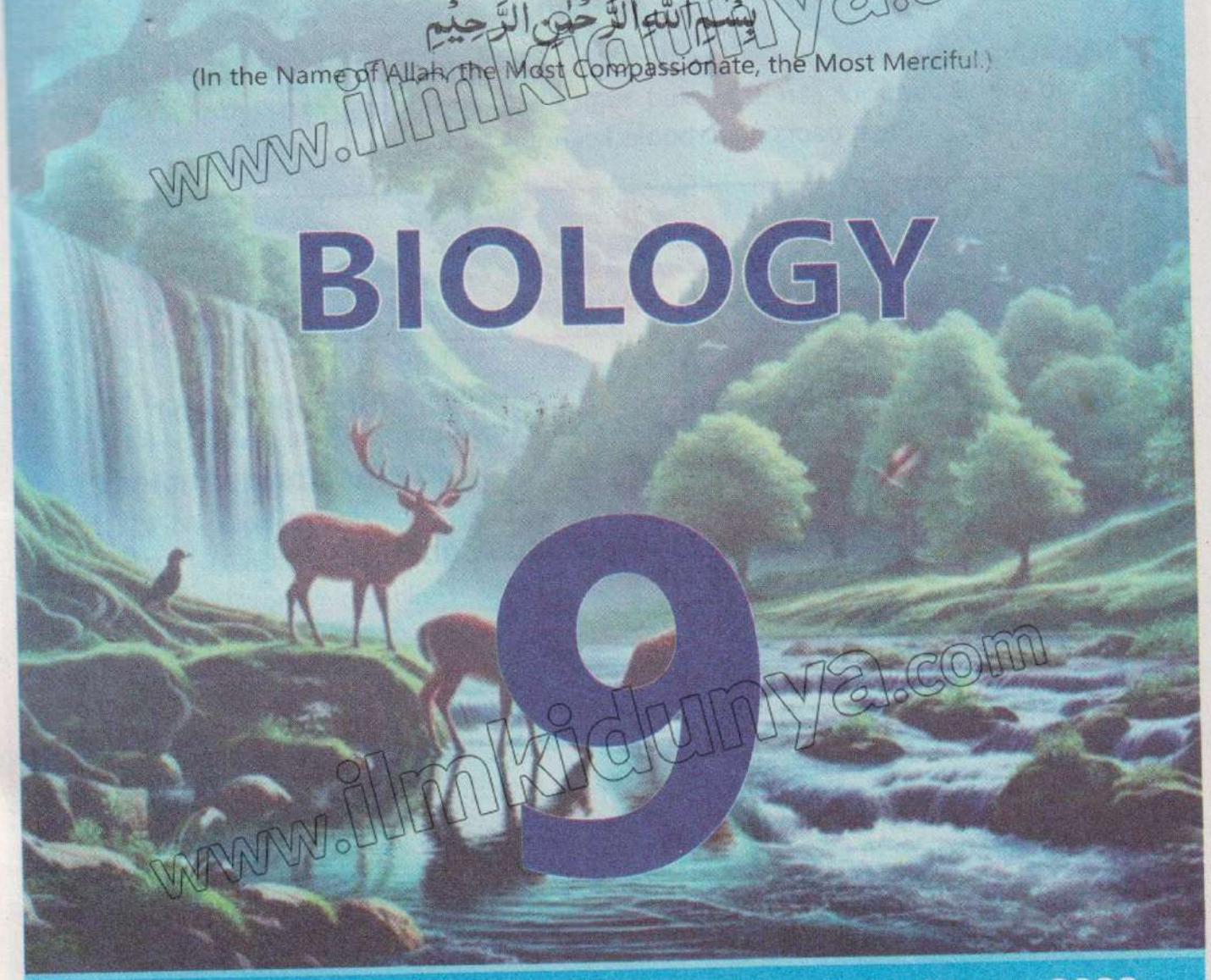
بِسۡمِ اللّٰہِ الرَّحۡمٰنِ الرَّحِیۡمِ

(In the Name of Allah, the Most Compassionate, the Most Merciful.)

BIOLOGY



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Based on Revised National Curriculum of Pakistan 2023

PUNJAB CURRICULUM AND
TEXTBOOK BOARD, LAHORE

BIOLOGY 9

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Chapter 1

THE SCIENCE OF BIOLOGY

After studying this chapter, students will be able to:

- Define Biology.
- State that the Holy Quran instructs to reveal the study of Life.
- Define major fields of Biology as Botany, Zoology and Microbiology.
- Define the sub-fields of Biology.
- Relate that Biology connects with other natural sciences.
- Distinguish in terms of the broad subject matter the fields (Biophysics, Biochemistry, Computational Biology, Biogeography, Biostatistics, Biotechnology, Bio-economics).
- Identify the careers in Biology.
- Explain with examples how Biology is a subset of the natural sciences and of the life sciences.
- Justify with examples that science is a collaborative field that requires interdisciplinary researchers working together to share knowledge and critique ideas.
- Describe the steps of the scientific method.
- Evaluate the terms 'hypothesis', 'theory' and 'law' in the context of research in the natural sciences.

