Freebooks.pk

Free Notes • Past Papers • Guides for Students

Biology Class 9 — Punjab Board (PECTAA)

CHAPTER 1

The Science of Biology

Key Concepts · Definitions · Short & Long Questions · MCQs · Diagrams · Exam Tips

© freebooks.pk — Original educational content

Free notes: freebooks.pk

Chapter 1: The Science of Biology

Chapter 1 of the new Biology Class 9 book (Punjab, 2025-26 edition) is an introduction to biology as a science. It explains what biology studies, how the subject is split into fields and branches, how it overlaps with physics, chemistry, mathematics, geography, economics and computing, and which careers are open to students who continue with biology after matric.

The second half of the chapter is about how biologists actually find things out. It walks through the scientific method step by step, separates the ideas of hypothesis, theory and law, and then shows the whole method in action through the story of how scientists worked out the cause of malaria and how it spreads. These notes summarise each part in simple language, add a few memory aids, and finish with practice questions and MCQs written for revision.

Learning Objectives

- Define biology and name its three major fields.
- Describe the main branches of biology and what each one studies.
- Explain how biology connects with other sciences such as chemistry, physics, mathematics and geography.
- List career options for students of biology and the degree each needs.
- Recall the Quranic verses quoted in the chapter that point towards the study of life.
- Give examples showing that modern science is a team effort across different fields.
- Describe the steps of the scientific method and use the terms hypothesis, deduction, theory and law correctly.
- Explain the malaria investigation as a worked example of the biological method.

Key Concepts

1.1 Biology and Its Major Fields

Biology is the science of life. The name joins two Greek words: bios, meaning life, and logos, meaning study. Biologists look at how living things are built, how they work and how they interact with each other and with their surroundings. Knowledge of biology is used to solve problems of health, food supply and the environment.

Because life is so varied, biology is divided into three major fields. Zoology deals with animals, botany deals with plants, and microbiology deals with microorganisms such as bacteria and microscopic fungi, including their effect on health and the environment.

1.1 Branches (Sub-fields) of Biology

Structure-based branches: morphology looks at the form and outward appearance of organisms as well as their organs; anatomy looks at internal structure, especially of the human body; histology is the microscopic study of tissues; cytology is the study of cells and cell division.

Function and development branches: physiology studies how body parts work, for example how

blood carries materials around the body; embryology follows the development of an organism from the fertilised egg; genetics studies how characteristics pass from parents to offspring; molecular biology studies biological molecules such as carbohydrates, proteins, lipids and nucleic acids.

Diversity and environment branches: taxonomy classifies organisms into groups on the basis of similarities and differences; palaeontology studies fossils to understand the history of life; ecology studies how organisms relate to their environment; marine biology studies life in the oceans.

Health-related branches: pathology studies diseases, their causes and effects; immunology studies the immune system and how it defends the body; pharmacology studies drugs and their effects, which helps in developing new medicines such as antibiotics.

1.2 Relation of Biology with Other Sciences

Living things obey the same chemical and physical rules as non-living matter, so biology overlaps with many other subjects. Biochemistry studies the chemical substances and reactions inside living things, such as the reactions of photosynthesis and respiration. Biophysics applies physics to life, for example using the principles of levers to explain how bones, joints and muscles move.

Computational biology uses mathematical models, algorithms and computer simulations to handle biological data, for example the order of amino acids in a protein. Biostatistics applies statistics to biological and health data. Biogeography studies where living things are found across the world and how climate change shifts their distribution.

Biotechnology uses living organisms or their parts to make useful products, the classic example being bacteria engineered to make human insulin for diabetic patients. Bio-economics looks at living things from an economic angle, such as working out the cost and profit of developing a new crop variety.

1.3 Careers in Biology

After FSc with biology, students can enter medicine and surgery (5-year MBBS), dentistry (4-year BDS), pharmacy (BS Pharmacy or Pharm-D), physiotherapy (4-year BS) and veterinary medicine. These careers focus on diagnosing and treating disease in humans or animals.

Other careers include agriculture, horticulture (fruits, vegetables and ornamental plants), forestry, animal husbandry (breeding and caring for livestock), fisheries and wildlife, and farming. Science-based options include biotechnology, forensic science (analysing evidence from crime scenes), microbiology, genetic counselling, nutrition and dietetics, public health, biomedical engineering and bioinformatics.

