RAXA H.SOLANKI
ASSOCIATE PROFESSOR
BIOLOGY
V.P.& R.P.T.P. SCIENCE COLLEGE

SARDAR PATEL UNIVERSITY

B.Sc. FIRST SEMESTER

Core Course - Biology US01CBIO21 (T)

CELL BIOLOGY AND BIODIVERSITY

Effective from June 2018 4 Credits, 4 periods per week Total Marks 100, Internal -30 Marks, External-70 Marks, exam duration: 3 hours

Unit 1 Cell & Cell organelles

- Cell as unit of structure and function Characteristics and cell structure of Prokaryotic cell and Eukaryotic cell
- Cell organelles – Structure and functions of : Cell wall, Plasma membrane, Nucleus, Chloroplast, Mitochondria, E.R., Golgi complex, Lysosomes,Ribosomes,
- Cell division – Cell cycle , Mitosis and Meiosis and Significance Structure of chromosome, Types based on the position of the centromere, Giant chromosomes

Unit -2 Bio molecules:

Carbohydrates – Nomenclature, Classification - Monosaccharide, Disaccharides, Polysaccharides and biological role

Lipids: Definition and classification; Fatty acids structure ; Essential fatty acids; biological role

Proteins – Definition, classification, Structure of Amino acids, Bonds responsible for protein structure, Protein denaturation and biological role of Proteins

Nucleic acids: Nitrogenous bases; Pentose sugars, Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA. Biological role.

Unit -3 Biodiversity

*__Viruses__- General structure, Replication, TMV, Bacteriophage

*General account of __Mycoplasma__

•General characteristics of __Bacteria__, Reproduction and economic importance

•*__Algae__ –General characteristics, Range of thallus structure and reproduction, economic importance of Algae, Life cycle of Volvox.

•*__Fungi__ - General characteristics, Range of thallus structure and reproduction, Economic importance of Fungi, Life cycle of Rhizopus.

•*Introduction to __Archegoniate__ : General characters and alternation of generation and outline lifecycles of following -

__A. Bryophyte__ – Riccia __B. Pteridophyta__ – Nephrolepis

•__C. Gymnosperms__ – Cycas

Unit -4 General Account of Invertebrates

* General characteristics and outline classification of Major Invertebrate Phyla
*Nutrition and reproduction in Protozoa Life cycle and pathogenicity of Plasmodium vivax and Entamoeba histolytica Life cycle and pathogenicity of Taenia solium and Wuchereria bancrofti Metamerism and Economic importance of Annelida Economic Importance of Arthropods Social Life of Insect
*Metamorphosis in Insects Economic Importance of Molluscs, Water vascular system in Asteroidea

SUGGESTED READINGS:

1 Cellbiology,Genetics,Molecular Biology, Evolution and Ecology-P.S.Verma and V.K.agarwal

2 Text book of Botany-Diversity of Microbes and Cryptogams-Singh,Pande and Jain

3 Biochemistry-U.Satyanarayan

4 Cell and Molecular Biology: De Robertis and De Robertis

5 Lehninger Principles of Biochemistry Book by Albert L. Lehninger, David L. Nelson, and Michael M. Cox

6 Modern Text Book Of Zoology Invertebrates- R. L .Kotpal

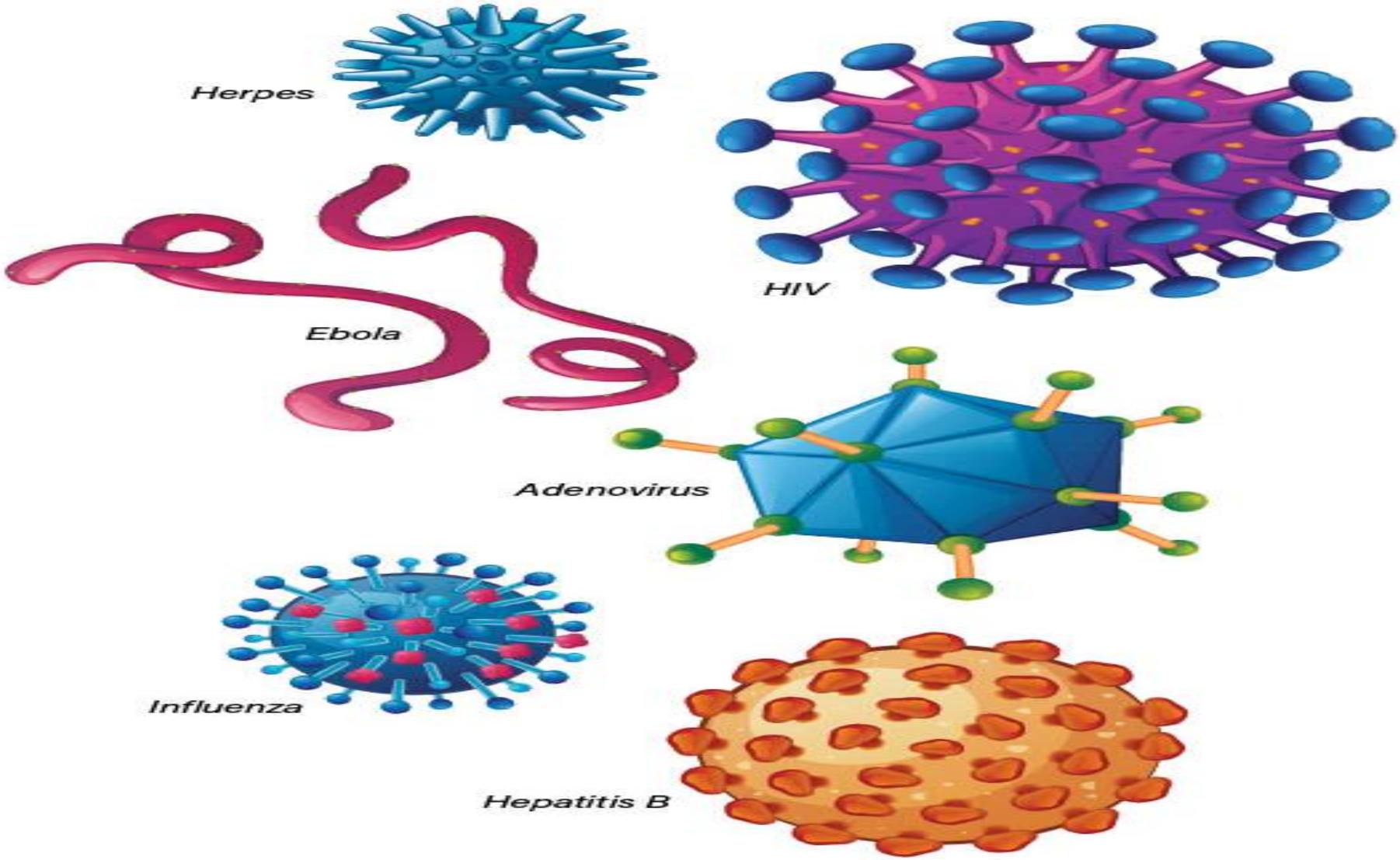
7 Economic Zoology - Shukla and Upadhyay

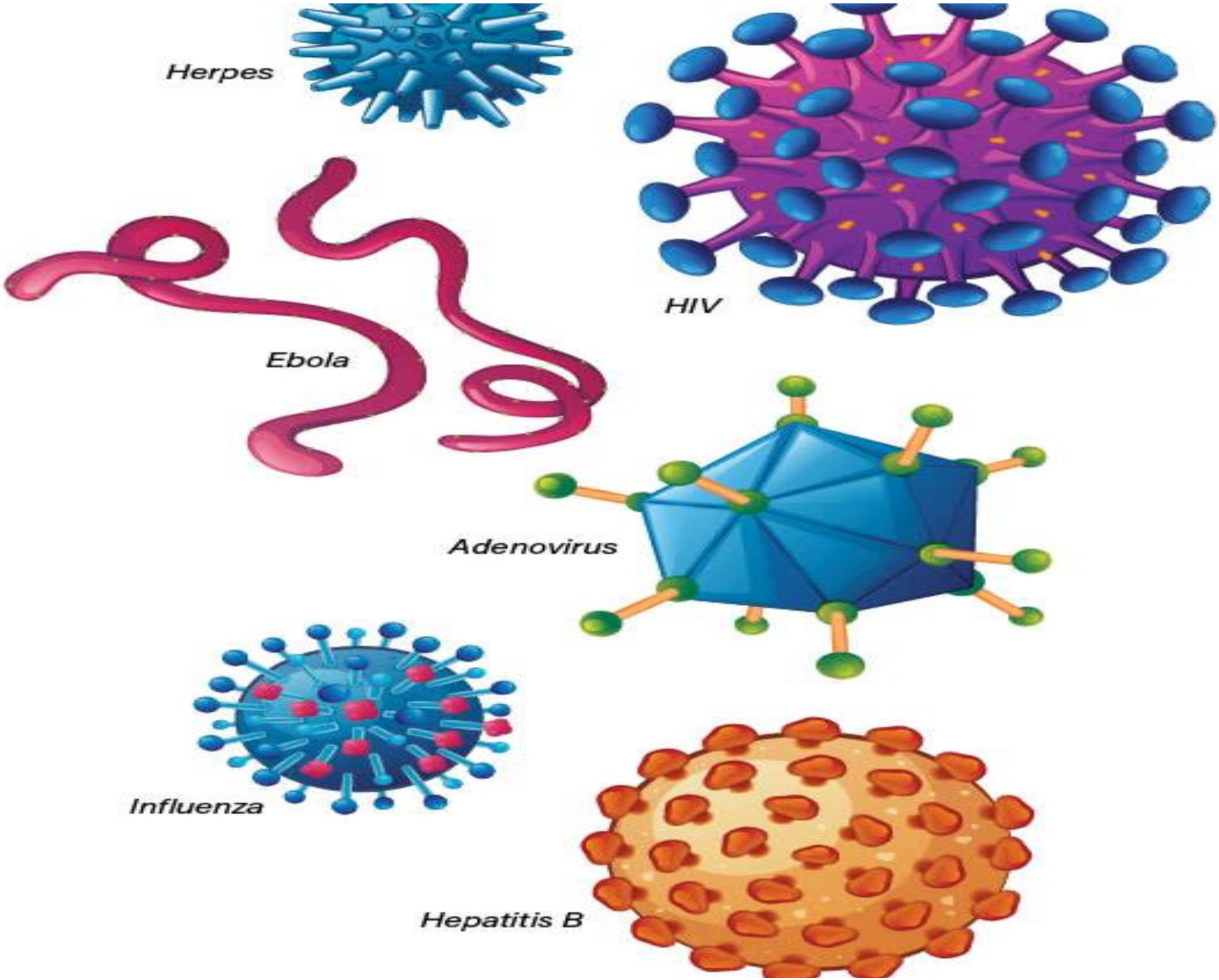
8 Medical Parasitology - Rajesh karyakarte, Ajit Damle

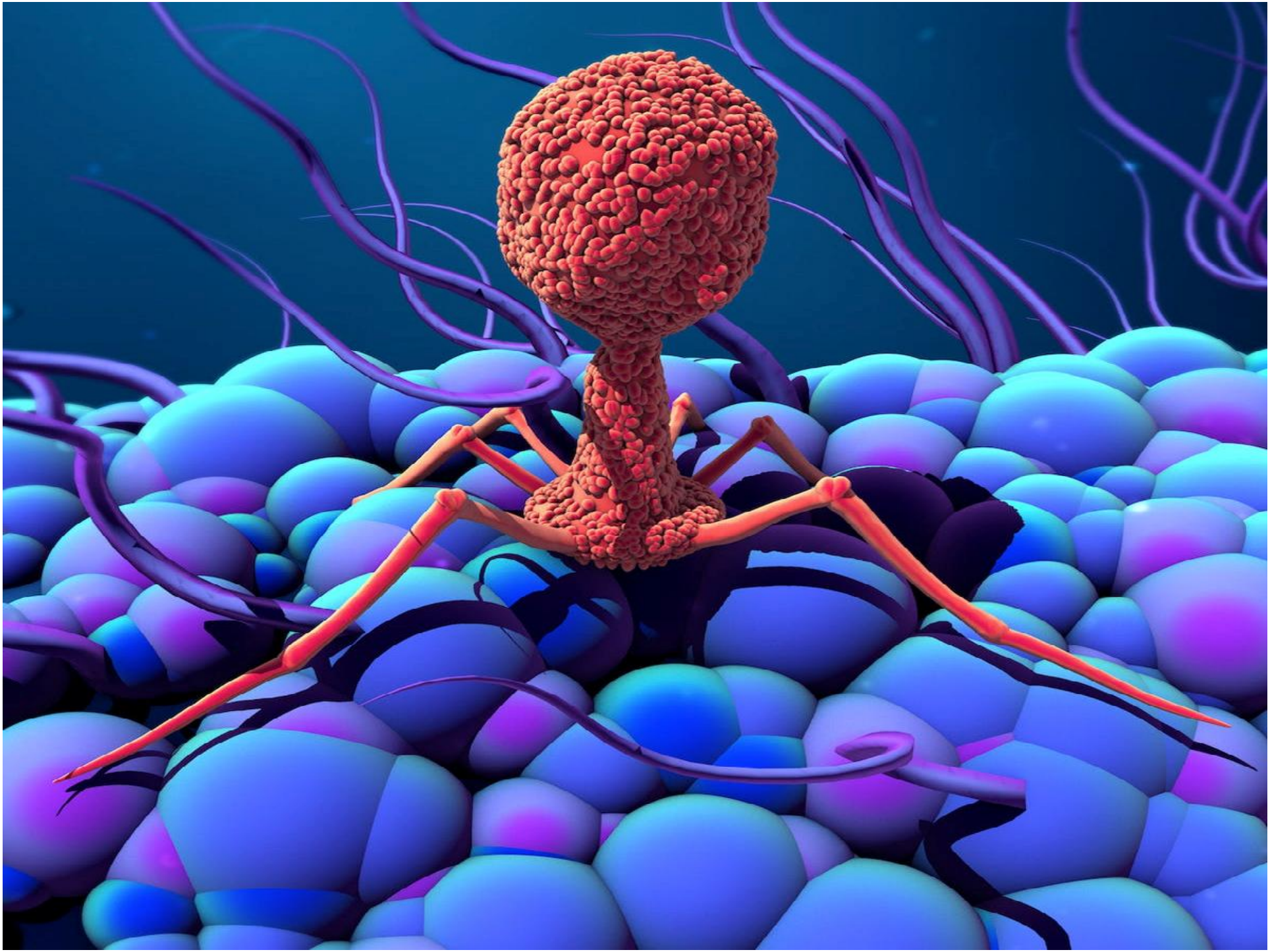
9 Invertebrate Zoology – E.L.Jordan and P.S.Verma

