

**UNIT**
01

The science of Biology

Descriptive Questions**Biology and its Branches****Q.1 What is science?**

09401001

Ans. Definition

It's a systematic way of studying the natural world through observation and experimentation.

Explanation

Making observations, asking questions and trying to find the answers is what science all about. The study of science helps us to answer the how, what, where and why of our surroundings.

Q.2 What is biology? Describe major divisions (fields) and branches of biology.

09401002

Ans. Definition

Biology is the study of living things.

Explanation of Word “Biology”

The word “Biology” comes from two Greek words i.e. “**bios**” (life) and “**logos**” (study).

Role of Biology

- i. It explores the structures, functions, and interactions of living organisms.
- ii. Understanding Biology helps us to address issues related to health, food, and the environment.
- iii. 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 has three major fields zoology, botany and microbiology.

- i. **Zoology:** It is the study of animals, including their structure, function, behaviour, and diversity.
- ii. **Botany:** It is the study of plants, including their structure, growth, reproduction, and interactions with their environment.
- iii. **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**1. Morphology**

Definition: Morphology is the study of the form and structure of organisms.

Applications

Morphology studies the outward appearance (shape, colour, pattern, etc.) as well as internal structures, like organs.



2. Anatomy

Definition: It is the branch of Biology that explores the internal physical structure of organisms, particularly humans.

Applications

It helps in disease diagnosis, medical device development, and improving quality of life.

Example

The study of the organs of the digestive system.

3. Physiology

Definition: It is the branch of Biology that deals with the functioning of body parts.

Example

Blood circulatory system transports vital substances throughout the body.

4. Embryology

Definition: It is the study of the process of development of organism from fertilized egg.

Applications: In this branch, scientists study tissue and organ formation, identify birth defects, and develop medical treatments.

5. Cytology

Definition: Cytology is the study of cells i.e., the building blocks of life.

Applications: Cytologists unravel the fundamental structures of cells and their organelles. They also study the mechanisms of cell division.

6. Genetics

Definition: It is the branch of Biology that deals with the study of transfer of characteristics from parents to offspring.

Applications: In Genetics, scientists also study the causes of genetic diseases, and develop better varieties of plants and animals.

7. Molecular Biology

Definition: It deals with the study of biological molecules like carbohydrates, proteins, lipids, and nucleic acids.

Applications: Molecular biologists also study fundamental life processes, develop drugs, and create genetically modified organisms.

8. Histology

Definition: It is the microscopic study of tissues. Tissues are groups of cells that have similar functions.

Applications: Tissue examination helps in disease diagnosis, drug studies, and understanding organ structure and function.

9. Palaeontology

Definition: It is the branch of Biology that deals with the study of fossils.

Application: The examination of fossils helps scientists to know the evolutionary history of organisms.

Example

Dinosaur fossils provide evidence of giant reptiles that roamed the Earth millions of years ago.

Fossils

Fossils are the remains of plants and animals that were preserved at high temperature and pressure for millions of years in rocks and other geological formations.



The Oldest Known Fossil

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

10. Taxonomy

Definition: It is the branch of Biology that deals with the classification of organisms into groups on the basis of similarities and differences.

Applications: Classification of organisms helps to organize and understand the diversity of life, identify new species, and study evolutionary relationships.

11. Ecology

Definition: It is the branch of Biology that deals with the relationships between organisms and their environment.

Applications: Ecology helps to conserve biodiversity and address environmental problems. The food chain, for instance, illustrates the interconnectedness of organisms for energy and nutrients.

12. Marine Biology

Definition: It is the branch of Biology that deals with the study of life in oceans.

Applications: It helps to understand ocean biodiversity, discover new species, and address marine conservation issues.

Example

Coral reefs support a wide variety of marine life.

13. Pathology

Definition: It is the study of diseases, their causes, and effects.

Applications: Pathology helps in disease diagnosis, prevention and treatment.

Example

Cancer, for instance, is characterized by uncontrolled growth and spread of abnormal cells.

14. Immunology

Definition: It is the branch in which we study the components of the immune system and their role against diseases.

Applications: Immunologists study to develop vaccines, treat autoimmune diseases, and improve immune responses to infections.

15. Pharmacology

Definition: It is the branch in which we study drugs and their effects on the body.

Applications: This helps in the development of new drugs.

Example

New antibiotics are developed that are used to kill bacteria and treat bacterial infections.

Role of Branches

Each branch offers unique insights into the fascinating world of life, contributing to our understanding of the complexity and beauty of our planet.

Relation of Biology with other Sciences

Q.3 Link the study of biology with that of Physics, Chemistry, Statistics, Geography, Economics and Computer Science? / How biology is related with other sciences? Show and explain the link.

09401003

Ans. Introduction

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.

Relation of Biology with other Sciences

Here are a few examples of how Biology is connected with other natural sciences.

1. Biochemistry

Biochemistry is the study of the structure and reactions of different chemical substances present in living systems.

Examples

The study of the chemical reactions of photosynthesis and respiration are examples of Biochemistry.

2. Biophysics

Definition: It deals with the study of the principles of Physics, which apply to biological processes.

Example

In Biophysics we study the rules of lever and motion for understanding the function of muscles, bones and joints.

3. Computational Biology

Definition: In Computational Biology, scientists use Mathematical models, algorithms, and computer simulations to understand biological systems and relationships.

