

Unit 1

Introduction to Biology

- Biology comes from the Greek word "bios" meaning life and "logos" meaning study.
Biology is the science that studies about various living organisms. A living organism could be a one-celled bacteria or a several-celled organism such as an animal or a plant.

What is difference between Prokaryotes and Eukaryotes?

Answer: There are following major differences given below:

	Prokaryote	Eukaryote
Nucleus	Absent	Present
Membrane-bound organelles	Absent	Present
Cell structure	Unicellular	Mostly multicellular; some unicellular
Cell size	Smaller (0.1-5 μm)	Larger (10-100 μm)
DNA Form	Circular	Linear
Examples	Bacteria, archaea	Animals, plants, fungi, protists

Branches of Biology

Botany: The study of plants.

Zoology: The study of animals.

What are the basic principles of life in biology?

Answer: Basic principles of biology:

- Cells are the basic building blocks of life.
 - Genes are responsible for passing traits from parents to their offspring.
 - The diversity of various species on Earth is because of evolution by natural selection.
 - Living beings possess the ability to transform energy
- **Cell:**

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- The basic membrane-bound unit that contains the fundamental molecules of life & of which all living things are composed. A single cell is often a complete organism in itself, such as a bacterium or yeast.
- The smallest known cells are a group of tiny bacteria called mycoplasmas.

Animal cell:

- **Cytoplasm** surrounds the cell's specialized structures, or organelles.
- **Ribosomes** are the sites of protein synthesis, are found free in the cytoplasm.
- Energy needed by the cell is released by the **mitochondria**.
- The **Golgi complex**, stacks of flattened sacs, processes and packages materials to be released from the cell in secretory vesicles.
- Digestive enzymes are contained in **lysosomes**.
- **Peroxisomes** contain enzymes that detoxify toxic substances.
- The **centrosome** contains the centrioles, which play a role in cell division.
- The **nuclear envelope**, a double membrane surrounding the nucleus, contains pores that control the movement of substances into and out of the nucleoplasm.
- **Chromatin**, a combination of DNA (deoxyribonucleic acid) and proteins that coil into chromosomes, makes up much of the nucleoplasm.
- The dense **nucleolus** is the site of ribosome production.

Animal cell

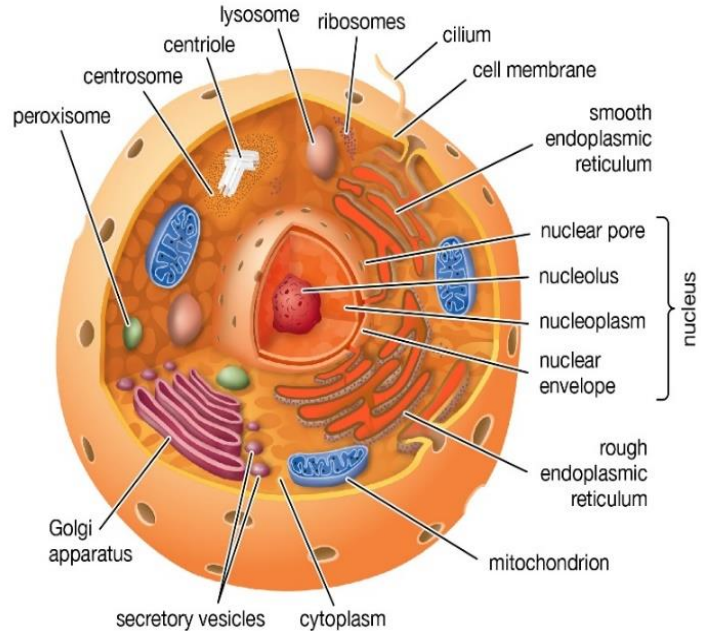


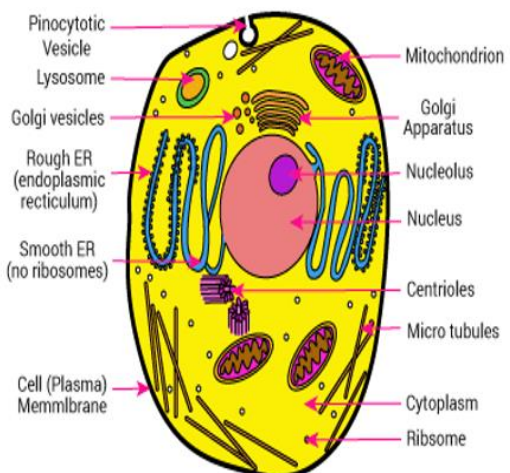
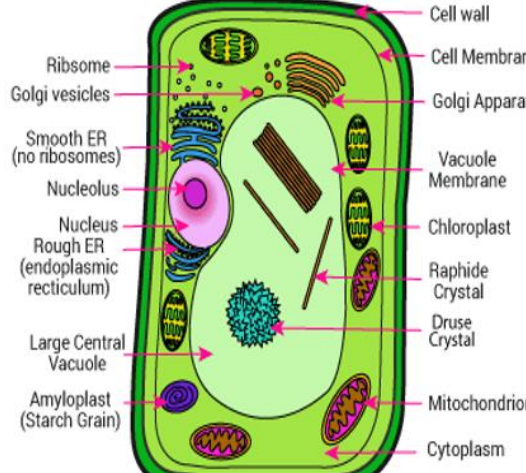
Fig. Principal structures of an animal cell