Ever wondered how plants grow or why animals behave the way they do? **Science** is all about exploring these mysteries! It's a systematic way of studying the natural world through observation and experimentation. To make it easier to learn, science is divided into different branches like Biology, Physics, Chemistry, and Mathematics. In this chapter, we will dive into the fascinating world of Biology that's the study of living things. We will see how biologists use scientific method to solve biological problems.

1.1 - BIOLOGY AND ITS BRANCHES

Biology is the science of life. The word "Biology" comes from two Greek words i.e., "bios" (life) and "logos" (study). It explores the structures, functions, and interactions of living organisms. Understanding Biology helps us to address issues related to health, food, and the environment. Biology offers a fascinating journey of discovery from the microscopic world of bacteria to the vast ecosystems of our planet.

Major Fields of Biology

Biology is a vast field that explores the incredible diversity of life on Earth. To better understand this complexity, scientists have divided Biology into three main fields:

Zoology: It is the study of animals, including their structure, function, behaviour, and diversity.

Botany: It is the study of plants, including their structure, growth, reproduction, and interactions with their environment.

Microbiology: The study of microorganisms, such as bacteria and microscopic fungi is called microbiology. It includes the study of the structures, functions, habitats and reproduction of microorganisms, and their impacts on health and environment.

Branches or Sub-Fields of Biology

Biology is divided into different branches to better understand the aspects of life.

Morphology is the study of the form and structure of organisms. Morphology studies the outward appearance (shape, colour, pattern, etc.) as well as internal structures, like organs.

Anatomy is the branch of Biology that explores the internal physical structure of organisms, particularly humans. It helps in disease diagnosis, medical device development, and improving quality of life e.g. the study of the organs of the digestive system.

Physiology is the branch of Biology that deals with the functioning of body parts. For example, how the blood circulatory system transports vital substances throughout the body.

Histology is the microscopic study of tissues. Tissues are groups of cells that have similar functions. Tissue examination helps in disease diagnosis, drug studies, and understanding organ structure and function.

Cytology is the study of cells i.e., the building blocks of life. Cytologists unravel the fundamental structures of cells and their organelles. They also study the mechanisms of cell division.

The human body contains over 30 trillion cells. Various types of cells possess unique structures.

Molecular Biology deals with the study of biological molecules like carbohydrates, proteins, lipids, and nucleic acids. Molecular biologists also study fundamental life processes, develop drugs, and create genetically modified organisms.

Embryology is the study of the process of development of organism from fertilized egg. In this branch, scientists study tissue and organ formation, identify birth defects, and develop medical treatments.

Genetics is the branch of Biology that deals with the study of transfer of characteristics from parents to offspring. In Genetics, scientists also study the causes of genetic disorders,and develop better varieties of plants and animals.

Palaeontology is the branch of Biology that deals with the study of fossils. The examination of fossils helps scientists to know the evolutionary history of organisms. For example, dinosaur fossils provide evidence of giant reptiles that roamed the Earth millions of years ago.

Fossils are the remains of plants and animals that were preserved in rocks and other geological formations.

The oldest known fossil is a Cyanobacterium, estimated to be 3.5 billion years old.

Taxonomy is the branch of Biology that deals with the classification of organisms into groups on the basis of similarities and differences. Classification of organisms helps to organize and understand the diversity of life, identify new species, and study evolutionary relationships.

Ecology is the branch of Biology that deals with the relationships between organisms and their environment. Ecology helps to conserve biodiversity and address environmental problems. The food chain, for instance, illustrates the interconnectedness of organisms for energy and nutrients.

Marine Biology is the branch of Biology that deals with the study of life in oceans. It helps to understand ocean biodiversity, discover new species, and address marine conservation issues. For example, coral reefs support a wide variety of marine life.

Pathology is the study of diseases, their causes, and effects. Pathology helps in disease diagnosis, prevention, and treatment. For example, pathologist studies how the uncontrolled division and spread of cells causes cancer.

Immunology is the branch in which we study the components of the immune system and their role against diseases. Immunologists study to develop vaccines, treat autoimmune diseases, and improve immune responses to infections.

Pharmacology is the branch in which we study drugs and their effects on the body. This helps in the development of new drugs. For example, new antibiotics are developed that are used to kill bacteria and treat bacterial infections.