Role of Computational Biology

It involves analysing biological data, such as sequence of amino acids in a protein.

4. Biogeography

Definition: It deals with the study of the distribution of living organisms in different geographical regions of the world.

Role of Study of Biogeography

The influence of climate change on the distribution of organisms is also studied in Biogeography.

5. Biostatistics

Definition: It deals with the principles of statistics to analyse and interpret data related to living organisms.

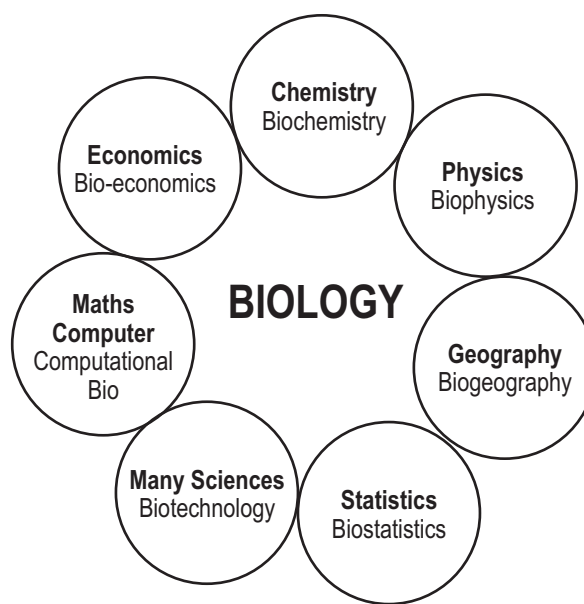


Figure 1.1: Relation of Biology with other Sciences

**Role of Biostatistics**

Biostatistics plays a crucial role in biological research, healthcare, and public health etc.

6. Biotechnology

Definition: 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.

Role of Biotechnology

Biotechnologists use bacteria for the production of insulin to treat diabetic patients.

7. Bio-economics

Definition: It deals with the study of organisms from economical point of view.

Role of Study of Bio-economics

In bio-economics, scientists calculate and compare the cost and profit of the biological projects e.g. production of new variety of crops.

Careers in Biology**Q.4 Explain how the study of biology can lead to different professional studies?**

09401004

Ans. Introduction

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

Explanation**1. Medicine and Surgery****Introduction**

The profession of medicine deals with the diagnosis and treatment of diseases. In surgery the defective parts of the body are repaired, replaced or removed.

Study Course

For this profession, students need to complete a 5-year Bachelor of Medicine, Bachelor of Surgery (MBBS) degree.

2. Dentistry**Introduction**

It is the study of diagnosis, prevention and treatment of diseases of gums teeth and mouth. Dentists specialize in oral health, diagnosing and treating dental issues and performing surgeries.

Study Course

For it, the students can pursue a 4-year Bachelor of Dental Surgery (BDS) degree.

3. Pharmacology**Introduction**

Pharmacology deals with the study of drugs. Pharmacologists study the effects of drugs on human body and develop new medications.

Study Course

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



4. Physiotherapy

Introduction

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 and function.

Study Course

To become a physiotherapist, 4 years BS degree in Physical Therapy or Physiotherapy is needed.

5. Fisheries and Wildlife

Introduction

This branch deals with breeding and conservation of aquatic organisms and wildlife. These experts work to conserve and manage the wildlife and aquatic organisms.

Study Course

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

Introduction

It deals with study of animals and plants used as source of food. Agricultural scientists improve farming practices, crop production, and sustainable agriculture techniques.

Study Course

A 4-year BS degree in Agriculture is required.

7. Animal Husbandry

Introduction

This field involves breeding and caring for livestock to improve their quality and productivity. Experts of this field work to improve quality and productivity of livestock.

Study Course

For it, students can pursue a 4-year BS degree in Animal Husbandry.

8. Horticulture

Introduction

It deals with the art of gardening. Horticulturists cultivate fruits, vegetables, flowers, and ornamental plants.

Study Course

A 4-year BS degree in Horticulture is required for it.

9. Forestry

Introduction

It deals with improvement and management of forests and wildlife. Foresters manage and conserve forests and wildlife.

Study Course

A 4-year BS degree in Forestry is necessary.

10. Farming

Introduction

Farming deals with maintenance and development of farms of plant crops and animals used as food. Farmers grow crops and raise animals for food and other products.



Study Course

A 4-year BS degree in Agriculture or specific farming courses are required for this profession.

11. Biotechnology

Introduction

It deals with the use of living organisms to make products for the welfare of mankind. Biotechnologists use biological processes to develop products and technologies in medicine, agriculture, and more.

Study Course

A 4-year BS degree in Biotechnology is required for this.

12. Forensics

Introduction

It deals with criminal investigations using principles of science. Forensic scientists analyse physical evidence from crime scenes to help in criminal investigations.

Study Course

A 4-year BS degree in Forensic Science is needed for this.

13. More Careers in Biology

Career	Major Jobs
Veterinary Medicine	Diagnosis and treatment of diseases in animals and surgeries.
Environmental Science	Solving issues related to pollution and natural resources.
Microbiology	Research on microorganisms to understand their impact.
Genetic Counseling	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.

Quranic Instructions to Reveal the Study of Life

Q.5 Describe Quranic instructions to reveal the study of life. / Explain the Islamic concept about the origin of life.

