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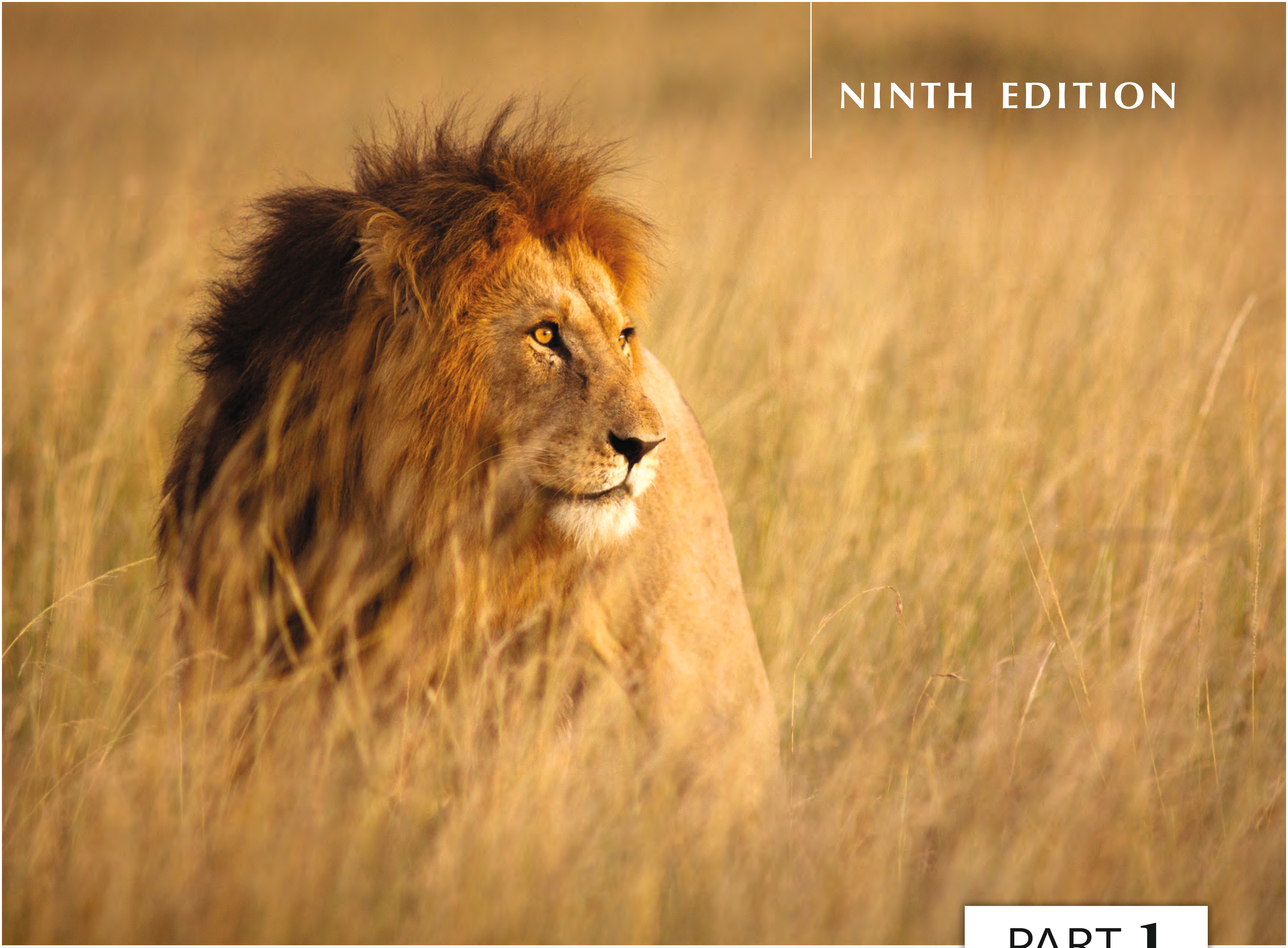

PART 1

Life Sciences

Fundamentals and Practice

PRANAV KUMAR   USHA MINA

Life Sciences

Fundamentals and Practice

Part-**1**

Ninth edition

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Life Sciences: Fundamentals and Practice

Ninth edition

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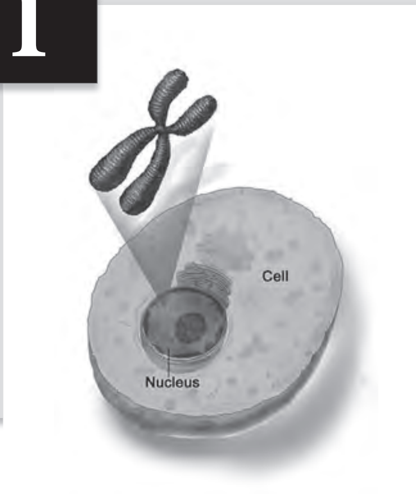