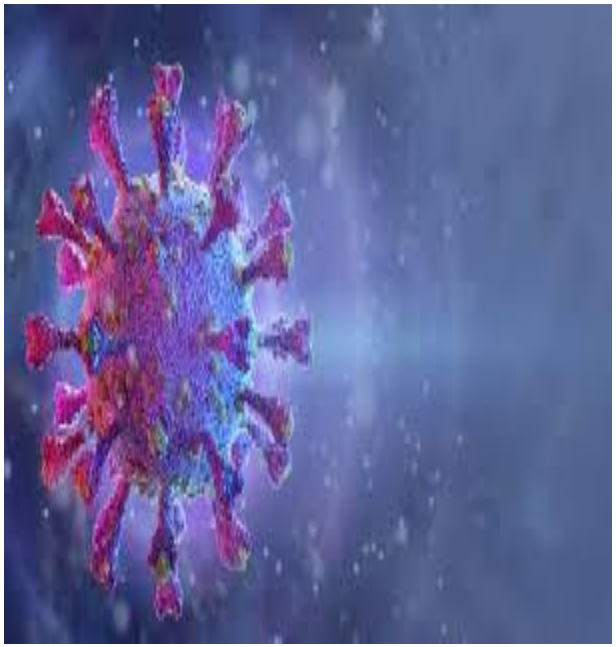
10 Cell Biology-P. S. Verma

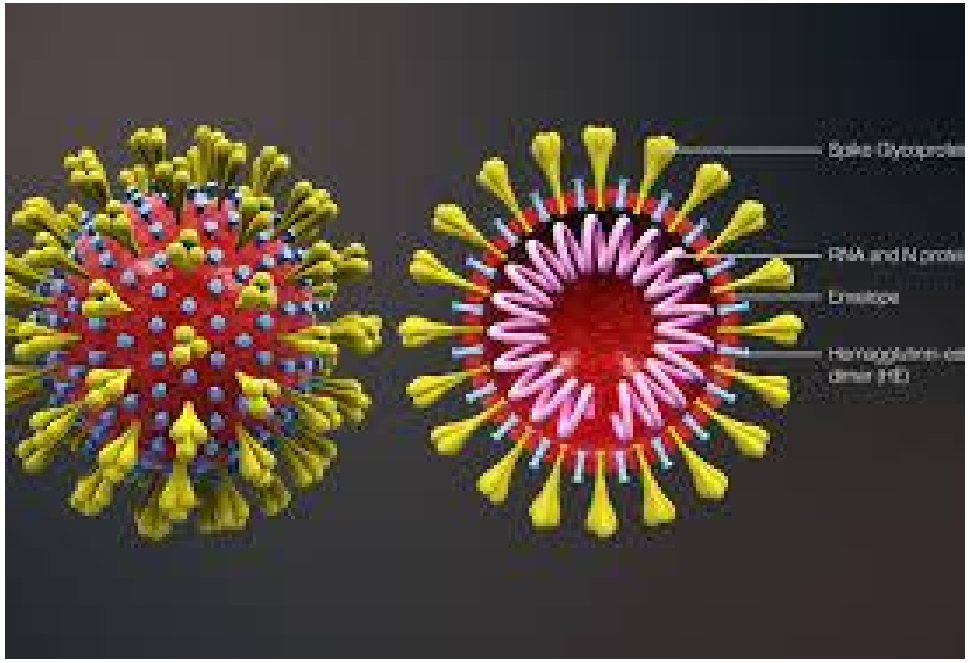
VIRUSES
General characteristics

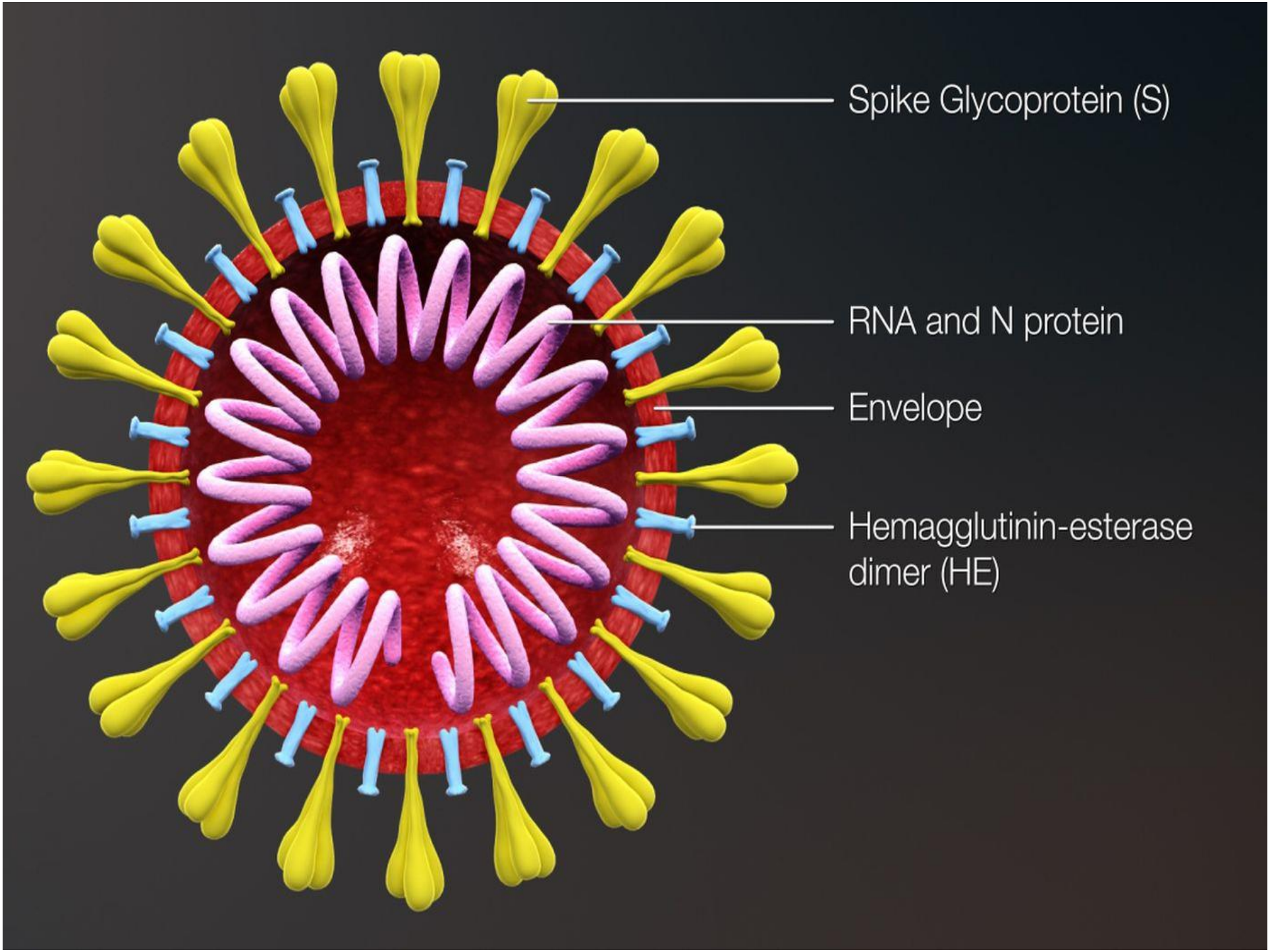



Herpes
HIV
Ebola
Adenovirus
Influenza
Hepatitis B

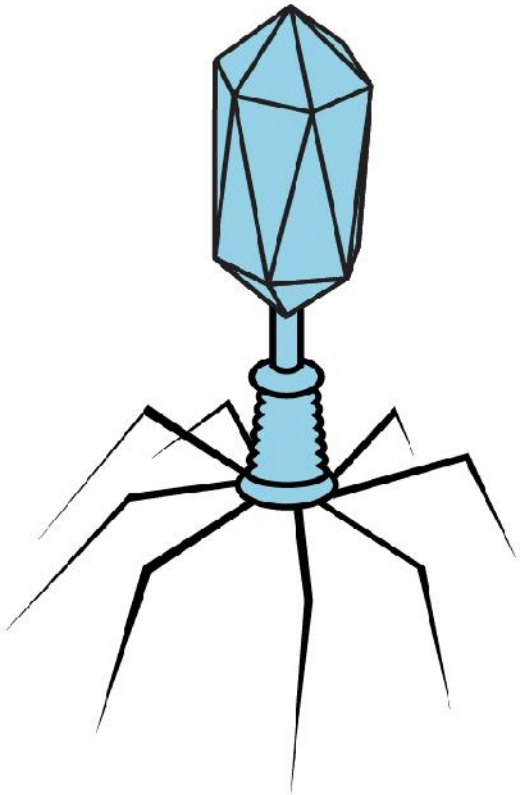




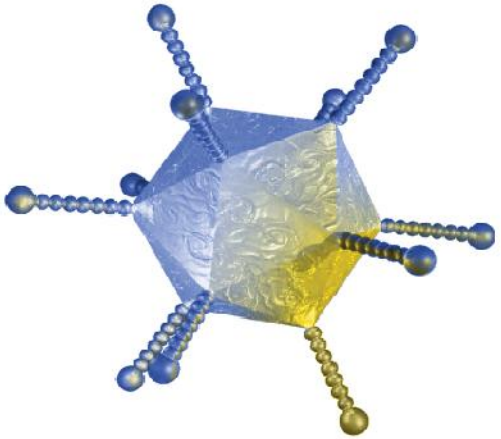

Envelope


Spike Glycoprotein (S)
RNA and N protein
Envelope
Hemagglutinin-esterase dimer (HE)

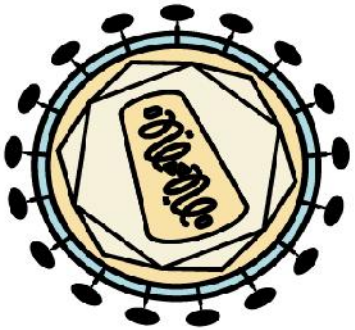
Types of viruses



Bacteriophage



Adenovirus



Human Immunodeficiency Virus

*A virus is a small collection of genetic code, either DNA or RNA, surrounded by a protein coat.

•A virus cannot replicate alone. Viruses must infect cells and use components of the host cell to make copies of themselves.

•*Often, they kill the host cell in the process, and cause damage to the host organism.

•*Viruses have been found everywhere on Earth. Researchers estimate that viruses outnumber bacteria by 10 to 1.

•*Because viruses don’t have the same components as bacteria, they cannot be killed by antibiotics; only antiviral medications or vaccines can eliminate or reduce the severity of viral diseases, including AIDS, COVID-19, measles and smallpox.

*Viruses (Latin Venum – poisonous fluid) are simplest forms of life.
*They are not cells, but their study has provided a great deal of information about cells.
*Study of viruses is a branch of biology called **Virology**.
•Viruses are cellular parasites.
•*They are smaller than bacteria and have a much more simplified organization.

Nature of Viruses:

Viruses are infective microorganisms.

They show several differences from typical bacterial cells:

1. Size:

On the whole viruses are much smaller than bacteria. Most animal and plant viruses are invisible under the light microscope. Some of smaller viruses are only 200Å in diameter.

2. No independent metabolism:

*Viruses cannot multiply outside a living cell.

*No virus has been cultivated in a cell-free medium.

*Viruses do not have an independent metabolism.

*They are metabolically inactive outside the host cell because they do not possess enzyme systems and protein synthesis machinery.

*Thus viruses are obligatory intracellular parasites

3. Simple structure:

*Viruses have a very simple structure.

*They consist of a nucleic acid core surrounded by a protein coat.

*In this respect they differ from typical cells which are made up of proteins, carbohydrates, lipids and nucleic acids.

*Myxoviruses have a membranous envelope consisting of proteins, carbohydrate and lipid outside the usual protein coat, but this envelope is derived from the host cell.

4. Absence of cellular structure:

Viruses do not have any cytoplasm, and thus cytoplasmic organelles like mitochondria, Golgi complexes, ribosomes, lysosomes etc. are absent. They do not have any limiting cell membrane.

5. Nucleic acids:

*Viruses usually have only one nucleic acid, either DNA or RNA. Typical cells have both DNA and RNA. Rous Sarcoma virus (RSV), producing certain cancer, is the only virus having both DNA and RNA.

6. Crystallization:

Many of the smaller viruses can be crystallized, and thus behave like chemicals.

7. No growth and division:

*Viruses do not have the power of growth and division.

*The genetic material of virus reproduces only in a host cell.

*Thus viruses do not show all the characteristics of typical living organisms.

*They, however, possess two fundamental characteristics of living systems.

*Firstly, they contain nucleic acid as their genetic material.

*The nucleic acid contains all the instructions for the structure and the function of the virus.

*Secondly , they can reproduce themselves, even if only by using the host cells' s synthesis machinery.

Structure of Viruses:

(a) Size:

Variable. Most viruses are much smaller than bacteria. The size ranges in between 100A to 250 mu. Some viruses are larger than bacteria, for example the psittacos is a virus measuring 0.75 mu in diameter.

(b) Symmetry:

*Viruses occur in three main shapes.

*They are spherical (Cubical or polyhedral), helical (Cylinderical or rod-like) and complex. Cubical viruses may be tetrahedral (4 faces) < dodecahedral (12 faces) or icosahedral (20 faces).

*The Herpes virus is dodecahedral.

*The Tobacco mosaic virus (TMV) and the bacteriophage are, respectively, helical and complex.

1. Spherical / Cubical:

Herpes virus, Tipula virus, Polyoma virus.

2. Helical / Cylindrical:
Tobacco Mosaic virus, Influenza virus Mumps virus.

3. Complex:
Vaccinia virus, ORF virus, Vesicular Stomatitis virus.

Fig. 3.1 Different kinds of viruses.

(c) Morphology:

*Morphologically a virus is a core of nucleic acid (DNA or RNA) surrounded by a protein shell.

*An intact virus unit is known as virion. Its protein coat is called capsid.

*The capsid is composed of a number of subunits of a particular shape. These sub-units are known as capsomeres.

*The capsid protects the nucleic acid against the action of nuclease enzyme.

*Some proteins of capsid help in binding the virus to the surface of host cells.

*Some surface proteins act as enzyme and dissolve the surface layer of host cell and thus help in penetration of its nucleic acid into the host cell.

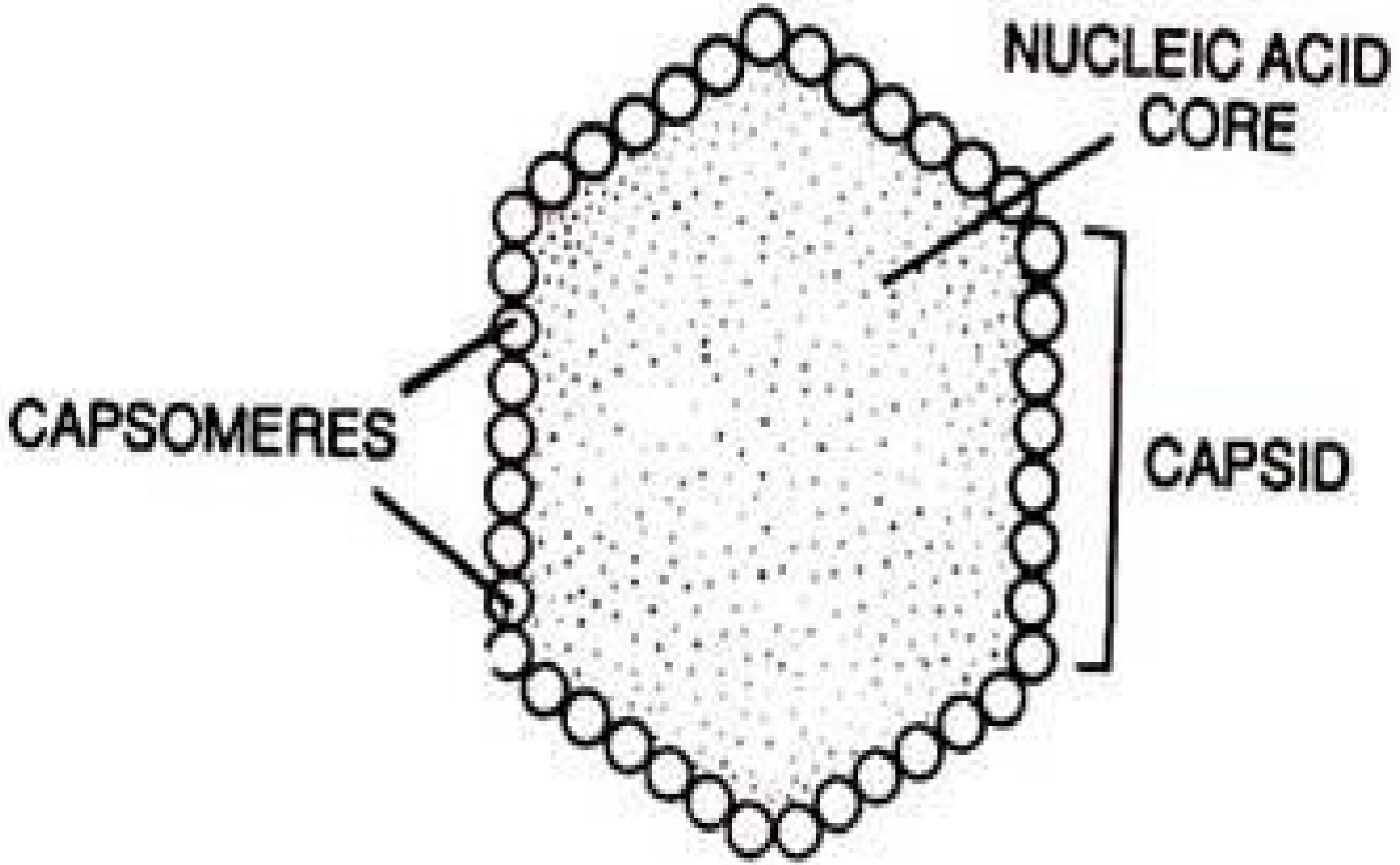


Fig. 3.2 Generalized diagram of Virion.

*The polio virus (Poliomyelitis) is a most extensively studied animal virus.
*It has a very simple organization. It consists of a protein coat built up out of 60 structurally equivalent, asymmetric protein subunits of approximately 60 Å in diameter.
* The spherical protein coat has a diameter about 300Å. It encloses the genetic material, RNA.
*The protein coat contains about 49, 600 amino acids and RNA contains about 5200 nucleotides.
*The single-stranded RNA of poliovirus, thus, has triplet codes for 1700 amino acids.
* During infection, it alters cell metabolism drastically and leads quick death of host cell.

*Tobacco mosaic virus is the most extensively studied plant virus.

*It is a helically symmetrical, rod-shaped virus having the length of 3000Å and diameter of 180A.

•It RNA is a single stranded spirally coiled molecule formed of 6500 nucleotides.

•* The capsid is formed of 2130 capsomeres, each with a molecular weight of 18,000.

•*The capsomeres are elliptical and remain arranged helically around to form capsid.

Classification of Viruses:

Viruses may be classified according to the type of the host, genetic material and number of strands.

On the basis of type of host, viruses are:

1. Animal Viruses:

*They live inside animal cells including man.

•On entering the cell, these disturb the metabolism of the host cell and cause various diseases.

•*The common animal viruses are small pox virus, influenza virus, mumps virus, polio virus and herpes virus.

•*In many animal viruses an extra envelope surrounds their protein coat.

•*The membrane consists of proteins, lipids and carbohydrates and is derived from the host plasma membrane.

*Animal viruses may enter cells by attaching to the surface. Some are then engulfed by the cell through pinocytosis or phagocytosis.
*In such cases, uncoating of the viral nucleic acid might occur within the cell.
*Inside the host cell they may multiply and form numerous new viral particles.
*Usually, animal viruses release from the host cells by the rupturing and subsequent death of the host cells.

Viral Diseases in Human Beings

Mumps	Encephalitis
Influenza	Rabies (hydrophobia)
Small pox	Yellow fever
Chicken pox	Dengue fever
Measles	AIDS
Cold	Poliomyelitis

Disease	Tissue affected	Transmission
1. Yellow fever	General infections	Mosquitoes
2. Dengue fever	General infections	Mosquitoes
3. Small pox	Skin & mucous membrane	Contact, sputum etc.
4. Chiken pox	" "	
5. Measles	"	Contact
6. Diarrhoea	Intestinal	Faeces
7. Influenza	Respiratory tract	Nasal & oral discharges
8. Cold	" "	
9. Viral peumonia	"	Sputum
10. Poliomyelitis	Nervous tissue	Faeces, Sputum
11. Rabies	"	Animal bites
12. AIDS	Immune system	Homosexuality

2. Plant Viruses:

*They are parasites of plant cells. Their genetic material is RNA which remains enclosed in the protein coat.

*The most important plant viruses are tobacco mosaic virus (TMV), tobacco rattle virus (TRV), potato virus (PV), southern bean mosaic virus (SBMV), beet yellow virus (BYV) and turnip yellow virus (TYV).

3. Bacterial virus:

*They are parasitic on bacteria and so also called bacteriophages.

*There are many varieties of bacteriophages.

*Their size and shape varies from species to species.

*Some phages are spherical, some comma-shaped whereas majority of them have tadpole-like appearance.

On the basis of nucleic acids, viruses are:

1. DNA viruses:

These viruses possess DNA as the genetic material. On replication this DNA produces new DNA. DNA transmits information for protein synthesis through RNA. (DNA → RNA → PROTEIN).

2. RNA viruses:

These viruses possess RNA as the genetic material. The RNA replicates directly to produce new RNA. Information for protein synthesis passes from RNA to protein without involment of DNA. (RNA → RNA → PROTEIN).

3. DNA – RNA viruses:

In a group of RNA tumour viruses called leukoviruses or rousviruses the genetic material is alternately DNA and RNA. In addition to the normal mode of transfer found in DNA viruses (DNA → RNA → PROTEIN) the rousviruses also transfer information from RNA to DNA (RNA-DNA-RNA -PROTEIN).

With respect to number of strands, four types of nucleic acids have been found in viruses:

1. Double stranded DNA:

Double stranded DNA has been reported in pox viruses, the bacteriophages T 2, T 4, T 6, T 3, T 7 and lamda, herpes viruses, adeno viruses, polyoma virus SV-40 and papilloma viruses.

2. Single stranded DNA:

Single stranded DNA is found in the bacteriophages ph i X 174 and M-13 and is cyclic.

3. Double stranded RNA:

Double stranded RNA has been found within viral capsid in the reoviruses of animals and in the wound tumour virus and rice dwarf viruses of plants.

4. Single stranded RNA:

Single stranded RNA is found in most of RNA viruses e.g. Tobacco mosaic virus, influenza virus, poliomylitis bacteriophage MS – 2, F – 2, Coliophage R 17 and the avian leukemia virus.

Characters of Virus:

In brief the important characters of viruses are:

(a) They are non-cellular, self-replicating agents.

(b) They can grow and multiply intracellularly as an obligate parasite (i.e., grow only in living host) or remain inert out-side the host.

(c) Depending on the symmetry, they are of three types: cubical, helical and com-plex.

(d) The viruses consist of two parts: the centrally placed nucleic acid, covered by protein coat.

(e) The nucleic acid is either DNA or RNA, but both do not remain together.

(f) The nucleic acid may be single or dou-ble stranded.
(g) The outer covering i.e., shell or capsid is made up of protein units, called capsomeres; except some animal viruses which are with additional polysaccharides.
(h) They have no machinery of their own for protein synthesis and thereby they use host machinery for the synthesis of protein.
(i) During replication their nucleic acid directs the host cell to make different parts of virus and when these parts assemble together they form a complete infectious particle, the virion.
(j) They are transmitted very easily from one organism to another organism.

points:

(a) The viruses are very much smaller.
(b) They lack the machinery for protein synthesis.
(c) They do not have cellular organization.
(d) They neither grow in artificial culture medium nor divide by binary fission.
(e) They have only one kind of nucleic acid.
(f) The viruses are resistant to antibiotic.

