## Section III

# BIODIVERSITY

Life is a continuum extending from the earliest organisms through various lineages to the great variety of forms alive today. In section III we will study the diversity of life today and trace the evolution of this diversity over 3.8 billion years of history.

## Chapter 5

# VARIETY OF LIFE

The drawing that opens this chapter dramatizes a remarkable event; the genetic takeover of a cell by a virus. In this case, the cell is the bacterium E. coli and the virus, looking something like a miniature lunar landing craft, is the bacteriophage $T_4$. The phage is infecting the cell by injecting its DNA.
There are varied kinds of life ranging from Viruses (border line between the living and non-living) to most highly evolved and complex-life in the form of humans. There are unicellular organisms with or without cell-wall and with or without chlorophyll.

### 5.1 CLASSIFICATION

It is also called **taxonomy** (Gr. Taxis = arrangement, Nomos = law) may be defined as techniques of describing, naming and classifying living organisms on the basis of the similarities and dissimilarities.

### 5.1.1 Needs and Bases of Biological Classification:

Early in human history it was found useful to know in advance, which Plants were poisonous, which animals were dangerous, which were good to hunt for food and so on. It was soon noticed that all the living organisms possessed certain consistent features or characters by which they could be identified and sorted into recognizable distinct groups.
The organisms can be identified or sorted into different groups on the basis of characters, they possess. Now the question arises "what is a taxonomic character"? A character can be defined as: any attribute or descriptive phrase, referring to form, structure or behaviour of a specific organism for a particular purpose, thus character is anything or any feature whose expression can be measured or otherwise assessed. Taxonomist mostly deals with the expressions of the character.
For example, **"Petal length"** may be considered as a character; but "Petal length 12 mm" is an expression of that character.
**"Corolla colour"** may be considered as a character, but "Corolla colour white" is an expression of that character.
The living organisms are classified on the bases of homology, comparative biochemistry, cytology and genetics.

### i) Homology:

The living organisms placed in a particular group all have many fundamental similarities in their structure. It is not always easy to recognize these basic similarities. At first sight, the flipper of a whale is used for swimming, the wing of a bat for flight, forelimb of cat for walking and the arm of man for grasping, do not seem to have much in common, yet if one examines their internal structure — the bones and muscles — it can be seen that these are very much alike (Fig. 5.1). The flipper, wing, forelimb and arm are all built on the same pattern. During the course of evolution, each has been modified from the basic pattern to serve a particular, and usually highly specialized, function, due to its adaptation to different environment/ habitat.

The flipper, wing, forelimb and arm are believed to resemble one another because they originated from the same structure in a common ancestor, and thus were once controlled by the same genes. Structures that are similar because of their common origin but may differ functionally are said to be **homologous.** It is principally the homologous structure that one consider in grouping animals in a classification scheme.
Whale
Figure 5.1 should not be misconstrued to mean that homology refers to gross structures alone. Nowadays cellular structures, especially chromosome number and type, are considered, too. Then there are physiological homologies, and even biochemical homologies. Structure and functions are always closely related.

**ii) Biochemistry (Chemical Constitution):**
Sometimes it is impossible to classify organisms using morphological criteria, so one resorts to comparing the chemical substances which they contain.
This is particularly useful when classifying organisms like bacteria which may all look alike and have an identical cellular structure. Using techniques such as chromatography and electrophoresis, it is possible to compare the amino acid sequence in the proteins of different organisms, or the order of bases in their DNA. This is useful not only in classifying organisms, but is indispensible when trying to establish evolutionary relationships.
Other characteristics used in classifying organisms include their immunological reactions, the types of symbionts with which they may associate.

**iii) Cytology:**
Although gross structure is a convenient basis for classification, sometimes microscopic features have to be used. For example, studies with the electron microscope have revealed that bacteria and cyanobacteria have a unique type of cell structure, for which reason they are now put together in a kingdom of their own. In this case microscopic observation of cell structure has been used to make a fundamental split in the classification of living things between prokaryotes and eukaryotes.
Microscopic structure can be useful at the generic and species levels too. For example, the number of chromosomes can enable entomologists to classify locusts and grasshoppers, and the surface features of seeds and pollen grains as revealed by the scanning electron microscope can be used in classifying flowering plants. Indeed, this sort of technique can show delicate differences between species or subspecies which are identical in many other respects.

**iv) Genetics:**
All the morphological biochemical properties and cytological characters of an individual of a species depend upon its genetic constitution. Hence the main tool helping in classifying organisms is genetics. As mentioned above the relevant base sequence in DNA is an important tool for classifying organisms.