Biomolecules and Catalysis

Learning objective

1.1 Amino acids and Proteins
1.2 Fibrous and globular proteins
1.3 Protein folding
1.4 Protein sequencing and assay
1.5 Nucleic acids
1.6 Structure of dsDNA
1.7 RNA
1.8 Carbohydrates
1.9 Lipids
1.10 Vitamins
1.11 Reactive oxygen species and antioxidants
1.12 Enzymes

Biomolecules are *carbon-based organic compounds* that are produced by living organisms. Most biomolecules can be regarded as derivatives of hydrocarbons, with hydrogen atoms replaced by a variety of functional groups that confer specific chemical properties on the molecule. These molecules consist of a relatively small number of elements. Approximately 25 naturally occurring chemical elements are found in biomolecules, and most of these elements have a relatively low atomic number. In terms of the percentage of the total number of atoms, hydrogen, oxygen, nitrogen, and carbon together makeup over 99% of the mass of most cells. Biomolecules include both small as well as large molecules. The **small biomolecules** are low molecular weight (less than 1000) compounds which include sugars, fatty acids, amino acids, nucleotides, vitamins, hormones, neurotransmitters, primary and secondary metabolites. Sugars, fatty acids, amino acids, and nucleotides constitute the four major families of small biomolecules in cells. Each of these small biomolecules is composed of a small set of atoms linked to each other in a precise configuration through covalent bonds. **Large biomolecules** which have high molecular weight are called *macromolecules* and mostly are polymers of small biomolecules. These macromolecules are proteins, carbohydrates, and nucleic acids.

Small biomolecules	Macromolecules
Sugars	Polysaccharides
Amino acids	Polypeptides (proteins)
Nucleotides	Polynucleotides (nucleic acids)

Nucleic acids and proteins are **informational macromolecules**. Proteins are polymers of amino acids and constitute the largest fraction (besides water) of cells. The nucleic acids, DNA and RNA, are polymers of nucleotides. They store, transmit, and translate genetic information. The polysaccharides, polymers of monosaccharides, have two primary functions: serving as a storage form of energy and as extracellular structural components.

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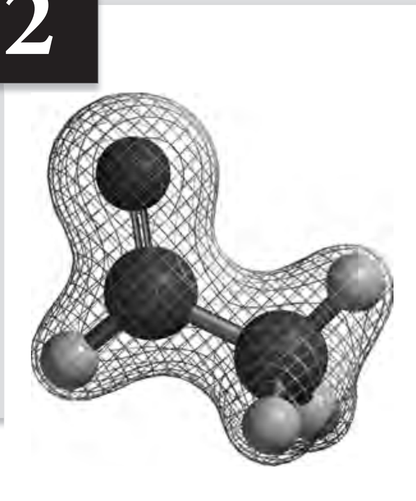
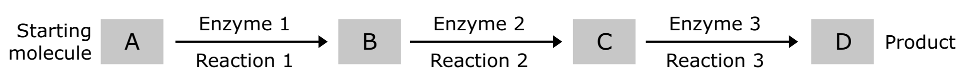


Metabolism

Learning objective

- **2.1 Respiration**
- **2.2 Glyoxylate cycle**
- **2.3 Pentose phosphate pathway**
- **2.4 Entner-Doudoroff pathway**
- **2.5 Photosynthesis**
- **2.6 Photorespiration**
- **2.7 Carbohydrate metabolism**
- **2.8 Lipid metabolism**
- **2.9 Amino acid metabolism**
- **2.10 Nucleotide metabolism**

All cells function as biochemical factories. Within the living cell, biomolecules are constantly being synthesized and transformed into some other biomolecules. This synthesis and transformation constantly occur through enzyme-catalyzed chemical reactions. More than a thousand chemical reactions take place in a cell. Most of these chemical reactions do not occur in isolation but are always linked to some other reactions. All the interconnected chemical reactions occurring within a cell are called **metabolism** (derived from the Greek word for a *change*). Metabolism serves two fundamentally different purposes: 1. Generation of energy to drive vital functions and 2. Synthesis of biological molecules. The precursor is converted into a product during metabolic processes through a series of metabolic intermediates called **metabolites**. Cell metabolism is organized by enzymes. Enzyme-catalyzed reactions are connected in series so that the product of one reaction becomes the starting material, or substrate, for the next. The series of enzyme-catalyzed reactions transform substrates into end products through many specific chemical intermediates constitutes a **metabolic pathway**. Metabolism is sometimes referred to as **intermediary metabolism**. The term *intermediary metabolism* is often applied to the enzyme-catalyzed reactions that extract chemical energy from nutrient molecules and use it to synthesize and assemble cell components. The flow of metabolites through the metabolic pathway has a definite rate and direction. Metabolism is highly organized and regulated. Metabolic pathways are regulated through control of (1) the amounts of enzymes, (2) their catalytic activities, and (3) the availability of substrates. In multicellular organisms, the metabolic activities of different tissues are also regulated and integrated by growth factors and hormones that act from outside the cell.