1.4 Quranic Instructions about the Study of Life

The chapter quotes verses that invite people to reflect on life. Surah Al-Anbiya (21:30) states that every living thing was made from water; biologists note that most organisms are 60 to 90 percent water. Surah Ar-Rahman (55:14) mentions the creation of man from clay like that of pottery.

Surah Al-Mu'minun (23:14) describes the stages of human development in the womb, from a drop to a clot, to a lump, to bones and then flesh covering the bones. Surah An-Nur (24:45) says that Allah created every animal from water and that some creep on their bellies, some walk on two legs and some on four. The book presents these verses as encouragement to study and think about

living things.

1.5 Science as a Collaborative Field

Big scientific problems are now solved by teams in which each member brings expertise from a different discipline. Working together lets the team check each other's ideas and reach answers faster.

Examples given in the chapter: the Human Genome Project, completed in 2003, which mapped the full human DNA sequence using molecular biologists, geneticists and computer scientists; climate change research, which joins atmospheric science, ecology, economics and sociology; cancer research, which needs oncologists, biochemists, geneticists, pharmacologists and statisticians; robotics and artificial intelligence; and space exploration programmes, which combine engineers, physicists, biologists and doctors.

1.6 The Scientific (Biological) Method

The scientific method is the set of steps scientists follow when they investigate a question; when it is used in biology it is often called the biological method. The steps are: recognising a problem, making observations, forming a hypothesis, making a deduction, testing by experiment, and then analysing and reporting the results.

Observations are made with the senses and by reading earlier research. Qualitative observations describe qualities such as colour or texture and cannot be counted; quantitative observations are measurements or counts, such as the number of birds in a tree, and are more reliable because they can be recorded exactly.

A hypothesis is a possible, testable answer to the problem that fits the observations; it must be possible to prove it wrong. A deduction is the logical consequence of a hypothesis, usually written as an if-then statement. Experiments test the deductions: they need an experimental group, which receives the condition being tested, and a control group, which is kept the same in every way except for that condition. Results are analysed, often with statistics and graphs, and shared through reports, journals and conferences.

1.7 Hypothesis, Theory and Law

When a hypothesis survives repeated experiments and is used to make further successful predictions, it becomes a theory: a well-supported explanation backed by a large amount of evidence from many researchers. The theory of evolution by natural selection is an example.

Scientists keep testing theories and try to disprove them. A theory that is confirmed again and again until it is accepted as a constant pattern of nature is called a law or principle. Mendel's laws of inheritance and the Hardy-Weinberg law are examples of laws in biology.

1.8 Malaria: The Biological Method in Action

Problem 1 was the cause of malaria. Doctors knew that malaria was linked with marshy areas, that quinine treated it, and that drinking marsh water did not cause it. In 1880 the French army doctor Alphonse Laveran saw tiny organisms, later named Plasmodium, in the blood of malaria patients.

Free notes: freebooks.pk

The hypothesis was that Plasmodium causes malaria; the deduction was that if this is true, malaria patients should carry Plasmodium in their blood. Blood tests comparing patients (experimental group) with healthy people (control group) supported the hypothesis.

Problem 2 was how Plasmodium enters human blood. In 1883 the American doctor A. F. A. King listed observations such as: people who slept outdoors caught malaria more often, people under fine nets caught it less, and people sleeping near smoky fires rarely caught it. He proposed that mosquitoes carry Plasmodium. The deduction was that if this is true, Plasmodium should be found inside mosquitoes.

Ronald Ross, a British army doctor in India, tested this in 1897-1898. He found Plasmodium developing in the stomach of a mosquito that had fed on a malaria patient, and then used birds to avoid risking human lives: Culex mosquitoes that fed on infected sparrows carried the parasite to their salivary glands and passed malaria to healthy sparrows. In 1898 Italian scientists confirmed the same in humans using Anopheles mosquitoes. Together these results established that mosquitoes transmit malaria.

Important Definitions

Biology
The scientific study of living things: their structure, functions, development and interactions.

Zoology
The major field of biology that studies animals.

Botany
The major field of biology that studies plants.

Microbiology
The major field of biology that studies microorganisms such as bacteria and microscopic fungi.

Morphology
The study of the form, shape and outward features of organisms and their organs.

Anatomy
The study of the internal structure of organisms, especially the human body.

Physiology
The study of how the parts of a living body work.

Histology
The microscopic study of tissues.