### 5.1.2 Concept of Species and Hierarchy of Biological Classification:
The basic unit of biological classification is the **species**. "A species is a group of organisms which have numerous physical features in common and which are normally capable of interbreeding and producing viable fertile offspring". Nowadays, biochemical, ecological and life cycle features are included with other physical characteristics in helping to classify species.
Closely related species are grouped together into **genera** (singular: genus). Genera are grouped into **families**, families into **orders**, orders **into classes**, classes into **phyla** (singular: phylum) and phyla into kingdoms. (When classifying plants and bacteria the term 'division' is sometimes used instead of phylum. Intermediate categories are sometimes used: for example, a **sub-phylum** may

be inserted between phylum and class, and **sub-classes** between class and order and so on.

**Classification of Wheat**

| | | |
|---|---|---|
| Kingdom | — | Plantae |
| Division | — | Tracheophyta |
| Class | — | Monocotyledonae |
| Order | — | Poales |
| Family | — | Poaceae |
| Genus | — | Triticum |
| Species | — | Triticum indicum |

**Classification of House Fly**

| | | |
|---|---|---|
| Kingdom | — | Animalia |
| Phylum | — | Arthropoda |
| Class | — | Insecta |
| Order | — | Diptera |
| Family | — | Muscidae |
| Genus | — | Musca |
| Species | — | Musca domestica |

This ascending series of successively larger, more inclusive, groups make up the taxonomic hierarchy. Each grouping of organisms within the hierarchy is called a **taxon** (plural: taxa) and each taxon has a rank and a name, for example, class mammalia or genus Homo.
Figure 5.2 shows two ways of illustrating how the hierarchical arrangement of the taxa can be represented: a 'box-in-box' arrangementor a 'tree-like' arrangement (dendrogram).

**Table 5.1 Classification of three well known organisms**

| Taxonomic rank | Plant example | Animal example | |
|---|---|---|---|
| Kingdom | Plantae | Animalia | Animalia |
| Phylum | Angiospermata | Annelida | Chordata |
| Class | Dicotyledonae | Oligochaeta | Mammalia |
| Order | Ranales | Terricolae | Primata |
| Family | Ranunculacae | Lumbricidae | Hominidae |
| Genus | Ranunculus | Lumbricus | Homo |
| Species | Ranunculus acris | Terrestris | Homo sapiens |
| Common name | Meadow buttercup | Earthworm | human |

Table 5.1 shows how three well-known organisms fit into the system. The lowest three taxa (family, genus and species) are named according to strict internationally agreed rules. The names of the four highest taxa (kingdom, phylum, class; and order) are often matters of opinion and are subject to the whims and fancies of individual taxonomists.

**Nomenclature:**
The modern system of naming species also dates from Linnaeus. Before him there had been little uniformity in the designation of species. Some species had a one-word name, others had two-word names, and still others had names consisting of long descriptive phrases. Linnaeus simplified things by giving each species a name consisting of two words: first the name of the genus to which the species belongs and second a designation for that particular species. The genus name is capitalized while the specific name is not. Both names are customarily printed in italics (underlined if handwritten or typed). This is called **Binomial Nomenclature.**

### 5.1.3 Two to Five Kingdom, Systems of Classification, including five kingdom systems by Robert Whittaker (1969) Margulis and Schwartz (1985):

One of the most difficult decision to make in systematic is how to divide living organisms into kingdoms.
Previously organisms were divided into two kingdoms: the animal-kingdom, which contained mainly motile organisms which are heterotrophic, lacking both

chlorophyll and cell wall and the plant kingdom which contained mainly organisms, which are autotrophic having cell wall with or without chlorophyll. Unicellular heterotrophs (protozoa) were put in the animal kingdom, and unicellular autotrophs were put in the plant kingdom with the algae. Fungi and bacteria were attached to the plant kingdom mainly on the grounds that like plants, they possessed a rigid cell wall. There are a number of problems with having only two kingdoms. The first concerns unicellular flagellates like Euglena and its relatives.

These were put with protozoa in the animal kingdom. However, some euglenoids, including Euglena itself, contain chorophyll, feed autotrophically by photosynthesis swim and move in response to light stimuli. Moreover, some flagellates can feed either autotorophically or heterotrophically depending on the conditions. With only two kingdom, we have to contend with the fact that these organisms can in fact, hop from one kingdom to the other.

Another problem concerns the fungi. Fungi are really very different from green plant. They lack chlorophyll and feed heterotrophically by an absorption method and their cellular structure differs from that of plants in several ways.