These are just a few of the many branches of Biology. Each branch offers unique insights into the fascinating world of life, contributing to our understanding of the complexity and beauty of our planet.

1.2- RELATION OF BIOLOGY WITH OTHER SCIENCES

Biology is closely linked with other natural sciences such as Chemistry, Physics, and Earth Sciences. These connections help us understand life processes, environmental interactions, and the complexities of living organisms.

The following are a few examples of how Biology is connected with other sciences.

1. Biochemistry

Biochemistry is the study of the structure and reactions of different chemical substances present in living systems. The study of the chemical reactions of photosynthesis and respiration are examples of Biochemistry.

2. Biophysics

It deals with the study of the principles of Physics, which apply to biological processes. For example, in Biophysics we study the rules of lever and motion for understanding the function of muscles, bones and joints.

3. Computational Biology

In Computational Biology, scientists use Mathematical models, algorithms, and computer simulations to understand biological systems and relationships. It involves analysing biological data, such as sequence of amino acids in a protein.

4. Biogeography

It deals with the study of the distribution of living organisms in different geographical regions of the world. The influence of climate change on the distribution of organisms is also studied in Biogeography.

5. Biostatistics

It deals with the principles of statistics to analyse and interpret data related to living organisms. Biostatistics plays a crucial role in biological research, healthcare, and public health etc.

6. Biotechnology

It deals with the use of living organisms or their components to develop beneficial products or processes for various fields, including healthcare, agriculture, and environmental management. For example, Biotechnologists use bacteria for the production of insulin to treat diabetic patients.

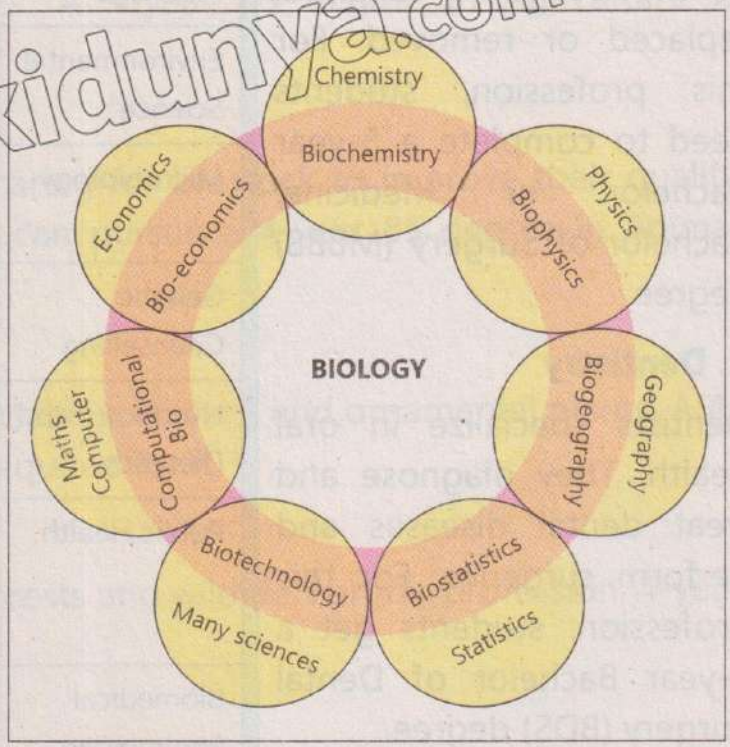

FIGURE 1.1: Relation of Biology with other sciences

7. Bio-economics

It deals with the study of organisms from economical point of view. In bio-economics, scientists calculate the cost and profit of the biological projects e.g. production of new variety of crops.

1.3- CAREERS IN BIOLOGY

The students of Biology get a comprehension of the various phenomena of life. After their FSc with Biology, they can select further studies for diverse careers, for example:

1. Medicine and Surgery

The profession medicine deals with the diagnosis and treatment of diseases. In surgery the defective parts of the body are repaired, replaced or removed. For this profession, students need to complete a 5-year Bachelor of Medicine, Bachelor of Surgery (MBBS) degree.

2. Dentistry

Dentists specialize in oral health. They diagnose and treat dental diseases and perform surgeries. For this profession, students get a 4-year Bachelor of Dental Surgery (BDS) degree.