Cytology
The study of cells, their organelles and cell division.

Embryology
The study of how an organism develops from a fertilised egg.

Genetics
The study of how characteristics are passed from parents to offspring.

Palaeontology
The study of fossils, the preserved remains or traces of ancient organisms.

Taxonomy
The branch that names and classifies organisms into groups based on similarities and differences.

Ecology
The study of the relationships between organisms and their environment.

Pathology
The study of diseases, their causes and their effects.

Immunology
The study of the immune system and its role in defending the body.

Pharmacology
The study of drugs and their effects on the body.

Hypothesis
A tentative, testable answer to a scientific problem that agrees with the available observations.

Deduction
A logical prediction drawn from a hypothesis, usually in the form of an if-then statement.

Theory
A hypothesis that has been supported by many experiments and a large body of evidence.

Law (principle)
A theory that has been confirmed so many times that it is accepted as a constant pattern of nature.

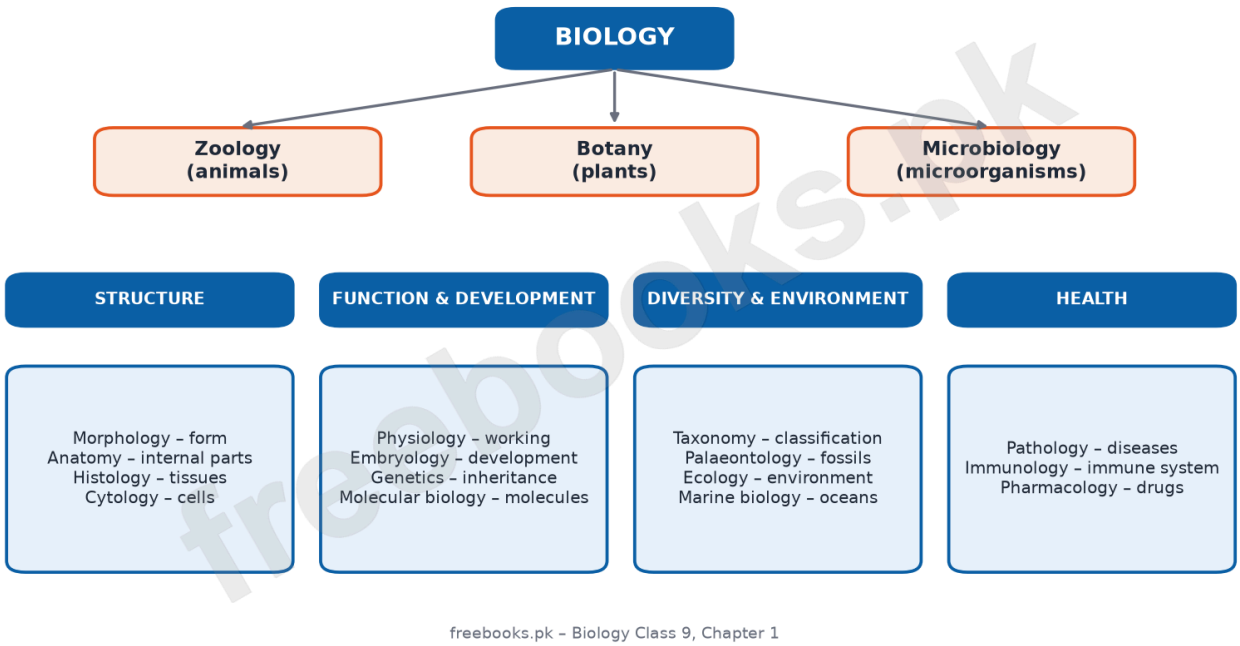
Control group
The group in an experiment that is kept under normal conditions for comparison with the experimental group.