What are the differences between Animal Cell and Plant Cell?

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Answer: There are following differences between Animal Cell & Plant Cell given below:

Animal Cell	Plant Cell
 <p>It does not have a cell wall</p>	 <p>Consists of a cellulose cell wall</p>
Irregular or round in shape	Square or rectangular in shape
Plastids are absent	Plastids are present
Cilia is present in most animal cells	Cilia is absent
Mode of nutrition is heterotrophic	Nutrition is primarily autotrophic

What are the similarities between Animal Cell and Plant Cell?

Answer: There are some similarities between animal and plant cell:

1. Both have a cell membrane or plasma membrane.
2. Both have ribosomes.
3. Both have endoplasmic reticulum.
4. Both possess a well-defined nucleus and cytoplasm. Genetic material DNA is also surrounded by a nuclear membrane.

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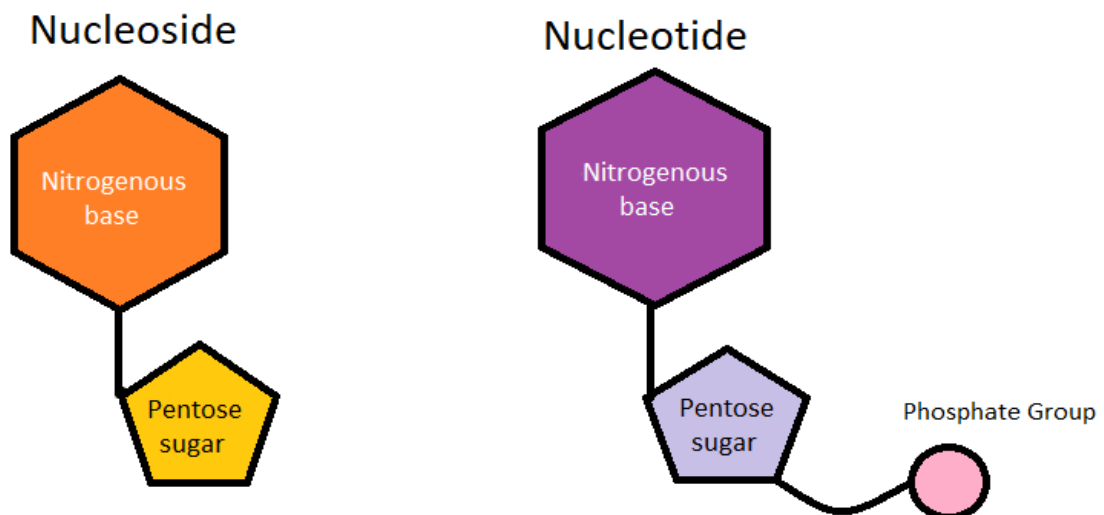
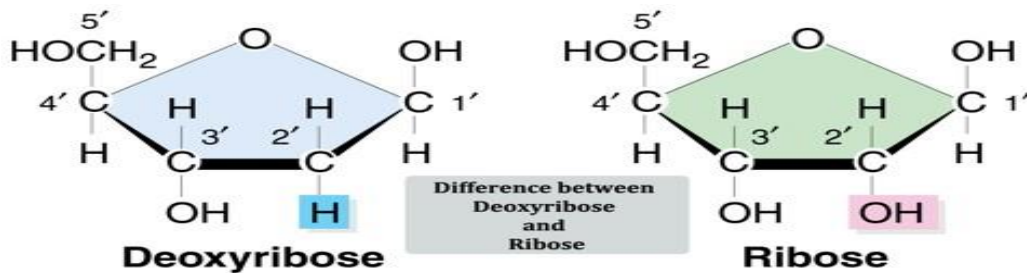
What are genes? What are they made of?

