Lesson: Introduction to cell

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Cell is unit of life

When you see the world around you, a distinction between living and nonliving can be made immediately. Let us see, how do you distinguish between these two?

The organisms, which are living, are able to grow (i.e., there is increase either in size of the organism, or in their mass), they can utilize energy from their surrounding for their growth, and they are able to reproduce i.e. they produce the progeny of their kind.

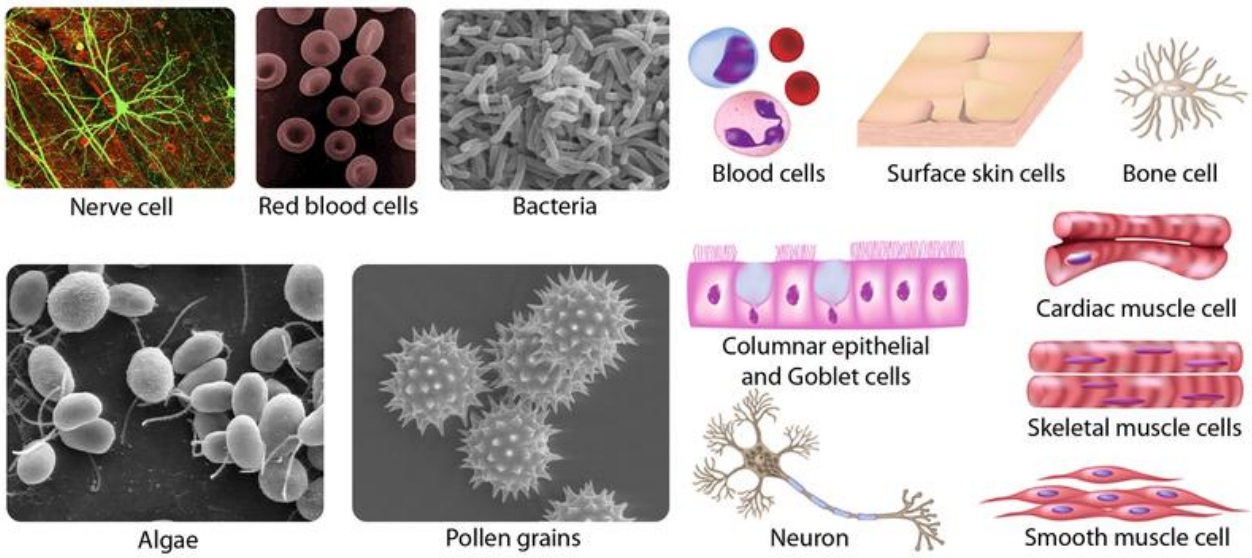


Figure: You see a great diversity of living organisms both in size, as well as in shape. Source: http://cimg1.ck12.org/datastreams/f-d%3A0517ff938b6d399c6c915fba103f142ed29e82bf4e8d71e7deccf02e%2BIMAGE%2BIMAGE.1 (CC-BY-SA)

Some of the living organisms are so small that you are not able to see them with your unaided eyes, These are smaller than 0.1 mm and are called microorganisms. Others can be as big as 300 meters e.g. redwood trees.

Microscopic study of all organisms suggests that they are made up of cells. Like a house, in which bricks are the basic unit of structure, **cells are the basic unit of structure and function** of all the living beings. Some organisms are made up of single cell and are called unicellular, while others have many cells, so are called multicellular.

In this chapter you will learn about: -

1. The characteristics of a living cell.
2. Discoveries that led to understanding of cell structure and cell function.
3. How did the concept of cell biology evolve?

4. Cell types and cell sizes.
5. Some of the acellular structures.

Characteristics of living cells

All the living cells have following characteristics:-

- Presence of a membrane around the cell, which restricts entry to only certain molecules, besides allowing free passage to water and to some of the gases such as oxygen and carbon-di-oxide. The membrane is able to separate the inside space of the cell from the surroundings. This helps in keeping the environment of the cell at optimal level suitable for various chemical reactions occurring inside the living cell.
- The cell has its own energy generating system. The energy, which is produced by the cell, is conserved in the form of ATP and it is this form of energy, which is utilized for various life functions.
- A cell has its own genetic information, which it has received from its parent cell.
- The cell has its own machinery by which it can copy, and translate the genetic information, which is present in it in the form of polymer of nitrogen bases. This information is translated to the sequence of amino acids of a protein molecule by the cell machinery.
- The cell is able to produce its own kind i.e. the cell is capable of forming new daughter cells. In plants this capacity of cell division is limited to the meristematic tissues, such as stem meristems, root meristems and intercalary meristems.

History of Cell Biology

Discovery of the cell was dependent on the invention and improvement of the microscope, the equipment used to observe the structures having dimensions lesser than 0.1 mm. Janssen had invented the first compound microscope in 1590 with the magnification of 9X. Robert Hooke used it in 1665 for the first time to observe a thin section of cork (cork was the piece of bark, which is outer dead layer of tree and it was being used as a stopper of the bottles). He observed that the section was like a honeycomb structure. It had a number of compartments, which were separated by a wall. He considered the wall as a living structure, which was enclosing the empty space. These empty spaces were called as 'Cells'. He thought these cells to be the containers of 'noble juices' or 'fibrous threads' of once living

cork trees. He published his observations made with the microscope in the book *Micrographia.*

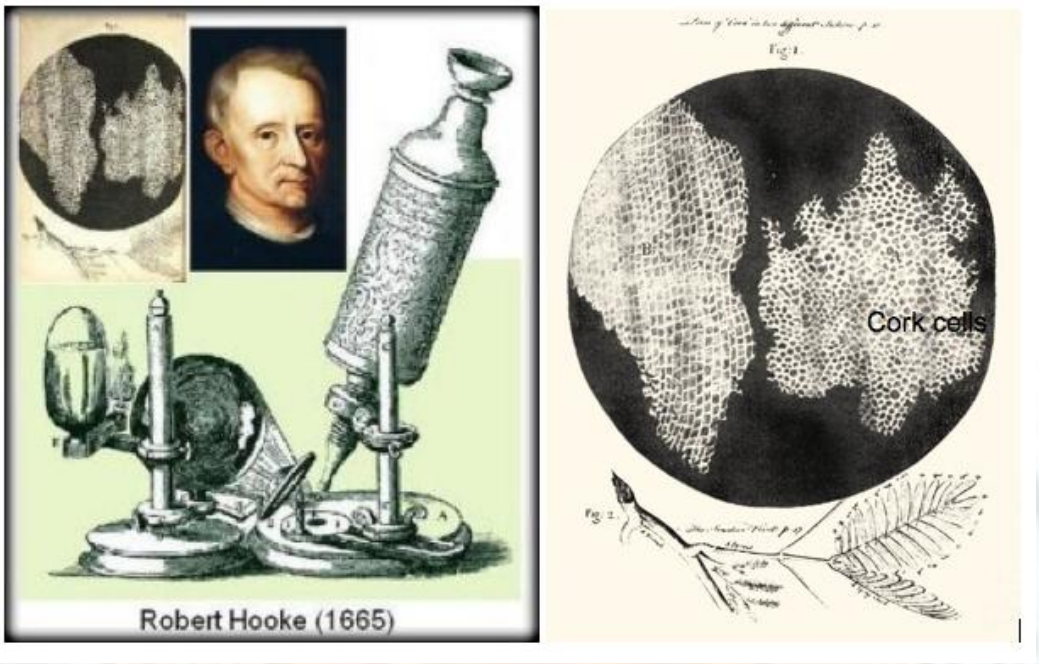


Figure: Robert Hooke (1665) used the first compound microscope to observe the cells (cork) .