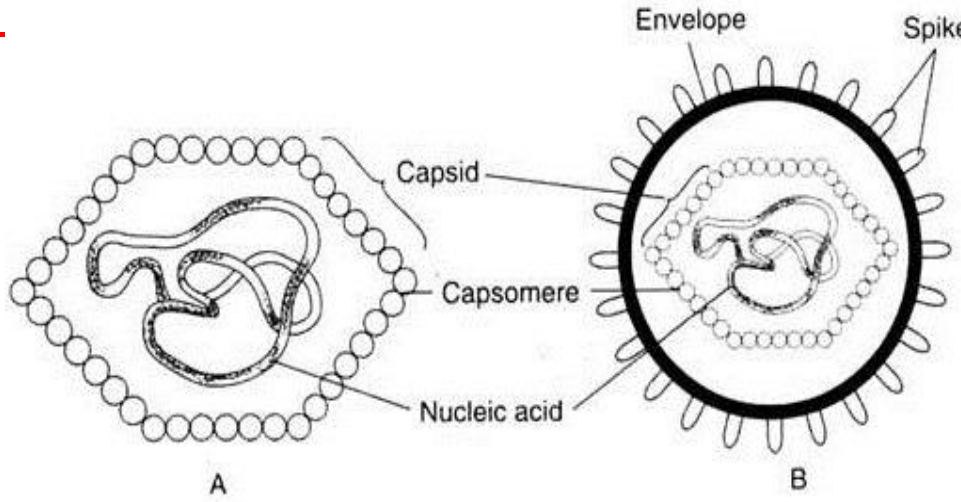


Fig. 2.39 : Naked virus (A) and enveloped virus (B) with spikes

Viruses have both living and non-living characters.

Living characters of viruses:

(a) They have the nucleic acid (DNA or RNA) i.e., the genetic material that can replicate.

(b) Mutation is well-established by the availability of mutant forms in some viruses.

(c) They are sensitive to stimulants like radiation, chemical substances etc.

(d) They can multiply in the living cells of the host.

(e) The viruses have antigenic property.

(f) They can attack specific host.

Non-living characters of viruses:

(a) The viruses remain as inert material outside their host.

(b) They are autocatalytic in nature.

(c) They are devoid of cell membrane and cell wall.

(d) The viruses are devoid of cellular organelles like ribosomes, mitochondria etc.

(e) The viruses can be crystallized.

The viruses have both harmful and useful activities:

A. Harmful activities:

(i) Viruses are responsible for various diseases of both plants (tobacco mosaic, yellow vein mosaic of lady's finger, leaf roll of potato, leaf curl of papaya etc.) and animals (small pox, meningitis, pneumonia, mumps, bronchitis etc.). The plant viruses cause damage to different parts like root, leaf, fruit, seed etc. and cause economic losses by reducing the quality and quantity of the plant products.

(ii) Phages often kill the beneficial micro-organisms during commercial produc-tion of antibiotics and milk products.

B. Useful activities:

(i) In space research, lysogenic phage cul-tures are used as radiation detector by Russians in the space ship.

(ii) Avirulent or temperate phages help in genetic recombination (transduction) and are used widely in genetic research.

(iii) Phages are used as scavengers to eradi-cate the bacteria present in the polluted water.

(iv) To a limited extent phages are used in therapy and prophylaxis of some bacte-rial diseases.

(v) By holding both the living and non-living characters, viruses got the impor-tance in determining the origin of life.

(vi) Viruses are utilized in the production of vaccines, used to develop immunity against viral infection.

Structure:
The virus consists of two parts:

(i) Nucleic acid (centrally placed), and
(ii) Protein coat, sometimes with additional envelope.

(i) Nucleic acid:

*Viruses contain only one type of nucleic acid i.e., either DNA or RNA.

*The DNA containing viruses are called Deoxyviruses, whereas viruses having RNA are called Riboviruses. They vary in the structure of their nucleic acid.

* Most of the plant viruses have RNA either single (TMV) or dou-ble stranded (Rice ragged stunt viruses), except a few have DNA either single (Gemini viruses) or double stranded (Dahlia mosaic virus).

*Animal viruses have mostly double stranded DNA or either single (Polio virus) or double (Reo virus) stranded RNA and bacterio-phages contain mostly double stranded DNA, but they also have single stranded RNA (f_2, R_{17},) or single stranded DNA .
*Each virion contains only one molecule of nucleic acid, called genome, consisting of nucleotide pairs whose number ranges from 1000-250,000 pairs.
*The amount of nucleic acid of a virion usually depends on its size.
*The number of genes per virion ranges from 4-8 for small viruses and 100-200 for the large viruses.

(ii) Protein coat:

*The protein coat surrounding the genome is called capsid and the capsid together with the enclosed nu-cleic acid is called nucleocapsid.

*The capsid is made up of a large number of protein subunits, called capsomeres.

*Many mammalian viruses have envelope made up of a bilayered lipoprotein, mainly of host cell origin that surrounds the nucleocapsid

Symmetry:
The capsid is symmetrically arranged around the central nucleic acid.
Based on symmetry of capsid, the viruses are grouped into three categories:
(a) Cubical (icosahedral),
(b) Helical, and
(c) Complex.
(a) Cubical (icosahedral) capsids (Fig. 2.38A):
They have a polygon with 12 corners (vertices), 20 sides (facets) and 30 edges. Each side is an equilateral triangle. They are of two types — Pentons (pentagonal capsomeres at the corners) and Hexons (hexagonal capsomeres at the corners), e.g., herpes and toga viruses are enve-loped and papova and adenoviruses are naked.

(b) Helical capsids:

Both nucleic acid and capsomeres are coiled together and form a spiral or helical tube. All the helical types are RNA viruses and most of them are enveloped, e.g., Tobacco mosaic virus (TMV), Influenza virus, etc.

(c) Complex capsids:

Viruses which do not conform to either of the above two types due to complexity of their struc-ture are called complex capsids, e.g., pox virus and bacteriophages like T_2, T_4, and T_6.

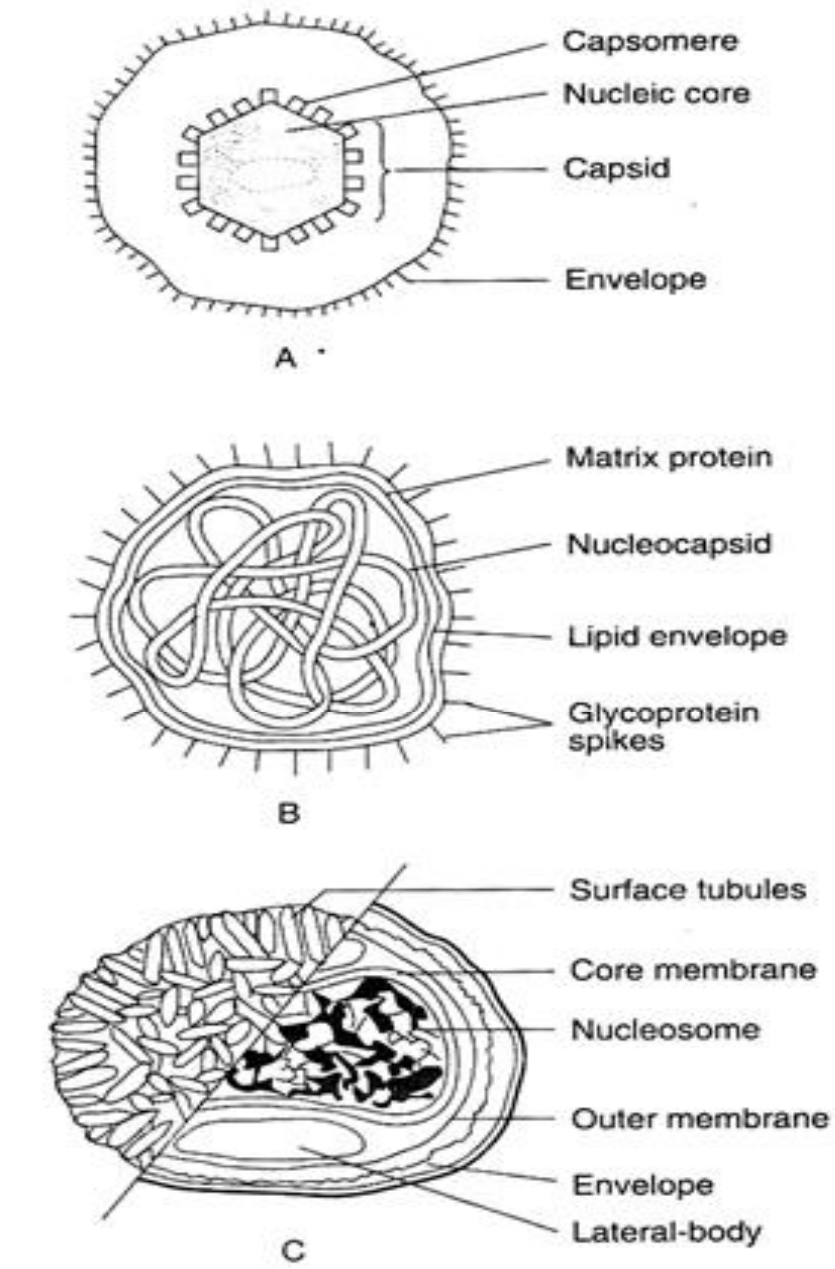


Fig. 2.38 : Diagram of virus particles. A. Enveloped virus with icosahedral symmetry, B. Virus with helical symmetry, C. Complex capsid

Types of Reproductive Cycle in Virus

The types are: 1. Lytic Cycle 2. Lysogenic Cycle.

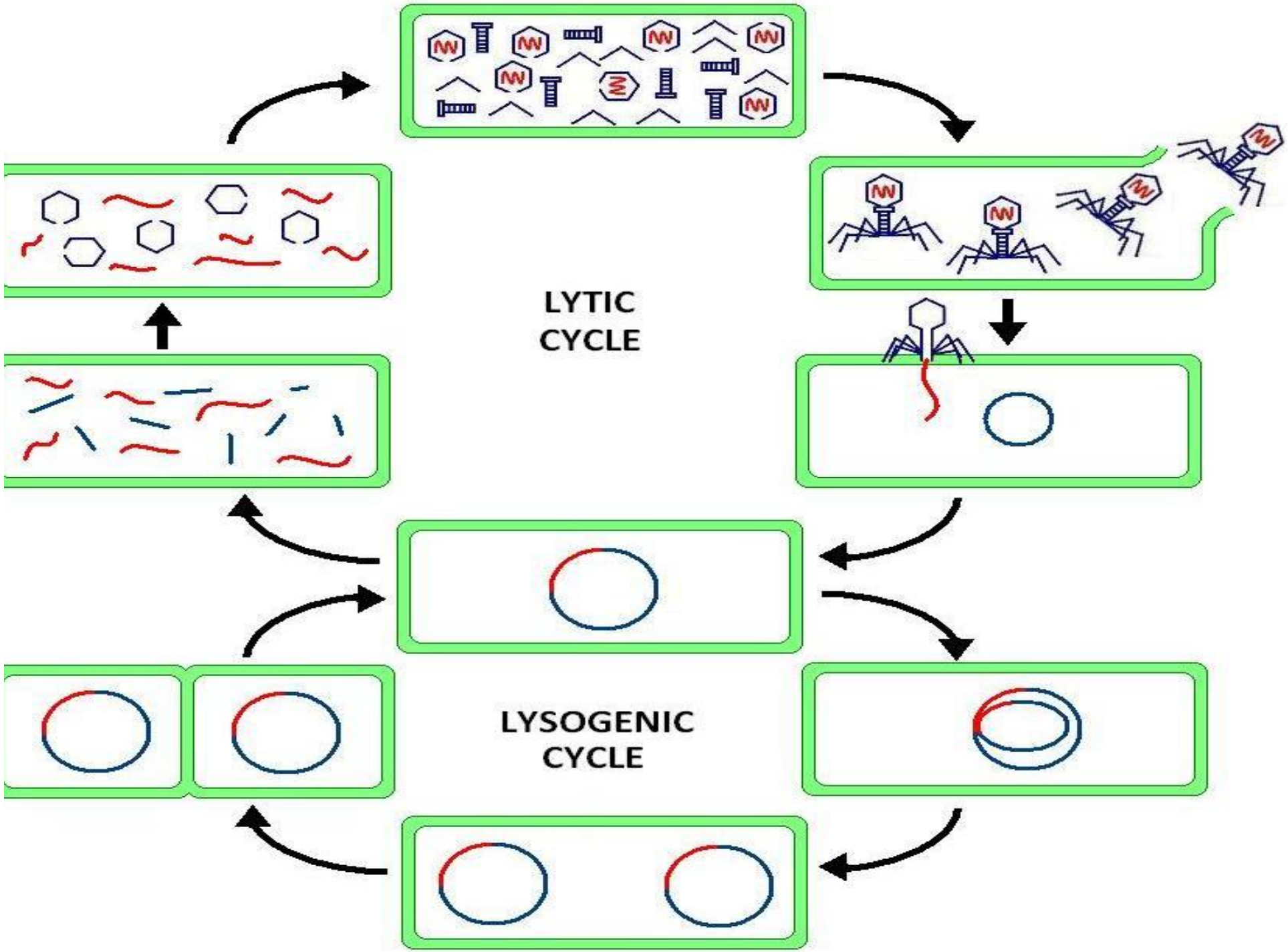
Type 1. Lytic Cycle:

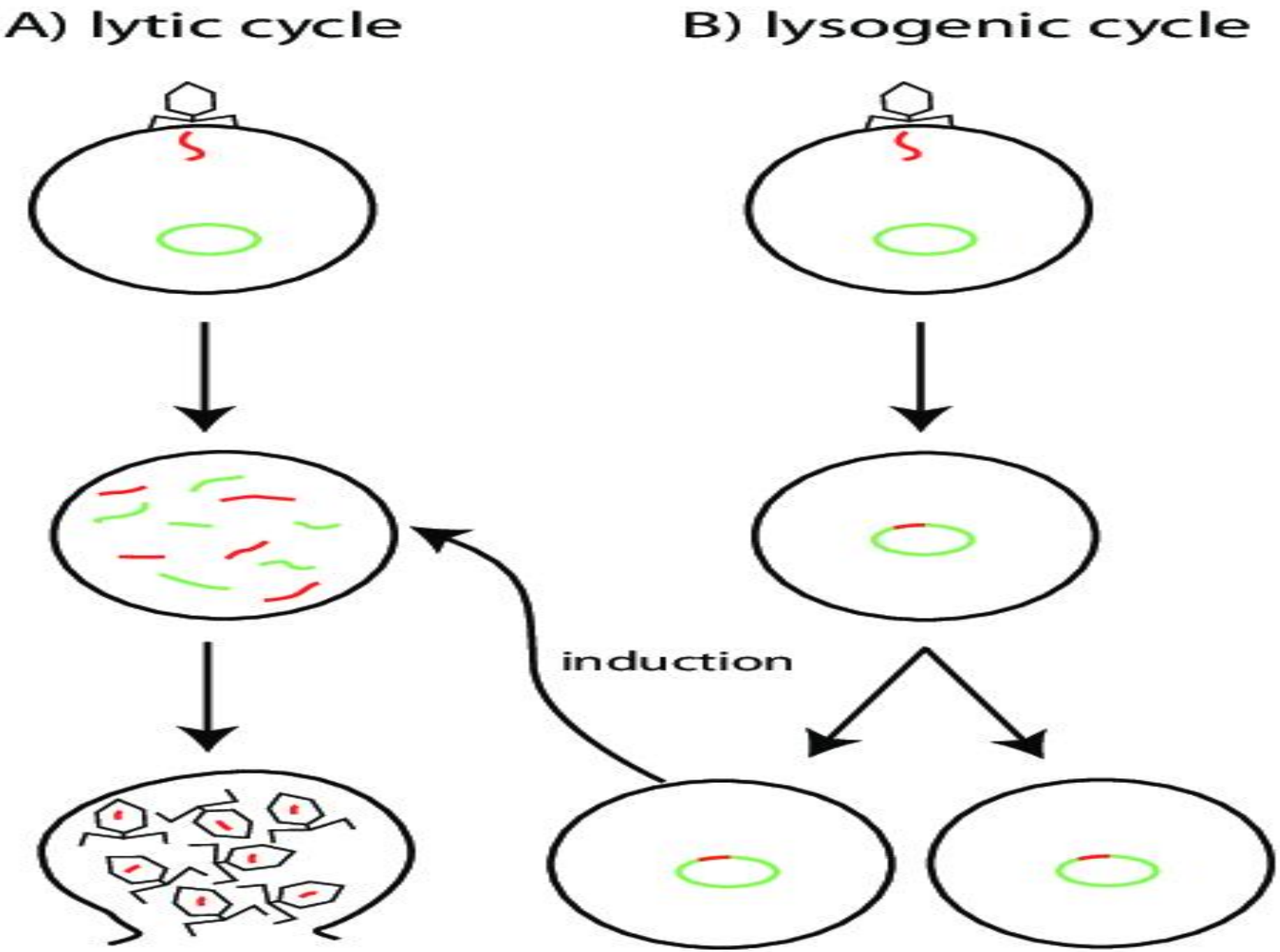
*It is the reproductive cycle of virulent phages, e.g., T_4 bacteriophage.

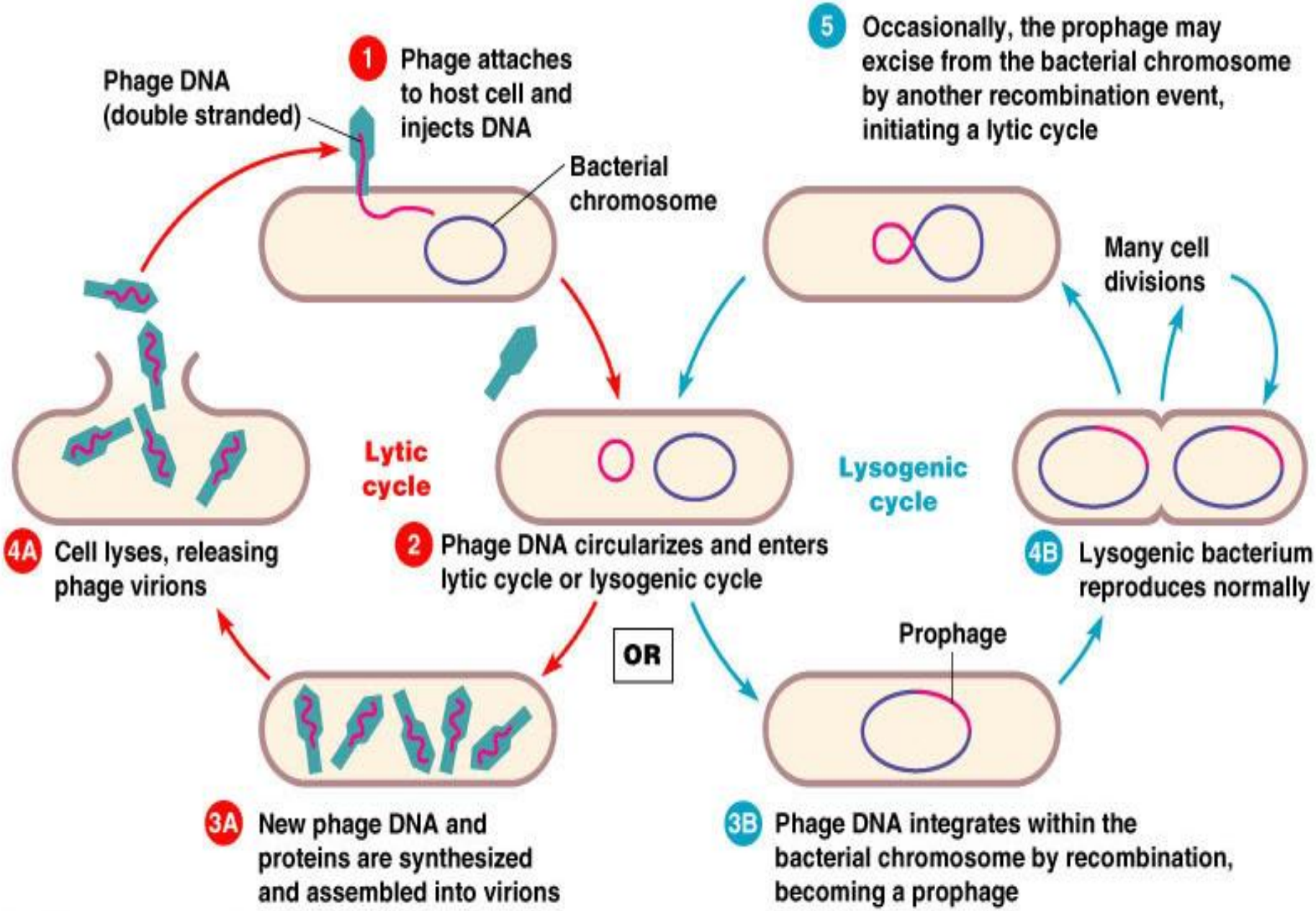
*The phage attaches itself to the host cell (e.g., Escherichia coli) through its tail fibres.