Metabolism consists of energy-yielding and energy-requiring reactions. The oxidation of carbon compounds is an important source of cellular energy. An energy currency common to all life forms, ATP, links energy-releasing pathways with energy-requiring pathways. ATP serves as the principal immediate donor of free energy in biological systems rather than as a long-term storage form of free energy.

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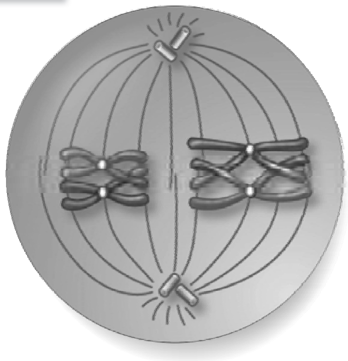
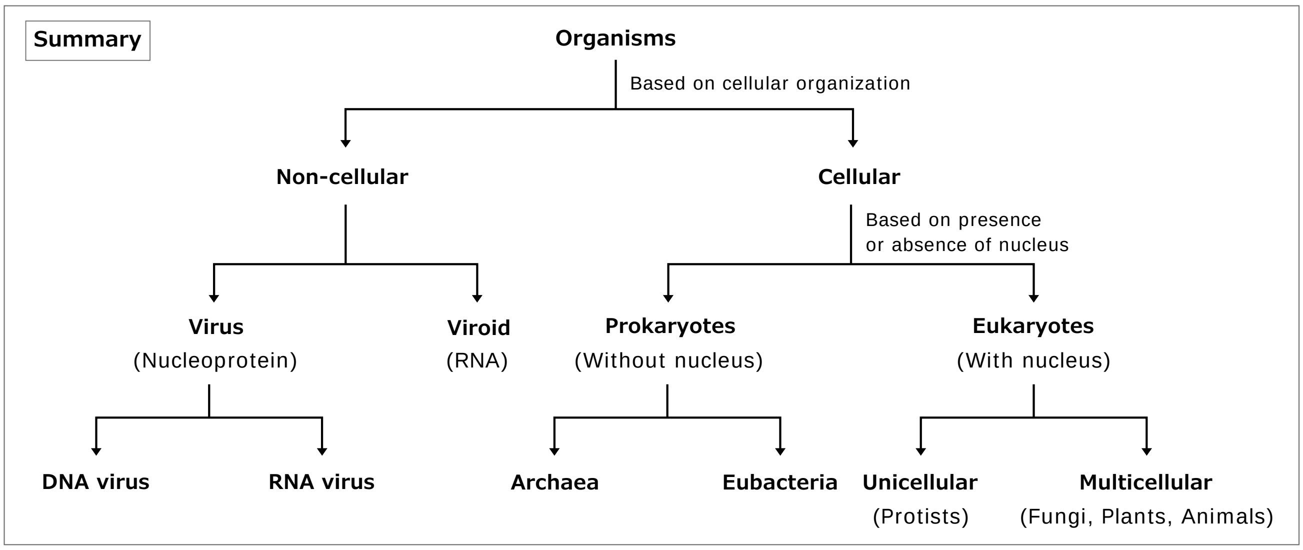


Cell Structure and functions

Learning objective

A great diversity of organisms are present on the Earth. These organisms can be classified into two broad categories- **cellular organisms** and **non-cellular organisms**. Cellular organisms are further subdivided into three distinct domains of life: *bacteria*, *archaea*, and *eukarya*. Bacteria and archaea are classified as **prokaryotes**, characterized by the absence of a nucleus. All **eukaryotes** belong to domain eukarya which includes *protists*, *fungi*, *plants* and *animals*. Both prokaryotes and eukaryotes are *cellular organisms*. Viruses and viroids are non-cellular organisms because they lack cell or cell-like structure.