Source: http://historymicrobio.files.wordpress.com/2012/07/robert-hooke.jpg?w=252&h=300, http://blogs.scientificamerican.com/history-of-geology/files/2013/07/HOOKE_1665_Micrographia_Cell.jpg

Anton Van Leeuwenhoek improved the lens system. Using the improved lens, he observed a number of moving structures in a drop of pond water, which he called *'animalcules'*. Similarly, Nehemiah Grew studied the sections of plant tissues and concluded that all the tissues consist of cells.

A brief historical account of the landmark researches is given in the table.

Table: History of Cell Biology

Source: Author

Year	Name of the Scientist	Contribution
1590	Janssen	Invented the compound microscope, which combines two lenses for greater magnification.
1665	Robert Hooke	Published *Micrographia*, in which he describes and

		illustrates the cellular structure of cork – using the term 'cell' to describe the basic units, he thought that cells were empty and walls were the living material.
1650-1700	Antony van Leeuwenhoek	Improved microscopic lens system and observed unicellular life forms including bacteria, which he described as *animalcules.*
1700-1800	Nehemiah Grew and Marcello Malpighi (were called founders of plant anatomy)	These were the first to use microscope to study morphology of plants and the drawings of the tissues were published in the book 'The Anatomy of Plants' although microscope was not improved.
1790	Peter Dollond	Improved quality of lenses. This was followed by rapid interest in microscopy.
1828	Wöhler	Synthesized urea in the lab discrediting the view that organic compounds can only be made by living things.
1831-33	Robert Brown	Reported existence of nuclei and also observed 'Brownian movement.
1838-39	Schleiden (Botanist) and Schwann (Zoologist)	Proposed the cell theory
1840	Johannes E. Purkinjee	Coined the term protoplasm.
1855	Rudolph Virchow	Proposed that cells arise from the pre-existing cells.

1866	Ernst Haeckel	He established that nucleus was responsible for storing and transmitting hereditary characters.
1805-72	Hugo von Mohl	Discovered Cell division, mitosis was was studied by W. Flemming 1882, Meiosis by Edonard van Beneden (1883, 1884)
1890	Waldeyer	Coined the term chromosomes to describe the filamentous structures, which became visible in the nucleus of cells (of *Ascaris* sp.) at the time of cell division.
1897	Edward Buchner	Alcoholic fermentation can be carried on by cell free extract of yeast.
1887-1900 Improvement in microscope.		
1907	Ross Harrison	Developed ways of growing isolated animal cells (frog nerve cells) in the lab so that future studies of cellular functions can be carried out under controlled conditions.
1931	Max Knoll & Ernst Ruska	Developed electron microscope, which improved the resolution of microscope to a great extent so that subcellular structures could be studied.

You will notice in the information given, that the knowledge about the structure of cell improved with the improvement in the resolving power of the microscopes. Not only that,

the activities which were once thought to be occurring only inside a living cell, could be reproduced outside the cell i.e. in the lab, for example Wöhler demonstrated that urea, which was once thought to be produced only by living beings only, could be synthesized in lab. So, it was understood that a number of molecules were being synthesized and broken down inside a living cell. That was the beginning of understanding of cellular chemistry.

Further, with the advancement of other techniques, such as cell fractionation, it was possible to isolate various cell components and associate various cellular functions with them. Almost at the same time it was also shown that cells were capable of producing its own type by cell division and the Mendelian factors which were responsible for transmission of heredity were actually localized in the nucleus of the cell. So, increase in the knowledge about cell structure (cytology), chemical reactions taking place within the cell (biochemistry) and cell reproduction (cytogenetics) took place simultaneously. All the information when converged, gave rise to a new discipline called 'Cell Biology'.

Staining techniques were improved both for light and electron microscopy. Techniques were also developed to visualize the living cells such as phase contrast microscopy, and fluorescence microscopy. It is possible to image viruses and large macromolecules by using magnetic resonance force microscope. Flow cytometry is being used to characterize and separate each specific cell. Ultra centrifuges have been developed which are capable of very high speeds, over 100,000 revolutions per minute! These can subject samples to forces exceeding 500,000 times of the force of gravity. These are used to separate and characterize the sizes of the biomolecules such as proteins, nucleic acids etc.

Biochemical techniques such as chromatography, and electrophoresis were developed which helped in isolation and characterization of various biomolecules. Mass spectrometry is used in the lab to characterize the protein molecules besides use of X-ray diffraction spectrometry. This technical advancement helped in understanding the cell structure and function.

Cell is the basic unit of structure and function

The cell theory or cell doctrine postulates –

i) All living substance is concentrated in cells.
ii) Cells in an organism are all individuals of the same organizational rank.
iii) Cell is the basic unit of structure and function.
iv) An organism is an aggregate of cells, which are its building blocks.
v) The action of an organism is the sum of many action of different kind of collaborating cells.

vi) All cells arise from pre-existing cells.

Simple organisms are unicellular, i.e. they consist of single cell which is capable of performing all the functions of living beings, while more complicated organisms consist of several cells and hence are called multicellular.

In a multicellular organism, many cells with similar structure and similar functions are organized to make a **tissue**. Different types of tissues, which are organized to carry out a particular function, are called **organs**, e.g. leaf is one of the organ, which function to synthesize food for the plant. In leaves similar cells are organized to form the epidermis of leaf, while other types of cells containing chloroplast are organized to from another type of tissue i.e., mesophylls.

Function of epidermal cells in the leaf is the protection of inner tissues, while that of chlorophyll containing mesophyll cells is to harvest the sunlight to prepare food. Xylem cells of vascular bundles (leaf veins) conduct water and minerals from soil to the leaf while function of phloem cells is to conduct sugar form site of its synthesis to different parts of the plant.

Different tissues such as epidermis, mesophylls and vascular bundles together make an organ such as leaf. An **organism** such as plant has different organs such as leaf, stem roots, flower, which perform specific function. Activities of an organism are the sum of coordinated activities of different organs. So, we see that it is the cell, which is the basic unit of structure and function of an organism.