*The fibres bend and bring the tip of tail in contact with the host cell wall.

*The tip of the tail produces a hole in the bacterial cell wall by means of enzyme lysozyme.


LYTIC
CYCLE
LYSOGENIC
CYCLE

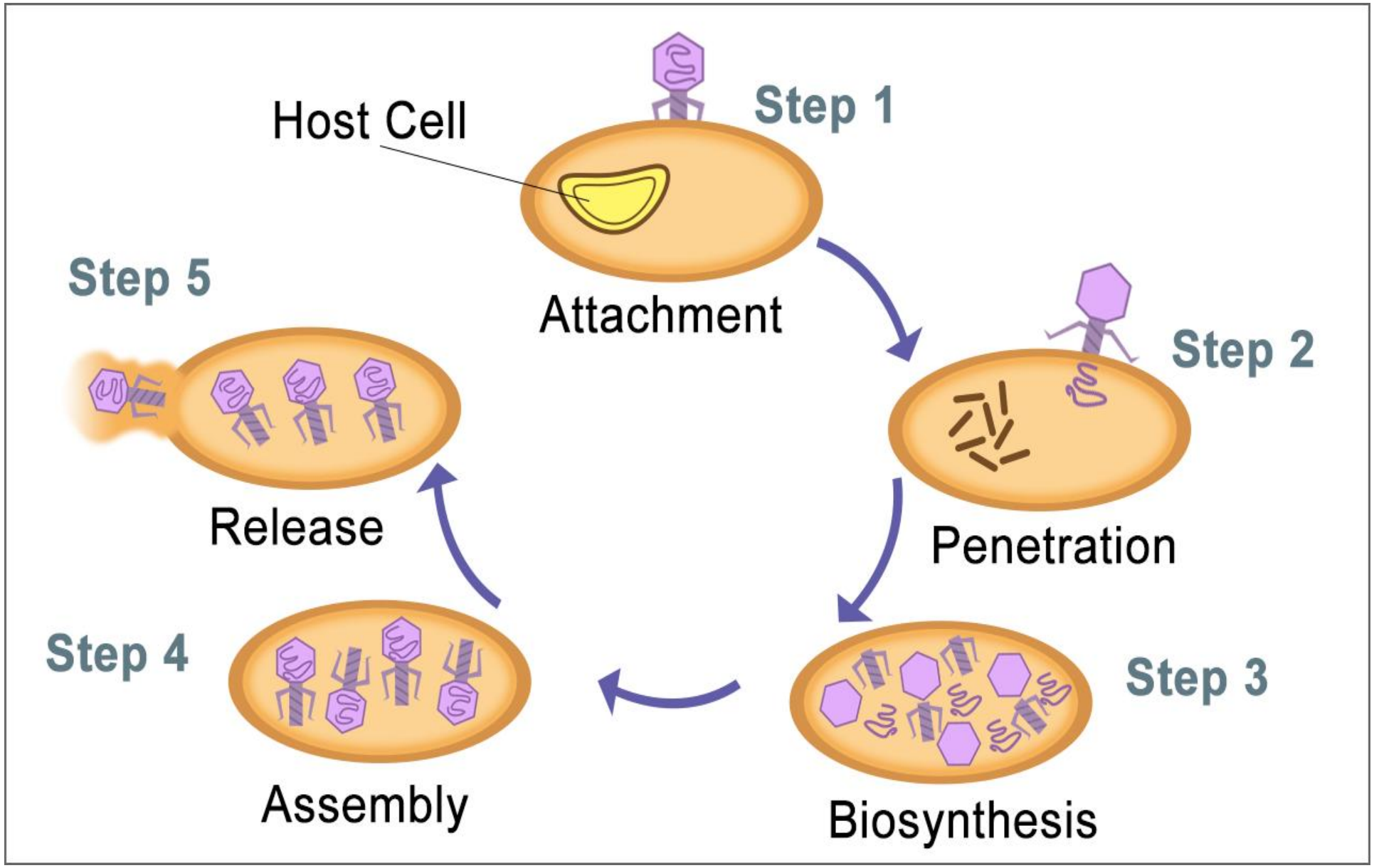

A) lytic cycle
B) lysogenic cycle
induction



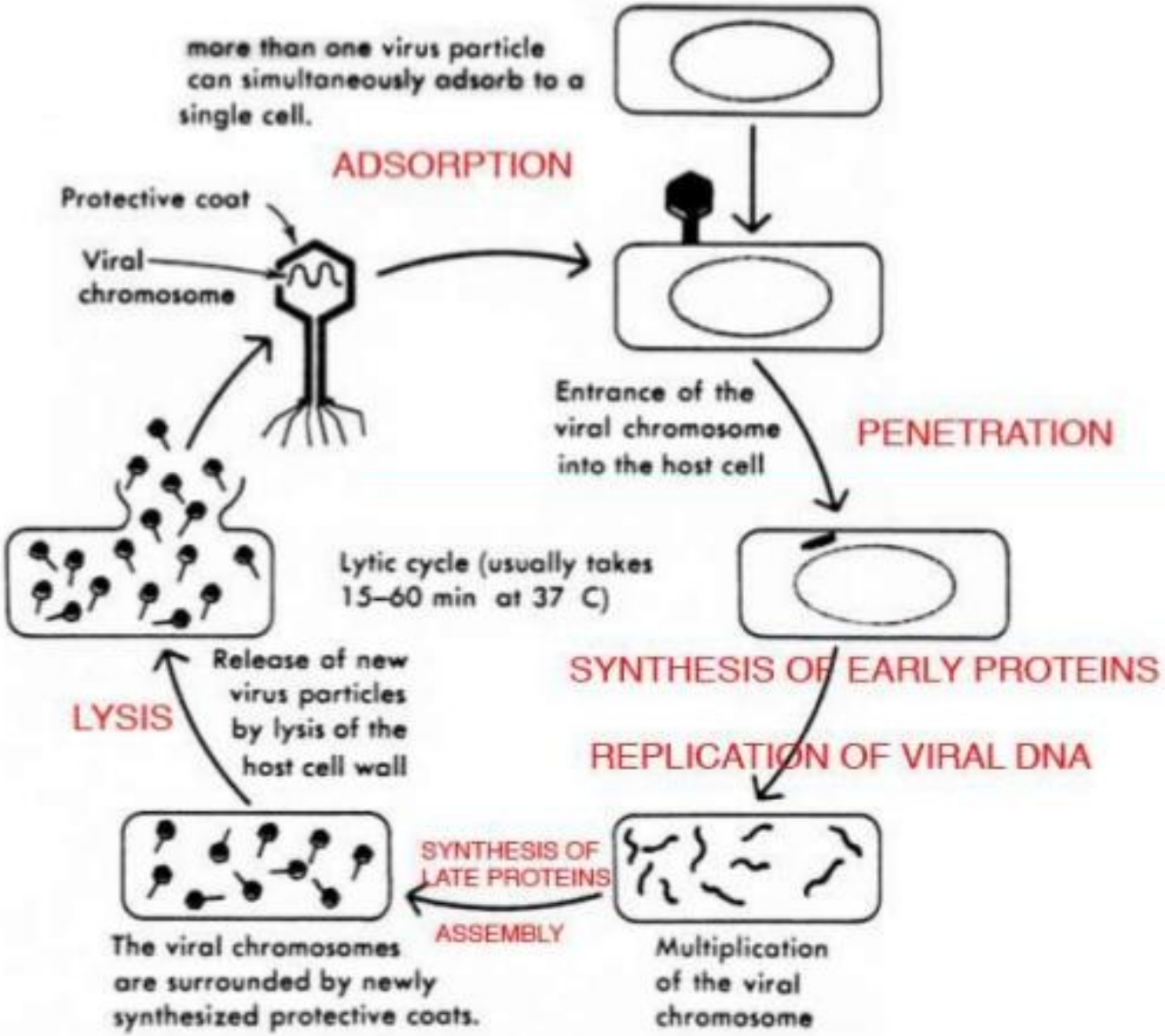
*The tail sheath contracts and injects the viral genome into host cell.
*After entering the host cell, the viral DNA transcribes some early mRNAs to form some enzymes over the host ribosome. Some of these are nucleases.
*They degrade host DNA and mRNAs.

*Ribosomes and tRNAs remain unaffected. Phage DNA and mRNA are also protected from nucleases due to methylation of their cytosine bases.
*Parent viral DNA functions as a template and rep-licates repeatedly with the help of bacterial nucleotides.
*Simultaneously, host machinery (ribosomes, tRNAs, amino acids, energy) is used by phage genes to synthesize proteins for vial lysozyme, internal proteins and capsid proteins.

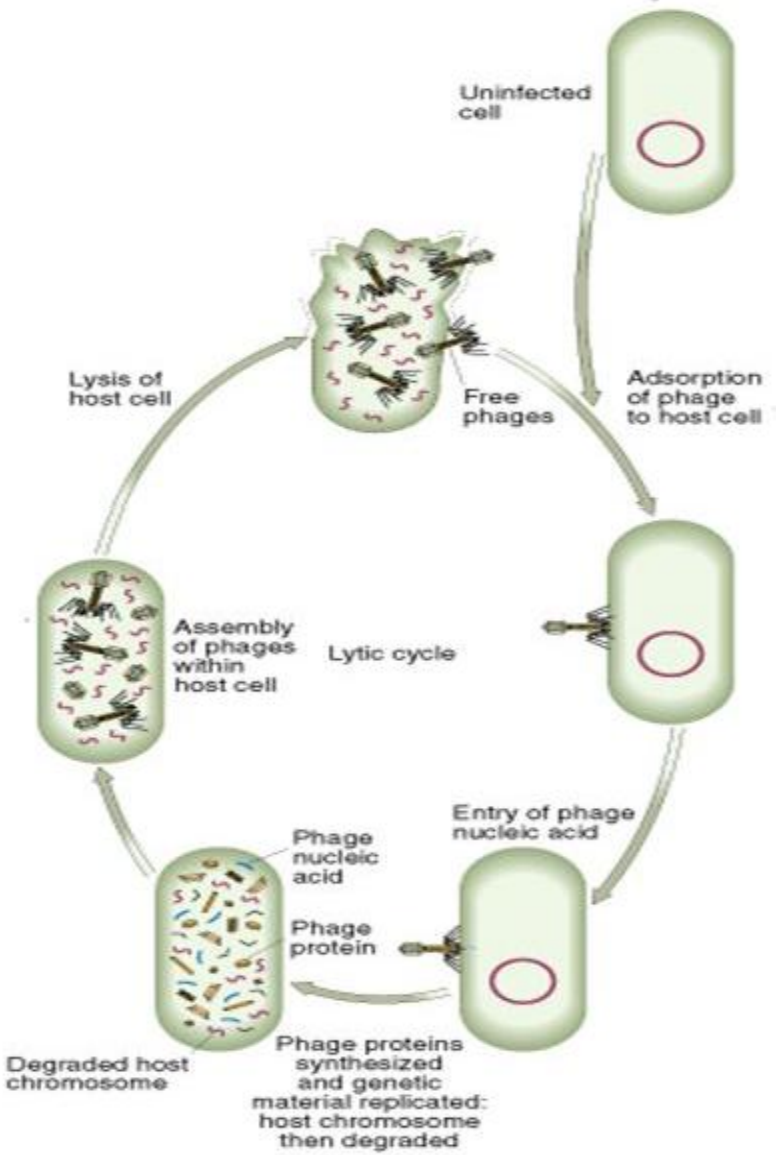
Lytic cycle


Host Cell
Step 1
Attachment
Step 2
Penetration
Step 3
Biosynthesis
Step 4
Assembly
Step 5
Release

Life Cycle of a Lytic Phage



Life Cycle of a Lytic Virus (cont'd)



1. ATTACHMENT – Virus attaches to cell wall (specific spot, "lock & key"
2. ENTRY – Viral nucleic acid enters cell through weak spot in cell wall
3. REPLICATION – viral DNA take over replication, make new viral DNA, "hijack"
4. ASSEMBLY – new virus particles are put together
5. LYSIS/RELEASE – cell wall digested, new virus is liberated

Lytic Cycle

*Different components combine to form new viruses or phage particles.
*The host cell ruptures by means of Lysozyme releasing the phage particles.
*The period between entry of viral nucleoid into host cell and bursting of host cell to release new viruses is called eclipse period.

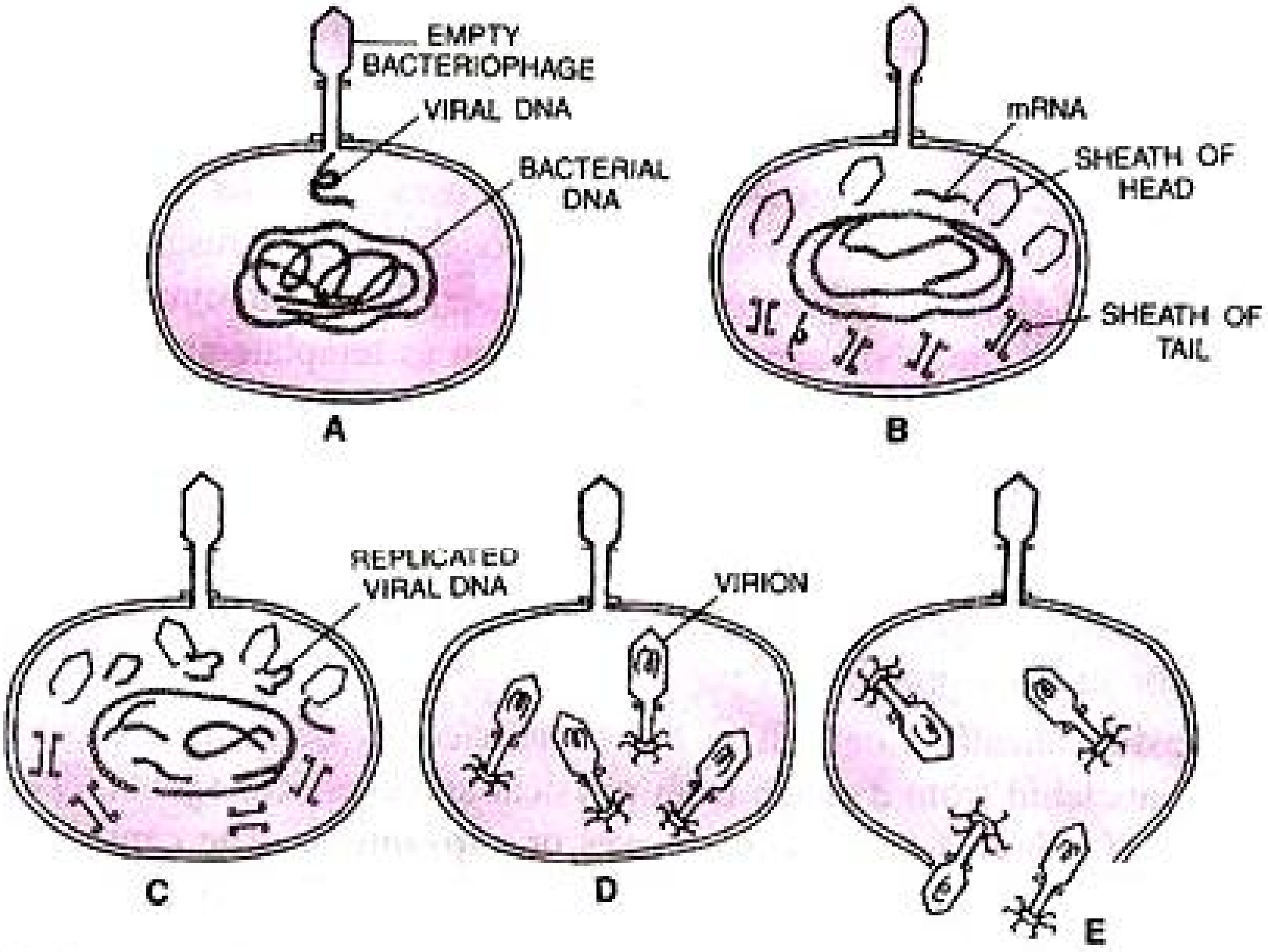


Fig. 2.5. Lytic cycle in bacteriophage T_4. A, injection of viral DNA. B, formation of proteins. C, replication of viral DNA. D, synthesis of new bacteriophages. E, lysis of the bacterium and release of bacteriophages.

Type 2. Lysogenic Cycle:

*Lambda phage (λ phage) has a higher degree of regu-lation of its genes.

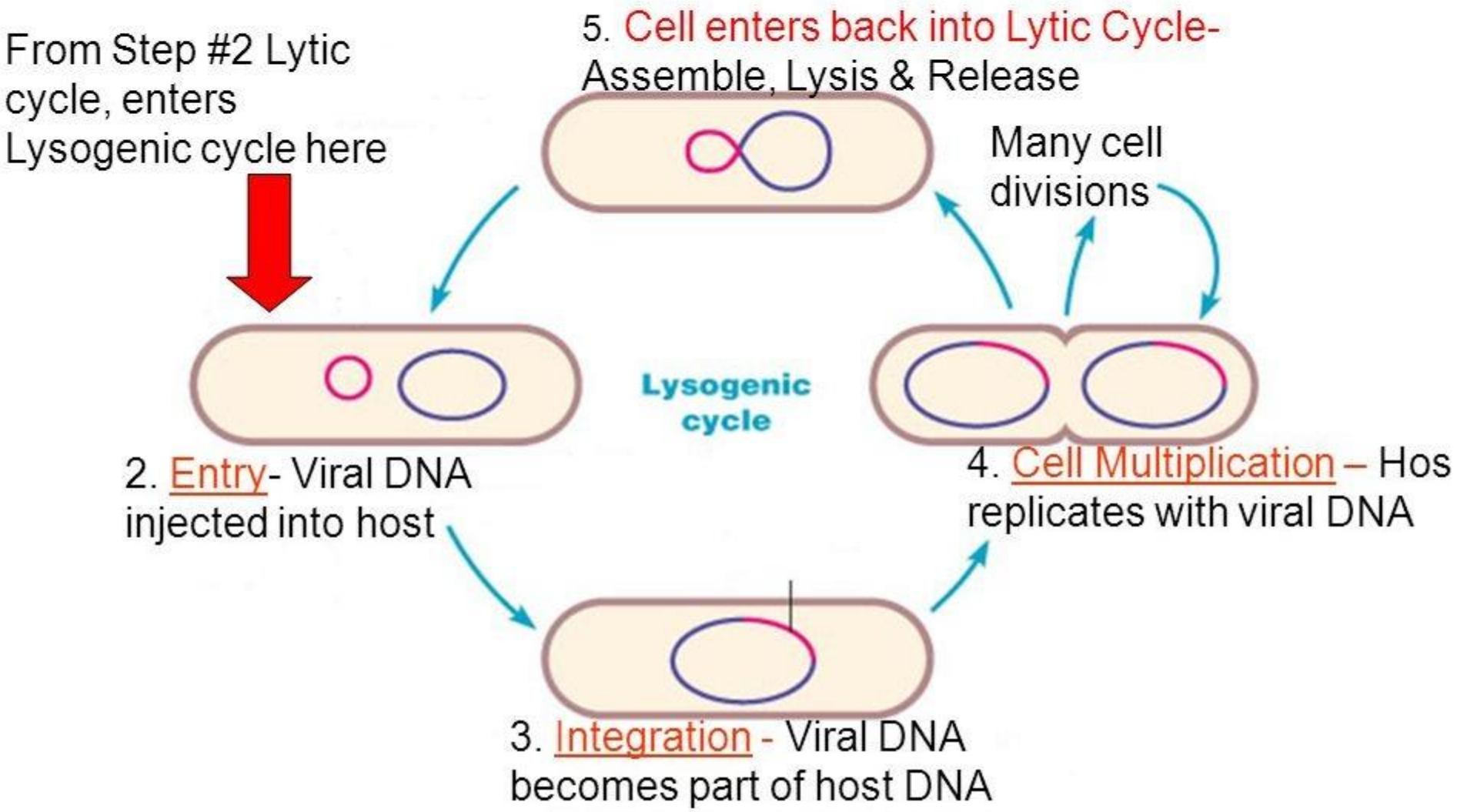
*The phage is parasitic over Escherichia coli. It does not possess tail fibres for attachment to bac-terial cell.