Key Facts at a Glance

Topic	Key point
Origin of the word biology	bios = life, logos = study (Greek)
Three major fields	Zoology, Botany, Microbiology
Cells in the human body	More than 30 trillion
Oldest known fossil	A cyanobacterium, about 3.5 billion years old
Water in organisms	About 60% to 90% of body mass
Human Genome Project	Completed in 2003
Steps of scientific method	Problem → Observation → Hypothesis → Deduction → Experiment → Results
Hypothesis → Theory → Law	Each stage needs more repeated experimental support
Plasmodium seen in blood	Laveran, 1880
Mosquito hypothesis	A. F. A. King, 1883 (20 observations)
Mosquito transmission shown	Ronald Ross, 1897-1898 (Culex and sparrows)
Human malaria vector	Female Anopheles mosquito
Dengue vector	Aedes mosquito
Insulin from bacteria	Example of biotechnology

Diagrams

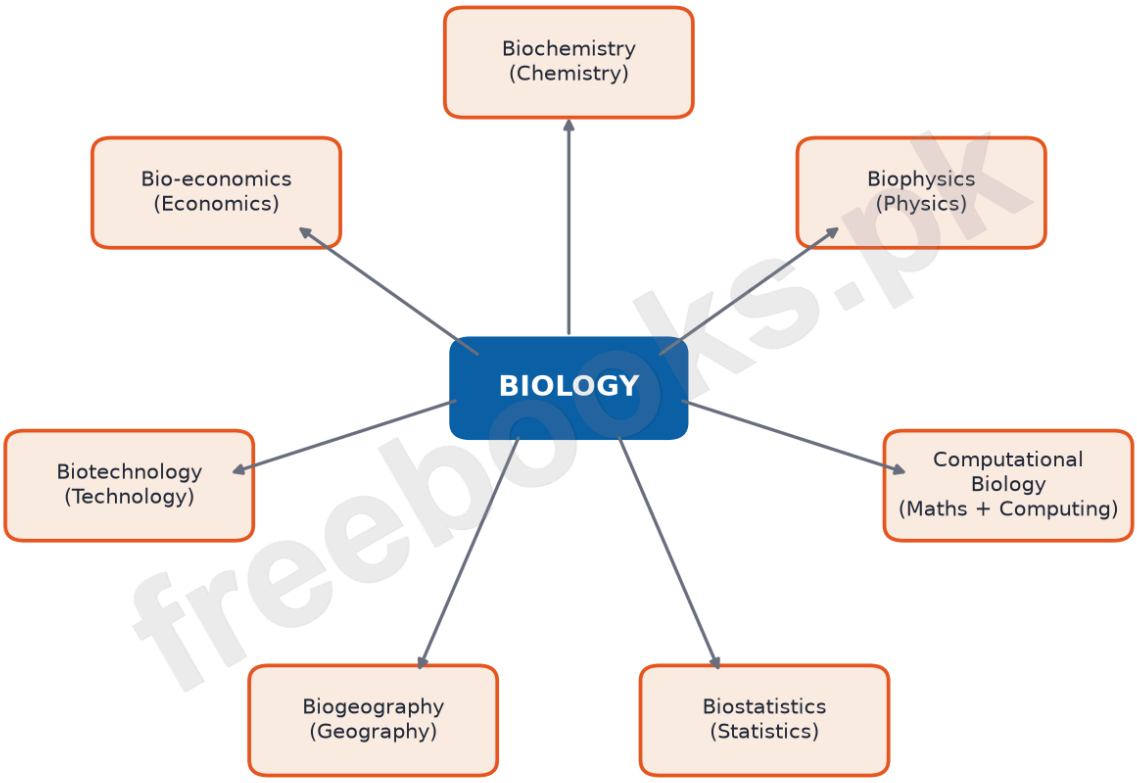
Fields and branches of biology: A map placing the three major fields at the top and grouping the main branches by what they study: structure, function and development, diversity and environment, and health.



Biology and other sciences: A hub diagram showing the interdisciplinary fields formed when biology meets chemistry, physics, mathematics and computing, statistics, geography, technology and economics.