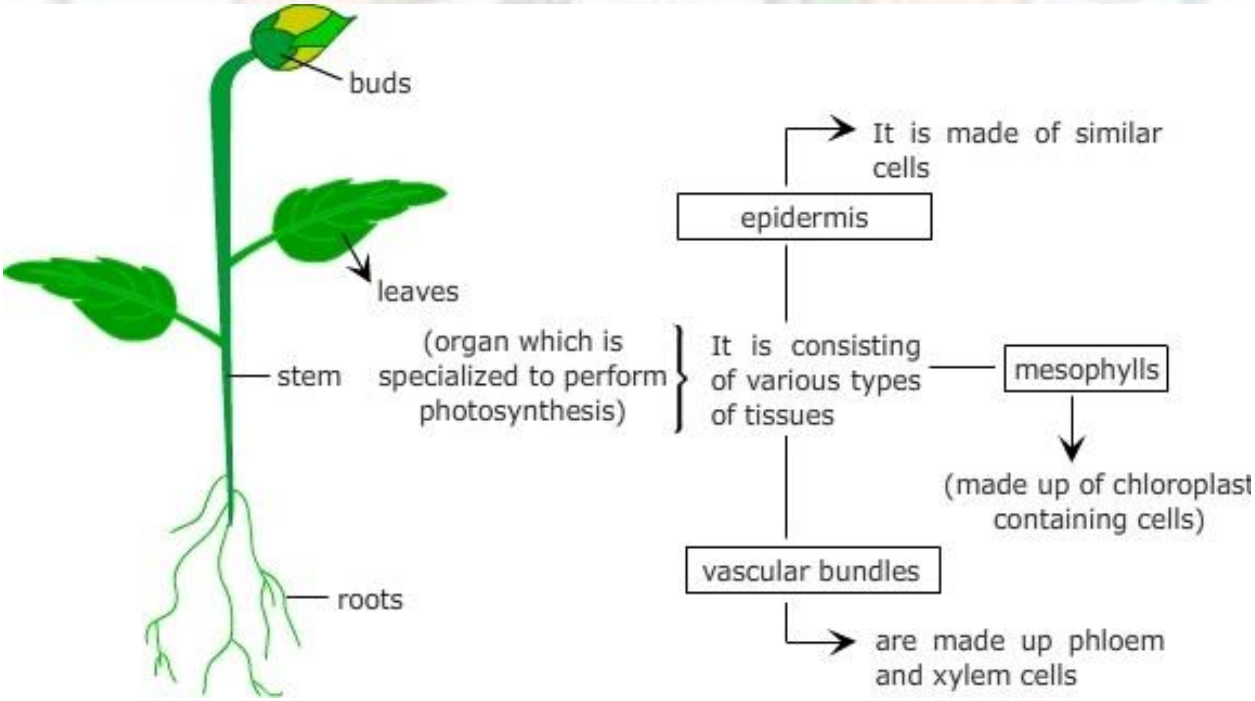
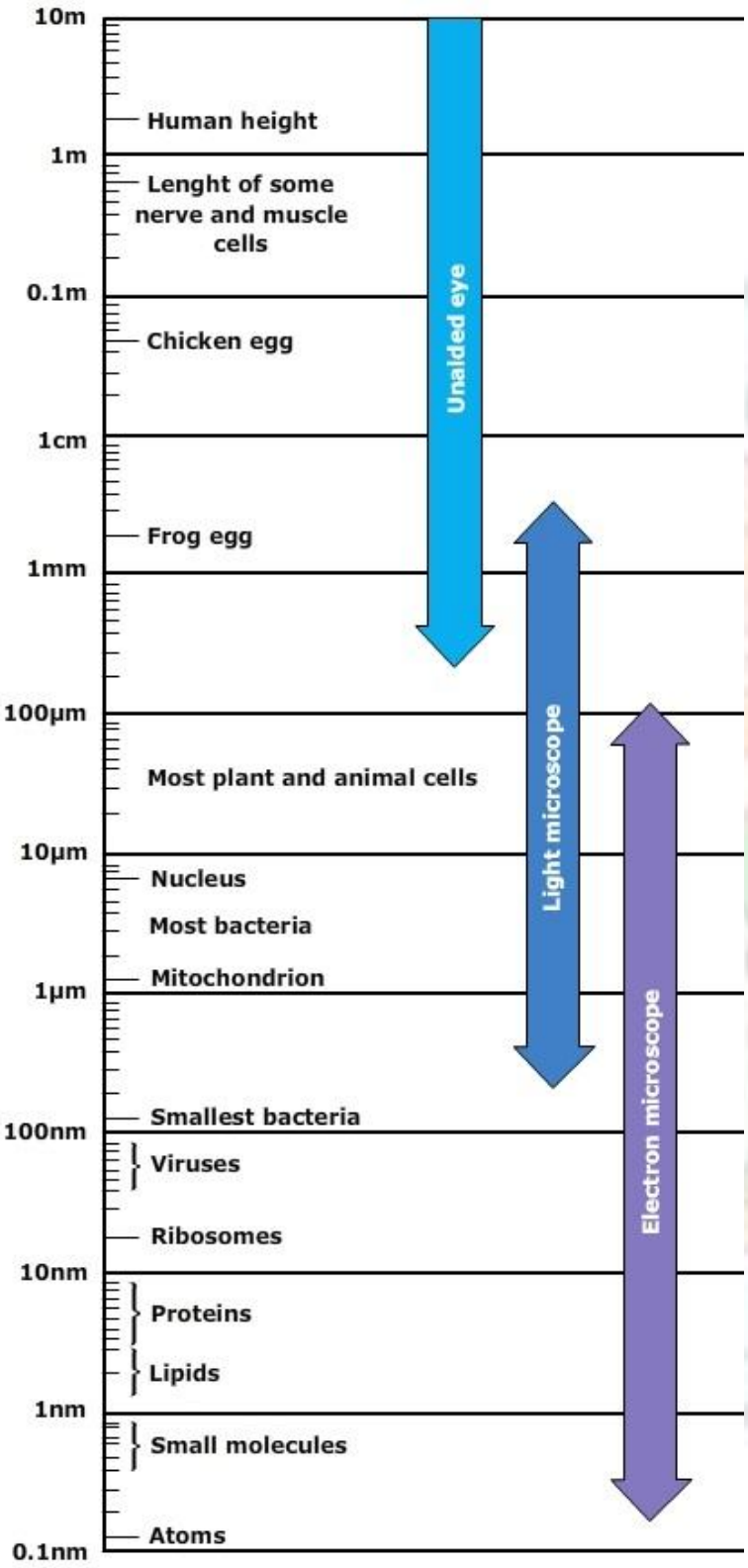


Figure: Showing cell as a unit of structure and function

Source: Author

Cell size

A great diversity in size of the cells is observed. Smallest living cell is that of *Mycoplasma*, with a minimum size of 1000 A° in diameter. Size of other bacteria may vary with a minimum size of 5000 A° for the *cocci* bacteria to 20 μm in length for some of the filamentous forms. Blue green algae are approximately 10 μm in diameter while RBCs of human blood are 7-8 μm in diameters. One of the flagellates, *Euglena*, can have the size up to 0.5 mm in length. The diatoms may be up to 100 μm or more in length. Amoeba is one of the largest unicellular organisms, which is about 1000 μm in length. Cells of most of the tissues of plant and animals have the size range of 20-30 μm. Largest single cell is the yolk of ostrich egg, which is about 5 cm. while size of the ovum in humans is 200 μm, and head of the spermatozoa measures 5 μm in length, with a tail of 30-50 μm in length.



1 centimeter (cm) = 10^{-2} meter (m) = 0.4 inch
1 millimeter (mm) = 10^{-3} m
1 micrometer (µm) = 10^{-3} mm = 10^{-6} m
1 nanometer (nm) = 10^{-3} µm = 10^{-9} m

Figure: Diversity in cell size

Source: Author

Cell Types

Right from simple unicellular organisms (such as *Mycoplasmas*) to the cells of complex multicellular organisms such as mammals, cells exhibit the common characteristics of living beings, which you have studied in the preceding text.

