

# **BIOLOGY**

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## **1. What is Science?**

- Science helps us **explore the mysteries** of the natural world.
  - It is a **systematic way** of learning about nature.
  - We use **observation** and **experimentation** to understand how things work.
  - It helps us find **facts and explanations** through careful study.
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## **2. Biology and Its Branches**

- **Biology** is the science of **life**.
  - The word “Biology” comes from two Greek words:
    - “**Bios**” meaning **life**
    - “**Logos**” meaning **study**
  - Biology studies the **structure, functions, and interactions** of living organisms.
  - It helps us understand important issues related to **health, food, and the environment**.
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## **3. Major Branches of Biology**

1. **Zoology**
    - Study of **animals**, their **structure, functions, behavior, and diversity**.
  2. **Botany**
    - Study of **plants**, including their **structure, growth, reproduction**, and how they interact with the **environment**.
  3. **Microbiology**
    - Study of **microscopic organisms** like **bacteria and fungi**.
    - Focuses on their **structure, functions, habitats, reproduction**, and their effects on **health** and the **environment**.
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### **Branches & Sub-fields of Biology**

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#### **4. Morphology**

- Study of the **form and structure** of organisms.
  - Includes **external features** (shape, color, pattern) and **internal organs**.
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5. **Anatomy**

- Study of the **internal body structure**, especially in **humans**.
  - Helps in **diagnosing diseases**, developing **medical tools**, and improving **life quality**.
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6. **Physiology**

- Focuses on the **functions of body parts**.
  - Example: How the **blood circulatory system** delivers nutrients and oxygen.
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7. **Histology**

- **Microscopic study of tissues** (groups of similar cells).
  - Important for **disease diagnosis**, **drug testing**, and understanding **organ function**.
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8. **Cytology**

- Study of **cells**, the basic units of life.
  - Includes **cell structure**, **functions**, and **division**.
  - The human body has over **30 trillion cells**, each with unique roles.
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9. **Molecular Biology**

- Study of biological molecules like proteins, fats, sugars, and DNA.
- Helps in understanding life processes, making medicines, and creating genetically modified organisms.

10. **Embryology**

- Study of how a baby (organism) develops from a fertilized egg.
- Helps detect birth defects and improve treatments.

11. **Genetics**

- Study of how traits are passed from parents to children.
- Explains genetic diseases and helps in improving plants and animals.

12. **Palaeontology**

- Study of fossils (remains of ancient organisms).
- Tells us about how life evolved on Earth.
- Example: Dinosaur fossils show us about ancient reptiles.

13. **Taxonomy**

- Study of classifying living things based on similarities and differences.
- Helps organize species, discover new ones, and understand their relationships.

## 14. Ecology

**Definition:**

Ecology is the study of **how living things interact with each other and their environment.**

**Why it's important:**

- Helps protect biodiversity (variety of life)
  - Helps solve environmental problems
  - **Example:** The *food chain* shows how animals depend on each other for food and energy.
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## 15. Marine Biology

**Definition:**

Marine biology is the study of **life in oceans.**

**Why it's important:**

- Helps understand ocean life and new sea creatures
  - Helps in ocean conservation
  - **Example:** *Coral reefs* support many kinds of sea animals.
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## 16. Pathology

**Definition:**

Pathology is the study of **diseases, their causes, and effects.**

**Why it's important:**

- Helps doctors diagnose and treat diseases
  - **Example:** A pathologist studies how *cancer spreads* in the body.
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## 17. Immunology

**Definition:**

Immunology is the study of the **immune system and how it fights diseases.**

**Why it's important:**

- Helps develop vaccines
  - Helps treat immune system problems
  - **Example:** Vaccines help the body *fight viruses* like flu or COVID-19.
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## 18. Pharmacology

### Definition:

Pharmacology is the study of **drugs and how they affect the body**.

### Why it's important:

- Helps make new medicines
  - **Example:** *Antibiotics* are made to kill bacteria and treat infections.
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## 1.2 – Relation of Biology with Other Sciences (Simplified Notes)

### Definition:

Biology is connected to other sciences like Chemistry, Physics, Earth Science, Math, and Computer Science. These connections help us understand how living things work.

### Important Branches:

#### 19. Biochemistry

Study of chemicals and chemical reactions in living things.

**Example:** Photosynthesis and respiration.

#### 20. Biophysics

Use of physics rules to understand the body's movements.

**Example:** Study of how muscles and bones move using the lever principle.

#### 21. Computational Biology

Use of computers and math to study biological problems.