A third problem concerns bacteria. The electron microscope has revealed that bacteria and cyanobacteria (Formerly called blue-green algae) have a simple prokaryotic cell structure, so the bacteria and cyanobacteria appear to be similar to each other and markedly different from all other organisms which are eukaryotic. Indeed, if living organism have to be divided into just two kingdoms, a division into prokaryotes and eukaryotes would probably be best. However, although it may be satisfactory for all the prokaryotes to be in one kingdom, the rest would form a very large and diversified group.

**The Five Kingdom System:**

To solve the problems already mentioned, a number of different schemes of classification have been proposed. All have more than two kingdoms, and one has eighteen. The scheme that has gained most support was proposed in 1969 by an American biologist, Robert H. Whittaker. He based his classification on two main criteria: the level of organisation of the organisms, and their methods of nutrition. He recognised three levels of organisation: Prokaryotes, Unicellular Eukaryotes and Multicellular Eukaryotes. The methods of nutrition were: heterotrophic (which could be further subdivided into ingestive and absorptive) and photosynthetic.

On this basis, Whittaker proposed the following five kingdoms:

1. Unicellular prokaryotes which feed by a variety of different methods— **Kingdom Monera**.

2. Unicellular eukaryotes which feed by a variety of different methods — **Kingdom Protista.**

3. Multicellular non-chlorophyllous eukaryotes which feed heterotrophically by absorption. Cell wall always present — **Kingdom Fungi.**

4. Multicellular chlorophyllous eukaryotes which feed autotrophically by photosynthesis. Cell wall always present — **Kingdom Plantae.**

5. Multicellular eukaryotes which feed heterotrophically by ingestion. They have neither chlorophyll nor cell wall — **Kingdom Animalia.**

Although Whittaker's scheme received wide spread approval, it had one major snag. This relates to the protist kingdom which contained all unicellular organisms, including those that formerly had been regarded, as animals

(Protozoans) and those that had been regarded as plants (unicellular algae). Indeed it solved the problem of Euglena like organisms, but placing of unicellular algae in protist and colonoid/ multicellular algae in plantae lead to confusion.This was unfortunate because the two algal groups, share many common features. Indeed, some of the simpler multicellular algae are little more than aggregates of the unicellular forms. This may be added to the fact that the algae as a whole have rather little in common with the rest of the plant kingdom.

This led two other American biologists, L. Margulis and K. Schwartz, to put forward a modification of Whittaker's scheme. They suggested that the multicellular algae should be removed from the plant kingdom and placed alongwith all unicellular organisms, in a new kingdom called the **protoctist** kingdom which would replace Whittaker's protist kingdom. This makes the plant kingdom a more natural group, and it brings the multicellular algae close to their unicellular relatives. However it results in the protoctist being something of a 'ragbag'containing a wide range of unicellular and multicellular organisms. Indeed it has been described as the kingdom that contains all those organism which can not be fitted into any of the other kingdoms.

In grouping organisms into kingdoms there are bound to be anomalies. The important thing is that the anomalies should be as few as possible and the classification consistent. Margulis and Schwartz's five kingdom scheme offers this, and is therefore commanded until a more rational system is proposed.

Viruses are not included in the five kingdoms the reason centres on the controversy, which has been going on ever since they were discovered, as to whether or not they should be regarded as living. A virus consists simply of nucleic acid surrounded by a protein coat, and it can only survive and reproduce inside a living cell. For these reasons most biologists regard it, not as living organism, but as aggregation of molecules similar to those normally found in living cells.

Viruses appear to be on the borderline between the living and non-living worlds. They could probably form another kingdom if scientist felt like creating one. Certainty a great deal of time and effort has been spent classifying them. This is based on their physical and chemical properties and the way they reproduce, and is essential in diagnosing the diseases which they cause.

In this book we will follow the modification of Whittaker's scheme put-forwarded by L. Margulis and K. Schwartz. According to this, there are five kingdoms of living organisms as listed below.



1. **Kingdom Prokaryotae (Monera):**
   It includes almost all the prokaryotes, e.g. bacteria and cyanobacteria etc.

2. **Kingdom Protoctista (Protista):**
   It includes all the unicellular eukaryotic organisms, which are no longer classified as animals, plants or fungi, e.g. Euglena, Paramecium, Chlamydomonas, Plasmodium etc. Multicellular algae and primitive fungi have also been included.

3. **Kingdom Fungi:**
   It includes non-chlorophyllus, multicellular (except yeast) organisms having chitinous cell wall and coenocytic body called mycelium, e.g. Agaricus (mushroom) yeast, etc. They are absorptive hetrotrophs.

4. **Kingdom Plantae:**
   It includes all the eukaryotic multicellular chlorophyllus photosynthetic autotrophs having cell wall made up of primarily of cellulose, zygote retained to become embryo and exhibiting heteromorphic alternation of generation, e.g. Moss, Fern, Pine, Apple, etc.