3. Pharmacology

Pharmacologists study the effects of drugs on human body and develop new medications. For this career,

More Careers in Biology

Career	Major Jobs
Veterinary Medicine	Diagnosis and treatment of diseases in animals and surgeries in animals
Environmental Science	Solving issues related to pollution and natural resources
Microbiology	Research on microorganisms to understand their impact
Genetic Counselling	Providing support to people on genetic conditions and testing
Nutrition and Dietetics	Advising on proper dietary habits to promote health.
Public Health	Improving the health of communities through education, policy-making, and research.
Biomedical Engineering	Designing and making medical equipment to improve patient care.
Bioinformatics	Analysis of biological data by using computational tools

a Bachelor of Studies (BS) degree in Pharmacy or Doctor of Pharmacy (D. Pharm) degree is required.

4. Physiotherapy

It is the therapy that is used to restore movement and physical function of body that has been impaired by disease or injury. Physiotherapists use physical exercise and physical modalities (such as massage) to improve patient's physical movement. To become a physiotherapist, a 4-year BS degree in Physical Therapy or Physiotherapy is needed.

5. Fisheries and Wildlife

Fisheries and wildlife departments also offer jobs to the biologists after a BS and Master of Studies (MS) degree in Zoology, Fisheries or Aquaculture.

6. Agriculture

Agricultural scientists improve farming practices, crop production, and sustainable agriculture techniques. A 4-year BS degree in Agriculture is required.

7. Animal Husbandry

This field involves breeding and caring for livestock to improve their quality and productivity. For it, students can pursue a 4-year BS degree in Animal Husbandry.

8. Horticulture

Horticulturists cultivate fruits, vegetables, flowers, and ornamental plants. A 4-year BS degree in Horticulture is required for it.

9. Forestry

Foresters manage and conserve forests and wildlife. For this profession, 4-year BS degree in Forestry is necessary.

10. Farming

The professionals of farming prepare farms e.g., animals farms, poultry farms, fruit farms. In such farms, they grow crops and raise animals for food and other products. A 4-year BS degree in Agriculture or specific farming courses is required for this profession.

11. Biotechnology

Biotechnologists use biological processes to develop products and technologies in medicine, agriculture, and more. A 4-year BS degree in Biotechnology is required for this.

12. Forensics

Forensic scientists analyse physical evidence from crime scenes in criminal investigations. A 4-year BS degree in Forensic Science is needed for this.

1.4- Quranic Instructions to Reveal the Study of Life

In the Holy Quran, there are several verses that highlight the study of life. Here are a few Quranic guidelines that encourage exploring and reflecting on the study of life:

وَجَعَلْنَا مِنَ الْمَاءِ كُلَّ شَيْءٍ حَيٍّ ۖ

"We made every living thing from water." (Sura: Al-Ambia, Verse: 30)

The Quran mentions in multiple verses that all living things were created from water.

Water is described as a divine blessing from *Allah*.The average water content in different organisms ranges between 60% to 90%. The above Verse hints at the common origin of all living things in the water.

خَلَقَ الْإِنسَانَ مِن صَلْصَالٍ كَالْفَخَّارِ ۝

"He made man from clay like the potter." (Sura: Al-Rehman, Verse: 14)

By the hints given in both these Verses, we can find the events that occurred in the creation of human beings. We are advised to think over the possible ways through which such events might have occurred. *Allah* also hints at the method of the development of animals including human beings.

ثُمَّ خَلَقْنَا النُّطْفَةَ عَلَقَةً فَخَلَقْنَا الْعَلَقَةَ مُضْغَةً
فَخَلَقْنَا الْمُضْغَةَ عِظَامًا فَكَسَوْنَا الْعِظَامَ لَحْمًا ۝

"Then fashioned We the drop a clot, then fashioned We the clot a little lump, then fashioned We the little lump bones, then clothed the bones with flesh."
(Sura: Al-Mominoon, Verse: 14)

Quran also describes the common origin and modification of animals.

وَاللّٰهُ خَلَقَ كُلَّ دَآبَّةٍ مِّنْ مَّآءٍ ۖ فَمِنْهُمْ مَّنْ يَّمْشِيْ عَلٰى بَطْنِهٖ وَمِنْهُمْ مَّنْ يَّمْشِيْ عَلٰى رِجْلَيْنِ ۚ
وَمِنْهُمْ مَّنْ يَّمْشِيْ عَلٰٓى اَرْبَعٍ ۚ يَخْلُقُ اللّٰهُ مَا يَشَآءُ ۚ اِنَّ اللّٰهَ عَلٰى كُلِّ شَيْءٍ قَدِيْرٌ

"Allah hath created every animal from water. Then some of them creep up over their bellies, others walk on two legs, and others on four. Allah creates what He pleases. Surely, Allah is most capable of everything." (Sura: Al-Nur, Verse: 45)

This verse explains that *Allah* created early life in water (fishes) and then animals with limbs were evolved. Among such animals some were created who creep over their bellies and then some were created who walk on two and some on four legs.

