

Introduction

What is Biology?

Biology is the study of life

What is life?

Hierarchy of Biological Organization

Atoms, the chemical building blocks of all matter, are ordered into complex biological **molecules**, i.e. proteins

The molecules of life are arranged into minute structures called **organelles**, which are in turn the components of **cells**

While some organisms are single cells, others are aggregates of many specialized types of cells

The cell happens to be the lowest level of structure that is capable of performing all the activities of life

The cell is, then, the basic unit of structure and function

In multicellular organisms, similar cells are grouped into **tissues**, and specific arrangements of different tissues forms **organs**

Collectively, organs combine to form **organ systems** and organ systems give rise to the body or **organism**

In the hierarchy of biological organization, there are tiers beyond the individual organism

A **population** is a localized group of organisms belonging to the same species

Populations of species living in the same area make up a biological **community**

And community interactions that include nonliving features of the environment form an **ecosystem**

Emergent Properties

With each step upward in the hierarchy of biological order, novel properties emerge that were not present at the simpler levels of organization

Emergent properties are properties that emerges as a result of interactions between components

Because life is associated with emergent properties and is, therefore, difficult to define in a simple one sentence definition, biologists tend to recognize life without defining it - life is recognized by what living things do

1. Order

2. Reproduction

3. Growth and Development
4. Energy Utilization
5. Response to the Environment
6. Homeostasis
7. Evolutionary Adaptation

Evolution: The Core (Unifying) Theme in Biology

The evolutionary perspective was brought into focus by Charles Darwin's publication of *On the Origin of Species by Means of Natural Selection*

Darwin's book, *Origin of Species*, had two major objectives:

1. He argued that contemporary species arose from a succession of ancestors through a process called **descent with modification** (=evolution)
2. Most importantly Darwin proposed a mechanism to explain how evolution occurs
Darwin called the mechanism **natural selection**

According to natural selection:

Individuals in a population exhibit varied traits that are inherited - heritable variation

The heritable variations are exposed to environmental factors that favor the reproductive success of some individuals over others

We see the products of natural selection in the rather exquisite **adaptations** of organisms to special problems in their environment

Evolution accounts for both the *unity* and the *diversity* of life

Unity - features that are shared by two species are due to their descent from common ancestors

Diversity - the differences between species is due to natural selection modifying ancestral traits in different environments

Science and the Scientific Method

Science is derived from a Latin verb meaning "to know"

The Scientific Method

1. *Observing nature*

2. *Asking questions*

3. *Formulate hypotheses*

Hypotheses are tentative explanations that are put forth to account for observed phenomena

A useful hypotheses have the following characteristics:

- a. *Hypotheses are possible causes.*
- b. *Hypotheses are reflections of past experience.*
- c. *Multiple hypotheses should be proposed whenever possible.*
- d. *Any hypothesis that is formulated must be able to be tested.*
- e. *Hypotheses can be eliminated but not confirmed with absolute certainty*
- f. *A hypothesis can be described as a logical link between **if** and **then***

4. *Conducting experiments*

Experiments are conducted to test the proposed hypothesis

When scientists perform experiments that include what is called a **control**, a check of the experiment that is based on keeping all factors (conditions) the same except for the one in question

5. **Conclusions**

A little Bit About Scientific Terminology

Hypothesis - an explanation for some kind of observation

Theory - An interpretation based on the conclusions of many experiments and observations

Or, a conceptual scheme that is supported by a large number of observations
e.g., theory of evolution

Law - An irrefutable fact

Science, Technology, and Society

Science and technology are interdependent

Science is a process, based on formulating and testing hypotheses that people use to answer their questions about nature

Technology, especially in the form of new instruments (i.e. electron microscopes) extends our ability to observe and measure and enables scientists to work on questions that were previously unapproachable

In turn, technology depends on science to generate new information that makes invention possible

e.g., Watson and Crick's discovery of the structure of DNA was science

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