**5. Kingdom Animalia:**

It includes all .eukaryotic, non-chlorophyllus, multicellular, ingestive heterotrophs with no cell wall. e.g. Hydra, Earthworm, Human etc.

## 5.2 VIRUSES

### 5.2.1 Discovery:

The word VIRUS is derived from a Latin word venom meaning "poison". This use of word goes back to many hundreds of years, long before anyone really knew whataviruswas, or that it even existed as we know it today. It was generally believed that these "viruses," or poisons, were carried in the air and could cause many unexplained diseases.

By the late 19th century pioneer biologists had demonstrated that many diseases of man and other organisms were caused by bacteria. Some diseases puzzled them. One such disease was found to occur in tobacco plants. It causes the leaves to wrinkle, and become mottled. The mottled effect has the appearance of a mosaic, and the disease was called **Tobacco Mosaic Disease.**

In 1892, a Russian biologist named Ivanowsky discovered that a virus could be transmitted from an infected organism to a healthy organism of the same kind.

By 1900, similar disease producing substance had been discovered in many organisms. The name filterable virus was given to these substances, which could pass porcelin filters through which bacteria could not pass. The list of filterable viruses was growing long.

The year 1935 was important in unravelling the story of what viruses really are and how they behave. A new kind of microscope—the electron microscope, had been constructed. It had 10000000 millimicron (m D) magnification. Wendell Stanley crystallized the infectious particle, now known as tobacco mosaic virus (TMV). Subsequently, TMV and many other viruses were actually seen with the help of the electron microscope.

### 5.2.2 Characteristics, Structure and Classification of Viruses

**1) Characteristics:**

Viruses are noncellular parasitic entities. They cannot live and reproduce outside of living cells since they lack the machinery to do so by themselves. They range in size from 20 nm to 250 nm.

Viruses are either virulent, destroying the cell in which they occur, or temperate, becoming integrated into their host genome and remaining stable there for long period of time.

The adhesion properties of viruses are determined by those of the proteins that make up their coats and envelops. The simplest viruses use the enzymes of the host cell for both their protein synthesis and gene replication; the more complex ones contain upto 200 genes and are capable of synthesizing through their host may structural proteins and enzymes.

AIDS is caused by HIV (human immunodeficiency virus), which possesses a glycoprotein on its surface that penetrates the cell membrane, sheds its protective coat, and reproduce.

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| Viruses are noncellular obligate parasites that always have a protein coat and a nucleic acid core. |

**2) Structure:**

They appear like little spheres or golf-balls, rod shaped, like tadpoles and may be polyhedral.

Viruses may consist of Viral-Genomes, Capsids, Envelopes and Tail-Fibers. Their **genomes** (sets of genes) may consist of a single or several molecules of DNA or

RNA. The smallest viruses have only four genes while the largest have several hundreds.

The protein coat that encloses the viral genome is called a capsid. It may be of different shapes. Capsid is made up of protein subunits called **Capsomeres.** The number of capsomeres is characteristics of a particular virus.

Some viruses have accessory structures called **viral-envelopes** that help them infect their hosts. They are membranous, cloaking their capsids. Bacteriophages have tail piece with **Tail Fibres**.

The simplest viruses consist of a single molecule of a nucleic acid surrounded by a capsid, which is made up of one or a few different protein molecules, repeated many times (Fig. 5.4). In more complex viruses, there maybe several different kinds of molecules of either DNA or RNA in each virus particle and many different kinds of proteins. Most viruses have an overall structure that is usually either helical or isometric. Helical viruses, such as the tobacco mosaic virus, have a rodlike or threadlike appearance, isometric ones have a roughly spherical shape.

**Bacteriophage (Bacterio = bacteria; phagein = to eat):**

Bacterial viruses, or bacteriophages, are among the most complex viruses (Fig. 5.5). Each of them is made up of at least five separate proteins; these make up the head, the tail core, the molecules of the capsid, the base plate of the tail and the tail fibers. A long DNA molecule is coiled within the head.

### 3) Classification:

Viruses are generally classified on the basis of morphology and nucleic acid, they contain. On the basis of morphology, viruses are classified into rod-shaped (T.M.V.), spherical (poliovirus) and tadpole (bacteriophage). The nucleic acid present may be DNA or RNA which may be naked enveloped or complex.

The diversity of the viruses is great and is almost certainly related to their modes of origin. To provide a systematic idea of some of this diversity, we will discuss the viruses under eight main headings. The main characteristics of these groups are given below.