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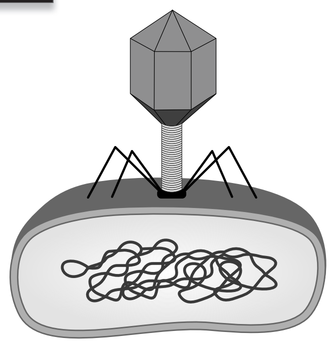

Prokaryotes and Viruses

Learning objective

Prokaryotes (*pro* means before and *karyon* means kernel or nucleus) are cellular organisms that include two domains– **Bacteria** (sometimes referred to as *true bacteria* or *eubacteria*) and **archaea** (also termed as *archaebacteria* or *archaeobacteria*). The term *bacteria* or *eubacteria* refers to those that belong to the domain Bacteria, and the term *archaea* is used to refer to those that belong to domain Archaea. *The informal name 'bacteria' is occasionally used loosely in the literature to refer to all the prokaryotes, and care should be taken to interpret its meaning in any particular context*. Prokaryotic organisms are usually microscopic, single-celled organisms that have a relatively simple structure – neither nucleus nor unit membrane-bound organelles. Prokaryotes can be distinguished from eukaryotes in terms of their cell structure and molecular make-up. Prokaryotic cells have a simpler internal structure than eukaryotic cells. Although many structures are common to both cell types, some are unique to prokaryotes. Most prokaryotic cells lack extensive, complex internal membrane systems. The major distinguishing characteristics of prokaryotic and eukaryotic cells are as follows:

Feature	Prokaryotic cells	Eukaryotic cells
Membrane-bound nucleus	Absent	Present
DNA complexed with histone	Absent	Present
Number of chromosomes	One (mostly)	More than one
Mitosis and meiosis	Absent	Present
Sterol (in plasma membrane)	Absent, except *Mycoplasma*	Present
Ribosome	70S (cytosol)	80S (cytosol)
Unit-mem. bound organelle	Absent	Present
Cell wall	Present in *most* of prokaryotic cells. In eubacteria, it is made up of peptidoglycan.	Made up of cellulose in plant and chitin in fungi. Absent in animal cells.

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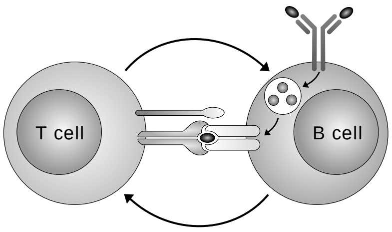

Immunology

Learning objective

Immunology is the science that is concerned with immune response to foreign challenges or simply, study of the body's defense against infection. It addresses the questions such as how does the body defend itself against infection, when an infection does occur, how does the body eliminate the pathogens and how does long-lasting immunity to many infectious diseases develop? The ability of an organism to resist infections by pathogens or state of protection against foreign organisms or substances is called **immunity** (derived from Latin term *immunis*, meaning 'exempt'). The array of cells, tissues and organs which carry out this activity constitute the **immune system**. The immune response is a complex process and is divided into two categories — **innate** (or **native**) and **adaptive** (or **acquired**) immunity. *Innate immunity* is a general, non-specific immune response which presents in all individuals at all times. In contrast to innate immunity, *adaptive immunity* is highly specific to the particular pathogen that induced it. It develops during the lifetime of an individual as a response to infection and adaptation to the infection. Thus, when a given pathogen is new to the host, it is initially recognized by the innate immune system and then the adaptive immune response is activated. Innate immunity is the most ancient form of defense, found in most multicellular organisms, while adaptive immunity is a recent evolutionary phenomenon, having arisen in vertebrates. Thus, vertebrates are protected by both innate immunity and adaptive immunity.

5.1 Innate immunity

Innate immunity is present since birth, evolutionarily primitive and is relatively nonspecific. It provides the *early defense* against pathogens, before adaptive immune responses can develop. It is not specific to any one pathogen but rather acts against all foreign molecules and pathogens. It also does not rely on previous exposure to a pathogen and response is functional since birth and has no memory.

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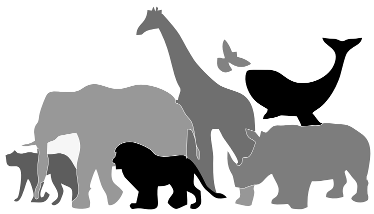

Diversity of Life

Learning objective

- **6.1 Taxonomy**
- **6.2 Five-kingdom system**
- **6.3 Protists**
- **6.4 Fungi**
- **6.5 Plantae**
- **6.6 Animalia**
- **6.7 Animal's classification**

Diversity of life can be summarized as 'variety of life on Earth.' The living world is enormously diverse. The total number of species on the Earth described so far is about 1.2 million. There are many more species that have not yet been described. Scientists are still discovering new species. Thus, we do not know for sure how many species really exist today. Current estimates of the total number of species range from 8 million to 10 million. The known species are unevenly distributed across taxonomic groups. More than 70 percent of all the species recorded are animals, while plants (including algae and fungi) comprise no more than 22 percent of the total. The variety of life on Earth plays a critical role in regulating the Earth's physical, chemical, and geological properties, from influencing the chemical and physical composition of the environment. To understand the diversity of life, it is important to organize the different kinds of organisms. Here the role of taxonomy comes which classify organisms in a way so that we can understand them better.