09401005

Ans. 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:

1. Origin of Life in Water

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 God. 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.

2. Creation of Man from Clay

خَلَقَ الْإِنْسَانَ مِنْ 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.

3. Method of Development

God also hints at the method of the development of animals including human beings.

ثُمَّ خَلَقْنَا النُّطْفَةَ عَلَقَةً فَخَلَقْنَا الْعَلَقَةَ مُضْغَةً

فَخَلَقْنَا الْمُضْغَةَ عِظًا فَكَسَّوْنَا الْعِظَ 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)

4. Concept of Common Origin and Modification of Animals

Quran also describes the common origin and modification of animals.

وَاللَّهُ خَلَقَ كُلَّ دَابَّةٍ مِنْ مَاءٍ فَمِنْهُمْ مَنْ يَمْشِي عَلَى بَطْنِهِ ۖ وَمِنْهُمْ مَنْ يَمْشِي عَلَى رِجْلَيْنِ

وَمِنْهُمْ مَنْ يَمْشِي عَلَى أَرْبَعٍ ۚ يَخْلُقُ اللَّهُ مَا يَشَاءُ ۚ إِنَّ اللَّهَ عَلَى كُلِّ شَيْءٍ قَدِيرٌ


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

This verse explains that God 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 walked on two and some on four legs.

Science as a Collaborative Field

Science as Collaborative Field

- ◆ Human Genome Project
- ◆ Medical Research
- ◆ Robotics and AI
- ◆ Space Exploration



CLASS 9th

SUBJECT Biology

TOPIC Science as Collaborative Field

LECTURE No 1

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Q.6 Science is a collaborative field in which scientists work together to share knowledge. Prove this statement by giving examples.

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Ans. Interdisciplinary Research Collaboration

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 more robust solutions.

Examples of Interdisciplinary Collaboration in Science

1. Human Genome Project

Introduction

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 biology, genetics, informatics, and computer science.

2. Climate Change Research

Introduction

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

3. Medical Research

Introduction

Advances in medical research often rely on interdisciplinary collaboration.

Role

For example, cancer research involves oncologists (cancer consultants), biologists, biochemists, geneticists, pharmacologists, and statisticians.

4. Robotics and Artificial Intelligence (AI)

Introduction

The field of robotics and AI is highly interdisciplinary. It involves computer science, engineering, mathematics, neuroscience, and psychology.

Role

This collaboration has led to significant advancements in robotic systems, autonomous vehicles, machine learning and natural language processing.

5. Space Exploration

Introduction

Organizations like NASA and the International Space Station (ISS) involve scientists from various fields, including astrophysics, planetary science, engineering, biology and medicine.

Role

These collaborations enable scientists to investigate the cosmos.

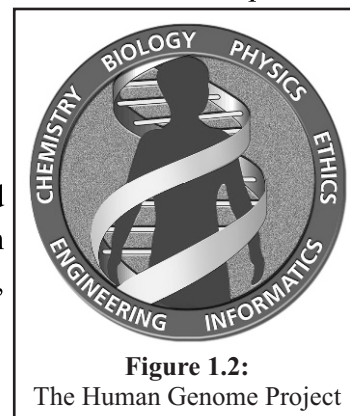


Figure 1.2:
The Human Genome Project



Figure 1.3: Robotic and artificial Intelligence



Scientific Method

Q.7 Define scientific method. What are basic steps a scientist adopts in order to solve scientific problems?

09401007

Ans. Introduction

Scientists take specific steps for doing scientific work or research. These steps are collectively called scientific method. For biological research, these steps are called biological method.

Steps in Scientific Method

The following steps are involved in scientific method:

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

1. Recognition of a Problem

Introduction

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

Example

A biologist notices that plants in a certain 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

Introduction

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.

Types of Observations

Observations may be qualitative or quantitative.

a. Qualitative Observations: It involve characteristics that cannot be measured with numbers.

Example: Describing the colour and texture of a flower.

b. Quantitative Observations: It involve measurements or numerical data that can be expressed in terms of quantity.

Example: Counting the number of birds in a tree (e.g., 5 birds).

Comparison of Qualitative and Quantitative Observations

Quantitative observations are more accurate than qualitative because quantitative observations are invariable, measurable and can be recorded in terms of numbers.



3. Hypothesis

Definition On the basis of observations, scientists develop a statement that may prove the answer of the identified problem / question. Such tentative answer of scientific problem is called hypothesis. Scientists make many hypotheses for a single-problem.

Characteristics of Hypothesis

A hypothesis has the following characteristics:

- 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.

Example

“Leaf discoloration and stunted growth in a plant are caused by a deficiency of iron in the soil.”

4. Deduction

Introduction

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.

Example

“If iron deficiency is causing the symptoms, then adding iron to the soil will lessen the leaf discoloration and promote healthier plant growth.”

5. Experiments

Introduction

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".

Example

We want to do experiment to test the necessity of carbon dioxide for photosynthesis. We shall arrange two similar plants. We will not provide carbon dioxide to one plant (**experimental group**). While we 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. Summarization and Reporting of Results

- (a) Scientists gather data from their experiments. They use statistical analyses, graphs, or any other relevant information to summarize the results. Scientists also include a list of all the references in the summary to acknowledge the sources of information.



- (b) Scientists publish their findings in scientific journals and books. They also share the findings with other scientists by creating a scientific report or presentation in talks at National and International meetings and in seminars.

