

1.2 Pure and applied fields of biology

Objectives

At the end of this section, the student will be able to:

- Classify the different sub-fields of Biology into pure and applied
- Define each sub-field of biology



What do we mean by pure and applied fields of biology?

Recall

The previous section described and briefly addressed various sub-fields of biology. Now, you will learn the category of biology as pure and applied sub-fields.

Pure biology is the study of how life functions in nature (behavior, internal and external structure, reproduction, etc.) whereas applied biology refers to using what you have learned in biology for (gardening, nursery work, agriculture, plant disease, forestry, poultry, etc.). Therefore, applied biology is the use of your knowledge of biology to manage life. The relationship is similar to anatomy and surgery.

Activity 1.4: Categorizing pure and applied fields of biology

Select pure and applied fields of biology from the list given in the columns on the left side in the table below and categorize them in their appropriate column on the right side (columns A & B).

Table 1.4 Pure and Applied fields of Biology

Fields of Biology		Pure Biology (A)	Applied Biology (B)
Agriculture	Biotechnology		
Morphology	Molecular Biology		
Taxonomy	Evolution		
Horticulture Cytology	Pathology		
Embryology	Physiology		
Histology	Forestry		
Poultry	Pharmacognosy		
Agroforestry	Pisciculture		
Apiculture	Paleontology		
Animal Husbandry	Bacteriology		
	Entomology		
	Sericulture		

Activity 1.5: THINK-PAIR-SHARE

In the previous parts of this unit, you have studied the different branches of biology. Now, in pair, take at least 3 fields of biology and think of their importance in other branches of science. Finally, share your ideas with each other.

In some branches of science, biology has become very important in this millennium. With the above idea, let us discuss some of the biological importance of the branches of biology in other branches of sciences.

- 1) **Biotechnology:** is the use of living organisms or their products for the welfare of humanity. It involves the technical manipulation of a living organism's genetic makeup (Genetic Engineering). A genetically modified and improved variety of crops and animals have been produced by biotechnology.
- 2) **Bioinformatics:** is concerned with the acquisition, storage, analysis, and dissemination of biological data, most often DNA and amino acid sequences. Bioinformatics uses computer programs for a variety of applications, including determining gene and protein functions, establishing evolutionary relationships, and predicting the three-dimensional shapes of proteins.
- 3) **Genetic Engineering:** is a means of extracting selected genes from an organism or synthesizing selected genes and these genes are inserted into another organism; as a result, an organism develops with a new combination of genes, and this process is called genetic engineering.
- 4) **Biomedical Engineering:** is the application of the principles and problem-solving techniques of engineering to biology and medicine. Biomedical engineering focuses on the advances that improve human health and health care at all levels
- 5) **Environment Management:** deals with environmental observation and finding out the solution to maintain the balance of nature.
- 6) **Forensic Science:** is the application of the knowledge of biological science (DNA fingerprints (unique patterns in DNA molecule), blood typing) to criminal and civil laws.

1.3 Major discoveries that revolutionized biology

Activity 1.6 Group discussion

In a group of 4 -5 students, discuss at least five major discoveries that revolutionized biology.

Let your group's secretary present your findings to the whole class.

Objectives

At the end of this section, the student will be able to:

- *Discuss at least five major discoveries that revolutionized biology*

Biology is a fascinating and diverse subject area. If you're thinking of studying Biology, here are the twelve famous discoveries to inspire you.

1. Aristotle (384–322 BC)

Despite the fact that his name is rarely mentioned when discussing important biological discoveries, the ancient Greek philosopher Aristotle was responsible for a breakthrough classification system for living things. Aristotle's classification system was known as the 'Ladder of Life' until the nineteenth century. For the first time, he established species relationships and grouped them correctly. He classified organisms based on their ability to move from one place to another and with their characteristics as herbs, shrubs, and trees.

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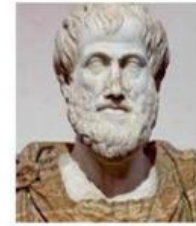


Figure 1.3 Aristotle

2. Galen (129–161 AD)

Galen's efforts transformed medical science. Galen had a significant impact on the advancement of numerous medical specialties, including Anatomy, Pathology, Physiology, and Neurology. Among his important findings were the distinctions between veins and arteries, as well as the recognition that the larynx produces voice. Although many of his concepts contained scientific mistakes, his contribution to medical science is undeniable.