6.1 Taxonomy

In order to study the diversity of organisms, biologists have evolved certain rules and principles for identifying, describing, naming, and classifying organisms. The branch of science dealing with these aspects is referred to as **taxonomy** (*arrangement by the rules*). Taxonomy is often used as a synonym for **systematics**. Taxonomy can be considered as a branch of systematics. The main difference between taxonomy and systematics is that *taxonomy* is involved in the description, identification, nomenclature, and classification of organisms. In contrast, *systematics* is, in principle, broader, covering all aspects of relationships among organisms.

Levels of taxonomy: The discipline of taxonomy traditionally covers three areas: alpha, beta and gamma taxonomy. **Alpha taxonomy** is concerned with finding, describing, and naming species. **Beta taxonomy** includes the identification of natural groups and biological classes. **Gamma taxonomy** includes the study of evolutionary processes and patterns.

Organisms were first classified more than 2,000 years ago by Greek philosopher *Aristotle*. He classified organisms as either plant or animal. Modern biological classification began with the eighteenth-century Swedish naturalist *C. Linnaeus*. He established a simple system for classifying and naming organisms. He developed a hierarchy (a ranking system) for classifying organisms that is the basis for modern taxonomy.

7

Ecology

Learning objective

Ecology is the scientific study of the relationships between organisms and their environment. These relationships are complex, varied and hierarchical. The word 'ecology' was first used by German biologist Ernst Haeckel in 1869. It is derived from the Greek words, *oikos* (meaning 'house' or 'dwelling place') and *logos* (meaning the study of). Haeckel defined ecology as '*the study of the natural environment including the relations of organisms to one another and to their surroundings*'. Ecology describes the relationships between living organisms and their environments, the interaction of organisms with each other and the pattern and cause of the abundance and distribution of organisms in nature. It is the science that attempts to answer questions about how the nature works.

7.1 The Environment

Organisms and their environments are dynamic and interdependent. The term '**environment**' etymologically means *surroundings*. It includes everything (biotic as well as abiotic) that surrounds an organism. Any factor, abiotic or biotic, that influences living organisms is called **environmental factor** (or *ecological factor* or *ecofactor*). **Abiotic factors** include factors such as temperature, sunlight levels, pH, salinity and soil composition. In contrast, **biotic factors** encompass producers, consumers and decomposers.

7.1.1 Physical environment

Soil

Soil constitutes the uppermost weathered layer of the Earth's crust. It is a mixture of weathered mineral rock particles, organic matter (i.e. both living and dead), water and air. Soil is a biologically active matrix and home of diverse organisms. The scientific discipline dedicated to the study of soil is known as **pedology**.

A letter from Bruce Alberts

(author of Molecular Biology of the Cell)

To: "Usha Mina" <ushamina@mail.jnu.ac.in>
Sent: Tuesday, January 3, 2023 11:14:02 AM
Subject: Re: Review of book

Some feedback on your two Life Sciences volumes – for authors only
Bruce Alberts

Dear Usha and Pranav,

I have finally finished reading through many sections of your large two-volume introductory biology textbook, and I write to provide some feedback that might possibly help with your next edition.

Let me start by saying how impressed I am that such a wide-ranging textbook was written by only two authors. For those sections where I am most knowledgeable – which I read closely -- I find it to be remarkably accurate. As you well know, most such textbooks that attempt to cover all of biology are written by a sizeable team of authors – each with a different expertise -- who in addition acknowledge help from a large number of other experts. And it is great to learn that you are able to provide these two volumes at a low price that Indian students can afford.

My first question concerns the way that this material has been divided up into two separate volumes. If I were a student, I would have felt a need to learn about genetic mechanisms (which you call "genetics") in volume 1, before learning about how proteins are sorted through internal membranes, for example.

A major concern that I would have is one of level. I find that in many places you go into considerably more detail that we do in MBOC (molecular biology of the cell), even though the latter book is aimed at a more advanced student population than I believe yours is. Biology is such a huge subject that we can easily lose students in all the details, when what is most important for them learn are the concepts. Students often feel a need to memorize such details: in our interviews with sets of students who had just used our textbook, we found that many (most?) lack the judgement to ignore them when preparing for exams. For the same reason, we also leave out many of the scientific words in our book, like 2.2_7 helix, linking number, abzyme, etc.

I hope that you find these comments useful, and I write to wish you the very best in 2023, as well as to encourage you in all of your future efforts!