Theory and Law / Principle

Q.8 How a hypothesis is converted to theory, law and principle?

09401008

Ans.

a. Formulation of a Theory

When experiments prove a hypothesis correct, scientists use such hypothesis for formulating further hypotheses. When new hypotheses are again proved by experiments, the original hypothesis becomes a theory. Theories are supported by extensive evidence and have been, repeatedly validated by multiple researchers and studies.

Example

The theory of evolution explains how species change over time through natural selection.

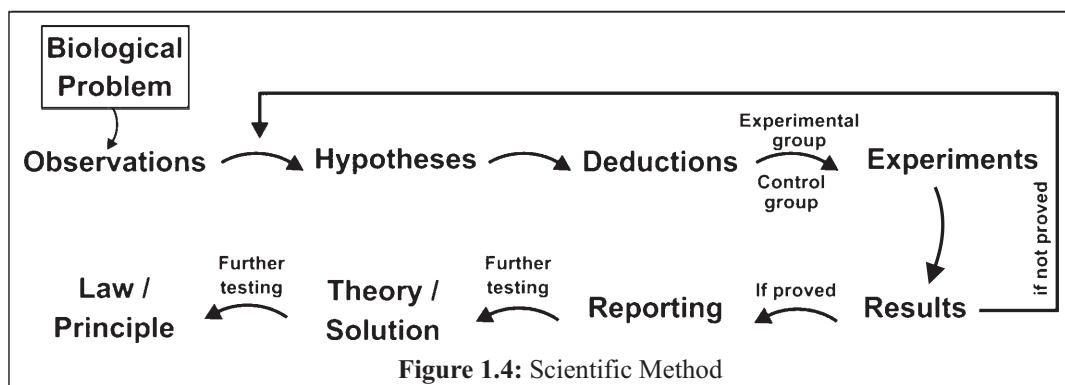
b. Formulation of a Law or Principle

Introduction

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.

Examples

Hardy-Weinberg law and Mendel's laws of inheritance.



Malaria-an Example of Biological Method

Q.9 Describe the work of different scientists in discovering the cause of malaria. / Explain biological method with an example of malaria.

09401009

Ans. Malaria-an Example of Biological Method

Malaria is a common disease in many countries including Pakistan. In human history, malaria has killed more people than any other disease.

Biological Problem 1: What is the cause of malaria?

1. Recognition of the Problem

This disease was known to physicians of the ancient times (more than 2000 years ago). Quinine was the only remedy for malaria from the 17th to the 20th century.



2. Observations

In the last part of 19th century, there were four major observations about malaria.

- Malaria and marshy areas have some relation.
- Quinine is an effective drug for treating malaria.
- Drinking the water of marshes does not cause malaria.
- *Plasmodium* was seen in the blood of malarial patients.

Work of Laveran

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*.

3. Hypothesis

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

4. 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*"

5. Experiments and Results

Experiments

In order to test the deduction biologists performed experiments. They examined the blood samples of 100 malarial patients and 100 healthy persons under microscope.

Experimental and Control Group

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

Results: The following were the results of these experiments;

- Most of the malaria patients had *Plasmodium* in their blood.
- Some healthy persons also had *Plasmodium* in their blood.

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

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

1. Recognition of Problem

The next biological problem was to learn about "How *Plasmodium* gets into the blood of man?"

2. Observations

Biologists were having following observations;

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

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

Work of A.F.A King

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 nets had less chances to get malaria than those who did not use such nets;
- Individuals who slept near a smoky fire usually did not get malaria.

3. Hypothesis

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

4. Deduction

Following deduction was made from this hypothesis.

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

5. Experiment and Results / Write a descriptive note on the experiments performed by Ross.

Introduction

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.

Experiment on Man

- 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.

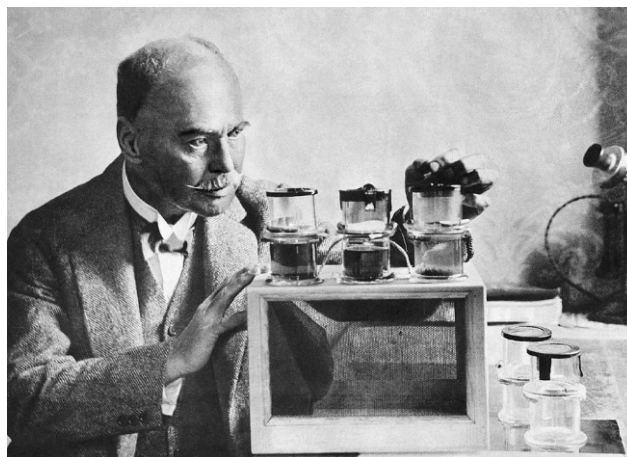


Figure 1.5: Ronald Ross with his experimental set-up

Experiment on Sparrows

- Ross performed his experiment again but used sparrows instead of man. He allowed a female *Culex* mosquito to bite a sparrow suffering from malaria. He studied some mosquitoes at various 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 previously healthy sparrows, he found many *Plasmodia* in it.

Result

So, it proved the hypothesis; “*Mosquitoes transmit Plasmodium*”. So, mosquitoes are involved in the spread of malaria.

Experiments on Human Beings

In the end, the hypothesis was tested by experiments on human beings. 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.