Figure 1.4 Galen

3. Antonie van Leeuwenhoek (1632–1723)

Antonie van Leeuwenhoek is well renowned for his contributions to microscopy and how he applied it to the field of biology. He invented a method for making strong lenses that, according to some, could magnify up to 500 times. Leeuwenhoek employed microscopes to learn more about the biological world; among his findings were bacteria and the vacuole of the cell.



Figure 1.5 Antonie van Leeuwenhoek

4. Carl Linnaeus (1707–1775)

Carl Linnaeus, a botanist, physician, and naturalist, devised the method for naming, ordering, and classifying creatures that we still use today. His extensive collection of plant, animal, and shell specimens inspired him to devise a system for classifying and naming species. He separated items into three categories – animals, plants, and minerals – and further organized living things into classes, orders, genera, and species. In *Homo sapiens*, for example - 'homo' is the genus and 'sapiens' is the species.



Figure 1.6 Carl Linnaeus

5. Charles Darwin (1809–1882)

Probably the most famous naturalist of all time, Charles Darwin's contribution to biology and society is immense. He established that all species of life descended over time from common ancestors, with species continuing to exist through the process of natural selection. His theory of evolution was published in *On the Origin of Species* in 1859 and it caused quite the stir – he was disputing the long-held belief that all species had been created by God at the beginning of the world. Evolution by natural selection combined with Mendelian genetics is now accepted.

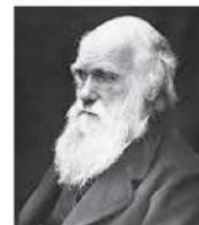


Figure 1.7 Charles Darwin

as the modern evolutionary synthesis and forms the foundations of much biological scientific endeavour.



Figure 1.8 Gregor Mendel

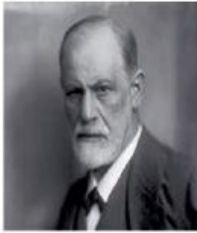


Figure 1.9. Louis Pasteur



Figure 1.11 Jane Goodall



Figure 1.12 Barbara McClintock

6. Gregor Mendel (1822–1884)

Gregor Mendel's extraordinary contribution didn't get the recognition it deserved until long after the friar's death. He used peas to discover and demonstrate the laws of genetic inheritance, coining the terms 'dominant' and 'recessive' genes in the process. The laws were rediscovered at the turn of the 20th century and provided the mechanism for Darwin's theory of natural selection to occur. The two theories combine to form our current understanding of the evolutionary process.

7. Louis Pasteur (1822-1895)

Louis Pasteur is regarded as the father of medical microbiology. His contributions to science, technology, and medicine are nearly unparalleled in history. He pioneered molecular asymmetry research, demonstrated that bacteria cause fermentation and disease, introduced pasteurization, rescued France's beer, wine, and silk industries, and developed anthrax and rabies vaccines.

8. Robert Koch (1843-1910)

Robert Koch was a well-known German physician who pioneered

9. Jane Goodall (1934)

Our knowledge of wildlife and conservation has been transformed by Jane Goodall, the UK ethologist. Best known for her career-long studies of chimpanzees, she discovered the animals are omnivores and tool users. She's a global leader in animal rights and was awarded a Ph.D. degree from the University of Cambridge without holding a bachelor's degree.

10) Barbara McClintock (1902–1992)

American geneticist Barbara McClintock spent her career analyzing maize, where she developed a technique for identifying and examining chromosomes individually. Despite it not being immediately recognized, her work made it possible for us to map human genomes. She was awarded the Nobel Peace Prize in 1983 for her discovery of transposition and how genes could turn their physical characteristics on and off.

11. Watson (1928–) and Crick (1916–2004)

James Watson and Francis Crick were shot to fame in 1962 for their discovery of the structure of DNA, winning the medical Nobel Prize in the process. Their model of DNA (double helix) explains how DNA replicates, and hereditary information is coded and passed on to descendants. The discovery of DNA structure has led to a much more developed understanding of function – used in disease diagnosis and treatment, forensics, and more.



Figure 1.13 Watson and Crick

12. Wilmot (1944) and Campbell (1954–2012)

In 1996 Ian Wilmot and Keith Campbell cloned a mammal, famously named Dolly the Sheep. The pair cloned Dolly using a single adult sheep cell and a process of nuclear transfer. Dolly died after six years but cloning continues, although still not perfect, and certainly not ready for human application.