1.5- Science as a Collaborative Field

Science is a collaborative field in which researchers from various disciplines (fields) work together to solve complex problems. Interdisciplinary teams can tackle problems more efficiently by leveraging the strengths and expertise of each discipline. It often leads to quicker and sustainable solutions. Let's discuss a few examples of interdisciplinary collaboration in science:

Human Genome Project

The Human Genome Project aimed to sequence and map the entire human genome. This project was completed in 2003. It involved researchers from various disciplines, including molecular biology, genetics, informatics, and computer science.

FIGURE 1.2: The Human Genome Project

Climate Change Research

Climate change requires collaboration among many disciplines, such as atmospheric science, ecology, economics, and sociology.

Medical Research

Medical research often depends on interdisciplinary collaboration. For example, cancer research involves oncologists (cancer consultants), biologists, biochemists, geneticists, pharmacologists, and statisticians.

Robotics and Artificial Intelligence (AI)

The field of robotics and AI is highly interdisciplinary. It involves computer science, engineering, mathematics, neuroscience, and psychology. This collaboration has led to significant advancements in robotic systems, autonomous vehicles, machine learning and natural language processing.

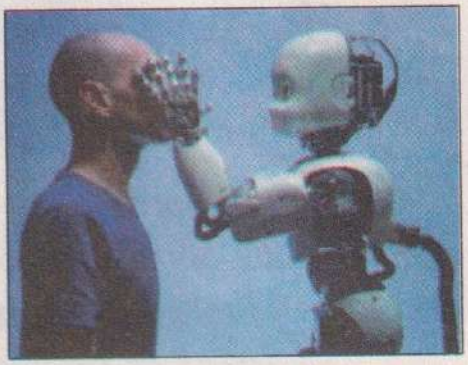

FIGURE 1.3: Robotic and artificial intelligence

Space Exploration

Organizations like NASA and the International Space Station (ISS) involve scientists from various fields, including astrophysics, planetary science, engineering, Biology, and medicine. These collaborations enable scientists to investigate the cosmos.

1.6- Scientific Method

Scientists take specific steps for doing scientific work or research. These steps are called the scientific method. For biological research, these steps are called biological method. The following steps are involved in scientific method:

1. Recognition of a scientific problem
2. Observation
3. Hypothesis
4. Deduction
5. Experiments
6. Results

In all branches of science, new things are being discovered and old theories are modified or replaced with better ones.

1. Recognition of a Problem

The first step involves identifying and defining a scientific problem (specific issue or phenomenon) that scientist wants to investigate. Such problem is either asked by someone or comes in biologist's mind by himself. For

example, a biologist notices that plants in an area are growing taller than usual. He develops a scientific problem: "What factors are responsible for the increased growth of these plants?" This problem becomes the starting point for a scientific inquiry.

2. Observations

Scientists make observations about the problem. They use five senses for making observation. They also read and study the previous researches on the same or related problems. Observations may be qualitative or quantitative.

Qualitative observations involve observations that cannot be measured with numbers. For example, the colour and texture of a flower.

Quantitative observations involve measurements or numerical data that can be expressed in terms of quantity. For example, the number of birds in a tree. Quantitative observations are more accurate than qualitative because quantitative observations are invariable, measurable and can be recorded in terms of numbers.

3. Hypothesis

On the basis of observations, scientists develop a statement that may prove the answer of the scientific problem under study. Such tentative answer of scientific problem is called hypothesis. Scientists make many hypotheses for a single problem. A hypothesis has the following characteristics:

Information is also gathered by reading books. It helps to understand existing knowledge and formulate a hypothesis.

- It is a proposed statement to answer the problem.
- It always matches with the available observations.
- It can be tested through experiments.
- There is always a way to disprove the hypothesis.

4. Deduction

Scientists develop logical results from their hypotheses. Such logical results of hypotheses are called deductions. Usually, deductions follow the pattern of "if-then" statements. Scientists assume that 'if' hypothesis is true 'then' what might be the results. For example:

- **Hypothesis:** "Leaf discoloration and stunted growth in a plant are caused by a deficiency of iron in the soil".
- **Deduction:** "If iron deficiency is causing the symptoms, then adding iron to the soil will improve the colours of leaves and promote plant growth".

5. Experiments

It is the most basic step of scientific method. Scientists perform experiments to test all hypotheses. In a successful experiment, one hypothesis is proved correct and the alternate hypotheses are proved incorrect. The incorrect hypotheses are rejected and the proved one is accepted. Scientists make new deductions from the accepted hypothesis. Then they perform further experiments and confirm the correctness of hypothesis.

Experimental Group and Control group

When scientists do experiments, they arrange two settings. One is called **"experimental group"** and the other is called **"control group"**.