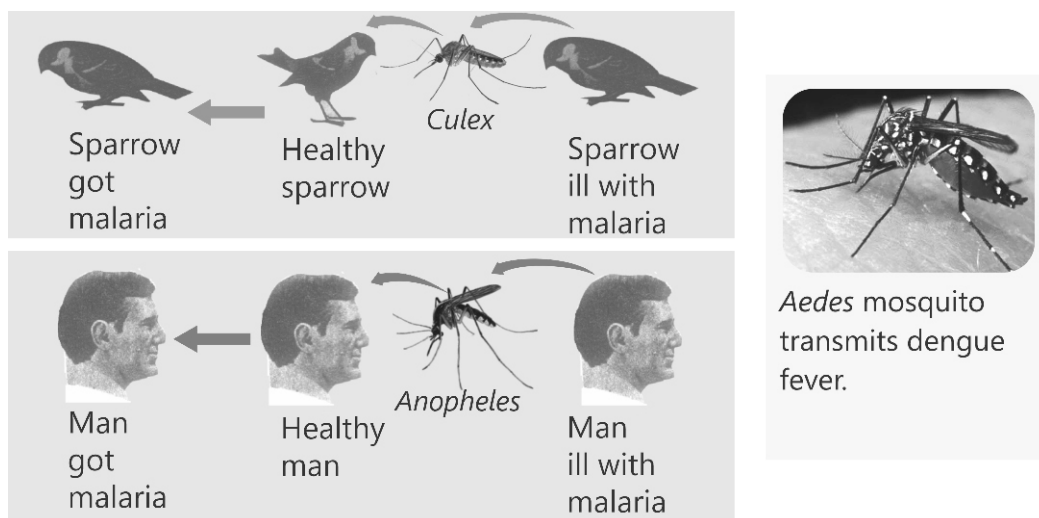


Figure 1.6: Malaria in sparrow and man is transmitted by *Culex* and *Anopheles* mosquitoes respectively

Multiple Choice Questions (Exercise)

- Which branch of Biology focuses on the study of the structure and function of cells? 09401010
(a) Cytology (b) Microbiology
(c) Histology (d) Ecology
- The study of the processes of heredity and variation in living organisms is known as: 09401011
(a) Ecology (b) Genetics
(c) Anatomy (d) Proteomics
- Insulin made through bacteria is an example of the technique of: 09401012
(a) Parasitology (b) Biotechnology
(c) Biochemistry (d) Histology
- Heart pumps, the brain memorizes, kidneys excrete. The statement comes from: 09401013
(a) Physiology
(b) Anatomy
(c) Morphology
(d) Cardiology
- Which branch of Biology involves the study of the classification of organisms? 09401014
(a) Taxonomy
(b) Physiology
(c) Palaeontology
(d) Biogeography
- Which step comes between making hypothesis and doing experiments? 09401015
(a) Making deductions
(b) Making observations
(c) Summarizing results
(d) Analysing data
- Which of the following is NOT a characteristic of the scientific method? 09401016
(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? 09401017

- (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? 09401018

- (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: 09401019

- (a) Always gets correct results
- (b) Disproves many hypotheses and gets some hypotheses proved
- (c) Is sure that he will prove the hypotheses
- (d) Gets a chance to work in the laboratory

Multiple Choice Questions (Additional)

Biology and its Branches

11. The study of functions of various organs of an organism is: 09401020

- (a) Morphology (b) Histology
- (c) Anatomy (d) Physiology

12. Histology is the microscopic study of: 09401021

- (a) Tissues (b) Cells
- (c) Fossils (d) Plants

13. Palaeontology is the study of: 09401022

- (a) Environment (b) Development
- (c) Fossils (d) Animals

14. The other name of environmental biology is: 09401023

- (a) Ecology (b) Biotechnology
- (c) Microbiology (d) Cell biology

15. Microbiology is the study of: 09401024

- (a) Fungi (b) Animals
- (c) Plants (d) Microorganisms

16. Biology is a word of which language 09401025

- (a) Latin (b) Arabic
- (c) Greek (d) English

17. The study of plants is called: 09401026

- (a) Biology (b) Zoology
- (c) Botany (d) Microbiology

18. Match anatomy with one of the following: 09401027

- (a) Physiology (b) Morphology
- (c) Embryology (d) Genetics

19. Biology is the scientific study of: 09401028

- (a) Earth (b) Water
- (c) Life (d) Non-living things

20. The branch deals with the study of form and structure of living organisms is called: 09401029

- (a) Cell biology (b) Physiology
- (c) Morphology (d) Genetics



21. The branch which deals with the study of cell division is called: 09401030

- (a) Physiology (b) Histology
(c) Cell biology (d) Entomology

22. The branch deals with the study of the interrelationship of organisms and their environment is called: 09401031

- (a) Biotechnology
(b) Molecular biology
(c) Entomology
(d) Environmental biology