*The tail directly comes in contact with bacte-rial cell, drills a hole in the wall and injects the phage DNA into the cell.

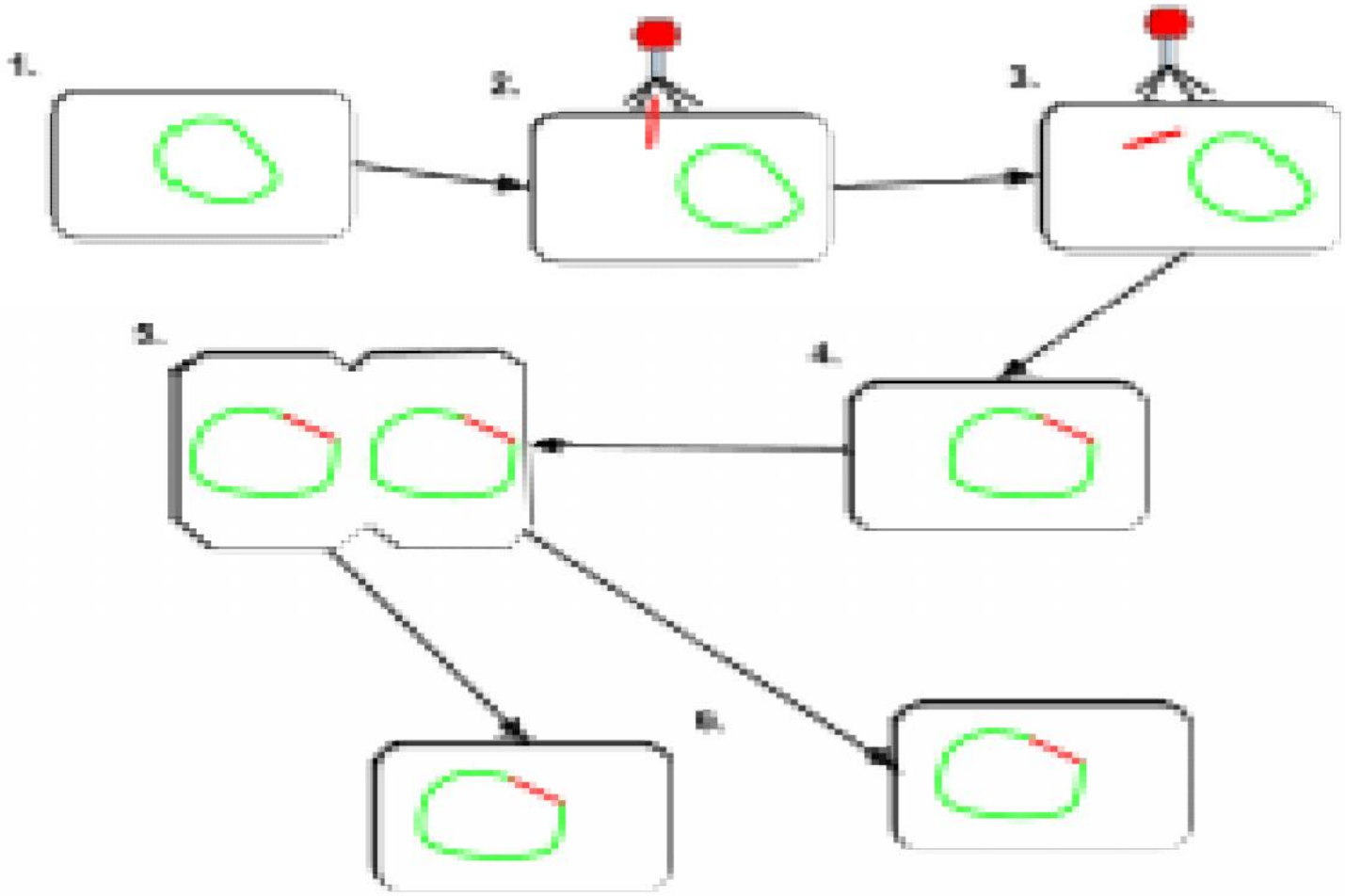
*In lysogenic cycle, the phage DNA does not take over the control of cellular machin-ery of the host.

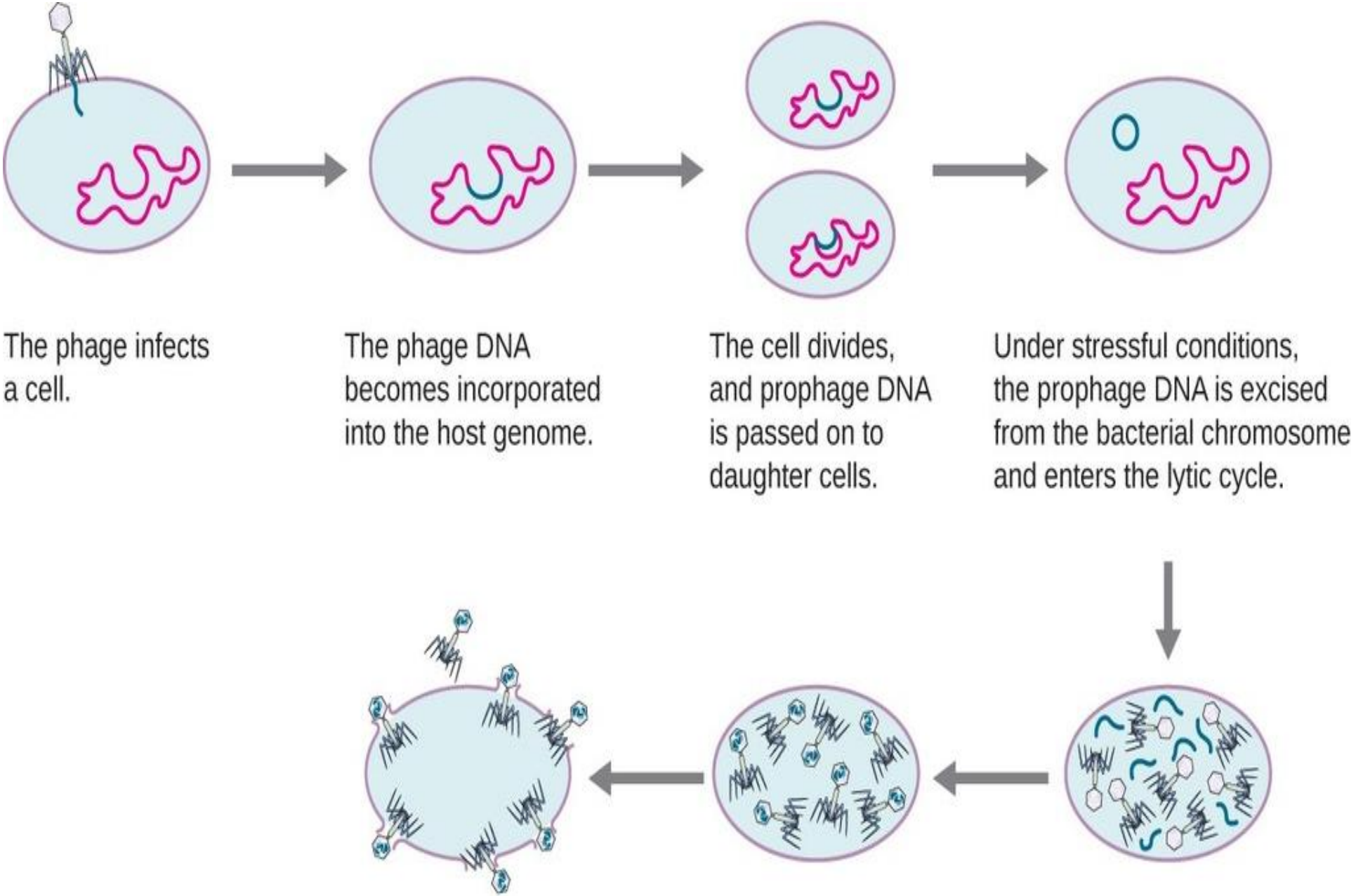
*Instead, it produces a repressor and undergoes reduction to temperate or non-virulent state.

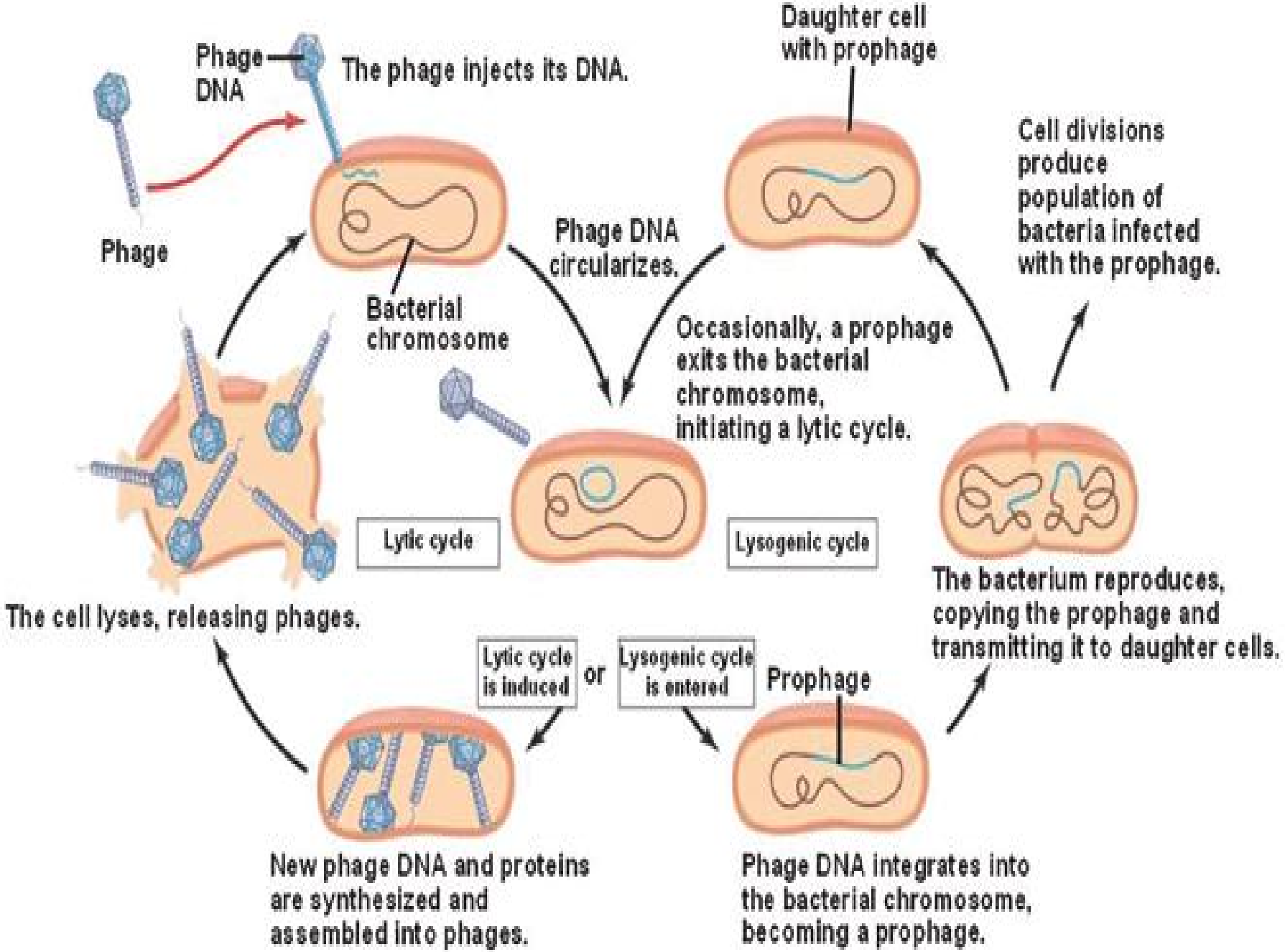
Lysogenic Cycle

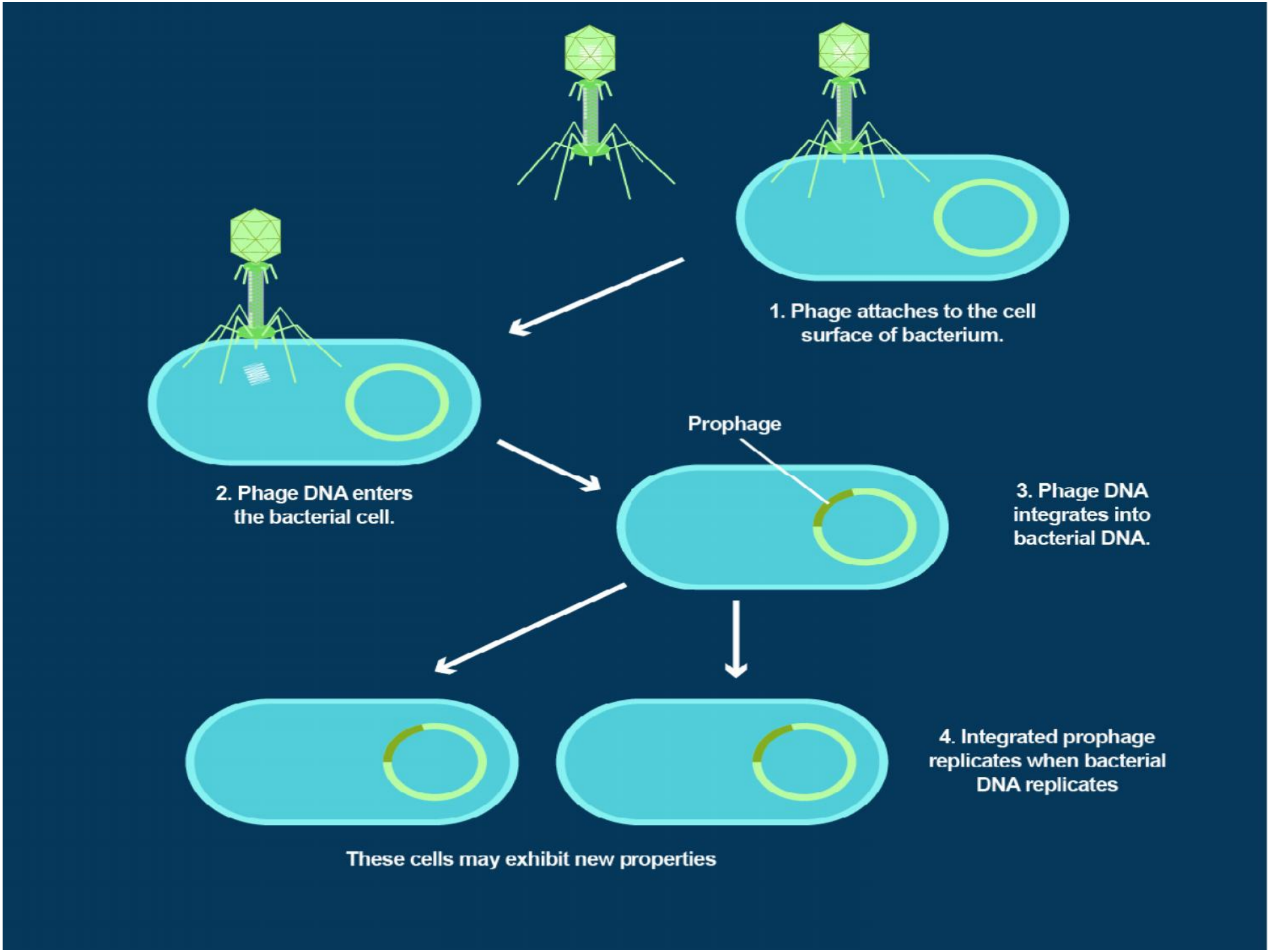


Lysogenic Cycle




The phage infects a cell.
The phage DNA becomes incorporated into the host genome.
The cell divides, and prophage DNA is passed on to daughter cells.
Under stressful conditions, the prophage DNA is excised from the bacterial chromosome and enters the lytic cycle.
Phage DNA replicates and phage proteins are made.
New phage particles are assembled.
The cell lyses, releasing the newly made phages.


Phage
DNA
The phage injects its DNA.
Phage
Bacterial chromosome
Phage DNA circularizes.
Daughter cell with prophage
Cell divisions produce population of bacteria infected with the prophage.
Occasionally, a prophage exits the bacterial chromosome, initiating a lytic cycle.
Lytic cycle
Lysogenic cycle
The cell lyses, releasing phages.
The bacterium reproduces, copying the prophage and transmitting it to daughter cells.
Lytic cycle is induced
or
Lysogenic cycle is entered
Prophage
New phage DNA and proteins are synthesized and assembled into phages.
Phage DNA integrates into the bacterial chromosome, becoming a prophage.


1. Phage attaches to the cell surface of bacterium.
2. Phage DNA enters the bacterial cell.
Prophage
3. Phage DNA integrates into bacterial DNA.
4. Integrated prophage replicates when bacterial DNA replicates
These cells may exhibit new properties

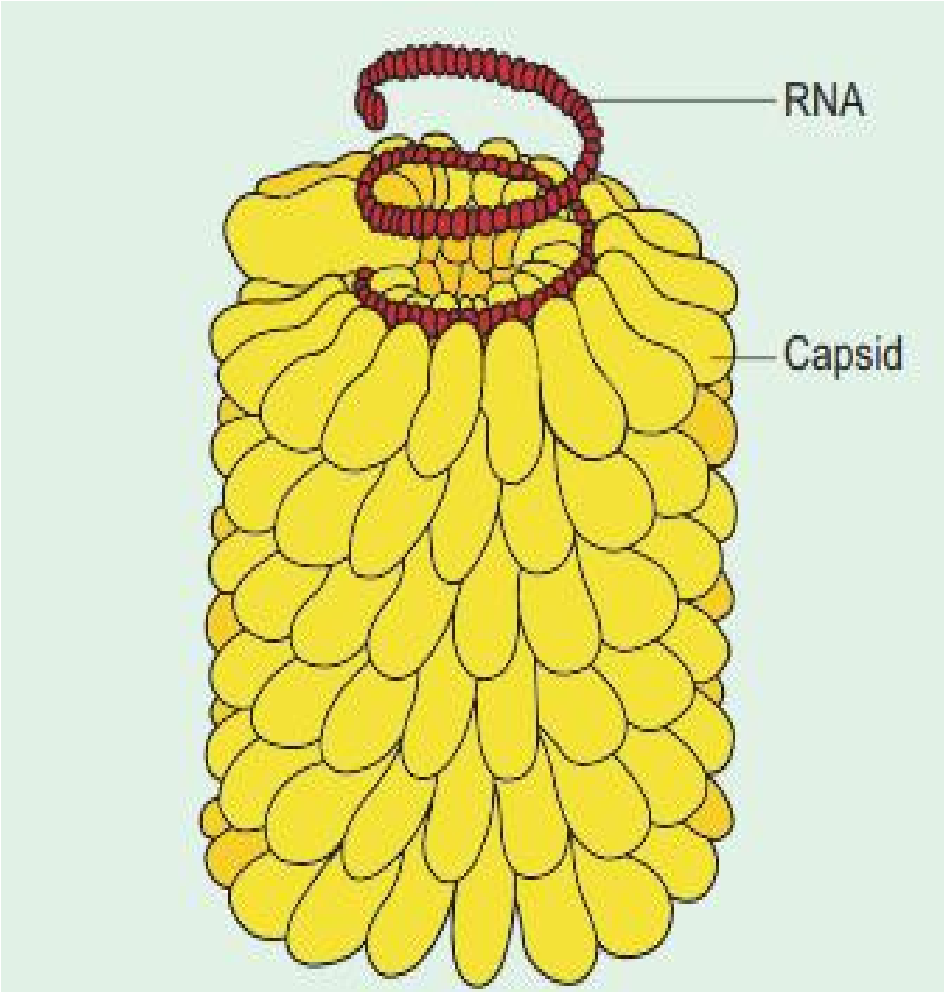
*With the help of enzyme integrate the viral genome becomes integrated with the chromosomal DNA of the bacterium at a specific site (e.g., galactose locus in λ phage).
*In this form the viral genome is called pro-phage. Pro-phage replicates along with bacterial chromosome and, therefore, gets distributed to the daughter bacteria.
*Pro-phage does not form virus particles because the genes connected with taking over of host machinery remain repressed due to formation of a repressor.