With my best wishes,

Bruce

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PART 2

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1

Genetics

Learning objective

All living organisms reproduce. Reproduction results in the formation of offspring of the same kind. However, the resulting offsprings need not and, most often, do not completely resemble the parents. Several characteristics may differ between individuals belonging to the same species. These differences are termed **variations**. The mechanism of transmission of characters, resemblances, and differences from the parental generation to the offspring is called **heredity**. The scientific study of heredity and variations is known as **genetics** (from the Greek word genno = give birth). The word 'genetics' was first suggested by prominent British scientist William Bateson. Genetics can be divided into three areas: *classical genetics, molecular genetics*, and *evolutionary genetics*. **Classical genetics** is concerned with the basic principles of heredity and how traits are passed from one generation to the next. It also addresses the relationship between chromosomes and heredity and the arrangement of genes on chromosomes. **Molecular genetics** covers the chemical nature of the gene and how genetic information is replicated and expressed, i.e., cellular processes of replication, transcription, and translation. **Evolutionary genetics** is the study of how genetic variation leads to evolutionary change. It is concerned with the evolution of genome structure, the genetic basis of speciation and adaptation, and genetic change in response to evolutionary processes such as natural selection, genetic drift, mutation, and gene flow in populations.

Classical genetics

1.1 Mendel's principles

Gregor Johann Mendel (1822–1884), known as the *father of genetics*, was an Austrian monk. He conducted a series of experiments using pea plants and showed that traits are passed from parents to offspring in predictable ways. By quantitative data analysis of results, he concluded that each trait in the pea plant is controlled by a pair of factors

2

Recombinant DNA technology

Learning objective

Recombinant DNA technology (also known as **genetic engineering**) is the set of techniques that enable the DNA from different sources to be identified, isolated and recombined so that new characteristics can be introduced into an organism. The invention of recombinant DNA technology—the way in which genetic material from one organism is artificially integrated into the genome of another organism and then replicated and expressed by that other organism—was largely the work of Paul Berg, Herbert W. Boyer and Stanley N. Cohen, although many other scientists also made important contributions to the new technology as well. Paul Berg developed the first recombinant DNA molecules that combined DNA from the SV40 virus and lambda phage. Later in 1973, Herbert Boyer and Stanley Cohen develop recombinant DNA technology, showing that genetically engineered DNA molecules may be developed and cloned in foreign cells. One important aspect of recombinant DNA technology is **DNA cloning**. It is a set of techniques that are used to design recombinant DNA molecules and to direct their replication within host organisms. The use of the word 'cloning' refers to the method used to generate identical DNA molecules.

2.1 DNA cloning

DNA cloning is the production of a large number of identical DNA molecules from a single ancestral DNA molecule. The essential characteristic of DNA cloning is that the desired DNA fragments must be *selectively amplified,* resulting in a large increase in copy number of selected DNA sequences. In practice, this involves multiple rounds of DNA replication catalyzed by a DNA polymerase acting on one or more types of the template DNA molecule. Essentially two different DNA cloning approaches are used: *Cell-based* and *cell-free DNA cloning*.

3

Plant Physiology and Development

Learning objective

Plants are multicellular, photoautotrophic eukaryotic organisms. It includes algae, bryophytes, pteridophytes, gymnosperms, and angiosperms. Bryophytes, pteridophytes, gymnosperms, and angiosperms are usually referred to as **land plants**. Angiosperms (also called **flowering plants**) are a major group of land plants. These plants are by far the most numerous, diverse, and successful terrestrial plants, representing more than 90% of all land plant species alive today. They range in size from tiny, almost microscopic *Wolfia* to tall trees of Eucalyptus (over 100 meters). Angiosperms are **vascular plants** containing two types of vascular tissue – **xylem** that conducts water and dissolved minerals upward from the roots and **phloem** that conducts food throughout the plant. Vascular tissues develop in the sporophytic body but (with a few exceptions) not in the gametophytic body. Angiosperms are also classified as **spermatophytes** (also known as **phanerogams**) because they produce seeds. A **seed** is an embryo packaged with a supply of nutrients inside a protective coat. In angiosperms, seeds develop inside ovaries, which mature into fruits. The seed is a crucial adaptation to life on land because it protects the embryo from drying out.

A typical flowering plant body can be divided into the **root** and **shoot systems**. The underground part of the flowering plant is the *root system*, while the portion above the ground forms the *shoot system*. The shoot system consists of stems, leaves, flowers and fruits.