For example, you want to do experiment to test the necessity of carbon dioxide for photosynthesis. You will arrange two similar plants. You will not provide carbon dioxide to one plant (experimental group). While you will provide carbon dioxide to the other plant (control group). The necessity of carbon dioxide will be proved when photosynthesis does not occur in the experimental group but occurs in the control group.

6. Results

Scientists gather data from their experiments. They use statistical analyses and graphs etc. to summarize the results. Scientists also include a list of all the references in the summary to acknowledge the sources of information. Scientists publish their findings in scientific journals and books. They also share the findings with other scientists. For this purpose, they create a scientific report and give presentation in National and International meetings and seminars.

1.7- Theory and Law (Principle)

When experiments prove a hypothesis correct, scientists use such hypothesis for making further hypotheses. When new hypotheses are again proved by

experiments, the original hypothesis becomes a theory. A theory is supported by extensive evidence and is repeatedly validated by multiple researchers. For example, the theory of evolution explains how species change over time through natural selection.

Scientists keep on testing the theories by doing experiments. They try their best to disprove the theory. If a theory is proved again and again by experiments, it becomes a law or principle. A scientific law is a uniform or constant fact of nature. The examples of biological laws are Hardy-Weinberg law and Mendel's laws of inheritance.

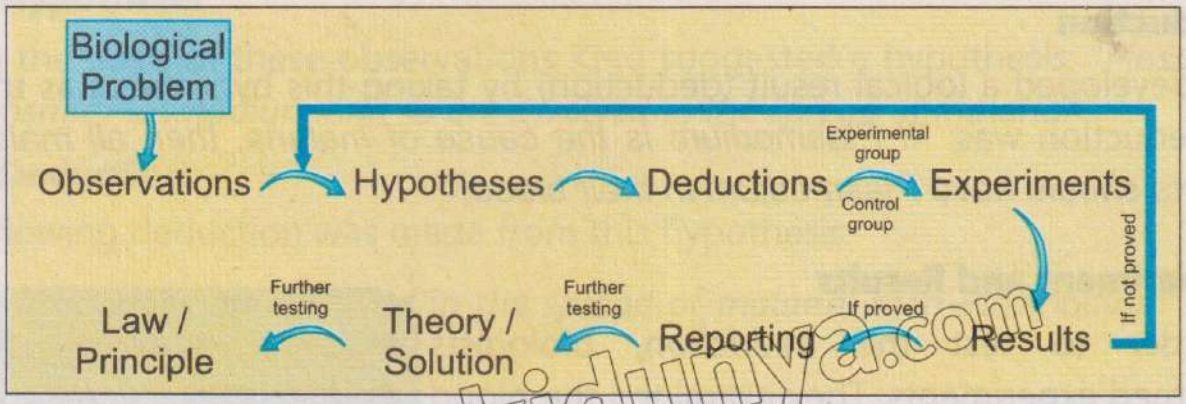

FIGURE 1.4: Flowchart of Scientific method

1.8- MALARIA - AN EXAMPLE OF BIOLOGICAL METHOD

Malaria is a common disease in many countries including Pakistan. You will know how biologists solved the biological problem concerning malaria.

In human history, malaria has killed more people than any other disease.

Biological Problem 1: What is the cause of malaria?

1. Observations

This disease was known to physicians of the ancient times (more than 2000 years ago). In the last part of 19th century, there were four major observations about malaria.

Quinine was the only remedy for malaria from the 17th to the 20th century.

- Malaria and marshy areas have some relation.
- Quinine is an effective drug for treating malaria.
- Drinking the water of marshy areas does not cause malaria.

- *Plasmodium* was seen in the blood of malarial patients.

In 1878, a French army physician **Laveran** did research on the "cause of malaria". He took the blood from a malarial patient and examined it under microscope. He noticed some microorganisms in the blood. The microorganism was given a name – ***Plasmodium***.

2. Hypothesis

Biologists thought on these observations and discoveries and developed a hypothesis i.e. "*Plasmodium is the cause of malaria*"

3. Deduction

They developed a logical result (deduction) by taking this hypothesis as true. The deduction was; *"If Plasmodium is the cause of malaria, then all malarial patients should have Plasmodium in their blood."*

3. Experiment and Results

In order to test the deduction, biologists performed experiments. They examined the blood samples of 100 malarial patients and 100 healthy persons under microscope. The following was the result of these experiments;

In these experiments, the malarial patients were the experimental group while the healthy persons were the control group.

- Most of the malarial patients had *Plasmodium* in their blood.

The result proved that the hypothesis "*Plasmodium is the cause of malaria*" was true.