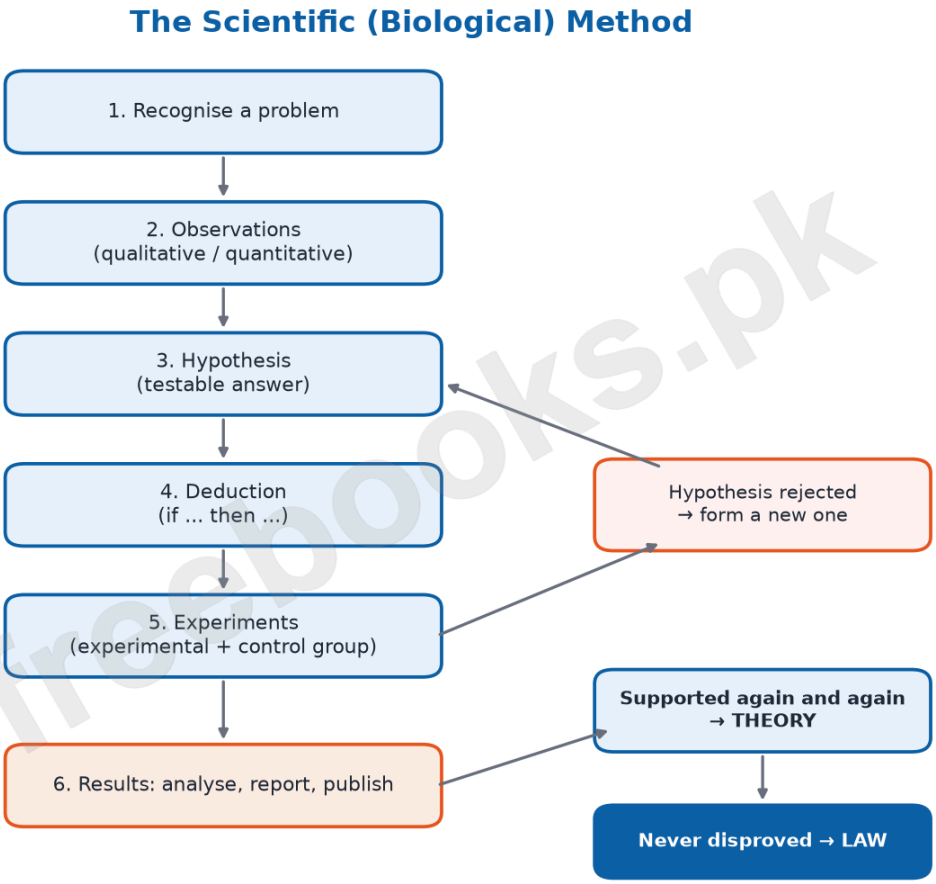
freebooks.pk

Biology and Other Sciences

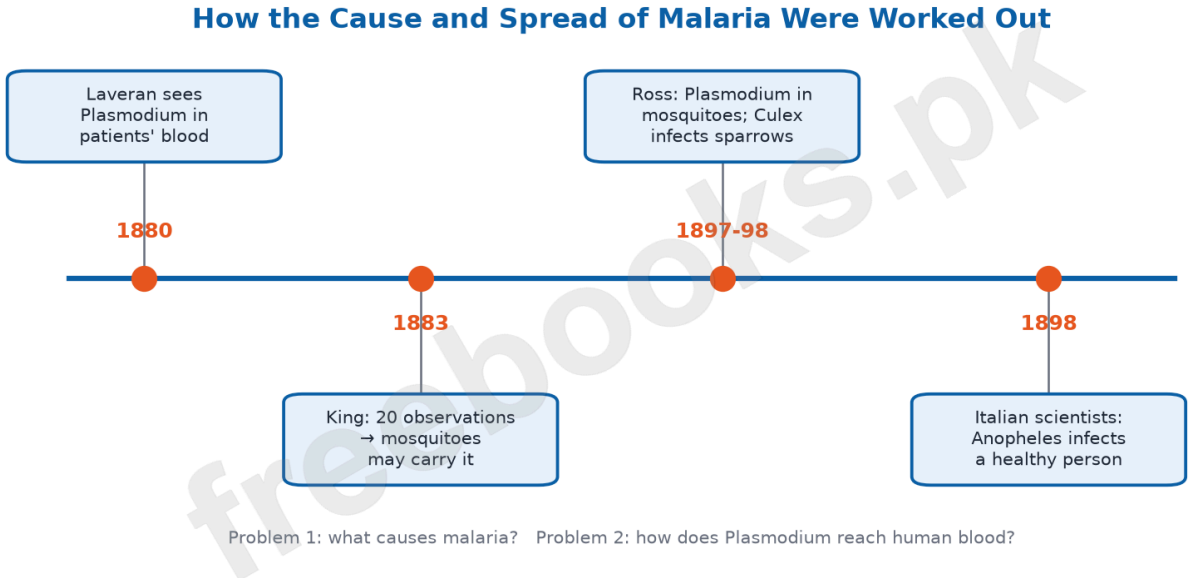


Flowchart of the scientific method: The steps from recognising a problem to reporting results, including what happens when a hypothesis is rejected and how a supported hypothesis can grow into a theory and then a law.

freebooks.pk



Timeline of the malaria investigation: Key observations and experiments from Laveran's discovery of Plasmodium to the confirmation of mosquito transmission in humans.