Root is typically a non-green underground structure. The first root in a vascular plant develops from the **radicle** of the embryo. The root develops from the direct elongation of the radicle is known as the **primary root**. Any root that develops from plant organs other than radicle is called an **adventitious root**. The primary root continues to grow and develops **lateral roots** (or **branch roots**) of several orders that are referred to as *secondary roots*, *tertiary roots* and so on. The primary roots and its branches constitute the **tap root system**. Commonly, the primary root in monocots such as wheat is short-lived, and it is replaced by the roots developing from the base of the stem. These stem-borne roots and their lateral roots constitute **fibrous root system**. The main functions of the root are absorption of water and minerals from the soil, anchorage, storage of reserve food material and synthesis of plant growth regulators. But, roots in some plants become modified to perform functions (such as respiration, support) other than anchorage and absorption of water and minerals.

4 Human Physiology

Learning objective

Like all multicellular animals, human body is composed of different types of cells. Groups of cells similar in structure and function are organized into *tissues*. Different tissues grouped together into a structural and functional unit called *organs*. An *organ system* is a group of organs that function together to carry out the principal activities of the body.

4.1 Tissues

A *tissue* is a group of similar cells that usually have a common embryonic origin and functions together to carry out specialized activities. On the basis of structure and function, animal tissues can be classified into four basic types: epithelial tissue, connective tissue, nervous tissue and muscular tissue.

1. Epithelial tissue

An *epithelial tissue* or **epithelium** consists of cells that form membranes, which cover and line the body surfaces and glands, which are derived from these membranes. Epithelial cells arranged in continuous sheets, in either single or multiple layers. Because the cells are closely packed and are held tightly together by many cell junctions, there is little intercellular space between cells. Three types of cell junctions are found in the epithelium and other tissues. These cell junctions are called as *tight*, *anchoring* (adherens junction and desmosome) and *gap junctions*. Epithelial tissue has its own nerve supply, but is **avascular**; that is, it lacks its own blood supply. The blood vessels that bring in nutrients and remove wastes are located in the adjacent connective tissue. Exchange of substances between epithelium and connective tissue occurs by diffusion. Epithelial tissue plays many roles such as protection, filtration, secretion, absorption and excretion. Because epithelial tissue subjected to wear and tear and injury, it has high capacity for renewal.

5

Animal Development

Learning objective

Animal development is a highly complex process that begins with a fertilized egg (or zygote) and leads to the birth of a complex organism with organs at precise positions and shapes. The stages of development between fertilization and birth are collectively called **embryogenesis** and its study is called **embryology**. Embryonic development begins with the fusion of the male and female gametes (**fertilization**). After fertilization, a multicellular organism's development proceeds through a process called **cleavage**, a series of mitotic divisions. Cleavage divides the zygote into numerous cells called *blastomeres*. By the end of cleavage, a solid or hollow fluid-filled ball of the blastomeres develops, known as a **blastula**. Cleavage is followed by **gastrulation**, a process that rearranges the blastomeres and forms the germ layers — *ectoderm*, *mesoderm*, and *endoderm*. Over time and space, these cells interact with one another and rearrange themselves to produce tissues and organs. This process is called **organogenesis**. Many animals have life cycles involving a larval stage specialized for feeding and dispersal. The larva undergoes **metamorphosis** to become a sexually mature adult.

5.1 Patterns and processes of animal development

Developmental biology aims to understand how an organism develops. During development, the zygote divides repeatedly to produce many different kinds of cells arranged in a specific pattern i.e., cells are organized in space and time so that a well-ordered structure develops within the embryo. Several key processes fundamentally occur during animal development. These processes include *cell proliferation*, which produces many cells from one; *cell-cell communications*, which coordinate the behavior of each cell with that of its neighbors; *cell differentiation*, which creates cells with different characteristics at different positions; and *cell movement*, which rearranges the cells to form structured tissues and organs.

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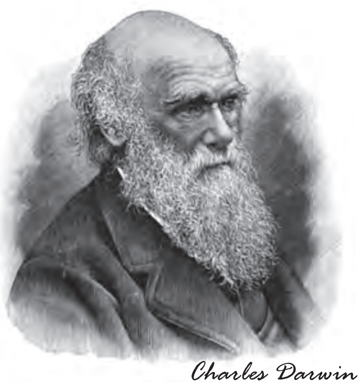

Evolution

Learning objective

Evolution refers to the changes that occur in life forms over time, leading to the development of many different forms of life. By understanding evolution, we can gain insight into how and why life has changed and diversified. It includes the study of evolutionary processes—how they operate, what they produce, and how they are likely to proceed in the future. It deals mainly with how life changed after its origin. It does not discuss about the *origin of life*. To understand evolution, it is also very important to understand how life originated? We should understand the physical and chemical conditions prevailing on the prebiotic Earth that could drive the first steps of the origin of life. We also have to address a simple question central to our understanding of the origin of life: how complex organic molecules formed and how they have become organized into cells?