**Example:** Finding the order of amino acids in proteins.

#### 22. Biogeography

Study of where living things are found in the world.

**Example:** How climate change affects animal and plant locations.

#### 23. Biostatistics

Use of statistics to study living things and health.

**Example:** Analyzing data in research and public health.

#### 24. Biotechnology

Using living things to make useful products.

**Example:** Making insulin using bacteria for diabetes treatment.

#### 25. Bioeconomics

Study of biology from a business point of view.

**Example:** Calculating cost and profit of growing new crops.

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### 1.3 – Careers in Biology (Simplified Notes)

#### Definition:

Biology students can choose many careers after studying life sciences, especially after completing FSc (Pre-Medical).

#### Career Options:

##### 26. Medicine and Surgery

Doctors diagnose and treat diseases. Surgeons fix or remove damaged body parts.

**Requirement:** 5-year MBBS degree.

##### 27. Dentistry

Dentists care for teeth and mouth.

**Requirement:** 4-year BDS degree.

##### 28. Pharmacology

Pharmacologists study how medicines work.

**Requirement:** BS in Pharmacy or Doctor of Pharmacy (D. Pharm).

##### 29. Physiotherapy

Helps patients regain movement after injury or illness using exercises.

**Requirement:** 4-year BS in Physical Therapy.

##### 30. Fisheries and Wildlife

Study and manage fish and animals in nature.

**Requirement:** BS or MS in Zoology, Fisheries, or Aquaculture.

##### 31. Agriculture

Work to improve farming and crop production.

**Requirement:** 4-year BS in Agriculture.

##### 32. Animal Husbandry

Taking care of animals to improve their health and productivity.

**Requirement:** 4-year BS in Animal Husbandry.

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#### ✓ Important Points & Simple Definitions

##### 33. Horticulture

- Horticulture is the **growing of fruits, vegetables, flowers, and decorative plants.**
- A **4-year BS degree in Horticulture** is needed for this job.

##### 34. Forestry

- Forestry means to **protect and manage forests and wildlife.**
- A **4-year BS degree in Forestry** is required.

##### 35. Farming

- Farming includes **raising animals** and **growing crops** on farms.
- There are different farms: **animal farms, poultry farms, and fruit farms.**
- A **BS degree in Agriculture** or **farming courses** are needed.

### 36. Biotechnology

- Biotechnology means **using living things (like bacteria or cells)** to make useful products (like medicine or crops).
- A **4-year BS degree in Biotechnology** is needed.

### 37. Forensics

- Forensics is the **study of crime evidence** (like blood, hair, etc.) to help in investigations.
- A **4-year BS degree in Forensic Science** is needed.

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## ☑ 1.4 - Qur'anic Instructions to Reveal the Study of Life

The **Holy Qur'an** encourages humans to **think, observe, and reflect** on the creation of life. It tells us about the **origin and development** of living things.

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### 38. ☐ Verse on Origin of Life from Water:

**"We made every living thing from water."  
(Surah Al-Anbiya, Verse 30)**

#### ☐ Explanation:

This verse shows that **all living things were created from water**. Water is a **blessing from Allah** and is found in every living organism — about **60% to 90%** of their body.

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### 39. Verse on Creation of Humans from Clay:

**"He created man from clay like the potter."  
(Surah Ar-Rahman, Verse 14)**

#### ☐ Explanation:

This verse tells us that **humans were first made from clay**, which is a natural material. This hints at the **early stages** of human creation.

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### 40. Verse on Development Stages in the Womb:

**"Then We made the drop into a clot, then We made the clot into a lump, then We made the lump into bones, then We clothed the bones with flesh."  
(Surah Al-Mu'minoon, Verse 14)**

□ **Explanation:**

This verse clearly explains the **stages of human development** in the mother's womb — from a **drop of fluid** to a **fully formed human body**.

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**41. Verse on Evolution of Animals:**

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

□ **Explanation:**

This verse tells us that animals also came from water. Later, animals developed in different forms:

- Some **crawl** (like snakes)
- Some **walk on two legs** (like humans and birds)
- Some **walk on four legs** (like cows and lions)

This supports the idea of **common origin and diversity of animals**.

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□ **42 - Science as a Collaborative Field**

- Science needs **teamwork**.
- Scientists from **different subjects** work together to solve **big problems**.