Figure 1.14 Wilmot and Campbell

Activity 1.7 Group and individual work

1. Mention at least ten more biological findings and explore their central issues in pairs. Finally, present them to the entire class.
2. What do you feel about biological discoveries? Do you have any possible issue in mind that can be discovered? Share with your friends.

Part I : Choose the correct answer for the following questions

1. What is the primary focus of pure biology?
 - A. The study of how life functions in nature.
 - B. The application of knowledge to manage agriculture and forestry.
 - C. The technical manipulation of a living organism's genetic makeup.
 - D. The digital storage and analysis of DNA and protein sequences.
2. Which of the following fields is classified as an applied field of biology?

A. Taxonomy.	B. Forestry.
C. Morphology.	D. Cytology.
3. The relationship between pure biology and applied biology is compared in the text to the relationship between:

A. Genetics and botany.	B. Zoology and paleontology.
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- C. Anatomy and surgery. D. Physics and chemistry.
4. What is the primary function of bioinformatics?
- A. The environmental observation to maintain the balance of nature.
- B. The application of engineering principles to medicine and human health.
- C. The extraction of selected genes and inserting them into another organism.
- D. The acquisition, storage, analysis, and dissemination of biological data.
5. Which ancient Greek philosopher developed a classification system known as the 'Ladder of Life'?
- A. Aristotle. B. Galen.
- C. Charles Darwin. D. Carl Linnaeus.
6. Whose medical contributions included distinguishing between veins and arteries and recognizing that the larynx produces voice?
- A. Antonie van Leeuwenhoek. B. Louis Pasteur.
- C. Galen. D. Robert Koch.
7. Antonie van Leeuwenhoek made major breakthroughs in biology primarily through his work with:
- A. Chromosome mapping in maize.
- B. High-magnification microscopes and lenses.
- C. Hybridization experiments on pea plants.
- D. DNA double helix crystallization.
8. What system of classification and naming did Carl Linnaeus devise that is still used today?
- A. Natural selection based on common descent.
- B. Binomial nomenclature utilizing genus and species.
- C. Genetic transposition mapping.
- D. The Ladder of Life classification based on mobility.

9. Charles Darwin's revolutionary contribution to biology was the theory of:
- A. Molecular asymmetry and fermentation causes.
 - B. Genetic inheritance laws and recessive traits.
 - C. Evolution by natural selection.
 - D. Mammalian cloning via nuclear transfer.
10. Gregor Mendel contributed to biology by discovering:
- A. The double helical structure of genetic material.
 - B. The cellular structure of bacteria and protozoa.
 - C. The existence of jumping genes and transposition in maize.
 - D. The fundamental laws of genetic inheritance using pea plants.
11. Louis Pasteur is widely regarded as the father of:
- A. Modern bacteriology.
 - B. Plant genetics and chromosome mapping.
 - C. Ethology and wildlife conservation.
 - D. Medical microbiology.
12. Which scientist is recognized as the father of modern bacteriology for pinpointing agents of tuberculosis, cholera, and anthrax?
- A. Louis Pasteur.
 - B. Robert Koch.
 - C. Ian Wilmut.
 - D. James Watson.
13. Jane Goodall transformed our understanding of wildlife conservation through her extensive career studying:
- A. Chimpanzees in the wild.
 - B. Maize chromosomes and transposition.
 - C. Bacterial pathogens and infectious diseases.
 - D. Mammalian nuclear transfer and cloning.

14. Barbara McClintock was awarded the Nobel Prize for her groundbreaking work on:
- A. The inheritance laws of dominant and recessive genes.
 - B. The double-helix molecular structure of DNA.
 - C. Transposition and how genes turn physical characteristics on and off in maize.
 - D. The mechanics of animal cloning via nuclear transfer.
15. Ian Wilmut and Keith Campbell achieved worldwide fame in 1996 when they successfully:
- A. Discovered the double-helix structure of hereditary molecules.
 - B. Cloned a mammal (Dolly the Sheep) using nuclear transfer from an adult cell.
 - C. Formulated the theory of natural selection.
 - D. Mapped the complete human genome.

