Tutorial Cell Biology and Biochemistry: Structure, Function, and Processes of Life

Senior Secondary
(Australian Curriculum)

Table of Contents

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1. Introduction to Cell Biology and Biochemistry

Cell biology and biochemistry are foundational to understanding how life works at a molecular level. Cells are the basic units of life, and they carry out countless processes necessary for survival. Biochemistry explains the chemical processes that happen within cells.

In this tutorial, we will explore:

- The structure and function of cells.
- The role of enzymes in biochemical reactions.
- The central dogma of molecular biology (DNA → RNA → Protein).

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2. Structure and Function of Cells

Cells are the building blocks of all living organisms. There are two major types of cells:

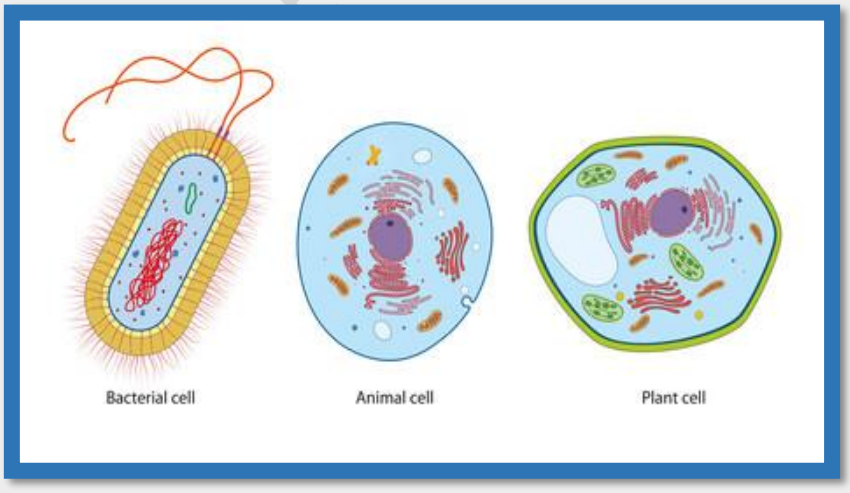
1. Prokaryotic Cells

- **Example:** Bacteria
- **Structure**: Simpler structure, lacking a nucleus. The DNA floats freely in the cytoplasm.
- **Key Features**: Cell wall, plasma membrane, ribosomes.

2. Eukaryotic Cells

- **Example:** Animal and plant cells
- **Structure**: More complex, with membrane-bound organelles and a defined nucleus where DNA is stored.
- **Key Features**:
  - **Nucleus**: Contains DNA.
  - **Mitochondria**: Powerhouse of the cell, generates energy (ATP).
  - **Endoplasmic Reticulum (ER)**: Smooth ER synthesizes lipids; Rough ER is involved in protein synthesis.
  - **Golgi Apparatus**: Packages proteins for transport.

Cell Diagram



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3. Enzymes: The Biological Catalysts

Enzymes are proteins that speed up chemical reactions in the body. They act as catalysts, lowering the energy needed for a reaction to

occur. Without enzymes, many biological processes would be too slow to support life.

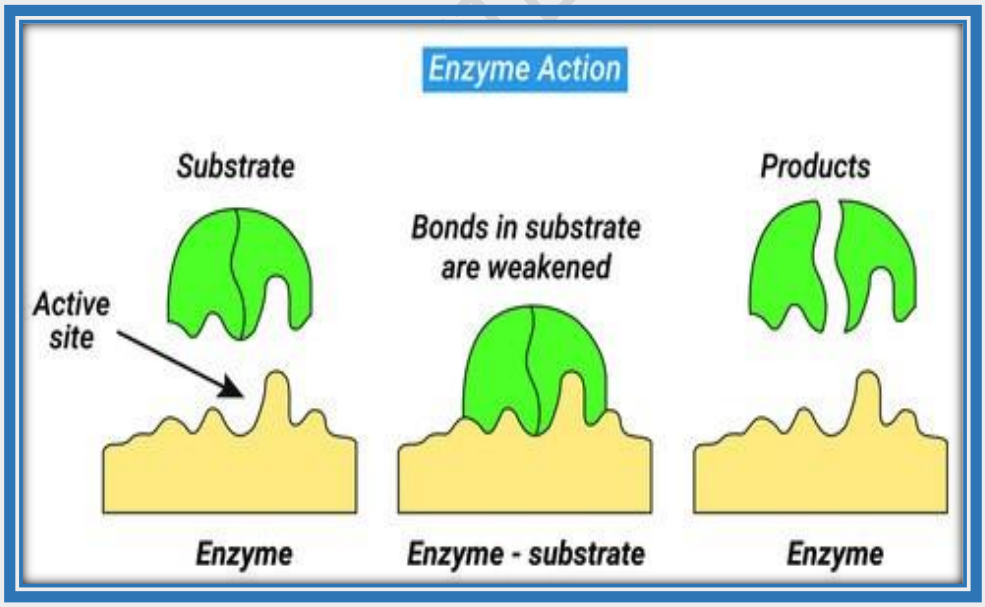
Key Characteristics of Enzymes:

- **Specificity**: Each enzyme is specific to a particular reaction or substrate.
- **Active Site**: The part of the enzyme that binds to the substrate.
- **Lock and Key Model**: The enzyme's active site is the "lock," and the substrate is the "key."

Example:

- **Amylase** is an enzyme found in saliva that breaks down starch into sugars during digestion.

Enzyme-Substrate Complex:



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4. DNA and RNA: The Molecules of Life

DNA and RNA are essential molecules involved in storing and transmitting genetic information.

DNA (Deoxyribonucleic Acid)

- **Structure**: A double-stranded helix made of nucleotides (adenine, thymine, cytosine, and guanine).
- **Function**: Stores genetic information, which is used to make proteins.
- **Replication**: Before a cell divides, the DNA replicates to ensure each new cell has a copy of the genetic material.

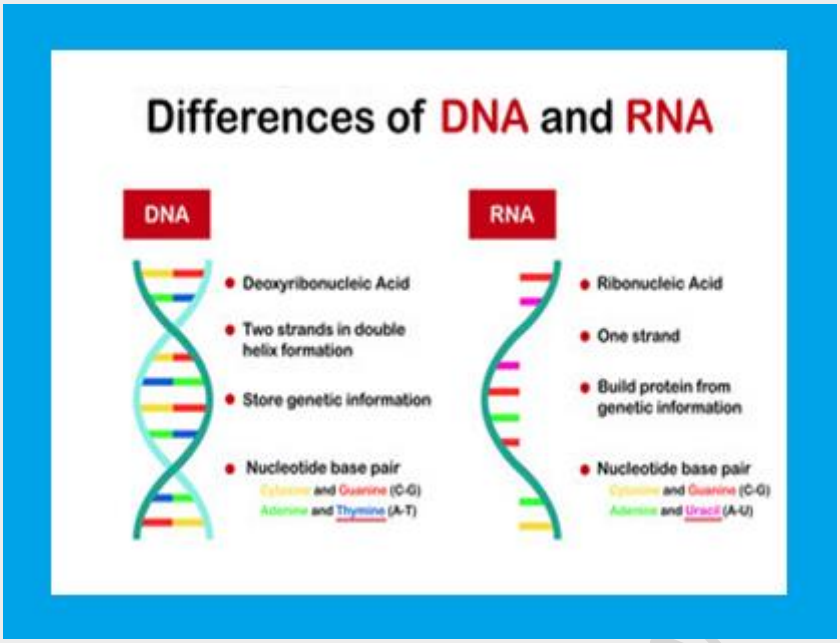
RNA (Ribonucleic Acid)

- **Structure**: A single-stranded molecule made of ribonucleotides (adenine, uracil, cytosine, and guanine).
- **Function**: RNA is involved in protein synthesis by transcribing the genetic code from DNA and translating it into proteins.

DNA to RNA: The process of Transcription.

- **Process**: The DNA sequence is copied into messenger RNA (mRNA), which carries the genetic code from the nucleus to the ribosomes.

- **DNA and RNA Comparison Diagram**: An image comparing the structures of DNA and RNA, showing the differences in bases and structure.



