

UNIT 01

The Science of Biology

Descriptive Questions

Biology and its Branches taleemzone.com

Q.1 What is science?

Ans.

Definition

Science is 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 is 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.

Ans.

Definition

Biology is the study of living things.

Explanation of Word "Biology"

The word "Biology" comes from two Greek words: "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

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

2. Anatomy

- o **Definition:** It is the branch of Biology that explores the internal physical structure of organisms, particularly humans.
- o **Applications:** It helps in disease diagnosis, medical device development, and improving quality of life.
- o **Example:** The study of the organs of the digestive system.

3. Physiology

- o **Definition:** It is the branch of Biology that deals with the functioning of body parts.
- o **Example:** Blood circulatory system transports vital substances throughout the body.

4. Embryology

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

- o **Applications:** In this branch, scientists study tissue and organ formation, identify birth defects, and develop medical treatments. Taleemzone.com

5. Cytology

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

6. Genetics

- o **Definition:** It is the branch of Biology that deals with the study of transfer of characteristics from parents to offspring.
- o **Applications:** In Genetics, scientists also study the causes of genetic diseases, and develop better varieties of plants and animals.

7. Molecular Biology

- o **Definition:** It deals with the study of biological molecules like carbohydrates, proteins, lipids, and nucleic acids.
- o **Applications:** Molecular biologists also study fundamental life processes, develop drugs, and create genetically modified organisms.

8. Histology

- o **Definition:** It is the microscopic study of tissues. Tissues are groups of cells that have similar functions.
- o **Applications:** Tissue examination helps in disease diagnosis, drug studies, and understanding organ structure and function.

9. Palaeontology

- o **Definition:** It is the branch of Biology that deals with the study of fossils.
- o **Application:** The examination of fossils helps scientists to know the evolutionary history of organisms.
- o **Example:** Dinosaur fossils provide evidence of giant reptiles that roamed the Earth millions of years ago.
- o **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.

10. Taxonomy

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

11. Ecology

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

- o **Definition:** It is the branch of Biology that deals with the study of life in oceans.
- o **Applications:** It helps to understand ocean biodiversity, discover new species, and address marine conservation issues.
- o **Example:** Coral reefs support a wide variety of marine life.

13. Pathology

- o **Definition:** It is the study of diseases, their causes, and effects.
- o **Applications:** Pathology helps in disease diagnosis, prevention and treatment.

- o **Example:** Cancer, for instance, is characterized by uncontrolled growth and spread of abnormal cells.

14. Immunology

- o **Definition:** It is the branch in which we study the components of the immune system and their role against diseases.
- o **Applications:** Immunologists study to develop vaccines, treat autoimmune diseases, and improve immune responses to infections. Taleemzone.com

15. Pharmacology

- o **Definition:** It is the branch in which we study drugs and their effects on the body.
- o **Applications:** This helps in the development of new drugs.
- o **Example:** New antibiotics are developed that are used to kill bacteria and treat bacterial infections.

The Oldest Known Fossil

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

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.

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

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

2. Biophysics

- o **Definition:** It deals with the study of the principles of Physics, which apply to biological processes.
- o **Example:** In Biophysics we study the rules of lever and motion for understanding the function of muscles, bones and joints.

3. Computational Biology

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

4. Biogeography

- o **Definition:** It deals with the study of the distribution of living organisms in different geographical regions of the world.
- o **Role of Study of Biogeography:** The influence of climate change on the distribution of organisms is also studied in Biogeography.

5. Biostatistics

- o **Definition:** It deals with the principles of statistics to analyse and interpret data related to living organisms. Taleemzone.com

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- o **Role of Biostatistics:** Biostatistics plays a crucial role in biological research, healthcare, and public health etc.

6. **Biotechnology**

- o **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.
- o **Role of Biotechnology:** Biotechnologists use bacteria for the production of insulin to treat diabetic patients.

7. **Bio-economics**

- o **Definition:** It deals with the study of organisms from economical point of view.
 - o **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.
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Careers in Biology

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

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**

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

2. **Dentistry**

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

3. **Pharmacology**

- o **Introduction:** Pharmacology deals with the study of drugs. Pharmacologists study the effects of drugs on human body and develop new medications.
- o **Study Course:** For this career, a Bachelor of Studies (BS) degree in Pharmacy or Doctor of Pharmacy (D. Pharm) degree is required.

4. **Physiotherapy**

- o **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.
- o **Study Course:** To become a physiotherapist, 4 years BS degree in Physical Therapy or Physiotherapy is needed.

5. **Fisheries and Wildlife**

- o **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.

- o **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

- o **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.
- o **Study Course:** A 4-year BS degree in Agriculture is required.

7. Animal Husbandry

- o **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.
- o **Study Course:** For it, students can pursue a 4-year BS degree in Animal Husbandry.

8. Horticulture

- o **Introduction:** It deals with the art of gardening. Horticulturists cultivate fruits, vegetables, flowers, and ornamental plants.
- o **Study Course:** A 4-year BS degree in Horticulture is required for it.