Answer: A gene is the basic physical and functional unit of heredity. Genes are made up of DNA. A gene consists of a long combination of four different nucleotide bases. The four nucleotides are: A (adenine), C (cytosine), G (guanine), T (thymine)

Q.6: What is difference between DNA and RNA?

Answer: DNA and RNA are both polymers of nucleotides. Differences are given below

	DNA	RNA
Pentose sugar	Deoxyribose	Ribose
Base Composition	Adenine (A) Guanine (G) Cytosine (C) Thymine (T)	Adenine (A) Guanine (G) Cytosine (C) Uracil (U)
Number of strands	Double stranded (forms a double helix)	Single stranded



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What is natural selection?

Answer: It is a mechanism of evolution in which organisms that are more adapted to their environment are more likely to survive and pass on the genes that aided their success. This process causes species to change and diverge over time.

What is meant by biological classification?

Answer: Biological classification is the process by which organisms are classified based on how similar they are.

Genus and species are two taxonomic rankings of the biological classification of organisms. Species is the fundamental taxonomic rank of organisms, which contains a group of **closely related organisms, interbreeding to produce a fertile offspring.**

A **genus** is a closely related group of **several species**.

Family is a taxonomic group containing **one or more related genera**.

Order is a taxonomic group containing **one or more families**. For example, the order, carnivore, includes many families.

Class is a taxonomic group consisting of **one or more related orders**.

Phylum is a level of taxonomic rank that exists below the kingdom and above the class.

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Kingdom is a taxonomic rank that is **composed of smaller groups called phyla** i.e. a kingdom is the second highest taxonomic rank, just below domain.

Domain is the highest taxonomic rank in the hierarchical biological classification system.

There are three domains of life, the Archaea, the Bacteria (prokaryote), and the Eukarya.

- Archaea can be spherical, rod, spiral, or irregular in shape. These are a primitive group of microorganisms that thrive in extreme habitats such as hot springs, cold deserts & hypersaline lakes.
- **In Plants classification,** Nonvascular plants (also known as bryophytes) are plants that do not have any special internal pipelines or channels to carry water and nutrients. Instead, nonvascular plants **absorb water and minerals directly through their leaf like scales**. Nonvascular plants are usually found growing close to the ground in damp, moist places.
- Nonvascular plants are a group of primitive plants that don't contain vascular tissues. Examples: mosses, hornworts, and liverworts. These small plants typically spend their lives in moist environments where they can absorb water and nutrients directly through the surface of the plant.
- **In animal classification,** Organisms with **bilateral symmetry** contain a **single plane of symmetry** which divides the organism into two roughly mirror image left and right halves.

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- Organisms with radial symmetry show a repeating pattern around a central axis such that they can be separated into several equal/unequal pieces when cut through the central point.
- Body pattern radiated out from central point.

Obligate Parasite and Facultative parasites

Parasites that are dependent on the host for completing their life cycle are called **obligate parasites**; they cannot survive independently without the host, hence they do not have their own metabolic mechanism and cannot reproduce without the presence of host machinery. These parasites are also called holoparasites.

Parasites that are not dependent on the host for completing their life cycle are called **facultative parasites**; they can survive independently without the host; hence, they have their own metabolic mechanism and can reproduce without host machinery. So the presence of hosts for these parasites is not an essential factor. They live freely and infect the host rarely in their life span.

	Obligate parasites	Facultative parasites
Definition	Parasites which are dependent on the host for completing their life cycle are called obligate parasites	Parasites which are not dependent on the host for completing their life cycle are called facultative parasites
Dependence on host	they cannot survive independently without the host	They can survive independently even without the host
Metabolic dependence	They do not have their own metabolic mechanism, without the host, their growth or development is stagnant or hindered	They have their own metabolic mechanism and can also reproduce without the presence of host machinery
Reproduction	Obligate parasites Cannot reproduce without the presence of host	Facultative parasites can reproduce without the presence of a host

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Mode of transmission	Can infect another host from the primary host, and transmit directly	Cannot transmit directly from one host to another and have a synchronized life cycle for transmission
Free living	Obligate parasite do not live freely, their growth and development is stagnant without the host	Facultative parasites can live freely, presence of host is not essential
Examples	Viruses, taenia soleum	<i>Mycobacterium tuberculosis</i>

Fungi:

Fungi (singular: fungus) are a kingdom of usually multicellular eukaryotic organisms that are heterotrophs (cannot make their own food) and have important roles in nutrient cycling in an ecosystem. Fungi reproduce both sexually and asexually, and they also have symbiotic associations with plants and bacteria. However, they are also responsible for some diseases in plants and animals. The study of fungi is known as mycology.