Short Questions and Answers

Why is biology called the science of life?

Because it studies everything about living things: how they are built, how their bodies work, how

freebooks.pk

they grow and reproduce, and how they interact with each other and their environment.

Name the three major fields of biology with one example of what each studies.
Zoology studies animals (for example the behaviour of birds), botany studies plants (for example how a seed germinates) and microbiology studies microorganisms (for example bacteria that cause disease).

How does anatomy differ from morphology?
Morphology looks at the overall form and outward appearance of an organism, while anatomy examines its internal structure, such as the arrangement of organs inside the body.

How are histology and cytology related but different?
Both are studied with a microscope. Cytology focuses on individual cells and their organelles, while histology studies tissues, which are groups of similar cells working together.

Which branch would study a newly found dinosaur bone, and why?
Palaeontology, because it studies fossils, the preserved remains of organisms that lived long ago, to understand the history of life.

Give one example each of biochemistry and biophysics.
Biochemistry: studying the chemical reactions of photosynthesis or respiration. Biophysics: using the principle of levers to explain how bones and muscles produce movement.

What does a computational biologist do?
A computational biologist uses mathematical models, computer programs and simulations to analyse biological data, such as the sequence of amino acids in a protein.

Why is insulin production by bacteria called biotechnology?
Because it uses living organisms (bacteria) to manufacture a useful product (human insulin) for medical treatment, which is exactly what biotechnology means.

How is a veterinary doctor's work different from animal husbandry?
A veterinary doctor diagnoses and treats diseases of animals, while animal husbandry is about breeding, feeding and caring for livestock to improve their quality and productivity.

Why is science described as a collaborative field?
Because complex problems such as mapping the human genome or understanding climate change need experts from several disciplines who share data, check each other's ideas and combine their skills.

What is the difference between qualitative and quantitative observations?
Qualitative observations describe qualities such as colour, smell or texture. Quantitative observations are numerical, such as length, mass or a count, and are more reliable because they can be measured and recorded exactly.

List the characteristics of a good hypothesis.
It proposes an answer to the problem, agrees with the observations already made, can be tested by experiment, and can in principle be shown to be wrong.

Why is a control group needed in an experiment?
The control group shows what happens under normal conditions. Comparing it with the experimental group proves that any difference is caused by the factor being tested and not by something else.

Why did people who slept near smoky fires rarely get malaria?
Smoke drives mosquitoes away, so these people were bitten less often and the parasite had fewer chances to enter their blood.

Why did Ronald Ross use sparrows instead of humans?
Infecting healthy people with malaria on purpose would have been dangerous and unethical, so he used birds, which suffer from a similar malaria carried by Culex mosquitoes.

Long Questions and Answers

Describe the major fields and the main branches of biology.

What are the major fields of biology?

Biology has three major fields. Zoology covers animals, botany covers plants and microbiology covers microorganisms such as bacteria and microscopic fungi. Each field studies the structure, functions, reproduction and environment of its own group of organisms.

Which branches deal with the structure of organisms?

Morphology studies form and outward appearance, anatomy studies internal structure, histology studies tissues under the microscope and cytology studies cells and their organelles. Together they describe how a living body is built, from whole organs down to single cells.

Which branches deal with function, development and inheritance?

Physiology explains how organs work, embryology follows development from the fertilised egg, genetics explains how traits pass from parents to offspring and molecular biology studies biological molecules such as proteins and nucleic acids.

Which branches deal with diversity, environment and health?

Taxonomy classifies organisms, palaeontology studies fossils, ecology studies organisms and their environment and marine biology studies ocean life. Pathology, immunology and pharmacology deal with disease, the body's defences and medicines.

Explain the relationship of biology with other sciences, with examples.

Why does biology overlap with other sciences?

Living things are made of the same matter and follow the same physical and chemical rules as the

rest of nature. Their data can be measured, counted and modelled, so biology naturally borrows ideas and tools from chemistry, physics, mathematics, geography and economics.

How do biochemistry and biophysics link biology with chemistry and physics?

Biochemistry studies the chemicals and reactions inside living things, such as photosynthesis and respiration. Biophysics applies physical principles to life, for example treating bones and joints as levers to explain movement.

How do computational biology and biostatistics link biology with mathematics?