#### i) Unenveloped Plus-strand RNA Viruses (Polio viruses, Rhino viruses):

They are called plus strand because they act directly as mRNA after infecting a hostcell, attaching to the host's ribosomes and being translated. As indicated by their name, these viruses lack envelopes and consist only of a nucleic acid core surrounded by a protein capsid. They infect plants and bacteria, causing polio and cold in human beings.

#### ii) Enveloped Plus-strand RNA Viruses (Hepatitis A and C viruses):

The enveloped Plus Strand RNA viruses, all of which parasitize animals, are distinguished from the members of the preceding group by their lipid-rich envelopes. They infect arthropods and vertebrates, causing Leukemia and yellow fever in human beings.

#### iii) Minus-strand RNA Viruses (Rhabdo viruses and Pox viruses):

Minus-Strand RNA viruses are distinguished from Plus-Strand RNA viruses because they carry the RNA strand complementary to the mRNA that carries the genetic information of the appropriate mRNA, which then functions in the cell. They infect plants and animals, causing flu, mumps and rabies in human beings.

#### iv) Reterovirus:

A virus that is replicated in a host cell via the enzyme reverse transcriptase to produce DNA from its RNA genome. They are enveloped viruses. Retroviruses are either single stranded RNA (e.g. HIV) or double stranded DNA (e.g. Hepatitis B) viruses.

**v) Double-strand RNA Viruses (Reo viruses):**
These are double-stranded, icosahederal RNA viruses, infect plants and animals, causing Colorado tick fever in human beings.

**vi) Small-Genome DNA Viruses (Parvo viruses):**
Many DNA viruses have Small genomes; some of these viruses have Single-Stranded DNA, others have Double-Stranded DNA. Among them are the parvoviruses, which infect animals, they are icosahedral and about 20 nanometers in diameter. They infect animals causing viral hepatitis and wartz in human beings.

**vii) Medium-Genome and Large-Genome DNA Viruses (Herpes viruses):**
The herpesviruses, one of the major group of large-genome, double-stranded DNA viruses. They cause herpes shingles, cancer and poxes in human beings.

**viii) Bacteriophage:**
A long DNA molecule is coiled within the head. They infect bacteria only.

**5.2.3 Life Cycle of a Bacteriophage:**
The phages are the best understood of all viruses. Research on phages led to the discovery that they can reproduce by two alternative mechanisms, the lytic cycle and lysogenic cycle.

**i) The Lytic Cycle:**
A viral reproductive cycle that culminates in death of the host cell is known as a lytic cycle. The term refers to the last stage of infection, during which the bacterium lyses (breaks open) and releases the phages that were produced within the cell. Each of these phages can then infect a healthy cell and a few successive lytic cycle can destroy the entire bacterial colony in a few hours. A virus that produces only by a lytic cycle is a virulent virus. Figure 5.6 uses the virulent phage $T_4$ to illustrate the steps of a lytic cycle.

**a)** The $T_4$ phage uses its tail fibers to stick to specific receptor sites on the outer surface of an E.coli cell (Escherichia coli).

**b)** The sheath of the tail contracts; thrusting a hollow core through the wall and membrane of the cell. The phage injects its DNA into the cell.

**c)** The empty capsid of the phage is left as a "ghost" outside the cell. The cell's DNA is hydrolysed.

**d)** The cell's metabolic machinery, directed by phage DNA, produces phage proteins, and nucleotides from the cell's degraded DNA, are used to make copies of the phage genome. The phage parts come together. Three separate sets of proteins assemble to form phage heads, tails, and tail fibers forming daughter phages.

**e)** These phages then direct production of lysozyme, an enzyme that digests the bacterial cell wall. With a damaged wall, osmosis causes the cell to swell and finally to burst, releasing 100 to 200 phage particles.

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| During the lytic cycle of a bacteriophage, the bacterial cell dies when the viral particles burst from the cell. During the lysogenic cycle, viral DNA is integrated into bacterial DNA for an indefinite period of time. |

### ii) The Lysogenic Cycle:

In contrast to the lytic cycle, which kills the host cell, the lysogenic cycle replicates the viral genome without destroying the host. Viruses that are capable of usingboth modes of reproduction within a bacterium are called temperate (lysogenic) viruses. To compare the lytic and lysogenic cycles, we will examine a temperate phage called lambda, abbreviated with the Greek letter λ: Phage resembles$T_4$, but its tail has only a single, short tail fiber which may be absent.
Infection of an E.coli cell by λ begins when the phage binds to the surface of the cell and injects its DNA (Fig. 5.7) within the host, the DNA molecule forms a circle. What happens next, depends on the reproductive, lytic cycle or lysogenic cycle. The DNA molecule is incorporated by genetic recombination into a specific site on the host cell's chromosome (chromatin body). It is then known as a prophage. One prophage gene codes for a protein that represents most of the other prophage genes. Thus, the phage genome is mostly silent with in the bacterium. How, then does the phage reproduce? Every time the E.coli cell prepares to divide, it replicates the phage DNA alongwith its own and passes on the copies to the daughter cells. A single infected cell can soon give rise to a large population of bacteria carrying the virus in prophage form. This mechanism enables viruses to propagate without killing the host cells upon which they depend.
The term lysogenic implies that prophages can, at some point, give rise to active phages that lyse their host cells. This occurs when the λ genome exits the bacterial chromosome. At this time, the genome commands the host cell to manufacture complete phages and then self-destruct, releasing the infectious phage particles. It is usually an environmental trigger, such as radiation or the presence of certain chemicals, that switches the virus from the lysogenic to the lytic mode.