Part II: Answer the following question as True or False

- 1. Pure biology focuses on applying biological knowledge to practical commercial activities such as poultry and gardening.
- 2. Aristotle classified living organisms based on their ability to move and categorized them into herbs, shrubs, and trees.
- 3. Carl Linnaeus proposed the theory of evolution by natural selection in his 1859 publication.
- 4. Gregor Mendel used garden pea plants to discover the fundamental laws of genetic inheritance.
- 5. Antonie van Leeuwenhoek discovered the double-helix structure of DNA in 1953.
- 6. Environmental management deals with environmental observation and finding solutions to maintain ecological balance.
- 7. Jane Goodall is best known for her career-long field studies demonstrating that chimpanzees are omnivores and tool users.
- 8. Biotechnology involves the technical manipulation of living organisms' genetic makeup, also known as genetic engineering.

9. Robert Koch was awarded a university degree without ever holding a bachelor's degree.
10. Barbara McClintock's analysis of maize chromosomes made it possible to understand transposition and helped pave the way for human genome mapping.
11. Dolly the Sheep was cloned in 1996 by Ian Wilmut and Keith Campbell using nuclear transfer from a single adult sheep cell.

Part III: Match each scientist or term given with their correct description or discovery in the list:

1. Aristotle
 - A. Pioneered molecular asymmetry and proved bacteria cause fermentation and disease.
 - B. Co-discovered the double helix structure of DNA.
 - C. Discovered genetic transposition using maize chromosomes.
 - D. Developed the 'Ladder of Life' classification system based on mobility and plant types.
2. Galen
 - A. Identified causal agents of tuberculosis, cholera, and anthrax.
 - B. Invented lenses magnifying up to 500 times to discover bacteria.
 - C. Formulated the theory of evolution by natural selection.
 - D. Distinguished between veins and arteries and recognized that the larynx produces voice.
3. Antonie van Leeuwenhoek
 - A. Invented strong lenses magnifying up to 500 times to observe bacteria and cell vacuoles.
 - B. Cloned a mammal named Dolly the Sheep using nuclear transfer.
 - C. Devised binomial nomenclature and classified creatures into three major categories.
 - D. Conducted long-term field studies showing chimpanzees are omnivores and tool users.
4. Carl Linnaeus
 - A. Devised binomial nomenclature to name and classify species into hierarchical categories.
 - B. Formulated the theory of evolution by natural selection.

- C. Discovered the fundamental laws of genetic inheritance using pea plants.
 - D. Advanced medical science by distinguishing veins and arteries.
5. Charles Darwin
- A. Developed the 'Ladder of Life' classification system.
 - B. Proposed that all species descended from common ancestors through natural selection.
 - C. Co-discovered the double-helix DNA model.
 - D. Identified bacterial agents responsible for anthrax and tuberculosis.
6. Gregor Mendel
- A. Devised a system for naming living things using genus and species.
 - B. Pioneered molecular asymmetry and pasteurization.
 - C. Studied chimpanzees and found they use tools and are omnivores.
 - D. Coined the terms 'dominant' and 'recessive' while discovering genetic inheritance laws.
7. Louis Pasteur
- A. Developed the 'Ladder of Life' classification scheme.
 - B. Analyzed maize chromosomes to study genetic transposition.
 - C. Cloned Dolly the Sheep using a single adult cell.
 - D. Regarded as the father of medical microbiology; developed anthrax and rabies vaccines.
8. Robert Koch
- A. Pioneered modern bacteriology by identifying causal agents of tuberculosis and cholera.
 - B. Discovered the double-helix structure of hereditary material.
 - C. Observed microorganisms using self-made high-power lenses.
 - D. Distinguished between veins and arteries in early medical practice.
9. Jane Goodall
- A. Conducted career-long field research demonstrating chimpanzees use tools and are omnivores.

- B. Created binomial nomenclature for classification.
- C. Discovered laws of genetic inheritance with garden peas.
- D. Formulated the theory of evolution by natural selection.

10. Barbara McClintock

- A. Established early species relationships with the 'Ladder of Life'.
- B. Cloned a mammal via nuclear transfer in 1996.
- C. Analyzed maize chromosomes to discover transposition and how genes turn traits on and off.
- D. Advanced medical specialties and recognized larynx voice production.

11. Watson and Crick

- A. Devised binomial species nomenclature.
- B. Discovered the double helix structure explaining how DNA replicates and codes hereditary info.
- C. Formulated natural selection theory.
- D. Pioneered modern bacteriology and identified anthrax bacilli.

12. Wilmut and Campbell

- A. Observed bacteria and cell vacuoles with powerful lenses.
- B. Successfully cloned a mammal (Dolly the Sheep) in 1996 using adult cell nuclear transfer.
- C. Studied primate behaviour and chimpanzee tool use.
- D. All