23. Into how many major divisions biology is divided? 09401032

- (a) 3 (b) 2
(c) 4 (d) 5

24. Mr. Nauman was busy in dissecting and analyzing the heart of frog. Probably he is a: 09401033

- (a) Cell biologist (b) Taxonomist
(c) Histologist (d) Palaeontologist

25. Being a biological research worker, you are studying "Markhor" which branch of biology it will be: 09401034

- (a) Botany (b) Zoology
(c) Palaeontology (d) Parasitology

26. Which of the following profession deals with the diagnosis and treatment of diseases in human? 09401035

- (a) Medicine (b) Surgery
(c) Biotechnology (d) Farming

27. Study of insects is called: 09401036

- (a) Immunology (b) Entomology
(c) Genetics (d) Ecology

28. The study of how living things interact with each other and their environment is known as: 09401037

- (a) Physiology (b) Anatomy
(c) Ecology (d) Genetics

29. What is the study of diseases and their causes called? 09401038

- (a) Pharmacology (b) Pathology
(c) Physiology (d) Anatomy

Relation of Biology with other Sciences

30. The study of occurrence and distribution of different species of living organisms in different geographical regions of the world is called: 09401039

- (a) Histology (b) Microbiology
(c) Biogeography (d) Parasitology

31. How many people get lung cancer by smoking? This question can be answered through: 09401040

- (a) Biometry (b) Biophysics
(c) Bio-economics (d) Biogeography

32. "The number of plants in desert are scarce". This could be the statement of: 09401041

- (a) Social biologist
(b) Taxonomist
(c) Biogeographer
(d) Palaeontologist

33. Which of the following best describes the field of biotechnology? 09401042

- (a) Study of diseases
(b) Study of marine life
(c) Use of biological processes to develop technologies
(d) Management of forest resources

34. Which field applies computer technology to biological research? 09401043

- (a) Biogeography
(b) Biostatistics
(c) Computational biology
(d) Bioeconomics



35. The oldest known fossil is a cyanobacterium estimated to be years old: 09401044

- (a) 2.4 billion
- (b) 1.4 billion
- (c) 3.5 billion
- (d) 4 billion

Careers in Biology

36. The new emerging careers of biology include: 09401045

- (a) Bioinformatics and biomedical engineering
- (b) Biotechnology
- (c) Genetics
- (d) All of above

37. What does MBBS stand for? 09401066

- (a) Bachelor of Medicine and Bachelor of Surgery
- (b) Master of Biology and Biological Studies
- (c) Bachelor of Medical Biological Science
- (d) Master of Biochemical Biological Studies

38. What does the field of forensic science involve? 09401047

- (a) Garden management
- (b) Examination of evidence from crime scenes
- (c) Livestock management
- (d) Drug development

39. What is the role of horticulturist? 09401048

- (a) Disease diagnosis
- (b) Plant breeding and cultivation
- (c) Performing surgeries
- (d) Developing medicines

Quranic Instructions to Reveal the Study of Life

40. "We made every living thing from water". This verse is from which sura of Holy Quran? 09401049

- (a) Al-Rehman
- (b) Al-Mominoon
- (c) Al-Ambia
- (d) Al-Noor

Science as Collaborative Field

41. Human Genome project was completed in: 09401050

- (a) 2000
- (b) 2001
- (c) 2002
- (d) 2003

Scientific Method

42. The starting point of scientific investigation is: 09401051

- (a) Hypothesis
- (b) Theory
- (c) Observation
- (d) Data

43. Information that is gathered as a result of an experiment is called: 09401052

- (a) Hypothesis
- (b) Data
- (c) Theory
- (d) Observation

44. Which of following statements best distinguishes hypotheses from theories in science? 09401053

- (a) Theories are hypotheses that have been proven true
- (b) Theories are based on limited data while hypotheses are based on wide range of data
- (c) Theories are uncertain while hypotheses are certain
- (d) Theories are educated guess while hypotheses are widely accepted explanation of natural phenomenon

45. You are doing a control experiment which: 09401054

- (a) Proceeds slowly enough that a scientist can record the results
- (b) May include experimental groups and control groups tested in parallel
- (c) Is repeated many times to make sure the results are accurate
- (d) Proceed slowly enough that a scientist can test predictions



46. A good hypothesis must be: 09401055

- (a) Proven right
- (b) Complex
- (c) Testable and potentially falsifiable
- (d) Based on a single observation

47. A well-substantiated explanation of hypothesis is called: 09401056

- (a) Observation (b) Deduction
- (c) Experimentation (d) Theory

48. Five senses are involved in: 09401057

- (a) Hypothesis (b) Observations
- (c) Deduction (d) Experiment

49. The logical consequences of hypothesis are: 09401058

- (a) Law (b) Deduction
- (c) Observations (d) Theory

50. Number of steps of biological method are: 09401059

- (a) Seven (b) Six
- (c) Two (d) Eight

51. The scientific method in which biological problems are solved is termed as: 09401060

- (a) Physical method
- (b) Biological method
- (c) Chemical method
- (d) Statistical method

52. Deductions are drawn from: 09401061

- (a) Experiments (b) Hypothesis
- (c) Theory (d) Law

53. In biological method the next step of hypothesis is called: 09401062

- (a) Deduction (b) Observation
- (c) Result (d) Experiment

54. The scientific method in biology starts with: 09401063

- (a) Hypothesis
- (b) Recognition of a problem
- (c) Analysis of results
- (d) Deduction

55. Following are the characteristics of a good hypothesis, EXCEPT. 09401064

- (a) Should be a complex statement
- (b) Should be a tentative idea
- (c) Should be testable
- (d) Should agree with available observations