9. Forestry

- o **Introduction:** It deals with improvement and management of forests and wildlife. Foresters manage and conserve forests and wildlife.
- o **Study Course:** A 4-year BS degree in Forestry is necessary.

10. Farming

- o **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.
- o **Study Course:** A 4-year BS degree in Agriculture or specific farming courses are required for this profession.

11. Biotechnology

- o **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.
- o **Study Course:** A 4-year BS degree in Biotechnology is required for this.

12. Forensics

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

Career	Major Jobs
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.

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

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

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

"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.

"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.

"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

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

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

- o **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

- o **Introduction:** Climate change requires collaboration among many disciplines, such as atmospheric science, ecology, economics, and sociology.
 - 3. **Medical Research**
 - o **Introduction:** Advances in medical research often rely on interdisciplinary collaboration.
 - o **Role:** For example, cancer research involves oncologists (cancer consultants), biologists, biochemists, geneticists, pharmacologists, and statisticians.
 - 4. **Robotics and Artificial Intelligence (AI)**
 - o **Introduction:** The field of robotics and AI is highly interdisciplinary. It involves computer science, engineering, mathematics, neuroscience, and psychology.
 - o **Role:** This collaboration has led to significant advancements in robotic systems, autonomous vehicles, machine learning and natural language processing.
 - 5. **Space Exploration**
 - o **Introduction:** Organizations like NASA and the International Space Station (ISS) involve scientists from various fields, including astrophysics, planetary science, engineering, biology and medicine.
 - o **Role:** These collaborations enable scientists to investigate the cosmos.
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Scientific Method

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

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.
 - o **a. Qualitative Observations:** It involve characteristics that cannot be measured with numbers.
 - **Example:** Describing the colour and texture of a flower.
 - o **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:**
 - o It is a proposed statement to answer the problem.
 - o It always matches with the available observations.
 - o It can be tested through experiments.
 - o 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?

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.

Figure 1.4: Scientific Method

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.

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

- o 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

- o 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.
- o **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

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

4. Deduction

- o 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

- o **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.
- o **Experimental and Control Group:** In these experiments, the malarial patients were the experimental group, while the healthy persons were the control group.
- o **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.
- o 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

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

2. Observations

- o Biologists were having following observations;
 - Malaria is associated with marshes.
 - Drinking water of marshes did not cause malaria.
- o When biologists noted these observations, they thought that *Plasmodium* was not in the marsh water.
- o **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

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

4. Deduction

- o 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.

- o **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.
- o **Experiment on Man:**
 - i. He allowed a female *Anopheles* mosquito to bite a malarial patient. He killed this mosquito and found *Plasmodium* multiplying in its stomach.
 - ii. 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.
- o **Experiment on Sparrows:**
 - i. 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.
 - ii. 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 *Plasmodium* in it.
- o **Result:** So, it proved the hypothesis; "*Mosquitoes transmit Plasmodium*". So, mosquitoes are involved in the spread of malaria.
- o **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)

1. Which branch of Biology focuses on the study of the structure and function of cells?
 - o (a) Cytology
 - o (b) Microbiology
 - o (c) Histology
 - o (d) Ecology
2. The study of the processes of heredity and variation in living organisms is known as:
 - o (a) Ecology
 - o (b) Genetics
 - o (c) Anatomy
 - o (d) Proteomics
3. Insulin made through bacteria is an example of the technique of:
 - o (a) Parasitology
 - o (b) Biotechnology
 - o (c) Biochemistry
 - o (d) Histology
4. Heart pumps, the brain memorizes, kidneys excrete. The statement comes from:
 - o (a) Physiology
 - o (b) Anatomy
 - o (c) Morphology
 - o (d) Cardiology
5. Which branch of Biology involves the study of the classification of organisms?
 - o (a) Taxonomy
 - o (b) Physiology
 - o (c) Palaeontology
 - o (d) Biogeography
6. Which step comes between making hypothesis and doing experiments?
 - o (a) Making deductions
 - o (b) Making observations
 - o (c) Summarizing results
 - o (d) Analysing data
7. Which of the following is NOT a characteristic of the scientific method?
 - o (a) It relies on evidence
 - o (b) It involves formulating hypotheses
 - o (c) Hypothesis will always be correct
 - o (d) It requires rigorous testing
8. The branch which deals with the study of cell division is called:
 - o (a) Physiology
 - o (b) Histology
 - o (c) Cell biology
 - o (d) Entomology
9. The branch deals with the study of the interrelationship of organisms and their environment is called:
 - o (a) Biotechnology
 - o (b) Molecular biology
 - o (c) Entomology
 - o (d) Environmental biology
10. Into how many major divisions biology is divided?

