Our energy requirements:
  – Energy must be released from food gradually.
  – Energy must be stored in readily accessible forms.
  – The release of energy from storage must be controlled so that it is available exactly when and where it is needed.
  – The right amount of energy must be released as heat to maintain a constant body temperature.
  – Energy in a form other than heat is needed to drive chemical reactions that are not favorable at body temperature.

Photosynthesis: An endothermic reaction that occurs in plants in the formation of glucose. The energy needed for photosynthesis comes from solar energy.

Metabolism: refers to all the chemical reactions that provide energy and the substances required for continued cell growth.
  – Catabolism: The metabolic reactions in which molecules are broken apart. These reactions are exergonic and provide energy.
  – Anabolism: The metabolic reactions in which molecules are built up from smaller pieces. These reactions are endergonic and require energy (usually from ATP).

\[
\begin{align*}
6 \text{CO}_2 + 6 \text{H}_2\text{O} & \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2 \\
\Delta G &= +686 \text{ kcal/mol} \text{ (endergonic, energy required)} \\
\text{Oxidation} & \quad \Delta G = -686 \text{ kcal/mol} \text{ (exergonic, energy released)}
\end{align*}
\]
Overview of Metabolism

Stage 1. Digestion
Bulk food is digested in the mouth, stomach, and small intestine to yield small molecules.

Stage 2. Acetyl-SCoA Production
Sugar, fatty acid, and amino acid molecules are degraded in the cytoplasm of cells to yield acetyl-SCoA.

Stage 3. Citric Acid Cycle
Acetyl-SCoA is oxidized inside mitochondria by the citric acid cycle to yield CO₂ and reduced coenzymes.

Stage 4. ATP Production
The energy transferred to the reduced coenzymes in stage 3 is used to make ATP by the coupled pathways of electron transport and oxidative phosphorylation.
Digestion of Carbohydrates

- **Dietary carbohydrates** (starch, glycogen, sucrose, lactose)
  - **Mouth**: Salivary α-amylase
  - **Stomach**: Pancreatic α-amylase, maltase, sucrase, lactase
  - **Small intestine**: Monosaccharides
  - **Absorption through small intestine lining**: Monosaccharides in bloodstream
Digestion of Proteins

Dietary protein

Mouth

Stomach $\text{HCl and pepsin}$

Denatured and partially hydrolyzed protein (large polypeptides)

Small intestine $\text{Proteases}$

Amino acids and some dipeptides

Transport across small intestine lining $\text{Proteases}$

Amino acids in bloodstream

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Digestion of Lipids

- Dietary triacylglycerols
  - Mouth and stomach
  - Undigested, in droplets
  - Small intestine
    - Glycerol and soluble fatty acids enter bloodstream
    - Bile acids and pancreatic lipase
      - Insoluble acylglycerols and fatty acids enter micelles
        - Absorption through small intestine lining
          - Triacylglycerols in chylomicrons
            - Absorption into lymph system
              - Triacylglycerols in chylomicrons
                - Delivery into bloodstream
                  - Triacylglycerols in chylomicrons ready for delivery to cells

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