### 5.2.4 Viroids and prions are infectious agents even simpler than viruses:

As small and simple as viruses are, the dwarf another class of pathogens, viroids. These are tiny molecules of naked circular RNA that infect plants. Only several hundred nucleotides long, viroids do not encode proteins but can replicate in host plant cells, apparently using cellular enzymes. Somehow, these RNA molecules can disrupt the metabolism of a plant cell and stunt the growth of the whole plant.
An important lesson from viroids is that a molecule can be an infectious agent that spreads a disease. But viroids are nucleic acid, whose ability to replicate is well known. More difficult to explain is the evidence for infectious proteins, called **prions**. Prions appear to cause a number of degenerative brain diseases, including scrapie in sheep and the "mad-cow disease." How can a protein, which cannot replicate itself, be a transmissible pathogen? According to one hypothesis, a prion is a misfolded form of protein normally present in brain cells. When the prion gets into a cell containing the normal of the protein, the prion somehow converts the normal protein to the prion version. In this way, prions might repeatedly trigger chain reactions that increase their numbers.

### 5.2.5 Viral Diseases: (Transmission / Spread and Control)

### i) Animal Diseases:

Several of the animal viruses cause important diseases. **Poliomyelitis** caused by **poliovirus** was a wide spread, crippling disease through the first half of the twentieth century. Although poliomyelitis is now largely under control "by vaccination in the industrialized countries, it remains a serious and common disease in the tropics and elsewhere in the less developed parts of the world.
**Colds** are viral infection of the upper respiratory tract. About one third of all colds are caused by the **rhinoviruses,** which are unenveloped plus-strand RNA viruses. There are dozens of different strains of cold-causing rhinoviruses alone, each of

them with different properties and none conferring cross-immunity to the others. More than200of viruses that cause colds have been identified, which makes the development of appropriate immunization methods very difficult, if not impossible.
Virus cause many widespread diseases, such as many kinds of **encephalitis,dengu**e and **yellow fever.** They are classified as **arboviruses** (arthropod-borne viruses) together with many unrelated viruses, because they are transmitted by insects and other arthropods.
**AIDS** (Acquired Immune Deficiency Syndrome) caused by HIV (retro viruses) was discovered in 1985.
**Rabies,** which was the subject of the path-breaking discoveries of Louis Pasteure in the nineteenth century, is caused by a **rhabdovirus** (rod shaped). A second group of minus-strand RNA viruses, the **paramyxoviruses,** includes those that cause **measles** and **mumps** in humans.
Today rabies is most often spread by small, mammals such as dogs, racoons and foxes. Fortunately, it is a simple matter to vaccinate pets against rabies, and human vaccines are also being developed. The rabies virus is spread by the saliva of the host animal, often after bites, but it can also be contracted from handling a dead infected animal. An animal infected with rabies may go into a mad frenzy, often running great distances in its confusion.
The **flu viruses, minus-strand RNA viruses**, resemble balls studded with spikes. Recombination of the genetic material of the flu viruses appears to play the critical role in causing worldwide flu epidemics.
The majority of human viral diseases are spread through droplet Infections possibly via wounds in skin, infected saliva, via human faeces etc. It may be through vectors (arthropods) or sexual intercourse (homo or heterosexual), handling of contaminated objects etc. Immunity or vaccination are the two best controls of viral diseases.

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| Viruses cause diseases in plants and animals. They have also been implicated in the development of cancer. |

**ii) Plant Diseases:**
We have already discussed one of the best known plant disease called tobacco mosaic virus. Plant viruses can stunt any plant growth and diminish crop yields. There are two major routes by which a plant viral disease can spread either by **Horizontal Transmission** or **Vertical Transmission**. In the first, a plant is infected from an external source of virus through injured parts or through insects. In the second, a plant inherits a viral infection from a parent.
Agriculturists have not yet devised cure for most viral diseases of plants. Therefore, their efforts have focused largely on reducing the incidence and transmission of such diseases and on breeding genetic varieties of crop plants that are relatively resistant to certain viruses.

