

A "courier" that transfers a high energy package.

Car Analogy:

Glucose is the fuel.

ATP is the energy from combustion that makes the car go.
Glycolysis

“Splitting of Sugar”

Phase I – Sugar Activation
Phase II – Sugar Cleavage
Phase III – Oxidation & ATP synthesis

Net Gain of Glycolysis
- 2 pyruvate molecules C3H4O3
- 2 net ATP’s
- 2 molecules of reduced NAD+ \( \rightarrow \) NADH + H+ (notice 2 hydrogens) these can be combined with oxygen to yield water.

Kreb’s Cycle

*aka Citric Acid Cycle*

Occur in the matrix of the Mitochondria.
Importance: pathway for the oxidation of food fuels.

End products:
- CO2
- ATP (1 per each pyruvate)

Electron Transport Chain

Occur on Mitochondrial Cristae.
Directly uses oxygen in this process. [Oxidative Phosphorylation.]

Movement of electrons along a protein gradient cascade in the membrane.
End-products
- Water
- ATP (at site of ATP synthase) 32-34 ATP result from each glucose molecule.

Anaerobic Metabolism

*aka Lactic Acid Fermentation*

Alternative energy pathway
Occurs in cells when oxygen is deficient e.g. bacteria.
Not as efficient as aerobic metabolism because the energy yield is less
\( \rightarrow \) Yields 2 ATP’s only per glucose.
End product is LACTIC ACID.

Burning Calories

A calorie is a measure of energy:
The amount needed to raise temp of 1 gram of water by 1 degree Celcius.

1 calorie (reported) = 1 kcal

Basal Metabolic Rate

Rate at which energy is spent/used by the body per unit of time while at rest.

Body requires energy for basic processes such as breathing and maintaining the heart beat. This minimal energy is the BMR.
Average person at rest uses \(~100\) kcal/hr.
Factors Affecting BMR

- Body surface area
- Age (higher when younger)
- Gender
- Stress
- Hormones
  - Thyroxine (direct correlation)

Other methods of liberating energy