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

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

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

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

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

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

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

14. Study of insects is called:

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

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

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

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

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

Relation of Biology with other Sciences

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

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

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

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

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

- o (a) Social biologist

- o (b) Taxonomist
- o (c) Biogeographer
- o (d) Palaeontologist

20. Which of the following best describes the field of biotechnology?

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

21. Which field applies computer technology to biological research?

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

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

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

Careers in Biology

23. The new emerging careers of biology include:

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

24. What does MBBS stand for?

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

25. What does the field of forensic science involve?

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

26. What is the role of horticulturist?

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

Quranic Instructions to Reveal the Study of Life

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

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

Science as Collaborative Field

28. Human Genome project was completed in:

- o (a) 2000

- o (b) 2001
- o (c) 2002
- o (d) 2003

Scientific Method

29. The starting point of scientific investigation is:

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

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

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

31. Which of the following statements best distinguishes hypotheses from theories in science?

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

32. You are doing a control experiment which:

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

33. A good hypothesis must be:

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

34. A well-substantiated explanation of hypothesis is called:

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

35. Five senses are involved in:

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

36. The logical consequences of hypothesis are:

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

37. Number of steps of biological method are:

- o (a) Seven
- o (b) Six

- o (c) Two
 - o (d) Eight
38. The scientific method in which biological problems are solved is termed as:
- o (a) Physical method
 - o (b) Biological method
 - o (c) Chemical method
 - o (d) Statistical method
39. Deductions are drawn from:
- o (a) Experiments
 - o (b) Hypothesis
 - o (c) Theory
 - o (d) Law
40. In biological method the next step of hypothesis is called:
- o (a) Deduction
 - o (b) Observation
 - o (c) Result
 - o (d) Experiment
41. The scientific method in biology starts with:
- o (a) Hypothesis
 - o (b) Recognition of a problem
 - o (c) Analysis of results
 - o (d) Deduction
42. Following are the characteristics of a good hypothesis, EXCEPT:
- o (a) Should be a complex statement
 - o (b) Should be a tentative idea
 - o (c) Should be testable
 - o (d) Should agree with available observations
43. Which of the following best describes the logic of the scientific process?
- o (a) If I generate a testable hypothesis, tests and observations will support it
 - o (b) If my prediction is correct, it will lead to a testable hypothesis.
 - o (c) If my observations are accurate, they will support my hypothesis
 - o (d) If my hypothesis is correct, I can expect certain test result

Malaria - an Example of Biological Method

44. Malaria is caused by:
- o (a) Mosquito
 - o (b) Stagnant water
 - o (c) Swamp
 - o (d) Plasmodium
45. 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?
- o (a) *Plasmodium* are dead
 - o (b) *Plasmodium* are in incubation period
 - o (c) *Plasmodium* are not mature
 - o (d) *Plasmodium* are inactive
46. A.F.A King listed observations:
- o (a) 10
 - o (b) 20
 - o (c) 30

- o (d) 40

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

Malaria in humans	Malaria in birds	Dengue fever
(a) Anopheles	Aedes	Culex
(b) Aedes	Culex	Anopheles
(c) Anopheles	Culex	Aedes
(d) Culex	Anopheles	Aedes

48. Who performed experiments on sparrow?

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

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

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

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

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

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	a	2	b	3	b	4	a	5	a
6	a	7	c	8	c	9	d	10	a
11	c	12	b	13	a	14	b	15	c
16	b	17	c	18	a	19	c	20	c
21	c	22	c	23	a	24	a	25	b
26	b	27	c	28	d	29	c	30	b
31	a	32	b	33	c	34	d	35	b

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1				3					
3	b	37	b	3	b	39	b	40	a
6				8					
4	b	42	a	4	d	44	d	45	b
1				3					
4	b	47	c	4	a	49	b	50	d
6				8					

Short Answer Questions (Exercise)

Q.1 Define the following branches of biology:

- (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?

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?

Ans.

Medicine and Surgery

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.

Animal Husbandry

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.

Ans.

Morphology

Definition: The study of the size, shape and structure of animals, plants and microorganisms is called morphology. This branch is also called external morphology.

Physiology

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

Example: Morphology of a flowering plant includes the structure of roots, stem, leaves, flowers and fruits.

Example: Circulatory system transports vital substances throughout the body.

Q.5 What is computational biology?

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

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.

Q.7 Differentiate between zoology and botany.

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:

- (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.

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.

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

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.

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."

Ans.

Qualitative Observations

- i. Colour of cat
- ii. Shape of leaves
- iii. Climate of desert
- iv. Song of a bird

Quantitative Observations

- i. Height of giraffe
- ii. Weight of mango fruit
- iii. Body temperature of birds
- iv. Volume of blood in humans
- v. Speed of tiger

Q.12 Differentiate between qualitative and quantitative observations.

Ans.

Qualitative Observations

- i. These involve characteristics that cannot be measured with numbers.
- ii. These are less accurate.

Quantitative Observations

- i. These involve measurements or numerical data that can be expressed in terms of quantity.
- ii. These are more accurate.

Qualitative Observations

Example: Colour of parrot.

Quantitative Observations

Example: Height of a human.

Q.13 Differentiate between theory and principle.

Ans.

Theory

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.

Principle

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?

Ans.

Characteristics of 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.

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

Ans.

Control 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 CO₂ to the plants as normal.

Experimental Group

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 CO₂ to plant to check its effect.

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

- (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?

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?

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.

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.

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