Earlier all the organisms were classified on the basis of apparent external morphologies. These were classified either as plants or animals. However, some of the organisms could neither be classified as plants nor as animals, such as bacteria or fungi. Though, these organisms did not possess chloroplasts, because of presence of rigid cell wall structure they were still classified along with plants. On the contrary due to absence of rigid cell wall, *Euglena* was placed in animal kingdom, even when chloroplasts were present like that of plants. So, system of classifying the living beings was modified. In early 1960s, Hans Ris classified all the organisms on the basis of cell structural organization. He used the terms **prokaryotes** and **eukaryotes** to describe the organisms on the basis of absence or presence of a well-defined nucleus.

In this lesson you will learn about –

1. Structure of Prokaryotic and eukaryotic cell

2.Comparison of the structure of prokaryotes and eukaryotes.

Prokaryotic cell

Characteristics

Prokaryotes include the most diverse organisms. Scientists believe that there are more than $5x10^{30}$ prokaryotes on earth. These have been found in most diverse habitats, ranging from being parasitic on animals/plants to the cytoplasm of prokaryotes, from distilled water to marine conditions, from Antarctic glaciers to thermal hot.

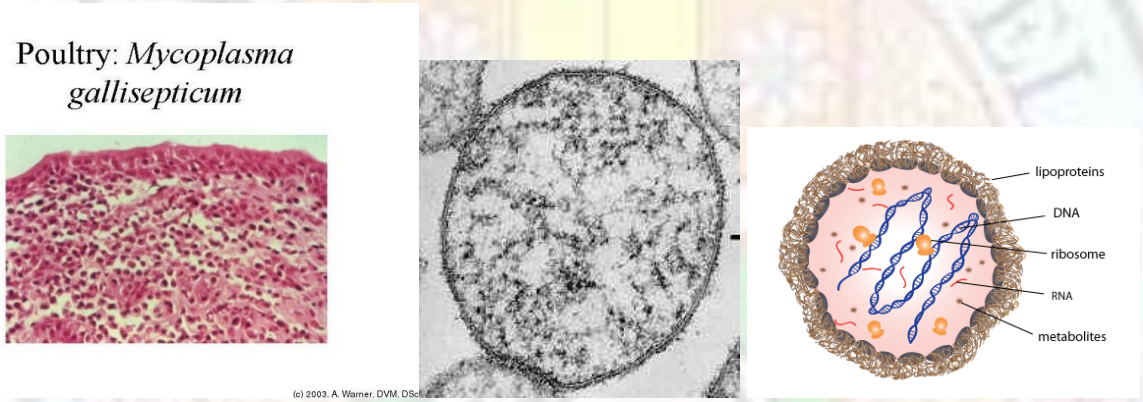
The term prokaryote is derived from Greek world, i.e. *pro* – means before and *karyon* – means nucleus. These are the cells, which have primitive nucleus and lack membrane bound organelles. These are single celled organisms in which genetic material is not separated from rest of the cell by membrane.

The prokaryotes can be classified as Bacteria and the Archaea (The Eukarya forms the third domain in the three domain classification) on the basis of molecular evolution (http://www.pnas.org/content/74/11/5088.full).

Diversity of prokaryotic cell

Mycoplasma

The smallest prokaryote is *Mycoplasma genetalium* with a size ranging from 0.2 µm to 0.8 µm. These prokaryotes lack cell wall but have tough cytoplasmic membranes. Many contain sterols in their membranes that give rigidity to the membrane. It is the living organism with the smallest known genome. It is believed to possess minimum complement of genes essential for life. There are around 480 protein-coding genes (in the genome of 5,80,070 nucleotide pairs), out of which 100 genes are of unknown function. This organism survives as a parasite in mammals, or survives on many readymade molecules supplied by the environment. However, it can synthesize its own large molecules, i.e., DNA, RNA and proteins, so that it is able to replicate. These are called *Mycoplasmas* because of their filamentous forms, which resemble filaments of fungi. These are facultative or obligatory anaerobes and colonize in animal or human bodies.



A **B** **C**

Figure: A. Section of poultry tissue showing presence of *Mycoplasma;* B. electron micrograph of a single cell and C. a diagrammatic representation

Source: http://ocw.tufts.edu/data/27/367629/367647_xlarge.jpg, http://serrano.crg.es/images/mycoplasma_EM.jpg,http://www.invivogen.com/images/Mycoplasma.gif

Bacteria

Bacteria include all other prokaryotes except Archaea.

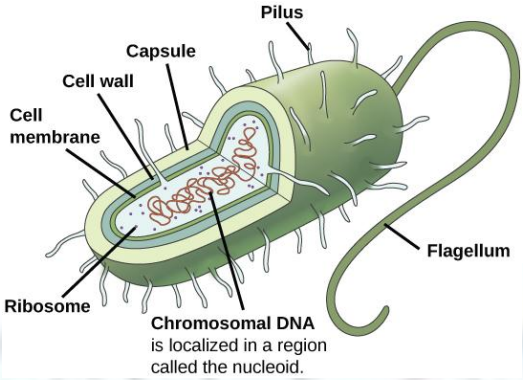


Figure: Structure of a typical prokaryotic cell

Source: http://cnx.org/content/m44605/latest/Figure_22_02_02.jpg (CC-BY-SA)

Cell is generally surrounded by cell wall. The region of the cell where genetic material is present is called 'nucleoid'. Chemical composition of prokaryotic cell wall is different from the cell wall of a plant cell. Cell wall of prokaryotic cell is made up of peptidoglycan, while plant cell wall is consists of mainly cellulose along with other heteropolymers.

In prokaryotes, DNA is not complexed with histones. Besides, unlike eukaryotic cell where the DNA present is linear, the DNA present in prokaryotes is circular. No membrane bound organelles are present in prokaryotic cell. Cytoskeletal filaments, if present, are much simpler in their structure and function. Prokaryotic cells have their own protein synthesis machinery, i.e. they have all the enzymes required for DNA duplication, transcription, and protein translation. The ribosomes present in prokaryotic cell are different from that of a eukaryotic cell. These are 70 S types and contain fewer components in comparison to that of eukaryotic cells where cytoplasmic ribosome are 80 S types.

Image:http://www.pc.maricopa.edu/Biology/rcotter/BIO%20205/LessonBuilders/Chapter%204%20LB/cow95289_04_01.jpg

Prokaryotic cells divide by **binary fission**. DNA duplication occurs followed by division of the cell into two daughter cells. Each daughter cell receives only one copy of the duplicated DNA. No spindle apparatus is formed.

Prokaryotic cells possess single copy of DNA, so there is no meiosis. Sexual reproduction occurs by means of conjugation, where a part of DNA is transferred from donor bacterium to recipient bacterium, through a tube like structure connecting the two bacteria.Locomotion of a prokaryotic cell is caused by flagellum, which is very simple in structure. It consists of thin protein filament called 'flagellin'.