6.1 Origin of Life

Life is characterized by the three functions: 1. **compartmentalization**: the ability to keep its components together and separate itself from the environment, 2. **replication**: the ability to process and transmit heritable information to progeny, and 3. **metabolism**: the ability to capture and utilize the energy and material resources, staying away from thermodynamic equilibrium.

The origin of life on Earth is a unique event and also one of the great mysteries. *Where and how did life on Earth originate*? It is difficult to determine because it began almost four billion years ago. Did life come from outer space? For a long time, it was believed that life didn't begin on Earth. It came from outside (i.e. extraterrestial origin). However, due to lack of any validation, it remained merely speculative. For many years it was also believed that life came out of decaying and rotting organic matters. This theory was termed as **theory of spontaneous generation**. Scientists have disproved this theory by performing controlled experiments. Louis Pasteur by careful experimentation demonstrated that life comes only from pre-existing life. Living things, no matter how small, do not come spontaneously from non-living matters. Living things come only from other living things (**biogenesis**). However, this did not answer how the first life form came on Earth.

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Dear Usha and Pranav,

I have finally finished reading through many sections of your large two-volume introductory biology textbook, and I write to provide some feedback that might possibly help with your next edition.

Let me start by saying how impressed I am that such a wide-ranging textbook was written by only two authors. For those sections where I am most knowledgeable – which I read closely -- I find it to be remarkably accurate. As you well know, most such textbooks that attempt to cover all of biology are written by a sizeable team of authors – each with a different expertise -- who in addition acknowledge help from a large number of other experts. And it is great to learn that you are able to provide these two volumes at a low price that Indian students can afford.

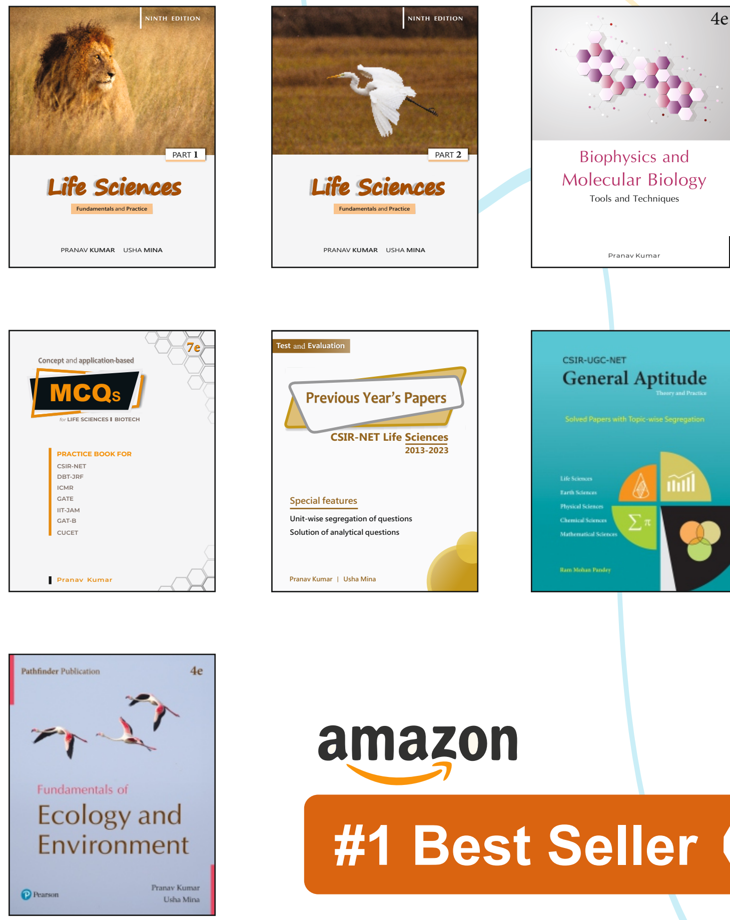
My first question concerns the way that this material has been divided up into two separate volumes. If I were a student, I would have felt a need to learn about genetic mechanisms (which you call "genetics") in volume 1, before learning about how proteins are sorted through internal membranes, for example.

A major concern that I would have is one of level. I find that in many places you go into considerably more detail that we do in MBOC (molecular biology of the cell), even though the latter book is aimed at a more advanced student population than I believe yours is. Biology is such a huge subject that we can easily lose students in all the details, when what is most important for them learn are the concepts. Students often feel a need to memorize such details: in our interviews with sets of students who had just used our textbook, we found that many (most?) lack the judgement to ignore them when preparing for exams. For the same reason, we also leave out many of the scientific words in our book, like 2.2_7 helix, linking number, abzyme, etc.

I hope that you find these comments useful, and I write to wish you the very best in 2023, as well as to encourage you in all of your future efforts!

With my best wishes,

Bruce



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