- Fungi are heterotrophs; they cannot make their own food and must obtain nutrients from organic material. To do so, they use their hyphae, which elongate and branch off rapidly, allowing the mycelium of the fungus to quickly increase in size.
- Some fungi are single-celled, while others are multicellular. Single-celled fungi are called yeast.
- A **mycorrhiza** is a symbiotic association between a green plant and a fungus. The plant makes organic molecules such as sugars by photosynthesis and supplies them to the fungus, while the fungus supplies the plant with water and mineral nutrients, such as

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phosphorus, taken from the soil. Mycorrhizas are located in the roots of vascular plants, but **mycorrhiza-like associations** also occur in bryophytes.

- The medical relevance of fungi was discovered in 1928, when Scottish bacteriologist Alexander Fleming noticed the green mold *Penicillium notatum* growing in a culture dish of *Staphylococcus* bacteria.

Bacteria:

- Bacteria are microscopic, single-celled organisms that exist in their millions, in every environment, both inside and outside other organisms.
- Some bacteria are harmful, but most serve a useful purpose. They support many forms of life, both plant and animal, and they are used in industrial and medicinal processes.
- Bacteria are thought to have been the first organisms to appear on earth, about 4 billion years ago. The oldest known fossils are of bacteria-like organisms.
- Bacteria can use most organic and some inorganic compounds as food, and some can survive extreme conditions.
- There are many different types of bacteria. One way of classifying them is by shape. There are three basic shapes.
- **Spherical:** Bacteria shaped like a ball are called **cocci**, and a single bacterium is a coccus. Examples include the *streptococcus* group, responsible for “strep throat.”
- **Rod-shaped:** These are known as *bacilli* (singular bacillus). Some rod-shaped bacteria are curved. These are known as vibrio. Examples of rod-shaped bacteria include *Bacillus anthracis* (*B. anthracis*), or anthrax.

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- **Spiral:** These are known as *spirilla* (singular spirillus). If their coil is very tight they are known as **spirochetes**.
- Bacteria that use photosynthesis are called photoautotrophs. Example cyanobacteria (also called blue-green algae), produce oxygen.
- Many of the bacteria in the body play an important role in human survival. Bacteria in the digestive system break down nutrients, such as complex sugars, into forms the body can use.

What is the major difference between Bacteria and Fungi.

Answer:

Parameter	Bacteria	Fungi
Characteristics	They are Prokaryotes, Single-celled without organelles.	They are Eukaryotes, Multi-celled with Organelles.
Nucleus	They lack the nucleus.	Nucleus present.
Cell wall Composition	consisting of peptidoglycan.	consisting of chitin.
Mode of reproduction	Asexual.	Can be either sexually or asexually.
Motility	Move through flagellum.	They are non-motile.
Mode of nutrition	Can be autotrophs, but usually heterotrophs.	Heterotrophs, usually feed on the dead and decayed matter.
Host	They need a host to grow	They grow on their own

Virus:

Virus are not cells as they do not contain any cellular components. They consist only DNA/RNA surrounded by a protein covering.

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Viruses are considered as something between living and non-living because they do not grow or reproduce by themselves. This makes them non-living. However, when a virus enters a living cell of an organism, it obtains energy from the host cell and starts reproducing.

What is the major difference between Bacteria and Virus?

Bacteria are single cells that can survive on their own, inside or outside the body. Viruses cause infections by entering and multiplying inside the host's healthy cells.

Bacteria	Virus
Outer Cell Wall	
Bacterial cell wall is made up of peptidoglycan	Viruses do not contain a cell wall. The genetic material is enveloped by a protein coat known as a capsid
Size	
Bacteria are large in size. The size ranges from 900 to 1000nm	Smaller in size. The size ranges from 30 to 50nm
Non-Living/Living	
They are living organisms	They can replicate only within the host cell
Mode of Reproduction	
Reproduce asexually by binary fission	Insert their genome in the host genome and make multiple copies
Host Dependence	
Host independent reproduction	Host dependent reproduction
Ribosomes	

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Present	Absent
RNA and DNA	
DNA or RNA is present in the cytoplasm	DNA or RNA are enveloped inside a protein coat known as a capsid
Infections	
Generally localised infection, e.g. Pneumonia	Generally systemic, e.g. flu
Note: An infection that is in the bloodstream is called a systemic infection. An infection that affects only one body part or organ is called a localized infection i.e. A systemic infection is being spread throughout the systems of the body as compared to local infections	
Diseases	
Pneumonia, meningitis, food poisoning, typhoid, etc.	Common cold, polio, smallpox, hepatitis, AIDS, etc.
Treatment	
Antibiotics	Vaccines and antiviral drugs
Examples	
<i>Salmonella typhoeae</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i>	Coronavirus, TMV, HIV, Hepatitis A, etc

What is Bioengineering and its applications?