### 5.2.6 Human Immuno deficiency Virus (HIV) — A RETROVIRUS

**AIDS — Symptoms, Transmission and its control**
In HIV, the infectious agent that causes AIDS, the glycoproteins of the envelope enable the virus to bind to specific receptors on the surface of certain white blood cells, although there are two RNA molecules. They are identical, not complementary strands.
**Acquired Immune Deficiency Syndrome (AIDS)** is a disorder which impairs the body's lymphocytic cell $T_4$ immune system in humans, in that the virus replicates within the $T_4$ or helper cell. Thus these cells can no longer help or induce other T cell, called killers, to fight invaders. The body's immune system breaks down, leaving the patient exposed to a variety of diseases.

It is important to realise, however, that infection with the virus (HIV) does not necessarily result in AIDS. As with other diseases, some people remain symptom less and are therefore termed carriers.

**Transmission**

The HIV-Virus can only survive in body fluids and is transmitted by blood or semen. In 90% of cases the transmission is achieved by sexual contact. People can contract the disease through:

**i) Intimate sexual contact:** It passes from the infected partner to his/ her unaffected partner through sexual contact.

**ii) Infected blood entering the bloodstream:**

**(a)** AIDS can also be contracted by intravenous drug users practising self-injection by means of unsterilised needles and syringes. HIVhas spread rapidly amongst intravenous drug users. Once in the blood stream of the drug addict it can be further passed on through sexual activity, not only to other drug users but also to the general public.

**(b)** Blood transfusions have unfortunately contracted the disease after being given blood or blood products already infected with HIV.

**(c)** Close contact between infected and non-infected people through cuts and open wounds has also been known to pass on the virus.

**(d)** Other ways: An infected pregnant woman can pass on the virus to her baby through the placenta at birth or through breast milk during suckling.

**Signs and Symptoms and Nature of the disease:**

Current information suggests that 1-2% of HIV infected persons will develop AIDS each year, and that 5-10% of HIV infected persons will develop AIDS-related symptoms each year.

First signs and symptoms are a short flu-like illness followed by no further effects for months or years. AIDS involves a defect in the cell-mediated immune response, hence the term immune deficiency. Opportunistic infections then ensue, that is micro-organisms that we normally live with, and which we can easily destroy, may cause killer diseases. Cause of death is commonly a rare type of pneumonia, many patients suffer a rare and disfiguring from skin cancer known as **Kaposi's sarcoma.** Other common signs and symptoms of AIDS included weight loss, fever, dementia, diarrhoea, septicaemia (blood poisoning) and other forms of cancer. Severity of immune deficiency varies and bouts of illness may persist for years.

By affecting lymphocytes, HIV may directly infect brain cells in more than 50% of cases, causing irreversible dementia and eventual death. The brain shrinks, with a loss of memory and mental agility, and behavioural changes occur.

**Control—Treatment and Prevention**

An enormous international effort is being made to devise methods of treating and preventing the disease. There are two lines of research, one into developing drugs which can be used to cure the disease, and one into developing a vaccine. Both approaches are at an early stage and require heavy financial investment. In the short-term the aim is to develop drugs to inactivate the virus, by blocking the pathogen's metabolism.

The best known drug used by 1987 was azidothymidine or zidovudine (formerly known as AZT) which slows progression of the disease and can attack the virus even in the brain (a major reservoir of infection) other drugs are being examinedsuch as Ribavarrin a drug used to treat other viral infection which has been found to suppress the AIDS virus under laboratory conditions. Sumarin, an antiparasitic drug has also shown encouraging results inhibiting viral reproduction in host.

**Prevention:**
The reduction in the spread of HIV could be brought about by the use of clean needles and sterilized syringes by drug addicts.
Education about the disease has an important part to play particularly in reassuring the public about the real risk. There is no evidence that infection can occur by droplet infection through the nose or mouth, or by casual contact such as shaking hands etc.

### 5.2.7 Hepatitis: A Serious Health Risk:
Hepatitis is an inflammation of the liver. It may be due to viral infection, toxic agents or drugs. It is characterized by jaundice, abdominal pain, liver enlargement, fatigue and some times fever.
There are various types of hepatitis.