Biological Problem 2: How Plasmodium gets into the blood of man?

The next biological problem was to learn about "*how Plasmodium gets into the blood of man*". Biologists were having following observations;

- Malaria is associated with marshes.
- Drinking water of marshes did not cause malaria.

When biologists considered these observations, they thought that *Plasmodium* was not in the marsh water.

1. Observations

In 1883, a physician, A. F. A. King, listed 20 observations. Some important observations of King were:

- People who slept outdoors had more chances to get malaria than those who slept indoors;
- People who slept under fine mosquito nets had less chances for getting malaria than those who did not use such nets;
- Individuals who slept near a smoky fire usually did not get malaria.

2. Hypothesis

On the basis of these observations King suggested a hypothesis: *"Mosquitoes transmit Plasmodium and so are involved in the spread of malaria."*

3. Deduction

Following deduction was made from this hypothesis.

"If mosquitoes are involved in the spread of malaria, then Plasmodium should be present in mosquitoes."

3. Experiment and Results

In order to test the above deduction, Ronald Ross performed important experiments in 1880s. He was a British army physician who was working in India.

FIGURE 1.5: Ronald Ross with his experimental set-up

He allowed a female *Anopheles* mosquito to bite a malarial patient. He killed this mosquito and found *Plasmodium* multiplying in its stomach. As the next experiment, he thought to allow an infected mosquito (having *Plasmodium)* to bite a healthy person. If the hypothesis was true, the healthy person would have got malaria. But he did not use human beings for such risky experiment.

Ross performed his experiment again but used sparrows instead of man. He allowed female *Culex* mosquitoes to bite a sparrow suffering from malaria. Then he studied some of these mosquitoes at different times. He found that

Plasmodium multiplied in the walls of the mosquito's stomach and then moved into its salivary glands. He allowed some infected mosquitoes to bite healthy sparrows. Ross found that these healthy sparrows got malaria. When he examined the blood of these sparrows, he found many *Plasmodia* in it. So, it proved the hypothesis; *Mosquitoes transmit Plasmodium. So, mosquitoes are involved in the spread of malaria.*

***Aedes* mosquito transmits dengue fever.**

Experiments on Human Beings

In the end, experiments were performed on human beings to test this hypothesis. In 1898, Italian biologists allowed an *Anopheles* mosquito to bite a malarial patient. The infected mosquito was then allowed to bite a healthy man. This person later became ill with malaria. In this way, it was confirmed that mosquitoes transmit *Plasmodium* and so are involved in the spread of malaria.

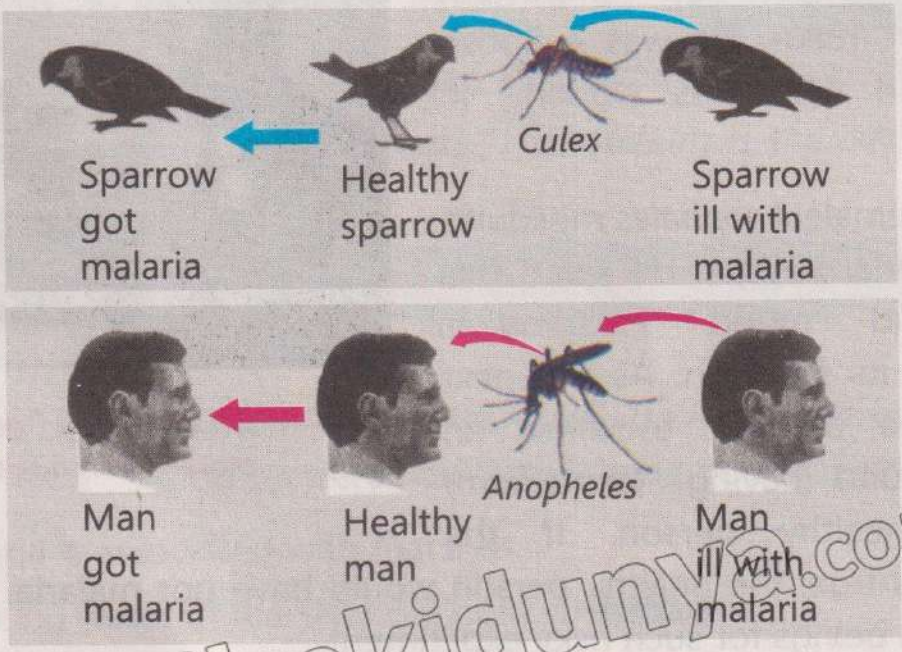

FIGURE 1.6: Malaria in sparrow and man is transmitted by Culex and Anopheles mosquitoes respectively