56. Which of the following best describes the logic of the scientific process? 09401065

- (a) If I generate a testable hypothesis, tests and observations will support it
- (b) If my prediction is correct, it will lead to a testable hypothesis.
- (c) If my observations are accurate, they will support my hypothesis
- (d) If my hypothesis is correct, I can expect certain test result

Malaria-an Example of Biological Method

57. Malaria is caused by: 09401066

- (a) Mosquito
- (b) Stagnant water
- (c) Swamp
- (d) *Plasmodium*

58. Malarial patient has *Plasmodium* in his blood, what would be the possible explanation if a healthy person who is not having any malarial symptoms shows *Plasmodium* in his blood? 09401067

- (a) *Plasmodium* are dead
- (b) *Plasmodium* are in incubation period
- (c) *Plasmodium* are not mature
- (d) *Plasmodium* are inactive

59. A.F.A King listed observations: 09401068

- (a) 10
- (b) 20
- (c) 30
- (d) 40



60. Which option has correctly matched disease and vector mosquito?

09401069

	Malaria in humans	Malaria in birds	Dengue fever
(a)	<i>Anopheles</i>	<i>Aedes</i>	<i>Culex</i>
(b)	<i>Aedes</i>	<i>Culex</i>	<i>Anopheles</i>
(c)	<i>Anopheles</i>	<i>Culex</i>	<i>Aedes</i>
(d)	<i>Culex</i>	<i>Anopheles</i>	<i>Aedes</i>

61. Who performed experiments on sparrow?

09401070

- (a) Ross
- (b) A. F. A. King
- (c) Laveran
- (d) None of these

62. For the first time, who found plasmodium in the blood of malarial patient?

09401071

- (a) Ronald Ross
- (b) Laveran
- (c) A.F.A King
- (d) Mendel

63. What is the correct experiment to know that *Plasmodium* destroys blood cells?

09401072

- (a) Examine the blood of a single healthy person
- (b) Examine the blood of a single infected person
- (c) Allow mosquito to bite a healthy person and examine his blood
- (d) Examine the blood of some healthy and also some infected persons

Answer Key

1	a	2	b	3	b	4	a	5	a
6	a	7	c	8	a	9	c	10	b
11	d	12	a	13	c	14	a	15	d
16	c	17	c	18	b	19	c	20	c
21	c	22	d	23	a	24	c	25	b
26	a	27	b	28	c	29	b	30	c
31	a	32	c	33	c	34	c	35	c
36	a	37	a	38	b	39	b	40	c
41	d	42	c	43	b	44	a	45	b
46	c	47	b	48	b	49	b	50	b
51	b	52	b	53	a	54	b	55	a
56	c	57	d	58	b	59	b	60	c
61	a	62	b	63	d				



Short Answer Questions (Exercise)

Q.1 Define the following branches of biology:

09401073

- (i) Genetics
- (ii) Anatomy
- (iii) Palaeontology
- (iv) Marine Biology
- (v) Pathology

Ans.

i. Genetics

Definition: It is the branch of Biology that deals with the study of transfer of characteristics from parents to offspring.

Applications: In Genetics, scientists also study the causes of genetic diseases, and develop better varieties of plants.

ii. Anatomy

Definition: It is the branch of Biology that explores the internal physical structure of organisms, particularly humans.

Application

It helps in disease diagnosis, medical device development, and improving quality of life.

Example

The study of the organs of the digestive system.

iii. Palaeontology

Definition: It is the branch of Biology that deals with the study of fossils.

Application: The examination of fossils helps scientists to know the evolutionary history of organisms.

Example

Dinosaur fossils provide evidence of giant reptiles that roamed the Earth millions of years ago.

iv. Marine Biology

Definition: It is the branch of Biology that deals with the study of life in oceans and salt water.

Applications: It helps to understand ocean biodiversity, discover new species, and address marine conservation issues.

Example

Coral reefs support a wide variety of marine life.

v. Pathology

Definition: It is the study of diseases, their causes, and effects.

Applications: Pathology helps in disease diagnosis, treatment development, and disease prevention.

Example

Cancer, for instance, is characterized by uncontrolled growth and spread of abnormal cells.

Q.2 Which branch of biology involves the study of the development and growth of organisms from fertilization to adulthood?

09401074

Ans. It is embryology. It is the study of the process of development of organism from fertilized egg to adulthood.

Applications: In this branch, scientists study organ and tissue formation, identify birth defects and develop medical treatments.



Q.3 How is the profession of medicine and surgery different from animal husbandry? 09401075

Ans.

Medicine and Surgery	Animal Husbandry
<ul style="list-style-type: none"> The profession of 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. 	<ul style="list-style-type: none"> This field involves breeding and caring for livestock to improve their quality and productivity. For this profession, students can pursue a 4-year BS degree in Animal Husbandry.

Q.4 Differentiate between morphology and physiology. 09401076

Ans.

Morphology	Physiology
<ul style="list-style-type: none"> Definition: The study of the size, shape and structure of animals, plants and microorganisms is called morphology. This branch is also called external morphology. Example: Morphology of a flowering plant includes the structure of roots, stem, leaves, flowers and fruits. 	<ul style="list-style-type: none"> Definition: It is the branch of Biology that deals with the functioning of body parts. Example: Circulatory system transports vital substances throughout the body.

Q.5 What is computational biology? 09401077

Ans. Definition

In Computational Biology, scientists use mathematical models, algorithms, and computer simulations to understand biological systems and relationships.