Answer: Bioengineering is a discipline that applies engineering principles of design and analysis to biological systems and biomedical technologies.

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Examples of bioengineering research include bacteria engineered to produce chemicals, new medical imaging technology, portable disease diagnostic devices, and tissue engineered organs.

Students in bioengineering are trained in fundamentals of both biology and engineering, which may include elements of electrical and mechanical engineering, computer science, materials science, chemistry, and biology.

What is Computational biology and its applications?

Answer: Computational biology (also known as **bioinformatics**) is the combined application of math, statistics & computer science to solve biology-based problems. Bioinformatics covers a wide range of biology topics, such as genetics, evolution, biochemistry, biophysics, and cell biology i.e. it is an interdisciplinary field that develops methods and software tools for understanding biological data.

- Computational biologists are tasked with the development and application of data-analytical tools, theoretical methods, mathematical modelling, and software simulation techniques to explore biological systems.
- Computation is now an essential part of biological research projects. For example, protein data banks, genomic databases and brain MRI images contain massive amounts of raw data that can be translated into insightful information about all aspects of biology.
- Computational biologists actually work in very different interdisciplinary sub-fields, such as systems biology, population genetics, molecular networks and medical, functional, comparative, agricultural genomics. Students must obtain a broad, interdisciplinary knowledge of the basic principles of math, biology and computational science.
- The **National Center for Biotechnology Information (NCBI)** advances science and health by providing access to biomedical and genomic information.
- The **Basic Local Alignment Search Tool (BLAST)** finds regions of local similarity between sequences.

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Difference between Prokaryotes and Eukaryotes

Properties	Prokaryote	Eukaryote
Nucleus	Absent	Present
Membrane-bound organelles	Absent	Present
Cell structure	Unicellular	Mostly multicellular; some unicellular
Cell size	Smaller (0.1-5 μm)	Larger (10-100 μm)
Complexity	Simpler	More complex
DNA Form	Circular	Linear
Examples	Bacteria, archaea	Animals, plants, fungi, protists

How do plant cells and animal cells differ with respect to their shape?

A plant cell has a square or rectangular shape while the animal cells have an irregular or round shape.

Why are plant cells generally larger in size compared to the animal cells?

Plant cells comprise a large central vacuole that occupies a majority of the volume and makes the cell larger. This vacuole is usually absent in the animal cell.

Name the cell organelle responsible for carrying out photosynthesis in plant cells.

Chloroplasts are responsible for carrying out photosynthesis in a plant cell.

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Objective Questions and Answers:

- | | |
|--|---|
| <p>1. Study of tissue/microscopic anatomy is termed as
 A. Ecology
 B. Cytology
 C. Histology
 D. Anatomy</p> | <p>6. Athlete's Foot or Tinia Pedis is caused by which of the following?
 A. Bacteria
 B. Fungi
 C. Algae
 D. Virus</p> |
| <p>2. Term biology was introduced by
 E. Lamarck and Traviranus
 F. B) Darwin
 G. C) John Ray
 H. D) Aristotle</p> | <p>7. Out of Diphtheria, Whooping cough, Typhoid, Diarrhea & Malaria which is not caused by bacteria?
 E. Whooping cough
 F. Typhoid
 G. Diarrhea
 H. Malaria</p> |
| <p>3. Myology belongs to study of
 I. Fungi
 J. Mammals
 K. Muscles
 L. D) None</p> | <p>8. A virus consists of:
 A. RNA or DNA and a cell membrane
 B. RNA or DNA and a protein coat
 C. RNA and DNA and a protein coat
 D. proteins, cell membrane and RNA</p> |
| <p>4. How do fungi obtain their nutrients?
 A. Extracellular digestion
 B. Photosynthesis
 C. Predation
 D. None</p> | <p>9. Bacteria are classified by which of the following shapes?
 A. rod, cone, spiral
 B. rod, sphere, spiral
 C. rod, sphere, cone
 D. sphere, cone, spiral</p> |
| <p>5. Some bacteria thrive in extreme environment conditions such as absence of oxygen, high salt concentration, high temperature and acidic pH. It is
 A. Eubacteria
 B. Cyanobacteria
 C. Archaeobacteria
 D. Fungi</p> | <p>10. Which of the following microscopic organisms is the smallest?
 A. bacteria
 B. fungi
 C. protists
 D. viruses</p> |
- 1. C; 2. A; 3. D*; 4.A; 5.C; 6.B; 7.D; 8.B; 9.B; 10.D**