**Examples of Collaboration:**

- **Human Genome Project**  
→ Scientists from biology, computer science, and genetics worked to **study all human genes**.
  - **Climate Change Research**  
→ Involves **weather experts, ecologists, economists**, etc.
  - **Medical Research**  
→ Needs help from **doctors, biologists, chemists, and data scientists**.
  - **Robotics & AI**  
→ Involves **computer experts, engineers, mathematicians, brain scientists**, etc.
  - **Space Exploration**  
→ NASA and ISS use knowledge from **physics, biology, and medicine** to study space.
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## 43 - Scientific Method (Biological Method)

Scientists use a fixed method to solve problems.

This method is called the **scientific method** (or **biological method** in biology).

### 44. Steps of the Scientific Method:

1. **Recognizing a Problem**  
→ Finding a question to study.  
*E.g.: Why are these plants growing taller?*
2. **Observation**  
→ Looking carefully at what is happening.
3. **Hypothesis**  
→ Making a smart guess or possible answer.
4. **Deduction**  
→ What should happen if your guess is true?
5. **Experiment**  
→ Testing the guess in real life.
6. **Results**  
→ Checking if your guess was correct or not.

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### Steps of the Biological Method

#### 45. Recognition of a Problem

- A scientist notices something unusual and asks a question.
- Example: Why are some plants growing taller than usual?

#### 46. Observations

- Scientists observe the problem using their five senses.
- **Qualitative Observations:** Describe qualities (e.g. color, shape).
- **Quantitative Observations:** Include numbers (e.g. height, amount).
- Quantitative data is more accurate because it can be measured.

#### 47. Hypothesis

- A **hypothesis** is a possible answer to the problem.
- It is based on observations and past knowledge.
- It can be tested and proven wrong.

#### 48. Deduction

- A **deduction** is a logical prediction based on the hypothesis.
- It uses an **if-then** statement.
- Example: *If iron is missing in the soil, then adding iron will help the plant grow better.*

#### 49. Experiment

- Scientists test the hypothesis through experiments.
- They use:
  - **Experimental group**: gets the special condition (e.g. no CO<sub>2</sub>).
  - **Control group**: normal condition (e.g. with CO<sub>2</sub>).
- The correct hypothesis is accepted; wrong ones are rejected.

#### 50. Results

- Data is collected and shown in charts or graphs.
  - Results are shared in reports, books, or scientific meetings.
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#### 51. Theory and Law

- A **theory** is a hypothesis that is tested and supported many times.
    - Example: Theory of Evolution.
  - A **law** (or principle) is a theory proven again and again without change.
    - Example: Mendel's Laws of Inheritance.
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#### 52. Example: Malaria – Use of Biological Method

**Problem:** What causes malaria?

**Observations:**

- Quinine treats malaria.
- Malaria is found near marshy areas.
- Marsh water does not cause malaria.
- A germ (Plasmodium) was found in patient blood.

**Hypothesis:** Plasmodium causes malaria.

**Deduction:** If this is true, all malaria patients should have Plasmodium in their blood.

**Experiment:**

- 100 sick and 100 healthy people were tested.
- **Result:** Most malaria patients had Plasmodium; healthy people did not.

✓ Hypothesis was **proved correct**.

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### 53. Biological Problem 2: How Plasmodium Gets into Human Blood

**Definition:**

**Plasmodium** is a parasite that causes **malaria**, a disease that affects human blood.

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**Key Points:**

**54. . Observations (By A.F.A. King, 1883):**

- People sleeping outdoors got malaria more often.
  - People using mosquito nets had less malaria.
  - People sleeping near smoke rarely got malaria.  
➔ *This showed that malaria might be spread by mosquitoes, not by drinking marsh water.*
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**2. Hypothesis:**

*Mosquitoes spread Plasmodium and are involved in spreading malaria.*

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**3. Deduction:**

*If this hypothesis is true, then Plasmodium should be found in mosquitoes.*

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**55. Experiment (By Ronald Ross, 1880s):**

- He let a female **Anopheles** mosquito bite a malaria patient.
- He found **Plasmodium multiplying in the mosquito's stomach.**
- He used **sparrows** (instead of humans) to test safely.
- Infected mosquitoes bit healthy sparrows, and they got malaria.  
➔ *Proved that mosquitoes carry and spread Plasmodium.*

**Final Proof (1898, Italian Biologists):**

- An infected mosquito bit a healthy human.
- The person got malaria.  
➔ *Confirmed that mosquitoes transmit malaria to humans.*

**Conclusion:**

**Mosquitoes, especially female Anopheles, spread Plasmodium.**

This is how malaria is transmitted to humans.