Computational biology uses models, algorithms and simulations to analyse large data sets such as protein or DNA sequences. Biostatistics applies statistical methods to biological and health data so that results can be judged reliably.

What are biogeography, biotechnology and bio-economics?

Biogeography studies the distribution of living things across regions and the effect of climate on it. Biotechnology uses organisms to make useful products such as insulin. Bio-economics weighs the costs and profits of biological projects such as new crop varieties.

Describe the steps of the scientific method.

How does a scientific investigation begin?

It begins when a scientist recognises a clear problem worth investigating, for example noticing that plants in one area grow taller than usual and asking what causes this. The problem then guides all later steps.

What role do observations play?

Observations collect information about the problem, using the senses and by reading earlier research. They can be qualitative, describing qualities, or quantitative, recording measurements; quantitative data are more reliable because they can be checked exactly.

How are a hypothesis and a deduction formed?

From the observations, the scientist proposes one or more hypotheses, which are possible answers that can be tested. A deduction is then drawn from each hypothesis as an if-then prediction, for example: if iron shortage causes yellow leaves, adding iron to the soil should make the leaves green again.

How are experiments and results handled?

Experiments test the deductions using an experimental group and a control group that differ only in the factor being tested. Hypotheses that fail are rejected and the supported one is tested further. Results are analysed with tables, graphs and statistics, then reported in journals and at conferences so other scientists can check them.

Distinguish between hypothesis, theory and law.

What is a hypothesis?

A hypothesis is a tentative explanation proposed to answer a specific problem. It is based on

observations, can be tested by experiments and may turn out to be wrong.

How does a hypothesis become a theory?

When repeated experiments support a hypothesis and it successfully predicts new results, it becomes a theory. A theory is backed by a large amount of evidence gathered by many researchers, such as the theory of evolution by natural selection.

How does a theory become a law?

Scientists keep testing theories and try to disprove them. If a theory holds true again and again without exception, it is accepted as a law or principle, a constant pattern of nature, such as Mendel's laws of inheritance or the Hardy-Weinberg law.

Explain how biologists discovered the cause of malaria and how it spreads.

What was known about malaria before the experiments?

By the late nineteenth century doctors knew that malaria was linked with marshy areas, that quinine was an effective treatment and that drinking marsh water did not cause the disease. In 1880 Laveran saw a microorganism, later named Plasmodium, in the blood of patients.

How was Plasmodium shown to cause malaria?

Biologists proposed that Plasmodium causes malaria and deduced that patients should carry it in their blood. Blood from malaria patients and from healthy people was compared under the microscope; Plasmodium was found in the patients, supporting the hypothesis.

How did King link malaria with mosquitoes?

In 1883 A. F. A. King noted that people sleeping outdoors fell ill more often, while people under fine nets or near smoky fires were protected. All of these point to an insect that bites at night, so he proposed that mosquitoes carry Plasmodium.

How did Ross and later workers prove mosquito transmission?

Ross found Plasmodium developing inside mosquitoes that had fed on patients. Using sparrows, he showed that Culex mosquitoes picked up the parasite from sick birds, carried it to their salivary glands and infected healthy birds. In 1898 Italian scientists showed the same in humans with Anopheles mosquitoes.

Multiple Choice Questions (MCQs)

A student examines a thin slice of a leaf under a microscope to see how its tissues are arranged. This work belongs to: (A) Histology (B) Ecology (C) Taxonomy (D) Embryology
Correct answer: (A) Histology. Histology is the microscopic study of tissues.

Which branch would explain how the kidneys filter blood? (A) Morphology (B) Physiology (C) Palaeontology (D) Taxonomy
Correct answer: (B) Physiology. Physiology deals with how body parts and organs work.

Studying why some children inherit their parents' eye colour is part of: (A) Immunology

(B) Genetics (C) Pharmacology (D) Cytology
Correct answer: (B) Genetics. Genetics studies the transfer of characteristics from parents to offspring.

Using the principle of levers to explain the movement of the forearm is an example of: (A) Biochemistry (B) Biophysics (C) Biogeography (D) Bio-economics
Correct answer: (B) Biophysics. Biophysics applies physical principles to living systems.

A scientist predicts how rising temperatures will change where a bird species lives. This falls under: (A) Biogeography (B) Histology (C) Embryology (D) Pathology
Correct answer: (A) Biogeography. Biogeography studies the distribution of organisms and how climate affects it.