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5. Protein Synthesis

Protein synthesis is the process by which cells build proteins, which are essential for structure, function, and regulation of the body's tissues and organs.

1. Transcription (DNA → mRNA)

- **In the Nucleus**: The DNA sequence of a gene is copied into mRNA.

2. Translation (mRNA → Protein)

- **In the Ribosome**: The mRNA travels to the ribosome, where it is translated into a specific sequence of amino acids to form a protein.

Steps of Translation:

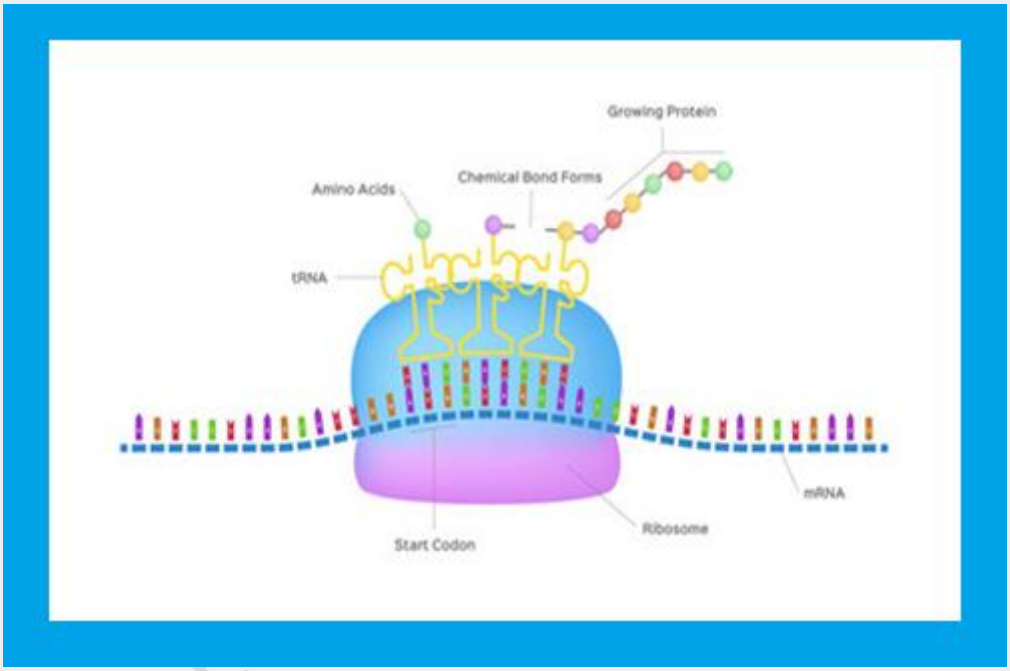
1. **Initiation**: The ribosome binds to the mRNA.

2. **Elongation**: tRNA molecules bring amino acids to the ribosome. Each tRNA matches its anticodon with the codon on the mRNA.
3. **Termination**: When the ribosome reaches a stop codon, the protein is released.

Example:

- **Haemoglobin**: The protein responsible for oxygen transport in red blood cells is produced through this process.

Protein Synthesis



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6. Conclusion

Cell biology and biochemistry are critical fields that explain the workings of life at the molecular level. From understanding how cells function, how enzymes catalyse reactions, to how genetic information is used to synthesize proteins, these concepts are foundational for students of biology.

Key Takeaways:

- Cells are the basic units of life, and they perform specialized functions within organisms.
- Enzymes are crucial for catalysing biological reactions.
- DNA and RNA store and transmit genetic information, which is used to synthesize proteins.
- The process of protein synthesis is key to cell function and organism development.

Interactive Activity (For Classroom Setting):

- **Activity**: create a model of protein synthesis using paper cutouts of DNA, mRNA, tRNA, and amino acids. "Translate" a gene and build a protein using these models.

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Curriculum Links (Australian Curriculum)

This tutorial aligns with the **Australian Curriculum** for Science, particularly:

- **ACSSU149**: The structure and function of cells.
- **ACSSU151**: The role of enzymes in living organisms.
- **ACSSU152**: The process of protein synthesis, including DNA and RNA.

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