Archaea

The word, *Archaea* orginates from a Greek word *arachios,* which means ancient or primitive. These grow both in moderate and extreme environmental conditions. The most known groups in archaea or archaebacteria are the ones, which grow in extreme temperatures (thermophiles; *Pyrolobus fumarii* is found at 113 ° C), or in extreme pH (For e.g. *Picrophilus* sp. is found in acidic soils of Japan existing at pH of 0) or salt condition (halophiles) while, some Archaea generate methane gas (methanogens).

A. **B.**

Figure: Some of the habitats occupied by the hardy Archaeans: A.Yellowstone national park, U.S.A.; B. Salt deposits at Dead Sea

Source: http://media-3.web.britannica.com/eb-media/49/124149-004-25A47D1C.jpg

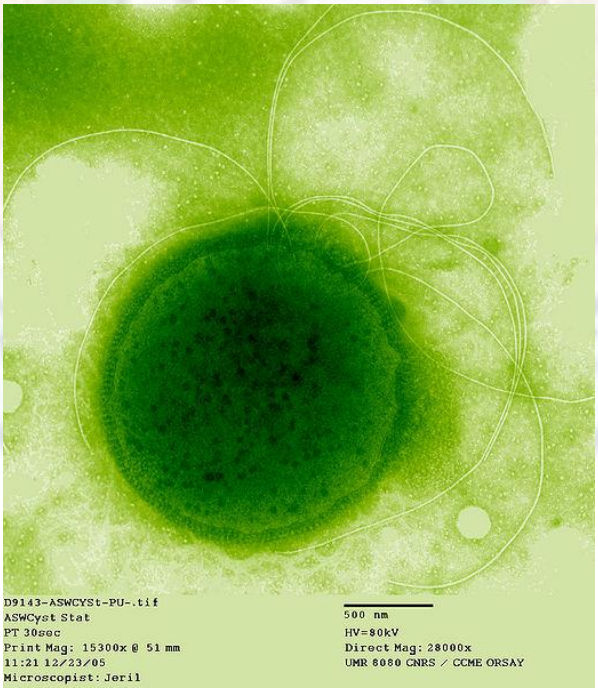


Figure: Micrograph of the Archaea *Thermococcus gammatolerans* that is known to survive at 160F in hot oxygen starved waters.

Source: http://commons.wikimedia.org/wiki/File:Thermococcus_gammatolerans.jpg

Archaebacteria differ from other prokaryotes in the following features:

i) Membrane lipids of archaebacteria have branched hydrocarbon chain and ether linkages.

ii) There is no peptidoglycan in their cell wall.

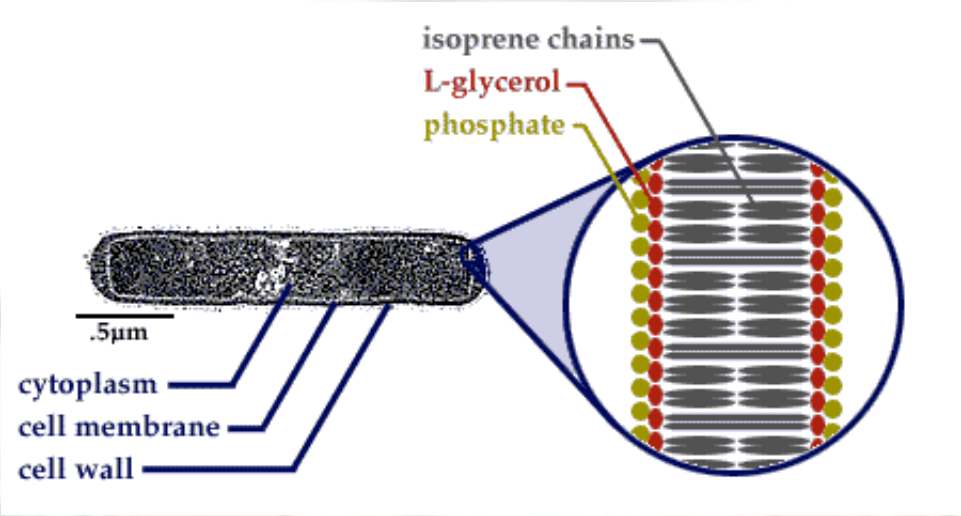


Figure: Archaeal cell membranes are different in possessing isoprene subunits

Source: http://www.ucmp.berkeley.edu/archaea/archaeamembrane.gif (Displayed with permission)

Archaebacteria resemble eukaryotes in the characteristic features that the starting codon AUG codes for methionine rather than N-formylmethionine. In other prokaryotes AUG codes for N-formylmethionine. Like bacteria the archaea divide by binary fisson.

For further details on archaea visit: http://www.ucmp.berkeley.edu/archaea/archaea.html, http://www.britannica.com/EBchecked/topic/32547/archaea ; (The discovery of Archaea - http://www.igb.illinois.edu/about/archaea).

Table: A comparative account of the eubacteria, archaea and eukaryotic cell is given in the table.

Source: Author

Characters	***Eubacteria***	***Archaea***	***Eukarya***
Cell wall	Made up of Peptidoglycan	Absent	Present in plant, chiefly made up of cellulose, hemicellulose and

			pectic substances
Lipids of the membrane	Unbranched hydrocarbons	Some branched hydrocarbons	Unbranched hydrocarbons
membrane bound organelles	absent	absent	present
Nuclear envelope	Absent	absent	present
histones	absent	Present in some species	present
chromosome	circular	circular	linear
Introns	Rarely present	Sometimes present	present
Initiator amino acid at the time of protein synthesis	Formyl-methionine	methionine	methionine
RNA polymerase	One type	Several types	Several types
Response to antibiotics such as streptomycin and chloramphenicol	Growth is inhibited	Growth is not inhibited	Growth is not inhibited.

Eukaryotic cell

The term, *eukaryote* was first of all used by Hans Ris in early 1960s, which means organisms, which possess true nucleus (Gr. *Eu*-true, *Karyon*-nucleus). The cells are characterized by the presence of nuclear membrane, which separates genetic material from rest of the cell. The size of the eukaryotic cell is much larger than that of prokaryotic cell.

Between the plasma membrane and nuclear envelope is present the cytoplasm. Many organelles are present in the cytoplasm, which have specific structure and function. The details about eukaryotic cell are discussed in the next chapter.

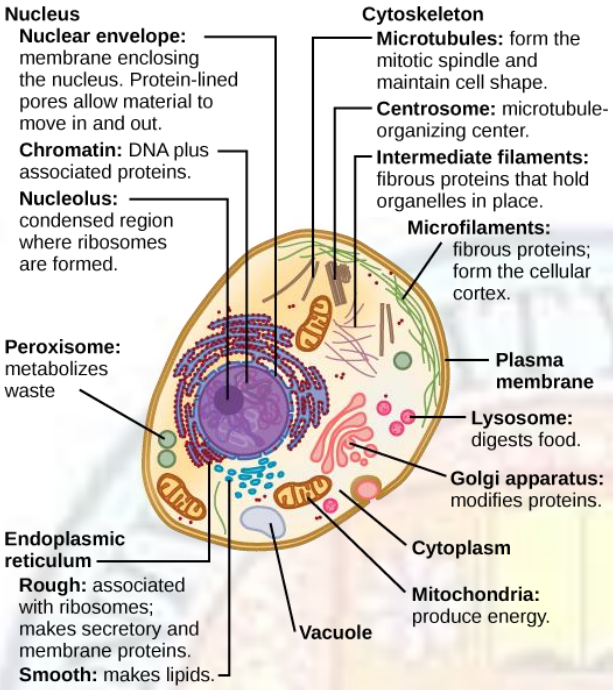


Figure: Animal cell

Source: http://cnx.org/content/m45432/latest/Figure_03_03_01a_new.png (CC-BY-SA)