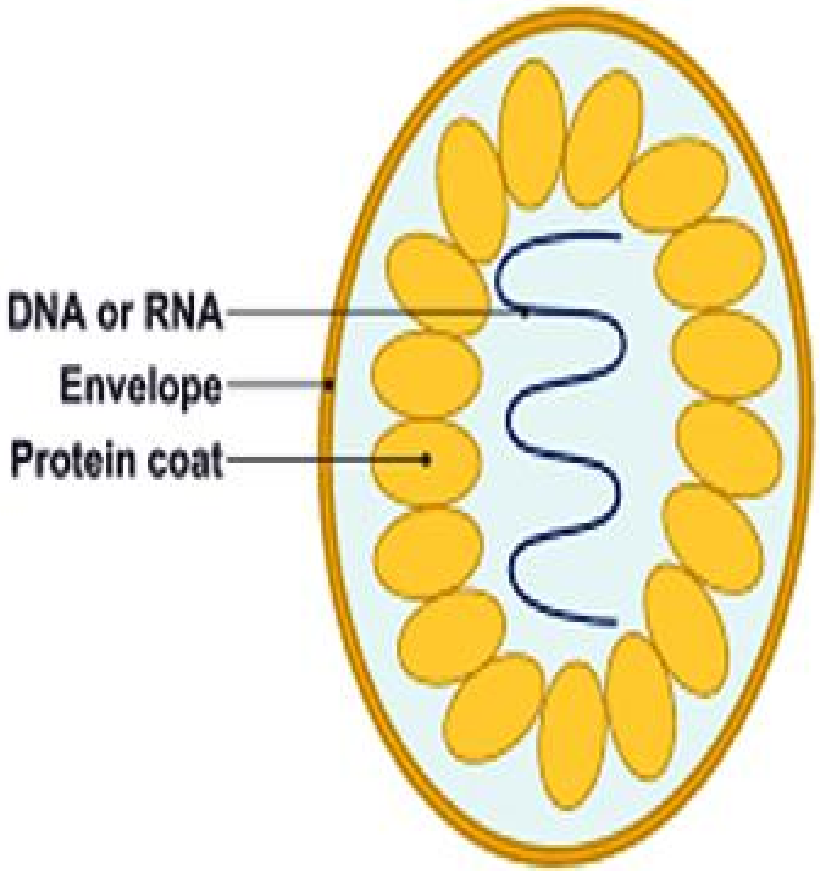
*At times the synthesis of repressor is stopped. Repressor can also be destroyed by chemicals, high energy radiations and other adverse conditions.

*This converts the temperate or non-virulent virus into virulent or lytic virus.

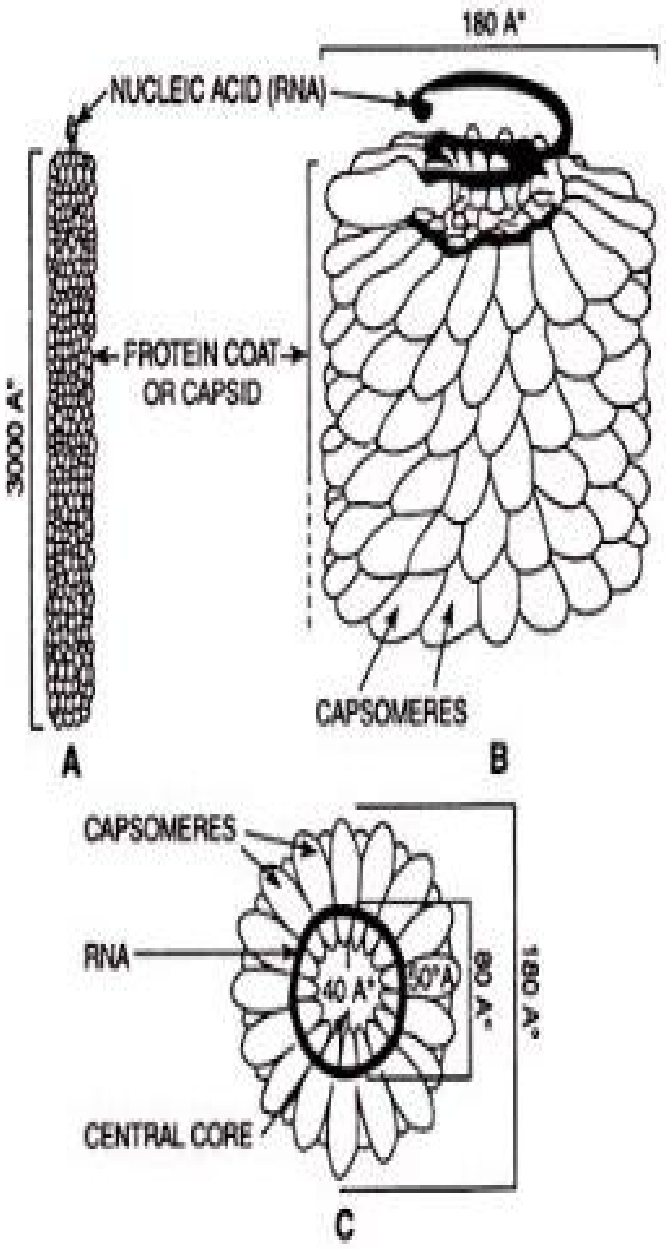
*Therefore, the bacterial cell carrying pro-phage is called lysogenic cell and the phenomenon of existence of virus genome in pro-phage state along-with host DNA is termed as lysogeny.

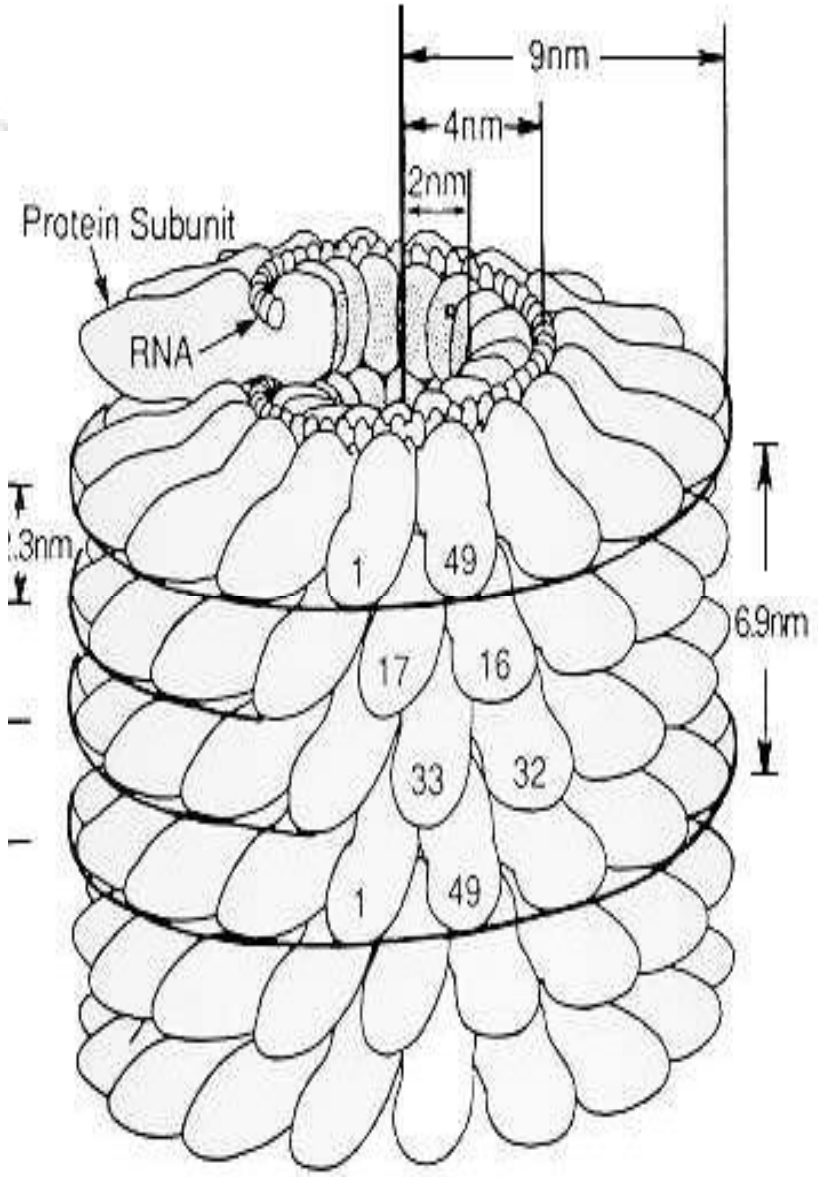
TMV (Tobacco Mosaic Virus)





*Tobacco mosaic virus (TMV) is one of the well-characterized plant viruses.
* The genome of TMV is a positive-sense, single-stranded RNA and encodes at least three non-structural proteins and a coat **protein** .
***Tobacco mosaic virus** has a rod-like appearance. Its capsid is made from 2130 molecules of coat protein (see image to the left) and one molecule of genomic single strand RNA, 6400 bases long.


160 A°
NUCLEIC ACID (RNA)
3000 A°
PROTEIN COAT
OR CAPSID
CAPSOMERES
A
B
CAPSOMERES
RNA
140 A°
80 A°
160 A°
CENTRAL CORE
C


9nm
4nm
2nm
Protein Subunit
RNA
1
49
17
16
33
32
1
49
6.9nm

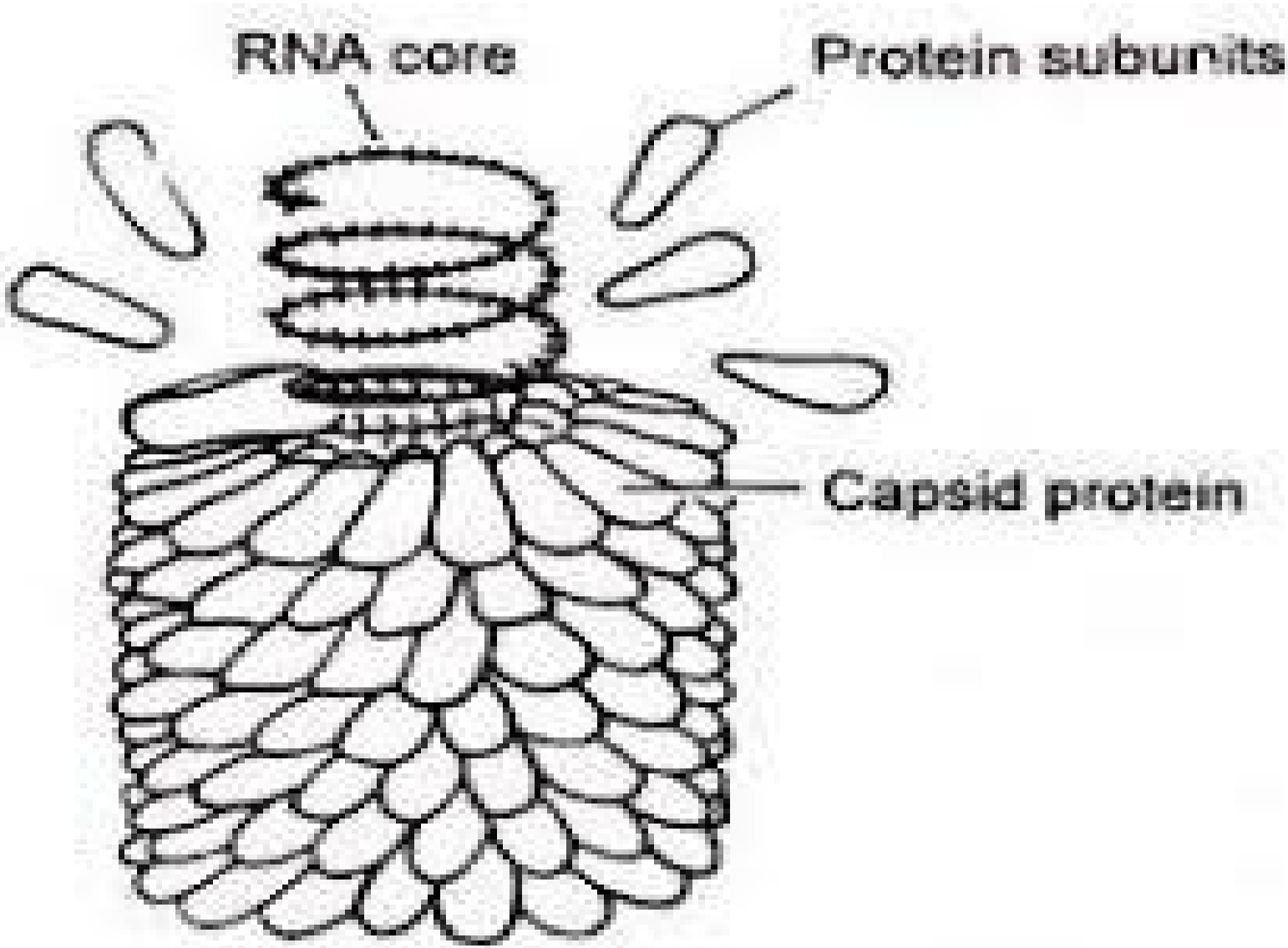


Fig. 1.18. TMV containing single stranded RNA

- Inside the protein capsid there is single stranded RNA molecule which is also spirally coind to form helix.
- Virus RNA consist of 6,500 nucleotides. In one turn the RNA contains 49 nucleotides.
- The number of protein subunits counting in three turns is 49 i.e. 49/3 subunits per turn.
- Therefore a single protein subunit is linked with 3 nucleotides of RNA. Arrangement of capsomere of RNA is shown in fig.

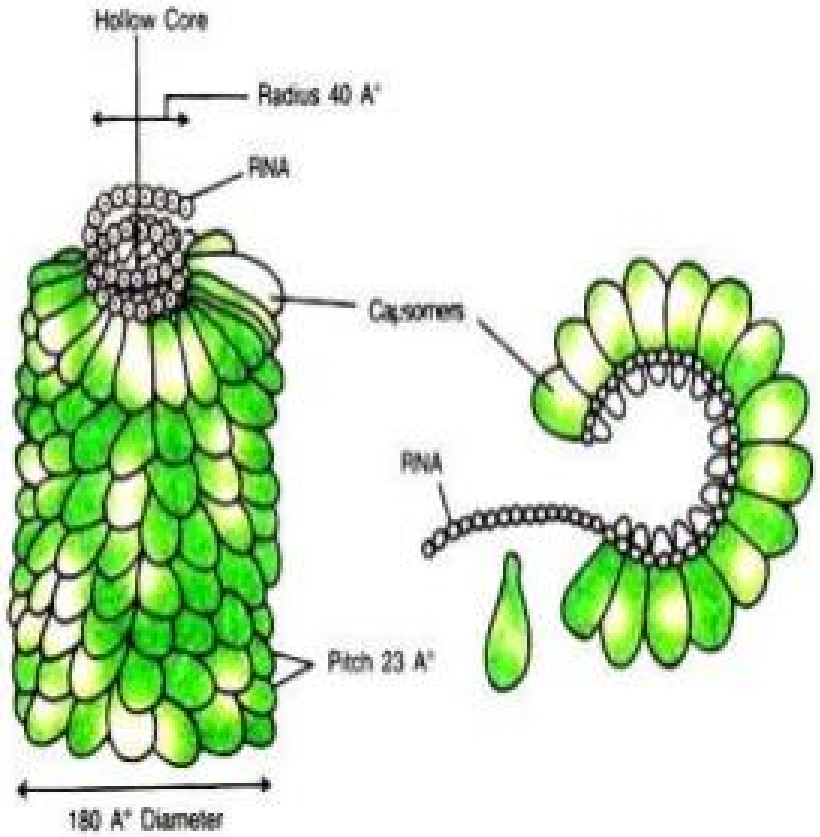
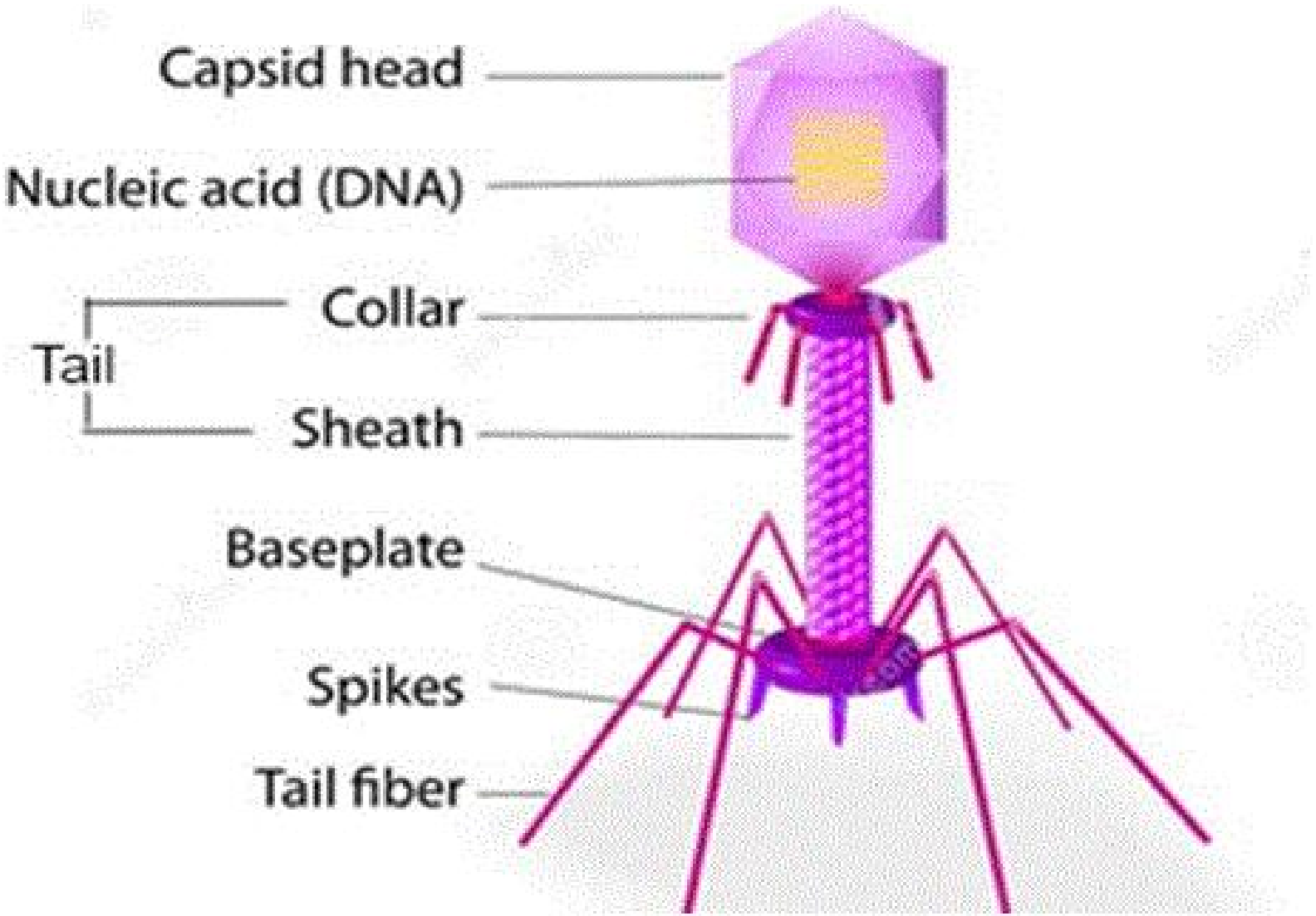


Fig. 16.4 : Structure of tobacco mosaic virus. A, helical model of TMV showing structure of RNA containing capsomers; B, arrangement or capsomers on RNA in one turn.