Role of Computational Biology

It involves analysing biological data, such as sequence of amino acids in a protein.

Q.6 What is the role of observation and experimentation in the scientific method?

Ans. Role of Observation 09401078

Observations are very important step in solving a biological problem. Observations are made by five senses of vision, hearing, smell, taste and touch.

Role of Experimentation

It is the most important step of biological method. Experiments are performed to prove if hypothesis is true or not. The deductions drawn from the hypothesis are subjected to rigorous testing. Through experimentation, biologist learns which hypothesis is correct.

Short Answer Questions (Additional)

Biology and Its Branches

Q.7 Differentiate between zoology and botany. 09401079

Ans. The division of biology which deals with the study of plants is called **botany**

e.g., mustard, rose. The division of biology which deals with the study of animals is called **zoology** e.g; frog.



Q.8 Define the following terms: 09401080

(i) **Cell biology** (ii) **Embryology**

Ans. (i) Cell Biology: The study of the structure and functions of the cell is called cell biology.

(ii) **Embryology:** The study of the developmental stages of an organism from

egg to the formation of a new organism is called embryology.

Q.9 Define the term fossil: 09401081

Ans. Fossils are remains of the living things preserved by natural process. Fossils help the study of life in the past and process of evolution.

Science as Collaborative Field

Q.10 How interdisciplinary collaboration is helpful in medical research? 09401082

Ans. Interdisciplinary collaboration promotes innovation and addresses real world challenges in medical research.

Example

In cancer research oncologists, biologists, biochemists, geneticists, pharmacologists and statisticians work in collaboration.

Scientific Method

Q.11 Observations are mainly of two types i.e., qualitative and quantitative. Sort the following observation according to these two types.

“Colour of cat, Height of giraffe, Weight of mango fruits, Body temperature of birds, Volume of blood in humans, Shape of leaves, Climate of desert, Speed of tiger, Song of a bird.” 09401083

Ans.

Qualitative Observations	Quantitative Observations
i. Colour of cat	i. Height of giraffe
ii. Shape of leaves	ii. Weight of mango fruit
iii. Climate of desert	iii. Body temperature of birds
iv. Song of a bird	iv. Volume of blood in humans
	v. Speed of tiger

Q.12 Differentiate between qualitative and quantitative observations. 09401084

Ans.

Qualitative Observations	Quantitative Observations
i. These involve characteristics that cannot be measured with numbers.	i. These involve measurements or numerical data that can be expressed in terms of quantity.
ii. These are less accurate. Example: Colour of parrot.	ii. These are more accurate. Example: Height of a human.

Q.13 Differentiate between theory and principle.

09401085

Ans.

Theory	Principle
<ul style="list-style-type: none"> If the hypothesis is found to be correct then it becomes a theory. It is supported by a number of evidences. A theory can be changed if better evidence is available. Example: The theory of evolution. 	<ul style="list-style-type: none"> A theory that has been verified and appears to have wide application may become biological principle or law. Example: Mendel's laws of inheritance.



Q.14 What are basic characteristics of hypothesis? 09401086

Ans. Characteristics of Hypothesis

A hypothesis has the following characteristics:

- 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.

Q.15 What is difference between control group and experimental group? 09401087

Ans.

Control Group	Experimental Group
i. The group in an experiment that does not receive the variable being tested. ii. It is used as a baseline to compare results. Example We will provide CO ₂ to the plants as normal.	i. The group in an experiment that receives the variable being tested. ii. It is used to test the effect of the variable. Example We will not provide CO ₂ to plant to check its effect.

Malaria-an Example of Biological Method

Q.16 What is the contribution of the following scientists? 09401088

(a) A.F.A. King (b) Ronald Ross
(c) Laveran

Ans. (a) A.F.A. King

In 1883, a Physician A.F.A. King listed twenty observations. Some important observations of King are:

1. People who slept outdoors were more likely to get malaria than those who slept indoors.
2. People who slept under fine nets were less likely to get malaria than those who did not use such nets.
3. People who slept near a smoky fire usually did not get malaria. On the basis of these observations King suggested a hypothesis: "*Mosquitoes transmit Plasmodium so are involved in the spread of malaria*".

(b) Ronald Ross

Ross, a British army physician working in India performed important

experiments to confirm that mosquito transmits plasmodium.

(c) Laveran

A French physician Laveran in 1882 formulated following hypothesis on the basis of malarial observations: "*Plasmodium is the cause of malaria*".

Q.17 How malaria is treated? 09401089

Ans.

- For the treatment of malaria, quinine extracted from the bark of Cinchona plant is used.
- Apart from quinine certain anti-malarial drugs are also used for the treatment.

Q.18 How the malarial parasite enters the body of healthy person? 09401090

Ans. Patients suffering from malaria have *Plasmodium* in their blood. When a female *Anopheles* mosquito bites a malarial patient, it sucks blood from him/her. Thus, the *Plasmodium* enters the body of the mosquito, when the infected mosquito bites a healthy person, it injects *Plasmodium* in his / her blood.



Q.19 Write major observations about malaria.

09401091

Ans. There were four major observations about malaria.

a) Malaria and marshy areas have some relation.

b) Quinine is an effective drug for treating malaria.

c) Drinking the water of marshes does not cause malaria.

d) *Plasmodium* is seen in the blood of malarial patient.