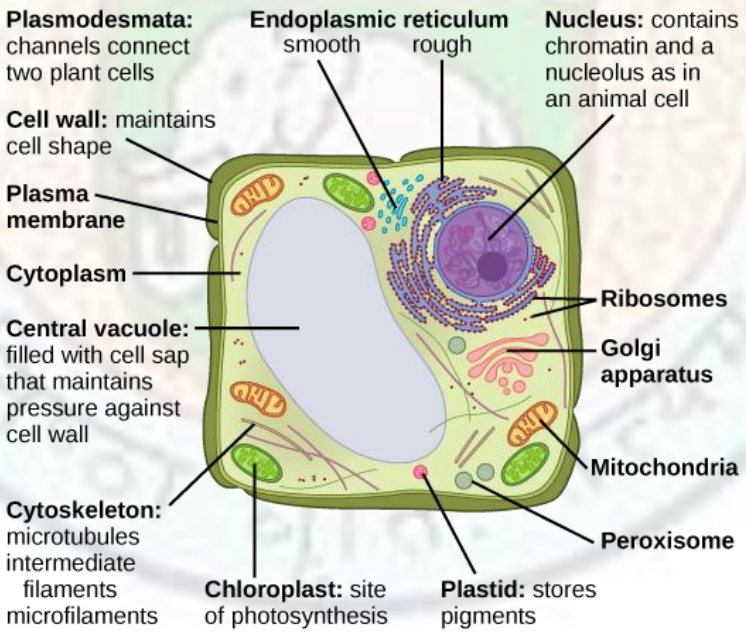


Figure: Plant cell

Source: http://cnx.org/content/m45432/latest/Figure_03_03_01b_new.png (CC-BY-SA)

Infective particles

In the previous section, you have studied about the characteristics of a living cell, and also the structure and types of the cells. However, there are certain disease causing agents which are acellular, i.e. these do not meet the characteristics of a living cell and cannot live on their own. They live as parasite on the host cell using the machinery of host cell. These lack cell structures, can neither metabolize, nor can grow or reproduce on their own or respond to the environment. These acellular structures include viruses, viroids and prions.

Viruses

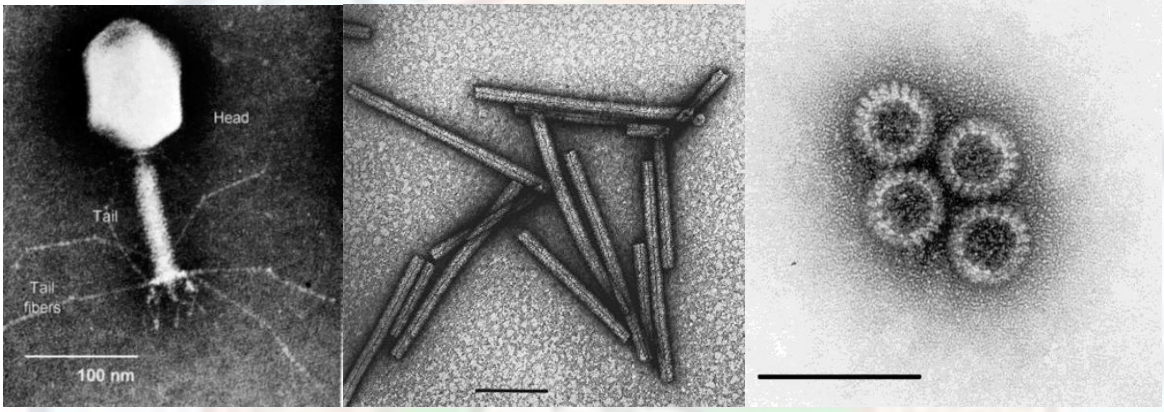


Figure: Electron micrograph of viruses- Bacteriophage, TMV, Rotavirus.
Source:http://i92.photobucket.com/albums/l40/bmahfood/Blog%20Photos/em_t4.gif, http://ictvdb.bio-mirror.cn/WIntkey/Images/em_tobam_HWA_TMV_399-18_350.jpg, http://ictvdb.bio-mirror.cn/Images/Cornelia/rota46.jpg (Displayed with permission)

These are tiny infectious agents with their nucleic acids (DNA/RNA) surrounded by protein coat, known as capsid. Nucleic acid and capsid together are called nucleocapsid. Capsid consists of protein subunits known as capsomeres. Viron is complete virus particle (i.e. nucleic acid and protein coat) when is present outside the cell. A membrane may be present or absent outside the protein coat. Nucleic acid may be single or double stranded DNA or RNA. There may be single or multiple molecules of nucleic acids, which may be present either as linear or circular structures. Virus need host cell for their replication. The host may be plants, animals or bacteria. The viruses that infect a bacterial cell are called bacteriophage.