Bacteriophage



*Like all viruses, phages are simple organisms that consist of a core of genetic material (nucleic acid) surrounded by a protein capsid. ...
*There are three basic **structural** forms of **phage**: an icosahedral (20-sided) head with a tail, an icosahedral head without a tail, and a filamentous form.

Bacteriophage, also called **phage** or **bacterial virus**, any of a group of viruses that infect bacteria. Bacteriophages were discovered independently by Frederick W. Twort in Great Britain (1915) and Felix d'Hérelle in France (1917).

*D’Hérelle coined the term *bacteriophage*, meaning “bacteria eater,” to describe the agent’s bactericidal ability.

*Bacteriophages also infect the single-celled prokaryotic organisms known as archaea.

Types of Bacteriophages:

The phages have specific host. E. coli has been studied most extensively from this point of view. The bacteriophage capable of destroying E. coli is called coli-phage. The types of coli-phages have been called as T-phages.

They have been classified into many arbitrary groups such as:

(i) T-Even Phages (T_2, T_4, T_6):

These phages have an angular head and contractile tail. The DNA contain a unique base 5-hydroxyl methyl cytosine in place of cytosine. These viruses are most thoroughly studied viruses. These are also called virulent as they cause death of the host cells.

(ii) T-Odd Phages (T_1, T_3, T_7):

These viruses have an angular head and a short non-contractile tail. The DNA contain cytosine. These are temperate viruses as their genetic material becomes integrated with bacterial chromosomes and the host remains unaffected.

(iii) T_5 Phages:

These viruses have an angular head and non-contractile tail. The DNA of these viruses also contains cytosine.

3. Structure of Bacteriophage:

*With the help of electron microscope, the morphology of the bacteriophage has been studied.

*The T even phages show complex symmetry. These viruses are generally tadpole shaped i.e., a 'head' followed by a 'tail'.

*The head is hexagonal and like a prism in outline.

•This shape is also known as elongated icosahedrons. It is 950 A° in length and 650 A° in width.

•* The head has a 2-layered protein wall that encloses the double stranded DNA.

•The wall is 35 A° thick and is composed of about 2000 similar capsomeres. DNA is tightly packed in the head and is about 50 µ long.

*Attached to one of the points of the head, through a neck and collar is the tail .
*The tail has a complex structure and proteinaceous in nature.
*It is made up of a cubical, hollow, cylindrical core.
•This core is 800 A° long, 70 A°in diameter and has 25 A° wide central canal.
•*This core is surrounded by a contractile sheath. The sheath is 165 A° in diameter.

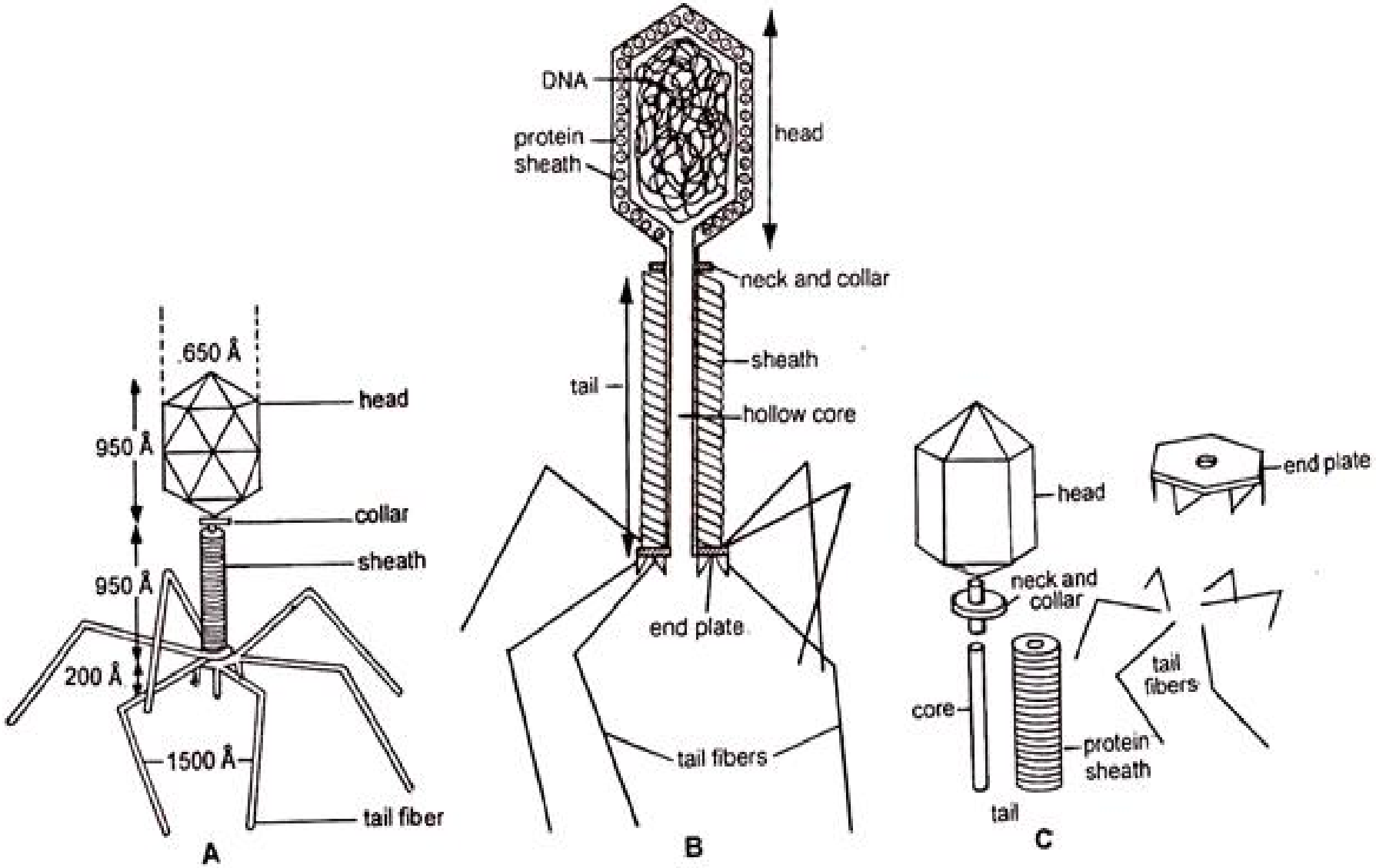
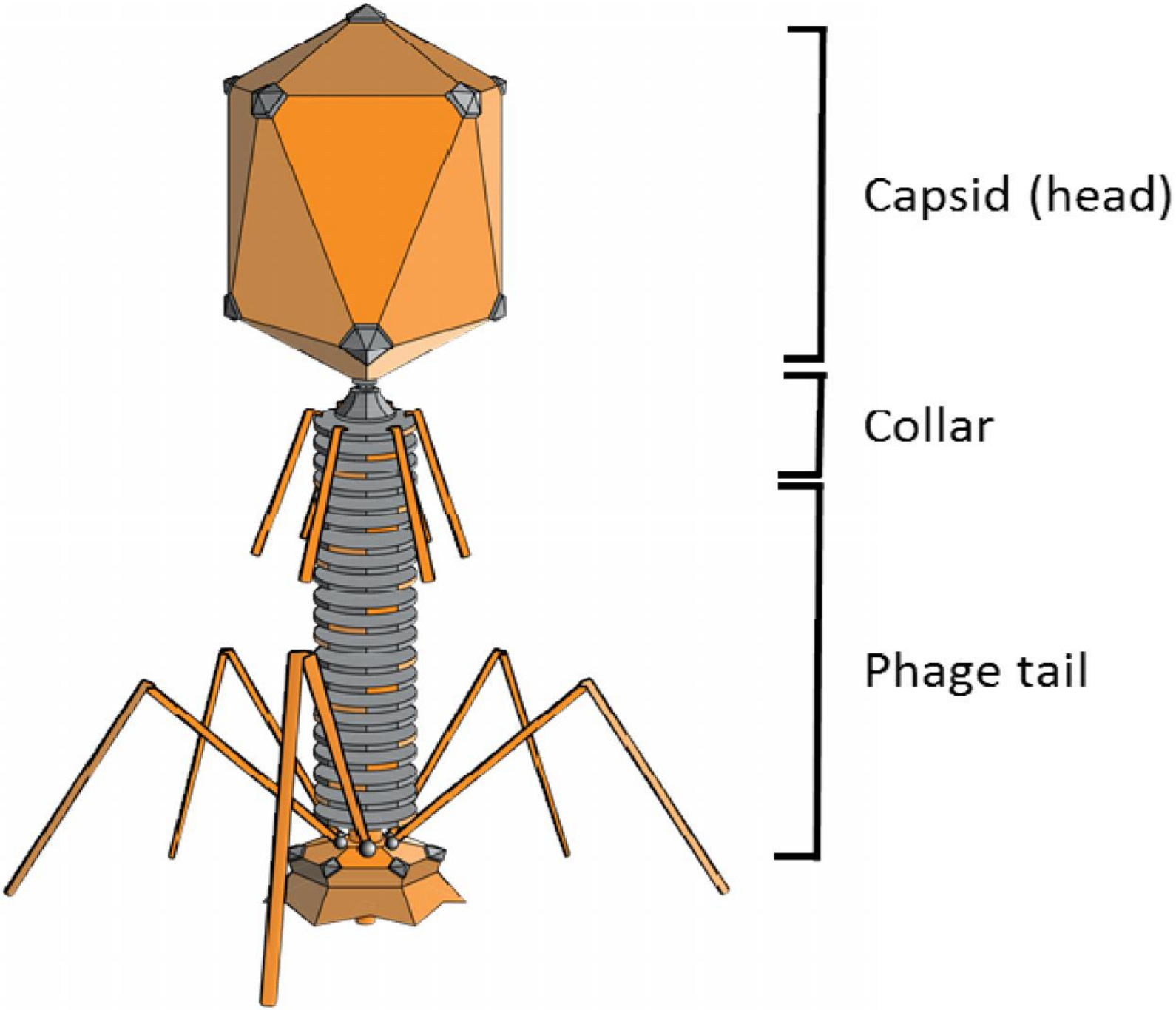


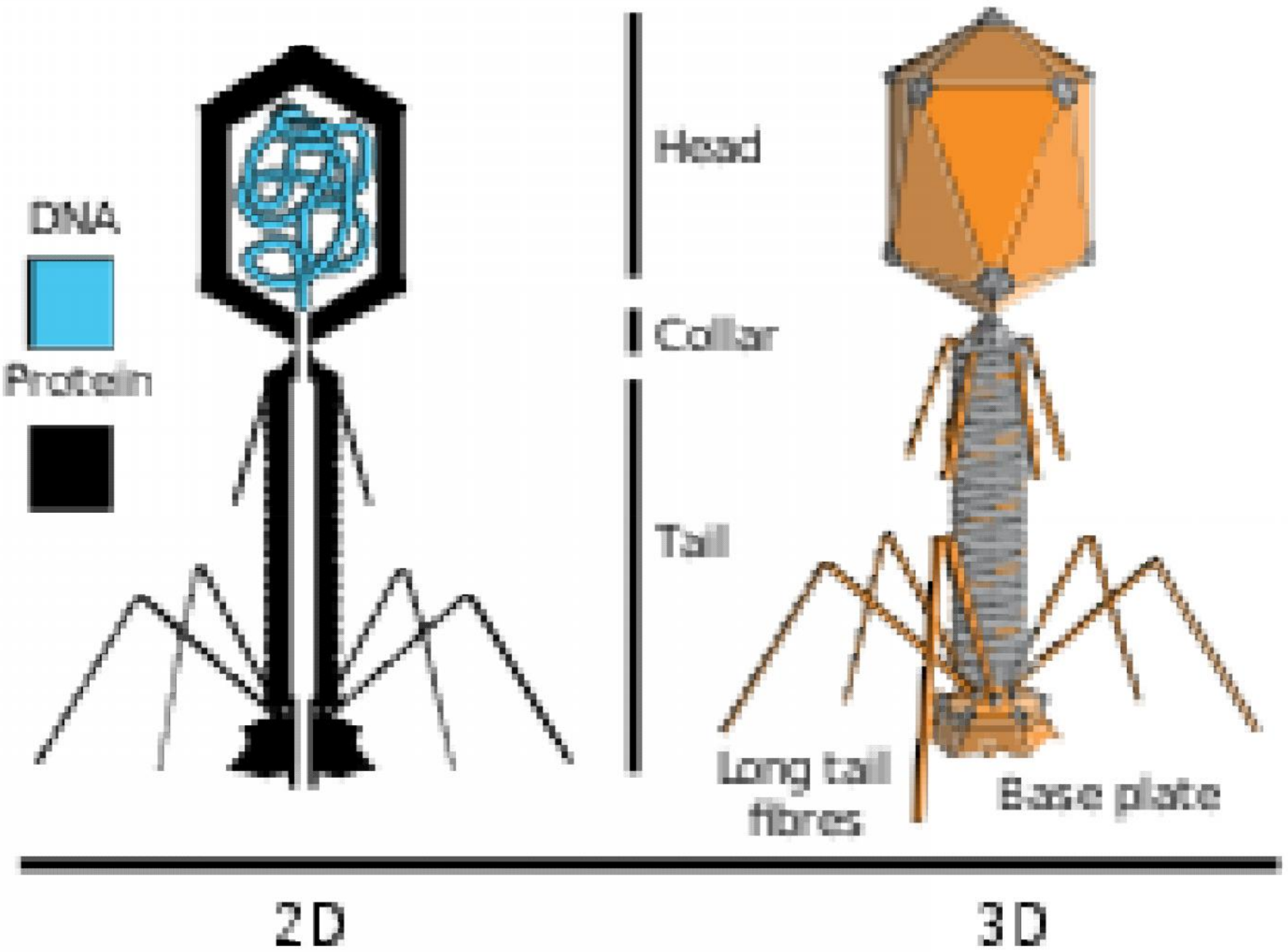
Fig. 5. (A-C) Bacteriophage : A. External morphology, B.L.S. of bacteriophage, C. Various components of bacteriophage

*The internal diameter of the tube formed by it is equal to core diameter of 70A°.
*The core is terminated into a hexagonal plate which has six small tail fibres (tail ‘pins’) at every corner and 6 tail fibres.
•Each tail fiber is 1500 A° long and is composed of fibrillar protein.
•* The main function of the short tail fibres is to hold the phage fast to the host during sheath contraction and DNA injection while long tail fibres helps in adsorption of the phage on the bacterial wall.

4. Chemistry of Bacteriophages:

Bacteriophages are made up of nucleoproteins. The proteins are about 50-60% and nucleic acid 40-50%. The nucleic acid is either double stranded DNA or single stranded DNA or single stranded RNA (Both never occur together).


Capsid (head)
Collar
Phage tail


DNA
Protein
Head
Collar
Tail
Long tail fibres
Base plate
2D
3D

Biological Importance of Bacteriophages:

*Bacteriophages have been used in prophylaxis and medical treatment against several pathogenic bacterial diseases e.g., cholera, plague, dysentery, enteric fever etc.

* They are also used in the diagnosis of certain infections like plague, cholera etc. Bacteriophages feed on pathogenic bacteria present in polluted water.

*So, they can also be used as scavengers. In many cases bacteriophages determine the micro-flora of the soil.

*Thus, they play an important role in agriculture. In space microbiology, lysogenic cultures are used as radiation detectors and are used in USSR spaceship Vostok 2.

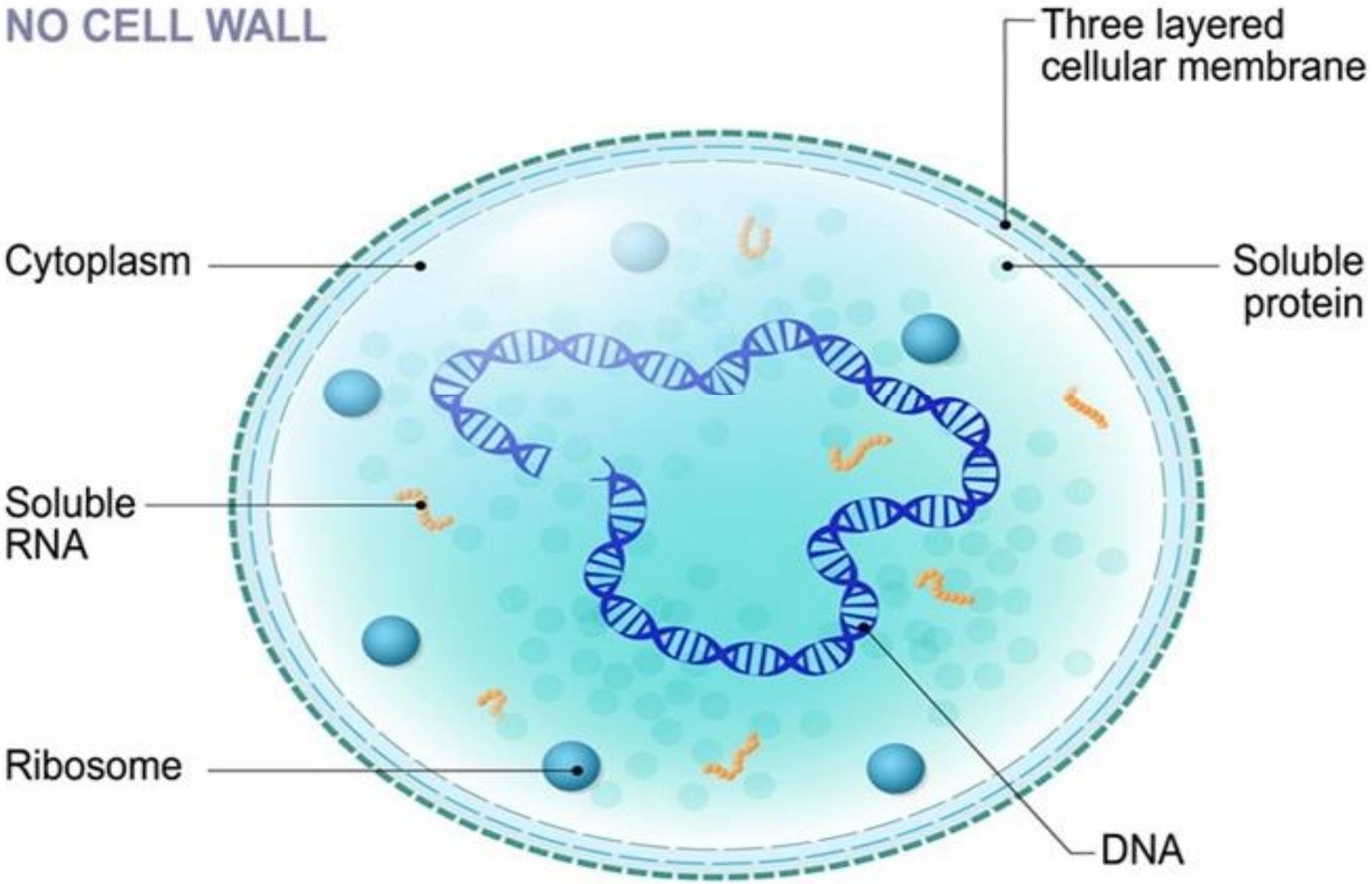
*Temperate phages serve as ‘vector in transferring the genetic material from one bacterial cell to another (transduction).