Which degree is needed to become a dentist in Pakistan? (A) MBBS (B) BDS (C) Pharm-D (D) BS Forestry
Correct answer: (B) BDS. Dentists complete the 4-year Bachelor of Dental Surgery (BDS).

A testable, possible answer to a scientific problem is called a: (A) Law (B) Theory (C) Hypothesis (D) Result
Correct answer: (C) Hypothesis. A hypothesis is a tentative answer that can be tested.

'If iron shortage causes yellow leaves, then adding iron will make them green.' This statement is a: (A) Observation (B) Deduction (C) Law (D) Control
Correct answer: (B) Deduction. Deductions are if-then predictions drawn from a hypothesis.

Counting the number of seeds in a pod is a: (A) Qualitative observation (B) Quantitative observation (C) Hypothesis (D) Theory
Correct answer: (B) Quantitative observation. It produces a number, so it is a quantitative observation.

In an experiment on the need for light in photosynthesis, the plant kept in normal light is the: (A) Experimental group (B) Control group (C) Hypothesis (D) Variable group
Correct answer: (B) Control group. The control group stays under normal conditions for comparison.

Mendel's laws of inheritance are examples of: (A) Hypotheses (B) Deductions (C) Scientific laws (D) Observations
Correct answer: (C) Scientific laws. They have been confirmed repeatedly and are accepted as laws.

Who first saw Plasmodium in the blood of malaria patients? (A) Ronald Ross (B) A. F. A. King (C) Alphonse Laveran (D) Gregor Mendel
Correct answer: (C) Alphonse Laveran. Laveran observed the parasite in patients' blood in 1880.

Ronald Ross showed malaria transmission in sparrows using which mosquito? (A) Aedes

(B) Culex (C) Anopheles (D) Housefly
Correct answer: (B) Culex. Bird malaria is carried by Culex mosquitoes; human malaria by Anopheles.

Which mosquito spreads dengue fever? (A) Aedes (B) Culex (C) Anopheles (D) None of these
Correct answer: (A) Aedes. Dengue is transmitted by the Aedes mosquito.

The Human Genome Project is a good example of: (A) Science as a collaborative field (B) A single scientist's work (C) Palaeontology (D) Bio-economics
Correct answer: (A) Science as a collaborative field. It joined molecular biologists, geneticists and computer scientists.

Quick Revision Summary

- Biology = study of life (bios + logos). Major fields: zoology, botany, microbiology.
- Structure branches: morphology, anatomy, histology, cytology. Function/development: physiology, embryology, genetics, molecular biology.
- Diversity/environment: taxonomy, palaeontology, ecology, marine biology. Health: pathology, immunology, pharmacology.
- Interdisciplinary fields: biochemistry, biophysics, computational biology, biostatistics, biogeography, biotechnology, bio-economics.
- Careers: MBBS (5 yr), BDS (4 yr), Pharm-D/BS Pharmacy, physiotherapy, agriculture, horticulture, forestry, animal husbandry, biotechnology, forensics and more.
- Scientific method: problem → observations → hypothesis → deduction → experiments (experimental + control group) → results and reporting.
- Hypothesis (testable guess) → theory (well-supported) → law (confirmed again and again).
- Malaria: Laveran found Plasmodium (1880); King linked mosquitoes (1883); Ross proved transmission with Culex and sparrows (1897-98); confirmed in humans with Anopheles (1898).

Exam Tips

- Learn the branches in four groups (structure, function, diversity, health); it is much easier than memorising a list of fifteen names.
- When a question gives an example and asks for the branch, look for the key word: tissue = histology, fossil = palaeontology, drug = pharmacology, classification = taxonomy.
- Always write a deduction as an if-then sentence; examiners look for that pattern.
- In the malaria example, keep the two problems separate: Problem 1 is the cause (Plasmodium), Problem 2 is the carrier (mosquito).
- Remember the mosquito pairs: Anopheles → human malaria, Culex → bird malaria, Aedes → dengue.
- For hypothesis vs theory vs law, write one line on each and give one example of a theory and one of a law.

Note on Facts

Some printed sources give 1878 for Laveran's discovery and the 1880s for Ross's mosquito work. The commonly cited dates are 1880 for Laveran and 1897-1898 for Ross, and these notes use those dates. If your teacher or board key uses the textbook's dates, follow them in the exam.