KEY POINTS

- Biology is the study of life. It deals with the structure of living things and the processes that occur in them.
- Major fields of Biology are Zoology (study of animals), Botany (study of plants) and Microbiology (study of microorganisms).
- The main sub-fields or branches of Biology include:

Branch	Study of;
Cytology	Cells
Histology	Tissues
Morphology	Form and structure of organisms
Anatomy	Internal physical structure of organisms
Physiology	Functioning of body parts
Embryology	Development of organism from fertilized egg
Genetics	Transfer of characteristics from parents to offspring
Molecular Biology	Biological molecules like carbohydrates, proteins, lipids, and nucleic acids
Palaeontology	Fossils
Taxonomy	Classification of organisms
Ecology	relationships between organisms and their environment
Marine Biology	Life in oceans
Pathology	Diseases, their causes, and effects
Immunology	Components of immune system and their role against diseases
Pharmacology	Drugs and their effects on the body

- Students of Biology can adopt careers like medicine and surgery, fisheries, agriculture, animal husbandry, biotechnology, horticulture, forestry and forensics.
- The scientific method involves basic steps like recognition of scientific problem, taking observations, making hypothesis, making deductions, performing experiments and summarizing and reporting results.
- A hypothesis is a tentative answer to the scientific problem.
- Deduction is the logical result of hypothesis.

- A scientific theory is an explanation based on the facts that have been repeatedly confirmed through experiments.
- If a theory is proved again and again by experiments, it becomes a law or principle.
- A scientific law is a uniform or constant fact of nature.

EXERCISE

A. Select the correct answers for the following questions.

1. Which branch of Biology focuses on the study of the structure and function of cells?
   a) Cytology
   b) Microbiology
   c) Histology
   d) Ecology
2. The study of the processes of heredity and variation in living organisms is known as:
   a) Ecology
   b) Genetics
   c) Anatomy
   d) Embryology
3. Insulin made through bacteria is an example of the technique of:
   a) Parasitology
   b) Biotechnology
   c) Biochemistry
   d) Histology
4. Heart pumps blood, stomach digests food, and kidneys excrete wastes. The statement comes from.
   a) Physiology
   b) Anatomy
   c) Morphology
   d) Histology
5. Which branch of Biology involves the study of the classification of organisms?
   a) Taxonomy
   b) Physiology
   c) Palaeontology
   d) Biogeography
6. Which step comes between making hypothesis and doing experiments?
   a) Making deductions
   b) Making observations
   c) Summarizing results
   d) Analysing data

7. Which of the following is NOT a characteristic of the scientific method?
   a) It relies on evidence
   b) It involves formulating hypotheses
   c) Hypothesis will always be correct
   d) It requires rigorous testing
8. Choose the correct sequence of steps of scientific method?
   a) Observations – hypothesis – deduction – experiments
   b) Observations – hypothesis – law – theory
   c) Hypothesis – observations – deduction – experiments
   d) Law – theory – deduction – observations
9. People who slept near smoky fire had less chance to suffer from malaria. Why?
   a) Smoke kills *Plasmodium* in their blood
   b) Fire increases temperature and *Plasmodium* are killed in air
   c) Mosquitoes cannot tolerate smoke and are repelled
   d) Smoke kills *Plasmodium* present in mosquitoes
10. Experiments are very important in scientific method because a researcher:
    a) Always gets correct results
    b) Disproves many hypotheses and gets some hypothesis proved
    c) Is sure that he will prove the hypotheses
    d) Gets a chance to work in the laboratory

B. Write short answers.

1. Define the following branches of Biology.

   Genetics, Anatomy, Palaeontology, Marine Biology, Pathology
2. Which branch of Biology involves the study of the development of organisms from fertilization to birth or hatching?
3. How is the profession of medicine and surgery different from animal husbandry?
4. Differentiate between Morphology and Physiology
5. What is Computational Biology?
6. What is the role of observation and experimentation in the scientific method?

1. Link the study of Biology with that of Physics, Chemistry, Statistics, Geography, Economics and Computer Science.
2. Explain how the study of Biology can lead to different professional studies.
3. Science is a collaborative field in which scientists work together to share knowledge. Prove this statement by giving examples.
4. How a hypothesis is converted to theory, law and principle?
5. What are the basic steps a scientist adopts in order to solve a scientific problem?
6. Describe the work of different scientists in discovering the cause of malaria.
7. Write a descriptive note on the experiments performed by Ross.

D. Inquisitive questions.

1. Why is it important to classify biology into different branches such as botany, zoology, and microbiology? How does specialization benefit scientific research?
2. How can a scientist apply the scientific method to confirm an observation that a certain plant species grows more quickly in shady places than in direct sunlight?