Chapter 1: The Science of Biology

Class	Biology

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1.1 — What is Science?

> Scientists are **constantly** testing, debating, and revising scientific explanations of events in the natural world.

- Scientists either understand or don’t

The Nature of Science

Science: the use of evidence to construct testable explanations and predictions of natural phenomena

- Science is a process (organized way to observe the natural world)
- Growing body of knowledge

Science deals **ONLY** with the natural world.

- Orderly fashion

- Explanations are based on *evidence* and *understanding*

The Goals of Science

The universe is composed of many parts that **INTERACT**.

- All objects in the universe and their interactions are governed by natural laws

Scientific Uncertainty

- Much of nature is still a mystery

The Scientific Methodology

- General style of scientific investigation

Observing & Asking Questions

Observation: act of noticing and describing events or processes in a careful way

Forming a Hypothesis

Inference: logical interpretation based on what scientists already know

Hypothesis: tentative explanation that can be tested

Controlled Experiments

Variables: factors that can change

Controlled Experiment: an experiment in which one variable is changed while the others are kept constant

- **Independent / Manipulated Variable:** the variable that is deliberately changed
- **Dependent / Responding Variable:** the observed variable that changes in response to the independent variable

Control Group: an experimental group that has no change in its independent variable

Data Collection & Analysis

Data: scientific information collected through experiments

- **Quantitative** → numerical
- **Qualitative** → descriptive

> Scientists must use **tools** to structure and organize their observations.

- Error must be as avoidable as possible

Drawing Conclusions

Analyzing data allows scientists to reach **conclusions**.

Not **ALL** hypotheses can be tested by experiments.

- Ethics can prevent experiments

1.2 — Science in Context

Exploration and Discovery

Scientific ideas come from curiosity, skepticism, open-mindedness, and creativity.

Ideas for scientific investigations can arise from *practical human issues*.

- Technology makes scientific experimentation easier

Communicating Results

Scientists often collaborate in groups.

- Scientists must appropriately publish their scientific work to benefit the general public.

Peer Review

- Review of scientific research

Peer reviewers look for mistakes, oversights, unfair influences, or fraud.

Sharing Knowledge

Once research is published, it can bring about new questions.

Scientific Theories

Theory: a reliable scientific explanation of the natural world that combines many observations and incorporates hypotheses

- Phenomena that have not been observed yet

> A theory is **NEVER** absolute truth.

- Science is always changing

Science & Society

> Science has **limitations**.

- Requires the understanding of society

Science only tells us facts about the *natural world*.

- No ethical or moral viewpoints

Avoiding Bias

Bias: a personal point of view on a subject

- Scientific data is interpreted in different ways

Recommendations with bias cannot be trusted.

Understanding & Using Science

Science occurs when *humans wonder about nature*.

- Biology allows us to think about ourselves and life in nature

1.3 — Studying Life

Characteristics of Living Things

Biology: the study of life

Living things are ...

- Made of cells
- Based on genetic code
- Obtain and use energy
- Grow and develop
- Reproduce
- Respond to environmental stimuli
- Maintain homeostasis
- Change over time

All living things are based on **DNA** (deoxyribonucleic acid).

- Molecule that contains a cell's genetic code

Stimulus: a signal that an organism responds to

- Comes from the environment

Homeostasis: keeping a stable internal environment

- Even if the external environment is extreme

Metabolism: the combination of chemical reactions that occurs as an organism builds up or breaks down materials

The Central Themes of Biology

All biological subjects are connected.

The Big Ideas of Biology

- Cellular Basis of Life
- Information & Heredity
- Matter & Energy
- Growth, Development & Reproduction
- Homeostasis
- Evolution
- Structure & Function
- Unity & Diversity of Life
- Interdependence in Nature
- Science as a "Way of Knowledge"

Cellular Basis of Life

All living things are made of **cells**.

- Some organisms are single-celled and some are multicellular.

Information & Heredity

DNA and genetic code influences every part of you.

Matter & Energy

Matter and energy allows for biological processes.

Growth, Development & Reproduction

New individuals grow into larger adults.

- Cells become specialized for different tasks

Homeostasis

Homeostasis maintains the organism’s internal environment

Evolution

Evolutionary change allows organisms to **adapt**.

Structure & Function

Each major part of a body has a different specialization.

- Performs different tasks

Unity & Diversity of Life

Life is very different externally.

- On a cellular level, life is very similar.

Interdependence in Nature

Biosphere: connections between all living things on Earth

- Relationships create cycles of matter and flow of energy

Science as a “Way of Knowledge”

Science is **NOT** a list of facts.

- Science is a *way to understand*.

Fields of Biology

- Biology has many overlapping fields

Biotechnology

- Field based on the editing of genetic code to redesign living things

Building the “Tree of Life”

Biologists want to organize all living things into a “Tree of Life”.

- There are more organisms to be discovered

Infectious Diseases

All diseases originate from a certain interaction between organisms and their environment

Genomics & Molecular Biology

- Studies of DNA and cellular molecules

Performing Biological Investigations

Scientific Measurement

> Most scientists use the **METRIC** system.

- International System of Units

Safety

- Lab Safety rules are crucial

Safety in biology for you and any living organisms you are studying.