**Hepatitis — A** is transmitted by contact with faeces from infected individuals. It is caused by enveloped RNA Virus.

**Hepatitis — B** (serum hepatitis) is caused by unusual DNA Virus.

The causative agent of hepatitis B. contains a small, circular molecule of partly, but not completely, double stranded DNA. The viral genome encodes two kinds of proteins, a core protein and a surface protein, as well as DNA polymerase.
The amount of genetic information in the hepatitis B viral genome-359 nucleotides-is less than that of any other pathogen, except of the viroids.
The hepatitis B virus poses a serious public health problem, particularly among Asians, Africans, and male homosexuals. It often persists in carriers without causing any symptoms, but it may still be highly infectious. People infected early in life often become carriers, and it is estimated that there are about 200 million such carriers worldwide. Since most of these people are not recognized as carriers, there is a real possibility of the frequent transmission of hepatitis through skin contacts, blood transfusion, and similar medical procedures. Not only is the hepatitis itself serious, but the virus also may play a role in causing human liver cancer, even among carriers, who show no other symptoms. New vaccines against the virus have been produced by recombinant DNA techniques and are of great importance, specially for those who require frequent blood transfusions, and other who run a severe and continuing risk of infection.

**Hepatitis — C** passes through blood transfusion, from mother to child during pregnancy and by sexual contact.

## KEY POINTS

- Living organisms are classified on the bases of homologies, comparative biochemistry, cytology and genetics.
- It is principally the homologous structure that one consider in grouping animals in a classification scheme.
- Sometimes it is impossible to classify organisms using morphological criteria, so one resorts to comparing the chemical substances which they contain.
- The basic unit of biological classification is the species.
- Previously organisms were divided into two kingdoms. The animal kingdom and the plant-kingdom.
- Whittaker proposed in 1969 that living organisms may be divided into fivekingdom.
- L. Margulis and K. Schwartz suggested that multicellular algae should be removed from the plant kingdom and placed alongwith all unicellular organisms, in a new kingdom called the Protoctist which would replace Whittaker's protistkingdom.
- The word virus is derived from a latin word meaning "Poison".
- Viruses are noncellular parasitic entities.
- Viruses may consist of viral-genomes, capsids, envelopes and tail fibres.
- A viral reproductive cycle that culminates in death of the host cell is known as Lytic Cycle.
- In contrast to lytic-cycle, which kills the host cell, the lysogenic cycle replicates the viral genome without destroying the host.
- Viruses cause many widespread diseases, such as yellow-fever, rabies, measles, mumps, aids etc.

## EXERCISE

**1. Encircle the correct choice:**

(i) Which branch of Biology is considered as the final main helping inclassifying organisms?
(a) Homology (b) Cytology
(c) Morphology (d) Genetics

(ii) Closely related orders are grouped together into
(a) Genus (b) Family
(c) Class (d) Division

(iv) Characteristically viruses are:
(a) Acellular (b) Cellular
(c) Non-cellular (d) Unicellular

(v) The adhesion properties of viruses are determined by:
(a) Proteins that make up their coats and envelop
(b) Viral DNA that they contain
(c) Viral RNA that they contain
(d) Viral Genomes that they contain

(vi) Which characteristic is not associated with Lytic-cycle
(a) Death of host cell (b) Viruses are virulent
(c) Formation of prophage (d) Bacterial cell fails to reproduce

(vii) Measles and mumps in humans is caused by:
(a) Rhinoviruses (b) Arbovirueses
(c) Paramyxoviruses (d) Rhabdovirueses

(viii) Thing not associated with Aids:
(a) Imparing of immune system
(b) Arboviruses
(c) Virus can only survive in human body fluid
(d) HIV

(ix) Hepatitis - type which pass through blood from mother to child during pregnancy.
(a) Hepatitis - A (b) Hepatitis - B
(c) Hepatitis - C (d) Hepatitis - D

(x) Previously living organisms were divided into plant and animal kingdoms mainly due to:
(a) Presence or absence of cell-wall (b) Type of nucleus
(c) Presence or absence of chlorophyll (d) Mode of nutrition

**2. Write detailed answers of the following questions:**

(i) What are the bases of classification of living organisms?
(ii) What do you mean by Taxonomic Hierarchy?
(iii) What changes are proposed by Marguiles and Schwartz in the five kingdom systems of R.Wittaker?
(iv) Give structure, characteristics and classification of viruses.
(v) Describe lytic cycle and distinguish it from lysogenic cycle.

**3. Write short answers of the following questions:**

(i) What is species?
(ii) Define taxonomy.
(iii) Point out the three problems with having only two kingdoms.
(iv) What was the major snag in Whittaker's scheme?
(iv) What modifications were suggested by Margulis and Schwarts and Whittaker's scheme?
(v) Name the five kingdoms of living organisms.
(vi) Name the different parts of viruses.
(viii) What do you mean by plus and minus — Strand RNA viruses?

**4. Define the following terms:**

(i) Species
(ii) Binomial nomenclature
(iii) Bacteriophage