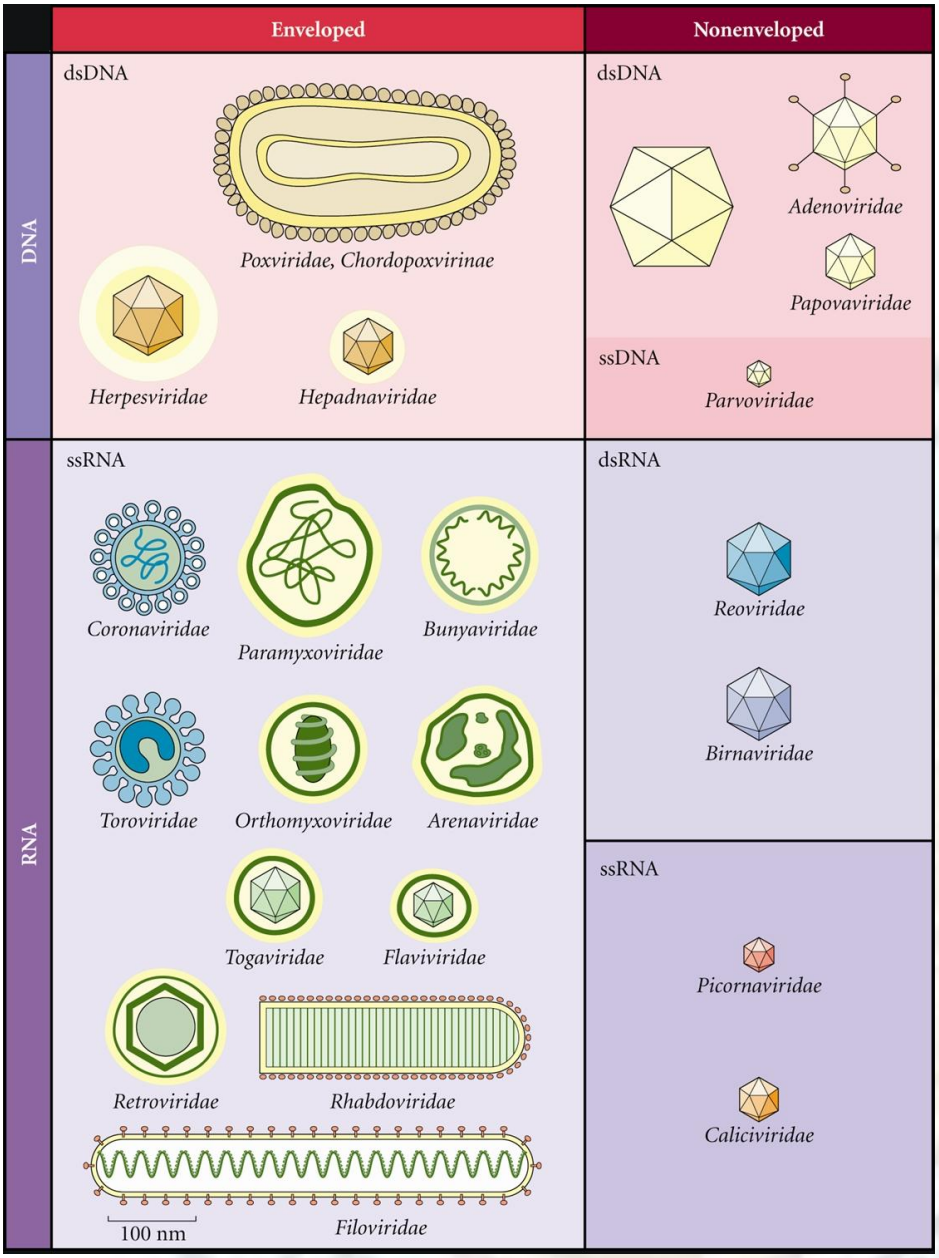


Figure: Diversity of viruses

Source: http://www.ppdictionary.com/viruses/virus_types.jpg (Displayed with permission)

The smallest virus is MS2, which is only 20 nm in diameter. It has single stranded RNA genome. Its genome encodes only three genes. The largest virus is mimivirus, which is dsDNA virus. Diameter of its capsid is 400 nm. Its genome contains 1.2 million bases estimated to be encoding 1000 genes. A virus may be called as DNA or RNA virus depending upon the nucleic acid, which makes up its genome.

Most of the bacteriophages are DNA viruses while those infecting plants are RNA viruses. Genome of animal viruses may be composed of either DNA or RNA. The genome may be

single or double stranded. All animal viruses with RNA genome have envelopes while envelope may be present in some of the DNA viruses. The glycoproteins present on the envelope help in recognizing the host by interacting with the glycoproteins present on the surface of the host cell. Virus genome is replicated inside the host cell using the host enzymes. The genetic information for the synthesis of glycoproteins present in viral envelope is also present in viral genome.

Retrovirus are the viruses in which the genome is ssRNA. This RNA, on entering host cell, is transcribed to DNA by reverse transcription. The transcribed DNA gets integrated into host genome and gets replicated along with host genome. This replicated DNA gets transcribed to RNA molecules, which serves as genome for new virus particles and also acts as mRNA, which is translated to capsomeres and glycoproteins. The most common reteroviruse known is HIV (human immunodeficiency virus), the virus that causes AIDS (acquired immunodeficiency syndrome). HIV is enveloped RNA virus that contains 2 identical ssRNA strands and two molecules of reverse transcriptase.

Most of the plant viruses are RNA viruses. More than 2,000 types of viral diseases of plants are known. Mode of reproduction of virus in plants is same as that in animals. Mode of transmission of viruses in plants may be horizontal or vertical. Horizontal transmission may be though the grazing animals or through various tools used while the vertical transmission may be due to getting infection from the infected seed or getting from the parent. Infection of a plant by viruses may be facilitated through the injury on the plant and it can get spread through the plasmodesmata connections.

Viroids

Another infectious agents are viroids. Meaning of viroids is virus like. These are smallest infectious agents. These are small RNA viruses without capsid being present. RNA genome is very small. It is 300-400 nucleotides long. It is circular. It does not code for any proteins. It is replicated in the host cell. These were discovered in 1971s by Theodore Diener and his colleagues.

Though RNA of viroids is circular, it appears to be linear molecule, because of formation of number of hydrogen bonds within the RNA molecule.

These are pathogenic to plants. One of the first Viroid studied was potato spindle tuber Viroid (PSTV). It is a circular RNA molecule, which consists of 359 nucleotides.

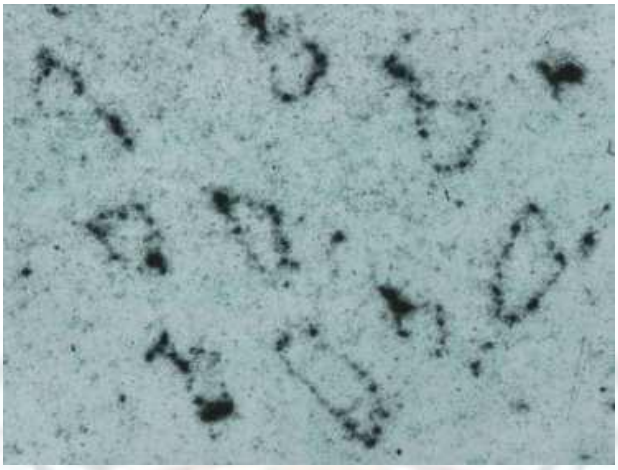


Figure: Electron micrograph of viroid PSTVd

Source: http://www.biologie.uni-hamburg.de/bzf/mppg/agviro2.jpg

Viroids alter the normal pattern of gene expression of the host cells, as a result of which pathogenic effects are caused. Viroids cause several plant diseases.