*Bacteriophages are very harmful during the process of manufacturing of antibiotic and milk products because they kill beneficial bacteria by their lysogenic activity.

Mycoplasma

*Mycoplasmas are the **“smallest, independently replicating prokaryotes”**.
*These organisms were first discovered by Pasteur in eighteenth century when he studied the causative agent of the “Bovine pleuropneumonia” (A pulmonary disease of cattle which appeared in Germany and Switzerland in 1713.
* Due to its resemblance with pneumonia symptoms this disease is called as Bovine Pleuropneumonia).

Mycoplasma


NO CELL WALL
Three layered cellular membrane
Cytoplasm
Soluble protein
Soluble RNA
Ribosome
DNA

*It was believed that the causal agent was Pleuropneumonia like organisms (PPLO).
*This causal agent was first isolated and cultured by **E. Nocard and E. R. Roux in 1898.**
*They established that these causal agents of pleuropneumonia can grow on complex nutrient media which do not contain cells.
*They also observed that these organisms show different forms, when grown on the culture media.
*These organisms were named as Asterococcus mycoides by Borrel et. al (1910).
*The generic name Mycoplasma was given by Nowak (1929) due to their fungi like resemblance.

Habit and Habitat of Mycoplasma:

*Mycoplasmas are parasitic as well as saprophytic.

- More than 200 mycoplasma like bodies are found to be associated with sewage, plants, animals, insects, humus, hot water springs and other high temperature environment.
- *They have been found in phloem tissues of diseased plants.

General Characters of Mycoplasma:

1. They are unicellular, smallest, non-motile and prokaryotic organisms forming fried egg shaped colonies.
2. They are pleomorphic i.e., able to change their shape depending upon culture media.
3. They may be rod like, ring like, globoid or filamentous. The filaments are of uniform diameter (100-300 nm) and vary in length from 3 nm to 150 nm.
4. Some mycoplasma predominantly assume spherical shape (300-800 nm in diameter).
5. They are ultra-filterable i.e., they can pass through bacteria-proof filters.
6. They do not possess rigid cell wall.

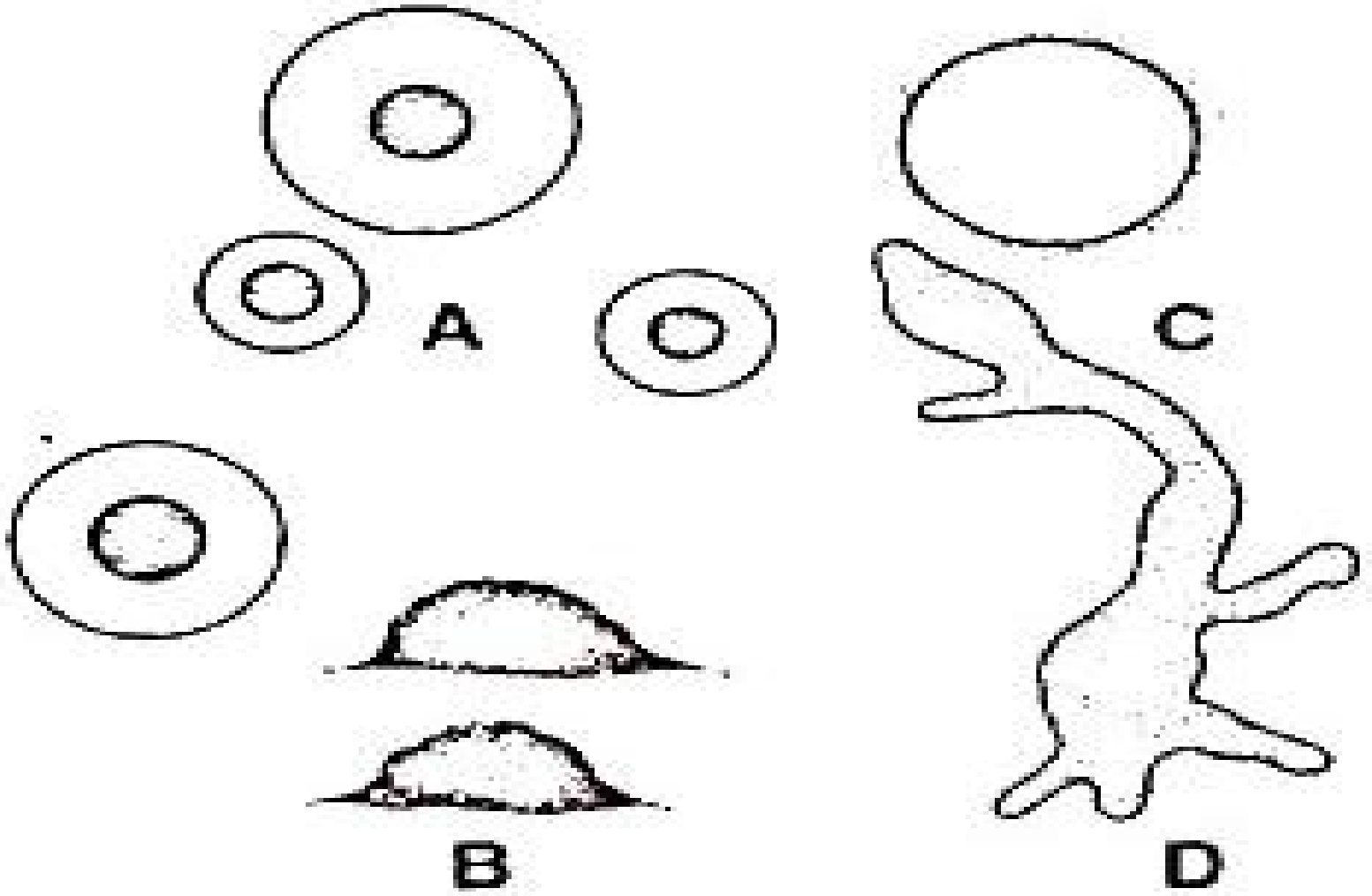


Fig. 5. (A–D). Mycoplasma : Colony morphology and cell shape. A. Entire colony, B. Longitudinal section of colony, C. Spherical form, D. Irregular filamentous form

7. The cells are delimited by soft triple layered lipo-proteinaceous membrane. It is unit membrane about 10 nm thick.
8. Within the cytoplasm ribosomes are found scattered in the peripheral zone. These are 14 nm in diameter and resemble with bacteria in sedimentation characteristic of both the nucleoprotein and nucleic acid.
9. The ribosomes are 72S type.
10. Within the cytoplasm fine fibrillar DNA is present. It is double stranded helix.

11. Mycoplasma generally grow more slowly than bacteria.
12. They require sterol for their nutrition.
13. They are usually resistant to antibiotics like penicillin, cephaloridine, vencomycin etc. which action cell wall.
14. They are sensitive to tetracycline.
15. They are also killed by temperature of 40-55°C in fifteen minutes.
16. They do not produce spores.
17. Like other prokaryotes, they usually divide by binary fission.

Cell Structure of Mycoplasma:

*In mycoplasma, the cells are small varying from 300 nm to 800 nm in diameter.

*Rigid cell wall is absent.

*Cells are surrounded by a triple layered lipo-proteinaceous unit membrane .

*It is about 10 nm thick. Unit membrane encloses the cytoplasm.

*Within the cytoplasm RNA (ribosomes) and DNA are present.
*The ribosomes are 14 nm in diameter and 72 S type. DNA is double stranded helix.
* It can be distinguished from bacterial DNA by its low guanine and cytosine content.

*The DNA is up to four percent and RNA is about eight percent and it is less than half that usually occurs in other protoplasm's. The guanine and cytosine (G and C).
*Contents in DNA range from 23-46 percent. In some species e.g., M. gallisepticum some polar bodies protrude out from one or the other end of the cell.
*These are called bleb and are considered to be the site of enzymatic activities and attachment during infection.

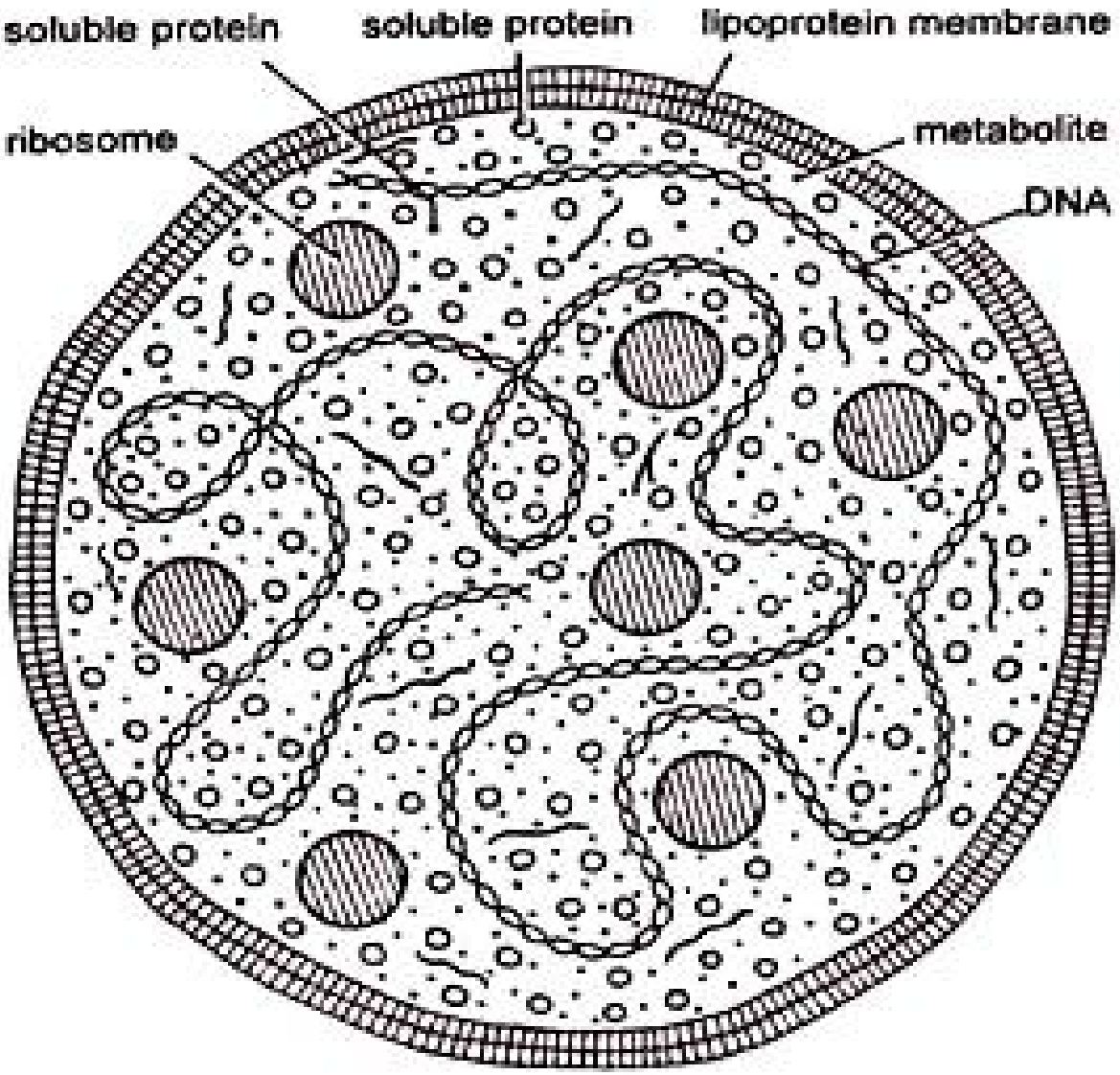
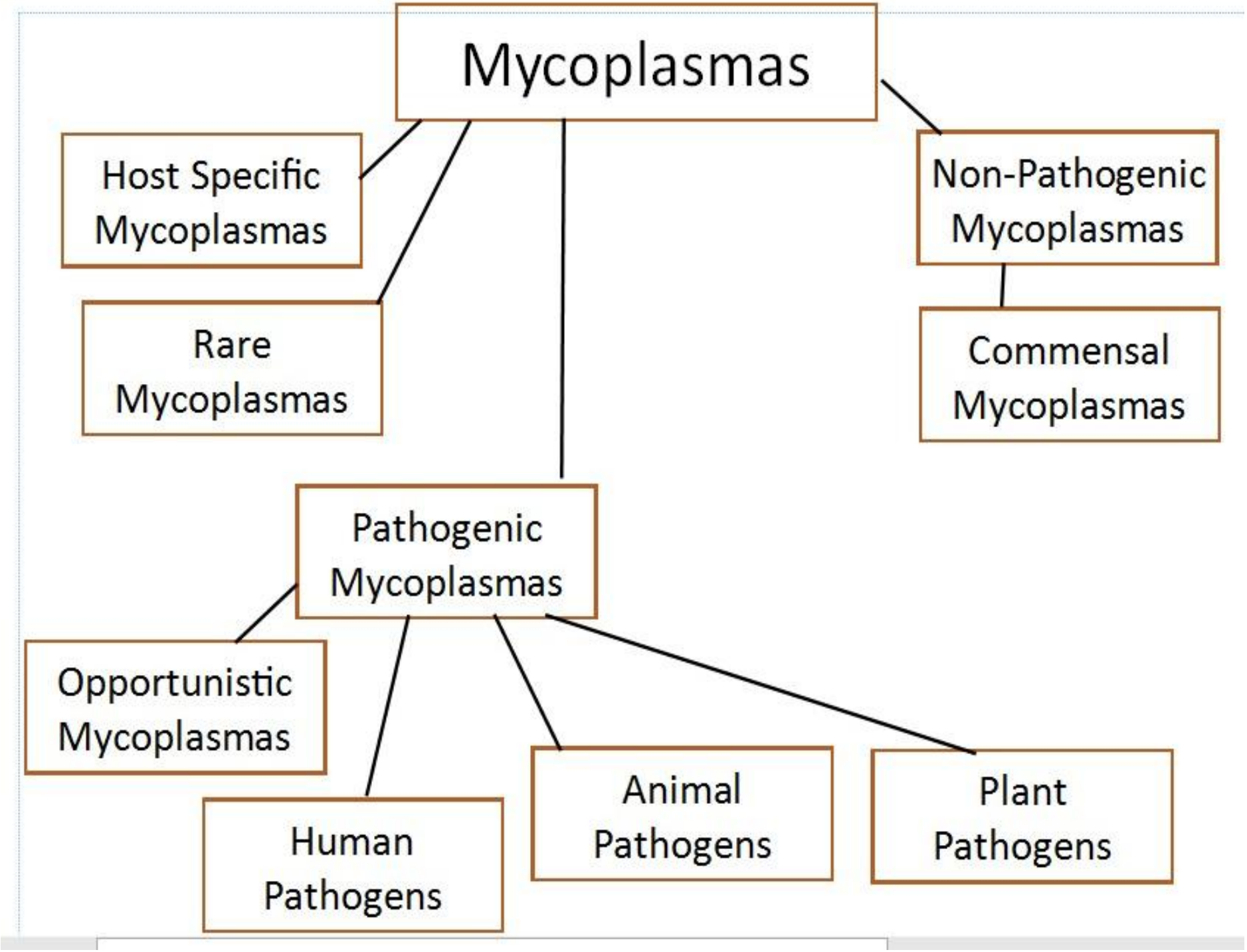


Fig. 6. Mycoplasma. Structure of a typical cell


Mycoplasmas
Host Specific Mycoplasmas
Rare Mycoplasmas
Non-Pathogenic Mycoplasmas
Commensal Mycoplasmas
Pathogenic Mycoplasmas
Opportunistic Mycoplasmas
Human Pathogens
Animal Pathogens
Plant Pathogens

Spread of Mycoplasma Infections

- The disease is world wide, and found in all age groups,
- Transmission by drop let infection of nasopharyngeal secretions.
- Spread is associated with close contact of infected person
- Important infection in Military personal.
- Even the persons recovered from infection will harbor the pathogens for 2 moths or more

Diseases Caused by Mycoplasma

Organism	Disease
M. pneumoniae	Upper respiratory tract disease, tracheobronchitis, atypical pneumonia, (chronic asthma??)
M. hominis	Pyleonephritis, pelvic inflammatory disease, postpartum fever
M. genitalium	Nongonococcal urethritis
U. urealyticum	Nongonococcal urethritis, (pneumonia and chronic lung disease in premature infants??)

N.B. Other organisms infect humans but their disease association is not known.

In humans, four species are of primary importance:

1. *Mycoplasma pneumoniae* causes pneumonia and has been associated with joint and other infections.
2. *Mycoplasma hominis* sometimes causes postpartum fever and has been found with other bacteria in uterine tube infections.
3. *Ureaplasma urealyticum* is a cause of nongonococcal urethritis in men and is associated with lung disease in premature infants of low birth weight.
4. *Mycoplasma genitalium* is closely related to *M pneumoniae* and has been associated with urethral and other infections.

Importance

- *Mycoplasma gallisepticum* is the most economically significant mycoplasma pathogen of poultry.
- *Mycoplasma gallisepticum* infections causes significant economic losses on poultry farms from:
  1. Chronic respiratory disease (CRD).
  2. Reduced feed efficiency.
  3. Decreased growth rate.
  4. Decreased egg production.
  5. Carcasses downgrades.

MYCOPLASMA IN CHILDREN

- In children younger than 3 years primarily develop upper respiratory infection.
- M.pneumoniae infection is uncommon in the first year of life; however in neonates, it may cause severe disease.
- M.pneumoniae infection is common in school aged children, with the highest rate of infection in individuals aged 5-20 years, in whom the tendency is to develop bronchitis and pneumonia.

Manner of transmission

*Plant disease mycoplasmas are carried from a diseased plant to a healthy one by piercing and sucking insects, often of the Homopteran order such as leafhoppers.

*These insects suck up the sap made by an infected plant and with it the mycoplasmas it contains.

•Mycoplasma transmission by leafhopper is circulating and persistent.

•* It requires a period of latency corresponding to its circulation and multiplication within the vector insect, which then remains infectious for the rest of its life.

•*The mycoplasmas are not however passed on to the offspring.

***No mycoplasma can be transmitted from plant to plant by physical contact, nor in seed.**

Symptoms observed

The facts presented here are not specific to cyclamen, since the literature mainly enumerates the symptoms by broad category of plant families. The diseases caused are known as ‘mycoplasmoses’, or ‘mycoplasmainfections’, and show very diverse symptoms.

In most cases one or more of the following symptoms are observed:

yellowing

various growth disorders such as dwarfism, polyphylly, witches’ brooms (abnormal development of axillary buds).

colour disorders such as variegation

flower deformation: virescence (leaf-like aspect of parts of flowers) and phyllody (elongation of the gynoecium as leaf-like structures)

*These disorders are essentially the result of disturbance in the functioning of the phloem: the transport and transfer of the energy-carrying molecules and mineral salts are upset and the action of growth and development factors (plant hormones) is disturbed.