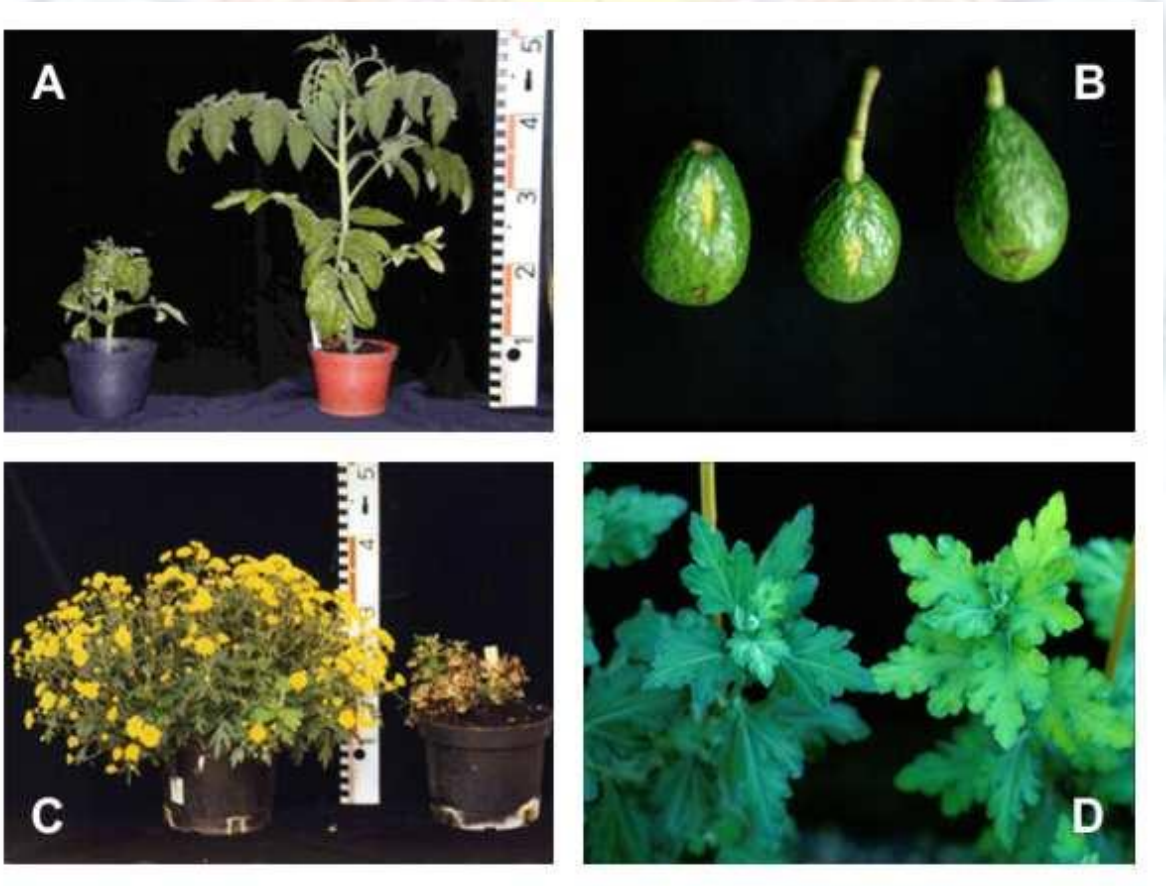


Figure: Symptoms of viroid diseases A. Potato spindle tuber on tomato; B. Avocado sun blotch; C. *Chrysanthemum* stunt and; D. *Chrysanthemum* Chlorotic mottle

Source: http://www.biologie.uni-hamburg.de/bzf/mppg/agviro1.jpg

Prions

Animation: http://highered.mcgraw-hill.com/sites/dl/free/0072835125/126997/animation44.html

These are another class of infective agents, which are just protein molecules. These are responsible for a neurodegenerative disease, called "mad cow" in humans. There was an epidemic of disease, which was known as bovine spongiform encephalitis in late 1980s in Great Britain and in 2000s in France. The disease spread in humans who had ingested prions infected beef.

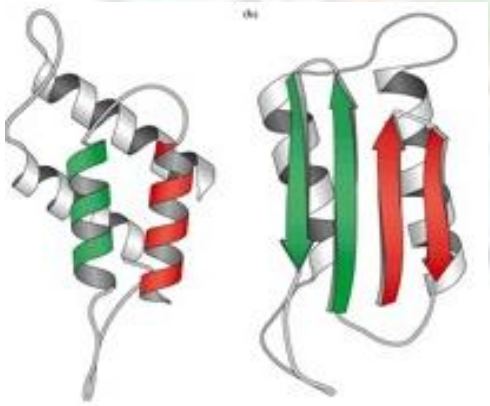
In 1982, Stanley Prusiner reported that protein molecule was responsible for the disease. The infectious protein molecule did not have any nucleic acid. Prusiner named such infectious protein molecules as Prions. It was difficult to accept Prions as disease causing agent, since there was no nucleic acid present. How could a protein molecule be synthesized without the directions of a nucleic acid? Later on, Stanley Prusiner explained role of Prions as disease causing agent and it was in 1997 he was awarded Noble Prize for the same.

Prions consist of single protein molecule (PrP). The protein exists in two conformations:-

i) Cellular PrP – This is a normal functional protein. All mammals have genes encoding for the sequence of amino acids of this protein. This can fold in secondary structure with several α–helices only. No β–sheet structure is present.

ii) Prion PrP – This is abnormally folded version of normal cellular proteins. This is the disease causing form, which has β–pleated sheet in secondary structure.

The normal PrP is required for normal cellular fucntions, which control signal events in brain cells. Prion PrP trigger changes in secondary structure of normal cellular PrP, so that it gets misfolded to Prion PrP. Prion PrP would interrupt the normal function of cellular PrP.



Cellular PrP Prion PrP

Figure: Prion proteins

Source: Author

For additional information on prions visit: http://faculty.washington.edu/chudler/mcd.html

Summary

- All the living beings consist of cells.
- The cell is characterized by the presence of a membrane with restricted entry, presence of hereditary material and machinery capable of replicating the hereditary material as well as protein translation.
- Depending upon presence or absence of well-defined nuclear membrane, the living beings are classified as prokaryotes and eukaryotes.
- Diversity in cell size has been observed.
- Based upon complexity of the cells, diversity of prokaryotic cells is there with the simplest being *Mycoplasma.*
- *Archaea* are the organisms, which have been classified under prokaryotes, live under harsh environmental conditions and are different from that of eubacteria.
- There are acellular structures that are infective yet do not meet the requirements of a living cell. These are infective particles, which include infective RNAs (viroids), infective protein molecules (prions) and nucleoproteins, which are known as viruses.

Exercises

Answer the following questions

1. On the basis of cell structure, all the organisms have been classified in two categories. Name them.
2. What is basis of this classification?
3. Name the smallest prokaryotic cell.
4. Expand the following –

   AIDS, HIV, PSTV, PrP
5. Name one disease caued by –
   i) Viroids
   ii) Prions
   iii) Retrovirus
6. What do you understand by cell biology?
7. List the characteristics of a living cell.
8. How are prokaryotes different from eukaryotes?
9. How are archaebacteria different from other eukaryotes?
10. What are Viroids?

11. What are prions? Name a disease caused by Prions.
12. Label different parts of bacteria: Visit http://www.neok12.com/diagram/Microorganisms-01.htm.

Glossary

Adenosine tri phosphate (ATP): it is a nucleotide in which adenosine is linked to three phosphate bonds by anhydride bonds.

Angstrom: a unit of measurement, i.e., 10^{-10} meters.

Micrometer: a unit of measurement equal to 10^{-6}m.

Flow cytometry: it is a technique for automated rapid analysis of cells stained with fluorescent dyes as they pass in a narrow stream through a laser beam.

X-ray crystallography: it is a technique which is used for determining three dimensional structure of macromolecules based on the pattern produced when a beam of X-ray is passed through the sample.

Mass spectrometry: a very sensitive high speed technique that uses magnetic and electrical field to separate protein molecules based on difference in their size and net charge.

Magnetic resonance force microscope: It is an imaging technique that acquires magnetic resonance images (MRI) at nanometer scales. With this technique it is possible to observe protein structure which otherwise cannot be seen with X-ray crystallography.

Centrifuge: machine for rapidly spinning a tube containing a fluid to subject its contents to centrifugal force.

Chromatography: the technique that utilizes flow of mobile phase over a stationary phase to separate molecules based on their relative affinities for the two phases.

Glycoprotein: Protein with one or more carbohydrate groups linked covalently to amino acid side chains.

Reverse transcription: It is the process in which DNA is synthesized using RNA as a template.

Retrovirus: Any RNA virus that uses reverse transcription to make a DNA copy of its RNA.

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Links

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